5a. WATER QUALITY IMPACT (TTAL SITE)

5a.1 Introduction

5a.1.1.1 This section presents an assessment of the potential water quality impacts associated with construction and operation of the IWMF at the TTAL site. Recommendations for mitigation measures have been provided, where necessary, to minimise the identified water quality impacts to an acceptable level.

5a.2 Environmental Legislation, Standards and Guidelines

5a.2.1 Environmental Impact Assessment Ordinance (EIAO)

5a.2.1.1 The Technical Memorandum on Environmental Impact Assessment Process (EIAO-TM) is issued by the EPD under Section 16 of the EIAO. It specifies the assessment method and criteria that need to be followed in EIA. Reference sections in EIAO-TM have provided the details of assessment criteria and guidelines that are relevant to the water quality impact assessment, including:

- Annex 6 Criteria for Evaluating Water Pollution
- Annex 14 Guidelines for Assessment of Water Pollution

5a.2.2 Water Pollution Control Ordinance (WPCO)

5a.2.2.1 The Water Pollution Control Ordinance (WPCO) provides the major statutory framework for the protection and control of water quality in Hong Kong. According to the WPCO and its subsidiary legislation, Hong Kong waters are divided into ten Water Control Zones (WCZ). Corresponding statements of Water Quality Objectives (WQO) are stipulated for different water regimes (marine waters, inland waters, bathing beaches subzones, secondary contact recreation subzones and fish culture subzones) in the WCZ based on their beneficial uses. With reference to the EIA Study Brief, the Study Area for this water quality assessment covers Deep Bay WCZ and North Western Water Control Zone (refer to **Figure 5a.1**). Their corresponding WQOs are listed in **Table 5a.1** and **Table 5a.2**.

Table 5a.1 Summary of Water Quality Objectives for Deep Bay WCZ

Parameters	Objectives	Sub-Zone
Offensive Odour, Tints	Not to be present	Whole zone
Visible foam, oil scum, litter	Not to be present	Whole zone
Dissolved Oxygen (DO) within 2 m of the seabed	Not less than 2.0 mg/L for 90% of samples	Outer Marine Subzone excepting Mariculture Subzone
Dissolved Oxygen (DO) within 1 m below surface	Not less than 4.0 mg/L for 90% of samples	Inner Marine Subzone excepting Mariculture Subzone
	Not less than 5.0 mg/L for 90% of samples	Mariculture Subzone
Depth-averaged DO	Not less than 4.0 mg/L for 90% of samples	Outer Marine Subzone excepting Mariculture Subzone
	Not less than 4.0 mg/L	Yuen Long & Kam Tin (Upper and Lower) Subzones, Beas Subzone, Indus Subzone, Ganges Subzone, Water Gathering Ground Subzones and other inland waters of the Zone

Parameters	Objectives	Sub-Zone
5-Day Biochemical Oxygen Demand (BOD_5)	Not to exceed 3 mg/L	Yuen Long & Kam Tin (Upper) Subzone, Beas Subzone, Indus Subzone, Ganges Subzone and Water Gathering Ground Subzones
	Not to exceed 5 mg/L	Yuen Long & Kam Tin (Lower) Subzone and other inland waters
Chemical Oxygen Demand (COD)	Not to exceed 15 mg/L	Yuen Long & Kam Tin (Upper) Subzone, Beas Subzone, Indus Subzone, Ganges Subzone and Water Gathering Ground
	Not to exceed 30 mg/L	Yuen Long & Kam Tin (Lower) Subzone and other inland waters
pH	To be in the range of 6.5 - 8.5, change due to waste discharges not to exceed 0.2	Marine waters excepting Yung Long Bathing Beach Subzone
	To be in the range of 6.5 – 8.5	Yuen Long & Kam Tin (Upper and Lower) Subzones, Beas Subzone, Indus Subzone, Ganges Subzone and Water Gathering Ground Subzones
	To be in the range of 6.0 –9.0	Other inland waters
	To be in the range of 6.0 – 9.0 for 95% samples, change due to waste discharges not to exceed 0.5	Yung Long Bathing Beach Subzone
Salinity	Change due to waste discharges not to exceed 10% of ambient	Whole zone
Temperature	Change due to waste discharges not to exceed 2 ^{o}C	Whole zone
Suspended solids (SS)	Not to raise the ambient level by 30% caused by waste discharges and shall not affect aquatic communities	Marine waters
	Not to cause the annual median to exceed 20 mg/L	Yuen Long & Kam Tin (Upper and Lower) Subzones, Beas Subzone, Ganges Subzone, Indus Subzone, Water Gathering Ground Subzones and other inland waters
Unionized Ammonia (UIA)	Annual mean not to exceed 0.021 mg/L as unionized form	Whole zone
Nutrients	Shall not cause excessive algal growth	Marine waters
Total Inorganic Nitrogen (TIN)	Annual mean depth-averaged inorganic nitrogen not to exceed 0.7 mg/L	Inner Marine Subzone
	Annual mean depth-averaged inorganic nitrogen not to exceed 0.5 mg/L	Outer Marine Subzone
Bacteria	Not exceed 610 per 100ml, calculated as the geometric mean of all samples collected in one calendar year	Secondary Contact Recreation Subzones and Mariculture Subzones
	Should be zero per 100 ml, calculated as the running median of the most recent 5 consecutive samples taken between 7 and 21 days.	Yuen Long & Kam Tin (Upper) Subzone, Beas Subzone, Indus Subzone, Ganges Subzone and Water Gathering Ground Subzones
	Not exceed 180 per 100ml, calculated as the geometric mean of the collected from March to October inclusive in one calendar year. Samples should be taken at least 3 times in a calendar month at intervals of between 3 and 14 days.	Yung Long Bathing Beach Subzone

Parameters	Objectives	Sub-Zone
	Not exceed 1000 per 100ml, calculated as the running median of the most recent 5 consecutive samples taken at intervals of between 7 and 21 days	Yuen Long & Kam Tin (Lower) Subzone and other inland waters
Colour	Not to exceed 30 Hazen units	Yuen Long & Kam Tin (Upper) Subzone, Beas Subzone, Indus Subzone, Ganges Subzone and Water Gathering Ground Subzones
	Not to exceed 50 Hazen units	Yuen Long & Kam Tin (Lower) Subzone and other inland waters
Turbidity	Shall not reduce light transmission substantially from the normal level	Yuen Long Bathing Beach Subzone
Phenol	Quantities shall not be sufficient to produce a specific odour or more than 0.05 mg/L as C_6H_5OH	Yuen Long Bathing Beach Subzone
Toxins	Should not cause a risk to any beneficial uses of the aquatic environment	Whole Zone
	Should not attain such levels as to produce toxic carcinogenic, mutagenic or teratogenic effects in humans, fish or any other aquatic organisms.	Whole Zone

Source: Statement of Water Quality Objectives (Deep Bay Water Control Zone)

Table 5a.2 Summary of Water Quality Objectives for North Western WCZ

Parameters	Objectives	Sub-Zone
Offensive Odour, Tints	Not to be present	Whole zone
Visible foam, oil scum, litter	Not to be present	Whole zone
Dissolved Oxygen (DO) within 2 m of the seabed	Not less than 2.0 mg/L for 90% of samples	Marine waters
Depth-averaged DO	Not less than 4.0 mg/L	Tuen Mun (A), Tuen Mun (B) and Tuen Mun (C) Subzones, Water Gathering Ground Subzones and other inland waters
	Not less than 4.0 mg/L for 90 % sample	Marine waters
pH	To be in the range of 6.5 - 8.5, change due to human activity not to exceed 0.2	Marine waters excepting Bathing Beach Subzones
	To be in the range of 6.5 – 8.5	Tuen Mun (A), Tuen Mun (B) and Tuen Mun (C) Subzones and Water Gathering Ground Subzones
	To be in the range of 6.0 –9.0	Other inland waters
	To be in the range of 6.0 –9.0 for 95% samples	Bathing Beach Subzones
Salinity	Change due to human activity not to exceed 10% of ambient	Whole zone
Temperature	Change due to human activity not to exceed 2 ^{o}C	Whole zone
Suspended solids (SS)	Not to raise the ambient level by 30% caused by human activity	Marine waters
	Not to cause the annual median to exceed 20 mg/L	Tuen Mun (A), Tuen Mun (B) and Tuen Mun (C) Subzones and Water Gathering Ground Subzones
	Not to cause the annual median to exceed 25 mg/L	Inland waters

