HZI, Besix and Itochu

Dubai Waste Management Center

Environmental Impact Assessment Rev 6

June 2020

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Document Status

Revision	Author	Reviewer		Approved for Issue		
		Name	Signature	Name	Signature	Date
Rev 0	Various[1]	G Squires	GS	S Bin Breik	SBB	12 Nov 2018
Rev 1	J Calpo	D Wright	DW	S Bin Breik	SBB	13 Dec 2018
Rev 2	J Calpo	D Wright	DW	S Bin Breik	SBB	13 Feb 2019
Rev 3	J Calpo	D Wright	DW	R Shine	RS	09 July 2019
Rev 4	J Calpo	D Wright	DW	R Shine	RS	03 Oct 2019
Rev 5	J Calpo	R. Shine	RS	R Shine	RS	19 Feb 2020
Rev 6	J Calpo	R. Shine	RS	R Shine	RS	07 Jun 2020

[1] Refer to Section 2.2 (Table 2-3)

Executive Summary

Introduction

Dubai Municipality (DM) (the Project Proponent) proposes the development of the Dubai Waste Management Center, a proposed Waste-to-Energy Plant (WtE plant), (Project) (Figure 1) at the existing DM owned and operated vehicle storage site in Warsan, Dubai. The proposed WtE plant will treat about 1,888,000 tonnes of municipal solid waste (MSW) per year, with an estimated nominal design capacity of 5,666 tonnes per day (tpd)) at 9.5 MJ/kg net calorific value (NCV), to generate an average net power output of 193 MW of electricity to power about 135,000 homes.

Under contract with the Project Proponent, Hitachi Zosen Inova (HZI), a global leader in Energy-from-Waste (EfW) technology, NV Besix SA, Sharjah branch (BESIX), a Belgian construction company, and Itochu, a Japanese company formed a partnership to build, operate and transfer (BOT) the WtE plant over a 35-year period. The contract is shared between a Special Project Vehicle (SPV) and Engineering, Procurement and Construction (EPC) partnership and Operations and Maintenance (O&M) partnership.

HZI commissioned GHD Global Pty Ltd (GHD) as the Project environmental consultant for the Project. The application for environmental clearance is made to the Dubai Municipality-Environmental Department (DM-ED) in accordance with Technical Guidelines 1 (Environmental Impact Assessment) and 2 (EIA for Land Development, Infrastructure and Utility Projects) (March 2019).

To support funding applications from international lending institutions, the Project will also comply with international guidelines such as the Eqeuator Principles (EP), International Finance Corporations (IFC) Performance Standards, and World Bank (WB) Environment, Health and Safety Guidelines.

A Preliminary Environmental Approval (PEA) was issued by the Dubai Municipality-Environment Department (DM-ED) on 20 May 2019 (Ref. No. EPBI-200519-00125); however, it was cancelled on 17 July 2019 (EPBI/200519-00125) and a revised Environmental Impact Assessment Report (EIAR) Rev 4 was submitted on 3 October 2019 to present the following modifications to the Project:

- Design improvement
- 12 weeks Incinerated Bottom Ash (IBA) maturation
- Covered IBA Maturation Area
- Mobile waste shredder
- Installation of 132kV underground cable and connection to DM STP substation

An Environmental Clearance (EC Ref. No. EPBI-090719-00145) was issued by DM-ED on 13 October 2019 for EIAR Revision 4.

On 19 February 2020, the Project Company requested a re-submission of EIAR (Rev 5) to incorporate the conditions of the EC into the report. As a response, DM-ED issued a number of comments and clarifications. This EIAR Rev 6 addresses these comments and submitted for DM-ED approval.

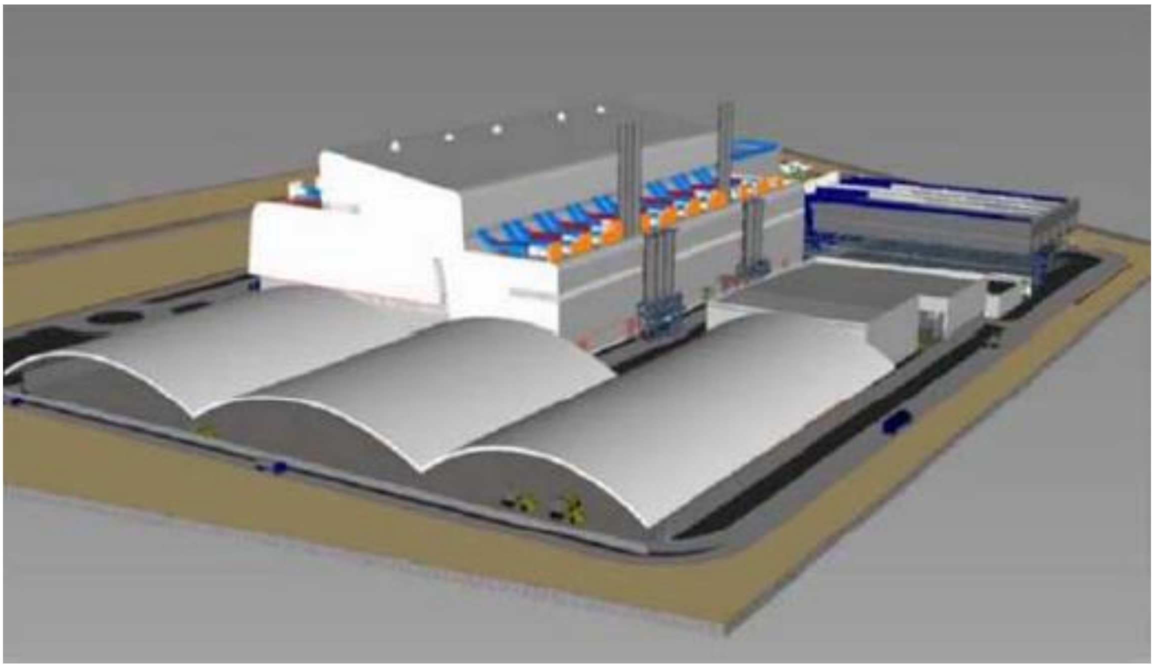

Figure 1 Dubai Waste Management Center Facility Rendering

Project Fact Sheet

Project Information	Description
Project Proponent	Dubai Municipality
SPV and EPC	HZI, Besix and Itochu
Project Name	Dubai Waste Management Center (Waste-to-Energy Plant)
Project Categorisation	According to DM-ED Technical Guideline No. 2 (March 2019), the Project requires the submission of Environmental Impact Assessment Report (EIAR).
	Under definition provided in Equator Principle 1 (2013), the Project is classified as Category A as it may potentially have significant adverse environmental and/or social impacts that can affect an area broader than the site that is subject to physical works. The impacts associated with the Project can be mitigated through appropriate environmental and social management and monitoring measures.
Design Capacity	5,666 tpd MSW at full capacity
Project Location	Al Warsan 2, Dubai, UAE
Total Area	506,096.14 m^2 (based on the Affection Plan)
Production Capacity	Average output of 193 MW at full capacity at 27°C ambient temperature
Design Standards	European Regulations/Industrial Emission Directive (Directive 2010/75/EU)

Project Information	Description
Manpower	Peak of construction: Over 2000 workers Normal operation conditions: 129 fulltime staff / workers Annual outage overhaul: Additional 120 external workers
Project Schedule	Detailed engineering is expected to be completed in Q2 2020. A three-year construction period is expected to commence in Q2 2020, and commissioning and trial run is anticipated 36 months after the start of construction.
Project Rationale	Consistent with the vision of the UAE towards integrated waste management and energy diversification in Dubai, the integrated strategic waste management master plan provides a roadmap for sustainable waste management practices in the Emirate of Dubai up to 2030. Key Performance Indicators (KPI) have been developed to drive the process of the waste management strategy, which include: minimising wastes, maximising environmentally sound waste reuse and recycling, promoting environmentally soune waste disposal and treatment and extending waste service coverage. A stable energy supply is anticipated to foster continued economic stability and growth in the country and surrounding areas. As such, the Project is considered to be in line with addressing the following overarching goals: • In line with 2050 Energy Strategy (MOEI, 2017) in diversifying energy resources (solar, nuclear, wind, WtE) • Assist the Emirate of Dubai reach its 98% landfill diversion target by 2030 (Mott MacDonald, 2013) • Support the goal of UAE Vision 2021 (i.e. avoid methane emission from landfills and fossil fuel displacement)

Project Structure

The Project is owned by DM. Under contract with the Project Owner, SPV, EPC and O&M have formed a partnership to build, operate and transfer (BOT) the WtE plant over a 35-year period. Various entities involved in the Project is shown in Figure 2.

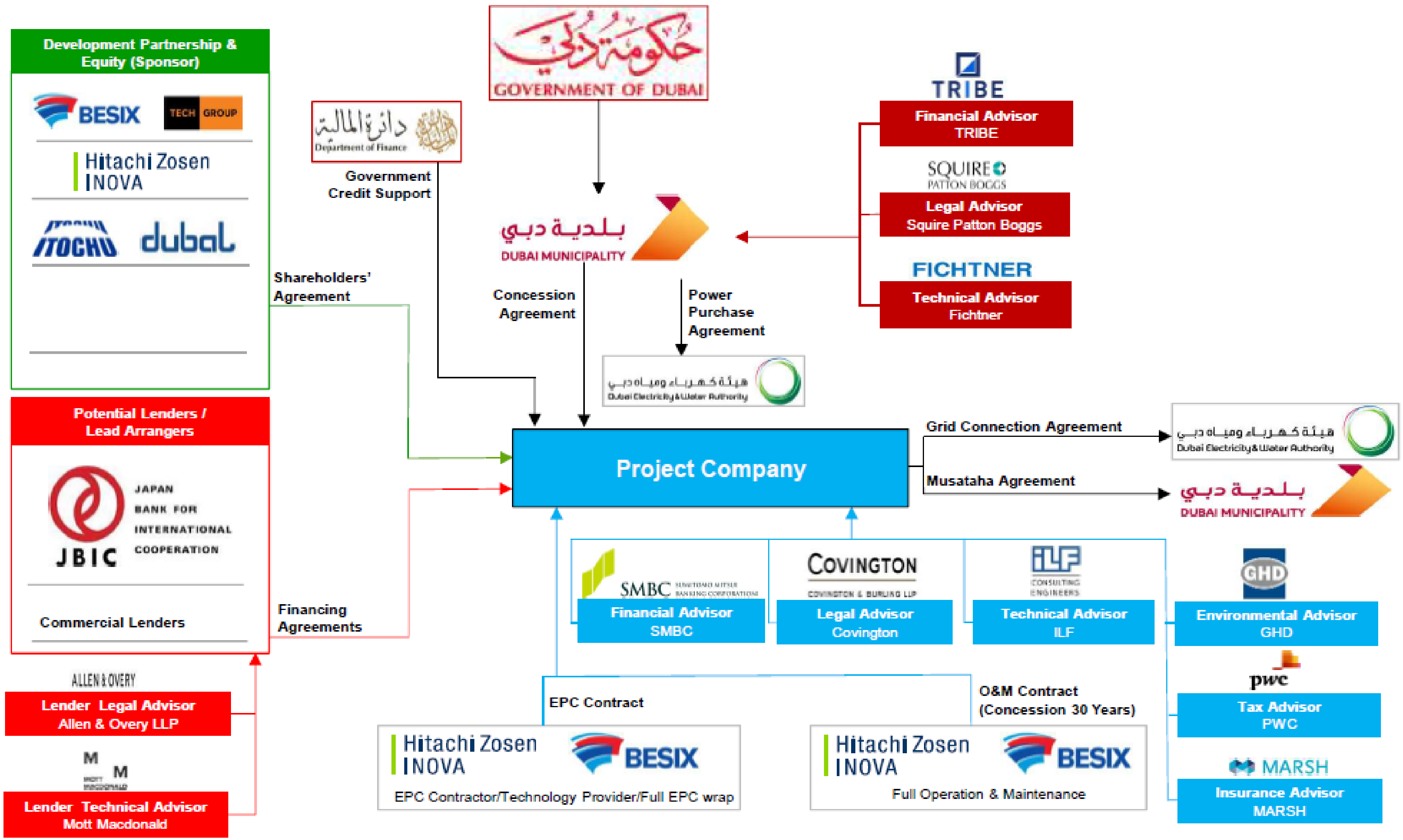

Figure 2 Project Structure

Project Location

The Project is proposed to be located at a DM-owned industrial site in Warsan, Dubai (specifically Warsan 2). The Project site is located within land comprises other DM functions including the Dubai Electricity and Water Authority (DEWA) Power Station to the southwest.

The site is located within a highly disturbed site within an operational industrial zone, with limited environmental flora and fauna values, and no wetlands or waterways present on site (Figure 3). There are no existing communities residing within the site limits that would be directly affected by the Project construction and operation phases.

Nearest residential area is located approximately 300 m north from the proposed site boundary. Individuals accessing the commercial and office facilities within the surrounding industrial and commercial areas may potentially be affected during the construction and operation of the Project.

There is currently an un-engineered Tadweer landfill located to the southwest of the Project.

There are no cultural sites within or surrounding the Project site (dubaiculture.gov.ae). The nearest cultural heritage site is the Al Fahidi Historical Neighborhood, which is about 18 km away from the site. The nearest protected area is the Al Wohoosh Desert Conservation Reserve located approximately 20 km east of the site.

Study Area

The EIA study was undertaken primarily within the vicinity of the proposed Project footprint and its potential impact areas. Baseline monitoring and sampling locations are provided in Figure 4.

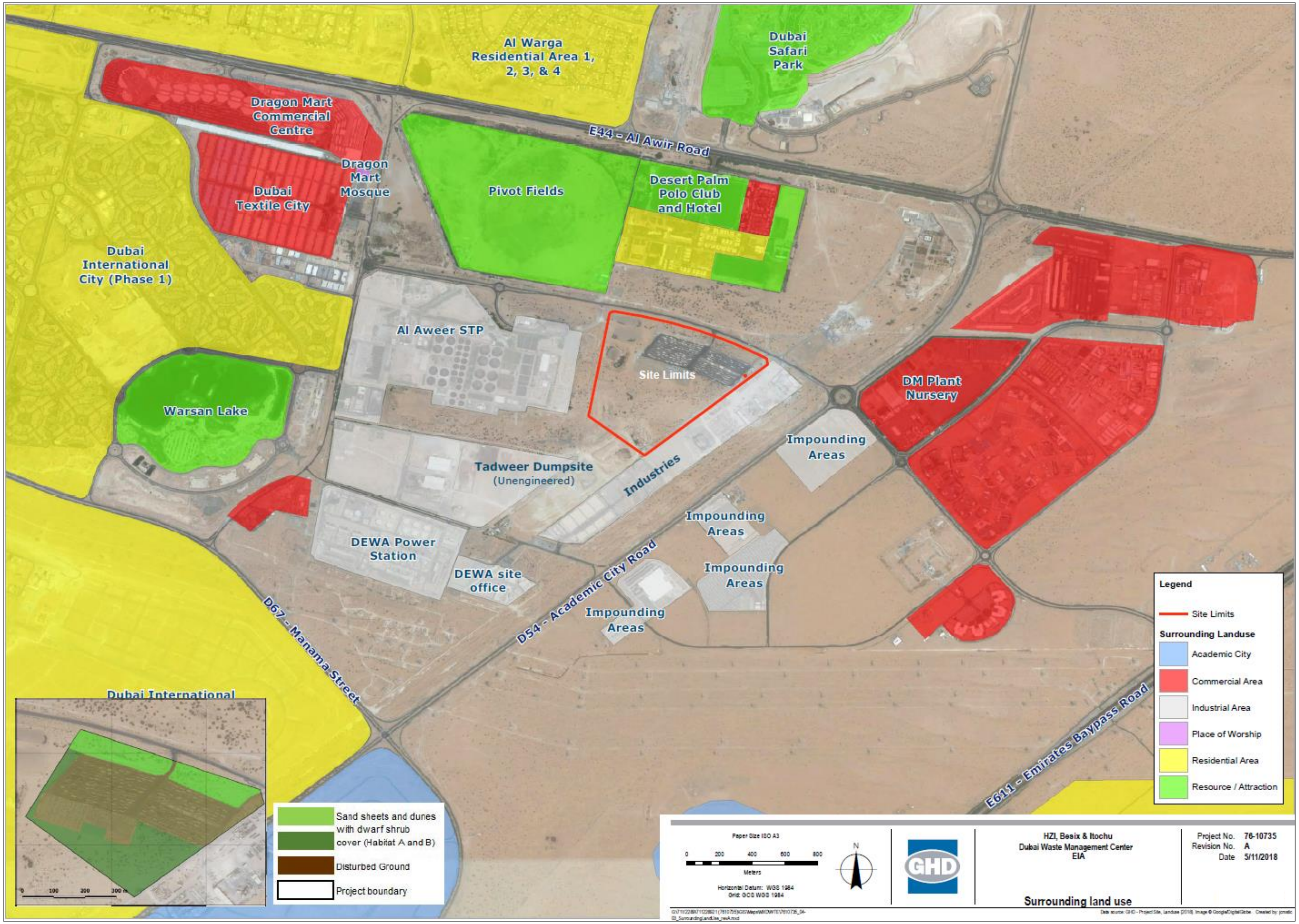

Figure 3 Project site

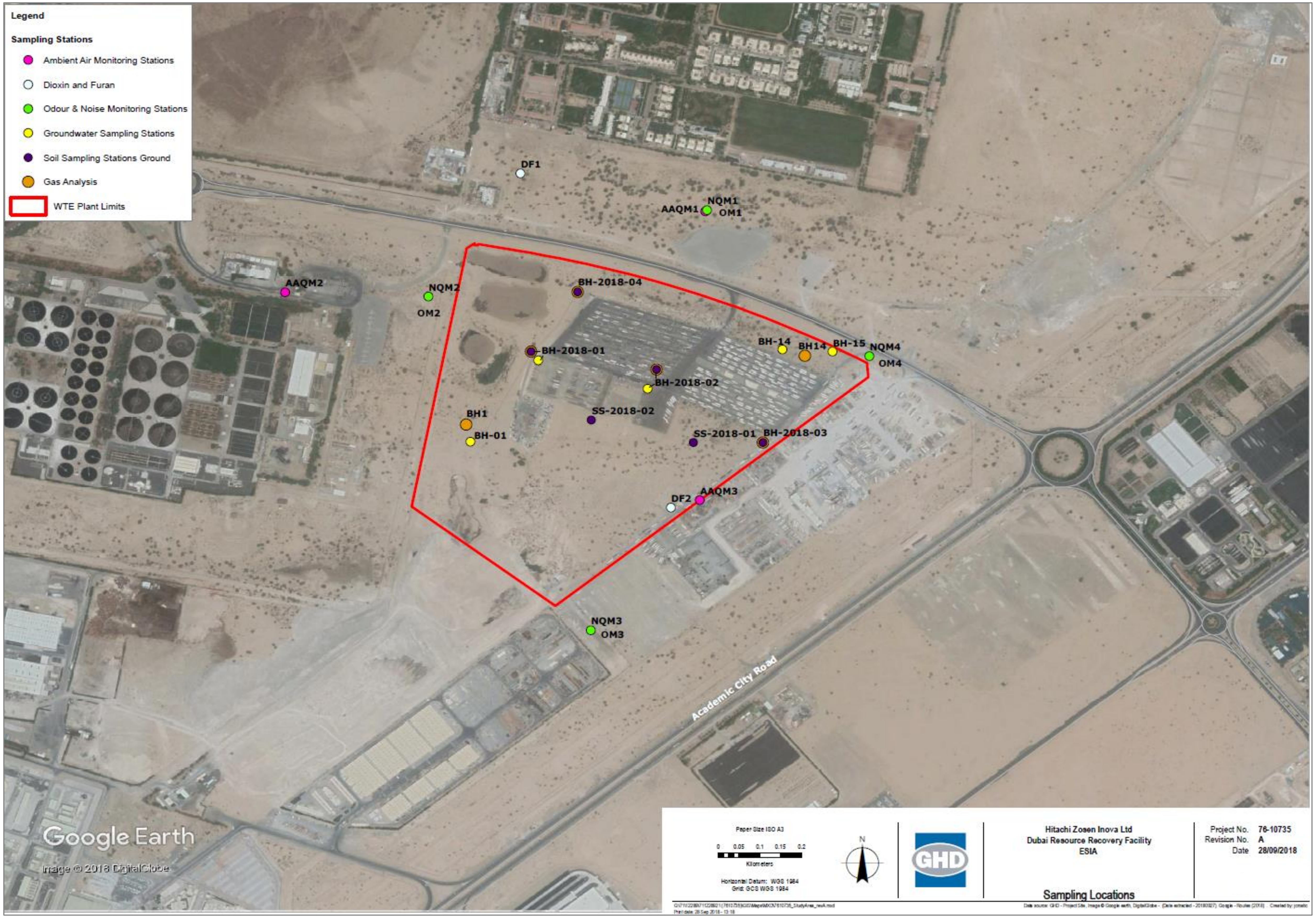

Figure 4 Sampling Locations

Schematic Diagram

The technological concent and the related volume streams for the proposed Project are illustrated in Figure 5.

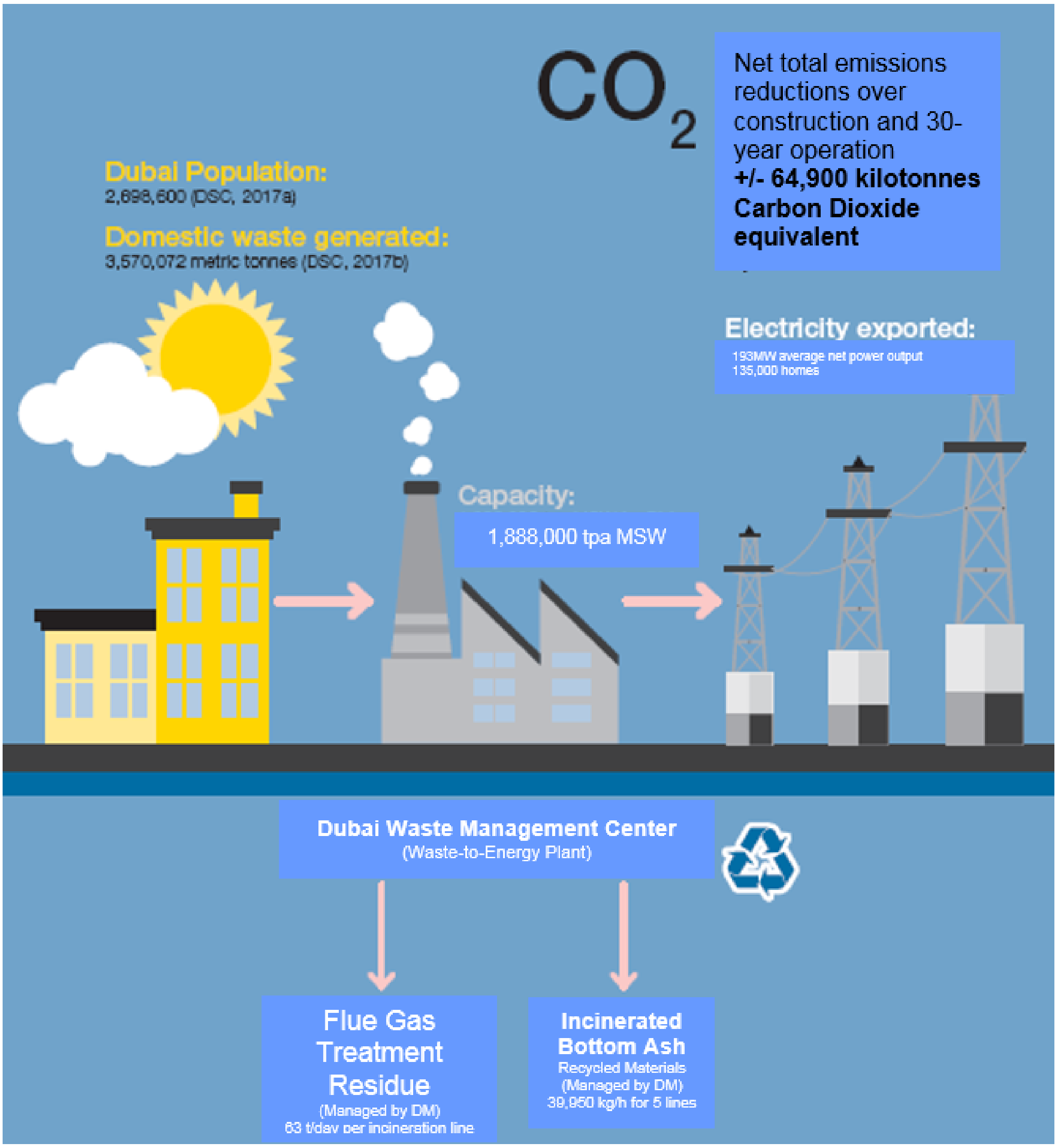

Figure 5 Schematic Diagram

Project Components

The general layout of the proposed WtE plant is provided in Figure 6. The WtE plant will comprise of the component provided in Table 1.

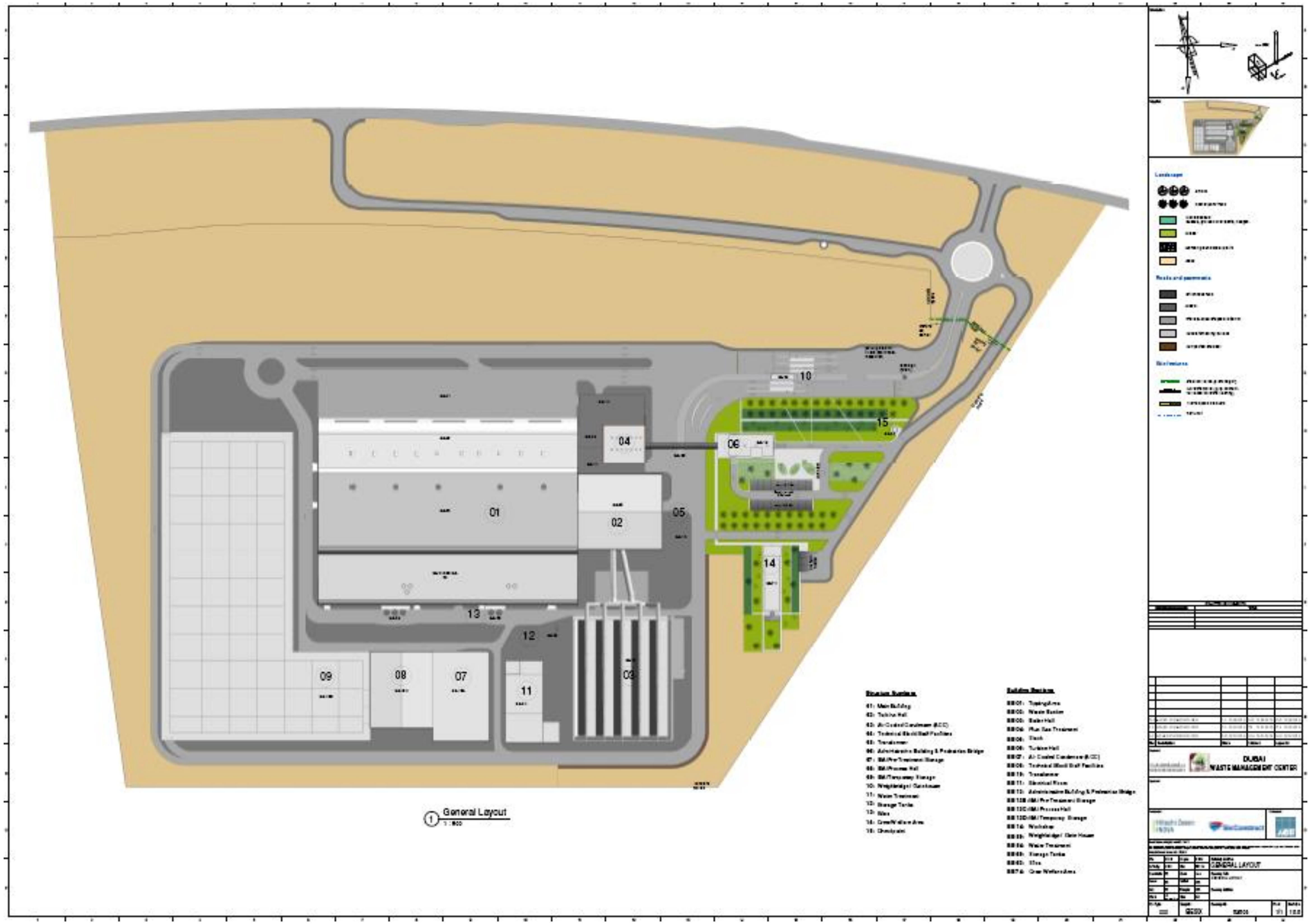

Figure 6 Project Layout

Table 1 Project Components

Buildings	Functional Description
Primary Supporting Facilities	
Administrative & Visitors Building and Operating and Maintenance Staff Facilities	The Administration Building will be designed and constructed to be able to accommodate 20 people on a permanent basis and additionally up to approximately 30 visitors on a temporary basis. The building comprises (i) offices and meeting rooms, (ii) cafeteria, (iii) archive room and storage rooms for office and cleaning supplies, (iv) restrooms, (v) kitchen, (vi) exhibition space, (vii) visitor area, (viii) training room and (ix)lifts for personnel.
Guardhouse	Trucks entry and exit
Weighbridge	Weighing of the waste deliveries (incoming truck weight minus outgoing truck weight) and acquisition of all relevant delivery data for inventory control. • Number of truck scales: 3 in - 2 out • Peak hourly truck entry: 80 trucks / h • Type truck scale: pit type / pitless type • Annual availability: 8,760 h/y / 24 h/day • Low and high temperatures:10 to 55ºC • Size of each platform (Length x width): 18m x 3m • Weighing range: 0.4-60 Mg • Weighing scaling intervals: max. 20kg • Horizontal movement of the platform in each direction: max. 10mm • Number of load cells per platform: 8 • Type of cell: digital • Load capacity per cell: Mg • Weighing accuracy according to OIML Standards: Class III • Weighing accuracy: Max. 0.025%

Buildings	Functional Description
	• Automatic vehicle identification: • Automatic ticket dispenser: 1 (exit scale) • Alphanumeric display and Intercom system: 2, one per scale • Automatic barriers: 2, one per scale Weighing software and complete PC with mouse, printer and screen
Checkpoint	Staff and visitors entry & exit
Accommodation Building	To accommodate 120 people
Primary Technical Buildings	
Main Electrical Station	The steam turbine generator will be connected through the Generator Circuit Breaker (GCB) to the Generator Step up Transformer. When sufficient steam is produced, the generator will be synchronized to the 132 kV grid. Once synchronized, the net power production is delivered to the Grid. The Facility electrical auxiliary system is fed from the 6.6kV metal-clad switchgear, which is connected to the Unit Auxiliary Transformer. The plant system will be supplied from the 6.6kV switchgear. Dry type distribution transformers 6.6kV/0.4kV will be used for low voltage consumers. Two (2) Emergency diesel generators for safe shut-down will be installed and connected to the 6.6 kV switchboard. In the event of total power failure, the redundant steady-state uninterruptible power supply system provides for the continuity of the power supply for the operational instrumentation and control system, i.e. the power supply for instrumentation, monitoring systems, the voice communications equipment, as well as the control voltage of the HV, MV and LV system.
Main Process Building: 1) Tipping Bay	The tipping bays allow the transfer of the waste from the reception area to the waste bunker and guide the waste trucks in the tipping area. The waste delivery trucks back up to their assigned tipping bay made of concrete and unload their load into the waste bunker. Air is drawn

Buildings	Functional Description
	from the waste bunker into the furnace combustion air. The resulting negative pressure within the waste bunker mitigates potential fugitive emissions of dust and odour from leaving the waste bunker.
2) Waste Bunker	Dimensions of waste bunker 1 (2 lines): • Width – 56.0 m • Height – 33.0 m • Depth – 23.0 m • Volume – 42,504 m^3 Dimension of waste bunker 2 (3 lines) • Width – 87 m • Height 33 m • Depth 23 m • Volume 66,033 m^3
3) Mobile Waste Shredder	The mobile waste shredder will be used for processing bulky waste, as a contingency plan should waste be received at the site that is unsuitable for feedstock to the incinerator lines.
4) Boiler Hall	The boiler converts the heat of the flue gas into superheated steam. It is designed as a natural circulation boiler and is diviced into five main subsystems: (i) the economiser system, (ii) the evaporator system, (iii) the superheater system, (iv) the boiler drum and (v) the boiler blow down.
5) Flue Gas Treatment (FGT) system	The dry flue gas treatment (FGT) process is designed to remove all dust particles, most of the acidic gaseous contaminants, by neutralisation with hydrated lime and organic pollutants (PCDD/F) as well as mercury and other heavy metals by adsorption on lignite coke. The system consists of a reactor with additive injection, fabric filter for solid-gas separation and residue recirculation. *SNCR Process* NOx reduction occurs in the combustion zone where an aqueous solution of urea is injected into the flue gas stream leaving the grate and reacts selectively with the NOx in the combustion chamber.

Buildings	Functional Description
	The DyNOR™ system is an advanced SNCR (Selective Non Catalytic Reduction) system, which has been developed with the objective to meet new European NOx standards with a SNCR-system.
6) Stacks	The stack expels the purged flue gas after the flue gas cleaning system to the atmosphere. Each incinerator line has one single self-standing stack of 70 m height. The Project comprise of five incineration lines; as such, a total of five stacks grouped in two and three is anticipated. NOx emission from the stacks will be reduced with the use of SNCR / DyNOR system.
Turbine Hall	The steam is transformed into electrical energy in a turbo-generator set that is used to cover the plant's own electricity needs and to feed to the public electrical grid. The primary elements of the heat utilization include (i) turbine unit, (ii) control and lubrication oil supply, (iii) generator, and (iv) cooling system.
Technical Block, Workshop and Electrical Rooms	*Technical Block*. The Technical Block will be designed and constructed to be able to accommodate 60 people during the dayshift and 17 people during the other shifts. In addition, during the 3-week overhaul period per individual line, there will be an additional 80-120 external workers using the locker rooms, showers and kitchen/canteen in the Technical Block. These overhauls will occur five times per year (because there are five lines). The technical block will comprise (i) kitchen, (ii) cafeteria, (iii) first aid room (or plant clinic), (iv) prayer rooms, (v) locker room, (vi) lift for personnel, and (vii) toilets for male and femal employees. *Workshop*. The Workshop will include maintenance manager's office, store room, large ans small spare parts storage, electrical workshop, instrumentation workshop, mechanical workshop, open area (e.g. for fabrication, temporary laydown), and storage for consumables (i.e. lubricants, etc.)
Air Cool Condenser	During regular plant operation, the exhaust steam from the turbine condenses in the air-cooled condenser (ACC), which is situated beside the turbine house. In case of start-up, shutdown, overload or trip of the turbine, all or a part of the live stream flows into the ACC via the turbine bypass system. The thermal capacity of the ACC is high enough so that it is able to condensate the saturated steam that bypasses the turbine at an ambient temperature of 45 ºC. In transitions from normal operation to exceptional cases, such as "island mode" and by-pass operation, excess steam may need to be blown off for a short period of time during in order to prevent a possible shutdown of the turbine or the plant. At ambient temperatures over

Buildings	Functional Description
	approximately 35°C, it may also be necessary to reduce the boiler load during island mode operation or for the transition from by-pass operation to normal turbine operation.
Bottom Ash Maturation Area	The bottom ash maturation area is where the incinerated bottom ash will be temporarily stored before removal from the site to an off-site location. It will comprise of the following: • IBA Pre-treatment hall where the IBA is stored up to five days to reduce moisture content prior to treatment / metal separation • IBA Process Hall where IBA are segregated into 0–10 mm, 10–40 mm and 40–200 mm fractions and ferrous and non-ferrous metals separation takes place • IBA Maturation area where the clean mineral fractions are stockpiled up to a maximum height of 4m. The setting and leaching processes are undertaken in this covered area which can take up to 12 weeks depending on the bottom ash composition. After this temporarily storage the material will be removed from site to an off-site location.
FGT Silos	The residue storage silo is an interim / temporary storage for the FGT residues. The silos are placed on an elevated steel structure prepared to the moistening system for open truck discharge. A total of five silos for the whole Dubai WtE plant are anticipated. Each silo has an storage volume of approximatly 350 m^3, corresponding to approximately four days storage capacity
Storage Tanks	Storage area for the following materials are anticipated: (i) fuel, (ii) aqueous urea solution, (iii) solid additives [hydrated lime], (iv) adsorbent, and (v) inert gas supply.
Installation of 132kV underground Cable and connection to DM substation	The Project will be connected through a high voltage (HV) single circuit to the DM STP substation.
Water Treatment Plant (WTP)	The WTP will treat secondary water. The key process elements for water treatment are as follows: • Pre-treatment. Comprise of de-oiling filter, ultra-filtration and activated carbon filters. This pre-treatment system is designed to produce water quality suitable to feed the demineralization unit. The water produced in this system will also be used as service water for the Project.

Buildings	Functional Description
	• Demineralization. This system is designed to produce softened water for the Air Cooled Condenser (ACC) and Close Unit Cooling Water (CCW) system.

Key Sensitive Receptors

Sensitive receptors are areas and environments where the occupants are more susceptible to the adverse effects of exposure to toxic chemicals, pesticides, and other pollutants (EPA, 2017). This typically includes, but is not limited to, hospitals, schools, daycare facilities, elderly housing and convalescent facilities.

Sensitive receptors categories relative to the Project, as per DM Technical Guideline No. 2 (2018), are shown in Figure 7 and described below:

- High Sensitivity (Type 1 Area) – high density residential block, hospitals and school premises
- Moderate Sensitivity (Type 2 Area) – light density residential block, public parks and natural body of water
- Light Sensitivity (Type 3 Area) – commercial buildings, offices and other public areas; agricultural crops and farmland
- Marginal Sensitivity (Type 4 Area) – industrial area

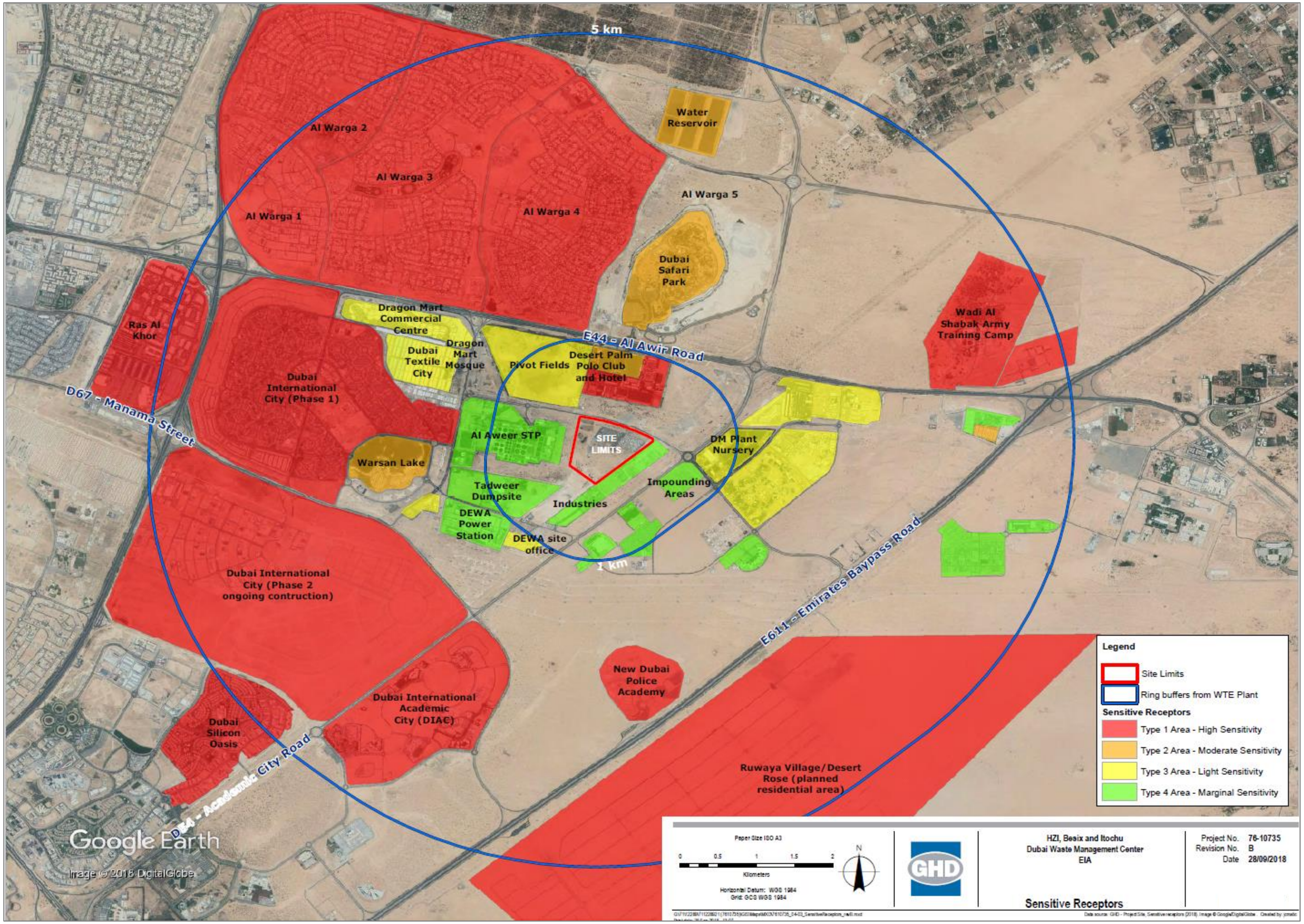

Figure 7 Receptors

Summary of Findings

The EIA has identified potential environmental and social impacts as well as mitigation or enhancement measures. The following section provides a summary of potential impacts associated with the Project.

It is concluded that the environmental and social impacts associated with the construction and operation of the WtE plant are manageable through the adoption and successful implementation of mitigation measures and the undertaking of the monitoring activities and do not present an unacceptable risk to the environment and social aspects.

Greenhouse Gas

Key features of the WtE greenhouse gas (GHG) emissions profile includes:

- The total construction emissions were estimated at 70 kt CO_2-e during the construction period of 49 months.
- The total emissions associated with operations were estimated as 25,300 kt CO_2-e over the project's 30 year lifetime.
- Emissions avoided by not sending waste to landfill were estimated as 71,700 kt CO_2-e over the project's 30 year lifetime equating to 2,400 kt CO_2-e avoided annually.
- Emissions avoided by generating electricity from waste were estimated as 18,600 kt CO_2-e over the project's 30 year lifetime equating to 620 kt CO_2-e avoided annually.
- Net total emissions reductions over the construction and operation stages were estimated at 64,900 kt CO_2-e.
- Average annual emissions reductions are estimated as 1.2 t CO_2-e/t waste treated.

GHG Assessment		
EIA Component	Construction Phase	Operation Phase
Impact Assessment	GHG emissions from consumption of fuel for commuting of construction personnel, delivery of construction materials and disposal of construction waste.	Emission from the WtE operation
Proposed Management	• Optimise energy efficiency • Implementation of waste management measures	Mitigation measure is not required as the impact is considered beneficial. The emisions from the WtE plant are more than offset by avoided landfill methane emissions and emissions from on-site electricity generation displacing existing sources
Residual Impact	No significant residual impact is anticipated with the implementation of management measures.	There will be a net positive impact from the operation of the WtE palnt, as it will result in a net total emissions reduction of 64,900 kt CO_2-e over the construction and operation phases.

Air Quality

Ambient air quality at the Project site and in the surrounding areas is influenced by the following:

- DEWA Power Station, with stationary source of emission, located to the southwest of the site
- Various industrial facilities to the immediate east and southeast of the Project site
- Combustion emissions from vehicles using the surrounding road infrastructure

A two-week ambient air monitoring program was undertaken at three sites in the vicinity of the Project site between 16 August to 9 September 2018. The results show that they were all compliant with the ambient air quality standards for all parameters specified by the UAE Federal Law and Dubai Municipality with the exception of PM_{10} at station AAQM2.

Air Quality Assessment		
EIA Component	Construction Phase	Operation Phase
Impact Assessment	Potential air quality impacts will be emissions from power generation sets and dust generation. Dust generated during construction, if properly mitigated, are not considered to represent significant source of emissions.	Air emissions for the facility will be emitted from five point sources (tall stacks) and IBA management area. Air quality criteria including Ministerial Order No. 12 of 2006, US OSHA 29 CFR Part 1910, USEPA NAAQs 40 CFR Part 50, WHO Ambient Quality Standards, the NSW AMMAAP and European Commission standards were reviewed, and the most appropriate of these used as a comparison to predict ground level concentrations (GLCs) of selected air pollutants. The results demonstrate predicted incremental GLCs for NO_2, SO_2, CO, TSP, PM_{10}, $PM_{2.5}$, HCl, HF, NH3, TCDD and Hg do not exceed the adopted assessment criteria, based on the stack characteristics and emission rates assumed for the Project. Results of the Air Quality Assessment are summarised below: • Predicted incremental 1-hour concentrations of Cd exceed the NSW AMMAAP guidelines, which is likely due to the conservative assumption that the IED emission limit of 0.05 mg/Nm^3, is 100% Cd as oppose to be the sum of Cd and thallium. Ambient concentrations of Cd associated with the stacks are likely to be lower in reality. The predicted annual concentrations of

Air Quality Assessment		
EIA Component	Construction Phase	Operation Phase
		Cd comply with the European Commission criteria at all sensitive receptors. • The maximum predicted cumulative concentration for 24-hour NO_2 exceeds the UAE criteria by 3%; however, the incremental concentration complies with the criteria. • The cumulative concentrations for PM_{10} exceed the UAE 24-hour and annual WHO criteria, while the cumulative concentrations for $PM_{2.5}$ exceed the WHO 24-hour and annual criteria due to the adopted background concentrations exceeding the criteria. • The incremental contribution of the WMC to TSP, PM_{10}, and $PM_{2.5}$ ambient concentrations are less than the respective assessment criteria, including the WHO Interim target 1.
Proposed Management	• All construction and maintenance equipment/vehicles to be maintained to manufacturers specifications • Defined haul routes to be used • Limit vehicular speed to 25 km/hour • Implement dust mitigation measures	Built-in (WtE plant design) management measures: use of flue gas treatment (FGT) system, which include: • Particle separation • Dry flue gas cleaning with lime and lignite coke • Selective non-catalytic reduction (SNCR) process).
Proposed Monitoring Programme	• Visual dust monitoring • Dust monitoring at one location where construction activities are undertaken.	• Stack emissions monitoring of parameters provided in the Continuous Environmental Monitoring System (CEMS) • Quarterly monitoring of HF, dioxin and furans, heavy metals, PM_{10} and $PM_{2.5}$ • Fixed and continuous monitoring of PM_{10} and $PM_{2.5}$ at one location

Air Quality Assessment		
EIA Component	Construction Phase	Operation Phase
Residual Impact	No significant residual impact is anticipated with the implementation of mitigation measures.	No significant residual impact is anticipated as the emissions from the WtE plant are more than offset by avoided landfill methane emissions and emissions from on-site electricity generation. The emission is extremely low since the Project is designed using Directive 2010/75/EU.

Odour

There are a number of potential odour sources around the proposed Project site. These include:

- The Tadweer landfill
- The Al Serkal/envirol grease trap waste recycling plant
- China state asphalt mixing plant
- Emirates beton readymix L.L.C (concentrate supplier)

A site investigation was undertaken to monitor the ambient air levels of odourous gases from potential odour sources around the Project site. Based on the odour monitoring results, majority of the target compounds were below the laboratory limit of detection.

Odour Assessment		
EIA Component	Construction Phase	Operation Phase
Impact Assessment	Poor management of sanitary and waste disposal facilities (e.g. septic tanks, putrescible waste bins) may result in odour causing a nuisance to people on or near the Project site. Good housekeeping, regular inspections and maintenance of waste disposal, transfer and storage facilities will minimise the risk of odour release.	The results of the dispersion modelling indicate that when negative pressure is maintained, predicted odour concentrations reaching the defined sensitive receptors will be undetectable to the majority of the population. If negative pressure is lost and a flow rate of 0.6 m/s is achieved, predicted odour concentrations at 7 out of 14 sensitive receptors should be undetectable. If worst case conditions prevailed resulting in a flow rate of 1.2 m/s during a loss of negative pressure, predicted odour concentrations at 2 out of 14 sensitive receptors should be undetectable.

Odour Assessment		
EIA Component	Construction Phase	Operation Phase
Proposed Management	• Locate toilet utilities, sewage tanks (if any) and waste storage facilities away from sensitive receptors • Maintain the sanitary and waste disposal facilities in good and clean conditions • Regular off-site disposal of waste	• Avoid waste storage for more than five days in the waste bunker • Installation of tipping bay gates • Ventilation / slight negative pressure at the waste bunker • Maintain operation of four out of five lines at any time to maintain slight negative pressure in the waste bunker
Proposed Monitoring Programme	• Not required as potential impact is negligible. • Complaints from surrounding land users will be recorded and addressed.	• Fixed and continuous monitoring of H_2S, NH_3, mercaptans, DMS and DMDS at two locations
Residual Impact	No significance residual impact is anticipated with the implementation of mitigation measures.	Residual impact is not anticipated as the emissions from the WtE plant are more than offset by avoided landfill odour emissions. Built-in odour management measures (e.g. tipping bays and ventilation at the waste bunker) will be installed to avoid odour emission.

Noise

Baseline noise monitoring was undertaken at four sites on 18 and 19 August 2018. The monitoring locations were selected due to their proximity sensitive receptors, which has the potential to be impacted by noise.

Noise monitoring results showed that average measurements (LAeq) recorded during daytime were compliant with the UAE Federal and World Bank Guidelines. Nighttime measurements at NQM1 exceeded the World Bank limit of 45 dBA during both weekends and weekdays. NQM1 is adjacent to an internal road leading to the industrial area. The exceedances are most likely associated with vehicle movement on the road as well as sound of insects/animals. An exceedance of the Federal Limit was also recorded at NQM4 on a weekday, where a minor exceedance of 1 dBA was recorded during night time. The minor exceedance is most likely attributed to passing vehicles.

Noise Assessment		
EIA Component	Construction Phase	Operation Phase
Impact Assessment	Construction noise is anticipated due to movement of heavy machinery moving about the Project site and operation of construction equipment. During any given period, the machinery items used in the Project area will operate at maximum sound power levels for only brief times. Thus, construction noise emissions will be intermittent and of short duration.	An impact assessment was performed to determine the severity of the impact of the Project operation at the nearest sensitive receptor. Based on the noise modelling, the impacts of the operational noise assessment at the identified sensitive receptor is predicted to be negligible for both daytime and night time.
Proposed Management	• Appropriate site layout (locate primary noise sources away from sensitive receptors • Maintain equipment in good working condition • Limit general construction activities to daytime (7 am to 8 pm)	Implement engineering measures: • Provide built-in insulation walls • Locate buildings close to the Project's boundary to provide shielding • Enclose plant / equipment considered causing major source of noise • Select quiet equipment
Proposed Monitoring Programme	• Noise monitoring at one location where construction activities are undertaken.	Fixed and continuous noise monitoring at four locations
Residual Impact	No significant residual impact is anticipated	No significant residual impact is anticipated

Soil and Groundwater

A total of 10 soil samples were collected at five locations (at 1 mbgl and 5 mbgl) within the Project site. Five groundwater samples were also collected from new groundwater wells.

The results of the soil quality analysis were compared to the limits set out by DM-ED Information Bulletin No. 2 *Land Contamination Indicator Levels* (May 2003) and *Dutch Soil Remediation Circular* (2009). Soil quality results show that majority of parameters were not detected in concentrations above their respective minimum detection limits (MDL). Parameters that were detected in concentrations above MDLs were within their respective standard limits.

The groundwater laboratory data was compared against the Intervention Values specified in *Dutch Soil Remediation Circular* (2009), which is accepted by DM-ED. Groundwater samples recovered from the monitoring wells did not report any analytes above the Dutch (2009) Intervention Values with the exception of toluene (CAS 108-88-3), which was detected from the sample taken from well BH-2018-02 (near Parking Area). According to Zogorski et.al. (2006), the sources of most gasoline hydrocarbons in aquifers are probably releases of gasoline or other finished fuel products. It is not possible to determine the exact cause of the elevated toluene concentrations from a single sampling event. However, it is likely highly that the source originates from the vehicles parked near the monitoring well. Further investigation of the source and extent of this impact is recommended.

Soil and Groundwater Assessment		
EIA Component	Construction Phase	Operation Phase
Impact Assessment	Typical impacts associated with construction activities include: • Land alteration • Soil erosion • Soil and groundwater contamination The risk associated with groundwater contamination is considered low for the following reasons: • The type of activities do not require or generate large amount of hazardous materials / wastes • The arid climate condition on-site, where there is no significant surface / stormwater flow that will infiltrate any contaminants into groundwater.	The operation of the Project is not considered to generate significant adverse impacts on the soil or groundwater condition. However, activities that have the potential to cause soil and/or groundwater contamination during the operation of the WtE plant include: • Leak or overflow of untreated sewage from sewage transfer infrastructure • Accidental spillage or leakage from storage of the feedstock on site (i.e. waste bunker) • Inappropriate storage of wastes (e.g. bottom ash and FGT residue) • Accidental spill or leakage from on-site bulk storage and handling of fuel and materials (i.e. aqueous urea solution, solid additives, adsorbent)
Proposed Management	• Implement erosion and sediment control plan • Progressive compaction and rehabilitation / lanscaping • Provide efficient temporary drainage system • Immediate clean-up of chemical and fuel spill • Implement appropriate hazardous waste / materials practices	• Appropriate design of on-site temporary bottom ash and FGT residue storage facilities • Implement soil and groundwater management (i.e. appropriately bunded areas, lined storage areas, etc.) • Appropriate waste management
Proposed Monitoring Programme	• Daily visual site inspection of potential soil contamination • Where dewatering activities are undertaken, sampling and testing will be undertaken on a monthly basis	• Regular inspection of waste management facilities • Daily visual site inspection of potential soil contamination • Quarterly sampling and groundwater analysis at one location

Soil and Groundwater Assessment		
EIA Component	Construction Phase	Operation Phase
Residual Impact	No significant residual impact is anticipated.	No significant residual impact is anticipated.

Biodiversity (Terrestrial Ecology)

A total of 39 species of flora and fauna were recorded at the Project site during the terrestrial survey, which was conducted from 19 to 20 August 2018 (two days and one night). The overall species richness of the area (approximately 3% of the total species of flora and fauna in the UAE) is considered to be very low.

Species identified at the Project site are not currently classified as threatened species under the IUCN 2018 Red List of Threatened Species, which suggests that only common and highly resilient species are present. All habitats identified on-site have a little conservation value. No threatened species or species that require specific habitat to survive are found.

Aquatic habitats are not present within or near the project site.

Biodiversity Assessment		
EIA Component	Construction Phase	Operation Phase
Impact Assessment	Vegetation clearing is an unavoidable impact. However, the impact on floral diversity is considered to be negligible given the plant species identified at the Project site. Further, the Project site has already been modified and disturbed and has limited conservation value. No threatened species or species that require specific habitat to survive are recorded for the project site.	No significant impact on flora and fauna is anticipated except for potential introduction of invasive species if waste is not properly managed.
Proposed Management	• Manage size of land disturbance for temporary construction laydown areas to minimum necessary • Reduce traffic speeds to prevent fauna injury and mortality	• Implement appropriate wheel washing of trucks prior to entering the site • Implement appropriate waste management plan
Proposed Monitoring Programme	• Visual observation on the presence of injured fauna	• Visual observation on the presence of injured fauna
Residual Impact	No significant residual impact is anticipated.	No significant residual impact is anticipated.

Access, Traffic and Transport

The proposed site is accessed via the existing E44 highway (or Al Khail Road or Dubai-Hatta Highway), a dual 4-lane highway that runs from the west to east. Other major routes to the west and east of the Project are E311 (Sheikh Mohammed Bin Zayed Road) and E611 (Emirates Road). The major roads surrounding the development include the Academic City Road to the south and the Al Awir Road to the north of the proposed development.

A Level 1 Traffic Impact Study was completed for the project.

From the E44 highway, the Project can be reached via D54 (or Sheikh Zayed Bin Hamdan Al Nahyan Street). The proposed development falls under medium industry with a total GFA of 58,089 m^2.

Traffic Assessment		
EIA Component	Construction Phase	Operation Phase
Impact Assessment	Construction activities will lead to a temporary increase in road traffic, which can potentially affect road safety at the Project site and nearby road networks if traffic is not properly managed. Transport requirements of the Project will comprise of daily transport of construction personnel to the Project site, delivery of construction materials and resources, delivery of site equipment and supporting facilities and collection of solid waste for off-site disposal. Potential impacts associated with the construction phase traffic include: • Increase in traffic congestion on the road network from Port Rashid leading to the Project site • Increased potential for vehicle accident / incident associated with a larger volume of traffic on the road network	Site access analysis has been carried out at the access points (1 and 2) to determine the impact of generated trips on the existing road traffic. The access locations are analysed using HCS 7 software. Site access analysis indicate that the access point will work at an acceptable level of service (LOS) for the opening year 2023 during AM and PM peak hours. The LOS are as follows: • Access 1: LOS A (AM) & LOS B (PM) • Access 2: LOS C (AM) & LOS B (PM)
Proposed Management	• Implement traffic management and access plan • Provide mass transport for workers	• Implement traffic management and access plan
Proposed Monitoring Programme	• Monitor traffic condition within the Project site	• Monitor traffic condition within the Project site
Residual Impact	An increase in traffic is an unavoidable but transient impact from the construction activities of the Project.	Residual impact is not anticipated as the LOS on the access roads (1 and 2)

Traffic Assessment		
EIA Component	Construction Phase	Operation Phase
		planned for the Project is considered sufficient.

Surface Water Resources

The nearest water body is the Al Warsan Lake located approximately 2.29 km west of the Project site. Al Warsan Lake is a wetland that has been created by taking treated effluent from the nearby Al Aweer STP and putting it in an unused quarry area (Nakheel, 2018). It is becoming home to various species of plants, animals, mammals, fish and reptiles.

The total installed desalination capacity available in Dubai is 470 million imperial gallons per day (MIGD) in addition to 32 MIDG from wells. Data shows that peak water demand increased by 2.96% (from 337 MIGD in 2015 to 347 MIGD in 2016). Residential areas consumed the most water in 2016 (60.72%) followed by commercial areas (26.57%).

Approximately 4.80 m^3/h of potable water will be used for domestic, sanitary as well as firefighting system while about 42.35 m^3/h (1 stream operation) or 76.06 ^{m3}/h (2 stream operation) will be required for operation. Potable water will be sourced from DEWA while sewage treated effluent (STE) from Al Aweer Sewage Treatment Plant (STP) will be treated for WtE operation.

Surface Water Resources		
EIA Component	Construction Phase	Operation Phase
Impact Assessment	Potable water and water for domestic and other washing activities on-site will be supplied by existing DEWA facilities on-site.	Water discharges from the plant operation include process and softened water, which can be reused. As such, there is no water discharged from the WtE operation. Recycling and reusing water from Al Aweer STP provides benefits such as conservation of potable / freshwater supply, reduces water discharge into water bodies and provide economic benefits.
Proposed Management	Implement the following water conservation measures: • Use of water efficient devices and practices (i.e. high-pressure water for equipment cleaning) • Frequent site inspections of water leaks and wastage	• Water efficiency measures are adopted as early as the design phase and on an ongoing basis during the operation phase • Built-in water management measures are incorporated in the design of the WtE plant; as such wastewater discharge is not anticipated

Surface Water Resources		
EIA Component	Construction Phase	Operation Phase
	• Limit dust suppression to what is necessary • Provide employee training on water use behaviour and best practice procedures • Re-use water (if applicable)	
Proposed Monitoring Programme	• Keep record of water consumption	• Keep record of water consumption
Residual Impact	No significant residual impact is anticipated	No significant residual impact is anticipated

Energy Resources

In 2015, DEWA produced a total gross generation of 42,006,335 MWh of power, which was produced mainly through the use of natural gas (DEWA, 2015). The total installed capacity of the power plants is 10,000 Megawatts (MW), which is greater than the 2016 peak demand of 7982 MW.

DEWA annual statistics for 2016 indicate that the annual average electricity consumption in 2016 was 43,093 Gigawatt hours (GWh), with the commercial sector reported as having the highest consumption of electricity, followed by residential areas.

Energy Resources		
EIA Component	Construction Phase	Operation Phase
Impact Assessment	Power requirements will most likely be supplied through power generating units, which causes air pollution emissions. Construction utilities and equipment will also require regular delivery of fuel, which may potentially cause oil spills and VOC emissions.	The completion and operation of the proposed WtE plant is considered to have a significant positive impact in terms of energy sufficiency, diversification of energy resources and contribution of additional power supply to meet the demands of increasing population and growing economy. The WtE plant itself will operate from energy produced from the processing of MSW.
Proposed Management	• Reduce electricity use (i.e. switch-off light when not in use, using energy efficiency light bulbs) • Optimising energy efficiency (i.e. no idling of equipment, use of cleaner	Mitigation measure is not required as the impact is considered beneficial

Energy Resources		
EIA Component	Construction Phase	Operation Phase
	fuel, use of equipment fitted with pollution control devices, maintain equipment and vehicles as per manufacturer's recommendation, use main electricity or battery-powered equipment)	
Proposed Monitoring Programme	• Keeping record of fuel use • Environmental incident reporting (i.e. fuel / oil spill)	• Not applicable
Residual Impact	No significant residual impact is anticipated	There will be a net positive impact from the operation of the WtE plant

Waste Management

In reference to the Strategic Integrated Plan for Solid Waste (Master plan) prepared for DM Waste Management Department (WMD) by Mott MacDonald (May 2013), the approximate tonnes of construction and demolition (C&D) waste generated per 1 million AED spent is about 500 tonnes. This can be used as a benchmark for the total construction waste estimated to be generated from the project. However, as fabrication of the technology will be completed off-site, there may be less waste attributed to this project than per typical construction projects in the property and buildings development market.

Waste generation during the construction phase include:

- Food waste – 30 to 75 kg/day
- Solid waste – 30 to 75 kg/day
- Sewage – 125 to 300 m^3/day
- Mixed waste -11,520 m^3
- Metals – 3600 tonnes (entire construction period)
- Concrete – 22,000 m^3 (entire construction period)
- Wood – 6000 m^3 (entire construction period)

Waste generation during the operation phase include:

- Food waste – up to 60 kg/day
- Solid waste – up to 120 kg/day
- Wastewater – 70 to 103 m^3/day
- Incineration bottom ash (IBA) – 39,950 kg/h bottom ash from wet extractor at LPN, total for five lines; 282,269 tpa mineralic aggregates to be produces after pre-treatment, processing and maturation.
- Boiler ash (non-hazardous) – 985 kg/h at LPN, total of tfive lines

- Flue gas treatment (FGT) residue (including fly ash (hazardous waste)) – 310 t/day for five inceneration lines

Waste Management Assessment		
EIA Component	Construction Phase	Operation Phase
Impact Assessment	Without appropriate management, the generation, storage and disposal of construction waste may lead to (i) soil and groundwater contamination, (ii) dispersion of waste in and around the project site, (iii) odour from storage of putrescible waste and sewage storage tanks, (iv) hazards to fauna, and (v) hazards to health and safety.	The benefits of the operation of the Project with respect to waste include the reduction of waste disposed to landfills. The WtE plant can utilise typical MSW, refuse-derived fuel from a materials recovery facility as well as commercial and industrial wastes that may otherwise be disposed of in a landfill. Operational waste generated by the Project will form additional loads to existing waste infrastructure and utilities; however, will also reduce the load on waste management facilities in the Dubai Emirate. Impacts of operational waste (including bottom ash and flue gas treatment residue), if not properly managed, are similar to construction waste impacts.
Proposed Management	• Implement waste management system to include waste minimisation, reuse, recycle and appropriate disposal. • Provide spill kits and fire extinguishers • Provide training and personal protective equipment (PPE) for workers for proper handling, storage and disposal of wastes	• Manage waste deliverables and unloading areas • Maintenance of waste bunkers and receiving areas • Maintenance of leachate collection system • Establish a comprehensive waste management system • Provide suitable waste storage facilities • Train workers on the waste management requirements
Proposed Monitoring Programme	• Daily visual inspection of waste storage facilities • Maintain waste registers	• Daily visual inspection of waste storage facilities • Maintain waste registers
Residual Impact	Waste generation cannot be wholly avoided nor will waste be entirely recycled or reused. However, with	There will be a net positive impact from the operation of WtE plant because of the overall reduction of waste disposed to the landfill.

Waste Management Assessment		
EIA Component	Construction Phase	Operation Phase
	proper handling and disposal, there should be minimal residual impact.	

Landscape and Visual Amenity

A roadway borders the site to the north, such that there is about 300 to 400 m of separation from the proposed plant to the residential area (i.e. Residential Villas at Desert Palm Polo Club). Southerly facing view shows exiting power plant (i.e. DEWA) stacks beyond the site limits. Easterly facing view shows industrial sites beyond the project site. Westerly facing view show Dubai Textile City beyond Al Aweer STP and sludge disposal.

Landscape and Visual Amenity Assessment	
EIA Component	Construction / Operation Phase
Impact Assessment	Potential visual impacts associated with the Project include increase in the number of trucks transporting construction materials (during construction phase) and waste (operation phase). Increased in dust levels associated with the increased vehicle movement is also anticipated. Visual impact to the residential villa to the north of the site within Desert Palm Polo Club are anticipated to be minimal given the existing landscape screening.
Proposed Management	• Implement traffic management plan • Implement dust management plan • Implement the following measures to ensure impacts on visual amenity is mitigated: – Colours and similar cladding harmonized with the adjacent industrial sites – Maintenance of exterior facades of the building – Landscaping around the WtE plant
Proposed Monitoring Programme	Not applicable
Residual Impact	Residual impact is not anticipated

Land Use

The existing site is operational as a vehicle storage area and there are no receptors within the site footprint. According to DM Planning Department (2012), the Project site is categorised as Area 2 (Metropolitan Area) or areas where ongoing, onhold or deferred mega projects are planned. As detailed in Dubai 2020 Urban Masterplan (DM Planning Department, 2012), the Project site is classified under *'land for future development subject to environmental investigations and detail studies'*.

Based on existing land use, majority of the areas adjacent the Project site are industrial and commercial facilities. A number of residential, institutional and resource/attraction areas are also found surrounding the Project site. The nearest residential and resource / attraction areas are found around 300 to 400 m north of the site.

Land Use Assessment	
EIA Component	Construction / Operation Phase
Impact Assessment	The proposed WtE plant is not anticipated to have any impact on land use and is consistent with the land use classification. The classification of the site as *'land for future development subject to environmental investigation and detail studies'* is satisfied through the preparation of this EIA report. Therefore, based on existing land use and future land use development according to DM Planning Department (2012), no impacts are anticipated in terms of conflict in land use.
Proposed Management	Mitigation measure is not required as impacts on land use is negligible.
Proposed Monitoring Programme	Not applicable
Residual Impact	Not applicable

Protected Areas

The nearest protected area is the Al Wohoosh Desert Conservation Reserve located approximately 20 km east of the site.

Protected Areas Assessment	
EIA Component	Construction / Operation Phase
Impact Assessment	The Project is located around 20 km east of a designated protected area; as such, encroachment of the Project is not anticipated. Further, environmental and social impacts (e.g. air emission, noise generation) generated during the construction and operation phases is not anticipated to impact the protected areas.
Proposed Management	Mitigation measure is not required as impacts on protected areas is negligible.

Protected Areas Assessment	
EIA Component	Construction / Operation Phase
Proposed Monitoring Programme	Not applicable
Residual Impact	Not applicable

Socio-economic

In 2016, the population of the Emirate of Dubai was approximately 2.97 million (Dubai Statistics Center, 2017). Around 91.76% of the population comprises expatriates while the remaining 8.23% are Emiratis. The Project site is located in Warsan 2, Dubai (Sector 5), which had a population of 764 at the end of 2017 equivalent to 0.02% of Dubai's population. At the end of 2017, Dubai's population consisted predominantly of males (70.18%); about 58.46% are concentrated in the 25–44 age bracket; and total dependency ratio of 19%. Economic indicators show that majority of the workforce is male, while the education indicaor shows a very high literacy rate (97.4% in 2015) and good health and living condition indicators.

The Dubai Economic Profile (Department of Economic Development - Dubai (DED) 2016) shows that the Emirate of Dubai accounts for 30% of the UAE's total GDP. Since 2014, Dubai's GDP increased by 0.3% resulting in a growth rate of 4.1% in 2015 (DED, 2016). In 2016, the real GDP growth rate was 2.9% as opposed to 4.1% in 2015 (DED, 2017). Stimulant policies applied by the Federal Government and the Government of Dubai contributed in boosting the economy, and hence, the continuation of growth in all sectors (DED, 2017).

In 2016, the wholesale, retail and repairing services sector (27.6%) has been contributing the most to Dubai's GDP followed by transport sector (11.6%), financial activities (10.6%), while real estate and construction added 6.6% and 6.4%, respectively (DED, 2017).

Socio-Economic Assessment		
EIA Component	Construction Phase	Operation Phase
Impact Assessment	*Socio-economic impacts:* The peak of the construction is anticipated to employ approximately 2000 workers. The Project will generate demand for construction materials that can be acquired from local areas in the UAE thereby contributing to overall economic growth of Dubai. *Impacts on workers:* Workforce will be provided with labour accommodation. The workers and staff members could be exposed to various	*Socio-economic impacts:* Provision of long-term employment opportunities to local Emiratis and migrant workers is considered to be a beneficial direct impact. The operation of the WtE plant is anticipated to reduce Dubai's reliance on imported energy supply from the Emirate of Abu Dhabi. *Impacts on workers:* The operation and maintenance of the WtE plant has associated occupational

Socio-Economic Assessment		
EIA Component	Construction Phase	Operation Phase
	occupational and safety hazards, which are inherent to construction works. Migrant workers may be exposed to adverse working and living conditions *Conflict with community:* Workers will most likely be migrants and increase in population may have adverse impact on the local community if not adequately managed.	health and safety risks, which include exposure to air emissions, noise and heat, electrical hazards, among others. Workers will be provided with labour accommodation. Migrant workers may be exposed to adverse working and living conditions
Proposed Management	*Enhancement measures for positive impacts:* • Priority given to local workforce and local companies • Just and fair compensation to workers • Regular monitoring will be undertaken to ensure that rights of workers are protected *Mitigation measues for potential adverse impacts:* • Appointment of community liaison officer (or similar) to maintain good relationship with the community and other stakeholders • Develop grievance management procedure and ensure that all complaints are addressed • To minimise the impacts associated with the influx of additional foreign / expatriate workers, the Project should utilise the workforce currently and readily available in Dubai • Induction training will be provided to foreign workers to include understanding and respecting culture and religion in the UAE • Compliance with local and international labour and working condition guidelines • Compliance with local and international labour accommodation guidelines • Develop and implement Occupational Health and Safety Plan (OHSP)	
Proposed Monitoring Programme	• Construction labour monitoring procedures (observation of work and living sites, interviews with workers and management, review of employers' systems and documents i.e. time keeping and payment) • Review of grievance registration log	
Residual Impact	There will be a net positive impact from the Project construction activities through the provision of employment and business opportunities as well as simulations of the local and regional economy.	With the completion and operation of the Project, reliance on fossil fuel and imported energy (from Abu Dhabi Emirate) will be reduced, improving long-term revenues in the Emirate of Dubai.

Public Health

Health indicators show a very good health and living conditions in the Emirate of Dubai. Based on the record of Dubai Health Authority (cited in DSC, 2016), the leading causes of morbidity in 2016 is chickenpox (38%) followed by pneumonia (13%).

Public Health Assessment		
EIA Component	Construction Phase	Operation Phase
Impact Assessment	Increased community and occupational health and safety risk (air emission, noise, waste generation and increased traffic).	
Proposed Management	• Implement environmental management measures (air and noise control measures) • Implement occupational and community health & safety plan • Implement traffic management plan • Implement grievance mechanism to address community complaints (if any)	
Proposed Monitoring Programme	• Air quality (dust), odour and noise monitoring (refer to the tables above) • Daily occupational health and safety inspections	
Residual Impact	Residual impact is not anticipated	

Archaeology and Cultural Resources

The proposed WtE plant will be located in a disturbed environment surrounded by industrial and commercial (i.e. warehouse and stores) facilities. All the archaeological and cultural resources identified by the Government of Dubai, represented by Dubai Culture, are considerably distant from the WtE plant.

Archaeology and Cultural Resources Assessment		
EIA Component	Construction Phase	Operation Phase
Impact Assessment	All the archaeological and cultural resources are considerably distant from the WtE plant and are not anticipated to be affected during the construction and operation of the Project.	
Proposed Management	No mitigation is required since the Project is not likely to have any impact on archaeological and cultural resources. Nonetheless, the Proponent will report any accidental findings to the relevant authorities (e.g. DM-Architectural Heritage and Antiquities Department, AHAD). Chance find procedures will therefore be developed and included in construction and operations management plans in case of chance findings of archaeological and cultural significance.	
Proposed Monitoring Programme	Not applicable	
Residual Impact	Not applicable	

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Appendices

Acronyms and Abbreviation

AAQM	Ambient Air Quality Monitoring
AAQS	Ambient Air Quality Standards
ACC	Air Cooled Condenser
ACF	Activated Carbon Filters
ACES	Arab Center for Engineering Studies
AD	Anaerobic Digestion
Al	Aluminium
As	Arsenic
B	Boron
Be	Beryllium
Ba	Barium
BAT	Best Available Technique
BESIX	NV Besix SA
BOT	Build Operate and Transfer
Ca	Calcium
CAIT	Climate Analysis Indicators Tool
Cd	Cadmium
CEMP	Construction Environmental Management Plan
C&D	Construction and Demolition
CBD	Convention on Biological Diversity
CCW	Close unit cooling water system
CEMS	Continuous Emission Monitoring System
Cl	Chloride
CO	Carbon Monoxide
CO_2	Carbon Dioxide
Co	Cobalt
CH_4	Methane
CN	Cyanide
CPT	Cone penetration tests
Cr	Chromium
CSP	Concentrated Solar Power
Cu	Copper
DAC	Dubai Accredited Center
DEWA	Dubai Electricity and Water Authority
DIAC	Dubai International Academic City
DIES	Dubai Integrated Energy Strategy
DIC	Dubai International City
DD	Data deficient
DL	Detection Level
DM	Dubai Municipality
DM-ED	Dubai Municipality Environment Department
DM-WMD	Dubai Municipality Waste Management Department
DSC	Dubai Statistics Center
DSCE	Dubai Supreme Council of Energy
DWC	Al Maktoum International Airport
DXB	Dubai International Airport
EDI	Electro-Deionization
ECS	Environmental Control Section
EF	Emission Factor
EfW	Energy-from-Waste
EHS	Environmental Health and Safety
EHSMS	Environmental Health and Safety Management System
EIA	Environmental Impact Assessment
EP	Equator Principles
EPC	Engineering, Procurement and Construction
EPAP	Equator Principles Action Plan
EPFI	Equator Principles Financial Institutions
ERA	Environmental Risk Assessment
EMMP	Environmental Management and Monitoring Programe
ESMS	Environmental and Social Management System
EU	European Union

Fe	Iron
FGT	Flue Gas Treatment
GCB	Generator Circuit Breaker
GCC	Gulf Cooperation Council
GDP	Gross Domestic Product
GHD	GHD Global Pty Ltd
GHG	Greenhouse Gas
GIS	Geographic Information System
GLC	Ground Level Concentrations
GPS	Global Positioning System
GWh	Gigawatt hour
GWP	Global Warming Potential
HCl	Hydrochloric Acid
HCM	Highway Capacity Manual
HF	Hydrogen Fluoride
HHRA	Human Health Risk Assessor
HIA	Health Impact Assessment
Hg	Mercury
HPW	High Purity Water
HSE	Health, Safety and Environment
HVS	High volume samplers
HZI	Hitachi Zosen Inova
IBA	Incineration Bottom Ash
IED	Industrial Emissions Directive
IEMA	Institute of Environmental Management and Assessment
IFC	International Finance Corporation
IoA	Institute of Acoustics
IP	Indigenous Peoples
IPCC	Intergovernmental Panel on Climate Change
IPP	Independent Power Producer
IUCN	International Union for Conservation of Nature
K	Potassium
KPI	Key Performance Indicator
kV	Kilovolts
LOAEL	Lowest Observed Adverse Effect Level
MCA	Multi Component Analyser
MBT	Mechanical Biological Treatment
MDL	Minimum detection limits
Mo	Molybdenum
MOE	Ministry of Energy
MOEW	Ministry of Environment and Water
MOHRE	Ministry of Human Resources and Emiratisation
Mg	Magnesium
Mn	Manganese
MRL	Minimal Risk Level
MRF	Material Recovery Facility
MSW	Municipal Solid Waste
MW	Megawatt
Na	Sodium
NAAQS	National Ambient Air Quality Standard
Ni	Nickel
N_2	Nitrogen
N_2O	Nitrous oxide
NCV	Net Calorific Value
NOC	No Objection Certificate
NOx	Nitrogen Oxide
NQM	Noise Quality Monitoring
NSW AMMAAP	Approved Methods for the Modelling and Assessment of Air Pollutants in New South Wales
NSW EPA	New South Wales Environment Protection Authority
NR	Negligible Risk
O_2	Oxygen
O&G	Oil and Grease
OCC	Old corrugated containers
ODS	Ozone Depleting Substances
OEP	Operational Emergency Plan

OEMP	Operational Environmental Management Plan
OHSP	Occupational Health and Safety Plan
Pb	Lead
PCDD	Polychlorinated dibenzo-p-dioxins
PCDF	Polychlorinated dibenzofurans
PO_4	Phosphate-Phorphorus
PD	Project Director
PM	Project Manager
PM	Particulate Matter
POP	Persistent organic pollutant
PPE	Personal protective equipment
PUF	poly-urethane foam
R&D	Research and Development
RDF	Refuse-derived Fuel
RO	Reverse Osmosis
S_2	Sulphide
SF_6	Sulphur hexaflouride
S&P	Standard & Poor
Sb	Antimony
SEP	Stakeholder Engagement Plan
SF_6	Sulphur hexafluoride
SIA	Social Impact Assessment
SNCR	Selective Non-Catalytic Reduction
SO_2	Sulphur Dioxide
SO_3	Sulphur Trioxide
SOP	Standard Operation Procedure
SoW	Scope of Work
SPV	Special Project Vehicle
STP	Sewage Treatment Plan
TCDD	Tetrachlorodibenzo-p-dioxin (Dioxin and Furan)
TEF	Total Equivalent Factor
TEQ	Total Equivalent Value
TIS	Traffic Impact Study
TOC	Total Organic Carbon
TSE	Treated sewage effluent
TSP	Total Suspended Particulates
UAE	United Arab Emirates
UF	Ultrafiltration
UNEP	United Nations Environment Programme
UPS	Uninterrupted Power Supply
US EPA	United States Environmental Protection Agency
VOC	Total Volatile Organic Compounds
WB	World Bank
WHO	World Health Organization
WMC	Waste Management Center
WtE plant	Waste to Energy
WTP	Water Treatment Plant
WMMP	Waste Management Master Plan
WMD	Waste Management Department
WWTP	Wastewater Treatment Plant
Zn	Zinc

Units and Variables

µg/m^3)	Micrograms (one-millionth of a gram) per cubic meter
°C	degrees Celsius
%	Percent
CO_2-e	Carbon dioxide equivalent
dBA	Decibels adjusted.
GW	Gigawatt
kg/t	kilogram per tonne
km^2	square kilometer
kV	Kilovolts
kWh	Kilowatt hour
kW/t	kilowatt per tonne
ha	hectare
m	meter
mm	millimeter
m^2	square meter
m^3	cubic meter
m^3/d	cubic meter per day
m^3/h	cubic meter per hour
m^3/yr	cubic meter per year
mbgl	meters below ground level
mg/Nm^3	milligrams per cubic meter
MJ/kg	megajoules per kilogram
tpa	tonnes per annum
tpd	tonnes per day
tph	tonnes per hour
TWh	terawatt hours

1. Introduction

1.1 Project Overview

As the Project Proponent, Dubai Municipality (DM) proposes the development of the Dubai Waste Management Center (WMC), a proposed Waste-to-Energy Plant (WtE plant), (Project) at the existing DM vehicle storage site in Warsan, Dubai, United Arab Emirates, specifically Warsan 2.

The proposed WtE plant is considered by the DM to be an outcome of the 2013 Strategic Integrated Waste Management Plan (Master Plan), in an effort to efficiently achieve sustainability initiatives in line with the Dubai Strategic Plan 2021, UAE National Agenda 2021 and Dubai Integrated Energy Strategy 2030 (DIES).

The proposed WtE plant will treat about 1,888,000 tonnes of municipal solid waste (MSW) per year, with an estimated nominal design capacity of 5,666 tonnes per day (tpd) at 9.5 MJ/kg net calorific value (NCV), to generate an average net power output of 193 MW of electricity to the local grid and resulting in power to about 135,000 homes.

Under contract with the Project Proponent, Hitachi Zosen Inova (HZI), a global leader in Energy-from-Waste (EfW) technology, NV Besix SA, Sharjah branch (BESIX), a Belgian construction company, and Itochu Corporation (Itochu), a Japanese company, formed a partnership to build, operate and transfer (BOT) the WtE plant after 35 years. The contract is shared between a Special Project Vehicle (SPV) and Engineering, Procurement and Construction (EPC) partnership.

HZI commissioned GHD Global Pty Ltd (GHD) as the Project environmental consultant to undertake the Environmental Impact Assessment (EIA) and prepare documentation to support applications for environmental clearance for the proposed Project.

The original Environmental Impact Assessment Report (EIAR) Rev 2 was submitted on 14 February 2019 (Ref. No. EPBI-121118-00005) and was re-submitted on 19 May 2019 (Ref. No. EPBI-200519-00125). A Preliminary Environmental Approval (PEA) was issued by the Dubai Municipality-Environment Department (DM-ED) on 20 May 2019 (Ref. No. EPBI-200519-00125) and valid until 18 May 2020.However, it was cancelled on 17 July 2019 (EPBI/200519-00125) and a revised EIAR Rev 4 is submitted on 3 October 2019 to present the following modifications to the Project:

- Design improvement
- 12 weeks Incinerated Bottom Ash (IBA) maturation
- Covered IBA Maturation Area
- Mobile waste shredder
- Installation of 132kV underground Cable and connection to DM STP substation

An Environmental Clearance (EC Ref. No. EPBI-090719-00145) was issued by DM-ED on 13 October 2019 for EIAR Rev 4.

On 19 February 2020, the Project Company requested a re-submission of EIAR Rev 5 to incorporate the conditions of the EC into the report. DM-ED issued a number of clarifications. This EIAR Rev 6 addresses the comments of DM-ED and submitted for approval.

1.2 Project Title and Project Proponent

1.2.1 Project Proponent

The details of the key point of contact at the Dubai Municipality are provided in Table 1-1.

Table 1-1 Project proponent details

Proponent	Dubai Municipality
Address	Dubai Municipality Headquarters
Telephone Number	+971 4 206 3131
Contact Person	Talib Abdulkareem Julfar
Email Address	TAMOHAMMED@dm.gov.ae

1.2.2 Development Partnership

The Proponent commissioned the partnership between HZI, BESIX and Itochu. The details of key contacts are provided in Table 1-2.

Table 1-2 EPC Contractor Details

Company Name	Hitachi Zosen Inova AG (HZI)
Abu Dhabi Business Center Commercial License No.	CN-2402965
Address	Branch Office Abu Dhabi Bin Hamoodah Tower, 9th Floor Office 904 Khalifa Street, PO Box 43199 Abu Dhabi, United Arab Emirates
Telephone Number	+971 2 626 0984
Facsimile Number	+971 2 627 6181
Contact Person	Mr. Roni Araiji Managing Director
Company Name	BESIX Group
Sharjah Economic Development Department License No.	531313
Address	11A Street Al Quoz 3 Dubai, United Arab Emirates
Telephone Number	+971 4 509 2222
Facsimile Number	+971 4 347 3512
Contact Person	Mr. Nico De Koning Bid Manager
Company Name	Itochu Corporation
JAFZA General Trading License	3369
Address	TOKAC Section

	5-1, Kita-Aoyama 2-chome, Minato-ku Tokyo 107-8077 Japan
Telephone Number	+81 3 3497 3120
Facsimile Number	+81 3 3497 4138
Contact Person	Yu Tanaka Project Leader Water & Environment Project Section

1.3 Project Rationale

The following general project introduction was prepared by DM for the Project (Request for Prequalification, *Project No. GS 002, Engineering, Procurement & Construction related to The Waste to Energy Project, Works Description & Pre-Qualification Criteria*, announcement date 12 May 2015):

> *Dubai is making great strides in the field of sustainability in line with the Dubai Strategic Plan 2021, UAE National Agenda 2021 and Dubai Integrated Energy Strategy 2030. These strategic plans aim to protect the environment and ensure sustainable development through various projects and initiatives for conservation of natural resources, rationalized consumption and inclusion of alternate and renewable energy resources to Dubai‟s energy mix*
>
> *In accordance with the objectives envisaged hereunder, Dubai Municipality is keen to strengthen the national as well as emirate's efforts to achieve the targets for minimizing the municipal wastes disposed in landfills and for developing alternate energy sources through prompt implementation of projects for the sustainable management of wastes, energy and environment. In all its endeavors related to waste to energy, Dubai Municipality partners with the Dubai Electricity & Water Authority (DEWA) and Dubai Supreme Council of Energy (DSCE).*
>
> *All of the electricity generated from this project after meeting its own power requirement will be fed into the DEWA Grid. The project thus have a high significance in contributing to the scaling up of sustainable energy solutions not only achieving reduction in landfill requirements, carbon footprint, impacts of climate change etc. but also offering various other environmental benefits.*
>
> *Dubai Municipality's core vision is "Creating an excellent city that provides the essence of success and comfort of sustainable living". This vision is underpinned by the key strategic directive "Ensuring a clean and sustainable environment in the Emirate of Dubai". To achieve this objective, Dubai Municipality (DM) has developed and adopted an Integrated Waste Management Master Plan (WMMP) for the Emirate of Dubai. The WMMP provides the roadmap and approach required to efficiently manage wastes generated from the Emirates.*
>
> *The Waste Management Department (WMD) of DM has the responsibility for management of waste generated in the Emirate of Dubai. This includes collection, treatment and disposal of wastes generated. Waste generated in Dubai is mainly classified based on its source and the predominant disposal method. This includes Municipal solid wastes, Construction and demolition wastes, Horticultural wastes, Hazardous wastes, Medical wastes, Tyres and Sewage sludge.*

In line with the UAE National Agenda 2021, Dubai Strategic Plan 2021, Dubai Integrated Energy Strategy (DIES) 2030 and the Strategic Integrated Master Plan for Solid Waste, the Project reflects the importance of accommodating a viable and efficient solution to achieve targets set for these plans and strategies.

In line with the UAE Vision 2021 National Agenda of diversifying energy mix and the growing energy demand, the country is forming a strategy to slow the growth in energy consumption and diversify supply sources (e.g. nuclear power, renewable energy, liquefied natural gas). This strategy will support the country to reduce its reliance on fossil fuels and meet the demand of rising energy (Ministry of Energy, 2015).

According to the Ministry of Energy (2015), the UAE's demand for energy grows by 9% annually in line with the growth of population. Dubai electricity consumption has increased by 5% in 2017 (45,162 GWh) compared to 43,093 GWh in 2016. Power demand projection has been conducted by DEWA reflecting the increase in available power capacity up to 2030 as shown in Figure 1-1 (DEWA, 2016).

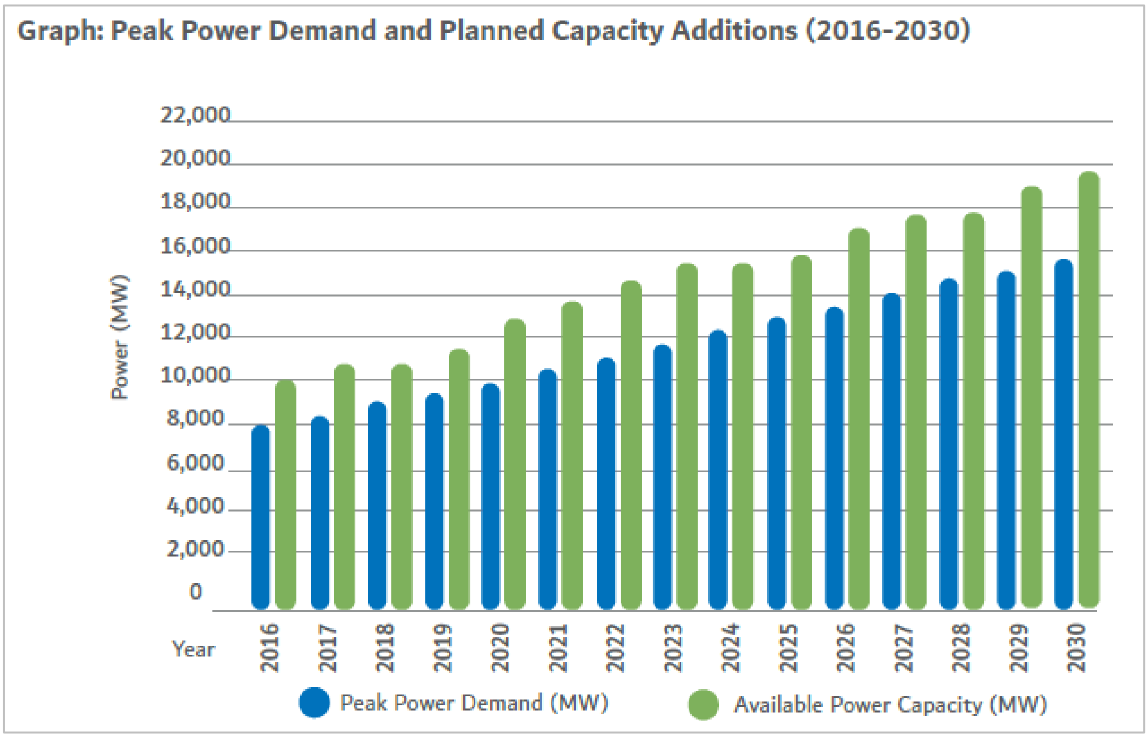


Figure 1-1 Power demand and planned capacity projection (2016 - 2030)

Source: DEWA Sustainability Report 2016

Consistent with the vision of the UAE towards integrated waste management and energy diversification in Dubai, the integrated strategic waste management master plan provides a roadmap for sustainable waste management practices in the Emirate of Dubai up to 2030 and Key Performance Indicators (KPIs) have been developed to drive the process of the waste management system strategy. These KPIs have been developed by the waste hierarchy and sustainable development background, which are:

- Minimising wastes
- Maximising environmentally sound waste reuse and recycling
- Promoting environmentally sound waste disposal and treatment
- Extending waste service coverage

This strategy could be achieved by improving air quality, preserving water resources, increasing the use of clean energy and implementing green growth plans. One of the indicators to achieve the vision is to produce clearner energy by increasing the percentage of treated waste via various treatment methods such as the use of WtE plant.

A stable energy supply is anticipated to foster continued economic stability and growth in the country and the surrounding areas. As such, the Project is considered by the proponent to be in line with addressing the following overarching goals:

- In line with 2050 Energy Strategy in investing in diversifying energy sources (solar, nuclear , waste to energy and wind)
- Assist the Emirate of Dubai reach its 98% landfill diversion target by 2030 (Mott MacDonald, 2013)
- Support the goal of UAE Vision 2021 and existing regulations (Table 1-3)
- Create business and job opportunities
- Encourage technology development by using renewable energy sources

Table 1-3 UAE Policy Framework in relation to WtE plant

	Index	UAE Vision 2021 Indicator [1]	Dubai Recovery Facility WtE Plant Contribution to 2021 Indicator
UAE Vision 2021	1	Air Quality Index	• Avoid methane emission from landfills: – Emissions avoided by not sending waste to landfill = 2400 kt CO_2-e annually • Continuing to landfill waste would be expected to result in higher levels of carbon dioxide (CO_2) and methane (CH_4) emissions contributing to greenhouse gas (GHG) emissions and ozone depletion, leading to climate change
	2	Percentage of treated waste out of total waste generated	• The Project will assist Dubai reach its 90% landfill diversion by 2030 • The Project will reduce land requirements for new or expanded landfill areas – landfill operations would generate community health and safety impacts
	3	Share of clean energy contribution	• The Project will help reduce the country's reliance on fossil fuels • The Project will contribute in producing clean energy • Emissions avoided by generating electricity from waste = 620 kt CO_2-e annually
	5	Share of UAE national in the workforce	• Employment of UAE nationals in addition to the experts in the field of waste management – assuring their professional development
	7	Emiratization rate in the private sector	• Use of Best Available Technique (BAT) and leading technologies developed by HZI, a global leader in waste-to-energy technology.

	Index	UAE Vision 2021 Indicator [1]	Dubai Recovery Facility WtE Plant Contribution to 2021 Indicator
	10	Global Innovation Index	• Avoid methane emission from landfills: – Emissions avoided by not sending waste to landfill = 2400 kt CO_2-e annually • Continuing to landfill waste would be expected to result in higher levels of carbon dioxide (CO_2) and methane (CH_4) emissions contributing to greenhouse gas (GHG) emissions and ozone depletion, leading to climate change
Federal Laws [2]	• Federal Law No. 2 of 1998 for Water and Electricity • Federal Law No. 24 of 1999 for the Protection and Development of the Environment • Executive Order of Federal Law No. 24 for Regulation in Handling Hazardous Materials, Hazardous Wastes and Medical Wastes • Federal Cabinet Decision 37 of 2001 – Environmental Protection Executive Regulations		

1 – www.vision2021.ae Sustainable Environment and Infrastructure Pillar
2 – Relevance of these laws and how it applies to the Project is provided in Chapter 3

1.4 Project Alternatives

This section discusses the project alternatives considered in determining the preferred Project concept defined in Section 4 (Project Description).

1.4.1 No Project Scenario

The Strategic Integrated Plan for Solid Waste Master Plan (Mott MacDonald, 2013) helped to clarify the two main objectives under waste management which are related to achieveing “integrated” waste management and, in general, to maintain the cleanliness of all areas within the Emirate of Dubai. The 2013 master plan outlined three options that were considered for waste management depending on population growth through 2030.

Master Plan Option 1 – Master Plan solution

Various types of waste treatment aimed at different years of operation such as source segregation, composting, Materials Recovery Facility (MRF), Anaerobic Digestion (AD) and Mechanical Biological Treatment (MBT).

Master Plan Option 2 - Energy from Waste (EfW)

All the waste treated at an EfW facility and the only byproduct would be the bottom ash. The concern with this option had been relative to economic viability. The 2013 Master Plan concluded that this option was considered economically unsustainable.

Master Plan Option 3 – Landfill

Also shows “do nothing” scenario, which assumes recycled materials will be in an un-centralised scheme and all the rest of the waste will end up at the landfill only, with minimal recycling. The plan notes that, “*In the long-term, the ‘do nothing scenario’ would require more than three times the landfill capacity than the ‘EfW’ scenario and over three and half times more than the Master*

Plan solution by 2030." The 2013 Master Plan concluded that this option was unsustainable in terms of landfill capacity.

The 'No Project' scenario or "do nothing" has a number of advantages and disadvantages outlined in Table 1-4. This option allows for the potential community health and safety issues (e.g. emission of air pollutants, increased noise, and traffic impact) on the nearby sensitive receptors to be avoided. The "No Project" scenario will not support Dubai to achieve the UAE National Agenda 2021 target and DM objectives related to waste management.

The advantages of building the Project outweighs the advantages of a 'No Project' scenario. With the Project, the goal of the Master Plan in diverting 98% of solid waste from landfill by 2030 would be achieved. Another advantage includes the country's reduction in its reliance on fossil fuels. The potential adverse impacts in terms of community health and safety brought about by the WtE plant can be mitigated through the installation of engineered environmental controls (e.g. flue gas treatment described in Section 4) and development of environmental management measures (defined in Section 7).

Table 1-4 Advantages and disadvantages of a 'No Project' scenario

Advantages	Disadvantages
Potential impacts on community health and safety (e.g. traffic) during delivery of materials will be avoided	Increased land requirements for new or expanded landfill areas. Landfill operations would generate community health and safety impacts.
Potential emission of air pollutants and increased noise during operation will be avoided	The goal of UAE Vision 2021 of diverting 75% solid waste from landfills into energy may not be achieved without implementation of the project
	Failing to achieve Dubai Emirate goal of 98% landfill diversion by 2030
	Depleting natural gas reserves in the country by not allowing for the development of alternative waste management strategies for energy diversification
Allows for alternative integrated waste management facilities to be pursued, or improvements made to new landfill cells	Continuing to landfill waste would be expected to result in higher levels of Carbon Dioxide (CO_2) and Methane (CH_4) emissions, contributing to greenhouse gas (GHG) emissions and ozone depletion, leading to climate change.

1.4.2 Project Site Alternatives

The project site selection was considered for the following reasons:

- Proximity to existing Warsan Landfill, which has minimal impact in transporting waste routed to the WtE plant
- Proximity to high voltage transmission line for connection to the grid, coordinated with DEWA
- Adjacency with other significant industrial installations and commercial uses such as the Al Aweer Sewage Treatment Plant (STP) and the existing concrete producing facilities
- Availability of suitable sized land

- Land ownership by DM and ability to relocate the existing vehicle storage area to alternative location
- Stable peace and order situation
- The area is an industrial zone and the Project is compatible with the existing land use
- Separation of the plant from residential facilities, but suitable proximity to avoid costly impacts due to energy distribution and grid transmission over a long distance

1.4.3 Technology Alternatives

In 2016 Fichtner, as the technical adviser of DM, defined the grate combustion technology and Industrial Emission Directive (IED) 2010/75/EU as the basis for the design compliance. Therefore, the design of the WtE plant is based on IED 2010/75/EU.

1.5 The Need for an EIA Report

This EIA was developed to identify and assess the potential environmental and social impacts of the proposed Project and facilitate that the Project complies with relevant local, federal and international standards, specifically the Equator Principle, International Finance Corporation (IFC) Performance Standards, World Bank Group Environmental Health and Safety (EHS) Guidelines. The requirements of these standards and guidelines are further detailed in Section 3.

This EIA was prepared to support obtaining permits required by the local authorities (e.g. Dubai Muncipality) for the Project. As such, the EIA was developed to meet the following objectives:

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

1.6 Structure of the EIA Report

This report presents the detailed findings of the environmental and social investigations and assessments undertaken for the Project and has the following structure with supporting appendices:

- Executive Summary
- Section 1 – Introduction
- Section 2 – Description of the Project’s EIA Process

- Section 3 – Reference Laws, Regulations, and Standards
- Section 4 – Description of the Project
- Section 5 – Description of the Environment
- Section 6 – Assessment of Environmental Impacts
- Section 7 – Mitigation Measures and Enhancement Plan
- Section 8 – Environmental Management and Monitoring Program
- Section 9 – Conclusions and General Recommendations
- Section 10 – Statement of Commitment
- Section 11 - References

1.7 EIA Review Chronology

No.	Description	Method	Date
1	Attempted submission of Scope of Work Report (Rev 0) to EPSS, denied due to requested additional documents to be submitted (i.e. Project Affection Plan, Valid DED license of Project Contractor[2])	In person	06 May 2018
2	Attempted submission of Scope of Work Report (Rev 0) to EPSS, denied at time of submission because lacking a current site Affection Plan (Attempt 2)	In person	13 May 2018
3	Request for updated Affection Plan from the DM	Email	13 May 2018
4	Receipt of an Affection Plan from the DM	Email	17 May 2018
5	Email from Eng. Saif regarding direction to proceed with the EIA study and to later submit the site/plot plan with the number 622-146	Email	16 May 2018
6	Attempted submission of Scope of Work Report (Rev 0) to EPSS, denied at time of submission because EPSS indicating no review needed for a DM-sponsored project (Attempt 3)	In person	17 May 2018
7	Acknowledgement by DM that Scope of Work Report can be submitted for review in line with international requirements for the Scoping Study approval by the regulatory authority	n/a	21 May 2018
8	Submission of Scope of Work Report (Rev 0) to EPSS (Attempt 4, completed)	In person	22 May 2018
9	Receipt of DM-EPSS Comments (by email)	By email	06 June 2018
10	Meeting with SPV to discuss comment resolution	In person	11 June 2018
11	GHD Summary of Preliminary Comment Resolution	By email	14 June 2018

[2] Note: In previous Projects with DM-ED, these documents were submitted along with the EIA Report.

No.	Description	Method	Date
12	Comment Resolution Meeting with EPSS	In person	19 June 2018
13	Comment Resolution Meeting with SPV and EPC	In person	21 June 2018
14	Agreement regarding comment resolution for comments by DM-EPSS dated 04 June 2018	By email	04 July 2018
15	Submission of Final Comment Resolution Sheet to EPSS	In person	09 July 2018
16	Submission of Scope of Work Report (Rev 1) to EPSS	In person	17 July 2018
17	Submission of additional documents for SoW Report to EPSS	By email	26 July 2018
18	Letter of Conditional Approval received from DM-ED	By email	09 August 2018
19	Submission of ESIA Rev 0 (EPBI-121118-00005)	Via DM online portal	12 Nov 2018
20	Received DM-EPSS comments		06 Dec 2018
21	Submisison of ESIA Rev 1		12 Dec 2018
22	Received DM-EPSS comments		23 Dec 2018
23	Submission of ESIA Rev 2		14 Feb 2019
24	Dubai Municipality, Project Company and GHD discussion	In person	06 March to 16 May 2019
25	Preliminary Environmental Approval (PEA) received from DM-ED (EPBI-200519-00125)	Via DM online portal	20 May 2019
26	Submission of ESIA Rev 3	Via DM online portal	09 July 2019
27	GHD letter of proposed changes to EPBI-200519-00125	By email	27 June 2019
28	DM-ED Letter No. EPSS/L/2019/096 - cancellation of PEA (EPBI-200519-00125)	By email	17 July 2019
29	EPBI/090719-00145 Amendment Request Comments	Via DM online portal	18 July 2019
30	Submission of ESIA Rev 4	Via DM online portal	03 Oct 2019
31	Environmental Clearance received (EPBI-090719-00145)	Via DM online portal	13 Oct 2019

No.	Description	Method	Date
32	Submission of GHD clarification letter	By email	08 Dec 2019
33	Dubai Municipality and GHD discussion on EPBI-090719-00145	In person	30 Dec 2019
34	Submission of EIAR Rev 5 (EPBI-190220-00228)	Via DM online portal	19 Feb 2020
35	Received DM-EPSS comments		27 Feb 2020
36	Submission of EIAR Rev 6		08 June 2020

2. Description of the Project's EIA Process

2.1 EIA Scope of Work

2.1.1 Technical Requirements

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

Local Requirements

Considering the nature and scale of the proposed Project, it is considered that an EIA is required[3]. As such, this EIA was prepared consistent with the requirements of the following documents:

- DM-ED Technical Guideline (TG) No. 1 – Environmental Impact Assessment (March 2019)
- DM-ED Technical Guideline (TG) No. 2 – EIA Requirements for Land Development, Infrastructure and Utility Projects (March 2019)
- Scope of Work (SoW) Report for the Project EIA (GHD, 2018) (Appendix E) (as approved by DM-ED)

International Requirements

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

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

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

Under definition provided in Table 2-1, the Project is classified as Category A as it may have potential significant adverse environmental and social risks and/or impacts that are diverse, irreversible and/or unprecedented. However, the impacts associated with the Project can be mitigated through appropriate environmental and social management and monitoring measures, presented in this EIA and provided in detail in the environmental management and monitoring programme (EMMP).

[3] As per DM-EPSS Technical Guideline Number 1: Environmental Imapct Assessment dated March 2014.

Table 2-1 Project categories

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

Source: Equator Principles 2013

2.1.2 EIA Scope

The scope of the EIA will cover:

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

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

- Air Quality
- Noise
- Water resources (reuse)
- Subsurface soils
- Water quality (surface waters and groundwater)
- Waste management
- Traffic
- Socio-economic and health

The proposed Project will be located within a previously disturbed and cleared industrial area; as such, significant impacts are not considered on the aspects listed below. Nevertheless, these aspects are addressed at a high level in the EIA report:

- Climate and meteorology
- Geology and seismicity
- Biodiversity and conservation
- Land use and visual amenity

- Archaeology and cultural resources

The Project is located approximately 20 kilometres (km) away from the coastal area of Dubai within a terrestrial environment. An assessment of impacts on marine ecosystems is excluded from the scope.

2.2 EIA Team

2.2.1 Environmental Consultant

GHD was appointed as environmental consultant for the Project. This EIA has been undertaken and prepared by GHD on behalf of the SPV, partnership between HZI, Besix and Itochu. The contact details for GHD are provided in Table 2-2. The professional staff involved in the preparation of the EIA and their relevant expertise is provided in Table 2-3.

Table 2-2 Contact details of environmental consultant

Name	GHD Global Pty Ltd.
Dubai Economy Licence	526735
Address	3rd Floor Guardian Tower, Danet Community P.O. Box 45921 Abu Dhabi United Arab Emirates
Telephone Number	+971 2 696 8750
Facsimile Number	+971 2 447 2915
Contact Person	Roland Shine Project Director

Table 2-3 Expertise of key team members

Name	Key Role in EIA	Expertise
Roland Shine	*Project Director* Oversee the program management to ensure delivery in accordance with HZI, Besix and Itochu’s expectations	EIA Study Contract Management
Salma Bin Breik	*Former Project Director (PD)* Oversee the program management to ensure delivery in accordance with HZI, Besix and Itochu’s expectations.	EIA Study Contract Management Waste Management
David Wright	*Project Manager (PM)* Responsible for the day-to-day project activities. David is familiar with project approvals for DM and brings industry leading experience in waste services.	EIA Study Project Management Waste Management

Name	Key Role in EIA	Expertise
Geraldine Squires	*Technical Lead – EIA* Provides technical advice throughout the Project and reviews all EIA deliverables. Reviews compliance to international requirements	EIA Study (Impact Assessment Specialist) Environmental Management Social Sustainability and Stakeholder Engagement
Sue Trahair	*Lead Environmental and GHG Auditor* Undertake the greenhouse gas (GHG) assessment for this project.	EIA Study GHG Assessment Lead
James Forrest	*Air and Noise Specialist* Undertake the air and noise modelling and impact assessment for the Project.	EIA Study Air and Noise Modelling Review
Jennifer Calpo	*Environmental Scientist / Stakeholder Engagement Specialist* Undertake stakeholder engagement, social impact assessment (SIA) and assist with all aspects of Project deliverables.	EIA Study Social Sustainability and Stakeholder Engagement Environmental and Social Management
Francis Ramacciotti	*Senior Human Health Risk Assessor* Undertake the qualitative Human Health Risk Assessment (HHRA) for this Project.	Human Health Risk Assessment
April Gowing	*Health, Safety and Environment Specialist / Human Risk Assessment* Undertake the qualitative Human Health Risk Assessment for this Project.	Human Health and Risk Assessment
Prasanna Wijesinghe	*Project Support* Field support	Field support
Dr David Maunder	*Technical Advisor* Provide technical advice to Project team on operational aspects related to the Project	Technical Support

2.2.2 Subconsultants

GHD engaged subconsultants during the baseline sampling and monitoring for the Project. Details are provided in Table 2-4.

Table 2-4 Subconsultants

Name	Key Role in EIA	Expertise
Core Laboratories	*Air and Noise Monitoring; Soil, Water and Groundwater Analysis* A Dubai Accredited Center (DAC) laboratory engaged by GHD to undertake baseline air and noise monitoring as well as analysis of soil, water and groundwater samples collected from the Project site.	Baseline monitoring Laboratory analysis
Al Futtain Exova	*Dioxin and Furan Monitoring, Odour Monitoring and Screening of Groundwater Wells* A DAC laboratory engaged by GHD to undertake monitoring of odour as well as dioxin and furan at the Project site. They were also engaged to do screening of groundwater wells for landfill gases.	Baseline monitoring Laboratory analysis
WKC Environmental Consultancy	*Terrestrial Ecology Survey, and Air Modelling (Peer Review) and Noise Modelling* A DM-EPSS registered environmental consultancy engaged by GHD to perform a single day terrestrial ecology survey and undertaken air and noise modelling for the Project	Baseline sampling Air Modelling (Peer Review) Noise Modelling Terrestrial Ecology Baseline
Arab Center for Engineering Studies (ACES)	*Geotechnical Investigation* A DAC laboratory engaged by GHD to undertake drilling of land boreholes to specific depths and collect soil and groundwater samples from the Project site.	Drilling

2.3 EIA Methodology

2.3.1 Overview

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

- Stakeholder consultation (i.e. liaison with DM-ED and consultation with stakeholders)
- Literature review
- Review of legislative framework

- Baseline data collection
- Qualitative and quantitative impact assessments and evaluation of findings
- Identification of appropriate mitigation measures
- Risk assessment and management
- Establishment of an environmental management programme

The key tasks and methodology for the EIA are outlined in Table 2-5 while a detailed EIA programme is attached in Appendix E.

Table 2-5 EIA Approach and Methodology

EIA Task Description	Methodology
1. Understanding the requirements of DM	• Review of DM Technical Guidelines on EIA and environmental management • Review of Federal (UAE) and Emirates (DM) environmental regulatory requirements • Preparation and submission of SoW Report for DM EPSS approval (Appendix E)
2. Understanding the international standards and the Lender's Requirements on EIA, and their relevance to the proposed Project	• Review the Equator Principles 1 to 10 (June 2013) • Review the IFC Performance Standards 1 to 8 (January 2012) • Review the World Band Group EHS) Guidelines (April 2007) and industry-specific guidelines
3. Understanding the Project	• Liaison with the Project proponent including its consultants and contractors • Literature review of Project reports issued by the consultants and contractors
4. Understanding the Project site	• Site walk-over / inspections • Literature review of relevant environmental data • Secondary data collection (desktop research) • Field surveys to collect primary data of the project site (refer to Items 4.1 to 4.6)
4.1 Baseline ambient air monitoring	• Literature review of air quality monitoring data in Dubai Emirate provided by DM-ED or via Dubai Statistics Center (DSC) • Two-week baseline real-time continuous monitoring at three locations • Evaluation of air baseline data against the Federal and Emirate ambient air standards
4.2 Dioxin and Furans	• Two months real-time active sampling of dioxin and furans at two monitoring locations

EIA Task Description	Methodology
	• Evaluation of data against the Federal and Emirate air quality standards
4.3 Odour assessment	• Field observations via deployment of odour monitoring stations (ambient air) at four locations (8 hours sampling duration per location)
4.4 Baseline noise monitoring	• Noise measurements at four locations • At each location, noise levels were measured for a period of 15 minutes during day and night on both weekday and on a weekend day • Evaluation of noise baseline data against the Federal and Emirate ambient noise standards
4.5 Soil sampling	• Collected at total of eight soil samples at four sampling sites at 1 m and 5 m below ground surface (BGS) • Collected two surface soil samples • Observed visual signs of contamination and potential sources of contamination • Evaluation of soil quality against Dutch Guideline
4.4 Groundwater sampling	• Collected four groundwater samples: two at two existing piezometers and two at new groundwater piezometers • Evaluation of groundwater quality against Dutch Guideline
4.5 Terrestrial ecology	• Walkthrough site observation • Observations were recorded with photographs in accordance with Brown and Boer (2004) • Observation of IUCN Red List of Species and Priority Habitats
4.6 Social and economic baseline survey	• Site walk over and inspection to identify land use near the project site and sensitive social receptors • Literature review of UAE and Dubai socio-economic data • Stakeholder Consultation
7. Human Health Risk Assessment (HHRA)	• Identification of exposure pathways • Evaluation of likelihood and consequence of exposure • Identification of mitigation measures
8. GHG Inventory	• Identification of relevant aspects of energy use and emissions from construction and operation phases • Identification and application of appropriate international emission factors

EIA Task Description	Methodology
	• Estimated the total GHG emissions attributable to the project • Discussed potential GHG mitigation and reduction opportunities
9. Impact identification and assessment	• Identification of Project activities, equipment and utilities which could potentially cause environmental impacts • Qualitative assessment of impacts • Quantitative assessment / modelling of major environmental impacts including air and noise (refer to Items 9.1 and 9.2, respectively)
9.1 Air dispersion modelling	• Review of meteorological data and source emission data • Undertake air dispersion modelling for one scenario with the WtE plant plan at full operating capacity (5,660 tonnes per day) • Identification of mitigation measures
9.2 Noise impact modelling	• Identification of key environmental noise catchment areas and noise sensitive receptors from aerial and terrestrial topography • Review of project specific noise goals for the operation of the plant • Identification of principal noise and vibration sources and review of potential impacts • Undertaken noise modelling scenario using SoundPLAN noise model
9.3 Odour Modelling	• Review WtE plant proposal including waste quantities and how it will be stored prior to incineration. • Review data from nearby air quality monitoring stations or other studies in the area • Prepare an odour inventory for the existing Al Aweer STP, Tadweer landfill and proposed WtE plant
10. Development of environmental mitigation measures	• Review of environmental regulatory standards and requirements applicable to the Project • Identification of mitigation measures
11. Environmental Management and Monitoring Programme	• Development of an Environmental Management and Monitoring Program (EMMP) for the construction and operation phase

2.3.2 Impact Assessment Methodology

Sensitivity

Sensitive receptors are areas where the occupants are more susceptible to the adverse effects of exposure to toxic chemicals, pesticides and other pollutants (EPA, 2017). The categories of sensitive receptors as per DM Technical Guideline No. 2 (2014) is presented in Table 2-6.

Table 2-6 Sensitive Receptors Area

Sensitivity and type of area	Description and features of the receptors area	Existing	Planned
High (Type 1 Area)	Protected areas for conservation of national or international importance	N	N
	Water supply reserves	N	N
	Hospitals and school premises	Y	N
	High density residential block, town center	Y	Y[1]
Moderate (Type 2 Area)	Vital utilities such as electricity and energy sources, natural wealth reserves and state-protected economic zones	Y	N
	Light density residential block, public parks	Y	Y[2]
	Natural body of water	Y	N
	Place of cultural heritage	Y	Y
Light (Type 3 Area)	Commercial buildings, offices and other public areas	Y	Y[3]
	Good products manufacturing premises	Y	N
	Agricultural crops farmland	Y	N
Marginal (Type 4 Area)	Industrial	Y	Y[4]
	Animal farmland but without dairy or meat food products processing	N	N

Source: DM Technical Guideline No. 2 (March 2014)

Notes: Existing – Baseline receptor; Planned – a receptor that will be introduced by the Project [1-International City (under construction) and Ruwaya Village (planned); 2-Labour Accommodation to be established during the operation phase; 3-Offices at the proposed Project site; 4-the proposed WtE plant Power Plant]

Magnitude of Impact

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

- Likelihood of the impact (Table 2-7): Almost certain, Likely, Possible, Unlikely and Rare
- Consequence level of the impact (Table 2-8): Catastrophic, Major, Moderate, Minor and Insignificant

The impact significance level is based on the following calculation:

Significance of impact = Likelihood Level x Consequence Level

Based on the above calculation, the level of the impact is classified in the following five levels and can be expressed in a matrix, as illustrated in Table 2-9.

- Extreme
- High
- Medium
- Low
- Negligible

Table 2-7 Likelihood of Impact

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

Table 2-8 Consequence of Impact

Consequence Rating	Explanation			
	Magnitude	Permanence	Reversibility	Example
1 – Insignificant	Only within the project site	No change or Temporary	No change or reversible	• Negligible and short term disruption to flora, fauna, habitats • Minor soil erosion • Temporary nuisances form emission / minor injuries requiring self-administered first aid. • No health effect on surrounding communities • Minimal use of energy and natural resources • Generation of non-hazardous wastes • Minor repairable damage to structure
2 – Minor	Only within the project site	Temporary	Reversible	• Minor impact on fauna, flora and habitat at non-ecologically sensitive areas • No significant loss of land / marine resources • Minor emissions with no lasting detrimental effect • No health effect on surrounding communities • Significant use of energy and natural resources • Minor infringement of cultural values • Minor injuries requiring on-site treatment by medical practitioner
3 – Moderate	Effect to areas immediately outside the project site	Permanent	Reversible	• Significant changes in flora and fauna communities (e.g. population, biodiversity), but yet to resulting in eradication of endangered species • Impact on the ecosystem is short-term (less than one year)

Consequence Rating	Explanation			
	Magnitude	Permanence	Reversibility	Example
				• Non-persistent but possibly widespread damage to land which could be remediated without long-term loss • Minor health effect on surrounding communities • Localised persistent damage • Emission at significant nuisance levels • Generation of hazardous wastes • Significant infringement of cultural values • On-going complaints raised by the surrounding communities • Serious injuries requiring off-site treatment by medical practitioner or immediate evacuation to hospital
4 – Major	Regional or national change or effects	Permanent	Irreversible	• Continuous and serious damage by erosion • Significant impact on ecologically sensitive areas / protected areas (e.g. causing death) • Emission due to uncontained release, fire or explosion • Significant health effect on surrounding communities • Significant damage to the structure, infringement of cultural values
5 – Catastrophic	Regional, national or international change or effects	Permanent	Irreversible	• Long-term and extensive change in the habitats, population of flora and fauna and biodiversity, eradication of endangered species • Depletion of groundwater resources • Extensive chronic discharge of persistent hazardous pollutants / transboundary dispersion of the pollutants

Consequence Rating	Explanation			
	Magnitude	Permanence	Reversibility	Example
				• Significant quantities of hazardous wastes generated • Irreparable damage to highly valued buildings / structures / location of cultural significance • Death in surrounding communities • Multiple fatalities

Table 2-9 Significance of environmental impact matrix

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

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

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

2.4 Assumptions and Limitations

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

- This EIA Report addresses the WtE Plant (i.e. nominal design capacity of 5,666 tpd at 9.5 MJ/kg NCV).
- The EIA Report will be limited to the Project site footprint and the area of impact immediately around it.
- The EIA Report is based on the Project's preliminary design. The final design will be provided by the EPC during detailed design stage but will generally comprise the same project components and parts as proposed.
- The EIA report excludes assessment of the permanent waste storage facility for the incinerated bottom ash (IBA) and flue gas treatment (FGT) residue. It therefore does not include the permanent ash storage/disposal facilities (e.g. municipal solid waste cell for bottom ash and hazardous waste storage cell for fly ash residue). An assessment and approval for the construction (if a new facility will be built) of the permanent storage facilities will be obtained separately by others (e.g. DM as the Project Proponent / Owner), if required.
- All information provided by the Project Proponent, which formed the basis of this EIA, is accurate at the time of issuance.

- All available information relevant to the Project and this EIA has been provided to GHD.
- Other future development around the WtE plant was not assessed as part of the EIA.

3. Reference Laws, Regulations, and Standards

3.1 Overview

The regulatory framework that govern the environmental performance of the Project comprise the following:

- DM legislation, guidelines, policies and procedures
- UAE Federal environmental legislation and policy
- Regional conventions and protocols
- International conventions, protocols and guidelines

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

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

3.2 Dubai Municipality Regulatory Framework

The environmental laws and regulations in the Emirate of Dubai that are applicable to the Project are provided in Table 3-1 and summarised in Appendix G. Where there are no standards or regulations existing in Dubai Emirate, the Federal law standards provided in Section 3.3 may be adopted. Existing environmental standards and regulations in the neighbouring Emirates (e.g. Abu Dhabi) may also be adopted where necessary and applicable to facilitate avoiding environmental harm.

Table 3-1 Applicable environmental legislative requirements in Dubai Emirate

Legislation	Project relevance	Aspect
DM Local Order No. 61 of 1991 on the Environment Protection Regulations in the Emirate of Dubai	The Project is identified as having the potential to impact on the environment and as such will be required to comply with the environmental protection regulations stipulated in this Local Order.	Overarching environmental assessment
DM Administrative Order No. 211 of 1991 on the Issue of Executive Regulations for the Local Order No. 61 of 1991 on the Environment Protection Regulations in the Emirate of Dubai	This Project may potentially use wastewater from the Al Aweer Wastewater Treatment Plan (WWTP). As such, will be required to comply with this Administrative Order.	Overarching environmental assessment

Legislation	Project relevance	Aspect
Local Order No. 11 of 2003 Concerning Public Health and Safety of the Society in the Emirate of Dubai	Air emissions and noise generation associated with the Project may impact on public health and amenity if unmitigated. This Local Order aims to ensure protection of public health and community safety, which will be complied with by the Project during construction and operation phases.	Public health and safety
DM-ED		
DM-ED Information Bulletin No. 2	The Project has the potential to cause impacts on environmental aspects. As such, it will be required to comply with the standards and allowable limits of polluants on land, water and air environment provided in this Information Bulletin.	Wastewater discharge, land contamination, emission limits
DM-EPSS		
Guidnce on the Environmental Clearance (EC) Requirements (2019)	The EIA was undertaken in accordance with the requirements of this TG.	Overarching environmental assessment
TG No. 07: Policy on the Control of Ozone Depleting Substances (December 2014)	Ozone depleting substances (ODS) listed in this TG will not be used for the Project.	GHG
TG No. 08: Requirements for the Discharge of Waste Gases, Fumes and Particulates to the Atmosphere (April 2011)	The Project has the potential to impact on air quality through the release of emissions. The stack of the Project was designed in line with the requirements of this TG.	Air quality
TG No. 09: Requirements for the Reduction of Construction and Demolition Noise (April 2011)	The Project has the potential to generate high noise level during construction, as such noise generation will be monitored to reduce construction noise in line with the requiremens of this TG.	Noise
TG No. 08: Management of Recyclable Waste Material (December 2014)	The Proponent has to ensure that waste recycling will be undertaken (where appropriate) in line with the requirements of this TG.	Waste management
TG No. 10: Waste Minimisation (December 2014)	The Proponent has to ensure that waste minimisation will be undertaken (where appropriate) in line with the requirements of this TG.	Waste management

Legislation	Project relevance	Aspect
Other Sections in DM Environment Department		
TG No. 01: Disposal of Hazardous Waste (May 2017) issued by ECS	Flue gas treatment (FGT) residue will be managed and disposed by DM-WMD in accordance with the requirements of this TG. (Note: This is not part of the scope but it will be ensured that FGT are managed by DM-WMD in accordance with this TG)	Waste management
TG No. 06: Bunding of Storage Tanks and Transfer Facilities (June 2011) issued by Environmental Control Section (ECS)	Bunding of storage tanks (i.e. fuel, sewage, etc.) at the Project site will be in compliance with this TG.	Waste management
TG No. 07: Development of Emergency Response Procedures for Incidents involving Dangerous Goods (June 2011) issued by ECS	An Emergency Response Procedure will be developed and implemented for the Project to address risks involving dangerous goods (i.e. fuel).	Storage of dangerous goods
TG No. 10: Guidelines for the Disposal and Re-Use of Used Chemical Containers (June 2011) issued by ECS	Service providers will be engaged in disposal and re-use of used chemical containers from the Projecct site.	Waste Management
Hazardous and General Waste Processing and Recycling Premises in the Emirate of Dubai 2017	Service providers to be engaged for waste management for the Project will include only entities approved by DM.	Waste management
Approved Hazardous Waste Transporter 2017		Waste management
Companies Permitted to Collect and Transport Oily Waste in the Emirate of Dubai for Purpose of Recycling / Reuse 2017		Waste management
Green Building Regulations and Specifications in the Emirate of Dubai	This regulation is relevant to the Project (i.e. Administration Building and Labour Accommodation Building) since it is applicable to all new buildings in the Emirate of Dubai.	Building Design
TG on Health and Safety	Air emission and noise generation associated with the Project may impact on publid health and amenity if unmitigated; as such, the Project will comply with all relevant health and safety guidelines issued by Dubai Municipality.	Health and Safety

Legislation	Project relevance	Aspect
Guidelines on Labour Accommodation issued by Public Health and Safety Department	Labour accommodation will be provided during the operation phase; as such, the Project will comply with all relevant guidelines on labour accommodation issued by Dubai Municipality.	Labour Accommodation

3.3 UAE Federal Regulatory Framework

UAE federal regulations relevant to the Project construction and operational activities are provided in Table 3-2 and summarised in Appendix G

Table 3-2 Federal Environmental Laws and Regulations Relevant to the Project

Legislation	Project relevance	Aspect
Federal Law No. (24) of 1999: Protection and Development of the Environment	The Project has the potential to cause impacts on environmental aspects. However, there is an opportunity to benefit the environment through the implementation of WtE plant technology. This EIA was prepared in compliance with this Federal Law.	Overarching environmental assessment
Executive Order issued by Council of Ministers Decree No. (37) of 2001: Regulation concerning Environmental Impact Assessment Projects	This EIA has been prepared in compliance with the executive order	Overarching environmental assessment
Ministerial Order No. (12) of 2006 regarding Regulation Concerning Protection of Air from Pollution	Air quality and noise impacts have the potential to be significant if appropriate mitigation measures are not implemented. Mitigation measures need to be implemented to comply with the standards and limits specified in this Ministerial Order. The standards and limits specified in this Ministerial are applicable to the Project and shall be maintained, to safeguard human health in the UAE.	Air and noise
Federal Law No. (07) of 2009 – Establishment of UAE Ministry of Environment and Water (MoEW)	The Project needs to comply with the standard operating procedures (SOP) of the Ministry in terms of its impacts on water and the environment, in general.	Water and environment (in general)
Executive Order issued by Council of Ministers Decree No. (37) of 2001 concerning Regulation for Handling Hazardous Materials, Hazardous Wastes and Medical Wastes	The Proponent has to ensure that the hazardous waste generated during the Project activities are managed in accordance with this Executive Order.	Waste management

Legislation	Project relevance	Aspect
Executive Order issued by Council of Ministers Decree No. (37) of 2001 – Regulation for Handling Hazardous Materials, Hazardous Wastes and Medical Wastes	Management and disposal of waste during the construction and operation phases will be in line with the requirements of this Executive Order.	Waste management
Federal Law No. (12) of 1986 concerning Regulations on Labour Relations (latest amendment to Federal Law No. (08) of 1980) or the UAE Labour Law	The Project needs to comply with the provisions stated in this Law regarding employment of women and children, employment contracts, records and wages, working hours, workers' safety, protection, health and social care, reporting and compensation for work related injuries and occupational disease.	Labour and working conditions
UAE Ministry of Human Resources and Emiratisation (MOHRE) Accommodation Decree issued in 2014	Accommodation of project workers will be provided in line with this Decree.	Labour Accommodation
Federal Law No (27) of 1981 concerning Prevention from Communicable Diseases	The Project needs to comply with the provisions of this Federal Law relevant to preventing and reporting suspected communicable diseases.	Worker and Community Helath

3.4 Regional Conventions and Protocols

Regional conventions and protocols that are considered relevant to the Project are summarised in Table 3-3 and discussed in subsections below.

