CONTENTS

1 INTRODUCTION

1.1 BACKGROUND

The Water Supplies Department (WSD) is undertaking a project named *"Desalination Plant at Tseung Kwan O"* (hereinafter referred to as the "Project"). This Project is to provide a medium-sized desalination plant in Hong Kong to produce potable water, as a new source of water supply to meet Hong Kong's water demand.

The proposed desalination plant is located in Tseung Kwan O (TKO) Area 137 with a reserved site area of about 10 hectares. TKO Area 137 is located to the south of the Southeast New Territories (SENT) Landfill and the Tseung Kwan O Industrial Estate. It faces the Clearwater Bay Country Park to its east, the Joss House Bay to its south and the Tathong Channel to its west (See *Figure 1.1*).

The proposed TKO Desalination Plant is a Seawater Reverse Osmosis (SWRO) plant (*Figure 1.2*). SWRO is a mature and preferred technology, which dominates the market due to its reliability and progressive reduction in cost as the technology advances. SWRO desalination plants are currently operated worldwide at countries in various regions including China, Singapore, Australia, Middle East, Africa, Europe, and North America.

The extent of the desalination plan is indicated in *Figure 1.1*. The key elements of the Project are:

a) Construction of a new desalination plant in TKO Area 137 with a capacity of 50 million m^3 per annum, expandable to 90 million m^3 per annum in the future;

b) Natural slope mitigation works consist of construction of debris barriers and boulder traps at the toe of and stabilization of natural slopes and boulders on the natural slope within the Clear Water Bay Country Park, which overlooks the northeast boundary of the new desalination plant at TKO Area 137;

c) Construction of a dedicated trunk feed system for the transfer of fresh water output from the desalination plant to the existing Tseung Kwan O Primary Fresh Water Service Reservoir (TKOPFWSR). The system consists of a new pumping station, a new treated water storage tank, about 9 km of 1200 mm diameter fresh water mains along Wan Po Road, Po Hong Road and Tsui Lam Road (fresh water main is indicated in *Figure 1.1)*, and the associated pipeworks and ancillary facilities including fittings/valves, leakage, flow and pressure monitoring facilities etc.; and

d) All the associated civil, structural, geotechnical, landscaping, electrical and mechanical works.

The Project requires an Environmental Permit from the Hong Kong SAR Government. In relation to this, WSD has prepared a Project Profile for application for an Environmental Impact Assessment (EIA) Study Brief which was submitted to Environmental Protection Department (EPD) on 5 December 2013. The EIA Study Brief (No. ESB-266/2013) was issued by EPD on 16 January 2014.

WSD commissioned the study *"Desalination Plant at Tseung Kwan O"* (Agreement No. CE 21/2012 (WS)) for the EIA and preliminary design studies of the Project. As part of the EIA, computational hydrodynamic and water quality modelling will be undertaken to quantify and evaluate potential water quality impacts associated with the construction and operation of this Project.

Figure 1.1 Location of the Proposed Desalination Plant at Tseung Kwan O

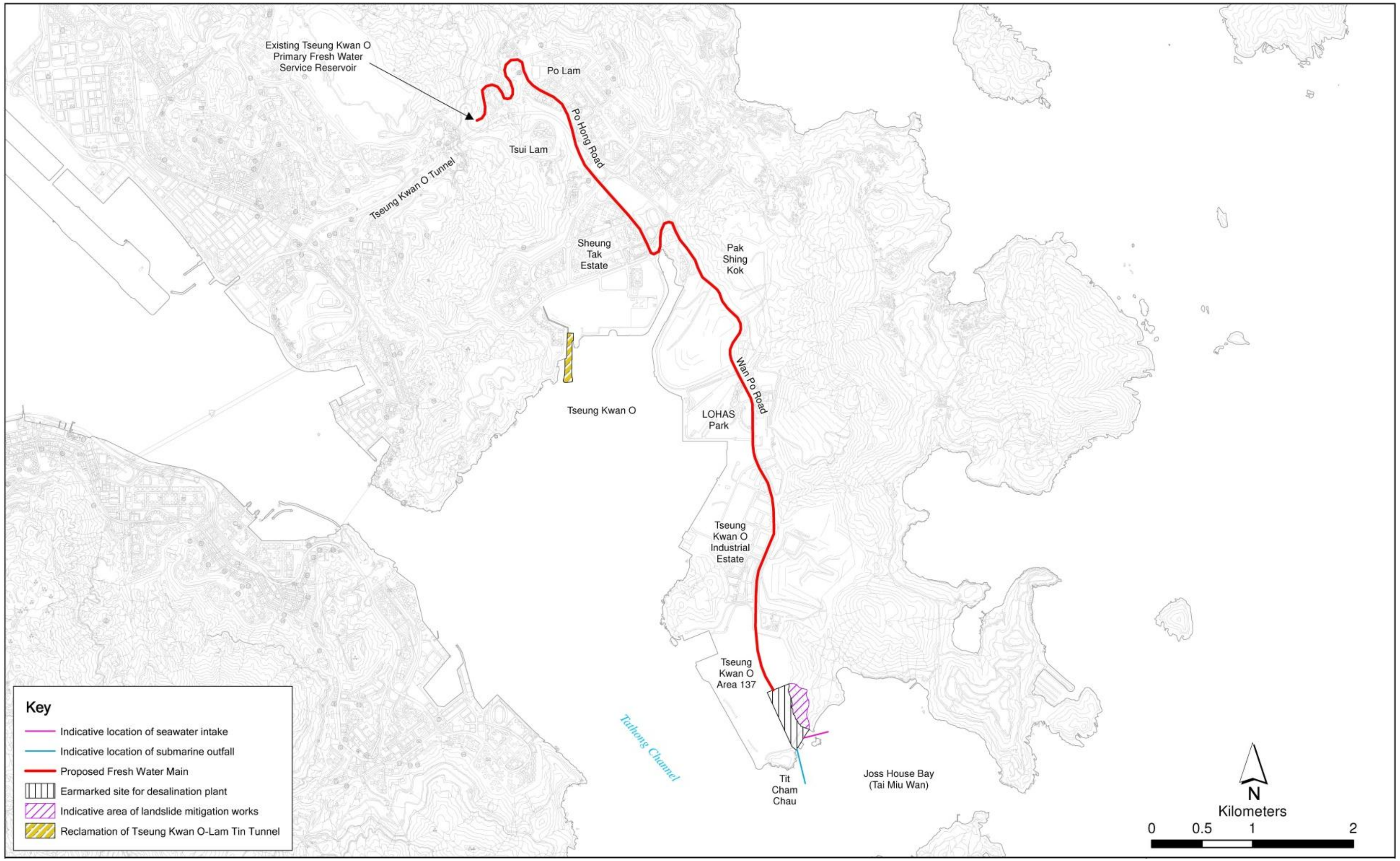
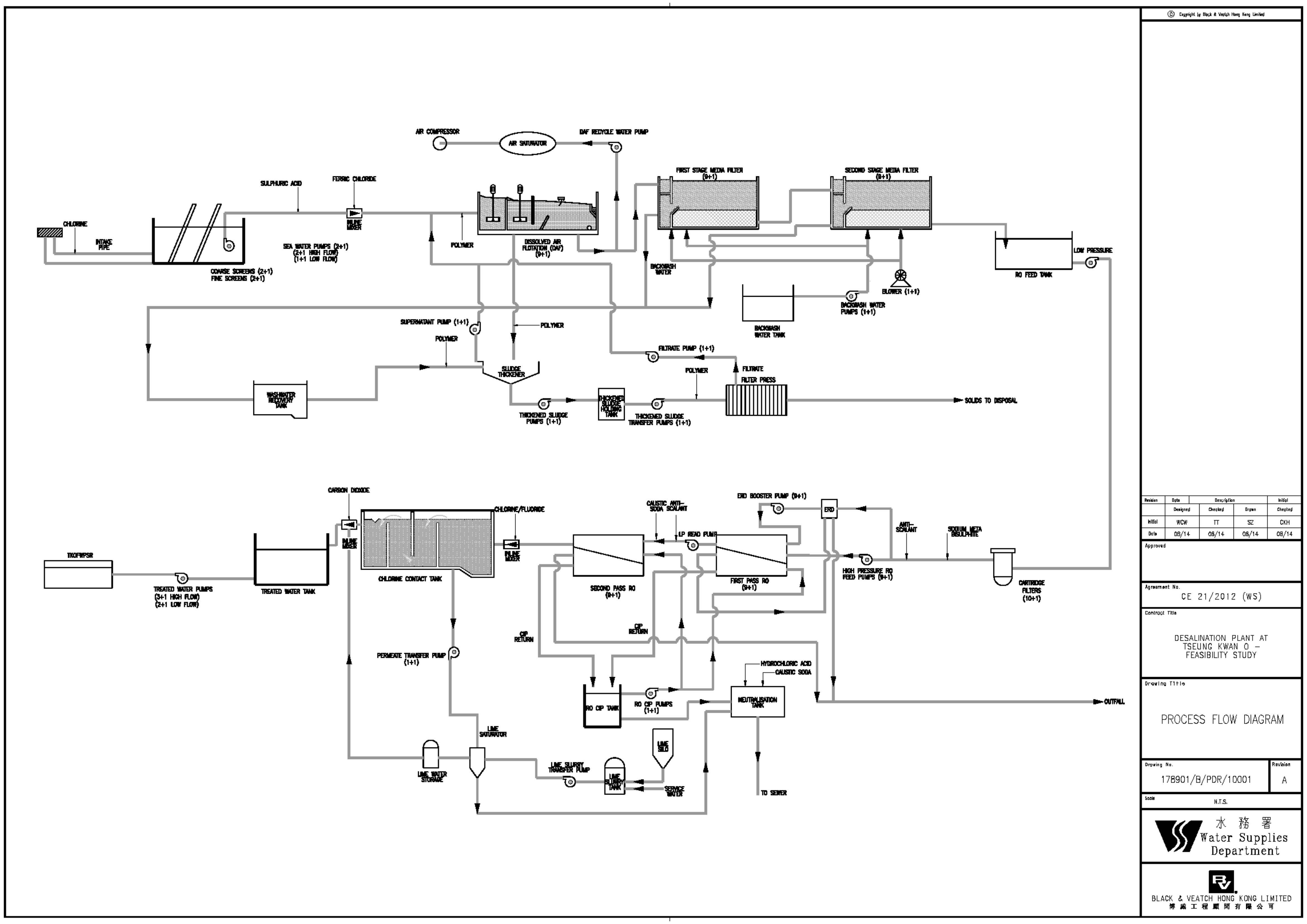


Figure 1.2 Flow diagram of desalination process for the proposed desalination plant



1.2 *PURPOSE OF THE METHOD STATEMENT*

This *Method Statement* presents information on the approach for numerical modelling and assessment works for the EIA. It is important to note that at the time of writing this *Method Statement* the detailed engineering information for both construction and operation activities is yet to be confirmed and therefore a general approach as to how the modelling works would be carried out is presented herein, with relevant assumptions provided as appropriate.