Parameters	Objectives	Sub-Zone
Unionized Ammonia (UIA)	Annual mean not to exceed 0.021 mg/L as unionized form	Whole zone
Nutrients	Shall not cause excessive algal growth	Marine waters
Total Inorganic Nitrogen (TIN)	Annual mean depth-averaged inorganic nitrogen not to exceed 0.3 mg/L	Castle Peak Bay Subzone
	Annual mean depth-averaged inorganic nitrogen not to exceed 0.5 mg/L	Marine waters excepting Castle Peak Bay Subzone
Bacteria	Not exceed 610 per 100ml, calculated as the geometric mean of all samples collected in one calendar year	Secondary Contact Recreation Subzones
	Should be less than 1 per 100 ml, calculated as the running median of the most recent 5 consecutive samples taken between 7 and 21 days.	Tuen Mun (A) and Tuen Mun (B) Subzones and Water Gathering Ground Subzones
	Not exceed 1000 per 100 ml, calculated as the running median of the most recent 5 consecutive samples taken between 7 and 21 days	Tuen Mun (C) Subzone and other inland waters
	Not exceed 180 per 100 ml, calculated as the geometric mean of all samples collected from March to October inclusive. Samples should be taken at least 3 times in one calendar month at intervals of between 3 and 14 days.	Bathing Beach Subzones
Colour	Not to exceed 30 Hazen units	Tuen Mun (A) and Tuen Mun (B) Subzones and Water Gathering Ground Subzones
	Not to exceed 50 Hazen units	Tuen Mun (C) Subzone and other inland waters
5-Day Biochemical Oxygen Demand (BOD_5)	Not to exceed 3 mg/L	Tuen Mun (A), Tuen Mun (B) and Tuen Mun (C) Subzones and Water Gathering Ground Subzones
	Not to exceed 5 mg/L	Inland waters
Chemical Oxygen Demand (COD)	Not to exceed 15 mg/L	Tuen Mun (A), Tuen Mun (B) and Tuen Mun (C) Subzones and Water Gathering Ground Subzones
	Not to exceed 30 mg/L	Inland waters
Toxins	Should not cause a risk to any beneficial uses of the aquatic environment	Whole zone
	Waste discharge shall not cause the toxins in water significant to produce toxic carcinogenic, mutagenic or teratogenic effects in humans, fish or any other aquatic organisms.	Whole zone
Phenol	Quantities shall not sufficient to produce a specific odour or more than 0.05 mg/L as C_6H_5OH	Bathing Beach Subzones
Turbidity	Shall not reduce light transmission substantially from the normal level	Bathing Beach Subzones

Source: Statement of Water Quality Objectives (North Western Water Control Zone)

5a.2.3 Technical Memorandum on Effluents Discharge Standard

5a.2.3.1 Discharges of effluents are subject to control under the WPCO. The Technical Memorandum on Standards for Effluents Discharged into Drainage and Sewerage Systems, Inland and Coastal Waters (TM-DSS), issued under Section 21 of the WPCO, gives guidance on permissible effluent discharges based on the type of receiving waters (foul sewers, storm water drains, inland and coastal waters). The limits control the physical, chemical and microbial quality of effluent. Any sewage from the proposed construction and operation activities must comply with the standards for effluent discharged into the foul sewers, inshore waters and marine waters of the Deep Bay WCZ provided in the TM-DSS.

5a.2.4 Practice Notes

5a.2.4.1 A practice note (PN) for professional persons was issued by the EPD to provide environmental guidelines for handling and disposal of construction site discharges. The ProPECC PN 1/94 "Construction Site Drainage" provides good practice guidelines for dealing with various types of discharge from a construction site. These include surface runoff, groundwater, boring and drilling water, bentonite slurry, water for testing and sterilisation of water retaining structures and water pipes, wastewater from building construction, acid cleaning, etching and pickling wastewater, and wastewater from site facilities. Practices outlined in the ProPECC PN 1/94 should be followed as far as possible during construction to minimize the water quality impact due to construction site drainage.

5a.3 Description of the Environment

5a.3.1 Inland Waters

5a.3.1.1 The construction of the IWMF has the potential to affect the inland watercourse of Tsang Kok stream within the Deep Bay WCZ. There is one EPD routine water quality monitoring station (DB8) along the Tsang Kok Stream. A summary of the monitoring data in 2008, which is the most recent monitoring data published on the EPD website at the moment of preparing this Report, is presented in **Table 5a.3**.

Table 5a.3 Summary of Inland Water Quality for Tsang Kok Stream in 2008

Parameter	Unit	DB8
Dissolved oxygen	mg/L	9.6 (7.6 – 11.4)
pH		8.2 (7.8 – 9.0)
Suspended solids	mg/L	4 (<1 – 45)
5-day Biochemical Oxygen Demand	mg/L	<1 (<1 – 2)
Chemical Oxygen Demand	mg/L	4 (<2 – 8)
Oil & grease	mg/L	<0.5 (<0.5 – <0.5)
Faecal coliforms	cfu/100mL	1200 (190 – 8700)
E.*coli*	cfu/100mL	61 (8 – 1500)
Ammonia-nitrogen	mg/L	0.03 (0.01 – 0.22)
Nitrate-nitrogen	mg/L	0.76 (025 – 2.90)
Total Kjeldahl Nitrogen	mg/L	0.17 (0.05 – 0.44)
Ortho-phosphate	mg/L	<0.01 (<0.01 – 0.01)
Total phosphorus	mg/L	<0.02 (<0.02 – 0.03)

Parameter	Unit	DB8
Total sulphide	mg/L	<0.02 (<0.02 – <0.02)
Aluminium	µg/L	95 (<50 – 210)
Cadmium	µg/L	<0.1 (<0.1 – <0.1)
Chromium	µg/L	<1 (<1 – <1)
Copper	µg/L	1 (<1 – 2)
Lead	µg/L	2 (<1 – 12)
Zinc	µg/L	10 (<10 – 20)

Notes:
1. Data source: River Water Quality in Hong Kong in 2008.
2. Data presented are in annual medians of monthly samples, except those for faecal coliforms and *E.coli* which are in annual geometric means. Figures in brackets are annual ranges.
3. Figures in brackets are annual ranges.

5a.3.1.2 River water quality monitoring data at DB8 in 2008 showed the overall compliance of the Tsang Kok stream. Full compliance with WQOs were achieved for pH, suspended solids (SS), dissolved oxygen (DO), COD and BOD_5. The water quality of this minor stream was reported to be excellent and free from point source pollution.

5a.3.2 Marine Water

5a.3.2.1 The EPD water quality monitoring station DM4 and DM5 in the Outer Deep Bay WCZ are the nearest monitoring stations in the vicinity of the Project area (see **Figure 5a.1**). Monitoring data collected at the Outer Deep Bay in 2008 is extracted from the EPD's publication "2008 Marine Water quality in Hong Kong", which is the latest information published on the EPD website at the moment of preparing this Report. A summary of the monitoring data (in 2008) for these stations are presented in **Table 5a.4**.

Table 5a.4 Summary of Marine Water Quality in Outer Deep Bay in 2008

Parameter		Outer Deep Bay		WPCO WQOs (in marine waters)
		DM4	DM5	
Temperature (^oC)		24.1 (15.9 – 29.5)	23.9 (15.8 – 28.9)	Not more than 2 ^oC in daily temperature range
Salinity		22.5 (11.4 – 30.0)	25.6 (14.5 – 31.8)	Not to cause more than 10% change
Dissolved Oxygen (DO) (mg/L)	Depth average	6.3 (3.3 – 9.4)	6.2 (4.1 – 8.1)	Not less than 4 mg/L for 90% of the samples
	Bottom	6.1 (3.1 – 10.9)	6.0 (3.5 – 8.0)	Not less than 2 mg/L for 90% of the samples
Dissolved Oxygen (DO) (% Saturation)	Depth average	85 (48 – 124)	85 (60 – 108)	Not available
	Bottom	82 (46 – 142)	82 (50 – 105)	Not available
pH		7.8 (6.8 – 8.3)	7.8 (7.0 – 8.5)	6.5 - 8.5 (± 0.2 from natural range)
Secchi disc Depth (m)		0.8 (0.1 – 1.4)	1.1 (0.5 – 1.8)	Not available
Turbidity (NTU)		16.9 (11.3 – 24.3)	13.4 (11.0 – 15.8)	Not available
Suspended Solids (mg/L)		11.6 (5.0 – 20.5)	7.0 (3.8 – 14.6)	Not more than 30% increase
5-day Biochemical Oxygen Demand (BOD_5) (mg/L)		0.9 (0.5 – 2.2)	0.7 (0.2 – 2.2)	Not available

Parameter	Outer Deep Bay		WPCO WQOs (in marine waters)
	DM4	DM5	
Ammonia Nitrogen (NH_3-N) (mg/L)	0.46 (0.16 – 1.51)	0.24 (0.10 – 0.48)	Not available
Unionised Ammonia (UIA) (mg/L)	0.014 (0.002 – 0.038)	0.007 (0.001 – 0.013)	Not more than 0.021 mg/L
Nitrite Nitrogen (NO_2-N) (mg/L)	0.156 (0.069 – 0.285)	0.104 (0.052 – 0.197)	Not available
Nitrate Nitrogen (NO_3-N) (mg/L)	0.633 (0.205 – 1.050)	0.493 (0.123 – 1.000)	Not available
Total Inorganic Nitrogen (TIN) (mg/L)	1.25 (0.47 – 2.85)	0.83 (0.30 – 1.65)	Not more than 0.5 mg/L
Total Kjeldahl Nitrogen (TKN) (mg/L)	0.72 (0.43 – 1.85)	0.44 (0.30 – 0.64)	Not available
Total Nitrogen (TN) (mg/L)	1.51 (0.70 – 3.19)	1.04 (0.48 – 1.82)	Not available
Orthophosphate Phosphorus (Ortho P) (mg/L)	0.058 (0.022 – 0.128)	0.035 (0.014 – 0.052)	Not available
Total Phosphorus (TP) (mg/L)	0.09 (0.07 – 0.16)	0.06 (0.04 – 0.09)	Not available
Silica (as SiO_2) (mg/L)	3.1 (0.7 – 6.6)	2.5 (0.7 – 5.6)	Not available
Chlorophyll-*a* (µg/L)	7.0 (0.7 – 40.0)	5.2 (0.5 – 35.7)	Not available
E. coli (cfu/100 mL)	330 (64 – 1200)	270 (66 – 780)	Not available
Faecal Coliforms (cfu/100 mL)	620 (96 – 2100)	620 (170 – 1400)	Not available

Note:
1. Data source: 2008 Marine Water Quality in Hong Kong
2. Except as specified, data presented are depth-averaged values calculated by taking the means of three depths: Surface, mid-depth, bottom.
3. Data presented are annual arithmetic means of depth-averaged results except for *E.coli* and faecal coliforms that are annual geometric means.
4. Data in brackets indicate the ranges.