Table 3-3 Regional Conventions and Protocol Relevant to the Project

Legislation	Project relevance	Aspect
Convention on Conservation of Wildlife and its Natural Resources in the GCC Countries	Biodiversity values associated with the Project site are limited. However, consideration will be given in compliance with this Convention. The Project needs to comply with the provisions of this convention in terms of biodiversity conservation.	Biodiversity

Convention on Conservation of Wildlife and Its Natural Habitats in the GCC Countries (2003)

This Convention is reportedly the first legal instrument binding the six member States of the Gulf Cooperation Council (GCC) to coordinate their activities toward the conservation of wildlife and natural habitats.

Parties to this Convention agree to undertake development and implementation of policies and activities for the purposes of wildlife and natural habitat conservation, rehabilitation and ensuring sustainable exploitation thereof.

This Convention provides the following Appendices listing the wildlife species requiring conservation:

- Appendix I – To be Protected Flora Species
- Appendix II – To be Protected Fauna Species
- Appendix III – Animal Species Threatened with Extinction

The Proponent will ensure that no damage to the wildlife species listed in the Convention during the construction and operation of the Project.

3.5 International Conventions and Protocols

The international conventions, protocols, guidelines and standards that were considered relevant to the construction and operation of the WtE plant are provided in this section.

3.5.1 The Common Approaches

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

- Equator Principles
- IFC Performance Standards
- World Bank Group EHS Guidelines

3.5.2 Equator Principles

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

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

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

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

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

Table 3-4 Applicability of Equator Principles at Various Phases of the Project

Equator Principle (June 2013)	Major requirements	Applicability of the Equator Principles		
		Design phase	Construction phase	Operation phase
Principle 1 Review and Categorization	Categorizing the project based on the magnitude of its potential environmental and social risks and impacts in accordance the International Financial Corporation (IFC) categorization criteria. *Note a.*	Y	Y	Y
Principle 2 Environmental and Social Assessment	The borrower to conduct an assessment process to address the relevant environmental and social risk and impacts of the proposed project (which may include the illustrative list of issues found Exhibit II of the Equator Principle).	Y	N/A *Note b*	N/A *Note b*
Principle 3 Applicable Environmental and Social Standards	The assessment process should demonstrate: • Compliance with relevant host country laws, regulations and permits that pertain to environmental and social issues • Applicable IFC Performance Standards on Environmental and Social Sustainability (Performance Standards) • The World Bank Group Environmental, Health and Safety Guidelines (Environment, Health and Safety (EHS) Guidelines)	Y	N/A *Note c*	N/A *Note c*
Principle 4 Environmental and Social Management System and Equator Principles Action Plan	The borrower is required to develop or maintain an Environmental and Social Management System (ESMS). Where the applicable standards are not met to the Equator Principles Financial Institutions (EPFI) satisfaction, the borrower and the EPFI will agree an Equator Principles Action Plan (EPAP) to outline gaps and commitments to meet EPFI requirements in line with the applicable standards.	Y	Y	Y

Equator Principle (June 2013)	Major requirements	Applicability of the Equator Principles		
		Design phase	Construction phase	Operation phase
Principle 5 Stakeholder Engagement	The borrower has to demonstrate effective Stakeholder Engagement as an ongoing process in a structured and culturally appropriate manner with affected communities and, where relevant, other stakeholders.	Y	Y	Y
Principle 6 Grievance Mechanism	As part of the Environment and Social Management System, the borrower has to establish a grievance mechanism designed to receive and facilitate resolution of concerns and grievances about the Project's environmental and social performance.	Y	Y	Y
Principle 7 Independent Review	An Independent Environmental and Social Consultant, not directly associated with the client, should be engaged to carry out an Independent Review of the Assessment Documentation including the Environmental and Social Management Plan, the Environment and Social Management System, and the Stakeholder Engagement process documentation.	Y	Y	Y
Principle 8 Covenants	The borrower has to provide periodic reports to the EPFI (not less than annually), prepared by in-house staff or third party experts, that: • document compliance with the Environmental and Social Management Plans and Equator Principles Action Plan (where applicable) • provide representation of compliance with relevant local, state and host country environmental and social laws, regulations and permits	N/A	Y	Y
Principle 9 Independent Monitoring and Reporting	The EPFIs will appoint an Independent Environmental and Social Consultant, or require that the borrower retain qualified and experienced external experts to verify its monitoring information which would be shared with the EPFI.	Y	Y	Y
Principle 10 Reporting and Transparency	The borrower will ensure that, at a minimum, a summary of the Environmental and Social Impact Assessment is accessible and available online.	N/A	N/A	Y

Equator Principle (June 2013)	Major requirements	Applicability of the Equator Principles		
		Design phase	Construction phase	Operation phase
	The borrower will publicly report GHG emission levels during the operational phase for Projects emitting over 100,000 tonnes of CO_2-equivalent annually. The EPFIs have to report on the implementation status of Equator Principles.			

Notes:

a: As per the impact scale of the proposed Project, the Project can be considered as Category A (Project with potential significant adverse environmental and social risks and/or impacts that are diverse, irreversible and/or unprecedented).

b: Should there be a significant change of the proposed project after the submission / approval of EIA, the lender should be consulted if an updated EIA is required.

c: The mitigation measures and environmental and social management programme specified in the EIA Report will be implemented during the construction and operation phases of the project, where appropriate.

3.5.3 IFC Sustainability Framework and Performance Standards on Environment and Sustainability

As per Equator Principle 3 (Applicable Environmental and Social Standards), for projects located in Non-Designated Countries[4] (including the UAE), the EPFIs require that the assessment process evaluates compliance with the then applicable IFC Performance Standards on Environmental and Social Sustainability (Performance Standards) and the World Bank Group Environmental, Health and Safety Guidelines (EHS Guidelines) (Exhibit III).

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

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

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

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

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

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

IFC requires the client to establish and maintain a process for identifying the environmental and social risks and impacts of the project

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

It should be noted that the IFC performance standards have been incorporated in the Equator Principles III (June 2013) and an assessment of this in terms of applicability to the Project is identified in Section 3.5.2.

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

Table 3-5 IFC Performance Standards relevant to the Project

Performance Standard	Objectives	Project relevance	Aspect
Performance Standard 1 Assessment and Management of Environmental and Social Risks and Impacts	This standard establishes the importance of (i) integrated assessment to identify the environmental and social impacts, risks, and opportunities of the project; (ii) effective community engagement through disclosure of project-related information and consultation with local communities on matters that directly affect them; and (iii) the client's management of environmental and social performance throughout the life of the project.	The provisions in this performance standard were considered in assessing the environmental and social impacts of the Project and in recommending the mitigation measures to prevent any adverse impacts associated with the Project.	Overarching EIA study
Performance Standard 2 Labour and Working Conditions	This standard recognizes that the pursuit of economic growth through employment creation and income generation should be accompanied by protection of the fundamental rights of the workers.	The requirements in this standard were taken into consideration in terms of planning for the hiring of workers, providing compensation and benefits, accommodation, and the total health and safety condition of workers. Labour and working condition were assessed and included in the social impact assessment.	Labour and working condition – social impact assessment
Performance Standard 3 Resource Efficiency and Pollution Prevention	This standard encourages more efficient and effective resource use, pollution prevention and GHG emission avoidance and mitigation with technologies and practices.	The provisions in this performance standard were considered in identifying the mitigation measures used in pollution prevention and GHG avoidance as well as use of more efficient and effective resources.	Air quality and GHG emissions Waste management
Performance Standard 4 Community Health, Safety and Security	This standard addresses the client's responsibility to avoid or minimize the risks and impacts of project activities, equipment and infrastructure to community health, safety and security.	The provisions in this performance standard were considered in the assessment of project impacts to the community arising from air emissions, noise generation as well as traffic and security within the Project site.	Social impact assessment – public health and safety

Performance Standard	Objectives	Project relevance	Aspect
Performance Standard 5 Land Acquisition and Involuntary Resettlement	This standard recognizes that project-related land acquisition and restrictions on land use have adverse impacts on communities and persons that use the land.	Land acquisition and resettlement are not proposed for the Project. The Project is proposed to be located within an industrial zone owned by the Project proponent. As such, this standard is not applicable. However, this standard will apply if surrounding communities need to be relocated if they are adversely affected by the Project operation.	Social impact assessment
Performance Standard 6 Biodiversity Conservation and Sustainable Management of Living Natural Resources	This standard recognized the importance of protecting and conserving biodiversity, maintaining ecosystem services and sustainably managing living natural resources in achieving sustainable development.	Biodiversity values associated with the Project area are limited in value. The provisions set out in this performance standard were considered in the assessment of terrestrial ecology.	Biodiversity (terrestrial ecology)
Performance Standard 7 Indigenous Peoples	This standard recognized that Indigenous Peoples (IPs) are often among the most marginalized and vulnerable segments of the population. IPs are vulnerable if their lands and resources are transformed, encroached upon, or significantly degraded.	The rights and heritage values associated with Indigenous Peoples are not expected to be impacted as a result of the Project. The Project is proposed to be located within a declared industrial zone, cleared and currently accommodating the Dubai Municipality vehicle storage area, owned by the Project proponent. As such, this standard is not applicable.	Social impact assessment
Performance Standard 8 Cultural Heritage	This standard recognizes the importance of cultural heritage for current and future generations.	Local heritage is not expected to be impacted as a result of the Project since the Project is proposed to be located within a declared industrial zone, cleared and currently accommodating the Dubai Municipality vehicle storage area, owned by the Proponent. As such, this standard is not applicable. However, this will apply in the event that important cultural and archaeological sites are identified during construction.	Archaeological and cultural resources

3.5.4 World Bank Group EHS Guidelines

The World Bank Group EHS Guidelines are technical reference documents with general and industry-specific examples of good international industrial practice. The IFC uses the World Bank EHS Guidelines as a technical source of information during project appraisals.

The proposed Project will comply with the World Bank EHS Guideline standards provided in Table 3-6.

Table 3-6 World Bank EHS Guidelines relevant to the Project

Legislation	Project relevance	Aspect
General EHS Guidelines	This guideline contains information on the performance levels and measures that are generally considered to be achievable in new facilities. As such, the provisions in this guideline were used together with the relevant industry-specific sector EHS guidelines in assessing the impacts of the proposed Project. Mitigation measures were also identified based on the recommendations provided in this guideline.	Environmental (e.g. air emissions, energy efficiency and GHG emissions, water consumption, effluents, solid wastes, hazardous materials and noise) and social (occupational health and safety, community health and safety) aspects
EHS Guidelines for Thermal Power	This guideline covers information relevant to combustion processes fuelled by gaseous, liquid, and solid fossil fuels and biomass. As such, the provisions in this guideline were considered in the assessment of project impacts on environmental and social aspects. Further, the measures recommended in this guideline were considered in the determining the mitigating and enhancement measures to address impacts of the proposed Project.	Environmental (e.g. air emissions, energy efficiency and GHG emissions, water consumption, effluents, solid wastes, hazardous materials and noise) and social (occupational health and safety, community health and safety) aspects
EHS Guidelines for Waste Management Facilities	This guideline covers facilities that include management of waste through incineration. As such, the provisions in this guideline were considered in the assessment of project impacts on environmental and social aspects. Further, the measures recommended in this guideline were considered in the determining the mitigating and enhancement measures to address impacts of the proposed Project.	Environmental aspects (e.g. air emissions, ash and residuals, water effluents, noise)

3.5.5 Other International Guidelines

International conventions and protocols that were considered relevant to the proposed Project are provided in Table 3-7. A summary of each protocol and convention is also provided in Appendix G.

Table 3-7 International Conventions and Protocols relevant to the Project

Convention / Protocols	Date of ratification / accessions	Project relevance
Dutch Circular on Target Values and Intervention Values for Soil Remediation	NA	This Circular was adopted for the soil and groundwater baseline data and impact assessment.
Montreal Protocol on Substances that Deplete the Ozone Layer of 1987 & Montreal Amendments	2005	Ozone depleting substances (ODS) listed in the Montreal Protocol will not be used during the construction and operation of the Project.
United Nations Framework Convention on Climate Change	1995	The provisions in this Convention were considered in recommending mitigation measures to minimise GHG emissions associated with Project construction and operation. The Project provides overall positive benefit from reduced use of fossil fuel as an energy use.
Kyoto Protocol to the United Nations Framework Convention on Climate Change	2005	The provisions in this Protocol were considered in recommending mitigation measures to minimise GHG emissions associated with Project construction and operation. The Project provides overall positive benefit from reduced use of fossil fuel as an energy use
United Nations Climate Change Conference	2016	The agreement on the reduction of climate change is taken into consideration in adopting technology for the proposed Project. The Project provides overall positive benefit from reduced use of fossil fuel as an energy use
Vienna Convention for the Protection of the Ozone Layer	2004	The Proponent will take into account the mechanisms adopted in this Convention.
Convention on Biological Diversity	1999	The provisions in this convention were considered in assessment of impacts on terrestrial ecology.
European Regulations/Industrial Emissions Directive (Directive 2010/75/EU)	2010	Directive on industrial emissions (integrated pollution prevention and control)

4. Description of the Project

4.1 Introduction

The DM proposes the development of the Dubai Waste Management Center comprising of a WtE plant that will treat approximately 1,888,000 tonnes of municipal solid waste (MSW) per year nominal design capacity at 9.5 MJ/kg NCV to generate an average net power output of 193 MW of electricity to the local grid, powering about 135,000 homes. The construction of the WtE plant is scheduled to commence in Q4 2019.

4.1.1 Basic criteria for the Project WtE Plant

The estimated nominal design capacity of the WtE plant is about 5,666 tonnes per day (tpd), consisting of five lines, each with a nominal capacity of 1,132 tpd. Based on the projected throughput, there will be an estimated production capacity power output of 193 MW of electricity generated to the electrical grid of Dubai Electricity and Water Authority (DEWA) and to Al Aweer Sewage Treatment Plan (STP). A summary of key performance data for the proposed WtE plant is shown in Table 4-1. At the time that the facility is operating at full capacity, it will be the largest WtE plant globally.

Table 4-1 Key performance data

Performance data	New Design (at full capacity of plant)
Daily MSW throughput by Plant (=5 incineration lines)	5,666 tpd
Daily MSW throughput per incineration line	1,132.8 tpd
Annual MSW throughput by Plant (=5 incineration lines)	min. 1,888,000 tpa
Annual incineration bottom ash (IBA) production by Plant (=5 incineation lines)	39,950 kg/h bottom ash from wet extractor at LPN 282,269 tpa mineral aggregates to be produces after pre-treatment, processing and maturation
Total net power output by Plan (=5 incineration lines)	193 MW @ 27°C ambient temperature
Estimated number of homes powered by Plant *if based on total net power output above*	135,000 homes

*LP N stands for nominal load point, which is the design load point of the WtE Plant

Source: HZI and Besix (2016b)

4.1.2 Basic overview of Waste to Energy

As per the World Energy Council 2013 report titled *World Energy Resources: Waste to Energy*, "*Waste-to-Energy (WtE plant) technologies consist of any waste treatment process that creates energy in the form of electricity, heat or transport fuels (e.g. diesel) from a waste source*." The same article notes that MSW, when coupled with proper environmental and pollution controls, can provide beneficial reuse of waste as a resource to support energy diversification for the "urban sustainable energy mix of tomorrow" (WEC 2013). According to WEC 2013, the following general observations are noted relative to WtE plant projects:

1. **Contributing factors to basis for projects in WtE plant** – Globally, the following factors are primary contributors to the pursuit of alternative waste treatment technologies, including WtE plant projects:
   - Growing urban populations with increased population density
   - Higher energy consumption on a per capita basis
   - Higher energy costs
   - Increasing waste generation on a per capita basis
   - Changing waste composition, with higher content of recycleables (plastics, paper)
   - Decreasing landfilling capacity
2. **Benefits of WtE plant projects** – WtE plant technologies offer the following typical benefits:
   - Converting the "energy content" of waste into energy
   - Producing power that can be distributed through electrical grid
   - Generating heat which can be used for thermodynamic processes
   - Managing residual materials that can be recycled such as metals recovery or ash reuse
3. **Challenges of WtE plant projects** – WtE plant technologies offer the following typical challenges:
   - Centralized waste management creating challenges for transportation and traffic
   - Incineration of waste requiring enhanced environmental and pollution controls
   - High degree of facility complexity with high operational and maintenance requirements
   - Emissions into the atmosphere, even with proper pollution controls

4.2 Project Location and Area

The Project location is at a DM owned industrial site in Warsan 2, Dubai (Parcel No. 6221673). A copy of the Affection Plan[5] is included in Appendix D. The geographical coordinates defining the boundary of the Project site is provided in Table 4-2 and shown in Figure 4-1. The total area, based on the Affection Plan, is 506,096.14 m^2.

The Project site is located within an area comprised of other DM functions, notably the Al Aweer STP to the west of the Project location, as shown in Figure 4-2. In general, the site is located approximately 40 km northeast of Al Maktoum International Airport (DWC), approximately 12 km southeast of Dubai International Airport (DXB), and approximately 17 km east of Burj Khalifa.

Electrical energy generated from the proposed WtE plant will be exported to the electrical grid of DEWA. The Al Aweer STP is anticipated to provide treated sewage effluent (TSE) to the WtE plant (as the WtE plants main process water source); the Al Aweer STP will also receive sanitary wastewater (no process water) from the WtE plant. Steam generated by the WtE plant will be managed on-site.

[5] Affection Plan is an official site plan document issued by the government of Dubai that includes a site map image detailing location (survey coordinates) and dimension of the plot. This is required to obtain a license to carryout proposed alterations / additions / construction of buildings.

Table 4-2 Geographical Coordinates of the Project

Corner	Northing	Easting
Point 1 (NE corner)	2783734.92	511544.94
Point 2 (E edge)	2783699.85	511547.77
Point 3 (E edge)	2783420.24	511205.01
Point 4 (SE corner)	2783350.29	511119.27
Point 5 (SW corner)	2783460.30	510718.58
Point 6 (NW corner)	2783987.38	510871.06
Point 7 (frontage)	2783975.35	510930.87
Point 8 (frontage)	2783877.14	511244.60
Point 9 (frontage)	2783820.32	511372.63

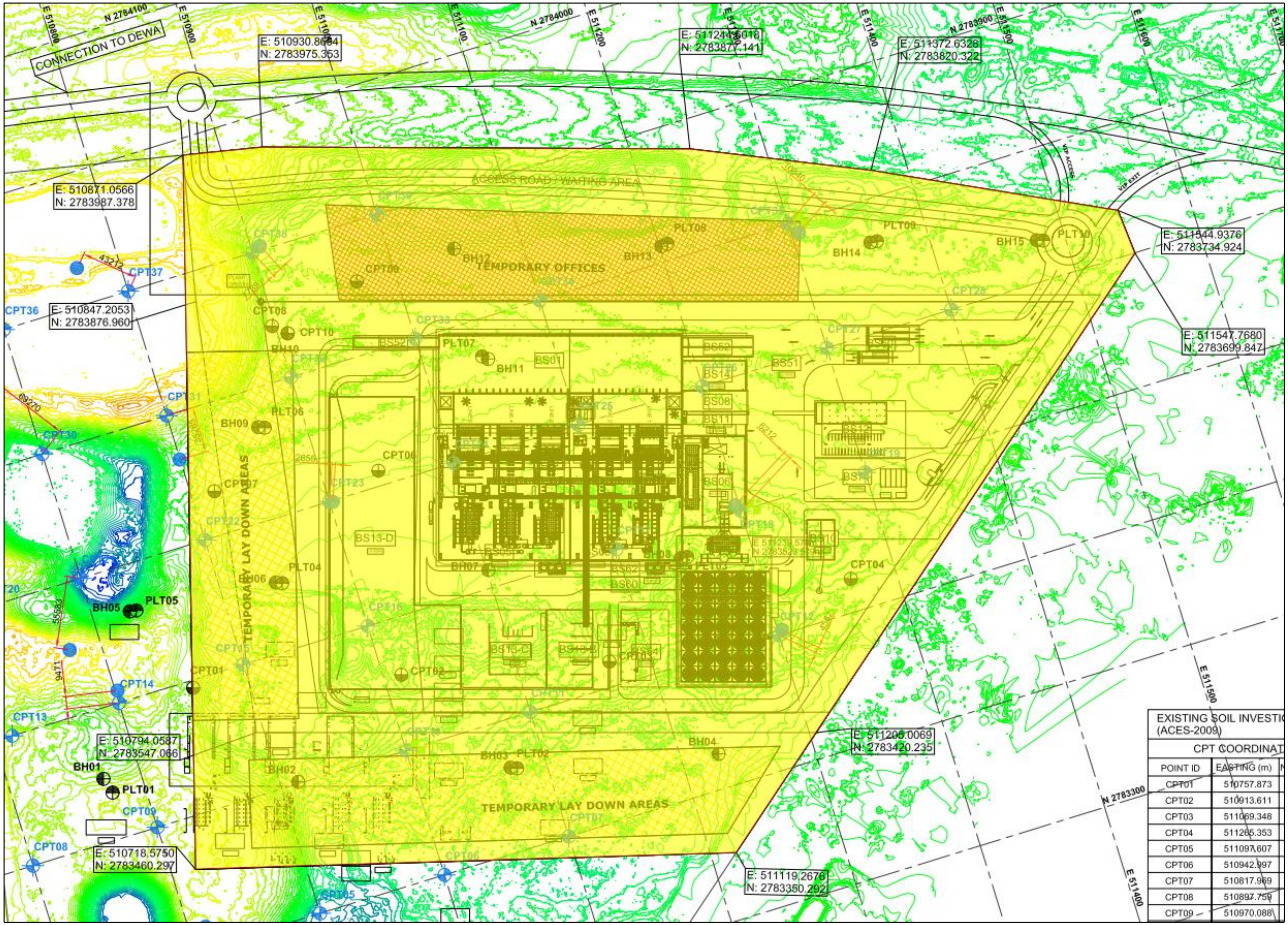


Figure 4-1 Approximate Project Boundary (Highlighted Region)

Figure 4-2 Regional Setting of the Project

4.3 Project Site Conditions and Surrounding Land Uses

4.3.1 Land Use

Land uses surrounding the proposed Project site are shown on Figure 4-3 and can be described as follows:

- **Industrial areas** (grey):
  - To the immediate west of the proposed Project site is the Al Aweer STP. As one of two wastewater treatment plants serving Dubai, the Al Aweer STP is an essential component of the wastewater treatment capacity of the Emirate. The plant receives both domestic wastewater and septage. The plant performs both tertiary wastewater treatment for irrigation reuse and sludge treatment for reuse as soil amendment. The plant was initially designed with a capacity of 130,000 m^3 per day, which was later upgraded to 260,000 m^3 per day.
  - To the southwest is the DEWA Power Station. Support facilities for the Power Station also include DEWA's corporate office and the DEWA Al Warsan Central Store.
  - To the southwest is also an un-engineered Tadweer landfill.
  - Industrial Facilities. To the immediate east and southeast of the Project site are a number of industrial facilities and storage areas such as German Ready Mix-RAK Mix, Arar Store, EEE Warsan Store, Emirates Beton, Readymix LLC, China Asphalt Mixing Plant, DEWA Al Warsan Central Store, among others.
  - To the southeast of the Project is the Dubai Police Transport Impounding Area.
- **Resource / Attraction** (green):
  - To the north of the Project site is the Desert Palm Polo Club and Hotel and Dubai Safari Park, both of these sites include recreational uses.
  - The Dubai Pivot Fields consisted of two circular grassy fields (watered by two pivotal watering structures). It was a location for bird watching. The site used to consist of a turf farm where there was recorded presence of masked shrikes and white-tailed lapwings. However, in the present-day condition, the site is inoperable, and the watering stopped in July 2015. The site is no longer grass covered because it is no longer maintained and not irrigated.
  - Al Warsan Lakes are two lakes connected to each other, located around 1.85 km west of the Project. Al Warsan Lakes used to be one of Dubai's birding sites but with the construction of facilities in the surrounding areas, it has shrunk in size and lost 90% of the birds used to be present (Pedersen, undated).
- **Residential areas** (yellow):
  - Al Warqa Neighbourhood is approximately 2 km north of the Project.
  - Dubai International City (DIC) Phase 1 is located around 2 km west of the Project.
  - DIC Phase 2, which is under construction, is located around 3 km southwest of the Project.
- **Commercial areas** (red):
  - Located around 2 km northwest of the Project is the Dubai Textile City, which consist of modern warehouses, offices and showrooms that exhibits Dubai's textile business.
  - Located northwest of the Project is the Dragon Mart Commercial Center, which is considered as the largest trading hub for Chinese products outside mainland China and offers a unique platform for traders of Chinese goods in the Middle Eastern and North African markets.

  - The Dubai Municipal Nursery is a plant nursery. At the site there are a variety of plants sold, and other gardening activities undertaken.

- **Academic City** (light blue): Located around 3 km south of the Project is the Dubai International Academic City (DIAC), which covers an area of 12,000,000 m^2 where educational institutions are based.
- **Place of Worship** (light purple). Located around 1.8 km northwest of the Project is the Dragon Mart Mosque.

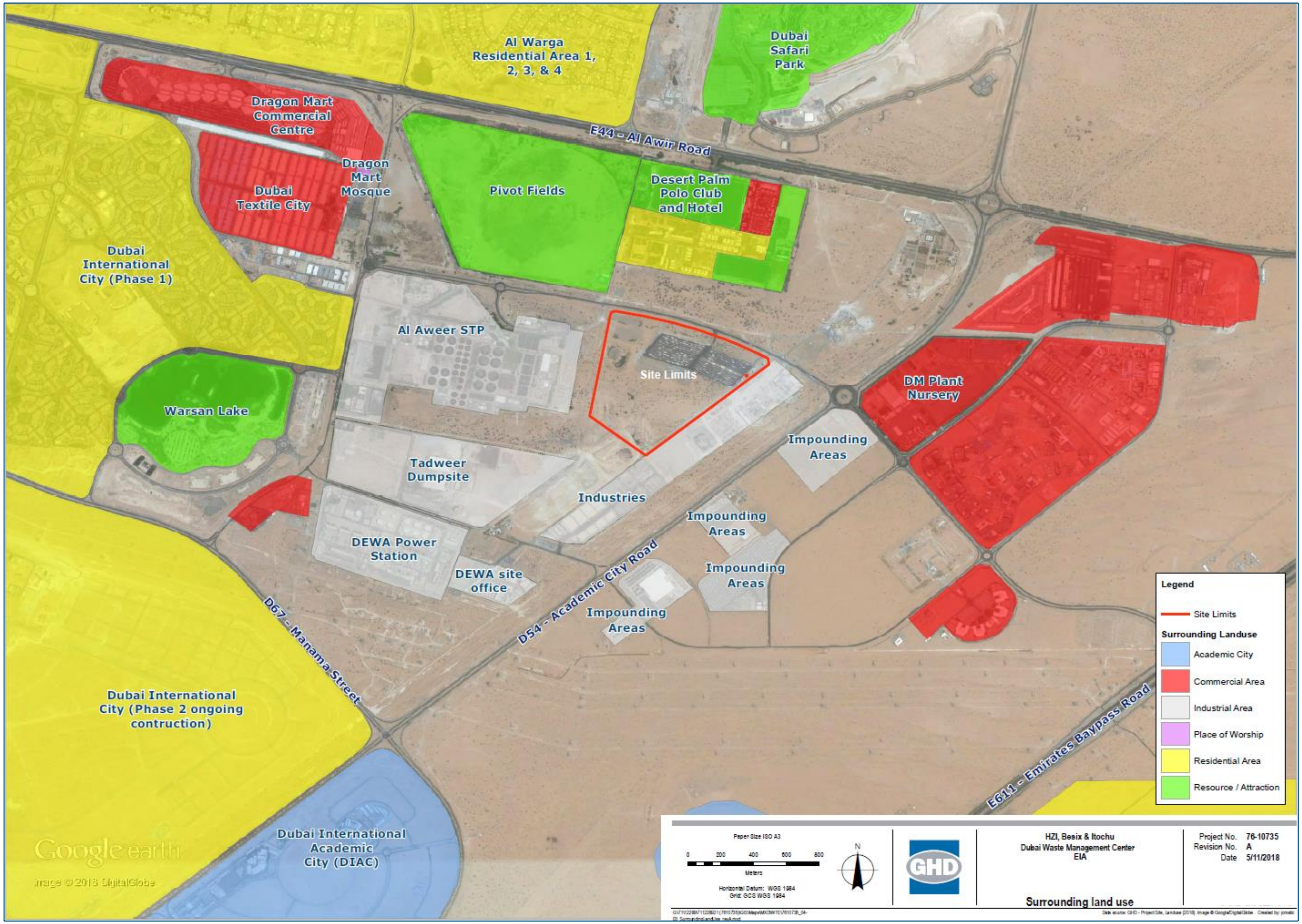


Figure 4-3 Surrounding Land Uses – 5 km radius

4.3.2 Existing Site Conditions

In the existing condition, the Project site is relatively flat and cleared. DM currently uses the site for storage of a variety of vehicles such as large long-haul trailers and other pedestrian vehicles. Trucks and other vehicles are stored at the site on existing asphalt-paved surfaces. The car parking area was noted by BESIX to be for DM, without much turnover in vehicles stored on-site. BESIX noted that DM overseen the operations and management of this area. There was a recent expansion of asphalt pavement (compacted millings) to the southern boundary of the paved area, which is not reflected in aerial photographs. Refer to Plate 4-1 and Plate 4-2 for panoramic views of the Project site

A description of the existing physical environment within and around the Project site, based on GHD site observations on 9 April 2018, is provided below.

4.3.2.1 Biodiversity

Biodiversity consists of the presence of natural communities, habitat and species. At the site currently, there exists both constructed/built environments and natural habitats. Due to the presence of on-site industrial uses and the surrounding industrial facilities, the site is considered to have a limited capacity to support biodiversity. Furthermore, there are waste deposition activities occurring nearby the site such as the ongoing landfilling and sludge dewatering lagoons, which do not provide historically suitable habitat for wildlife.

Limited-to-no surface water habitats exist within the proposed development footprint. Surface water bodies present are most likely formed from leachate outbreaks from the adjacent waste landfill and the sludge deposition area.

Detailed terrestrial ecology baseline study is provided in Section 5.5.3.

4.3.2.2 Noise

The site and surrounding land uses comprise heavy industrial uses. It is observed that there are both traffic noise and operational noise from the adjacent waste disposal area (compactor and truck deliveries of waste), concrete producing plants (typical cement production equipment noises and truck noise) and road network (vehicle traffic). On-site noise impacts are also attributed to truck traffic within the vehicle storage area and existing generators for office/construction trailers on-site, which generate ambient background noise.

There are no known existing noise monitoring stations at the Project site. Detailed noise studies undertaken for the Project is provided in Section 5.4.

4.3.2.3 Air Quality

Cement dust, most likely from concrete producing plants, was evident across the surface of the sand adjacent to these facilities (eastern boundary of the site). There also appears to be concrete washout occurring to the south of the site limits, and adjacent to the existing landfill area. There is concrete along the embankment slope and miscellaneous concrete debris at this location. Entrained dust has also been observed as is expected given the open area and exposed sand dunes.

While there are existing undeveloped areas, the adjacent land uses present odour conditions typical for industrial zoned areas, specifically odours from landfilling (waste/refuse), concrete producing plants (industrial/oil smells), the power plant to the south of the site, and organic odours from the Al Aweer STP and sludge disposal areas.

There are no known existing air monitoring stations at the Project site. Air monitoring activities undertaken for the Project is detailed in Section 5.3.

4.3.2.4 Soil and Groundwater

Landfill Disposal Area

There is an active landfilling taking place at the disposal area (Warsan Landfill) to the southwest of the Project site. The waste disposal area is generally covered with mounded sand, and a steep slope rises from a shallow surface water body at the toe of slope. Given the appearance of this water, there exists a potential for leachate impacts in proximity to the landfill cell.

Surface Soil

There was evidence of a possible oil/petroleum spill near the edge of the existing site limits. The oil was running from a point upland near one of the existing cement plants. The oil appeared dried at the surface, so the spill was not recent. In addition, the source of the spill could not be identified, and the oil generally appeared at the surface. Subsurface investigations were not carried out at the time of the site visit.

Sludge Pit

The sludge disposal areas at the western site boundary appear to be in limited use, but recent sludge deposition was observed at the pit furthest north. The elevation of these pits is much higher than the proposed development site grade. Similar to the landfill cell, pooling surface water with associated reed growth was observed at the foot of the slope leading up to the lower of the pits (closest to the Project site).

Previous Soil and Groundwater Studies

ACES completed a site soil survey in 2009. An additional site soil survey was completed in 2018 by ACES under contract by BESIX. The site investigation report from the recent survey is currently being prepared. ACES (2009) indicates that surface soils are generally sand in native areas, but there were signs of waste (blowing garbage) and cement dust impacts within the site vicinity adjacent to industrial facilities. The paved parking area is primarily asphalt, stone/aggregate or asphalt millings.

As per BESIX, groundwater depths vary across the Project site, and typically within a range of 7 to 10 metres (m) below existing ground surface. An updated site investigation was completed by ACES in March 2018, and have been considered further for the EIA as discussed in Section 5.5. ACES also completed additional groundwater and soil sampling for the EIA.

4.3.2.5 Road and traffic network

The Project site is accessed via the existing E44 highway (also known as Al Khail Road or Dubai-Hatta Highway). The E44 is a dual 4-lane highway and runs from the west to east. The E44 bisects Al Warqa area to the north and Warsan area to the south. The congestion levels on this highway are high during rush hours. From the E44, the Project can be reached via D54 (or the Sheikh Zayed Bin Hamdan Al Nahyan Street) and an internal road to access the Al Aweer STP.

The other major routes to the west and east of the Project are E311 (Sheikh Mohammed Bin Zayed Road) and E611 (Emirates Road).

No detailed information is currently available regarding traffic levels on local access roads around the immediate vicinity of the Project, but based on preliminary observations at site, traffic levels appear to be generally low and uncongested. No new roads or accesses are proposed to be constructed off-site in relation to the Project. Internal access roads will be constructed to facilitate construction and operations. Detailed discussion on road and traffic network in provided in Section 5.7, and a Level 1 Traffic Impact Study was undertaken for the Project.

4.3.2.6 Social and Cultural

The site and surrounding land uses comprise heavy industrial uses. The estimated area of disturbance is approximately 320,000 m^2, is an industrial area. The northern part of the site, where the WtE plant will be constructed, is currently used for storage of a variety of vehicles. There are no communities residing within the site limits that would be directly affected by the Project construction and operation.

Based on Dubai Statistics Report (2017), Warsan 2 (i.e., location of Project site) has a population of 764 or about 0.02% of the population in the Emirate. The majority of the population in Warsan 2 reside in residential villas inside the Desert Palm, Dubai, which is located approximately 300 m away from the proposed site boundary. Individuals accessing the commercial and office facilities within the surrounding industrial areas may potentially be affected during the construction and operation of the Project.

In reference to Dubai Heritage site listings (dubaiculture.gov.ae) there are no cultural sites within or surrounding the Project site. Based on a review of literature, the nearest cultural heritage site is the Al Fahidi Historical Neighbourhood, which is about 18 km away from the site.

Detailed discussion on social and cultural aspect is provided in Section 5.11.

4.3.2.7 Visual Resources

There appears to be a direct line of sight from the Desert Palm Polo Club and Hotel properties located to the north of the project site, although there exists both a landscape buffer and highway between. A new building is being constructed to the northwest of the project site. It will sit at an elevation above the site grade. A complete discussion on visual resources is provided in Section 5.10.

Plate 4-1 Panoramic view facing to the south from the approximate midpoint of the site

Plate 4-2 Panoramic view facing to the east from the existing sludge pits

Photographs of the existing site conditions taken on 9 April 2018 are include in the following Plate 4-3.

View of millings driving surface, asphalt paved area with truck parking beyond (facing north)

View of existing parking area over asphalt pavement (facing east from edge of site)

Eastern boundary of the proposed Project area

View of existing natural area at approximate mid-point of plot (facing south towards landfill area beyond)

View of existing maintenance area (facing southeast from edge of site)

View of off-site sludge management area (Al Aweer STP), off-site (facing south)

View of concrete producing plant(s) along western site boundary (facing west)

Continued from previous page

View of existing landfill with power plant stacks shown beyond (facing southwest)

Existing landfill along western site boundary, beyond limits of project disturbance (facing northwest)

View of active landfilling area (facing southwest)

View of natural vegetation (interior of plot)

View of existing site (facing east towards concrete producting plants from interior of plot)

View of existing site (facing north towards car park from interior of plot)

Plate 4-3 Existing Site Conditions surrounding the Project Area

4.4 Potential Key Sensitive Receptors

Based on the site assessment and literature review on land uses around the Project site, anticipated potential sensitive receptors have been considered in the environmental impact assessment process.

Sensitive receptors are areas where the occupants are more susceptible to the adverse effects of exposure to toxic chemicals, pesticides, and other pollutants (EPA, 2017). This include, but are not limited to, hospitals, schools, daycare facilities, elderly housing and convalescent facilities. Sensitive receptors categories, as per DM Technical Guideline No. 2 (2014), are defined for the Project in Table 4-3 and their locations shown on Figure 4-4.

An assessment of the Project's potential impacts on sensitive receptors is included within the EIA report. Reference is given to air, odour and noise baseline data obtained during the EIA baseline survey to assess potential impacts during the construction and operation phases of the Project (Sections 5.3 and 5.4, respectively).

Table 4-3 Receptors identified within 5 km from the site

Sensitivity and type of area [1]	Description and features of the receptors area [1]	Receptors within 5 km of the Project	
		Existing (baseline receptor)	Planned (a receptor that will be introduced by the Project or planned by other entities)
High (Type 1 Area)	Protected areas for conservation of national or international importance	None	None
	Water supply reserves	None	None
	Hospitals and school premises *(i.e. workers, patients, students)*	Desert Palm Riding Schools (370 m north)	None
		Dubai Academic City (2–5 km southwest)	
		New Dubai Police Academy (2.5 km south)	
		Wadi Al Shabak Army Training Camp (4 km northeast)	
	High density residential block, town center *(i.e. residents and visitors)*	Desert Palm Residential Villas (300 m north)	International City Phase (under construction) (edge is 3.25 km southwest)
		Al Warqa 4 (1.3 km northeast)	Ruwaya Village / Desert Rose (planned) (edge is 3.82 km south, southeast)
		Al Warqa 1, 2 and 3 (2.5–5 km northwest)	
		Dubai International City (1.5 km west)	
Moderate (Type 2 Area)	Vital utilities such as electricity and energy resources, natural wealth reserves and state-protected economic zones	None	None
	Light density residential block, public parks *(i.e. residents and visitors)*	Dubai Safari Park (public park) (1.3 km north)	WtE Plant Accommodation (light density) (within project boundary)
		Desert Palm Polo Club Resort and Hotel (public park) (620 m north)	
		Al Naboodah Labour Accommodation (light density) (4 km east)	
	Natural body of water *(i.e. tourist/visitors to the site)*	Warsan Lake (1.6 km west)	None
	Place of cultural heritage	None	None

Sensitivity and type of area [1]	Description and features of the receptors area [(1)]	Receptors within 5 km of the Project	
		Existing (baseline receptor)	Planned (a receptor that will be introduced by the Project or planned by other entities)
Light (Type 3 Area)	Commercial buildings, offices and other public areas *(i.e. workers, costumers and visitors)*	Dragon Mart Mosque (public area) (1.6 km northwest)	Offices at the project site - -future workers / visitors at the Project site
		Pivot Fields (public area) (300 m northwest)	
		DEWA Headquarters (offices) (200 m southwest)	
		Dubai Textile City (commercial building) (1.6 km northwest)	
		Dragon Mart Commercial Center (commercial building) (2 km northwest)	
		Commercial areas northeast of the Project site: Hardware and Building Material Market, ENOC Substation, RTA Bus Depo (1.59 km northwest)	
		Commercial areas east of the Project site: Emirates Transport Driving, restaurants and groceries (1.64 km east)	
	Good products manufacturing premises	None	None
	Agricultural crops farmland *(i.e. workers, costumers and visitors)*	Dubai Municipality Plant Nursery (500 m east)	None
		Warsan Plant Nurseries (1.5 km east)	None
Marginal (Type 4 Area)	Industrial *(i.e. workers and visitors)*	Unibeton – International City (concrete supplier) (350 m northeast)	The Project - future workers / visitors at the Project site
		Industrial Area adjacent to the site (Concrete suppliers: German Ready Mix, Emirates Beton Readymix LLC, China State Asphalt Mixing Plant) & Warehouse (Al Warsan Store and Arar Store)	
		Dubai Police Vehicle Impound Center (790 m southeast)	

Sensitivity and type of area [1]	Description and features of the receptors area (1)	Receptors within 5 km of the Project	
		Existing (baseline receptor)	Planned (a receptor that will be introduced by the Project or planned by other entities)
		Dubai Police Traffic Department and Impound Yard (1.20 km south)	
		Emirates Engine Maintenance Center (1.12 km south)	
		Power Station (edge is 350 m south)	
		Al Aweer STP (edge is 200 m west)	
		Envirol Plant (recycling facility) (390 m west)	
		Tasjeel (car inspection station) (1.2 km southwest)	
		DEWA Al Warsan Central Store (10 m southeast)	
		Tadweer Waste Treatment LLC (1.3 km west)	
		TransPro Systems (4.10 km east)	
		Trucks and Used Spare Part Market (3.92 km southeast)	
	Animal farmland but without dairy or meat food products processing *(i.e. workers and visitors)*	Dubai Bird and Pets Market (2 km southeast)	None

(1) - Categorisation of sensitive receptors is defined in DM-EPSS Technical Guideline No. 02 (March 2014)

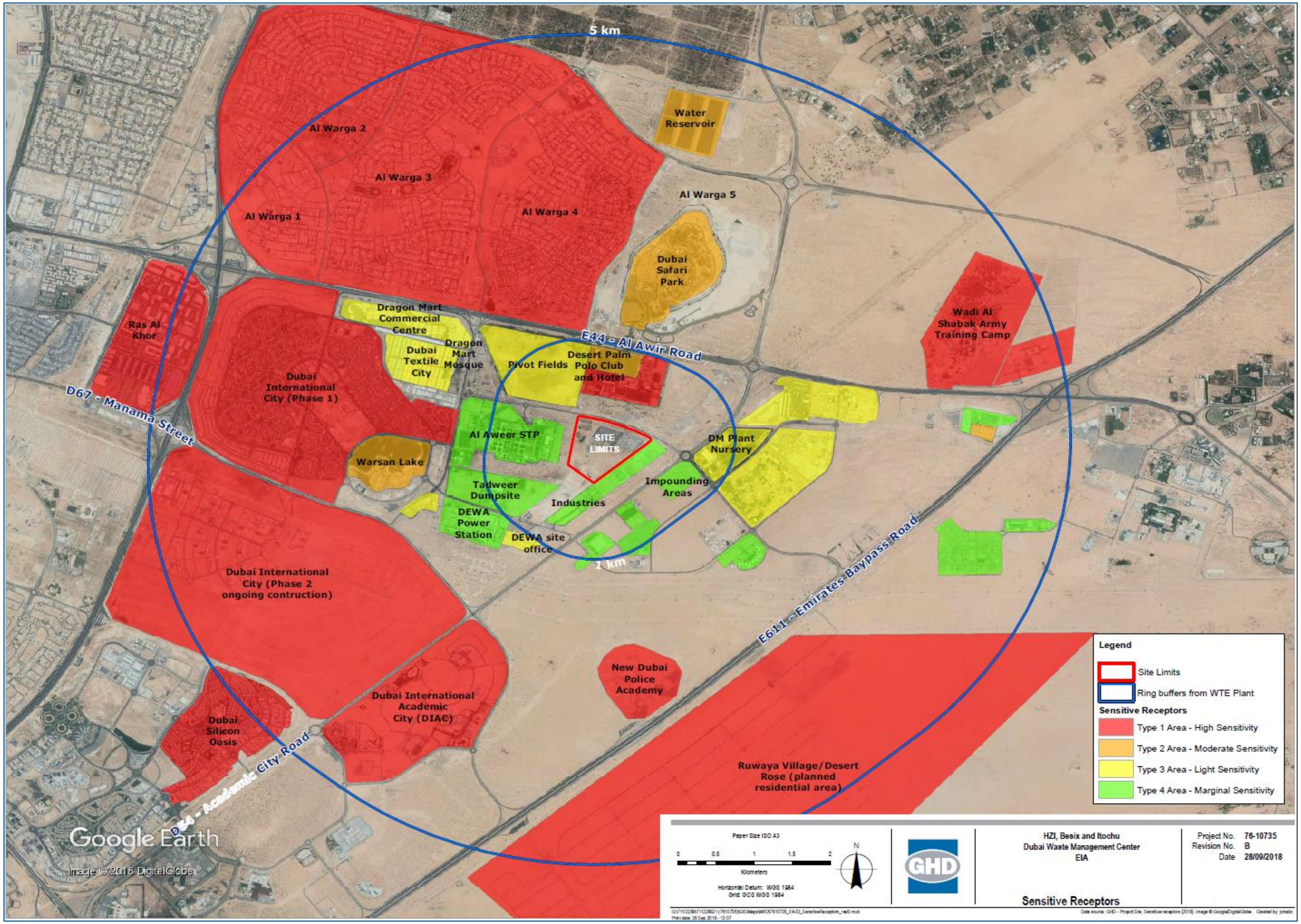


Figure 4-4 Existing Potential Sensitive Receptor Categories

4.5 Project Layout

The general project layout of the proposed WtE plant is provided in Figure 4-5. Project rendering is shown in Figure 4-6. It should be noted that the layout provided in this report is preliminary; the final layout will be provided by the EPC during detailed design stage but will generally comprise the same project components and parts as proposed. It is assumed that the final design / layout will reflect the current impacts and assessment. In the event that final design / layout differ from the preliminary design presented in this EIA, and EIA Addendum will be submitted to DM detailing the proposed changes and anticipated impacts.

The WtE plant will comprise of the components provided in Table 4-4, grouped as primary supporting functions and primary technical buildings.

Detailed description of the above facilities and buildings are provided in Appendix H with further discussion in subsequent sections describing processes and functions associated with key components and areas.

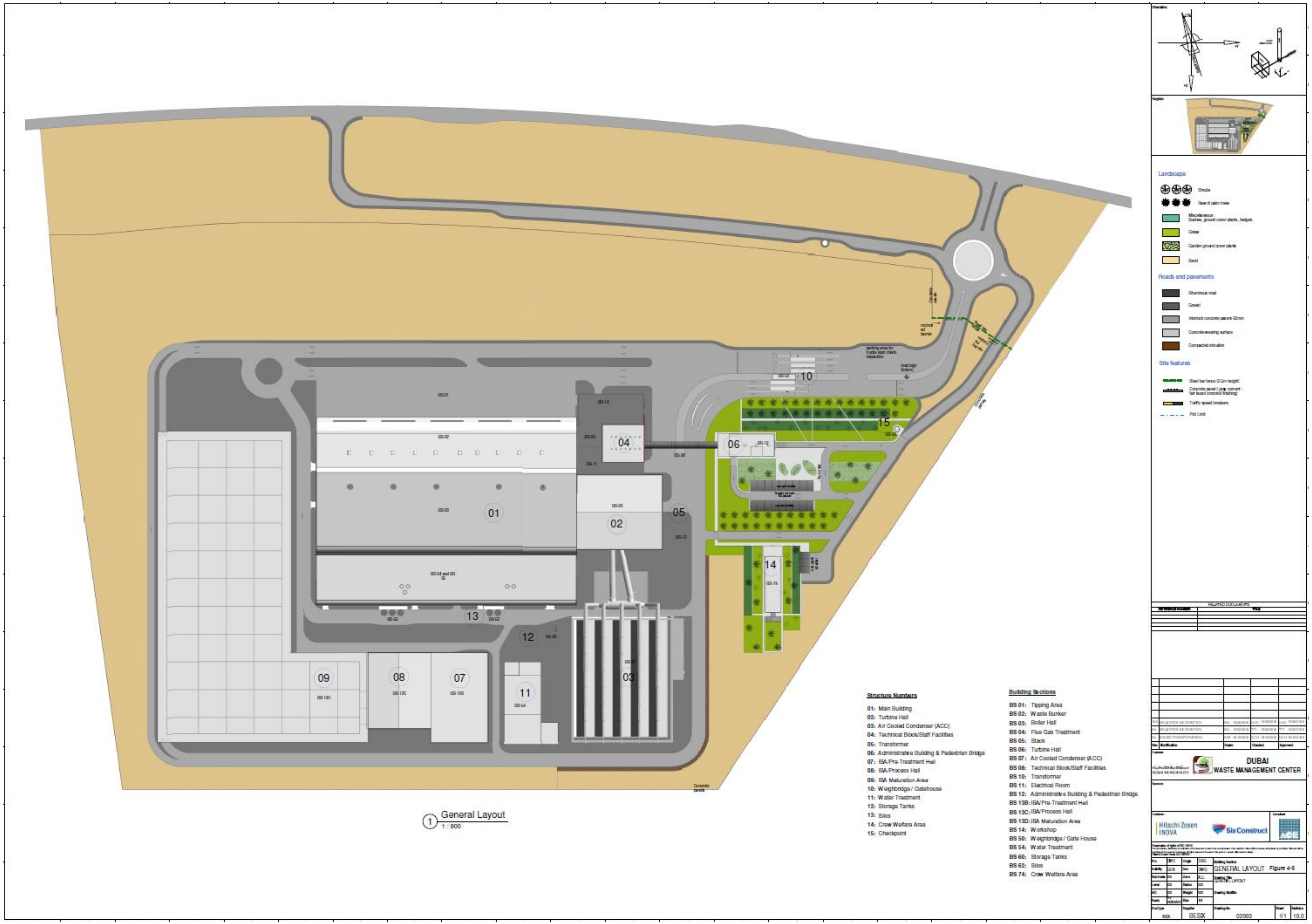


Figure 4-5 Project Layout

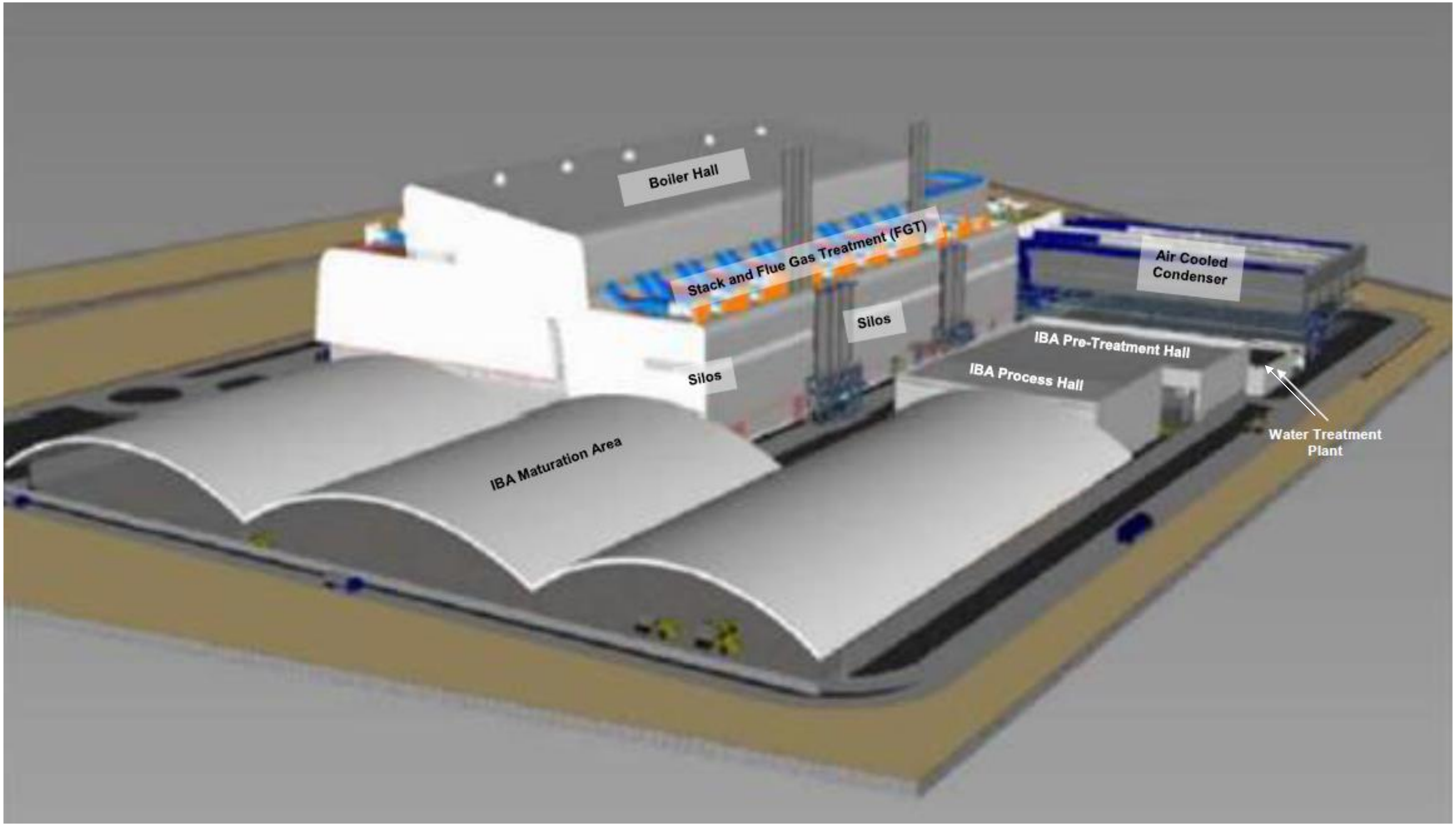


Figure 4-6 Project Rendering (View from South-West)

Table 4-4 Project Components

Buildings	Functional Description
Primary Supporting Facilities	
Administrative & Visitors Building and Operating & Maintenance Staff Facilities	The Administration Building will be designed and constructed to be able to accommodate 20 people on a permanent basis and additionally up to approximately 30 visitors on a temporary basis. The building comprises (i) offices and meeting rooms, (ii) cafeteria, (iii) archive room and storage rooms for office and cleaning supplies, (iv) restrooms, (v) kitchen, (vi) exhibition space, (vii) visitor area, (viii) training room and (ix)lifts for personnel.
Guardhouse	Trucks entry and exit
Weighbridge	Weighing of the waste deliveries (incoming truck weight minus outgoing truck weight) and acquisition of all relevant delivery data for inventory control. • Number of truck scales: 3 in - 2 out • Peak hourly truck entry: 80 trucks / h • Type truck scale: pit type / pitless type • Annual availability: 8,760 h/y / 24 h/day • Low and high temperatures:10 to 55ºC • Size of each platform (Length x width): 18m x 3m • Weighing range: 0.4-60 Mg • Weighing scaling intervals: max. 20kg • Horizontal movement of the platform in each direction: max. 10mm • Number of load cells per platform: 8 • Type of cell: digital • Load capacity per cell: Mg • Weighing accuracy according to OIML Standards: Class III

Buildings	Functional Description
	• Weighing accuracy: Max. 0.025% • Time for one weighing process: max. 60sec • Automatic vehicle identification: • Automatic ticket dispenser: 1 (exit scale) • Alphanumeric display and Intercom system: 2, one per scale • Automatic barriers: 2, one per scale • Weighing software and complete PC with mouse, printer and screen
Checkpoint	Staff and visitors entry & exit
Accommodation Building	To accommodate 120 people
Primary Technical Buildings	
Main Electrical Station	The steam turbine generator will be connected through the Generator Circuit Breaker (GCB) to the Generator Step up Transformer. When sufficient steam is produced, the generator will be synchronized to the 132 kV grid. Once synchronized, the net power production is delivered to the Grid. The Facility electrical auxiliary system is fed from the 6.6kV metal-clad switchgear, which is connected to the Unit Auxiliary Transformer. The plant system will be supplied from the 6.6kV switchgear. Dry type distribution transformers 6.6kV/0.4kV will be used for low voltage consumers. Two (2) Emergency diesel generators for safe shut-down will be installed and connected to the 6.6 kV switchboard. In the event of total power failure, the redundant steady-state uninterruptible power supply system guarantees the continuity of the power supply for the operational instrumentation and control system, i.e. the power supply for instrumentation, monitoring systems, the voice communications equipment, as well as the control voltage of the HV, MV and LV system.

Buildings	Functional Description
Main Process Building: 1) Tipping Bay	The tipping bays allow the transfer of the waste from the reception area to the waste bunker and guide the waste trucks in the tipping area. The waste delivery trucks back up to their assigned tipping bay made of concrete and unload their load into the waste bunker. Air is drawn from the waste bunker into the furnace combustion air. The resulting negative pressure within the waste bunker ensures that dust and odour are prevented from leaving the waste bunker.
2) Waste Bunker	Waste bunker for two lines (please refer to PDE-HZI-50071808_1.0 in Appendix H and Section 4.7.2 for detailed design of waste bunker): Dimensions of bunker 1 (2 lines): • Width – 56.0 m • Height – 33.0 m • Depth – 23.0 m • Volume – 42,504 m^3 Dimension of waste bunker 2 (3 lines) • Width – 87 m • Height 33 m • Depth 23 m • Volume 66,033 m^3
3) Mobile Waste Shredder	The mobile waste shredder will be used for processing bulky waste. Detailed description is provided in Section 4.7.3.
4) Boiler Hall	The boiler converts the heat of the flue gas into superheated steam. It is designed as a natural circulation boiler and is diviced into five main subsystems: • The economiser system • The evaporator system

Buildings	Functional Description
	• The superheater system • The boiler drum • The boiler blow down
5) Flue Gas Treatment	Refer to Section 4.7.6
6) Stacks	The stack expels the purged flue gas after the flue gas cleaning system to the atmosphere. Each incinerator line has one single self-standing stack of 70 m height. The Project comprise of five incineration lines; as such a total of five stacks grouped in two and three is anticipated. NOx emission from the stacks will be reduced with the use of SNCR / DyNOR system (refer to Section 4.7).
Turbine Hall	Refer to Section 4.7.5
Technical Block, Workshop and Electrical Rooms	*Technical Block*. The Technical Block will be designed and constructed to tbe able to accommodate 60 people during the dayshift and 17 people during the other shifts. In addition, during the 3-week overhaul period per individual line, there will be an additional 80-120 external workers using the locker rooms, showers and kitchen/canteen in the Technical Block. These overhauls will occur five times per year (there are five lines. The technical block will comprise (i) kitchen, (ii) cafeteria, (iii) first aid room (or plant clinic), (iv) prayer rooms, (v) locker room, (vi) lift for personnel, and (vii) toilets for male and femal employees. *Workshop*. The Workshop will include maintenance manager's office, store room, large ans small spare parts storage, electrical workshop, instrumentation workshop, mechanical workshop, open area (e.g. for fabrication, temporary laydown), and storage for consumables (i.e. lubricants, etc.)
Air Cool Condenser	During regular plant operation, the exhaust steam from the turbine condenses in the air-cooled condenser (ACC), which is situated beside the turbine house. In case of start-up, shutdown, overload or trip of the turbine, all or a part of the live stream flows into the ACC via the turbine bypass system. The thermal capacity of the ACC is high enough so that it is able to condensate the saturated steam that bypasses the turbine at an ambient temperature of 45 ºC.

Buildings	Functional Description
	In transitions from normal operation to exceptional cases, such as island mode and by-pass operation, excess steam may need to be blown off for a short period of time during in order to prevent a possible shutdown of the turbine or the plant. At ambient temperatures over approx. 35°C, it may also be necessary to reduce the boiler load during island mode operation or for the transition from by-pass operation to normal turbine operation.
Bottom Ash Maturation Area	Refer to Section 4.7.7
FGT Silos	The residue storage silo is an interim / temporary storage for the flue gas treatment residues. The silos are placed on an elevated steel structure prepared to the moistening system for open truck discharge. A continuous weighing device and analogue level measurement are fitted underneath the silo to monitor the filling level of the silo. A binary level switch is installed for overfill protection. A safety valve is installed to protect the silo against over and under pressure. A total of five silos for the whole Dubai WtE plant are anticipated. Each silo has an storage volume of approximatly 350 m^3, corresponding to approximately four days storage capacity
Storage Tanks	*Fuel oil tank (1x130m^3 and 1x200m^3).* Two containerized tanks will be located south of the main process building at a safe distance. The fuel will be unloaded from the delivery truck by means of its pump. *Aqueous urea solution tank (1 tank at 60 m^3)*. The 32.5% urea solution (NH_4OH) is stored in a steel tank. According to the effective regulations the filling line and the tank are equipped with safety equipment necessary for unloading and storage of the urea solution. The tank is located outside the main process building and sun shielded by roofs. A filling pump including necessary fittings is installed on a rack close to the unloading area. The tank truck must be able to receive the displaced urea gas exhaust during the unloading process via a return pipe. *Reception and storage of Solid Additives (hydrated lime) 5 silos each 150m^3.* The storage of hydrated lime is done in dust-tight silos. The product is delivered by silo trucks. On-site unloading of the trucks is done pneumatically using conveying air generated by the vehicle's on-board compressor. During silo filling the exhaust filter is cleaned automatically by compressed air pulses. The filling of a silo is released from the control room and started by the truck driver from a local control panel in the vicinity of the unloading station. When the filling is started the filling valve is opened and the exhaust filter cleaning is started. A silo is monitored with level switches in order to prevent overfilling of the silo and to indicate a low level. In addition, an

Buildings	Functional Description
	analogous level measurement is installed. A silo is equipped with a safety valve in order to protect the silo against over- and sub-pressure. The safety valve is connected to an exhaust pipe to the atmosphere. The silo is supported on an independent steel structure that is put onto weighing cells. At the bottom outlet of the silo a manually operated slide valve is installed. The discharge of the silo is ensured by means of a pneumatic discharge system using compressed air. *Storage of adsorbent (PAC or lignite coke) 2 silos, each 80m^3*. The adsorbent applied is activated carbon. The storage of adsorbent is done in two silo for the whole WtE plant. The adsorbent is delivered by silo trucks. On-site unloading takes place pneumatically using conveying air pressure generated by the vehicle's on-board compressor. The exhaust filter is cleaned automatically by a differential pressure controller. The cleaned exhaust air is expelled into the atmosphere. The fill level of the silo is monitored with level switches in order to prevent overfilling of the silo and to indicate the low level. The silo is equipped with a safety valve against over- and sub-pressure. At the bottom outlet a manually operated slide valve is installed. The silo is controlled by temperature measurements installed at the bottom and at the top of the silo. In case of an unusual temperature excursion the silo is rendered inert with inert gas. The inerting is to be released manually by the operating staff. *Inert gas (N_2) supply.* Two locations at the two adsorbent silos with bundles of bottles, each in total minimum 2100 litres (and bottle gas pressure 200 barg). Local UAE supplier will provide 40-litre as per below specifications. So, for a capacity on-site of 2100 litres, and each at 40-litre per unit, this would result in about 53 units per each location, or about 106 units in total. [NITROGEN GAS 240 CFT (40 LTR), Bottle gas pressure 2000 psI (Pounds per square inch)]. The The inert gas system smothers potential adsorbent fires in the conveying system, the adsorbent silos and the fabric bag filter by flooding them with inert gas. Potential fires, in particular smouldering in silos, are detected by temperature measurements as quick as possible and fought as a first measure by manually activating inert gas flooding of the affected area. The inert gas storage system is designed to ensure that typical smouldering fires may be extinguished or delayed until the fire brigade is on site and/or respective countermeasures, e.g. emptying of silos towards the incinerator, can be executed. The inert gas used is Nitrogen (N_2). Compared to the use of carbon dioxide (CO_2) the risk of smothering of staff is much lower due to the fact that nitrogen is immediately mixing up with air in an open system. Cylinder banks at about 200 bar cylinder pressure are available as inert gas storage. The cylinder banks, including fitting and gauge, are supplied by the Client and can be procured on a leased basis from a

Buildings	Functional Description
	nitrogen supplier. Inert gas is distributed by a piping system including necessary fittings to the respective consumer.
Installation of 132kV underground cable and connection to DM substation	The Project will be connected through a high voltage (HV) single circuit to the DM STP substation. Refer to Section 4.7.8 for detailed description.
Water Treatment Plant (WTP)	Refer to Section 4.7.9

4.6 Material Balance

The technological concept and the related volume streams for the proposed Project are illustrated in Figure 4-7. It should be noted that the figures provided in this section are preliminary and will be revised once final design is completed.

The primary input materials include MSW, diesel for start-up and water. The WtE plant requires approximately 5,666 tpd of fuel source (i.e. waste) at a net calorific value (NCV) of 9.5 MJ/kg, approximately 85 to 100 m^3/hour of water and diesel fuel used for auxiliary burners. Details regarding the gross, parasitic, net power, bottom ash generation, and air emissions are shown in Figure 4-8.

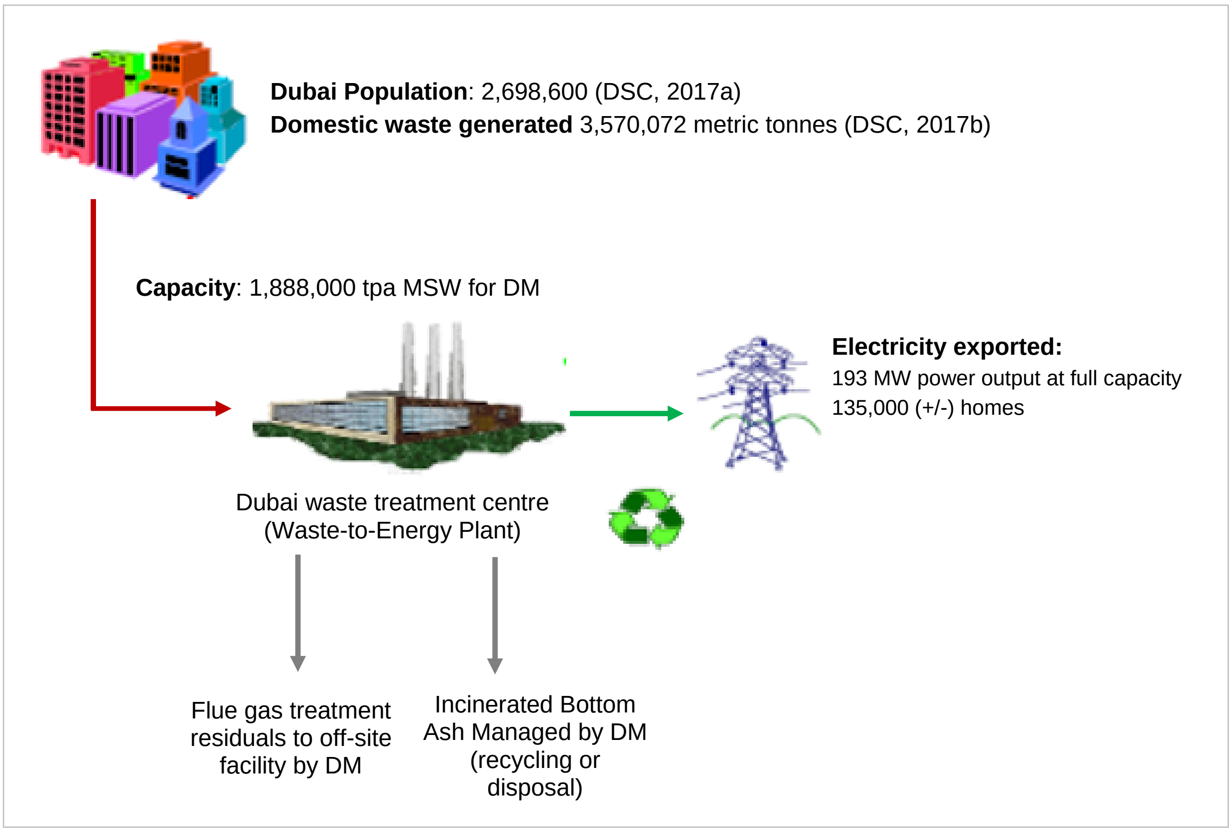
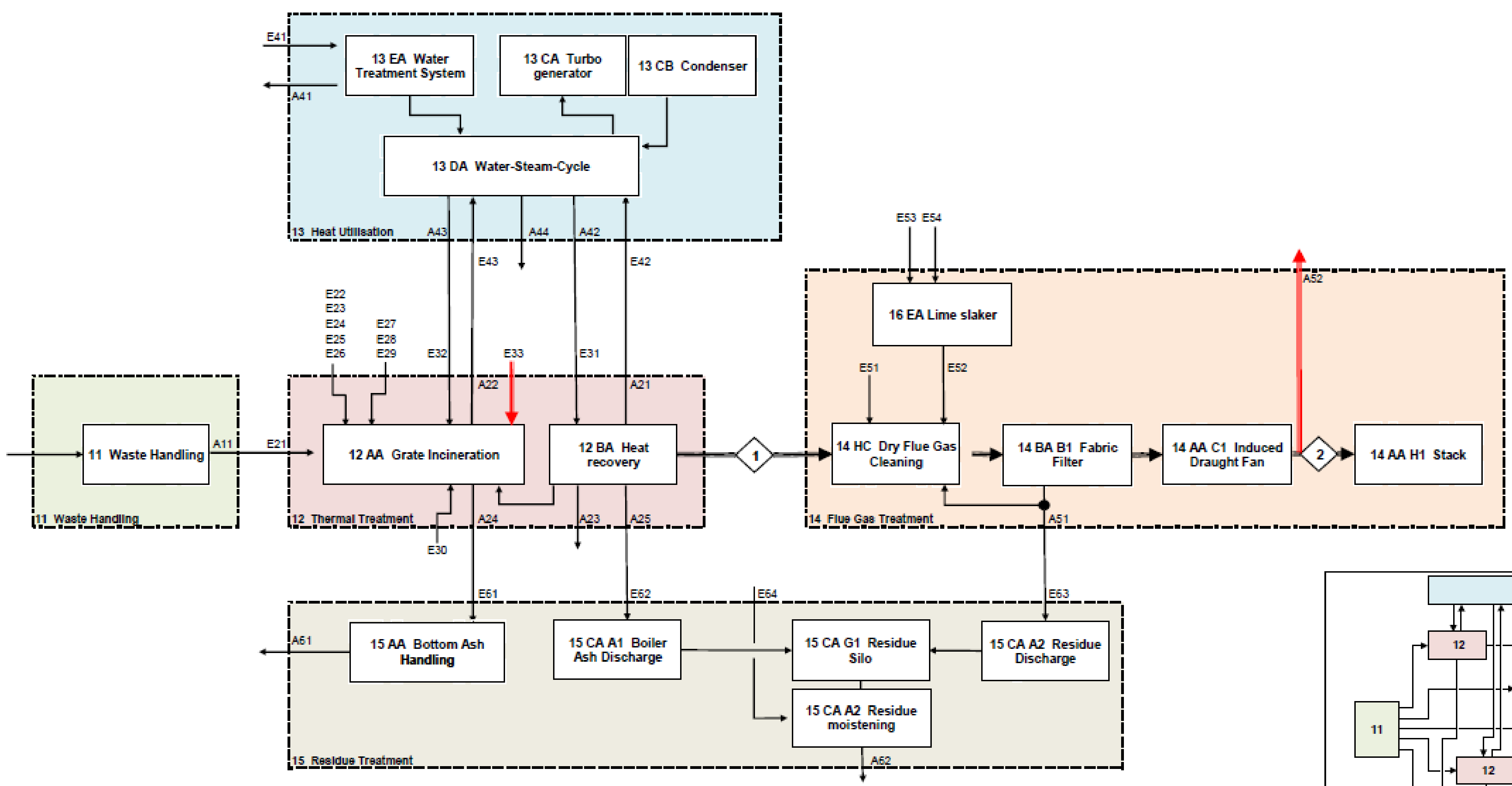
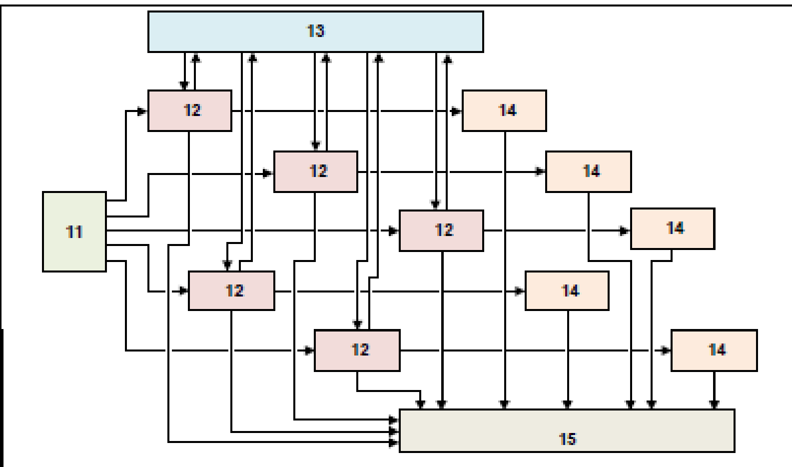


Figure 4-7 Technological concept diagram



Flue gas data: Composition and Emission			1 Boiler exit	2 clean gas
Flow rate		Nm3/h	234'064	210'873
Density		kg/Nm3	1.24	1.24
Temperature	(3)	°C	135	135
Composition				
H2O		Vol%	21.6	21.5
O2		Vol%	4.5	4.6
N2		Vol%	63.4	62.4
CO2		Vol%	10.4	11.5
Others		Vol%	0.1	0.0
Total		Vol%	100.0	100.0
Content of emission Emissions referring to dry gas at 11%O2 at reference conditions				
Flow rate	11%O2, dry	Nm3/h	280'580	250'623
Dust		mg/Nm3	3004	2
CO		mg/Nm3	20	20
TOC		mg/Nm3	2	2
NOx		mg/Nm3	200	200
HCl		mg/Nm3	1200	9
SO2		mg/Nm3	350	20
HF		mg/Nm3	10	0.1
NH3		mg/Nm3	2	2
Heavy metals				
Hg		mg/Nm3	0.5	<0.01
Cd+Tl		mg/Nm3	2	<0.02
Sb+As+Pb+Cr+Co +Cu+Mn+Ni+V		mg/Nm3	10	<0.2
Dioxins / furans TEQ		ng/Nm3	5	<0.05



Plant Configuration

Remarks

Indicated values are expected average operating values and not guarantee values
The Reference Condition for gas volumes (described as Nm3) is: 0.0 °C / 1013.25 mbar
Air density: 1.277 kg/Nm3
(1) Steam parameters: 77.0 bara 432 °C
(2) Feedwater temperature: 120 °C
(3) Expected average temperature between manual boiler cleanings

Input				Output			
11 Waste Handling							
E11	Waste	236'110	kg/h	A11	Waste	236'110	kg/h
E12				A12			
E13				A13			
12 Thermal Treatment							
E21	Waste	47'222	kg/h	A21	Superheated steam (1)	158'454	kg/h
E22	Primary air	123'384	Nm3/h	A22	Condensate air preheater	8'693	kg/h
E23	Secondary air	34'049	Nm3/h	A23	Continuous boiler blowdown	470	kg/h
E24	Burner cooling air	4'200	Nm3/h	A24	Bottom + boiler ash 2nd pass, wet	8'187	kg/h
E25	Parasitic air through feed hopper	1'500	Nm3/h	A25	Boiler ash (to FGT)	282	kg/h
E26	Air through cleaning devices	3'088	Nm3/h	A26			
E27	Air to rear ventilated refractory	4'250	Nm3/h	A27			
E28	SNCR solution reaction medium	30	kg/h	A28			
E29	SNCR injection air	908	Nm3/h	A29			
E30	Water bottom ash extractor	1'910	kg/h	A30			
E31	Feedwater (2)	158'924	kg/h	A31			
E32	Steam air preheater LP+MP	8'693	kg/h	A32			
E33	Recirculation flue gas	24'690	Nm3/h	A33			
E34				A34			
E35				A35			
E36				A36			

Input				Output			
13 Heat Utilisation							
E41	Water to water treatment system	17'740	kg/h	A41	Blowdown water treatment system	6'050	kg/h
E42	Superheated steam (1)	792'270	kg/h	A42	Feedwater (2)	794'620	kg/h
E43	Condensate air preheater	43'465	kg/h	A43	Steam air preheater LP+MP	43'465	kg/h
E44				A44	Cycle losses & sampling	3'830	kg/h
E45				A45			
E46				A46			
14 Flue Gas Treatment							
E51	Activated carbon	12	kg/h	A51	Residues FGT dry	2'166	kg/h
E52	Hydrated lime Ca(OH)2	838	kg/h	A52	Recirculation flue gas	24'690	Nm3/h
E53	Quick lime CaO	633	kg/h	A53			
E54	Water lime slaker	419	kg/h	A54			
E55				A55			
E56				A56			
15 Residue Treatment							
E61	Bottom ash, wet	40'935	kg/h	A61	Bottom ash, wet	40'935	kg/h
E62	Boiler ash	1'410	kg/h	A62	Residues moistened	14'443	kg/h
E63	Residues FGT dry	10'830	kg/h	A63			
E64	Water moistening boiler ash & residues	2'203	kg/h	A64			
E65				A65			
E66				A66			

Indicated values taken from the following design calculations:

	Prog. No.	Doc. No.	Rev.	Date
Heat Mass Balance - Boiler	CB-005	50056196	3	05.04.2019
Water balance	CSP-104	50056645	7	10.04.2019
	-	N/A	0	xx.xx.xxxx
	-	N/A	0	xx.xx.xxxx

Rev.	Date	Description
0.7	11.04.19	Capacity increase (102%)
0.6	13.12.18	A62 Residues moistened corrected
0.4	28.08.18	SNCR reagent consumption based on urea
0	26.10.16	First issue

Project Name		Project No	Load point	
Dubai WtE BOT		YE-3256	LP N	Hitachi Zosen INOVA
	Date	Name	BLOC DIAGRAM Figure 4-8	
Prepared	11.04.2019	Elc		
Checked		Kas / Casa / Hea	HZI doc. N° :	Revision
Approved			50056194	0.7
Prog. No. CSP-103 / V2.0			Print date : 28.05.19	Page : 1/1

R:\VRU-SP\Angebotsprojekte\YE-3256 Dubai WtE BOT\13 Prozess\03 Fliessbilder\Grundfliessbild\[PDE-HZI-50056194_0.7_Bloc Diagram_in work.xlsm]Diagram

Figure 4-8 Bloc diagram (preliminary design to be finalised)

4.7 Technology Overview

As per HZI, the proposed technology is based on the most reliable and continuously improved solution that complies with European Regulations/Industrial Emission Directive (Directive 2010/75/EU), allows for environmentally and ecologically optimised operation, and provides for maximum flexibility. In 2016 Fichtner, as DM's technical adviser, defined the IED 2010/75/EU as the basis for the design compliance. The design of the WtE plant, therefore, is based on IED.

The proposed Project consists of five lines each comprising a furnace equipped with the Selective Non Catalytic Reduction (SNCR) process for nitrogen oxide (NOx) control, a HZI 4-pass heat recovery boiler, the HZI-dry flue gas treatment system and, for all units, a common water-steam-cycle with an effective turbine-generator set for the heat utilisation.

A block diagram of incinerator-boiler and dry flue gas treatment sysem is provided Figure 4-9.

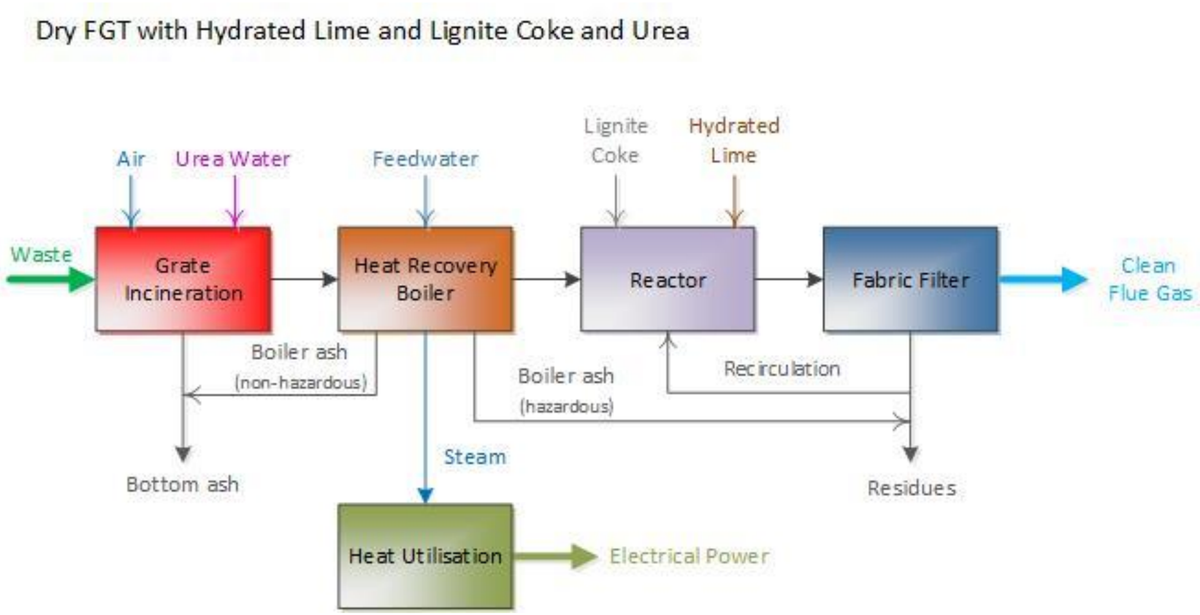


Figure 4-9 Block diagram showing incineration-boiler and dry flue gas treatment system

4.7.1 Feedstock (Waste) Handling

For the Project, and at the time of the EIA development, input MSW as feedstock to the WtE plant will be sourced from the Dubai Municipality. MSW is currently disposed of at DM's Al Qusais Landfill, which is approximately 13 km north of the Project site. Transportation of MSW will generally be via the existing road network, but not necessarily rerouted from the landfill because trucks can deliver directly from the source of generation ("pick-up") to the WtE plant ("drop-off").

At the WtE plant, the waste handling system will consist of tipping bays for receiving waste, and a waste crane for feeding the thermal treatment system. Waste delivery vehicles are anticipated to be registered into a database of certified haulers and identified by means of an electronic card system, or equivalent, to facilitate efficient scaling (weigh-in) for delivered materials.

In parallel with the EIA, a traffic impact study (TIS) was completed to assess the impacts associated with transporting of MSW associated with the Project. A copy of the TIS is included in Appendix Q and potential impacts are assessed in Section 5.7.

4.7.2 Waste Bunker

One waste bunker hall with two waste bunker pits will be installed. The waste bunker pits will be separated by the central control room block (i.e. the waste is physically stored within two waste bunker compartments but they share the same ‘headspace’ – including common waste crane rails – and roof and air).

Dimension of the waste bunker 1 (2 lines) is:

- Width – 56.0 m
- Height – 33.0 m
- Depth – 23.0 m
- Volume – 42,504 m^3

Dimension of the waste bunker 2 (3 lines) is:

- Width – 87 m
- Height 33 m
- Depth 23 m
- Volume 66,033 m^3

Illustration of waste bunker is shown in Figure 4-10. Set-up within waste bunker hall is as follows:

- Waste bunker compartment 1 with 2 incineration lines
- Waste bunker compartment 2 with 3 incineration lines

Therefore, if 1 out of 2 or 3 respectively, incineration lines are in operation, the slightly negative pressure in the waste bunker hall can be maintained.

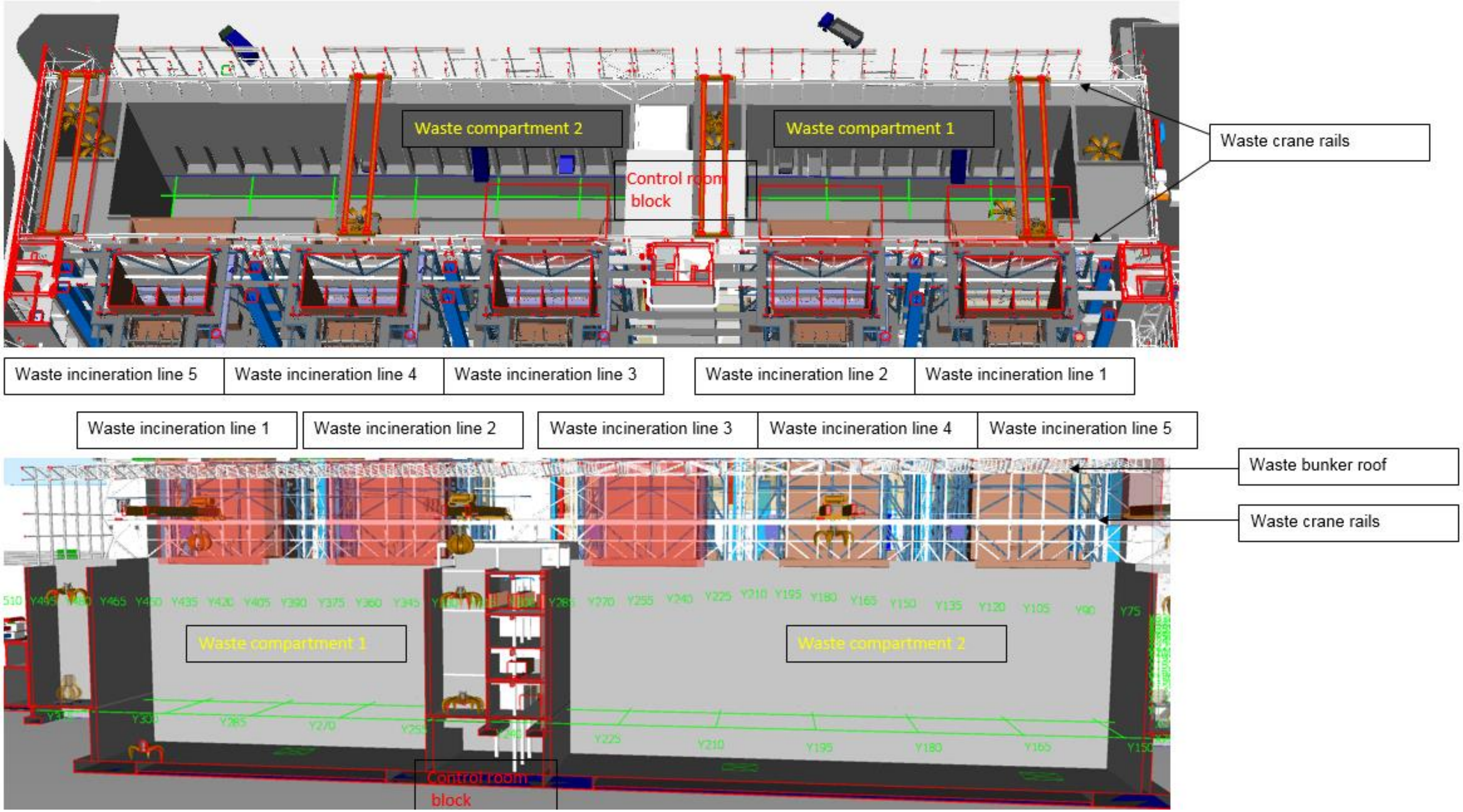


Figure 4-10 Waste Bunker

4.7.3 Mobile Waste Shredder

A mobile waste shredder is proposed to be used for processing bulky waste, as a contingency plan should waste be received at the site that is unsuitable for feedstock to the incinerator lines. A two-shaft shredder (Urraco 75 or similar) will be used (Figure 4-11). Detailed description of the proposed mobile shredder is provided in Appendix S.

The mobile waste shredder has the following descriptions:

- Mobile shredder will be positioned in the corner of the waste bunker area (Figure 4-12). If bulky waste is received (requiring shredding) then the mobile shredder will be used to reduce the waste to suitable size processing.
- The unit will be installed within the interior of the building, with two roller access doors (Figure 4-13). The shredder will be placed in a closed door to avoid noise emissions. The roller access doors will only open to load the shredder with bulky waste and during picking up of shredded material by the wheel loader. The shredder should be switched off while the access doors are open.
- Waste will be loaded into the unit, and then the doors closed while the unit is operating (shredding the waste).
- When the shredding is completed, the shredded waste will be moved via front-end loader from the shredding area to the waste bunder for processing with MSW.

Figure 4-11 Two Shaft Mobile Waste Shredder

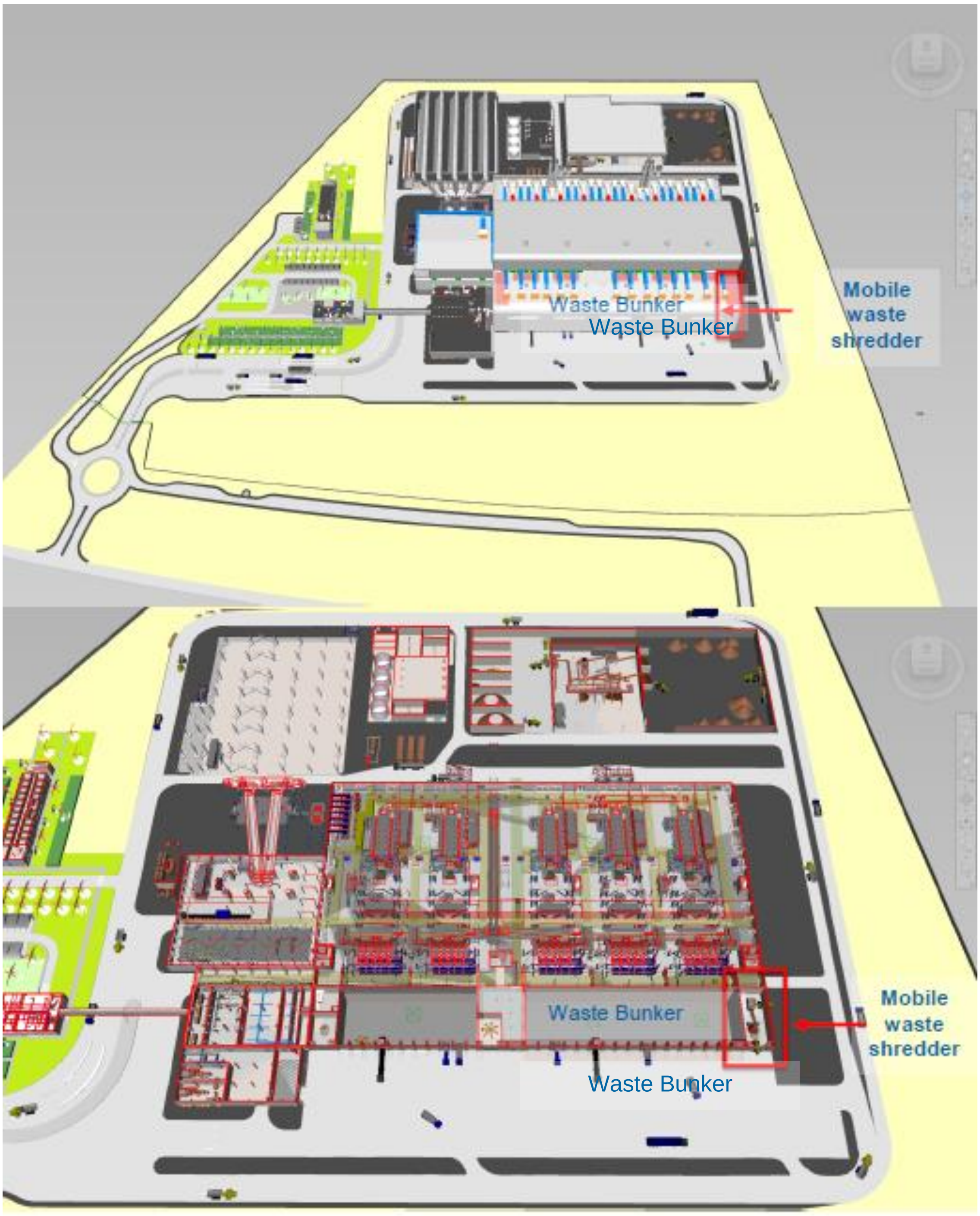


Figure 4-12 Location of mobile waste shredder

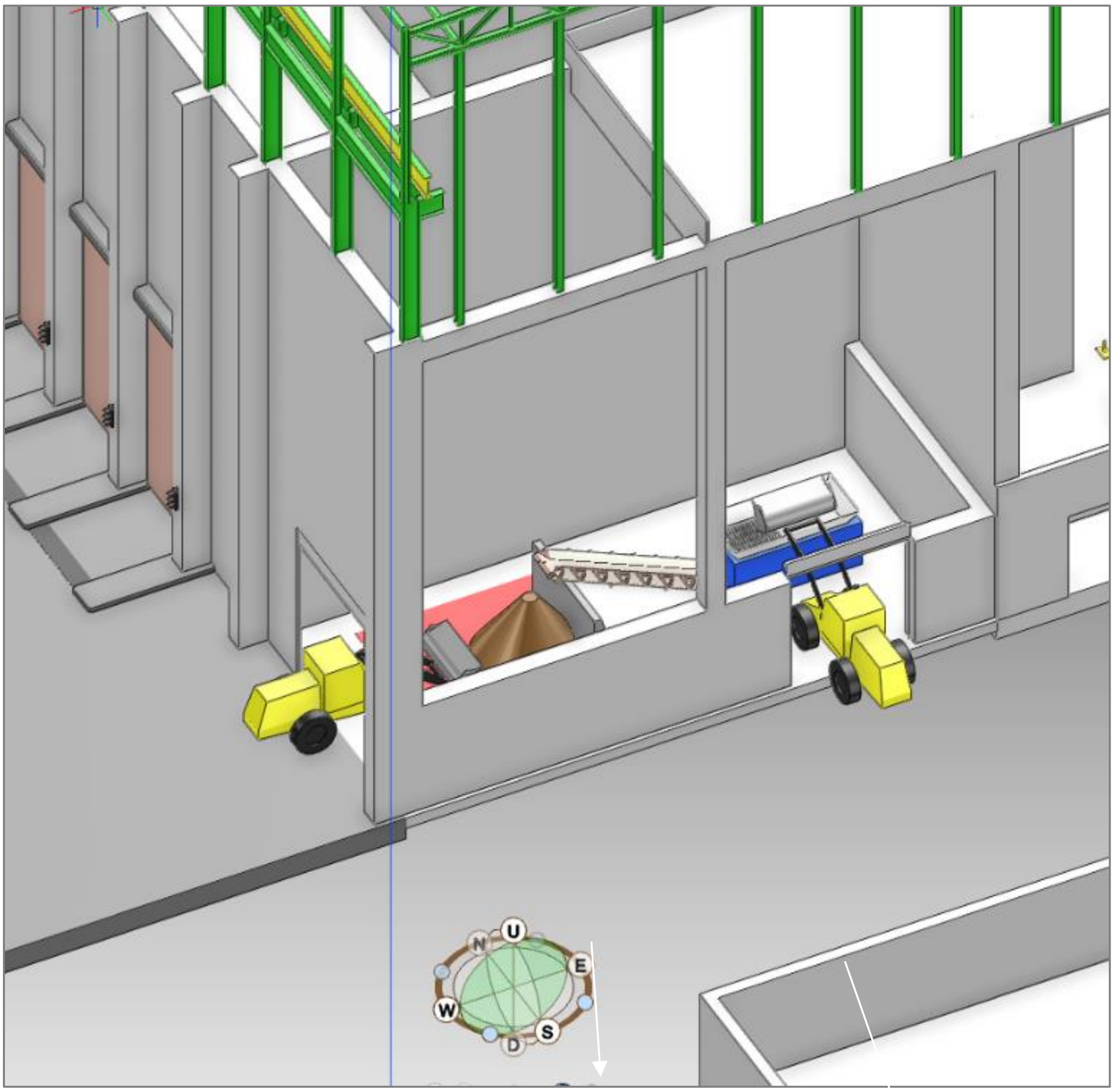


Figure 4-13 Operation Mobile Waste Shredder

4.7.4 Thermal Treatment

The thermal treatment system consists of an air-cooled grate, combined with a 4-pass tail end heat recovery boiler, which forms the basis for this WtE plant's conversion technology (Figure 4-14). In general, a 4 pass boiler is designed to provide improved "opportunity" for hot gasses to transfer heat to the water in a boiler, which allows for more efficiency in the operation, i.e., yielding a higher overall heat-transfer coefficient (Industrial Boiler & Mechanical, 2018).

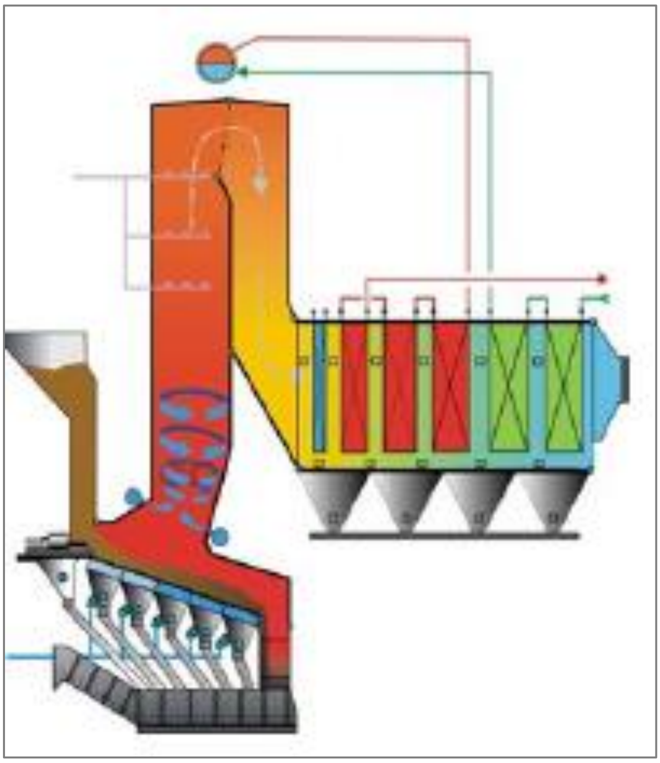


Figure 4-14 Thermal treatment schematic

For the project: 4 pass heat recovery boiler with 2 vertical empty passes, 1 horizontal pass and 1 vertical economiser pass (VVHV)

Source: HZI and Besix (2016a)

4.7.4.1 Combustion Control System

The combustion control is fully automatic (Figure 4-15). The operator only selects the desired steam output and all other parameters (waste feeding, grate speed, amount of combustion air etc.) are handled by the control system itself. This secures that the plant operates continuously at an optimum regarding efficiency, environmental protection and life expectancy of the equipment.

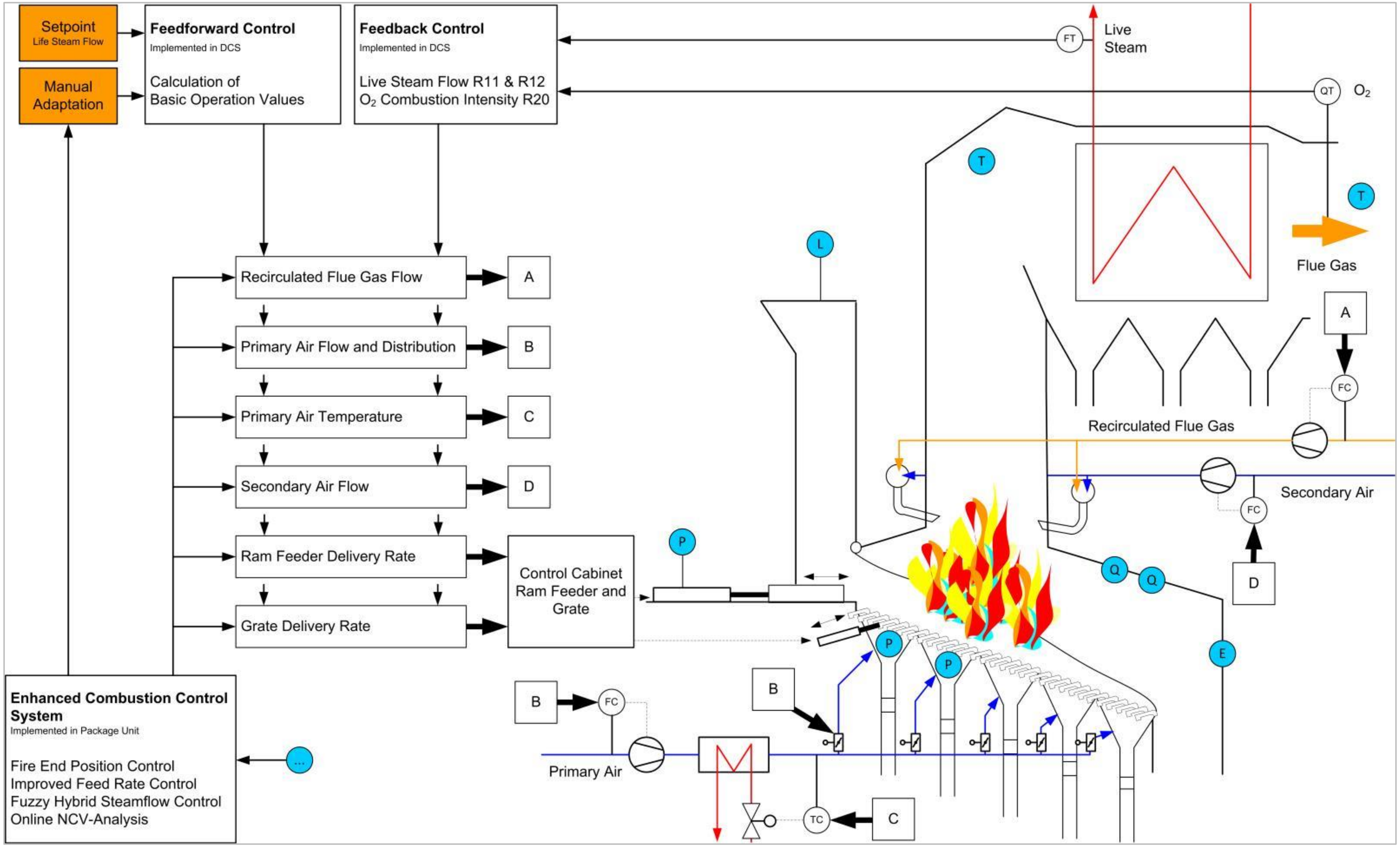


Figure 4-15 Combustion Control System for a 5-zones grate with recirculated flue gas

Source: HZI and Besix (April 2018)

4.7.4.2 Incineration Design

The incineration system grate is designed primarily for municipal waste. It is also capable of treating industrial and commercial waste with similar characteristics. The specific thermal and static surface loads are important design parameters of an incineration unit, which is expected to demonstrate low wear and long life expectancy. For the given calorific values, the HZI air-cooled grate serves best with its well proven design.

The furnace is designed for continuous waste combustion in the range between 70 and 100% of the thermal design load. Short-term peaks caused by the non-homogeneity of the waste are absorbed by the system up to 110% of the design load.

In case the temperature in the secondary combustion chamber drops below the legal permit limit, oil fired support burners automatically start operation. Experience shows that such activation occurs very rarely. Predominantly the burners remain in a stand-by position and are cooled by cooling air fans. The burners are, however, routinely used for start-up and shut down of the plant.

Combustion Temperature

Temperature controls for incineration are closely related to the overall design compliance strategy as per European Regulations/Industrial Emission Directive 2010/25/EU.

The furnace temperature is compliant with European Regulations/Industrial Emission Directive (Directive 2010/75/EU) as follows: "WtE Plant furnaces temperature maintained for at least two seconds after the last injection of combustion air and in the presence of sufficient oxygen to meet IED 2010/75 EU for all points within the Combustion Diagram ≥850°C".

Temperatures are variable across the combustion chambers. For simplicity, the temperatures in the combustion chambers can be generally defined and outlined in the following way:

- **Primary combustion chamber**: regarding the temperature in the primary combustion chamber, only a theoretical value can be given, that is what is referred to as "theoretical adiabatic temperature". It is the combustion temperature that theoretically the flue gas will reach in case of complete combustion (100% of the combustion air participates to the combustion, while in reality there is a split in the total flow in primary and secondary air) and no heat exchanged with the combustion chamber itself (walls etc.). This temperature is 1312°C at the design load point LPN.
- **Secondary combustion chamber**: assuming that one defines the secondary combustion chamber as the portion of the furnace after the injection of the secondary air, then different temperatures can be calculated at different positions. As an example, in the design load point LPN at the end of the first pass we calculate 927°C (with a fouled boiler).

These values are expected averages in the furnace section, that is, assuming uniform temperature distribution in the cross sectional area of the furnace. Again, the temperature compliance is in line with IED specifications referenced above.

4.7.4.3 Flow optimised SCC with Swirl Injection

The geometry of the secondary combustion chamber (SCC) is designed for optimal flow conditions. In addition, a further improvement is accomplished by the arrangement of the secondary air nozzles which create a swirl in the SCC. Due to this swirl the flow is homogenised with respect to temperature, velocity and concentrations. Peaks in temperature, velocity and concentrations are minimised in order to:

- Improve burn-out of the flue gas

- Provide a uniform temperature profile across the secondary combustion chamber
- Reduce CO-concentrations
- Minimise risk of corrosion of unprotected heating surfaces
- Improve burn-out of fly ash
- Reduce the amount of fly ash
- Reduce the formation of dioxins

The swirl injection (Figure 4-16) has been applied with great success in all recent HZI plants.

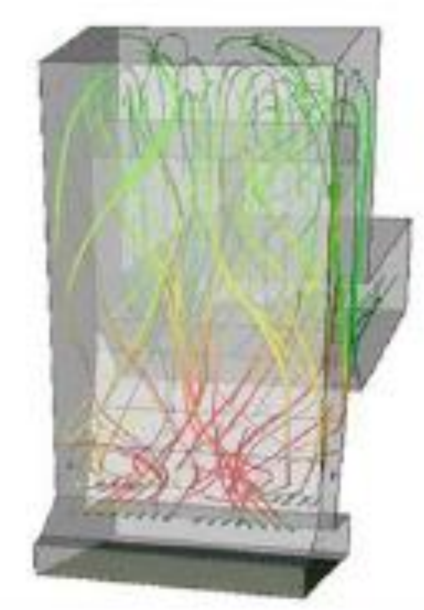


Figure 4-16 Swirl Injection

4.7.5 Heat Utilisation

The steam is transformed into electrical energy in a turbo-generator set that is used to cover the plant's own electricity needs and to feed to the public electrical grid (Figure 4-17). The primary elements of the heat utilization include:

- *Turbine Unit*. A steam turbine transforms the thermal energy of the high-pressure steam into a rotary motion and, coupled with a generator, electricity can be produced. Bleed pipes located at three locations on the turbine body allow to extract steam at several pressure levels, so that different internal steam consumers within the WtE plant can be supplied.
- *Control and Lubrication Oil Supply*. This system supplies the turbine with oil to lubricate the bearings of the turbine shaft and to operate the control valves.
- *Generator*. The generator system transforms the mechanical energy into electrical energy.
- *Cooling System*. This is designed as a closed circuit to cool down the oil circuit of the steam turbine, the generator, the steam / water sampler as well as other process equipment that requires active cooling.

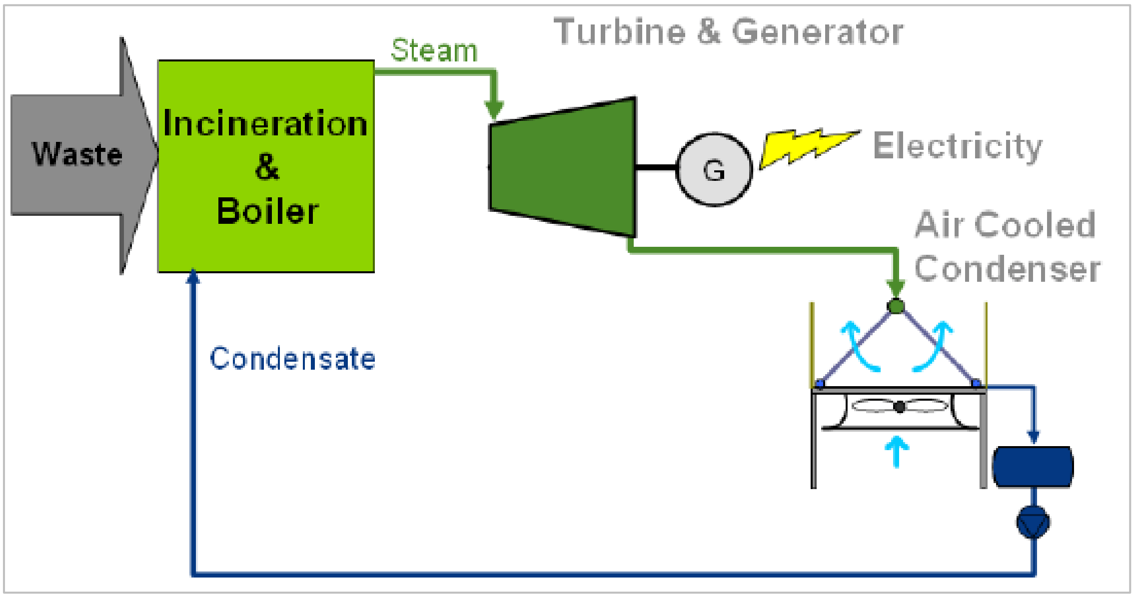


Figure 4-17 Turbine generator within the WtE plant

Source: HZI and Besix (2016b)

4.7.6 Flue Gas Treatment

Flue gas is a mixture of gases resulting from combustion and other reactions in a furnace, passing off thourgh the smoke stack (MerriamWebster). Flue gases from WtE plant contain substances such as particulate matter, acid gases or organochlorides (HCl and HF), sulphur dioxide (SO_2), nitrogen oxides (NOx), heavy metals (mercury, lead, cadmium, chromium, copper, zinc, nickel, etc.), carbon monoxide (CO), together with hightly toxic polyhalogenated aromatics as the dioxins, a class of species including polychlorinated dibenzo-p-dioxins (PCDDs) and dibenzofurans (PCDFs) (ScienceDirect, 2016).

4.7.6.1 Particle Separation

A fabric filter will be used for the separation of solids from the flue gas. In the physical process of separation, the solids are filtrated on the surface of a gas-permeable fabric. Due to the intensive contact of the flue gas and the adsorbents in the filter layer, the removal of pollutants from the flue gas is further improved.

The fabric filter is a pulse jet, multi chamber bag filter with several compartments (Figure 4-18). It is designed to reduce welding work and mounting time on site: the compartments are assembled to a high degree in the workshop, with a positive effect to final quality.

The fabric filter separates solid reaction products from the flue gas. Solids collected in the filter hoppers are transported with chain conveyors to collecting bins. From the first collecting bin the solids are recirculated back to the reactor. Overflown residues coming directly from the first to the second collecting bin are pneumatically transported to the residue storage silos, which are interim storage for the FGT residues. Silos are placed on an elevated steel structure prepared to the moistening system for open truck discharge and then removed from the WtE plant site by DM-WMD registered haulers for disposal[6].

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[6] The EIA excludes assessment of the waste storage facility for the bottom ash and flue gas treatment (FGT) residue. An assessment and approval for the construction (if a new facility will be built) of the permanent storage facilities will be obtained separately by others (e.g. DM-WMD as the Project Owner), if required. Letter of Understanding / Commitment from DM-WMD is provided in Appendix B.

Figure 4-18 Principal function of bag filter and pulse-jet on-line cleaning

Source: HZI and Besix (2016b)

4.7.6.2 Dry Flue Gas Cleaning with Lime and Lignite Coke

The dry flue gas treatment process is designed by HZI specialists to remove all dust particles, most of the acidic gaseous contaminants, by neutralisation with hydrated lime and organic pollutants (PCDD/F) as well as mercury and other heavy metals by adsorption on lignite coke (Figure 4-19). The system consists of a reactor with additive injection, fabric filter for solid-gas separation and residue recirculation. To achieve the best adsorption performance with minimum additive consumption, solids from the fabric filter are recirculated into the reactor.

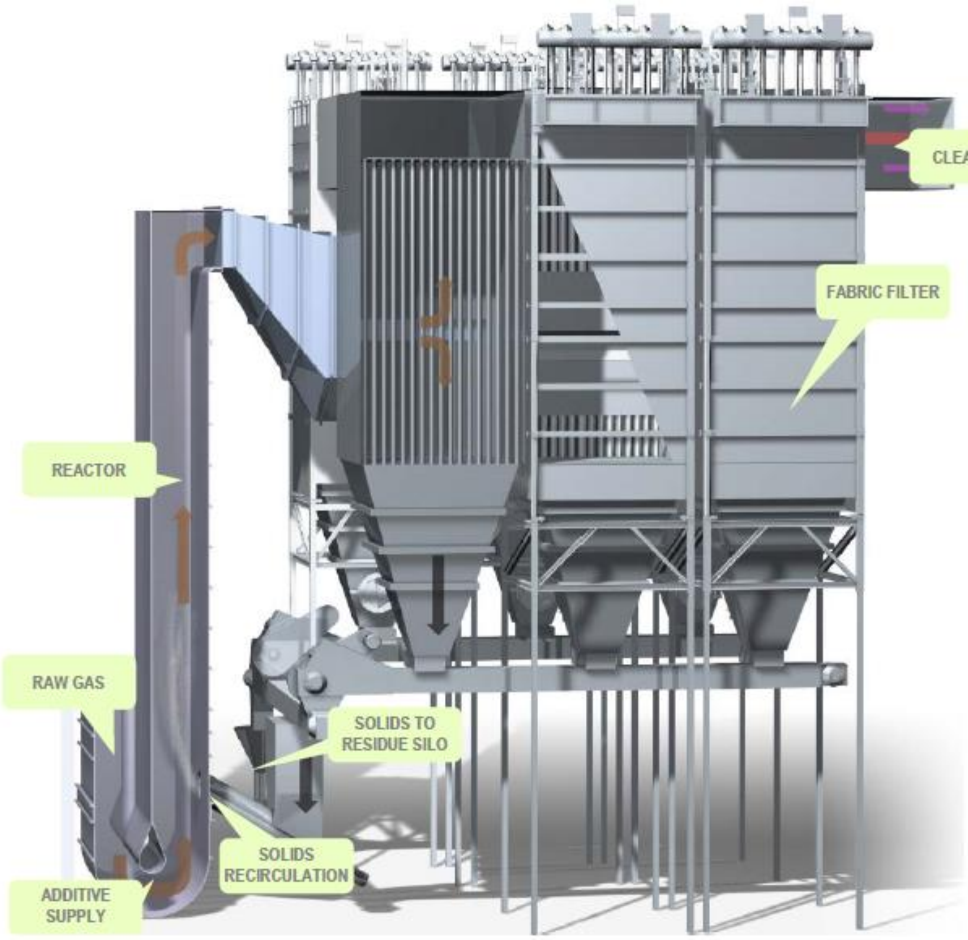


Figure 4-19 Principle of HZI Dry Process – XeroSorp®

Source: HZI and Besix (2018)

The Xerosorp® flue gas treatment process is characterised by the following features:

- Simple design of the reactor ensures high availability, low maintenance and operation cost
- Reduction in residue costs and additive amount due to residue circulation
- High energy efficiency thanks to dry injection of additives and low pressure drop over reactor
- Dry injection of additives enables adsorption without waste water
- Recirculated solid injection in addition to fresh additives enables to smooth emission peaks and low stoichiometric ratio

4.7.6.3 SNCR Process

NO_x reduction occurs in the combustion zone where an aqueous solution of ammonia is injected into the flue gas stream leaving the grate and reacts selectively with the NO_x in the combustion chamber.

Due to the optimised flue gas flow and well-designed distribution of reagent solution, a high removal efficiency of NO_x and low excess of ammonia is achieved.

The results are:

- Well controlled emissions of NO_x
- Optimised consumption of ammonia solution

4.7.6.4 DyNOR^{TM} – Advanced SNCR

The DyNOR^{TM} system is an advanced SNCR (Selective Non Catalytic Reduction) system which has been developed by HZI with the objective to meet new European NOx standards with a SNCR-system. With today's SNCR-systems the limits set by the EU-directive can be easily met with a minimum ammonia slip. If lower NOx limits are requested either a SNCR-system combined with a wet flue gas cleaning system and an ammonia recovery from the waste water or a SCR-system - Selective Catalytic Reduction - is required. Both alternatives cause much higher internal consumption of power and heat.

The essestial measures for an advanced SNCR-system are:

- Quick temperature measurement
- Precise and fast-acting distribution of reagent injection
- Virtual segmentation of the boiler

Urea solution is injected into the secondary combustion chamber depending on the temperature profile exactly on the level where the best reaction is expected. It is injected simultaneously on one or more levels (Figure 4-20). The measurements comparing the operation with the regular SNCR-system and the advanced SNCR-system DyNOR^{TM} in the same WtE plant show a significant improvement (Figure 4-21).

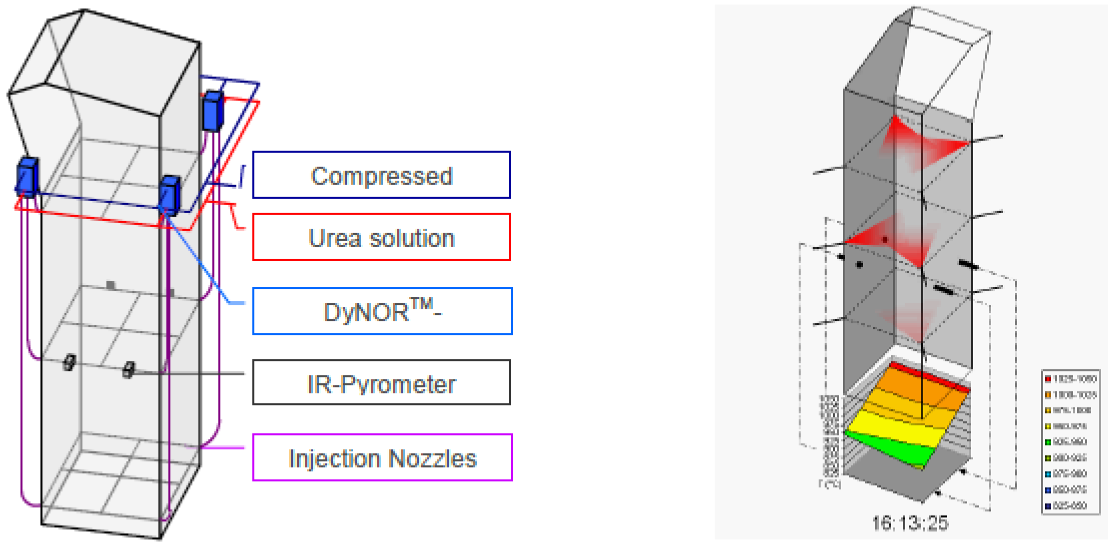


Figure 4-20 Injection of Urea Solution

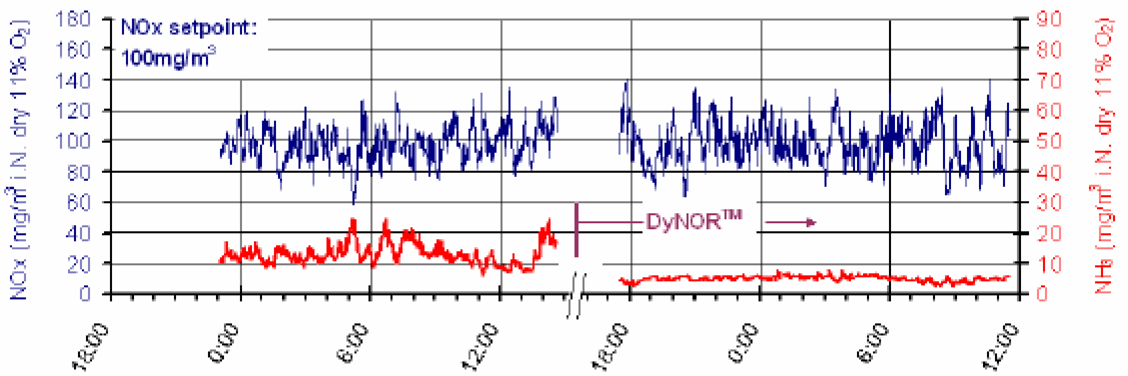


Figure 4-21 Comparison between regular SNCR-system and advanced SNCR-system DyNOR^{TM}

4.7.7 Bottom Ash and FGT Residue

The Project will be compliant with the stringent European Regulations/Industrial Emissions Directive (Directive 2010/75/EU) with regard to ash quality. The by-products of the WtE plant are bottom ash, boiler ash and flue gas treatment (FGT) residue. Fly ash is the residue composed of fine particles that rise with the flue gas while bottom ash is the ash collected at the bottom of the furnace. Boiler ash is formed as the hot flue gases are led up through the boiler.

4.7.7.1 Bottom Ash Treatment Area

Bottom ash primarily comprise of silicon, calcium, iron, aluminium and sodium. The appearance of bottom ash is a mix of a very fine grey porous material, inert components such as fine gravel, rocks, glass, ceramics and metallic items (ISWA, 2015).

On-site IBA management comprise of the following:

- *IBA Pre-treatment Hall (refer to Section 4.5 Figure 4-5 Area 07 [structure number] and Building Section BS13-B)*. The IBA is conveyed to this covered area where it is stored up to five days to reduce moisture content prior to the treatment / metal separation in BS13-C Process Hall.
- *IBA Process Hall (refer to Section 4.5 Figure 4-5 Area 08 [structure number] and Building Section BS13-C).* In this covered area, the IBA from the Pre-treatment Hall is processed. The Bottom Ash Treatment diagram is illustrated in Figure 4-22. An extraction of ferrous and non-ferrous metals takes place in this area with a series of different flows including crusher, overband magnets, magnetic drum, eddy current separators, a hand sorting platform, screens and belts, producing mineral fractions of diffrerent particle sizes.
- *IBA Maturation (refer to Section 4.5 Figure 4-5 Area 09 [structure number] and Building Section BS13-D). After passing the IBA Process Hall, the clean mineral fractions (0–10 mm, 10–40 mm, 40–200 mm) are expected to be stockpiled in the covered maturation area. The term "maturation" is widely used within the IBA treatment sector to describe "weathering" and "aging" which includes the following:*

  Highly reactive bottom ash is exposed to the atmosphere to allow metal oxides and hydrates to react with water and carbon dioxide to form carbonates (=carbonation), including the reduction of pH value. These reactions reduce the leaching ability of the metals and reduce potential impact on the environment. Reactions with water can cause swelling of the materials, therefore weathering is essential. Weathering (maturation) is normally achieved by leaving the ash in a stockpile to allow water and time to complete the reactions.

  In this area, as maturation is going on, the material is setting and moisture adjustment is being made. Depending on the bottom ash composition, these processes can take up to 12 weeks. To enable the maturation processes, the material is moistened and restacked periodically. When the maturation is finished, the material is loaded onto trucks and removed from the site.

  The covered IBA Maturation area has the following description:

  – De-dusting spraying frequency – as required
  – Runoff and process water management for de-dusting water – not applicable[7]
  – Number of operating vehicles and type – one front loader and one tipping truck

[7] Moisture addition processes within bottom ash piles are needed as part of the maturation (with the help of moisture contained within bottom ash and additional water spraying from top) but no standing water extected at concrete floor which would require a runoff collection / management due to ambient temperatures and evaporation taking place.

4.7.7.2 Residue Handling

The boiler ash is discharged partly to the FGT residue silo and partly to the bottom ash extractor. The hazardous boiler fly ash from the third pass of the boiler is transported to the FGT residue silo via a pneumatic conveying system, while the non-hazardous fly ash from the second boler pass is transported to the bottom ash extractor by a trough chain conveyor.

A redundant pneumatic system will be installed to transport the residues from the collecting container towards the residue silos. In case of malfunction of the residue transport system, it can be discharged into big bags via chutes.

A total of five FGT residue silos is anticipated for the Project with an approximate storage capacity of 350 m^3 each or corresponding to approximately four days storage capacity.

The residue storage silo is an interim / temporary storage for the FGT residues. Silos are placed on an elevated steel structure prepared to the moistening system for open truck discharge and then removed from the WtE plant site by DM-WMD registered haulers for final disposal[8].

The FGT diagram is provided in Appendix I (Drawing Reference EVB 90107029).

4.7.8 Connection to DEWA 132kV Grid

The Dubai WMC will be connected through a high-voltage (HV) single circuit between the facility general step up transformer on the plant side to the DM STP Substation on the grid side. Refer to Appendix I (Drawing No. 03055-01-8.2 Mechanical and Electrical External Connections).

The EPC project interface point is the 132 kV bay terminals provided by DM at the DM STP Substation.

The HV underground cable route is still under discussion.

[8] As above.