The methodology has been based on the following three focus areas, as follows:

- Model Selection;
- Input Data; and
- Scenarios.

1.3 *INTERPRETATION OF THE REQUIREMENTS: KEY ISSUES AND CONSTRAINTS*

The objectives of the modelling exercise are to assess:

- Water quality impacts from construction, which comprises the study of the dispersion of sediments released during the construction/ installation of a seawater intake (approximately 250 m long) and a submarine outfall (approximately 350 m long) connected to the TKO Desalination Plant;

- Water quality impacts of operation due to the operational discharges from the desalination plant via the outfall; and

- Any cumulative impacts due to other projects or activities within the study area.

The construction and operational impacts on water environment will be studied by means of computer models.

1.4 *MODEL SELECTION*

The Delft-3D suite of models will be utilized to provide a modelling platform for hydrodynamic and water quality modelling. A 3-dimensional Refined Model using Delft-3D will be built up for this Project to provide a detailed assessment on hydrodynamics and water quality, respectively, during construction and operation of the Project. The spatial extent of the Refined Model covers the waters extending up about 7 km away from the Project site (*Figure 1.3*).

In order to assess the immediate dispersion and dilution effects of effluent discharge at point of discharge, one near field simulation of dilution in the mixing zone will be modelled. The near-field simulation will be conducted using CORMIX model.

The grid size of the Update Model [(1)] near the Project is in the order of about 500 m × 1500 m. The model grid resolution in the area of interest is however considered too coarse and therefore a Delft-3D far field model, namely the refined TKO model ("Refined Model") will be developed by linking to the existing the Update Model. Local grid refinement would be carried out to provide improved resolution (less than 75 m) in the key area of interest based on the Update Model grid. The refined grid size ranges from about 50 m x 50 m in the immediate vicinity of the Project to about 150 m x 150 m (*Figure 1.4 and Figure 1.5*). The adjusted model grids in the vicinity of the Project and higher resolution DD domains will be included as follows:

- Update Model: an overall domain which is used as the original model;
- Refined Model: local domain with highest resolution.

It is noted that the original Update model for 2012 was retrieved from archive records and represents the model as provided to the EPD as part of the Update Study [(1)]. The hydrodynamic model of the Update model provides the initial and boundary conditions of 2012. Therefore, the Update Model will be set up for 2020, with significant changes to the land boundary, compared to that of the 2012 setup. The hydrodynamic model of the Update Model will be used to provide boundary and initial hydrodynamic conditions to the detailed Refined Model via a nesting procedure for the dry and wet seasons for 2020. The extent of the Update Model in relation to that of the Refined Model is shown in *Figure 1.3* below.

(1) Hyder Consulting and Manusell Environmental Management Consultants in association with Delft Hydraulics: Update on Cumulative Water Quality and Hydrological Effect of Coastal Developments and Upgrading of Assessment Tool (Agreement No. CE 42/97, Environmental Protection Department Water Policy and Planning Group)