5a.3.2.2 According to the “2008 Marine Water Quality in Hong Kong”, full compliance with WQO for bottom DO, depth-average DO and unionised ammonia were achieved at the two monitoring stations. Non-compliance was recorded with the WQO for total inorganic nitrogen which was reported to be the result of a persistent nutrient pollution problem.

5a.4 Water Sensitive Receivers

5a.4.1.1 Two moderate sized streams are located at the southern part of the Ash Lagoon and discharge into a tidal channel to the east of the ash lagoon area (refer to **Figure 5a.1**). The lower reaches of stream W1 are routed through a man-made, tidally influenced channel to the south of the ash lagoons. Although the substrate of this channel is natural, the banks have been lined with geo-textile matting. The second stream (stream W2) drains into the tidal channel from the southeast. The section of stream flowing through the existing WENT Landfill site has been wholly channelized with concrete.

5a.4.1.2 Marine water sensitive receivers also include a cooling water intake of the Black Point Power Station, secondary contact recreation subzone at Black Point, as well as the coastal waters of Deep Bay. Locations of water quality sensitive receivers are shown in **Figure 5a.1.**

5a.4.1.3 Details of the ecological resources identified within the Study Area are provided in **Section 7a**.

5a.5 Assessment Methodology

5a.5.1.1 The Assessment Area as specified in the EIA Study Brief covers an area within 300m of the Project site boundary, and all relevant water sensitive receivers, nearby watercourses and the associated water systems in the Deep Bay and North Western WCZ.

5a.5.1.2 The water sensitive receivers that may be affected by various construction activities for the IWMF were identified. Potential sources of water quality impact that may arise during the construction and operation phase of the Project were described. All the identified sources of potential water quality impact were then evaluated and their impact significance determined. The need for mitigation measures to reduce any identified adverse impacts on water quality to acceptable levels was determined.

5a.6 Identification of Environmental Impacts

5a.6.1 Construction Phase

5a.6.1.1 The major construction works of the Project would be site formation, construction of facilities and construction of the access road. Potential water quality impact during construction phase of the IWMF would be occurred from:

- Drainage and construction site runoff during site formation and foundation piling;
- General construction activities;
- Accidental spillage and accumulation of solid wastes;
- Sewage effluent produced by on-site workforce;
- Release of pulverized fuel ash leachate from ash lagoon into the aquatic environment.

<u>Drainage and Construction Site Runoff</u>

5a.6.1.2 Runoff from the construction works area may contain increased loads of sediments, other suspended solids and contaminants. Potential sources of pollution from site drainage include:

- Runoff and erosion from exposed soil surfaces, earth working areas and stockpiles;
- Release of grounting and cement materials with rain wash;
- Wash water from dust suppression sprays; and
- Fuel and lubricants from maintenance of construction vehicles and mechanical equipment.

5a.6.1.3 Sediment laden runoff during site formation works, if uncontrolled, may carry pollutants (adsorbed onto the particle surfaces) into the nearby stream and coastal waters.

<u>General Construction Activities</u>

5a.6.1.4 Land-based construction works may have the potential to cause water pollution. Various types of construction activities would generate wastewater. These include general cleaning and polishing, wheel washing, dust suppression and utility installation. These types of wastewater would contain high concentration of suspended solids. Wastewater would also be generated from the accumulation of solid waste such as debris, rubbish, plastic package and construction materials. If uncontrolled, these would lead to deterioration in water quality.

Accidental Spillage

5a.6.1.5 Variety of chemicals would be used for carrying out construction activities. These chemicals may include petroleum products, spent lubrication oil, grease, mineral oil, solvent and other chemicals. Accidental spillages of chemicals in the works area may contaminate the surface soils. The contaminated soil particles may be washed away by construction site runoff causing water pollution.

Sewage Effluent

5a.6.1.6 Domestic sewage would be generated from the workforce during the construction phase. However, this sewage can be adequately treated by interim sewage treatment facilities, such as portable chemical toilets, which can be installed within the construction site.

Release of PFA Leachate from Ash Lagoon into the Aquatic Environment

5a.6.1.7 The IWMF will be located in the middle part of the existing ash lagoon area. The ash lagoons were constructed in the mid- to late 1980's and were divided by bunds into the East, Middle and West Lagoons. Since 1989, the lagoons have been used for the storage of PFA, a by-product of the coal-burning. PFA is a fine, grey powder formed from the rock particles contained within coal, consisting mainly of silica, alumina and iron oxide.

5a.6.1.8 In 1997, China Light and Power (CLP) began to use the Middle Lagoon as part of its water collection and conservation system. The ash lagoon area is underlain by marine deposits which consist of fine grained material. Alluvium is present underneath the marine deposits. Depths of alluvium may vary from approximately 4.0 to 19.0m. The layer of alluvium is underlain by completely decomposed granite (CDG) with depths ranging from approximately 3.5 to 15.2m [(1)]. There is liner, which was constructed of cementitious materials, at the bottom of the ash lagoons.

5a.6.1.9 The marine deposits in the sea wall location have been removed prior to the sea wall construction. In order to prevent leakage of PFA leachate through the sea wall to Deep B[a]y, filter layers are laid underneath the amour stone on the inner face of the sea wall. On the seaward side of the outer sea wall, armour stone and wave wall are provided to resist the storm effects.

5a.6.1.10 During construction phase of the Project, piling would be applied for foundation construction. The piles would penetrate through the base of the Middle Lagoon to the hard granite bedrock to support the facility and the soil layer underneath the lagoon would be disturbed. However, the piling activities are unlikely to cause significant changes in geological structure of the lagoon site. The present of piles would restrict the movement of groundwater in the soil layer. The low permeability values of the marine deposits and alluvium underneath the PFA layer would limit the seepage of PFA leachate. Leakage of PFA leachate through the base of the Middle Lagoon to Deep Bay after the pile construction, if any, would not be much different from the existing condition.

5a.6.1.11 To evaluate the potential impacts of the PFA leachate to the nearby aquatic environment, the chemical characteristics of the PFA leachate and chemical toxicity data for aquatic life have been reviewed as detailed in **Section 5a.7**.

5a.6.2 Operation Phase

5a.6.2.1 Potential sources of water quality impacts generated from the operation of the Project include:

(1) Environmental Impact Key Issue Report on Tsang Tsui PFA Lagoon prepared by L. G. Mouchel and Partners (Asia) in association with others.

- Wastewater generated from the Waste Treatment Process;
- Sewage generated from floor & vehicle washing;
- Sewage generated from the IWMF staff & visitors; and
- Discharge of saline water from the proposed desalination plant.

Wastewater Generated from the Waste Treatment Process

5a.6.2.2 The IWMF will comprise a 3,000 tpd of moving grate incineration plant and a demonstration scale mechanical treatment plant of about 200 tpd capacity. Desalination plant may also be adopted as a water supply system in the IWMF. Wastewater will be generated from the mechanical treatment plant, the incineration plant and the desalination plant (if adopted) in the IWMF. No spent cooling water discharge is anticipated from the Project operation.

Mechanical Treatment Plant

5a.6.2.3 In the IWMF, "mechanical treatment + dewatering + post-composting" process is recommended for the mechanical treatment plant. A relatively small amount of wastewater will be generated from the mechanical treatment processes.

Incineration Plant

5a.6.2.4 Wastewater will also be generated from various processes throughout the incineration plant including:

5a.6.2.5 *Boiler* - The practice of continuously removing a small percentage of boiler feed water from the boiler to maintain boiler water chemistry is referred to as boiler blowdown. Although the boiler steam cycle is essentially a closed-loop system, impurities can build up in the boiler which, over time, cause scaling and corrosion of the boiler tubes. These effects eventually lead to boiler tube failure. To reduce such problems, continuous boiler blowdown is employed. The hot blowdown water is passed through a heat exchange to recover heat before becoming a source a plant wastewater. The blowdown water is replaced with contaminant-free feed water make-up.