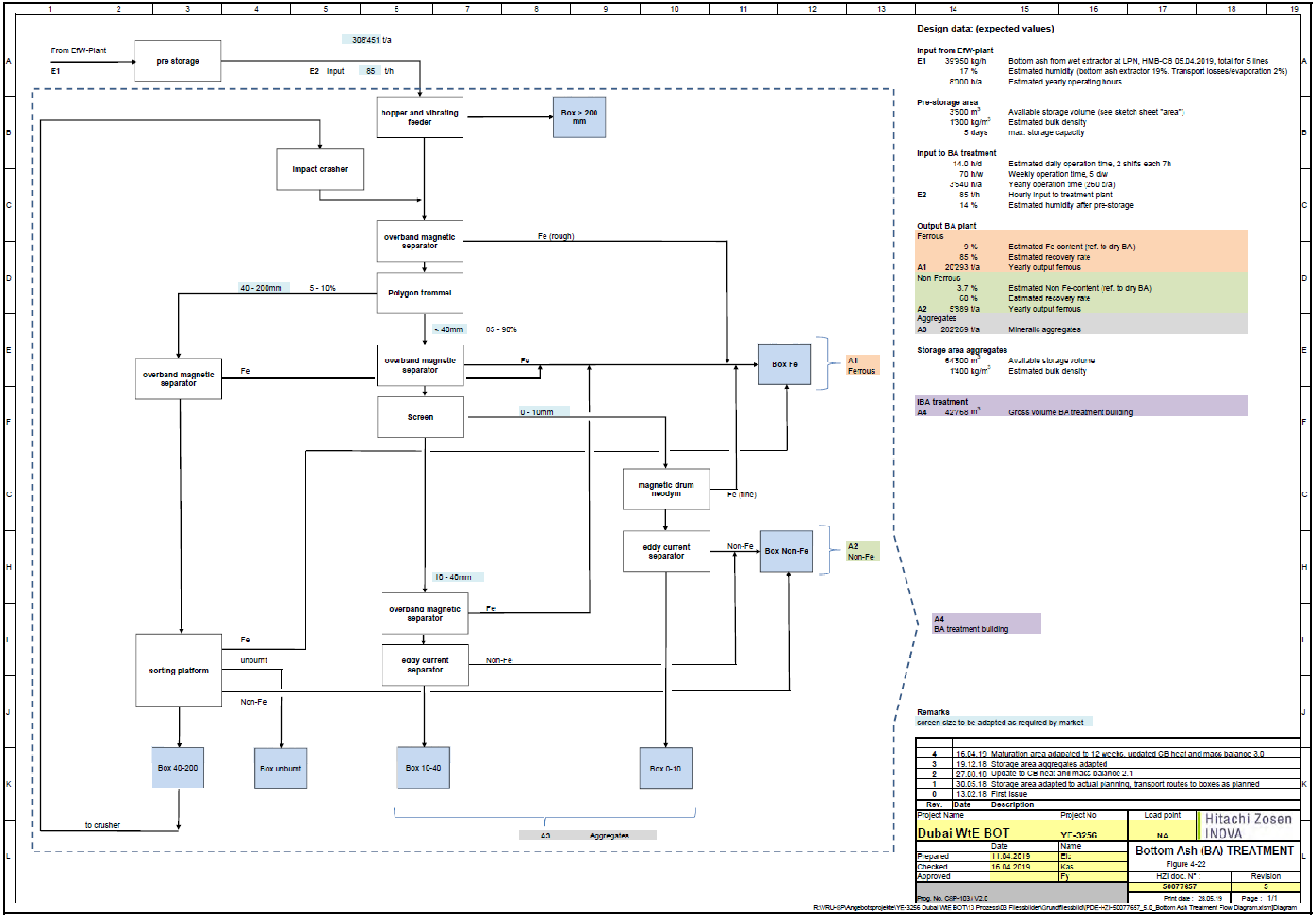


Figure 4-22 Bottom Ash Treatment Flow Diagram

4.7.9 Water Treatment Plant

The proposed Water Treatment Plant (WTP) will treat seconday water generated from Al Aweer STP as main source. As an alternative source of supply for the demineralized water requirement, the Reverse Osmosis (RO) and Electro-Deionization (EDI) plant can use drinking water. On the advice of Al Aweer STP Management, the proposed typing point (TP 02) has been relocated and corresponds now to the discharge of DS167 (chlorinated effluent of 60,000 m^3/day capacity in Al Aweer before it is blended with the effluent of the largest plant) as shown in Appendix I (External Connections).

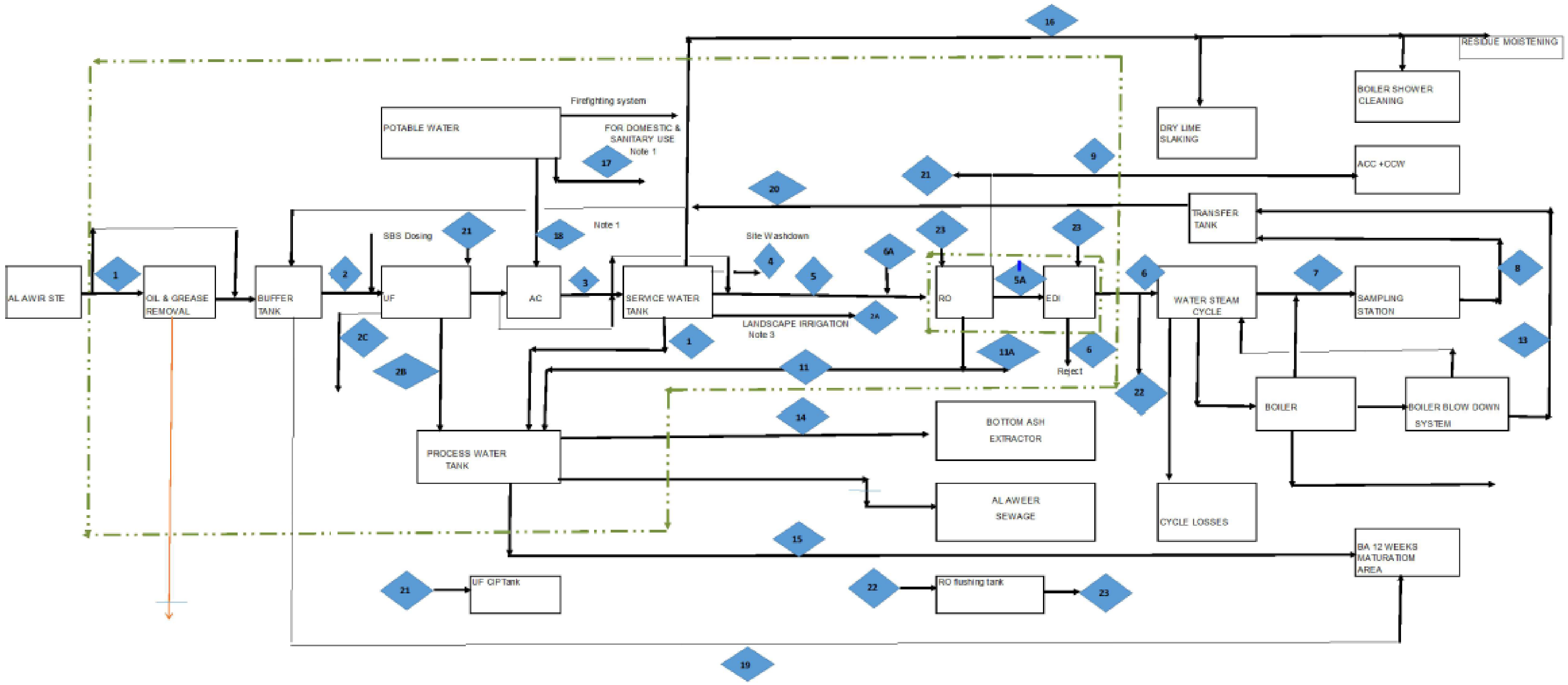
The key process elements for water treatment can be segregated in two systems:

- Pre-treatment, composed of de-oiling filter, ultra-filtration and activated carbon filters
- Demineralisation plant, composed of RO and EDI

The Pre-treatment system is designed to produce water quality suitable to feed the demineralization unit. In addition, this water will be used as service water for the entire WtE plant site.

The Demineralization system is designed to produce softened water for the Air Cooled Condenser (ACC) and Close Unit Cooling Water (CCW) system (after the first pass of the RO) and water quality suitable for the stream cycle water (boiler make-up, after the EDI units).

The WTP flow diagram for the Project is provided Figure 4-23 and briefly discussed below.



Parameters	1	2	2A	2B	2C	3	4	5	5A	6	6A	7	8	9	11	12	13	14	15	16	17	18	19	20
flow 1 stream (m3/h)	42.35	44.59	1.6	up to 3	2.60	37.22	1.25	31.76	22.22	20.00	2.22	0.72	0.72	1.40	11.75	Up to2.37	2.35	11.40	0.35	2.61	4.8	35	0	3.07
Peak m3/h -2 stream @100	76.06	77.64	1.6	up to 3	1.30	69.00	1.25	63.50	44.44	40.00	4.44	0.72	0.72	1.40	11.75	Up to2.37	2.35	11.40	0.35	2.61	4.8	70	0	3.07
TDS (Max condition, mg/l)	1953	<1860	<1860	<1860	<1860	<1860	<1860	<1860	<1.5		<50		<30		6400	<1860	<30	6400	6400	<1860	<200	<200		<30
TDS (Ave condition, mg/l)	1000	<950	<950	<950	<950	<950	<950	<950	<2.5		<50		<30		3300	<950	<30	3300	3300	<950	<200	<200		<30

Note :

1. Stream 18 - Provision of using potable water as backup source for DEM water plant (RO , EDI) in case of non availability of Al Aweer effluent .
2. Temperature basis 25 C. This diagram showns the maximum design condition of TDS close to 2000 mg/l
3. Irrigation water to be used once TDS<= 1500 mg/l

PRELIMINARY

PROJECT TITLE:
DUBAI SOLID WASTE TO ENERGY PROJECT

DUBAI MUNICIPALITY

CONTRACTOR:
Hitachi Zosen INOVA
SixConstruct

ARCHITECT & MEP CONSULTANT:
BOGAERT ARCHITECTURE
CREW

DRAWING TITLE:
Figure 4-23
MASS FLOW DIAGRAM
WTP / WTE

DATE:	DRAWN:	CHECKED:	FORMAT:	SCALE:
03/05/2018	RAJ	RS	A1	NTS

PRO:	ORG:	ACTIVITY:	DOC:
DWE	SAN	PCS	PFD

DWG. NO:	REV:	ZONE:
06402	0,1	BS54

Figure 4-23 Mass flow diagram – Water Treatment Plant

The key process elements of the water treatment can be segregated into two systems:

- Pre-treatment – composed of de-oiling filter, ultra-filtration and activated carbon filters; and
- Demineralisation plant – componsed of RO and EDI

4.7.9.1 Water Treatment Plant

The sewage treatment effluent (STE) from the Al Aweer STP will be routed to the WTP. The WTP will comprise of the following:

- *TSE Transfer Pumps (two units TSE pump sets, complete with drive motor, coupling and coupling protection*). This will pump the STE from the Al Aweer STP.
- *Automatic Backwash strainers (two units)*. An authomatic backwash strainer is a pressure filter with an automatic flushing arrangement. These are provided to protect the coalescing filters.
- *Coalescing Filters (two units): Oil and Grease (O&G) Removal System*. The highest level of O&G recorded in 2015 is 91 mg/l; as such, coalescent filter will be provided for O&G removal.
- *TSE buffer tank (one unit), with all connections, piping and fittings (including provision of overflow and drain line)*. The purpose of the buffer tank is to provide continuous supply of treated effluent to downstram ultrafiltration unit for further treatment. Sodiuim chloride dosing will be provided to prevent bacterial growth in the buffer tank.
- *Ultrafiltration (UF) feed pump sets complete with drive motor equipped with variable speed drives, coupling and coupling protection*. UF system will be provided to remove suspended solids and turbidity from STE water to improve feed SDI of downstream RO system.
- *Activated Carbon Filters (ACF)*. The treated sewage from ultrafiltration unit is then passed through the ACF for enhanced removal of organic compound and iron content from water. The filtration medium consists of a layer of gravel along with Activated Carbon. Bypass line is provided to bypass filters if necessary. The ACF will be to be used for two purposes: Filtration of effluent from Al Aweer after being filtrated in the UF or, Filtration of potable water when this is used as a backup for the supply of the DEMI plant (RO/EDI plant).
- *Service Water Storage Tank*. The service water tank Capacity is 1100 m^3. The service water tank is designed to serve following service water demand in the WtE Plant:
  - Supply of 2.37 m^3/hr transfer to Process water tank as make up service water utility
  - Supply of 2.61 m^3/hr connection for residue moistening , Boiler shower cleaning , Dry lime slaking
  - Landscaping Irrigation (Provisional supply) up to 1.6 m^3/hr, potential increase to 2.25 is achievable by increase the operational flow from the UF.
  - To serve downstream RO system demineralization tank with polished TSE or alternative water supply DEWA in case of unavailability of Al Aweer TSE (It is strongly advised that in normal operation, feeding of the RO treatment is couple directly from the pre-treatment plant, however the design makes provision of connection to feed from the service water tank).
  - Supply of Wash-down service water (Provision up to 1.25 m^3/hr.)
- *Sodium Hypochlorite – Chlorination*. This system is used for chlorination (disinfection) system at the following locations:

- Pre-chlorination-upstream of buffer tank
- Potable water tank – Potable water chlorination
- Service water tank (Provision

- *Process Water Tank.* The capacity for this tank is 600 m^3. The Process water tank is designed to store reject water from RO. A provision is made to fill this tank with service water and or directly from the UF filtrate. Process water will be used for the following purposes:
  - Supply of 11.40 m^3/hr to serve Bottom ash extractor area utility (5 lines)
  - BA 12 maturation area Utility requirement.

4.7.9.2 Demineralized Water System

The demineralization system is designed in two parallel streams working as duty - standby in normal operation or two duty during peak flow condition. The demineralized water treatment process for contain following treatment units: (i) Reverse Osmosis (RO) system and (ii) Electro-deionisation (EDI) system.

- *LP RO Feed Pumps*. Filtrate from UF and activated carbon unit further fed to RO cartridge /RO unit with RO feed pumps.
- *RO Cartridge Filters*. A set of cartridge filters are provided to safeguard the RO membranes against any traces of fine solids escaping from UF.
- *High Pressure Pumps (1st pass)*. High Pressure Pump is VFD operated to maintain flow and system recovery within design limits.
- *High Pressure Pumps (2nd pass)*. High pressure feed pumps shall be provided with 2 nos. (1 duty per stream) vertical multi-stage centrifugal type, to feed the RO membranes. Each pump is selected to pump out the filtered water at required flow rate and pressure rating as per process requirement.
- *Reverse Osmosis System*. Treated Sewage effluent from UF fed to reverse osmosis unit for removal of ions, molecules and dissolved solids. Osmosis is a natural phenomenon where water diffuses through a semi-permeable membrane toward region of higher concentration to equalize solution strength. At equilibrium, the height difference between the concentrated and dilute sides corresponds to the osmotic pressure differential between the two sides. Applying pressure, in excess of osmotic pressure, reverses water flow direction. Hence, the term “Reverse Osmosis” is derived. Pressurized Treated effluent is fed to RO Units thru high Pressure Pump. The RO system reduces the TDS in permeate. The overall recovery of RO system is 63% (overall including RO pass 1 and pass 2).

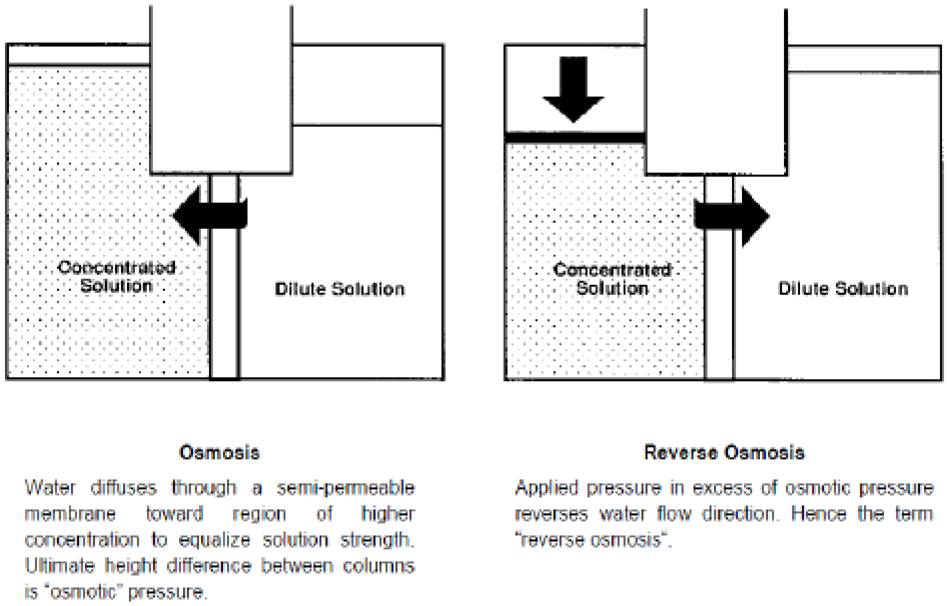


Figure 4-24 Reverse Osmosis (general)

4.7.9.3 Electro-Deionization (EDI) Process

De-carbonated water (CO_2 free water) enters to Electro deionization unit for further removal of excess ions and polar species to treat water up to meet boiler make up water requirement. Electro deionization uses an electric field to remove ions and polar species from an aqueous stream. EDI is used with reverse osmosis to replace ion exchange resin-mixed beds, which require onsite or offsite chemical regeneration. By eliminating resin-regenerating chemicals, EDI delivers significant economic and environmental benefits. In addition, EDI's continuous process improves water quality by reducing spikes and upsets.

Electrodeionization modules are used to produce High Purity Water (HPW) by removing ionisable species from liquids using electrically active media and an electrical potential to effect ion transport. CEDI is a process which combines semi-impermeable membrane technology with ionexchange media to provide a high efficiency demineralization process. Reject quality from EDI and second pass RO units are still at better quality than the filtered water supplied to first pass RO system and is thus returned back to the filtered water tank for water conservation. Reject from first pass RO and backwash dirty water are directed to process water tank.

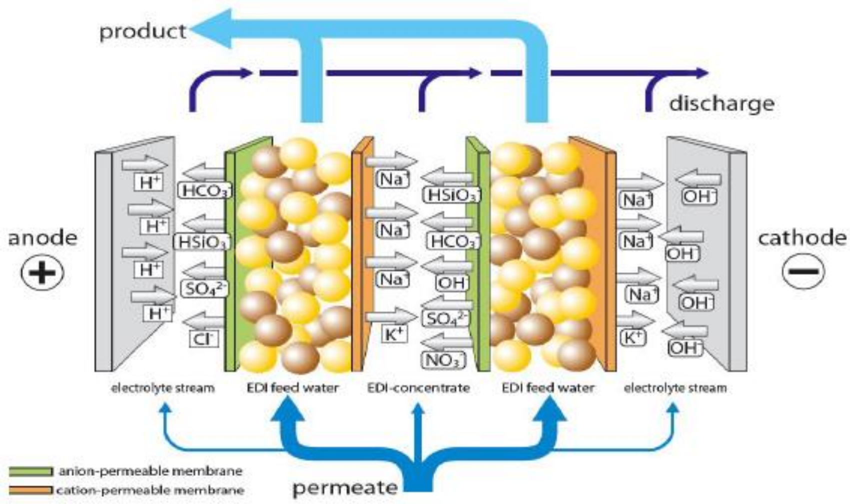


Figure 4-25 EDI Membrane Deionization Process (general)

4.7.9.4 Potable Water Supply

A potable water supply is required for the following purpose:

- Makeup water requirement in case no availability of Al Aweer TSE (back up supply for the ROEDI plant)
- Firefighting system
- Domestic Potable water

Potable Water Storage Tank

Potable water from DEWA water network shall be stored in a Potable water storage tank to serve sanitary, firefighting requirement and steam cycle make requirement plant in case of no availability of Al Aweer STP effluent:

- For firefighting system Supply
- Supply of 4.8 m3/hr for domestic and sanitary use
- Alternative water supply for the demineralized plant in case of no availability of Al Aweer TSE (Up to 70 m^3/h of drinking water).

Potable Water Booster Pumps

The purpose of the potable water booster pumps is to feed the make water demineralization plant in case of issues with TSE supply from Al Aweer STP.

Main Storage Tanks

The design basis for the main storage tanks is summarised in Table 4-5.

Table 4-5 Process Tank Design Basis

Item	Tank volume
Buffer tank	880 m^3
Service water tank	1100 m^3
Process water tank	600 m^3
Potable water tank	Domestic water requirement = 40 m^3 Firefighting water requirement = 1000 m^3 Backup water requirement = 560 m^3 Provided tank volume = 1600 m^3
Demineralization water tank	900 m^3, 2 nos. tanks 450 m^3
Softened water tank	900 m^3, 2 nos. tanks 450 m^3

4.7.10 Continuous Emission Measurement System (CEMS)

The Continuous Emission Measurement System (CEMS) monitors the flue gas properties and detects the composition in the flue gas duct after the last flue gas cleaning stage or the stack respectively. The CEMS is designed to meet the particular requirements of the operating permit for the WtE Plant as well as applicable directives for installation and quality assurance (EN 14181).

The CEMS includes the following components:

- Sampling system with extraction device, hose, pump, trace heating etc.
- Instruments for temperature, pressure and flow rate measurement
- Measurement instrument for particulate matter
- MCA (Multi Component Analyser). Extractive gas concentration measurement system for determination of gaseous flue gas components (H_2O, O_2, CO, HCl, SO_2, NOx, NH_3, TOC)
- CEMS-PC. Computer-based data acquisition system; calculation, standardisation and validation of the emission data
- Data Exchange Unit
- Calibration gas preparation and transport with automatic calibration devices and control system
- Ethernet or Modem for remote maintenance
- CEMS enclosure

4.8 Project Utility Requirements

Water and power supply connections are shown in Appendix I (External Connections) and briefly described below.

4.8.1 Water Supply

WtE plant operation requires approximately 42.35 m^3/h (1 steam in operation) or 76.06 m^3/h (2 steam in operation) of water, which will be sourced from Al Aweer STP. The water will be treated (refer to Section 4.7.9) before it is fed into the water / steam cycle. Further, approximately 1.80 m^3/h of potable water will be used for domestic and sanitary use as well as firefighting system (1000 m^3/d).

4.8.2 Power Supply and Distribution System

The steam turbine generator will be connected through the Generator Circuit Breaker (GCB) to the Generator Step-up Transformer. The generator will be synchronized to the 132 kV grid. Once synchronized, the net power production is delivered to the Grid.

The WtE plant electrical auxiliary system is fed from the 6.6 kV metal-clad switchgear, which is connected to the Unit Auxiliary Transformer. The plant system will be supplied from the 6.6 kV switchgear.

Two emergency diesel generators will be installed and connected to the 6.6 kV switchboard for safe shutdown in case of power failure. In the event of total power failure, the redundant steady-state uninterruptible power supply system guarantees the continuity of the power supply for the operational instrumentation and control system, i.e. the power supply for instrumentation, monitoring systems, the voice communications equipment, as well as the control voltage of the HV, MV and LV system.

4.9 Description of WtE Plant Development

The following subsections delineate the activities involved in the development of the WtE plant.

4.9.1 Pre-Construction

The pre-construction phase of the Project consists of the planning, financing, conceptual and detailed engineering works. It is also at this phase that engineering and environmental and social studies, such as the EIA, are undertaken to facilitate / inform decisions made at the detailed design phase with a view to ensure these decisions are being carried into the construction of the Project.

It also entailed the following site preparation and development activities:

- Sourcing of suppliers, contractors and other service providers
- Acquisition of necessary permits and licenses
- Fuel supply and power offtake arrangements

Planned Staggering for Construction and Operation Phases

There is planned staggering for the construction and operation of the WtE plant. Lines 1 and 2 will be the first built and operated; followed by Lines 3, 4 and 5 to be built and operated approximately 6 months later.

4.9.2 Construction Phase

4.9.2.1 Construction Activities

An overview of the general anticipated construction activities is provided below. The complete methodology of construction activities will be provided once contractors for the Project are engaged.

- Site Development Works – this includes earthmoving, clearing, excavation, fill placement, grading and other ground preparation works.
- Construction Activities – this includes construction and installation of the WtE plant components, its auxiliary facilities and the temporary storage facility for bottom ash and FGT residue[9].

4.9.2.2 Materials

Typical construction materials will be used for the Project, which may likely include ready mix concrete, concrete products, pre-fabricated concrete, steel reinforcement, rock, pipes, etc. Where possible, these materials will be sourced locally.

4.9.2.3 Construction Equipment

The equipment to be used for the construction of the facility is listed below. It should be noted that the quantities of equipment are tentative and may changed during the construction period.

- Asphalt Pavers (1 unit)
- Tampers / Rammers (2 units)
- Plate Compactors (2 units)
- Rollers (3 units)
- Surfacing equipment (1)
- Signal boards (10 units)
- Excavators (10 units)
- Cranes (11 units)
- Rubber-tyred Loaders (10 units)
- Rubber-tyred Dozers (3 units)

[9] On-site management of bottom ash and FGT residue are discussed in Section 4.7.7. Off-site disposal of bottom ash and FGT residue is under separate review by DM Waste Management Department (WMD)

- Tractors/Loades/Backhoe (2 units)
- Skid Steer Loaders (1 unit)
- Dumpers /Tenders (30 units)
- Generators <50 hp or 37 kW (2 units)
- Welders <50 hp (16 units)
- Forklifts (2 units)

4.9.2.4 Temporary Facilities

To facilitate the construction activities, temporary facilities will be required on-site. These facilities may include, but are not be limited, to the following:

- Site offices
- Welfare facilities / clinic
- Security facilities
- Parking facilities
- Fencing and barrier
- Project signage
- Traffic signage
- Portable toilets
- Water tanks
- Septic tanks
- Power generators
- Fuel storage tanks
- Storage areas and warehouse
- Plant yards
- Laydown areas
- Waste management areas
- Wash-down facilities

These temporary facilities will be situated within the temporary laydown and construction staging areas surrounding the proposed WtE plant.

4.9.2.5 Waste Generation

Expected wastes to be generated during the construction phase are listed below. A complete description and management measures to address waste generation is provided in Section 5.9.

- Sediment and rocks from earthmoving activities
- Oil and fuel from construction equipment and vehicles
- Waste from septic tank
- General construction wastes (e.g. concrete, timber, etc.)
- Hazardous waste from hazardous materials and substances (e.g. paint, oil, fuel)

4.9.3 Operation Phase

4.9.3.1 Operation Activities

The main activities during the operation phase include 24/7 operation of the power plant and its auxiliaries, sourcing and delivery of waste, unloading of waste at the feeding system, waste handling and combustion for electricity generation. Relative to operations, the following provides a high-level overview:

- **Typical Operations Scenario**
  - WtE plant operations on a 24-hour, 7-day per week schedule
  - 4 shifts anticipated, each shift to be an estimated 12 hours
- **Delivery of MSW from Dubai Municipality**
  - MSW deliveries from Dubai Municipality up to a maximum of 80 waste delivery trucks per hour during peak times
- **Waste Mass Flows during Peak Waste Truck Traffic**
  - Table 4-6 shows the various plant data and parameters that are relevant for analysing what type of peak operating conditions the plant can successfully accommodate.
- **Reference Waste Composition**
  - Ash in percent by weight (design estimate): 16%, estimated range of 15 to 22%
  - Moisture in percent by weight (design estimate): 39%, estimated range of 25 to 50%
  - Combustible in percent by weight (design estimate): 45%, estimated range 35 to 53%
  - Net Calorific Value (NCV) in MJ/kg (design estimate): 9.5, estimated range 7.0 to 14.0

Maintenance of the plant facilities, including the waste receiver area as well as environmental pollution control and monitoring will also be part of the operational activities. Environmental management measures (defined in Section 7) will be implemented during the operational phase. EPC Performance Guarantees are provided in Appendix K.

4.9.3.2 Waste Generation

The estimated waste generation during the operation phase is provided below. A complete description of, and management measures for waste generation during the operation phase are provided in Section 5.9.

- Wastewater
  - Domestic sewage estimated at 170 m^3 per day
  - Plant area surface water will be transferred to the collection pond
  - Process area cleansing water estimated at 40 tonne/week will be reused within the process system
- Hazardous waste
  - A marginal amount of painting residues and batteries
  - A minimum amount of aged oil due to periodic exchange of hydraulic oil and lubricants are typically sent to specialized oil reprocessing or dedicated incineration
- Solid wastes
  - Incinerator bottom ash (non-hazardous)
  - Flue gas treatment residue (commonly considered as hazardous waste)
- Dry flue gas systems will be used; as such, semi-solid waste is not anticipated

4.9.3.3 Management of Waste during Peak Waste Delivery

Plant Design and Traffic Swept Path for Waste Delivery

The Project comprise of a main gate and entrance together with three incoming weighbridges and two outgoing weighbridges (but three exit lanes), road lanes to the tipping area, the tipping area as well as array of 27 tipping bays that lead into the waste bunker (refer to Figure 4-5). The waste bunker is designed with a four-day capacity of waste under nominal operating conditions.

The traffic swept path of the waste delivery trucks on the tipping areas of both Block 1 and Block 2 when manoeuvring to unload the waste to the tipping bays is shown in Figure 4-27. It shows swept path for two types of waste delivery trucks:

- A truck with an overall length of 12 m and no trailer
- A trailer truck configuration with an overall length of 16.2 meters

Waste Mass Flows during Average and Peak Waste Truck Traffic

Table 4-6 shows the various plant data and parameters that are relevant for analysing what type of peak operating conditions the plant can successfully accommodate.

Table 4-6 Management of Waste during Peak Delivery Conditions

No.	Item	Line / Plant	Value	Unit
1	Waste throughput at Design Point LP N	Per Line	47.222	t/h
2	Waste throughput at Design Point LP N	Plant	236.11	t/h
3	Incoming peak waste mass flow	Plant	535	t/h
4	Peak hourly number of waste trucks	Plant	80	Trucks/h
5	Average turnaround time per truck	Plant	35	Min
6	Number of tipping bays	Plant	27	–
7	Max. Tipping time for trucks		15	Min/truck
8	Average tipping time where the roll gates are open		6	Min/truck
9	Frequency of waste trucks exiting plant – peak	Plant	1.33	Trucks/min
10	Number of incoming weighbridges	Plant	3	Weighbridges
11	Number of exiting weighbridges	Plant	2	Weighbridges
12	Frequency of waste trucks on weighbridge exiting plant - peak	Plant	0.66	Trucks/min
13	Available time for weighing on exit weighbridge - peak	Plant	91	s/Truck

The nominal waste throughput per line at the incineration design point LP N is 47.222 t/h. Multiplying that by 5 lines for the whole plant, the total nominal waste throughput of 236.11 t/h is obtained at the design point LPN. At maximum load point conditions LP1 these values will be respectively 53.5 and 267.5 ton/h.

During peak delivery conditions the plant will be able to accommodate a peak truck traffic of 80 trucks per hour and a peak waste mass flow equal to 2 times the maximum load conditions of LP1 equivalent to 535 t/h.

Average Turnaround Time per Truck

Table 4-7 below shows the average turnaround time per truck, broken down into its various constituent steps.

Table 4-7 Average Turnaround Time per Truck

Step	Description	Time	Time Unit
1	Weighing time IN	1	minute
2	Driving from weighbridge IN to tipping floor	2	minute
3	Time between trucks on tipping floor	2	minute
4	Manoeuvring time IN	4	minute
5	Maximum tipping time	15	minute
6	*Average tipping time where the roll gates are open*	*6*	*minute*
7	Manoeuvring time OUT	3	minute
8	Driving from tipping floor to weighbridge OUT	7	minute
9	Weighing time OUT	1	minute
	Total time (in minutes)	35	Minutes

Figure 4-26 A typical waste delivery truck tipping off the waste into tipping bay

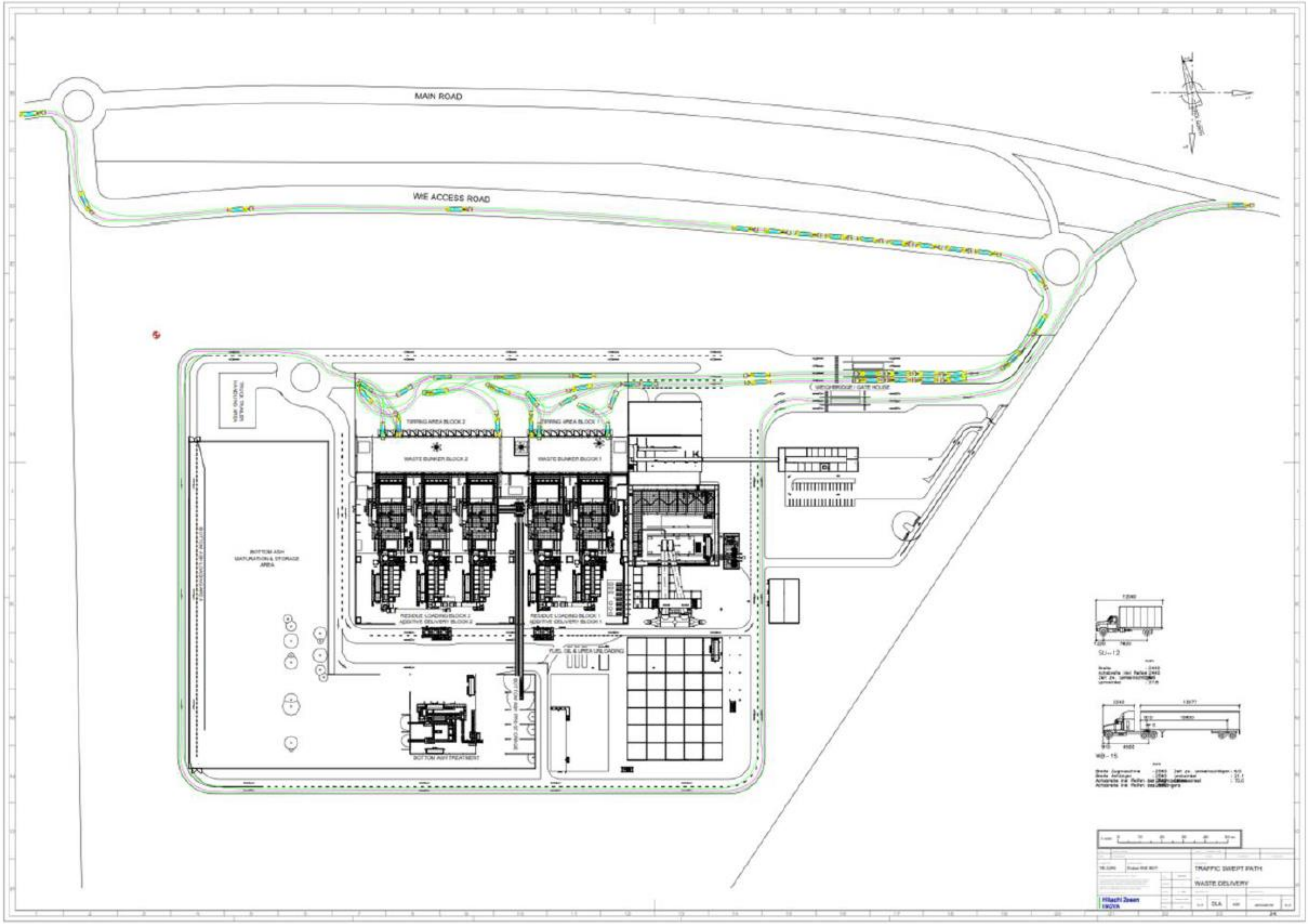


Figure 4-27 Traffic Swept Path / Waste Delivery

Waste Bunker Capacity as Buffer for Peak Conditions

The waste bunker is designed with a capacity of four (4) days of nominal operation at design point LPN. The peak delivery conditions may occur several times per day for a short period of time, usually about an hour. During these times, the rate of the waste delivery will increase above the nominal delivery rates.

Typically, the high and low delivery periods during a 24-hour period, cancel each other out so that the daily average equals the nominal conditions. Since the bunker has a four day capacity, even longer variable deliveries can be averaged out.

Frequency of Trucks Exiting the Plant for Peak Conditions

Table 4-6 shows that during times of peak delivery conditions, there will be 1.33 trucks leaving the plant every minute, which corresponds to one (1) waste truck leaving every 45 seconds. The plant road is designed such that it can accommodate this kind of peak waste truck traffic.

Available Time for Weighing Trucks on Weighbridges For Peak Conditions

As provided in Table 4-6, the frequency of waste trucks on the weighbridges during peak delivery conditions is 0.66 trucks per minute, which means that the available time for weighing trucks on the exit weighbridges is 91 seconds per truck. Considering that the weighbridges are fully automated and digitized with no required manual operation either by the driver or weighbridge operator, this available time is sufficient to perform the exit weighing of the waste trucks.

4.9.3.4 Emergency Procedure

An Operational Emergency Plan (OEP) will be developed and agreed with the DM six months prior to commencement of operations. The OEP will cover all aspects to comply with the requirements of local and federal emergency procedures. It will also provide detail of how the WtE plant will be operated under emergency situations to ensure it remains compliance with all appropriate consents and permissions, where possible, including any requirement for the controlled shut down of processes.

The following scenarios will be covered in the OEP for the Project:

- Major fire, including administrative block and visitor center fire, vehicle fire, refuse bunker fire, propane fire, diesel oil fire
- Major flooding
- Earthquake
- Major ground condition incident
- Major injury accident
- Terrorist action
- Site evacuation
- Explosion
- Major spillage of different chemicals (i.e. lime, ammonia, activated carbon, diesel, etc.)
- Intruder on site
- Serious loss of site electrical supples
- Significant breack of environmental permit (including but not limited to emissions to air, ground, water, noise, dust, odour, vermin, etc.)

Framework Emergency Procedures and Response Plan (EPRP) specific to address environmental emergencies are provided Appendix J and listed below:

- Environmental Emergency Management Plan Framework;
- Framework Fugitive Emissions Management Plan;
- Fire, Emergency and Self-Protection Plan; and
- Design Basis Fire and Life Safety Strategy.

4.9.4 Decommissioning Phase

The projected operating life of the WtE plant is projected at over 35 years. However, shutdown of the plant may be necessary due to the following potential scenarios:

- Unsuitable business operations due to economic downturns
- Accidents and emergencies, either natural or manmade, that resulted in severe facility damage and loss of human life
- Closure order from government agencies
- Changes in the waste generation or economic model for the plant

In the event that the Proponent decides to decommission the plant and/or shutdown the Project area, the following basic steps will be carried out:

- All excess materials, chemicals and supplies will be transported offsite where cradle-to-grave management will be undertaken in full compliance with UAE and Dubai Emirate regulation on solid waste, toxic substances and hazardous waste
- Structures shall be removed from the site and taken offsite for recycling to re-use
- Trash materials and other residual solid wastes will be collected and hauled to a designated disposal area
- Recyclable wastes such as metals, glass, rubber and plastics shall be collected and forwarded to a recycling facility
- Rehabilitation and restoration measures will be conducted for areas occupied by structures. These activities will be done in accordance with the conditions stipulated in the permits provided by relevant authorities. Site restoration will include revegetation or replanting of suitable species.

Prior to the end of the Project's operating life, a more detailed decommissioning or abandonment plan will be developed in line with the existing UAE and Dubai Emirate regulations.

4.10 Manpower Requirements

Consistent with development goals and objectives, DM is committed to enhance socio-economic conditions by implementing the Emiratisation Policy[10], paying appropriate salary and benefits to the workers and minimising environmental and social impacts to the sensitive receptors.

[10] To overcome the structural division in the labour market, the UAE Governmnet launched Emiratisation (TaWtE planten in Arabic) campaign, which mandates the inclusion of Emiratis in the job sector, particularly in the private sector. Emiratisation aims to increase the number of Emiratis in the job market and their contribution to the Economy (Government.ae, 2018)

Table 4-8 presents the estimated manpower required during all phases of the Project. Different manpower requirements, for both skilled and non-skilled workers, are required depending on the development phase.

For the Project, priority will be given to hiring of locals whose skills and experience match the Project's specific needs.

Table 4-8 Estimated Manpower Requirements

Project phase	Estimated manpower requirements	Tasks	Skill requirement(s)
Pre-construction phase	50 technical staff including consultants	Complete feasibility study, detailed engineering designs, detailed drawings, permit requirement and tender documents	Engineers, project managers, financial managers, technical advisers
Construction	Approximately 2950 during peak construction[11]	Civil works, architectural and electro-mechanical works	Engineers, project managers, skilled and non-skilled labourers
Operation	During normal operation conditions, a total of 129 fulltime staff / workers will be employed.[12] Additional 120 external workers will be engaged during the annual outage overhaul of a single incineration line, which lasts approximately 20 consecutive days.[13]	Oversee the entire operations of the Project, including emergency situations Ensure safety and welfare of personnel Maintain conformity of Project to relevant local and international laws, regulations, standards and guidelines Promote and uphold a harmonious relationship with the stakeholders	Management and administration skills, operations and maintenance staff with general knowledge on operation of the WtE plant including environmental, labour and regulations (local and international)
Decommissioning	TBC	Design of abandonment or decommissioning plan	As required
Decommissioning construction works	TBC	Decomissioning or abandonment works	Engineers, project managers, skilled and non-skilled labourers

[11] BESIX EPC and its Subcontractors totals approximately 850 workers and staff, while HZI EPC and its subcontractors totals approximately 2100 workers and staff during the peak of construction.
[12] The 129 staff and workers during the operation phase comprise of 45 technical staff, 72 non-technical staff, five office staff and seven managerial staff.
[13] Five lines will be hauled sequentially during the operation phase; as such, there will be a total of 100 days of overhaulling annually.

Labour Accommodation

In accordance with labour laws and related legal requirements (e.g. Ministerial Resolution No. (591) of 2016; health and safety requirements), labour accommodation for the workers will be provided.

All worker accommodation during the construction phase will be external to the Project site and will be provided by subcontractors. Transportation services to and from the labour camp will be provided by contractors.

Labour accommodaton for the operation and maintenance phase is proposed to be located at the southeastern part of the plot proximate to the Administration and Visitors Building (refer to Figure 4-5).

4.11 Access Roads

The Project site can be accessed via the existing E44 highway (also known as Al Khail Road or Dubai-Hatta Highway). The E44 is a dual 4-lane highway and runs from the west to east. The E44 bisects Al Warqa area to the north and Warsan area to the south. The congestion levels on this highway are high during rush hours. From the E44, the Project can be reached via D54 (or the Sheikh Zayed Bin Hamdan Al Nahyan Street) and an internal road to access the Al Aweer STP. The other major routes to the west and east of the Project are E311 (Sheikh Mohammed Bin Zayed Road) and E611 (Emirates Road). A complete description of access, traffic and transport to be implemented during the construction phase is provided in Section 5.7.

It is noted that a No Objection Certificate (NOC), where required, for this access road will be obtained by the Proponent prior to operation. Further, a traffic management plan will be developed to minimise potential impacts of transporting material, workers and wastes on sensitive receptors.

4.12 Project Scope

The Project scope includes the following:

- Detailed engineering studies and designs
- Acquisition of necessary permits and licenses
- Site preparation
- Construction of facilities
- Procurement and installation of technology components
- Procurement of necessary equipment and materials
- Environmental management and protection (e.g. air pollution devices, water treatment facilities and ash disposal facilities)
- Start-up and commissioning
- Environmental management and monitoring activities
- Operational management (35-year BOT contract)

4.13 Project Status and Schedule

4.13.1 Project Status

The proposed Project is currently in the preparation phase (pre-construction) where finance, design, permitting and approval from various government authorities are obtained.

4.13.2 Project Schedule

Detailed engineering is expected to be completed in Q2 2020. A three-year construction period is expected to commence in Q2 2020, and commissioning and trial run is anticipated 36 months after the start of construction. A preliminary schedule is provided in Appendix L.

4.14 Project Cost

The EPC has requested that costing figures relating to the Project remain confidential at this stage for commercial reasons.

5. Description of the Environment

5.1 EIA Study Area

The EIA study was undertaken primarily within the vicinity of the proposed Project foorprint and its potential impact areas. Summary of baseline monitoring and sampling locations as well as loation of receptors who were consulted (i.e. within 5-km radius from the boundary of the project site) is provided in Figure 5-1.

5.2 Climate and Meteorology

5.2.1 Overview

5.2.1.1 Weather Patterns

The Gulf is located in the subtropical high-pressure region, where the climate is classified as arid. The climate can be divided into two main seasons with two transition periods as follows:

- The summer season – from June to September
- Fall transition season – during October and November
- The winter season – from December to March
- Spring transition season – during April and May (Walters, 1990)

During transition periods, the weather is commonly unstable with no well-defined weather patterns, and tropical storms are common (Al Senafi and Anis, 2015).

Summer in the northern Gulf is influenced by two main pressure systems. The first is the stationary summer monsoon low pressure system centerd over north west of India extending west to the south east of the Gulf. The second is the stationary high pressure system over the east of the Mediterranean with a ridge extending south east towards the north west of the Gulf. These two systems produce a steep pressure gradient in between, which lies over the north east of the Gulf (Nasrallah *et al,.* 2004) and produces strong north westerly winds (7–13 m/s^{-1}) (Bartlett, 2004) known as summer Shamals (Rao *et al.*, 2003), which could last up to weeks at a time (Wilkerson, 1991). The summer Shamals commonly bring dust or ‘blazes’ of hot (up to 51°C) and dry air.

The winter season in the northern Gulf is influenced by cold air carried into the region by the quasi-stationary Siberian high-pressure system in the east (Crook, 2009). This climate is often interrupted by frontal systems that build up in the eastern Mediterranean and move south east due to the upper-westerlies, namely the Polar Front Jet. These moisture bearing frontal systems are the primary source of precipitation in the region (Barlow et al., 2005). As the frontal system moves towards the Gulf, the Polar Front Jet behind the frontal system and the Sub-Tropical Jet ahead of it converge, strengthen the system and generate strong winds at the front. On the passage of the front over the northern Gulf, strong north westerly winds develop with fivefold the initial speed and reach values up to 15–20 m/s^{-1} near the surface at the center of the Gulf (Thoppil and Hogan, 2010); these are known as winter Shamals. The duration of a winter Shamal event depends on the speed of the upper air moving through the region, however, typical duration of a Shamal event is two to five days (Ali, 1994).

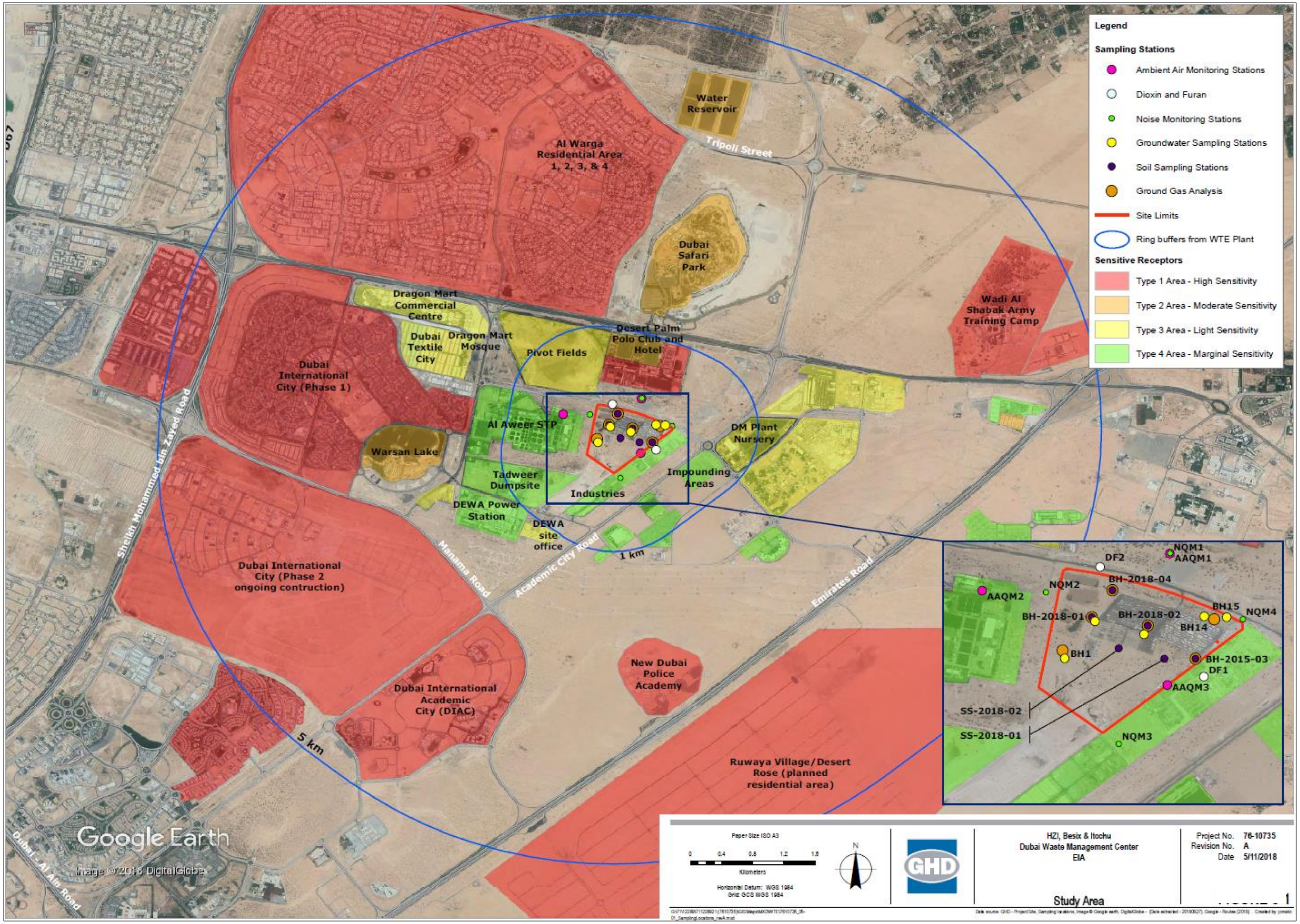


Figure 5-1 EIA Study Area

5.2.1.2 Precipitation and Temperature

Precipitation occurs almost exclusively in winter and is highly variable in both volume and spatial occurrence. The annual precipitation levels in the Emirate of Dubai are low. Between 2015 and 2017, there were on average 17 rainy days per year and total annual rainfall was in the range of 14.4 mm to 22.8 mm (Dubai Statistics Center, 2018).

The coastal areas of Dubai are influenced by the waters of the Arabian Gulf and as such have a lower maximum but a higher average temperature and a higher humidity. The mean monthly temperature in the Emirate of Dubai for 2013 - 2015 is shown in Figure 5-2, while the mean monthly relative humidity is presented in Figure 5-3.

The average daily temperature in 2015 ranged between 16.5 °C to 43.3 °C (Dubai Statistical Center, 2016). The 2015 climate data showed that August had the highest average daily maximum temperatures while the lowest average daily minimum temperature was recorded in January.

The average monthly relative humidity from 2013 to 2015 ranged from 13% to 82%. In 2015, May had the lowest average daily minimum relative humidity whereas the highest average of daily maximum relative humidity was recorded in January.

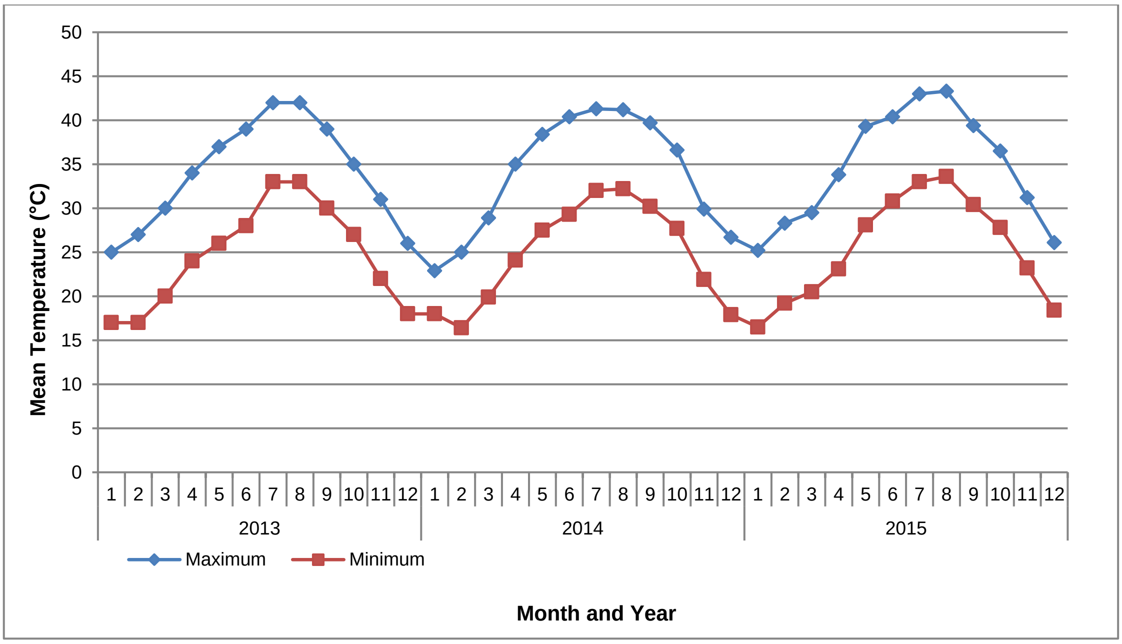


Figure 5-2 Mean monthly temperature in the Emirate of Dubai (2013–2015)

Source: Dubai Statistics Center, 2016

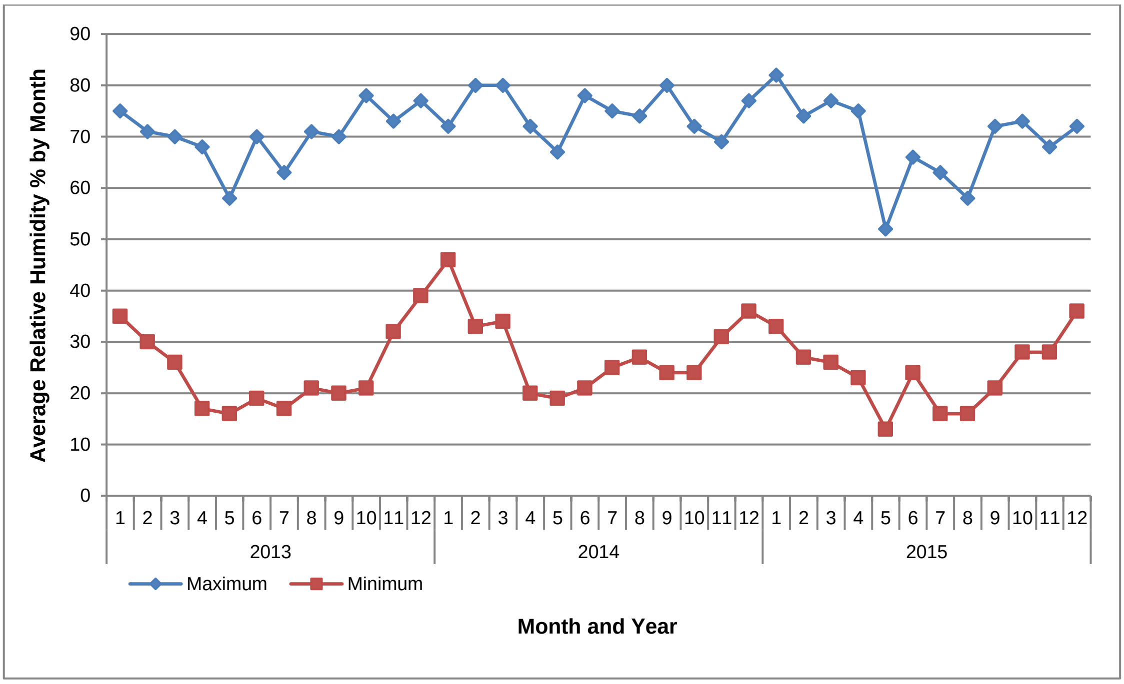


Figure 5-3 Mean monthly relative humidity in the Emirate of Dubai (2013–2015)

Source: Dubai Statistics Center, 2016

5.2.2 Climate Change

A summary of estimated GHG emissions in the UAE for the year 2013 is provided in Table 5-1 The data was obtained from the World Resources Institute, Climate Analysis Indicators Tool version 2.0 (CAIT 2.0), accessed on 22 May 2017. Data for 2013 was the most recent data available at the time of writing this report.

Table 5-1 Summary of GHG emissions for UAE for 2013

Source and sink category	Emissions (Mt CO_2-e)
Energy	203.13
Industrial processes	12.17
Agriculture	1.64
Land use change and forestry	-0.21
Waste	4.47
Total national emissions	221.42
Net national emissions	221.21

Statistics published by the United States Energy Information Administration for total CO_2 emissions from the consumption of energy indicate that UAE's emissions totalled 229 million metric tonnes in 2014, which is 70% higher than the CO_2 emissions in 2004 (134 million metric tonnes) (United States Energy Information Administration, 2015). UAE was ranked 26th highest globally in terms of CO_2 emissions in 2013, with a per capita emission record of 18.7 tonnes (third highest in the world), as compared to the global average of approximately 5 tonnes (World Bank, 2015).

Major GHG mitigation strategies that have been developed in the UAE include sustainable (green) building codes, ecological footprint assessment, low carbon electricity using renewable energy, nuclear energy, natural gas, sustainable transport initiatives, and increasing climate change awareness. The strategies are projected to yield reductions of about 1.0 billion tonnes of CO_2 – equivalent cumulatively through 2030.

DIES 2030 was developed in 2010 to support the UAE's commitments to mitigate climate change. The strategy was implemented in January 2011 in order *'to set the strategic direction of Dubai towards securing sustainable supply of energy and enhancing demand efficiency (water, power and transportation fuel)* (Dubai Supreme Council of Energy, 2012).

The following strategies will be undertaken by the Dubai Supreme Council of Energy as part of the DIES 2030:

- Carbon dioxide baseline study
- Complete a detailed inventory of Dubai's greenhouse gas emissions in line with the requirements of the IPCC, and the United Nations Framework Convention on Climate Change
- Develop a monitoring, reporting and verification framework, in order to harmonise and streamline data collection from the Council's members, which include the main energy, manufacturing and utilities companies in Dubai
- Recommend / establish viable targets for reducing CO_2 and GHGs, and a methodology to monetise emissions, similar to the European Trading Scheme, the Clean Development Mechanism developed under the Kyoto Protocol, and other carbon reduction schemes

In 2013, the 13 MW solar photovoltaic power plant, which comprised the first phase of the landmark Mohammed bin Rashid Al Maktoum Solar Park, was completed. The solar power plant is expected to generate approximately 24 million kilowatt hours of electricity per year, which will on average displace approximately 15,000 metric tons of CO_2 annually (Ministry of Environment and Water, 2014).

Under the DIES 2030, Dubai's projected fuel use will be altered towards use of sustainable energy (Figure 5-4).

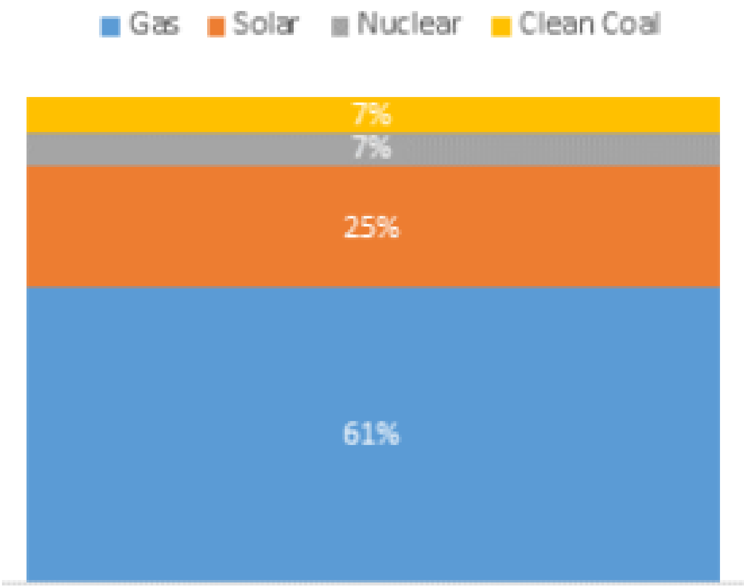


Figure 5-4 Projected use of fuel types in Dubai, 2030

Adapted from Dubai Supreme Court of Energy (2017)

5.3 Air Quality

5.3.1 Air Quality

5.3.1.1 Overview

Air pollution has been stated as the primary environmental threat to public health in the UAE and ambient air quality has been recorded to be steadily deteriorating (Willis et al., 2010, Environment Agency Abu Dhabi, 2017).

Gaseous Emissions

Common pollutants emitted by major sources in the UAE include sulphur dioxide (SO_2), ozone (O_3), nitrogen oxide (NO), nitrogen dioxide (NO_2), cyanide (CN) and aerosols, largely produced by transportation and the construction industry (Climatology Research Group, 2004). According to the State of the Environment Report (Tolba and Saab, 2008), CO_2 emissions in the UAE increased from 80.8 million tonnes in 1990 to over 94 million tonnes in 2002. Pollution levels are generally highest along the coastal interface and over refineries and oilfields (Climatology Research Group, 2004).

Haze layers are commonly observed over the UAE due to stable air layers that reduce the vertical motion of air. These stable layers play a key role in the UAE's air quality, as gaseous emissions are frequently trapped at ground level resulting in elevated pollutants.

Emissions from the coastal areas are typically transported in-land through advection in the form of afternoon sea breezes, while transport offshore at night occurs through the reverse process.

Seasonal comparisons of average sulphur dioxide, ozone and NOy concentrations across urban areas of the UAE (Climatology Research Group, 2004) are provided in Figure 5-5 and are summarised as follows:

- Sulphur dioxide (SO_2) concentrations in Dubai are similar to those recorded in Abu Dhabi and Al Ain, at approximately 25 parts per billion (ppb). As SO_2 has a relatively short residence time, concentrations are highly dependent on proximity to the source;
- Ozone (O_3) concentrations in Dubai are somewhat similar across the urban areas and are all generally higher in the winter seasons. Average Dubai concentrations are approximately 46 ppb; and
- Total reactive oxides (NOy) concentrations are significantly greater during summer than winter in all measured urban locations. This correlates with the reduced ozone during summer, as nitrogen oxides break down ozone molecules. Average Dubai concentrations range between 3 and 15 parts per billion for winter and summer, respectively.

Air monitoring within the Dubai Emirate has been undertaken by the Dubai Municipality-Environment Department at 13 sites across urban and industrial areas. The results from 2013 to 2017 are provided in Table 5-2 and show that ambient concentrations of CO, O_3, SO_2 and NO_2 are generally within the ambient air quality objectives.

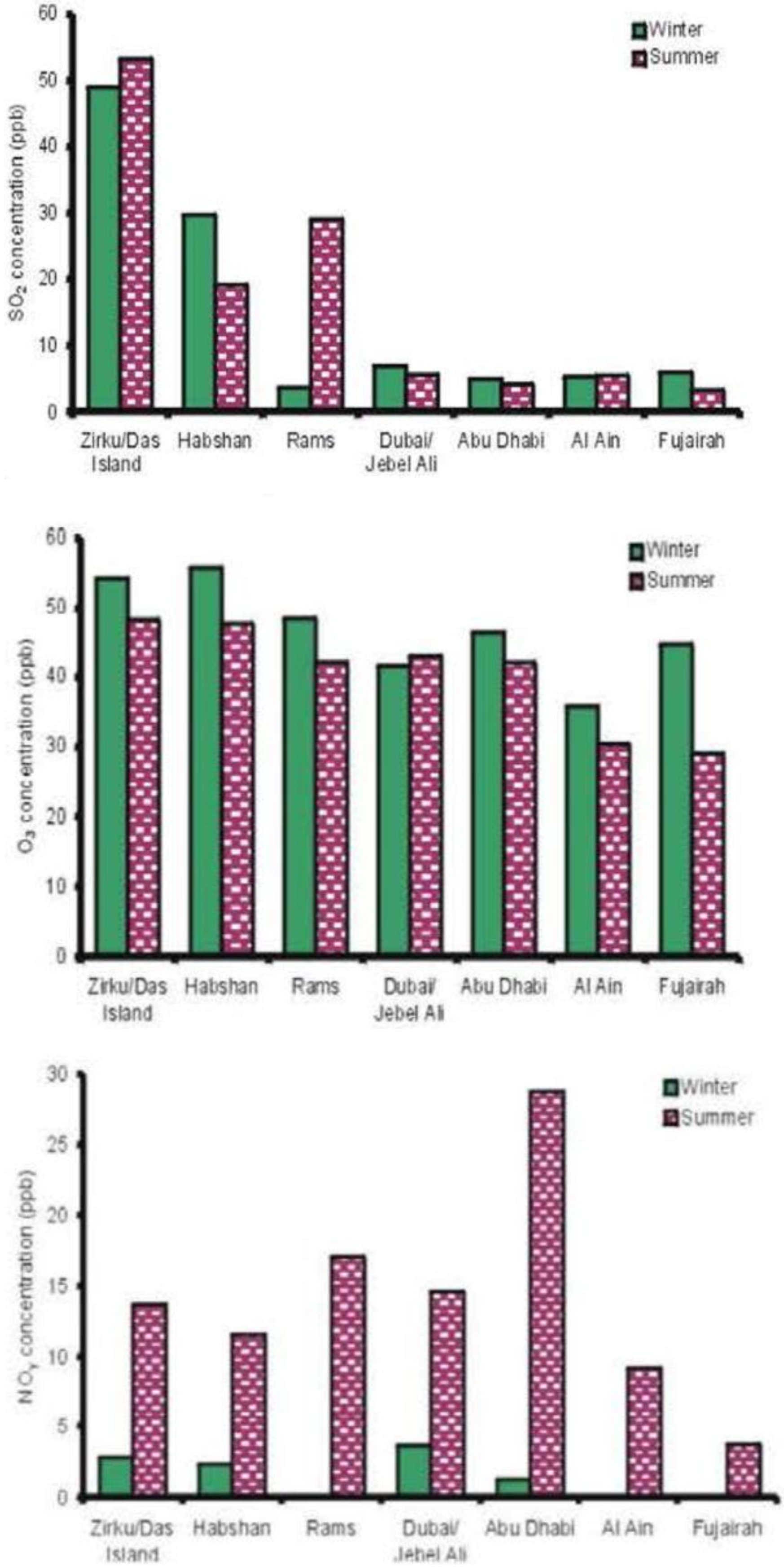


Figure 5-5 Seasonal Comparison of Air Pollutants in the UAE

Source: Climatology Research Group, 2004

Particulates

According to the World Health Organisation (2017), the region including UAE, Kuwait, Saudi Arabia, Bahrain, Qatar and Oman recorded the highest levels of dust (PM_{10}) in the world from 2008 to 2015. In 2013, at the mean annual PM_{10} in UAE urban areas ranged between 123 and 146 µg/Nm^3, while $PM_{2.5}$ ranged between 52 and 62 µg/Nm^3 (WHO, 2016b). The mean annual concentration of fine particulate matter ($PM_{2.5}$) in urban areas of the UAE in 2014 was 64 µg/Nm^3, ranking 12th highest in the world (WHO, 2016a).

Ambient concentrations of airborne particulates, PM_{10} and $PM_{2.5}$, throughout the UAE are commonly recorded in higher concentrations than the World Health Organization (WHO, 2006) annual mean limits of 20 μg/m^3 and 10 μg/m^3, respectively (Table 5-2). This is largely attributable to the prevalence of dry sandy soils inherent in the desert environment. Anthropogenic activities such as the large-scale construction projects, industrial discharges, increased number of vehicles on the roads, the removal of natural vegetation and increases in off-road driving activities all contribute to elevated ambient levels of airborne particulates in the UAE.

Table 5-2 Air pollution indicators at monitoring sites in Dubai (2013–2017)

Indicator	Carbon monoxide (CO) (max) [1]			Ozone (O_3) (max) [1]			Nitrogen dioxide (NO_2) (max) [1]			Sulphur dioxide (SO_2) (max) [1]			Particulate matter (PM_{10})[2] ($\mu g/m^3$)	Particulate matter ($PM_{2.5}$) ($\mu g/m^3$)
Objective	20 ppm			0.80 ppm			0.15 ppm			0.13 ppm			20 $\mu g/m^3$ [2]	10 $\mu g/m^3$ [2]
Year	2017	2016	2015	2017	2016	2015	2017	2016	2015	2017	2016	2015	2017 [3]	2017 [3]
Sheikh Zayed Road	2.55	2.19	2.69	0.12	0.06	--	0.08	0.10	0.12	0.04	0.04	0.06	--	--
Dubai Airport	2.26	2.53	2.36	0.13	0.12	--	0.09	0.11	0.10	0.04	0.04	0.10	--	--
Emirates Hills	2.5	2.17	1.45	0.13	0.14	0.08	0.07	0.09	0.09	0.05	0.03	0.05	131	--
Zabeel Park	2.64	2.48	2.28	0.21	0.11	0.10	0.08	0.13	0.08	0.05	0.04	0.09	--	--
Al Karama	2.72	3.71	2.47	0.6	0.12	--	0.08	0.12	0.08	0.04	0.03	0.09	--	--
Safa Park	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Deira	2.52	2.39	2.27	0.2	0.13	0.09	0.09	0.11	0.11	0.04	0.04	0.07	--	--
Sheikh Mohammed Bin Zayed Road	1.57	1.68	1.87	0.13	0.09	0.00	0.09	0.13	0.10	0.04	0.03	0.09	157	50
Warsan	1.3	1.6	1.53	0.11	0.12	0.06	0.08	0.10	0.07	0.03	0.03	0.10	--	--
Hatta Station	1.69	1.53	1.27	0.12	0.11	0.10	0.05	0.08	0.08	0.02	0.02	-	--	--
Jebel Ali Port	1.43	--	--	0.11	--	--	0.11	--	0.13	0.1	--	0.08	--	--
Jebel Ali Village	1.57	2.23	1.53	0.11	0.14	0.10	0.08	0.11	0.08	0.07	0.04	0.06	--	--
Mushrif Park	4.38	2.61	--	0.13	0.13	0.10	0.09	0.11	0.11	0.03	0.03	--	141	48

Sources: (1) Dubai Statistics Center (2018 and 2016); (2) World Health Organization, 2006; (3) DM-ED (2018)

5.3.1.2 Baseline Air Quality Monitoring

Adopted Assessment Criteria

Following review of the relevant legislation and guideline criteria for air quality standards (refer to Section 3 of the Air Quality Assessment Report in Appendix N), it is evident that some criteria are more stringent than others. Therefore, for assessment purposes, the more stringent air quality standards have been selected for comparison of the predicted GLCs. The adopted criteria are provided in Table 5-3.

Table 5-3 Adopted Assessment Criteria

Pollutant	Averaging time	Authority	Criteria (µg/m^3)
NO_2	1-hour	UAE[1]	400
		WHO[2]	200
	24-hour	UAE	150
	Annual	WHO	40
SO_2	1-hour	UAE	350
	24-hour	UAE	150
		WHO	20
	Annual	UAE	60
CO	1-hour	UAE	30000
	8-hour	UAE	10000
TSP	24-hour	UAE	230
	Annual	UAE	90
PM_{10}	Annual	WHO	20
	24-hours	UAE	150
$PM_{2.5}$	24-hours	WHO	25
	Annual	WHO	10
HCl	1-hour 99.9th percentile	NSW AMMAAP[3]	140
HF	24-hour	NSW AMMAAP	2.9
TCDD	1-hour 99.9th percentile	NSW AMMAAP	2.00E-06
NH_3	1-hour 99.9th percentile	NSW AMMAAP	330

Pollutant	Averaging time	Authority	Criteria ($\mu g/m^3$)
Hg	1-hour 99.9th percentile	NSW AMMAAP	1.8
Cd	1-hour 99.9th percentile	NSW AMMAAP	0.018

Notes:
1 – UAE Federal Ambient Air Quality Standards (Source: Cabinet Decree (12) of 2006 Regarding Regulation Concerning Protection of Air from Pollution, Annex (4).
2 – World Bank / WHO Ambient Air Quality Standards
3 – Approved Methods for the Modelling and Assessment of Air Pollutants in New South Wales, Australia (NSW AMMAAP)

Monitoring Methodology

Air Quality

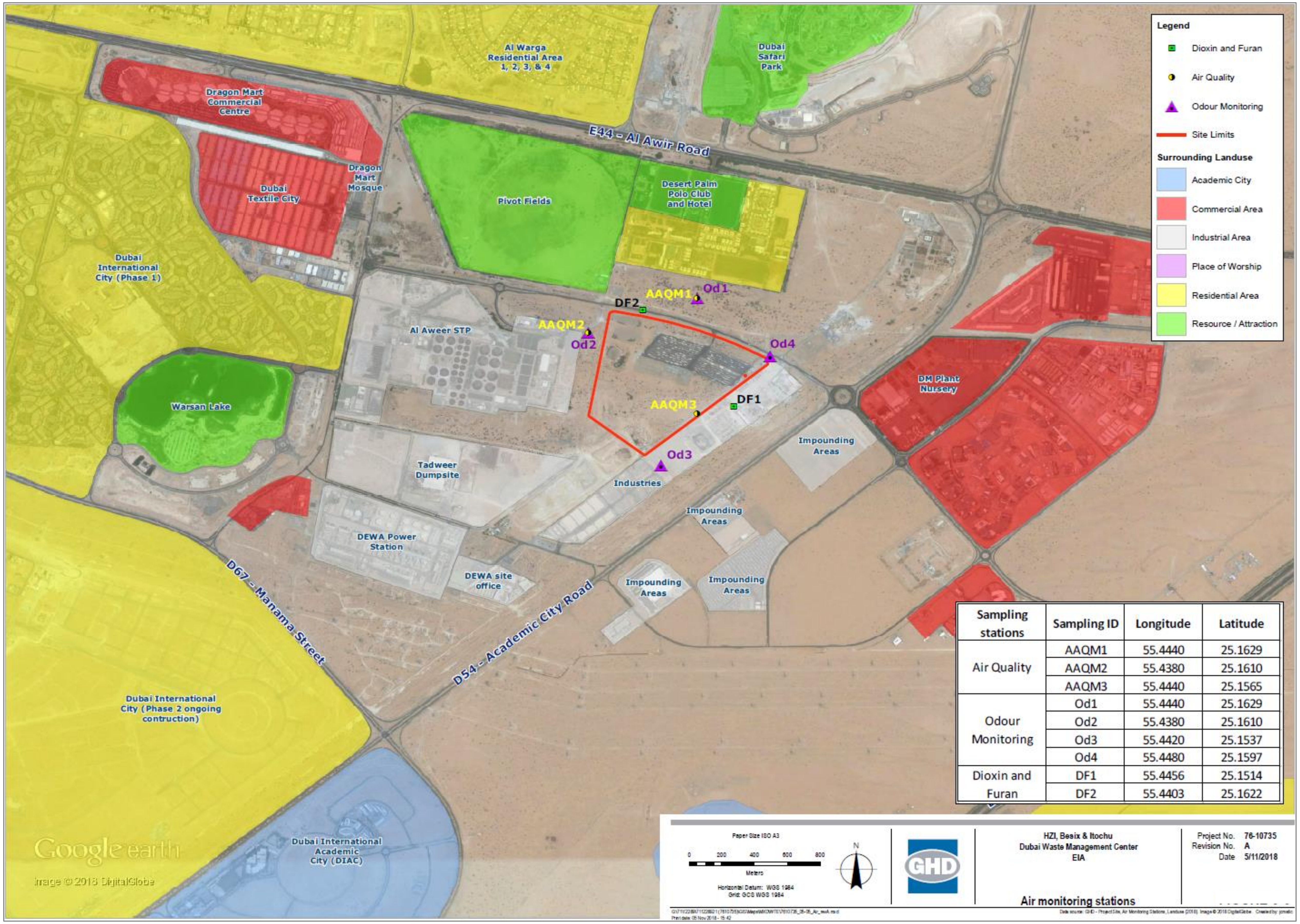
Baseline air monitoring was undertaken for two weeks at three sites in vicinity to the Project site. Air quality monitoring stations AAQM1 and AAQM3 were installed between 16 to 30 August 2018 by a DAC accredited laboratory while station AAQM2 was deployed from 26 August to 09 September 2018 using DM Mobile Station. These locations are detailed in Table 5-4 and illustrated in Figure 5-6. The sites comprised areas proximate to identified sensitive receptors. The air quality monitoring parameters and monitoring methods utilised are summarised in Table 5-5

The calibration certificate for the air sampler is provided in Appendix M.

Table 5-4 Baseline Air Quality Monitoring Locations

Site Name	Site Description	Approximate Minimum Distance to Project (m)	Coordinates – World Geodetic System of 1984 datum
AAQM1	Located between the Project site and the existing Desert Palm Dubai Resort and Hotel. This station represents the closest sensitive receptor to the Project site, and includes residential uses (i.e. residential villas are found inside the Desert Palm Dubai Resort and Hotel)	250	25.162863, 55.444350
AAQM2	Located between the Project site and the existing Al Aweer STP. During the initial site walkthrough, GHD personnel observed prevailing wind direction from the STP towards the proposed WtE plant. Therefore, there is a need to consider the up-gradient wind impacts from the existing facilities to the west. There is also a new commercial building being developed to the northwest of the area. Furthermore, the existing DIC Phase 1 is further to the west and A2 should be between the DIC Phase 1 and proposed WtE plant.	300	25.161090, 55.435300

Site Name	Site Description	Approximate Minimum Distance to Project (m)	Coordinates – World Geodetic System of 1984 datum
AAQM3	Located between the Project site and industrial facilities south of the site. This station represents the closest industrial facilities to the Project site.	16	25.156539 55.444237



Sampling stations	Sampling ID	Longitude	Latitude
Air Quality	AAQM1	55.4440	25.1629
	AAQM2	55.4380	25.1610
	AAQM3	55.4440	25.1565
Odour Monitoring	Od1	55.4440	25.1629
	Od2	55.4380	25.1610
	Od3	55.4420	25.1537
	Od4	55.4480	25.1597
Dioxin and Furan	DF1	55.4456	25.1514
	DF2	55.4403	25.1622

Figure 5-6 Air Monitoring Stations

Table 5-5 Baseline air monitoring parameters and methodology (need to confirm with Core Laboratories)

Air Quality Parameter	Monitoring Method / Principle	Monitoring Equipment
Particulate Matter (PM_{10}).	US CFR Title 40, Appendix B to Part 50	Fine Particulate Sampler APM 550
Total Suspended Particles (TSP)		
Oxides of Nitrogen (NOx) & Nitrogen Dioxide (NO_2)	US CFR Title 40, Appendix S to Part 50	Sampling: APM 433 Gaseous Pollutants Sampler Lab test: Spectrophotometer
Sulphur Dioxide (SO_2)	US CFR Title 40, Appendix A2 to Part 50	
Total Volatile Organic Compounds (VOC)	Electrochemical Sensors / Cells	RAE Monitoring System
Carbon monoxide (CO)		
Ozone (O_3)		

Dioxin and Furan

There is no existing guideline for undertaking ambient air monitoring of dioxins and furans in the Emirate of Dubai. Accordingly, the Project used international standards by the United States Environmental Protection Agency (USEPA), as recommended by Exova, a DAC qualified laboratory.

In the UAE, there are emission limits for dioxins and furans as referenced to Cabinet Decree No. 12 of 2006; however, there are not well-defined locally established or international limits, for ambient air concentrations of dioxins and furans.

In international contexts, including the USA, EU and Japan, few studies have been undertaken for dioxins and furans. As quoted from the Central Pollution Control Board, Ministry of Environment & Forests (Delhi, India), "Owing to the difficult sampling and analytical problems in determining submicro level … of dioxin and furan, there are only few studies and reporting on levels of PCDDs and PCDFs in air environment."[14] Also, ambient air concentrations of dioxins and furans can be influenced by concentration of emissions sources, commercial processes, geographical influences and/or climatic variations, so it is considered inappropriate to compare ambient air concentrations of dioxins and furans across a global context. In general, the following summary is referenced from eurofins (2013)[15]:

> *"The group of Polychlorinated Dibenzo-p-dioxins (PCDDs, Dioxins) and Polychlorinated Dibenzofurans (PCDFs, Furans), colloquially often referred to as "Dioxins" consists of 210 tricyclical chlorine organic compounds (congeners), that differ widely in the chlorine content and their respective toxicity. In particular 17 of the 210 compounds are extremely toxic. These congeners have a chlorine substitution in the 2,3,7,8-position. The most well-known*

[14] Central Pollution Control Board at ENVIS Centre, Delhi, India (December 2004). Dioxins (PCDDs) and Furans (PCDFs) – Critical Persistant Organic Pollutants (POPs). Retrieved from www.cpcb.delhi.nic.in on 23 October 2018
[15] Eurofin (2013). Dioxins and Furans. Retrieved from www.dioxine.de on 23 October 2018

compound is the 2,3,7,8-Tetrachlorodibenzo-p-dioxin (2,3,7,8-TCDD) which is generally known as "Seveso Dioxin". In February 1997 the World Health Organisation (WHO) declared this substance as carcinogenic for humans."

Furthermore, USEPA states "Of all of the dioxins and furans, one, 2,3,7,8-tetrachloro-p-dibenzo-dioxin (2,3,7,8 TCDD) is considered the most toxic."[16] Accordingly, this is the parameter assessed for the emissions model.

For comparative purposes and general information, the USEPA completed "The National Dioxin Air Monitoring Network (NDAMN)" final report in August 2013, and an extraction of their summary table for the concentrations observed is provided below in Figure 5-7 (reference Table 4-5 "Survey-wide statistics for all congeners and homologue groups" concentrations in fg/m3, from the referenced USEPA report).

The USEPA study was completed from June 1998 through November 2004. The full database composed of 685 samples, measured for 17 dioxin and furan congeners. The overall average total toxic equivalent (TEQ) concentration was 11.1 fg/m^3 with dioxin-like PCBs contributing only 0.8 fg/m^3 (7%) of this total.

[16] USEPA. Dioxins and Furans. Retrieived from US EPA Archives on 23 October 2018

Table 4-5. Survey-wide statistics for all congeners and homologue groups (concentrations in fg/m^3)

Congener	Percentage Detected	Mean	SD	95% CI	Median	Max
2,3,7,8-TCDD	85	0.6	1.2	0.5–0.7	0.3	23
1,2,3,7,8-PeCDD	89	3.1	5.9	2.7-3.6	1.7	87
1,2,3,4,7,8-HxCDD	94	4.2	10.4	3.4–5.0	2.1	209
1,2,3,6,7,8-HxCDD	97	7.3	15.3	6.1–8.4	3.8	257
1,2,3,7,8,9-HxCDD	96	7.2	15.3	6.1–8.3	3.5	305
1,2,3,4,6,7,8-HpCDD	100	102.3	243.6	85.4–120.5	52.8	5,487
OCDD	100	352.8	973.4	28–425	187.4	23,953
2,3,7,8-TCDF	96	2.1	9.6	1.4–2.8	1.1	249
1,2,3,7,8-PeCDF	94	2.4	14.1	1.3–3.4	1.1	361
2,3,4,7,8-PeCDF	96	4.3	28.8	2.1–6.4	1.7	738
1,2,3,4,7,8-HxCDF	98	5.6	41.4	2.6–8.7	2.2	1,056
1,2,3,6,7,8-HxCDF	98	4.9	31.1	2.6–7.2	2.0	787
2,3,4,6,7,8-HxCDF	99	6.4	41.3	3.3–9.5	2.6	1,031
1,2,3,7,8,9-HxCDF	74	1.5	22.3	0–3.1	0.3	597
1,2,3,4,6,7,8-HpCDF	100	27.3	178.1	14.0–40.6	11.3	4,498
1,2,3,4,7,8,9-HpCDF	91	3.5	25.2	1.6–5.4	1.2	644
OCDF	99	21.9	142.8	11.2–32.5	9.8	3,721
Total TCDF	99	75.4	263.2	55.7–94.9	44.1	6,300
Total TCDD	98	18.4	69.9	13.2–23.6	9.0	1,732
Total PeCDF	98	57.2	303.4	34.6–79.8	26.6	7,619
Total PeCDD	94	40.0	132.5	30.1–49.8	18.1	2,962
Total HxCDF	99	58.2	262.7	38.9–77.8	26.9	6,467
Total HxCDD	99	102.1	220.2	85.7–118.5	52.3	3,293
Total HpCDF	99	43.9	232.7	26.6–61.3	19.2	5,735
Total HpCDD	98	241.6	520.0	202.8–281.3	131.1	10,975
PCB 77	100	157.2	1,286.7	61.3–253.0	36.9	31,167
PCB 81	100	12.5	104.8	1.0–24.1	2.9	1,539
PCB 105	99	629.8	3,601.8	361–898	188.3	80,653
PCB 114	100	47.4	375.3	6.4–88.9	13.9	6,895
PCB 118	99	1,430.3	6,248.5	965–1,896	489.5	134,846
PCB 123	100	32.8	273.8	2.7–62.9	9.1	4,923

Table 4-5. Survey-wide statistics for all congeners and homologue groups (concentrations in fg/m^3) (continued)

Congener	Percentage Detected	Mean	SD	95% CI	Median	Max
PCB 126	100	6.9	32.7	4.5–9.3	3.0	758
PCB 156	99	67.7	168.6	55.1–80.2	30.2	2,633
PCB 157	99	14.9	37.9	12.1–17.7	6.8	590
PCB 167	100	22.2	67.4	14.8–29.6	9.9	1,083
PCB 169	83	0.9	9.7	0.2–1.7	0.3	260
PCB 189	100	2.7	4.6	2.2–3.2	1.7	50
TEQ DF		10.5	33.2	8.1–12.9	5.9	773
TEQ P		0.8	3.7	0.6–1.1	0.4	84
TEQ DFP		11.3	36.1	8.7–13.9	6.5	857

Notes: TCDD = tetachlorodibenzo-*p*-dioxin; PeCDD = pentachlorodibenzo-*p*-dioxin; HxCDD = hexachlorodibenzo-*p*-dioxin; HpCDD = heptachlorodibenzo-*p*-dioxin; OCDD = octochlorodibenzo-*p*-dioxin; TCDF = tetrachlorodibenzofuran; PeCDF = pentachlorodibenzofuran; HxCDF = hexachlorodibenzofuran; HpCDF = heptachlorodibenzofuran; OCDF = octachlorodibenzofuran; TCB = tetrachlorobiphenyl; PeCB = pentachlorobiphenyl; HxCB = hexachlorobiphenyl; HpCB = heptachlorobiphenyl.; DF=dioxins and furans when used in TEQ DF; P = PCBs when used in TEQ P; DFP = dioxins, furans, and PCBs when used in TEQ DFP.

n = 685 except for PCBs 81, 114, 123, 167, and 189, where n = 318. See Section 3.1 for more detail.

Figure 5-7 Survey Summary of NDAMN by USEPA (August 2013)

The duration of sample collection was defined by detection limits and in consideration of the proximity or relative contribution of “source generators” for the emissions of interest. The sample duration was specified considering a toxic equivalency, which can be measured by accumulating analytes in a high volume sampler over specified duration.

A 24-hour real-time active sampling approach was undertaken at two sampling locations (refer to Figure 5-6) during two sampling events (Table 5-6).

The sample equipment, analysis and reporting was provided by Exova who is a DAC registered laboratory, and testing analysis was completed in accordance with US EPA Method TO-9A. The dioxin and furan compounds that were considered are provided in Table 5-8.

Table 5-6 Dioxin and furan monitoring schedule

Locations	Coordinates	Event 1		Event 2	
		Start date / time	End date / time	Start date / time	End date / time
DF1	25.1514 55.4456	11-Sep-2018 12:38	12-Sep-2018 12:38	01-Oct-2018 11:30	02-Oct-2018 11:30
DF2	25.1622 55.4403	10-Sep-2018 11:14	11-Sep-2018 11:14	30-Sep-2018 10:54	01-Oct-2018 10:54

Table 5-7 Parameters and Equipment

Parameter	Equipment
Dioxin and Furan	High volume samplers (HVS) and poly-urethane foam (PUF) sampling heads

Table 5-8 Dioxin and Furans that were considered

Compound	WHO-2005 TEF[(1)]
2,3,7,8-TCDD	1
1,2,3,7,8- PeCDD	1
1,2,3,4,7,8-HxCDD	0.1
1,2,3,6,7,8-HxCDD	0.1
1,2,3,7,8,9-HxCDD	0.1
1,2,3,4,6,7,8-HpCDD	0.01
OCDD	0.0003 [(2)]
2,3,7,8-TCDF	0.1
1,2,3,7,8-PeCDF	0.03 [(2)]
2,3,4,7,8-PeCDF	0.3 [(2)]
1,2,3,4,7,8-HxCDF	0.1
1,2,3,6,7,8-HxCDF	0.1
1,2,3,7,8,9-HxCDF	0.1
2,3,4,6,7,8-HxCDF	0.1
1,2,3,4,6,7,8-HpCDF	0.01
1,2,3,4,7,8,9-HpCDF	0.01
OCDF	0.0003 [(2)]

Source: WHO, 2009

(1) WHO-2005 TEF means World Health Organization (2005) Total Equivalency Factor

(2) Change in TEF value from WHO (1998)

CDD, chlorodibenzodioxin; CDF, chlorodibenzofuran; Hp, hepta; Hx, hexa; O, octa; Pe, penta; T, tetra

Air Monitoring Results

Ambient Air Quality

The monitoring results are summarised in Table 5-9. The results show they were all compliant with the ambient air quality standards for all parameters as specified by the Federal Law and Dubai Municipality with the exception of PM_{10} at station AAQM2.

Ambient concentrations of airborne particulates (PM_{10} and TSP) throughout the UAE are commonly recorded in higher concentrations than the national limit. This is largely attributable to the prevalence of dry sandy soils inherent in the desert environment. Anthropogenic activities such as large scale consstrution projects, industrial emissions, increase vehicles on the UAE’s roads, and increaseds in off-road driving activities all contribute to elevated ambient levels of airborne particulates in the UAE.

The remaining parameters (i.e. NO_2, SO_2, CO and O_3) were all below the guidelines. It is worth noting that the average values recorded for NO_2, SO_2, CO and O_3 were overall slightly higher at Station AAQM1. Station AAQM1 is located approximately 150 m from an internal road, while AAQM3 is approximately 500 m away. As such, it is suggested that the higher number of vehicles travelling on the internal road could be contributing to the slight increase in levels of these parameters in AAQM1 compared to the levels recorded at AAQM3.

It should be noted that the two-week monitoring period provides only a snap shot of conditions at the Project site. Monitoring results are to be used with consideration of the following limitations:

- Short-term measurements made over a limited sampling period involve a large uncertainty as to the representativeness throughout the various times of the year.
- The data was collected during the period of summer season, during which time conditions can fluctuate with days. Summer in the northern Gulf in influrenced by summer Shamals which commonly bring dust or ‘blazes’ of hot and dry air.

Ambient air quality at the Project site and in the surrounding areas is most likely to be influenced by the following:

- DEWA Power Station to the southwest of the site with stationary sources of emission
- Various industrial facilities to the immediate east and southeast of the Project site
- Combustion emissions from vehicles using the surrounding road infrastructure

Table 5-9 Baseline Ambient Air Quality Monitoring Results

Measurement	Daily Average								
Sampling Date	Parameter	Nitrogen Dioxide (NO_2)	Sulfur Dioxide (SO_2)	Carbon Monoxide (CO)	Ozone (O_3)	VOC	TSP	PM_{10}	$PM_{2.5}$
	Unit	µg/m^3	µg/m^3	mg/m^3	µg/m^3	mg/m^3	µg/m^3	µg/m^3	µg/m^3
	UAE Limit (average)	1-hour: 400; 24-hour: 150	1-hour: 350; 24-hour: 150	1-hour: 30; 8-hour: 10	1-hour: 200; 8-hour: 120	–	24-hour: 230	24-hour: 150	–
16 Aug 2018	AAQM1	84.24	72.11	1.43	73.72	0.46	127.35	95.29	-
	AAQM3	78	6.00	0.53	25	0.35	133	112	-
17 Aug 2018	AAQM1	76.43	64.10	0.98	66.25	0.27	149.44	103.06	-
	AAQM3	72.18	2.34	0.42	38.06	0.16	194.02	142.77	-
18 Aug 2018	AAQM1	101.44	67.89	1.43	70.86	0.33	125.70	74.02	-
	AAQM3	71.94	0.00	0.45	29.83	0.07	168.80	121.01	-
19 Aug 2018	AAQM1	112.78	48.11	1.54	79.92	0.23	129.72	80.54	-
	AAQM3	59.94	0.00	0.48	18.99	0.05	165.24	111.10	-
20 Aug 2018	AAQM1	87.98	54.59	1.85	87.80	0.24	115.55	71.00	-
	AAQM3	70.45	2.95	0.47	25.79	0.19	139.67	90.90	-
21 Aug 2018	AAQM1	91.23	71.75	1.75	90.01	0.25	98.51	57.33	-
	AAQM3	54.15	0.93	0.34	24.27	0.06	106.08	73.78	-

Measurement	Daily Average									
Sampling Date	Parameter	Nitrogen Dioxide (NO_2)	Sulfur Dioxide (SO_2)	Carbon Monoxide (CO)	Ozone (O_3)	VOC	TSP	PM_{10}	$PM_{2.5}$
	Unit	µg/m^3	µg/m^3	mg/m^3	µg/m^3	mg/m^3	µg/m^3	µg/m^3	µg/m^3
	UAE Limit (average)	1-hour: 400; 24-hour: 150	1-hour: 350; 24-hour: 150	1-hour: 30; 8-hour: 10	1-hour: 200; 8-hour: 120	–	24-hour: 230	24-hour: 150	–
22 Aug 2018	AAQM1	88.44	67.79	2.21	90.09	0.29	108.99	61.23	-
	AAQM3	61.28	0.00	0.36	25.33	0.06	88.16	70.08	-
23 Aug 2018	AAQM1	118.57	69.01	1.37	77.88	0.25	127.00	53.58	-
	AAQM3	69.50	1.72	0.41	17.21	0.05	144.23	93.18	-
24 Aug 2018	AAQM1	106.10	66.15	1.50	98.33	0.25	93.53	44.57	-
	AAQM3	60.12	2.23	0.35	29.05	0.12	106.69	71.64	-
25 Aug 2018	AAQM1	99.41	60.43	1.24	59.41	0.16	106.97	54.58	-
	AAQM3	67.40	17.36	0.50	11.69	0.29	166.20	106.99	-
26 Aug 2018	AAQM1	87.96	62.89	1.35	78.86	0.14	96.64	46.62	-
	AAQM3	59.93	8.97	0.46	17.88	0.23	130.68	88.80	-
27 Aug 2018	AAQM1	103.07	65.41	1.95	83.20	0.27	89.70	50.76	-
	AAQM3	62.77	1.58	0.37	18.01	0.14	137.16	85.50	-
28 Aug 2018	AAQM1	89.10	59.05	1.87	76.12	0.23	102.66	66.30	-

Measurement	Daily Average								
Sampling Date	Parameter	Nitrogen Dioxide (NO_2)	Sulfur Dioxide (SO_2)	Carbon Monoxide (CO)	Ozone (O_3)	VOC	TSP	PM_{10}	$PM_{2.5}$
	Unit	µg/m³	µg/m³	mg/m³	µg/m³	mg/m³	µg/m³	µg/m³	µg/m³
	UAE Limit (average)	1-hour: 400; 24-hour: 150	1-hour: 350; 24-hour: 150	1-hour: 30; 8-hour: 10	1-hour: 200; 8-hour: 120	–	24-hour: 230	24-hour: 150	–
	AAQM2	0.028 ppm	0.009 ppm	0.25 ppm	0.026 ppm	-	-	212	55
	AAQM3	63.13	0.57	0.42	8.96	0.06	155.53	103.25	-
29 Aug 2018	AAQM1	99.63	51.35	1.36	83.49	0.18	78.38	57.26	-
	AAQM2	0.022 ppm	0.008 ppm	0.21 ppm	0.037 ppm	-	-	203	39
	AAQM3	66.82	15.63	0.39	16.88	0.20	114.04	74.45	-
30 Aug 2018	AAQM1	109.57	68.58	1.18	64.63	0.08	110.88	68.94	-
	AAQM2	0.025 ppm	0.008 ppm	0.20 ppm	0.023 ppm	-	-	219	50
	AAQM3	61.97	14.60	0.35	11.06	0.09	135.44	81.67	-
31 Aug 2018	AAQM2	0.022 ppm	0.009 ppm	0.26 ppm	0.034 ppm	-	-	167	43
01 Sep 2018	AAQM2	0.032 ppm	0.010 ppm	0.33 ppm	0.032 ppm	-	-	160	57
02 Sep 2018	AAQM2	0.033 ppm	0.011 ppm	0.30 ppm	0.031 ppm	-	-	171	61
03 Sep 2018	AAQM2	0.028 ppm	0.010 ppm	0.23 ppm	0.035 ppm	-	-	111	51
04 Sep 2018	AAQM2	0.022 ppm	0.011 ppm	0.18 ppm	0.028 ppm	-	-	180	72

Measurement	Daily Average								
Sampling Date	Parameter	Nitrogen Dioxide (NO_2)	Sulfur Dioxide (SO_2)	Carbon Monoxide (CO)	Ozone (O_3)	VOC	TSP	PM_{10}	$PM_{2.5}$
	Unit	µg/m^3	µg/m^3	mg/m^3	µg/m^3	mg/m^3	µg/m^3	µg/m^3	µg/m^3
	UAE Limit (average)	1-hour: 400; 24-hour: 150	1-hour: 350; 24-hour: 150	1-hour: 30; 8-hour: 10	1-hour: 200; 8-hour: 120	–	24-hour: 230	24-hour: 150	–
05 Sep 2018	AAQM2	0.019 ppm	0.013 ppm	0.15 ppm	0.032 ppm	-	-	280	54
06 Sep 2018	AAQM2	0.025 ppm	0.011 ppm	0.19 ppm	0.027 ppm	-	-	241	51
07 Sep 2018	AAQM2	0.023 ppm	0.009 ppm	0.24 ppm	0.042 ppm	-	-	145	-
08 Sep 2018	AAQM2	0.043 ppm	0.010 ppm	0.47 ppm	0.028 ppm	-	-	190	-
09 Sep 2018	AAQM2	0.033 ppm	0.008 ppm	0.35 ppm	0.037 ppm	-	-	180	59
10 Sep 2018	AAQM2	0.027 ppm	0.009 ppm	0.25 ppm	0.032 ppm	-	-	178	45

Source: DM-ED Mobile Station provided data for AAQM2, for 30-minute, 1-hour and 24-hour averages taken from 08 August 2018 to 10 September 2018.

Dioxin and Furan

The summary of results is provided in Table 5-10 while actual concentration for each compound, or compound group, is provided in Table 5-11. The complete laboratory report is provided in Appendix M.

There does not exist a local UAE standard for ambient air concentration of dioxins, furans and dioxin-like PCBs; therefore, and in consultation by the EPSS, reference is made to an ambient air concentration of **0.1 pg TEQ/m^3** (24-hour) as per Ontario, Canada reference titled “Ontario’s Ambient Air Quality Criteria – Sorted by Contaminant Name.” This document lists the Ambient Air Quality Criteria (AAQCs) developed by the Ontario Minitstry of the Environment and Climate Change. As stated by them, “An AAQC is a desireable concentration of a contaminant in air and is used to assess general air quality resulting from all sources of a contaminant to air,” and “AAQCs are most commonly used in environmental assessments, special studies using ambient air monitoring data, assessment of general air quality in a community and annual reporting on air quality across the province.”

The concentrations of both dioxins and furans in stations DF1 and DF2 during Events 1 and 2 are below the WHO-2005 TEF values (Table 5-11). It is worth noting that the 2,3,7,8-TCDD compound, which is the most potent congener of this group of related compounds and considered one of the most potent toxicants and carcinogens known to date (WHO, 2009), was not detected in both monitoring stations during Event 1 and at station DF2 during Event 2.

Table 5-10 Summary of results

Stations	Events	Sampling volume (m^3)	Analysis result (ng TEQ)	Concentration (ng/m^3 TEQ)
DF1	Event 1	322.56	0.00242	0.000007
	Event 2	322.56	0.00589	0.000018
DF2	Event 1	322.56	0.00194	0.000006
	Event 2	322.56	0.00172	0.000005

(1) – Annex 1 of Cabinet Decree (12) of 2006

(2) – Annex 3 of Cabinet Decree (12) of 2006

TEQ - Toxic Equivalent Value

As shown in the above table, the TEQ is approximately 18% (at maximum-recorded concentration) and 5% (at minimum-recorded concentration) of the criteria from Ontario, Canada, for AAQCs.

Table 5-11 Dioxin and furan monitoring laboratory results

Compound	WHO (2005) TEFs	DF1 (N22'09'25 E55'26"44)								DF2 (N25'09"44 E55'26"25)							
		Event 1 (10-11 Sep 2018)				Event 2 (30 Sep to 02 Oct 2018)				Event 1 (10-11 Sep 2018)				Event 2 (30 Sep to 02 Oct 2018)			
		Conc	TEFs	TEQ[1]	TEQ[2]	Conc	TEFs	TEQ[1]	TEQ[2]	Conc	TEFs	TEQ[1]	TEQ[2]	Conc	TEFs	TEQ[1]	TEQ[2]
2,3,7,8-TCDD	1	*	1.000	0.0002	0.0000	0.000154	1.000	0.0002	0.0002	*	1.000	0.0002	0.0000	0.000157	1.000	0.0002	0.0002
1,2,3,7,8-PCDD	1	*	0.500	0.0002	0.0000	0.000557	0.500	0.0003	0.0003	*	0.500	0.0001	0.0000	*	0.500	0.0001	0.0000
1,2,3,4,7,8-HxCDD	0.1	0.000294	0.100	0.0000	0.0000	0.000609	0.100	0.0001	0.0001	0.00033	0.100	0.0000	0.0000	0.00025	0.100	0.0000	0.0000
1,2,3,6,7,8-HxCDD	0.1	0.000771	0.100	0.0001	0.0001	0.000784	0.100	0.0001	0.0001	0.00127	0.100	0.0001	0.0001	0.000616	0.100	0.0001	0.0001
1,2,3,7,8,9-HxCDD	0.1	0.000387	0.100	0.0000	0.0000	0.000817	0.100	0.0001	0.0001	0.000568	0.100	0.0001	0.0001	0.000214	0.100	0.0000	0.0000
1,2,3,4,6,7,8-HpCDD	0.01	0.0057	0.010	0.0001	0.0001	0.00647	0.010	0.0001	0.0001	0.00683	0.010	0.0001	0.0001	0.00579	0.010	0.0001	0.0001
1234678-OCDD	0.0003	0.0126	0.001	0.0000	0.0000	0.0108	0.001	0.0000	0.0000	0.0124	0.001	0.0000	0.0000	0.0111	0.001	0.0000	0.0000
2,3,7,8-TCDF	0.1	0.00132	0.100	0.0001	0.0001	0.0033	0.100	0.0003	0.0003	0.00125	0.100	0.0001	0.0001	0.00121	0.100	0.0001	0.0001
1,2,3,7,8-PeCDF	0.03	0.000639	0.050	0.0000	0.0000	0.00205	0.050	0.0001	0.0001	0.000268	0.050	0.0000	0.0000	0.000484	0.050	0.0000	0.0000
23478-PeCDF	0.3	0.00194	0.500	0.0010	0.0010	0.00425	0.500	0.0021	0.0021	0.000729	0.500	0.0004	0.0004	0.00112	0.500	0.0006	0.0006
1,2,3,4,7,8-HxCDF	0.1	0.00165	0.100	0.0002	0.0002	0.00858	0.100	0.0009	0.0009	0.00237	0.100	0.0002	0.0002	0.00165	0.100	0.0002	0.0002
1,2,3,6,7,8-HxCDF	0.1	0.00185	0.100	0.0002	0.0002	0.00683	0.100	0.0007	0.0007	0.00114	0.100	0.0001	0.0001	0.00128	0.100	0.0001	0.0001
2,3,4,6,7,8-HxCDF	0.1	0.00224	0.100	0.0002	0.0002	0.00687	0.100	0.0007	0.0007	0.00316	0.100	0.0003	0.0003	0.00171	0.100	0.0002	0.0002
1,2,3,7,8,9-HxCDF	0.1	0.000222	0.100	0.0000	0.0000	0.000455	0.100	0.0000	0.0000	0.000303	0.100	0.0000	0.0000	0.000302	0.100	0.0000	0.0000
1,2,3,4,6,7,8-HpCDF	0.01	0.00884	0.010	0.0001	0.0001	0.0311	0.010	0.0003	0.0003	0.0114	0.010	0.0001	0.0001	0.00625	0.010	0.0001	0.0001
1,2,3,4,7,8,9-HpCDF	0.01	0.000297	0.010	0.0000	0.0000	0.000709	0.010	0.0000	0.0000	0.000462	0.010	0.0000	0.0000	0.000239	0.010	0.0000	0.0000
123467-OCDF	0.0003	0.00541	0.001	0.0000	0.0000	0.00971	0.001	0.0000	0.0000	0.00659	0.001	0.0000	0.0000	0.00343	0.001	0.0000	0.0000
TEQ (NATO)				0.00242	0.00204			0.00589	0.00589			0.00194	0.00162			0.00172	0.0016

*	Isomer not detected
TEQ	Toxic Equivalent Value
TEF	Toxic Equivalent Factor
Conc	Concentration[17]
DL	Detection Value
REC	Recovery
TEQ[1]	Concentration of Non Detected Congeners at Detection Limit (ng/sample)
TEQ[2]	Concentration of Non Detected Congeners at Zero (ng/sample)

[17]The actual concentration in the sample for each compound, or compound group, as determined by analysis (ALS Laboratory Group).

5.3.2 Odour Monitoring

Nuisance odour emissions may cause environmental nuisance and has the potential to cause for complaint by the local community. Odour sources can be continuous or intermittent, point source (e.g. chimneys, stacks or building vent/exhaust pipes), area sources (e.g. stockpiles, ponds or open-topped tanks) or volume sources (e.g. building with many opening from which odour escapes) (Department of Environment and Heritage Protection, undated).

A review of the existing condition around the proposed WtE plant indicates that there are a number of potential odour sources, which include:

- The Tadweer landfill;
- The Al Aweer STP;
- The Al Serkal / Envirol grease trap waste recycling plant;
- Chinal state asphalt mixing plant; and
- Emirates beton readymix LLC (concrete supplier).

A site investigation was undertaken to monitor the ambient air levels of odourous gases from potential odour sources around the Project site. Sampling was conducted by pumping ambient air on to various sampling media to capture the target compounds (Table 5-12).

Table 5-12 Target compounds and sampling methodology

Target compounds	Sampling media	Analysis
Hydrogen Sulphide (H_2S)	Orbo 34 Tube	Ion Chromatography
Ammonia (NH_3)	Treated Silica Tube	Ion Chromatography
Mercaptans	Treated Filter	GC-MS
Dimethyl Disulphide (DMDS)	Charcoal Tube	GC-FID
Dimethyl Sulphide (DMS)	Charcoal Tube	GC-FID

Baseline odour monitoring was conducted by Al Futtaim Elements Materials Technology (2018) at four locations at the Project site, as shown in Figure 5-6 and detailed in Table 5-13. Odour monitoring was carried out for a period of eight hours at each monitoring location. Prevailing meteorological conditions at Dubai International Airport on the day of sampling are also included in Table 5-13.

Table 5-13 Odour monitoring schedule

Location	Coordinates	Date / Time	Averaging period	Wind direction (° from North)	Wind strength (km/hr)	Temperature (°C)	Humidity (%)
Od1 (1)	25.1629; 55.4444	15 Oct 2018 (08:15–16:15)	8 hours	West	23	35	47
Od2 (2)	25.1610; 55.4384	15 Oct 2018 (08:30–16:30)	8 hours	West	23	35	47
Od3 (3)	25.1537; 55.4419	16 Oct 2018 (08:00–16:00)	8 hours	Northwest	17	33	57
Od4 (4)	25.1597; 55.4479	16 Oct 2018 (08:20–16:20)	8 hours	Northwest	17	33	57

(1) Al Warsan N1 in laboratory report

(2) Al Warsan N2 in laboratory report

(3) Al Warsan N3 in laboratory report

(4) Al Warsan N4 in laboratory report

Results

Odour monitoring results is summarised in Table 5-14 while detailed laboratory result is provided in Appendix M.

It can be seen that concentrations of H_2S are highest at Od2, which is west of the proposed WtE plant and east of the Al Aweer STP. On this occasion, wind was blowing west dispersing H_2S from the STP in the direction of the monitor.

Concentrations of NH_3 were only high enough to be detected by the equipment at one monitoring location. This was at Od3, situated south of the proposed WtE plant and east of the STP. On this occasion, winds were blowing from a north westerly direction carrying NH_3 from the STP.

Concentrations of dimethyl disulphide and dimethyl sulphide were not high enough to be detected by the equipment at any monitoring location throughout the monitoring period.

Table 5-14 Odour monitoring results

Location	H_2S (µg/m^3)	NH_3 (µg/m^3)	Mercaptans (µg/m^3)	DMDS (µg/m^3)	DMS (µg/m^3)
Od1	6	<1	<10	<5	<5
Od2	20	<1	<10	<5	<5
Od3	11	3	<10	<5	<5
Od4	<5	<1	<10	<5	<5

< Denotes the result is less than the laboratory limit of detection

5.4 Noise

Dubai is subject to relatively high levels of traffic and construction noise as a result of the high level of development and growth of the country. In a study conducted to evaluate the impact of air and noise from transportation in Dubai, noise levels recorded within the city of Dubai were higher than those recorded outside the city due to increased human activity. The main sources of noise included road traffic and aircraft movement from the Dubai Airport (Al Mehairi, 1995). In the absence of local noise data, this section details the methodology and results of a baseline noise survey undertaken around the Project site.

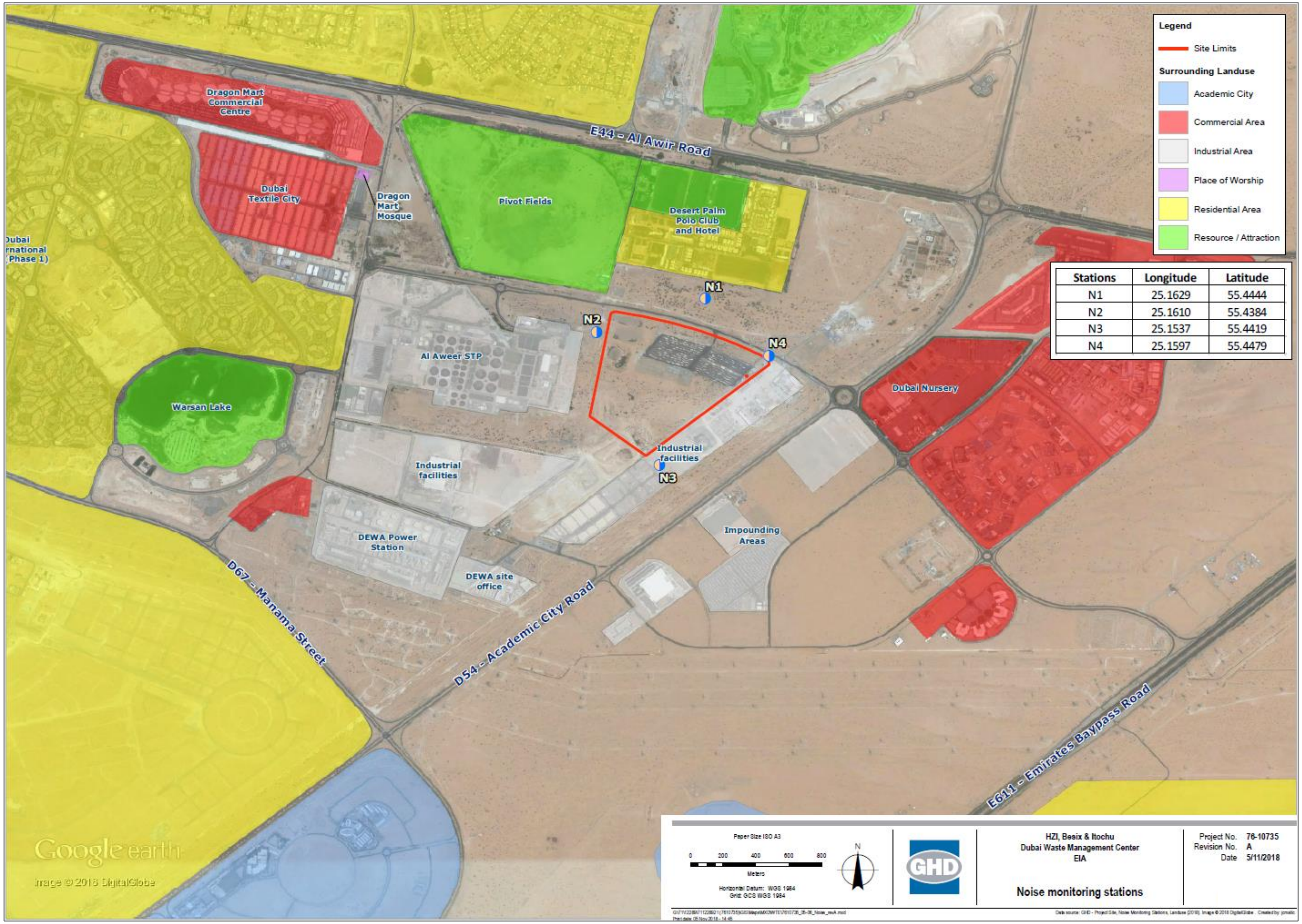
5.4.1 Baseline Noise Survey

5.4.1.1 Monitoring Methodology

Baseline noise monitoring was undertaken at four sites over two monitoring periods on 18 and 19 August 2018. These locations are detailed in Table 5-15 and illustrated in Figure 5-8. The monitoring locations were selected due to their proximity to the Project and potential to be impacted by noise.

Table 5-15 Baseline noise monitoring locations

Site Name	Site Description	Approximate Minimum Distance to Project (m)	Coordinates – *World Geodetic System of 1984 datum*
NQM1	Located between the Project site and the existing Desert Palm Dubai Resort and Hotel. This station represents the closest sensitive receptor to the Project site, and includes residential uses (i.e. residential villas are found inside the Desert Palm Dubai Resort and Hotel)	250	25.162889, 55.444389
NQM2	Located between the Project site and the existing Al Aweer STP. During the initial site walkthrough, GHD personnel observed prevailing wind direction from the STP towards the proposed WtE plant. Therefore, there is a need to consider the up-gradient wind impacts from the existing facilities to the west. There is also a new commercial building being developed to the northwest of the area. Furthermore, the existing DIC Phase 1 is further to the west and N2 should be between the DIC Phase 1 and proposed WtE plant.	300	25.161000, 55.438389
NQM3	Located at the southeast of the Project site near the existing concrete producing plants. This location considers the existing noise from adjacent facilities relative to cumulative impacts.	650	25.153694, 55.441889
NQM4	Located near the internal road access and northeast corner of the Project site. This location is important to document the existing traffic noise from highway relative to cumulative impacts.	110 m	25.159694, 55.447889



Stations	Longitude	Latitude
N1	25.1629	55.4444
N2	25.1610	55.4384
N3	25.1537	55.4419
N4	25.1597	55.4479

Figure 5-8 Baseline noise monitoring stations

The objective of the baseline monitoring survey was to measure current daytime and night time ambient noise. A total of four measurements were taken for a duration of 15-minutes at each site, comprising:

- One measurement on a week day (Sunday – Thursday) during day time (7 am to 8 pm);
- One measurement on a week day during night time (8 pm to 7 am);
- One measurement on the weekend (Friday or Saturday) during day time; and
- One measurement on the weekend during night time.

For each measurement, the following parameters were measured:

- L_{Aeq} – The average measured noise level;
- L_{Amax} – The highest single noise level;
- L_{Amin} – The lowest or minimum noise level measured;
- L_{A10} – The average noise level exceeded for ten percent of the duration of the measurement; and
- L_{A90} – The noise level which is exceeded for an average of 90 percent of the duration of the measurement.

Measurements were taken using a Cirrus CR:171B sound level meter in accordance with EPA Victoria (Australia) Publication 280-1991. Readings were taken at approximately 1.5 m above the ground level. Other details such as surrounding activities and noise sources at the time of measurement were noted.

Immediately prior to and following each noise measurement, the accuracy of the sound level meter was checked by a sound level calibrator generating a known sound pressure level at a known frequency. Measurements were accepted as valid only if the calibration levels before and after the noise measurements agreed to within 1.0 dB. Noise level data obtained during rain and wind with an average speed exceeding 5 m/s or wind with gusts exceeding 10 m/s was not accepted. The calibration certificate for the sound level meter and calibrator as well as laboratory reports are provided in Appendix M.

5.4.1.2 Adopted Guidelines

Federal Laws and Ministerial Decrees - Council of Minister Decree No. 12 of Year 2006 under Federal Law No. 24

Ministerial Decree No. 12 (UAE MoEW, 2006) was enacted in line with the air pollution control objective of Federal Law No. 24 of 1999, which also provides regulations concerning the protection of the environment from noise pollution. The regulations outline the required ambient noise levels for different types of land use such as residential, commercial and industrial.

The allowable noise limits stipulated in the regulations are shown in Table 5-16.

World Bank Guidelines

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

The guideline also states that noise impacts should not exceed the maximum allowable daytime and night-time noise levels shown in Table 5-16 or result in a maximum increase in background levels of 3 dB at the nearest sensitive receptor location off-site.

World Health Organisation Guidelines

World Health Organisation – Guidelines for Community Noise, 1999

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

World Health Organisation – Night Noise Guidelines for Europe, 2009

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

Noise and vibration criteria adopted for the assessment are summarised in Table 5-16 and Table 5-17.

Table 5-16 Summary of adopted noise assessment crtieria

Area	Adopted noise limits L_{Aeq} dB(A)	
	Daytime	Night-time
FEA Federal Law[a]		
Residential areas which include some workshops and commercial business or residential areas near the highways	50–60	40–50
Industrial areas (heavy industry)	60–70	50–60
IFC World Bank[b]		
Residential; institutional; educational[18]	55	45
Industrial; commercial	70	70
OR		
All sensitive receptors [d]	≤ Background level + 3 dB(A)	
WHO[c]		
Sleep Disturbance	-	40 $L_{night, outside}$

[a] Daytime is defined as period of the day between 7:00 am to 8:00 pm and night-time is defined as period of the day between 8:00 pm to 7 am.

[b] Daytime is defined as period of the day between 7:00 am to 10:00 pm and night-time is defined as period of the day between 10:00 pm to 7:00 am.

[c] Night-time is defined as period of the day between 11 pm to 7 am.

[d] The incremental noise impact criteria were based on IFC (WB) guideline, recommending that *'noise impacts should not result in a maximum increase in background levels of 3 dB at the nearest receptor location off-site.'*

Table 5-17 Summary of adopted vibration assessment crtieria

Line	Receptors description	Guideline values for velocity (mm/s)
Human comfort		
-	Vibration might be just perceptible in the most sensitive situations for most vibration frequencies associated with construction.	≤ 0.14
Structural damage		
1	Buildings used for commercial purposes, industrial buildings, and buildings of similar design.	≤ 20
2	Dwellings and buildings of similar design and/or occupancy	≤ 5
3	Structures that, because of their particular sensitivity to vibration, cannot be classified under lines 1 and 2 and are of great intrinsic value (e.g. listed buildings under preservation order)	≤ 3

5.4.1.3 Noise Monitoring Results

The measurement period for weekend and weekday measurements are summarised in Table 5-18 and Table 5-19, respectively. The ambient noise measurements recorded at the identified locations at daytime and night-time are summarised in Table 5-20 and Table 5-21, respectively.

Table 5-18 Weekend survey timing and schedule

Station	Site description	Daytime Measurements			Night-time Measurements		
		Date	Start Time	End Time	Date	Start Time	End Time
NQM1	North point	18 Aug 2018	10:40	10:55	18 Aug 2018	21:15	21:30
NQM2	West point	18 Aug 2018	11:20	11:35	18 Aug 2018	21:30	21:45
NQM3	South point	18 Aug 2018	09:30	09:45	18 Aug 2018	20:15	20:30
NQM4	East point	18 Aug 2018	10:20	10:45	18 Aug 2018	20:50	21:10

Table 5-19 Weekday survey timing and schedule

Station	Site description	Daytime Measurements			Night-time Measurements		
		Date	Start Time	End Time	Date	Start Time	End Time
NQM1	North point	19 Aug 2018	11:15	11:30	19 Aug 2018	20:45	21:00
NQM2	West point	19 Aug 2018	11:40	11:55	19 Aug 2018	21:15	21:30
NQM3	South point	19 Aug 2018	10:25	10:40	19 Aug 2018	20:00	20:15
NQM4	East point	19 Aug 2018	11:05	11:20	19 Aug 2018	21:35	21:50

Table 5-20 Ambient noise survey results: daytime noise levels

Station	Site description	Weekend (18 Aug 2018)		Weekday (19 Aug 2018)	
		Leq dBA	L90 dBA	Leq dBA	L90 dBA
NQM1	North point	55	48	50	46
NQM2	West point	53	47	59	42
NQM3	South point	53	39	52	45
NQM4	East point	55	47	60	45
Guideline limits:					
Federal allowable limit for residential areas near highways – NQM1					50–60
Federal and World Bank allowable limit for industrial areas – NQM2, NQM3 & NQM4					60–70
World Bank allowable limit for residential area – NQM1					55

dBA – means decibels adjusted. dBA is used for determining the sound exposure to humans

Table 5-21 Ambient noise survey results: night-time noise levels

Station	Site description	Weekend (18 Aug 2018)		Weekday (19 Aug 2018)	
		Leq dBA	L90 dBA	Leq dBA	L90 dBA
NQM1	North point	49	46	48	45
NQM2	West point	49	42	56	48
NQM3	South point	42	40	49	47
NQM4	East point	45	40	61	48
Guideline limits:					
Federal allowable limit for residential areas near highways – NQM1					40–50
Federal and World Bank allowable limit for industrial areas – NQM2, NQM3 & NQM4					50–60
World Bank allowable limit for residential area – NQM1					45
World Bank allowable limit for industrial areas – NQM2, NQM3 & NQM4					70

dBA – means decibels adjusted. dBA is used for determining the sound exposure to humans

As can be seen from the results above, the daytime measurements for locations NQM2, NQM3 and NQM4 on weekdays and weekends were below the relevant limits. Night time measurements for NQM2, NQM3 and NQM4 were below the relevant limits except for exceedances of the lower end of the standard at NQM2 and the upper limit at NQM4 during the weekday measurements. These exceedances are most likely attributed to passing vehicles.

The daytime measurement at NQM1 is above the lower limit (50 dBA) of the Federal standard for residential areas near highways while night time measurementas exdeeded the World Bank limit of 45 dBA as well as the Federal Guideline of 40 dBA (lower limit) during both weekends and weekdays. NQM1 is adjacent to an internal road leading to the industrial area. The exceedances are most likely associated with vehicle movement on the road as well as sound of insects/animals (Table 5-22).

Table 5-22 Site Observation and Sources of Noise

Station	Weekend (18 August 2018)		Weekday (19 August 2018)	
	Daytime	Night time	Daytime	Night time
NQM1	Open area Sound of wind	Open area Sound of wind and animals/insects	Open area Sound of wind	Open area Sound of wind
NQM2	Vehicles / Tankers Unloading vehicles passing (less frequent)	Vehicles Noise generated by passing vehicle from Envirol Company Sound from animals/insects	Vehicle / Tankers Unloading vehicles passing (less frequent)	Vehicles Noise generated by passing vehicle from Envirol Company Sound from animals/insects

Station	Weekend (18 August 2018)		Weekday (19 August 2018)	
	Daytime	Night time	Daytime	Night time
NQM3	Open area Sound of wind	Open area Sound of wind and animals/insects	Open area Sound of wind	Open area Sound of wind and animals/insects
NQM4	Vehicles / Tankers Unloading vehicles Passing light moving vehicles (less frequendt)	Passing light moving vehicles (cars)	Vehicle / trucks passing and light moving vehicles (cars)	Passing light moving vehicles (cars)

5.5 Geology, Seismicity, Soil and Groundwater

5.5.1 Geology and Geomorphology

5.5.1.1 Geology

The Arabian Gulf measures approximately 1000 km in length and 200 to 300 km in width. The water depth profile is generally shallow, with the deepest water (about 100 m) being located near Iran. The Arabian Gulf is a shallow tectonic depression formed in the tertiary period (approximately 7 million years ago) in front of the rising Zagros Mountains (Zaghloul, 2008).

The asymmetry of the depression results in steep coastal slopes and deeper water on the Iranian side, and the low-lying Arabian coastline with adjacent shallow sea floor on the other. This geological structure has resulted in the UAE incorporating an extensive low-lying plain on the west side, which gradually climbs to the Hajar Mountains in the east (Figure 5-9). In general, Dubai consists of a linear coastline dissected by creeks with superficial deposits comprising beach dune sands with marine sands and silts. Erosion, the capillary rise phenomena and evaporation have led to extensive silt deposits in some areas, especially near creeks. These superficial deposits are underlain by alternative layers of calcarenite, carbonate sandstone, sands as well as cemented sand layers (Tarawaneh and Matraji, 2014).

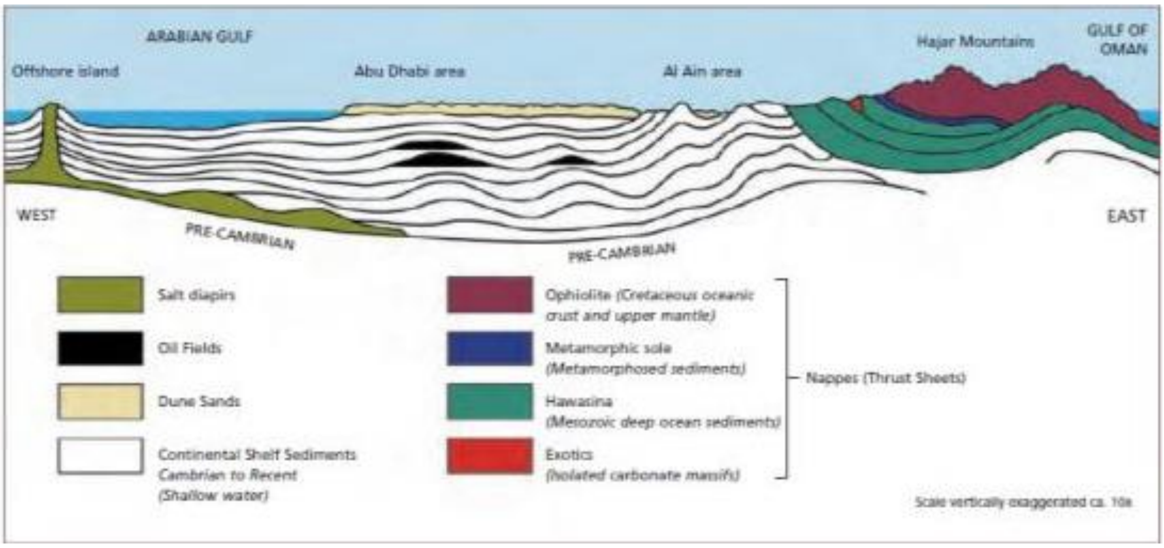


Figure 5-9 Geology of the UAE

5.5.1.2 Seismicity

The Arabian Peninsula lies on the Arabian Plate, which is bordered to the south by the African Plate and to the east by the Indian Plate. To the west lies a lateral fault known as the Dead Sea Transform Fault and a divergent boundary, known as the Red Sea Rift, which runs the length of the Red Sea. To the north lies the Eurasian Plate. The Arabian, African and Indian plates are all moving northward, colliding with the Eurasian Plate and causing the uplift of mountain ranges, most notably the Zagros Mountains of Iran (Figure 5-10).