Figure 1.3 Spatial Extent of the Refined Model

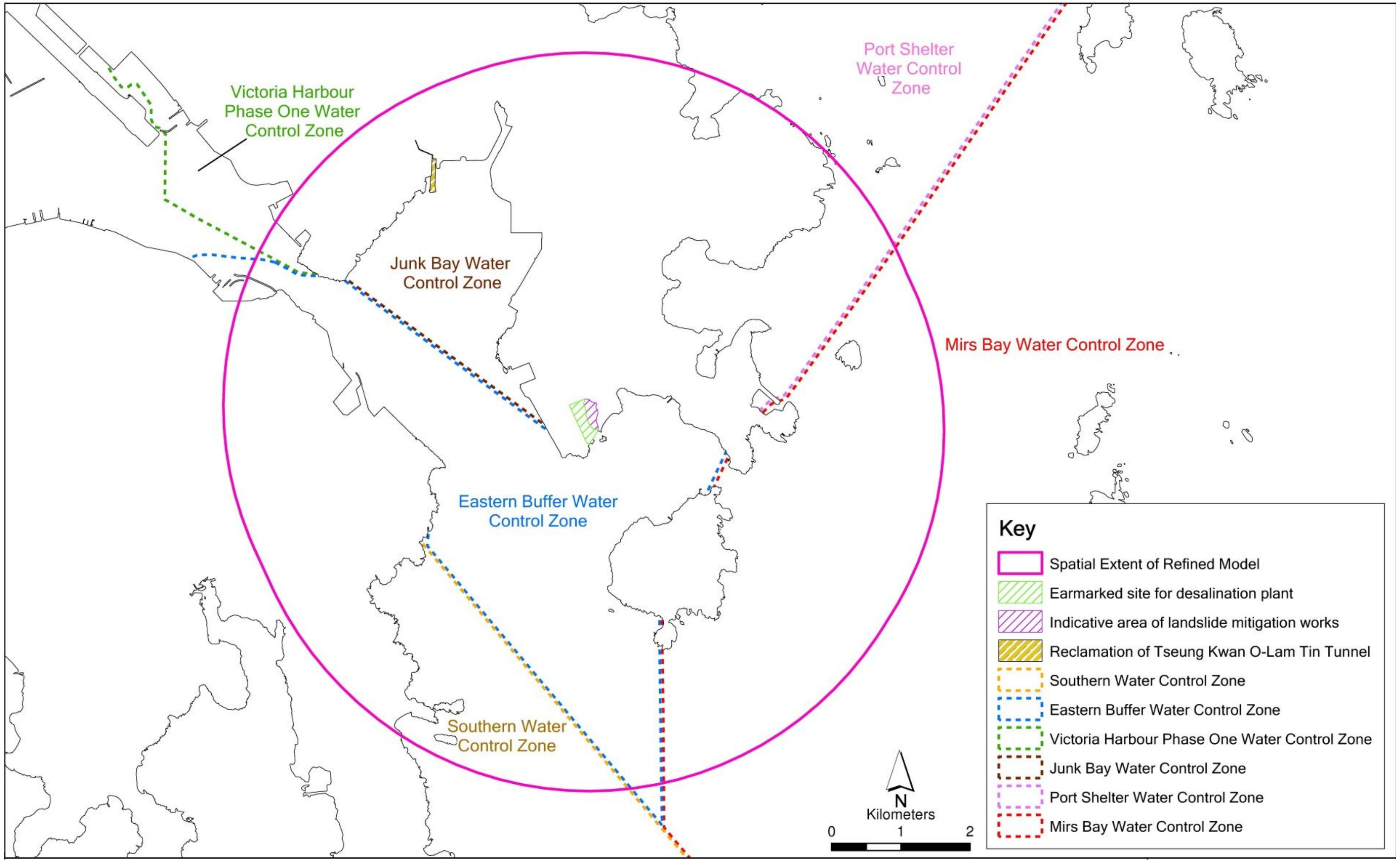


Figure 1.4 Model Grid of the Refined Local Model and Update Model Grid

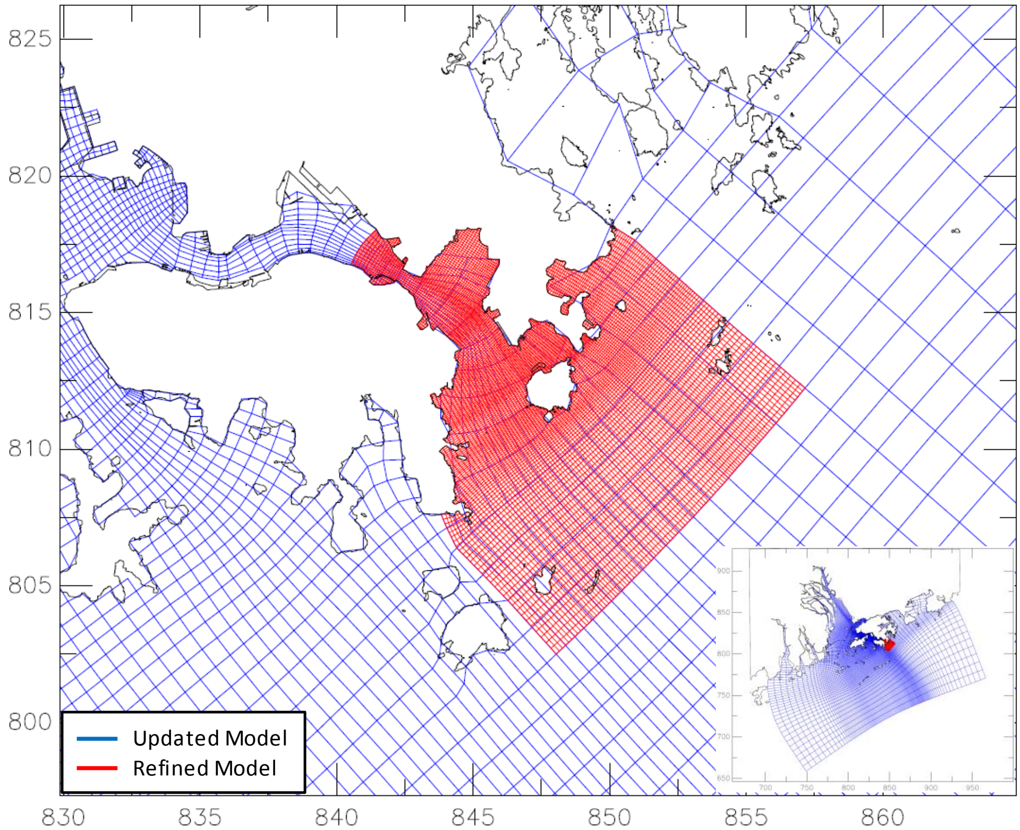
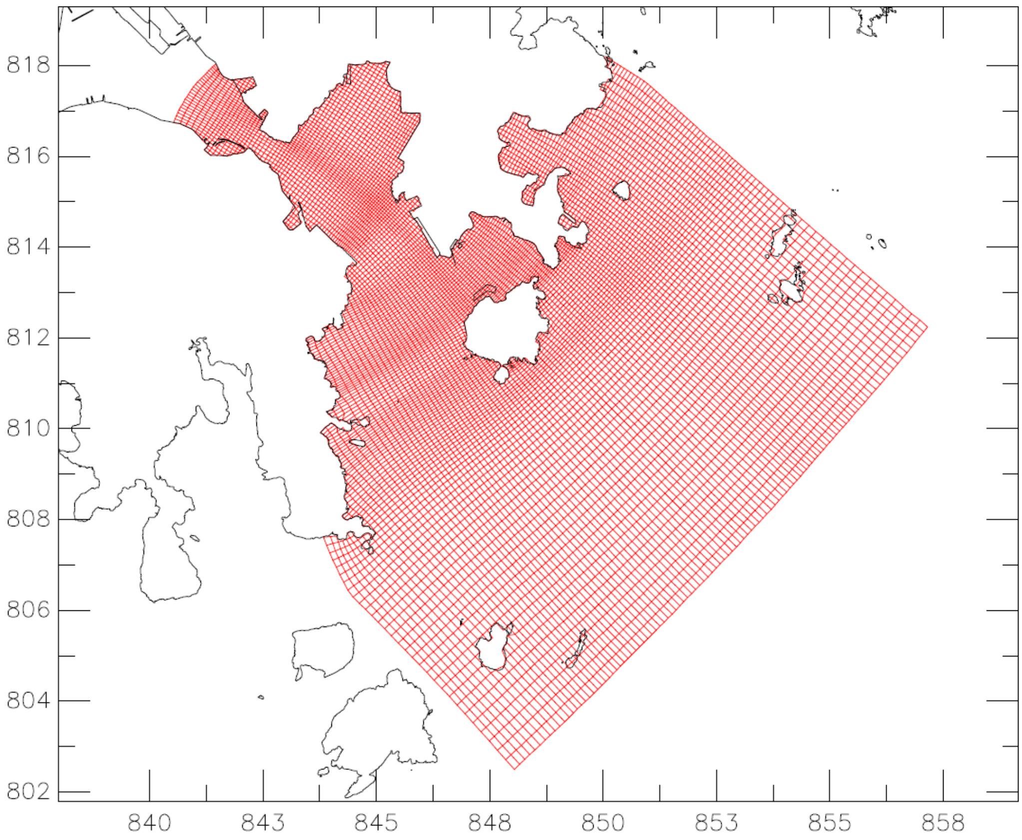


Figure 1.5 *Model Grid of the Refined Local Model*



Since parts of the Update Model will be refined to compute flow behavior with a higher resolution in the vicinity of the Project, the Refined Model will be validated by demonstrating the consistency of the Refined Model with the Update Model for the computed hydrodynamic outputs of the same scenario. This comparison aims to ensure that the introduction of the grid refinement in the vicinity of the proposed Project would not alter the established calibration of the Update Model and that the spin-up period is sufficiently long enough to allow the model to reach equilibrium.

Computed water levels, salinity, temperature, current speed and directions will be compared at selected corresponding locations for different water levels in both models. Comparisons will be made between the two models for both wet and dry seasons.

The detailed inputs to the TKO Refined Model are present in the following sections.

1.5 *COASTLINE CONFIGURATIONS & BATHYMETRY*

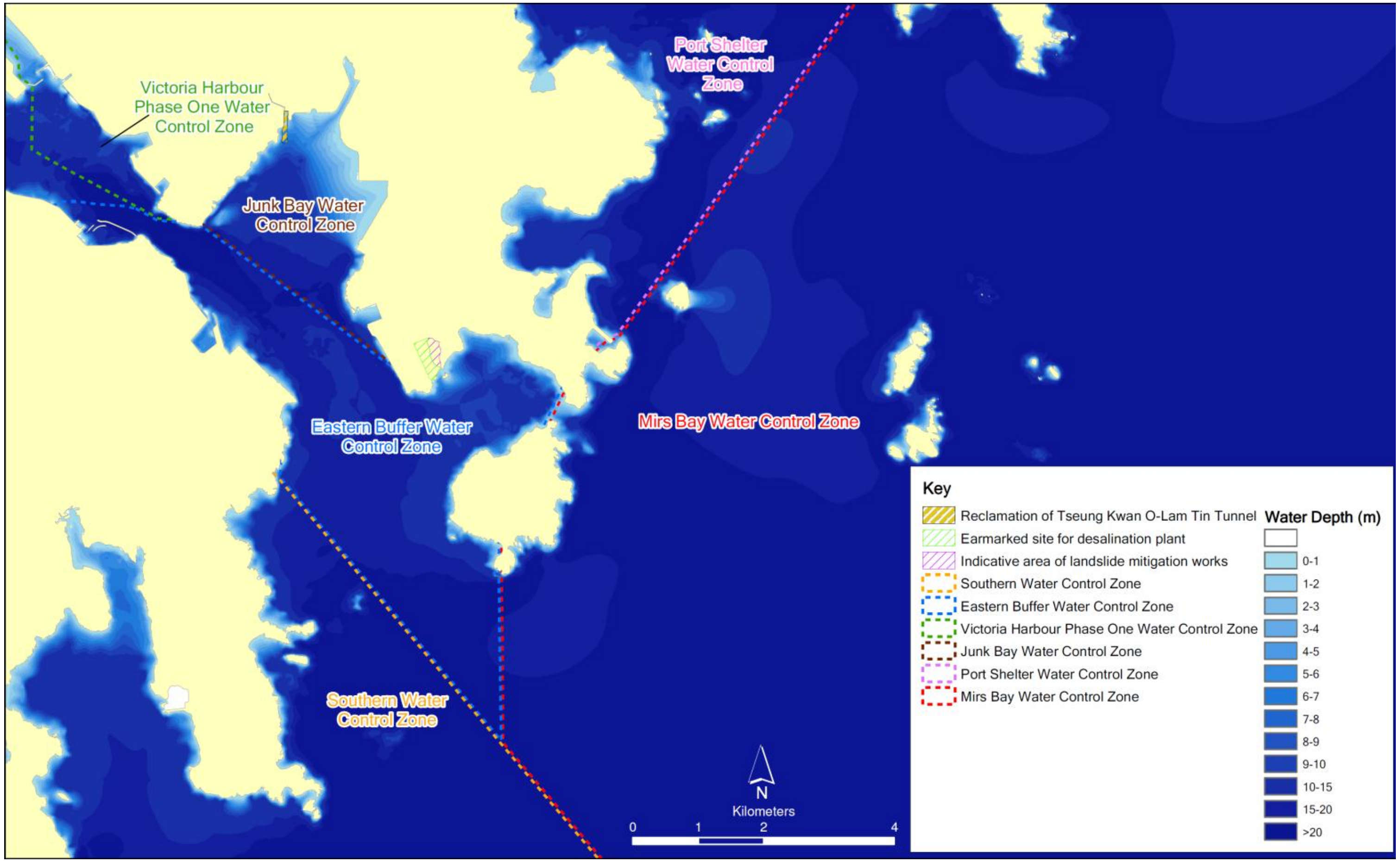
The latest coastline configuration for the assessment year of 2020 will be adopted in model simulations of the potential impact from the Project in this EIA study. Changes in coastline configuration due to reclamation and other development activities will be reflected in the model setup. The changes in coastline configuration [1] include the effects by the following development projects:

- Sunny Bay Reclamation;
- Further Development of Tseung Kwan O;
- Tuen Mun – Chek Lap Kok Link (TMCLKL);
- Hong Kong – Zhuhai – Macao Bridge Hong Kong Boundary Crossing Facilities (HKZMB - HKBCF);
- Hong Kong – Zhuhai – Macao Bridge Hong Kong Link Road;
- Wanchai Reclamation Phase II;
- Kwai Tsing Container Terminal Basin dredging;
- Tseung Kwan O – Lam Tin Tunnel and Cross Bay Link;
- Cruise Terminal at Kai Tak; and
- Lantau Logistic Park.

The coastline configuration and bathymetry in the vicinity of the Project as shown in *Figure 1.6* are used for the TKO Refined Model. The bathymetry data are obtained from the Hydrographic Office, Hong Kong Electronic Navigational Chart (ENC), 2011. The bathymetry information from the Update Model is used as a base. The reference level of the TKO Refined Model is Principal Datum Hong Kong and the depth data are relative to this datum.

(1) Atkins China Limited (2013). EIA Study for Outlying Island Sewerage Stage 2 - Upgrading of Cheung Chau Sewage Collection, Treatment and Disposal Facilities for DSD. EIA-219/2013.

Figure 1.6 Coastline and Bathymetry to be used in the Refined Model



Source: (1) Hydrographic Office, Hong Kong Electronic Navigational Chart (ENC), 2011

1.6 BOUNDARY CONDITIONS AND INITIAL CONDITIONS

The TKO Refined Model is linked to the Update Model via nesting. The hydrodynamic modelling of the Update Model covers the outer regions of Pearl River Estuary, Macau, Lamma Channel and Deep Bay. All major influences on hydrodynamics in the outer regions are therefore incorporated.

Hydrodynamic computations are first carried out using the Update Model to generate the open boundary conditions the Refined Model. Water levels and three-dimensional velocities generated by the Update Model are defined at the open boundaries of Refined Model. In order to transfer information from the Update Model to the Refined Model thoroughly, the open boundaries in Refined Model are divided into small segments. In total, there are four open boundaries for the TKO Refined Model in the northeast, southeast, southwest and northwest direction.