5a.6.2.6 *Evaporative Quench Tower* - If the incineration plant adopts an evaporative quench tower, a fraction of the water from the cooling system loop is continuously blown down as in the boiler system. Since a considerable amount of the cooling water is lost through evaporation in the cooling tower, high concentrations of impurities would develop in the cooling water if blowdown was not used.

5a.6.2.7 *Boiler Feedwater Treatment System* - The purpose of the boiler feedwater treatment system is to provide demineralized water for boiler make-up. Demineralized water is needed in the boiler to prevent scaling and corrosion due to mineral deposits. The treatment system typically involves filtering the feed water to remove suspended solids, and removing metals and minerals in a de-mineralizer. The de-mineralizer contains cation and anion exchangers are periodically regenerated using sulfuric acid and caustic soda respectively. Oxygen is removed from the demineralized water using a deaerator. Processed demineralized water is then stored in tanks and drawn off as needed for boiler feeder water, cooling water and other processes. The operation of the various filters, ion exchangers and deaerators requires periodic back flushing of the system to remove the collected contaminants from the treatment system. This process wastewater is then stored in a neutralization tank where appropriate amounts of acid or caustic are add to adjust the pH.

5a.6.2.8 *MSW Bunker Leachate / Ash Leachate* - Includes free water that drains from the MSW or ash. This wastewater is typically collected using floor drains and stored in sumps.

5a.6.2.9 *Miscellaneous Blowdown Sources* - Other processes that use process water can be minor sources of process water blowdown, these may include water cooled feed chutes, water cooled bearings, cooling water jacketing etc.

<u>Sewage Generated from Floor & Vehicle Washing</u>

5a.6.2.10 Approximately 31m^3 of sewage would be generated daily during floor washing and vehicle washing in the IWMF. As the sewage would contain contaminants from MSW, treatment of the sewage will be required before disposal or reuse for other applications.

<u>Sewage Generated from the IWMF Staff & Visitors</u>

5a.6.2.11 The sewage generated from human activities in the IWMF would include the sewage from the IWMF staff and visitors, as well as the sewage generated from the canteen, and community facilities. It is estimated that approximate 96.25 m^3/d sewage would be generated from the IWMF staff and visitors and the associated activities, as shown in **Table 5a.4a**.

Table 5a.4a Estimated Amount of Sewage Generated from the IWMF Staff & Visitors and the Associated Activities

Items	No. of Employee or Visitor	Unit Flow Factor (1) (m^3/d/person)	Flow (m^3/d)
Staff and Visitors			
Staff of incineration plant, MT plant, canteen and community facilities	200	0.08	16.00
Visitors	450	0.06	27.00
Activities			
Staff canteen	25	1.50	37.50
Community facilities	20	0.35	7.00
		Sub-total	87.50
		10% Contingency	8.75
		Total	**96.25**

Note (1): The unit flow factors adopted to estimate the sewage flow generated from the staff and visitors in the IWMF are primarily based on the guidelines laid down in EPD's Guidelines for Estimating Sewage Flows for Sewage Infrastructure Planning Version 1.0 (GESF).

<u>Reuse and Treatment of Wastewater Generated from Waste Treatment Process and Sewage from Floor & Vehicle Washing and the IWMF Staff & Visitors</u>

5a.6.2.12 **Table 5a.5** shows the estimated quantity and possible characteristic of wastewater generated from treatment process and sewage from floor & vehicle washing and the IWMF staff & visitors.

Table 5a.5 Estimated Quantity and Possible Characteristics of Wastewater Generated from Treatment Process and Sewage from Floor & Vehicle Washing and the IWMF Staff & Visitors

		Flow (m^3/d)	pH	BOD (mg/L)	COD (mg/L)	SS (mg/L)	Temp. (℃)	Chloride (mg/L)
Incineration Plant	Miscellaneous Blowdown Sources	1	6-8	50	30	50	20	-
	Boiler Feedwater Treatment System (Demineralizer	30	9-11	-	-	20	20	3,000

		Flow (m^3/d)	**pH**	**BOD (mg/L)**	**COD (mg/L)**	**SS (mg/L)**	**Temp. (℃)**	**Chloride (mg/L)**
	Drain)							
	Pump Leak Water	10	6-8	-	-	50	20	50
	Boiler and Evaporative Quench Tower (Boiler Blow Drain)	80	10-12	-	-	50	50	50
Mechanical Treatment Plant Drain		5	6.5 - 9	6,000 – 8,500	20,000 - 25,000	9,000 - 10,000	-	-
Sewage from Floor and Vehicle Washing	Floor Washed Drain	1	7-9	50	30	500	20	100
	Vehicle Washed Drain	30	6-8	300	200	500	20	100
Sewage from the IWMF Staff & Visitors		97	6-8	250	520	250	20	-

5a.6.2.13 Generally, wastewater shown in **Table 5a.5** can be categorized into two types including high organic loading wastewater and low/nil organic loading wastewater. High organic loading wastewater such as sewage from floor & vehicle washing (about 31 m^3/d) and from the IWMF staff & visitors (about 97 m^3/d) will be treated by secondary wastewater treatment plant provided on-site to remove the organic pollutants for reuse on-site (see Section 5a.6.2.14 below). The bunker leachate / ash leachate from incineration plant (as described in Section 5a.6.2.8) would be highly polluted and would be conveyed to the incineration plant and co-incinerated with MSW and is therefore not included in **Table 5a.5**. On the other hand, low/nil organic loading wastewater coming from plant machinery such as demineralizer drain, contains only trace amount of or no organic pollutants. It only requires simple treatment such as sedimentation or neutralization or even not requires any treatment before being used for flue gas cooling in quench tower or ash quenching. As the TTAL site would be built within the sensitive area of Deep Bay WCZ, it is envisioned that the IWMF would be designed with a net zero discharge of process and sanitary wastewater.

5a.6.2.14 A wastewater treatment plant would be provided on-site to treat high organic loading wastewater generated from the IWMF (such as sewage from floor & vehicle washing and from the IWMF staff & visitors) for reuse in the incineration plant and mechanical treatment plant or for washdown and landscape irrigation in the IWMF site following the effluent qualities shown below. The following recommended effluent qualities for reuse purposes are based on the "*Guidelines for Water Reuse*" published by the USEPA.

- pH : 6 – 8
- BOD : 10 mg/L
- Turbidity : 2 NTU
- Total Coliform/100 mL : non-detectable
- Cl_2 residual : 1 mg/L

5a.6.2.15 Because of the compacted area in TTAL, membrane bioreactor (MBR), which requires small footprint, is proposed for the IWMF for mainly human sewage treatment. Based on the above effluent standards and wastewater characteristics and quantity shown in **Table 5a.5**, the wastewater treatment facilities enclosed by the reinforced concrete structure under the reception hall of the incineration plant would occupy an area of about 2,000m^2.

Desalination Plant

5a.6.2.16 If desalination plant is adopted as a water supply system in the IWMF, the brine water generated would be either discharged back to the sea where the seawater is collected for desalination or reused for ash quenching. The brine water drained from the desalination plant is concentrated seawater (about 1.7-1.8 time more concentrated than the raw seawater). The design flow of the desalination plant, if required will be about 1,520 m^3 per day. The potential water quality impacts due to the discharge of saline water have been assessed by mathematical modelling as described in **Section 5a.7**.

5a.7 Prediction and Evaluation of Environmental Impact

5a.7.1 Construction Phase

Drainage and Construction Site Runoff

5a.7.1.1 Runoff from the construction works area may contain increased loads of sediments, other suspended solids and contaminants. As a good site practice, mitigation measures should be implemented to control construction site runoff and drainage from the works areas, and to prevent runoff and drainage water with high levels of suspended solids from entering the nearby water bodies. With the implementation of adequate construction site drainage and provision of sediment removal facilities as described in **Section 5a.8.1.1**, it is anticipated that unacceptable water quality impacts would not arise. The construction site drainage would be collected by the temporary drainage system installed by the Contractor and then treated on-site before discharging into the sea via silt removal facilities. Water pumped out from foundation piling would also be discharged into the sea via silt removal facilities. The Contractor would be required to obtain a license from EPD for discharge to the coastal waters.

General Construction Activities

5a.7.1.2 Land-based construction activities may generate wastewater and cause water pollution. Their impacts are likely to be minimal, provided that good construction practices and proper site management would be observed. Effluent discharge from temporary site facilities should be controlled to prevent direct discharge to the neighbouring water environment. It is anticipated that water quality impacts caused by general construction activities would be insignificant with adequate implementation of recommended mitigation measures.

Accidental Spillage

5a.7.1.3 Site drainage should be well maintained and good construction practices should be observed to ensure that oil, fuels and solvents are managed, stored and handled properly and do not enter the nearby water streams. No adverse water quality impacts are expected with proper implementation of the recommended mitigation measures.

Sewage Effluent

5a.7.1.4 Domestic sewage would be generated from the workforce during the construction phase. However, this sewage can be adequately treated by interim sewage treatment facilities, such as portable chemical toilets, which can be installed within the construction site. It is unlikely that sewage generated from the site would have a significant water quality impact, provided that sewage is not discharged directly to the water environment, and chemical toilets are used and properly maintained.