The Zagros Fold and Thrust Belt and Makran Subduction Zone are the only fault systems that have a direct effect on the seismicity of the UAE (Abdalla and Al-Homoud, 2004). In this region, the Arabian tectonic plate has been pushing against the Eurasian plate at a rate of approximately 22 mm per year (Johnson and Stern, 2010).

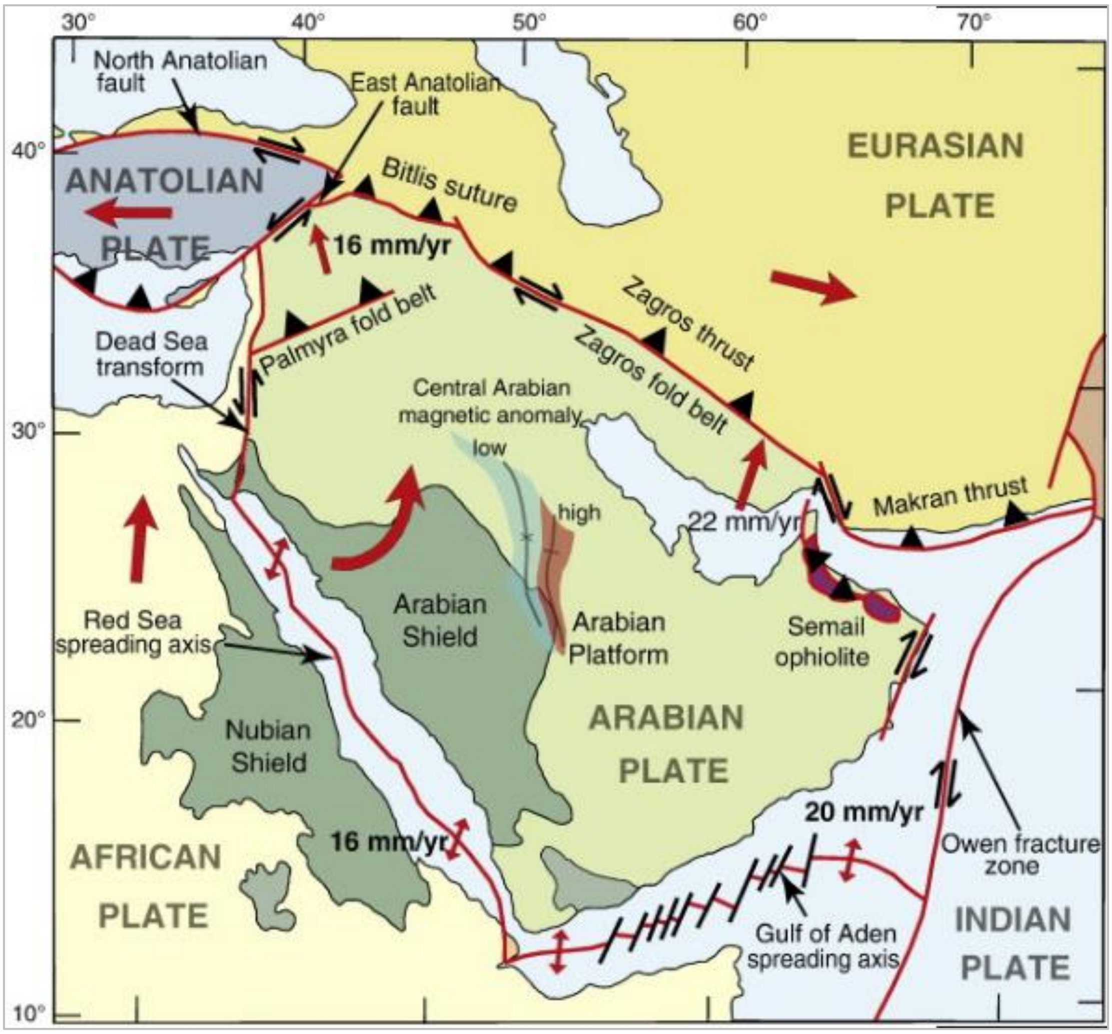
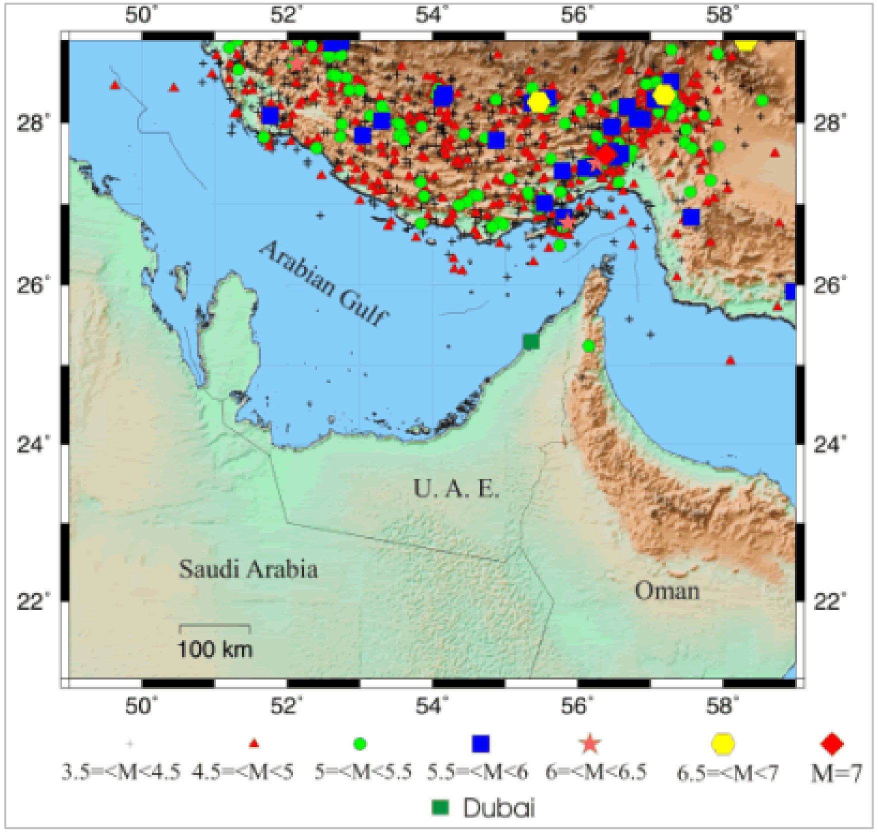


Figure 5-10 Tectonic Plates and Faults on Arabian Peninsula

Adapted from: Johnson and Stern, 2010

Limited seismic activity takes place at the UAE's local fault zones that are located in the vicinity of Dibba. Unlike the Western Region, the northern emirates have experienced earthquakes several times since March 1999. Almost all regional earthquakes are located on the northern side of the Arabian Gulf, within the Straits of Hormuz and Gulf of Oman and in southern Iran. Tremors from earthquakes in Southern Iran and South West Pakistan measuring 5.5 and 7.8 on the Richter scale were felt in Dubai in April 2014 and May 2016 respectively, indicating that there is a degree of seismic risk in the UAE (UAE Interact, 2014 and Time Out, 2016). On a lesser scale, tremors measuring 2.6 on the Richter scale were felt in Dibba in Fujairah on the east coast of the UAE in February and August 2016. The effects of the shudders were minimal, with no reports of injuries or structural damage (Time Out, 2016).

The Abu Dhabi Municipality Town Planning Sector publish seismic hazard assessment maps (Abu Dhabi Municipality, 2012). The maps identify Dubai as falling within a low seismic area with a peak ground acceleration of between 0.07 g and 0.08 g (0.7 to 0.8 m/s^2) for a 475 year return period event (typically used for design). Similarly, even for a 1 in 2475 year extreme event, peak ground acceleration values are below 0.2 g. Available maps plotting recent seismic activity from 1973 to 2006 (Figure 5-11) and December 2013 to March 2014 (Figure 5-12) indicate minimal seismic activity in the Dubai Emirate.



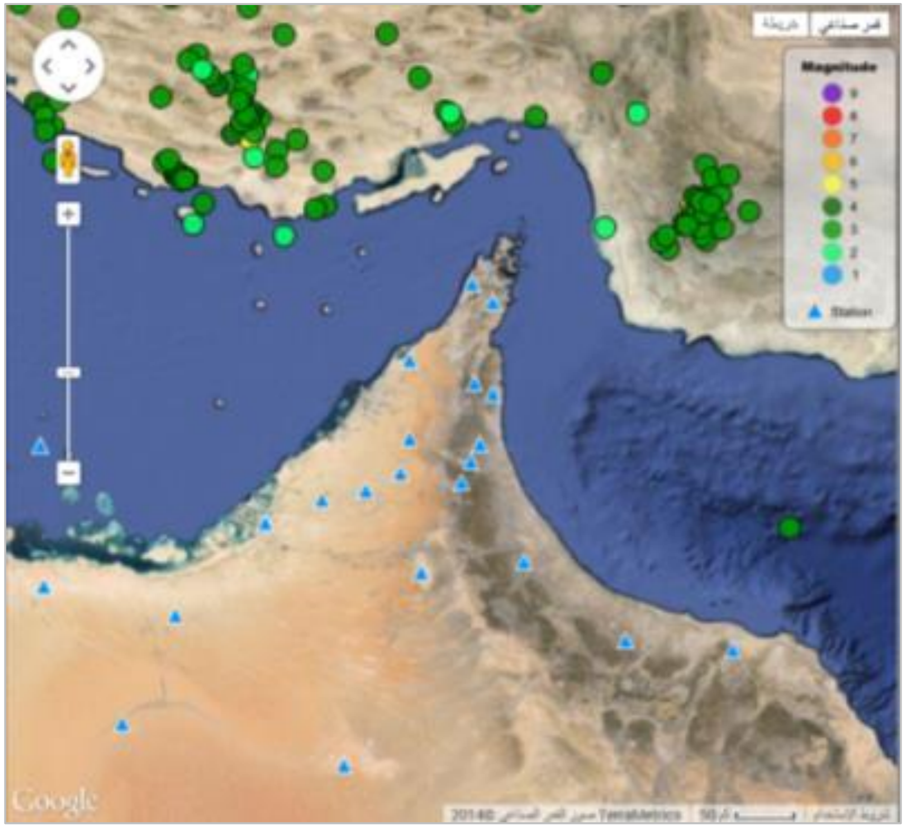


Figure 5-11 Seismic activity in & around the UAE 1973 – 2006

Source: [*http://www.seismo.geodesy.ae/images.aspx?img=figureS3.gif&wid=526*](http://www.seismo.geodesy.ae/images.aspx?img=figureS3.gif&wid=526)

Figure 5-12 Seismic activity in & around the UAE Dec 2013 to Current

Source: [*http://seismology.ncms.ae/earthquakes*](http://seismology.ncms.ae/earthquakes)

5.5.1.3 Soil

A soil survey of the Northern Emirates was conducted during 2010-2012 by the Environment Agency-Abu Dhabi (EAD) in partnership with the Ministry of Environment and Water (MOEW) (Pain, 2012). The investigation noted that the most predominant deposits in the UAE desert environment are Aeolian deposits (Figure 5-13), which are soil deposits formed through transportation of soil material via wind. Soils formed through this process are the least developed young soils without any horizon development, and are very widely distributed in the Emirate of Dubai in the form of loose sandy, hummocky dune soils (Shahid and Abdelfattah, 2008).

Sandy soils are characterised by a high infiltration rate, which is more than 250 mm/hr, very high drainage capacity, moderate to rapid permeability, low runoff and highly prone to wind erosion. Climatic conditions prevailing in the country, such as high temperatures, evaporation, relative humidity, and low average rainfall, play a major role in the degradation of land, and contribute greatly to the emergence of fragile ecosystems characterized by vulnerable vegetation and predominant erodible soil.

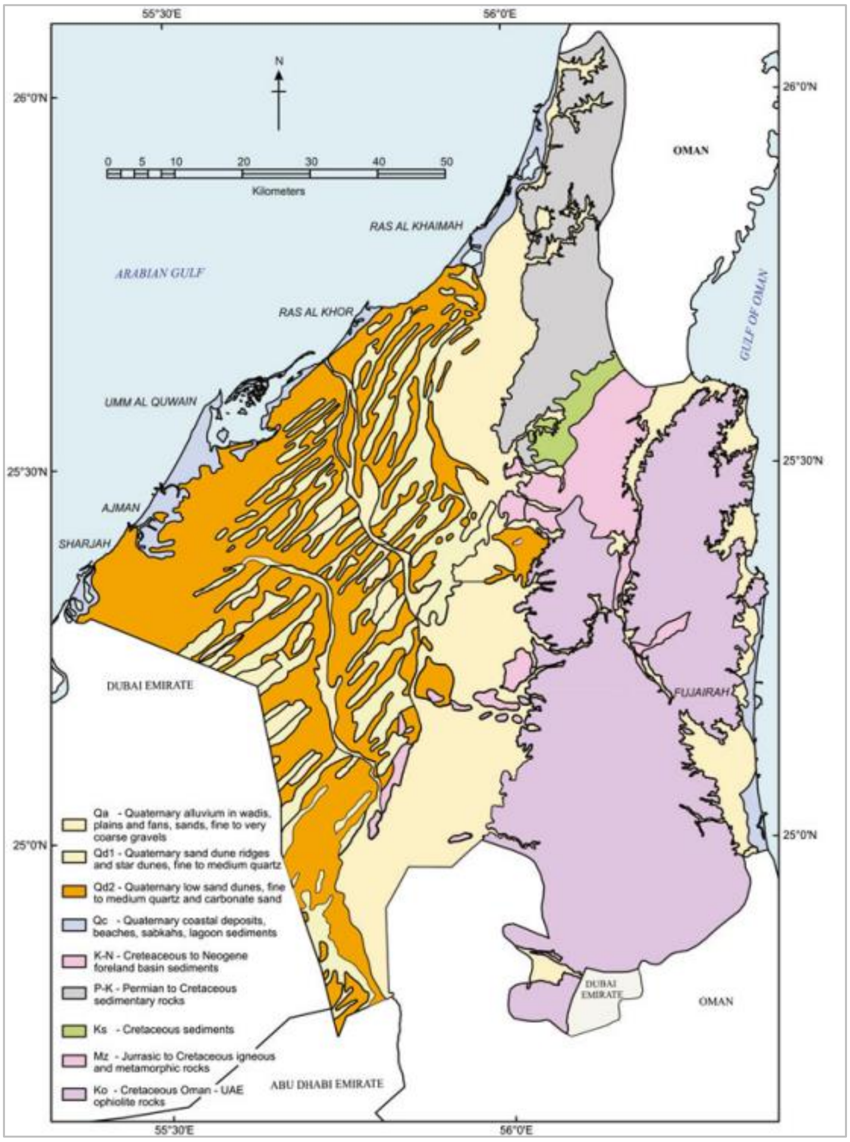


Figure 5-13 Soils of Northern Emirates

(Source: M.A. Abdelfattah, 2014)

5.5.1.4 Groundwater

Groundwater is the main natural resource and most used water resource in the UAE accounting for 44% of the total water resources used (Ministry of Environment and Water (MOEW), 2015). Most of the groundwater is used in the agricultural sector. Over the years, pumping has exceeded annual feeding rates, resulting in a net reduction in groundwater levels of ten meters per decade until the mid-nineties and by 70 meters since then (MOEW, 2015).

A groundwater salinity map for the UAE is provided in Figure 5-14, which shows that hyper-saline waters in excess of 150,000 mg/L total dissolved solids (TDS) are found along the Abu Dhabi coastline, while lower values of around 50,000 mg/L are present further north along the Dubai coastline. Salinities generally decrease with distance from the coastline with some potable water being observed deep in the western and eastern regions of the Abu Dhabi Emirate (Environment Agency – Abu Dhabi, 2008).

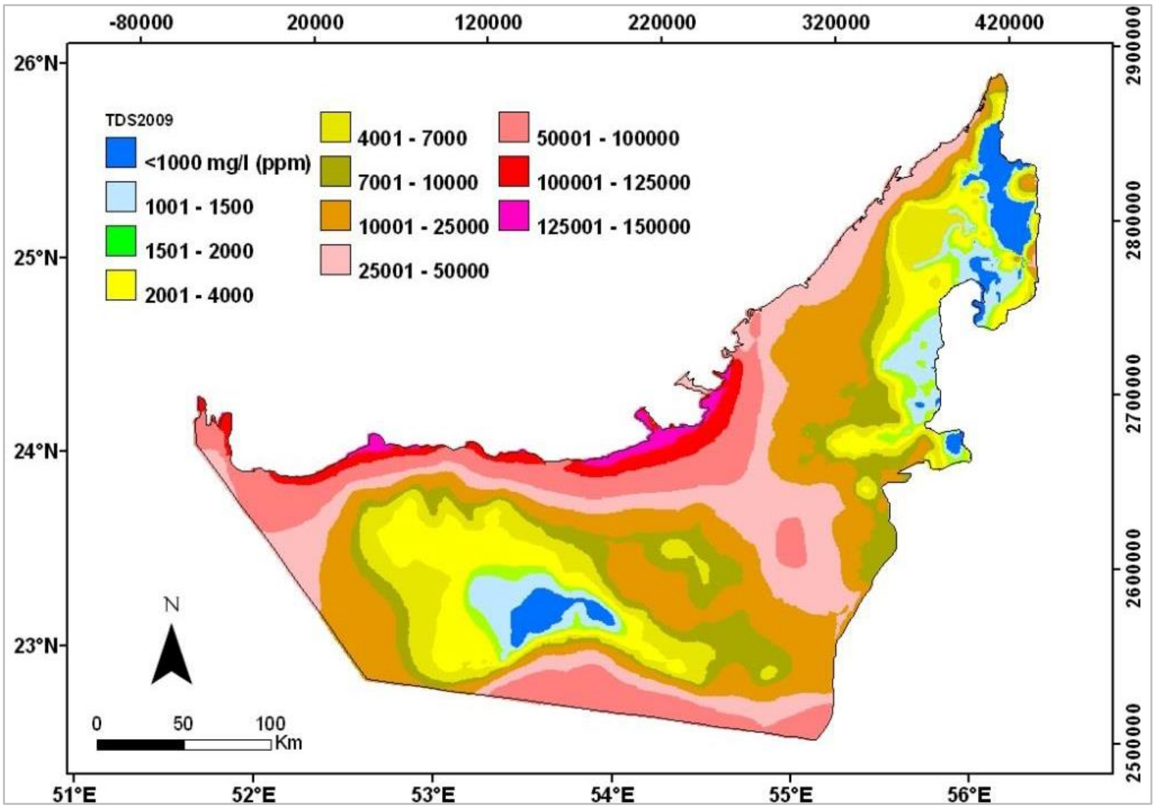


Figure 5-14 Groundwater salinity map of UAE

5.5.2 Baseline Soil and Groundwater Survey

5.5.2.1 Previous Studies

GHD was provided with copies of the following site investigation reports:

- *Geotechnical Site Investigation for Proposed Warsan Landfill Waste to Energy Project on Plot No- 622-146, Al Warsan Second Dubai - UAE* (Report No. SS18000022, Rev. 00) – Draft Factual Report, dated 15 April 2018, prepared for M/S. Six Construct, Sharjah, UAE; and
- *Site Investigation, Proposed Warsan Landfill Waste to Energy Project, Plot No- 622-146, Al Warsan Second, Dubai - UAE* (Report No. S/D08-178, Rev. 0) – Final Interpretative Report, dated 7 April 2009, prepared for M/S. Dubai Municipality, Dubai, UAE.

For the 2018 site investigation, the following was completed by ACES:

- Excavation of four (04 Nos.) trial pits to varying depths;

- Conducting thirty nine (39 Nos.) cone penetration tests (CPT); and
- Monitoring groundwater levels at two (02 Nos.) existing standpipe piezometers.

During the 2018 site investigation, ACES took only groundwater level readings from previous borings numbers BH-01 and BH-14 (existing piezometers), using a dip meter, as summarized in Table 5-23.

Table 5-23 Summary of soil investigation taken by ACES

BH No.	Elevation (m DMD)	Date	Time	Ground Water Depth [Below EGL (m)]	GW Reduced Level (DMD) (m RL)
BH-01	44.92	05 April 2018	10:30 AM	15.70	29.22
BH-14	38.07	05 April 2018	10:40 AM	7.32	30.75

Taken from Appendix E, Site Investigation Report (Draft) prepared by ACES dated 15 April 2018 Revision 00

In general, groundwater levels at the above two locations were reported in a range of 7.32 to 15.70 m below existing ground level, but the groundwater elevation was relatively consistent at 29.22 m and 30.75 m, at BH-01 and BH-14, respectively.

For the 2018 site investigation, it is GHD understanding that there were no surface soil or groundwater samples taken by ACES. However, groundwater sampling was carried out during the 2009 site investigation. The chemical testing completed in 2009 is provided in Table 5-24. Findings of the 2009 survey were limited.

Table 5-24 Summary of chemical testing

No.	Chemical Testing
1	Determination of Sulphate for Soil and Groundwater – BS 1377: Part 3; 1990, Cl.5 (Amd. 9028/96)
1	Determination of Chloride for Soil and Groundwater – BS 1377: Part 3: 1990, CL.7 (Amd. 9028/96)
1	Determination of pH for Soil and Groundwater – BS 1377: Part 3: 1990, CL.9 (Amd. 9028/96)
1	Determination of Carbonate Content – BS 1377: Part 3: 1990, CL.6.3 (Amd. 9028/96)
1	Determination of Organic Matter Content – BS 1377: Part 3: 1990, CL.3 (Amd. 9028/96)
2	Determination of Magnesium Content of Soil by using AA/Spectro Photometer APHA/AAS
2	Determination of the Ammonia Content APHA / Ammonia Chem Kit
2	Determination of Water Soluble Salt Content BA 1377: Part 3, Cl.8, 1990 & Eart Manual, Des. 8
2	Determination of Bicarbonate Content ASTM D 1067-92, Text Method B

Taken from Section 6.0 Laboratory Testing, Site Investigation Report prepared by ACES (2009)

5.5.2.2 Site Walkthrough

A site walkthrough was undertaken by GHD staff on 9 April 2018. The following general observations were made, and informed the sample collection locations for soil and groundwater (refer to Section 5.5.2.3):

- It was observed that along the western site boundary there is presence of standing surface water at the toe of the landfill slope and base of the sludge fill area. While the extent of the proposed Project development will not disturb these existing areas, this indicates a potential that groundwater may exhibit potential contamination in this vicinity. Given the proximity of the landfill and sludge disposal areas to the west, GHD has planned for two borings (or test pits) to be provided in this area.
- In the vicinity of the proposed footprint of the WtE plant, GHD has planned for two borings (or test pits) to be provided for subsurface soil samples. Given the vehicle traffic and storage of vehicles in this area, there is potential for petroleum impacts below asphalt or at the edge of the asphalt paved areas.

5.5.2.3 Soil and Groundwater Sampling

Sampling Methodology

Soils Survey

Soil samples were collected at five locations at the project site. Samples were collected at regular intervals: surface, 1 m and 5 m; therefore, 10 samples were collected for soil analysis. Where there is visible change in strata or 'horizon' from each discrete layer within the boring or where there is visual or olfactory evidence of potential contamination, one sample was collected and analysed. The soil samples were digested and analysed in a Dubai Accredited Center (DAC) laboratory.

Groundwater Survey

Five groundwater samples were collected from new groundwater wells and were analysed for the full suite of parameters. Boreholes were drilled to the specified depths and groundwater samples recovered from select boreholes:

- A new disposable bailer were used for each borehole to ensure that there is no cross contamination between monitoring locations, disposable sampling bailers were used.
- Before sampling, each well were purged by removing a volume of groundwater to approximately three times the theoretical volume of each well. After the purge volume has been removed, samples were taken using the bottom end sampling method.
- The groundwater sample in the bailer (one sample per each of the sampling locations) were poured into suitable sample bottles with pre-added chemical preservatives appropriate to the tests (where applicable).

Sampling Locations

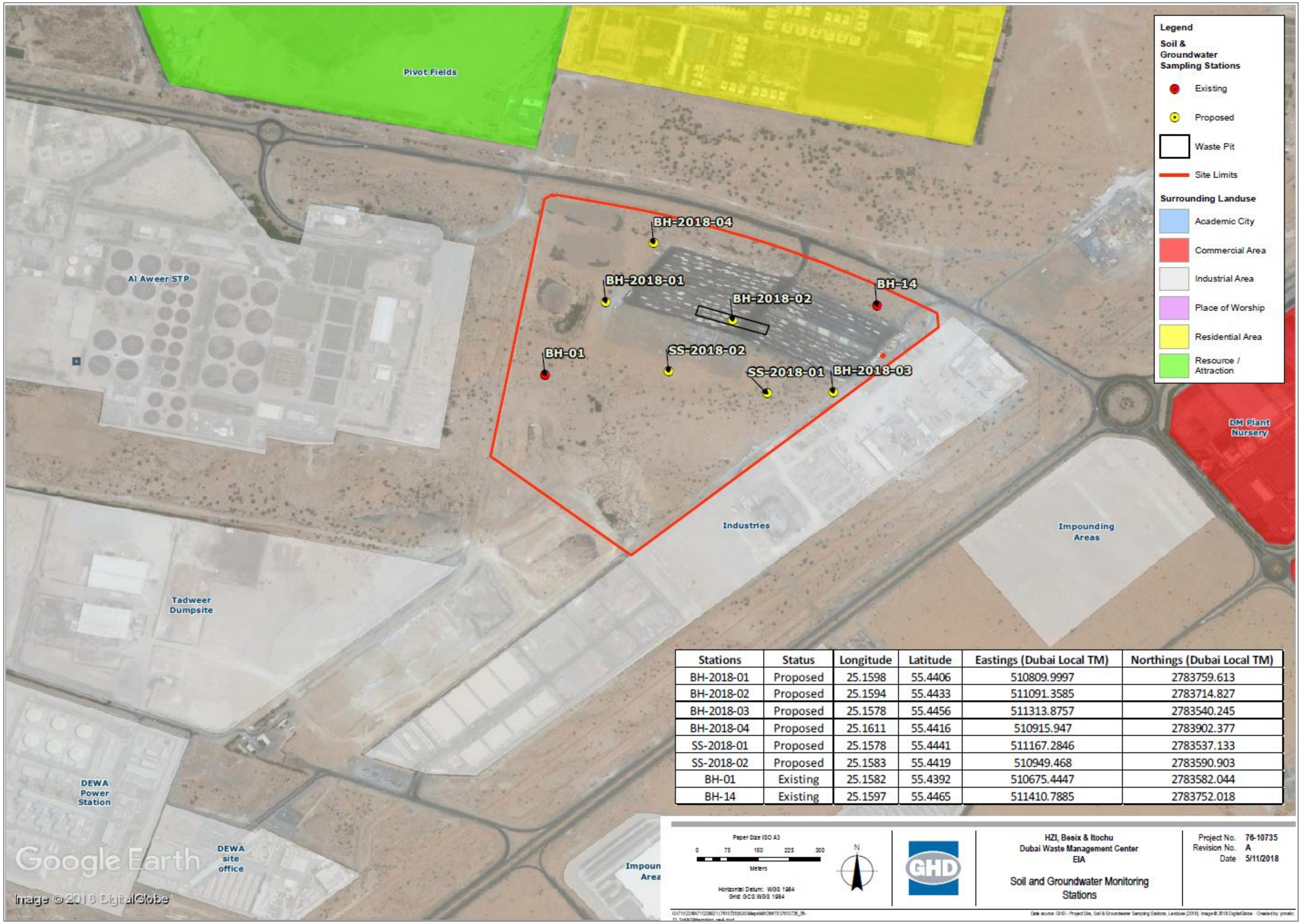
Soil and groundwater samples were collected at the following locations:

- Two borings, each to an estimated depth of 10 to 15 m (or until groundwater encountered), with piezometers installed for groundwater sampling;
- Two borings (or test pits) for soil sample recovery, each to 5 m depth, soil samples to be collected from 1 m and 3 m depths below existing ground surface level; and
- Additional groundwater samples were collected from the two existing piezometer locations at BH-01 and BH-14.

A summary of the proposed baseline sampling is provided in Table 5-25 while approximate sampling locations is provided in Figure 5-15.

Table 5-25 Environmental baseline sampling locations

Description	Label / ID	Assumed depth	Groundwater sample	Soil sample(s)
Existing Piezometer	Existing BH-01	--	1 sample	--
Existing Piezometer	Existing BH-14	--	1 sample	--
New Groundwater Well with Piezometer	BH-2018-01(P)	15 m BGS	1 sample, 1-week after purge	1 sample at 1 m BGS 1 sample at 5 m BGS
New Groundwater Well with Piezometer	BH-2018-02(P)	15 m BGS	1 sample, 1-week after purge	1 sample at 1 m BGS 1 sample at 5 m BGS
New Bore Hole (no Piezometer)	BH-2018-03	5 m BGS	--	1 sample at 1 m BGS 1 sample at 5 m BGS
New Bore Hole (no Piezometer)	BH-2018-04	5 m BGS	--	1 sample at 1 m BGS 1 sample at 5 m BGS
Surface soil sample	SS-2018-01	0.5 to 1 m BGS	--	1 sample from surface soil, hand auger method
Surface soil sample	SS-2018-02	0.5 to 1 m BGS	--	1 sample from surface soil, hand auger method
Totals			4 groundwater samples	10 soil samples



Stations	Status	Longitude	Latitude	Eastings (Dubai Local TM)	Northings (Dubai Local TM)
BH-2018-01	Proposed	25.1598	55.4406	510809.9997	2783759.613
BH-2018-02	Proposed	25.1594	55.4433	511091.3585	2783714.827
BH-2018-03	Proposed	25.1578	55.4456	511313.8757	2783540.245
BH-2018-04	Proposed	25.1611	55.4416	510915.947	2783902.377
SS-2018-01	Proposed	25.1578	55.4441	511167.2846	2783537.133
SS-2018-02	Proposed	25.1583	55.4419	510949.468	2783590.903
BH-01	Existing	25.1582	55.4392	510675.4447	2783582.044
BH-14	Existing	25.1597	55.4465	511410.7885	2783752.018

Figure 5-15 Soil and groundwater monitoring stations

Soil Sampling Results

The results of the soil quality analysis were compared to the limits set out by DM-ED via Information Bulletin No. 2 Land Contamination Indicator Levels (May 2003) and Dutch Soil Remediation Circular (2009). A summary of the results is presented in Table 5-26, while a more complete set of results for all samples analyses and associated laboratory reports is presented in Appendix M.

The results show that the majority of parameters were not detected in concentratrions above their respective minimum detection limits (MDL). Parameters that were recorded in concentrations above their respective MDLs include Nitrite, Phosphate, Boron, Chromium III, Cobalt, Copper, Iron, Lead, Manganese, Nickel and Zinc although all parameters were considered to be within expected natural background concentrations.

Although there are no standards available for assessment of nutrients, it should be noted that Nitrite Nitrogen and Phosphate were reported above their respective MDLs at several sites. These parameters are potentially being stored in the soil due to the presence of nutrients. Concentrations of BTEX, gasoline range, diesel range and motor oil range all remained below their respective laboratory MDL. As a consequence, there is no evicence of petroleum hydrocarbon or volatile contamination of soil at the Project site.

Table 5-26 Baseline Soil Sampling Results

Parameters	Unit	MDL	Test Method	Guidelines		Results									
				Dubai Municipality[1]	Dutch Guidelines (Intervention Values)[2]	BH-2018-01		BH-2018-02		BH-2018-03		BH-2018-04		SS-2018-01	SS-2018-02
						1 m	5 m	1 m	5 m	1 m	5 m	1 m	5 m	0.50 m	0.50 m
Cyanide as CN	mg/kg	0.002	Pyridine Pyrazalone	10	20	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002
Nitrate Nitrogen as NO_3-N	mg/kg	1.5	Cadmium Reduction	–	–	<1.5	<1.5	<1.5	<1.5	4.9	10.7	6.9	<1.5	<1.5	2.4
Nitrite Nitrogen as NO_2-N	mg/kg	0.010	Diazotization	–	–	0.571	0.563	0.571	0.299	0.034	0.010	0.020	<0.002	0.247	0.175
Phosphate Phosphorus as PO_4	mg/kg	0.10	USEPA PhosVer3	–	–	444.70	493.50	502.10	333.6	427.30	433.70	428.20	531.00	573.40	517.00
Benzene	mg/kg	0.05	USEPA 8260	1	1.1	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05
Toluene	mg/kg	0.05	USEPA 8260	–	32	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05
Ethylbenzene	mg/kg	0.05	USEPA 8260	–	110	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05
Xylene	mg/kg	0.05	USEPA 8260	–	17	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05
Gasoline Range (C5-C10)	mg/kg	2.0	USEPA 8015	–	–	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0
Diesel Range (C11-C28)	mg/kg	20.0	USEPA 8015	–	–	<20.0	<20.0	<20.0	<20.0	<20.0	<20.0	<20.0	<20.0	<20.0	<20.0
Motor Oil Range (C29-C40)	mg/kg	50.0	USEPA 8015	–	–	<50.0	<50.0	<50.0	<50.0	<50.0	<50.0	<50.0	<50.0	<50.0	<50.0
Antimony as Sb	mg/kg	1.0	APHA AWWA 3120 B	–	22	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
Arsenic as As*	mg/kg	5.0	APHA AWWA 3120 B	50	76	<5.0	<1.0	<5.0	<1.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0
Beryllium as Be	mg/kg	1.0	APHA AWWA 3120 B	–	30	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
Boron as B*	mg/kg	1.0	APHA AWWA 3120 B	–	–	20.8	14.7	20.7	17.3	12.7	12.8	16.9	13.3	20.5	18.7
Cadmium as Cd*	mg/kg	2.0	APHA AWWA 3120 B	5	13	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0
Trivalent Chromium as Cr III	mg/kg	1.0	APHA AWWA 3120 B / Calculation	250	180	33.6	20.2	26.1	29.3	16.9	27.1	21.4	20.3	27.4	24.1
Hexavalent Chromium as Cr VI	mg/kg	5.0	USEPA 3060 / APHA AWWA 3120 B	–	78	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0
Cobalt as Co*	mg/kg	2.0	APHA AWWA 3120 B	–	190	2.5	1.6	2.5	2.6	<1.0	1.6	1.8	1.1	2.4	2.4
Copper as Cu*	mg/kg	1.0	APHA AWWA 3120 B	100	190	9.3	6.9	8.8	7.9	16.9	10.5	10.0	10.4	7.2	8.5
Iron as Fe*	mg/kg	1.0	APHA AWWA 3120 B	–	–	5371.0	4050.5	5370.7	5615.5	4021.9	4396.4	5038.7	3911.6	5311.8	4717.3
Lead as Pb*	mg/kg	1.0	APHA AWWA 3120 B	200	530	1.7	2.1	1.7	2.0	<1.0	1.5	1.4	3.3	1.8	1.2
Manganese as Mn*	mg/kg	2.0	APHA AWWA 3120 B	700	–	206.8	135.9	213.9	204.0	114.5	142.4	169.8	104.5	223.8	215.4

Parameters	Unit	MDL	Test Method	Guidelines		Results									
				Dubai Municipality[1]	Dutch Guidelines (Intervention Values)[2]	BH-2018-01		BH-2018-02		BH-2018-03		BH-2018-04		SS-2018-01	SS-2018-02
						1 m	5 m	1 m	5 m	1 m	5 m	1 m	5 m	0.50 m	0.50 m
Mercury as Hg	mg/kg	1.0	APHA AWWA 3120 B	2	4 (organic)	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
Nickel as Ni*	mg/kg	2.0	APHA AWWA 3120 B	–	100	30.0	18.4	23.2	31.1	13.2	20.2	18.8	15.3	24.0	25.2
Selenium as Se*	mg/kg	1.0	APHA AWWA 3120 B	2	100	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
Zinc as Zn*	mg/kg	2.0	APHA AWWA 3120 B	500	720	12.0	7.7	10.0	9.2	6.5	7.4	8.9	7.5	10.3	9.5

1 – Dubai Municipality Environment Department (DM-ED) Information Bulletin No. 2 Environmental Standards and Allowable Limits of Pollutants on Land, Water, and Air Environment (May 2003)

2 –Dutch Soil Remediation Cirular, 2009

* - This result is accredited by Dubai Municipality (DAC)

Groundwater Sampling Results

In-situ groundwater quality was undertaken using Multi-Parameter Probe. The analyses focused on six sampling parameters that include:

- pH
- Electrical Conductivity
- Salinity
- Temperature
- Dissolved Oxygen
- Total Dissolved Solids

In-situ groundwater quality monitoring results are summarised in Table 5-27 while a complete report and calibration certificate is provided Appendix M.

One groundwater sample was recovered from each of the two existing boreholes (BH-01 and BH-14) and three new boreholes (BH-2018-01, BH-2018-02 and BH-15). Samples were submitted to Core Laboratory, a DAC-approved laboratory, for analysis of a broad suite of metals, inorganic substances, aromatic compounds and chlorinated hydrocarbons.

The laboratory data was compated against the Intervention values specified in *Dutch Soil Remediation Circular* (2009), which is accepted by DM-ED. A summary of groundwater laboratory data is presented in Table 5-28 while complete laboratory report is provided in Appendix M.

The key findings of the groundwater assessment include:

- Groundwater samples recovered from the monitoring wells did not report any analytes above the Dutch (2009) Intervention Values with the exception of:
  - Toluene, reported in one sample from well BH-2018-02 (located near Parking Area) at concentration of 1728 µg/l, was above the intervention limit of 1000 µg/l. Toluene may be introduced into the environment through petroleum seepage and weathering of exposed coal containing strate and into groundwater from petroliferous rocks. The anthropogenic contamination forms include chemical spills, spills of petroleum products, and from discharges of industrial effluents (Government of Canada, 1992). Soluble components such as benzene, toluene, ethylbenzene and xylenes (BTEX) are washed out of petroleum and fuels, in water presence (Prince, et.al, 2016). According to Zogorski et.al. (2006), the sources of most gasoline hydrocarbons in aquifers are probably releases of gasoline or other finished fuel products. It is not possible to determine the exact cause of the elevated toluene concentrations from a single sampling event. However, it is likely highly that the source originates from the vehicles parked near the monitoring well. Further investigation of the source and extent of this impact is recommended.

Table 5-27 Summary of Groundwater *In-situ* Data

Parameters	Unit	MDL	Test Method	Results				
				BH-2018-01	BH-2018-02	BH-01[1]	BH-14[1]	BH-15
				9.96 m	8.37 m	15.34 m	7.24 m	7.24 m
				25.159603 55.440754	25.158983 55.443112	25.157818 55.439291	25.159838 55.446015	25.159797 55.447094
pH @25ºC*	–	2.0	APHA AWWA 4500 H^+B	7.3	7.3	7.4	7.1	7.0
Electrical Conductivity @25ºC*	µS/cm	0.1	APHA-AWWA 2510 B	3870.0	4960.0	6780.0	6950.0	6940.0
Salinity	psu	0.01	APHA-AWWA 2510 B	1.96	2.68	3.66	3.86	3.85
Temperature *	ºC	0.1	APHA-AWWA 2510 B	33.8	33.6	32.6	32.6	35.6
Dissolved Oxygen	mg/l	0.1	HACH LDO Method	3.8	4.0	4.7	3.4	3.3
Total Dissolved Solids *	mg/l	9	APHA AWWA 2540 C	2008	3125	4020	3840	3790

Table 5-28 Summary of Groundwater Laboratory Data

Parameters	Unit	MDL	Test Method	Dutch Guideline (Intervention Values)** (µg/l)	Results				
					BH-2018-01	BH-2018-02	BH-01[1]	BH-14[1]	BH-15
Benzene	µg/l	1	USEPA 8260	30	<1	<1	<1	<1	<1
Toluene	µg/l	1	USEPA 8260	1000	604	1728	<1	<1	<1
Ethylbenzene	µg/l	1	USEPA 8260	150	<1	<1	<1	<1	<1
Xylene (sum)	µg/l	1	USEPA 8260	70	<1	<1	<1	<1	<1
TPH Gasoline Range (C5-C10)	mg/l	0.02	USEPA 8015	–	0.53	1.40	<0.02	<0.02	<0.02
TPH Diesel Range (C11-C25)	mg/l	0.10	USEPA 8015	–	<0.10	<0.10	<0.10	<0.10	<0.10
TPH Motor Oil Range (C29-C40)	mg/l	0.50	USEPA 8015	–	<0.50	<0.50	<0.50	<0.50	<0.50
Antimony (Sb) *	mg/l	0.10	APHA AWWA 3030 E / 3120 B	20	<0.10	<0.10	<0.10	<0.10	<0.10
Arsenic (As) *	mg/l	0.01	APHA AWWA 3030 E / 3120 B	60	<0.01	<0.01	<0.01	<0.01	<0.01
Barium (Ba) *	mg/l	0.01	APHA AWWA 3030 E / 3120 B	625	0.12	0.10	0.05	<0.01	0.01
Cadmium (Cd) *	mg/l	0.002	APHA AWWA 3030 E / 3120 B	6	<0.002	<0.002	<0.002	<0.002	<0.002
Chromium (Cr) *	mg/l	0.006	APHA AWWA 3030 E / 3120 B	30	0.088	0.037	0.177	<0.006	<0.006

Parameters	Unit	MDL	Test Method	Dutch Guideline (Intervention Values)** (µg/l)	Results				
					BH-2018-01	BH-2018-02	BH-01[1]	BH-14[1]	BH-15
Cobalt (Co) *	mg/l	0.002	APHA AWWA 3030 E / 3120 B	100	<0.002	<0.002	<0.002	<0.002	0.002
Copper (Cu) *	mg/l	0.006	APHA AWWA 3030 E / 3120 B	75	0.012	0.014	0.011	0.013	0.014
Lead (Pb) *	mg/l	0.015	APHA AWWA 3030 E / 3120 B	75	0.032	0.018	<0.015	<0.015	0.016
Manganese (Mn) *	mg/l	0.002	APHA AWWA 3030 E / 3120 B	[3]	0.034	0.168	0.012	0.040	0.039
Mercury (Hg) *	mg/l	0.001	APHA AWWA 3030 E / 3120 B	0.03	<0.001	<0.001	<0.001	<0.001	<0.001
Nickel (Ni) *	mg/l	0.005	APHA AWWA 3030 E / 3120 B	75	<0.005	0.010	<0.005	<0.005	<0.005
Zinc (Zn) *	mg/l	0.006	APHA AWWA 3030 E / 3120 B	800	0.026	0.036	0.023	0.020	0.035
pH @25ºC* (Laboratory)	-	0.1	APHA AWWA 4500 H+B	–	7.5	7.5	7.5	7.2	7.2
Electrical Conductivity @25ºC* (Laboratory)	µS/cm	0.1	APHA AWWA 2510B	–	4050.0	5060	6900	7050	7100
Temperature @ site	ºC	-	APHA AWWA 2550B	–	33.8	33.6	62.6	32.6	35.6
Total Dissolved Solids @ 180ºC*	mg/l	9	APHA AWWA 2540C	–	2100	3580	4200	4000	4100
BOD @ 5days	mg/l	6	ASTM D 888	–	15	18	<6	<6	<6
Oil & Grease (Free) *	%	0.001	Gravimetric / IP-13	–	-<0.001	<0.001	<0.001	<0.001	<0.001

Parameters	Unit	MDL	Test Method	Dutch Guideline (Intervention Values)** (µg/l)	Results				
					BH-2018-01	BH-2018-02	BH-01[1]	BH-14[1]	BH-15
Oil & Grease (emulsified) *	mg/l	10	APHA AWWA 5520 B	–	<10	<10	<10	<10	<10
Chloride (Cl-) *	mg/l	1	APHA AWWA 4500 Cl B	[3]	1281	1009	1941	1242	1274
Total Sulfates (SO_4) *	mg/l	8	APHA AWWA 4500 SO_4 C	–	261	850	450	950	1090
Total Chlorine	mg/l	0.01	USEPA DPD Method	–	<0.01	0.02	0.02	0.01	0.02
Cyanide (CN) *	mg/l	0.002	Pyridine Pyrazalone Method	1500 [2]	<0.002	<0.002	<0.002	<0.002	<0.002
Colour	Pt-Co	15	Platinum-Cobalt Method	–	<15	<15	<15	<15	<15
Dissolved Oxygen (Laboratory)	mg/l	0.1	APHA AWWA 4500-O H/G	–	4.0	4.1	4.9	3.6	3.5
Nitrate (NO_3) *	mg/l	0.01	Cadmium Reduction Method	[3]	6.60	6.60	59	20.30	25.60
Phosphate-Phorphorus (PO_4) *	mg/l	0.02	USEPA Phos Ver 3	[3]	<0.02	<0.02	<0.02	<0.02	<0.02
Sulphide (S2-) *	mg/l	0.005	USEPA Methylene Blue Method	–	<0.005	0.006	0.013	0.010	0.005
Turbidity *	NTU	0.1	USEPA 180.1	–	1.9	0.4	0.9	1.5	1.4
Pesticide (Non-Chlorinated)	mg/l	0.01	USPEA 8081	–	<0.01	<0.01	<0.01	<0.01	<0.01

Parameters	Unit	MDL	Test Method	Dutch Guideline (Intervention Values)** (µg/l)	Results				
					BH-2018-01	BH-2018-02	BH-01[1]	BH-14[1]	BH-15
Phenol	mg/l	0.005	USEPA 528	2000	<0.005	<0.005	<0.005	<0.001	<0.005
1,2-Dichloroethane	mg/l	0.001	USEPA 8260	900	<0.001	<0.001	<0.001	<0.001	<0.001
Dichloromethane	mg/l	0.001	USEPA 8260	1000	<0.001	<0.001	<0.001	<0.001	<0.001
Aluminium (Al) *	mg/l	0.01	APHA AWWA 3030 E/3120 B	[3]	<0.01	<0.01	<0.01	<0.01	<0.02
Boron (B) *	mg/l	0.01	APHA AWWA 3030 E/3120 B	–	1.51	2.75	3.00	4.06	4.16
Beryllium (Be)	mg/l	0.01	APHA AWWA 3030 E/3120 B	15 [4]	<0.01	<0.01	<0.01	<0.01	<0.01
Calcium (Ca)	mg/l	0.10	APHA AWWA 3030 E/3120 B	–	247.00	621.00	240.50	890.00	850.00
Iron (Fe) *	mg/l	0.011	APHA AWWA 3030 E/3120 B	–	0.038	0.048	0.049	0.068	0.079
Magnesium (Mg)	mg/l	0.10	APHA AWWA 3030 E/3120 B	[3]	91.50	234.00	86.00	319.50	311.00
Molybdenum (Mo) *	mg/l	0.01	APHA AWWA 3030 E/3120 B	300	<0.01	0.06	0.02	0.05	0.06
Potassium (K) *	mg/l	0.10	APHA AWWA 3030 E/3120 B	–	36.70	67.50	42.95	88.50	84.50
Sodium (Na) *	mg/l	0.10	APHA AWWA 3030 E/3120 B	–	440.00	571.00	467.00	622.00	496.00
Escherichia coli	CFU/100 ml	1	APHA AWWA 9222 G	–	ND	ND	ND	ND	ND
Total Coliforms	CFU/100 ml	1	APHA AWWA 9222 B	–	ND	ND	ND	ND	ND

1 – Existing

2 – Cyanides (free) (complex)

3 – It was decided not to derive a proposal for an intervention value for thes parameters (New Dutch Guidelines, 2000).

- Aluminium (Al), Magnesium (Mg) and Manganese (Mn) naturally occurs in high concentrations in the soil. High concentrations in groundwater are more likely to be a result of aciditication than from increase emissions. Preference for testing these in other contexts.
- Nutrients (Phosphate and Nitrogen compounds) in principle has short residence time in soil: however repeated input into the soil takes place and, through the soil, into groundwater. For this reason, elimination of such compounds is mainly a question of regulating the input.
- Chloride: Too short residence time in the soil. Preference of tackling this is by legislative frameworks. Because chloride's toxicity for plant and animal life, an intervention value for groundwater might be considered, but then proper account has to be taken at areas subject to marine influence.

4 – Indicative level of serious contamination

* This test is accredited by DAC

** Soil Remediation Circular

ND – Not Detected (<1)

CFU – Colony Forming Unit

5.5.3 Ground Gas Sampling

Ground gases are frequently encountered in areas that are potentially contaminated. However, it is also important to recognise that a wide range of potential sources of ground gases exist, both anthropogenic and natural. The natural sources of ground gases include soil (physical, chemical and biological weathering, swamps and wetlands (anaerobic microbial decay of organic material), coal measures strata (coal-seam methane), carbonate strata (dissolution of carbonates by acidic groundwater), natural gas traps (leakage), and granites (radioactive decay of uranium) (NSW EPA, 2012). The potential sources of ground gas at the project site are provided in Table 5-29.

Table 5-29 Potential sources of ground gas at the site

Source	Origin
Project site – vehicle storage site	Petroleum fuel spills and leak from parked vehicles
Tadweer site	Anaerobic microbial decay of putrescible waste, organic materials Decay of timber, green waste, etc. co-disposed with inert waste
Al Aweer STP	Anaerobic migrobial decay of organic material

A site investigation was undertaken to determine the presence of ground gases at the existing site. Monitoring was undertaken from the ground surface using a portable handheld multi-gas meter for measurement of the following parameters:

- Methane (CH_4)
- Hydrogen sulphide (H_2S)
- Carbon monoxide (CO)
- Carbon dioxide (CO_2)
- Oxygen (O_2)

Initial monitoring was undertaken at the time of piezometer establishment on 28-29 August 2018 (Event 1), while second observation was undertaken on 23 September 218 (Event 2). The summary of ground gas monitoring schedule is provided in Table 5-30. Monitoring locations were undertaken at two existing boreholes (BH1 and BH14) and four new boreholes (BH-201-01, BH-201-02, BH-201-03 and BH-201-04). The location of these boreholes are shown in Section 5.5.2 (Figure 5-15).

Table 5-30 Ground gas monitoring schedule

Borehole No.	Event 1	Event 2	Averaging period
BH1	29-Aug-2018; 11:20-11:30	23-Sep-2018; 09:25-09:35	10 min
BH14	28-Aug-2018; 10:40-10:50	23-Sep-2018; 08:40-08:50	10 min
BH-2018-01	29-Aug-2018; 10:55-11:05	23-Sep-2018; 10:05-10:15	10 min
BH-2018-02	29-Aug-2018; 11:40-11:50	23-Sep-2018; 10:25-10:35	10 min
BH-2018-03	28-Aug-2018; 11:40-11:50		10 min

Borehole No.	Event 1	Event 2	Averaging period
BH-2018-04	28-Aug-2018; 11:10-11:20	The trial pit has collapsed to a current depth of 2.5 m	10 min

Results

The result of analysis of ground gas is provided in Table 5-31 while a complete laboratory report is provided in Appendix M. Hydrogen sulphide (H_2S) was not detected at the Project site while low concentrations of methane (CH_4), carbon dioxide (CO_2) and carbon monoxide (CO) were recorded.

Low concentrations of methane were detected near the Al Aweer STP (BH1 and BH-2018-01) and northeastern boundary (BH-14) of the site while methane was not detected at three locations within the Project boundary (BH-2018-02, BH-2018-03 and BH-2018-04). The average and peak concentrations of methane were below the explosive limits of 5–15%.

Carbon dioxide (CO_2) was detected at four sites during Event 1 while it was not detected during Event 2. Carbon monoxide (CO) was detected at northeastern boundary of the site (BH14) during Events 1 and 2 and at northwestern boundary during Event 1. The concentrations of CO observed at the project site are below the explosive limits and workplace exposure standards as defined by Safe Work Australia Hazardous Chemicals Information System (HCIS).

Table 5-31 Ground gas sampling laboratory analysis

Borehole No.	Methane (CH_4) (%)				Carbon Dioxide (CO_2) (%)		Carbon Monoxide (CO) (ppm)		Oxygen (O_2) (%)		Hydrogen Sulfide (H_2S) (ppm)			
	Event 1		Event 2		Event 1	Event 2	Event 1	Event 2	Event 1	Event 2	Event 1		Event 2	
	Average	Peak	Average	Peak	Average	Average	Average	Average	Average	Average	Average	Peak	Average	Peak
BH1	0.07	0.3	0.0	0.0	0.28	0	0	0	20.0	20.8	0	0	0	0
BH14	0.88	2.0	0.1	0.2	0.2	0	1.4	0.7	20.6	20.5	0	0	0	0
BH-2018-01	0.04	0.4	0.0	0.0	0	0	0	0	20.5	20.5	0	0	0	0
BH-2018-02	0.0	0.0	0.0	0.0	0	0	0	0	20.8	20.8	0	0	0	0
BH-2018-03	0.0	0.0	-	-	0.01	-	0	-	20.8	-	0	0	0	0
BH-2018-04	0.0	0.0	-	-	0.25	-	2.6	-	20.6	-	0	0	0	0
Hazardous properties (1)														
Lower explosive or flammable limit (v/v)	5				Non-combustible		12.5		–		4.5			
Upper explosive or flammable limit (v/v)	15				Non-combustible		74.2		–		45.5			
Toxicity	Not toxic (but can cause asphyxiation by displacing oxygen)				Headaches and shortness of breath at 3% v/v becoming severe at 5% v/v.		Symptom of mild poisoning include headaches and flu-like effects. Greater exposure		–		At 20–150 ppm watering eyes, blurred vision, shortness of breath, sore throat.			

Borehole No.	Methane (CH_4) (%)				Carbon Dioxide (CO_2) (%)		Carbon Monoxide (CO) (ppm)		Oxygen (O_2) (%)		Hydrogen Sulfide (H_2S) (ppm)			
	Event 1		Event 2		Event 1	Event 2	Event 1	Event 2	Event 1	Event 2	Event 1		Event 2	
	Average	Peak	Average	Peak	Average	Average	Average	Average	Average	Average	Average	Peak	Average	Peak
					Loss of consciousness at 10%, fatal at 22%		can lead to loss of consciousness and death.				At 400–500 ppm pulmonary oedema, headache, dizziness, coma, asphyxiation			
Workplace exposure standards (Safe Work Australia HCIS)	None				TWA: 5000 ppm STEL: 30,000 ppm		TWA: 30 ppm		–		TWA: 10 ppm STEL: 15 ppm			
Environmental guideline levels for air (WHO 2000a and 2000b)	–				–		• 100 mg/m^3 (90ppm) for 15 minutes • 60 mg/m^3 (50 ppm) for 30 minutes • 30 mg/m^3 (25 ppm) for 1 hour) • 10 mg/m^3 (10 ppm) for 8 hours		–		7 µg/m^3 (aesthetic) 150 µg/m^3 (health)			
Notes	Explosive limit changes when oxygen concentration reduces. When CO_2 concentration reaches 24.5% v/v methane is non-flammable. Oxidises to CO_2 by bacterial action.				–		–		–		After short period of exposure the gas paralyses the sense of smell			

Source: (1) – Physical, chemical and toxicological properties of ground gases (NSW EPA, 2012); Notes: v/v – concentration; TWA – Time Weighted Average; STEL – Short Term Exposure Limit

5.6 Biodiversity and Conservation

5.6.1 Overview

Located in the arid tropical zone extending across Asia and northern Africa, the UAE's major terrestrial habitat is sandy desert that supports varying amounts of sparse seasonal vegetation (WWF, 2017). The City of Dubai is characterised as a highly urbanised environment, where native vegetation and undisturbed environments are largely absent.

The Project site is comprised of historically disturbed, developed, regraded, or natural terrestrial land. Native terrestrial fauna within the Project site is present to some extent.

Introduced terrestrial fauna species such as the adaptable five-striped palm squirrel (*Funambulus pennantii*), feral cats (*Felis catus*) and rats (*Rattus sp*.) may be present, but are considered a pest species and likely to move out of any area under disturbance.

5.6.2 Initial Site Assessment

5.6.2.1 Survey Methodology

For the baseline survey of existing conditions, two GHD staff performed a half-day site walkthrough on 9 April 2018. The purpose of the walkthrough was to provide high-level visual observations of the terrestrial environment. The site survey was completed via foot and observations were logged with photographs. The focus of the review was within the proposed development limits of the project, which is the northern half of the project site.

5.6.2.2 Survey Results and Discussion

There is an existing asphalt paved area used by the DM for vehicle storage in the proposed development footprint of the WtE plant. At the time of the site visit, the limits of project disturbance were not delineated in the field, but in general, the building development and primary construction disturbance will be over an existing asphalt paved area. To the south of this area, BESIX indicated that development would extend an additional 50 m, for site levelling and temporary construction staging. Further to the south, it was noted that the existing site conditions would remain undisturbed for the Project.

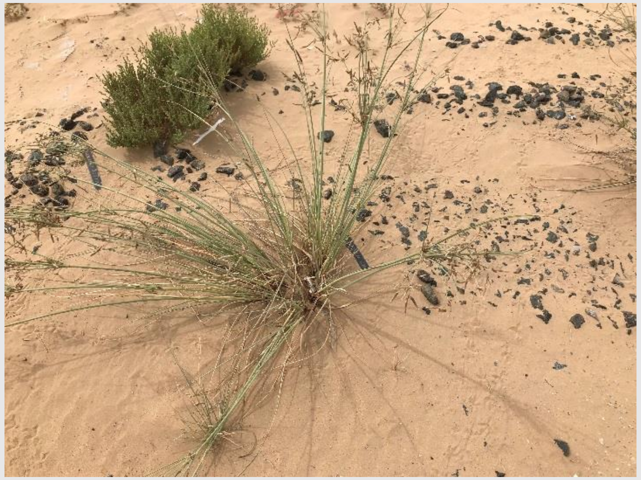
Biodiversity

The remaining undeveloped land adjacent to the parking and sludge disposal areas consists of a mix of naturally occurring sand sheets with dunes and gravel plains. Areas of lithified sand dunes were also observed throughout the site.

Relatively high-density vegetation for a desert landscape was present and included common desert shrubs and perennials Table 5-32.

Table 5-32 Flora species recorded at the Project site

Scientific name	Perennial / Annual	Conservation status (IUCN Red List)	Example from site
Zygophyllum qatarense	Annual	Not Evaluated by IUCN	
Calotropis procera	Perennial	No known conservation measures place for this species	

Scientific name	Perennial / Annual	Conservation status (IUCN Red List)	Example from site
Hyparrhenia hirta	Perennial	Not Evaluated by IUCN	
Convolvulus virgatus	Perennial	Not Evaluated by IUCN	

Scientific name	Perennial / Annual	Conservation status (IUCN Red List)	Example from site
Tribulus terrestris	Annual / Biennial	Not Evaluated by IUCN	
Leptadenia pyrotechnica	Perennial	Not Evaluated by IUCN	

No protected or culturally significant flora with conservation status, such as the Ghaf tree (*Prosopis cineraria*) was identified within or near to the plot limits. A single Ghaf was observed well outside the southern extent of the plot limits, along a sloped sand embankment near to the existing landfill site.

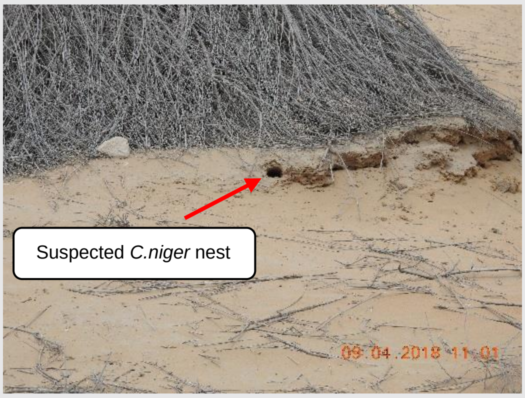
Invertebrates

Invertebrates were observed throughout the site and are expected to be relatively abundant given the density of flora present. Species identified within the site are listed in Table 5-33.

These species are not currently evaluated under the IUCN list of threatened species and their conservation status can therefore be considered *data deficient*[19].

Several burrows or nests were observed around the site, some of which may belong to active colonies the species of ant observed at the site, indicated above (*Cataglyphis niger*), the Desert Runner).

Table 5-33 Invertebrates recorded at the Project site

Scientific name	Common Name	Example from Site
Apis florea	Little Honey Bee	*No photo*
Cataglyphis niger	Desert Runner Ant	
Evippa arenaria	Wolf Spider (Arenaria species)	

[19] Data Deficient (DD) is a category applied by IUCN, other agencies and individuals to a species when the available information is not sufficient for a proper assessment of conservation status to be made. This does not necessarily indicate that the species has not been extensively studied, but it does indicate that little or no information is available on the abundance and distribution of the species (The Animal Files, 2014).

Avifauna

Avifauna observed at the site are provided in Table 5-34. Both birds are listed by IUCN as '*Least Concern'* and indicate increasing population trends based on current data. Collard Doves (*Streptopelia decaocto*) were abundant throughout the site and particularly nearest to the landfill site to the south.

Table 5-34 Bird species recorded at the Project site

Scientific name	Common name	Example from site
Streptopelia decaocto	Collared Dove	
Merops orientalis	Green Bee Eater	

Mammals and Reptiles

Mammals and reptiles were not directly observed at the site during the walkover. However, tracks belonging to lizards, snakes and quadrupedal mammals were observed. Due to the relatively fine nature of the sand at the site, a positive identification could not be made based on tracks alone. However, a lack of sufficiently size burrows at the site suggest that the protected Egyptian Spiny Tailed or *Dhub* lizard (*Uromastyx aegyptia*) is likely not present within the construction footprint of the site. Lizard tracks observed suggested smaller species.

Plate 5-1 Suspected lizard tracks observed at the Project site

The prevalence of smaller burrows at the site suggests also that smaller mammals may be present, such the Cheeseman's Gerbil (*Gerbillus cheesmani*) or similar species. This could not be confirmed, however. This species is listed as *Least Concern* according to IUCN's Red List of Threatened Species.

Plate 5-2 Suspected small mammal burrow observed at the Project site

Larger mammal tracks were observed, likely belonging to feral dogs or cats or possibly one or more resident Red Fox (*Vulpes vulpes arabica*), also listed as *Least Concern* by the IUCN, and known to thrive near areas of human habitation. As described above, a positive ID could not be made due to the nature of the sand, resulting in relatively undefined tracks.

Plate 5-3 Suspected large mammal tracks likely feral dog or fox observed at the site

Small snake tracks were observed at the site periphery. As described above, a positive ID could not be made due to the nature of the sand, resulting in relatively undefined tracks, also snake tracks can be ambiguous. No sitings occurred during the time of the site visit.

Plate 5-4 Suspected small snake tracks

The site is separated from other potential habitats by a road to the north, a construction site to the east and a landfill to the south. West of the project are some limited areas of similar desert habitat, as well as north beyond the existing road. However, each of these lies within otherwise developed sub-urban/city infrastructure and utilities zones and likely do not link to broader habitats due to the barriers that surrounding roads and land development create. Overall the site appears to be of low ecological value.

5.6.3 Terrestrial Survey

The terrestrial ecology survey was conducted from 19 to 20 of August 2018 (two days and one night) with the following objectives:

- Survey for flora and fauna present at the Project site
- Determine the species richness, composition and conservation value
- Identify environmentally sensitive terrestrial areas and critical habitats within the Project area
- Identify and map terrestrial habitat types present in the area

A combination of transect counts, quadrat sampling, trapping and general observations were employed to assess the flora and fauna in the Project area. An assessment of current satellite imagery of the Project area was also undertaken prior to mobilisation to identify hotspots for targeted surveys. Detailed methodology employed during the survey is provided in Appendix P.

5.6.3.1 Habitat Types and Associated Flora and Fauna

The habitat types prominent in the study area, based on EAD Habitat Classification (Brown, 2004), are Habitat 4130 and Habitat 9600. Description of these habitat types are provided below.

Habitat 4130 – Sand sheets and dunes with dwarf shrub cover

Habitat 4130 is the only natural habitat type present onsite. This habitat type is subdivided into two substypes based on dominant plant communities (Plate 5-5).

- *Habitat 4130 A*. This sub-habitat type is located at the northern section of the survey area in which Zygophyllum-Heliotropium community is the dominant vegetation type. The plant density and species richness in this habitat can be considered as relatively high when compared with Habitat 4130 B and Habitat 9600. A total of 12 plants, nine birds, three mammals and four reptiles were recorded in this habitat. The Bean Caper (*Z. qatarense*) and Turnsole (*H. kotschyi*) are the dominant plant species in this habitat type. Several flowering and fruiting individuals of Sodom's Apple (*C. procera*) have been observed. Furthermore, Sind saw-scaled viper (*E. carinatus sochureki*) was observed in this area. Compared with Habitat 4130 B, this area is also relatively undisturbed.
- *Habitat 4130 B*. This sub-habitat type is located at southern part of the Project site in which Leptodinia-Calatropis community are the dominant vegetation type. The plant density and species richness in this vegetation type is low when compared with Habitat 4130 A. This habitat type is dominated by Broom Brush (*L. pyrotechnica*) whilst scattered individuals of Sodom's Apple (*C. procera*) were also observed. The remaining plant species are restricted in northern section of this habitat. A total of 10 plants, 13 birds, one mammal and four reptiles were recorded in this habitat. The relatively high bird species richness in this area could be due to several flowering individuals Broom Brush (*L. pyrotechnica*) and Sodom's Apple (*C. procera*) as the majority of the mixed feeding units were observed in areas where patches of these species exist.

Plate 5-5 Habitat 4130 – Sand sheets and dunes with dwarf shrub cover

Habitat 9600 – Disturbed Ground

Habitat 9600 is located at the middle and western sections of the Project site and is considered as the dominant habitat type onsite. Species richness in this area is very low when compared with Habitat 4130 A and Habitat 4130 B, which could due to complete alteration of the natural landscapes into asphalt paved parking spaces (Plate 5-6). Three species of plants and five species of birds were recorded in this habitat.

Plate 5-6 Habitat 9600 – Disturbed Ground

The location of different habitat types identified at the Project site is provided in Figure 5-16.

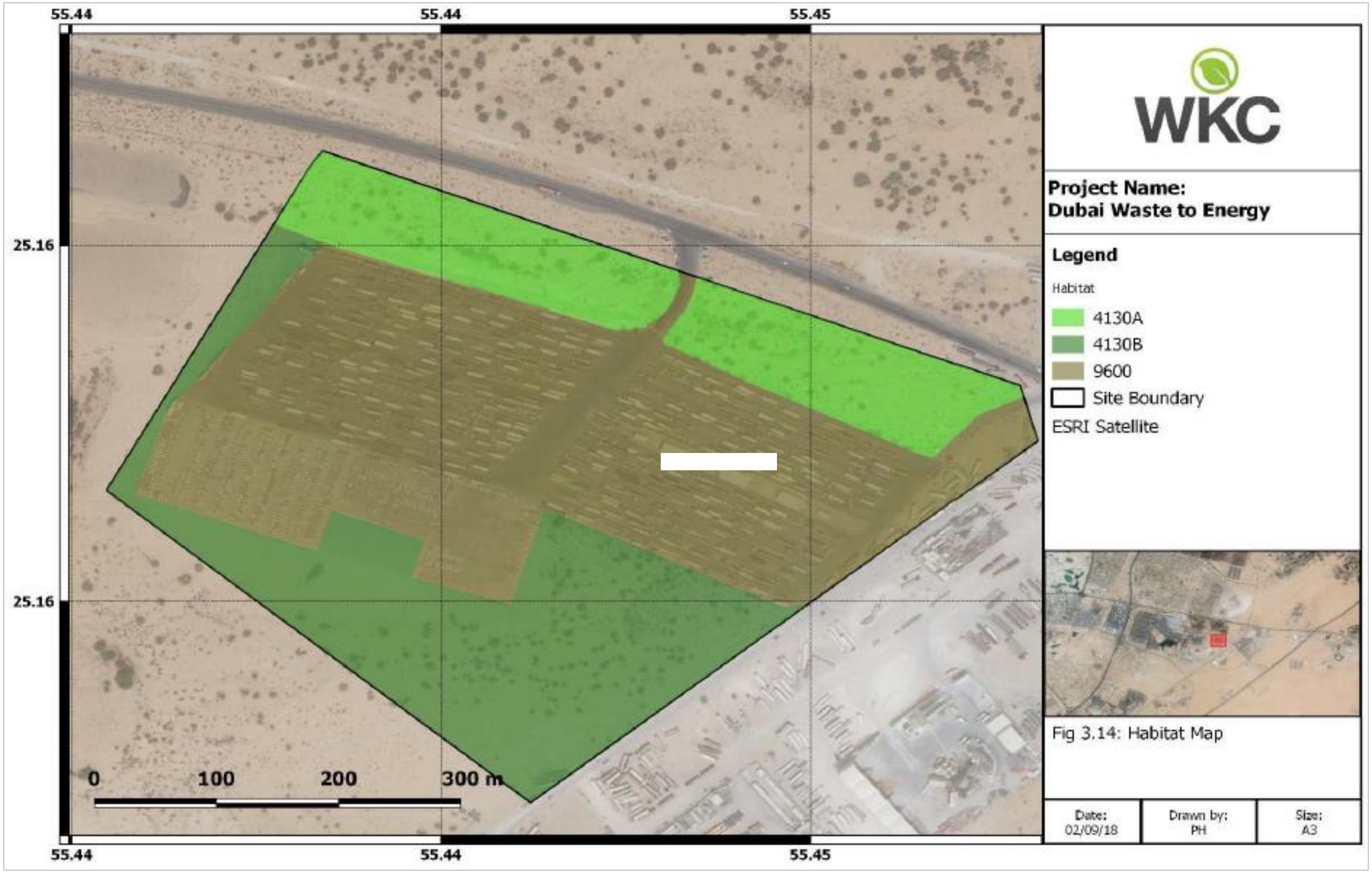


Figure 5-16 Habitat map

5.6.3.2 Flora

Species Richness

The study area is sparsely vegetated with a low species diversity of about 12 species (less than 2 % of the total species present in the UAE). The main vegetation consists of scattered large and small shrubs, and perennial grasses. The majority of the species are present in the northern and southern sections of the study area. Several species of plants such as Broom Brush (*Leptodinia pyrotechnica*), Sodom's Apple (*Calatropis procera*), alqa (*Dipterygium glaucum*), Rusty Indigo (*Indigofera colutea*) and Devil's thorn (*Tribulus terrestris*) were observed to be on the flowering and/or fruiting stages (Plate 5-7).

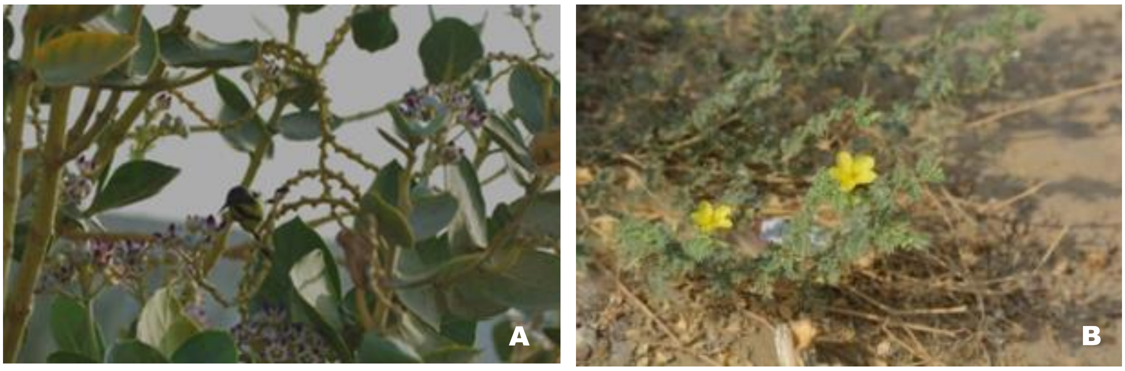


Plate 5-7 Flora observed on-site (A) Flowering Sodom's Apple (*Calatropis procera*); and (B) Devil's Thorn (*Tribulus terrestris*)

All plants recorded during the survey are native species and are well adapted to desert environment. The status of majority of the plant species observed at the site is currently unknown as the International Union for Conservation of Nature (IUCN) Red List of Threatened Species has not yet assessed their respective populations (IUCN, 2018). All the recorded plant species in the study area are commonly found in the desert environment of the Emirate of Dubai (Jongbloed, 2003). The species list which includes the local distribution, population status, and habitat observed during the survey is provided in Table 5-35.

Table 5-35 Plant Species recorded at the Project Site

Common Name	Scientific Name	Local Distribution [1]	IUCN Red List [2]	Habitat
Family Poaceae				
Turgid panic grass	*Panicum turgidum*	Common and widespread	Not Yet Assessed	A, B
Desert grass	*Stipagrostis plumosa*	Common and widespread	Not Yet Assessed	A, B
Family Cyperaceae				
Cyperus	*Cyperus conglomeratus*	Common and widespread	Not Yet Assessed	A, B, C
Family Asclepiadaceae				
Broom Brush	*Leptodinia pyrotechnica*	Common and widespread in Northern Emirates	Not Yet Assessed	A, B, C

Common Name	Scientific Name	Local Distribution [1]	IUCN Red List [2]	Habitat
Sodom's Apple	*Calatropis procera*	Common and widespread in Northern part of the country	Not Yet Assessed	A, B
Family Boraginacae				
Turnsole	*Heliotropium kotschyi*	Common and widespread	Not Yet Assessed	A, B
Family Capparaceae				
Alqa	Dipterygium glaucum	Common and widespread	Not Yet Assessed	A, B, C
Family Cucurbitaceae				
Desert squash	*Citrullus colocynthis*	Common and widespread	Not Yet Assessed	A
Family Fabaceae				
Rusty Indigo	*Indigofera colutea*	Locally common	Not Yet Assessed	A
Family Tamaricaceae				
Tarfa	*Tamarix cf. nilotica*	Common along the Arabian Gulf coast and sandy desert area	Least Concern	A, B
Family Zygophyllaceae				
Devil's thorn	*Tribulus terrestris*	Not common but widespread in urban areas	Not Yet Assessed	A, B, C
Bean Caper	*Zygophyllum qatarense*	Common and widespread along the Arabian Gulf coast	Not Yet Assessed	A, B

Notes: A - Habitat 4130 A; B - Habitat 4130 B; C - Habitat 9600

Sources: 1 - Jongbloed (2003); 2 - IUCN (2018)

Vegetation Type and Species Dominance

The floristic association of the vegetation types in the Project are as follows:

- The Zygophyllum-Heliotropium Type is found mainly in the northern part of the area. The plant density in this area is relatively high and species richness consists of 12 species, with unpalatable species the most common. The dominant species are Bean Caper (*Zygophyllum qatarense*) and Turnsole (*Heliotropium kotschyi*) whilst Broom Brush (*Leptodinia pyrotechnica*) and Sodom's Apple (*Calatropis procera*) are also abundant. In addition, scattered individuals of Alqa (*Dipterygium glaucum*), Rusty Indigo (*Indigofera colutea*), and Devil's thorn (*Tribulus terrestris*) were noted in this vegetation. Three species of grass were found to be common in this vegetation type.
- Leptodinia-Calatropis Vegetation Type is found in the southern part of the area. The plant density and species richness (10 species) in this vegetation type is lower when compared with Zygophyllum-Heliotropium type. The dominant species are Broom Brush (*L. pyrotechnica*) and Sodom's Apple (*C. procera*). Scattered individuals of Bean Caper (*Z. qatarense*), Turnsole (*H. kotschyi*), Alqa (*D. glaucum*) and Devil's thorn (*T. terrestris*) area were also noted in this vegetation type. Cyperus (*Cyperus conglomeratus*) is the only representative of the grass group in this area during the survey.

Plate 5-8 Dominant Plant Specis at the Project site: (A) *Leptadenia pyrotechnica*, and (B) *H bacciferum*

5.6.3.3 Birds

Species Richness

Bird species diversity onsite is low, with 17 species representing seven avian families, which is approximately 4% of the total number (445) of bird species recorded in the UAE. As provided in Table 5-36) the avifauna recorded in the Project site is composed of 12 (71 %) breeding resident, three (18%) introduced species with stable breeding population and two (12%) species that have resident and migrant populations (Aspinall, 2011 & UBC, undated). The majority of recorded birds onsite are common and well adapted to desert environment specifically on dune with dwarf shrubs habitat. Several species of birds such as Rock Dove (*Columba livia*), Rose-ringed Parakeet (*Psittacula krameri*), Common Myna (*Acridotheres tristis*) and House Sparrow (*Passer domesticus*) are well known to be associated with human influenced landscapes such as parks and farmland.

All species recorded during the survey period are classified as Least Concern species in IUCN Red List of Threatened Species (IUCN, 2018).

Table 5-36 Bird Species recorded at the Project Site

Common Name	Scientific Name	OSME [1]	IUCN Red List [2]	Habitat
Family Phasianidae				
Grey Francolin	*Francolinus pondicerianus*	Very common and widely distributed	Least Concern	B
Family Charadriidae				
Red-wattled Lapwing	*Vanellus indicus*	Very common resident, passage migrant and winter visitor	Least Concern	A, B
Family Columbidae				
Laughing Dove	*Spilopelia senegalensis*	Abundant and widespread resident.	Least Concern	A, B, C
Eurasian Collared-dove	*Streptopelia decaocto*	Locally abundant	Least Concern	A, B, C
Rock Dove	*Columba livia*	Very common	Least Concern	A, B, C
Family Psittacidae				
Rose-ringed Parakeet	*Psittacula krameri*	Common resident	Least Concern	A, B
Family Meropidae				
Green Bee-eater	*Merops orientalis*	Common to very common resident	Least Concern	A, B
Family Alaudidae				
Crested Lark	*Galerida cristata*	Very common to abundant resident	Least Concern	A, B
Family Cisticolidae				
Graceful Prinia	*Prinia gracilis*	Very common breeding resident	Least Concern	A
Family Leiotrichidae				
Arabian Babbler	*Turdoides squamiceps*	Common breeding resident	Least Concern	A, B
Family Laniidae				
Lesser Grey Shrike	*Lanius minor*	Fairly common migrant, April to May, uncommon	Least Concern	A, C

Common Name	Scientific Name	OSME [1]	IUCN Red List [2]	Habitat
		late August to mid-November		
Family Pycnonotidae				
White-eared Bulbul	*Pycnonotus leucotis*	Common and widespread	Least Concern	A, B, C
Red-vented Bulbul	*Pycnonotus cafer*	Common and range expanding	Least Concern	A, B
Family Sturnidae				
Common Myna	*Acridotheres tristis*	Very common, introduced	Least Concern	A, B, C
Family Nectariniidae				
Purple Sunbird	*Cinnyris asiaticus*	Common breeding resident	Least Concern	A, B
Family Estrildidae				
Indian Silverbill	*Euodice malabarica*	Very common resident	Least Concern	A, B
Family Passeridae				
House Sparrow	*Passer domesticus*	An abundant resident	Least Concern	A, B, C

Notes: A - Habitat 4130 A; B - Habitat 4130 B; C - Habitat 9600

Sources: 1 - UBC (undated), 2 - IUCN (2018)

Species Relative Abundance and Feeding Guild

The analysis of species relative abundance (RA) values indicates that House sparrow (*P. dometicus*) (RA of16%), Indian Silverbill (*E. malabarica*) (RA of 13%) and Laughing Dove (*Spilopelia senegalensis*) (RA of 10%) were the three most abundant species in the Project site. These species are commonly observed in large feeding flocks onsite.

The Lesser Grey Shrike (*Lanius minor*) with RA value of 1% is considered as rare or uncommon species onsite as only one individual was observed during the survey period. The remaining bird species onsite such as Eurasian Collared-dove (*Streptopelia decaocto*), Purple Sunbird (*Cinnyris asiaticus*) and Common Myna (Acridotheres tristis) are considered common species.

Small mixed flocks or feeding units normally composed two to five individuals of Rose-ringed Parakeet (*Psittacula krameria*), Arabian Babbler (*Turdoides squamiceps*), White-eared Bulbul (*Pycnonotus leucotis*), Purple Sunbird (*C. asiaticus*), Indian Silverbill (*E. malabarica*) and House sparrow (*P. dometicus*) were observed onsite. These small feeding units were usually observed feeding in areas with flowering and/or fruiting individuals of Sodom's Apple and Broom Brush.

Plate 5-9 Bird Species observed at the Project site: (A) *Passer Domesticus*, and (B) *Euodice malabarica*

The foraging behaviours of bird species onsite were grouped into seven feeding guilds to determine the feeding behaviours of different bird species and the food resources at the Project site (Figure 5-17). The granivore/insectivore guild is comprised of species from Family Columbidae (doves) and Crested Lark (*Galerida cristata*) whilst omnivores are represented by Grey Francolin (*Francolinus pondicerianus*), Arabian Babbler (*T. squamiceps*) and Common Myna (*A. tristis*). Nectivore/insectivore (5.88%), which is comprised of Purple Sunbird (*C. asiaticus*) is considered as the rarest feeding guild in the Project area during the survey period. The analysis of the feeding guilds suggests insects and grains/seed producing plants are the main food resources onsite.

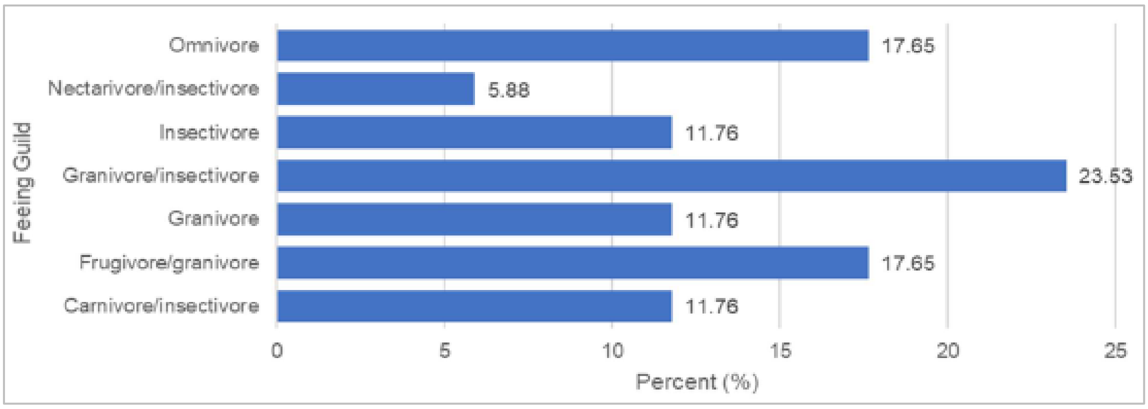


Figure 5-17 Feeding Guilds of Avifauna Onsite

5.6.3.4 Mammals

Species Richness and Population Status

The mammalian species diversity onsite is low with a total of five species recorded during the survey period. The majority of the species onsite are listed as data deficient (DD) or additional data are required to assess the local population in the UAE (ERWDA, 2005). However, except for the Feral cat (*Felis cattus*), the remaining mammalian species are classified as Least Concern species in the IUCN Red List of Threatened Species (IUCN, 2018) (Table 5-37). The survey points where different species of mammals were recorded onsite are presented in Figure 5-18.

Table 5-37 Mammalian Species recorded at the Project site

Common Name	Scientific Name	EAD Red List[1]	IUCN Red List [2]	Habitat
Family Muridae				
Cheesman's Gerbil	*Gerbillus cheesmani*	Least Concern	Least Concern	B
Family Felidae				
Feral Cat	*Felis cattus*	Not Listed	Not Listed	B
Family Vespertilionidae				
Kuhl's Pipistrelle	*Pipistrellus kuhli*	Data Deficient	Least Concern	A, B
Common Pipistrelle	*Pipistrellus pipistrellus*	Data Deficient	Least Concern	A, B
Muscat Mouse-tailed Bat	*Rhinopama muscalletum*	Data Deficient	Least Concern	A

Notes: A - Habitat 4130 A; B - Habitat 4130 B; C - Habitat 9600

Sources: 1 - ERWDA (2005), 2 - IUCN (2018)

Non-Volant (Small Mammal)

Two species of small non-volant mammals representing two mammalian families were recorded onsite. Three individuals of Cheesman's Gerbril (*Gerbillus cheesmani*) were caught via Sherman traps in Habitat B. This nocturnal and solitary rodent species is well adapted in arid areas and commonly found on sandy soils and mud flats in eastern deserts and is considered common in the Arabian Peninsula (IUCN, 2018). Although Cheesman's Gerbril (G. cheesmani) was only recorded in Habitat B it is highly likely that it is also present in Habitat A since both habitats are generally classified as Habitat 4310, which is a known habitat of the species. In addition, potential burrows of this species were also observed in Habitat A.

A juvenile feral cat (*Felis cattus*) was recorded at Habitat B during the night survey. The population of feral cat in the UAE is growing exponentially, and impacts associated with feral cat predation on native species is well documented throughout the world. In the UAE, a further impact is the cross breeding of wild-domestic felines with Gordon's Wild Cat (*Felis silvestris gordoni*).

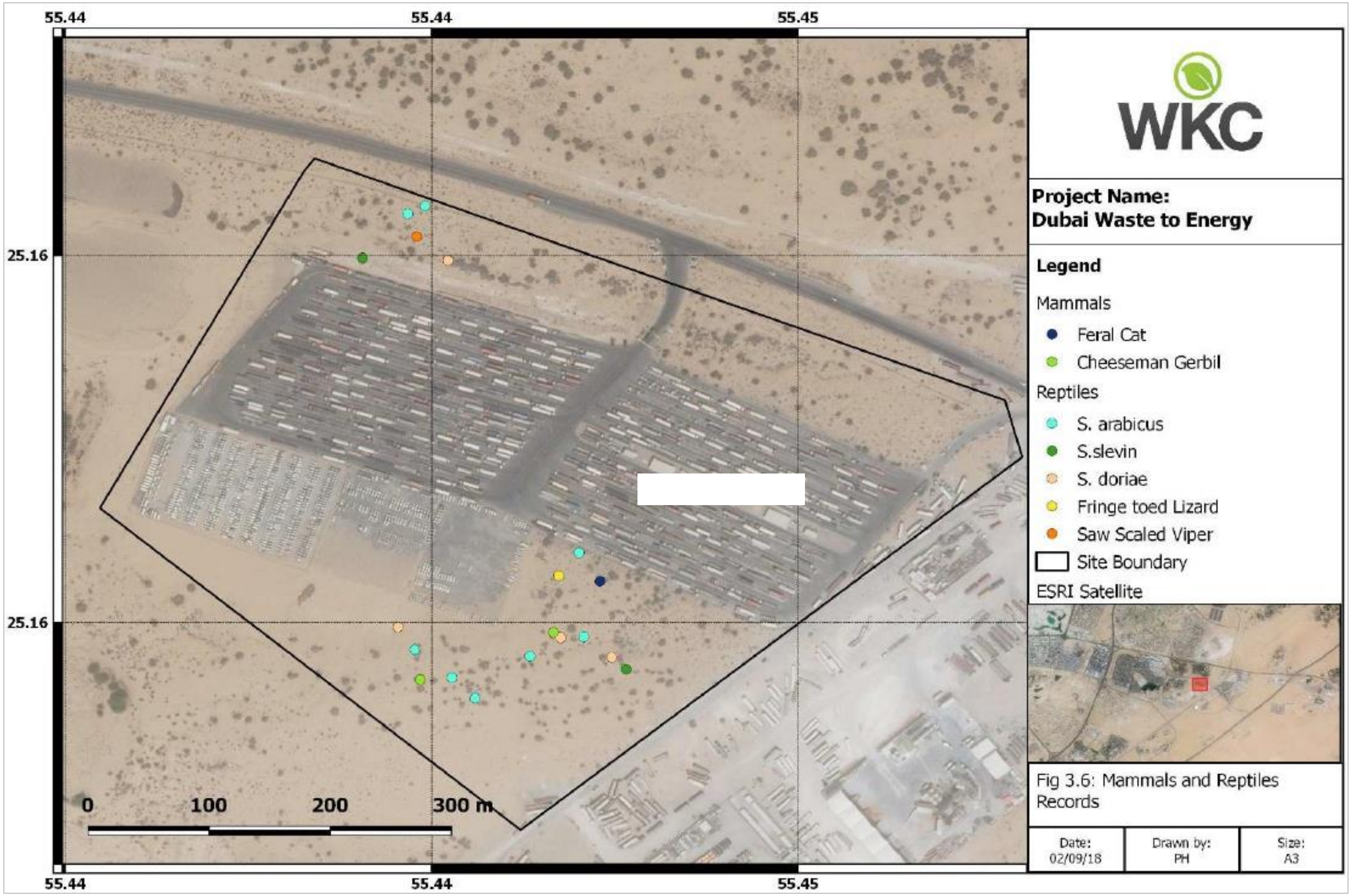


Figure 5-18 Mammals and Reptiles recorded at the Project site

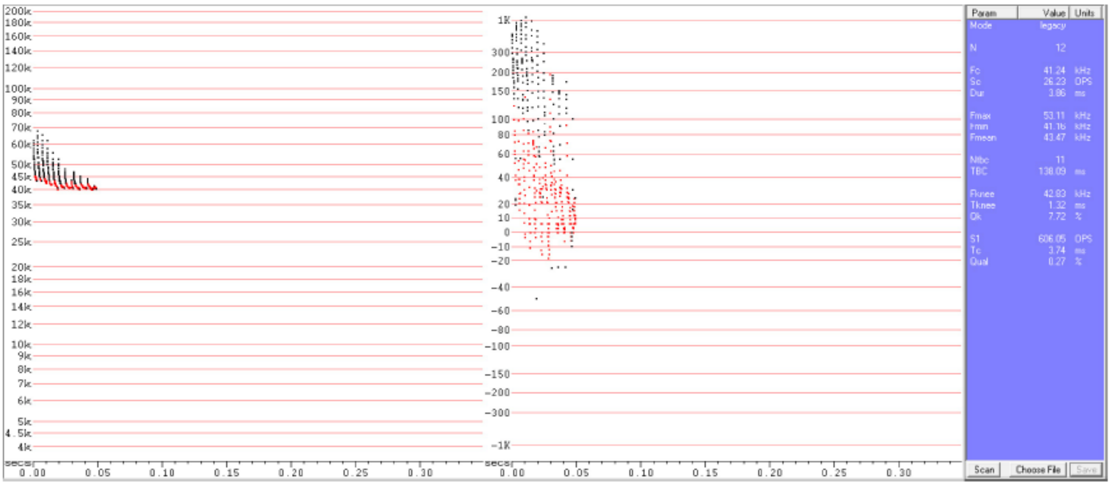
Volant Mammals (Bats)

The volant mammal survey using Anabat Express bat detectors recorded three species of volant mammals representing two mammalian families onsite:

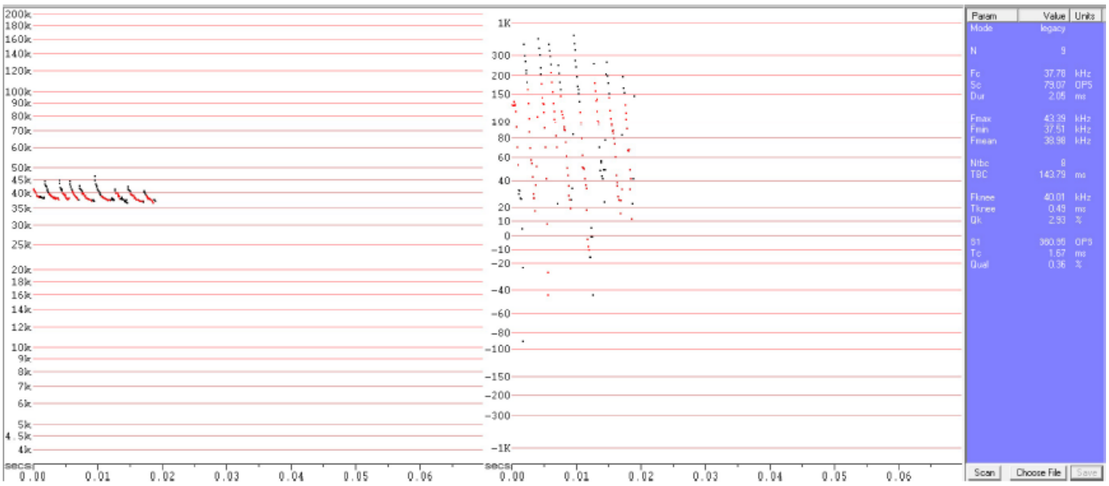
- Kuhl's Pipistrelle (*Pipistrellus kuhli*). This species is recognised as one of the most common bat species in the Middle East. Kuhl's Pipistrelle is a common and widespread species, that can be found from Europe to the Middle-east and North Africa. Pipistrelle bat species have been recorded utilising a variety of habitats, inclusive of urban and agricultural areas where they predate on insects. It has been reported that urbanisation, particularly in Dubai, has benefitted this species with the provision of favourable roost sites and an increase in prey items due to changes in habitat composition. Throughout the Project site, 60 registrations identified as Kuhl's Pipistrelle were recorded during the single evening of monitoring. Highlighted within Figure 5-19 (A), is a registration assigned to Kuhl's Pipistrelle. Note that the Fknee (knee frequency) in the call is registered at 42.83khz whilst the Fmin (minimum frequency) and Fmax (maximum frequency) are 41.16khz and 53.11khz respectively. These registrations are all within the assigned call frequency for Kuhl's Pipistrelle in the Middle East.
- Common Pipistrelle (*Pipistrellus pipistrellus*). Whilst the species is considered common and widespread throughout Europe, is yet to be confirmed in the Middle East. In the instance of detailed bat studies conducted throughout the Middle East to date, there is an increase in data suggesting that this species may occur from western Kingdom of Saudi Arabia (KSA) to the UAE. As highlighted in Figure 5-19 (B), the call range comprises of a Fmax at 50.56khz whilst the Fmin is 40.04khz. Of importance however is the Fknee, that dictates the differentiation between Kuhl's Pipistrelle and possible Common Pipistrelle with in this instance, the echolocation registering a Fknee of 41.97khz.

  There is limited data available on the distribution of Common Pipistrelle in the Middle East, with confirmed records obtained in Jordan and more recently, western KSA. In both instances, the calls recorded are of similar frequency to those obtained on the Project site. However, detailed assessment of call frequency variation associated with the pipistrelle family is yet to be conducted in the Middle East, and whilst the species has provisionally been identified as Common Pipistrelle, there is the possibility that it may be Arabian Pipistrelle (*Pipistrellus arabicus*), a species with a similar call range.

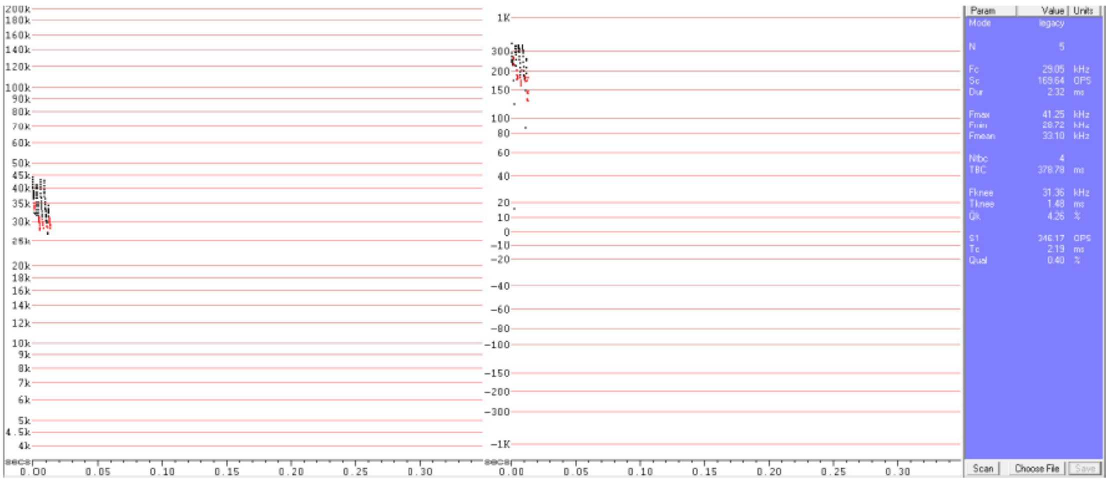
  Common Pipistrelle will forage in a variety of habitats, including open woodland and woodland edges, semidesert, farmland, rural gardens and urban areas. Predating on primarily small moths and flies, this species are biological controls for mosquito populations. Roosts are commonly found throughout buildings and trees. Owing to large scale development and creation of landscaped facilities, this species is likely to have benefitted from urbanisation in the Middle East.
- Muscat Mouse-tailed Bat (*Rhinopama muscalletum*). A solitary registration assigned to the species Muscat Mouse-tailed Bat was recorded (Figure 5-19 [C]). This species is considered common throughout the UAE, however it is primarily associated with mountain and rocky areas, where suitable roost locations are available. Within the middle east, this species is at present restricted to the UAE and Oman, with populations recorded throughout southern Iran.



A. Kuhl’s Pipistrelle Bat echolocation



B. Possible Common Pipistrelle echolocation



C. Muscat Mouse-tailed Bat echolocation

Figure 5-19 Echolocation of Volant Mammals observed at the Project Site

Species Relative Abundance and Feeding Guild

Species relative abundance for this group was not assessed as the Anabat data do not provide the actual number of individuals recorded onsite. The assessment of feeding guild of mammalian fauna onsite indicates that insectivorous mammals (all bats) are the dominant feeding trophic onsite. It suggests insects are stable food resource onsite. The feeding guilds of the mammalian fauna onsite are presented in Figure 5-20.

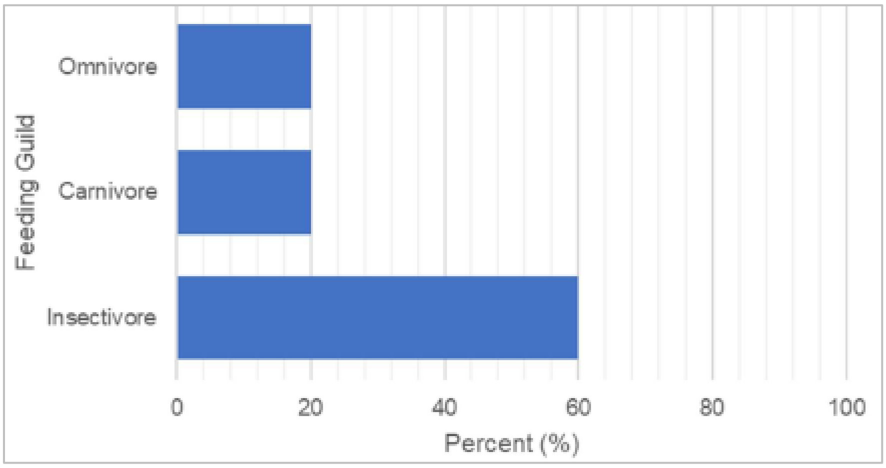


Figure 5-20 Feeding Guild of Mammals Onsite

5.6.3.5 Reptiles

Species Richness and Population Status

Species richness of reptiles recorded onsite is low with a total of five species, which is approximately 9% of the herpetofauna (54) of the UAE. The herpetofauna onsite is composed of three geckoes, one lizard and one species of snake representing three reptilian families (Table 5-38). With the exception of the Sind saw-scaled viper (*Echis carinatus sochureki*), which is not yet assessed by the IUCN, the remaining species on the list are classified as Least Concern species. All reptilian species recorded during this survey are considered as common in the UAE.

Table 5-38 Reptiles Recorded at the Project Site

Common Name	Scientific Name	EAD Red List [1]	IUCN Red List [2]	Habitat
Family Gekkonidae				
Arabian Sand Gecko	*Stenodactylus arabicus*	Not yet assessed	Least Concern	A, B
Dune Sand Gecko	*Stenodactylus doriae*	Not yet assessed	Least Concern	A, B
Slevin's sand gecko	*Stenodactylus slevini*	Not yet assessed	Least Concern	A, B
Family Lacertidae				
Schmidt's Fringe-toed Lizard	*Acanthodactylus schmidtii*	Not yet assessed	Least Concern	A, B

Common Name	Scientific Name	EAD Red List [1]	IUCN Red List [2]	Habitat
Family Viperidae				
Sind saw-scaled viper	*Echis carinatus sochureki*	Not yet assessed	Not yet assessed by IUCN	A

Notes: A - Habitat 4130 A; B - Habitat 4130 B; C - Habitat 9600

Sources: 1 - ERWDA (2005), 2 - IUCN (2018)

Species Relative Abundance and Feeding Guild

Species RA values for the reptiles indicate that Arabian Sand Gecko (*Stenodactylus arabicus*) is the most abundant in the study area with a value of 50% followed by Dune sand gecko (*Stenodactylus doriae*) and Slevin's sand gecko (*Stenodactylus slevini*) with RA values of 25% and 12.5%, respectively. The Schmidt's fringe-toed Lizard and Sind saw-scaled viper with R.A value of 6.25 % are considered as uncommon in the Project area. The assessment of feeding guilds of reptiles onsite indicates that insectivore (80%) and carnivore (20%) are the only feeding guilds in the study area (Figure 5-21). The insectivores are composed of geckos such as Arabian Sand Gecko and Schmidt's fringe-toed Lizard. The dominance of the insectivores suggest that the habitat onsite supports a healthy insect population.

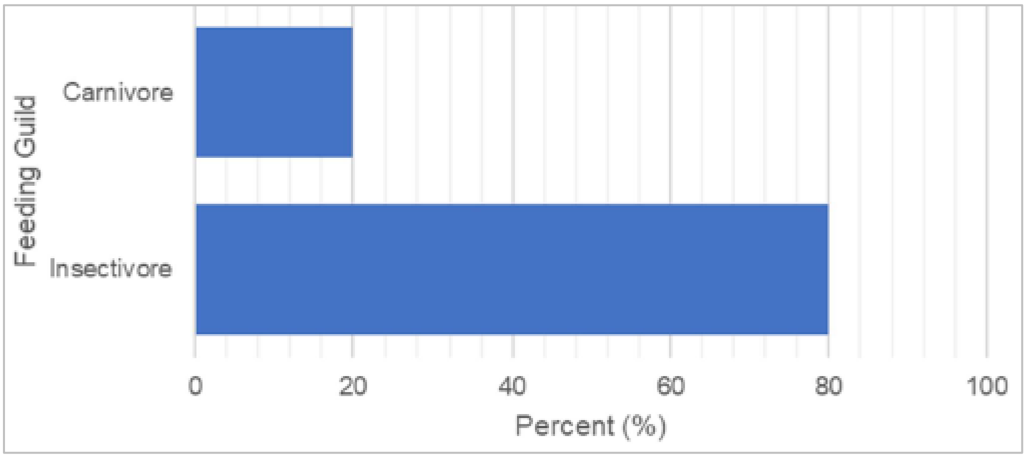


Figure 5-21 Feeding Guild of Herpetofauna observed at the Project site

Plate 5-10 Reptiles observed at the Project site: (A) *Stenodactylus arabicus*, (B) *Acanthodactylus schmidti*, and (C) *Echis carinatus*

5.7 Access, Traffic and Transport

5.7.1 Accessibility

The proposed site is accessed via the existing E44 highway (or Al Khail Road or Dubai-Hatta Highway), a dual 4-lane highway and runs from the west to east. Other major routes to the west and east of the Project are E311 (Sheikh Mohammed Bin Zayed Road) and E611 (Emirates Road). The major roads surrounding the development include the Academic City Road on the south and the Al Awir Road on the north of the proposed development.

From the E44 highway, the Project can be reached via D54 (or Sheikh Zayed Bin Hamdan Al Nahyan Street) and an internal road to access the Al Aweer STP. The access route of the development is provided in Figure 5-22.

The proposed development falls under medium industry with a total GFA of 58,089 m^2. Detailed description of the land use at the site is provided in Section 5.10.1.

5.7.2 Traffic

The congestion levels on E44 is high during rush hours. No detailed information is currently available regarding traffic levels on local access roads around the immediate vicinity of the Project; however, based on preliminary observations at site, traffic levels appear to be generally low and uncongested.

5.7.3 Public Transportation

The existing public transport provision to the Project site is a bus-based network, which serves residents, employees and visitors. The Dubai Roads and Transport Authority (RTA) website indicates that the following buse services operates in the vicinity of the site:

- Route No. 16 from Sabhka Bus Station to Hatta Bus Station. Operates with one-hour frequency on Fridays and two-hour frequency from Saturday to Thursday. The nearest bus stop to the Project site is located in Al Awir Road (named Awir, Sewage Treatment Plant 1).
- Route No. X23 (from Gold Souq Bus Station to International City), Route No. 366 (from Rashidiya Metro Station to Silicon Oasis), and Route No. 53 (from Gold Souq Bus Station to International City). These bus services operate with 15 to 20-minute frequency all day. The nearest bus stops to the Project are located in Dubai Textile City Main Gate, Dubai Textile City and International City.

The Project site is a walking distance away from the bus stops (i.e. 1 to 2 km or 20 to 30 minutes walk). The existing bus route with service headway information is shown in Figure 5-23.

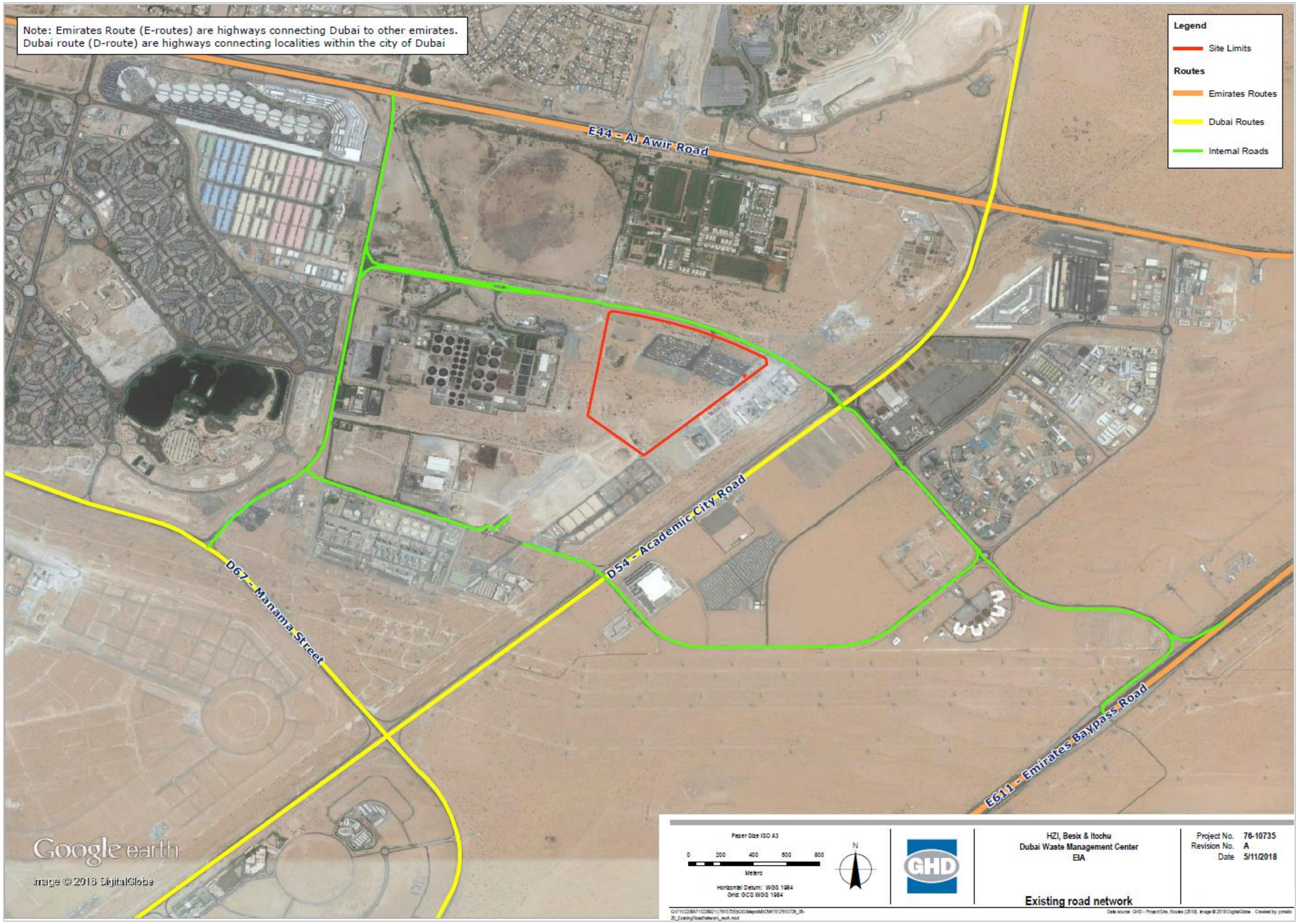


Figure 5-22 Existing Road Network

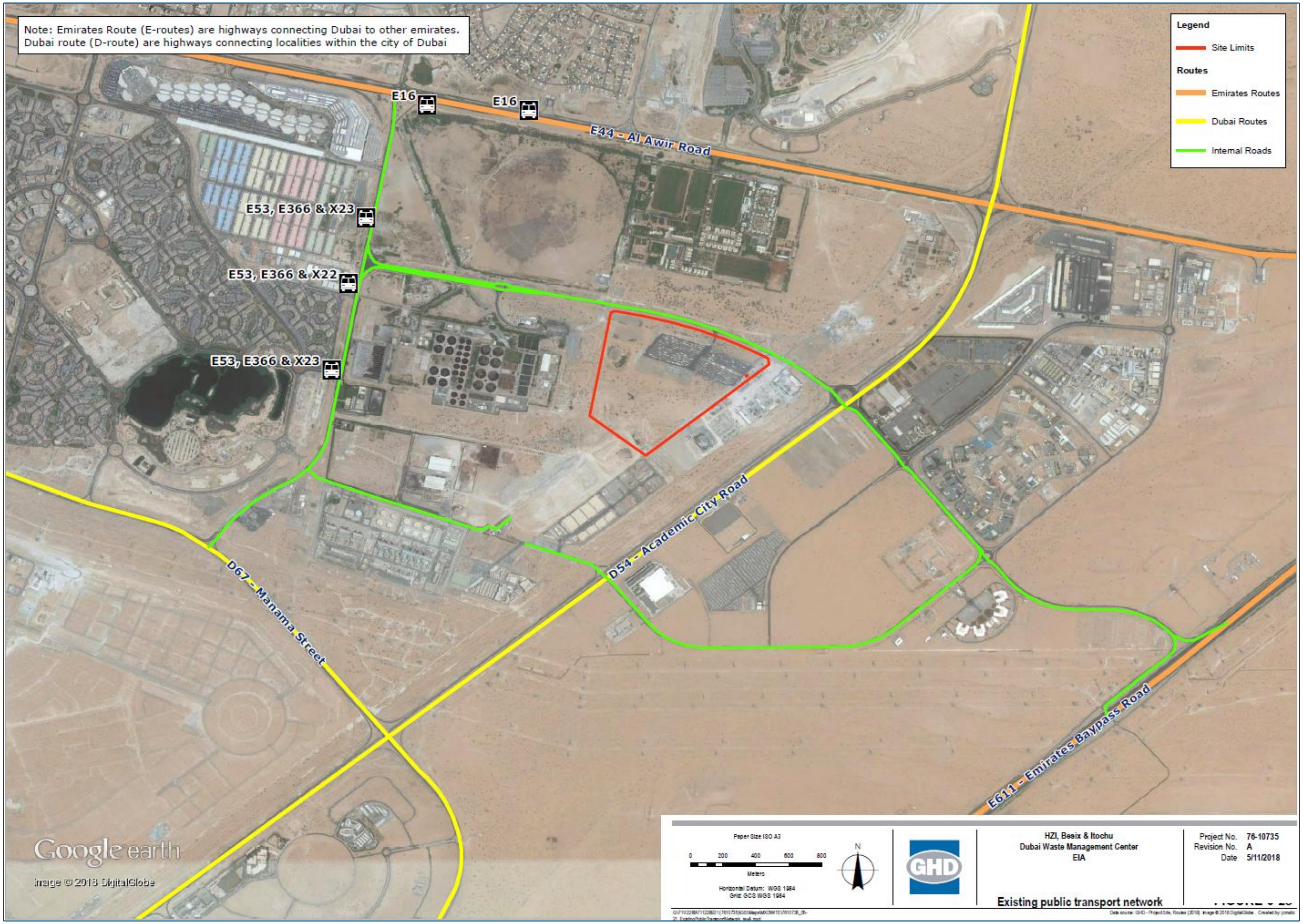


Figure 5-23 Existing Public Transport Network

5.8 Water and Energy Resources

5.8.1 Surface Water Resources in Dubai

5.8.1.1 Introduction

This section describes baseline conditions concerning surface water and energy resources within the Emirate of Dubai. The information inclused baseline hydrological conditions including surface water resources found in relative proximity to the Project site.

Groundwater resources are addressed in Section 5.5 of this EIA Report.

5.8.1.2 Existing Condition

The existing surface water bodies in Dubai relative to the Project are listed in Table 5-39 and locations are provided in Figure 5-24. The nearest water body to the Project site is the Al Warsan Lake located approximately 2.29 km west of the proposed WtE plant.

Al Warsan Lake is a man-made wetland that has been created by taking treated effluent from the nearby Al Aweer STP and storing it in an unused quarry area (Nakheel, 2018). The lake is also frequented by at least 186 bird species, which is roughly 44% of the total number of species known to inhabit or migrate through the UEA (Nakheel, 2018) and is also home to various species of plants, mammals, fist and reptiles since it was established.

Table 5-39 Distance of water bodies from the proposed WtE Plant

Name of water resource	Distance from the proposed WtE plant	Location relative to the proposed WtE plant
Al Warsan Lake (W1)	2.29 km	West
Ponds at Nad Al Sheba area (W2)	7.62 km	West
Ras Al Khor (W3)	8.25 km	Northwest
Dubai Creek (W4)	11.45 km	West
Dubai Coastal area (W5)	23 km	West

There are no surface water bodies, creeks or wetlands within the proposed Project's construction or operational footprint. Water supply for construction and operation will not be sourced or abstracted from natural sources or near the site.

Near the project site are small "pockets" (or pools) of surface water features that may have been formed from the leaching of water from the adjacent industrial site uses. A small surface water body was observed (GHD 2018) at the toe of the slope of the existing sludge management area and a small surface water body was observed at the toe of slope of the existing solid waste landfilling area.

Photo A – Surface Water Body, Suspected Leachate, at Toe of Slope of Sludge Disposal Area (not within Project’s construction limits of disturbance)	Photo B – Surface Water Body, Suspected Leachate, at Toe of Slope of Solid Waste Landfill Area (not within Project’s construction limits of disturbance)
	

Figure 5-24 Surface water resources in the Emirates of Dubai

5.8.2 Energy Resources

5.8.2.1 Energy Resources in the UAE

As per the DEWA Sustainability Report 2016, "*our [Dubai's] generation capacity has expanded to 10,000 Megawatts (MW) …as of the year 2016*."

The UAE Government developed UAE Vision 2021 to ensure sustainable development while preserving the environment. It has set a target of a 24% clean energy contribution under the UAE National Agenda Vision 2021. This could be achieved through the establishment of both nuclear and clean-energy projects:

- *Oil and Natural Gas*. The UAE has the seventh largest proven oil and natural gas reserved in the world, and this industry has been the backbone of the economy since its foundation. Around 95% of oil reserves and more than 92% of gas reserves belong to the Emirate of Abu Dhabi (UAE Ministry of Environment and Water, 2014). The Emirate of Dubai as well as the northern emirates in general have small reserves of oil and natural gas. Records show that domestic production of natural gas meets about 50% of electricity demand, with the rest currently being imported (Ministry of Energy, 2015).
- *DEWA 2,400 MW Hassyan clean coal power station*. Under contract with DEWA, ACWA Power and Harbin Electric consortium begun construction of a 2,400 MW Hassayan clean coal power station, based on the Independent Power Producer (IPP) procurement model. The project is currently under construction as of the timing of the EIA study.
- *Solar*. The UAE has a massive solar generation potential. The Renewable Energy Policy Network (2014) reported that the UAE ranked third in the world in the production of concentrated solar power (CSP) in 2013. Solar power plants installed in the country are as follows:
  - 10 MW solar PV plant in Masdar City;
  - Shams 1 – 100 MW CSP in the Western Region of Abu Dhabi; and
  - 13 MW solar PV facility at in Seih Al Dahal, first development within the Mohammed bin Rashid Al Maktoum Solar Park
- *Nuclear Power*. UAE is investing in a nuclear power plant, which is projected to generate 5.6 GW of low carbon electricity by 2020. The first reactor, with a capacity of 1.4 GW, is expected to be commissioned in 2018.
- *Waste-to-Energy*. In addition to the proposed Project what will supply 200 MW, a 100 MW waste-to-energy facility is planned in Abu Dhabi and a 26 to 29 MW waste-to-energy facility is planned in Sharjah, namely the Sharjah Multifurel Waste-to-Energy Plant.

The UAE Energy Plan for 2050 was launched by the Vice President and Prime Minister of the UAE in order to achieve a balance between energy production and consumption by 2050 and help the country meet international environmental commitments (Gulf News Energy, 2017).

The strategy will achieve the UAE's energy mix of clean energy (44%), gas (38%), clean coal (12%) and nuclear energy (6%) as shown in Figure 5-25. The strategy will be implemented within three main themes:

- Initiatives for the quick transition of power consumption efficiency;
- Diversifying its energy sources; and
- Ensuring security of energy supply.

Diversifying energy resources will focus on finding new solutions that complements power and transport systems while development and innovation will be undertaken to ensure security of energy supply.

Figure 5-25 UAE 2050 Energy Goals

Source: Gulf News Energy, 2017

5.8.2.2 Energy Consumption in the UAE

Energy consumption in the UAE has grown at an annual average of 4% over the past six years, with estimates that it will increase by 5% through 2020 as shown in Figure 5-26 (Strategy&, 2015). According to the FEWA, an average UAE resident consumes 25 kWh of electricity per day in comparison with the global average of 15 kWh (UAE Ministry of Energy, 2016). The energy consumption and electricity installed capacity in the UAE from 2008 to 2013 is provided in Table 5-40. Between 2012 and 2013, energy consumption increased by about 3.84% from 101.5 to 105.4 TWH while installed energy capacity increased by 0.71%.

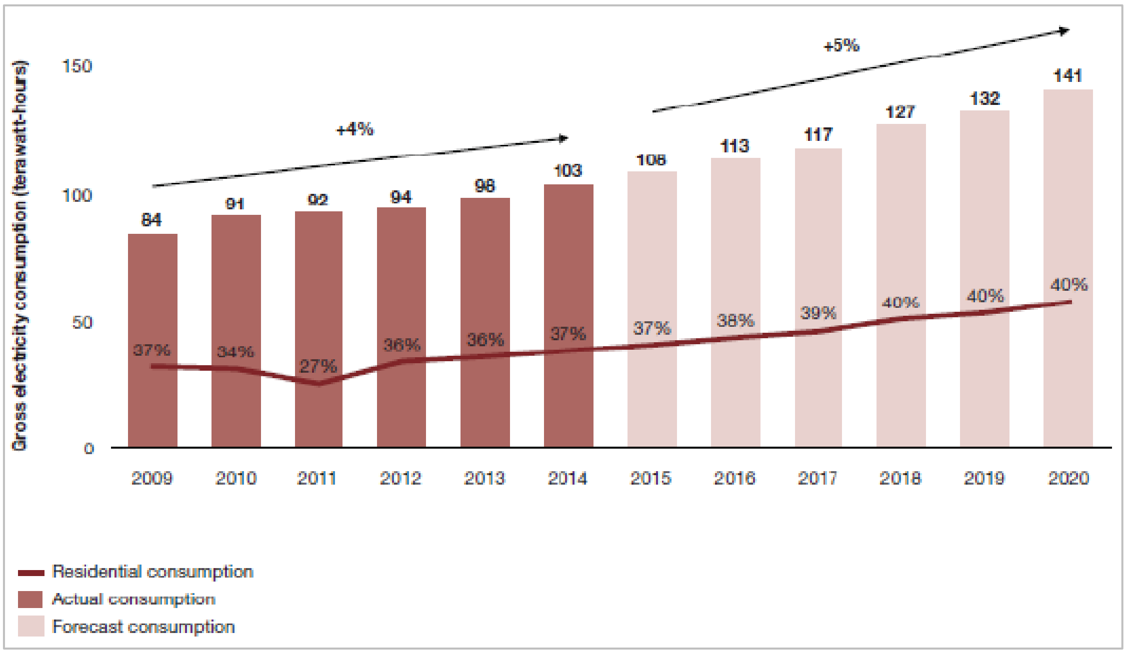


Figure 5-26 Total electricity consumption and residential percentage total

Source: The Economist Intelligence Unit, 2015; International Energy Agency (IEA) cited by Strategy&, 2015

Table 5-40 Energy consumption and installed capacity in the UAE

Year	Energy consumption (TWH)	Installed capacity (MW)	Peak load (GW)
2013	105.4	27,374	19.7
2012	101.5	27,180	19.1
2011	95.5	26,086	17.7
2010	89.6	23,199	16.8
2009	84.4	20,565	15.6
2008	77.9	19,814	14.5

Source: UAE Ministry of Energy, 2016

5.8.3 Power and Water Supply in Dubai

DEWA is the service provider of electricity and water supply in the Emirate of Dubai.

5.8.3.1 Power supply

DEWA Sustainability Report (2015) stated that the existing capacity within the water and electrical generation system is sufficient to meet the demand with a reserved margin minimum of 15% (Figure 5-27). It reported that resources for future plant additions have already been identified and budgeted to meet forecasted demand until 2030.

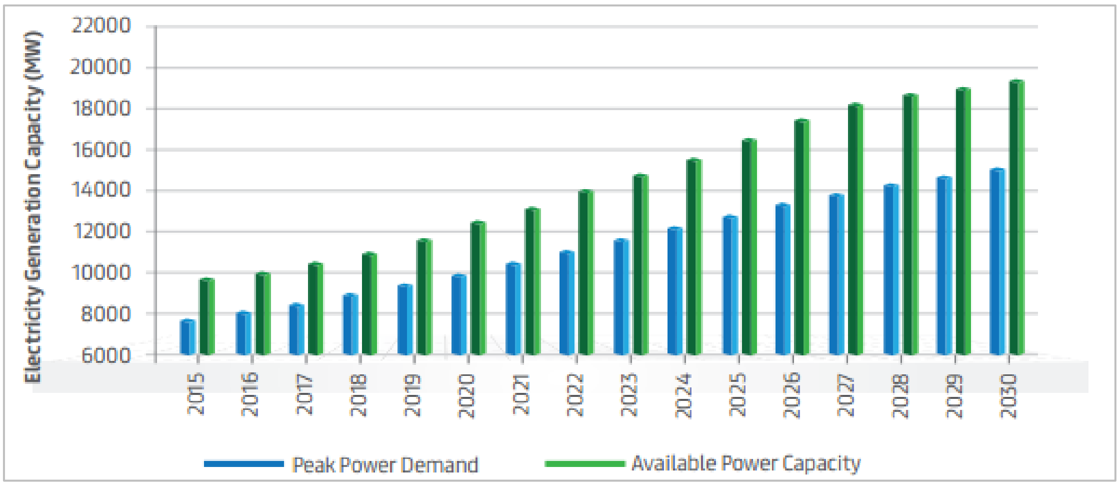


Figure 5-27 Peak demand and planned capacity additions

Source: DEWA Sustainability Report, 2015

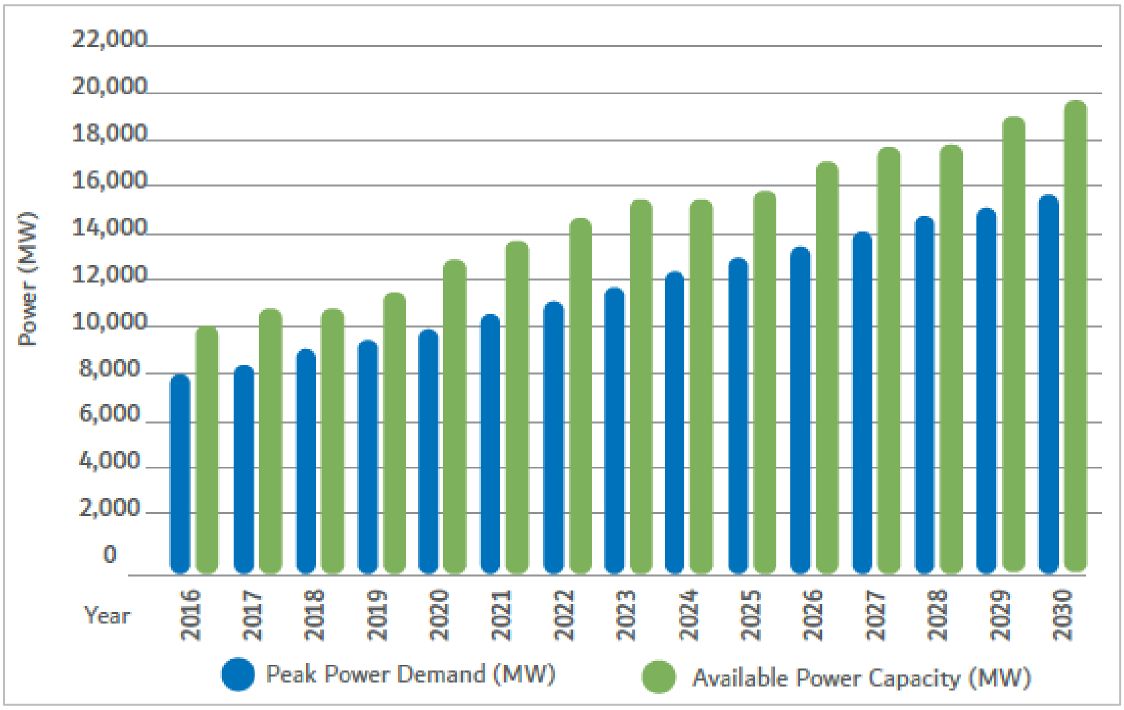


Figure 5-28 Peak power demand (MW) and available power capacity (MW)

Source: DEWA Sustainability Report, 2016

DEWA has a number of power plants in Jebel Ali, Al Aweer, and Mohammed bin Rashid Al Maktoum Solar Park, located approximately 34 km southwest, 1.2 km southwest and 44 km south from the Project site respectively. The total installed capacity of the power plants is 10,000 Megawatts (MW), which is greater than the 2016 peak demand of 7982 MW (Figure 5-29). DEWA annual statistics for 2016 indicate that the annual average electricity consumption in 2016 was 43,093 Gigawatt hours (GWh), with the commercial sector reported as having the highest consumption of electricity, followed by residential areas (Figure 5-30). Energy consumption for the commercial sector has decreased by 0.37% over the past three years (2014-2016), while an increase of 0.32% is recorded for residential areas.