1.7 AMBIENT ENVIRONMENTAL CONDITIONS – BACKGROUND TEMPERATURE, SOLAR RADIATION AND WIND

The ambient environmental conditions are closely linked to the processes of hydrodynamic changes. The wind conditions applied in the hydrodynamic simulation are 5 m/s NE for dry season and 5 m/s SW for the wet season. The same average wind speed and direction were adopted in the Update model. On the other hand, monthly averaged values of solar surface radiation are used in the model. The monthly averaged solar radiation is calculated based on the hourly data recorded at this station. The average values of solar radiation adopted from the Update Model are 132 W/m^2 in the dry season and 237 W/m^2 in the wet season.

The same settings for background temperature are adopted from Update Model. The average background temperature values used in the hydrodynamic model are 20 °C in the dry season and 30 °C in the wet season.

It is assumed that wind speed, solar radiation and background temperature are constant over the entire domain of the model.

1.8 SIMULATION PERIODS

The simulation periods covered by the TKO Refined Model are the same as those covered by the Update Model as presented in *Table 1.1*. The simulation periods covered 15-day of model spin-up prior to the actual 15-days spring-neap tidal cycle. A computational time step of 15 and 6 seconds was adopted in the model simulation in dry season and wet season respectively.

Table 1.1 Model Simulation Periods

Season	Spin Up	Model Start Time	Model End Time

Season	Spin Up	Model Start Time	Model End Time
Wet	16 July 00:00:00 – 31 July 00:00:00	31 July 00:00:00	15 Aug 00:00:00
Dry	07 Feb 00:00:00 – 22 Feb 00:00:00	22 Feb 00:00:00	09 Mar 00:00:00

1.9 VECTOR INFORMATION

The current patterns under the baseline situation will be generated as an output of the baseline hydrodynamic modelling. Vector plots for mid-ebb and mid-flood condition for the updated model and the Refined Model are provided in *Annex A*.

1.10 MODEL VERIFICATION

The key parameters of interest in the verification of hydrodynamic modelling include water level, salinity, temperature, current direction and current magnitude. The results of model verification are provided in *Annex A*. As shown in *Annex A*, the simulated water level, salinity, current magnitude, current direction and water temperature of the Refined Model match well with those of the Updated Model. Minor deviations from on current magnitude and direction are observed and are considered the results of a combination of change in grid resolution, bathymetry, control volume and coastline refinement. These minor deviations are considered acceptable. In conclusion, the model performance of the Refined Model is consistent with the updated model and is considered suitable for use under this study.

1.11 UNCERTAINTIES IN ASSESSMENT METHODOLOGIES

1.11.1 Uncertainties in Sediment Transport Assessment

Uncertainties in the assessment of the impacts from suspended sediment plumes will be considered when drawing conclusions from the assessment. In carrying out the assessment, the worst case assumptions have been made in order to provide a conservative assessment of environmental impacts. These assumptions are as follows:

- The assessment is based on the peak dredging rates. In reality, these will only occur for short period of time;
- The calculations of loss rates of sediment to suspension are based on conservative estimates for the types of plant and methods of working;
- The modelled dredging locations are selected such that the sediment sources are at its shortest distance from the nearest sensitive receivers. This ensures the worst case water quality impact be modelled and assessed in this Study; and

- While the dredging works required would last for only 2 to 3 days at the proposed dredging rate, the modelled sediment release at the dredging locations last for a 15 days (i.e. one typical spring-neap cycle in Hong Kong). This ensures the worst tidal conditions are modelled and conservative predictions could be made.

1.11.2 *Uncertainties arising from Operations*

The following uncertainties in the operations have not been included in the modelling assessment:

- *Ad hoc* navigation of marine traffic;
- Propeller scour of seabed sediments from vessels;
- Near shore scouring of bottom sediment; and
- Access of marine barges back and forth the site.

1.11.3 *Limitation in Near Field Models*

CORMIX has two key limitations. It assumes steady-state conditions and unidirectional, uniform flow in the receiving water body. Secondly, CORMIX has simplified geometric capabilities. It assumes an idealized water body with straight sides and a uniform bottom along the flow direction.

2 *WATER SENSITIVE RECEIVERS*

The water quality sensitive receivers (WSRs) have been identified in accordance with *Annex 14* of the *Technical Memorandum on EIA Process* (*EIAO, Cap.499, S.16*) and *Environmental Impact Assessment Study Brief for Desalination Plant at Tseung Kwan O (No. ESB-266/2013).* These WSRs are illustrated in and listed in *Figure 2.1* and *Table 2.1.* The representative WSRs as discrete model output points are shown in *Figure 2.2.*

Table 2.1 Water Quality Sensitive Receivers (WSRs) in the Vicinity of the Project Site

Description	**Location**	**Model Output Location**
Fisheries Sensitive Receivers		
Fish Culture Zones	Tung Lung Chau	SR2
	Po Toi O	SR27
Ecological Sensitive Receivers		
Coral Communities	Junk Bay	SR20-22
	Fat Tong Chau	SR16
	Tai Miu Wan	SR4
	Cape Collinson	SR10-12
	Tung Lung Chau	SR1, 3, 6-9
	Tai Long Pai	SR32
	Coral Survey Locations D-W, D-T, D-L	SR33 – SR35
	Kwun Tsai	SR36
	Tit Cham Chau	SR37
Water Quality Sensitive Receivers		
Gazetted Bathing Beaches	Big Wave Bay	SR12
	Clear Water Bay	SR29,30
	Shek O	SR15
	Rocky Bay	SR14
Coastal Protection Areas	Clear Water Bay	SR28-31
	Po Toi O	SR27
	Tai Miu Wan	SR4,5
	Cape Collinson	SR10,11
	Big Wave Bay	SR13
	Tai Tam	SR25,26
Seawater Intakes	Tseung Kwan O New Town	SR19
	Siu Sai Wan	SR16,17
	Heng Fa Chuen	SR23,24

Figure 2.1 Water Sensitive Receiver near the Project

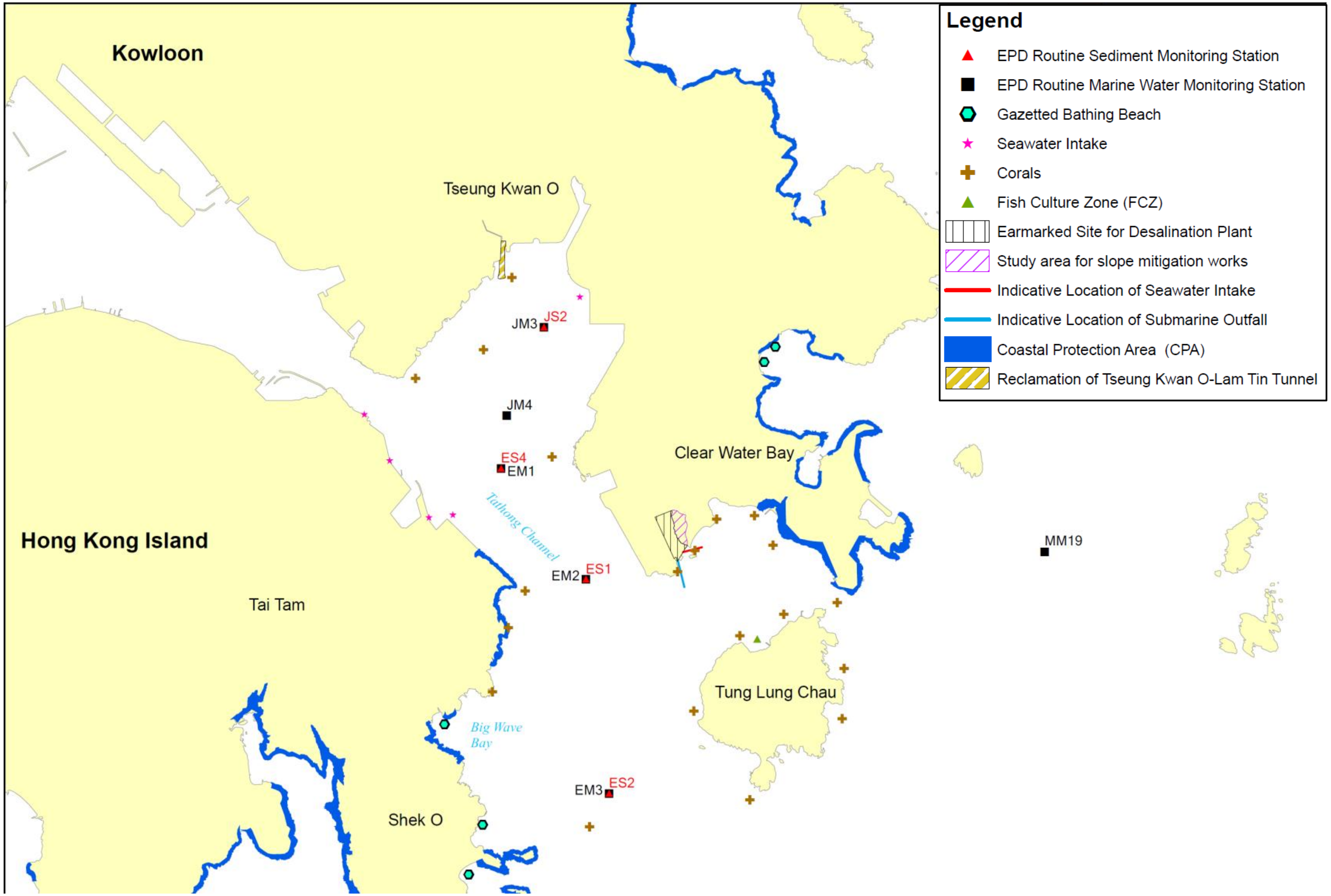
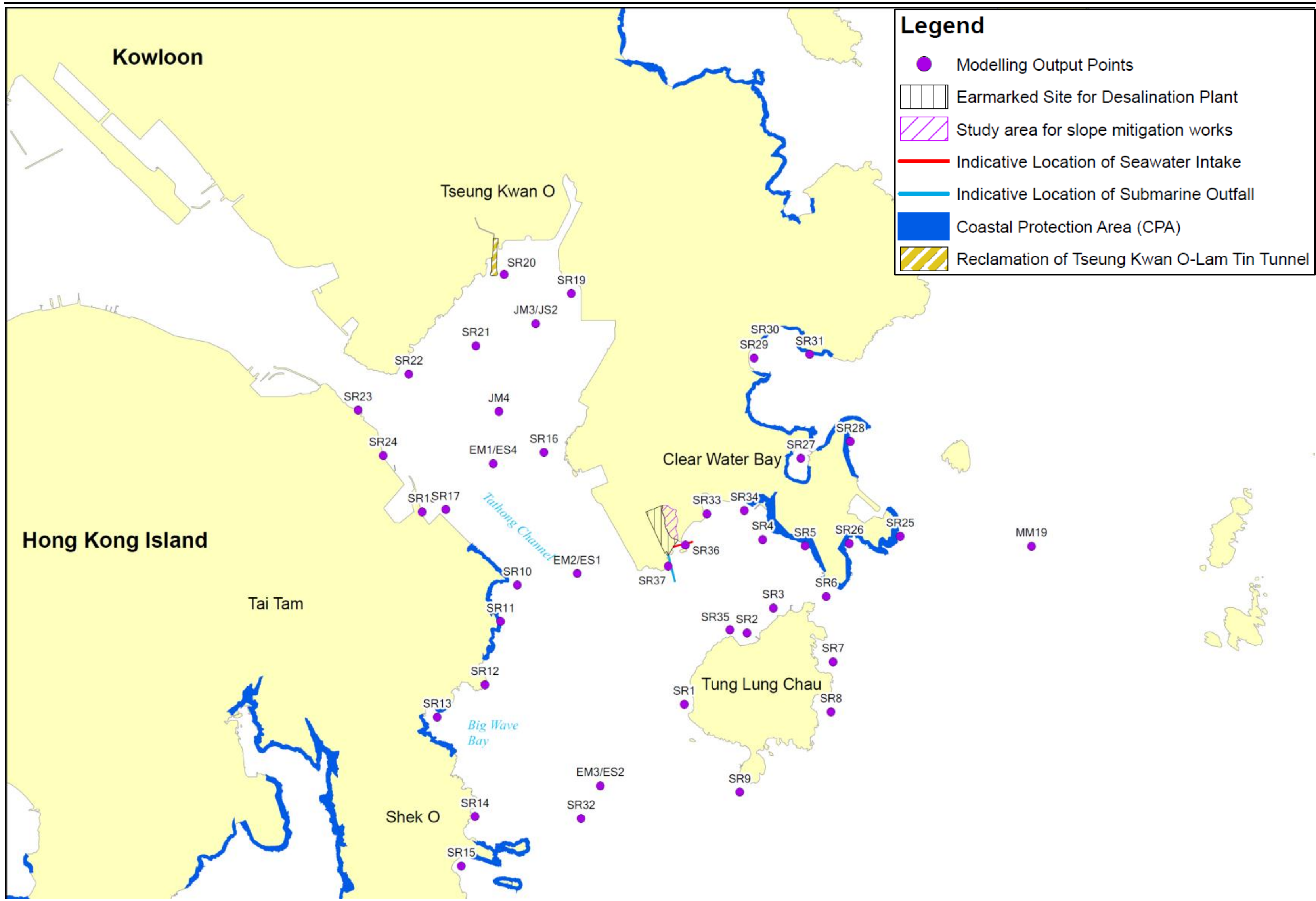