Release of PFA Leachate from Ash Lagoon into the Aquatic Environment

5a.7.1.5 To evaluate the potential impacts of the PFA leachate to the nearby aquatic environment, the chemical characteristics of the PFA leachate and chemical toxicity data for aquatic life have been reviewed. The PFA leaching trial using seawater was conducted by Scott Wilson Kirkpatrick (1991) (2). The leaching trial result showed that the metals contents in the PFA varied with the type of coal and the length of PFA aging. Only low concentrations of potential contaminants were leached into seawater solution. The contaminants with the greatest tendency to leach into solution were found to be cadmium, chromium and aluminium. Fresh PFA tended to leach more metals compared to the lagooned PFA and was more variable among various coal types. Results from the lagooned PFA showed smaller variations and metal leaching was more consistent.

5a.7.1.6 **Table 5a.6** shows the concentrations of different parameters from the lagooned PFA leaching trials. The major heavy metals released from the lagooned PFA were aluminium and chromium, with maximum concentrations of 900 and 300 μg/l respectively. The maximum cadmium concentration measured in the leaching trials was 4 μg/l. There was an uncertainty of the actual concentration of copper and nickel released from lagooned because of the high reporting limits. The analytical instrument for the seawater solution in the leaching trials was only available to detect copper concentration higher than 75μg/l and nickel higher than 25μg/l.

Table 5a.6 Comparison of Leaching Trial Results with the Background Levels and USEPA Water Quality Standards

Parameter	Leaching Trial Results (μg/l)	Background Concentration (μg/l) Note 1	USEPA Water Quality Standard for Saltwater (μg/l)
Aluminium	900	132	n/a
Chromium	300	1.5	50 (210) Note 2
Cadmium	4	< 0.05	9.3
Copper	<75	< 5	2.9
Zinc	30	6	86
Nickel	<25	< 5	8.3
Iron	20	145	n/a
Lead	6	0.9	8.5
Manganese	3	17.5	n/a
Selenium	14	< 1	71
Arsenic	3	1.2	36

Notes:
1. The background concentrations were based on the results measured around Black Point and Tap Shek Kok abstracted from Scientific Series, Chemical Analysis Report 20/91.
2. The value of 50 μg/l represents the standard for Chromium (VI) in saltwater and there is no standard for Chromium (III) in saltwater. The criterion for Chromium (III) in freshwater is 210 μg/l.

5a.7.1.7 **Table 5a.6** also provided the concentration of trace metals measured around Black Point and Tap Shek Kok in 1991 as background concentration, as well as USEPA Water Quality Standards for Saltwater. Concentrations for aluminium, iron and manganese are not available in the USEPA standard. Comparison result of the leaching trial of these three parameters with the background concentration presented that both iron and manganese were below the background concentration, whiles aluminium concentration is about 7 times higher than background concentration. When diluted by the ambient

(2) Scott Wilson Kirkpatrick (1991). Privatisation of SENT Landfill – Results of PFA Leaching Trials.

seawater, the aluminium concentration would be indistinguishable from the background level within a short distance from the release point.

5a.7.1.8 To compare other parameters with the USEPA standard, the concentrations of all metals except chromium are below the USEPA standards. In the event that release of PFA leachate occurs, the potential water quality would be low. In fact, most of the ash would remain in the Middle Lagoon and there would be no off-site disposal of ash into the aquatic environment.

5a.7.1.9 A monitoring programme was conducted by CLP between 1987 and 1988 to monitor water quality at the location outside the Middle Lagoon. The monitoring result is shown in **Table 5a.7** indicating that there was no likely correlation between the trace metal results measured outside the Middle Lagoon and at oyster buoy and farm in Deep Bay. To compare these monitoring results with the background concentrations of trace metals measured around Black Point and Tap Shek Kok measured in 1991, no evidence shows that the operation of the Tsang Tsui Lagoons has caused adverse water quality impacts in the vicinity of the lagoon site.

Table 5a.7 Results of CLP monitoring programme between 1987 and 1988

Parameters	Monitored Average Concentrations (μg/l)		Background Concentration (μg/l)
	At Location Immediately Outside the Middle Lagoon (Sep 1988 – Jan 1989)	At Oyster Buoy and Farm in Deep Bay (Jun 1987 – Nov 1987)	
Cadmium	0.09	0.41	< 0.05
Copper	3.6	2.1	< 5
Lead	2.3	1	0.9
Zinc	7	23	6
Arsenic	< 5	5.1	1.2
Selenium	< 10	No data available	< 1

5a.7.1.10 Chemical toxicity data for aquatic life have been reviewed in order to evaluate the potential impacts of the PFA leachate. High concentrations of heavy metals can be detrimental to aquatic life. The effects of high concentration of metals may cause the changes in tissues, growth rates, blood chemistry, behaviour and reproduction of aquatic organisms. Fish can excrete excess heavy metals but bivalves cannot regulate excess heavy metals resulting in metal accumulation in the tissues.

5a.7.1.11 There are no relevant aquatic life criteria in Hong Kong. The USEPA Aquatic Life Criteria (estuarine/coastal), which provide a general guide to assess the potential risk to the environment in the presence of excess metal, is applied to compare with the leaching trial results (as shown in **Table 5a.8**). The parameters of aluminium, chromium, iron and manganese are not available in the USEPA estuarine/coastal Aquatic Life Criteria. Except the uncertainty due to the high reporting limits for copper and nickel, most of the listed heavy metal concentrations are lower than the criteria.

Table 5a.8 Comparison of the Leaching Trial Results with the USEPA Aquatic Life Criteria

Parameter	Leaching Trial Results (μg/l)	USEPA Aquatic Life Criteria (μg/l)
Aluminium	900	-
Chromium	300	-
Cadmium	4	8
Copper	<75	2.9
Zinc	30	76.6
Nickel	<25	7.1

Parameter	Leaching Trial Results (μg/l)	USEPA Aquatic Life Criteria (μg/l)
Iron	20	-
Lead	6	5.8
Manganese	3	-
Selenium	14	71
Arsenic	3	50

5a.7.1.12 The water quality guidelines for general saltwater aquaculture uses adopted in the New Zealand Guidelines for Fresh and Marine Water Quality (**Table 5a.9**) and the UK Water Quality Standards for the Protection of Saltwater Life (**Table 5a.10**) are also applied to compare with the leaching trial results. Concentrations of aluminium, chromium, copper, iron and selenium are higher than the New Zealand Guidelines, while concentrations of chromium, cadmium and copper are higher than the UK Standards.

5a.7.1.13 Dilution for these metals could lower the concentrations to meet the New Zealand Guidelines and the UK Standards. The estimated dilution rates are shown in **Table 5a.9** and **Table 5a.10**. In order to meet the New Zealand Guidelines, the highest dilution rate would be >90 for aluminium. Chromium and copper would require a dilution rate of >15 and iron and selenium require a dilution rate of >2. To meet the requirements of the UK Standards, the highest dilution rate is >20 for chromium, while required dilution rate for cadmium and copper are 1.6 and 20 respectively. The nearest oyster beds at Pak Nai are approximately 3 km away from the lagoons. The required dilutions are likely to be achieved for pollutants in the moving tidal current travelling for such a long distance. It is anticipated that the potential impacts to the nearby oyster beds would be insignificant.

Table 5a.9 Comparison of the Leaching Trial Results with the New Zealand Guidelines for Fresh and Marine Water Quality

Parameter	Leaching Trial Results (μg/l)	New Zealand Water Quality Guidelines for the Inorganic Chemicals (μg/l)	Required Dilution to Meet the Guidelines
Aluminium	900	< 10	> 90
Chromium	300	< 20	> 15
Cadmium	4	< 5	-
Copper	<75	< 5	> 15
Zinc	30	< 100	-
Nickel	<25	< 100	-
Iron	20	< 10	> 2
Lead	6	< 20	-
Manganese	3	< 100	-
Selenium	14	< 10	> 2
Arsenic	3	< 30	-

Source: Australian and New Zealand Guidelines to Fresh and Marine Water Quality – Volume 1 (July 1999)

Table 5a.10 Comparison of the Leaching Trial Results with the UK Water Quality Standards for the Protection of Saltwater Life

Parameter	Leaching Trial Results (μg/l)	UK Water Quality Standards (μg/l)	Required Dilution to Meet the Standards
Aluminium	900	-	-
Chromium	300	15	>20
Cadmium	4	2.5	>1.6
Copper	<75	5	>15
Zinc	30	40	-
Nickel	<25	30	-

Parameter	Leaching Trial Results (μg/l)	UK Water Quality Standards (μg/l)	Required Dilution to Meet the Standards
Iron	20	1000	-
Lead	6	25	-
Manganese	3	-	-
Selenium	14	-	-
Arsenic	3	25	-

5a.7.1.14 **Table 5a.11** lists the chemical toxicity data for aquatic life. LC_{50} (concentration at which 50% mortality occurs) of the heavy metals for the species that could be found in Deep Bay are present. Based on the available data of the LC_{50}, exposure of polychaete worm to aluminium of 405μg/L for 96 hours would cause 50% mortality. The maximum concentration of aluminium (900μg/L) detected in the leaching trials is higher than the reference concentration. A dilution rate of 3 times of the initial concentration would reduce the maximum concentration of aluminium to around 300μg/L. It is also observed that exposure of mytilus edulis to zinc of 10μg/L for 14 days would cause 50% mortality. A dilution rate of 3 times of the initial concentration of zinc (30μg/L) is required to reduce the maximum concentration to around 10μg/L. This low dilution rate is likely to be achieved in a moving water environment. The potential impact due to high concentration of aluminium would be insignificant. The concentrations of other parameters from the leaching trials are much lower than the corresponding LC_{50} concentrations.