Plant upgrades are not required to accommodate the additional 200 MW to be supplied by the proposed project and that the use of power by the project for construction will not require the addition of power sources and can be accommodated within the existing capacity of the DEWA system. The Dubai Economic Report 2017 stated that *Dubai government has succedded in covering 100 percent of the electricity requirements for both industry and the population* (DED 2017).

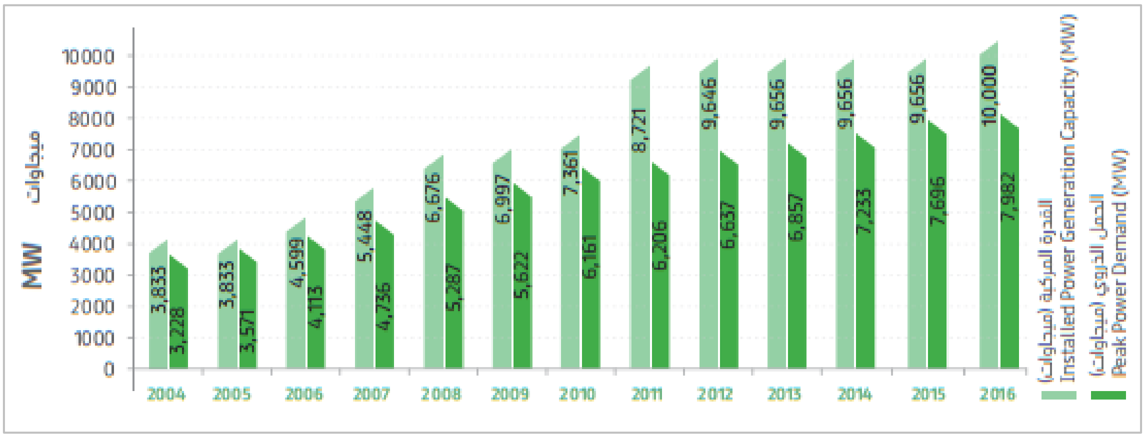


Figure 5-29 Power installed capacity and peak demand in the Emirate of Dubai

Source: DEWA Annual Statistics Report, 2016

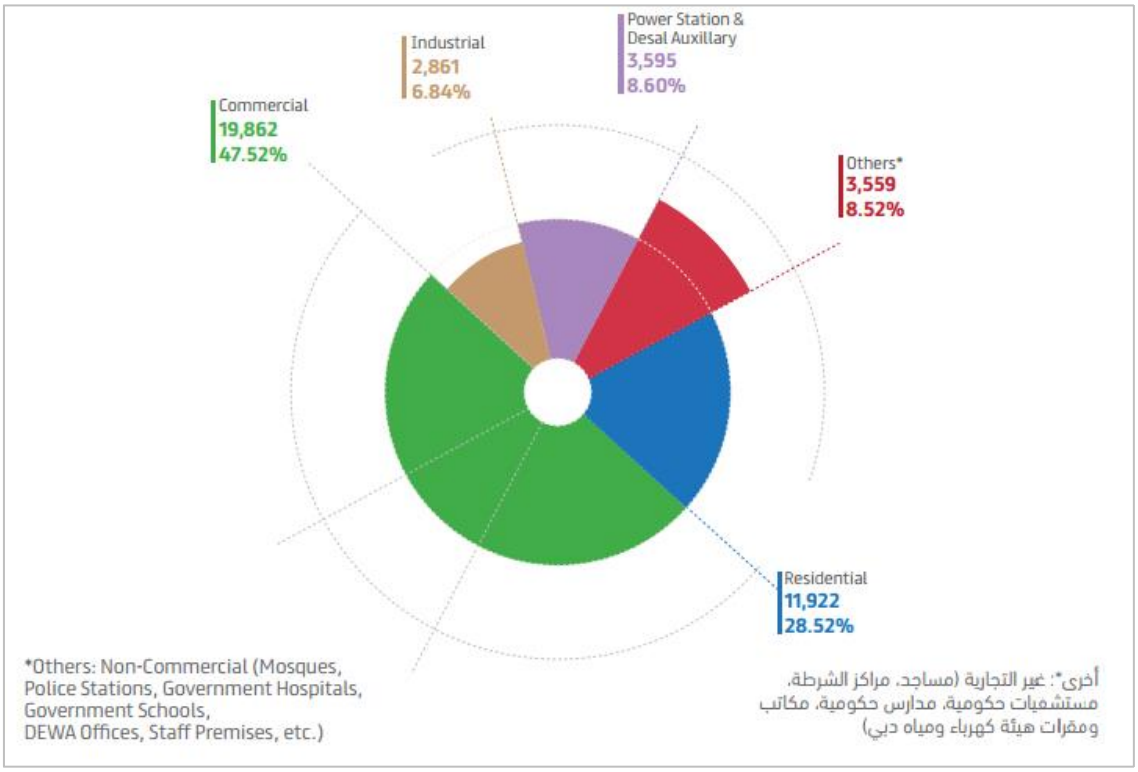


Figure 5-30 Electricity consumption by type of consumer

Source: DEWA Annual Statistics Report, 2016

5.8.3.2 Water consumption

DEWA's desalination plants are located in Jebel Ali. Total water production capacity in 2016 as shown in Figure 5-31 taken from the DEWA Sustainability Report for 2016.

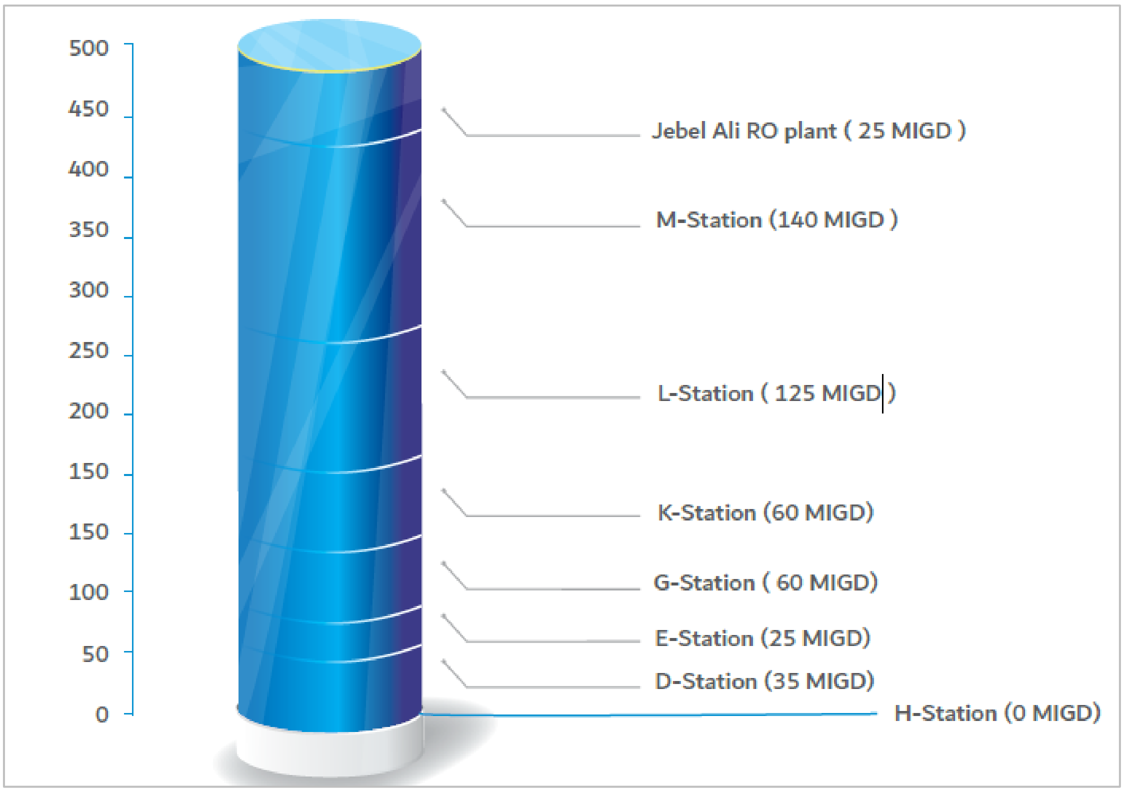


Figure 5-31 Total water production capacity in 2016 (million imperial gpd)

Source: DEWA Annual Statistics Report, 2016

DEWA is meeting the Dubai's needs of water sufficiently from eight water desalination plants (DED 2017). In 2016, the total installed desalination capacity available in Dubai is 470 million imperial gallons per day (MIGD) in addition to 32 MIGD from wells (Figure 5-32) while the peak water demand is 347 MIGD. The current supplies are adequate to support the development needs of the proposed project and no new sources are to be built.

Data shows that peak water demand increased by 2.96% (from 337 MIGD in 2015 to 347 MIGD in 2016). Residential areas consumed the most water in 2016 (60.72%) followed by commercial areas (26.57%) (Figure 5-33). Data indicates that water consumption in residential areas has increased by 3.68% since 2014, while consumption in commercial areas has decreased by 1.37% since 2014.

The average water consumption in the UAE is reported to be 550 L/day per person, almost twice the international average of 170–300 L/day per person (Khaleej Times, 2016). According to the United Nations Environment Programme (UNEP), the UAE has the world's third largest per capita consumption of water (Fisher, 2014). Water demand and scarcity was one of the three key issues raised by the United Nations Environment Programme report for the UAE (Fisher, 2014).

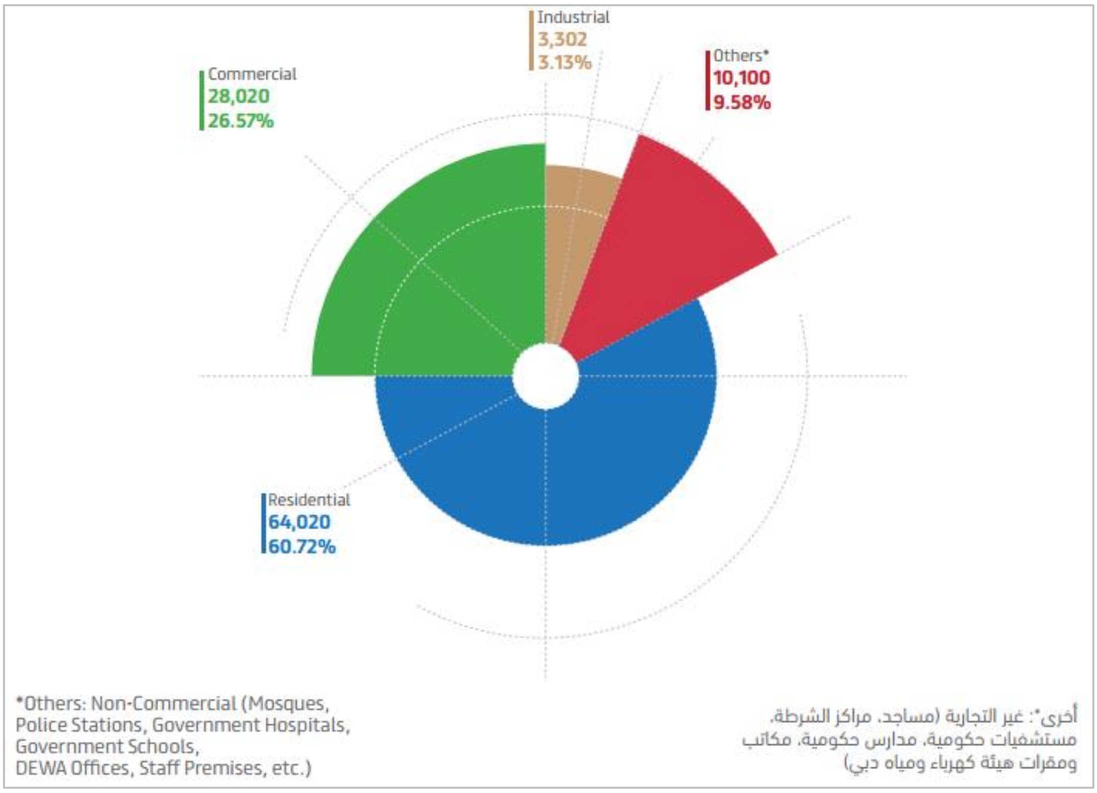


Figure 5-32 Desalination capacity and peak water demand in the Emirate of Dubai

Source: DEWA Annual Statistics Report, 2016

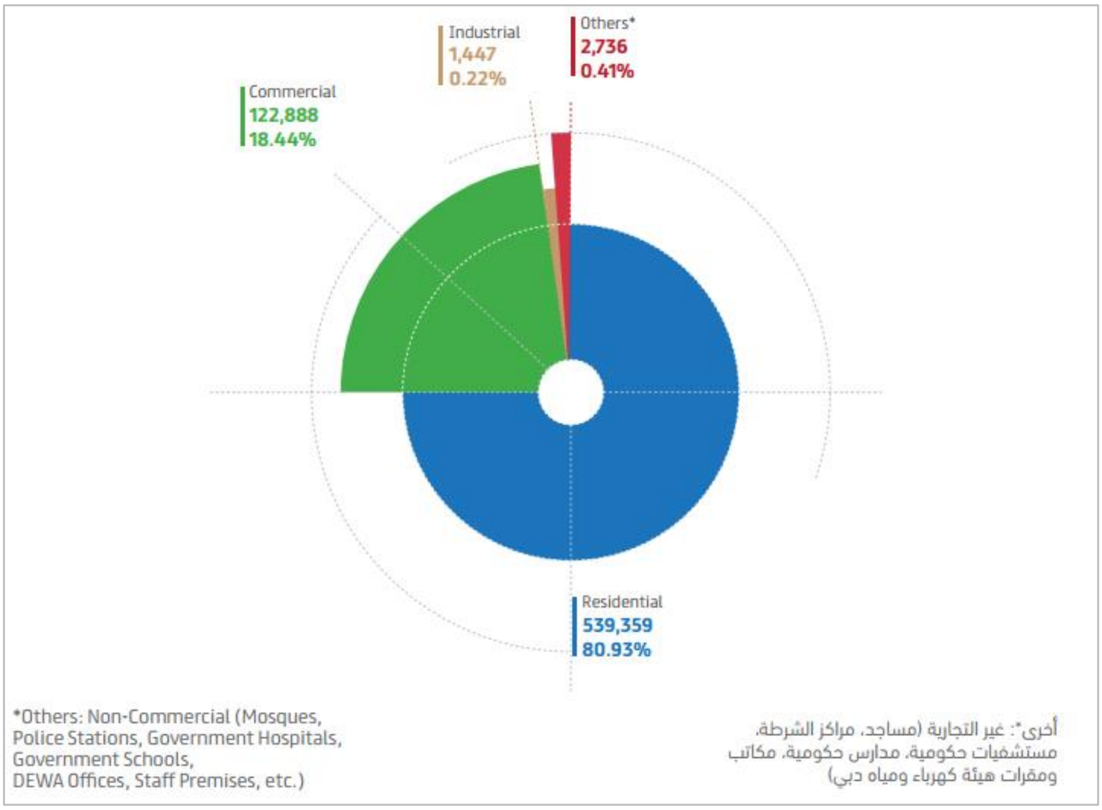


Figure 5-33 Water consumption by type of customer

Source: DEWA Annual Statistics Report, 2016

5.9 Waste Management

This section relates to Waste Management, and deals with two primary considerations:

1) A general overview of waste management in Dubai

2) Waste management considerations for the Project's construction and operation phases; excludes waste management activities[20] associated with the plant operation that are described in Section 2.4 "Description of the Project's EIA Process (Assumptions and Limitations)"

The Project is a key strategy of Dubai's integrated waste management plan. The proposed WtE plant seeks to change Dubai's waste management strategy through reuse of municipal solid waste and reduce the reliance on disposal of waste to landfill

5.9.1 Waste Management in Dubai

In a strategic effort, DM is committed to maintaining Dubai as one of the most sustainable and physically clean cities in the world. From a historical perspective, landfilling has been the predominant waste management strategy for the Emirate. However, there is increasing momentum towards development of strategic alternative waste treatment facilties, including the proposed Project WtE plant, with a goal of increasing recycling opportunities and minimizing the harmful environmental impacts associated with landfilling, or dumping in some cases.

Overarching benefits associated with the recycling of waste as a fuel source during operations are discussed earlier in the EIA report (refer to Section 1.3), such as reduced reliance on fossil fuels (energy diversification), reduced waste to landfill management practices, and meeting greenhouse gas and climate targets set by government. For this section, consideration is given regarding annual waste quantities and waste management planning in Dubai, in general.

In the 2013 Strategic Integrated Plan for Solid Waste (master plan) three possible scenarios were considered for the future management of waste in Dubai. These included:

- A master plan solution, which involved a multifaceted approach including multiple waste treatment technologies: source segregation, composting, materials recovery facility (MRF), anaerobic digestion (AD), and mechanical biological treatment (MBT);
- An energy from waste option, which was considered as the sole technology to be developed within this scenario and considerations given to economic viability; and
- A landfilling option, which represented a "no change" condition from the existing waste management strategies at that time.

In recent years, stressors on waste management in Dubai resulted from both rapid construction of infrastructure and facilities and an increasing population. In general, the UAE has one of the highest per capita waste levels per person in the world with waste generation rates, estimated to be approximately 1.66 kg per capita per day of municipal solid waste over the period of 2012 to 2014 (EAD, 2016). The daily domestic waste output in Dubai is slightly higher than the national average, at about 2.03 kg per person per day, based on the most recent data reported by DM (The National UAE, 2017).

Table 5-41 shows the estimated daily waste generation volumes in Dubai over a 5-year period.

[20] Assessment of the waste storage facility for the bottom ash and flue gas treatment (FGT) residue.

Table 5-41 Estimated Annual Waste Generation from Dubai (tpd)

Year	Domestic Waste	Horticultural waste	Construction Waste
2017	3,570,072	139,938	18,870,968
2016	3,343,724	119,491	15,685,714
2015	3,181,063	116,913	11,116,212
2014	2,596,587	113,399	7,607,943
2013	2,590,020	118,629	7,418,781
2012	2,676,297	138,901	6,630,332

According to the UAE National Bureau of Statistics, the quantity of waste collected in the UAE in 2016 was 34.7 million tonnes with approximately 19.5 million tonnes produced in Dubai (UAE Federal Competitiveness and Statistics Authority, 2016). In 2016, about 4% of the waste produced in Dubai was diverted away from landfill (or dumping) to alternative disposal, treatment or recycling facilities within the Emirate of Dubai.

In 2016, DSC (2016) reported that approximately 19.15 million cubic meters of solid waste was generated in Dubai, a significant increase of 32.8% compared to the waste generated in 2015. Construction waste formed the majority of the waste stream comprising 78% of the total solid waste. This also showed a significant increase of 41% compared to the total construction waste produced in 2015. In general, construction waste has increased on average by 43.5% per year over the past three years (2014-2016) (DSC, 2016).

In Dubai, waste recycling generally occurs within the following framework:

- Collection of recycleable materials by private companies. Primary collected waste is Old Corrugated Containers (OCC). Limited amounts of plastics, glass and metals are also collected. DM also has begun public-private partnerships to address other types of waste.
- The Jebel Ali Hazardous Waste Treatment Facility is the only facility available within the Dubai emirate. It should be noted that there is Local Order (No.) 7 for the year 2002 on Management of Waste Disposal Sites in the Emirate of Dubai; as amended by Local Order No. (5) of 2003) that waste created in the emirate should be treated in that emirate and cannot travel across borders.

Dubai waste generally includes the following principle waste streams:

- Municipal Solid Waste (MSW), or referred to as “domestic waste” (including MSW from residential, commercial and industrial sectors)
- Construction and Demolition (C&D) waste
- Horticultural / Agricultural waste
- Hazardous waste
- Medical waste

Dubai has experienced rapid population growth since 1975. Coupled with increasing population, increasing business activities have also resulted in growing solid waste quantities. The construction industry represents the largest contributer to waste generation, with significant growth from years 2015 to 2017, as shown in Figure 5-34. Opportunities for waste recycling and diversion from landfill, therefore, become important environmental considerations.

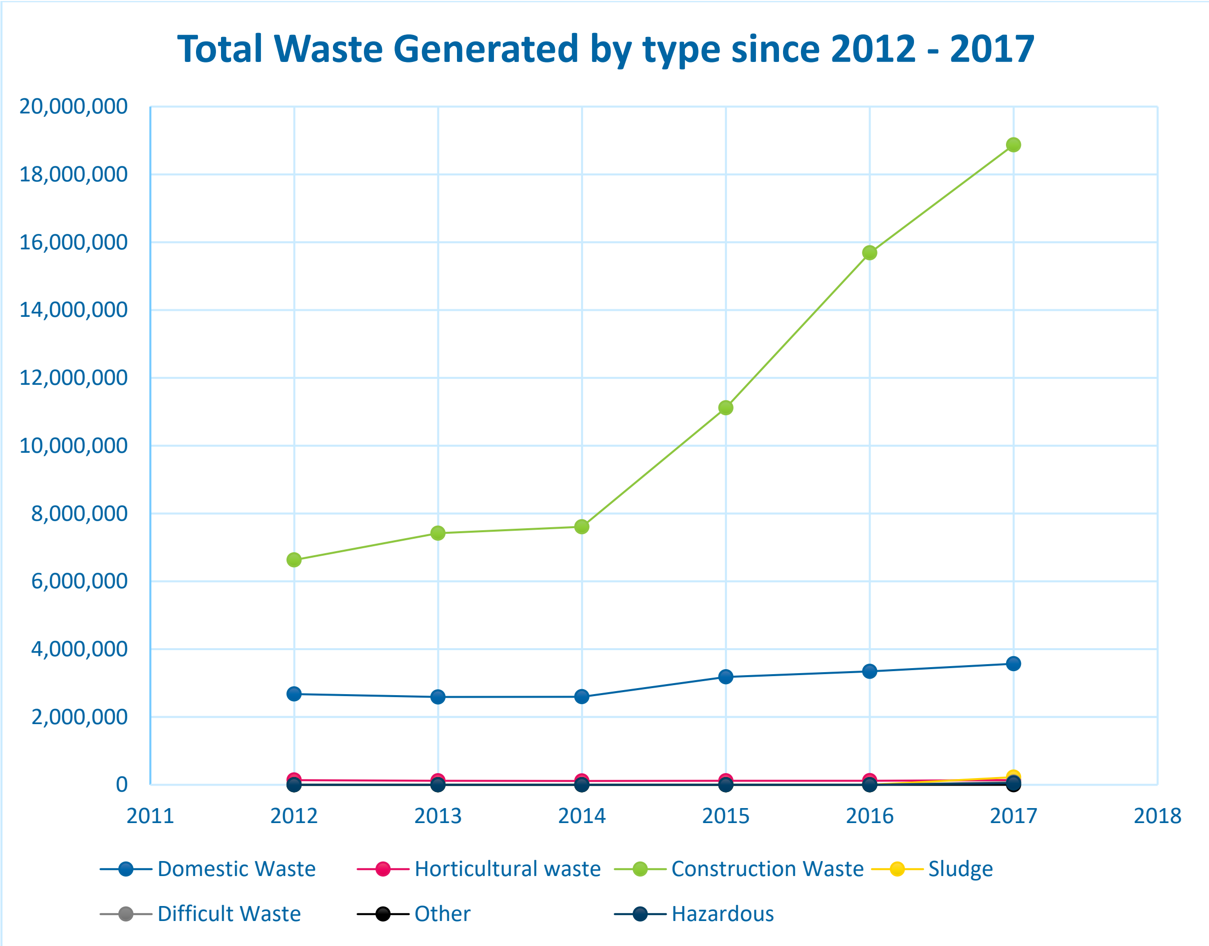


Figure 5-34 Waste Changes over Years

The waste facilities in Dubai as part of the Master plan are detailed in Table 5-42.

Table 5-42 Existing Dubai Waste Management Facilities

Site	Type	Wastes Accepted	Basic Criteria
Al Qusais	Landfill	General Waste	Operated since 1976 From 1998 to 2011, 23.4 M tonnes recorded Nearing full capacity
Warsan	Landfill	General Waste	Operated since 2006 No base liner, leachate or landfill gas management systems Receives residual waste from Tadweer MRF
Lehbab	Landfill	General Waste	30 km from Dubai Operated by DM No containment engineering, leachate or gas management
Al Warqaa	Landfill	General Waste	Closed, domestic waste landfill No engineering controls
Hatta	Landfill	General Waste	Operated by Hatta Local Municipality
Jebel Ali	Landfill	General Waste	Operational since 2003 No containment engineering, leachate or gas management
Al Bayadha	Landfill	C&D Waste	100 million tonnes received between 2005 and 2013
Jebel Ali	Landfill	Hazardous Waste	Single and double-lined engineered landfills
Tadweer	MRF	General Waste	Operational since 2006 under a 25 year BOO contract 4000 tonnes per day of Domestic waste Dirty MRF
Tadweer	Composting	Horticultural Waste (not operating*)	500 tpd composting
Al Qusais	Tyre Recycling	Tyres	BOO contract with Emirates Recycling Group Estimated 3000 tyres per month
Al Lusaili	Recycling Facility	C&D	25 year BOOOT contract with Emirates Recycling LLC

Site	Type	Wastes Accepted	Basic Criteria
			Estimated 560 tonnes per hour
Jebel Ali	Incinerator	Clinical Waste	Vertical system with capacity of 19.2 tonnes per day Scrubbing technology not designed to remove dioxins
Jebel Ali	Treatment Facility	Hazardous Waste	Built in 2000 Number of treatment facilities, including new (2018) liquid waste treatment facility

Source: Mott MacDonald, 2012

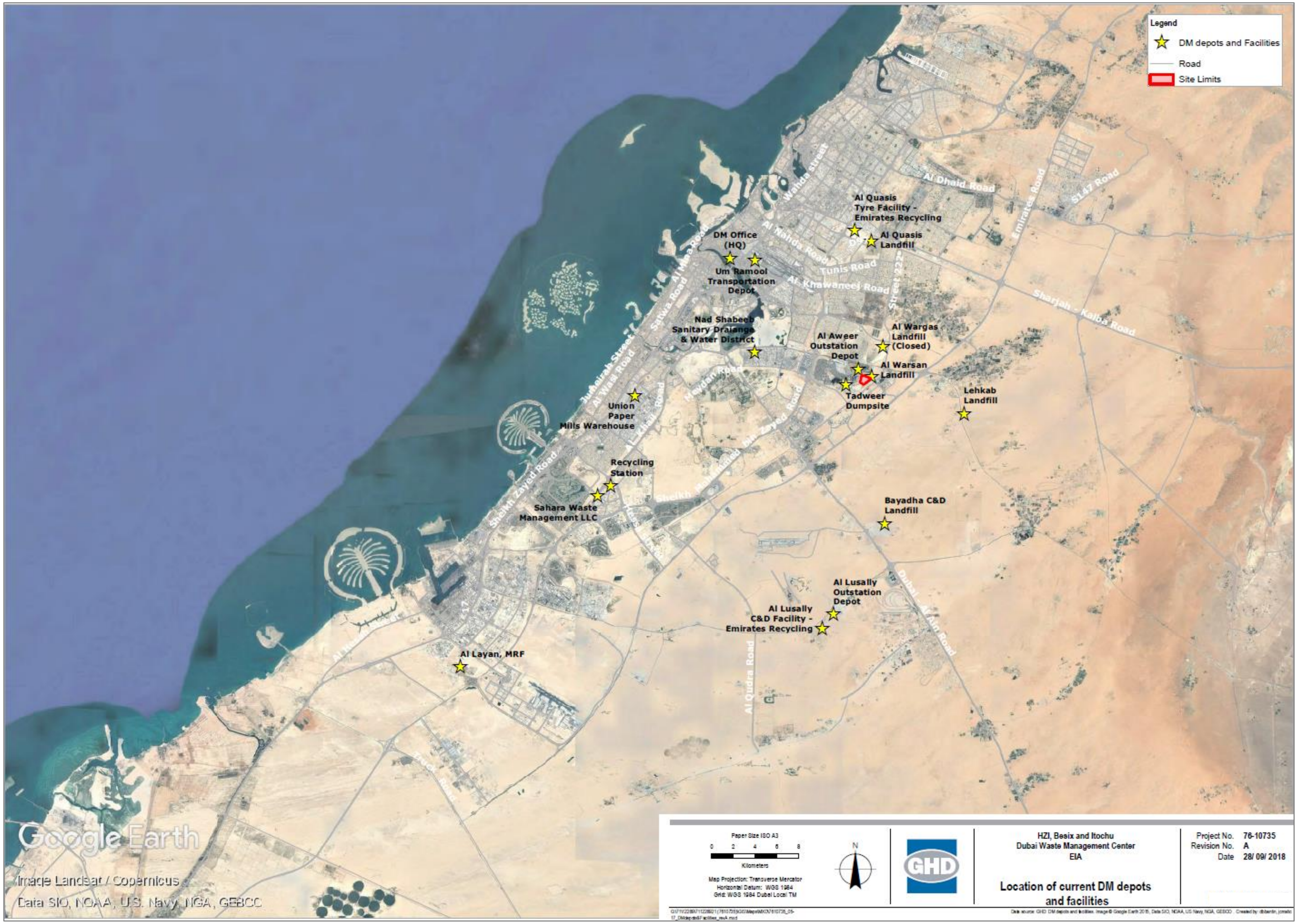


Figure 5-35 Location of current DM depots and facilities

Souce: Mott MacDonald, 2013

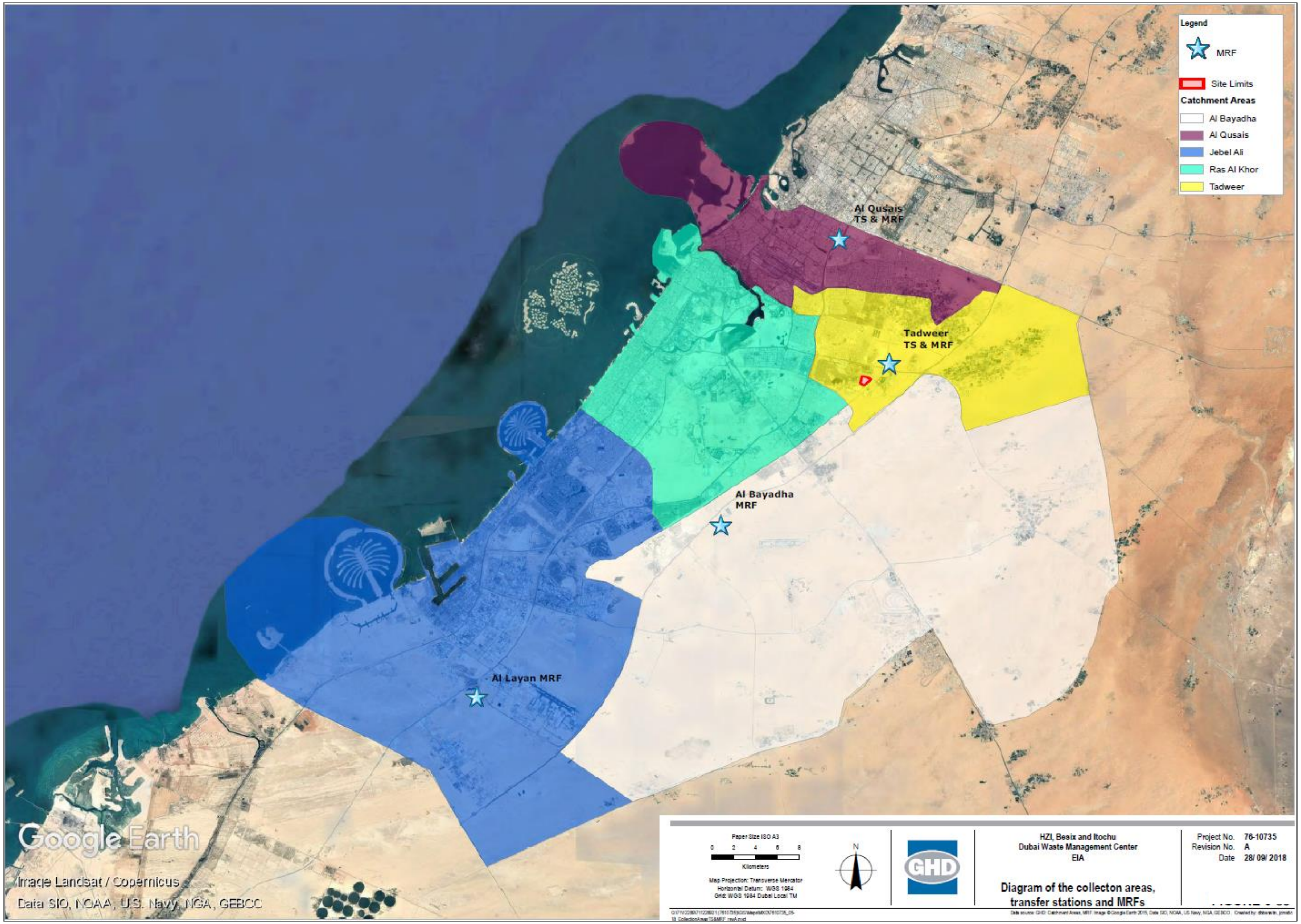


Figure 5-36 Diagram of the collection areas, and the transfer stations and MRFs

Souce: Mott MacDonald, 2013

5.9.2 Projections of Waste Diversion to WtE plant

Relative to the Project, anticipated inputs to the proposed WtE Plant are anticipated to primarily include Domestic and/or C&D waste. It is envisaged, in line with the integrated waste management plan, that alternative recycling or dispoal options will be continued for the management of other waste streams.

As is typical with most municipalities, it would not be realistic to assume 100-percent capture and recovery of all the suitable waste to the proposed WtE plant, so some assumptions are made relative to waste inputs and variability over time. Waste generation data was compiled by HZI and provided to GHD, including a projection for future years through 2030. While there are a variety of factors influencing waste generation, a percentage based increase was assumed.

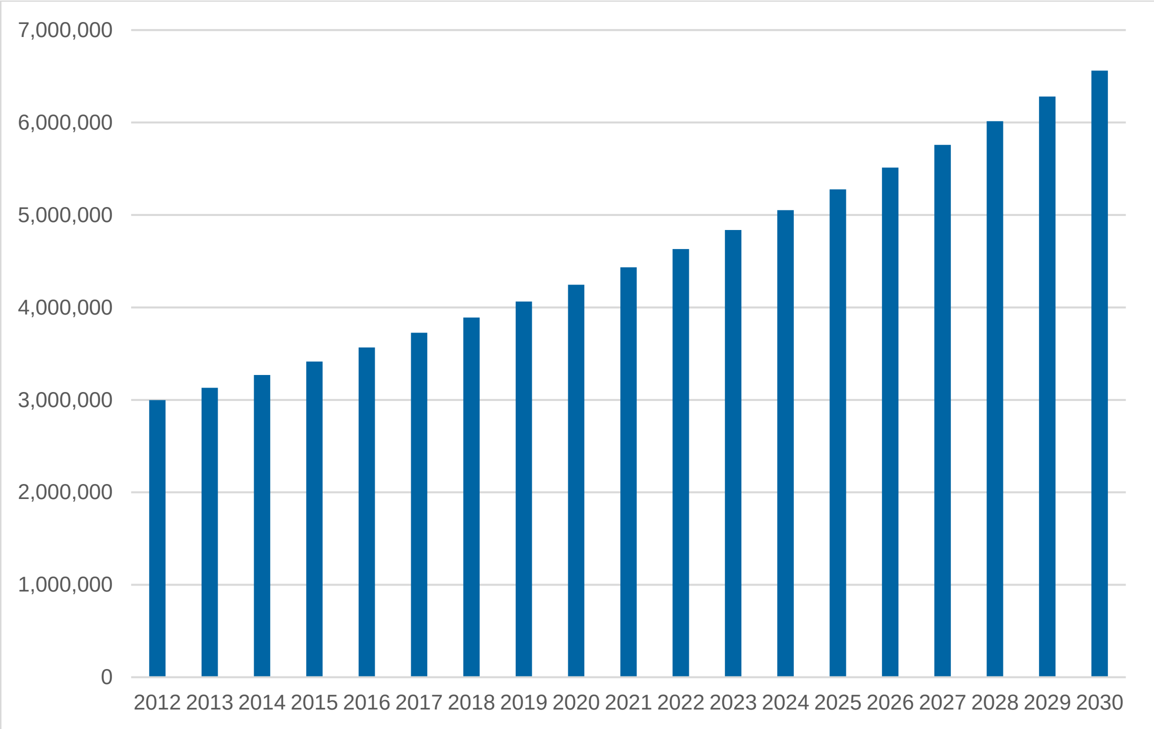


Figure 5-37 Annual Projected MSW Generation (Tonnes)

Source: Hitachi Zosen Inova (HZI)

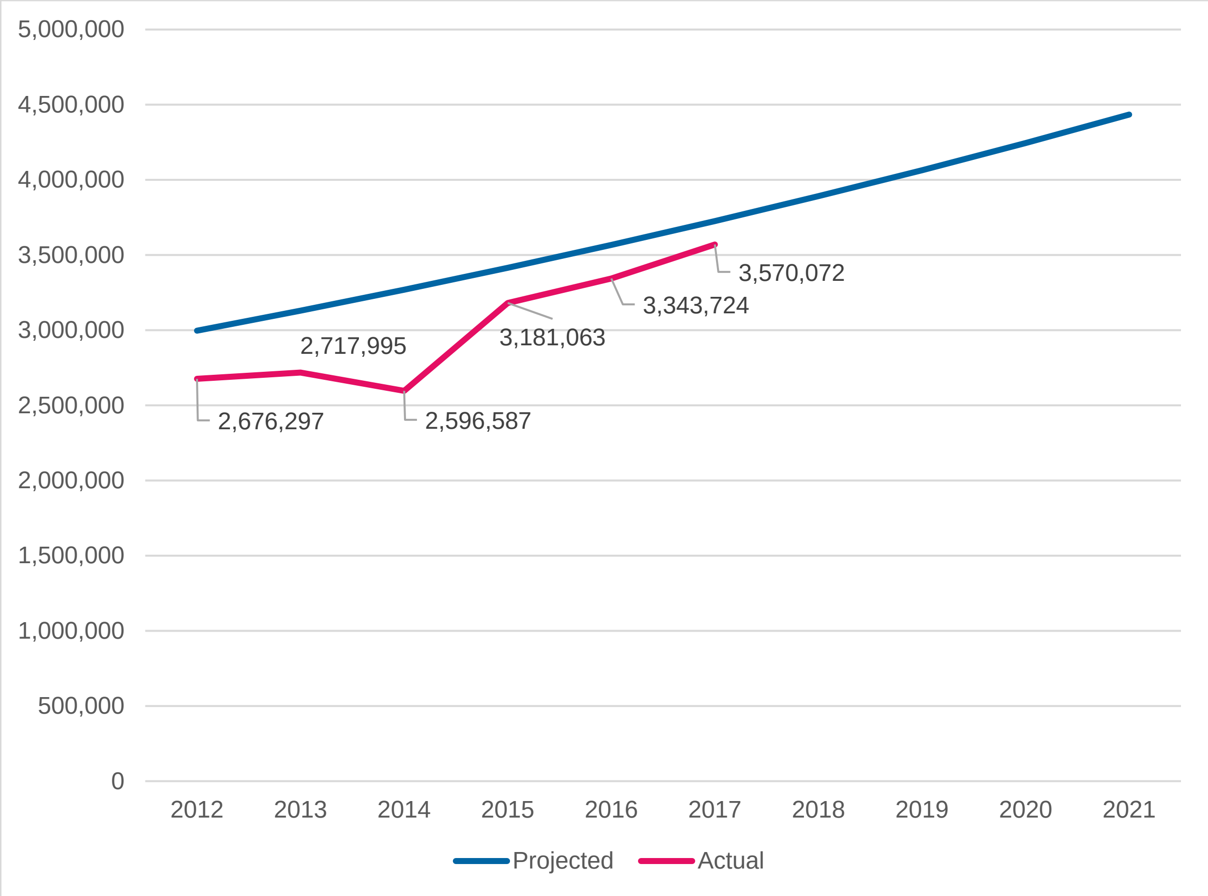


Figure 5-38 MSW Generation (Projected vs Actual) (Tonnes)

Source: Hitachi Zosen Inova (HZI)

5.9.3 Waste Generation for Project (Construction and Operation)

Consistent with the IFC requirements and regulations in Dubai, waste minimization is a top priority for the Project. In practicality, however, there will be waste generated from both construction and operational phases of the project. As a significant infrastructure development, waste management remains a necessary environmental requirement, and, therefore, an understanding of estimated generation rates is important to characterizing potential environmental impacts and necessary mitigation measures and waste management strategies.

This section identifies the Project's waste generation for both Construction and Operation phases.

5.9.3.1 Construction Waste

In reference to the Strategic Integrated Plan for Solid Waste (Master plan) prepared for Dubai Municipality WMD by Mott MacDonald (May 2013), the approximate tonnes of C&D generated per 1 million AED spent is about 500 tonnes. This can be used as a benchmark for the total construction waste estimated to be generated from the project. However, as fabrication of the technology will be completed off-site, there may be less waste attributed to this project than per typical construction projects in the property and buildings development market.

Solid Waste

Solid wastes generated during construction include:

- Spoil from site clearing activities
- Vegetative waste from site clearing actitivites

- Food waste
- Timber waste
- Concrete and cement waste
- Plastic waste (e.g. packaging)
- Scrap metals
- Paper products (cardboard, or other packaging)
- General refuse consisting of office waste, garbage, etc.

These types of wastes are generally easy to manage, with a large component that can potentially be reused or recycled. There are existing waste management services and facilities in Dubai that will be considered for managing construction waste generated by the Project.

Liquid Waste / Effluent

Liquid wastes generated during construction include:

- Domestic sewage
- Equipment and vehicle washdown (e.g. concrete / cement trucks)

The construction workforce is expected to be comprise between 850 to 2000 workers typically, and exceeding 2,000 workers during periods of peak construction**.** An approved service provider will collect sewage from the portable toilets for offsite disposal.

Hazardous Waste

Hazardous wastes generated during construction include:

- Paint
- Oil, fuel and grease
- Batteries
- Light bulbs
- Chemical waste (e.g. adhesives)
- Containers of hazardous materials
- Industrial wastes

5.9.3.2 Operation Waste

During operations, domestic waste produced will be incorporated as MSW inputs (feedstock) to the WtE Plant. Management of residuals (incinerated bottom ash and flue gas treatment residuals); however, is an important consideration.

Solid Waste

Solid wastes generated during the operation phase include:

- Food waste
- Office waste
- General refuse

Solid wastes that will be generated by the Project consist mainly of domestic wastes such as food, papers and other residual wastes from office operation. Solid wastes generated by the WtE plant and its associated facilities shall be segregated into hazardous and non-hazardous wastes. Non-hazardous solid wastes shall be further classified as compostable, recyclable and residual waste and shall be managed as appropriate. The WtE plant operator will be responsible for managing waste to appropriate disposal or recycling facilities.

Liquid Waste / Effluent

Liquid wastes generated during operations include:

- Domestic sewage (operation workforce is expected to be approximately 129 staff and workers)
- Plant area surface water

Wastewater will be generated from the WtE plant's use of water for cooling and domestic purposes. Industrial wastewater generated from the plant site will be treated through the existing industrial wastewater treatment plant while the domestic wastewater will be treated through the domestic wastewater treatment facility.

Incineration Bottom Ash (IBA)

Incinerator Bottom Ash (IBA) is residue left behind in a WtE incinerator and typically about 20 to 30% of the input waste.[21] World Bank 1999 report for Municipal Solid Waste Incineration (World Bank Technical Guidance Report) states that the main components of IBA include metals, glass, and mineral constituents of the waste, but some salts—in particular, sodium chloride (NaCl). World Bank also states that the most common disposal method is landfilling, and pre-treatment can be completed via washing or sorting processes.[22]

The appearance of bottom ash is typically a mix of very fine grey porous material, inert components such as fine gravel, rocks, glass, ceramics and metallic items (ISWA, 2015). In most global context, IBA is defined as non-hazardous material, and beneficial reuses are pursued for recycling of IBA as road aggregates, or similar recycling strategy. Sometimes, however, IBA material is disposed to landfill either due to its chemical composition or a lack of appropriate recycling options.

A 2006 report by the ISWA Working Group Thermal Treatment provided a review of IBA across ISWA countries, including Denmark, France, Germany and the Netherlands. This report highlights that, "more and more consideration is given to recycling and reuse of residues for construction purposes" and in 2006, about 11 million tonnes of IBA was produced within 11 European countries. Legislation regarding the utilization of bottom ash, however, varies throughout these countries in the EU, USA and Canada.

In some international jurisdictions there are specifications placed on the ash quality or certification of IBA for reuse.[23] From Table 1.2 of the 2006 report by ISWA-WGTT, the following major chemical constituents are typically found in IBA, and there is noted presence of calcium and other salts, sometimes in relatively high concentrations.

[21] Hitachi Zosen Inova, Re-Use of IBA aggregates in the UK, Draft
[22] World Bank Technical Guidance Report for Municipal Solid Waste Incineration. The World Bank, Washington, D.C. USA (1999).
[23] International Solid Waste Association Working Group Thermal Treatment, Subgroup Bottom Ash from WTE-Plants (ISWA-WGTT, 2006). Management of Bottom Ash from WTE Plants: An overview of management options and treatment methods.

Table 5-43 Major Chemical Constituents Present in MSW Combustor Ash (ISWA-WGTT, 2006)

Parameter	Example IBA percentage range
Silicum	16.8 – 27.4
Calcium	5.12 – 10.3
Iron	2.11 – 11.5
Magnesium	0.19 – 1.18
Potassium	0.72 – 1.16
Aluminium	3.44 – 6.48
Sodium	2.02 – 4.80

In general, relative to the reuse of IBA, proper legislation for reuse criteria applies in most developed countries, and in Western European context specifically, it is common for regulations to reference leaching limit values relative to the classification of IBA. In the case of Dubai, there does not (yet) exist a standard for the reuse and recycling of IBA material, but there are laws for waste management and disposal, including a series of Technical Guidelines (TGs) published by the Waste Management Department. Relevant to the management of IBA, recycling or disposal will need to comply with the applicable TGs.

Specifically, for the Project, approximately 282,269 t/a of mineral aggregates are expected to be produced out of the IBA treatment and potentially temporarily stored on site in stockpiles if not straight away transported off site. The covered IBA maturation area is approximately 20,000 m^2 (refer to Section 4.5, Figure 4-5-BS13-D). Depending on the bottom ash composition, settling and leaching processes in the maturation area can take up to 12 weeks. Estimated moisture content is 14% depending on the actual moisture content of the input material, losses during treatment, natural evaporation and moistening of the aggregates for dust suppression) and estimated bulk density is 1400 kg/m^3.[24]

On-site IBA management is provided in Section 4.7.7.1.

Flue gas treatment residue (hazardous waste)

FGT residue will be temporarily stored in silos. A total of five FGT silos are foreseen for the Project. Each silo has a capacity of approximately 350 m^3, corresponding to approximately four days storage capacity.

5.9.3.3 Decommissioning Waste

Wastes generated during decommissioning will include:

- Food waste
- Solid waste
- Demolition waste
- Wastewater (sewage)
- Hazardous waste

[24] All this can only be an estimate as it strongly depends on the actual waste composition and subsequent IBA treatment process.

5.9.3.4 *Summary of Waste Generated*

Wastes produced during the construction, operation and decommissioning phases of the Project and their respective estimated quantities are summarised in Table 5-44.

Table 5-44 Summary of Waste Generated

Waste Stream	Estimated Quantity
Construction	
Food waste	30 to 75 kg/day
Solid waste	30 to 75 kg/day
Wastewater (sewage)	125 to 200 m^3/day
Mixed waste	11,520 m^3 during the entire construction period
Metals and steel (including pipes)	HZI: 7525 m^3 during the entire construction period Besix: 3600 tonnes for the entire construction period (estimated reinforcement is 18,000 tonnes with 2% wastage) Besix: Estimated wastage of 4% from MEP
Concrete	Besix: 22,000 m^3 for the entire construction period (estimated 110,000 m^3 of concrete will be used with 2% wastage)
Wood / Timber / Plywood	HZI: 5,635 m^3 during the entire construction period Besix: 980 m^3
Paper	Besix: 20 to 30 kg/day
Plastic	HZI: 1250 m^3 during the entire construction period
Hazardous waste	HZI: 10 to 15 tonnes per year
Operation	
Food waste (from offices and labour accommodation)[1]	Up to 60 kg/day
Solid waste (from site offices and labour accommodation)	Up to 120 kg/day
Wastewater (sewage)[2]	70 m^3/ day to 103 m^3/ day
Oil drums	50 m^3/year to 320 m^3/year
Incineration bottom ash (IBA) (non-hazardous waste)	39,950 kg/h bottom ash from wet extractor at LPN, total for five lines 282,269 t/a mineralic aggregates to be produces after pre-treatment, processing and maturation
Boiler ash (non-hazardous)	985 kg/h at LPN, total for five lines

Waste Stream	Estimated Quantity
Flue gas treatment residue, including fly ash (hazardous waste)	63 t/day per incineration line 310 t/day per five incineration line
Process water and soft water	No wastewater generated by WtE plant process
Decommissioning	
Food waste	20 kg/day
Solid waste	15 kg/day
Wastewater (sewage) [4]	Unknown (to be confirmed prior to decommissioning)
Demolition waste [4]	Unknown (to be confirmed prior to decommissioning)
Hazardous wastes [4]	Unknown (to be confirmed prior to decommissioning)

Notes:

1. Based on World Bank figures for average waste generated per capita per day in MENA, with 120 employees present 24 h/day and 9 employees working in day shift only
2. First value valid during 265 days/year (only 129 own permanent employees), second value valid during remaining 100 days per year for line overhaul outages occurring sequentially (on the average with an extra 120 external workers; each overhaul lasts 20 days; there are 5 lines)
3. Requires more time for realistic estimates of waste streams for decommissioning steel, concrete, manpower estimates, etc.
4. To be confirmed during the decommissioning phase. A waste manifest will be prepared to be submitted to DM.

5.10 Land Use and Visual Amenity

5.10.1 Land Use

According to DM Planning Department (2012), the Project site is categorized under Area 2 (Figure 5-39). Area 2 (Metropolitan Area) comprise areas where on-going, on-hold or deferred mega projects are planned. As detailed in Dubai 2020 Urban Masterplan (DM Planning Department, 2012), the Project site is classified under ‘*land for future development subject to environmental investigations and detail studies*’ (Figure 5-40). Based on existing land use (refer to Section 4.3.1 Figure 4-3), the majority of the areas adjacent the Project site are industrial and commercial facilities. A number of residential, institutional and resource/attraction areas are also found surrounding the Project site. The nearest residential and resource / attraction areas are found around 300 m north of the site. A detailed discussion on surrounding land uses is provided in Chapter 4.

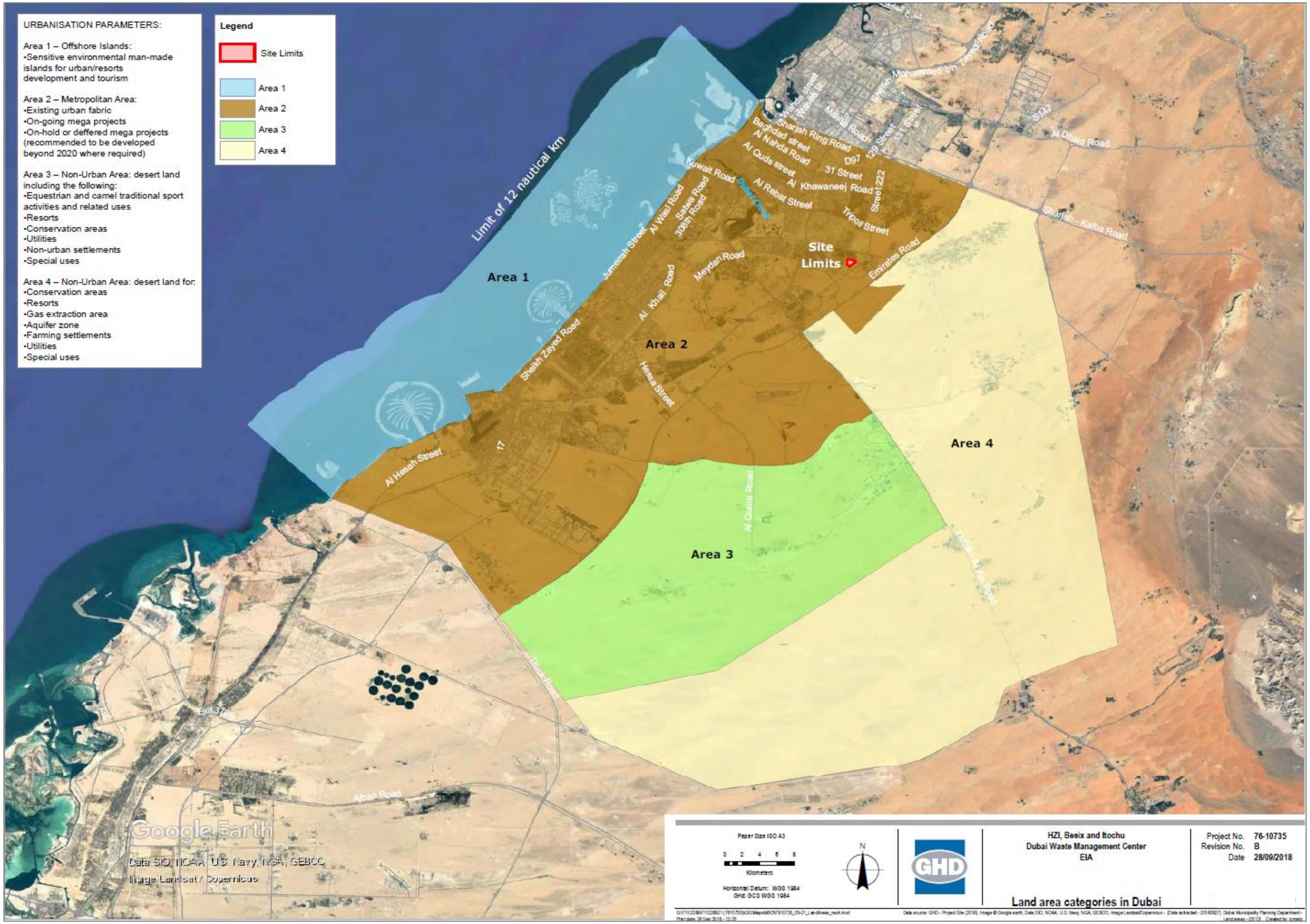


Figure 5-39 Land area categories in Dubai

Source: Dubai Municipality Planning Department, 2012

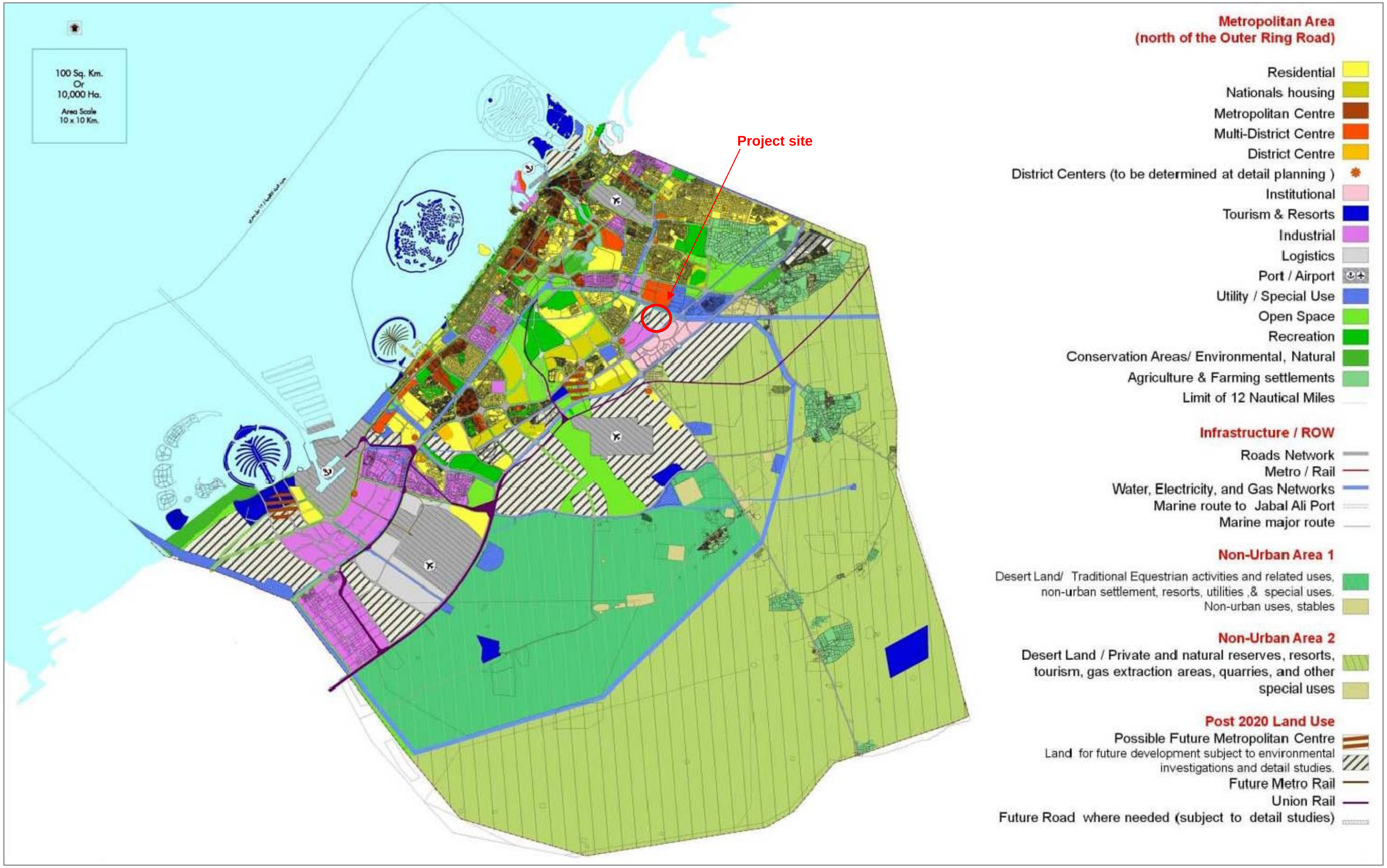


Figure 5-40 Dubai 2020 Urban Masterplan

Source: Dubai Municipality Planning Department, 2012

5.10.2 Protected Areas

The protected areas in Dubai are provided in Table 5-45 and shown in Figure 5-41. The nearest protected area is the Al Wohoosh Desert Conservation Reserve located approximately 20 km east of the site.

Table 5-45 Location of protected areas from the proposed WtE plant

Protected areas	Type	Distance from the proposed WtE plant	Location relative to the proposed WtE plant
Hatta Mountain Conservation Area	Terrestrial / Mountain	80 km	Southeast
Jabal Nazwa Conservation Reserve	Terrestrial / Mountain	30 km	Southeast
Dubai Desert Conservation Reserve	Terrestrial / Desert	42 km	Southeast
Al Wohoosh Desert Conservation Reserve	Terrestrial / Desert	20 km	East
Al Marmoum Conservation Reserve	Terrestrial / Desert	42 km	South
Ghaf Nazwa Conservation Reserve	Terrestrial / Desert	31 km	Southeast
Jabal Ali Marine Sanctuary	Marine / Coastal	53 km	Southwest

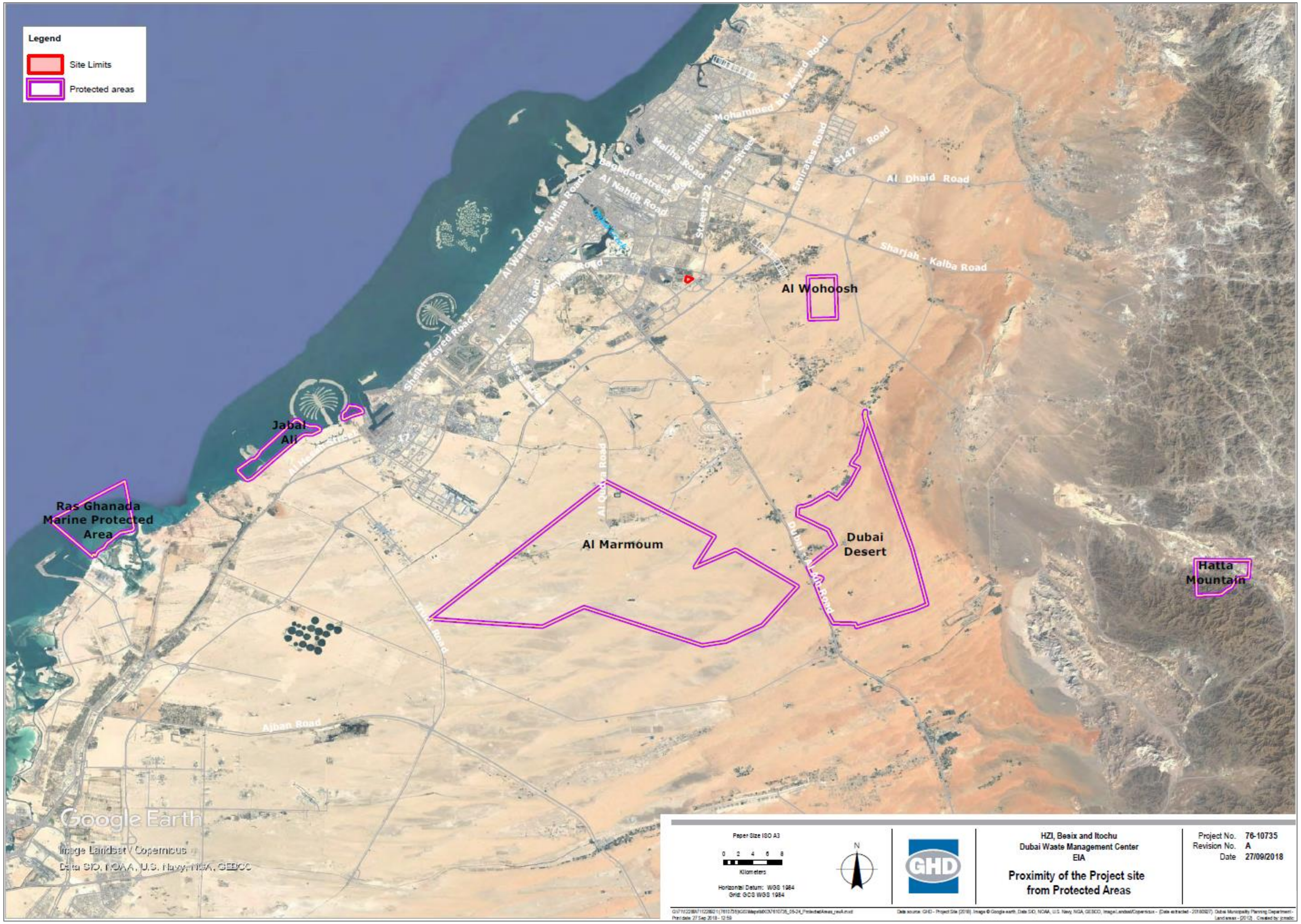


Figure 5-41 Proximity of the Project site from Protected Areas

5.10.3 Existing Conditions

The existing site is operational as a vehicle storage area, and surrounding areas comprise industrial uses and there are no identified sensitive receptors within the existing site footprint. There are no existing buildings or structures within the existing Project footprint. Some vegetation are found within the site – these are discuseed in Section 5.5.3.

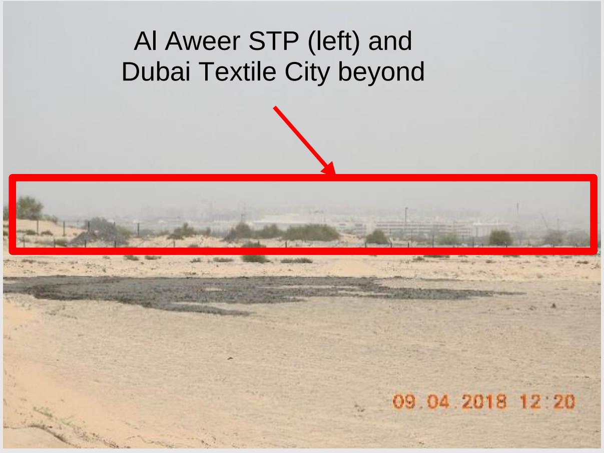
Furthermore, the design of the WtE plant is seeking to remain consistent with the industrial conditions prevalent at the adjacent sites. A site walkthrough was undertaken at the site to assess the existing land uses around the project site. The image below (Figure 5-42) shows an elevation view of the existing site conditions taken in March 2018 during an aerial survey via drone that was completed by BESIX, and Figure 5-43 and Table 5-46 includes photos showing the general "view shed" surrounding the project site.

Figure 5-42 View of the existing site conditions

Figure 5-43 View shed surrounding the Project site

Table 5-46 View shed surrounding the Project site

Direction	Vew Shed (Photographic Representation)	Observations
Northerly facing viewshed (existing conditions)	 Photo taken (zoomed in) towards the suspected residential areas at the Dubai Polo Club, about 300 to 400 m from the proposed WtE plant facility.	A roadway borders the site to the north, so there is about 300 to 400 m of separation from the proposed plant to the residential area. Residential view shed (at the southern edge) will face the proposed WtE plant.
Southerly facing viewshed (existing conditions)	 Photo taken facing generally south, power plant stacks are visible in distance.	Generally southerly facing view (in background), showing existing power plant stacks beyond the site limits.
Easterly facing viewshed (existing conditions)		Generally easterly facing view, industrial sites beyond the project site, showing the existing paved parking area in the foreground.

Direction	Vew Shed (Photographic Representation)	Observations
Westerly facing viewshed (existing conditions)		Generally westerly facing view, showing Dubai Textle City beyond and Al Aweer STP to the left of the photo, sludge disposal area shown in foreground (Note that this photo is taken from top of berm, and western berm will hide the proposed facilities with exception of taller building walls and/or stack.)

5.11 Socio-Economics, Culture and Health

5.11.1 Socio-Economic Factors

5.11.1.1 Population and Demography

In 2017, the population of the Emirate of Dubai was approximately 2.97 million (Dubai Statistics Center, 2017). Around 91.76% of the population comprises expatriates while the remaining 8.23% are Emiratis. The active day population comprises tourists, sailors, temporary residents and persons working in Dubai but living outside the city.

The Project site is located in Warsan

2, Dubai (Sector 5), which had a population of 764 at the end of 2017. The annual population growth rate in Dubai from 2013 to 2015 was recorded at 5%, which indicated a decrease from the annual growth rate of 7% recorded between 2009 and 2010 (DED, 2016).

Based on data provided by Dubai Statistics Center (2016), the population in Dubai has the following associated demographics:

- At the end of 2017, Dubai's population consisted predominantly of males (70.18%). This is attributed to an influx of foreign workers consisting mostly of working-age males who are not accompanied by their family members;
- About 58.46% (1,740,053) of the population is concentrated in the 25–44 age bracket, where the 30–34 age group has the highest number of individuals representing 17.91% of the total population;
- The total dependency ratio in 2017 was 19%, which indicates that less than a quarter of the population in the Emirate comprise of children (aged under 15 years) or adults over 65 years;
- The Project site is part of Warsan 2, Sector 5 of Dubai, which had a reported population of 764 in 2017 equivalent to 0.02% of Dubai's population; and
- The estimated number of active individuals during peak hours (day) in Dubai is 4.1 million individuals, which is attributed to additional 1.186 million workers residing outside Dubai and temporary residents who move to Dubai during daytime for economic reasons.

A breakdown of socio-economic indicators in the Emirate of Dubai for the years 2013 to 2016 (DSC, 2016) is provided in Table 5-47. Economic indicators show that the majority of the workforce is male, while the education indicator shows a very high literacy rate and good health and living condition indicators.

Table 5-47 Socio-demographic indicators in the Emirate of Dubai

Indicators	2013	2014	2015	2016	2017
Demography (numbers)					
Males (population by thousands)	1579.1	1613.2	1703.4	1888.5	2088.8
Females (population by thousands)	634.7	714.2	743.3	810.0	887.6
Educational indicators (percentage)					
Literacy rate (15 years and above)	97.3	97.4	97.4	NA	NA
Illiteracy rate for males (15 years and above)	2.7	2.7	2.8	NA	NA
Illiteracy rate for females (15 years and above)	2.5	2.5	2.4	NA	NA
Economic indicators (percentage)					
Unemployment rate for males	0.2	0.2	0.2	0.2	0.3
Unemployment rate for females	0.8	0.8	0.9	1.2	1.5

Source: DSC, 2017

Note: NA – Not available

5.11.1.2 Gross Domestic Product (GDP)

The Dubai Economic Profile (Department of Economic Development – Dubai (DED) 2016) shows that the Emirate of Dubai accounts for 30% of the UAE's total GDP. Since 2014, Dubai's GDP increased by 0.3% resulting in a growth rate of 4.1% in 2015 (DED, 2016). In 2016, the real GDP growth rate was 2.9% as opposed to 4.1% in 2015 (DED, 2017) (Table 5-48). Stimulant policies applied by the Federal Government and the Government of Dubai contributed in boosting the economy, and hence, the continuation of growth in all sectors (DED, 2017).

Table 5-48 Dubai GDP Growth Rate

Unit	2010	2011	2012	2013	2014	2015	2016	2017*
Annual growth, %	3.5	3.0	4.1	4.6	3.8	4.1	2.9	3.1

Source: Dubai Statistics Center as cited in DED, 2017

* Forecast: Dubai Economy

In 2016, the wholesale, retail and repairing services sector (27.6%) has been contributing the most to Dubai's GDP followed by transport sector (11.6%), financial activities (10.6%), while real estate and construction added 6.6% and 6.4%, respectively (Table 5-49) (DED, 2017).

Table 5-49 Dubai's GDP Structure

Sectors	2015	2016
Wholesale and Retail Trade	27.9	27.5
Manufacturing	9.4	9.5
Transport and Storage	11.4	11.6
Real Estate	6.4	6.6
Finance and Insurance	10.8	10.6
Construction	6.7	6.4
Accommodation and food	4.7	5.1
Others	22.7	22.7

Source: Dubai Economic Profile 2017

UAE Interact (2015) reported that the UAE government plans to increase the contribution of the non-oil sector to 80% of the nation's GDP from the present figure of 70% in the next 10 to 15 years. The government has a policy of economic diversification to reduce dependence on oil reveue to the overall GDP of the country (UAE Interact, 2015).

The economic structure is further broken down by activity area in Table 5-50. This shows that the arts, entertainment and recreation sector only contributed 0.2% of economic activity in 2015 and construction activities contributed 6.8% of activity.

Table 5-50 Economic activity area

Economic Activity	Growth Rate (%)	2015		2014	
		Percentage Contribution	Value (Mill AED)	Percentage Contribution	Value (Mill AED)
Agriculture, forestry and fishing	3.0	0.1	475	0.1	461
Mining and quarrying	-3.0	1.8	6,699	2.0	6,904
Manufacturing	3.4	9.8	36,019	9.9	34,845
Electricity, gas, steam and air conditioning supply	5.7	2.4	8,882	2.4	8,406
Water supply; sewerage, waste management and remediation activities	2.1	0.0	103	0.0	101
Construction	0.9	6.8	24,925	7.0	24,698
Wholesale and retail trade; repair of motor	4.9	27.9	101,941	27.7	97,141

Economic Activity	Growth Rate (%)	2015		2014	
		Percentage Contribution	Value (Mill AED)	Percentage Contribution	Value (Mill AED)
vehicles and motorcycles					
Transportation and storage	5.1	11.8	43,191	11.7	41,098
Accommodation and food service activities	8.0	4.4	16,150	4.3	14,949
Information and communication	5.2	3.9	14,100	3.8	13,408
Financial and insurance activities	3.7	10.8	39,648	10.9	38,248
Real estate activities	3.5	6.3	23,106	6.4	22,327
Professional, scientific and technical activities	2.3	3.3	12,172	3.4	11,903
Administrative and support service activities	-0.3	2.5	9,187	2.6	9,219
Public administration and defence; compulsory social security	4.3	5.2	18,967	5.2	18,188
Education	9.5	0.6	2,302	0.6	2,101
Human health and social work activities	9.7	1.0	3,670	1.0	3,344
Arts, entertainment and recreation	7.3	0.2	820	0.2	764

Source: Dubai Statistics Center 2015

The Project is included within the electricity and gas sector. The electricity and gas sector has made much progress in recent years, reaching an output (in constant prices) of AED9.3 billion in 2016, and a growth rate of 4.6% compared to 2015 (DED, 2017). Employment in the electricity sector increased by around 19% between 2010 the 2015 as a result of the increasing demand for electricity and gas due to population growth and from rising demand from the industrial, real estate and tourism sectors (DED 2017).

5.11.2 Archaeological and Heritage Resources

The proposed WtE plant will be located in a disturbed environment surrounded by industrial and commercial (i.e. warehouse and stores) facilities.

The archaeological and heritage sites in the Emirate of Dubai are listed in Table 5-51 and and their locations shown in Figure 5-44. All the archaeological and cultural resources identified by the Government of Dubai, represented by Dubai Culture, are considerably distant (more than 18 km) from the proposed WtE plant and are not anticipated to be affected during the construction and operation of the Project.

Table 5-51 Archaeological and heritage resources in Dubai

Archaeological and Cultural sites	Location from the site	Approximate distance from the WtE Plant
Archaeological sites		
Saruq Al-Hadid Archaeological Site	South	55.0 km
Jumeirah Archaeological Site	West	20.70 km
Heritage sites		
Heritage House	Northwest	19.10 km
Traditional Architectural Museum	Northwest	19.60 km
Diving Village	Northwest	19.45 km
Sheikh Saeed Al Maktoum House	Northwest	19.45 km
Majilis Ghorfat Umm Al Sherif	West	21.57 km
Jumaa and Obaid Bin Thani House	Northwest	19.39 km
Hatta Heritage Village	Southeast	79.27 km
Heritage Village	Northwest	19.79 km
Al Fahidi Historical Neighbourhood	Northwest	18.31 km
Al Ahmadiya School	Northwest	19.04 km

Sources: Dubai Culture, 2017; Dubai Tourism (2018)

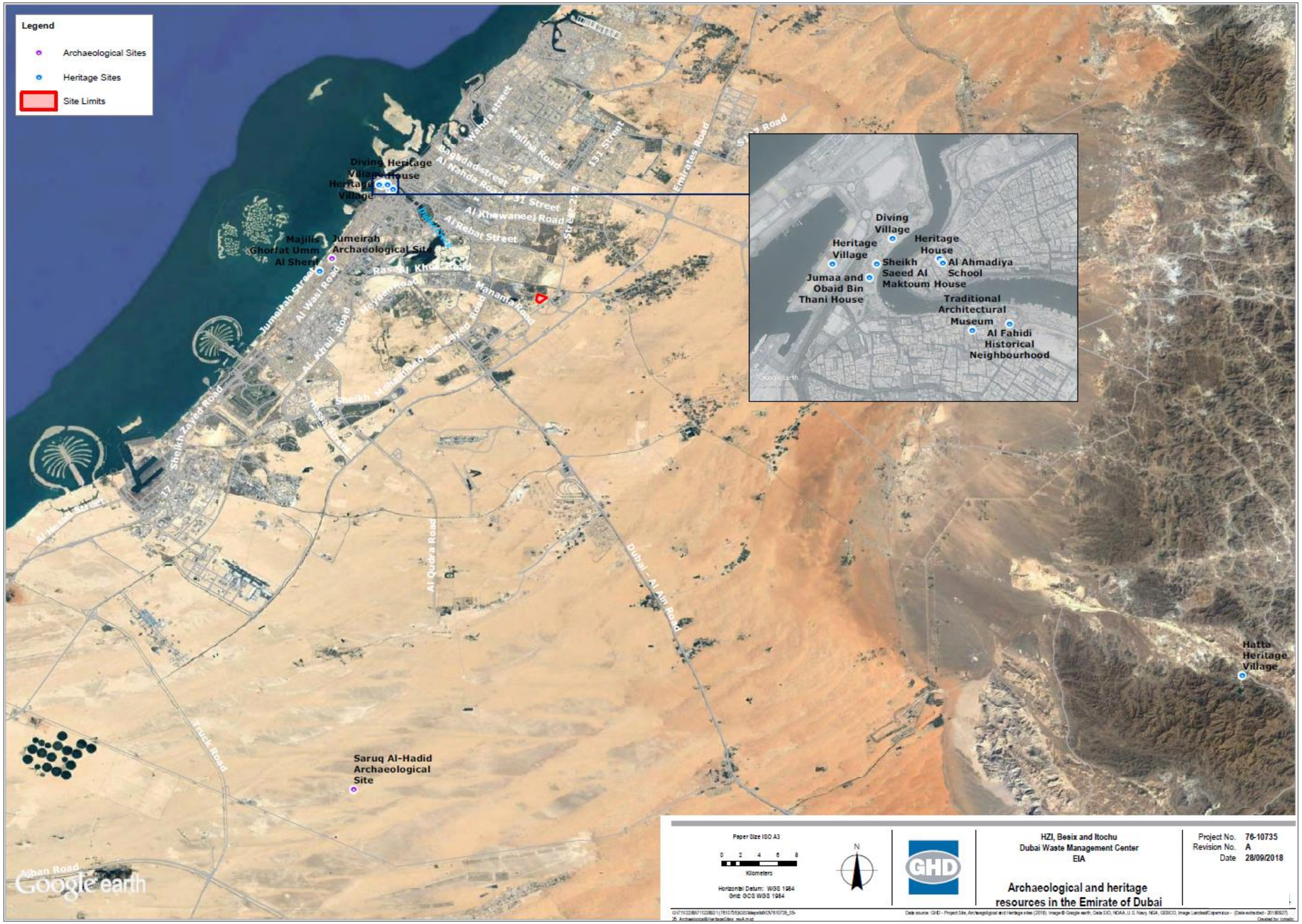


Figure 5-44 Archaeological and heritage resources in the Emirate of Dubai

5.11.3 Public Health

Health indicators (Table 5-52) show a very good health and living conditions are experienced in the Emirate of Dubai. Based on the records of Dubai Health Authority (cited in DSC, 2016), the leading causes of morbidity in 2016 was chickenpox (38%) followed by pneumonia (12%) (Table 5-53).

Table 5-52 Health indicators in the Emirate of Dubai

Indicators	2013	2014	2015
Health indicators			
Average number of doctors per 1000 population (excluding administrators)	3.7	3.0	3.6
Average number of beds per 1000 population	1.8	1.8	2.0
Number of hospitals	31	33	35
Living conditions			
% of households with access to potable water	100	100	100
% of households with access to electricity	100	100	100
% of households with access to sanitation facilities	100	100	100

Source: DSC, 2016

Table 5-53 Leading causes of morbidity in the Emirate of Dubai (2016)

Disease	Nationality					
	Emirati		Non- Emirati		Grand Total	
	Number	%	Number	%	Number	%
Chickenpox	434	43	3,642	37	4,076	38
Pneumonia	130	13	1,154	12	1,284	12
Viral hepatitis (B)	39	4	801	8	840	8
Malaria	0	0	826	8	826	8
Viral hepatitis (C)	125	12	544	6	669	6
Pulmonary tuberculosis	26	3	622	6	648	6
Herpes zoster	39	4	554	6	593	5
Typhoid and para Typhoid	7	1	238	2	245	2
Mumps	21	2	153	2	174	2

Disease	Nationality					
	Emirati		Non- Emirati		Grand Total	
	Number	%	Number	%	Number	%
Viral hepatitis (A)	0	0	0	0	0	0
HIV / AIDS	0	0	0	0	0	0
Other	181	18	1,253	13	1,434	13
Total	1,002	9	9,787	91	10,789	100

Source: DSC, 2016

6. Assessment of Environmental Impacts

6.1 Introduction

This section identifies and evaluates the environmental and social impacts of construction and operation of the proposed Project. The assessment of the impacts was based on the Project information provided by the Proponent and EPC (Section 4) and the baseline conditions of the Project site and its vicinity (Section 5).

The identification and assessment of impacts was performced through a process comprising on-site observations, field surveys for acquiring quantitative baseline data, literature review, consultation with DM and experience from similar projects. In addition, quantitative air, noise and odour modelling was carried out for the operational phase of the Project.

The degree of impact was classified into five levels (Extreme, High, Medium, Low and Negligible as per the methodology provided in Section 2.3.2), documented in this section along with the impacts parties and nature of the impact (i.e. beneficial/positive or adverse/negative impact).

Where negative impacts are identified, mitigation measures are discussed to avoid or minimise the impact to an acceptable level (Section 7).

The following aspects were examined for the potential impacts, detailed in the corresponding subsections of this section:

- Greenhouse gas assessment
- Air quality
- Noise
- Geology, Soil and Groundwater
- Biodiversity and Conservation
- Access, Traffic and Transport
- Water and Energy Resources
- Waste
- Land Use and Visual Amenity
- Socio-economic, Culture and Health

6.2 Greenhouse Gas Assessment

6.2.1 Scope of Work

This scope of work includes a quantitative greenhouse gas (GHG) emissions assessment for the Waste to Energy (WtE plant) plant. The assessment considers emissions from the following sources:

- Construction
  - Fuel and electricity consumption
  - Construction personnel commuting
  - Freight of construction materials and waste
  - Disposal of construction waste
- Operation
  - Energy (fuel and electricity) consumption during operation of the WtE plant:
    - Backup generators
    - Diesel used during start-up and shut-down
    - Ancillary and own electricity use
  - Combustion of feedstock
  - Sulphur hexafluoride in electrical equipment

- Employee commuting
- Transport of feedstock to the WtE plant
- Disposal of residual WtE plant process by-products

- Avoided emissions
  - Landfill methane emissions (avoidance of wastes disposed to landfill)
  - Electricity displacement (generation of electricity from non-fossil fuel sources)

6.2.2 International Standards

The GHG emissions assessment considered the following key international standards and guidelines:

- Equator Principles
- International Finance Corporation (IFC) Performance Standards on Environmental and Social Sustainability
- World Bank Group Environmental, Health and Safety Guidelines

These standards require that Scope 1 and Scope 2 emissions be quantified annually where a project produces more than 25,000 tonnes of CO_2-equivalent GHG emissions annually.

Where Scope 1 and Scope 2 emissions are expected to be more than 100,000 tonnes of CO_2 equivalent (CO_2-e) annually, an alternatives analysis would need to be conducted to evaluate less GHG intensive alternatives.

Public reporting requirements would be triggered by GHG emissions greater than 100,000 tonnes of CO_2-e during the operational phase of the project.

6.2.3 Methodology

The GHG emissions assessment was prepared to satisfy the requirements of the guidelines listed above. The guidelines do not recommend any particular standard, methodology or protocol for the GHG assessment. This assessment has been undertaken in accordance with the general principles of:

- 2006 International Panel on Climate Change (IPCC) Guidelines for National Greenhouse Gas Inventories; and
- *Greenhouse Gas Protocol: A Corporate Accounting and Reporting Standard* (Revised Edition) developed by the World Business Council for Sustainable Development and the World Resources Institute (GHG Protocol).

These are considered representative of good international practice in GHG accounting.

6.2.3.1 Greenhouse gases considered

The greenhouse gases considered in this assessment and the corresponding global warming potential (GWP) for each GHG are listed in Table 6-1. The GWPs from the IPCC Fourth Assessment report were used in this assessment for consistency with the IPCC guidelines.

Table 6-1 Greenhouse gases and 100 year global warming potentials

Greenhouse gas	Global warming potential
Carbon dioxide (CO_2)	1
Methane (CH_4)	25

Greenhouse gas	Global warming potential
Nitrous oxide (N_2O)	298
Sulphur hexafluoride (SF_6)	22,800

6.2.3.2 Emission scopes

Emissions have been separated into Scope 1 and 2 in accordance with the GHG Protocol. These scopes are defined as follows:

- Scope 1 emissions are GHG emissions created directly by a person or business from sources that are owned or controlled by that person or business.
- Scope 2 emissions are GHG emissions created as a result of the generation of electricity, heating, cooling or steam that is purchased and consumed by a person or business. These are indirect emissions as they arise from sources that are not owned or controlled by the person or business who consumes the electricity.

Scope 1 emissions are produced by the combustion of fuels in vehicles and equipment, which the Proponent owns and has operational control over. Emissions occurring during both construction and operation of the facility have been considered in the assessment.

Scope 2 emissions arise from the consumption of electricity at the development site, in plant and equipment that is owned and operated by the Proponent. Note that emissions created as a result of combustion of waste for electricity generation at the WtE plant facility are considered scope 1 emissions (not scope 2).

Scope 3 emissions, i.e. GHG emissions that are generated in the wider economy as a consequence of a person's or business's activities, are not required to be estimated for this project (such as downstream use of electricity generated at the site and embodied emissions in materials). However, Scope 3 emissions associated directly with freight of construction materials and construction waste, and landfill emissions from construction and operational waste were included to indicate the magnitude of these emissions.

6.2.3.3 Exclusions

Exclusions from the GHG assessment included:

- Consequential emissions from use of electricity produced
- Scope 3 emissions including:
  - Transmission and distribution emissions of electricity imported and exported
  - Embodied emissions of construction materials
  - Emissions from extraction and transport of fuels
- Emissions associated with vegetation removal were assumed to be negligible, as the project area is already mostly cleared of dense areas of vegetation, and new vegetation will be added with landscaping improvements and palm tree buffer along select property boundary.
- Emissions from the generation, storage, or use of perfluorocarbons. The development is unlikely to store, generate, or use perfluorocarbons.
- Emissions associated with the leakage of hydrofluorocarbons. The project may use negligible quantities of hydrofluorocarbons for refrigeration and air conditioning during construction and operation. However, the associated emissions are likely to be negligible compared with other emissions from the project and therefore were excluded from the assessment.

- Other emissions considered to be negligible compared with the total emissions for the project, including emissions associated with:
  - the decommissioning and rehabilitation of the project site
  - combustion of oils and greases and minor fuels at the plant
  - wastewater treatment emissions during construction or operation

6.2.3.4 Assumptions

Activity data was sourced from the Proponent's facility design documentation, and email correspondence. The key information provided includes:

- A construction period of 49 months
- A project life of 35 years
- A daily treatment capacity of 5,666 tonnes/day (tpd) of waste at nominal design capacity
- An annual operating capacity of approximately 8000 hours
- An annual scheduled outage of 496 hours
- Average calorific value of waste of 9.5 MJ/kg
- Gross power output of 208 MWe
- Net power output of 193 MWe

Where activity data was unavailable, conservative assumptions were applied, as detailed in Table 6-2.

Table 6-2 Assumptions for the GHG assessment

Parameter	Assumptions
Construction	Emissions
Fuel generators	Fuel consumption and machine scheduling data were not provided. Equipment ratings were provided. As a result, fuel emissions were calculated by applying the following parameters to equipment ratings: • Power factor of 0.95 adapted for electricity consumption recommended by Dubai Electricity & Water Authority, Regulations for Electrical Installations (2017) • 20 hours of operation for all equipment per construction day • Conservative diesel generator efficiencies • Total estimated diesel use was 19,800 kL over the construction period.
Staff travel	Travel distance (one-way) for 'Client's Site Management', 'HZI Site Management' and 'HZI Subcontractor Management' was conservatively estimated as 50 km. Travel was assumed to be by gasoline fuel passenger transport with a fuel economy of 0.124 L/km. Other construction workers would travel to site by bus. Total estimated gasoline use was 84 kL over the construction period.

Parameter	Assumptions
Freight of materials and waste	Travel distance for normal and heavy transport of construction materials conservatively assumed as 500 km (one way). Travel distance for transport of construction waste from WtE plant to Al Qusais waste landfill estimated to be 24 km, with a total number of 190 trips during construction.
Construction waste disposal	Approximately 6,300 tonnes of construction waste was estimated as requiring disposal to landfill.
Operations	Emissions
Electricity usage	Electricity from the grid is only consumed during times of scheduled maintenance, as all on-site electricity demand will be met by the WtE plant's energy production. Operational usage was estimated as 8.9 GWh/a.
Start-up and shutdown	Diesel is used during start-up and shutdown of the incinerator lines. Estimated fuel usage for the five lines is 980 kL/a.
Freight of feedstock	Travel distance for feedstock from Al Qusais waste landfill and/or additional transport to the WtE plant was estimated to be 24 km. This allows for either mining of waste from the existing landfill or transporting feedstock from source the additional distance to the landfill.
Operational waste disposal	Approximately 400 ktonnes/a of waste was estimated as requiring disposal to landfill during operations.
Staff travel	Travel distance (one-way) for 'off-site dwellers' was conservatively estimated as 50 km. Travel was assumed to be by gasoline fuel passenger transport with a fuel economy of 0.124 L/km and total estimated gasoline use of 30 kL/a
Fuels for emergency generators	A quantity of diesel use for emergency power generation was applied to two weeks of continuous running, with estimated diesel fuel use of 170 kL/a.
Sulphur hexafluoride	Sulphur hexafluoride may be used in electrical equipment (substation and circuit breakers). A conservative amount of the total storage inventory was assumed to be leaked each year.
Waste incineration	1,888,000 tpa of waste incinerated. The WtE plant can accept municipal solid waste (MSW), refuse-derived fuel (RFD) from the Materials Recovery Facility (MRF) and commercial and industrial (C&I) waste. Waste composition is based on the typical composition of municipal solid waste in Dubai. Derived emission factor (EF) for the combustion of incinerated waste is 0.43 t CO_2-e/ t waste.

Parameter	Assumptions
Operations	Emissions avoided
Electricity displacement	The WtE plant will generate approximately 1,400 GWh/a electricity net, which will be exported to the grid. This is equivalent to grid electricity displaced (not derived directly from fossil fuels). The Scope 2 EF for electricity was sourced from Dubai's DEWA Sustainability Report equal to 0.4382 kg CO_2-e/ kWh.
Waste emissions avoided	1,888,000 tpa of waste will be incinerated, instead of landfilled, thus avoiding emissions of methane from landfill. Derived EF for waste avoided was 1.3 t CO_2-e/ t waste.

6.2.4 Calculation procedures

The derivation of the estimated total fuel and electricity use, waste disposed or avoided and transport were as described in the table above, for each parameter. Each parameter was multiplied by the relevant emission factor (EF) to obtain the total carbon dioxide equivalent. These values were then summed to estimate the total GHG emissions attributable to the project for the construction and operations stages. Emission factors were based on those available at the time of the assessment. Note that potential future changes in emission factors were not considered.

6.2.5 Assessment results

6.2.5.1 Predicted project emissions

The GHG emissions for the project were calculated based on estimated energy usage during construction and operations, and electricity generated in a business-as-usual scenario. The emissions results were assessed based on the project life (i.e. 30 years) and on an annualised basis. These are discussed below.

Project life emissions

Project life Scope 1 and 2 emissions are summarised in Table 6-3. Emissions are estimated as 70 kt CO_2-e during construction and 25,300 kt CO_2-e during operations. Emissions avoided by not sending waste to landfill amount to approximately 71,700 kt CO_2-e. Emissions avoided by generating electricity on-site (and hence displacing electricity produced from fossil fuels) are approximately 18,600 kt CO_2-e. Overall, this results in a net reduction in emissions of approximately 64,900 kt CO_2-e over the life of the project.

Table 6-3 Summary of project life greenhouse gas emissions

Project phases	Emissions (kt CO_2-e)		
	Scope 1 & 3	Scope 2	Total emissions
Construction			
– Fuels - diesel generators	53		53
– Staff travel	<1		<1
– Freight of materials and waste	14		14

Project phases	Emissions (kt CO_2-e)		
	Scope 1 & 3	Scope 2	Total emissions
– Waste disposal	2		2
Total construction emissions	***70***	***0***	***70***
Operational emissions			
– Fuels from line start-ups and shutdowns	76		76
– Ancillary and own-use electricity consumption		117	117
– Freight of feedstock	308		308
– Sulphur hexafluoride	6		6
– Staff travel	2		2
– Feedstock incineration	23,567		23,567
– Operational waste disposal	1,213		1,213
– Fuels for emergency generators	14		14
Total operational emissions	***25,186***	***117***	***25,303***
Operations emissions avoided			
– Landfilled waste	– 71,723	0	– 71,723
– Electricity generation	0	– 18,559	– 18,559
Total emissions avoided	***– 71,723***	***– 18,559***	***–90,282***
Net lifetime emissions	**– 46,467**	**– 18,442**	**–64,909**

Annualised emissions

Annualised scope 1 and 2 emissions for the project are summarised in Table 6-4. Emissions are estimated as approximately 840 kt CO_2-e/a during operations. Emissions avoided by not sending waste to landfill amount to approximately 2,400 kt CO_2-e/a. Emissions avoided by generating electricity on-site (and hence displacing electricity produced from fossil fuels) are approximately 620 kt CO_2-e/a. Overall, this results in a net reduction in emissions of approximately 2,200 kt CO_2-e/a.

Table 6-4 Summary of annual greenhouse gas emissions

Project phases	Emissions (kt CO_2-e/a)		
	Scope 1 & 3	Scope 2	Total emissions
Operational emissions			
– Fuels from line start-ups and shutdowns	3	-	3

Project phases	Emissions (kt CO_2-e/a)		
	Scope 1 & 3	Scope 2	Total emissions
– Ancillary and own-use electricity consumption	-	4	4
– Freight of feedstock	10	-	10
– Sulphur hexafluoride	<1	-	<1
– Staff travel	<1	-	<1
– Feedstock incineration	786	-	786
– Operational waste disposal	40	-	40
– Fuels for emergency generators	<1	-	<1
Total operational emissions	***840***	***4***	***844***
Operations emissions avoided			
– Landfilled waste	– 2,391	0	– 2,391
– Electricity generation	0	– 619	– 619
Total emissions avoided	***– 2,391***	***– 619***	***– 3,010***
Net annual emissions	**– 1,551**	**– 615**	**– 2,166**

6.2.5.2 Impact and alternatives assessment

United Arab Emirates baseline greenhouse gas emissions

A summary of estimated GHG emissions for the UAE for the year 2014 is provided in Table 6-5. The summary data was sourced from the World Resources Institute, Climate Analysis Indicators Tool, accessed 09/08/18. Data for 2014 was the most recent data available at the time of this report.

Table 6-5 Summary of greenhouse gas emissions for United Arab Emirates for 2014

Source and sink category	Emissions (Mt CO_2-e)
Energy	205.44
Industrial processes	9.80
Agriculture	1.68
Land use change and forestry	-0.21
Waste	4.60
Total national emissions	221.51
Net national emissions	221.29

Based on currently available data, the average annual GHG emissions for the project are estimated as approximately 0.84 Mt CO_2-e per annum (refer to Table 6-4). Compared with estimated GHG emissions for the UAE in 2014 of 221 Mt CO_2-e, the average annual emissions from the project were estimated to be approximately 0.4% of the UAe's annual GHG emissions.

The emissions from the WtE plant are more than offset by avoided landfill methane emissions and emissions from on-site electricity generation displacing existing sources as shown in Table 6-3 and Table 6-4. Overall, the WtE plant project will result in an estimated net reduction of 2,200 kt CO_2-e per year and 64,900 kt CO_2-e over the project life. This is significantly better than the 'do nothing' alternative where waste would continue to be landfilled and electricity generated from other sources including fossil fuels.

Emissions intensity

The net emissions intensity is -1.2 CO_2-e/t waste (total lifetime emissions divided by total lifetime waste treated). This means that for every tonne of waste sent to the waste to energy plant, approximately 1.2 t CO_2-e is avoided.

The net emissions intensity of electricity production from the incineration of waste was estimated as 0.6 kg CO_2-e/ kWh (total lifetime emissions divided by total lifetime electricity output). This is comparable with the current carbon intensity for Dubai of 0.43 kg CO_2-e/kWh and is significantly lower than fossil fuel power projects emitting approximately 0.78 kg CO_2-e /kWh (emission factor from UK's DEFRA Conversion Factors for Middle East).

6.2.6 Summary of Impacts

Key features of the WtE plant GHG emissions profile includes:

- The total construction emissions were estimated at 70 kt CO_2-e during the construction period of 49 months.
- The total emissions associated with operations were estimated as 25,300 kt CO_2-e over the project's 30 year lifetime.
- Emissions avoided by not sending waste to landfill were estimated as 71,700 kt CO_2-e over the project's 30 year lifetime equating to 2,400 kt CO_2-e avoided annually.
- Emissions avoided by generating electricity from waste were estimated as 18,600 kt CO_2-e over the project's 30 year lifetime equating to 620 kt CO_2-e avoided annually.
- Net total emissions reductions over the construction and operation stages were estimated as 64,900 kt CO_2-e.
- Average annual emissions reductions are estimated as 1.2 t CO_2-e/t waste treated.

The assessed impact level on climate during the construction and operation phases of the Project (before implementation of mitigation measure) is provided in Table 6-6.

Table 6-6 Potential unmitigated impacts on climate change and meteorology

Potential impact	Initial impact				Status of Impact
	Likelihood	Consequence	Impact Rating	Aspect impacted	
Construction phase					
GHG emissions from consumption of fuel and electricity for commuting of construction personnel, delivery of construction materials and disposal of construction waste	Almost certain	Insignificant	Low	Atmosphere	Negative
Operation Phase					
Emission from the WtE plant operation	Almost certain	Moderate	High	Atmosphere	Positive

6.3 Air Quality

6.3.1 Construction Phase

6.3.1.1 Air Quality

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

Heavy machinery and plant

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

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

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

Construction dust

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

Potential health impacts are attributable to the concentration of respirable particles in ambient air. Respirable particles of dust (PM_{10}) would have maximum impact under light winds and stable atmospheric conditions. These conditions most frequently occur overnight and very early in the morning and therefore, become more significant only if construction operations extend outside typical operating hours. $PM_{2.5}$ has not been assessed for the Project due to insufficient available data.

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

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

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

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

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

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

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

VOC Emissions

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

6.3.1.2 Odour Emissions

Poor management of sanitary and waste disposal facilities (e.g. septic tanks, putrescible waste bins) may result in odour causing a nuisance to people on or near the Project site. Good housekeeping, regular inspections and maintenance of waste disposal, transfer and storage facilities will minimise the risk of odour release.

Poor quality of fill material, if used on site during the construction phase, may also cause odoor emissions. To prevent this, fill material will undergo analysis prior to delivery to site and only materials of appropriate quality will be used.

6.3.2 Operation Phase – Cumulative Impact Assessment

6.3.2.1 Air Dispersion Modelling

Adopted background concentrations

Annual average background concentrations

For a cumulative assessment of annual average concentrations, data presented in Table 4.1 of the Air Quality Assessment Report (refer to Appendix N) was adopted as background concentrations. As the sensitive receptors are located in residential areas, data from the closest residential AQMS was used, this being Mushrif Park, highlighted in Table 4-1 in bold.

24-hour background concentrations

Direct 24-hour background air quality measurements were not available from the AQMS discussed in Section 4.1 of the Air Quality Assessment Report (refer to Appendix N). However, it is considered appropriate to apply a factor to an annual concentration in order to determine short-term ambient concentrations to use as background concentrations in an air quality assessment such as this. The United Kingdom Environment Agency guideline (United Kingdom Environment Agency 2016) suggests adopting a 24-hour background concentration based on the annual average ambient concentration multiplied by a factor of two.

1-hour background concentrations

For a cumulative assessment of 1-hour average concentrations, the Air Pollution Indicators (where available) have been adopted as the background concentrations and are considered a conservative estimate. Data from the most recent monitoring period (2017) was used, highlighted in Table 4-3 (in bold) of the Air Quality Assessment Report (refer to Appendix N).

PM_{10} and $PM_{2.5}$ ambient air quality

Ambient air quality monitoring was carried out in 2017 for PM_{10} at Emirates Hill, Mushrif and Sheikh Mohammed Bin Zayed Road. Similarly, ambient air quality monitoring for $PM_{2.5}$ was carries out for Mushrif and Sheikh Mohammed Bin Zayed Road. The 75th percentile 24-hour and annual averages for PM_{10} and $PM_{2.5}$ are displayed in Table 4-4 of the Air Quality Assessment Report (refer to Appendix N). Both parameters exceeds both the 24-hour and annual WHO criteria. The maximum of this data were used as part of the cumulative assessment, highlighted in Table 4-4.

Emission Sources

Air emissions for the facility will be emitted from:

- Five point sources (tall stacks), which are associated with fuel combustion sources from the boilers. The stacks will be located at the main building.
- IBA management area. This will consist of:
  - Wheel-generated dust from IBA product being transported offsite.
  - Wheel-generated dust will be assessed for TSP, PM_{10} and $PM_{2.5}$ only.
  - There are no dust emissions associated with wind erosion from any IBA stockpiles, as the stockpiles within the IBA maturation area are entirely enclosed in the IBA building.
  - Similarly, there are no dust emissions from loading of IBA product, as this will occur within an enclosed IBA building.
  - There will be no emissions from the IBA pre-treatment or IBA process hall as both areas are located within a building.

Calculation methodology for both stack emissions wheel-generated dust are discussed below.

Main Building - Stack emissions

HZI, Besix and Itochu provided stack air emissions information to GHD for use in the air assessment. The emissions information consisted of a technical process description and emission guarantees for the various pollutants, which are expected to be produced from the WMC. Stack parameters and stack gas flow emission loads were also provided. Table 6-7 summarises the stack parameters for the WMC as used in the modelling.

The following assumptions have been made by GHD in the modelling assessment:

- Building wake effects were modelled based on provided building dimensions
- Source locations were provided by HZI, Besix and Itochu to GHD for use in the dispersion model

One operating case has been identified in which a thermal load of 100% is assumed. Boiler emission rates modelled (g/s) and the total annual emissions (kg/yr) are presented in Table 6-8. Air pollutant emission rate estimations were calculated using IED, Annex VI, Part 3 (Tables 1.1, 1.3 and sections 1.4 and 1.5) (European Union 2010) and methods from NSW AMMAAP (NSW DEC 2005). An oxygen content of 11 percent was assumed as per IED. The following emission concentrations limits, controls and considerations have been made for this assessment:

- NOx to NO_2 ratio of 40 percent has been assumed. A ratio of 20 percent to 30 percent is typical for combustion sources in low background ozone atmosphere, such as the Project area. Therefore, the adopted conversion rate is considered appropriate for this assessment.
- Modelled NOx emission rates correspond to a concentration of 200 mg/Nm^3 (daily)
- Modelled SO_2 and CO emission rates each correspond to a concentration of 50 mg/Nm^3 (daily)
- Modelled TSP and HCl emission rates each correspond to a concentration of 10 mg/Nm^3 (daily)
- Modelled HF emission rates correspond to a concentration of 1 mg/Nm^3 (daily)
- Modelled NH^3 emission rates correspond to a UAE stack limit concentration of 10 mg/Nm^3 (Federal Environment Agency 2006)
- Modelled Dioxins and furans emission rates correspond to a concentration of 0.1 ng/Nm^3 (six to eight hours)
- Modelled Hg and Cd emission rates each correspond to a concentration of 0.05 mg/Nm^3 (30 minutes to eight hourly). It is noteworthy that the emission limit for Cd is specified in the IED as the total of Cd and thallium, equal to 0.05 mg/Nm^3. A conservative approach was taken, assuming that 100% of the emissions are Cd. A comparison of Cd emissions from other WMCs constructed by Hitachi Zosen Inova is shown in Section 5.1.1 of the Air Quality Assessment Report (refer to Appendix N).
- A conservative approach of the ratio of 1:1 was assumed for TSP to PM10 and PM2.5
- The daily IED concentrations were adopted for NOx, SO_2, CO, TSP and HCl over the half hour limits as the shorter duration limits are designed for upset conditions, which typically do not last longer than half an hour. As this assessment relates to ambient air quality associated with typical plant operation, it is not considered appropriate to use the IED half hour limits, as this will result in unrealistic emissions, and would not represent long-term plant operation. Further, a similar facility built by HZI has demonstrated NOx (as NO_2) half hourly average values to be between 150 mg/m^3 and 196 mg/m^3 (Element 2020), which is less than half the half hourly limit for NO_2 of 400 mg/m^3. Using the half hourly limit would therefore severely over-predict ambient concentrations. Finally, HZI Besix and Itochu have committed to a NOx control system to be implemented, which will control NOx to ensure an average concentration of NOx below 200 mg/Nm^3, and with few peaks above this. The control system for NOx will therefore ensure that the concentration will not reach the half hour emission limit value of 400 mg/Nm^3.

Table 6-8 presents the adopted emission rates for activities associated from the stacks.

IBA Management Area Emissions

As discussed above (emission sources), the transportation of IBA product is likely to cause particulate emissions from the IBA management area. The activities occurring at the IBA management area are:

- IBA pre-treatment hall – IBA is conveyed (via enclosed conveyor) to a covered storage area where it is stored up to five days to reduce the moisture content prior to the treatment / metal separation in the IBA process hall. Dried IBA is conveyed (via enclosed conveyor) to the process hall.
- IBA process hall – IBA from pre-treatment storage is processed and is undertaken for ferrous and non-ferrous metals by a series of different flows including crusher, overband magnets, magnetic drum, eddy current separators, a hand sorting platform, screens and belts, producing mineral fractions of different particle sizes. The IBA is then transferred by a front-end loader to the IBA maturation area, which is enclosed in the IBA building.
- IBA maturation area – Different mineral fractions are stockpiled for up to 12 weeks for maturation and further stibilization with periodical moistening and restacking, resulting in aggregates as the final product of this stage. The moistening also allows for dust suppression.
- Once IBA maturation has been completed, the material is loaded onto a tipping truck and transported offsite.

An indicative sketch of the IBA management area is shown in Figure 6-1.

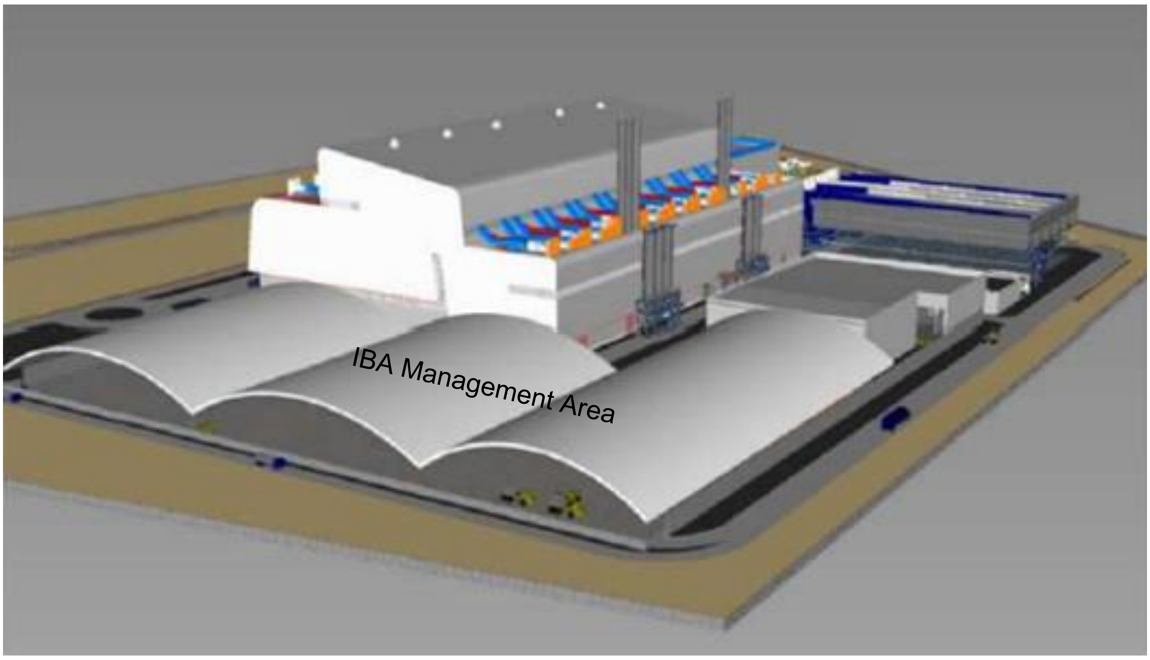


Figure 6-1 IBA Management Area

Emission factors for fugitive road dust were estimated based on emission rates for fly ash in coal fired power stations (Mueller et al., 2013). This is likely to lead to an over estimation and therefore the assessment is considered conservative. The emission rates were based on the following assumptions for activities occurring at the IBA maturation area:

- 282,300 tpa of mineralic aggregate is expected to be transported offsite during either the temporary or maturation process.
- Stockpiles and temporary storage of IBA will be enclosed within the covered IBA building.

- Loading/unloading of material will occur within the IBA building and is therefore expected to generate negligible dust.
- A conservative approach was taken as 50% TSP assessed as PM_{10}.
- For all the factor listed above, two scenarios were modelled:
  - Without dust control
  - With dust control. Dust control includes water spraying, as frequently as required on transport routes. This will result in 50% dust control efficiency for fugitive road dust emissions.

Meuller *et al*. (2013) estimated fly ash emission rates based on field data and AP-42 emissions estimation techniques. For this assessment, this assessment has adopted the emission factors estimated based on field trial data for the fugitive road dust emissions.

Table 6-8 presents the adopted emission rates for activities occurring at the IBA management area. Location of emissions sources modelled are shown in Figure 6-2.

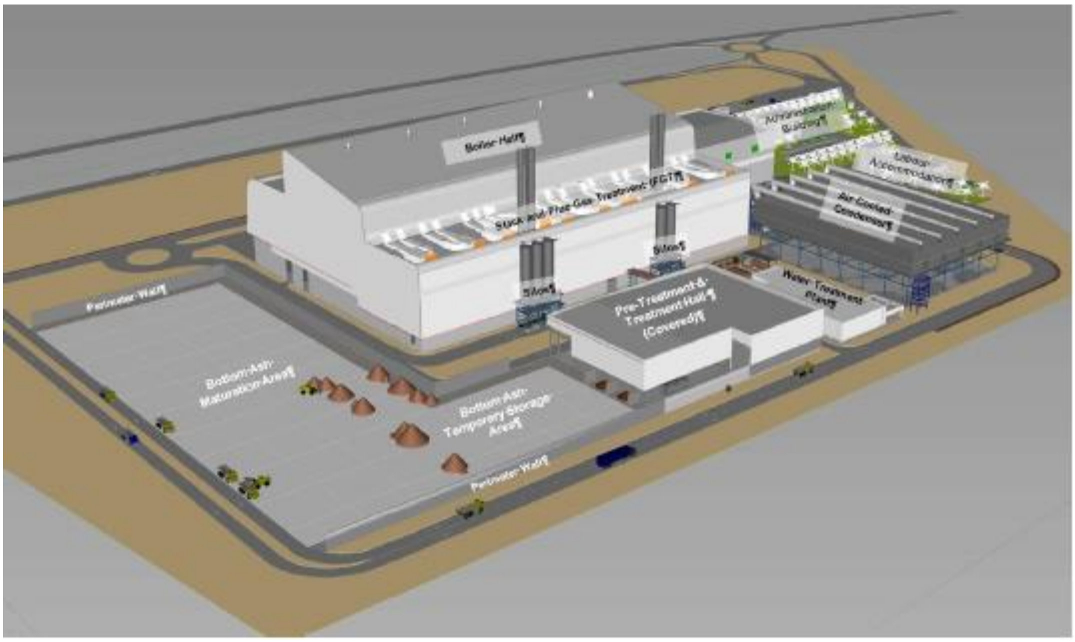


Figure 6-2 Source Locations

Table 6-7 Emission source parameters as used in the AERMOD model

Source ID	Activity description	Source type	Location (UTM)	Stack base elev. (m)	Stack height (m)	Stack diameter (m)	Exit velocity (m/s)	Exit temp (ºK)
1	Stack 1	Point source	343046 E 2783416 N	34	70	2.4	19	408.2
2	Stack 2	Point source	343051 E 2783414 N	34	70	2.4	19	408.2
3	Stack 3	Point source	343047 E 2783411 N	34	70	2.4	19	408.2
4	Stack 4	Point source	343118.7 E 2783393 N	35	70	2.4	19	408.2
5	Stack 5	Point source	343123 E 2783391 N	35	70	2.4	19	408.2
Source ID	Activity description	Emissions type	Location (UTM)	Effective height (m)	Base elevation	Initial sigma z (m)		
6	Truck	Volume	342884 E 2783471 N	1	37	1		

Table 6-8 Source emission rates for modelling

Emissions type		Emission rate	Unit
Stacks			
NOx		5.47	g/s
		172,411	kg/yr
SO_2		3.42	g/s
		107,757	kg/yr
CO		3.42	g/s
		107,757	kg/yr
TSP, PM_{10} and $PM_{2.5}$		0.68	g/s
		21,551	kg/yr
HCl		0.68	g/s
		21,551	kg/yr
HF		0.068	g/s
		2155	kg/yr
NH3		0.68	g/s
		21,551	kg/yr
TCDD		6.83×10^{-9}	g/s
		0.00022	kg/yr
Cd		0.0034	g/s
		108	kg/yr
Hg		0.0034	g/s
		108	kg/yr
IBA and mineral fractions		Emission rate	Unit
Fugitive road dust	TSP – No dust control	0.81	g/s
		25,597	kg/yr
	TSP – Dust control	0.41	g/s
		12,798	kg/yr
	PM_{10} – No dust control	0.41	g/s

Emissions type		Emission rate	Unit
		12,798	kg/yr
	PM_{10} – Dust control	0.20	g/s
		6,399	kg/yr
	$PM_{2.5}$ – No dust control	0.05	g/s
		1,419	kg/yr
	$PM_{2.5}$ – Dust control	0.02	g/s
		710	kg/yr

In Table 6-8, the emission rate for Cd for this Project is shown to be calculated at 0.0034 g/s, or 108 kg/yr. A comparison to the most recently built WMCs by Hitachi Zosen Inova is hereby included to demonstrate the conservative nature of the emission rate for Cd used in this assessment. Table 6-9 shows the Cd emission rates as monitored at several WMCs.

Table 6-9 Comparison of estimated emission rates of Cd for this Project and monitored emission rates of Cd for a number of existing WMCs

	Dubai WMC (this Project) – emission estimation	FCC Waste Services (UK) Ltd, Millerhill – December 2018[1]	FCC Waste Services (UK) Ltd, Millerhill – February 2019[1]	Covanta, Dublin 4, Line 1– September 2017[1]	Covanta, Dublin 4, Line 2– September 2017[1]
Cd and thallium total emission rate (g/s)	0.0034[1]	0.00003	0.00006	<0.00004	<0.00004
Cd and thallium total emission rate (kg/yr)	108[1]	1.05	1.75	<1.31	<1.14

Source: Email correspondence with Hitachi Zosen Inova

Note that monitored emission rates of Cd were provided in g/hr and were converted to g/s and kg/yr for comparative purposes

1. Cd emission rate as 100%

From Table 6-9, it is evident that the emission rate for Cd and Thallium as monitored at the existing Hitachi Zosen Inova WMCs is significantly less than the rate calculated for use in this assessment. The FFC Waste Services WMC at Millerhill has an identical air pollution control system as designed for the Dubai WMC, so it is expected that emissions of Cd in reality, will be closer to 0.00006 g/s or 0.00003 g/s as opposed to the estimated 0.0034 g/s used in this assessment.

Model Description

Atmospheric dispersion modelling for regulatory purposes requires meteorological data that is representative of conditions at the site for input into the modelling software. GHD has used meteorological data from the nearby Dubai International Airport. Data from the year 2015 was used as this year is relatively recent and is generally seen to be representative of average weather, with no unusual weather events. The meteorological parameters provided in the file include temperature, wind speed and direction, cloud cover and ceiling height.

The AERMOD meteorological processor, AERMET, was used to synthesize the AERMOD meteorological file. This process was undertaken in accordance with US EPA guidance. AERMET was used in 'on-site' observation mode using the input raw, hourly meteorological data obtained from Dubai International Airport and appropriate land use categorisations for the site. The non-default approved option of "Adjust Surface Friction Velocity (ADJ_U*)" was applied.

At the time of writing this report, the acceptable modelling method included the usage of the non-default options of "LOWWIND3" and "FASTALL" which were generally accepted to better resolve dispersion associated with light wind conditions. Since then, the US EPA approved modelling methods have changed, allowing the modeller to carry out sensitivity testing with these non-default options and choose the most appropriate method. Therefore, sensitivity testing was carried out for this assessment with both the "LOWWIND3" and "FASTALL" options both on and off. Subsequent predicted concentrations were found to differ minimally, and were considered a nominal difference for the purpose of this assessment. In general, these non-default options are important for ground level sources and less so for elevated sources, such as the tall stacks in this assessment. It is noteworthy that with the "LOWWIND3" and "FASTALL" options both on, concentrations were slightly higher and therefore these options were used in the modelling described below for a more conservative approach.

Dispersion Modelling Results – Cumulative impact at sensitive receptors

Nitrogen dioxide (NO_2)

Table 6-10 shows the predicted 1-hour, 24-hour and annual GLCs for NO_2.
The adopted background concentrations for NO_2 are:

- 1-hour concentration – 185 µg/m^3, which is 46 percent of the UAE assessment criteria of 400 µg/m^3.
- 24-hour concentration – 68 µg/m^3, which is 45 percent of the UAE assessment criteria of 150 µg/m^3.
- Annual concentration – 34 µg/m^3, which is 85 percent of the WHO assessment criteria of 40 µg/m^3.

Using the NOx to NO_2 ratio of 40 percent, the highest predicted cumulative concentrations fall below the assessment criteria, with one exception only. This occurs at Residential Villas (Desert Palm), with a cumulative annual average concentration of 41 µg/m^3, equating to 103 percent of the WHO criteria of 40 µg/m^3.

It is noteworthy that the NOx to NO_2 conversion ratio of 40 percent is conservative. It is likely that ambient concentrations of NO_2 associated with the operation of the stacks will be lower in reality (in the range of 20 percent NOx to NO_2). The incremental and cumulative 1-hour NO_2 ground level concentration contours are presented in Figure 6-3 and Figure 6-4 respectively.

Table 6-10 Predicted 1-hour, 24-hour and annual NO_2 concentrations

Receptor	Incremental 1-hour NO_2 (µg/m³)	Cumulative 1-hour NO_2 (µg/m³)	Cumulative % of criteria	Incremental 24-hour NO_2 (µg/m³)	Cumulative 24-hour NO_2 (µg/m³)	Cumulative % of criteria	Incremental annual NO_2 (µg/m³)	Cumulative annual NO_2 (µg/m³)	Cumulative % of criteria
Criteria (µg/m³)	400 (UAE)			150 (UAE)			40 (WHO)		
Dubai International City-EMR 14, Emirates Cluster	88	273	68%	11	79	53%	2	36	89%
International City Phase II (under construction)	81	266	66%	15	83	55%	1	35	87%
Residential Villas (Desert Palm)	173	358	90%	45	113	76%	7	41	103%
AL Warqa 4 (north of Al Awir Road)	127	312	78%	23	91	61%	3	37	92%
Dragon Mart Mosque	90	275	69%	6	74	49%	1	35	87%
Dragon Mart Commercial Centre	97	282	71%	9	77	51%	1	35	87%
Dubai Textile City	103	288	72%	8	76	51%	1	35	87%
Desert Palm Resort and Hotel	137	322	80%	27	95	64%	4	38	96%
Dubai Plant Nursery	144	329	82%	23	91	61%	3	37	92%
Dubai Safari Park (north of Al Awir Road)	110	295	74%	16	84	56%	2	36	91%
Pivot Fields	166	351	88%	34	102	68%	5	39	97%
Desert Palm Polo Club	141	326	82%	23	91	61%	5	39	97%
Desert Palm Riding Schools	146	331	83%	34	102	68%	6	40	99%
Warsan Lake	104	289	72%	15	83	55%	2	36	89%

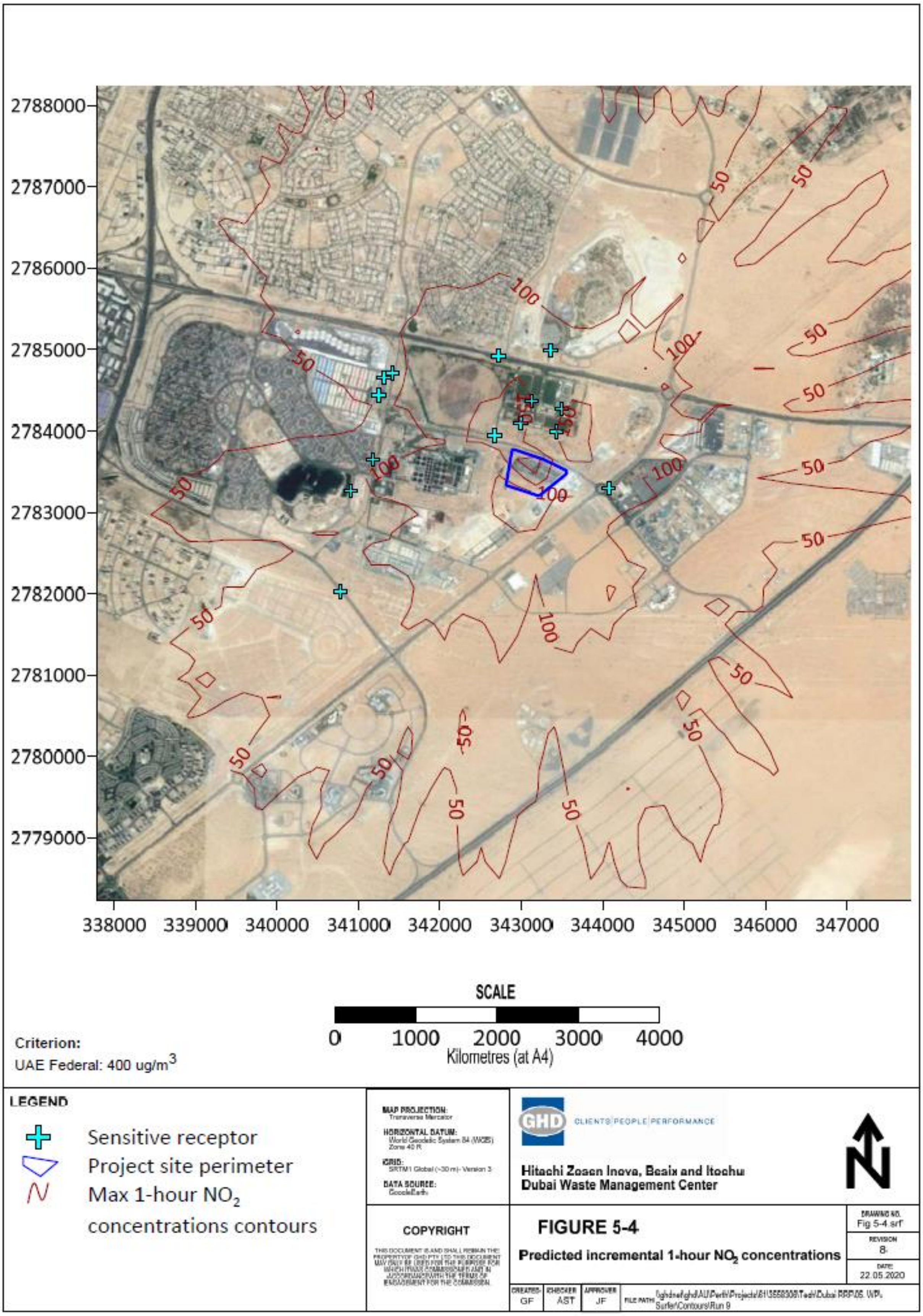


Figure 6-3 Predicted incremental 1-hour NO_2 concentrations

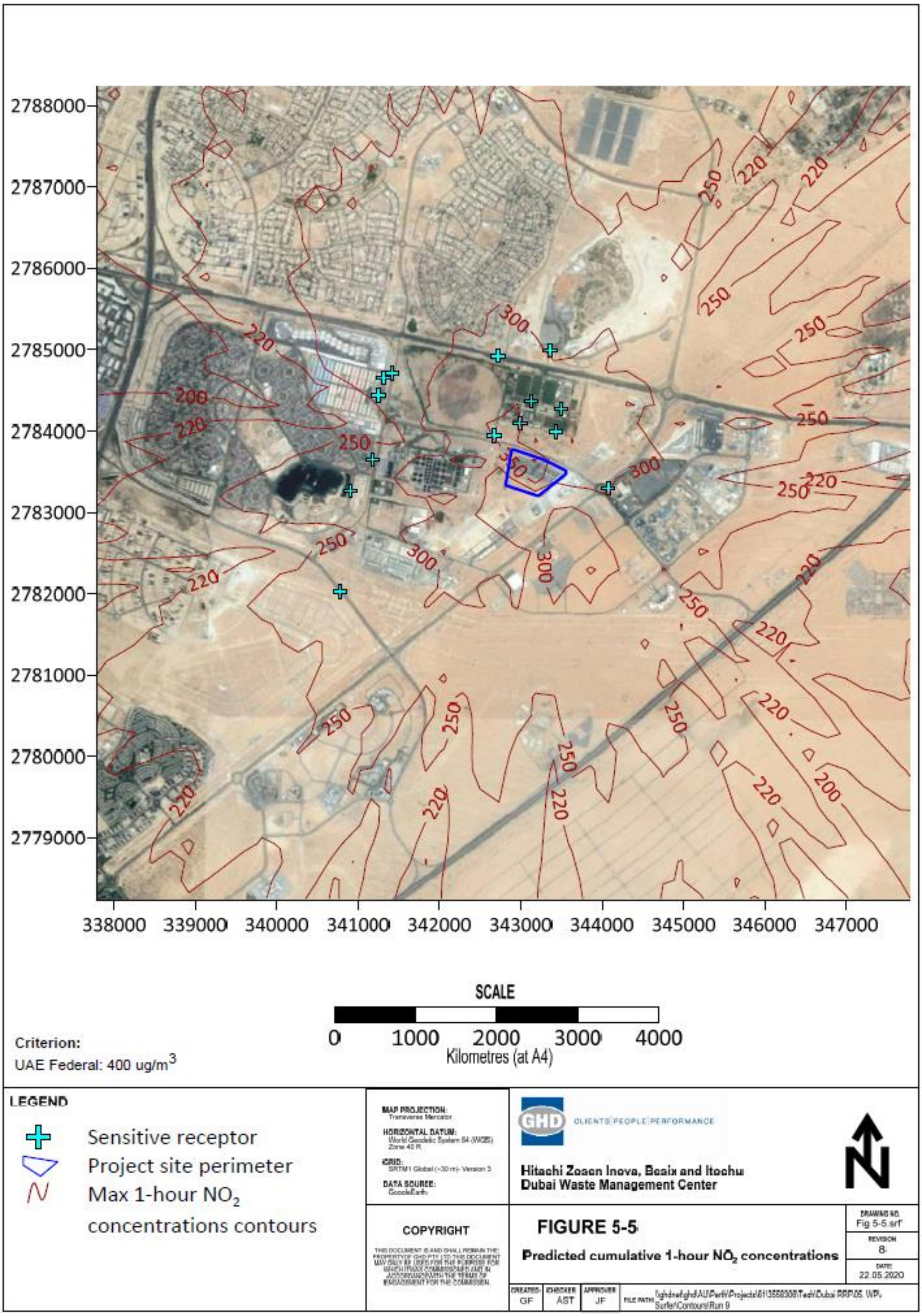


Figure 6-4 Predicted cumulative 1-hour NO_2 concentrations

Sulphur dioxide

Table 6-11 shows the predicted 1-hour, 24-hour and annual GLCs for SO_2.