Figure 2.2 Location of Modelling Output Points



3 *CONSTRUCTION PHASE*

For the construction phase the Delft-PART model will be used to directly simulate the following parameters:

- Suspended sediments (SS); and
- Sediment deposition.

It is assumed that the worst-case construction phase impacts will be at the commencement of dredging, when there is no depression formed to trap sediments disturbed during dredging works.

Note that dissolved oxygen (DO) depletion, total inorganic nitrogen (TIN), unionized ammonia (UIA), heavy metals and organic compounds will be calculated using the modeled maximum SS concentrations. This method has been adopted in recently approved EIAs (1) (2).

3.1 *ASSESSMENT CRITERIA FOR CONSTRUCTION PHASE*

The study area will cover Junk Bay, Eastern Buffer, Port Shelter, Mirs Bay and Southern Water Control Zones (WCZs) as shown in *Figure 1.3*. Hence, Water Quality Objectives (WQOs) in these WCZs will be used to assess water quality impacts in SS, DO, TIN and NH_3-N released in the process of dredging (*Table 3.1*).

Table 3.1 Summary of Assessment Criteria (WQOs) for Construction Phase

Parameters (1)	Junk Bay	Eastern Buffer	Port Shelter	Mirs Bay	Southern
Dissolved Oxygen (Bottom) (mg/L)	Not less than 2 mg/L for 90% of samples for all WCZs				
Dissolved Oxygen (Depth-averaged) (mg/L)	Not less than 4 mg/L for 90% of samples for all WCZs				
Total Inorganic Nitrogen (mg/L)	< 0.3	< 0.4	< 0.1	< 0.3	< 0.1
Unionized Ammonia (mg/L)	< 0.021 mg/L for all WCZs				
Suspended Solids (mg/L)	Not to raise the natural ambient level by 30%				

The Agriculture, Fisheries and Conservation Department (AFCD) have developed a guideline for the protection of water quality at Fish Culture Zones (FCZs) and a maximum SS value of 50 mg/L is recommended. This

(1) ERM - Hong Kong, Ltd (2006) EIA Study for Liquefied Natural Gas (LNG) Receiving Terminal and Associated Facilities. For CAPCO. Register No.: AEIAR-106/2007, http://www.epd.gov.hk/eia/register/report/eiareport/eia_1252006/html/index.htm

(2) ERM - Hong Kong, Ltd (2010) EIA Study for Black Point Gas Supply Project. For CAPCO. Register No. AEIAR-150/2010, http://www.epd.gov.hk/eia/register/report/eiareport/eia_1782009/index.html

criterion has been adopted in previous approved EIA Reports [(1) (2) (3)]. Thus, for the purposes of assessment, the AFCD criterion is considered to be applicable for the Tung Lung Chau and Po Toi O Fish Culture Zone.

In accordance with the WQO, the DO criterion for FCZs is set at > 5 mg/L measured as water column average.

The Water Supplies Department (WSD) has a set of standards for the quality of abstracted seawater (Table 3.2). Water quality of WSD's seawater intakes have been assessed against an SS criterion of < 10 mg/L and DO criterion of >2 mg/L.

Table 3.2 WSD Water Quality Criteria for Flushing Water Intakes

Parameter	Criterion
Colour (HU)	< 20
Turbidity (NTU)	< 10
Threshold Odour No.	< 100
Ammoniacal Nitrogen (mg/L)	< 1
Suspended Solids (mg/L)	< 10
Dissolved Oxygen (mg/L)	> 2
5-day Biochemical Oxygen Demand (mg/L)	< 10
Synthetic Detergents (mg/L)	< 5
E. coli (cfu/100mL)	< 20,000

There are no existing regulatory standards or guidelines for dissolved metals and organic contaminants in the marine waters of Hong Kong. It is thus proposed to make reference to relevant international standards and this approach has been adopted in previous approved EIAs, i.e., *EIA for Decommissioning of Cheoy Lee Shipyard at Penny's Bay* [(4)], *EIA for Disposal of Contaminated Mud in the East Sha Chau Marine Borrow Pit* [(5)], *EIA for Wanchai Development Phase II* [(6)], *EIA for Liquefied Natural Gas (LNG) Receiving Terminal and Associated Facilities* [(7)],*EIA for Hong Kong Offshore Wind Farm in Southeastern Waters* [(8)] and *EIA for Shatin to Central Link Cross Harbour Section (Phase II -*

(1) ERM – Hong Kong, Ltd (2002) EIA for the Proposed Submarine Gas Pipeline from Cheng Tou Jiao Liquefied Natural Gas Receiving Terminal, Shenzhen to Tai Po Gas Production Plank, Hong Kong. Final EIA Report. For the Hong Kong and China Gas Co., Ltd.

(2) Maunsell (2001) EIA for Tai Po Sewage Treatment Works - Stage V. Final EIA Report. For Drainage Services Department, Hong Kong SAR Government.

(3) ERM - Hong Kong, Ltd (2007) Liquefied Natural Gas (LNG) Receiving Terminal and Associated Facilities. For CAPCO. Final EIA Report. December 2006

(4) Maunsell (2002). EIA for Decommissioning of Cheoy Lee Shipyard at Penny's Bay. For Civil Engineering Department, Hong Kong SAR Government.

(5) ERM – Hong Kong (1997). EIA for Disposal of Contaminated Mud in the East Sha Chau Marine Borrow Pit. For Civil Engineering Department, Hong Kong SAR Government.

(6) Maunsell (2001). EIA for Wanchai Development Phase II - Comprehensive Feasibility Study. For Territory Development Department, Hong Kong SAR Government.

(7) ERM - Hong Kong, Ltd (2006) Op Cit

(8) BMT Asia Pacific Ltd (2009). EIA for Hong Kong Offshore Wind Farm in Southeastern Waters. For HK Offshore Wind Limited

Hung Hom to Admiralty) [1]. *Table 3.3* shows the assessment criteria for dissolved metals and organic pollutants for this Study.

Table 3.3 ***Summary of Assessment Criteria for Dissolved Metals and Organic Compounds for Construction Phase***

Parameter	Unit	Assessment Criteria for this Study
Metals		
Cadmium (Cd)	µg/L	2.5 (a) (b)
Chromium (Cr)	µg/L	15 (a) (b)
Copper (Cu)	µg/L	5 (a) (b)
Nickel (Ni)	µg/L	30 (a) (b)
Lead (Pb)	µg/L	25 (a) (b)
Zinc (Zn)	µg/L	40 (a) (c)
Mercury (Hg)	µg/L	0.3 (b)
Arsenic (As)	µg/L	25 (a) (b)
Silver (Ag)	µg/L	1.9 (d)
Total PAHs	µg/L	3.0 (f)
PCBs		
Total PCBs	µg/L	0.03 (d)
Organotins		
Tributyltin (TBT)	µg/L	0.1 (e) (maximum concentration)

Notes:

(a) UK Environment Agency, Environmental Quality Standards (EQS) for List 1 & 2 dangerous substances, EC Dangerous Substances Directive (76/464/EEC) (http://www.ukmarinesac.org.uk/activities/water-quality/wq4_1.htm).