5a.7.1.15 As the leakage through the base of the Middle Lagoon would not be significant, the PFA leachate in the Middle Lagoon is unlikely to cause unacceptable impact on the aquatic environment from an ecotoxicological point of view. The site conditions of Middle Lagoon during construction and operation phases would not be much different from the existing conditions. As most of the ash would remain in the Middle Lagoon and would not be disposed of into the aquatic environment, detailed ecotoxicological assessment and additional toxicity test are considered not necessary.

Table 5a.11 Chemical Toxicity Data for Aquatic Life

Parameter	Leaching Trial Results (µg/l)	Crassostrea gigas (Pacific Oyster)		Mytilus edulis (Common Bay Mussels)		Oryzias laptipes (Medala, high-eyes)		Scylla serrata (Green Crab)		Crangon crangon (Common Shrimps)		Artermia salina (Brine Shrimps)		Amphiphods		Polychaete Worm	
		LC_{50}	Conc. (µg/L)	LC_{50}	Conc. (µg/L)	LC_{50}	Conc. (µg/L)	LC_{50}	Conc. (µg/L)	LC_{50}	Conc. (µg/L)	LC_{50}	Conc. (µg/L)	LC_{50}	Conc. (µg/L)	LC_{50}	Conc. (µg/L)
Aluminium	900	48h	1000000	-	-	-	-	-	-	-	-	3d	3100	-	-	96h	405
Chromium	300	-	-	-	-	96h	120000	-	-	48h	100000	24h 48h	5300 3540	-	-	96h	1000
Cadmium	4	4h 96h	85 19500	96h	960	48h	560000	-	-	96h	460	24h 48h	3100 1540	4d	14.5	10d 28d	83 39
Copper	<75	14h 96h	100 560	10d	45	24h 48h	610 410	-	-	48h	10000	24h 48h	800 440	-	-	4d 28d	77 44
Zinc	30	4d	100	14d	10	24h	20000	-	-	48h	100000	24h 48h	4460 1700	-	-	28d	350
Nickel	<25	-	-	-	-	-	-	-	-	48h	100000	48h	162985	-	-	7d 10d	7700 16090
Iron	20	-	-	-	-	24h	18500	-	-	48h	33000	-	-	-	-	-	-
Lead	6	-	-	105h 150h	5000 500	24h 48h	350000 205000	-	-	96h	63000	24h 48h	10000 5010	-	-	96h 28d	7660 1430
Manganese	3	-	-	-	-	24h	1000000	-	-	48h	3300	-	-	-	-	-	-
Selenium	14	-	-	-	-	-	-	24h 72h	68000 33000	-	-	-	-	-	-	-	-
Arsenic	3	21d	10	-	-	-	-	-	-	96h 192h	96000 70000	24h	1.3 umol/L	-	-	96h	7400

Note:
The media type of the underlined data is freshwater and the media type is marine water for the other data.
Source of information: Ecotox Database System

5a.7.2 Operation Phase

Wastewater from Waste Treatment Process and Sewage from Floor & Vehicle Washing and IWMF Staff & Visitors

5a.7.2.1 As discussed in **Section 5a.6**, the IWMF facilities would be designed with a net zero discharge of process and sanitary wastewater. A wastewater treatment plant would be provided on-site to treat high organic loading wastewater such as sewage from floor & vehicle washing (about 31m^3/day) and from the IWMF staff & visitors (about 97 m^3/day) for reuse in the incineration plant and the mechanical treatment plant or for washdown and landscape irrigation. The total amount of sewage to be treated is about 128m^3/day. Therefore, the designed Average Dry Weather Flow (ADWF) of the on-site wastewater treatment plant is 128 m^3/day. The bunker leachate / ash leachate from incineration plant (as described in Section 5a.6.2.8) would be highly polluted and would be conveyed to the incineration plant and co-incinerated with MSW. All other wastewater (i.e. low/nil organic loading wastewater coming from plant machinery such as dimineralizer drain) only requires simple treatment such as sedimentation or neutralization or even not requires any treatment before being used for flue gas cooling in quench tower or ash quenching. **Table 5a.12** shows the amount of water required for landscape irrigation and floor/vehicle washing as well as the amount of treated effluent generated from the wastewater treatment plant. All the treated effluent from the secondary wastewater treatment plant and wastewater with simple treatment or without any treatment would be fully reused without being discharged to the sea nearby. Therefore, no adverse water quality impact would be expected.

Table 5a.12 Amount of Water Demand for Landscape Irrigation and Washing

Description	Amount
Water Required for Landscape Irrigation	340 m^3/d
Water Requried for Floor / Vehicle Washing	31 m^3/d
Total Daily Demand of Reclaimed Water	371 m^3/d
Amount of Treated Effluent	128 m^3/d(1)

Note:
(1) Amount of treated effluent = 31 m^3/d (floor and vehicle washing) + 97 m^3/d (staff and visitors)

Discharge of Saline Water from Desalination Plant

5a.7.2.2 Approximately 1,520 m^3/day of saline water would be generated from the proposed desalination plant and discharged to the sea. As the IWMF would be in 24-hour operation, continuous water supply will be required. Location of the discharge outfall is shown in **Figure 5a.2**. The peak saline water discharge rate is expected to be similar to the average discharge rate. The brine water drained from the desalination plant is just concentrated seawater (about 1.7 – 1.8 time more concentrated than the raw seawater) with a low discharge volume. There will be no temperature elevations in the brine water discharge as compared to the ambient water temperature. No biocides / anti-fouling chemicals (such as chlorine and C-treat-6) will be used for the proposed desalination plant. Instead, membrane would be backwashed frequently to prevent fouling problem.

5a.7.2.3 A comparison of the characteristics of the saline water discharge with the standards for effluents discharged into the inshore waters of Deep Bay Water Control Zone is given in **Table 5a.13** below.

Table 5a.13 Comparison of Saline Water Discharge from Desalination Plant with Effluent Discharge Standard

Parameter	Saline Water Note 1	Discharge Standard Note 2 & 3	Compliance with Discharge Standard
pH	6 – 8	6 – 9	Yes
Temperature (^{o}C)	16 – 29	45	Yes
Suspended solids (mg/L)	7 – 26	25	Yes
BOD (mg/L)	0.4 – 4	10	Yes
Total Residual Chorine (mg/L)	<1	<1	Yes

Notes:

1. It is calculated based on the assumption that the brine water produced is generally 1.7-1.8 times more concentrated than raw seawater for SS and BOD. There will be no temperature elevations in the saline water discharge as compared to the ambient water temperature. The characteristics of the baseline seawater quality are obtained from 2008 Marine Quality in Hong Kong published by EPD.
2. Discharge standard for flow rate of >1500 and ≤2000 m^3/day based on *Technical Memorandum – Standards for Effluents Discharged into Drainage and Sewerage Systems, Inland and Coastal Waters* (TM-DSS).
3. The effluent discharge standards do not specify a standard for salinity.

5a.7.2.4 The WQO stated that change of salinity due to human activity should not exceed 10% of ambient levels. Based on the assumption that the salinity in the effluent of the desalination plant will be raised 1.8 times of feedwater (ambient seawater), the required dilution to meet the WQO was calculated to be about 8 times. The near-field effluent dispersion model, namely the VISJET model, was used to simulate the impact of the saline water discharges. Key inputs to the near-field dispersion model including outfall configuration, ambient current speed, vertical density profile and effluent flow rate. The ambient current speed and vertical density profile were extracted from the far field hydrodynamic model output from the Delft3D Update Model developed under the EPD Study "*Agreement No. CE 42/97 Update on Cumulative Water Quality and Hydrological Effect of Coastal Developments and Upgrading of Assessment Tool*". A monitoring point was set up in the hydrodynamic model of the Update Model near the proposed Project effluent point at northern boundary of Tsang Tsui Ash Lagoon. The far field hydrodynamic model of the Update Model is 3 dimensional with a total of 10 vertical water layers.

5a.7.2.5 The density profiles at the monitoring point were extracted and analyzed on days of spring tide and neap tide in both dry and wet seasons. Stratifications of seawater were observed in both dry and wet seasons, where a higher degree of stratification was predicted during the wet seasons. Based on analysis of the ambient density data, two sets of vertical density profile were adopted in the near field modelling, including one set of density profile predicted in the dry season (with the lowest degree of stratification) and one set of density profile predicted in the wet season (with the highest degree of stratification). The current profile extracted at the same monitoring point was also analyzed and calculated as 10 and 90 percentile values (for dry and wet seasons). The near field impact was simulated for different combinations of vertical density profile and ambient current velocity using the design effluent flow rate (1,520m^3/day) to determine the minimum initial dilution rate. Details of the ambient density profile and current velocity profile are given in **Table 5a.14** and **Table 5a.15**. It is assumed that the desalination plant would discharge the brine water through a seawall discharge outfall at 0.5 m below the chart datum, which would be submerged under the water during low tides. Details of the near field modelling scenarios are given in **Table 5a.16**. The minimum initial dilution obtained from the VISJET modelling was used to assess the salinity impact upon the nearby water and ecological sensitive receivers including the gorgonians identified along the seawall (~10 m away from the proposed outfall). Details of the ecological resources identified within the Study Area are provided in Section 7a.