The adopted background concentrations for SO_2 are:

- 1-hour concentration – 86 µg/m^3, which is 25 percent of the UAE assessment criteria of 350 µg/m^3.
- 24-hour concentration – 12 µg/m^3, which is eight percent of the UAE assessment criteria of 150 µg/m^3.
- Annual concentration – 6 µg/m^3, which is 10 percent of the UAE assessment criteria of 60 µg/m^3.

The highest predicted cumulative concentrations fall below the assessment criteria.

The incremental and cumulative 1-hour SO_2 ground level concentration contours are presented in Figure 6-5 and Figure 6-6 respectively.

Table 6-11 Predicted 1-hour, 24-hour and annual SO_2 concentrations

Receptor	Incremental 1-hour SO_2 (µg/m^3)	Cumulative 1-hour SO_2 (µg/m^3)	Cumulative % of criteria	Incremental 24-hour SO_2 (µg/m^3)	Cumulative 24-hour SO_2 (µg/m^3)	Cumulative % of criteria	Incremental annual SO_2 (µg/m^3)	Cumulative annual SO_2 (µg/m^3)	Cumulative % of criteria
Criteria (µg/m^3)	350 (UAE)			150 (UAE)			60 (UAE)		
Dubai International City-EMR 14, Emirates Cluster	48	134	38%	7	19	13%	1	7	12%
International City Phase II (under construction)	44	130	37%	9	21	14%	1	7	11%
Residential Villas (Desert Palm)	103	189	54%	28	40	27%	4	10	17%
AL Warqa 4 (north of Al Awir Road)	73	159	45%	14	26	18%	2	8	13%
Dragon Mart Mosque	51	137	39%	3	15	10%	1	7	11%
Dragon Mart Commercial Centre	52	138	40%	6	18	12%	1	7	11%
Dubai Textile City	53	139	40%	5	17	11%	1	7	11%
Desert Palm Resort and Hotel	81	167	48%	17	29	19%	3	9	15%
Dubai Plant Nursery	86	172	49%	14	26	17%	2	8	13%
Dubai Safari Park (north of Al Awir Road)	67	153	44%	10	22	15%	2	8	13%
Pivot Fields	100	186	53%	21	33	22%	3	9	15%
Desert Palm Polo Club	85	171	49%	14	26	18%	3	9	15%
Desert Palm Riding Schools	88	174	50%	21	33	22%	4	10	16%
Warsan Lake	53	139	40%	9	21	14%	1	7	12%

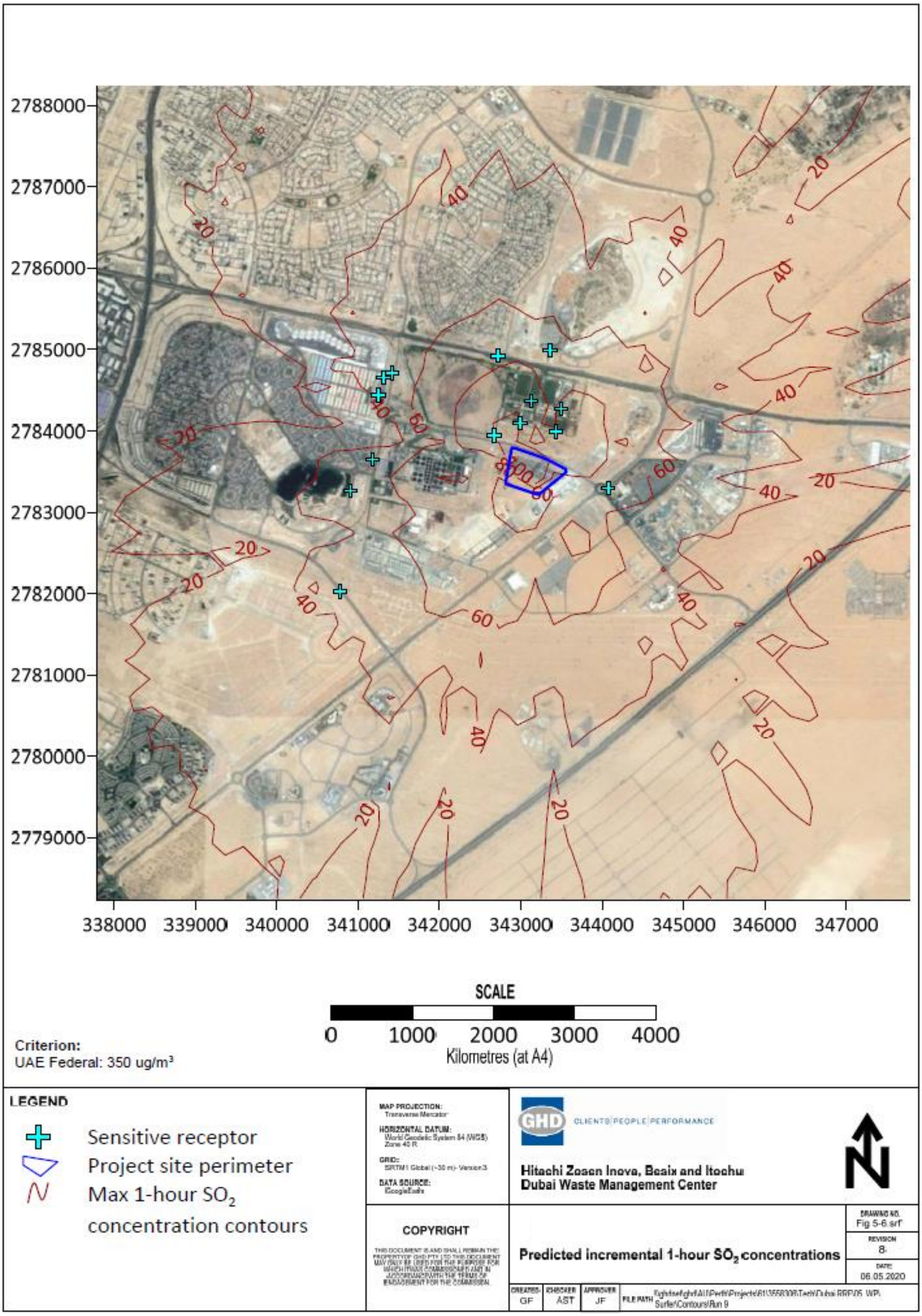


Figure 6-5 Predicted incremental 1-hour SO_2 concentrations

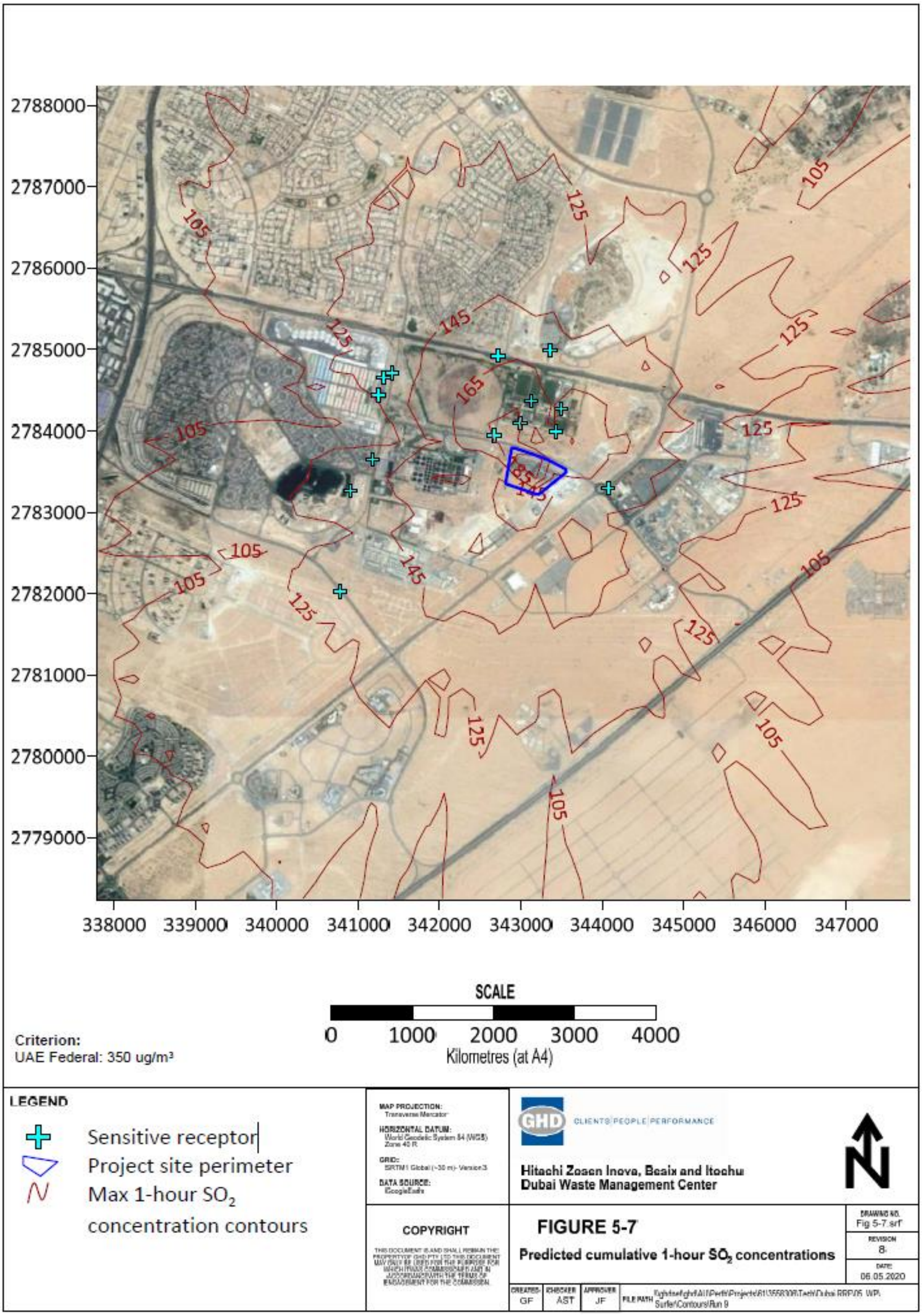


Figure 6-6 Predicted cumulative 1-hour SO_2 concentrations

Carbon monoxide

Table 6-12 shows the predicted 1-hour and 8-hour GLCs for CO.

The adopted background concentrations for CO are:

- 1-hour concentration – 5477 µg/m^3, which is 18 percent of the UAE assessment criteria of 30,000 µg/m^3.
- 8-hour concentration – no data available, incremental assessment only is shown.

The highest predicted cumulative (1-hour averaging period) and incremental (8-hour averaging period) concentrations fall below the assessment criteria.

For the incremental assessment, the highest predicted 8-hour concentration occurs at Pivot Fields, equating to <1 percent of the UAE assessment criteria. This complies comfortably with the WHO guideline regarding 25 percent of the criteria.

The incremental and cumulative 1-hour CO ground level concentration contours are presented in Figure 6-7 and Figure 6-8 respectively.

Table 6-12 Predicted 1-hour and 8-hour CO concentrations

Receptor	Incremental 1-hour CO (µg/m³)	Cumulative 1-hour CO (µg/m³)	Cumulative % of criteria	Incremental 8-hour CO (µg/m³)	Incremental % of criteria
Criteria (µg/m³)	30000 (UAE)			10000 (UAE)	
Dubai International City-EMR 14, Emirates Cluster	48	5525	18%	13	0.1%
International City Phase II (under construction)	44	5521	18%	15	0.2%
Residential Villas (Desert Palm)	103	5580	19%	49	0.5%
AL Warqa 4 (north of Al Awir Road)	73	5550	18%	38	0.4%
Dragon Mart Mosque	51	5528	18%	9	0.1%
Dragon Mart Commercial Centre	52	5529	18%	17	0.2%
Dubai Textile City	53	5530	18%	14	0.1%
Desert Palm Resort and Hotel	81	5558	19%	39	0.4%
Dubai Plant Nursery	86	5563	19%	23	0.2%
Dubai Safari Park (north of Al Awir Road)	67	5544	18%	24	0.2%
Pivot Fields	100	5577	19%	56	0.6%
Desert Palm Polo Club	85	5562	19%	33	0.3%
Desert Palm Riding Schools	88	5565	19%	44	0.4%
Warsan Lake	53	5530	18%	15	0.2%

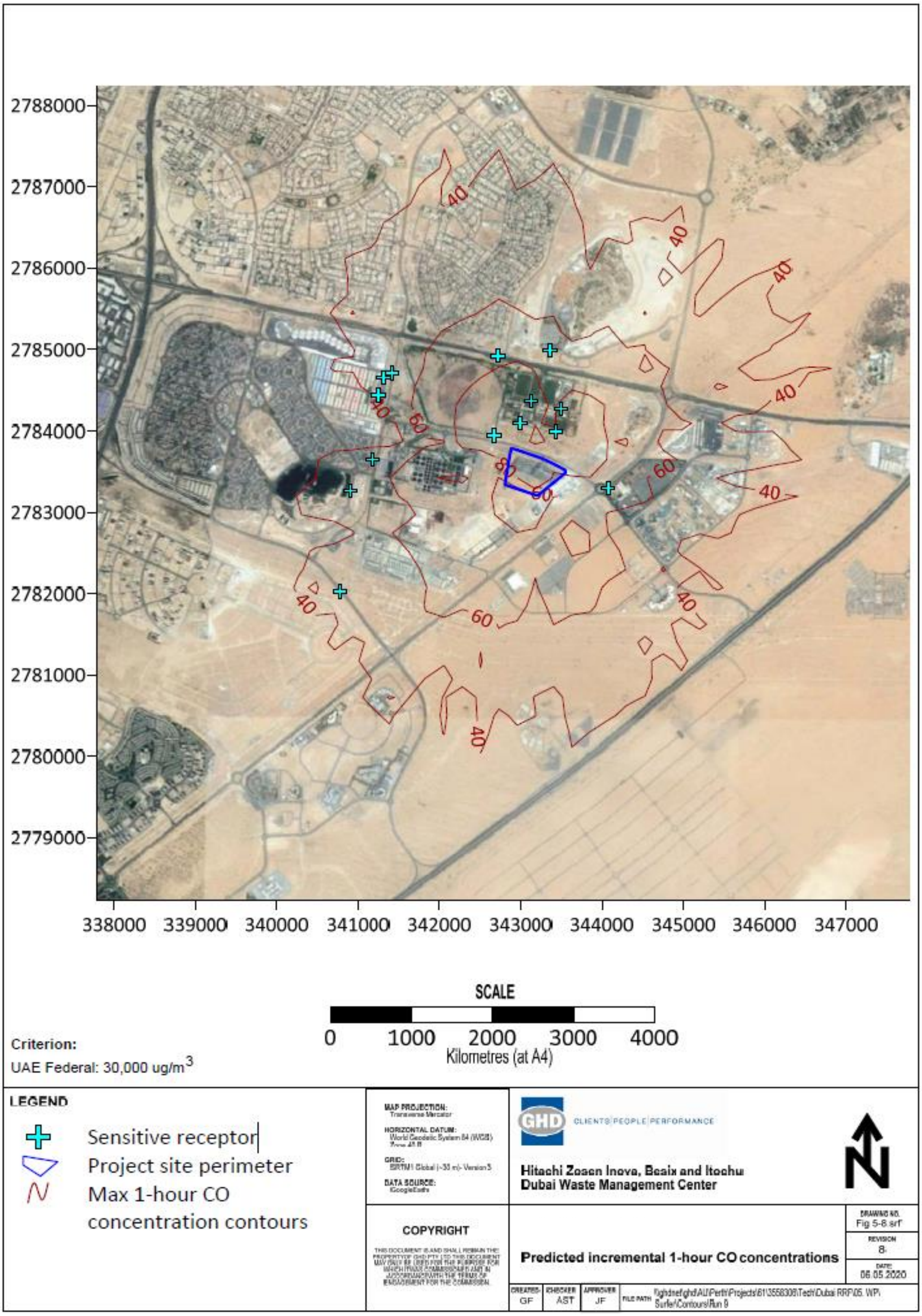


Figure 6-7 Predicted incremental 1-hour CO concentrations

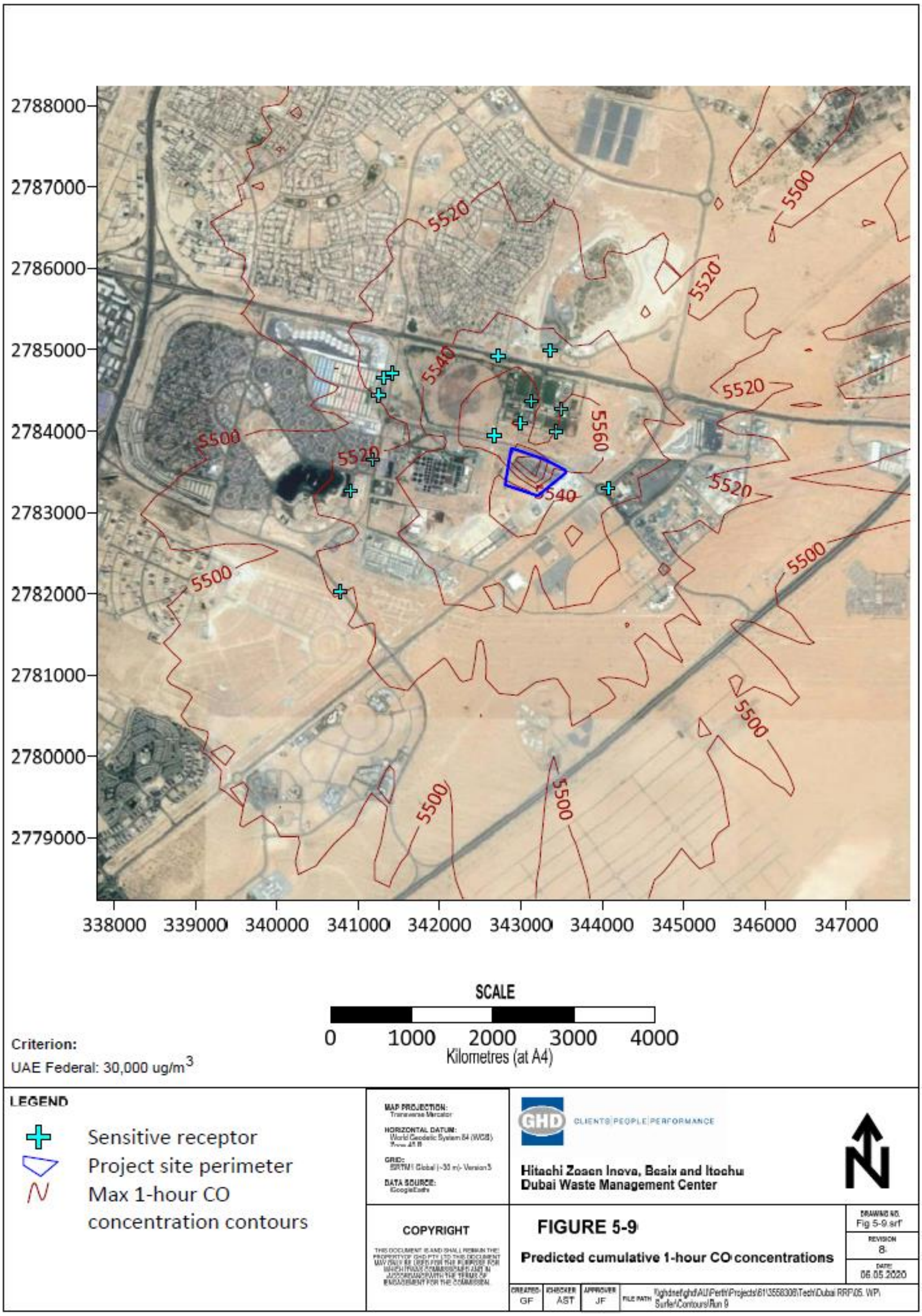


Figure 6-8 Predicted cumulative 1-hour CO concentrations

Total suspended particulates

Table 6-13 and Table 6-14 show the predicted 24-hour and annual GLCs for TSP without and with dust control respectively, as described in Section 5.1 of the Air Quality Assessment Report.

Background concentrations were not included for TSP, as appropriate data were not available for use in this assessment. Therefore, an incremental assessment only is shown.

Results have been presented as stack TSP concentrations, IBA TSP concentrations and total TSP concentrations in order to give a greater understanding of the proportion of TSP being emitted at each source.

For no dust control (Table 6-13), the highest predicted incremental 24-hour and annual averaging period concentrations fall below the assessment criteria for both the stack and IBA emissions, as well as the total of these. The highest predicted incremental 24-hour and annual total TSP concentrations both occur at Pivot Fields, equating to 5 percent and 1.9 percent of the UAE assessment criteria respectively. These comply comfortably with the WHO guideline regarding 25 percent of the criteria.

Similarly, with dust control (Table 6-14), the highest predicted incremental 24-hour and annual averaging period concentrations fall below the assessment criteria for both the stack and IBA emissions, as well as the total of these. The highest predicted incremental 24-hour total TSP concentration occurs at Pivot Fields, equating to 3 percent of the UAE assessment criteria. The highest predicted incremental annual total TSP concentration occurs at Pivot Fields and Residential Villas (Desert Palm) equating to 1.3 percent of the UAE assessment criteria. These comply comfortably with the WHO guideline regarding 25 percent of the criteria.

The predicted maximum 24-hour concentration from stack emissions do not necessarily occur on the same day as predicted maximum 24-hour concentrations from the IBA management area. Hence summed stack 24-hour TSP concentrations with IBA management area’s 24-hour TSP concentrations do not equal the Project’s total predicted maximum TSP concentrations. This is due to daily varying meteorological parameters, such as wind speed and wind direction enabling a differing TSP dispersion patterns.

The incremental 24-hour TSP ground level concentration contours without and with dust control are presented in Figure 6-9 and Figure 6-10 respectively

Table 6-13 Predicted 24-hour and annual TSP concentrations – no dust control

Receptor	Incremental stack 24-hour TSP (µg/m³)	Incremental IBA 24-hour TSP (µg/m³)	Incremental total 24-hour TSP (µg/m³)	Incremental % of criteria	Incremental stack annual TSP (µg/m³)	Incremental IBA annual TSP (µg/m³)	Incremental total annual TSP (µg/m³)	Incremental % of criteria
Criteria (µg/m3)	230 (UAE)				90 (UAE)			
Dubai International City-EMR 14, Emirates Cluster	1	1	2	1%	0.2	0.1	0.3	0.3%
International City Phase II (under construction)	2	0.4	2	1%	0.1	0.0	0.1	0.1%
Residential Villas (Desert Palm)	6	6	7	3%	0.9	0.7	1.5	1.7%
AL Warqa 4 (north of Al Awir Road)	3	1	4	2%	0.4	0.2	0.5	0.6%
Dragon Mart Mosque	1	1	1	1%	0.1	0.1	0.2	0.2%
Dragon Mart Commercial Centre	1	1	2	1%	0.1	0.1	0.2	0.2%
Dubai Textile City	1	1	1	1%	0.1	0.1	0.2	0.2%
Desert Palm Resort and Hotel	3	2	5	2%	0.6	0.1	0.7	0.8%
Dubai Plant Nursery	3	2	4	2%	0.3	0.1	0.4	0.4%
Dubai Safari Park (north of Al Awir Road)	2	1	2	1%	0.3	0.1	0.4	0.5%
Pivot Fields	4	7	11	5%	0.6	1.1	1.7	1.9%
Desert Palm Polo Club	3	3	5	2%	0.6	0.3	0.9	1.0%
Desert Palm Riding Schools	4	2	5	2%	0.7	0.2	0.9	1.0%
Warsan Lake	2	1	3	1%	0.2	0.1	0.3	0.3%

Table 6-14 Predicted 24-hour and annual TSP concentrations – with dust control

Receptor	Incremental stack 24-hour TSP (µg/m³)	Incremental IBA 24-hour TSP (µg/m³)	Incremental total 24-hour TSP (µg/m³)	Incremental % of criteria	Incremental stack annual TSP (µg/m³)	Incremental IBA annual TSP (µg/m³)	Incremental total annual TSP (µg/m³)	Incremental % of criteria
Criteria (µg/m3)	230 (UAE)				90 (UAE)			
Dubai International City-EMR 14, Emirates Cluster	1	0.5	2	1%	0.2	0.05	0.2	0.3%
International City Phase II (under construction)	2	0.2	2	1%	0.1	0.01	0.1	0.1%
Residential Villas (Desert Palm)	6	3.1	6	3%	0.9	0.3	1.2	1.3%
AL Warqa 4 (north of Al Awir Road)	3	0.7	3	1%	0.4	0.1	0.5	0.5%
Dragon Mart Mosque	1	0.5	1	0.4%	0.1	0.04	0.1	0.2%
Dragon Mart Commercial Centre	1	0.5	2	1%	0.1	0.04	0.2	0.2%
Dubai Textile City	1	0.4	1	1%	0.1	0.04	0.1	0.2%
Desert Palm Resort and Hotel	3	1.2	4	2%	0.6	0.1	0.6	0.7%
Dubai Plant Nursery	3	1.1	3	1%	0.3	0.03	0.4	0.4%
Dubai Safari Park (north of Al Awir Road)	2	0.5	2	1%	0.3	0.1	0.4	0.4%
Pivot Fields	4	3.7	7	3%	0.6	0.5	1.1	1.3%
Desert Palm Polo Club	3	1.7	3	2%	0.6	0.2	0.7	0.8%
Desert Palm Riding Schools	4	1.1	4	2%	0.7	0.1	0.8	0.9%
Warsan Lake	2	0.4	2	1%	0.2	0.04	0.2	0.3%

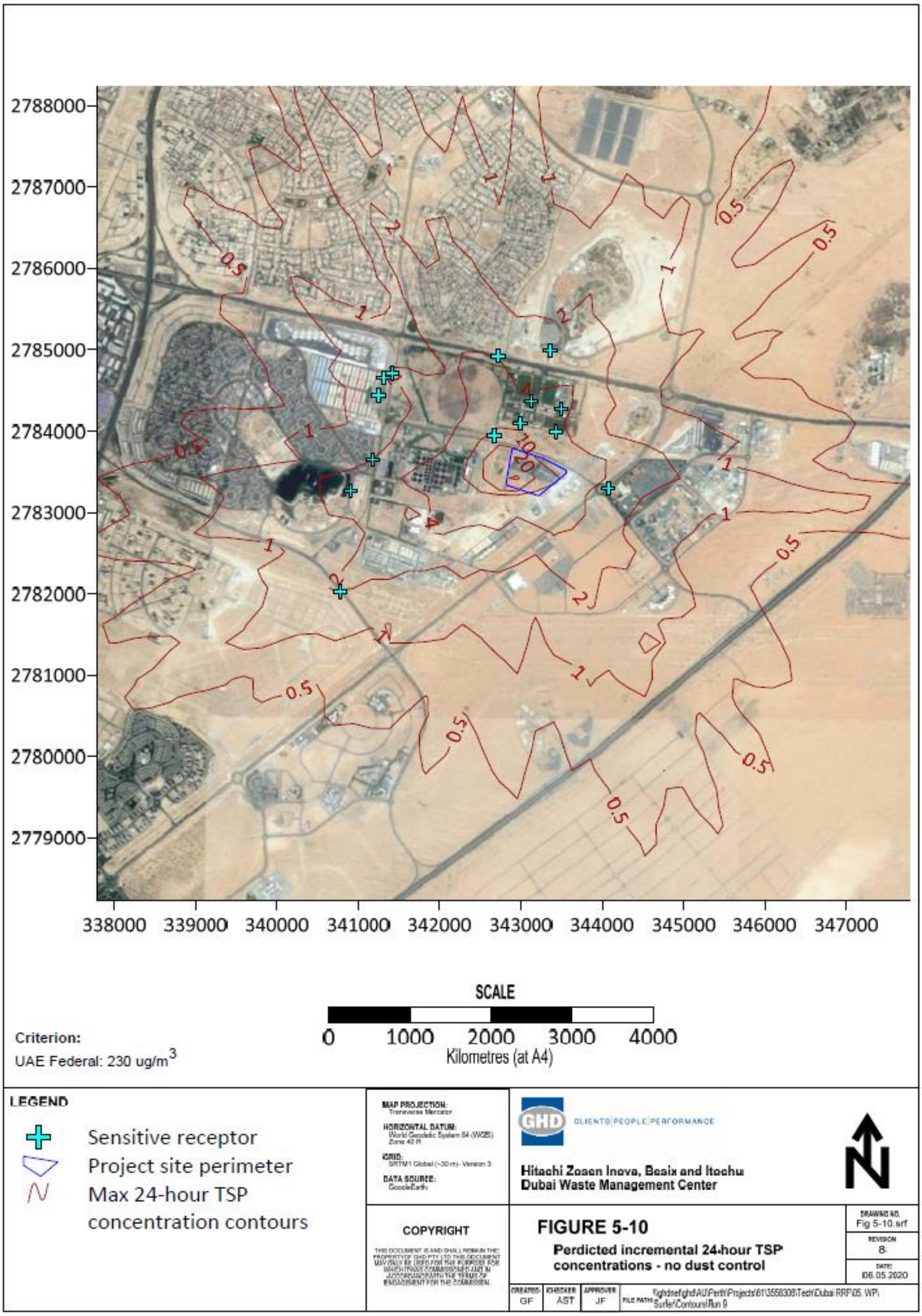


Figure 6-9 Predicted incremental 24-hour TSP concentrations – No dust control

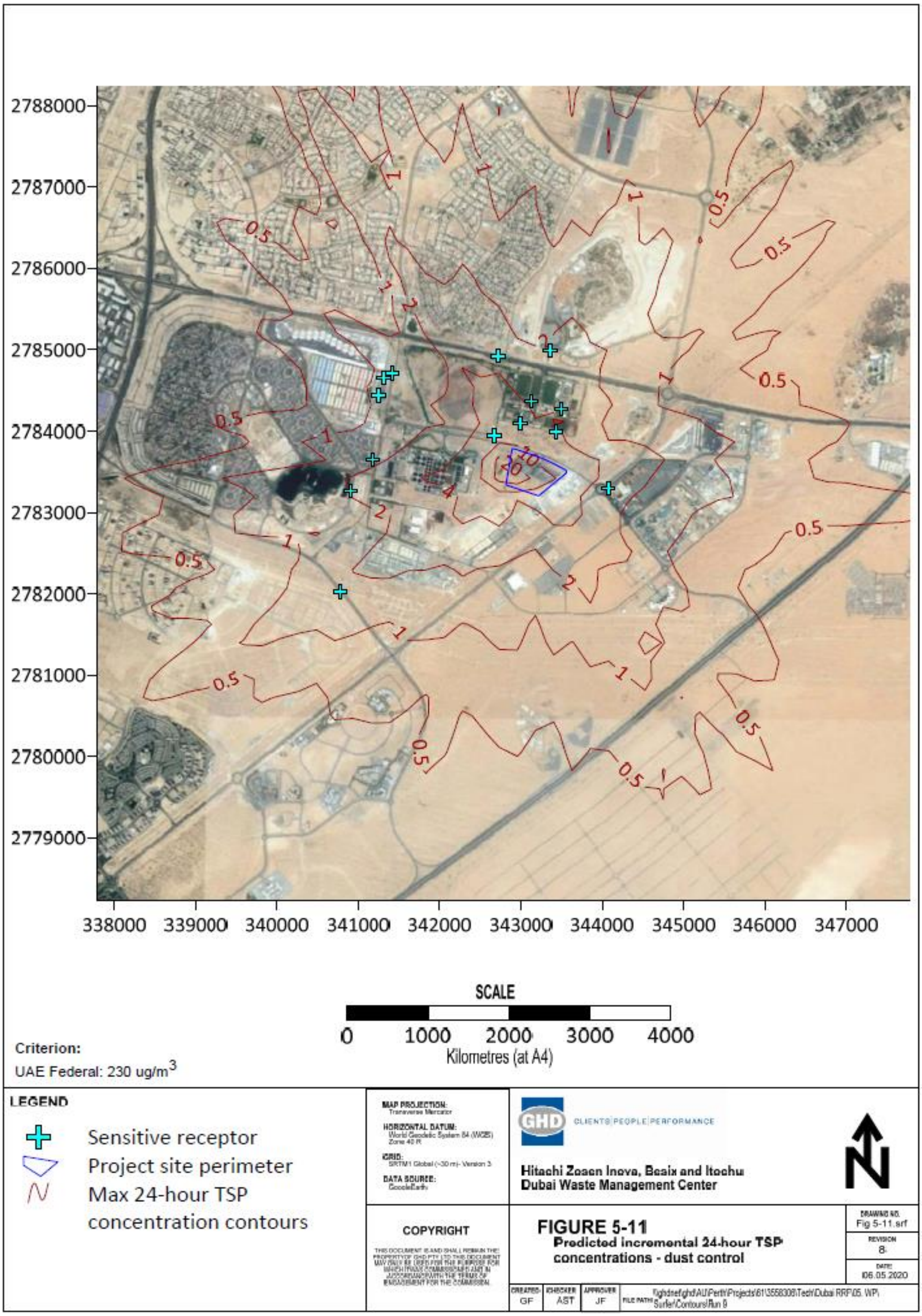


Figure 6-10 Predicted incremental 24-hour TSP concentrations – with dust control

PM_{10}

Table 6-15 and Table 6-16 show the predicted 24-hour and annual GLCs for PM10 without and with dust control respectively, as described in Section 5.1 of the Air Quality Assessment Report.

The adopted background concentrations for PM_{10} are:

- 24-hour concentration – 169 µg/m^3, which is 113 percent of the UAE assessment criteria of 150 µg/m^3.
- Annual concentration – 141 µg/m^3, which is 705 percent of the WHO assessment criteria of 20 µg/m^3.

Stack emissions were calculated assuming a conservative ratio of 1:1 for TSP to PM_{10} and wheel-generated emissions were calculated using emission-specific factors.

Results have been presented as stack PM_{10} concentrations, IBA PM_{10} concentrations and total PM_{10} concentrations in order to give a greater understanding of the proportion of PM_{10} being emitted at each source.

For no dust control (Table 6-15), the highest predicted incremental 24-hour and annual averaging period concentrations fall well below the assessment criteria for both the stack and IBA emissions, as well as the total of these. The predicted cumulative 24-hour total PM_{10} concentrations exceed the UAE criteria (with a maximum of 176 µg/m^3 occurring at Pivot Fields, equating to 117 percent of the criteria) due to the background concentration exceeding the criteria. The predicted cumulative annual total PM_{10} concentrations exceed the WHO criteria (with a maximum of 142 µg/m^3 occurring at Pivot Fields and Residential Villas (Desert Palm), equating to 711 percent of the criteria) due to the background concentration exceeding the criteria.

Similarly, with dust control (Table 6-16), the highest predicted incremental 24-hour and annual averaging period concentrations fall well below the assessment criteria for both the stack and IBA emissions, as well as the total of these. The predicted cumulative 24-hour total PM_{10} concentrations exceed the UAE criteria (with a maximum of 175 µg/m^3 occurring at Residential Villas (Desert Palm), equating to 117 percent of the criteria) due to the background concentration exceeding the criteria. The predicted cumulative annual total PM_{10} concentrations exceed the WHO criteria (with a maximum of 142 µg/m^3 occurring at Pivot Fields and Residential Villas (Desert Palm), equating to 711 percent of the criteria) due to the background concentration exceeding the criteria.

The predicted maximum 24-hour concentration from stack emissions do not necessarily occur on the same day as predicted maximum 24-hour concentrations from the IBA management area. Hence summed stack 24-hour PM_{10} concentrations with IBA management area's 24-hour PM_{10} concentrations do not equal the Project's total predicted maximum PM_{10} concentrations. This is due to daily varying meteorological parameters, such as wind speed and wind direction enabling a differing PM_{10} dispersion patterns.

The incremental and cumulative 24-hour PM_{10} ground level concentration contours with no dust control are presented in Figure 6-11and Figure 6-12 respectively. The incremental and cumulative 24-hour PM_{10} ground level concentration contours with dust control are presented in Figure 6-13 and Figure 6-14 respectively.

Table 6-15 Predicted 24-hour and annual PM_{10} concentrations – no dust control

Receptor	Incremental 24-hour Stack PM_{10} ($\mu g/m^3$)	Incremental 24-hour IBA PM_{10} ($\mu g/m^3$)	Incremental total 24-hour PM_{10} ($\mu g/m^3$)	Cumulative total 24-hour PM_{10} ($\mu g/m^3$)	Cumulative % of criteria	Incremental stack annual PM_{10} ($\mu g/m^3$)	Incremental IBA annual PM_{10} (μg/m3)	Incremental total annual PM_{10} ($\mu g/m^3$)	Cumulative total annual PM_{10} ($\mu g/m^3$)	Cumulative % of criteria
Criteria (μg/m3)			150 (UAE)					20 (WHO)		
Dubai International City- EMR 14, Emirates Cluster	1	0.5	2	170.6	114%	0.2	0.05	0.2	141.2	706%
International City Phase II (under construction)	2	0.2	2	170.9	114%	0.1	0.01	0.1	141.1	706%
Residential Villas (Desert Palm)	6	3.1	6	175.2	117%	0.9	0.33	1.2	142.2	711%
AL Warqa 4 (north of Al Awir Road)	3	0.7	3	172.2	115%	0.4	0.09	0.5	141.5	707%
Dragon Mart Mosque	1	0.5	1	170.0	113%	0.1	0.04	0.1	141.1	706%
Dragon Mart Commercial Centre	1	0.5	2	170.6	114%	0.1	0.04	0.2	141.2	706%
Dubai Textile City	1	0.4	1	170.2	113%	0.1	0.04	0.1	141.1	706%
Desert Palm Resort and Hotel	3	1.2	4	172.9	115%	0.6	0.07	0.6	141.6	708%
Dubai Plant Nursery	3	1.1	3	172.0	115%	0.3	0.03	0.4	141.4	707%
Dubai Safari Park (north of Al Awir Road)	2	0.5	2	171.2	114%	0.3	0.06	0.4	141.4	707%
Pivot Fields	4	3.8	7	176.2	117%	0.6	0.55	1.1	142.1	711%
Desert Palm Polo Club	3	1.8	3	172.5	115%	0.6	0.16	0.7	141.7	709%
Desert Palm Riding Schools	4	1.1	4	173.4	116%	0.7	0.09	0.8	141.8	709%
Warsan Lake	2	0.4	2	171.2	114%	0.2	0.04	0.2	141.2	706%

Table 6-16 Predicted 24-hour and annual PM_{10} concentrations – with dust control

Receptor	Incrementa l 24-hour Stack PM_{10} ($\mu g/m^3$)	Incremental 24-hour IBA PM_{10} ($\mu g/m^3$)	Incremental total 24-hour PM_{10} ($\mu g/m^3$)	Cumulative total 24-hour PM_{10} ($\mu g/m^3$)	Cumulative % of criteria	Incremental annual Stack PM_{10} ($\mu g/m^3$)	Incremental annual IBA PM_{10} ($\mu g/m^3$)	Incremental total annual PM_{10} ($\mu g/m^3$)	Cumulative annual PM_{10} ($\mu g/m^3$)	Cumulative % of criteria
Criteria (µg/m3)	150 (UAE)					20 (WHO)				
Dubai International City- EMR 14, Emirates Cluster	1	0.2	1	170.5	114%	0.2	0.02	0.2	141.2	706%
International City Phase II (under construction)	2	0.1	2	170.9	114%	0.1	0.004	0.1	141.1	706%
Residential Villas (Desert Palm)	6	1.5	6	174.9	117%	0.9	0.16	1.0	142.0	710%
AL Warqa 4 (north of Al Awir Road)	3	0.4	3	171.9	115%	0.4	0.04	0.4	141.4	707%
Dragon Mart Mosque	1	0.2	1	169.8	113%	0.1	0.02	0.1	141.1	706%
Dragon Mart Commercial Centre	1	0.2	1	170.4	114%	0.1	0.02	0.1	141.1	706%
Dubai Textile City	1	0.2	1	170.0	113%	0.1	0.02	0.1	141.1	706%
Desert Palm Resort and Hotel	3	0.6	4	172.5	115%	0.6	0.03	0.6	141.6	708%
Dubai Plant Nursery	3	0.6	3	171.9	115%	0.3	0.01	0.3	141.3	707%
Dubai Safari Park (north of Al Awir Road)	2	0.2	2	171.1	114%	0.3	0.03	0.3	141.3	707%
Pivot Fields	4	1.9	6	174.7	116%	0.6	0.27	0.9	141.9	709%
Desert Palm Polo Club	3	0.9	3	172.1	115%	0.6	0.08	0.7	141.7	708%
Desert Palm Riding Schools	4	0.6	4	173.3	116%	0.7	0.04	0.8	141.8	709%
Warsan Lake	2	0.2	2	171.0	114%	0.2	0.02	0.2	141.2	706%

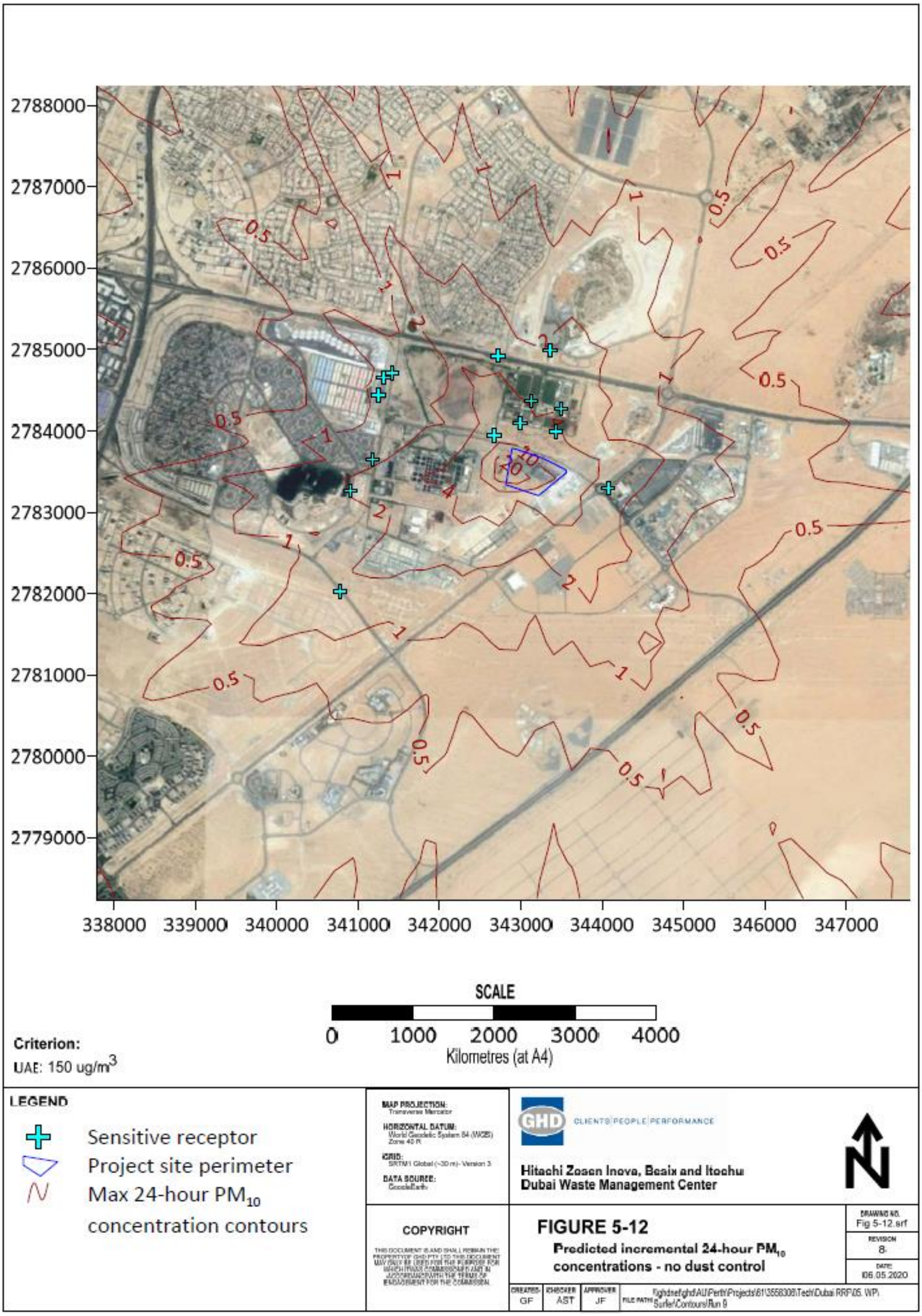


Figure 6-11 Predicted incremental 24-hour PM_{10} concentrations – no dust control

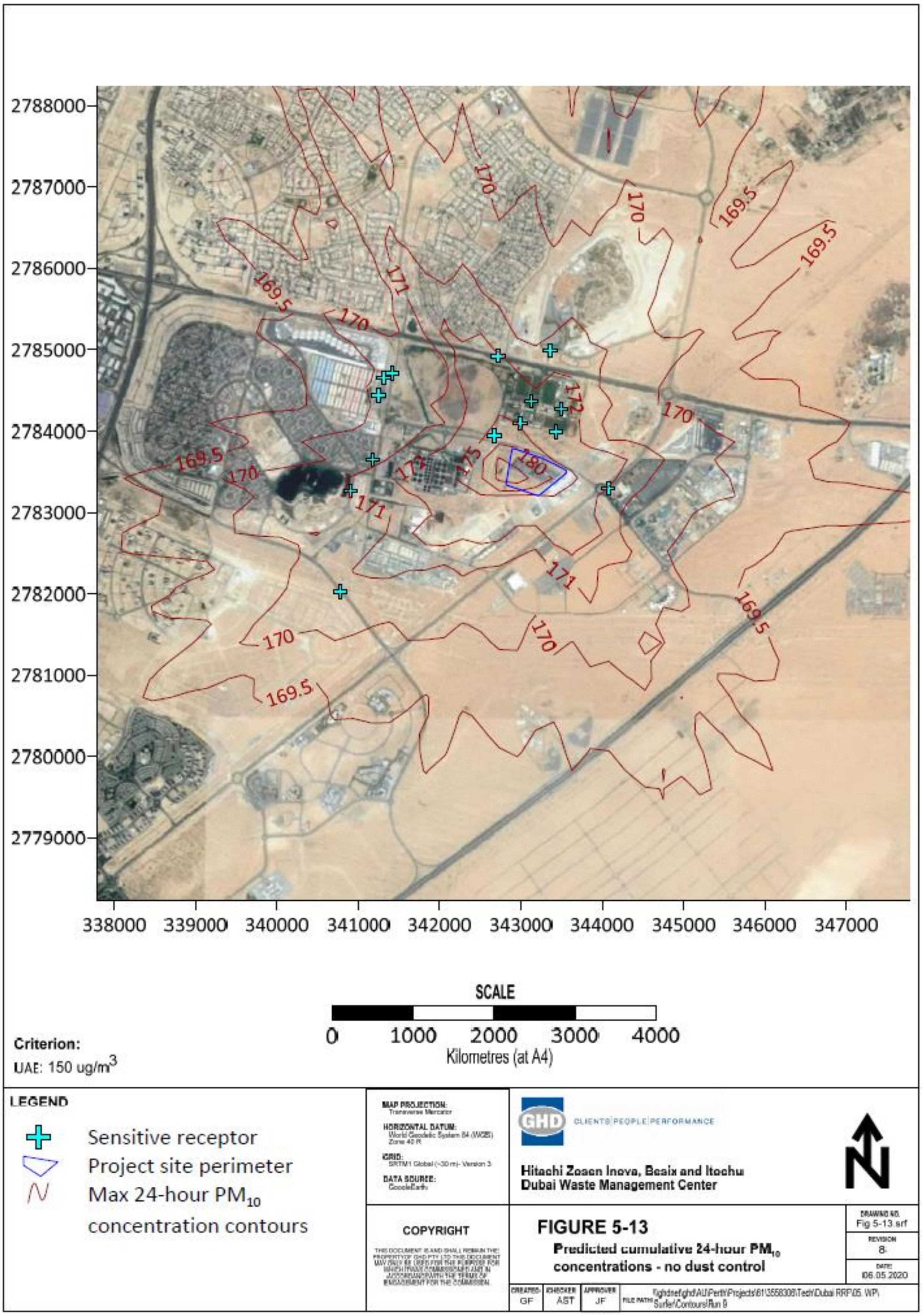


Figure 6-12 Predicted cumulative 24-hour PM_{10} concentrations – no dust control

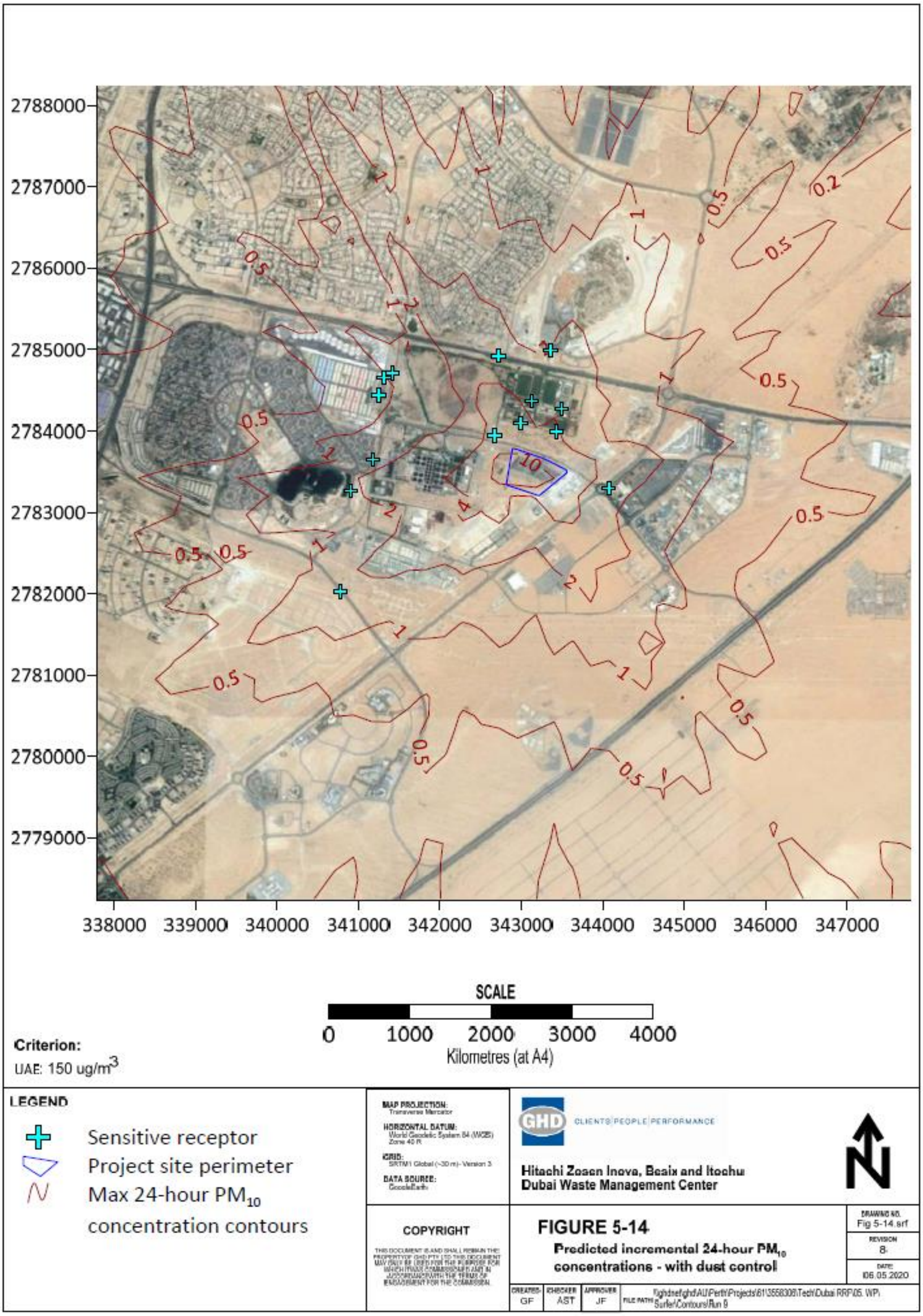


Figure 6-13 Predicted incremental 24-hour PM_{10} concentrations – with dust control

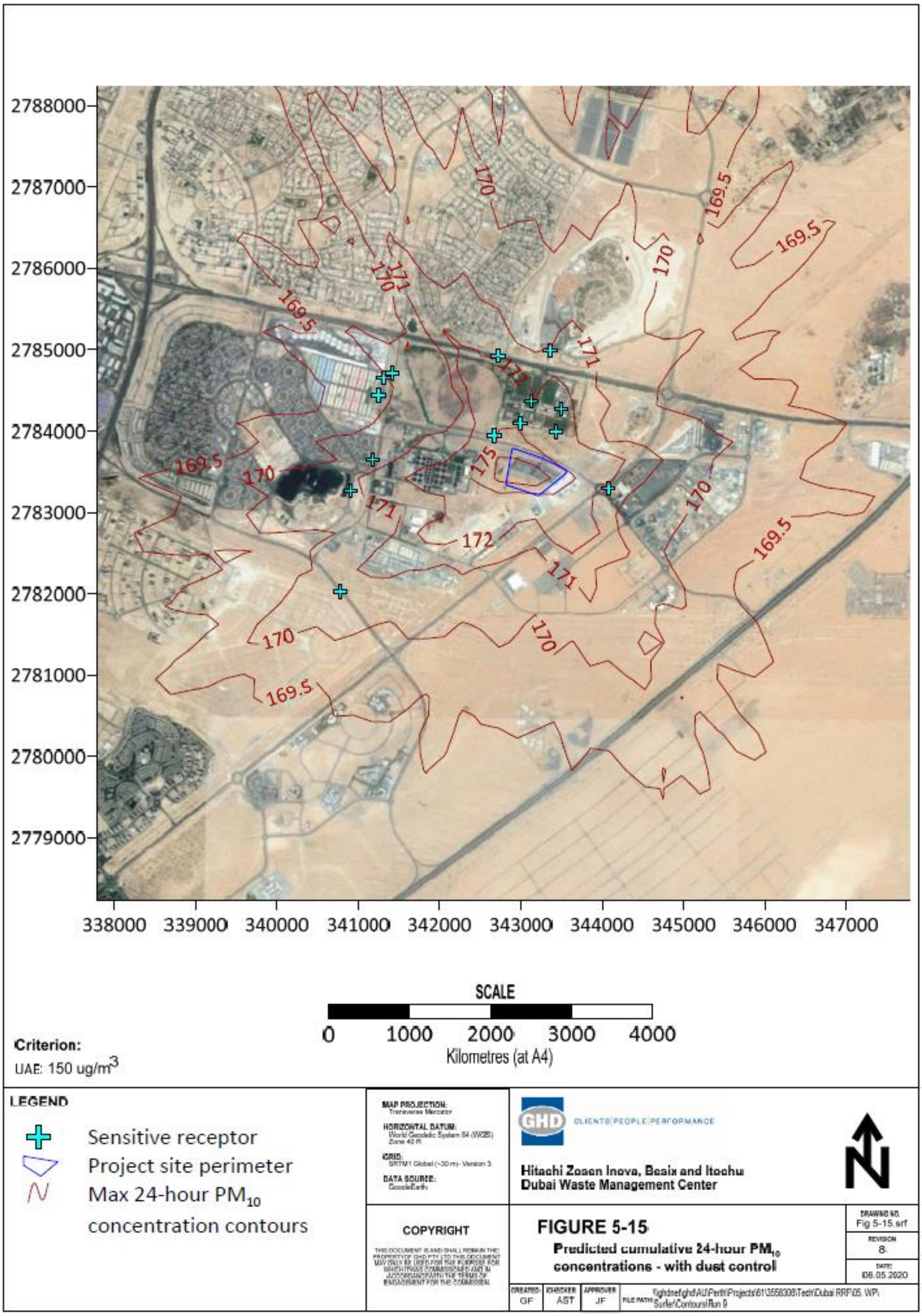


Figure 6-14 Predicted cumulative 24-hour PM_{10} concentrations – with dust control

$PM_{2.5}$

Table 6-17 and Table 6-18 show the predicted 24-hour and annual GLCs for $PM_{2.5}$ without andwith dust control respectively, as described in Section 5.1 of the Air Quality Assessment Report.

The adopted background concentrations for $PM_{2.5}$ are:

- 24-hour concentration – 60 μg/m^3 , which is 240 percent of the WHO assessment criteria of 25 μg/m^3.
- Annual concentration – 48 μg/m^3, which is 480 percent of the WHO assessment criteria of 10 μg/m^3.

Stack emissions were calculated assuming a conservative ratio of 1:1 for TSP to $PM_{2.5}$ and wheel-generated emissions were calculated using emission-specific factors.

Results have been presented as stack $PM_{2.5}$ concentrations, IBA $PM_{2.5}$ concentrations and total $PM_{2.5}$ concentrations in order to give a greater understanding of the proportion of $PM_{2.5}$ being emitted at each source.

For no dust control (Table 6-17), the highest predicted incremental 24-hour and annual averaging period concentrations fall well below the assessment criteria for both the stack and IBA emissions, as well as the total of these. The predicted cumulative 24-hour total $PM_{2.5}$ concentrations exceed the WHO criteria (with a maximum of 66 μg/m^3 occurring at Residential Villas (Desert Palm), equating to 263 percent of the criteria) due to the background concentration exceeding the criteria. The predicted cumulative annual total $PM_{2.5}$ concentrations exceed the WHO criteria (with a maximum of 49 μg/m^3 occurring Residential Villas (Desert Palm), equating to 489 percent of the criteria) due to the background concentration exceeding the criteria.

Similarly, with dust control (Table 6-18), the highest predicted incremental 24-hour and annual averaging period concentrations fall well below the assessment criteria for both the stack and IBA emissions, as well as the total of these. The predicted cumulative 24-hour total $PM_{2.5}$ concentrations exceed the WHO criteria (with a maximum of 66 μg/m^3 occurring at Residential Villas (Desert Palm), equating to 263 percent of the criteria) due to the background concentration exceeding the criteria. The predicted cumulative annual total $PM_{2.5}$ concentrations exceed the WHO criteria (with a maximum of 49 μg/m^3 occurring at Residential Villas (Desert Palm), equating to 489 percent of the criteria) due to the background concentration exceeding the criteria.

The predicted maximum 24-hour concentration from stack emissions do not necessarily occur on the same day as predicted maximum 24-hour concentrations from the IBA management area. Hence summed stack 24-hour $PM_{2.5}$ concentrations with IBA management area's 24-hour $PM_{2.5}$ concentrations do not equal the Project's total predicted maximum $PM_{2.5}$ concentrations.

This is due to daily varying meteorological parameters, such as wind speed and wind direction enabling a differing $PM_{2.5}$ dispersion patterns. The incremental and cumulative 24-hour $PM_{2.5}$ ground level concentration contours with no dust control are presented in Figure 6-15 and Figure 6-16 respectively. The incremental and cumulative 24-hour PM2.5 ground level concentration contours with dust control are presented in Figure 6-17 and Figure 6-18 respectively.

Table 6-17 Predicted 24-hour and annual $PM_{2.5}$ concentrations – no dust control

Receptor	Incremental 24-hour Stack $PM_{2.5}$ (µg/m³)	Incremental 24-hour IBA $PM_{2.5}$ (µg/m³)	Incremental total 24-hour $PM_{2.5}$ (µg/m³)	Cumulative total 24-hour $PM_{2.5}$ (µg/m³)	Cumulative % of criteria	Incremental stack annual $PM_{2.5}$ (µg/m³)	Incremental IBA annual $PM_{2.5}$ (µg/m³)	Incremental total annual $PM_{2.5}$ (µg/m³)	Cumulative total annual $PM_{2.5}$ (µg/m³)	Cumulative % of criteria
Criteria (µg/m³)			25 (WHO)					10 (WHO)		
Dubai International City- EMR 14, Emirates Cluster	1	0.1	1	61.4	246%	0.2	0.006	0.2	48.2	482%
International City Phase II (under construction)	2	0.03	2	61.8	247%	0.1	0.001	0.1	48.1	481%
Residential Villas (Desert Palm)	6	0.4	6	65.7	263%	0.9	0.041	0.9	48.9	489%
AL Warqa 4 (north of Al Awir Road)	3	0.1	3	62.9	251%	0.4	0.011	0.4	48.4	484%
Dragon Mart Mosque	1	0.1	1	60.7	243%	0.1	0.004	0.1	48.1	481%
Dragon Mart Commercial Centre	1	0.1	1	61.2	245%	0.1	0.005	0.1	48.1	481%
Dubai Textile City	1	0.0	1	61.0	244%	0.1	0.004	0.1	48.1	481%
Desert Palm Resort and Hotel	3	0.1	3	63.4	254%	0.6	0.008	0.6	48.6	486%
Dubai Plant Nursery	3	0.1	3	62.9	251%	0.3	0.004	0.3	48.3	483%
Dubai Safari Park (north of Al Awir Road)	2	0.1	2	62.0	248%	0.3	0.007	0.3	48.3	483%
Pivot Fields	4	0.5	5	64.6	258%	0.6	0.067	0.7	48.7	487%
Desert Palm Polo Club	3	0.2	3	62.9	252%	0.6	0.019	0.6	48.6	486%
Desert Palm Riding Schools	4	0.1	4	64.3	257%	0.7	0.011	0.7	48.7	487%
Warsan Lake	2	0.1	2	61.9	247%	0.2	0.005	0.2	48.2	482%

Table 6-18 Predicted 24-hour and annual $PM_{2.5}$ concentration – with dust control

Receptor	Incremental 24-hour Stack $PM_{2.5}$ (µg/m³)	Incremental 24-hour IBA $PM_{2.5}$ (µg/m³)	Incremental total 24-hour $PM_{2.5}$ (µg/m³)	Cumulative total 24-hour $PM_{2.5}$ (µg/m³)	Cumulative % of criteria	Incremental stack annual $PM_{2.5}$ (µg/m³)	Incremental IBA annual $PM_{2.5}$ (µg/m³)	Incremental total annual $PM_{2.5}$ (µg/m³)	Cumulative total annual $PM_{2.5}$ (µg/m³)	Cumulative % of criteria
Criteria (µg/m³)			25 (UAE)					10 (WHO)		
Dubai International City- EMR 14, Emirates Cluster	1	0.03	1	61.4	245%	0.2	0.003	0.2	48.2	482%
International City Phase II (under construction)	2	0.01	2	61.8	247%	0.1	0.0005	0.1	48.1	481%
Residential Villas (Desert Palm)	6	0.17	6	65.7	263%	0.9	0.019	0.9	48.9	489%
AL Warqa 4 (north of Al Awir Road)	3	0.04	3	62.8	251%	0.4	0.005	0.4	48.4	484%
Dragon Mart Mosque	1	0.03	1	60.7	243%	0.1	0.002	0.1	48.1	481%
Dragon Mart Commercial Centre	1	0.03	1	61.2	245%	0.1	0.002	0.1	48.1	481%
Dubai Textile City	1	0.02	1	61.0	244%	0.1	0.002	0.1	48.1	481%
Desert Palm Resort and Hotel	3	0.07	3	63.4	254%	0.6	0.004	0.6	48.6	486%
Dubai Plant Nursery	3	0.06	3	62.8	251%	0.3	0.002	0.3	48.3	483%
Dubai Safari Park (north of Al Awir Road)	2	0.03	2	62.0	248%	0.3	0.003	0.3	48.3	483%
Pivot Fields	4	0.21	4	64.4	258%	0.6	0.031	0.6	48.6	486%
Desert Palm Polo Club	3	0.10	3	62.9	252%	0.6	0.009	0.6	48.6	486%
Desert Palm Riding Schools	4	0.06	4	64.3	257%	0.7	0.005	0.7	48.7	487%
Warsan Lake	2	0.02	2	61.8	247%	0.2	0.002	0.2	48.2	482%

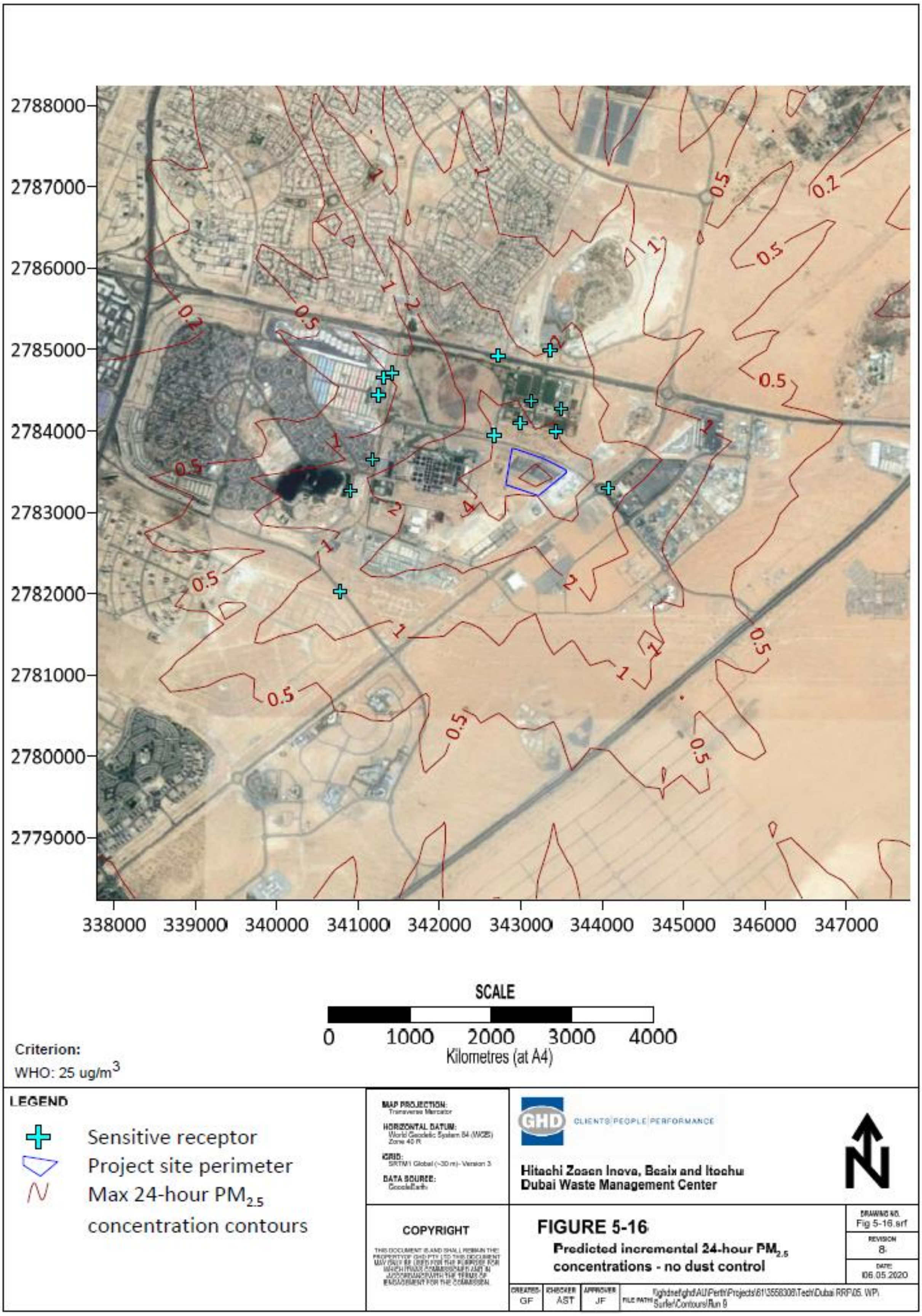


Figure 6-15 Predicted incremental 24-hour $PM_{2.5}$ concentrations – no dust control

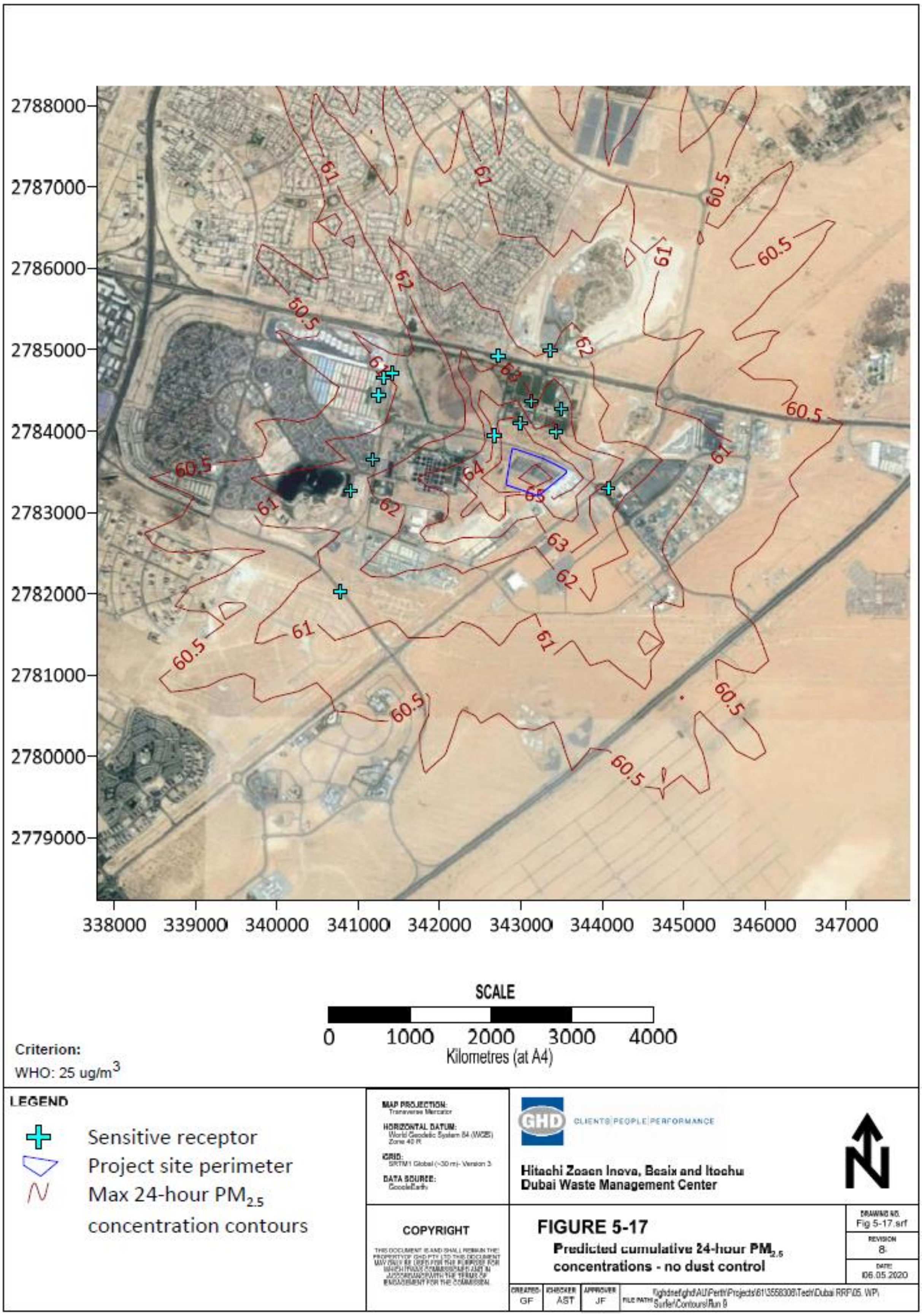


Figure 6-16 Predicted cumulative 24-hour $PM_{2.5}$ concentrations – no dust control

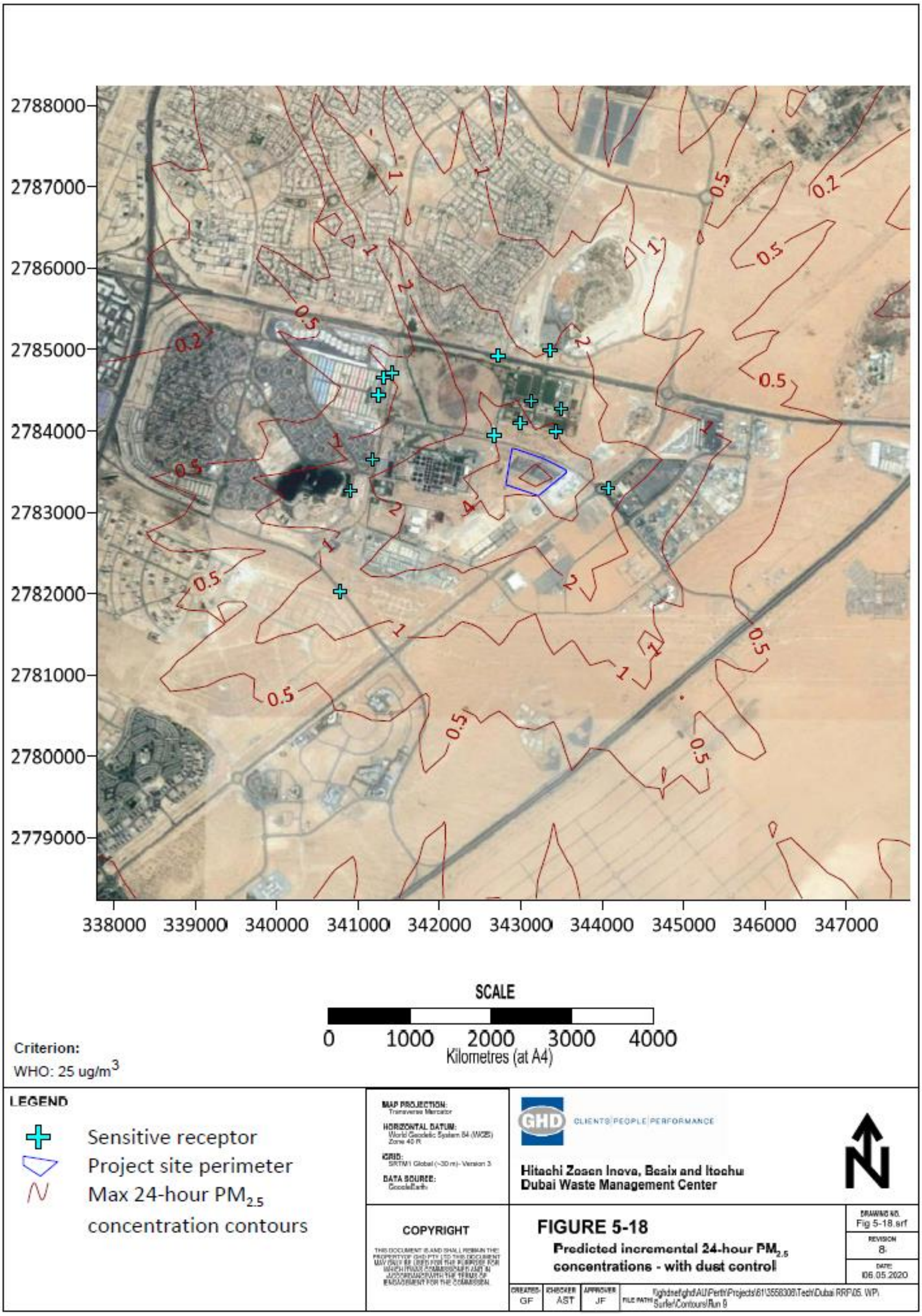


Figure 6-17 Predicted incremental 24-hour $PM_{2.5}$ concentrations – with dust control

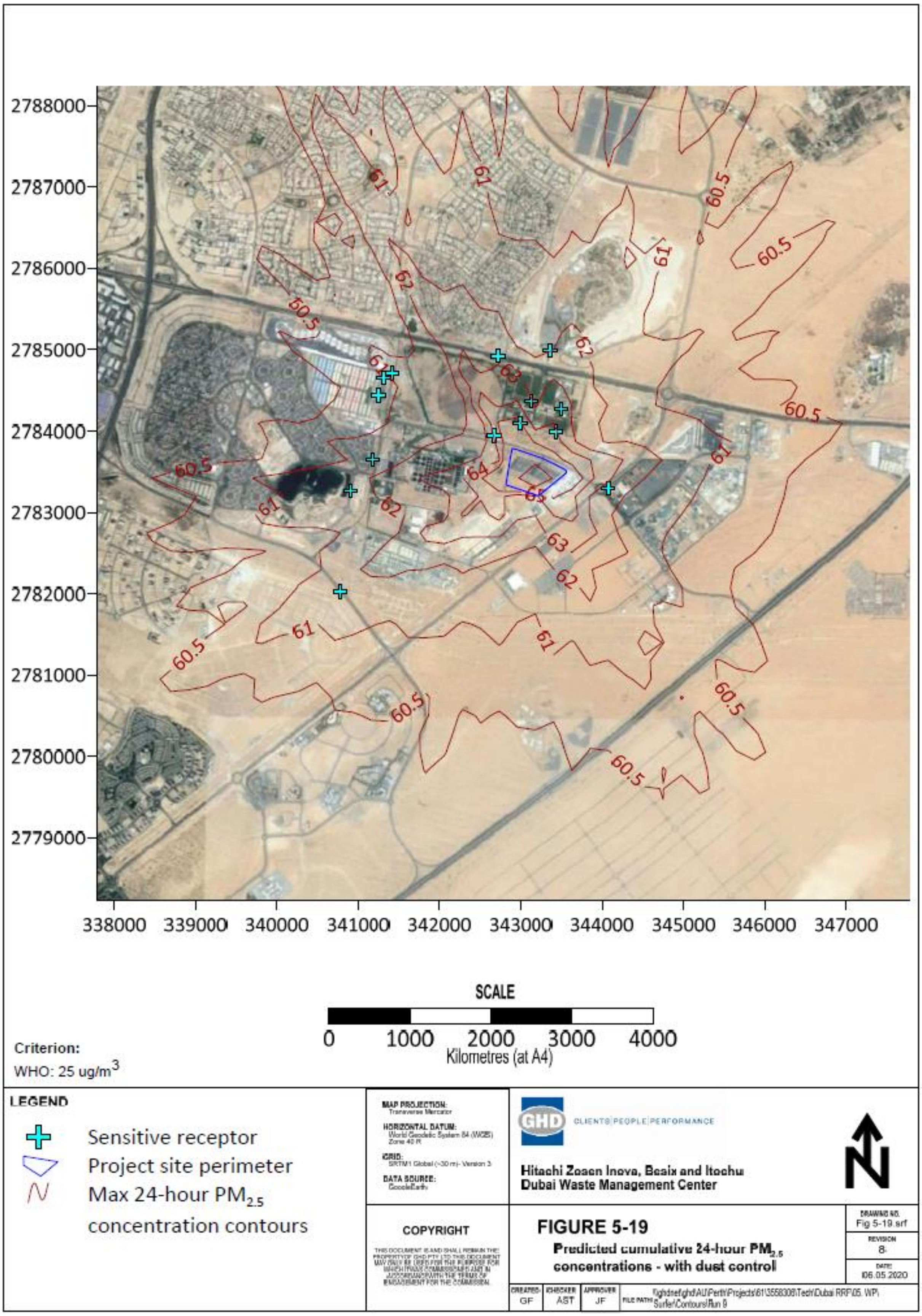


Figure 6-18 Predicted cumulative 24-hour $PM_{2.5}$ concentrations – with dust control

Acid gases (hydrogen chloride and hydrogen fluoride)

Table 6-19 shows the predicted 99.9th percentile 1-hour HCl and 24-hour HF ground level concentrations.

Background concentrations were not included for HCl or HF, as appropriate data were not available for use in this assessment. Therefore, an incremental assessment only is shown.

The highest predicted 1-hour 99.9th percentile concentration for HCl occurs at Pivot Fields, Residential Villas (Desert Palm) and Desert Palms Riding Schools, equating to 12 percent of the NSW AMMAAP assessment criteria. This complies comfortably with the WHO guideline regarding 25 percent of the criteria.

The highest predicted 24-hour concentration for HF occurs at Residential Villas (Desert Palm), equating to 19 percent of the NSW AMMAAP assessment criteria. This complies with the WHO guideline regarding 25 percent of the criteri

Table 6-19 Predicted 99.9th percentile 1-hour HCl and 24-hour HF concentrations

Receptor	Incremental 1-hour 99.9th HCl (µg/m³)	Incremental % of criteria	Incremental 24-hour HF (µg/m³)	Incremental % of criteria
Criteria (µg/m³)	140(NSW AMMAAP)		2.9(NSW AMMAAP)	
Dubai International City- EMR 14, Emirates Cluster	7	5%	0.14	5%
International City Phase II (under construction)	9	6%	0.18	6%
Residential Villas (Desert Palm)	17	12%	0.56	19%
AL Warqa 4 (north of Al Awir Road)	13	9%	0.28	10%
Dragon Mart Mosque	6	4%	0.07	2%
Dragon Mart Commercial Centre	10	7%	0.11	4%
Dubai Textile City	10	7%	0.10	3%
Desert Palm Resort and Hotel	14	10%	0.34	12%
Dubai Plant Nursery	9	7%	0.28	10%
Dubai Safari Park (north of Al Awir Road)	13	9%	0.20	7%
Pivot Fields	17	12%	0.42	15%
Desert Palm Polo Club	15	11%	0.29	10%
Desert Palm Riding Schools	17	12%	0.43	15%
Warsan Lake	6	4%	0.18	6%

Ammonia and dioxins and furans

Table 6-20 shows the predicted 99.9th percentile 1-hour TCDD and NH_3 ground level concentrations.

Background concentrations were not included for TCDD or NH_3, as appropriate data were not available for use in this assessment. Therefore, an incremental assessment only is shown.

The highest predicted 1-hour 99.9th percentile concentration for TCDD occurs at Pivot Fields, Residential Villas (Desert Palm) and Desert Palms Riding Schools, equating to 9 percent of the NSW AMMAAP assessment criteria. This complies comfortably with the WHO guideline regarding 25 percent of the criteria.

The highest predicted 1-hour 99.9th percentile concentration for NH_3 occurs at Pivot Fields, Residential Villas (Desert Palm) and Desert Palms Riding Schools, equating to 5 percent of the NSW AMMAAP assessment criteria. This complies comfortably with the WHO guideline regarding 25 percent of the criteria.

Table 6-20 Predicted 1-hour TCDD and NH_3 concentrations

Receptor	Incremental 1-hour 99.9th TCDD (ng/m³)	Incremental % of criteria	Incremental 1-hour 99.9th NH_3 (µg/m³)	Incremental % of criteria
Criteria (µg/m³)	2.00E-06 (NSW AMMAAP)		330 (NSW AMMAAP)	
Dubai International City- EMR 14, Emirates Cluster	7.11E-08	4%	7	2%
International City Phase II (under construction)	8.54E-08	4%	9	3%
Residential Villas (Desert Palm)	1.72E-07	9%	17	5%
AL Warqa 4 (north of Al Awir Road)	1.31E-07	7%	13	4%
Dragon Mart Mosque	5.85E-08	3%	6	2%
Dragon Mart Commercial Centre	1.01E-07	5%	10	3%
Dubai Textile City	1.03E-07	5%	10	3%
Desert Palm Resort and Hotel	1.44E-07	7%	14	4%
Dubai Plant Nursery	9.43E-08	5%	9	3%
Dubai Safari Park (north of Al Awir Road)	1.32E-07	7%	13	4%
Pivot Fields	1.72E-07	9%	17	5%
Desert Palm Polo Club	1.54E-07	8%	15	5%
Desert Palm Riding Schools	1.73E-07	9%	17	5%
Warsan Lake	5.99E-08	3%	6	2%

Mercury and cadmium

Table 6-21 shows the predicted 99.9th percentile 1-hour and annual Hg and Cd ground level concentrations.

Background concentrations were not included for Hg or Cd, as appropriate data were not available for use in this assessment. Therefore, an incremental assessment only is shown.

The highest predicted 1-hour 99.9th percentile concentration for Hg occurs at Pivot Fields, Residential Villas (Desert Palm) and Desert Palms Riding Schools, equating to 5 percent of the NSW AMMAAP assessment criteria. This complies comfortably with the WHO guideline regarding 25 percent of the criteria.

Predicted 1-hour concentrations of Cd exceed the criteria at all sensitive receptors. However, the NSW AMMAAP can be considered a guideline only as opposed to a strict limit and states “toxic air pollutants must be minimised to the maximum extent achievable through the application of best-practice process design and/or emission controls” (NSW DEC, 2005). As this is a national guideline designed for relevance to Australian projects, it is apparent that the European Commission criteria are more suitable since the stack emissions of the WMC are complying with the European IED. The highest predicted annual concentration for Cd occurs at Residential Villas (Desert Palm), equating to 87 percent of the European Commission criteria.

Cd emission rates for this assessment were based on the regulatory IED concentration of 0.05 mg/Nm3, equating to an emission rate of 0.0034 g/s. This rate is for the total of Cd and thallium emissions combined and therefore a conservative approach was taken, assuming that 100% of the emissions are Cd. However, it is noteworthy that Cd levels in MSW are expected to be relatively low and therefore, emission rates of the pollutant would not reach the levels demonstrated. As shown in Section 5.1.1, WMCs most recently constructed by Hitachi Zosen Inova showed emission rates of Cd and thallium to range between 0.00003 g/s to 0.00006 g/s for the WMC with an identical air pollution control system to be implemented in the Dubai WMC. Therefore, the expected maximum ambient concentration of Cd at the sensitive receptors in reality is likely to be significantly lower.

Table 6-21 Predicted 1-hour and annual mercury and cadmium concentrations

Receptor	Incremental 1-hour 99.9th Hg (µg/m³)	Incremental % of criteria	Incremental 1-hour 99.9th Cd (µg/m³)	Incremental % of criteria	Incremental annual Cd (µg/m³)	Incremental % of criteria
Criteria (µg/m³)	1.8 (NSW AMMAAP)		0.018 (NSW AMMAAP)		0.005 (European Commission)	
Dubai International City- EMR 14, Emirates Cluster	0.04	2%	0.04	197%	0.001	19%
International City Phase II (under construction)	0.04	2%	0.04	236%	0.001	12%
Residential Villas (Desert Palm)	0.09	5%	0.09	475%	0.004	87%
AL Warqa 4 (north of Al Awir Road)	0.07	4%	0.07	362%	0.002	36%
Dragon Mart Mosque	0.03	2%	0.03	162%	0.001	11%
Dragon Mart Commercial Centre	0.05	3%	0.05	280%	0.001	12%
Dubai Textile City	0.05	3%	0.05	286%	0.001	11%
Desert Palm Resort and Hotel	0.07	4%	0.07	399%	0.003	56%
Dubai Plant Nursery	0.05	3%	0.05	261%	0.002	33%
Dubai Safari Park (north of Al Awir Road)	0.07	4%	0.07	364%	0.002	31%
Pivot Fields	0.09	5%	0.09	474%	0.003	59%
Desert Palm Polo Club	0.08	4%	0.08	427%	0.003	57%
Desert Palm Riding Schools	0.09	5%	0.09	478%	0.004	71%
Warsan Lake	0.03	2%	0.03	166%	0.001	21%

Summary

For this assessment, air quality criteria including Ministerial Oder No, 12, 2006, US OSHA, 29 CFR, Part 1910, US EPA NAAQs 40 CFR Part 50, WHO Ambient Air Quality Standards, the NSW AMMAAP and European Commission standards were reviewed, and the most appropriate of these used as a comparison to predicted GLCs of selected air pollutants. The results demonstrate predicted incremental GLCs for NO_2, SO_2, CO, TPS, PM_{10}, $PM_{2.5}$, HCl, HF, NH_3,TCDD and Hg do not exceed the adopted assessment criteria, based on the stack characteristics and emission rates assumed for the Project.

Predicted incremental 1-hour concentrations of Cd exceed the NSW AMMAAP guidelines. This is likely due to the conservative assumption that the IED emission limit of 0.05 mg/Nm^3, was 100% Cd as opposed to the total of Cd and thallium, as the IED limits state. Ambient concentrations of Cd associated with the stacks are likely to be lower in reality. As discussed in above, WMCs most recently constructed by Hitachi Zosen Inova showed emission rates of Cd and thallium to range between 0.00003 g/s to 0.00006 g/s as opposed to the 0.0034 g/s used in this assessment. Further, the European Commission annual standard for Cd is considered more relevant for this assessment over the Australian guidelines (NSW AMMAAP). The predicted annual concentrations of Cd comply with the European Commission criteria at all sensitive receptors.

The maximum predicted cumulative concentration for 24-hour NO_2 exceeds the UAE criteria by 3 percent, however the incremental concentration complies with the criteria. The cumulative exceedance is attributed to the background concentration being 85% of the criteria. It is also noted that the conservative NOx to NO_2 ratio of 40 percent was used, where in reality, this ratio is likely to be around 20 percent for combustion sources.

The cumulative concentrations for PM_{10} exceed the UAE 24-hour and annual WHO criteria, while the cumulative concentrations for $PM_{2.5}$ exceed the WHO 24-hour and annual criteria due to the adopted background concentrations exceeding the criteria. The incremental contribution of the WMC to TSP, PM_{10}, and $PM_{2.5}$ ambient concentrations are less than the respective assessment criteria, including the WHO Interim target 1.

6.3.2.2 Odour Emissions – Qualitative Assessment

GHD have reviewed the following documents in the preparation of this qualitative assessment:

- Al Aweer Sewage Treatment Plant (STP) Environmental Performance Audit Report (Hyder 2017)
- Odour Monitoring Report Al Warsan, Dubai (January 19, 2017)

Odour Criteria

In the absence of odour criteria in Dubai, the Australian *The Approved Methods for the Modelling and Assessment of Air Pollutants in New South Wales* (‘the Approved Methods’) (EPA, 2016) have been adopted for this assessment. The Approved Methods list the statutory methods for modelling and assessing emissions of air pollutants from stationary sources in New South Wales, Australia. The assessment criteria for odour is applied at the nearest existing or likely future off-site sensitive receptor.

The Approved Methods also defines odour assessment criteria and specifies how they should be applied in dispersion modelling to assess the likelihood of nuisance impact arising from the emission of odour.

Odour impact is a subjective experience and has been found to depend on many factors, the most important of which are the:

- **F**requency of the exposure
- **I**ntensity of the odour
- **D**uration of the odour episodes
- **O**ffensiveness of the odour
- **L**ocation of the source.

These factors are often referred to as the FIDOL factors.

The odour assessment criteria is defined to take account of two of these factors (**F** is set at 99th percentile; **I** is set at from 2 to 7 OU). The choice of assessment criteria is also dependent on the population of the affected area as shown in Table 6-22.

Table 6-22 Odour Criteria for the Assessment of Odour (EPA, 2016)

Population of affected community	Odour performance criteria (nose response odour certainty units at 99th percentile[1])
Single Residence (≤ ~2)	7
~10	6
~30	5
~125	4
~500	3
Urban (≥~2000)	2

Note 1: This is a prediction of the odour level that may occur 1% of the time, or one hour in one hundred. Odour performance criteria are designed to be precautionary, so that impacts on sensitive receivers can be minimised.

The criteria assumes that 7 OU at the 99th percentile would be acceptable to the average person, but as the number of exposed people increases there is a chance that sensitive individuals would be encountered. The criteria of 2 OU at the 99th percentile is considered to be acceptable for large populations (more than 2,000 people).

The criteria have also been specified at an averaging time of nominally 1 second. The choice of the short averaging time recognises that the human nose has a response time of less than 1 second, so that modelling of odour impact should allow for the short-term concentration fluctuations in an odour plume due to turbulence.

For urban areas located adjacent to the proposal, the 2 OU criteria would be applicable.

Existing environment and sensitive receptors

A review of the existing environment around the WtE indicates that it is currently surrounded by a number of potential odour sources. These include:

- The Tadweer landfill
- The Al Aweer STP
- The Al Serkal/envirol grease trap waste recycling plant
- China state asphalt mixing plant
- Emirates beton readymix L.L.C (concentrate supplier).

The nearest sensitive receptors to the proposed WtE plant are:

- Dubai International City to the west, located adjacent to the Al Aweer STP
- Ruwaya Village (Planned residential area) to the South
- Desert Palm Polo club to the North

Odour sources (existing)

The major existing odour sources in the area include the Tadweer landfill and the Al Aweer STP.

Potential odour sources from the Tadweer landfill would include:

- Active tipping face
- Daily cover
- Intermediate cover
- Leachate pond(s).

The exact contributions from each of these sources to the overall environment would depend on their areas, volume of handled waste, age of the waste and the level of current odour mitigation measures in place.

Potential odour sources from the Al Aweer STP would include:

- Odour control unit stacks
- Primary, secondary and tertiary settling tanks
- Sludge disposal, storage and drying areas.

The exact contributions from each of these sources to the overall environment would depend on their areas, duration of sludge drying, the level of current agitation/aeration in the settling tanks and the level of current odour mitigation measures in place.

Odour sources (WtE)

Potential odour sources from the proposed WtE include:

- Odour from bottom ash
- Odour from pollutants emitted from the stack
- Odour from outdoor storage of putrescible waste and sewage storage tanks
- Waste spill during transportation of waste from sources to the project site
- Settling tanks and/or sludge storage/disposal areas associated with the wastewater treatment plant

Additionally, air quality impacts (NO_2, SO_2, H_2S, etc.) may result from the combustion process, the boiler system and the FGT system. These would need to be considered as part of a detailed air quality assessment.

Qualitative assessment and recommendations

Based on a review of the provided information, GHD note the following:

- The Al Aweer STP is the dominant odour source in the area and for winds from the East, cumulative odour impacts are likely to be dominated by the STP at the Dubai International City
- For the residential areas to the South of the proposal, the STP, landfill and the proposed WtE may potentially contribute to cumulative odour impacts

- For the residential areas directly to the North of the proposal, the WtE plant is likely to be the dominant odour contributor.

6.3.2.3 Odour Modelling Result

A summary of the odour modelling study undertaken for the proposed project is provided below while the detailed report is presented in Appendix N.

Assessment Criteria

There are no odour criteria for the UAE. As an alternative, odour criteria from Environmental Protection Agency was used for this assessment, *The Approved Methods for the Modelling and Assessment of Air Pollutants in New South Wales* (EPA, 2016) list the statutory methods for modelling and assessing emissions of air pollutants from stationary sources in New South Wales, Australia. The assessment criteria for odour is applied to the defined sensitive receptors in Section 4.4.

Odour impact is subjective and can be described using the following factors, called the FIDOL factors:

- ***F***requency of exposure
- ***I***ntensity of odour
- ***D***uration of odour episodes
- ***O***ffensiveness of odour
- ***L***ocation of odour source

The odour assessment criteria is defined to take account of two of these factors (F is set at the 99th percentile; I is set from 2 to 7 OU). The choice of assessment criteria is also dependent on the population of the affected area as shown in Table 6-23.

Table 6-23 Odour assessment criterion

Population of affected community	Odour performance criteria (nose response odour certainty units at 99th percentile)
Single residence (≤~2)	7
~10	6
~30	5
~125	4
~500	3
Urban (≥~2000)	2

The criteria assumes that 7 OU at the 99th percentile would be acceptable to the average person, but as the number of exposed people increases there is a chance that sensitive individuals would be encountered. The criteria of 2 OU at the 99th percentile is considered to be acceptable for large populations (more than 2000 people).

The criteria have also been specified at an averaging time of 1 second. The choice of the short averaging time recognises that the human nose has a response time of less than 1 second, so that modelling of odour impact should allow for the short-term concentration fluctuations in an odour plume due to turbulence.

For urban areas located adjacent to the proposed WtE plant, the 2 OU criteria would be applicable and is adopted for this assessment.

Reference to nearby odour sources

To gauge the level of odour the proposed site is predicted to contribute to the local environment, odour concentrations from this assessment will also be compared to predicted odour concentrations from nearby odour sources.

Odour impact from the Al Aweer STP was assessed by Hyder in an Environmental Performance Audit Report for the Dubai Municipality in 2017 (Hyder 2017). The report predicted odour concentrations at Al Aweer STP, Tadweer Materials Recovery Facility (MRF), Al Aweer Landfill and Al Serkal/Envirol Grease Trap Waste Recycling Plant. These odour sources are situated within 1.5 km of the proposed WtE plant, the locations of which are shown in Figure 6-19. The predicted odour contour plots are shown in Figure 6-20.

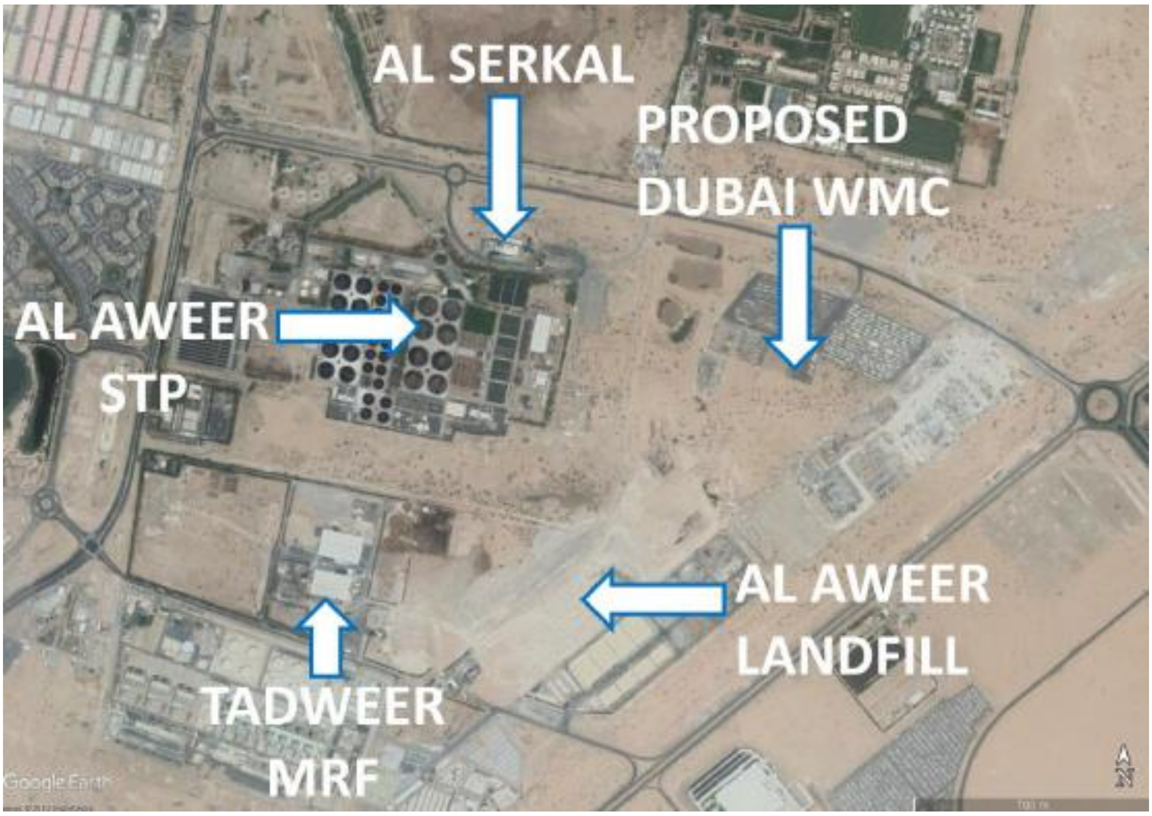
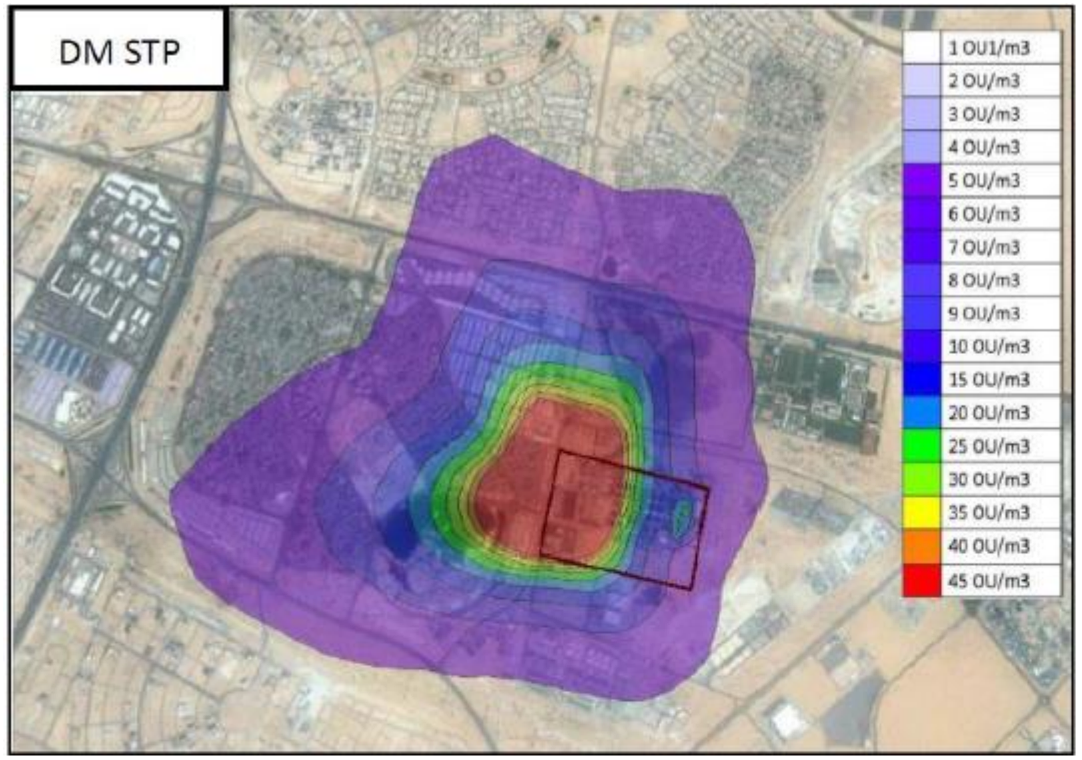


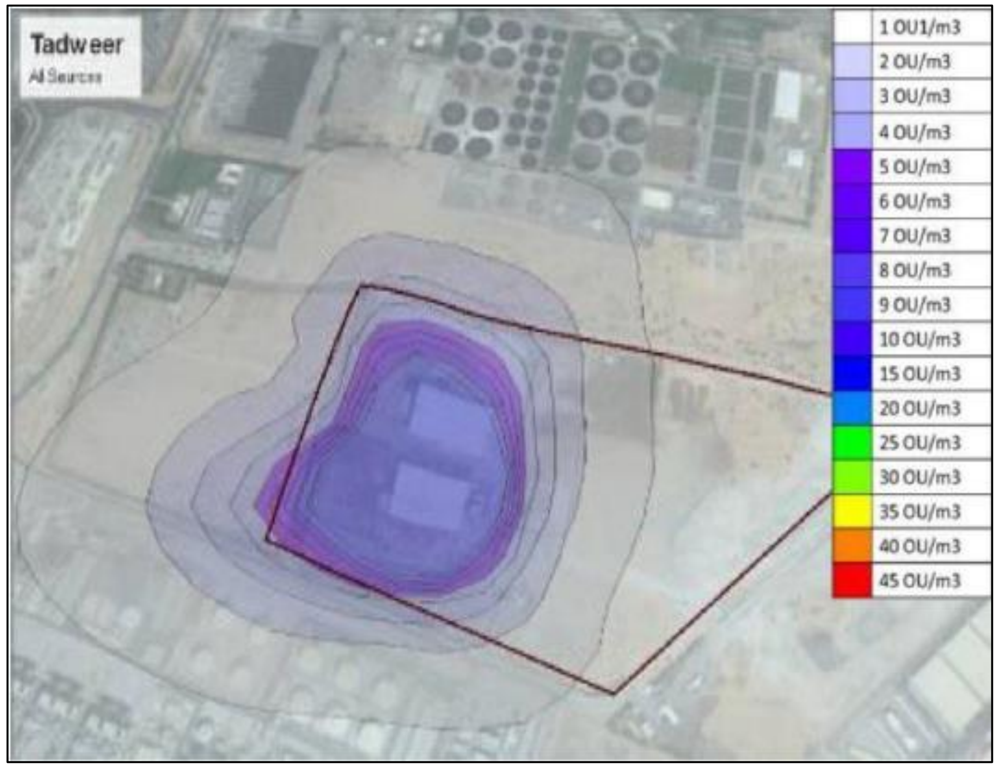
Figure 6-19 Nearby odour sources

Figure 6-20(A) shows that odour concentrations at the STP reach up to 45 OU/m^3 immediately surrounding the source, and extends to sensitive receptors Dubai International City, Dubai Textile City.

At the remaining three sources, odour concentrations range between 10 OU/m^3 and 5 OU/m^3, with concentrations not dispersing as far as any defined sensitive receptors.

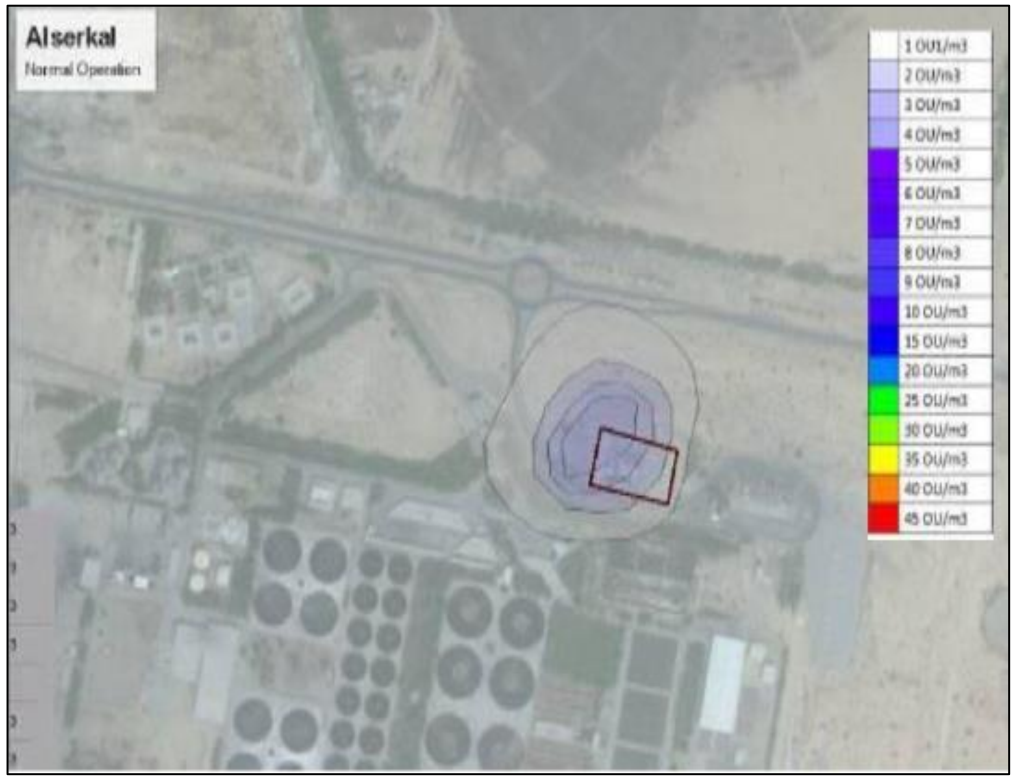


A. Predicted 1-hour, 99th percentile odour concentration plots for Al Aweer STP



B. Predicted 1-hour, 99th percentile odour concentration plots for Tadweer MRF

C. Predicted 1-hour, 99th percentile odour concentration for Al Aweer Landfill



D. Predicted 1-hour, 99th percentile odour concentration plots for Al Serkal Waste Recycling Plant

Figure 6-20 Predicted odour contour plots around the Project site

Odour modelling was carried out at the Tadweer Waste Treatment LLC and the 1-hour 98th percentile odour concentration was predicted. Model results showed that the Tadweer Waste Treatment LLC emitted odour concentrations of 5 OU at the perimeter boundary of the facility. The contour figure for the assessment are shown in Figure 6-21.

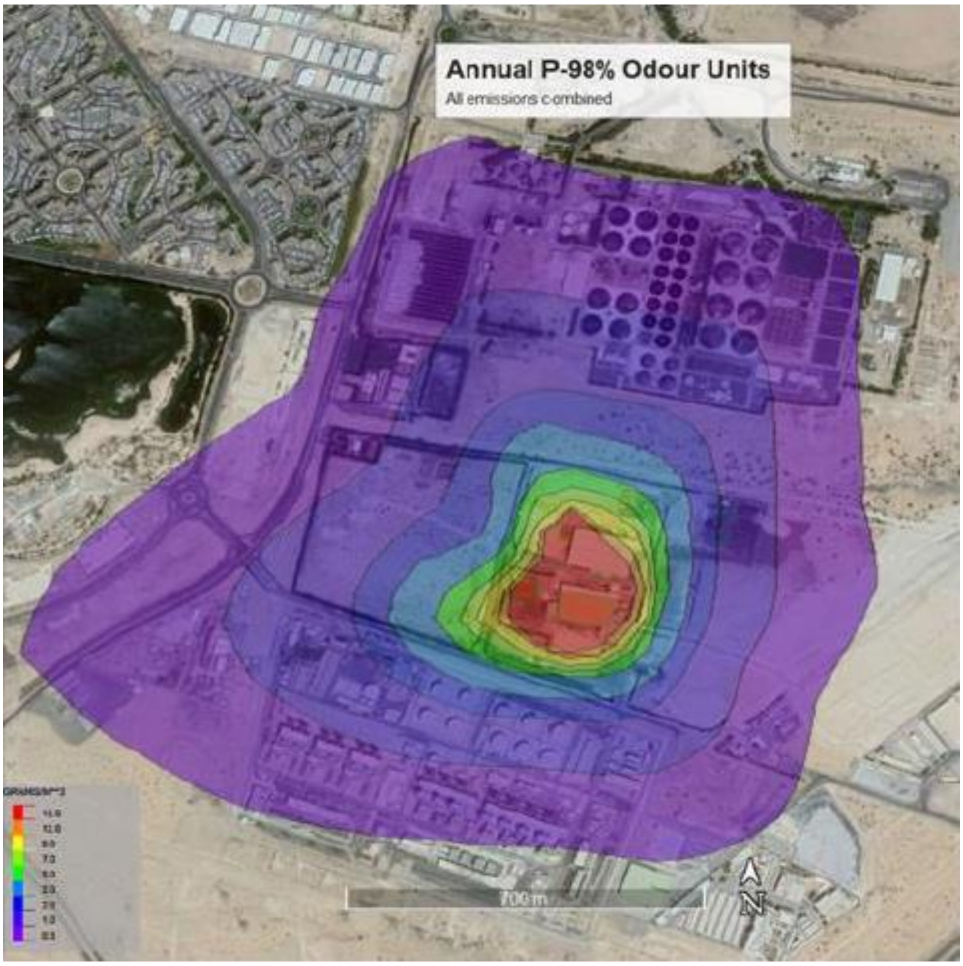


Figure 6-21 Predicted 98th percentile 1-hour average ground level odour concentrations

Estimated emissions

Odour Sources

The main source of odour in the WtE plant is the MSW stored in the waste bunker. The odour results from the waste composition and the aging process of the waste. The waste bunker is split into two compartments, with shared airspace, one of which serves two of the incineration lines, and the other serves the remaining three incineration lines. The waste bunker is located within the main building as shown in Figure 6-22.

The waste bunker is accessed by 27 tipping bays, each of which have a roller door which remain open only during the presence of a waste delivery truck (for approximately 6 minutes per delivery). Forty-four (44) waste truck deliveries are anticipated every hour. The waste bunker is expected to manage a nominal throughput of 236.11 t/hour. It is designed with a four day capacity of waste under nominal operating conditions equating to a storage capacity of 22,666 tonnes (HZI 2018).

The waste bunker dimensions were taken from HZI (2018) to be a total of 33 m in height, 23 m depth and 143 m in width. Therefore, the total volume of the bunker is 108,537 m^3.

For the purpose of this assessment, when the tipping bay doors are closed, the fugitive odour emissions from the waste bunker are considered negligible. Similarly, as the trucks are enclosed, any odorous emissions from trucks are assumed negligible. No odour emissions are expected from the stacks as the odorous compounds would have undergone chemical decomposition during incineration.

Figure 6-22 Waste bunker and tipping area locations

Upset conditions

During normal operating procedure, air in the waste bunker is sucked into the boiler for combustion and is replaced by fresh air. This flow of air provides a sufficient negative pressure in the waste bunker, preventing the majority of odour from escaping. A minimum of two of the five incineration lines will be in operation at any one time in order to maintain the slight negative pressure and prevent the release of odorous gas.

This assessment was carried out for three operating scenarios, one of which represents nominal operating conditions and two of which represent upset conditions to simulate worst case for odour dispersion. The worst case conditions used in the model consist of:

- Temporary loss of negative pressure in the waste bunker due to shutdown of all five incineration lines
- The delivery of MSW as normal (44 truck deliveries per hour)

Adopted OER inventory

In order to best estimate the odour emissions from the facility during a loss of negative pressure, the model was set up with regard to the number of tipping bay doors, tipping bay door dimensions and the duration the doors are open. It was estimated that during nominal operation, four tipping bay doors would remain open continuously each hour. Therefore, the source was configured to represent the equivalent of having four tipping bay doors open. It was assumed that the area of each roller door would be 4.4 m in width and 9 m in height, resulting in an area of 39.6 m^2.

- *Flow rate.* Flow rate accounts for the volumes of air that escape the tipping bay when the doors are open. Several flow rates were used for sensitivity testing of the model reflecting negative pressure maintained and negative pressure lost. Flow rates used were 0.1 m/s (negative pressure maintained), 0.6 m/s (based on two air exchanges per hour when negative pressure is lost) and 1.2 m/s (worst case scenario based on four air exchanges per hour when negative pressure is lost).
- *Peak to mean ratio*. The Gaussian Plume model used in this assessment for the dispersion modelling of odour can only predict odour concentrations over an averaging

period of 3-minutes or more. However, as discussed above (odour assessment criteria), the human response time to odour is approximately 1 second. During a 3-minute period, odour levels can fluctuate significantly. The peak to mean ratio is the ratio between the one second peak concentrations and three minute and longer average period concentrations. Katestone Scientific Pty Ltd (1995, 1998) were commissioned by the EPA to determine a suitable peak to mean ratio for a Gaussian Plume model and this ratio was adopted for this assessment. The peak to mean ratio used was 2.3.

- *OER*. As no site specific OERs were available for the Project as it was still in the approvals phase, the OER was adopted from PEL 2015, which is considered to be representative of odour emission rates at the WtE plant. The odour concentration adopted from PEL 2015 was supported by an article by Loghurst (2007), exploring the principle of landfill odour emission. The OER for the WMC was estimated using the following equations:

$$\textit{OER} = (\textit{Odour conc x area})\ \textit{flow rate x PMR}$$
$$\textit{Modelled OER for volume source} = \textit{OER x } n_{\textit{open tipping bay doors}}$$

Where:

Odour concentration:	558 OU
Area:	39.6 m^2
Flow rate:	0.1 m/s, 0.6 m/s or 1.2 m/s
PMR:	2.3
$n_{\text{open tipping bay doors}}$:	4

The modelled OER are presented in Table 6-24.

Table 6-24 Modelled odour emission rates for each scenario

Flow rate (m/s)	Modelled OER (OU.m^2/s)
0.1 (nominal conditions)	20,328
0.6 (upset conditions)	121,974
1.2(upset conditions – worst case)	243,948

Approach to Odour Modelling

AERMET is the meteorological pre-processor to AERMOD, which uses measured (or modelled) meteorological observations to generate two meteorological input files required by AERMOD. These two files consist of a surface file and an upper air file, which are used by AERMOD to characterise boundary layer characteristics which influences dispersion in the atmosphere.

Using monitored data from Dubai International Airport, the following parameters were input into AERMET, for the period 1 January 2015 to 31 December 2015:

- Year
- Month
- Day
- Hour
- Wind speed
- Wind direction
- Temperature

- Cloud cover
- Ceiling height

The USEPA preferred model – AERMOD is chosen for this assessment based on relatively short distance between emission source and sensitive receptors. AERMOD is a steady-state Gaussian Plume model that incorporates air dispersion based on planetary boundary layer turbulence structure and scaling concepts, including treatment of both surface and elevatedsources and both simple and complex terrain.

The odour source was modelled as a volume source in AERMOD, with the size of the source representative of 4 tipping bay doors open at any one time. The volume source parameters used in the model are displayed in Table 6-25.

Table 6-25 Volume source parameters used in model

Source coordinates	343091.26 m N 2783498.58 m E
Base elevation	34.73 m
Release height	4.5 m (taken as half the roller door height)
Length of side of source	17.6 m (to reflect 4 doors X 4.4 m width)
Initial lateral dimension	4.093 (calculated by AERMOD)
Initial vertical dimension	15.35 m (calculated by AERMOD)

Assessment of Impacts

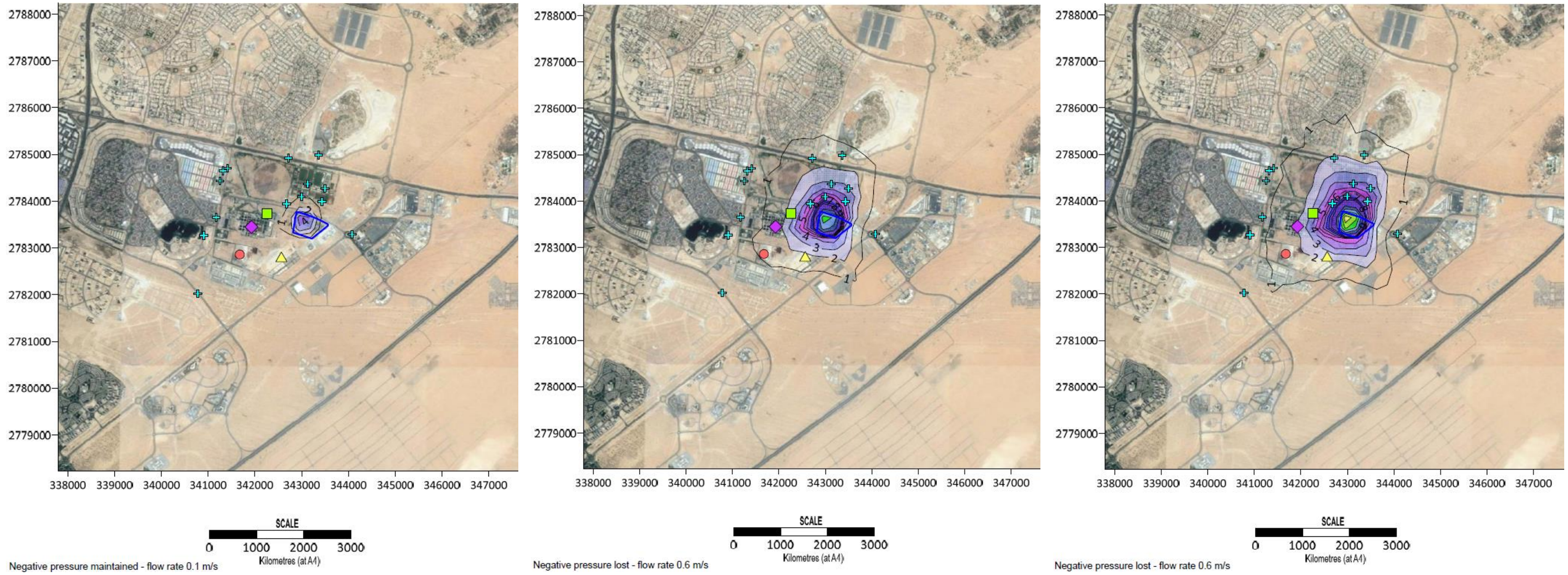
Incremental impact

Based on dispersion modelling results, the predicted operational odour impacts on nearby receptors is presented numerically in Table 6-26 and graphically as contours in Figure 6-23.

Table 6-26 Predicted 1-hour 99th percentile peak odour concentration

Receptor	Predicted odour concentration (OU)		
	Flow rate 0.1 m/s (negative pressure maintained)	Flow rate 0.6 m/s (negative pressure maintained)	Flow rate 1.2 m/s (negative pressure maintained)
Dubai International City – EM14, Emirates Cluster	0.11	0.6	1.3
International City Phase II (under construction)	0.06	0.4	0.7
Residential Villas (Desert Palm)	0.93	5.6	11.1
Al Warqa 4 (north of Al Awir Road)	0.27	1.6	3.2
Dragon Mart Mosque	0.11	0.7	1.3

Receptor	Predicted odour concentration (OU)		
	Flow rate 0.1 m/s (negative pressure maintained)	Flow rate 0.6 m/s (negative pressure maintained)	Flow rate 1.2 m/s (negative pressure maintained)
Dragon Mart Commercial Center	0.10	0.6	1.2
Dubai Textile City	0.10	0.6	1.2
Desert Palm Resort and Hotel	0.58	3.5	7.0
Dubai Nursery (plants)	0.08	0.5	0.9
Dubai Safari park	0.22	1.3	2.6
Pivot Fields	0.85	5.1	10.1
Desert Palm Polo Club	0.54	3.2	6.5
Desert Palm Riding Schools	0.73	4.4	8.8
Warsan Lake	0.08	0.5	1.0



A. Flow rate 0.1 m/s

B. Flow rate 0.6 m/s

C. Flow rate 1.2 m/s

Legend:

- Sensitive receptor
- Project site perimeter
- 1-hour 99th percentile odour concentrations
- Al Aweer landfill
- Tadweer MRF
- Al Aweer STP
- Al Serkal

Figure 6-23 Predicted 1-hour 99th percentile odour conditions

Review of Table 6-26 indicates that with the negative pressure maintained, predicted odour concentrations at the defined sensitive receptors are lower than 1 OU. It is likely that with negative pressure maintained odour from the WtE plant will not be detectable by the majority of the population. This complies with the EPA assessment criterion of 2 OU.

With negative pressure lost and a flow rate of 0.6 m/s assumed (typical two air exchanges per hour), predicted odour concentrations range from less than 1 OU (Dubai International City, International City Phase II, Dragon mart Mosque, Dragon Mart Commercial Centre, Dubai Textile City, Dubai Nursery and Warsan Lake) to 5.6 OUs (Residential Vilas). The EPA assessment criterion of 2 OU is predicted to be exceeded at five defined sensitive receptor (Residential Vilas, Desert Palm Resort and Hotel, Pivot Fields, Desert Palm Polo Club and Desert Palm Riding Schools).

With negative pressure lost and a worst case flow rate of 1.2 m/s assumed (conservative four air exchanges per hour), odour concentrations range from less than 1 OU (International City Phase II and Dubai Nursery) to 11.1 OUs (Residential Vilas) at the defined sensitive receptors. This is considered a worst case scenario as the flow rate of 1.2 m/s is conservative. The EPA assessment criterion of 2 OU is predicted to be exceeded at seven defined sensitive receptors (Residential Vilas, Al Warqa 4, Desert Palm Resort and Hotel, Dubai Safari Park, Pivot Fields, Desert Palm Polo Club and Desert Palm Riding Schools).

The contour plots in Figure 6-23 indicate that the highest odour concentrations are found to occur within the north-east boundary of the WtE plant, which is supported by the predicted concentrations in Table 6-26.

Cumulative impact

To assess cumulative impacts of the WtE plant on sensitive receptors, the predicted odour concentrations from the proposed site were added to the predicted odour concentrations from the Al Aweer STP discussed above (Reference to nearby odour sources).

With negative pressure maintained, the contribution of odour from the WtE plant to the cumulative odour impact at sensitive receptors Dubai International City, Dubai Textile City and Warsan Lake is negligible (approximately 2% of the STP odour concentration).

With negative pressure lost, the contribution of odour from the WMC to the cumulative odour impact at sensitive receptors Dubai International City, Dubai Textile City and Warsan Lake remains negligible for both flow rates (approximately 3% of the STP odour concentration).

The defined sensitive receptors that are predicted to be impacted the most from odour concentrations from the WtE plant are not predicted to be impacted by odour concentrations from the STP (Residential Vilas and Pivot Fields). I.e. there is no cumulative impact predicted for these sensitive receptors.

6.3.3 Summary of Impacts

As ambient/background levels are typically relatively high in a desert environment, additional dust sources have potential to exacerbate nuisance and health effects. Therefore, it is suggested that a high level dust management plan is adopted as part of a site wide construction environmental management framework for th Project.

Air Quality Assessment

The predicted results from air dispersion modelling of the proposed operations of the WtE plant indicates that the Project is not anticipated to exceed relevant guidelines provided that emission concentration guarantees, stack parameter as well as emission rates are met.

Odour Assessment

The results of the dispersion modelling indicate that when negative pressure is maintained, predicted odour concentrations reaching the defined sensitive receptors will be undetectable to the majority of the population. If negative pressure is lost and a flow rate of 0.6 m/s is achieved, predicted odour concentrations at 7 out of 14 sensitive receptors should be undetectable. Predicted odour concentrations at some sensitive receptors north of the WtE plant site may experience odour concentrations of up to 5.6 OU. If worst case conditions prevailed resulting in a flow rate of 1.2 m/s during a loss of negative pressure, predicted odour concentrations at 2 out of 14 sensitive receptors should be undetectable. Predicted odour concentrations at some sensitive receptors may experience odour concentrations of up to 11.1 OU.

Table 6-27 provides the unmitigated impact level on air quality during the construction and operation phases.