(b) Annual average dissolved concentration (i.e. usually involving filtration a 0.45-um membrane filter before analysis).

(c) Annual average total concentration (i.e. without filtration).

(d) U.S. Environmental Protection Agency, National Recommended Water Quality Criteria, 2009. (http://www.epa.gov/waterscience/criteria/wqctable). The Criteria Maximum Concentration (CMC) is an estimate of the highest concentration of a material in surface water (i.e. saltwater) to which an aquatic community can be exposed briefly without resulting in an unacceptable effect. CMC is used as the criterion of the respective compounds in this study.

(e) Salazar MH, Salazar SM (1996) Mussels as Bioindicators: Effects of TBT on Survival, Bioaccumulation, and Growth under Natural Conditions. In Organotin, edited by M.A. Champ and P.F. Seligman. Chapman & Hall, London.

(f) Australian and New Zealand Environment and Conservation Council (ANZECC), Australian and New Zealand Guidelines for Fresh and Marine Water Quality (1992)

There are no existing regulatory standards or guidelines for total PCBs, total PAHs and TBT in water and hence reference has been made to the USEPA water quality criteria, Australian water quality guidelines, and international literature, respectively. The assessment criteria for total PCBs, total PAHs and TBT are 0.03 µg/L, 3.0 µg/L and 0.1 µg/L respectively. The same assessment criteria for these 3 chemicals are adopted in past approved EIA such as the approved EIA of Shatin to Central Link.

(1) AECOM (2011). EIA for Shatin to Central Link Cross Harbour Section (Phase II - Hung Hom to Admiralty) for MTR

3.2 *Working Time*

At this early stage it is understood that the intake structures and outfall diffusers of the proposed TKO Desalination Plant will be installed by trenchless method. As such dredging is limited to an area of the seabed for the installation of the above-seabed portion of the outfalls and intake structures.

The works programme for construction activities for the submarine facilities is based on the assumption of a 12 working hour day with 7 working days per week.

3.3 *Overview Of Dredging Plant - Grab Dredgers*

Grab dredgers may release sediment into suspension by the following mechanisms:

- Impact of the grab on the seabed as it is lowered;
- Washing of sediment off the outside of the grab as it is raised through the water column and when it is lowered again after being emptied;
- Leakage of water from the grab as it is hauled above the water surface;
- Spillage of sediment from over-full grabs;
- Loss from grabs which cannot be fully closed due to the presence of debris;
- Release by splashing when loading barges by careless, inaccurate methods; and
- Disturbance of the seabed as the closed grab is removed.

In the transport of dredging materials, sediment may be lost through leakage from barges. However, dumping permits in Hong Kong include requirements that barges used for the transport of dredging materials have bottom-doors that are properly maintained and have tight-fitting seals in order to prevent leakage. Given this requirement, sediment release during transport is not proposed for modelling and its impact on water quality will not be addressed under this Study.

Sediment is also lost to the water column when discharging material at disposal sites. The amount that is lost depends on a large number of factors including material characteristics, the speed and manner in which it is discharged from the vessel, and the characteristics of the disposal sites. It is considered that potential water quality issues associated with disposal at the intended government disposal site(s) have already been assessed by Civil Engineering and Development Department (CEDD) and permitted by EPD, hence and the environmental acceptability of such disposal operations is demonstrated. Therefore modelling of impacts at disposal sites does not need to be addressed and reference to relevant studies will be provided in the EIA for this Project where appropriate.

Loss rates have been taken from previously accepted EIAs in Hong Kong [(1)(2)(3)] and have been based on a review of worldwide data on loss rates from dredging operations undertaken as part of assessing the impacts of dredging areas of Kellett Bank for mooring buoys [(4)]. The assessment concluded that for 8 m^3 (minimum) grab dredgers working in areas with significant amounts of debris on the seabed (such as in the vicinity of existing mooring buoys) that the loss rates would be 25 kg m^{-3} dredged, while the grab dredger bucket size in areas where debris is less likely to hinder operations could be 12 or 16 m^3, with a loss rate of 17 kg m^{-3}. It is assumed there is little debris based on the fact the area is away from marine works and heavy marine traffic / industry. The value of 17 kg m^{-3}, for dredgers with grab size of 12 or 16 m^3, will therefore be used for this Study.

Generally, a split-bottom barge could have a capacity of 900 m^3. A bulk factor of 1.3 would normally be applied, giving a dredging rate of about 700 m^3 per barge. The hopper dry density for an 800 to 1,000 m^3 capacity barge is around 0.75 to 1.24 ton m^{-3}. Assuming 12 working hours per day for the proposed construction activities, with allowance on the demobilisation of filled barge and remobilisation of empty barges, approximately 5 barges could be filled per day, giving a daily dredging rate of approximately 3,500 m^3.

3.4 *CONSTRUCTION SCENARIO – GRAB DREDGING FOR SUBMARINE OUTFALL*

The dredging operations for the outfall and seawater intake will be carried out by one closed grab dredger. The estimated dredged volumes are approximately 1,740 m^3 (seawater intake) and 4,590 m^3 (submarine outfall). Working hours are assumed to be 12 hours per day with a maximum dredging rate of 3,500 m^3 day^{-1} (i.e. 0.081 m^3 s^{-1}) per dredger, giving a rate of release (in kg s^{-1}) of sediment for one dredger as follows:

Loss Rate (kg s^{-1})

*= Dredging Rate (m^3 s^{-1}) * Loss Rate (kg m^{-3})*

*= 0.081 m^3 s^{-1} * 17 kg m^{-3}*

(1) ERM - Hong Kong, Ltd (2006) *EIA Study for Liquefied Natural Gas (LNG) Receiving Terminal and Associated Facilities.* For CAPCO. Register No.: AEIAR-106/2007, http://www.epd.gov.hk/eia/register/report/eiareport/eia_1252006/html/index.htm

(2) ERM (2005). *Detailed Site Selection Study for a Contaminated Mud Disposal Facility within the Airport East/East of Sha Chau Area. EIA and Final Site Selection Report*. For CEDD. Approved on 1 September 2005. Register No.: AEIAR-089/2005, http://www.epd.gov.hk/eia/register/report/eiareport/eia_1062005/index.htm

(3) ERM (2000). *Construction of an International Theme Park in Penny's Bay of North Lantau together with its Essential Associated Infrastructures – Final EIA Report.* For CEDD. Approved on 28 April 2000. Register No.: AEIAR-032/2000 http://www.epd.gov.hk/eia/register/report/eiareport/eia_0412000/index.html

(4) ERM (1997). *EIA: Dredging an Area of Kellett Bank for Reprovisioning of Six Government Mooring Bays. Working Paper on Design Scenarios.* For CEDD.

= 1.3773 kg s⁻¹

Therefore a continuous release rate of **1.3773 kg s^{-1}** for one dredger will be adopted in the model for release throughout the whole water column. Given the small extent of marine dredging area, one stationary source at the outfall discharge point is assumed in the model to represent the grab dredger. It should be noted that while the whole dredging would last for only 2 days at the assessed peak dredging rate (6,330 m^3 ÷ 3,500 m^3/day = 1.81 day), the modelled sediment release would last for a whole 15-day spring-neap cycle to ensure all possible worst-case tidal conditions are included in the simulation. The sediment plume modelling period would last for one more spring-neap cycle (total simulation period: 30 days) to allow sufficient time for any suspended solid release to reach the potential WSRs.

Table 3.3 summarises the inputs defined in the sediment dispersion simulation for construction phase modelling scenario.

Table 3.4 Summary of Model Inputs for Construction Phase Modelling

Emission Point		Dredging for Submarine Outfall
No. of Working Plant		1 Grab Dredger with a grab size of 12 or 16m^3
Dredging Rate	**m^3/day/plant**	3,500
Operation Duration	**hours**	12
Loss Type		Continuous
Loss Rate	**kg m^{-3}**	17
Loss Rate	**kg s-1**	1.3773
Input Layer		Whole Column

3.5 *SEDIMENT INPUT PARAMETERS*

For simulating sediment impacts the following general parameters will be assumed:

- Settling velocity – 0.5 mm/s
- Critical shear stress for deposition – 0.2 N/m^2
- Critical shear stress for erosion – 0.3 N/m^2
- Number of particles used – 4,462,500
- Resuspension rate – 30 g/m^2/d

The above parameters have been used to simulate the impacts from sediment plumes in Hong Kong associated with uncontaminated mud disposal into the Brothers MBA [(1)] and dredging for the Permanent Aviation Fuel Facility at Sha Chau [(2)]. The critical shear stress values for erosion and deposition were

(1) Mouchel (2002a). *Environmental Assessment Study for Backfilling of Marine Borrow Pits at North of the Brothers. Environmental Assessment Report.*

(2) Mouchel (2002b). *Permanent Aviation Fuel Facility. EIA Report.* Environmental Permit EP-139/20

determined by laboratory testing of a large sample of marine mud from Hong Kong as part of the original Water Quality and Hydraulic Mathematical Model (WAHMO) studies associated with the new airport at Chek Lap Kok.

4 OPERATION PHASE

4.1 ASSESSMENT CRITERIA FOR OPERATION PHASE

Five types of waste streams during operation of the desalination plant are discussed. These waste streams are listed in *Table 4.1* and are further discussed in sections below. Sewage effluent from working staff during Project operation would be discharged to public sewer and would be addressed qualitatively in the EIA but not addressed further in the sections below.