Table 5a.14 Density Profile at TTAL IWMF Desalination Plant Outfall

Depth from water surface (m)	Density (kg/m^3)	
	Dry Season (D)	Wet Season (W)
0.21	1.0102	0.9971
0.64	1.0106	0.9973
1.06	1.0111	0.9987
1.49	1.0111	1.0009
1.91	1.0115	1.0034
2.34	1.0117	1.0041
2.76	1.0118	1.0041
3.19	1.0119	1.0042
3.61	1.0119	1.0044
4.04	1.0119	1.0095
4.25	1.0119	1.0095

Table 5a.15 Current Velocity Profile at TTAL IWMF Desalination Plant Outfall

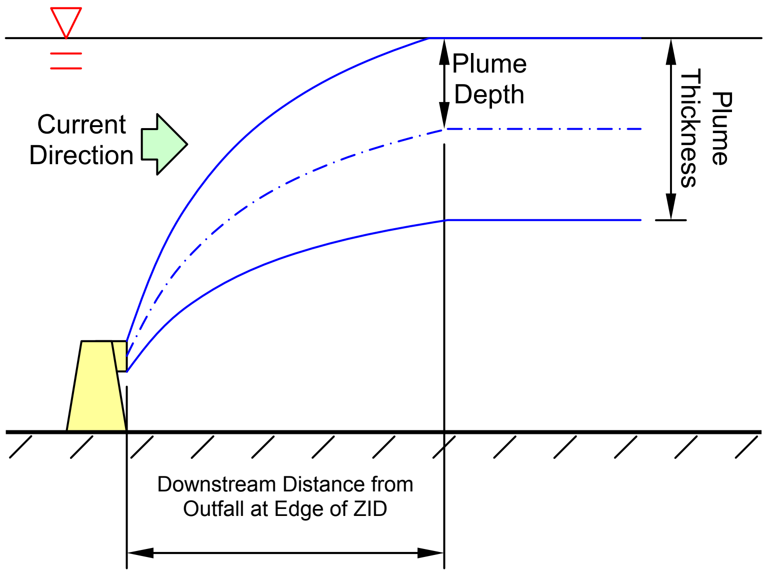
Depth from water surface (m)	Current Velocity (m/s)			
	Dry Season		Wet Season	
	10%ile (dv10)	90%ile (dv90)	10%ile (wv10)	90%ile (wv90)
0.21	0.0795	0.7185	0.0993	0.6218
0.64	0.0719	0.7053	0.1020	0.6477
1.06	0.0672	0.6604	0.0955	0.6245
1.49	0.0820	0.6002	0.0929	0.5637
1.91	0.0677	0.4886	0.0896	0.5273
2.34	0.0631	0.4366	0.0973	0.4710
2.76	0.0658	0.3951	0.0945	0.4010
3.19	0.0595	0.3654	0.0909	0.3686
3.61	0.0556	0.3383	0.0875	0.3271
4.04	0.0497	0.2940	0.0717	0.2711
4.25	0.0497	0.2940	0.0717	0.2711

Table 5a.16 Summary of Proposed Model Runs

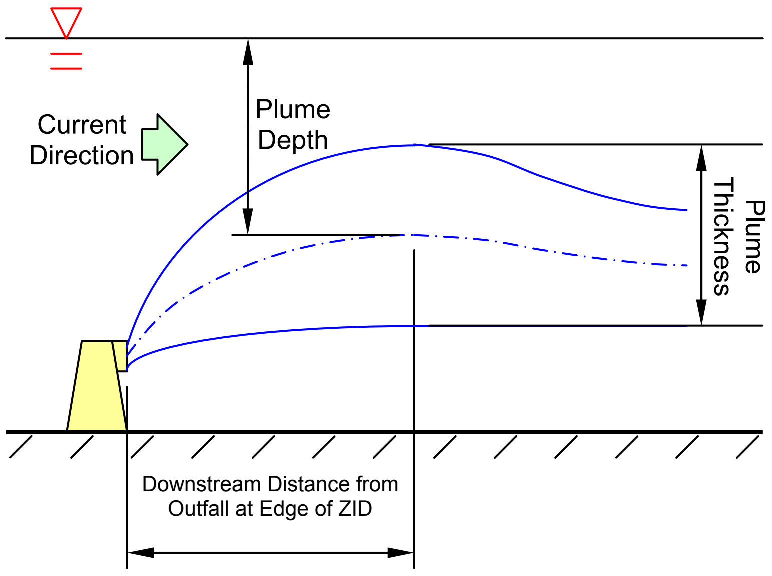
Model Run No.	Run ID	Density Profile	Ambient Current Velocity
1	D-dv10	D	dv10
2	D-dv90	D	dv90
3	W-wv10	W	wv10
4	W-wv90	W	wv90

Prediction and Evaluation of Near Field Modelling Results

5a.7.2.6 The VISJET model was used to simulate the near-field plume behavior of the outfall discharges within a relatively short distance from the effluent discharge location. Hence, the zone of initial dilution (ZID) of the effluent plume could be located. For a surface plume, initial dilution is defined as the dilution obtained at the centre line of the plume when the sewage reaches the surface. For a trapped plume, initial dilution is defined as the dilution obtained at the center line of the plume where the plume reaches the maximum rise height when the vertical momentum / buoyancy of the plume become zeros. Key model outputs include initial dilution and downstream distance from the seawall discharge outfall at the edge of the ZID. Effluent plume properties of surfacing plume and trapped plume is illustrated in **Plate 5a.1** below.



Case 1 – Plume Hits Water Surface



Case 2 – Plume Trapped

Plate 5a.1	**Illustration of Plume Properties of Surfacing Plume and Trapped Plume**

5a.7.2.7 **Table 5a.18** summarizes the results from the VISJET simulations. The predicted initial dilutions in **Table 5a.18** were corrected with the background concentration build up due to the tidal effects. The basic assumption of any near field model is mixed with clean water. In actuality this is not true, particularly in a tidally mixed environment. The average tracer background build up concentrations were calculated from the far field Update model. The background build up was quantified by performing a conservative tracer run on the effluent. A conservative tracer, i.e. without decay or reaction, was used. The initial concentration of the tracer in the desalination plant seawall discharge outfall was set to be 1000 mg/l. It should be noted that the results from the grid cell into which the tracer is loaded is not representative of the true background build up as this cell will always contain the background build up plus the continuous tracer loading. Therefore, the necessary far field tracer results were taken from a cell located adjacent to the outfall grid cells. The average tracer results were predicted in both dry and wet seasons and were used for the background build up corrections. **Table 5a.17** shows an example of the background build up correction (Run ID: W-wv10).

Table 5a.17 Example of Background Build Up Correction

Run ID	Minimum Initial Dilution [1]	Initial Tracer Concentration in Effluent [2] (mg/L)	Average Tracer Concentration [3] (mg/L)	Corrected Minimum Initial Dilution [4]
	(A)	(B)	(C)	(D)
W-wv10	15.6	1000	1.81	15.2

Note:
1. Minimum initial dilution predicted by VISJET model. This dilution occurred in the wet season (Run ID: W-wv10).
2. Effluent tracer concentration assumed in the far field modelling.
3. Average background build up concentration for dry season predicted by the far field model.
4. The average background build up concentration for dry season was used for the correction in this case as the minimum dilution occurred under the dry season scenario. Corrected Initial Dilution, (D) = (B) ÷ {[1 x (B) + ((A) – 1) x (C)] ÷ (A)}

Table 5a.18 Summary of Initial Dilutions Predicted at the Edge of ZID

Run ID	Initial Dilution at the Edge of ZID [1]	Corrected Initial Dilution at the Edge of ZID [2]	Downstream Distance from Centre of the Outfall at the Edge of ZID (m) [3]
D-dv10	36	29	0.8
D-dv90	77	51	47
W-wv10	16	15	2.8
W-wv90	30	28	21

Notes:
1. Initial dilutions at the edge of the ZID calculated by VISJET model
2. Initial dilutions at the edge of ZID were corrected using the background build up concentration predicted by the far field Update model.
3. Definition of ZID is provided in Section 5a.7.2.6.

5a.7.2.8 As shown in **Table 5a.18**, the predicted minimum dilution rate is 15 which would occur in the wet season with the smallest ambient current velocity (W-wv10). The predicted minimum dilution rate of 15 is much greater than the required dilution rate of 8 times to meet the WQO. The closest identified sensitive receiver is about 10m away from the outfall (gorgonians). **Table 5a.19** below shows the dilution rate at 10m away from the proposed outfall predicted under Scenarios D-dv90 and W-wv90 (both of these scenarios have a predicted downstream distance of more than 10m, refer to **Table 5a.18**). The model results indicated that a dilution rate of no less than 17 would be achieved at a downstream distance of 10m from the outfall, which is well above the required dilution of 8 times. Hence, no exceedance of WQO for salinity would occur at the closest sensitive receivers (gorgonians). It is therefore expected that the water quality impact due to the discharge of saline water from the desalination plant is negligible.