Table 6-27 Potential unmitigated impacts on air quality

Potential impact	Initial impact				Status of Impact
	Likelihood	Consequence	Impact Rating	Aspect impacted	
Construction phase					
Fugitive dust emission from site development / earthmoving works and wind erosion on unpaved surfaces	Almost certain	Moderate	High	Workers / staff and visitors on-site Occupants of surrounding land uses	Negative
Emission of exhaust gases from the operation of equipment, plant, tools and utilities using fuel	Almost certain	Insignificant	Low	Workers / staff and visitors on-site Occupants of surrounding residential and commercial areas	Negative
VOC emissions	Likely	Insignificant	Low	Workers / staff and visitors on-site Occupants of surrounding residential and commercial areas	Negative

Potential impact	Initial impact				Status of Impact
	Likelihood	Consequence	Impact Rating	Aspect impacted	
Odour emission from sanitary and waste disposal facilities, and poor quality dredged material	Likely	Insignificant	Low	Workers / staff and visitors on-site Occupants of surrounding residential and commercial areas	Negative
Operation Phase					
Emissions from furnace / boiler	Almost certain	Minor	Medium	Workers and occupants on site and surrounding communities	Negative
Exhaust gases and particulates emitted from road traffic	Almost certain	Minor	Medium	Residents, visitors and occupants of the Project site and surrounding residential and commercial areas	Negative
Odour emission from waste composition and aging process of waste	Unlikely	Minor	Low	Workers / staff and visitors on-site Occupants of surrounding residential and commercial areas	Negative

6.4 Noise

6.4.1 Construction Phase

6.4.1.1 Construction Noise

The major noise sources during the construction phase will include a range of construction activities, earthmoving and construction equipment as well as traffic noise from nearby roads. As observed during the baseline noise monitoring, road traffic noise was observed to be a major source of noise at the Project site. Vehicles accessing the site during delivery of materials and collection of waste, as well as transportation of workers and employees will also generate noise.

The increase in noise levels is anticipated to negatively affect the nearby noise sensitive receptors (NSRs), if appropriate noise abatement and management measures are not implemented. The principal NSRs include the residents of the Desert Palm Residential Villas located approximately 350m North of the Project site as well as workers and occupants at the commercial and industrial facilities surrounding the Project site.

Noise impacts associated with the WtE plant construction were estimated using the following distance attenuation relationship:

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

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

Q = directivity index (2 for a flat surface)

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

SWL = sound power level of the source (dB)

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

Noise produced by anticipated activities during the construction of the Project are shown in Table 6-28 for a variety of distances, with no noise barriers or acoustic shielding in place and with each plant item operating at full power. The sound pressure levels shown are maximum levels produced when machinery is operated under full load.

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

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

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

Table 6-28 Predicted plant activity noise level (dBA)

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

Notes:

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

(2) GHD (2018)

The closest noise sensitive receptor to any potential noise source during the construction of the WtE plant is Dubai Palm Residential Villas located about 350 m from the boundary of the site. From Table 6-28, noise levels exceeding the Federal Law prescribed noise limit during daytime (upper limit of 60 dBA for residential areas near highways) are not expected to impact on the closest sensitive receptor, except when jack hammers are used during construction. The use of jackhammers will be minimised as much as practicable during construction and where required will be used for a short duration.

A number of equipment exceeds the night-time Federal limit of 50 dBA (upper limit). General construction activities will be limited to day time working hours, where feasible and reasonable.

6.4.1.2 Construction Vibration

Vibration Criteria

Human Comfort Vibration Criteria

In the absence of local legislation and standards, the *British Standard BS 6472:2008 - Guide to evaluation of human exposure to vibration in buildings - Part 1: Vibration sources other than blasting* (BS 6472, 2008) is commonly recognised as the preferred standard for assessing human comfort criteria for residential receptors. Table 6-29 includes the acceptable values of vibration dose for residential receptors during daytime and night-time periods.

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

Table 6-29 Vibration dose value (VDV) ranges and probabilities for adverse comment to intermittent vibration ($m/s^{1.75}$)

Location	Low probability of adverse comment [(a)]	Adverse comment possible	Adverse comment probable [(b)]
Residential buildings 16-hour day (7:00 am to 11:00 pm)	0.2 to 0.4	0.4 to 0.8	0.8 to 1.6
Residential buildings 8-hour (11:00 pm to 7:00 am)	0.1 to 0.2	0.2 to 0.4	0.4 to 0.8

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

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

Humans are capable of detecting vibration at levels, which are well below those causing risk of damage to a building. The degree of perception for humans is suggested by the vibration level categories given in *BS 5228-2:2009 – Code of practice for noise and vibration control on construction and open sites: Part 2 Vibration* (BS 5228.2, 2009), as shown in Table 6-30.

Table 6-30 Guidance on the effects of vibration levels

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

Based on Table 6-30 above, human response to vibration could be summarised as below:

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

Structural Damage Vibration Criteria

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

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

Measured values exceeding those listed in Table 6-31 *"… does not necessarily lead to damage; should they be significantly exceeded, however further investigations are necessary*."

Table 6-31 Guidance values for short-term vibration on structures

Line	Type of structure	Guideline values for velocity v(t) (a) (mm/s)		
		1 Hz to 10 Hz	10 Hz to 50 Hz	50 Hz to 100 Hz (b)
1	Buildings used for commercial purposes, industrial buildings, and buildings of similar design	20	20 to 40	40 to 50
2	Dwellings and buildings of similar design and/or occupancy	5	5 to 15	15 to 20
3	Structures that, because of their particular sensitivity to vibration,	3	3 to 8	8 to 10

Line	Type of structure	Guideline values for velocity v(t) (a) (mm/s)		
		1 Hz to 10 Hz	10 Hz to 50 Hz	50 Hz to 100 Hz (b)
	cannot be classified under lines 1 and 2 and are of great intrinsic value (e.g. listed buildings under preservation order)			

(a) The terms vi refers to vibration levels in any of the x, y or z axis
(b) Where frequencies are above 100 Hz the values given in this column may be used as minimum values.

The vibration criteria presented in German Standard DIN 4150.3:1999 exceed human comfort criteria presented in Table 6-30. Therefore, the human comfort criteria should be the over-riding criteria for the assessment of any vibration.

Adopted Criteria

Vibration criteria adopted for the assessment is summarised in Table 6-32.

Table 6-32 Summary of adopted vibration assessment criteria

Level /Line	Receptor description	Guideline values for velocity (mm/s)
Human comfort		
1	Vibration might be just perceptible in the most sensitive situations for most vibration frequencies associated with construction	0.14
2	Vibration might be just perceptible in residential environments	0.30
3	It is likely that vibration at this level in residential environments will cause complaints, but can be tolerated if prior warning and explanation has been given to residents	1.0
4	Vibration is likely to be intolerable for any more than a brief exposure to this level.	10
Structural damage		
1	Buildings used for commercial purposes, industrial buildings, and buildings of similar design	≤ 20
2	Dwellings and buildings of similar design and/or occupancy	≤ 5
3	Structures that, because of their particular sensitivity to vibration, cannot be classified under lines 1 and 2 and are of great intrinsic value (e.g. listed buildings under preservation order)	≤ 3

Assessment

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

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

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

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

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

D = distance from equipment to the receiver in meters

n = 1.3 (the value related to the attenuation rate through ground)[26]

Table 6-33 Predicted vibration impacts at nearest receptor

Equipment [a]	Reference PPV at 7.6 m (mm/s) [b]	Predicted vibration amplitude at nearest receptor (350 m)
Clam shovel drop (slurry wall)	5.1	0.47 mm/s
Hydromill (slurry wall)	0.2 (in soil)	0.02 mm/s
	0.4 (in rock)	0.04 mm/s
Vibratory roller	5.3	0.49 mm/s
Hoe ram	2.3	0.21 mm/s
Large bulldozer	2.3	0.21 mm/s
Caisson drilling	2.3	0.21 mm/s
Loaded trucks	1.9	0.18 mm/s
Jackhammer	0.9	0.08 mm/s
Small bulldozer	0.1	0.01 mm/s

Notes:
(a) The above equipment are typically used in construction sites and may or may not be used for the WtE plant site.

(b) Adapted from Hanson et.al. (2006) as cited by the Cenek et.al. (2012)

[25] Taken from California Department of Transportation (2013). Page 37.
[26] The suggested value for "n" is 1.1 because vibration from equipment originates primarily near the ground surface.

From Table 6-33, equipment proposed for site preparation and construction of the project will generate low levels of vibration (between 0.01 to 0.49 mm/s), which are unlikely to cause human discomfort or result vibration risks to structures.

6.4.2 Operation Phase

6.4.2.1 Methodology

Operational noise modelling was undertaken using modelling software SoundPLAN© to predict the potential noise impact due to operation of the Project.

SoundPLAN© 8 is an internationally recognised noise modelling software that adopts ISO 9613 (Acountics – Attenuation of Sound During Propagation Ourdoors), and has been used to estimate the operational noise levels associated with the Project. This software allows for a spatially-constructed model, incorporating noise emission parameters of the Project facilities/activities, and calculates sound propagation and attenuation by recognised methods in order to predict the levels of environmental noise at a distance from the modelled sources. The method predicts the LAeq under meteorological conditions favourable to propagation from sources of known sound emission.

The criteria for the assessment of change in noise levels arising at noise sensitive receptors (NSRs) from the operation of the Project have been adapted from the joint Institute of Environmental Management and Assessment (IEMA) and the Institute of Acoustics (IoA) guidelines for noise and vibration impact assessment categories and are given in Table 6-34.

Estimated sound power levels used in the model are presented in Table 6-35.

Table 6-34 Noise impact assessment criteria

Impact category	Incremental change in ambient noise level	Description of impact
No Effect	0 dBA	Not discernible
Negligible	0.1–2.9 dBA	Not discernible – marginal changes in noise levels of less than 3 dBA in residential areas, or outdoor recreational areas in close proximity to main roads.
Minor Negative	3 to 4.9 dBA	Noticeable adverse – noise levels of 3–5 dBA in residential areas, or at ourdoor recreational areas.
Moderate Negative	5 to <10 dBA	Considerable adverse – noise levels warrant mitigation of residential properties on a widespread basis in a community, or for outdoor recreation areas close to main roads.
Major Negative	10 dBA or more	Major adverse – noise increases to a level where continued residential use of individual properties is inappropriate, or where the use of a community building could be inappropriate.

Table 6-35 Noise log (model inputs)

Equipment description	LW (dBA)	Octave Band Central Frequency Spectrum Noise (dB)							
		63 Hz	125 Hz	250 Hz	500 Hz	1k Hz	2k Hz	4k Hz	8k Hz
Waste bunker	69.5	88.0	77.0	78.0	69.0	70.0	46.0	38.0	30.0
Flue Treatment Hall	69.1	90.0	83.0	78.0	70.0	61.0	58.0	48.0	39.0
Boiler Hall	65.1	90.0	82.0	73.0	62.0	63.0	47.0	35.0	25.0
Steam Turbine Hall	75.5	88.0	88.0	76.0	71.0	67.0	66.0	62.0	58.0
IBA	70.0	90.0	82.0	75.0	70.0	63.0	62.0	49.0	43.0
Tipping Area	118.0	123.0	118.0	113.0	108.0	111.0	111.0	111.0	108.0
Stack Body	97.0	101.0	100.0	104.0	93.0	72.0	70.0	70.0	70.0
Stack Opening	100.0	116.0	112.0	106.0	88.0	70.0	68.0	68.0	68.0
ACC Inlet	112.0	119.0	117.0	112.0	109.0	108.0	99.0	95.0	91.0
ACC Outlet	108.0	116.0	114.0	109.0	106.0	104.0	96.0	90.0	85.0
ACC Steam Duct	108.0	104.0	104.0	98.0	97.0	98.0	105.0	95.0	92.0
ACC Recoolers	106.0	106.0	109.0	106.0	105.0	100.0	96.0	90.0	87.0
Transformer	104.0	107.0	107.0	104.0	104.0	98.0	93.0	88.0	81.0
IBA Conveyor	95.0	97.0	95.0	93.0	92.0	91.0	87.0	84.0	83.0
IBA Covered handling	110.0	112.0	115.0	110.0	105.0	103.0	102.0	100.0	95.0

6.4.2.2 Modelling Assumptions

The following assumptions have been made for the modelling assessment, and wherever possible, a conservative approach has been taken:

- Only normal operations have been modelled;
- In the absence of a detailed equipment list, all noise sources have been based on data provided by HZI;
- Equipment has been modelled at heights based on provided data where possible, where not identifiable heights have been assumed;
- All equipment has been modelled as either point, area, line or block sources;
- Due to the absence of a detailed equipment list and associated plot plan, some equipment locations were estimated based on the general areas provided;
- The model does not incorporate features which might provide partial screening (e.g., columns, pipe racks, structural steelwork, and small equipment);
- Ground absorption has been modelled as a mixture of hard and soft ground (having an absorption coefficient of 0.6) to maintain a conservative assessment;
- Reasonable worst-case meteorological conditions have been applied, i.e. steady wind conditions blowing in each direction.

6.4.2.3 Site Boundary Contributions

For the purposes of assessment, point receptors were set up on the boundary fence of the site. A Boundary Limit of 70 dBA has been applied at the boundary as per the UAE Federal Environment Agency's Industrial limit. The boundary noise contributions from the plant is detailed below.

Figure 6-24 details the locations of the modelled point receptors at the WtE plant's boundary used to carry out the boundary noise assessment.

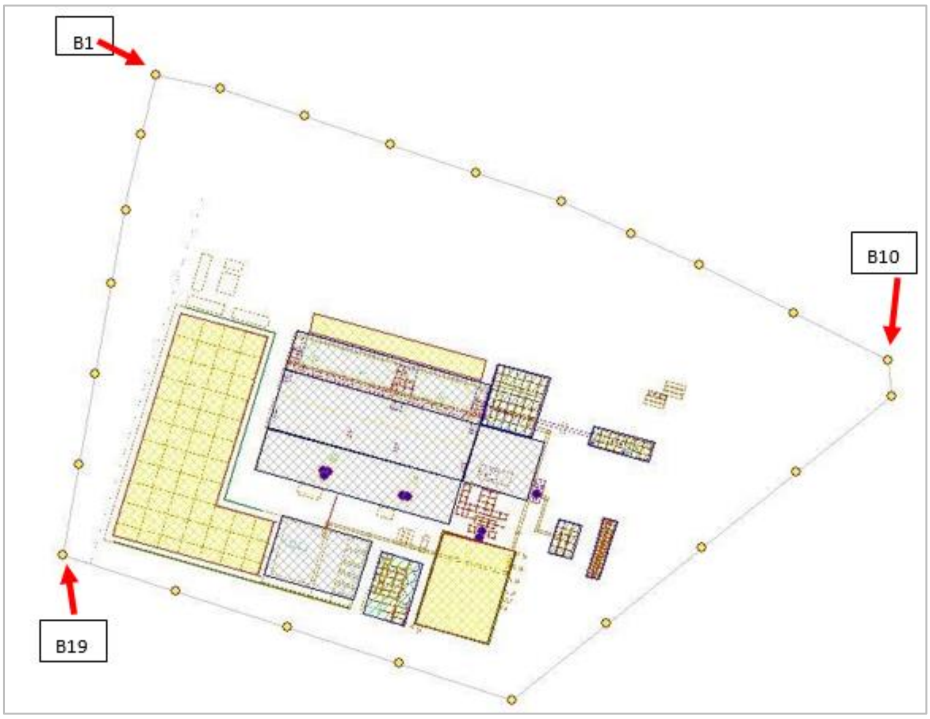


Figure 6-24 WtE plant boundary point receiver locations

Table 6-36 details the modelled noise contribution of the project equipment at the point receptors on the boundary of the site. The average baseline noise level recorded at the closest measurement location, NQM4, has been applied along the power plant site boundary to determine the potential operational cumulative noise levels.

Based on the point receiver noise levels along the site boundary, the WtE plant is not anticipated to exceed the boundary noise limit. The highest value achieved was 64.2 dBA on the southern boundary, this value is significantly below the limit of 70 dBA.

Table 6-36 Boundary contribution from Project noisy equipment

Receiver reference	Boundary noise contribution (dBA)	Receivier reference	Boundary noise contribution (dBA)
B1	55.8	B13	56.0
B2	57.4	B14	60.3
B3	60.3	B15	61.7
B4	61.9	B16	64.2
B5	62.3	B17	59.7
B6	61.3	B18	56.9
B7	60.0	B19	57.1
B8	57.2	B20	60.3
B9	53.6	B21	58.9
B10	52.8	B22	59.0
B11	53.0	B23	59.3
B12	54.6	B24	56.9
B7	60.0	B19	57.1
B8	57.2	B20	60.3
B9	53.6	B21	58.9
B10	52.8	B22	59.0
B11	53.0	B23	59.3
B12	54.6	B24	56.9

6.4.2.4 Environmental Noise Assessments

The environmental noise assessment takes into account all provided noise sources of the WtE plant. The guidelines state that the noise levels in the residential areas should not exceed 55 dBA during the day and 45 dBA at night time. As provided in the noise contributions at the measurement locations in Table 6-37, the predicted noise levels are below both the night time and daytime noise limits.

Table 6-37 Contributed noise levels at sensitive receptor

ID	Description	UAE Federal Environment Agency Noise Limits (dBA)		Daytime modelled results (dBA)	Night time modelled results (dBA)
		Day	Night		
SR1	Northern residences (i.e. Desert Polo Club)	55	45	51.6	41.8

6.4.3 Cumulative Impact Assessment

An impact assessment was performed in order to determine the severity of the impact of the Project at the nearest sensitive receptor location (Figure 6-25). The results of the Project noise contribution and resulting impact at SR1 is presented in Table 6-38 for daytime and night time operations. NQM1 has been used as representative of the baseline noise level at SR1 due to the proximity of the location.

The impacts of the operational noise assessment at the identified sensitive receptor is predicted to be negligible based on the results of the study. Contour maps generated for the Project are provided in Figure 6-26 to Figure 6-31.

Figure 6-25 Noise measurement location

Table 6-38 Operational Impact Assessment

ID	Description	Project noise contribution (dBA)	Baseline noise level (dBA)	Cumulative noise level (dBA)	Maximum change in noise level at receptor (dBA)	Impact severity
Daytime operational impact assessment						
SR1	Northern residences (i.e. Desert Polo Club)	51.6	55	56.6	1.6	Negligible
Night time operational impact assessment						
SR1	Northern residences (i.e. Desert Polo Club)	41.8	49	49.8	0.8	Negligible

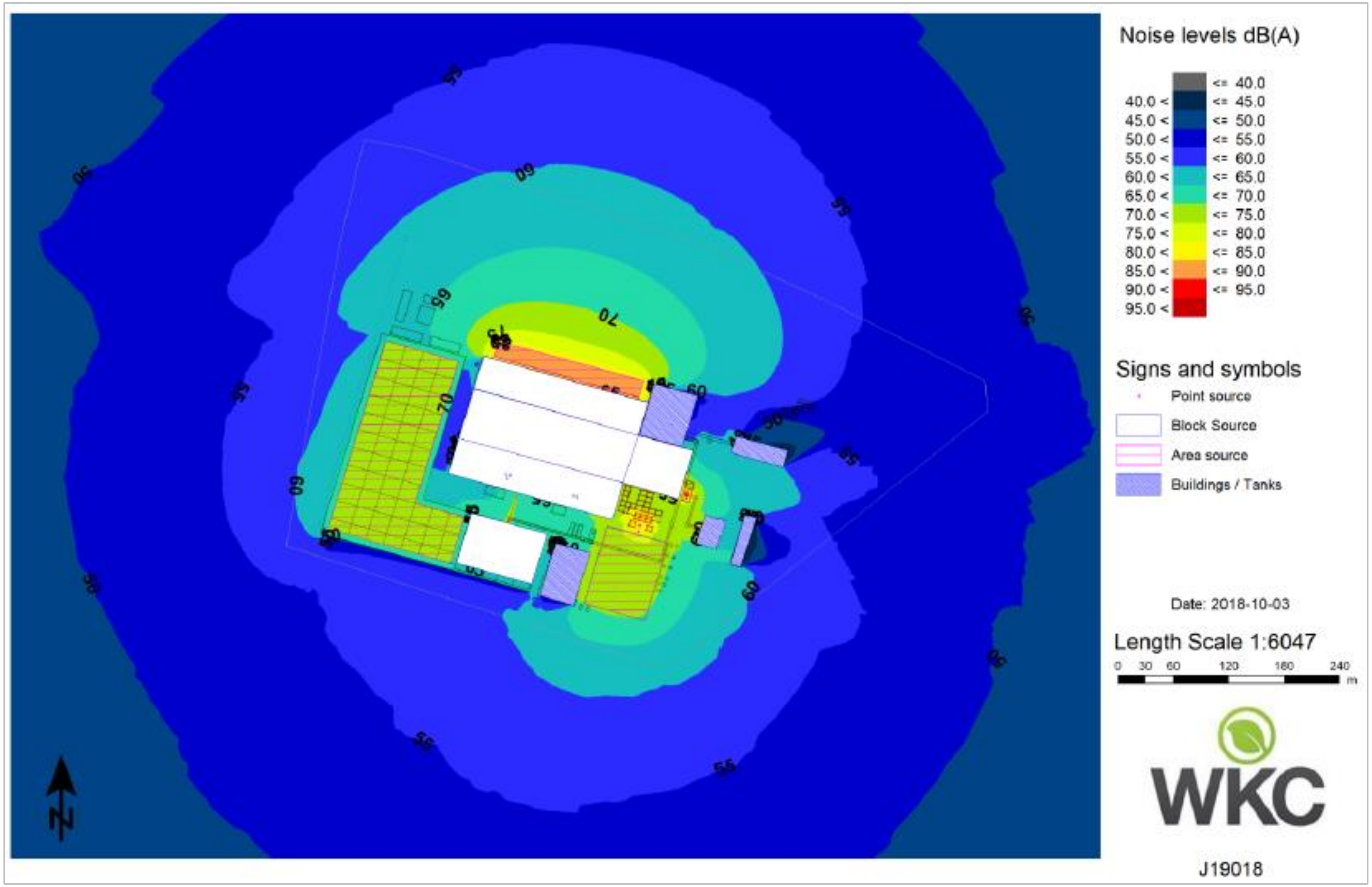


Figure 6-26 Overall Daytime Contour

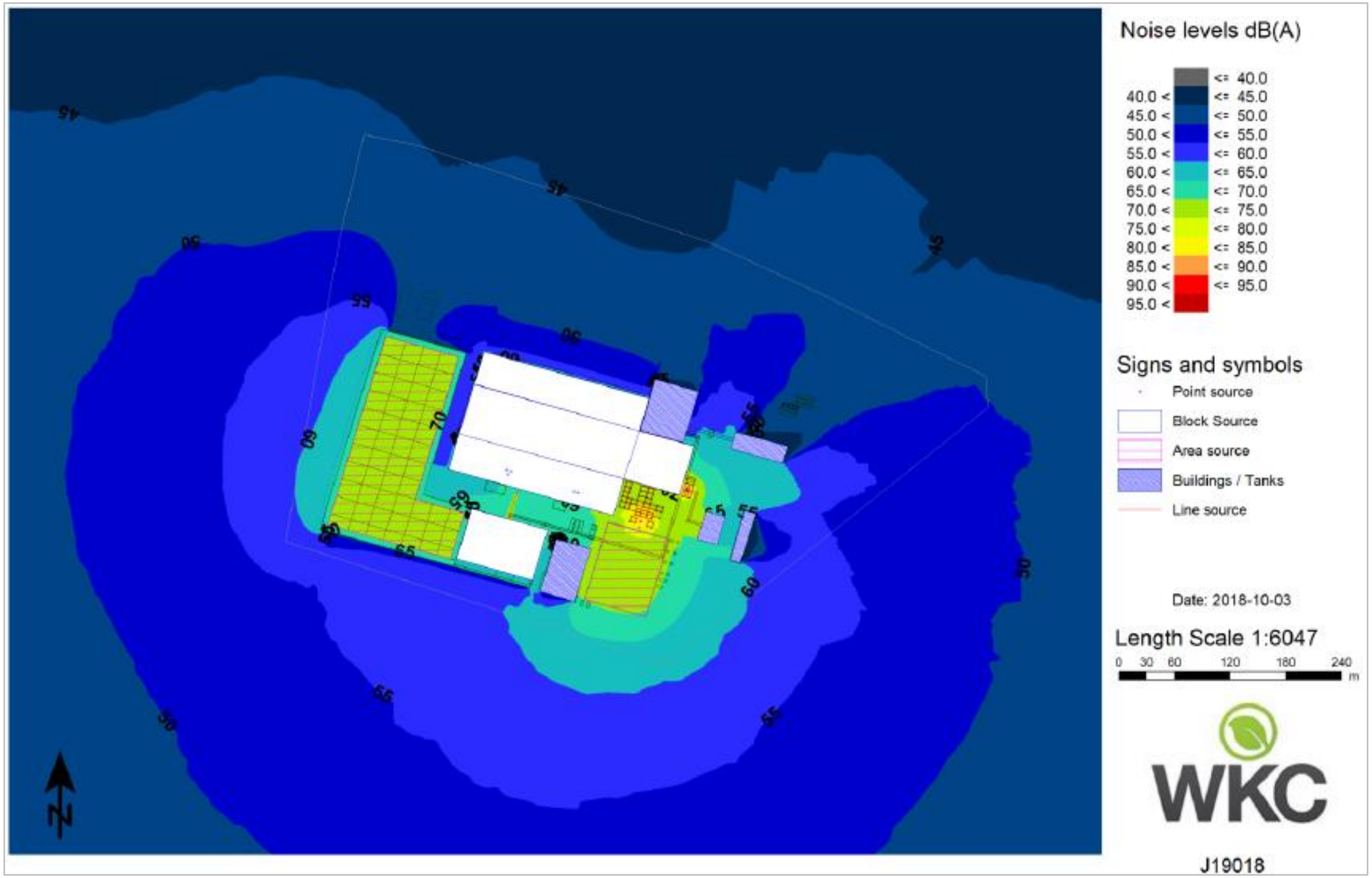


Figure 6-27 Overall Night-time Contour Plot

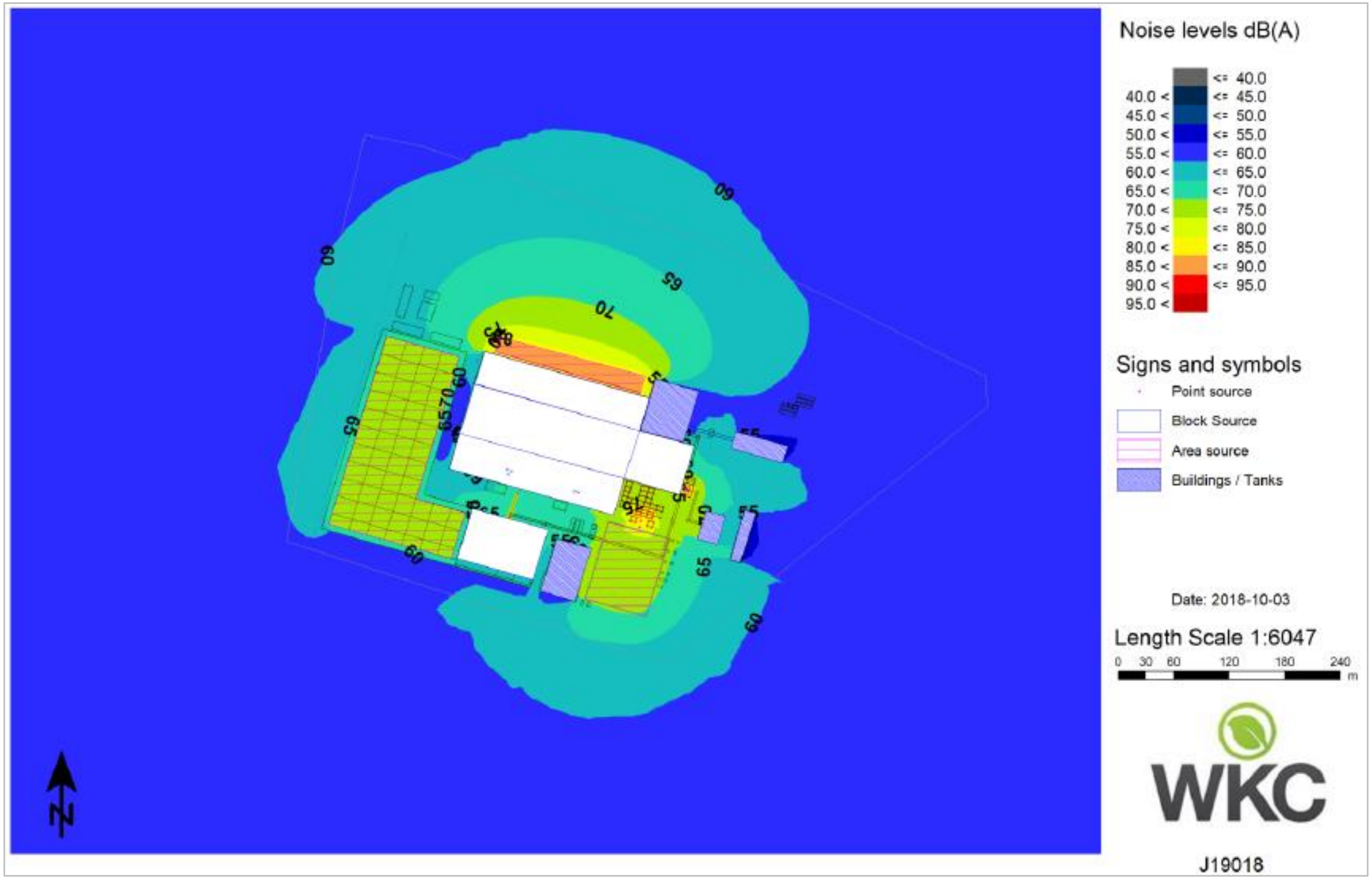


Figure 6-28 Overall Daytime Contour with Baseline

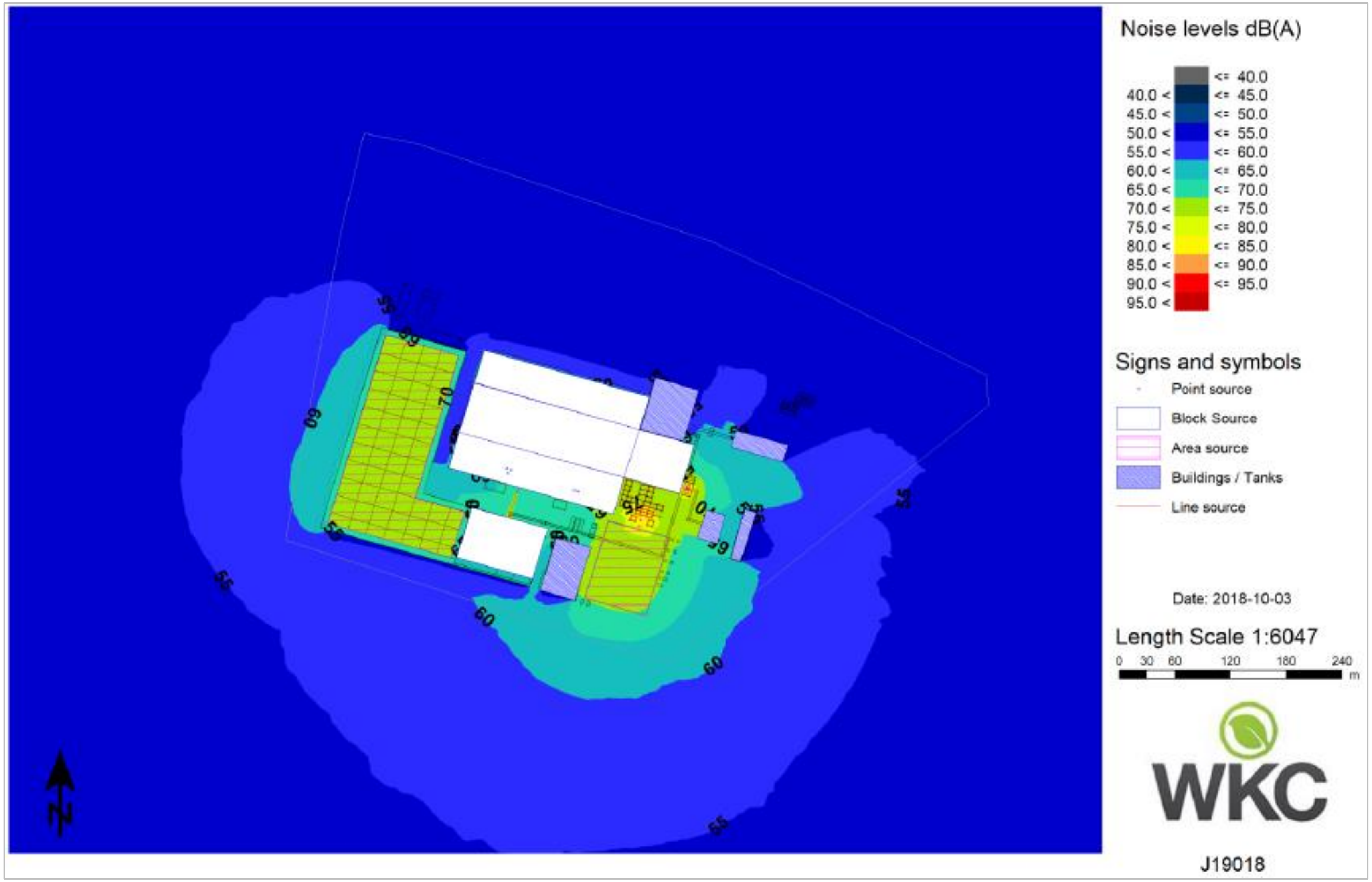


Figure 6-29 Overall Night-time Countour with Baseline

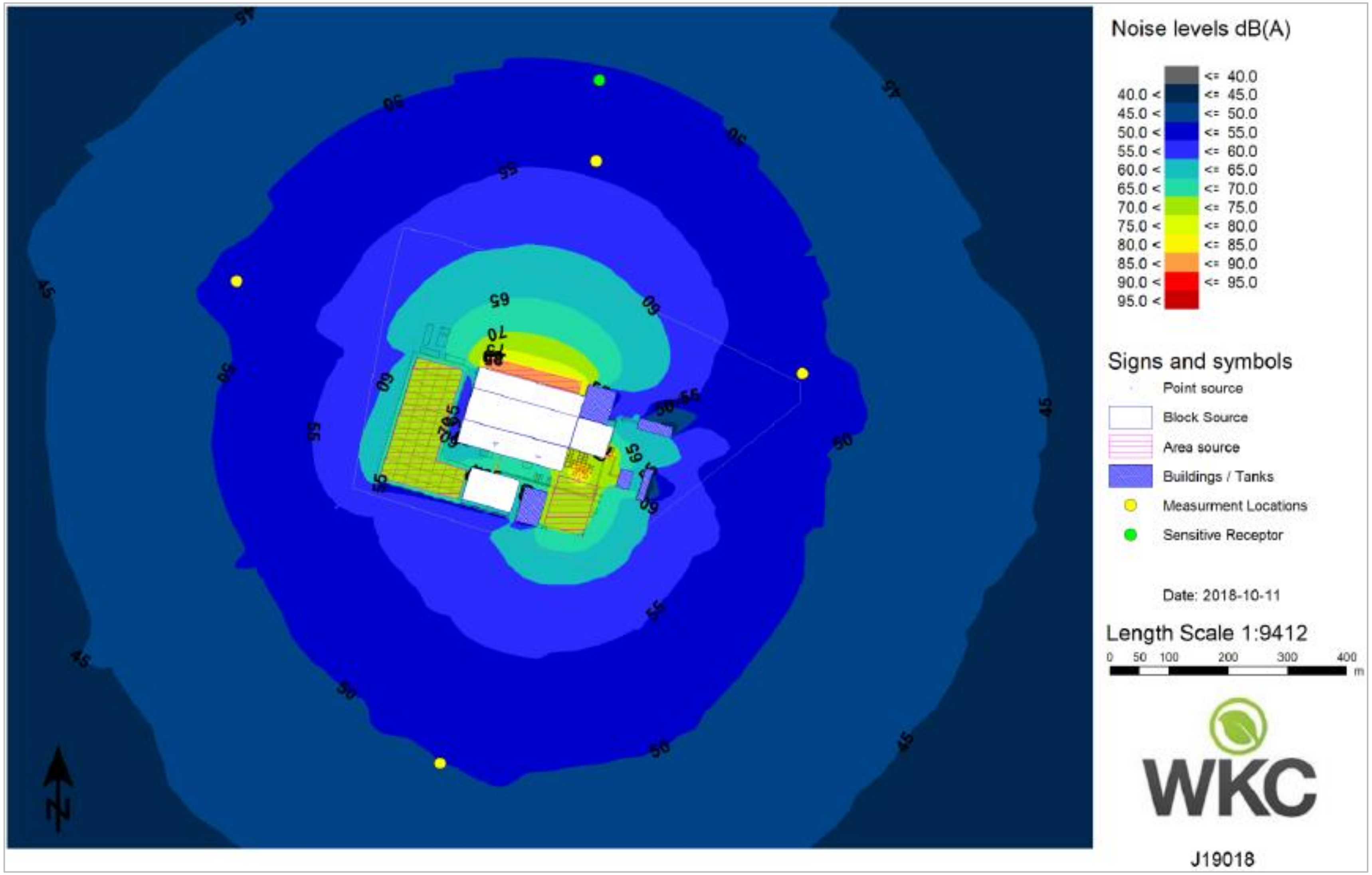


Figure 6-30 Daytime Contour with Receptors

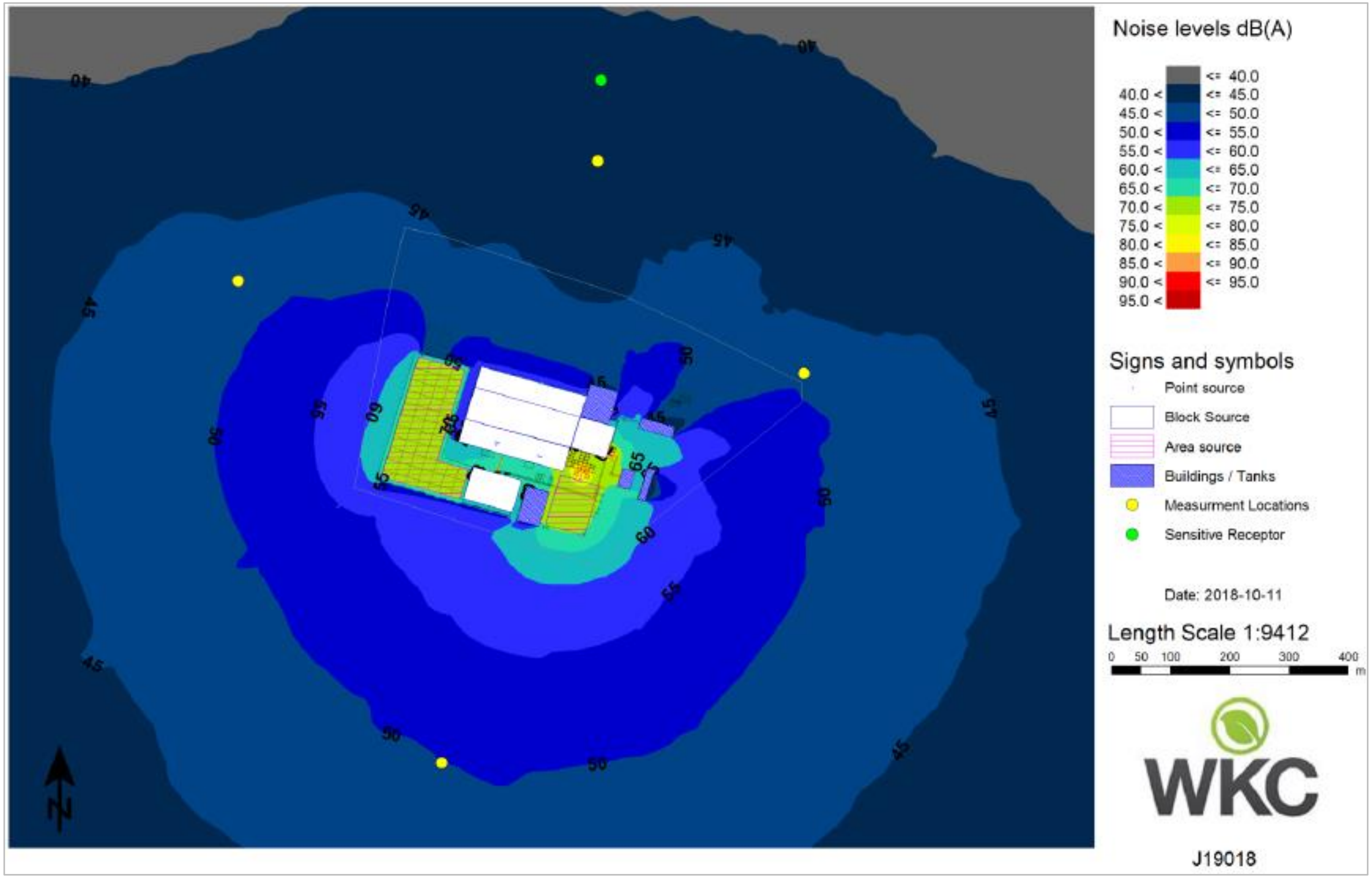


Figure 6-31 Night-time Countour with Receptors

6.4.4 Summary of Impacts

The boundary limit of 70 dBA was predicted to be not exceeded at any point along the property fence line boundary. The cumulative noise impacts due to the operation of the WtE plant are predicted to be negligible for both daytime and night-time periods.

The potential unmitigated impacts associated with noise generated during the construction and operation phases of the Project are summarised in Table 6-39.

Table 6-39 Potential unmitigated impacts on noise

Potential impact	Initial impact				Status of Impact
	Likelihood	Consequence	Impact Rating	Aspect impacted	
Construction phase					
Construction noise (causing sleep disturbance annoyance and hearing impairment)	Almost certain (closest sensitive receptor)	Moderate	High	Workers and occupants on site and surrounding communities	Negative
Construction vibration (causing sleep disturbance and annoyance)	Almost certain (closest sensitive receptor)	Insignificant	Low	Workers and occupants on site and surrounding communities	Negative
Operation Phase					
Operational noise (causing sleep disturbance, annoyance and hearing impairment)	Possible (closest sensitive receptor)	Moderate	Medium	Surrounding communities	Negative

6.5 Geology, Seismicity, Soil and Groundwater

6.5.1 Construction Phase

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

- *Land alteration*: Construction requires a range of site development works including earthmoving, excavation, fill placement, grading, cable installation activities and other ground preparation works that will directly impact on landform
- *Soil erosion:* Site topography, soil composition and structure can be altered by:
  - Soil erosion associated with deep excavation works (maximum of 7 mbgl) and stockpiling of fill materials on-site
  - Soil erosion caused by movement of construction vehicles

- Soil erosion caused by runoff from dust suppression water

- *Soil Contamination*: The risk of construction activities resulting in soil contamination is associated with the following events:
  - Introduction of contaminants via the use of contaminated fill material on-site
  - Accidental spill or leak of fuel, lubricants, paint, solvents and / or other hazardous chemicals and materials resulting from inappropriate storage and handling practices
  - Leak or spill of sewage from temporary septic tanks and portable toilets onsite
  - Inappropriate storage and management of wastes
  - Contaminated water (from water tankers) used for dust suppression and wash down of vehicles, equipment and machinery on site

The risk of soil contamination is generally considered to be low and can readily be controlled via implementation of appropriate mitigation measures. Any soil contamination arising from most of the above-mentioned events will likely be localised issues, readily addressed and remediated.

Water supply during construction is not anticipated to be significant and will be delivered to site via tanker or will be sourced from the existing water supply from DEWA, therefore groundwater will not be used during construction. Impacts to groundwater quality, through pollution, are generally indirect or secondary to soil quality issues. Typically, groundwater contamination occurs where there is sufficient percolation or intrusion of contaminated water / hazardous liquid through the vadose zone (area of aeration above the water table) and into the underlying aquifer.

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

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

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

6.5.2 Operation Phase

The operation of the Project is not considered to generate significant adverse impacts on the soil or groundwater condition. However, activities that have the potential to cause soil and/or groundwater contamination during the operation of the WtE plant include:

- Leak or overflow of untreated sewage from sewage transfer infrastructure
- Accidental spillage or leakage from storage of the feedstock on site (i.e. waste bunker)
- Inappropriate storage and disposal of wastes (e.g. bottom ash and FGT residue)
- Accidental spill or leakage from on-site bulk storage and handling of fuel and materials (i.e. aqueous urea solution, solid additives, adsorbent)

6.5.3 Cumulative Impact

Appropriate management of hazardous materials as well as waste (i.e. bottom ash and FGT residue) will be implemented to prevent soil and groundwater contamination. Further, the WtE plant components (i.e. waste bunker, FGT silo, bottom ash maturation area and storage tanks) will be designed to prevent potential for soil and groundwater contamination.

Proper coordination with DM-WMD or its representatives (i.e. accredited waste collector and disposal facilities) will be undertaken for the final disposal of bottom ash and FGT residue. Hazardous waste management plan will also be prepared in coordination with DM-WMD to prevent soil and groundwater contamination.

6.5.4 Summary of Impacts

The potential unmitigated impacts associated with noise during the construction and operation phases is summarised in Table 6-40.

There is the potential for soil and groundwater contamination to occur if accidental spillage or leakage occurs from the raw materials storage areas or if waste management practices are inadequate. The risk of soil and groundwater contamination is considered low and will be further reduced and mitigated by suitable mitigation measures.

Table 6-40 Potential unmitigated impacts on soil and groundwater

Potential impact	Initial impact				Status of Impact
	Likelihood	Consequence	Impact Rating	Aspect impacted	
Construction phase					
Seismic tremor causing collapse of infrastructure, that is under construction and not yet able to withstand earthquake tremors	Rare	Major	Medium	Workers and visitors of the site during construction	Negative
Spread of potential pre-existing soil contamination via movement of contaminated fill / stockpiled material	Unlikely	Minor	Low	Terrestrial ecology	Negative
Soil contamination from using contaminated water for dust suppression	Unlikely	Minor	Low	Terrestrial ecology Employees and visitors on-site	Negative
Soil contamination due to handling, storage and use of hazardous materials (e.g. oil, fuel, paint and other chemicals)	Likely	Minor	Medium	Terrestrial ecology Employees and visitors on-site	Negative

Potential impact	Initial impact				Status of Impact
	Likelihood	Consequence	Impact Rating	Aspect impacted	
Soil erosion due to earthmoving activities (stockpiling)	Likely	Minor	Medium	Terrestrial ecology	
Groundwater contamination as a result of spill / leak of potentially hazardous material (i.e. oil, fuel, sewage, paint and other chemicals)	Unlikely	Major	Medium	Terrestrial flora and fauna Marine flora and fauna	Negative
Groundwater contamination as a result of inadequate waste management (e.g. hazardous waste, sewage)	Unlikely	Major	Medium	Terrestrial flora and fauna	Negative
Operation Phase					
Potential soil and groundwater contamination from inappropriate waste storage (e.g. feedstock [waste] storage and IBA/FGT residue storage)	Possible	Moderate	Medium	Soil and Groundwater	Negative
Potential soil and groundwater contamination from fuel and raw material storage	Possible	Minor	Low	Soil and Groundwater	Negative

6.6 Biodiversity and Conservation

6.6.1 Construction Phase

During the site development phase, the removal of vegetation is unavoidable; however, the impact on floral diversity is not anticipated to be significant considering that most of the plant species identified at the Project site are considered common and widespread in the UAE, and either not yet assessed or are considered Least Concern by the IUCN. Plants recorded within the site are also common and can be found in nearby areas. Further, the middle and western sections of the Project site is categorised as Habitat 9600 or Disturbed Ground where the natural landscape was completely altered into asphalt paved parking spaces (refer to Section 5.6.3). As such, the construction of the WtE plant is not anticipated to induce additional impact on habitat loss.

No invasive species were observed at the Project site during the terrestrial survey. However, equipment and machinery brought to the Project site during the construction phase may carry pests and weed species if not properly cleaned and managed.

Dust emissions and noise may be generated from construction activities as well as movement of vehicles and equipment that could result in negative health effects on local terrestrial fauna. General dust and noise are expected to be localised and intermittent; as such, the impact is not considered significant. Terrestrial fauna species are adapted to such type of disturbances brought about by the existing industrial activities in the area.

Mitigation measures that will be implemented during the construction phase to prevent adverse impacts on terrestrial flora and fauna are discussed in Section 7.5.

6.6.2 Operation Phase

Increased air and noise emissions and artificial lighting could disturb or result in negative health and behavioural effects to local terrestrial fauna during Project operation; however, considering the the Project is within an industrial area, no notable change in disturbance to terrestrial fauna is anticipated during the operation compared with existing conditions.

If wastes are not properly managed during the operation phase it may lead to an increase in the number of invasive species especially introduction of rodents or other vectors. Appropriate mitigation measures and vector attraction reduction methods will be implemented to address potential impacts of invasive species on the Project site.

6.6.3 Cumulative Impact

Based on the foregoing, cumulative impacts on terrestrial flora and fauna is not anticipated.

6.6.4 Summary of Impacts

Based on the assessment above, no significant impact on flora and fauna is expected due to the construction and operation of the WtE plant. The potential unmitigated impact of the Project on biodiversity (terrestrial) and conservation is summarised in Table 6-41.

Table 6-41 Potential unmitigated impacts on biodiversity and conservation

Potential impact	Initial impact				Status of Impact
	Likelihood	Consequence	Impact Rating	Aspect impacted	
Construction phase					
Habitat loss due to excavation and earthworks	Likely	Insignificant	Low	Vegetation at the Project site	Negative
Disturbance of fauna species due to noise impacts	Possible	Minor	Low	Fauna species at the Project site	Negative
Operation Phase					

Potential impact	Initial impact				Status of Impact
	Likelihood	Consequence	Impact Rating	Aspect impacted	
Noise generated from operation activities	Likely	Insignificant	Low	Fauna species at the Project site	Negative
Introduction of invasive species	Possible	Moderate	Medium	Site workers and nearby community	Negative

6.7 Access, Traffic and Transport

6.7.1 Construction Phase

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

Potential impacts associated with the construction phase traffic include:

- Increase in traffic congestion on the road network from several ports in the UAE leading to the Project site
- Increased potential for vehicle accident / incident associated with a larger volume of traffic on the road network

Transportation of construction equipment and materials from Port Rashid (nearest Port to the site) to the site will use existing road networks (Figure 6-32). Road networks that lead to the site from Port Rashid include:

- Via Rebat St / D83 – 31.1 km (fastest route / usual traffic)
- Via Manama St / D67 – 30.6 km
- Via Al Ain Road / E66 – 34.4 km

It is assumed that these routes have previously been used to support construction and operation activities (such as those undertaken by various industries surrounding the Project site), and is currently used for the day-to-day operation of the Al Aweer STP and Tadweer Waste Treatment LLC (dumpsite). As such, the increase in traffic volumes associated with the construction works is not anticipated to cause an unacceptable level of traffic congestion on the surrounding network. Construction work shifts[27] will differ from regular office work shifts (between 8:00 am to 5:00 pm) so that traffic periods will be spread from 6:30 am to 9:00 am and 4:00 pm to 6:00 pm.

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

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

Where traffic congestion may be caused as a result of the construction works, this is likely to generate significant disruption and ill feeling amongst members of the surrounding residential areas as well as workers / visitors at the industrial and commercial areas that are adjacent to the Project site. Traffic impacts during construction of the Project can be managed via appropriate site traffic management and logistical planning, which would include on-site queing.

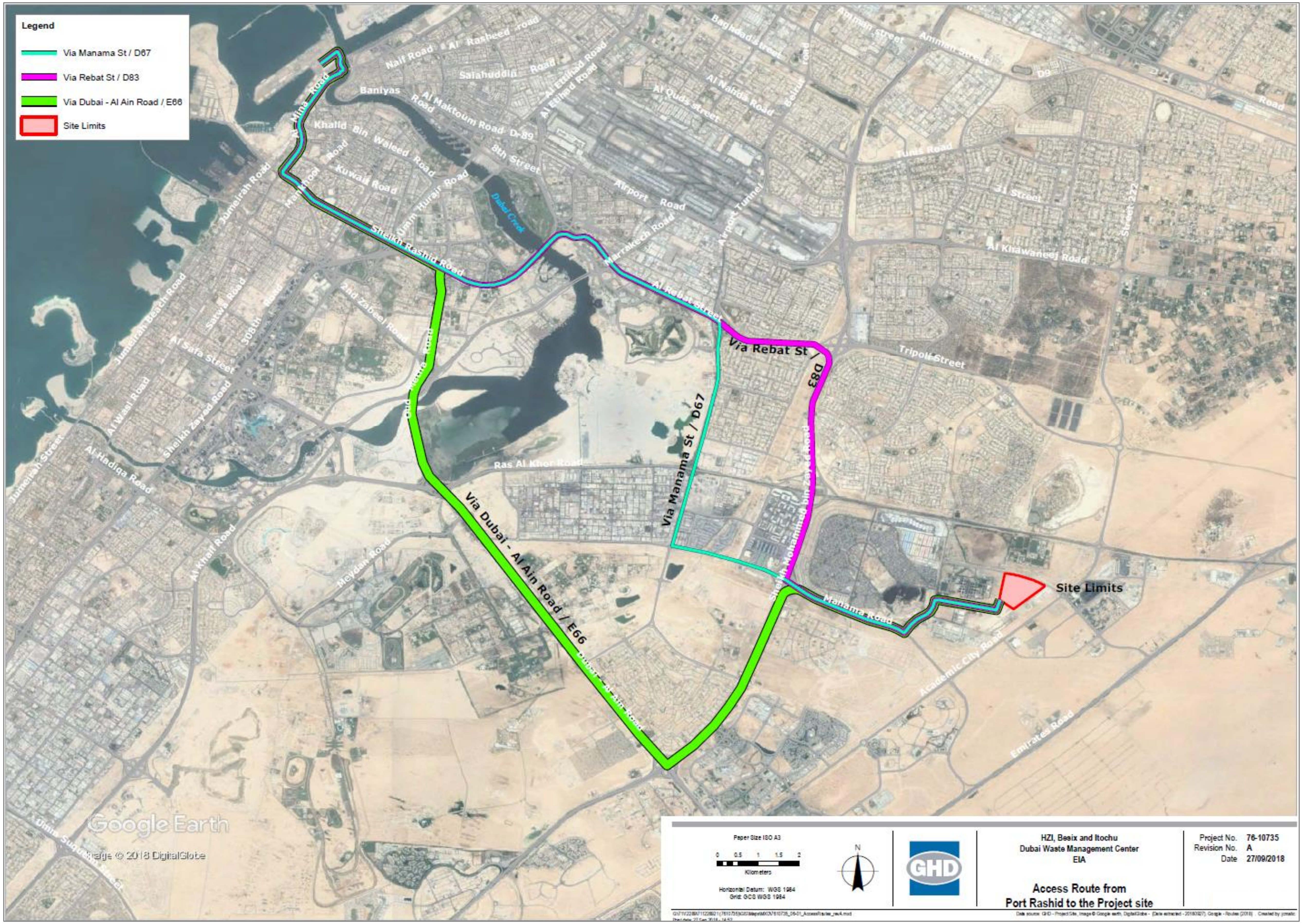


Figure 6-32 Access road from Port Rashid to the Project site

6.7.2 Operation Phase

The traffic impact associated with the Project's normal operations include:

- Daily delivery of MSW from Dubai Municipality
- Collection of FGT residue and bottom ash for off-site disposal

Assuming an average capacity of 5.391 tonnes per truck (refer to Section 4.9.3.3 Table 4-6), MSW deliveries from DM is anticipated at 44 waste delivery trucks per hour on average and approximately 80 waste delivery trucks per hour during peak times.

A Level 1 Traffic Impact Study (TIS) was completed (refer to Appendix Q) for the project, and is described in the subsequent subsections.

Trip Generation

The traffic expected to be generated by the development is evaluated by applying the rates in the Dubai Trip Generation and Parking Rates Manual 2013. The applicable trip generation rates for the critical AM, LT, PM and Peak Hour Generator are tabulated in Table 6-42. Table 6-43 provides the trip generation of the development estimated by applying the rates mentioned in Table 6-42.

Table 6-42 Trip Generation Rates

Land use	Class	Unit	AM Peak			LT Peak			PM Peak			Peak Hour Generator		
			Rate	In	Out	Rate	In	Out						
Medium Industry	621	100 m^2 of GFA	0.424	51%	49%	0.52	47%	53%	0.28	49%	51%	0.52	47%	53%

Source: RTC Road and Traffic Engineering, 2018

Table 6-43 Trip Generation Summary

Land use	Class	Unit	AM Peak			LT Peak			PM Peak			Peak Hour Generator		
			Rate	In	Out	Rate	In	Out						
Medium Industry	621	58,089	247	126	121	303	142	161	163	80	83	303	142	161

Source: RTC Road and Traffic Engineering, 2018

Standard Parameters

Traffic analysis for site access of the proposed development is performed based on the Highway Capacity Manual (HCM) procedure. To determine the operating conditions of a roadway, the concept of level of service (LOS) is commonly used. The LOS grading system is a rating scale ranging from LOS A to LOS F, where LOS A represents free-flow conditions and LOS F represents congested or jammed conditions. Table 6-44 shows the factors and assumptions used in the analysis.

Table 6-44 Standard Parameters

Factor / Assumption	Value
PHF	0.95
Lane width	3.65 m
Lane utilization	Varies
Ideal intersection capacity per lane	1900
Ideal freeway capacity per lane	2000
% of heavy vehicles	2%

Source: RTC Road and Traffic Engineering, 2018

Level of Service Criteria

Roadway LOS describes the operating conditions determined for a group of vehicles passing over a given segment of the roadway during a specified period of time. It is a qualitative measure of several factors, which include speed, travel time, traffic interruptions, freedom to manoeuvre, driver comfort, convenience, safety and vehicle operating costs. The roadway LOS analysis is performed using the method contained in the HCM where six Levels of Service have been established by which we assess roadway performance, designated by the letters A through F. These LOS levels are defined as follows:

- LOS A – free flow, individual users virtually unaffected by the presence of others
- LOS B – stable flow with a high degree of freedom to select operating conditions
- LOS C – flor remains stable, but with significant interactions with others
- LOS D – approaching unstable flow, freedom to manoeuvre is severely restricted
- LOS E – unstable flow, with volumes approaching capacity of the roadway
- LOS F – forced flow in which traffic exceeds the amount that can be serviced

LOS describing the operation of the access is based on delay occurring for vehicles. Table 5 shows the LOS and corresponding delay used to evaluate traffic conditions at the access points.

Table 6-45 LOS - Delay

LOS	Delay (in seconds)
F	50 and above
E	35 – 50
D	25 – 35

LOS	Delay (in seconds)
C	15 – 25
B	10 – 15
A	0 – 10

Source: RTC Road and Traffic Engineering, 2018

Site Access Analysis

Providing effective and efficient access to the development is an important aspect to be considered to ensure that safe and efficient flow of traffic is achieved through the access / egress system.

The development has two access points. Access point 1 has both has both entrance and exit accesses while Access point 2 has only entry access. Access analysis is carried out for the opening year 2022 by adding the project trips with the project traffic count.

Site Access Analysis – Opening Year 2022

Site access analysis has been carried out at the access points to determine the impact of generated trips on the existing road traffic. The access locations are analysed using HCS 7 software. The resulting delay and LOS are shown in Table 6-46. Detailed analysis results of the site access are provided in Appendix Q. The below table indicate that the access point will work at an acceptable LOS for the opening year 2022 during AM and PM peak hours.

Table 6-46 Site Access Analysis – Opening Year 2022

Access	AM		PM	
	LOS	Delay(s)	LOS	Delay(s)
Access 1	A	9.3	A	8.0
Access 2	C	22.4	B	12.1

Source: RTC Road and Traffic Engineering, 2018

Parking Demand Supply and Circulation

The number of parking spaces required for the development is estimated from the DTGPRM 2013 parking rates and DM regulations. It is ensured that proper parking arrangement as well as internal circulation is provided. Table 6-47 and Table 6-48 reflect the parking calculation of the development as per DTGPRM 2013 parking rates and DM guidelines. Table 6-49 gives the parking supply of the development.

Review of the above table indicates that the proposed development will adequately meet the parking demand in accordance with DM parking regulations. The traffic circulation within the project site has been designed to ensure no delay is formed at the access points. The circulation plans along with the swept path analysis is provided in Appendix Q.

Table 6-47 Parking Circulation (DTGPRM 2013)

Land use	Unit	Quantity	Parking Rate	Parking Demand
Medium industry	m^2 of GFA	58,089	0.357	208
Total				208

Source: RTC Road and Traffic Engineering, 2018

Table 6-48 Parking Circulation - DM

Land use	Unit	Quantity	Parking rate	Parking Demand
Medium industry	m^2 of GFA	58,089	1 parking per 750 ft^2 of office area	58
Total				58

Source: RTC Road and Traffic Engineering, 2018

Table 6-49 Parking Supply

Parking Level	No. of Parking
Ground floor	69

Source: RTC Road and Traffic Engineering, 2018

6.7.3 Cumulative Impact

The Project would add to the existing road congestion within the area. The increase in traffic is an unavoidable impact fom the construction and operation activities of the Project. The increased predicted, however, will not significantly impact the overall capacity available for the traffic network.

6.7.4 Summary of Impacts

The potential unmitigated impacts of the Project on access, traffic and transport is summarised in Table 6-50.

Table 6-50 Potential unmitigated impacts on access, traffic and transport

Potential impact	Initial impact				Status of Impact
	Likelihood	Consequence	Impact Rating	Aspect impacted	
Construction phase					
Increase in road traffic in the vicinity of the Project site	Almost certain	Minor	Medium	Residents of local community Users and workers of neighbouring inductrial and	Negative

Potential impact	Initial impact				Status of Impact
	Likelihood	Consequence	Impact Rating	Aspect impacted	
				commercial facilities	
Potential traffic congestion on the road network from the port leading to the Project site	Possible	Minor	Low	Residents of local community Users and workers of neighbouring inductrial and commercial facilities	Negative
Noise, dust and air emissions due to truck movements	Possible	Moderate	Medium	Employees and workers of HZI, BESIX and subcontractors Residents / users of facilities surrounding the site	Negative
Operation Phase					
Increase in traffic movement within the WtE plant	Likely	Minor	Medium	Residents / users of facilities surrounding the site Workers at the WtE plant	Negative
Noise, dust and air emissions due to truck movements	Likely	Minor	Medium	Workers within the WtE PLANT	Negative

6.8 Water and Energy Resources

6.8.1 Construction Phase

6.8.1.1 Utility requirements during Construction

During the construction phase, temporary service utilities will be provided on-site to facilitate construction of the facility. This would include temporary source of water and energy supply. The operation and maintenance of construction equipment and utilities on-site have associated environmental issues, which could potentially lead to adverse impacts. The following subsections discuss the key environmental issues associated with the operation of temporary utilities on-site.

Water Resources

Potable water will be supplied on-site for consumption of workers and visitors. Water requirements will be supplied by the existing DEWA facilities via water tankers. Temporary water storage tanks will also be provided on-site to supply water for domestic and other washing activities on site (e.g. equipment and concrete washing). Dewatering effluent, if available, is a potential resource that can be reused for dust suppression measures. Given that excavating significant areas is unlikely, dewatering effluent may not be available; as such, recycled water from other sources (i.e. Al Aweer STP) will be delivered on site via tanker to be used for dust suppression measures.

Power Supply

Temporary power requirements for the Project's construction will most likely be supplied through power generating units, which have the following associated impacts:

- Air pollutant emissions (NO_2, SO_2, TSP, HC, CO and O_3). Emissions from power units are typically localised, short term in nature and not significant; and
- Construction utilities and equipment will require regular delivery and storage of fuel on-site. The temporary oil storage facilities may potentially cause oil spills and VOC emissions.

6.8.1.2 Potential impacts on existing infrastructure and utilities

The Project site is located in an industrial area where utilities and infrastructure network including water and power supply/distribution system are present. Without proper construction management, site activities could potentially result in property damage and interruptions of service to nearby industrial facilities and to local communities. This is particularly related to development of areas where service lines could potentially be running and also to utility works during which the Project service lines are to be connected to existing networks.

The risk of Project construction works resulting in utility / infrastructure damage or service interruptions is considered low where management measures (e.g. early and close coordination with utility providers) are implemented.

6.8.2 Operation Phase

6.8.2.1 Water Resources

During the operation phase, approximately 4.80 m^3/h of potable water will be used for domestic and sanitary use as well as firefighting system (1000 m^3/d). Potable water will be sourced from DEWA while water for plant operation will be sourced from Al Aweer STP. Approximately 42.35 m^3/h (1 stream in operation) or 76.06 m^3/h (2 stream in operation) of water from Al Aweer STP will be required during the operation. The water from Al Aweer STP will be treated in the Water Treatment Plant (discussed in Section 4.7.9 [Description of the Project]) before it is fed to the water / steam cycle.

Water discharges during the plant operation include process water and softened water. Process water can be reused, as follows:

- Reuse for the Bottom Ash Extractor: 11.76 m^3/h (1 or 2 steam in operation). During normal operation, no return of process water from the WtE plant is foreseen to be sent to Al Aweer (at "TP-04"). All the brine or rejects produced in the plant will be used for cooling the bottom ash and for maturation and dust suppression of the stockpiled IBA in the IBA Maturation Area (refer to Figure 4-5-BS13-D).
- Reuse for the Bottom Ash at the IBA Maturation Area: 0.35 m^3/h (1 or 2 steam in operation)

- Overflow / Return to Al Aweer STP: 0.00 m^3/h (1 or 2 steam in operation)

Softened water, which is approximately 1.40 m^3/h (1 or 2 steam in operation) can be fed to the air cool condenser (ACC) for cleaning or close unit cooling water system (CCW). The CCW is a sprinkler system where water evaporates; as such, there is no water discharge. As provided above, both the process and softened water can be reused; as such, no wastewater will be generated by the Project. Water balance for the Project is provided in Figure 6-33.

Recycling and reusing water from Al Aweer STP supports the sustainability goal of Dubai and it provides environmental as well as economic benefits, such as:

- *Conserved potable / freshwater supply*. Using recycled water conserves potable water supplied by DEWA; hence reducing air emissions and marine impacts associated with desalination.
- *Reduce water discharge*. Using recycled water reduces the amount of treated water discharged into water bodies; hence preventing potential water pollution.
- *Commercial benefits*. Recycled water costs less than potable water and the Project will pay less for the same volume of water.

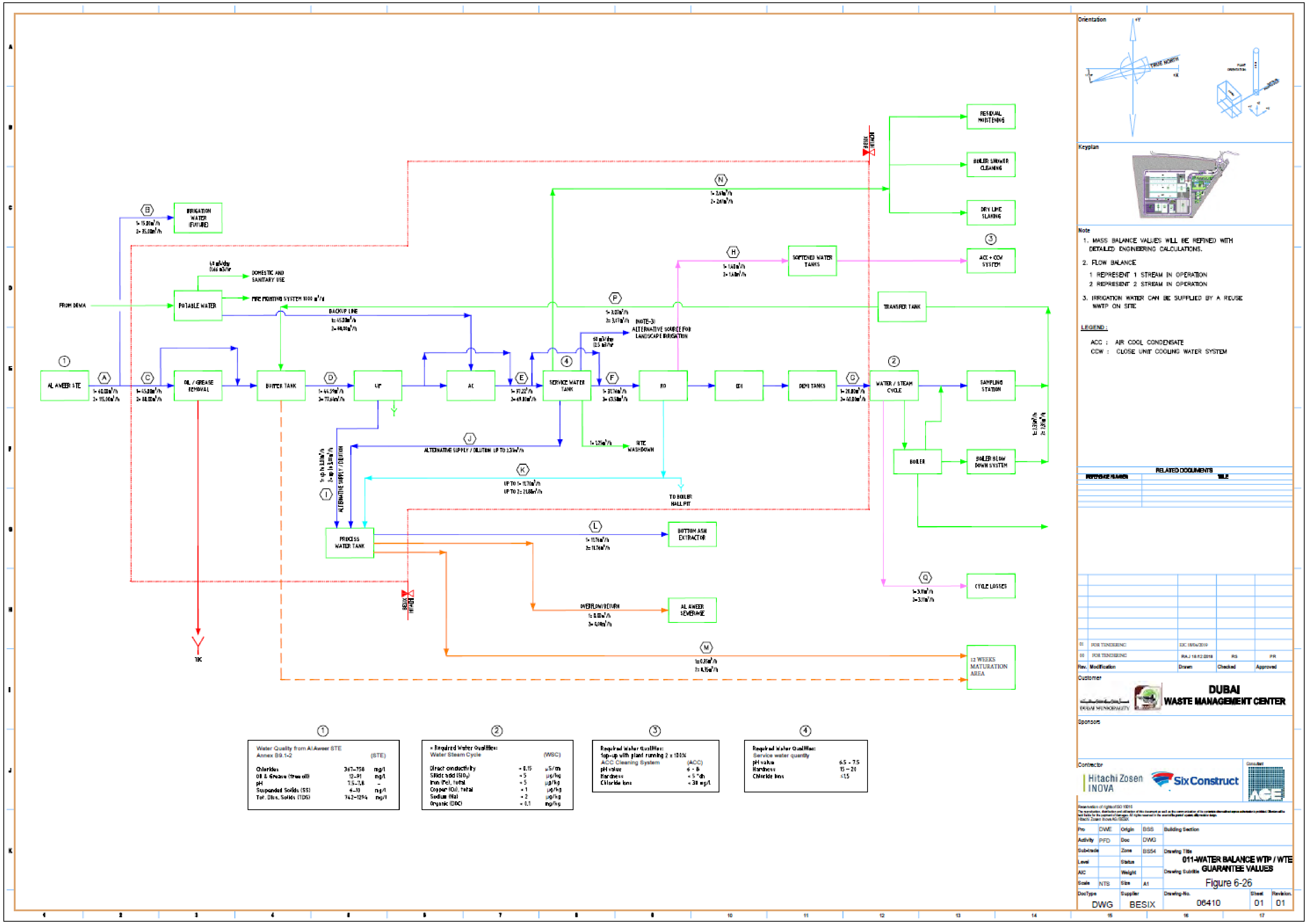


Figure 6-33 Water Balance

6.8.2.2 Power Supply

The completion and operation of the proposed WtE plant is considered to have a significant positive impact in terms of energy sufficiency, diversification of energy resources and contribution of additional power supply to meet the demands of increasing population and growing economy. The WtE plant itself will operate from energy produced from the processing of MSW.

The proposed WtE plant will contribute in producing clean energy and an additional net power output of 193 MW to the electricity grid, which could power approximately 135,000 houses in the Emirate of Dubai.

The WtE plant operation is considered to continuously contribute, albeit on a minimal scale, to the adverse environmental impacts associated with the operation of the power plants. Key impacts of power plant operation include air emissions and noise generation. Air pollution and noise generation control measures are provided in Section 7.2 and Section 7.3, respectively.

6.8.3 Cumulative Impact

Cumulative impacts on water and energy resources is considered to be of low significance as construction activities is temporary and short term. Emissions from power units are typically localised, short-term in nature and not significant.

During the operation phase, cumulative impact on water resources is considered low given the following reasons:

- Minimal amount (approximately 4.80 m^3/h) of potable water from DEWA
- Recycling and reusing of water from Al Aweer STP
- Process water will be reused in plant operation; as such water discharges are not anticipated

Cumulatie impacts arising from WtE plant operation in terms of power supply is considered to be a significant benefit in terms of energy efficiency and diversification of energy resources.

6.8.4 Summary of Impacts

Based on the assessment above, no significant impace on water and energy resources is expected due to construction and operation of the Project. There will be a net positive impact on the power generation from the operation of the WtE plant. The potential unmitigated impacts of the Project on water and energy resources is summarised in Table 6-51.

Table 6-51 Potential unmitigated impacts on water and energy resources

Potential impact	Initial impact				Status of Impact
	Likelihood	Consequence	Impact Rating	Aspect impacted	
Construction phase					
Water supply competition with other users / consumers of DEWA	Unlikely	Minor	Low	Other water users	Negative

Potential impact	Initial impact				Status of Impact
	Likelihood	Consequence	Impact Rating	Aspect impacted	
Additional traffic on the existing road traffic network due to the distribution of water on-site	Unlikely	Minor	Low	Workers and residents in surrounding areas	Negative
Power / fuel consumption causing localised air pollution, noise emissions	Almost certain	Minor	Medium	Construction site workers and visitors Workers and residents of surrounding areas	Negative
Potential risk of spill from delivery and on-site storage of fuel, potentially resulting in soil and groundwater contamination	Unlikely	Minor	Low	Surface and groundwater sources	Negative
Operation Phase					
Fuel consumption for plant start-up and equipment / vehicle use causing risk of spill from delivery and on-site storage of fuel	Possible	Minor	Low	Water resources Site workers and visitors	Negative
Water conservation, recycling and reusing of water from Al Aweer STP for plant operation	Almost certain	Moderate	High	Water resources Water users	Positive
Contribute to producing clean energy and additional energy resource in the Emirate of Dubai and the UAE in general	Almost certain	Moderate	High	Energy consumers in the Emirate of Dubai and the UAE in general	Positive

6.9 Waste Management

This section considers a qualitative assessment of environmental impacts due to waste generated as a result of the project during construction and operation phases.

6.9.1 Assessment Methodology

This waste assessment has been prepared in accordance with Dubai Municipality, UAE and International legislation, guidelines, conventions, protocols, policies and procedures (detailed in Chapter 3) specifically including:

- Dubai Municipality Technical Guideline Number 02, EIA Requirements for Development, Infrasturcture, and Utility Projects (August 2018)
- Executive Order issued by Council of Ministers Decree No. 37 of 2001 concerning Regulation for Handling Hazardous Materials, Hazardous Wastes and Medical Wastes
- IFC Performance Standard 3 – Resource Efficiency and Pollution Prevention (2012)
- World Bank EHS Guidelines including the General Guideline (2007), Guideline for Thermal Power (2008) and Guideline for Waste Management Facilities (2007)

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

- Describing waste generation and management practices in the UAE and Dubai Emirate based on a review of available data (e.g. solid waste generated and waste management facilities) as well as the existing waste management facilities in Dubai and the proposed WtE plant for the Project
- Identifying waste types and streams (e.g., solid, liquid; hazardous or non-hazardous) and quantities produced during construction, operation and decommissioning phases of the WtE plant facility
- Assessing impacts associated with waste generation and management (such as health hazards [Section 6.11], odour emissions [Section 6.3], soil and groundwater contamination and impacts to existing waste management infrastructure in Dubai) using the impact assessment criteria methodology outlined in Section 2.3 and discussing the benefits of the Project
- Identifying mitigation measures to reduce the waste impacts including consideration of the legislation and guidelines
- Summarising impacts along with the mitigation measures and identifying the residual impacts
- Developing a framework monitoring program to monitor waste generated and how it is managed

The assessment of waste impacts is usually associated with the impacts on receptors and resources including waste infrastructure. The indirect impacts of waste management will be addressed in other environmental components such as air quality (Section 7.1), soil and groundwater (Section 7.4).

6.9.2 Construction Phase

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

- *Soil and groundwater contamination*. The risk is primarily associated with storage of sewage, waste oil and chemical waste onsite (and other hazardous materials and substances). Due to the depth of groundwater (on average 7.24 to 15.34 mbgl), it is considered possible that there could be groundwater contamination at the WtE plant site as a result of a spill (refer to Section 6.4.4 for detailed assessment of spill). Any spills or leaks at the WtE plant site should be rectified in a timely manner
- *Litter from the site could disperse in and around the project site*. This is comparable condition as most infrastructure development projects. Although an impact may not be readily apparent at the time of the discharge, some contaminants (e.g. oil, trace metals from waste paints) tend to accumulate over time
- *Odour from storage of putrescible wastes and sewage storage tanks*. This impact is typically localised and will affect construction workers. Odour may also be a potential indication of contamination (e.g. leak / spill of sewage, chemical or oil)
- *Hazards to fauna. Construction debris / litter could also pose an injury hazard to fauna*. Desert animals could potentially ingest waste or injure themselves from sharp or hazardous waste items
- *Health and safety*. Construction debris / litter could potentially cause injury or fatalities to workers or visitors to the site from contact with sharp, flammable or hazardous materials

The above potential environmental impacts and safety issues are predicted to be similar to impacts experienced during decommissioning activities. Construction waste from the Project will add to the waste loads of the existing waste management infrastructure and services. It should be noted, however, that current facilities have adequate capacity to accommodate waste generated. Potential cumulative waste impacts of the Project can be reduced by implementing the proposed mitigation measures provided in Section 7.8.1. Segregation of wastes during construction will be crucial, with proper signage and disposal containers allotted for separation of different waste streams.

6.9.3 Operation Phase

The benefits of the operation of the Project with respect to waste include the reduction of waste disposed in the landfills. The WtE plant can utilise typical MSW, refuse-derived fuel from a materials recovery facility as well as commercial and industrial wastes that may otherwise be disposed of in a landfill.

Operational waste generated by the Project will form additional loads to existing waste infrastructure and utilities; however, will also reduce the load on waste management facilities in the Dubai Emirate. Similar to construction waste, operational waste may result in potential impacts if not properly managed, including:

- *Soil and groundwater contamination*. The risk is primarily associated with storage of sewage, waste oil and chemical waste onsite. Due to the distance to groundwater (7.24 to 15.34 mbgl), and containment of waste inputs and residual materials within engineered containment areas, it is considered unlikely that there would be groundwater contamination at the WtE Plant site. As for construction, any spills or leaks at the WtE Plant site should be rectified in a timely manner

- Litter from the site, or during deliveries of wastes, could disperse in and around the project site. Although an impact may not be readily apparent at the time of the discharge, some contaminants (e.g. oil, trace metals from waste paints) tend to accumulate over time
- *Hazards to fauna*. Waste could also pose an injury hazard to fauna. Desert animals could potentially ingest waste or injure themselves from sharp or hazardous waste items however, this is less likely to occur during operations due to the reduction in waste generated
- *Health and safety*. Waste could potentially cause injury or fatalities to workers or visitors to the site from contact with sharp, flammable or hazardous materials

With consistent implementation of the selected waste mitigation measures (Section 7.8.1), unacceptable waste impacts from the Project are not anticipated during its operational phase.

6.9.4 Cumulative Impact

While the Project may contribute to other environmental issues associated with waste transport and landfill operations including land degradation, risk of soil and groundwater contamination and GHG emissions, the cumulative impact of the Project would be the benefit in the overall reduction of waste disposed to landfill.

6.9.5 Summary of Impacts

No significant impact on waste management is anticipated for the Project. There will be a net positive impact from the operation of the WtE plant due to the overall reduction of waste disposed to the landfill. The potential unmitigated impacts of the Project on waste management is provided in Table 6-52.

Table 6-52 Potential unmitigated impacts on waste management

Potential impact	Initial impact				Status of Impact
	Likelihood	Consequence	Impact Rating	Aspect impacted	
Construction phase					
Potential soil and/or groundwater contamination due to storage, handling and transport of waste	Possible	Moderate	Medium	Soil	Negative
Litter of waste on site	Almost certain	Insignificant	Low	Soil, site workers and fauna	Negative
Odour from storage of putrescible wastes and sewage storage tanks	Almost certain	Insignificant	Low	Site workers and visitors	Negative
Hazards to fauna	Possible	Moderate	Medium	Terrestrial fauna on the Project site	Negative

Potential impact	Initial impact				Status of Impact
	Likelihood	Consequence	Impact Rating	Aspect impacted	
Operation Phase					
Potential soil and/or groundwater contamination due to storage, handling and transport of waste	Possible	Minor	Low	Soil	Negative
Litter of waste on site	Almost certain	Insignificant	Low	Soil, site workers, fauna	Negative
Hazards to fauna	Possible	Moderate	Medium	Terrestrial fauna on the Project site	Negative
Health and safety hazards to workers and visitors	Possible	Moderate	Medium	Site workers and visitors	Negative

6.10 Land Use and Visual Amenity

6.10.1 Construction Phase

Change / Inconsistency with Land Use

Based on existing land uses within and around the project site, the majority of the areas adjacent to the proposed Project location comprise of industrial and commercial facilities; as such, the proposed WtE plant is not anticipated to have any impact or result in a significant change to the intended land use for the area. The classification of the site as '*land for future development subject to environmental investigation and detail studies*' is satisfied through the preparation of this EIA report. Therefore, based on existing land use and future land use development according to DM Planning Department (2012), no impacts are anticipated in terms of conflict in land use.

Encroachment in Environmental Protected Areas

As provided in Section 5.10.2, the Project is located around 20 km east of a designated protected area; as such, encroachment of the Project is not anticipated. Further, environmental impacts (e.g. air emission, noise generation) generated during the construction phase is not anticipated to impact the protected areas (detailed assessment on air quality and noise generation is provided in Sections 6.3 and 6.4, respectively).

Impacts on Landscape and Visual Amenity

Potential visual impacts associated with construction phase include:

- Traffic – increase in the number of trucks transporting construction material may be noticed on the access road (public road and internal project site road). Traffic impact on receptors is discussed in Section 6.7;
- Dust – potential increased dust levels associated with the construction impacts and increased vehicle movements. Potential impacts associated with construction dust are assessed in Section 6.3;

It is worthy to note that the abovementioned visual impacts are transient and inherent to construction activities. As such, the overall impact of the proposed Project on landscape and visual amenity is considered of very low significance.

6.10.2 Operation Phase

The land use, landscape and visual impacts of the Project during the operation phase are considered to be negligible. Visual impact to the villa accommodations to the north of the site within the Desert Palm Polo Club area are anticipated to be minimal, given the existing landscape screening, and a general improve aesthetic when changing the asphalt paved vehicle storage area to a facility with architectural features.

The WtE plant is considered to conform to the overall industrial land use of the site and surrounding areas. However, to ensure integration of the new infrastructure, the colours and similar cladding will be used to harmonize with the adjacent industrial sites and facilities. Additional measures are provided in Section 7.9.

6.10.3 Cumulative Impact

Cumulative impacts are not anticipated.

6.10.4 Summary of Impacts

Impacts on land use, landscape and visual amenity is negligible and consistent with an industrial zoned land use. The impacts of the Project (prior to implementation of mitigation measures) is summarised in Table 6-53.

Table 6-53 Potential unmitigated impacts on land use and visual amenity

Potential impact	Initial impact				Status of Impact
	Likelihood	Consequence	Impact Rating	Aspect impacted	
Construction phase					
Change / inconsistency with land use	Rare	Insignificant	Negligible	NA	Negative
Increased in the number of trucks transporting construction materials	Possible	Moderate	Medium	Community and business establishments leading to the Project site	Negative
Potential increase in dust levels	Likely	Minor	Medium	Community and business	Negative

Potential impact	Initial impact				Status of Impact
	Likelihood	Consequence	Impact Rating	Aspect impacted	
associated with the construction impacts and increased vehicle movement				establishments leading to the Project site	
Operation Phase					
Visual impact associated with the installation of new infrastructure	Unlikely	Minor	Low	Community and business establishments leading to the Project site	Negative

6.11 Socio-Economic, Culture and Health

6.11.1 Construction Phase

6.11.1.1 Socio-Economic Impacts

Generation of Employment and Business Opportunities

During the construction phase, a significant positive impact of the Project will be the generation of employment and business opportunities. The Project is anticipated to employ approximately 2,000 workers during the peak of construction, which will generally comprise of construction labourers and skilled trades people.

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

6.11.1.2 Impacts on Workers

Workforce Accommodation and Labour Conditions

As per existing polices and practices in Dubai, majority of the construction workforce are provided with accommodation; as such, accommodation facilities will be provided to workers during the construction phase. Existing labour camps used by the Contractors are located in Al Quoz and Jebel Ali Area. Transportation services from labour accommodations to the WtE plant site will be provided by the contractor/s.

In addition to the construction labour accommodation, some staff would be permanent employees or contractors living locally or within the vicinity of the Project. Separate arrangements will be put in place for these types of workers to comply with the local and international requirements. Whether existing labour accommodation will be used or temporary/permanent facilities will be established, it should meet the requirements of the following standards:

- Health Requirements for the Services provided inside Labours Accommodation, Public Health and Safety Department (Doc Ref: DM-PH&SD-P7-WI18);
- Health Requirements for Permanent Labour Accommodation, Public Health and Safety Department (Doc Ref: DM-PH&SD-P7-Wi02); and
- Health Requirements for Labour Accommodation, Public Health and Safety Department (Doc Ref: DM-PH&SD-P6-WI-02).

If the above standards are adhered to, then the standard of living for the personnel working on the Project would be deemed acceptable and will not pose a negative socio-economic or health impact.

Occupational Health and Safety

The workers or staff members at the Project site could be exposed to various occupational and safety hazards (e.g. exposure to heat, noise, electrical hazards, fire and explosion, fall from height, inhalation of toxic chemicals, dangers associated with general construction equipment and materials, etc.) which are inherent to construction works. Contractors will be required to develop safe work methodologies to ensure protection of workers from injuries or ill health effects. The Proponent, through the contractors, will ensure that construction work will meet all UAE and Dubai Labour Law requirements including:

- Dubai Municipality Code of Construction Safety Practice (Latest Version);
- Provision of Local Order No. (3) of 1999 on Construction Activities Regulations in the Emirate of Dubai;
- Provision of Local Order No. (11) of 2003 on Public Health and community Safety in the Emirate of Dubai;
- Code of Construction Safety Practice (Adopted Under Local Order 61/1991); and
- UAE Fire & Life Safety Code of Practice outlined by the Civil Defence, which includes “Chapter 12 - Fire & Safety Codes during Construction and Maintenance”.

Protecting the Work Force

Child labour and forced labour will not be tolerated at all phases of project development. The Proponent will ensure that safety and protection of workers will be prioritised. A Human Resource Management Plan will be prepared to ensure that employment of juveniles (under the age of 15) and forced labour will be avoided. In the event juveniles (youth between the ages 15 and 18) are employed (e.g. on-the-job training), it will be ensured that requirements of the Ministry of Human Resources and Emiratization (MoHRE) on juvenile work permit issuance are complied with. Appropriate measures to protect their rights will also be established. Appropriate penalties and disciplinary action will be imposed in case of child labour, forced labour and other forms of workers’ right violation.

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

6.11.1.3 Community and Public Health Impact

Visual Amenity

The WtE plant will be located at the existing vehicle storage site owned by DM and surrounded by industrial and commercial (warehouse and storehouses) facilities. The construction laydown area will be located south of the proposed WtE plant in an already cleared area. The topography of the site is lower than the surrounding site. As such, the overall impact of the construction activities on visual amenity is considered of very low significance.

Potential visual impacts associated with the construction phase include:

- Traffic due to the anticipated increase of trucks transporting construction materials, which may be observed on the access road. Traffic impact assessment is provided in Section 6.7
- Potential increase of dust levels associated with the construction impacts and increase vehicle movements (Section 6.3)

It is worthy to note that the abovementioned visual impacts are transient and inherent to construction activities. Further, the Project will conform with what would be expected to be observed within an industrial area and consistent with the surrounding industrial landscape.

Disruption from Construction Traffic

Construction traffic could potentially result in increased congestion and disturbance to local residents, schools and workers. Working hours for the construction site will be established outside the normal working and school hours (i.e. 8:00 AM and 5:00 PM) to prevent traffic and congestion. Working hours at the construction site are as follows:

- Saturday to Thursday – 07:00 to 18:00; and
- Summertime restricted hours Saturday to Thursday – 05:30 to 12:30 and 15:00 to 18:00 (or as dictated by the Local Authorities due to climatic conditions (heat) and the requirement to manage fatigue).

Any work outside these hours will require prior approval from authorities (e.g. Road and Transport Authority) at least 48 hours in advance. Working hours and conditions will comply with the UAE Labour Law and directives issued by Dubai Municipality. A traffic management plan will also be developed to manage construction traffic entering and exiting the project site (as discussed in Section 7.6).

Air Quality and Noise Impacts

The construction activities are likely to emit fugitive dust and gaseous pollutants and generate noise that could potentially cause annoyance or sleep disturbance to surrounding sensitive receptors, in case night-time construction activities are undertaken. The workers may also be exposed to hazardous substances when hazardous materials and their wastes are delivered to and removed from the construction site, respectively, if they are not properly handled.

Air and noise emissions during construction are likely to be temporary, reversible and localised. Air and noise impacts on sensitive receptors are discussed in Section 6.3 and 6.4, respectively, while an assessment of waste is provided in Section 6.7.

Conflict between Workers and Local Residents / Occupants

The potential influx of a large number of construction workers can be a challenge to the local communities located close to the Project site. Some residents at the residential and resource / attraction areas close to the site may find the behaviour of the workers a nuisance/disturbance (e.g. hanging around and utilising areas in the local communities during rest breaks). Behavioural or cultural differences and misconduct (e.g. littering) by construction workforce may result in public health and safety concerns. The construction site is surrounded by industrial facilities, and local communities and schools are not within the immediate vicinity of the site. As such, opportunities for conflict between workers and local residents / occupants to arise is considered limited.

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

6.11.1.4 Impacts on Archaeology and Cultural Resources

Based on available online information, construction of the proposed WtE plant is not likely to have any impact on the archaeological and cultural resources of the Emirates of Dubai.

6.11.2 Operation Phase

6.11.2.1 Socio-Economic Impacts

The Project is anticipated to generate long term employment opportunities as it requires approximately 129 full time staff to oversee the entire operation of the WtE plant. Additional 120 external workers will be employed during the annual outage overhaul. The skills required for the operations phase will be technical, management and administration staff. As with the current trend in Dubai and the UAE in general, employees will likely consist mostly of expatriates although priority will be provided to local Emiratis.

The workers' wages will contribute to the local economy as a result of multiplier effect that will potentially benefit local businesses such as food and beverages, tourism and other establishments. Operation and maintenance activities will also generate business opportunities in relation to maintenance and material supplies.

The long-term business and employment opportunities brought about by the Project will contribute to the overall socio-economic development in the Emirate of Dubai. The operation of the WtE plant is also anticipated to reduce Dubai's reliance on imported energy supply from the Emirate of Abu Dhabi.

6.11.2.2 Impacts on Workers

Occupational Health and Safety Impacts

The operation and maintenance of the WtE plant have associated occupational health and safety risks, which require control measures to ensure protection of workers as mandated in the UAE Labour Law. The plant operator will be directly responsible for managing health and safety risks associated with the operation the WtE plant and activities of the employees.

The following occupational health and safety risks will be considered in developing the OHS Plan:

- Heat exposure during operation and maintenance of combustion units, pipes and related hot equipment
- Exposure to air quality emissions
- Exposure to noise in combustion facilities
- Working in confined spaces (e.g. turbines, condensers, stack, etc.)
- Electrical hazards due to energized equipment and power lines

- Fire and explosion hazards;
- Chemical hazards (e.g. ammonia for NOx control system)
- Hazardous waste management (e.g. flue gas residue)

Labour and Working Conditions

Accommodation facilities will be established southeast of the WtE plant. All temporary and permanent labour accommodation will be established to meet the requirements of the following standards:

- Health Requirements for the Services provided inside Labours Accommodation, Public Health and Safety Department (Doc Ref: DM-PH&SD-P7-WI18);
- Health Requirements for Permanent Labour Accommodation, Public Health and Safety Department (Doc Ref: DM-PH&SD-P7-Wi02); and
- Health Requirements for Labour Accommodation, Public Health and Safety Department (Doc Ref: DM-PH&SD-P6-WI-02).

Labour accommodation is considered to be a residential area; as such, it should conform with guideline limits in terms of air and noise threshold criteria. Air and noise impact assessments for the labour accommodation are provided in Sections 6.3 and 6.4, respectively.

6.11.2.3 Community and Public Health Impacts

Visual Amenity

Changes to visual amenity are considered to be permanent and irreversible; however, these changes are consistent with the existing industrial landscape already established in the Project site.

Odour Annoyance and Nuisance

Results of the odour dispersion modelling indicate that:

- When negative pressure is maintained, predicted odour concentrations will be undetectable to majority of the population;
- If negative pressure is lost and a flow rate of 0.6 m/s is achieved, predicted odour concentrations at 7 of the 14 receptors should be undetectable and some sensitive receptors north of the WtE plant may experience odour concentrations of up to 5.6 OU; and
- In a flow rate of 1.2 m/s during a loss of negative pressure, predicted odour concentrations at 2 receptors should be undetectable while some receptors may experience odour concentrations of up to 11.1 OU.

Proposed mitigation measures to prevent odour concentrations reaching the identified sensitive receptors are provided in Section 7.2.2.2.

Human Health Risks

Hazards

Many studies have been performed at incnerators around the world to characterise the health impacts associated with WtE plants. The following hazards were considered in this assessment:

- *Emissions*. Contaminants evaluated in air dispersion model (refer to Section 6.3.2.1) include NO_2, SO_2, CO, TSP, acid gases (HCl, HF and NH_3) dioxins (2,3,7,8 TCDD), Hg and Cd.

- *Ash*. Short-term storage of IBA and FGT residues will be provided at the WMC. The IBA will be pretreated and managed by DM prior to use as aggregate on Dubai roadways. The FGT residues will also be managed by DM, however the final disposal option is currently not known but it is defined as a hazardous waste in most contexts. Heavy metal concentrations in leachate from ash disposal present the greatest risk based on several studies (Alba et al., 1997) (Chichester and Landsberger, 1996) (Buchholz and Landsberger, 1995). Leachate could contaminate groundwater, which could subsequently lead to contamination of the groundwater resources. However, the pretreatment of the ash should stabilize it to control leachate thereby reducing the potential impacts to ground water. Furthermore, groundwater was encountered between 7 to 15 metres below ground level (mbgl). Consequently, adverse human health impacts from the leachate associated with ash re-use or disposal are not expected to be of consequence. Airborne dust from the ash will be minimized through the use of covered vehicles and dust control measures at the facility. The potential risk to human health associated with airborne dust from the ash is similar to the potential risks associated with emissions from the incineration process and will be discussed generally as a component of emissions.

Exposure Routes

Exposure to pollutants associated with WtE plant could occur through the following:

- *Inhalation*. Pollutants of concern could be found in gas or particulate form emitted from the incinerator stack or residual ash. Inhalation of these gasses or particulates provides a pathway for pollutants to impact human health. Preliminary studies have been done to evaluate wind conditions and dispersion of emissions from the WtE plant as described in the Air Quality Assessment Report (refer to Appendix N).
- *Ingestion*. Incidental ingestion of particulate matter from incinerator emissions or airborne dust from incinerated bottom ash and flue gas treatment (FGT) residue is unlikely but could occur if these particulates were to settle on food or in water that is subsequently consumed by workers or the general public.
- *Dermal contact*. Dermal contact is possible for workers working with the incinerator bottom ash. Deposition of particulates or airborne dust on non-workers under proper operation of the emission control systems is anticipated to be negligible. However, the management measures that will be in place should eliminated or minimize any potential exposure for the workers.

Exposure response

- *Inhalation*
  - *Nitrogen Dioxide (NO_2)*. As numerous epidemiological studies have used NO_2 as a marker for the mixture of combustion-related pollutants, in particular, those emitted by road traffic or indoor combustion sources, therefore, it has been difficult to provide a robust basis for the health effects associated with inhalation of NO_2 (WHO, 2005). However, epidemiological studies have shown that bronchitic symptoms of asthmatic children increase in association with annual NO_2 concentration, and that reduced lung function growth in children is linked to elevated NO_2 concentrations within communities already at current North American and European urban ambient air levels (WHO, 2005). Section 6.3.2.1 shows the highest predicted cumulative concentrations fall below the assessment criteria using the NOx to NO_2 ratio, with the exception of Residential villas.

As the cumulative annual average concentration are above the WHO criteria, there may be times when annual average of the NO_2 levels may result in decrease in pulmonary function for some individuals, particularly those with asthma.

– *Sulfur Dioxide (SO_2)*. Inhalation exposure to SO_2 primarily impacts the respiratory system resulting in bronchoconstriction; asthmatics are particularly prone to adverse health impacts associated with exposure to SO_2 (ATSDS, 1998). Studies have been conducted in controlled chamber experiments for short-term exposure and observational studies in urban areas for 24-hour and long-term exposure (WHO, 2005).

The controlled chamber experiments indicate that "response to inhaled SO_2 is rapid, the maximum effect usually being reached within a few minutes" (WHO, 2005). However, lung function returns to normal after the exposure ceases.

Observation studies in urban areas provide estimates of the correlation between SO_2 concentrations in ambient air and mortality rate. Many of these studies indicate a correlation exists between a decrease in the ambient SO_2 concentrations and a decrease in mortality rates. However, "there is still considerable uncertainty as to whether SO_2 is the pollutant responsible for the observed adverse effects or, rather, a surrogate for ultrafine particles or some other correlated substance" (WHO, 2005). Using these studies, the WHO established 24-hour average target air quality guidelines for SO_2 concentrations. The WHO concluded that compliance with the 24-hours guideline would assure low levels for the annual average and, consequently, an annual average was not warranted.

The ATSDR within the US Department of Health and Human Services developed a toxicological profile for SO_2 as part of its evaluation of hazardous substances most commonly found at National Priority List sites identified under the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA). ATSDR evaluated clinical studies, occupational exposure incidents, and non-occupational exposure studies. Using these studies, the ATSDR established a minimal risk level (MLR) and lowest-observed-adverse-effect level (LOAEL). The MLR "is defined as an estimate of daily human exposure to a substance that is likely to be without an appreciable risk of adverse effects (noncarcinogenic) over a specified duration of exposure" (ATSDR, 1998). The acute ATSDR MRL for SO_2 is 0.01 part per million (ppm) or 26.2 µg/m^3. Acute MRLs typically applied for 1 to 14 day exposures, therefore the acute ATSDR MRL is comparable to more conservative the WHO 24-hour average of 20 µg/m^3, therefore a direct comparison was not undertaken.

Section 6.3.2.1 shows the predicted 1-hour, 24-hour and annual incremental GLCs for SO_2. The highest predicted incremental concentrations fall below the assessment criteria for all averaging periods. These modelled concentrations should not result in any adverse human health effects. Therefore, these modelled concentrations should not result in any adverse human health effects.

– *Carbon Monoxide (CO).* Carbon monoxide is absorbed through the lungs and reacts in the blood stream with hemoglobin to form carboxyhemoglobin, which impairs the oxygen carrying capacity of the blood (HSDB, 2014). In addition to its reaction with hemoglobin, CO combines with myoglobin, cytochromes, and metalloenzymes. Unchanged CO is eliminated through the lungs when exhaled (HSDB, 2014). When CO poisoning occurs, it has been reported to cause tissue damage, to include the heart, brain, liver, kidney, and muscles. The symptom and signs of CO poisoning include neurological effects such as headaches, dizziness, weakness, nausea, confusion, disorientation, and visual disturbances, exertional dyspnea, and increase in pulse and respiratory rates (HSDB, 2014). Complications such as immediate death, myocardial impairment, hypotension, arrhythmias, and pulmonary edema occur frequently from CO poisoning (HSDB, 2014).

Section 6.3.2.1 shows the predicted 1-hour and 8-hour GLC for CO. Results do not exceed the UAE Federal criteria of 10,000 µg/m^3. Therefore, these modelled concentrations should not result in any adverse human health effects.

– *Total Suspended Particles (TSP) and Particulate Matter (PM).* TSP is a mass concentration of particulate matter (PM) in ambient air. PM refers to all airborne solid and liquid particles (except water) that are microscopic in size. Particle diameters may range from approximately 0.005 µm to 100 µm (CEPA, 1999). The most studied particles are the PM_{10} and the $PM_{2.5}$. PM_{10} is generally subdivided into a fine fraction (>2.5 µm) (PM2.5) and coarse fraction (>2.5 µm). TSP generally consists of particles less than 40 µm. Up to 80% of PM_{10} and 60% of TSP are made up of $PM_{2.5}$ (CEPA, 1999). The major components of the fine fraction include sulphate, nitrate, ammonium, lead, elemental carbon, metals, and hundreds of different organic carbon compounds that are generally of primary anthropogenic origin (CEPA, 1999). The coarse fraction consists of materials that are common to the earth's crust such as oxides of iron, calcium, silicon, and aluminum and sea spray (sodium and chloride) (CEPA, 1999).

In evaluating potential health effects associated with inhalation of particulates, the particulate size is of importance. Ultrafine and fine particulate matter are of greatest concern to human health "*because they can be transported long distances, penetrate indoors readily, reach deep into the lung, and are the particles most enriched in toxic compounds*" (Committee on Health Effects of Waste Incineration, Board on Environmental Studies and Toxicology, Commission on Life Sciences, National Research Council, 2000). Facility-specific information regarding particulate size in the emissions fro mthe proposed incinerator is not available.

Section 6.3.2.1 shows predicted 24-hour and annual ground level incremental concentrations of TSP. Results have been presented as stack TSP concentrations, IBA TSP concentrations, and total TSP concentrations. For both no dust control and with dust control, the highest predicted incremental concentrations for 24-hour and annual averages fall below the assessment criteria. Although the background concentrations were not available for TSP near the Project area, the low predictions of GLCs indicate that the contribution to the air shed at the defined sensitive receptor from the proposed Project will be minimal.

The respirable portion of TSP, PM_{10} and especially particles with aerodynamic diameters less than 2.5 µm (PM2.5), pose the greatest health risk (Yang, 2016, VOL. 66, NO. 8) (WHO, 2005) (US EPA, accessed October 4, 2018) because they can be inhaled deep into the lungs. The WHO established air quality guidelines for annual average and 24-hour mean PM_{10} and $PM_{2.5}$. These guidelines were established as targets that would allow for significant reductions in acute and chronic adverse health effects. The US EPA has annual National Ambient Air Quality Standard (NAAQS) for fine particulate matter (PM2.5, i.e., particles smaller than 2.5 µm in aerodynamic diameter) to 12 µg/m^3. The criteria for $PM_{2.5}$ was set to protect healthy and sensitive populations (e.g., pregnant women, people with preexisting conditions, obese population) against adverse health effects linked to acute and chronic particulate mater exposure. Exposure to particulate matter has been linked with adverse health outcomes (e.g., premature death, cardiovascular effects, and respiratory effects). The 24-hour health standard for $PM_{2.5}$ is 35 µg/m^3. Coarse particulate matter (PM_{10}, i.e., particles between 2.5 and 10 µm in aerodynamic diameter) has been set at 150 µg/m^3.

Assuming a conservative ratio of 1:1 for TSP and PM_{10}, Section 6.3.2.1 shows the predicted 24-hour and annual GLCs for PM_{10}. The results in the tables have been presented as stack PM_{10} concentrations, IBA PM_{10} concentrations and total PM_{10} concentrations in order to give a greater understanding of the proportion of the PM_{10} being emitted from each source. For no dust control and with dust control, the highest predicted incremental concentrations for 24-hour and annual averages fall below the assessment criteria. The predicted culumative 24-hour total PM_{10} concentrations exceed the UAE criteria due to the background concentrations exceeding the criteria.

Assuming a conservative ratio of 1:1 for TSP to $PM_{2.5}$, Section 6.3.2.1 shows the predicted 24-hour and annual GLCs of $PM_{2.5}$. For both no dust and with dust control, the highest predicted incremental concentrations for 24-hour and annual averages fall below the assessment criteria. The predicted cumulative 24-hour and annual total $PM_{2.5}$ concentrations exceed the WHO criteria due to the background concentration exceeding the criteria.

The health effects would be associated with the existing adopted background air concentrations. The small cumulative increase in the ambient air concentration due to the modelled emissions for TSP, PM_{10}, and $PM_{2.5}$ from the WMC is not anticipated to result in a significant change to the air quality of the airshed or associated health effects. The low predictions of GLCs indicate that the contribution to the air shed at the defined sensitive receptor from the proposed Project will be minimal.

– *Acid Gases (HCl and HF).* Corrosive burns may result from the inhalation of acid fumes and from skin contact with or the ingestion of strong acid. Symptoms after ingestion or skin contact include immediate pain and ulceration of all membranes and tissues, which come in contact with the acid. Ingestion may be associated with nausea, vomiting and intense thirst; corrosion of the stomach may lead within a few hours or a few days to gastric perforation and peritonitis. Late esophageal, gastric and pyloric strictures and stenoses should be anticipated. Contact with concentrated acid with the eye can cause extensive necrosis of the conjunctiva and corneal epithelium, resulting in perforation or opaque scarring. Chemical pneumonitis can be expected after respiratory exposure to acid vapors or after tracheobronchial aspiration of ingested acid. Death may occur due to complications such as circulatory shock, asphyxia due to glottic or laryngeal edema, perforation of the stomach with peritonitis, gastric hemorrhage, infection or anition due to stricture formation (HSDB, 2014).

  Section 6.3.2.1 shows the predicted 99.9th percentile 1-hour HCl and 24-hour HF GLCs. The highest predicted incremental concentrations are below the assessment criteria. Although background concentrations were not available for HCl and HF near the Project area, the low predictions of GLCs indicate that the contribution to the air shed at the defined sensitive receptors from the proposed Project will be minimal. Therefore, these modelled concentrations should not result in any adverse human health effects.

– *Dioxins/Furans (TCDD) and Ammonia*. Chlorinated dibenzo p dioxins/furans (dioxins/furans) are a group of compounds (congeners) that exist as mixtures. Of all the dioxin/furan congeners, 2,3,7,8 Tetrachlorodibenzo-p-dioxin (TCDD) is the best studied, and is the reference compound for this group. Dioxins are combined to provide a single meta parameter, 2,3,7,8 TCDD TEQs. The use of TEQs is widely accepted in the international scientific community and is commonly used in the evaluation of dioxins/furans. Emission factors from the WtE plant were not provided on a congener specific basis, rather as a total 2,3,7,8 TCDD TEQ. Therefore, dioxin and furan emissions from the Project used in this HHRA were reported on a 2,3,7,8 TCDD TEQ basis. They represent the suite of dioxin and furan congeners that are used to assess the toxicity of these chemicals as a mixture. Only a very low level of dioxin and furans would be expected in the MSW that is to be the feedstock material for the WtE plant. These chemicals are formed in the WtE plant as a result of incomplete combustion of organic material and will be emitted to the environment in low concentrations.

The primary and most immediate effect of ammonia exposure is due to its irritant and corrosive properties, which results in burns to the eyes, skin, and respiratory tract. The alkaline properties and high water solubility of ammonia allows it to dissolve in moisture on the mucous membranes, skin, and eyes forming ammonium hydroxide. Ammonium hydroxide causes liquefaction necrosis of the tissues (ATSDR, 2004). Airway blockage and respiratory insufficiency may result from exposure to anhydrous ammonia vapours or concentrated aerosols. Ingestion of concentrated solutions of ammonia may produce severe hemorrhage of the upper gastrointestinal tract in addition to severe burns.

Section 6.3.2.1 shows the predicted 99.9th percentile 1-hour TCDD and NH_3 GLCs. The highest predicted incremental concentrations fall below the assessment criteria. Although background concentrations were not available for TCDD near the Project area, the low predictions of GLCs indicate that the contribution to the air shed at the defined sensitive receptors from the proposed Project will be minimal. Therefore, these modelled concentrations should not result in any adverse human health effects.

– *Mercury (Hg) and Cadmium*. Respiratory, cardiovascular, gastrointestinal, hematological, neurological and renal effects have been observed in both humans and animals after acute duration inhalation exposure to metallic mercury (ATSDR, 1999). Tremors, irritability, and decreased motor functions and reflexes were common neurological symptoms following high level acute duration exposures to metallic mercury vapors. Short-term exposure to high levels of metallic mercury vapor can also damage the lining of the mouth and irritate the respiratory tract, causing tightness of the breath, burning sensation in the lungs and coughing. Other effects from mercury vapor exposure include nausea, vomiting, diarrhea, increase in blood pressure or heart rate, skin rashes, and eye irritation (ATSDR, 1999). Mercury has not been classified as a probable human carcinogen. The primary target organ for exposure to mercury via inhalation is the nervous system (USEPA, 1995).

  Cadmium exposure, inhaled or ingested, can adversely impact the kidneys, respiratory system, and skeletal structure in humans (WHO, 2010). Cadmium is also a known human carcinogen. The kidneys are the primary target organ associated with chronic exposure to Cd since it accumulates in the kidneys and is not readily excreted. Acute exposure to high levels of inhaled Cd can result in death within days of exposure; although, the instances of death due to high-dose exposure are associated with occupational exposure in industries involved with heavy metals (WHO, 2005) (ATSDR, 2012).

  Section 6.3.2.1 shows the predicted 99.9th percentile 1-hour Hg and Cd ground level concentrations. While the highest predicted incremental concentrations for Hg are below the assessment criteria, the predicted 1-hour incremental concentration for Cd exceeds the NSW AMMAAP. However, the NSW AMMAAP can be considered a guideline only as opposed to a strict limit. As this is a national guideline designed for relevance to Australian projects, it is apparent that the European Commission criteria are more suitable since the stack emissions of the WMC are complying with the European IED. The highest predicted annual concentration for Cd occurs at Residential Villas (Desert Palm), equating to 87 percent of the European Commission criteria.

Although background concentrations were not available for Hg near the Project area, the low predictions of GLCs indicate that the contribution to the air shed at the defined sensitive receptors from the proposed Project will be minimal.

It is noteworthy that WMCs most recently constructed by Hitachi Zosen Inova showed emission rates of Cd and thallium to range between 0.00003 g/s to 0.00006 g/s for the WMC with an identical air pollution control system to be implemented in the Dubai WMC. Therefore, the expected maximum ambient concentration of Cd at the sensitive receptors in reality is likely to be significantly lower.

Acute inhalation exposure guidelines were developed for 1 to 14 days exposure duration, therefore comparison to an one hour average is conservative. Therefore, these modelled concentrations should not result in any adverse human health effects. For Cd, the regulatory maximum emission rate was used in the modelling which is a conservative approach and it is considered unlikely that emissions in reality would reach this limit. Therefore it is expected that the contribution of Cd to the air shed would be lower in reality

- *Ingestion*. Ingestion of the contaminants associated with emissions from the WtE plant could occur through deposition of these materials on food, water, food crops, or animal feed. Dioxins/furans in particular bioaccumulate in the food chain potentially leading to adverse human health impacts if dioxin-contaminated food is consumed. Food crops and animal farms are not located within the study area. Consequently, bioaccumulation of contaminants through food production and plant or animals for human consumption, is not likely. Warsan Lake was identified as one of the sensitive receptor locations, so there is potential that deposition on to the lake and surrounding habitat may impact the soil and sediments. Therefore, bioaccumulation up the food chain for the ecological receptors living within Warsan Lake and surrounding habitat may occur but these ecological receptors will not be used for human consumption.
- *Dermal contact*. Dermal contact with the contaminants in the vapour or particulate phase that will be emitted from the WtE plant are not anticipated to result in adverse human health effects due to low concentrations in the emissions.

6.11.3 Cumulative Impact

6.11.3.1 Socio-Economic Impact

There will be a net positive impact from the Project construction activities through the provision of employment and business opportunities as well as stimulation of the local and regional economies.

With the completion and operation of the Project, reliance on fossil fuel and imported energy (from Abu Dhabi Emirate) will be reduced, improving long-term revenues in the Emirate of Dubai.

6.11.3.2 Community and Public Health Impacts

The majority of the predicted incremental GLCs for the pollutants assessed are below the adopted assessment criteria, based on the stack characteristics and emission rates assumed for the Project. Therefore, these modelled air concentration should not result in an adverse effect to human health for the sensitive receptors via the inhalation exposure pathway.

The maximum predicted 1-hour NO_2 concentration at a defined sensitive receptor exceeded the WHO criterion when added to the adopted background concentrations. However, a conservative conversion rate for NOx to NO_2 was assumed (80%), which in reality is likely to be much lower.

Similarly, the cumulative concentration for PM_{10} and $PM_{2.5}$ exceeds the WHO criteria when background concentrations are considered. Again, the contribution of the WMC to PM_{10} and $PM_{2.5}$ concentrations are less than the 25% of the criteria, showing compliance with the IFC guideline. The health effects would be associated with the existing adopted background air concentrations. The small incremental increase in the ambient air concentration due to the modelled emissions from the WMC are not anticipated to result in a significant change to the air quality of the airshed or associated health effects.

The highest predicted maximum for Cd exceed the criteria at grid maximum and three of the sensitive receptor locations. However, the predicted concentrations at the sensitive receptor locations were below the acute ATSDR MRL. It should be noted that the maximum emission rate used in the model demonstrates a worst-case scenario and it is understood that emission rates are likely to be lower in reality.

6.11.4 Summary of Impacts

There will be a net positive impact from the Project construction through the provision of employment and business opportunities. With the completion and operation of the Project, reliance on fossil fuel and imported energy will be reduced.

The majority of the predicted incremental GLCs for the pollutants assessed are below the adopted assessment criteria, based on the stack characteristics and emission rates assumed for the Project. Therefore, these modelled air concentration should not result in an adverse effect to human health for the sensitive receptors via the inhalation exposure pathway.

The potential unmitigated impacts of the Project during the construction and operation phases is summarised in Table 6-54.

Table 6-54 Potential unmitigated impacts on socio-economic, culture and health aspects

Potential impact	Initial impact				Status of Impact
	Likelihood	Consequence	Impact Rating	Aspect impacted	
Construction phase					
Generation of employment and business opportunities	Almost certain	Minor	Medium	Local residents and business owners Expatriates / foreign workers	Positive
Reduced amenity due to traffic and construction activities and visual impact from the construction site	Almost certain	Minor	Medium	Local residents and business owners Workers and customers of retail and commercial establishments	Negative

Potential impact	Initial impact				Status of Impact
	Likelihood	Consequence	Impact Rating	Aspect impacted	
Increased health and safety risk	Almost certain	Moderate	High	Construction workforce and site visitors	Negative
Conflict between local residents and workers	Possible	Moderate	Medium	Local residents Workers and customers of industrial and commercial facilties surrounding the site Workers on-site	Negative
Poor labour and working conditions	Possible	Moderate	Medium	Construction workforce	Negative
Chance find of resources with archaeological and cultural significance	Rare	Major	Medium	Archaeological and cultural resources	Negative
Operation Phase					
Generation of employment and business opportunities	Almost certain	Minor	Medium	Local residents and business owners Expatriates / foreign workers	Positive
Reduced amenity due to traffic	Almost certain	Minor	Medium	Local residents and business owners Workers and customers of retail and commercial establishments	Negative
Increased occupational health and safety risk	Almost certain	Moderate	High	Construction workforce and site visitors	Negative

Potential impact	Initial impact				Status of Impact
	Likelihood	Consequence	Impact Rating	Aspect impacted	
Community health and safety impacts	Possible	Moderate	Medium	Local residents Workers and customers of industrial and commercial facilties surrounding the site	Negative
Conflict between local residents and workers	Possible	Moderate	Medium	Local residents Workers and customers of industrial and commercial facilties surrounding the site Workers on-site	Negative
Poor labour and working conditions	Possible	Moderate	Medium	Construction workforce	Negative

7. Mitigation Measures and Enhancement Plan

7.1 Greenhouse Gas Assessment

7.1.1 Construction Phase

The GHG emissions associated with the consumption of fuel and electricity for the construction of the Project can be mitigated by implementing the management measures aimed at increasing energy efficiency, as discussed in Section 7.2.

7.1.2 Operation Phase

Mitigation measures are not required as the emissions from the WtE plant are more than offset by avoided landfill methane emissions and emissions from on-site electricity generation displacing existing sources.

7.1.3 Residual Impacts

No significant residual impact is anticipated with the implementation of management measures.

There will be a net positive impact from the operation of the WtE plant, as it will result in a net total emissions reduction of 64,900 kt CO2-e over the construction and operation phases.

7.2 Air Quality

7.2.1 Construction Phase

7.2.1.1 Air Quality

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

Dust Control from General Earthmoving and Vehicle Movement

- Erect hoarding of at least 2.5 m along the site boundary and/or areas where dusty activities are performed to minimise off-site dispersion of dust.
- Locate the dust generating activities, haulage routes, stockpiles and dusty materials away from the sensitive receivers as far as possible (taking the predominant wind direction into consideration).
- Provide surfacing and / or compaction of site access roads to minimise dust generated by vehicle movements on-site.
- Provide hard surface and / or compaction of unsurfaced areas as soon as possible once earthworks are complete to minimise areas susceptible to wind erosion.
- Dusty materials on site or being transported (within and outside the site) are to be covered by impervious sheet to prevent wind erosion.
- Impose and signpost a maximum speed limit of 20 km/h to minimise the emission of dust on unsurfaced roads and apply designated traffic routes to reduce traffic on unsurfaced areas.

- Undertake dust suppression through water spraying on unsurfaced areas and areas where dusty work is performed (cutting, grinding and sawing).
- Undertake wheel washing at site exits to minimise dust and soil on wheels being transferred off-site.
- Minimise drop heights from conveyors, loading shovels, hoppers, loading or handling equipment and use water sprays on such equipment / work areas where possible.
- Enclose chutes and conveyors and cover skips to prevent suspension of dust.
- Suspend dusty works during periods of high wind speed, where possible.
- Implement a construction logistic plan and construction traffic management plan to manage the sustainable deliveries of machinery, materials, workers and staff members.

Dust Control from Stockpiles

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

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

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

- Idling of equipment and vehicles will be prohibited, equipment and vehicles to be turned off when not in use to minimise gaseous emissions and fuel consumption[28].
- Use low sulphur diesel, ultra-low sulphur diesel or bio-diesel to minimise the emission of sulphur dioxide, where practical.
- Use equipment fitted with pollution control devices (e.g. diesel particulate matter filter), where possible.
- Maintain equipment and vehicles as per manufacturer recommendations and remove any malfunctioning or sub-standard equipment and vehicles from service, particularly if observed to be emitting black smoke.

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

- Implement a construction logistic plan and construction traffic management plan to manage the sustainable delivery of machinery, materials, workers and staff members.
- Open burning on site will be prohibited.

Control of VOC Emissions

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

7.2.1.2 Odour Emission

To control odour emission during the construction phase, the following measures will be implemented:

- Locate toilet utilities, sewage tanks (if any) and waste storage facilities away from sensitive receptors on-site (e.g. site office, works area) and off-site (neighbouring residential villas).
- Maintain the sanitary and waste disposal facilities in good, clean conditions with any leaks fixed as soon as possible.
- Waste bins holding putrescible waste should be covered to minimise odour emission and attraction of vectors.
- Regular off-site disposal of waste should be arranged.

7.2.2 Operation Phase

7.2.2.1 Air Quality

The predicted incremental results from air dispersion modelling of the proposed operations of the WMC indicates the Project is not anticipated to exceed relevant air quality criteria for NO_2, SO_2, CO, TSP, PM_{10}, $PM_{2.5}$, HCl, HF, NH_3, TCDD and Hg provided that:

- The emission concentration guarantees listed in IED, Annex VI, Part 3 (Tables 1.1, 1.3 and Section 1.4 and 1.5) (European Union 2010) and set out in Section 6.3.2.1 are met.
- The stack parameters and emission rates used in this assessment as detailed in Section 6.3.2.1 (Table 6-7 and Table 6-8 respectively) are adhered to.
- Throughputs of IBA remain at the assumed rate (282,300 tpa).

Although the model predictions indicate exceedances of 1-hour incremental Cd for the NSW AMMAAP criteria, this is only a guideline, and the European Commission annual criteria is considered more appropriate. Predicted annual Cd concentrations comply with the European Commission criteria. Further, the modelled emission rate reflects the regulatory maximum of 0.05 mg/Nm^3 (sum of Cd and Tl), and it is considered unlikely that the emission rate for Cd in reality would reach this level.

As outlined in section 4.7.4.2, the air pollution controls consists of a robust system, which includes a dry flue gas treatment process. For the dry flue gas treatment process, the system is designed to remove dust particles, most of the acidic gaseous contaminants by hydrated lime and organic pollutants, as well as mercury and other heavy metals by absorption on lignite coke.

Specifically, and for the bag house filter, the fabric / bag house filter is used for the separation of solids from the flue gas. In the physical process of separation the solids are filtrated on the surface of a gas permeable fabric. Due to the intensive contact of the flue gas and the adsorbents in the filter layer the removal of pollutants from the flue gas is further improved.

- The fabric filter is a pulse jet, multi chamber bag filter with several compartments.
- Each chamber has an inlet and outlet damper with one drive; operation in "n-1 chamber" mode in case of a problem with a bag is possible at nominal load.
- Cleaning is done with classic pulse jet principal.

The filter control system has the following characteristics:

- Simple installation with bus connection within the filter (master and slaves) and to DCS
- Early bag rupture detection with dust sensor and software
- Diaphragm valve monitoring with cleaning pressure monitoring
- Standard software and components

The filter bags are automatically cleaned in relation to the pressure drop. In order to prevent dew point undershooting and solids deposition during start-up and shutdown phases as well as during operational interruptions the fabric filter hoppers are heated with electric heaters. To detect material deposits, the filter hoppers are equipped with level and temperature measurements.

7.2.2.2 Odour Emission

The proposed WtE plant consist of five incineration lines. Yearly revision works will be planned to ensure that, as a minimum, two incineration lines are in operation at all times. This facilitates sufficient negative pressure in the waste bunker.

To reduce the odour resulting from the aging process of the waste, the waste should not be stored significantly longer than five days in the waste bunker. The storage capacity of the waste bunker is four days.

Aside from the odour issue, the aging process brings additional undesirable side effects like decrease of the waste quality needed for an optimal incineration process and an increased risk of smouldering fire in the depth of the waste stock. As such, waste is not anticipated to be stored longer than five days.

The following WtE plant components are installed to avoid odour emission during the operation phase:

- *Tipping bay gates*. The only direct and open contact of the waste bunker to the environment is the tipping bay. Each tipping bay will be equipped with a roller shutter door which remains closed if no waste truck has to unload waste into the waste bunker.
- *Ventilation / slight negative pressure*. By sucking the primary air for the combustion out of the waste bunker, a slight negative pressure is produced in the waste bunker. As a result, fresh air is continuously entering in series the waste bunker, thus avoiding odour emissions leaving the process building. This concept is state of the art best available technique (BAT) for waste incineration plants as described by the European commission in the IPPC "Waste Incineration".

The following measures should be undertaken in order to reduce the impact of odour on nearby receptors:

- To reduce the odour resulting from the aging process of the waste, the waste should not be stored significantly longer than five days in the bunker. The storage capacity of the waste bunker in the WtE plant is four days' worth of MSW at nominal operating conditions.
- Maintain operation of two out of five lines at any one time (shutdown of one line at a time for maintenance purposes) to maintain slight negative pressure in the waste bunker and ensure continual flow of fresh air into the waste bunker and avoid the escape of odorous air.

No additional odour treatment system based on suction / filter type will be required for the WtE plant due to the following justifications:

- The primary air flow is sufficient for producing the required negative pressure in the waste bunker.
- During maintenance works on an incineration line, the remaining lines will be in operation and the volume flows will be sufficient for ventilation purposes.
- Too high negative pressure in the waste bunker would disturb the functionality of the tipping bay doors.
- The MSW will be continuously mixed and fed to the incineration, helping to reduce odour formation due to aging.
- The composition of the MSW is expected to contain a rather small biodegradable portion leading to increased odour development.

Odour Management Plan (OMP)

The Operator will ensure that all emissions to air from the proposed Project shall be free from offensive odor, as perceived by an Authorised Person (i.e. DM-ED), outside the site boundary.

Within three (3) months prior to Commissioning of the Project or part thereof, the Operator shall prepare, implement, maintain and submit to DM-ED an Odor Management Plan (OMP) setting out the steps to be taken by the Operator to ensure that all appropriate preventative measures are taken against odor pollution and that no significant odor pollution is caused.

The OMP shall include:

- Identification of those process operations which have the potential to be odorous.
- Identification of techniques to ensure al sources of potentially offensive odors are, as far as practicable, enclosed.
- Procedures for managing odor particularly when parts of the process are shutdown.
- A methodology for undertakin an olfactory survey of the Permitted Installation only.
- Procedures for investigation, recording and subsequent remedial action following odor complaints or detection of odor during olfactory surveys.

The Operator shall record:

- The results of each olfactory survey.
- The results of each investigation and any remedial action undertaken in compliance with existing regulations.

At least every two years, or whenever there is change which could have an impact on emissions of odor, the Operator shall review the OMP. Each review of the plan and any revisions shall be recorded and the revised OMP shall be reported to DM-ED.

All doors and openings to the waste bunker and areas where odor is likely to be generated shall be kept closed at all times other than to allow entry and exit of vehicles and personnel.

7.2.3 Residual Impact

During the construction phase, no significant residual impact is anticipated with the implementation of mitigation measures.

During the operation of the project, significant residual impact is not anticipated as the emissions from the WtE plant are more than offset by avoided landfill odour emissions. Built-in odour management measures (e.g. tipping bays and ventilation at the waste bunker) will be installed to avoid odour emission.

7.3 Noise

7.3.1 Construction Phase

7.3.1.1 Construction Noise

- The construction sites should be laid-out in such a way that the primary noise sources are at a maximum distance from sensitives receptors, with solid structures (sheds, containers, etc.) placed between sensitive receptors and noise sources and as close to the noise sources as is possible. This would include items such as the power generator proposed at the construction depot
- Engines and exhaust are typically the dominant noise sources on mobile plant such as compactors, trucks, etc. Residential grade mufflers fitted on this mobile plant would minimise noise emissions from these sources
- All equipment should be selected to minimise noise emissions and maintained in good repair (kept properly serviced). Equipment such as generators, etc., should be fitted with appropriate silencers and acoustic enclosures (where practical) and be in good working order. Machines found to produce excessive noise compared to normal industry expectations should be removed from the site or stood down until repairs or modifications can be made
- Where practical, machines should be operated at low speed or power and be switched off when not being used rather than left idling for prolonged periods
- To reduce the annoyance associated with reversing alarms, broadband alarms (audible movement alarms) should be used for all site equipment and reversing kept to a minimum through improved route choice/layout/dimensions, and operational procedures (reversing beepers are a key complaint issue among residents near construction sites). Loader/dozer manoeuvring using the ‘swivel technique’ for turning may reduce the frequency of reversing beeper use for this piece of equipment. Satisfactory compliance with occupational health and safety requirements would need to be achieved and a safety risk assessment may need to be undertaken to determine that safety is not compromised
- Optimise the number of deliveries to the site by amalgamating loads where possible and scheduling arrivals within designated hours
- General construction activities should be limited to daytime (7am to 8pm) working hours, where feasible and reasonable
- Where practical, machines should be switched off when not being used rather than left idling for prolonged periods
- All mechanical plant and equipment should be checked regularly to avoid any unnecessary noise caused by lack of maintenance

- Truck drivers should be kept informed of designated vehicle routes, parking locations, operating hours and on-site speed limit
- All engine covers should be kept closed when equipment is operating

7.3.1.2 Construction Vibration

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

7.3.2 Operation Phase

In addition to the specific requirements for insulation of steel walls and roofing for the condensers as well as insulation of the steel boiler wall above the waste bunker, the following mitigation measures are recommended during the operation of the Project:

- Buildings should be located close to the Project site's boundary as much as practicable to provide shielding effects of operational noise emanating from the site
- Plant and equipment considered to be the major noise sources and those located close to the Project site's boundary should, as much as practicable, be enclosed to minimise off-site noise impact
- Selection of quiet equipment/system as early as the design phase should be considered in the development of the Project's operational noise management measures. A 'buy quiet' purchasing policy should be established, where all equipment is purchased to meet the dB(A) standard. This policy would assist in minimising the off-site impact and help in preserving the hearing quality and reducing the Health and Safety risk for on-site employees
- In line with the previous item, the WtE plant should be designed such that the noise levels in the general workplace are as low as possible and meet the relevant Health and Safety regulations as practicable through optimal engineering design
- Machines found to produce excessive noise compared to normal industry expectations should be removed from the site or stood down until repairs or modifications can be made
- To reduce the annoyance associated with reversing alarms, broadband alarms (audible movement alarms) should be used for all site equipment. Satisfactory compliance with occupational health and safety requirements would need to be achieved and a safety risk assessment may need to be undertaken to determine that safety is not compromised
- All equipment should be selected to minimise noise emissions and maintained in good repair (kept properly serviced). Equipment should be filled with appropriate silencers and be in good working order
- All mechanical plant and equipment should be checked regularly to avoid any unnecessary noise caused by lack of maintenance
- Truck drivers should be kept informed of designated vehicle routes, parking locations, operating hours and on-site speed limit

7.3.3 Residual Impact

With the implementation of the above mitigation measures, residual impacts of noise are expected to be negligible.