Table 4.1 Various Types of Discharge from the Project during Operation

Waste Stream Discharge	Occasion / Frequency	Description
Reverse osmosis concentrate	Normal operation	Effluent contains components of concentrated seawater
Bio-growth control at inlet	6 hours per 5 days	Sodium hypochlorite or chlorine would be used for anti-fouling. Sodium metabisulphite would be used for dechlorination.
Bio-growth control at pretreatment unit	30 min per 24 hours	Sodium hypochlorite or chlorine would be used for anti-fouling. Sodium metabisulphite would be used for dechlorination.
Effluent from chemical cleaning of RO unit	4 to 8 hours for every 4 to 6 months	Acids, base and surfactant would be used for chemical cleaning. All wastewater from chemical cleaning RO unit would be neutralized before discharge to public sewer.
Emergency discharge	During power failure and plant failure	Water extraction and the desalination process would stop. No uncontrolled discharge expected.

4.1.1 *Reverse osmosis concentrate*

Based on the preliminary design of the Desalination Plant, the proposed effluent standards upon commissioning of the Project are summarised in *Table 4.2*. It is important to note that there will be no additional particulate contaminants, metal contaminants and nutrients (nitrogen- or phosphorus-bearing) in the reverse osmosis (RO) concentrate. The major constituents that are presented are soluble cations /anions (sodium, potassium, calcium, magnesium, strontium, sulphate, chloride and boron) which originate from the extracted marine water. These ions are themselves highly abundant in marine water and are of no particular water quality or environmental concern. Since no heating is involved in the desalination process, the temperature of the RO concentrate would be similar to the ambient water temperature. The effluent will also have a dissolved oxygen (DO) level that is similar to ambient

DO level in the seawater. Chemicals added for coagulation (ferric chloride and polymer) and pH adjustment (sulphuric acid and hydrochloric acid) would be removed during the pre-treatment process or neutralized and would not be present in the RO concentrate at a significant level. Consequently, the above constituents will not be quantitatively assessed in the assessment. Antiscalant would also be added during the desalination process and is expected to present in the RO concentrate. With reference to the characteristics of effluent from the desalination plant (see *Table 4.2*), the operation phase modelling will consider five key parameters, namely salinity, iron (Fe), antiscalant, total inorganic nitrogen (TIN) and suspended solids (SS), for a focused assessment. The pretreatment unit will be backwashed from time to time to remove the substance accumulated. Yet all the wash water from backwash will be treated to remove solid constituent and be recycled into the inlet. No discharge would be involved.

WQOs will be used as criteria to assess salinity and SS change as shown in *Table 4.3*. The assessment criterion for Fe is with reference to *Australian and New Zealand Guidelines for Fresh and Marine Water Quality* (ANZECC). This assessment criterion is deemed the most conservative when compared with a number of water quality criteria adopted around the world, which include,

(1) The UK Technical Advisory Group on the Water Framework Directive recommended level of 1 mg/L for long-term standard in saltwater. (http://www.wfduk.org/sites/default/files/Media/Environmental%20standards/Specific%20pollutants%20proposals_Final_010608.pdf, page 77 referred)

(2) ANZECC recommended 0.3 mg/L as interim indicative working level due to insufficient data. (http://www.environment.gov.au/system/files/resources/e10f8ee3-54b4-4e90-8694-50b6a3194b9d/files/nwqms-guidelines-4-vol2.pdf, page 241 referred)

(3) Canadian Water Quality Guidelines for the Protection of Aquatic Life recommended 0.3 mg/L for protection of freshwater aquatic life. No water quality guideline for protection of marine life is recommended due to insufficient data. (https://www.halifax.ca/energy-environment/environment/documents/CWQG.PAL.summaryTable7.1.Dec2007.pdf, page 4 referred)

(4) Ministry of Environment, Province of British Columbia recommended short-term maximum guideline for total iron is 1 mg/L and for dissolved iron is 0.35 mg/L for protect freshwater aquatic life. No water quality guideline for protection of marine life is recommended due to insufficient data. (http://www.env.gov.bc.ca/wat/wq/BCguidelines/iron/iron_overview.pdf, page 3 referred)

(5) There are no established national 304(a) acute or chronic criteria for iron from the USEPA due to insufficient data. A level of 1 mg/L is recommended in the USEPA Quality Criteria of Water (A.K.A. the Red Book) for protection of freshwater aquatic life. But there is no corresponding criterion for marine water. (http://water.epa.gov/scitech/swguidance/standards/criteria/current/upload/2009_01_13_criteria_redbook.pdf, page 181 referred)

Based on the material safety data sheet (MSDS) of typical anti-scalant products (phosphonate-based and polymer-based), anti-scalant is known to be low in toxicity to aquatic fish and human. Toxicity studies indicated that LC50 for most test organisms would be in the order of hundreds or thousands of mg/L, which would be well above the expected discharge concentration and is not considered a major concern on water quality. As such, there is no commonly used water quality standard for anti-scalant. For the purpose of deriving a Predicted No-Effect Concentration (PNEC) from the toxicology data of the antiscalant, reference would be made to the method proposed under the *Technical Guidance Document on Risk Assessment* by the European Chemical Bureau of the Institute for Health and Consumer Protection under the European Commission. An assessment factor of 1000 would be applied to the available LC50 data of the proposed antiscalant, i.e. the proposed assessment criteria for the antiscalant would be one thousandth of the LC50 data available, for conservative assessment. The lowest LC50 value (362 mg/L for algae) from the MSDSs of the potential antiscalant candidates would be used for the calculation and the assessment criteria for antiscalant under this Study would be 0.362 mg/L.

Table 4.2 Proposed Effluent Discharge Standards of TKO Desalination Plant upon Commissioning

Parameters	Upper Limit
Discharge from Normal Operation	
Discharge Flow Rate	464000 m^3/day
Fe	0.6 mg/L
Total Phosphorus	1 mg/L
Total Inorganic Nitrogen	2 mg/L
Salinity	65000 mg/L
pH	6-9
SS	13 mg/L
Anti-scalant	8 mg/L
Discharge to Marine Water during Bio-growth control	
pH	6-9
Sodium Metabisulphite (SMBS)	0.5 mg/L
Total Residual Chlorine (TRC)	0.1 mg/L
Discharge to Public Sewer during Chemical Cleaning	
Maximum Amount Discharged per Event	514.8 m^3
Fe	0.6 mg/L
pH	6-9
SS	13 mg/L
Citric acid	10-30 mg/L
Sodium lauryl sulphate	10-30 mg/L

Table 4.3 Summary of Assessment Criteria for Operation Phase

Parameters	**Assessment Criteria**				
	Junk Bay	**Eastern Buffer**	**Port Shelter**	**Mirs Bay**	**Southern**
Salinity (mg/L)	Change not to exceed 10% of natural ambient level				
Iron (mg/L)	< 0.3 mg/L [(a)]				
pH	6.5-8.5				
Total Inorganic Nitrogen (mg/L)	< 0.3	< 0.4	< 0.1	< 0.3	< 0.1
Suspended Solids (mg/L)	Not to raise the natural ambient level by 30%				
SMBS	Oxygen depletion due to sodium metabisulphite not to exceed WQO criterion (5 mg/L for fish culture zones, 4 mg/L for other WSRs)				
TRC	0.02 mg/L [(b)]				
Antiscalant	0.362 mg/L (One thousandth of the levels indicated by the available LC50 data [(c)])				

Notes:

(a) Australian and New Zealand Environment and Conservation Council (ANZECC), Australian and New Zealand Guidelines for Fresh and Marine Water Quality (2000) – Interim indicative working level. (http://www.environment.gov.au/system/files/resources/e10f8ee3-54b4-4e90-8694-50b6a3194b9d/files/nwqms-guidelines-4-vol2.pdf).

(b) Tender Ref. WP 98-567 Provision of Service for Ecotoxicity Testing of Marine Antifoulant – Chlorine in Hong Kong Final Report January 2000. Submitted to Environmental Protection Department by the Centre for Coastal Pollution and Conservation, City University of Hong Kong.

(c) Technical Guidance Document on Risk Assessment. European Chemical Bureau, Institute for Health and Consumer Protection, European Commission. (http://ihcp.jrc.ec.europa.eu/our_activities/public-health/risk_assessment_of_Biocides/doc/tgd/tgdpart2_2ed.pdf)

4.1.2 Bio-growth control at inlet/Bio-growth control at pretreatment unit

Chlorine / sodium hypochlorite will be used for bio-growth control at inlet and pretreatment unit. SMBS would be added to the effluent to remove any TRC as far as practicable. The reaction between TRC and SMBS would results only chloride, sodium and sulphate ions, which are all highly abundant in marine environmental, low or nil toxicity and are considered not to be of concern to water quality. These ions would be discharged as part of the RO concentrate into marine water. As shown in *Table 4.3*, low level of unreacted chlorine and SMBS may be left in the discharged effluent. The level of TRC and SMBS at WSRs would be assessed would be predicted using CORMIX (near field) and Delft3D PART.

It should be noted that the level of organics in marine water near the Project (indicated by the average 5-day biochemical oxygen demand at EPD monitoring station EM2) is quite low (below 1.1 mg/L in 2013). The amount of organics available for reaction with chlorine from bio-growth control would be limited and the generation of chlorination-byproducts is expected to be limited as well. The addition of antiscalant, which is organic in nature, would be conducted after the removal of chlorine from the bio-growth control exercise. The risk of formation of chlorination-by-products would also be low. No unacceptable water quality impact from chlorination by-products is expected.

Since the effluent from the treatment plant would be completely sterile due to the chlorination upstream, there is no need for bio-growth control for the outlet.

Same as other water treatment plants, the processed potable water stream will also be chlorinated at the final stage of treatment. Yet this stream would unlikely be discharged into marine water in any mean. No adverse water quality impact is expected.