Table 5a.19 Dilution Rate at 10 m away from TTAL IWMF Desalination Plant Outfall

Run ID	Distance from Centre of the Outfall (m)	Initial Dilution at 10m away from Centre of the Outfall	Corrected Initial Dilution at 10m away from Centre of the Outfall
D-dv90	10	24	21
W-wv90	10	18	17

5a.8 Mitigation Measures

5a.8.1 Construction Phase

<u>Drainage and Construction Site Runoff</u>

5a.8.1.1 The site practices outlined in ProPECC PN 1/94 “Construction Site Drainage” should be followed as far as practicable in order to minimise surface runoff and the chance of erosion. These practices include the following items:

- At the start of site establishment, perimeter cut-off drains to direct off-site water around the site should be constructed with internal drainage works and erosion and sedimentation control facilities implemented. Channels (both temporary and permanent drainage pipes and culverts), earth bunds or sand bag barriers should be provided on site to direct storm water to silt removal facilities. The design of the temporary on-site drainage system will be undertaken by the contractor prior to the commencement of construction.
- Boundaries of earthworks should be surrounded by dykes or embankments for flood protection, as necessary.
- Sand/silt removal facilities such as sand/silt traps and sediment basins should be provided to remove sand/silt particles from runoff to meet the requirements of the TM-DSS. The design of efficient silt removal facilities should be based on the guidelines in Appendix A1 of ProPECC PN 1/94, which states that the retention time for silt/sand traps should be 5 minutes under maximum flow conditions. The detailed design of the sand/silt traps shall be undertaken by the contractor prior to the commencement of construction.
- Water pumped out from foundation piles must be discharged into silt removal facilities.
- Measures should be taken to minimize the ingress of site runoff and drainage into excavations. Drainage water pumped out from excavations should be discharged into storm drains via silt removal facilities.
- During rainstorms, exposed slope/soil surfaces should be covered by a tarpaulin or other means, as far as practicable. Other measures that need to be implemented before, during and after rainstorms are summarized in ProPECC PN 1/94.
- Exposed soil areas should be minimized to reduce potential for increased siltation and contamination of runoff.
- Earthwork final surfaces should be well compacted and subsequent permanent work or surface protection should be immediately performed.
- Open stockpiles of construction materials or construction wastes on-site should be covered with tarpaulin or similar fabric during rainstorms.
- All vehicles should be cleaned before leaving the works area to ensure no earth, mud and debris is deposited on roads. An adequately designed and sited wheel washing bay should be provided at every site exit. The wheel washing facility should be designed to minimize the intake of surface water (rainwater). Wash-water should

have sand and silt settled out and removed at least on a weekly basis to ensure the continued efficiency of the process.

General Construction Activities

5a.8.1.2 Construction solid waste should be collected, handled and disposed of properly to avoid entering to the nearby watercourses and public drainage system. Rubbish and litter from construction sites should also be collected to prevent spreading of rubbish and litter from the site area. It is recommended to clean the construction sites on a regular basis.

5a.8.1.3 There is a need to apply to EPD for a discharge licence for discharge of effluent from the construction site under the WPCO. The discharge quality must meet the requirements specified in the discharge licence. All the run-off and wastewater generated from the works areas should be treated so that it satisfies all the standards listed in the TM-DSS. The beneficial uses of the treated effluent for other on-site activities such as dust suppression and general cleaning etc., can minimise water consumption and reduce the effluent discharge volume. If monitoring of the treated effluent quality from the works areas is required during the construction phase of the Project, the monitoring should be carried out in accordance with the relevant WPCO licence which is under the ambit of regional office of EPD.

Accidental Spillage

5a.8.1.4 Contractor must register as a chemical waste producer if chemical wastes would be produced from construction activities. The Waste Disposal Ordinance (Cap 354) and its subsidiary regulations in particular the Waste Disposal (Chemical Waste) (General) Regulation should be observed and complied with for control of chemical wastes.

5a.8.1.5 Maintenance of vehicles and equipments involving activities with potential for leakage and spillage should only be undertaken within the areas which appropriately equipped to control these discharges.

5a.8.1.6 Oils and fuels should only be used and stored in designated areas which have pollution prevention facilities. All fuel tanks and storage areas should be sited on sealed areas in order to prevent spillage of fuels and solvents to the nearby watercourses. All waste oils and fuels should be collected in designated tanks prior to disposal.

5a.8.1.7 Disposal of chemical wastes should be carried out in compliance with the Waste Disposal Ordinance. The Code of Practice on the Packaging, Labelling and Storage of Chemical Wastes published under the Waste Disposal Ordinance details the requirements to deal with chemical wastes. General requirements are given as follows:

- Suitable containers should be used to hold the chemical wastes to avoid leakage or spillage during storage, handling and transport.
- Chemical waste containers should be suitably labelled, to notify and warn the personnel who are handling the wastes, to avoid accidents.
- Storage area should be selected at a safe location on site and adequate space should be allocated to the storage area.

Sewage Effluent

5a.8.1.8 Temporary sanitary facilities, such as portable chemical toilets, should be employed on-site where necessary to handle sewage from the workforce. A licensed contractor would be responsible for appropriate disposal and maintenance of these facilities.

Release of PFA Leachate from Ash Lagoon into the Aquatic Environment

5a.8.1.9 The past monitoring data showed that the water quality at the location outside the ash lagoon area was not affected by the PFA filling operation. The low permeability values of the marine deposits and alluvium underneath the PFA layer would limit the seepage of PFA leachate. The foundation construction of the IWMF is not likely to accelerate the release of PFA leachate through the base of the lagoon site.

5a.8.2 Operation Phase

Site Effluent

5a.8.2.1 The Project site will be equipped with an adequately sized wastewater treatment plant to provide treatment to some wastewater generated from the IWMF (mainly human sewage) for reuse in the incineration plant and the mechanical treatment plant or for washdown and landscape irrigation in the IWMF site. A "net zero discharge" scheme will be adopted during the operation of the IWMF.

5a.8.2.2 A small amount of brine water will be discharged into the marine water from the proposed desalination plant via a seawall discharge outfall at the northern boundary of the TTAL site. The potential water quality impact from the brine water discharge has been assessed to be negligible and therefore no mitigation measure specific to the brine water discharge is required.

Surface Runoff

5a.8.2.3 A pipeline drainage system will serve the development area collecting surface runoff from paved areas, roof, etc. Sustainable drainage principle would be adopted in the drainage system design to minimize peak surface runoff, maximize permeable surface and maximize beneficial use of rainwater.

5a.8.2.4 Oil interceptors should be provided in the drainage system of any potentially contaminated areas (such as truck parking area and maintenance workshop) and regularly cleaned to prevent the release of oil products into the storm water drainage system in case of accidental spillages. Accidental spillage should be cleaned up as soon as practicable and all waste oils and fuels should be collected and handled in compliance with the Waste Disposal Ordinance.

5a.9 Residual Environmental Impacts

5a.9.1.1 With the implementation of the recommended mitigation measures for the construction and operation phases of the proposed Project, no unacceptable residual impacts on water quality are expected.

5a.10 Environmental Monitoring and Audit

5a.10.1.1 To ensure no adverse water quality impact to the nearby stream due to the discharge of surface runoff and drainage from the works areas, water quality monitoring of the Tsang Kok stream is recommended during site formation. Marine water quality monitoring is also recommended during foundation pilling of the IWMF to ensure that the foundation construction would not cause unacceptable release of PFA leachate into the Deep Bay waters. Details of the recommended water quality monitoring parameters to be measured and the proposed monitoring locations are provided in the stand-alone EM&A Manual for the Project. It is also recommended that regular site inspections be undertaken to inspect the construction activities and works areas in order to ensure the recommended mitigation measures are properly implemented.

5a.11 Conclusion

5a.11.1.1 The potential sources of water quality impact arising during the construction phase of the Project include construction site runoff and drainage, wastewater generated from general construction activities and sewerage from the workforce. With implementation of the recommended mitigation measures and site practices outlined in ProPECC PN 1/94, no unacceptable residual impacts on water quality are expected.

5a.11.1.2 During the operation phase of the Project, wastewater will be generated from the proposed incineration plant and mechanical treatment plant. An on-site wastewater treatment plant will be provided. All generated wastewater will be discharged to the on-site wastewater treatment plant and treated. The treated effluent from the wastewater treatment plant will be reused in the incineration plant and the mechanical treatment plant or washdown and landscape irrigation in the IWMF site. A “net zero discharge” scheme will be adopted during the operation of the IWMF.

5a.11.1.3 Saline water would be discharged from the proposed desalination plant in a low discharge rate. The saline water has been quantitatively assessed to be minor and acceptable. Adverse impacts on water quality due to the proposed saline water discharge would not be expected.

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