7.4 Geology, Seismicity, Soil and Groundwater

7.4.1 Construction Phase

The risk for construction activities to generate significant soil and groundwater contamination is considered to be minimal, provided that adequate mitigation measures are adopted and consistently implemented on-site.

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

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

7.4.2 Operation Phase

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

- Temporary bottom ash and FGT residue storage facilities will be designed, constructed, and maintained for the materials stored in accordance with applicable safe handling and disposal measures

- Regular general inspections and monitoring of temporary facilities (e.g. fly and bottom ash storage facilities)
- Development and implementation of a soil and groundwater management and remediation plan should soil and groundwater contamination occur
- Appropriate disposal of any contaminated soil and groundwater will be in accordance with applicable management guidelines

With the implementation of the proposed waste management initiatives, in particular, the construction of an adequate IBA maturation area and consolidation of other wastes into one location, the potential for soil and groundwater contamination is reduced.

7.4.3 Residual Impact

Post mitigation, residual impacts on soil and groundwater quality are considered negligible.

7.5 Biodiversity and Conservation

7.5.1 Construction Phase

Impacts of construction activities on the terrestrial ecology (fauna) will be managed through the implementation of noise control measures (Section 7.3.1). In order to mitigate risks of injuries or fatality of fauna species, immediate reporting to the concerned individuals (e.g. Site Environmental Engineer or HSE Officer) will be undertaken. Traffic control measures such as use of designated areas, reducing speed limits, limiting night time delivery and movements across the site when reptiles are more active will be implemented.

7.5.2 Operation Phase

A Waste Management Plan will be developed and implemented to avoid the introduction of invasive species (e.g. rodents, cockroach). The plan will include proper handling, disposal and treatment of wastes. Pest management plan will be in place to control introduced species especially invasive ones, which can potentially cause ill health effects to the site workers and nearby community.

7.5.3 Residual Impact

Residual impact on terrestrial ecology is not anticipated.

7.6 Access, Traffic and Transport

7.6.1 Construction Phase

During the construction phase, a construction traffic management plan that complies with the Dubai Road and Transport Authority (RTA) will be prepared to facilitate smooth traffic flow in the vicinity of the construction site. The plan will include the following measures:

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

- All delineating devices required to form the taper including the illuminated flashing arrow sign at the end of the taper, where required
- Delineation past the work area
- All other required warning and regulatory sign

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

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

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

To mitigate traffic impact associated with noise, dust and air emissions, air quality management measures (Section 7.2) and noise control measures (Section 7.3) will be implemented.

7.6.2 Operation Phase

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

To minimise impacts of noise, dust and air emissions due to truck movements, measures identified in air quality management (Section 7.2) and noise control (Section 7.3) should be implemented.

7.6.3 Residual Impact

An increase in traffic is unavoidable but transient impact from the construction activities of the Project. During the operation phase, residual impact is not anticipated as the LOS on access roads planned for the Project are considered sufficient.

7.7 Water and Energy Resources

7.7.1 Construction Phase

Contractors will be required to provide suitable service utilities and ensure they are maintained in good operating conditions. Relevant regulatory NOCs will be obtained, if required, for the temporary utilities to be used on-site.

Other proposed measures for managing environmental issues associated with the operation of construction utilities are provided below.

7.7.1.1 Water conservation measures

The use of water on-site will be minimised through the use of water efficient devices and practices, where feasible. Potential water conservation measures include:

- Use of high-pressure water spray for equipment cleaning
- When cleaning small tools and equipment, use buckets, as opposed to running water
- Utilise auto-shut off taps and ensure water supply is able to be switched off at the point of use
- Use closed-loop systems for plant and equipment
- Site inspections for water leaks and wastage are to be carried out frequently
- Use of water efficient bathroom products and taps in site offices
- When concreting, use water from settled concrete wash out area to clean equipment
- Limit dust suppression to what is necessary (avoid over watering)
- Provide employee training on site water use behaviour and best practise procedures

7.7.1.2 Energy conservation measures

Reduce electricity use

Energy use can be reduced at site offices by employing energy efficient practises such as switching off lights when not in use, using automatic or timed light systems, using energy efficient light bulbs (CFL or LED), switching off equipment when not in use and adjusting temperature set points where possible in site offices.

Optimising energy efficiency

The following measures for increasing energy efficiency will minimise the demand for non-renewable energy and reduce air emissions:

- No idling of equipment and vehicles
- Use of cleaner fuel (e.g. low sulphur diesel, ultra-low sulphur diesel or bio-diesel)
- Use of equipment fitted with pollution control devices
- Maintain equipment and vehicles as per manufacturer's recommended intervals and withdraw malfunction equipment
- Implementing a Construction Logistic Plan and Construction Traffic Management Plan
- Using battery powered equipment

7.7.2 Operation Phase

The relevant authorities / agencies are being consulted with regards to the availability of required service utilities (e.g. water supplies) and the respective connection points.

Early engagement of the authorities / service providers will enable the Project Proponent to identify any constraints. Similarly, this provides an opportunity for the authorities to assess the available resources and capacity of infrastructure against the current and future demands of the Emirate in general. As provided in Section 5.8, sufficient water and energy supplies are available to support the development needs of the Project. DEWA will participate in coordinated discussions regarding the export of electrical energy to the grid.

The environmental issues associated with the Project's additional load to the existing service utilities can be addressed via the following measures.

Water Supply

Water supply during the operation phase is not anticipated to be significant. Water will be supplied by DEWA. Although potential impacts of WtE plant operation on water supply is considered of low significance, the following measures should be implemented:

- *Optimising water efficiency*. Water efficiency measures shall be adopted (i.e. using grey water for irrigation of landscaped areas) as early as the design phase and on an ongoing basis during the operation phase of the Project. This is particularly important given that potable water is scarce in Dubai and the UAE.
- *Wastewater discharge management*. Built-in water management measures are incorporated in the design of the WtE plant. Wastewater will not be discharged to the receiving environment and will be recycled and reused.

Power Supply

The design of the Project's buildings components (i.e. administration building and labour accommodation facilities) shall comply with the requirements of the *Green Building Regulations and Specifications in the Emirate of Dubai* with regard to energy efficiency, where appropriate.

In terms of power supply, mitigation measures are not required as the operation of the WtE plant is considered to be an advantage and provides benefit to Dubai and the UAE. The Project supports diversified energy sources and contributes to additional power supply to meet the growing demand of the country. This will help achieve stable and optimal energy rates that will result in continued economic stability and growth.

7.7.3 Residual Impact

Residual impact on water and energy resources is not anticipated during the construction phase. There will be a net positive impact from the operation of the WtE plant in terms of energy sufficiency, diversification of energy resources and contribution of additional power supply to meed the demands of increasing population and growing economy.

7.8 Waste Management

This section deals with waste generated by the proposed Project during the construction and operation phases. Benefits associated with the use of waste materials as a fuel source during operations are addressed in Section 1.2.2 including reduced reliance on fossil fuels, reduced waste to landfill and meeting greenhouse gas and climate targets set by government.

7.8.1 Mitigation Measures

The measures recommended in the IFC and World Bank guidelines were considered in determining the mitigating and enhancement measures to address waste-related impacts of the Project.

IFC Performance Standard 3

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

World Bank EHS General Guideline

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

World Bank EHS Guidelines for Waste Management Facilities

The World Bank's EHS Guidelines for Waste Management Facilities and the EHS Guidelines for Thermal Power Plants are relevant to the WtE Plant. They detail environmental issues including air emissions (addressed separately in Section 7.2), energy efficiency, greenhouse gases (addressed separately in Section 7.1), water consumption, effluents, wastes, hazardous materials and oil and noise (addressed separately in Section 7.3).

Executive Order by Council of Ministers Decree No. 37 of 2001

Any hazardous wastes generated during the Project activities should be managed in accordance with the Executive Order issued by Council of Ministers Decree No. 37 of 2001 concerning Regulation for Handling Hazardous Materials, Hazardous Wastes and Medical Wastes.

7.8.1.1 Management of Project Wastes

The proposed Project will utilise Advanced Moving Grate Combustion Technology and will incinerate an estimated 236.11TPH of waste.

The waste produced by the construction and operation of the Project will be managed by Dubai Municipality facilities, as described in Table 7-1. Detailed waste treatment practices (in line with the waste management guidelines described above) will be provided in the CEMP and OEMP, if required by DM.

Table 7-1 Waste Generation and Disposal

Major Waste Type	Potential Disposal Site / Treatment Facility
Construction and demolition waste (including metals, steel, timber, concrete, rocks, sediments)	DM – Construction and Demolition Waste Recycling Facility
Recyclable waste (except construction and demolition waste) (including food waste, municipal wastes, plastic/cardboard)	DM – Material Recovery Facility
Non-recyclable waste (non-hazardous) (including food waste, municipal wastes)	DM – Landfill
Wastewater (sewage)	Collected for off-site disposal
Hazardous waste (including oils and lubricants)	Specialised oil reprocessing or dedicated incineration
Incineration bottom ash (IBA)	On-site IBA maturation area

Major Waste Type	Potential Disposal Site / Treatment Facility
	Transported to DM waste management facility (landfill) by Contractor.
Flue gas treatment residue including fly ash (hazardous waste)	Transported to DM Jebel Ali Hazardous Waste Treatment Facility (landfill) by the Contractor where it will bestabilised and stored in a dedicated cell.
Wastewater (sewage)	Collected for off-site disposal

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

7.8.1.2 Construction Phase

Consistent with the hierarchy of waste management, the following measures will be implemented during construction. Contractor(s) (including sub-contractors) as well as other relevant entities (e.g., site visitors) will be required to adhere to these measures at all times:

- Contractors and sub-contractors will be required to identify the types of waste generated from their activities. Waste registers will be maintained and kept updated on a regular basis (i.e. minimum of monthly) depending on waste generation rates
- Waste minimisation can be achieved through efficient design, procurement and material management practices. Construction Work Methods will be developed and corresponding site instruction issued to facilitate the efficient use of construction materials and minimise waste generation.
- Implement procurement procedures to minimise use of construction materials, consumables and equipment / plant including measures such as specifying the actual quantity of construction materials required, ordering materials in bulk; and organising arrangements with the suppliers for the return or buy-back of containers and packing materials; and preference for environmentally friendly materials
- Reuse and recycle scrap materials for site works including measures such as:
  - Establishment of waste segregation areas on construction sites. The minimum requirement is to segregate the hazardous waste from the non-hazardous stream. Further, segregation (e.g. paper, wood, metal, plastic) will facilitate recycling
  - Re-use of excavated materials for fill purposes during site development or foundation works provided it is of suitable quality
  - Use of scrap materials such as wood and metals for formworks and other temporary structures onsite
  - Recycling through approved service provider. Where possible, paper, wood, metal and plastic wastes will be sent to suitable recycling facilities
- Provide appropriate waste bins for different waste e.g. food wastes require bins with lids to avoid vermin infestation, and sharp waste materials will require sturdy waste bins. Skips and bins will also be covered to prevent littering by light-weight materials, particularly during periods of strong wind which could disperse litter offsite
- Label waste bins / containers and collection areas in English and other languages understood by the general workers including the name of the waste and safety risks and

precautions (i.e. for hazardous waste) to assist workers in segregating waste and reduce cross contamination

- Locate waste bins / containers where waste is produced (e.g. work areas, canteen) will be provided with suitable waste bins / containers. Waste stockpiles will be located away from stormwater flow paths
- Provide suitable temporary sewage holding tank onsite. The tank will be leak proof to prevent soil contamination or health issues. A contractor will be used to ensure that the volume of sewage will not exceed 80% of tank capacity, and regular collection of sewage for offsite disposal will be arranged. Sewage tanks will be located away from sensitive receptors
- Designate bunded areas for equipment and vehicle washing; the wastewater will be collected in tanks for offsite disposal
- Provide bunded storage area and drip trays for hazardous waste with a capacity of at least 110% of the volume of the largest container. Where practical, bunded areas will be provided with a roof to prevent them from being filled with water during heavy rains. Drip trays will also be provided for petrol-operated equipment and during handling of chemicals (e.g. at workshops).
- Spill kits and fire extinguishers will be available where there is a risk of spill and fire, respectively
- Provide training and personal protective equipment (PPE) for workers for the proper handling, storage and disposal of waste as well as the proper use of PPE. Restrict access to waste storage areas, particularly hazardous waste

With consistent implementation of the above mitigation measures, waste and other associated impacts from the construction are not anticipated to adversely affect the site and surrounding areas.

7.8.1.3 Operation Phase

Measures to manage waste produced during operation will include:

- Management of waste deliveries and unloading areas, with routine housekeeping practices and litter collection at the site.
- Maintenance of waste bunkers and receiving areas. Leachate generation would be attributed to the putrescible municipal solid waste delivered to the WtE plant and received in the designated Waste Bunker. The Waste Bunker has been designed as a water retaining structure, considering 0.2mm maximum crack width, which is considered to be water tight, and is thus able to accommodate the material. Based on the design controls, leachate outbreak from the Waste Bunker is not to be expected. Furthermore, it can be clarified that Stormwater drainage has been considered in the overall plant design. A drainage network has been allowed for, which leads the clean rainwater to the service water tank and the dirty rainwater to the Boiler Hall pit. Dirty rain water (i.e. rain water that precipitate upon process areas) is collected (if any) and transferred via the boiler hall pit to the process water tank which mainly provides water for the bottom ash extraction (internal re-use and recycling within the process).
- Establish a comprehensive waste management system for operation integrated with the DM waste management program to optimise waste management practices across the site
- Develop a waste management plan for implementation during the operation phase including proper handling, disposal and treatment of wastes that will be generated by the project activities

- Provide suitable waste storage facilities for all wastes including:
  - Providing 110% capacity bunded areas for hazardous waste
  - Labelling waste containers / storage areas with the name of materials contained and hazard warnings in accordance with the relevant regulatory requirements
  - Allocating spill kits and fire extinguishers, where risks are identified
  - Establishing adequate waste documentations including waste inventory
- Train workers on the waste management requirements relevant to their line of work

7.8.1.4 Decommissioning Phase

The WtE Plant is projected to have an operating life of over 30 years. In the event that the plant is decommissioned, the following steps will be carried out:

- All excess materials, chemicals and supplies will be transported offsite where cradle-to-grave management will be undertaken in full compliance with the UAE and Dubai Emirate regulation on solid waste, toxic substances and hazardous waste
- Structures shall be demolished, deconstructed and materials removed from the site and taken offsite for recycling or re-use
- Technology components should be decommissioned and salvaged, with options considered for re-use or reconditioning of components (if applicable or cost advantageous)
- Trash materials and other residual solid wastes will be collected and hauled to a designated disposal area
- Recyclable wastes such as metals, glass, rubber and plastics shall be collected and forwarded to a recycling facility
- Rehabilitation and restoration measures will be conducted for areas occupied by structures. These activities will be done in accordance with the conditions stipulated in the permits provided by relevant authorities. Site restoration will include revegetation or replanting of suitable species.

Prior to the end of the project operating life, a detailed decommissioning, demolition or abandonment plan will be developed in line with the UAE and Dubai Emirate regulations

7.8.2 Residual Impact

Waste cannot be wholly avoided nor will waste be entirely recycled or reused. However, with propoer handling and disposal, there should be minimal residual impact during the construction phase.

There will be a net positive impact from operation of the WtE plant because of the overall reduction of waste disposed to the landfill.

7.9 Land use and Visual Amenity

7.9.1 Construction Phase

Impacts on land use is negligible; hence, mitigation measure is not required.

Mitigation measures to minimise impacts on visual amenity are as follows:

- Implementation of traffic management plan (Section 7.6); and
- Implementation of dust management plan (Section 7.2).

A temporary fence of 1.80 m high minimum will be installed all around the site perimeter during the construction phase to provide a temporary visual barrier.

7.9.2 Operation Phase

The impacts on land use, landscape and visual amenity is considered to be insignificant. However, to ensure that impact on visual amenity is mitigated, the following measures will be implemented:

- Facades and buildings:
  - Colours and similar cladding harmonized with the adjacent industrial sites; and
  - Maintenance of exterior facades of the building.
- During the operation phase, a plain fence made of concrete or blockwork of about 1.80 m high will be constructed around the site perimeter to provide a visual barrier.
- Landscaping features:
  - North of the field:
    - Double row of palm trees bordering the main access road to the plant;
    - Displaced excavation soil to be used to construct mounded berm with an estimated maximum height of 5 m; and
    - Scattered plantings (shrubs) and isolated trees (palm and acacias) located around the site and located close by the guardhouse and weighbridge areas.
  - East of the field:
    - Around the supporting functions (Administration, Accomodation and Checkpoint), grass will be planted and with diverse plantings (shrubs of different specieis, palms, acacias);
    - Double row of palm trees bordering the eastern fence;
    - Ground surface to remain sand; and
    - Pathways to guide visitors and staff, consisting of interlocking concrete pavers.
  - West of the field:
    - Remain unchanged, compacted sand.

7.9.3 Residual Impact

The main residual impact will be the development of the Waste Treatment Center in an area set aside for industrial development.

7.10 Socio-economics, Culture and Health

The following measures will be implemented during both the construction and operation phases of the Project.

7.10.1 Enhancement Measures for Positive Impacts

In order to optimise the benefits from employment and business opportunities, the following enhancement measures shall be implemented:

Priority given to local workforce

As with the current trend in Dubai and the UAE, workers will most likely consist of expatriates; however, local workers (based in Dubai) will be prioritised. This is in line with the UAE's Emiratisation Policy. Further, this measure will subsequently minimise impacts associated with the influx of migrant workers; hence narrowing the gap between expatriates and local Emirati population and cultural differences.

Priority given to local companies

During procurement of materials and services required for the Project, priority shall be given to local suppliers and service companies, if available. This will optimise the economic benefits to the Emirate and the UAE in general.

Just and fair compensation to workers

All parties involved in the Project (e.g. contractors and suppliers) shall comply with the UAE Labour Code provisions on the minimum salary, working hours and working conditions (e.g. occupational health and safety, labour accommodation).

Workers' protection

All forms of forced or compulsory labour will be prohibited. Regular monitoring will be undertaken to ensure that workers' rights are protected. Collective bargaining agreements do not exist in the UAE. In order for the Project to comply with IFC requirements, the Proponent, contractors and suppliers should provide reasonable working conditions and terms of employment in line with the UAE Labour Law (e.g. minimum wage, maximum working hours, payment for overtime work, minimum leave for vacation, holiday, illness, injury, maternity, and health and safety protections).

7.10.2 Mitigation Measures for Potential Adverse Impacts

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

Appointment of Community Laiason Officer (or similar)

The Proponent or the contractor (i.e. SPV) shall appoint a Community Liason Officer (or similar) to maintain a good relationship with the local communities or other stakeholder groups who may potentially be affected by construction and operation activities. Where possible, regular project updates should be disseminated to the stakeholders via Proponent's website, newsletter and / or posters onsite.

Grievance management procedure

A grievance management procedure will be developed to ensure that all complaints are addressed appropriately. Any complaints received with regard to the Project should be logged through a Complaints Register. Any feedback, both positive and negative, received will be considered by management, registered, investigated and addressed through appropriate management measures.

Environmental management measures

With consistent implementation of environmental management measures described throughout the EIA, potential nuisance / disturbance / adverse impacts (e.g. dust, odour, noise, traffic) to nearby communities can be avoided. Similarly, any reduced amenity impacts in the surrounding areas will be minimised.

Built-in pollution control measures are included in the design to avert the perceived adverse impacts of the Project. This includes the use of flue gas treatment system and bottom ash treatement.

Site logistics

The site layout, construction logistics and method will consider the potential environmental, health and safety risk to the local communities. This will include review of procurement and logistics schedules to minimise deliveries as far as practicable; limit deliveries to day time hours to reduce night time noise; limit deliveries and workforce transport outside of peak hours to reduce congestion; and implementation of air and noise control measures (as described in Section 7.2 and Section 7.3, respectively) to minimise health impacts.

Use of local workforce

Where possible, the Project shall utilise the workforce currently and readily available in Dubai instead of hiring workers outside the Emirate or the UAE. This measure will subsequently minimise the impacts associated with the influx of additional foreign / expatriate workers (e.g. population gap between expatriates and local Emirati population and cultural differences).

Induction

The induction training provided to foreign workers will include understanding and respecting culture and religion of the UAE and the Emirate, life style and preferences of the local community residents, rules and practices to be observed in order to ensure the harmony between the local communities and foreign workforce.

Provision of a healthy and safe working environment

Project and site specific Occupational Health and Safety Plan (OHSP) in line with internationally acceptable standards (ISO 14001 and OHSAS 18001) [client need to confirm this commitment], shall be developed and strictly implemented during the construction and operation phases to minimise risk to workers. Further, the Proponent will prepare a Community Health and Safety Plan to address the perceived adverse impacts of the Project to the surrounding occupantsOperation Phase

Archaeology and Cultural Assessment

No mitigation is required since the Project is not likely to have any impact on archaeological and cultural resources. Nonetheless, the Proponent will report any accidental findings to the relevant authorities (e.g. DM-Architectural Heritage and Antiquities Department, AHAD). Chance find procedures will therefore be developed and included in construction and operations management plans in case of chance findings of archaeological and cultural significance.

7.10.3 Residual Impact

There will be a net positive impact from the Project construction activities through the provision of employment and business opportunities as well as simulations of the local and regional economy. With the completion of the Project, reliance on fossil fuel and imported energy will be reduced, improving long-term revenues in the Emirate of Dubai.

Post mitigation, residual health impacts is not anticipated.

7.11 Environmental Impacts Summary

The environmental impact levels before and after the implementation of mitigation measures during the construction and operation phases of the project are consolidated in Table 7-2 and

Table 7-3, respectively.

Table 7-2 Environmental and social impact ratings before and after mitigation – Construction Phase

Project Impact	Initial Impact (before implementing mitigation measures)				Mitigation Measures	Residual Impact (after implementing mitigation measures)		
	Likelihood	Consequence	Impact Rating	Impacted Parties		Likelihood	Consequence	Impact Rating
1. Greenhouse Gas								
GHG emissions from consdumption of fuel and electricity for commuting of construction personnel, delivery of construction materials and disposal of construction waste	Almost certain	Insignificant	Low	Atmosphere	• Optimise energy efficiency: – No idling of equipment and vehicles – Use of cleaner fuel – Use of equipment fitted with pollution control devices – Proper and on-time maintenance of equipment and vehicles – Implementation of Construction Logistic and Traffic Management Plan – Use of battery-powered equipment	Likely	Insignificant	Low
2. Air Quality and Odour Emission								
Fugitive dust emission from site development / earthmoving works and wind erosion on	Almost certain	Moderate	High	Workers / staff and visitors on-site Occupants of surrounding land uses	• Dust control including erection of hoarding, site planning with dust generating activities / sources located away from sensitive receivers, phasing of earthmoving works, stabilisation / compaction of unsurfaced areas. Detailed list provided in Section 7.2.1.1.	Likely	Minor	Medium

Project Impact	Initial Impact (before implementing mitigation measures)				Mitigation Measures	Residual Impact (after implementing mitigation measures)		
	Likelihood	Consequence	Impact Rating	Impacted Parties		Likelihood	Consequence	Impact Rating
unpaved surfaces								
Emission of exhaust gases from the operation of equipment, plant, tools and utilities using fuel	Almost certain	Insignificant	Low	Workers / staff and visitors on-site Occupants of surrounding residential and commercial areas	• Ban open burning on site. • Use of cleaner fuel. • Use of equipment fitted with pollution control devices (e.g. diesel particulate matter filter), where possible. • Maintain the equipment and vehicles as per the manufacturer's instructions. • Implementing a Construction Logistic Plan and Construction Traffic Management Plan. • No idling of equipment and vehicles.	Possible	Insignificant	Negligible
VOC emissions	Likely	Insignificant	Low	Workers / staff and visitors on-site Occupants of surrounding residential and commercial areas	• Provision of a well-ventilated storage facility for fuel, paints and other volatile materials. • Storage areas to be located away from sensitive receptor areas. • Quantity of volatile materials to be stored on-site shall be kept to minimum.	Possible	Insignificant	Negligible

Project Impact	Initial Impact (before implementing mitigation measures)				Mitigation Measures	Residual Impact (after implementing mitigation measures)		
	Likelihood	Consequence	Impact Rating	Impacted Parties		Likelihood	Consequence	Impact Rating
Odour emission from sanitary and waste disposal facilities, and poor quality dredged material	Likely	Insignificant	Low	Workers / staff and visitors on-site Occupants of surrounding residential and commercial areas	• Locate toilet utilities, sewage tanks (if any) and waste storage facilities away from sensitive receptors. • Sanitary and waste disposal facility to be kept in good condition at all times. • Implement appropriate waste management measures, ensuring proper waste storage and regular waste collection for off-site disposal.	Possible	Insignificant	Negligible
3. Noise								
Construction noise (causing sleep disturbance annoyance and hearing impairment)	Almost certain (closest sensitive receptor)	Moderate	High	Workers and occupants on site and surrounding communities	• Appropriate site layout (primary noise sources are located away from sensitive receptors) • Provide mufflers / silences and acoustic enclosures on mobile plant equipment • Use equipment with low noise emission • Maintain equipment in good working condition • Operate equipment in low speed or power	Likely	Insignificant	Low

Project Impact	Initial Impact (before implementing mitigation measures)				Mitigation Measures	Residual Impact (after implementing mitigation measures)		
	Likelihood	Consequence	Impact Rating	Impacted Parties		Likelihood	Consequence	Impact Rating
					• Broadband alarms should be used • Reversing should be kept to a minimum • Optimise the number of deliveries • Limit general construction activities to daytime (7 am to 8 pm) • Switch-off machine when not in use • Inform truck drivers of designated traffic routes			
Construction vibration (causing sleep disturbance and annoyance)	Almost certain (closest sensitive receptor)	Insignificant	Low	Workers and occupants on site and surrounding communities	• Implement vibration sensitive activities during lease sensitive time periods • Vibration activities should be sequenced • Locate vibration intensive activities away from sensitive receptors	Likely	Insignificant	Low
4. Geology, Geomorphology, Seismicity, Soil and Groundwater								
Seismic tremor causing collapse of infrastructure, that is under	Rare	Major	Medium	Workers and visitors of the site during construction	• Design and construct the Project in accordance with the requirements of the DM Building Code and the findings of the site's geotechnical investigation. Ensure	Rare	Moderate	Low

Project Impact	Initial Impact (before implementing mitigation measures)				Mitigation Measures	Residual Impact (after implementing mitigation measures)		
	Likelihood	Consequence	Impact Rating	Impacted Parties		Likelihood	Consequence	Impact Rating
construction and not yet able to withstand earthquake tremors					sufficient compaction and land stability is achieved prior to commencing building and infrastructure works.			
Spread of potential pre-existing soil contamination via movement of contaminated fill / stockpiled material	Unlikely	Minor	Low	Terrestrial ecology	• Any imported fill should be clean-fill only and obtained from an approved source. • Imported topsoil for landscaping should be from an approved supplier.	Rare	Minor	Negligible
Soil contamination from using contaminated water for dust suppression	Unlikely	Minor	Low	Terrestrial ecology Employees and visitors on-site	• Water used for dust suppression should meet municipal health standards and should not exceed the salinity levels of soil on-site.	Rare	Minor	Negligible
Soil contamination due to handling, storage and use of hazardous materials (e.g. oil, fuel, paint and other chemicals)	Likely	Minor	Medium	Terrestrial ecology Employees and visitors on-site	Hazardous materials management ensuring the following are provided: • Appropriate storage facilities (suitably bunded). • Siting the storage facility away from marine environment and sensitive areas.	Possible	Minor	Low

Project Impact	Initial Impact (before implementing mitigation measures)				Mitigation Measures	Residual Impact (after implementing mitigation measures)		
	Likelihood	Consequence	Impact Rating	Impacted Parties		Likelihood	Consequence	Impact Rating
					• Spill and fire response procedure and equipment. • Materials inventory / register and MSDS files. • Labelling of containers and areas. Labels to include name of chemical, hazard and precautionary measures. • Standard operating procedures for materials handling. • Access restrictions at storage areas. • Relevant staff to be provided with training and PPE.			
Soil contamination from inadequate waste management (e.g. hazardous waste, sewage)	Likely	Minor	Medium	Terrestrial ecology Employees and visitors on-site	• Implementation of appropriate waste management measures, ensuring provision of suitable collection and storage facilities (e.g. bund systems) • Toilet facilities located at regular intervals within site for workers ease of access. • Direct discharge of site offices effluent to the municipal sewage system where feasible. • Portable toilets or facilities with septic tanks to be regularly	Possible	Minor	Low

Project Impact	Initial Impact (before implementing mitigation measures)				Mitigation Measures	Residual Impact (after implementing mitigation measures)		
	Likelihood	Consequence	Impact Rating	Impacted Parties		Likelihood	Consequence	Impact Rating
					checked for signs of leaks or overflow. Storage tanks to be emptied when ¾ full. • Routine checking of equipment, machinery and vehicles to ensure no leakage of oil and fuel. • Washout of concrete trucks only in designated and fully bunded concrete wash areas. • No routine maintenance activities to be carried out at the Project site. Emergency maintenance only in designated maintenance zones with impermeable surfaces (such as concrete slabs).			
Soil erosion due to earthmoving activities (stockpiling)	Likely	Minor	Medium	Terrestrial ecology	• The site should undergo progressive compaction (stabilisation) immediately after earthmoving activity. • Site roads and tracks should be surfaced with milled asphalt or gatch to reduce suspension of dust and erosion of soil. • An efficient temporary drainage system within the Project area should be provided to prevent loose soil from being scoured off by surface runoff.	Possible	Minor	Low

Project Impact	Initial Impact (before implementing mitigation measures)				Mitigation Measures	Residual Impact (after implementing mitigation measures)		
	Likelihood	Consequence	Impact Rating	Impacted Parties		Likelihood	Consequence	Impact Rating
					• Excavation work plans should specify cut slope and maximum height to prevent erosion and to minimise the area of disturbed and unconsolidated soil. • Soil stockpiles should be maintained at minimum height and located on flat areas and away from stormwater flow paths.			
Groundwater contamination as a result of spill / leak of potentially hazardous material (i.e. oil, fuel, sewage, paint and other chemicals)	Unlikely	Major	Medium	Terrestrial flora and fauna Marine flora and fauna	• Implementation of mitigation measures for soil contamination impacts.	Unlikely	Minor	Low
Groundwater contamination as a result of inadequate waste management (e.g. hazardous waste, sewage)	Unlikely	Major	Medium	Terrestrial flora and fauna Marine flora and fauna	• Implementation of mitigation measures for soil contamination impacts.	Unlikely	Minor	Low

Project Impact	Initial Impact (before implementing mitigation measures)				Mitigation Measures	Residual Impact (after implementing mitigation measures)		
	Likelihood	Consequence	Impact Rating	Impacted Parties		Likelihood	Consequence	Impact Rating
5. Biodiversity and Conservation								
Habitat loss due to excavation and earthworks	Likely	Insignificant	Low	Vegetation at the Project site	• Manage size of land disturbance for temporary construction laydown areas to minimum necessary	Possible	Insignificant	Negligible
Disturbance of fauna species due to noise impacts	Possible	Minor	Low	Fauna species at the Project site	• Implement noise control measures	Possible	Insignificant	Negligible
6. Access, Traffic and Transport								
Increase in road traffic in the vicinity of the Project site	Almost certain	Minor	Medium	Residents of local community Users and workers of neighbouring inductrial and commercial facilities	• Develop and implement construction traffic management plan to ensure traffic flow and reduce traffic congestion • Arrange for shared transport where possible to minimise trips • Manage material delivery schedule and avoidance during rush hours	Possible	Minor	Low

Project Impact	Initial Impact (before implementing mitigation measures)				Mitigation Measures	Residual Impact (after implementing mitigation measures)		
	Likelihood	Consequence	Impact Rating	Impacted Parties		Likelihood	Consequence	Impact Rating
					• Arrange delivery of materials in bulk			
Potential traffic congestion on the road network from the port leading to the Project site	Possible	Minor	Low	Residents of local community Users and workers of neighbouring inductrial and commercial facilities	• Develop and implement logistics plan – Use of truck road – Material delivery outside of peak traffic periods – Use of convoys of heavy and oversized vehicles • Arrange delivery of materials in bulk	Unlikely	Minor	Low
Noise, dust and air emissions due to truck movements	Possible	Moderate	Medium	Employees and workers of HZI, BESIX and subcontractor s Residents / users of facilities surrounding the site	• Implementation of air quality management measures (refer to air section) • Implementation of noise control measures (refer to noise section)	Unlikely	Minor	Low
7. Water and Energy Resources								
Water supply competition with other users /	Unlikely	Minor	Low	Other water users	• Implement water conservation measures • Re-use water, if applicable	Unlikely	Minor	Low

Project Impact	Initial Impact (before implementing mitigation measures)				Mitigation Measures	Residual Impact (after implementing mitigation measures)		
	Likelihood	Consequence	Impact Rating	Impacted Parties		Likelihood	Consequence	Impact Rating
consumers of DEWA								
Additional traffic on the existing road traffic network due to the distribution of water on-site	Unlikely	Minor	Low	Workers and residents in surrounding areas	• Implement site traffic management plan • Manage delivery schedule, minimise delivery of water supply during peak traffic hours • Limit night time deliveries (or no night time deliveries)	Unlikely	Insignificant	Negligible
Power / fuel consumption causing localised air pollution, noise emissions	Almost certain	Minor	Medium	Construction site workers and visitors Workers and residents of surrounding areas	• Optimise energy efficiency	Almost certain	Insignificant	Low
Potential risk of spill from delivery and on-site storage of fuel, potentially resulting in soil and groundwater contamination	Unlikely	Minor	Low	Surface and groundwater sources	• Develop and implement oil spill preventive and contingency management plan / procedure • Provide onsite spill recovery kits for a quick clean up • Provide inductions and appropriate training to respond to hazardous spills	Rare	Minor	Negligible

Project Impact	Initial Impact (before implementing mitigation measures)				Mitigation Measures	Residual Impact (after implementing mitigation measures)		
	Likelihood	Consequence	Impact Rating	Impacted Parties		Likelihood	Consequence	Impact Rating
8. Waste Management								
Potential soil and/or groundwater contamination due to storage, handling and transport of waste	Possible	Moderate	Medium	Soil	• Provide spill kits where there is a risk of spill • Provide suitable waste storage facilities	Possible	Minor	Low
Litter of waste on site	Almost certain	Insignificant	Low	Soil, site workers and fauna	• Provide suitable waste storage facilities • Locate waste bins / containers where waste is produced	Possible	Insignificant	Negligible
Odour from storage of putrescible wastes and sewage storage tanks	Almost certain	Insignificant	Low	Site workers and visitors	• Provide suitable temporary sewage holding tank onsite • Locate sewage tanks away from sensitive receptors	Possible	Insignificant	Negligible
Hazards to fauna	Possible	Moderate	Medium	Terrestrial fauna on the Project site	• Provide suitable waste storage facilities • Locate waste bins / containers where waste is produced	Unlikely	Minor	Low
Health and safety hazard to	Possible	Moderate	Medium	Site workers and visitors	• Provide training and PPE for workers for the proper handling, storage and disposal of waste	Unlikely	Minor	Low

Project Impact	Initial Impact (before implementing mitigation measures)				Mitigation Measures	Residual Impact (after implementing mitigation measures)		
	Likelihood	Consequence	Impact Rating	Impacted Parties		Likelihood	Consequence	Impact Rating
workers and visitors					• Label waste containers / storage areas			
9. Land Use and Visual Amenity								
Change / inconsistency with land use	Rare	Insignificant	Negligible	NA	• Not applicable since impact is negligible and use is consistent with zoning and land use	Rare	Insignificant	Negligible
Increased in the number of trucks transporting construction materials	Possible	Moderate	Medium	Community and business establishments leading to the Project site	• Implement traffic management measures (refer to Item 6 of this table)	Possible	Minor	Low
Potential increase in dust levels associated with the construction impacts and increased vehicle movement	Likely	Minor	Medium	Community and business establishments leading to the Project site	• Implement dust management plan (refer to Item 2 of this table)	Likely	Insignificant	Low

Project Impact	Initial Impact (before implementing mitigation measures)				Mitigation Measures	Residual Impact (after implementing mitigation measures)		
	Likelihood	Consequence	Impact Rating	Impacted Parties		Likelihood	Consequence	Impact Rating
10. Socio-economic, Culture and Health								
Generation of employment and business opportunities	Almost certain	Minor	Medium (Positive)	Local residents and business owners Expatriates / foreign workers	• Prioritise local companies and local workers • Provide just and fair compensation to workers	Almost certain	Moderate	High (Positive)
Reduced amenity due to traffic and construction activities and visual impact from the construction site	Almost certain	Minor	Medium	Local residents and business owners Workers and customers of retail and commercial establishment s	• Implement environmental management measures • Develop grievance management procedure and address complaints of stakeholders • Appoint Community Laiason Officer (or similar) to coordinate / address complaints • Develop and implement Community Health and Safety Plan • Develop and implement Traffic Management Plan	Possible	Minor	Low
Increased health and safety risk	Almost certain	Moderate	High	Construction workforce and site visitors	• Consider the potential risk of site layout, logistics and construction activities to workers, visitors and local communities	Possible	Moderate	Medium

Project Impact	Initial Impact (before implementing mitigation measures)				Mitigation Measures	Residual Impact (after implementing mitigation measures)		
	Likelihood	Consequence	Impact Rating	Impacted Parties		Likelihood	Consequence	Impact Rating
					• Develop and implement Occupational Health and Safety Plan (OHSP)			
Conflict between local residents and workers	Possible	Moderate	Medium	Local residents Workers and customers of industrial and commercial facilties surrounding the site Workers on-site	• Include cultural sensitivity and respect in Workers Induction Program • Ensure provision of adequate service utilities and infrastructure for wokers to avoid competition with local residents and workers • Consult with the relevant service providers for utility planning and management	Unlikely	Minor	Low
Poor labour and working conditions	Possible	Moderate	Medium	Construction workforce	• Ensure that workforce accommodation meet local and international requirements • Provide transportation services • Provide health benefits • Ensure that sanitary facilities, rest area, kitchen and dining area are provided at the work place	Unlikely	Minor	Low
Chance find of resources with archaeological	Rare	Major	Medium	Archaeological and cultural resources	• Report chance findings to DM Architectural Heritage and Antiquities Department (AHAD)	Rare	Moderate	Low

Project Impact	Initial Impact (before implementing mitigation measures)				Mitigation Measures	Residual Impact (after implementing mitigation measures)		
	Likelihood	Consequence	Impact Rating	Impacted Parties		Likelihood	Consequence	Impact Rating
and cultural significance					• Implement chance find procedure • Stop work until approval from AHAD is sought			

Table 7-3 Environmental and social impact ratings before and after mitigation – Operation Phase

Project Impact	Initial Impact (before implementing mitigation measures)				Mitigation Measures	Residual Impact (after implementing mitigation measures)		
	Likelihood	Consequence	Impact Rating	Impacted Parties		Likelihood	Consequence	Impact Rating
1. Greenhouse Gas								
Emission from the WtE plant operation	Almost certain	Moderate	High (Positive)	Atmosphere	• Mitigation measure is not required as the impact is considered beneficial. The emisions from the WtE plant are more than offset by avoided landfill methane emissions and emissions from on-site electricity generation displacing existing sources	Almost certain	Moderate	High (Positive)
2. Air Quality and Odour Emission								
Emissions from furnace / boiler	Almost certain	Minor	Medium	Workers and occupants on site and	• The emission concentration guarantees listed in IED, Annex VI, Part 3 are met	Possible	Minor	Low

Project Impact	Initial Impact (before implementing mitigation measures)				Mitigation Measures	Residual Impact (after implementing mitigation measures)		
	Likelihood	Consequence	Impact Rating	Impacted Parties		Likelihood	Consequence	Impact Rating
				surrounding communities	• The stack parameters and emission rates (refer to Section 6.3.2.1) are adhered to			
Exhaust gases and particulates emitted from road traffic	Almost certain	Minor	Medium	Residents, visitors and occupants of the Project site and surrounding residential and commercial areas	• Implementation of Traffic Management Plan.	Likely	Insignificant	Low
Odour emission from waste composition and aging process of waste	Unlikely	Minor	Low	Workers / staff and visitors on-site Occupants of surrounding residential and commercial areas	• Installation of built-in management measures: tipping bays will be equipped with roller shutter door • Odour emission leaving the process building is not anticipated due to proper ventilation / slight negative pressure • Waste should not be stored longer than five days in the waste bunker • Maintain operation of two out of five lines at any one time	Unlikely	Insignificant	Negligible
3. Noise								
Operational noise (causing sleep	Possible (closest sensitive	Moderate	Medium	Surrounding communities	*Implement engineering measures*: • Provide built-in insulation walls	Possible	Insignificant	Negligible

Project Impact	Initial Impact (before implementing mitigation measures)				Mitigation Measures	Residual Impact (after implementing mitigation measures)		
	Likelihood	Consequence	Impact Rating	Impacted Parties		Likelihood	Consequence	Impact Rating
disturbance, annoyance and hearing impairment)	receptor)				• Locate buildings close to Project's boundary to provide shielding • Enclose plant / equipment considered to be causing major source of noise • Select quiet equipment / system as early as design phase • WtE plant should be designed in line with relevant Health and Safety regulations • Remove machines from the site that are found to be producing excessive noise • Use broadband alarms for site equipment • Maintain all equipment / machine in good working conditions • Inform truck drivers of designated traffic routes			
4. Soil and Groundwater								
Potential soil and groundwater contamination	Possible	Moderate	Medium	Soil and Groundwater	• Waste bunker, IBA maturation area and FGT residue temporary storage facilities must be	Possible	Minor	Low

Project Impact	Initial Impact (before implementing mitigation measures)				Mitigation Measures	Residual Impact (after implementing mitigation measures)		
	Likelihood	Consequence	Impact Rating	Impacted Parties		Likelihood	Consequence	Impact Rating
from leachate generated by inappropriate waste storage (e.g. feedstock [waste] storage and IBA/FGT residue onsite management)					designed, constructed and maintained for the materials stored in accordance to applicable safe handling and disposal measures • Regular general inspections and monitoring of ash disposal facilities • Development and implementation of soil and groundwater management and remediation plan should soil and groundwater contamination occur • Appropriate disposal of any contaminated soil and groundwater in accordance with applicable management guidelines			
Potential soil and groundwater contamination from fuel and raw material storage	Possible	Minor	Low	Soil and Groundwater	• Fuel and raw material storage areas must be designed, constructed and maintained for the materials stored or used in the area according to the applicable MSDS safe handling and control measures • Regular inspections and monitoring of storage facilities	Unlikely	Insignificant	Negligible

Project Impact	Initial Impact (before implementing mitigation measures)				Mitigation Measures	Residual Impact (after implementing mitigation measures)		
	Likelihood	Consequence	Impact Rating	Impacted Parties		Likelihood	Consequence	Impact Rating
					• Where materials are stored in tanks, drums or other containers, they must have appropriate containment structures • Development and implementation of soil and groundwater management and remediation plan should soil and groundwater contamination occur • Appropriate disposal of any contaminated soil and groundwater in accordance with applicable management guidelines			
5. Biodiversity and Conservation								
Noise generated from operation activities	Likely	Insignificant	Low	Fauna species at the Project site	• Implement noise control measures	Possible	Insignificant	Negligible
6. Access, Traffic and Transport								
Increase in traffic movement within the WtE plant	Likely	Minor	Medium	Residents / users of facilities surrounding the site Workers at the WtE plant	• Implement traffic management plan to include: – Designated route of transport – Speed limit within the site • Schedule delivery of MSW during non-peak hours, where possible	Likely	Insignificant	Low

Project Impact	Initial Impact (before implementing mitigation measures)				Mitigation Measures	Residual Impact (after implementing mitigation measures)		
	Likelihood	Consequence	Impact Rating	Impacted Parties		Likelihood	Consequence	Impact Rating
					• Schedule FGT residue and bottom ash collection during non-peak hours, where possible • Provision of competency trainings on drivers • Ensure that trucks and other equipment are in proper condition			
Noise, dust and air emissions due to truck movements	Likely	Minor	Medium	Workers within the WtE PLANT	• Implementation of air quality management measures • Implementation of noise control measures	Likely	Insignificant	Low
7. Water and Energy Resources								
Fuel consumption for plant start-up and equipment / vehicle use causing risk of spill from delivery and on-site storage of fuel	Possible	Minor	Low	Water resources Site workers and visitors	• Implement energy efficiency measures • Develop and implement oil spill preventive and contingency management plan / procedure • Provide onsite spill recovery kits for a quick clean up • Provide inductions and appropriate training to respond to hazardous spills • Provide storage within bunded containers and/or areas	Possible	Insignificant	Negligible

Project Impact	Initial Impact (before implementing mitigation measures)				Mitigation Measures	Residual Impact (after implementing mitigation measures)		
	Likelihood	Consequence	Impact Rating	Impacted Parties		Likelihood	Consequence	Impact Rating
					• Routinely inspect fuel / oil storage areas and all containers for any spill or leaks • Handle all substances in accordance with relevant instructions (i.e. MSDS)			
Water conservation, recycling and reusing of water from Al Aweer STP for plant operation	Almost certain	Moderate	High (Positive)	Water resources Water users	• Mitigation measure is not required as this is considered a beneficial impact of the Project • Incorporate water conservation measures during design phase to minimise water use during operation phase	Almost certain	Moderate	High (Positive)
Contribute to producing clean energy and additional energy resource in the Emirate of Dubai and the UAE in general	Almost certain	Moderate	High (Positive)	Energy consumers in the Emirate of Dubai and the UAE in general	• Mitigation measure is not required as this is considered a beneficial impact of the Project	Almost certain	Moderate (3)	High (Positive)
8. Waste Management								
Potential soil and/or groundwater contamination due to storage, handling and	Possible	Minor	Low	Soil	• Provide spill kits where there is a risk of spill • Provide suitable waste storage facilities	Unlikely	Minor	Low

Project Impact	Initial Impact (before implementing mitigation measures)				Mitigation Measures	Residual Impact (after implementing mitigation measures)		
	Likelihood	Consequence	Impact Rating	Impacted Parties		Likelihood	Consequence	Impact Rating
transport of waste								
Litter of waste on site	Almost certain	Insignificant	Low	Soil, site workers, fauna	• Provide suitable waste storage facilities • Locate waste bins / containers where waste is produced	Possible	Insignificant	Negligible
Hazards to fauna	Possible	Moderate	Medium	Terrestrial fauna on the Project site	• Provide suitable waste storage facilities • Develop a waste management plan	Unlikely	Minor	Low
Health and safety hazards to workers and visitors	Possible	Moderate	Medium	Site workers and visitors	• Provide training and PPE for workers for the proper handling, storage and disposal of waste	Unlikely	Minor	Low
10. Land Use and Visual Amenity								
Visual impact associated with the installation of new infrastructure	Unlikely	Minor	Low	Community and business establishments leading to the Project site	Impact is negligible, but to ensure integration of the new infrastructure the following will be implemented: • Façade and buildings: (i) the colours and similar cladding harmonized with the existing facilities; and (ii) maintenance of exterior facades • Landscaping features: (i) plant tree buffers to the north and east	Unlikely	Insignificant	Negligible

Project Impact	Initial Impact (before implementing mitigation measures)				Mitigation Measures	Residual Impact (after implementing mitigation measures)		
	Likelihood	Consequence	Impact Rating	Impacted Parties		Likelihood	Consequence	Impact Rating
					of the Project site; (ii) use excavated soil to construct mounded berm with an estimated maximum height of 5 m (where required); and (iii) install interlocking concete pavers (where required)			
11. Socio-economic, Culture and Health								
Generation of employment and business opportunities	Almost certain	Minor	Medium (Positive)	Local residents and business owners Expatriates / foreign workers	• Prioritise local companies and local workers • Provide just and fair compensation to workers	Almost certain	Moderate	High (Positive)
Reduced amenity due to traffic	Almost certain	Minor	Medium	Local residents and business owners Workers and customers of retail and commercial establishments	• Implement environmental management measures • Develop grievance management procedure and address complaints of stakeholders • Appoint Community Laiason Officer (or similar) to coordinate / address complaints • Develop and implement Community Health and Safety Plan	Possible	Minor	Low

Project Impact	Initial Impact (before implementing mitigation measures)				Mitigation Measures	Residual Impact (after implementing mitigation measures)		
	Likelihood	Consequence	Impact Rating	Impacted Parties		Likelihood	Consequence	Impact Rating
					• Develop and implement Traffic Management Plan			
Increased occupational health and safety risk	Almost certain	Moderate	High	Construction workforce and site visitors	• Consider the potential risk of Plant general layout, logistics (delivery of MSW and flue gas residue, bottom ash) and other operation activities to workers • Develop and implement Occupational Health and Safety Plan (OHSP)	Possible	Moderate	Medium
Conflict between local residents and workers	Possible	Moderate	Medium	Local residents Workers and customers of industrial and commercial facilties surrounding the site Workers on-site	• Include cultural sensitivity and respect in Workers Induction Program • Ensure provision of adequate service utilities and infrastructure for wokers' use to avoid competition with local residents and workers • Consult with the relevant service providers for utility planning and management	Unlikely	Minor	Low
Poor labour and working conditions	Possible	Moderate	Medium	Construction workforce	• Ensure that workforce accommodation meet local and international requirements • Provide transportation services • Provide health benefits	Unlikely	Minor	Low

Project Impact	Initial Impact (before implementing mitigation measures)				Mitigation Measures	Residual Impact (after implementing mitigation measures)		
	Likelihood	Consequence	Impact Rating	Impacted Parties		Likelihood	Consequence	Impact Rating
					• Ensure that sanitary facilities, rest area, kitchen and dining area are provided at the work place			

8. Environmental Management and Monitoring Program

8.1 Introduction

The framework Environmental Management and Monitoring Program (EMMP) forms part of this EIA report to provide a mechanism for the development and implementation of mitigation measures against potential adverse environmental impacts from the Project construction and operational activities. It also incorporates actions necessary for the monitoring, reporting and auditing of the Project's environmental performance in line with DM standard requirements and relevant international standards such as the IFC Performance Standards, Equator Principles (EP) and the IFC World Bank General and Industry-specific Environmental Health and Safety (EHS) Guidelines.

This framework EMMP is a guideance document to be referred to when developing the more comprehensive and site-specific Construction and Operation Environmental Management Plans (C- and O-EMP), which are stand-alone documents that may be needed to be submitted to DM-EPSS post EIA.

8.2 Objectives

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

Specific objectives of this EMMP are to:

- Provide guidance for the development of the Construction and Operational EMPs (when required by DM-EPSS).
- Outline mitigation measures and management procedures to be implemented in order to guide Project design, construction and operation in accordance with the requirements of relevant environmental legislation, policy and guidelines.
- Provide a mechanism for monitoring and reporting of the various environmental undertakings of the Project, which will include routine liaison with DM-EPSS and other regulatory authorities.
- Define roles, responsibilities and accountabilities of parties and individuals, ensuring that all parties and individuals involved in the Project understand and adhere to the environmental management requirements relevant to their line of work.
- Set the requirements for environmental induction and training programs.
- Facilitate continuous improvement of the Project's overall environmental performance through a regular review of specific EMPs and audit of the Project's compliance to the requirements.

8.3 Implementation

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

Managers and supervisors are responsible for providing assurance that their work unit complies with the requirements in this framework EMMP as translated to Construction and Operation EMPs. This can be done via conducting regular inspections, monitoring and audits of the Project management system and / or specific EMPs.

Audits can be undertaken as regular internal or end of phase 'milestone' checks against regulatory guidelines by internal staff or independent external auditors. A documented auditable trail should be established for verification purposes.

8.4 Environmental Management Plans

CEMP and OEMP will be developed prior to the construction and operation phases of the Project to ensure environmental and social aspects are managed. Further details on the CEMP and OEMP requirements are provided in the following sub-sections.

8.4.1 Construction Environmental Management Plan

The work- and project-specific CEMP will be developed, where required, to prior to construction and will comprise the following items as a minimum:

- **Introduction –** Introduce the Project and the CEMP including the objectives and structure.
- **Overview of the Project Development –** Provide an overview of the Project including any changes / updates since completion of this EIA Report. The overview should include details of sensitive receptors, project phases, information on temporary construction-phase utilities, laydown areas, offices and other ancillary facilities.
- **Environmental Management –** Provide company policy statement on environment, occupational health and safety, labour and working condition and community.
- **Risk and Impacts Identification –** Detailed information on the construction methods to be employed, including workforce, schedule and equipment as well as summary of key environmental impacts with the construction activities
- **Management Programs –** The measures to be implemented to mitigate the key impacts of the project – this will include environmental, labour and community concerns.
- **Organizational Capacity and Competency –** List of which personnel / companies will be responsible for each aspect of the environmental management / mitigation. Training requirements should also be included.
- **Incident/Emergency Preparedness and Response –** Provide the emergency response plan for key potential emergencies. This should include the protocol, required training, drills, responsible personnel and appropriate contact numbers.
- **Stakeholder Engagement –** Outline of stakeholder engagement activities during the construction phase.
- **External Communication and Grievance Mechanism –** Develop grievance mechanism procedure for the workers (including supply chain) and community as well as external communication channels.
- **Ongoing Reporting to Affected Communities –** Outline performance and compliance reporting to regulatory authorities and other stakeholders (i.e. surrounding communities). Details on how the monitoring (and other environmental data) will be managed and reported on.
- **Monitoring and Review –** A detailed environmental performance monitoring programme based on the construction impacts and areas. The monitoring plan should include the

exact locations, duration, frequency, method and comparison criteria for each component to be monitored.

8.4.2 Operation Environmental Management Plan

A site-specific OEMP will be developed, where required, prior to commissioning and will contain only applicable project components as stipulated in the approved EIA. The OEMP will comprise of the following items as a minimum:

- **Introduction –** Introduce the Project and the OEMP including the objectives and structure.
- **Overview of the Project Operation –** Provide an overview of the Project operation including any changes / updates since completion of this EIA Report. The overview should include details of sensitive receptors, project components, offices and other ancillary facilities, waste handling and storage and other operation and maintenance activities.
- **Environmental Management –** Provide company policy statement on environment, occupational health and safety, labour and working condition and community.
- **Risk and Impacts Identification –** Detailed information on the operation methods to be undertaken, including workforce, schedule and equipment as well as summary of key environmental impacts relative to the operation activities.
- **Management Programs –** The measures to be implemented to mitigate the key impacts associated with the project operation – this will include environmental, labour and community concerns.
- **Organizational Capacity and Competency –** List of which personnel / companies will be responsible for each aspect of the environmental management / mitigation. Training requirements should also be included.
- **Incident/Emergency Preparedness and Response –** Provide the emergency response plan for key potential emergencies. This should include the protocol, required training, drills, responsible personnel and appropriate contact numbers.
- **Stakeholder Engagement –** Outline ongoing stakeholder engagement activities during the operation phase.
- **External Communication and Grievance Mechanism –** Develop grievance mechanism procedure for the workers (including supply chain) and community as well as external communication channels.
- **Ongoing Reporting to Affected Communities –** Outline performance and compliance reporting to regulatory authorities and other stakeholders (i.e. surrounding communities). Details on how the monitoring (and other environmental data) will be managed and reported on.
- **Monitoring and Review –** A detailed environmental performance monitoring programme based on the operation impacts and areas. The monitoring plan should include the exact locations, duration, frequency, method and comparison criteria for each component to be monitored.

8.4.3 Summary of Impacts and Management Requirements

The following matrix (Table 8-1) provide a summary of the proposed environmental management measures associated with the Project. These management plans will be included in the CEMP or OEMP.

Table 8-1 Impact management plan

Item	Activity / Project phase	Environmental aspect likely to be affected	Potential impact	Options for prevention / mitigation / enhancement	Responsible entity	Management / Control Plan to be prepared [1]
Pre-Construction Phase						
P1	Social acceptability	People	Public resistance due to development	Conduct stakeholder engagement activities.	Project Owner	Stakeholder Engagement Plan
Construction Phase[2]						
C1	Site development (clearing, civil works and earthmoving)	Geomorphology	Change in surface landform (negligible impact)	No mitigation measure required.	HZI and BESIX Subcontractors	None
C2	Excavation works	Subsurface gas migration	Migration of subsurface gas from nearby landfill or sludge disposal area	Design management strategies for gas management	HZI and BESIX Subcontractors	Contingency Plan for Potential Gaseous Conditions
C3	Excavation works	Contaminated soils	Possibility of leachate-impact subsurface soil conditions	Excavated soil management plan	HZI and BESIX Subcontractors	Excavated Materials Management Plan
C4	Site development (clearing, civil works and earthmoving)	Soil	Soil erosion	Loose vegetation should be vegetated, paved or covered / stabilised. Installation of slope protection measures (where required). Immediate re-vegetation (where appropriate).	HZI and BESIX Subcontractors	Erosion Control Plan, Excavated Materials Control Plan (Earthworks and Fill)
C5	Site development (clearing, civil works and earthmoving)	Flora and fauna	Clearing of vegetation	Revegetation around the Project site once construction is done (where appropriate). Limit clearing activities to designated construction areas. No introduction of exotic or invasive alien species during revegetation.	HZI and BESIX Subcontractors	Biodiversity Management Plan
C6	Site development (clearing, civil works and earthmoving)	Air quality Public health	Dust resuspension from earthmoving activities and vehicle movement	Water sprinkling (wetting).	HZI and BESIX Subcontractors	Dust Management Plan Air Quality Monitoring Plan
C7	Site development (clearing, civil works and earthmoving)	Cultural resources	Accidental discovery of resources with cultural significance	Develop and implement chance find procedure.	HZI and BESIX Subcontractors	Chance Find Procedure
C8	Transport of construction materials, waste and workers	Public safety	Safe to public safety due to additional vehicles on the road	Develop and implement traffic management plan. Develop and implement emergency response plan.	HZI and BESIX Subcontractors	Traffic Management Plan Emergency Response Plan
C9	Transport of construction materials, waste and workers	Worker safety	Exposure of workers to unsafe working conditions (i.e. injury and fatality)	Develop and implement traffic management plan. Develop and implement emergency response plan.	HZI and BESIX Subcontractors	Occupational Health and Safety Plan Traffic Management Plan Emergency Response Plan
C10	Transport of construction materials, waste and workers.	Public amenity	Impair visual amenity at surrounding areas especially tourist attractions near the Project site (i.e. Desert Palm Resort)	Implement traffic management measures.	HZI and BESIX Subcontractors	Traffic Management Plan
C11	Noise from machinery / equipment operation and movement of vehicle	Fauna species	Disturbance of fauna species due to noise impact (low impact)	Implement noise control measures	HZI and BESIX Subcontractors	Noise Control Plan Biodiversity Management Plan

Item	Activity / Project phase	Environmental aspect likely to be affected	Potential impact	Options for prevention / mitigation / enhancement	Responsible entity	Management / Control Plan to be prepared [1]
C12	Nosie from equipment / plant / vehicles	Public health	Noise pollution impacts on residents / users of facilities surrounding the site	Provide engineering measures on equipment (i.e. mufflers, enclosures) to attenuate noise generation.	HZI and BESIX Subcontractors	Noise Control Plan Community Health and Safety Plan
C13	Nosie from equipment / plant / vehicles	Worker health	Noise pollution impacts on employees and workers of HZI, BESIX and subcontractors	Provide engineering measures on equipment (i.e. mufflers, enclosures) to attenuate noise generation. Provision of appropriate personal protective equipment (PPE) such as hearing protection to those working in noisey areas. Limit exposure of workers to 8 hours per day at construction areas with noise level greater than 85 dBA.	HZI and BESIX Subcontractors	Noise Control Plan Occupational Health and Safety Plan
C14	Dewatering activities	Soil and groundwater quality	Soil and groundwater contamination due to discharge of surface runoffs	Develop and implement dewatering effluent control plan.	HZI and BESIX Subcontractors	Dewatering Effluent Control Plan
C15	Water distribution to the Project site	Public health	Additional load to the existing road traffic network	Develop and implement traffic management plan. Manage delivery schedule, minimise delivery of water supply during peak traffic hours.	HZI and BESIX Subcontractors	Traffic Management Plan
C16	Water use / consumption at the Project site	Public services	Water competition with other users / customers of DEWA	Implement wate conservation measures. Re-use water (use for dust suppression), if applicable. Coordinate with DEWA to ensure availability for connection to an existing water supply and distribution network.	HZI and BESIX Subcontractors	Water Conservation Plan
C17	Laydown areas, construction activities	Public amenity	Impair visual amenity at surrounding areas	Implement proper housekeeping. Use hoarding or barriers. Regular site inspections.	HZI and BESIX Subcontractors	None
C18	Air emission from plant / equipment operation	Air quality	Air pollution from particulate matter, carbon monoxide, sulphur dioxide, and nitrogen oxides emission	Built-in management measures (i.e. FGT system)	HZI and BESIX Subcontractors	Air Quality Control Plan
C19	Increased dust levels	Air quality	Impact visual amenity at surrounding areas	Develop and implement dust management plan.	HZI and BESIX Subcontractors	Dust Control Plan
C20	Energy / fuel consumption	Energy resources	High energy consumption depleting resources	Optimise energy efficiency.	HZI and BESIX Subcontractors	Energy Efficiency Plan
C21	Fuel and oil storage on site during construction	Soil and groundwater quality	Potential spill from delivery and onsite storage of fuel causing soil and groundwater degradation	Develop and implement spill prevention and contingency plan. Appropriate storage and handling of fuel and raw materials in accordance with MSDS.	HZI and BESIX Subcontractors	Soil and Groundwater Control Plan Spill Prevention and Contingency Plan
C22	Generation of hazardous and non-hazardous waste	Soil and groundwater quality	Soil and groundwater contamination due to improper disposal of waste	Develop and implement waste management plan	HZI and BESIX Subcontractors	Waste Management Plan Soil and Groundwater Control Plan

Item	Activity / Project phase	Environmental aspect likely to be affected	Potential impact	Options for prevention / mitigation / enhancement	Responsible entity	Management / Control Plan to be prepared [1]
C23	Generation of hazardous and non-hazardous waste	Public and worker health and safety	Exposure of public and workers to vectors and contaminants	Develop and implement waste management plan. Develop and implement occupational health and safety plan.	HZI and BESIX Subcontractors	Waste Management Plan Occupational Health and Safety Plan Community Health and Safety Plan
C24	General construction activities (e.g. working from heights, workin in confined spaces, significant lifting, carrying or repetitive motions, etc.)	Worker health and safety	Working injuries, chronic conditions or fatality due to accidents	Develop and implement occupational health and safety plan. Provision of appropriate PPEs to workers.	HZI and BESIX Subcontractors	Occupational Health and Safety Plan
C25	Use of large equipment in operations	Worker health and safety	Working injuries, chronic conditions or fatality due to accidents	Ensure that workers are knowledgeable and have extensive experience in using large equipment. Develop and implement occupational health and safety plan. Provision of appropriate PPEs to workers.	HZI and BESIX Subcontractors	Occupational Health and Safety Plan
C26	Irregular inspection and maintenance of electrical equipment	Worker health and safety	Electric shock and electrocution	Develop and implement occupational health and safety plan. Provision of appropriate PPEs to workers.	HZI and BESIX Subcontractors	Occupational Health and Safety Plan
C27	Construction activities during summer months	Worker health and safety	Heat and sun-induced illnesses due to workers long work hours in areas with exposure to sunlight and / or excessive heat	Implement engineering controls and ventilation. Restrict work hours during summer time (i.e. 05:30 to 12:30 and 16:00 to 19:00 or as dictated by the Local Authorities). Monitor weather forecasts for outdoor work to provide advance warning of extreme weather and scheduling work accordingly. Provide appropriate PPEs to workers (i.e. protective clothing). Provide temporary shelters for use as rest areas. Provide easy access to hydration (i.e. drinking water or electrolyte).	HZI and BESIX Subcontractors	Occupational Health and Safety Plan Human Resources Plan (i.e. working hours)
C28	Delayed construction activities	Worker health and safety	Lack fluctuations in working hours based on work demand which may cause excessive overtime (i.e. no payment of overtime or layoffs)	Overtime payments and working hours should be clearly explained to the workers. Communicate the delay down the chain of command. Maintain a well-informed, multidisciplinary and competent project management team.	HZI and BESIX Subcontractors	Human Resources Plan (i.e. working hours and overtime payment)
Operation Phase[3]						
O1	Air emissions during operation (SOx, NOx, PM_{10}, $PM_{2.5}$, etc.)	Air quality	Particulate matter pollution in ambient air	Built-in management measures to mitigate emission of particulate matter (e.g. flue gas treatment (FGT) system, bag house, etc.)	Operator	Air Control Plan Operation Manual
O2	Air emissions during operation (SOx, NOx, PM_{10}, $PM_{2.5}$, etc.)	Public health	Impacts on respiratory health of residents and other users of surrounding facilities as well as workers	Built-in management measures to mitigate emission of particulate matter (e.g. flue gas treatment (FGT) system, bag house, etc.)	Operator	Air Control Plan Operation Manual Occupational Health and Safety Plan

Item	Activity / Project phase	Environmental aspect likely to be affected	Potential impact	Options for prevention / mitigation / enhancement	Responsible entity	Management / Control Plan to be prepared [1]
						Community Health and Safety Plan
O3	Ancillary activities – vehicle and equipment use	Air quality	Air pollution from particulate matter, carbon monoxide, sulphur dioxide, and nitrogen oxides emission	Operators should implement manufacturer recommended engine maintenance program. Replace vehicles with newer, more efficient alternatives. Converting high-use vehicles to cleaner fuels, where feasible. Installing and maintaining emissions control devices (i.e. catalytic converters). Implement regular vehicle maintenance and repair program.	Operator	Air Quality Control Plan
O4	Ancillary activities – vehicle and equipment use	Public health	Impacts on respiratory health of residents and other users of surrounding facilities as well as workers	Sealed road, if applicable. Dust suppression (i.e. wetting) for unconsolidated areas.	Operator	Air Quality Control Plan Occupational Health and Safety Plan Community Health and Safety Plan
O5	Waste spill during transportation of waste from sources (i.e residential areas) to the Project site	Public health	Impact on public health from exposure to vectors	Develop and implement traffic management plan. Do not transport waste during peak hours. Ensure that trucks and other equipment are in proper condition. Select vehicles and containers that minimise air/odour emissions.	DM-WMD registered waste haulers	Traffic Management Plan Spill Management Plan Occupational Health and Safety Plan Community Health and Safety Plan
O6	Movement of vehicles and equipment inside the Project site (i.e. internal traffic)	Worker/visitor health and safety	Impact on safety of employees and visitors of the site	Develop and implement internal traffic management plan (i.e. speed limit, etc.). Provide adequate traffic signage and signallers on-site. Identify pedestrian-only areas where vehicles are completely not allowed. Identify vehicle-only areas, especially in areas of limited space or traffic is heavy.	Operator	Traffic Management Plan
O7	Unloading of municipal solid waste / refuse to waste storage areas then to boiler hall	Worker/visitor health and safety	Accidents and injuries during transfer of waste involving trucks and other moving equipment Exposure to chemicals, pathogens and vectors	Develop traffic management systems and appoint traffic controllers. Provide (for internal employees) and required (for waste haulers) suitable PPEs. Provide refuse collection vehicles with audible reversing alarms and visible reversing lights. Design collection/transfer routes to minimise/eliminate crossing traffic that is going in the opposite direction. Restrict access to waste storage areas such that only trained personnel with PPEs are permitted in high-risk areas. Use automated system to transfer waste to the boiler hall (i.e. conveyor system). Control and characterise incoming waste.	DM-WMD registered waste haulers Operator	Traffic Management Plan Occupational Health and Safety Plan Pest Management Plan

Item	Activity / Project phase	Environmental aspect likely to be affected	Potential impact	Options for prevention / mitigation / enhancement	Responsible entity	Management / Control Plan to be prepared [1]
				Implement washing programs for waste collection vehicles and for company-owned waste collection and transfer containers. Provide adequate personnel facilities, including washing areas and areas to change clothes. Ventilate enclosed processing areas. Prohibit eating, smoking and drinking except in designated areas. Integrate pest control approaches to control vermin. Maintain good housekeeping Provide prompt medical attention to cuts and bruises. An on-site health facility / clinic and a medical practitioner should provided on-site.		
O8	Waste storage areas	Worker / visitor / community health and safety	Odourous emissions fron the waste storage areas	Use enclosed waste handling and storage areas. Use odour-neutralising spray where necessary. Implement good housekeeping procedures. Use enclosed/covered waste storage areas. Locate waste storage facilities away from sensitive receptors (i.e. administration area, accommodation area, community)	Operator	Incorporate health and safety measures in plant design Occupational Health and Safety Plan
O9	Noise and vibration including traffic, loading equipment, and plant operation	Worker / visitor / community health	Annoyance and hearing impairment	Include noise and vibration considerations during design. Maintain site roads in good condition to reduce noise and vibration from vehicle movements. Use acoustic screens around fixed / mobile plant and equipment. Select equipment that has low noise emission levels. Use buildings to contain inherently noise fixed plant and consider use of sound-insulating materials. Install vibration isolation for mechanical equipment. Relocate noise sources to less sensitive areas. Develop mechanism to record and respond to complaints.	Operator	Noise Management Plan Traffic Management Plan Grievance Mechanism Occupational Health and Safety Plan Community Health and Safety Plan
O10	Ash (incinerated bottom ash [IBA] and flue gas treatment [FGT] residue) handling and disposal	Soil and groundwater quality	Potential spill of ash to the ground causing soil contamination at the Project site	Built-in management measures (IBA maturation area and FGT residue silo (refer to Section 4.7.7)) Develop and implement spill management plan	Operator	Spill Management Plan Soil and Groundwater Control Plan
O11	Ash (IBA and FGT residue) – transportation from the Project site to disposal area	Public health	Risk to public safety due to additional vehicles on the road	Develop and implement traffic management plan. Develop and implement emergency response plan.	DM Waste Management Department	Traffic Management Plan Emergency Response Plan Community Health and Safety Plan

Item	Activity / Project phase	Environmental aspect likely to be affected	Potential impact	Options for prevention / mitigation / enhancement	Responsible entity	Management / Control Plan to be prepared [1]
O12	Ash (IBA and FGT residue) – transportation from the Project site to disposal area	Soil and groundwater quality	Potential spill of ash to the ground causing soil contamination at public areas (i.e. road from Project site to disposal area)	Develop and implement traffic management plan. Develop and implement spill management plan. Develop and implement emergency response plan.	DM Waste Management Department	Spill Management Plan Emergency Response Plan Community Health and Safety Plan
O13	Final disposal of ash (IBA and FGT residue)	Air quality, water quality, soil and groundwater, occupational and public health impacts	Potential environmental and social issues	To be considered in separate EIA by DM-WMD (when required)	DM Waste Management Department	To be considered in separate EIA by DM-WMD (when required)
O14	Installation and operation of new infrastructure	Public amenity	Impact visual amenity at surrounding areas	Façade and buildings: (i) the colours and similar cladding harmonized with the existing facilities, (ii) maintenance of exterior facades. Landscaping features: (i) plant tree buffers around the facility, (ii) use excavated soil to construct mounded berm (where required), and (iii) install interlocking concrete pavers (where required).	Operator	None required as the impact is negligible
Risks on labour and working conditions during all phases fo the Project						
LWC1	Job hiring	Labour and working condition	Potential discrimination due to hiring, compensation and promotion of workers not based on the job requirements and skills	Implement strict compliance with UAE Labour Law. Develop and implement non-discrimination and equal opportunity policy (to address racial discrimination, disability, gender discrimination, harassment, migrant workers), which should also be implemented by subcontractors and supply chain workers. Develop and implement an anti-harassment policy. Review recruitment practices to ensure they are not based on irrelevant personal characteristics. Define objective work requirements. Keep up-to-date records on recruitment, training and promotion.	Project Owner HZI and BESIX Subcontractors	Human Resources Management Plan Grievance Mechanism Procedure
LWC2	Job hiring	Labour and working condition	Potential hiring of children / young workers	Implement strict compliance with UAE Labour Law. Develop and implement a policy against employing, using or benefiting from child labour, which should also be implemented by subcontractors and supply chain workers. Develop and implement procedure in verifying the age of workers at the time of hiring. Develop reporting mechanism [i.e. where child labour is discovered, remove the child from hazardous condition (but do not remove from work as it may cause financial harm) and report to authorities]. If young workers are hired (i.e. on-the-job training), ensure that they are not exposed to hazardous job conditions and parents / guardians are informed of the job description.	Project Owner HZI and BESIX Subcontractors	Human Resources Management Plan

Item	Activity / Project phase	Environmental aspect likely to be affected	Potential impact	Options for prevention / mitigation / enhancement	Responsible entity	Management / Control Plan to be prepared [1]
LWC3	Job hiring	Labour and working condition	Forced labour or harassment (includes requirements of monetary deposits, limitations on freedom of movement, lengthy worker notice periods, substantial and inappropriate fines, loss or delays in wages)	Implement strict compliance with UAE Labour Law. Freedom of employment should be clearly defined in the contract. Provide training on workers' rights. Conduct monitoring or audition to ensure that there is no forced labour. If forced labour are discovered, report it to authorities. Re-establish procedures to prevent forced labour. Develop and implement anti-forced labour and harassment polic, which should also be implemented by subcontractors and supply chain workers.	Project Owner HZI and BESIX Subcontractors	Human Resources Management Plan Grievance Mechanism Procedure
LWC4	Working condition	Labour and working condition	Problems / conflict between workers arising at the construction site	Implement strict compliance with UAE Labour Law. Develop and implement anti-harassment, anti-discrimination policy. Develop and implement grievance mechanism for the workers to freely communicate any instances of abuse, discrimination, harassment, etc. Develop and implement disciplinary actions. Develop and implement workers' Code of Conduct	Project Owner HZI and BESIX Subcontractors	Human Resources Management Plan Grievance Management Procedure
LWC5	Working condition	Worker health and safety	Worker illnesses due to lack of access to separate and clean areas for eating, changing clothes, rest area and sanitation facilities at the Project site	Provide clean and separate areas for eating, changing clothes, rest and sanitation. Regular housekeeping. Ensure routine monitoring of workers health and wellbeing.	HZI and BESIX Subcontractors	Human Resources Management Plan Grievance Management Procedure
LWC6	Transportation of worker to and from the Project site	Worker living condition	Accident or use of inappropriate vehicle (i.e. truck)	Provide appropriate transportation services to workers. If transportation services is not provided, include transporation allowance in their wages.	HZI and BESIX Subcontractors	Human Resources Management Plan
LWC7	Provision of labour accommodation	Worker living condition	Illnesses and health hazards due to poor living conditions	Provide appropriate housing accommodation to workers, which address the basic services: minimum space, sufficient supply of water, adequate sewage and garbage disposal systems, appropriate protection against heat and other environmental stressors, fire, disease-carrying animals, adequate sanitary and washing facilities, ventilation, cooking and storage facilities, natural and artificial lighting and basic medical services. Labour accommodation should be in line with local and international guidelines. If accommodation services is not provided, include accommodation allowance in their wages.	HZI and BESIX Subcontractors	Human Resources Management Plan Grievance Management Procedure

1 – To be included in the CEMP / OEMP where required by DM-EPSS

2 – Management plans will be prepared prior to start of construction

3 – Management plans will be prepared prior to commissioning

8.5 Monitoring and Record Management

Environmental monitoring will be required throughout the Project lifecycle and should be developed according to the following objectives:

- Facilitate consistent implementation of the proposed mitigation measures.
- Assess whether the mitigation measures in place are adequate and identify any requirement for additional measures to confirm that impacts are minimised, where possible, and reduced to acceptable level.
- Assess Project's compliance to the relevant local and international environmental and social regulatory requirements / standards.

Ultimately, the program will facilitate continuous improvement of the Project's overall environmental performance. The environmental monitoring plan is provided in Section 8.6. An Environmental Monitoring Program Register should be maintained to facilitate a well-documented and accurate assessment of the Project's overall environmental performance. The register should include, but not be limited to, the following information / documents:

- Daily site inspection checklist
- Environmental monitoring results (e.g. air, noise, soil and groundwater) and compliance status with environmental standards specified by Federal Law and/or DM as well as international requirements
- Audit reports
- Incident reports including corrective actions
- Non-compliance reports including corrective actions
- Complaint register and management reports.

The documents listed above shall prove useful in providing compliance evidence during environmental audits.

8.6 Environmental Monitoring Plan

The formulation of an environmental monitoring plan will provide assurances that the responsible entity will immediately address any adverse impact on the environment aspects during the construction and operation phases of the Project.

8.6.1 Construction Phase

The proposed monitoring plan for the project construction phase is presented in Table 8-2. It includes information on the parameter to be monitored, facility, frequency and procedure. Generally, the sampling and analytical methods that will be employed for the monitoring activities, as may be required will conform to existing local guidelines and acceptable procedure of relevant authorities (e.g. Dubai Municipality).

Table 8-2 Environmental monitoring plan – Construction Phase

Key environmental aspects	Potential impacts	Parameters to be monitored	Sampling and measurement plan				Reporting Schedule	Trigger level for corrective actions	Actions to be taken in the event that trigger level is exceeded	Responsibility
			Method	Frequency and duration	Location	Equipment & Schedule of Calibration				
Air quality	Dust emission	• PM_{10} (24-hour) • TSP (24-hour)	Title 40, CFR, Chapter 1, subchapter C, Appendix J to Part 50 Reference Method for the Determination of Particulate Matter as PM_{10} in the Atmosphere	Monthly site monitoring: • One measurement on weekday • One measurement on weekend day (when construction is carried out) On each of the following event, the following will be undertaken: • PM_{10} sampling for period of 24-hour • TSP sampling for a period of 24-hour	• One location • Monitoring station is subject to change and will be located where construction activities are undertaken	High volume sampler or equivalent	• Monthly internal reporting by contractor to EPC • Quarterly reporting of project performance to DM-ED (when required) • Annual reporting to Project lenders (when required)	• UAE Federal ambient air quality standard [PM_{10}: 150 µg/m^3 (24-hour); TSP: 230 µg/m^3 (24-hour) • Visible dust emission • Community complaints	The activities carried out on the construction site and in the vicinity of the monitoring location shall be reviewed (field record sheet) to determine if exceedances are associated with the Project construction activities on site. • If exceedances is associated with the Project, cease the construction activity causing the exceedance and identify / implement appropriate corrective actions • If the exceedance is not associated with the Project construction activities, actions are not required	• Project Company
Noise	Noise generation	• L_{Aeq} • L_{A10} • L_{A50} • L_{A90} • L_{Amax} • L_{Amin}	ISO 1996-1:2003, Acoustics – Description, measurement and assessment of environmental noise – Part 1: Basic quantities and assessment procedures	Monthly site monitoring: • One measurement on weekday during daytime • One measurement on weekday during night-time (if construction work is carried out) • One measurement on weekend during daytime (if construction is carried out) • One measurement on weekend during night-time (if construction is carried out)	• One location • Monitoring station is subject to change and will be located where construction activities are undertaken	Sound Level Meter and Sound Calibrator (Type 1 or above)	• Monthly internal reporting by contractor to EPC • Quarterly reporting of project performance to DM-ED (when required) • Annual reporting to Project lenders (when required)	• Federal allowable limits for residential areas with some workshops and commercial business or residential areas near highways: – Daytime: 50 to 60 dBA – Night time: 40 to 50 dBA • Industrial areas (heavy industry): – Daytime: 60 to 70 dBA – Night time: 50 to 60 dBA • Community complaints		• Project Company
Dewatering effluent	Water contamination	• pH • Salinity • Turbidity • Suspended solids • Nitrate-Nitrogen • Sulphides • BOD5 • COD • Phosphate-Phosphorus • Ammonia • Metals (Cu, Pb, Cd, Ni, Co, Zn) • Faecal coliform	Sampling and laboratory testing by DAC approved laboratory	• As per requirement specified in the Environmental Permit / No Objection Certificate to discharge groundwater • In the event that frequency is not indicated in the permit / certificate, sampling and testing will be undertaken on a semi-annual or quarterly basis, where dewatering activities is undertaken • Dewatering quality will only be monitored if the effluent is being used for irrigation or dust suppression	• From dewatering tank to assess quality prior to discharge	Grab sample collected in a sample container made of material which complies with APHA recommendation (or equivalent) followed by laboratory testing YSI 6920 V2 Multi-Parameter Intelligent Logger (or similar)	• Monthly internal reporting by contractor to EPC • Quarterly reporting of project performance to DM-ED • Annual reporting to Project lenders (when required)	• DM Effluent Standards for Marine Water Discharge (if discharged in marine environment)	• Contaminated dewatering effluent shall not be used for irrigation or dust suppression • Offsite disposal via Dubai Municipality approved waste contractors should be considered	• Project Company

Key environmental aspects	Potential impacts	Parameters to be monitored	Sampling and measurement plan				Reporting Schedule	Trigger level for corrective actions	Actions to be taken in the event that trigger level is exceeded	Responsibility
			Method	Frequency and duration	Location	Equipment & Schedule of Calibration				
Worker and public	Exposure of workers and public to health and safety risks	• Morbidity / Mortality rates of workers • Compliance with Occupational Health and Safety Requirements of Dubai Municipality • Number of complaints received from the community on public health and safety	Records on fatality / mortality / health and safety incident rates of workers and people in the surrounding areas Records of workers / community complaints	• Daily occupational health and safety inspections at the Project site • Annual health and safety audits	• Construction site • Project sensitive receptors	Not applicable	• Monthly internal reporting by contractor to EPC • Annual reporting to Project lenders (when required)	• High rate of fatality / morbidity / health and safety incidents due to project construction activities • Community complaints	• Investigation will be undertaken if fatality / morbidity / health and safety incidents are caused by project construction activities • If Project construction activities caused the fatality / morbidity / health and safety incidents, cease construction activity and implement appropriate corrective action / measure • If incident is not associated with the Project construction activities, actions are not required	• Project Company
Labour and working condition	Exposure of workers to labour rights issues	• Work and living sites / conditions • Worker and management relationship (i.e. HR and Finance procedures and implementation process)	Interview with workers and management (i.e. HR, Finance, Labour Accommodation Supervisor) Review of Employer's systems and documents (i.e. timekeeping and payment) Site visit and inspection of construction site and labour accommodation	• Weekly inspection at the Project site (i.e. included in weekly environmental site inspection) • Semi-annual / annual inspection of management-worker relationship and labour accommodation site	• Construction / Project site • Labour accommodation site	Not applicable	• Monthly internal reporting by contractor to EPC • Annual reporting to Project lenders (when required)	Non-compliance with the following: • Federal (UAE) and local (Dubai) Labour Law • Federal and local guidelines on Health and Safety in Workplace / construction site • Federal and local guidelines on Labour Accommodation • Non-compliance with IFC / EBRD Workers' accommodation: process and standards • IFC Performance Standard on Labour and Working Condition • Complaints from workers	• Corrective action measures will be implemented	• Project Company

8.6.2 Operation Phase

The proposed monitoring plan during the operation phase is detailed in Table 8-3. It includes information on the parameter, facility, frequency and procedure. The sampling and analytical methods that will be employed for the monitoring activities will conform to the existing local guidelines and acceptable procedure of DM-ED.

The Project Company is not free from responsibilities or obligations with respect to ambient air (dust), odour and noise emissions. DM's guidance document "Guidance on the Environmental Clearance (EC) Requirements for Development and Infrastructure Projects in the Emirate of Dubai" sets out the system under which any suspected or observed environmental violations will be investigated and the subsequent actions that will be taken on behalf of all parties involved.

Any investigation into suspected or observed environmental violations will take into account the existing conditions at the Project site including the surrounding area and current baseline data as follows, and the pre-operation baseline data yet to be gathered at the time of issuing this EIA document:

- ***Existing air emission sources***. Ambient air quality at the Project site are most likely to be influenced by the DEWA Power Station located southwest of the site with stationary sources of emission, various industrial facility to the immediate southeast of the Project site and combustion emissions from vehicles using the surrounding road infrastructure. Baseline ambient air quality monitoring results undertaken by GHD (refer to Section 5.3.1) showed exceedance of PM_{10} against the UAE Cabinet Decree No. 12 of 2006 at station AAQM2. Further, ambient air quality monitoring carried out by Dubai Municipality for the year 2017 at Emirates Hill, Mushrif and Sheikh Mohammed Bin Zayed Road showed PM_{10} and $PM_{2.5}$ exceedances.
- ***Existing odour sources***. A review of the existing environment indicates that a number of potential odour sources currently surrounds the proposed WMC. This includes Tadweer landfill, Al Aweer STP, Al Serkal/envirol grease trap waste recycling plant, China asphalt mixing plant and Emirates beton readymix LLC. Baseline odour monitoring results (refer to Section 5.3.2) showed exceedance against the limits specified in Annex 5 of the DM-ED technical guideline entitled "Guidance on the EC Requirements for Development and Infrastructure Projects in the Emirate of Dubai" at odour monitoring (OM) locations Od2 and Od3.
- ***Existing noise sources***. Existing noise sources close to the Project site that has the potential to cause noise exceedances include vehicle movement on the road surrounding the site as well as existing industrial facilities. Noise exceedances were recorded at NQM1 during the baseline noise monitoring (refer to Section 5.4.1).

Any investigation will take into consideration the Project Company's duties under the noise/dust/odour management plan. The management plan will take account of Good Industry Practice, the Operating Procedures, the O&M Manual, and good community communication to mitigate and control noise so as to avoid a nuisance being caused. The Project Company is not free from responsibilities or obligations with respect to groundwater. If the quarterly report reveals exceedances with respect to proposed standard (Dutch Guidelines 2000), an investigation will be undertaken to determine whether the exceedances are attributable to the Project taking account of existing conditions at the Project site including the surrounding area and the current baseline data as follows and the pre-operation baseline data:

- ***Existing activities surrounding the site***. A number of activities surrounding the Project site that have the potential to contribute to groundwater contamination include the un-engineered Tadweer dumpsite, the Al Aweer STP and several industrial and storage facilities. Baseline groundwater sampling and analysis showed exceedances against the Dutch Intervention Values (refer to Section 5.5.2).

Table 8-3 Environmental monitoring plan – Operation Phase

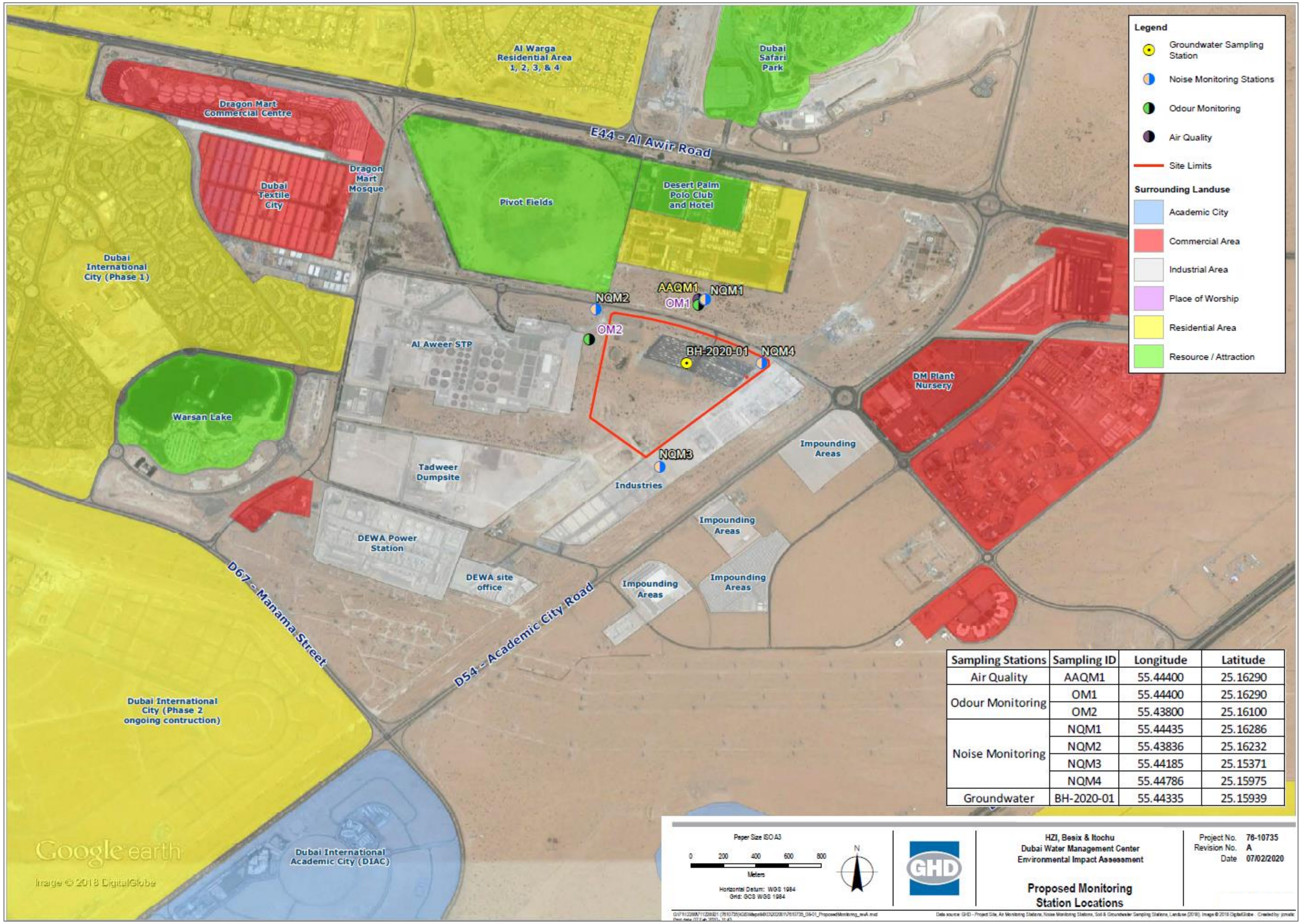
Key environmental aspects	Potential impacts	Parameters to be monitored	Sampling and measurement plan				Reporting Schedule	Reference Guideline	Responsibility
			Method	Frequency and duration	Location	Equipment & Schedule of Calibration			
Air quality 2	Stack emissions	• Water (H_2O) • Oxygen (O_2) • Hydrogen chloride (HCl) • Sulphur dioxide (SO_2) • Nitrogen oxide (NOx) • Carbon monoxide (CO) • Ammonia (NH_3) • Total Organic Carbon (TOC) • Dust	• Continuously via Continuous Environmental Monitoring System (CEMS) at every stack	• CEMS	• WtE plant stacks (there are 5 proposed stacks)	Continuous Emissions Monitoring System (CEMS)	• The CEMS shall be linked to the DM Air Monitoring Network central server upon Project commissioning	• UAE Cabinet Decree No. 12 of 2006 • IED 2010/75/EU including the exceedance allowances as stated in IED 2010/75/EU[1]	• Operator
Air quality	Stack emissions	• Hydrogen fluoride (HF) • Dioxin & Furans • Heavy metals • PM_{10} • $PM_{2.5}$	• Sampling and laboratory analysis	• Quarterly	• WtE plant stacks (there are 5 proposed stacks)	TBC	• Included in Quarterly Environmental Performance Report (EPR) to be submitted to DM-ED Environmental Control Section (ECS)	• IED 2010/75/EU including the exceedance allowances as stated in IED 2010/75/EU	• Operator
Air quality	Fugitive dust emissions	• PM_{10} • $PM_{2.5}$	• Fixed and continuous monitoring system	• Continuous	• One (1) location (refer to Figure 8-1 for proposed locations) to be approved by DM-EPSS	Fixed and continuous monitoring equipment	• Monitoring stations shall be commissioned and linked to the DM Air Monitoring Network central server		• Operator[3]
Odour	Odour emissions	• Hydrogen Sulphide (H_2S) • Ammonia (NH_3) • Mercaptans • Dimethyl sulphide • Dimethyl disulphide	• Fixed and continuous monitoring system	• Continuous	• Two (2) locations (refer to Figure 8-1 for proposed locations) to be approved by DM-EPSS	Fixed and continuous monitoring equipment	• Monitoring stations shall be commissioned and linked to the DM Air Monitoring Network central server	• Annex 5 of the DM-ED technical guideline entitled "Guidance on the Environmental Clearance (EC) Requirements for Development and Infrastructure Projects in the Emirate of Dubai"	• Operator[3]
Noise	Noise generation	• L_{Aeq} • L_{Amin} • L_{Amax} • L_n	• Fixed and continuous monitoring system	• Continuous	• Four (4) locations (refer to Figure 8-1 for proposed locations) to be approved by DM-EPSS	Fixed and continuous monitoring equipment	• Monitoring stations shall be commissioned and linked to the DM Air Monitoring Network central server	• UAE Cabinet Decree No. 12 of 2006	• Operator[3]
Groundwater	Groundwater contamination	• As per Dutch Target and Intervention Values, 2000 (the New Dutch List)	• Sampling and laboratory analysis	• Quarterly	• One (1) location (refer to Figure 8-1 for proposed locations) to be approved by DM-ED Natural Resources	TBC	• Groundwater Monitoring Report shall be submitted as part of the EPR to be submitted to DM-ED	• Dutch Target and Intervention Values, 2000 (the New Dutch List) [2]	• Operator

Key environmental aspects	Potential impacts	Parameters to be monitored	Sampling and measurement plan				Reporting Schedule	Reference Guideline	Responsibility
			Method	Frequency and duration	Location	Equipment & Schedule of Calibration			
					Conservation Section (NRCS)		ECS on a quarterly basis		
Worker and public health	Exposure of workers and public to health and safety risks	• Morbidity / Mortality rates • Compliance with Occupational Health and Safety Requirements of Dubai Municipality	• Health records on fatality / mortality / health and safety incident rates of workers and people in the surrounding areas	• Daily occupational health and safety inspections • Annual health and safety audits	• Project site • Project sensitive receptors	Not applicable	• Annual reporting to Project Lenders (when required)	• Technical guidelines issued by Federal (UAE) and the Emirate of Dubai (i.e. DM Public Health and Safety Department)	• Operator
Labour and working condition	Exposure of workers to labour rights issues	• Work and living sites / conditions • Worker and management relationship (i.e. HR and Finance procedures and implementation process)	Interview with workers and management (i.e. HR, Finance, Labour Accommodation Supervisor) Review of Employer's systems and documents (i.e. timekeeping and payment) Site visit and inspection of construction site and labour accommodation	• Annual inspection of management-worker relationship and labour accommodation site	• Project site • Labour accommodation site	Not applicable	• Annual reporting to Project Lenders (when required)	• Federal (UAE) and local (Dubai) Labour Law • Federal and local guidelines on Health and Safety in Workplace / construction site • Federal and local guidelines on Labour Accommodation • Non-compliance with IFC / EBRD Workers' accommodation: process and standards • IFC Performance Standard on Labour and Working Condition • Complaints from workers	• Operator

[1] As discussed and agreed with DM-EPSS, it is accepted that compliance with IED 2010/75/EU will satisfy compliance of UAE Cabinet Decree No. 12 of 2006 without the need for duplicating tests to cover specific time averaging, temperature and O_2 values specific to the latter

[2] In the event of exceedances against the proposed standard, an investigation will be undertaken to determine whether the exceedances are associated with the Project.

[3] Sponsors (through EPC) will procure the initial monitoring systems and the integration into the DM monitoring network. The equipment will be handed over to DM at the Commercial Operation Date (ie completion of the Project).



Sampling Stations	Sampling ID	Longitude	Latitude
Air Quality	AAQM1	55.44400	25.16290
Odour Monitoring	OM1	55.44400	25.16290
	OM2	55.43800	25.16100
Noise Monitoring	NQM1	55.44435	25.16286
	NQM2	55.43836	25.16232
	NQM3	55.44185	25.15371
	NQM4	55.44786	25.15975
Groundwater	BH-2020-01	55.44335	25.15939

Figure 8-1 Proposed monitoring stations – Construction and Operation Phases

8.7 Organisation Structure

The Project is owned by DM. Under contract with the Project Owner, HZI, BESIX and Itochu have formed a partnership to build, operate and transfer (BOT) the WtE plant over a 35-year period. The contract is shared between a Special Project Vehicle (SPV) and Engineering, Procurement and Construction (EPC) partnership and Operations and Maintenance (O&M) partnership. The organization structure for the Project is provided in Figure 8-2.

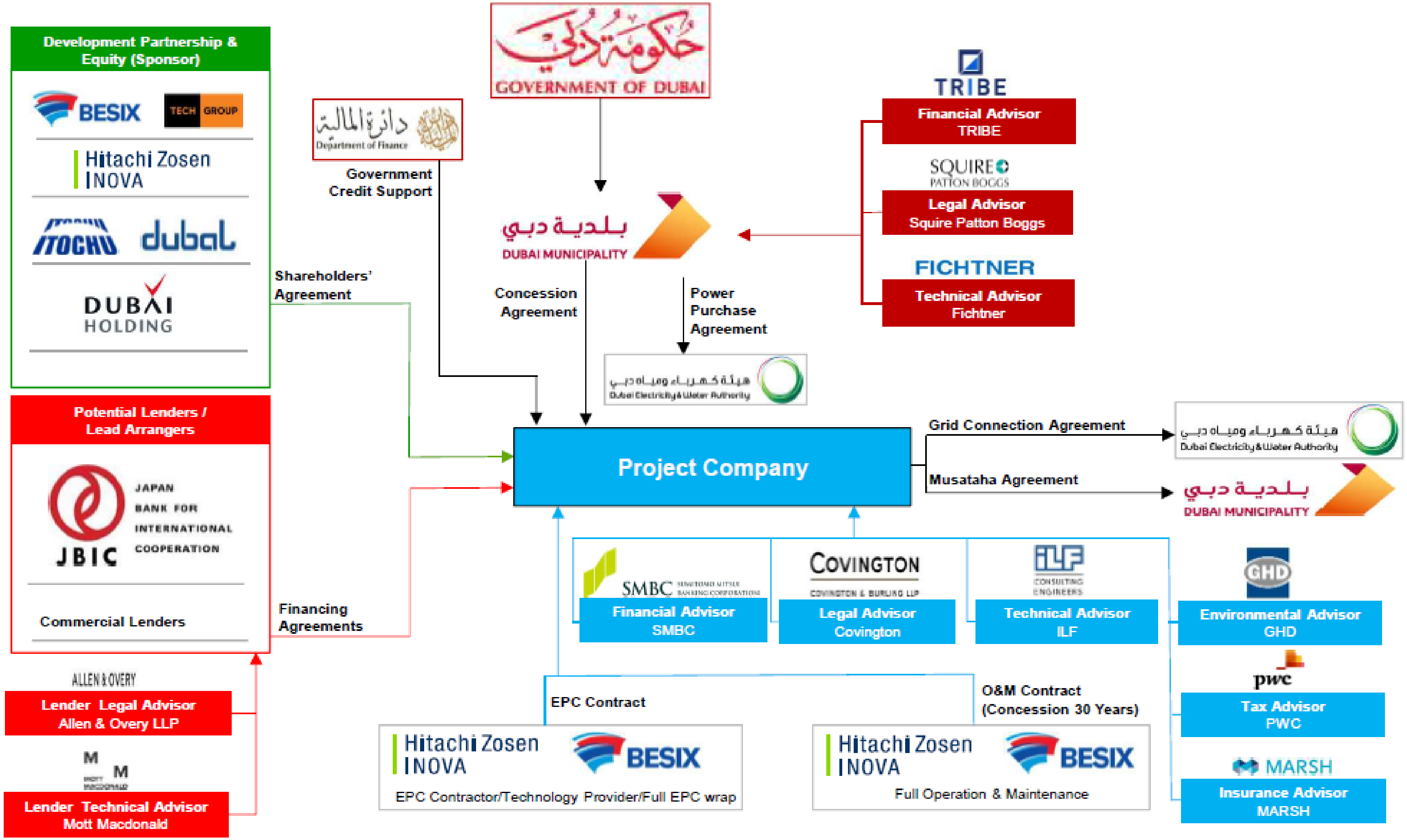


Figure 8-2 Project Structure

8.7.1 Construction Phase

The EPC contractor and technology provider during the construction phase is shown in Figure 8-3. As the EPC contractors, HZI and BESIX are the responsible entities in ensuring that the construction of the Project are undertaken in accordance with the requirements of this framework EMMP.

The implementation of this EMMP during the construction phase will be in accordance with the organizational structure shown in Figure 8-4. It is likely that a number of main contractors and sub-contractors will be engaged for the construction of different Project components.

EPC Contractor/Technology Provider/Full EPC wrap:

BESIX

Civil Works EPC

- Site Infratructure
- Site Preparation / Soil Improvement
- Main Cvil & Underground Works
- Building Steel Structure
- Building Services
- Water Treatment

Hitachi Zosen INOVA

Process Works EPC:

- Combustion and Steam Production
- Flue Gas Treatment
- Water Steam Cycle
- Electrical & Control Systems
- Mechanical & Electrical Installation

Figure 8-3 EPC Contractor/Technology Provider

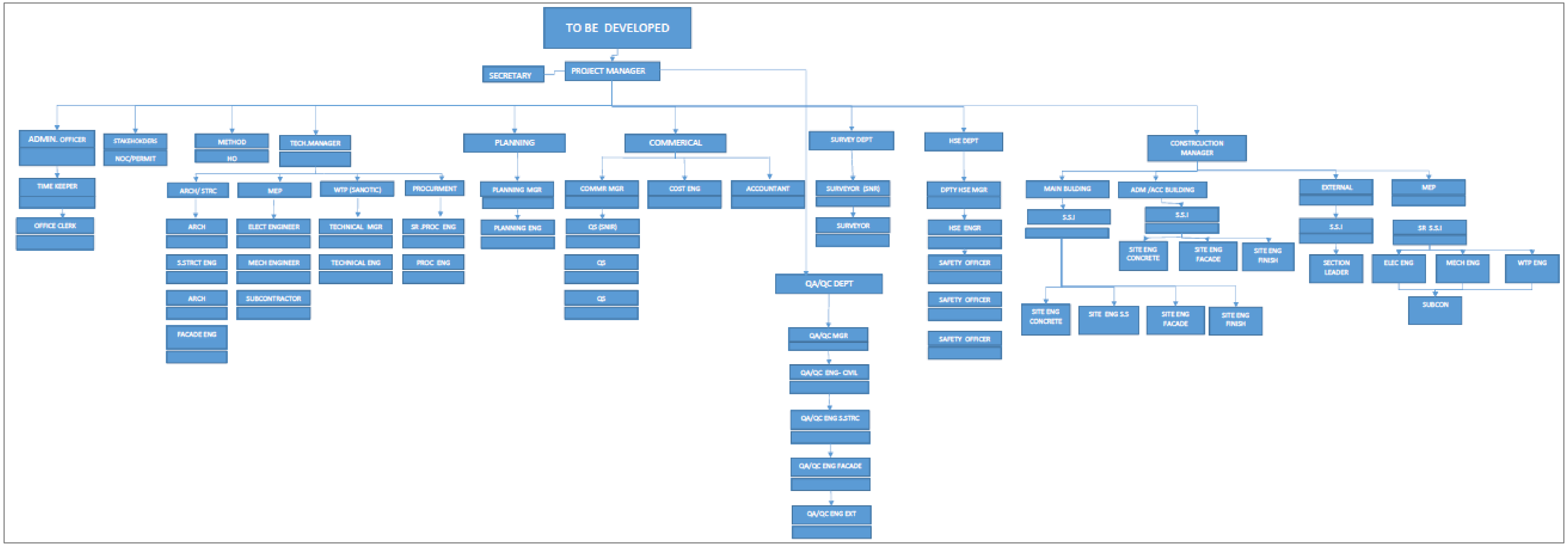


Figure 8-4 Preliminary organization structure – construction phase

8.7.2 Operation Phase

The organization structure to be adopted during the operation phase is provided in Figure 8-5. The contract between the Project Owner and the Prime Contractors includes build, operate and transfer (BOT) after 35 years. DM will be responsible for waste acquisition and energy sales. DM will be the main contact point in stakeholder engagement activities during the operation phase.

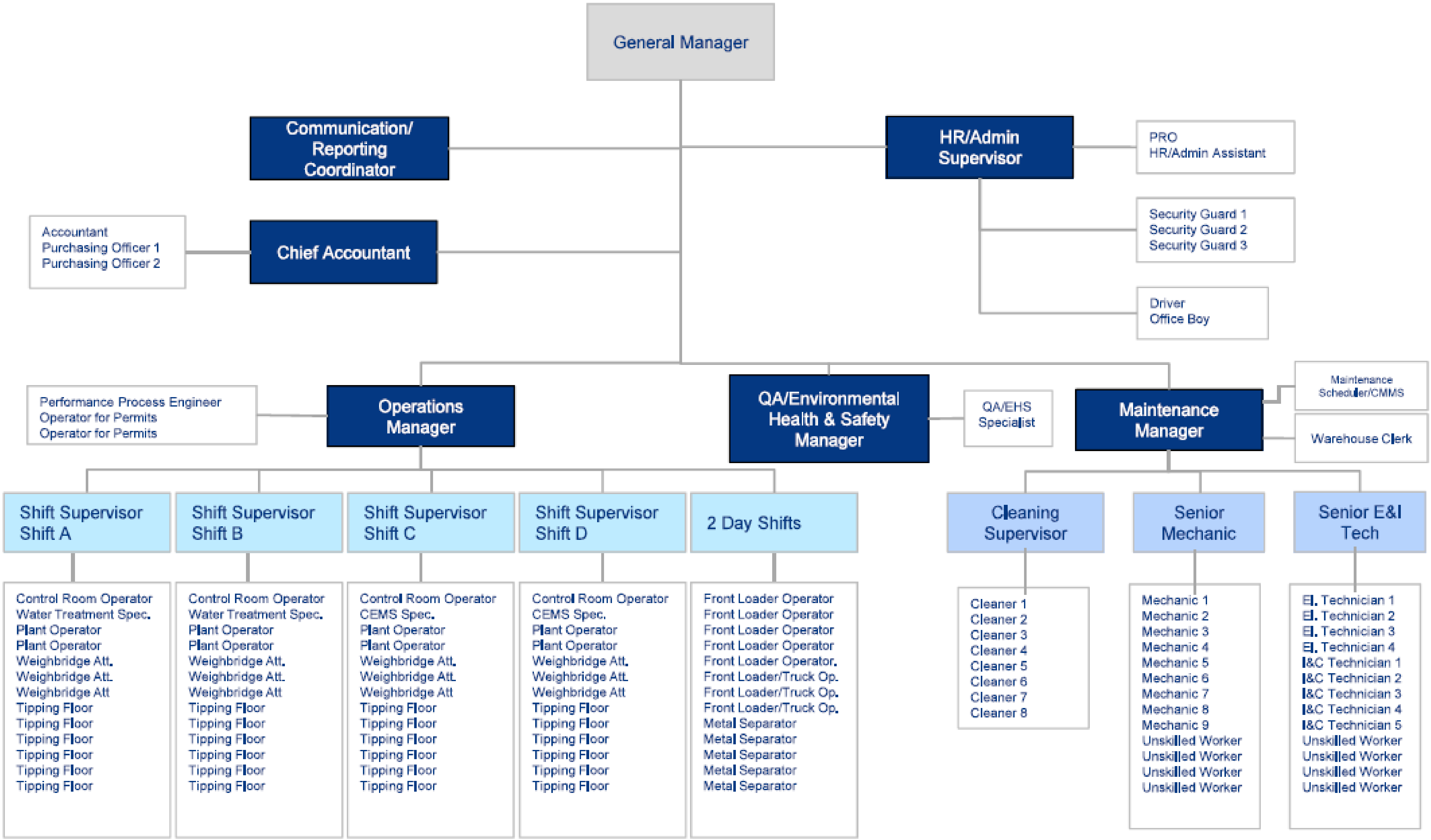


Figure 8-5 Preliminary organization structure – operation phase

8.8 Responsibilities

As the Primec Contractor, HZI and BESIX have the overall responsibility of ensuring that adequate environmental management measures are continuously implemented throughout the Project development and operation. However, the construction and operation of the Project will involve a number of parties and individuals, which will have direct and indirect contribution to, and consequently influence on the overall environmental performance of the Project. In order to facilitate effective implementation of this EMMP, specific duties and responsibilities are delegated as outlined in Table 8-4.

Table 8-4 Roles and Responsibilities in the Implementation of EMMP during the Construction Phase

Party	Responsibilities
Project Owner: Dubai Municipality	• During the construction and operation phases, DM will be the main contact point for the stakeholder engagement activities. • During the operation phase, DM will be responsible for: – Waste acquisition; – Waste management [i.e. collection and disposal of incinerated bottom ash (IBA) and flue gas treatment (FGT) residue]; and – Energy sales.
EPC Contractor: HZI and BESIX	• Monitor relevant subcontractors' compliance with the environmental management and monitoring requirements of this framework EMMP. • Monitor subcontractors' compliance with environmental instructions. This can be done by incorporating environmental or social contractual clauses in work instructions, service contracts and lease agreements. • Require evidence or documentation within the CEMP and OEMP that subcontractors including their supervisory and management staff are competent and committed to their responsibilities in accordance with this EMMP. • Allocate appropriate and adequate resources to allow for the effective implementation of the environmental management and monitoring requirements of this EMMP. • Conduct periodic reviews of the Project's environmental performance. • Report to Dubai Municipality Environment Department (DM-ED) any major environmental incidents that may have significant impact on the surrounding environment. • Undertake corrective actions, where required, in order to safeguard the environment and public health and safety. • According to the Project scope and when required, appoint a DM-accredited third party consultant to conduct periodic environmental site audits to check compliance with the CEMP or OEMP, and submit report to DM-EPSS.

Party	Responsibilities
	• Appoint dedicated Project environmental personnel (or engage a third party environment consultant) that manage construction activities on site. • Support the Project Owner in addressing / investigating the complaints of the external stakeholders (i.e. surrounding communities).
Subcontractors	• Be aware of and understand the environmental management and monitoring requirements of this framework EMMP as may be relevant to their scope of work. • Carry out all works in a manner that will have the least impact on the environment and surrounding community. • Establish an Environmental Management Team (typically integrated into Environment, Health and Safety (EHS) Management Team) and designate competent personnel to oversee the day-to-day environmental undertakings on-site. • Undertake internal audits to monitor personnel adherence to these requirements. Where necessary, work method statement should be developed incorporating appropriate environmental controls. • Provide training and provide records to demonstrate that all site workers are competent to undertake their designated works. This should include environmental training for personnel and subcontractors. • Develop environmental safeguards and precautions and provide evidence of implementation throughout the construction. Regular site inspections, monitoring and audits should be undertaken and documented through formal periodic reports. • Report to the Prime Contractor all environmental incidents as soon as practicable. • Undertake corrective actions, where required, in order to safeguard the environment and public health and safety.
HSE Department or Environment Consultant (where required by DM-ED)	• Perform environmental and social (i.e. workers) monitoring activities and regular site inspections to assess compliance against this EIA and Project-specific CEMP and OEMP. • Investigate and report environmental incidents and non-conformances to the Prime Contractor along with the required corrective actions. • Process environmental monitoring data and consolidate subcontractors' monthly environmental monitoring reports to be submitted to DM-EPSS (where required). • Communicate with DM-EPSS and other subcontractors on environment matters (where required).

8.9 Resources

The Prime Contractor will allow for and provide appropriate resources to facilitate the effective implementation of the proposed mitigation and monitoring measures proposed in this EIA. Examples of resources include:

- Competent and experienced personnel appointed to manage environmental issues.
- Provision of environmental training.
- Adequate time and budget allocated for personnel to manage environmental issues (e.g. environmental monitoring, training).
- Provision of suitable documentation including environmental monitoring records, incident reports and corrective action plans.
- Purchase of appropriate devices and equipment for pollution control and monitoring.

8.10 Induction and Training

The Prime Contractor will ensure that all entities involved in the construction and operation of the Project receive adequate induction and orientation. Environmental induction and trainings will be carried out to create awareness, delegate responsibilities and seek commitment among the personnel involved in the Project.

During the operation phase, WtE plant personnel will be provided with appropriate types or levels of training commensurate to the nature of their work. Training methods will be selected based on their job description, experience and qualifications. The EHS Manager shall keep records of trainings to be conducted.

Induction and trainings should be developed to provide all relevant entities a clear understanding of the following:

- The requirements and importance of complying with environmental standards, regulations, laws and policies.
- The environmental aspects of their activities and the benefits of improved personal environmental performance.
- Specific roles and responsibilities in implementing environmental management measures and monitoring.
- The environmental management and monitoring programs developed for the Project / relevant to their line / scope of work.
- The potential consequences of non-compliance with the environmental management and monitoring activities.

9. Conclusions and General Recommendations

It is anticipated that minor environmental impacts will be generated on geology, soil and groundwater, biodiversity (terrestrial ecology), water and energy resources, socio-economics and culture. The environmental and social impacts considered in the EIA for the construction and operational phases of the proposed Project are summarised below.

9.1 Construction Phase

Key environmental considerations during the construction phase are discussed below while proposed mitigation measures and and monitoring program is detailed in Table 9-1.

Increase dust levels

Construction activities such as earthworks, grinding and stockpiling have inherent risk of producing elevated dust concentrtations, particularly in the Middle East where the surface comprises sand and dust material. Elevated dust emissions can cause irritation to the eyes and throat for both human and animal receptors, in addition to increasing the likelihood of respiratory diseases such as asthma. Significant irreversible long-term adverse impact on air quality at nearby air sensitive receptors is unlikely given that the construction works are relatively short-term in nature and that ambient conditions in Dubai are often characterised by elevated levels of airborne particulate matter. Ambient air monitoring undertaken at the Project site indicated PM_{10} levels are not compliant with DM guidelines in AAQM2 station.

Increase in noise levels

Increase in noise levels could result in detrimental impacts such as sleep disturbance and potential minor hearing loss for nearby sensitive receivers and workers within the construction site. The results showed that daytime average measurement were compliant with the guidelines while nighttime measurement at one station exceeded the World Bank limit of 45 dBA.

Health and Safety

Activities associated with the construction of the WtE plant may potentially affect site personnel and residents living close to the Project site. The construction of the project will generate increased air and noise emissions, increased vehicle traffic and alter visual landscape in the Project site. Air and noise emissions are likely to be temporary, reversible and localised. Increased vehicle traffic and associated air and noise emissions are also likely to be temporary and reversible. On the other hand, changes to visual impact are considered to be permanent and irreversible; however, these changes are consistent with the existing industrial landscape in the Project site. In view of the duration and scale of the construction, air and noise emissions, traffic impact and changes in aesthetics are not anticipated to result in any significant disturbances or adverse health impacts onsite and offsite receptors.

Table 9-1 Key considerations - construction phase

Key considerations	Proposed mitigation measures	Monitoring methodology
Increase dust levels	Prepare a detailed dust control plan as part of the CEMP, which would include the following measures as a minimum: • Site layout: locate the dust generating activities, haulage routes, stockpiles and dusty materials away from the sensitive receivers as far as possible (taking the predominant wind direction into consideration). • Surfacing and/or compaction of site access roads to minimise dust generated by vehicle movement on-site. • Application of water for dust suppression on stockpiles and haulage roads and during dust generating activities. • Erection of hoarding. • Limit the traffic speed on site.	Dust monitoring (TSP and PM_{10}) at monthly intervals at one location near the air sensitive receivers of the Project site.
Increase in noise levels	Prepare a detailed noise control plan as part of the CEMP, which would include the following measures as a minimum: • Erection of hoarding / noise barrier along the site boundary and/or areas where activities emitting high noise levels are performed. • For construction works carried out adjacent to NSRs and particularly at N1, which is near a residential area, erection of noise barriers made of sound absorbent materials is required. • Construction work programme (i.e. timings) and method to be sequenced so as to minimize noise emissions impacts, particularly during night time. • Deployment of quiet equipment.	Noise monitoring to be performed on a monthly basis (to be undertaken during both weekdays and weekends and dring daytime and night time) at one location near the noise sensitive receptor of the Project site.
Health and safety	Prepare a detailed Occupational Health and Safety Plan, which would include the following measures as a minimum: • Implement air quality control measures. • Implement noise control measues.	• Implement air quality monitoring program methodology • Implement noise monitoring program methodology

Key considerations	Proposed mitigation measures	Monitoring methodology
	• Implement traffic control measures. • Implement Environmental Health and Safety Management System (EHSMS) • Provision of personal protective equipment (PPE). • Undertake regular health and safety inspections.	• Implement traffic monitoring program • Maintain communication records and track actions taken to resolve health and safety issues.

9.2 Operation Phase

Key environmental and social aspects considered during the operation of the project are discussed below. Summary of management measures and monitoring program for each environmental aspect considered is provided in Table 9-2.

Ambient Air

The predicted incremental results from air dispersion modelling of the proposed operations of the WMC indicates the Project is not anticipated to exceed relevant air quality criteria for NO_2, SO_2, CO, TSP, PM_{10}, $PM_{2.5}$, HCl, HF, NH_3, TCDD and Hg provided that:

- The emission concentration guarantees listed in IED, Annex VI, Part 3 (Tables 1.1, 1.3 and Section 1.4 and 1.5) (European Union 2010) and set out in Section 6.3.2.1 are met.
- The stack parameters and emission rates used in this assessment are adhered to.
- Throughputs of IBA remain at the assumed rate (282,300 tpa).

Although the model predictions indicate exceedances of 1-hour incremental Cd for the NSW AMMAAP criteria, this is only a guideline, and the European Commission annual criteria is considered more appropriate. Predicted annual Cd concentrations comply with the European Commission criteria. Further, the modelled emission rate reflects the regulatory maximum of 0.05 mg/Nm^3 (sum of Cd and Tl), and it is considered unlikely that the emission rate for Cd in reality would reach this level.

Odour

A quantitative assessment of potential odour impacts from the operation of the WtE plant has been conducted, based on measured meteorological data from the Dubai International Airport for the year 2015 and AERMOD plume dispersion modelling. The intention of this assessment was to demonstrate odour concentrations for the WMC during upset conditions. Nominal conditions (flow rate of 0.1 m/s) were modelled as a baseline. Results for the worst case scenario (flow rate of 1.2 m/s) are considered highly conservative with results for the upset conditions with a flow rate of 0.6 m/s considered to be more representative of realistic conditions.

The results of the dispersion modelling indicate that when negative pressure is maintained, predicted odour concentrations reaching the defined sensitive receptors will be undetectable to the majority of the population. If negative pressure is lost and a flow rate of 0.6 m/s is achieved, predicted odour concentrations at 7 out of 14 sensitive receptors should be undetectable. Predicted odour concentrations at some sensitive receptors north of the WtE plant site may experience odour concentrations of up to 5.6 OU. If worst case conditions prevailed resulting in a flow rate of 1.2 m/s during a loss of negative pressure, predicted odour concentrations at 2 out of 14 sensitive receptors should be undetectable. Predicted odour concentrations at some sensitive receptors may experience odour concentrations of up to 11.1 OU.

Noise

Operational noise modelling was undertaken to predict the potential noise impact due to the operation of the Project. Based on the point receiver noise levels along the site boundary, the Project is not anticipated to exceed the boundary noise limit. The highest value was 64.2 dBA on the southern boundary, which is significantly below the limit of 70 dBA.

A cumulative assessment was conducted at nearby sensitive receptors. Results showed that the predicted impacts due to the operation of the plant for both daytime and night time periods are negligible (based on IEMA and IoA noise impact assessment criteria), with cumulative noise impact levels of 56.6 dBA at day time and 49.8 dBA during night-time.

Waste Management

The benefits of the operation of the Project with respect to waste include the reduction of waste disposed to landfills. The WtE plant can utilise typical municipal solid waste (MSW), refuse-derived fuel (RDF) from a materials recovery facility as well as commercial and industrial (C&I) wastes that may otherwise be disposed of in a landfill.

Operational waste generated by the Project (i.e. bottom ash and flue gas treatment residue) will form additional loads to the existing waste infrastructure and utilities; however, the reduction of MSW, RDF and C&I wastes also reduce the load on landfill facilities in the Dubai Emirate.

Impacts of operational wastes, if not properly managed, may lead to soil and groundwater contamination, dispersion of waste in and around the project site, odour from putrescible waste storage tanks, hazards to fauna and to health and safety of workers.

Socio-Economy

The Project is anticipated to provide long-term employment opportunities to local Emiratis and migrant workers and reduce Dubai’s reliance on imported energy supply; therefore providing a very high significant economic benefit for the UAE nations and local economy.

Health and Safety

Workers, the community and surrounding land users may be exposed to health and safety risks if the project is not properly operated. Health and safety risks associated with the Project operation include exposure to air emissions, noise, heat, electrical hazards, among others.

The majority of the predicted incremental GLCs for the pollutants assessed are below the adopted assessment criteria, based on the stack characteristics and emission rates assumed for the Project. Therefore, these modelled air concentration should not result in an adverse effect to human health for the sensitive receptors via the inhalation exposure pathway.

Table 9-2 Key considerations – operation phase

Key considerations	Enhancement / Mitigation Measures	Monitoring Methodology
Air emission	• Use of flue gas treatment (FGT) system, which include particle separation, dry flue gas cleaning and selective non-catalytic reduction (SNCR) to control emission of air pollutants and comply with IED/2010/75/EU • Transport equipment and vehicles operated and maintained to manufacturer's specifications	• Continuous stack monitoring using CEMS of H_2O, O_2, HCl, SO_2, NOx, CO, NH_3, TOC and dust • Quarterly monitoring of HF, dioxins & furans heavy metals, PM_{10} and $PM_{2.5}$ • Fixed and continuous dust monitoring (PM_{10} and $PM_{2.5}$) at one location
Increased noise levels	Implement the following engineering measures: • Provide built-in insulation walls • Locate buildings close to the Project's boundary to provide shielding • Enclose plant / equipment considered causing major source of noise • Select quiet equipment	• Fixed and continuous noise monitoring stations at four locations
Waste management	• Mange waste deliverables and unloading areas • Maintenance of waste bunkers and receiving areas • Establish a comprehensive waste management system • Provide suitable waste storage facilities • Train workers on the waste management requirements	• Daily visual inspection of waste storage facilities • Maintain waste registers • Odour monitoring for H_2S, NH_3, mercaptans, dimethyl sulphide and dimethyl disulphide at two locations
Socio-economic benefits	• Priority given to local workforce and local companies • Just and fair compensation to workers in line with UAE Labour law • Regular monitoring to ensure that rights of workers are protected	• Labour monitoring • Review of employer's systems (i.e. timekeeping and payment)
Health and safety risks	• Develop and implement occupational health and safety plan • Develop and implement community health, safety and security plan	• Daily occupational health and safety inspections • Annual health and safety audits (internal)

Key considerations	Enhancement / Mitigation Measures	Monitoring Methodology
	• Implement environmental management measures (i.e. air pollution control, noise control, traffic control, waste management)	• Implement environmental monitoring programs

10. Statement of Commitment

The Project Company[29] are committed to undertake the following:

1. Comply with "Federal Law No. 24 of 1999 for the Protection and Development of the Environment" and its Implementing Rules and Regulations.
2. Adhere to all permitting regulations and procedures required by the Dubai Municipality noting that the EC is not substitute for other regulatory permits. The issuance of EC does not exempt the Project Developer and Operator from securing other government approvals, and preclude other agencies/departments from enforcing their rules and regulations. Necessary permits will be obtained from the Public Health and Safety Department with regard to the occupational health and safety of the workers.
3. Prior to the commencement of the Project's operations another round of baseline sampling covering the relevant environmental parameters for air, noise, groundwater and soil shall be executed. The Environmental Baseline Study (EBS) report will be submitted to DM-EPSS 30 days prior to start of operations. This sampling will assist to further develop the existing baseline data pre-operation.
4. Seek approval from the DM-EPSS for any modifications on the Project, which may include, but not limited to, increase in capacity, change in technology (i.e. incinerator and pollution control design), and change in stack specifications.
5. Adhere to environmental monitoring program presented in Section 8.6 of this EIA Report.
6. Submit an Environmental Performance Report (EPR) to the Environmental Control Section (ECS) during operation on a quarterly basis. It will include sampling and laboratory analysis of HF, dioxin and furans, heavy metals, PM_{10} and $PM_{2.5}$, in accordance with the European Regulations/Industrial Emission Directive (IED 2010/75/EU) as set out in Section 8.6.2 (Table 8-3). Groundwater Monitoring Report of quarterly groundwater sampling shall also be submitted as part of the EPR.
7. Comply with European Regulations/Industrial Emission Directive (IED 2010/75/EU) for air emissions limits including technical provisions and exceedance allowances as specified in IED for waste incineration plants.
8. Comply with Dutch Guidelines (2000) as per Section 3.5.5 for groundwater quality; subject to investigation to determine if Project Company is responsible for contamination.
9. The Project Company will be held liable to immediately implement appropriate measures/corrective actions, settle environmental disputes, and bear all responsibilities and cost of any environmental pollution/damages caused by Project Company during the Project's operation. The Project Company will also accept a penalties as per published environmental laws and legislations in the UAE and the Emirate of Dubai.

[29] Represented by Hitachi Zosen Innova (HZI), N.V. Besix SA (BESIX) and Itochu

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