4.1.3 Effluent from chemical cleaning of RO unit

Chemical cleaning is a process of removal of mineral scale, biological matter, colloidal particles and insoluble organic constituents deposited on the RO membrane by chemical method. The deposited substance, which deposited on the RO membrane due to the local increase of solute concentration during the RO process, would be dissolved, detach or re-suspended in the cleaning solution in response to the change in pH, allowing easy removal. Based on the latest design information, acids (hydrochloric acid and citric acid), base (sodium hydroxide) and surfactant (sodium lauryl sulphate) would be used to remobilize the deposited substance from the RO unit. The amount of wash water is expected to be below 514.8 m^3 for each cleaning event, which would last for 4 to 8 hours. The wash water would be neutralized and treated to the relevant WPCO standard before discharge into the public sewer. No adverse water quality from the chemical cleaning of RO unit is expected.

4.1.4 Emergency discharge

In case of plant failure or power failure, the desalination plant would stop extracting water from the intake. Any effluent discharge would stop soon afterwards. No uncontrolled discharge is expected and no adverse water quality impact is expected from plant failure or power failure.

4.2 MODELLING SCENARIOS FOR OPERATION PHASE

For the study of operational effects, the approach requires several steps:

1) Running Delft3D-Flow model without the operational of the desalination plant for the baseline conditions.

2) Running a near-field model (i.e. CORMIX) for the operational discharges to characterise the initial mixing of the effluent discharge. Flow generated by Delft3D-Flow will be used as input for CORMIX to provide hydrodynamic conditions for near-field modelling. The results from the CORMIX analysis will also provide information of the near field dispersion and dilution of the effluent plumes.

3) Running Delft3D-FLOW model with adapting the operation of the desalination plant for the new condition (wet/dry season) covering a spring-neap cycle. The vertical profile of effluent plume predicted under the CORMIX near field modelling would be adopted in the far field saline discharge of the FLOW simulation. Compare changes in hydrodynamic (if any) for with and without project scenarios and determine whether rerun of near-field model would be required. Repeat step 2 above as appropriate. Salinity and Temperature will be specifically assessed for the compliance with Water Quality Objectives (WQOs) upon the modelling results.

4) Running Delft-PART model. A Delft-PART model approach is proposed in which SS, Fe, TRC and SMBS will be simulated respectively and explicitly. The objective of the Delft-PART model is to quantitatively assess the concentrations of key water quality variables (SS, iron, SMBS and TRC) as a result of effluent discharge from the submarine outfall in the far field. In the modelling process, it is assumed that Fe and SMBS is a conservative substance and no adsorption process occurs. This is a rather conservative method to assess the impacts from Fe and SMBS. For SMBS, the maximum oxygen depletion due to the presence of SMBS would be compared against the allowed level by WQO. For TRC, the chlorine decay value (T90 = 8289s), which were adopted in both EIAs of HATS 2A [(1)] and Express Rail Link [(2)], would be used under this Study. This T90 factor is the most conservative value and upon our review of relevant past EIA studies.

4.2.1 *Effluent Discharge and Submarine Outfall Design*

The latest project information suggests that the discharge rate will be 464,000 m^3/day. The discharge stream will be simulated in the operation phase modelling scenarios using CORMIX.

Tentative outfall design and modelling parameters for CORMIX are tabulated in *Table 4.3* and *Table 4.4* at this stage of assessment. Further results of near field modelling would be provided in the water quality section of the EIA.

It should be noted that the discharge of RO concentrate may alter the far field hydrodynamic near the outfall. Such effect has not been taken into account in the far field model which provides the ambient flow condition for the near field CORMIX simulation. To ensure the robustness of the simulation and modelling prediction, an additional iteration of far field hydrodynamic modelling (Delft3D FLOW) would be conducted taking into account the effluent discharge from the desalination plant outfall. Another additional iteration of near field CORMIX modelling would be conducted based on the ambient conditions provided by the second iteration of far field modelling.

(1) ENSR Asia (HK) Ltd (2008). *Harbour Area Treatment Scheme Stage 2A EIA Study – Investigation. Environmental Impact Assessment Report.*

(2) AECOM Asia Co. Ltd (2009). *Environmental Impact Assessment of Hong Kong Section of Guangzhou-Shenzhen-Hong Kong Express Rail Link. Environmental Impact Assessment Report.*

The results of two iterations of the near field simulations would be compared and checked to see if the far field effect of the discharge from the desalination plant has been sufficient taken into account.

Table 4.4 Tentative Outfall Design

Parameter	Information
No. of discharge ports in the diffuser	36
Diameter of discharge port	150 mm
Configuration of discharge port	Ports are alternating and to be inclined at 60 degree to horizontal. Port spacing is 4.2 m.
Location of diffuser from the nearest coastline	The first diffuser is designed to be 200 m away from the nearest coastline
Discharge Depth	10 m

Table 4.5 CORMIX Modelling Scenarios and Corresponding Parameters

<table>
<tr><th colspan="2" rowspan="3">Parameter</th><th colspan="2">Scenarios</th></tr>
<tr><th>D10 / D50 / D90</th><th>W10 / W50 / W90</th></tr>
<tr><th>Dry season</th><th>Wet season</th></tr>
<tr><td rowspan="3">Discharge Parameters</td><td>Discharge Type</td><td colspan="2">Submerged discharge (60 degree to horizontal) at sea bottom with 1500 mm diameter pipe</td></tr>
<tr><td>Total discharge flow rate</td><td colspan="2">464000 m^3/day</td></tr>
<tr><td>Upper limit Concentration of Effluent</td><td colspan="2">SS = 13 mg/L
Fe = 0.6 mg/L
Tin = 2 mg/L
Anti-scalant = 8 mg/L
SMBS = 0.5 mg/L
TRC = 0.1 mg/L
Salinity = 65000 mg/L</td></tr>
<tr><td rowspan="5">Ambient Conditions</td><td>Ambient Velocity (1)</td><td>D10: 0.048 m/s;
D50: 0.122 m/s;
D90: 0.188 m/s.</td><td>W10: 0.071 m/s;
W50: 0.103 m/s;
W90: 0.156 m/s.</td></tr>
<tr><td>Water Depth at discharge outfall</td><td colspan="2">10 m</td></tr>
<tr><td>Average Surface (1) Water Density</td><td>1023.71 kg/m^3</td><td>1022.49 kg/m^3</td></tr>
<tr><td>Average Bottom (1) Water Density</td><td>1023.72 kg/m^3</td><td>1024.40 kg/m^3</td></tr>
<tr><td>Ambient Wind Speed</td><td colspan="2">2 m/s
(CORMIX's recommended value for conservative design condition)</td></tr>
</table>

Note:

(1) The water density is derived from simulated temperature and salinity from Delft3D FLOW modelling of TKO Refined Model at proposed submarine outfall. Ambient velocity and current direction is also derived from simulation results of Delft3D Flow modelling.

(2) Based on the results of far-field hydrodynamic simulation, the ambient current is close to orthogonal to the outfall alignment. As such, all CORMIX simulations are carried out in cross-flow configuration.

5 CUMULATIVE IMPACTS

According to publicly available sources, a list of identified projects in the vicinity of TKO desalination plant is summarized below in *Table 5.1*.

Table 5.1 Nearby Projects Identified

Project	Duration	Location	Major Marine Activity
Project Asia Pacific Gateway – Tseung Kwan O	2014 Q1-Q3	Junk Bay, Eastern Buffer, Southern and Mirs Bay Water Control Zone	Submarine cable installation
Cross Bay Link	January 2017 - July 2020	Junk Bay	Construction of bridge piers
Tseung Kwan O – Lam Tin Tunnel and Associated Works	February 2016 - April 2020	Junk Bay	Reclamation
Truck Road T2	Late 2015 - Late 2020	Kwun Tong Typhoon Shelter	Construction of submarine tunnel
Backfilling Marine Borrow Areas at East Tung Lung Chau	Closure date unknown	Marine Waters east of Tung Lung Chau	Marine dumping

5.1 PROJECT ASIA PACIFIC GATEWAY – TSEUNG KWAN O

According to project profile of direct-to-permit application DIR-233/2013, this project involves laying of cable in marine waters from Junk Bay, Eastern Buffer, Southern and Mirs Bay Water Control Zone. The marine works would last for around 60 days and is scheduled from Q1 to Q3 of 2014. No cumulative water quality impact is expected from this project.

5.2 CROSS BAY LINK

Based on the approved EIA of the captioned project, this project involves the construction of an approximately 1.8 km long dual two-lane road mainly on viaduct with a footpath and a cycle track. The construction of the Cross Bay Link is scheduled from January 2017 to July 2020 while the marine dredging and foundation working would be completed in 2018. It is expected that the marine works under the Cross Bay Link may potentially be conducted concurrently with marine working under this Project. To ensure consistency of modelling results with the approved EIA, the maximum SS elevation predicted at nearby WSRs under the approved EIA would be taken into account in assessing the cumulative water quality impact.

5.3 *TSEUNG KWAN O – LAM TIN TUNNEL AND ASSOCIATED WORKS*

Based on the approved EIA of the captioned project, this project involves the construction of a dual two-lane highway connecting Tseung Kwan O at Po Yap Road in the east with Trunk Road T2 in Kai Tak Development in the west and Lei Yue Mun Road Underpass. The project involves a 4.8 km long highway with about 3 km of the highway in the form of a tunnel. The Tseung Kwan O – Lam Tin Tunnel will connect Cross Bay Link to form a new external road link to meet the anticipated traffic flow in connection with further population intake and development in Tseung Kwan O New Town. The construction of the Tseung Kwan O – Lam Tin Tunnel and Associated Works is scheduled from February 2016 to April 2020 while the marine dredging and foundation working would be conducted between in May 2018 to August 2018. It is expected that the marine works under the Tseung Kwan O – Lam Tin Tunnel and Associated Works may potentially be conducted concurrently with marine working under this Project. To ensure consistency of modelling results with the approved EIA, the maximum SS elevation predicted at nearby WSRs under the approved EIA would be taken into account in assessing the cumulative water quality impact. It should be noted that the water quality modelling of the EIAs for the Cross Bay Link and the Tseung Kwan O – Lam Tin Tunnel were conducted together and the cumulative impact from both projects would be considered at the same time under this Project.

5.4 *TRUNK ROAD T2*

Based on the approved EIA of Truck Road T2 (AEIA174/2013), the project is to construct a dual two-lane trunk road of approximately 3 km long with about 2.7 km of the trunk road in form of tunnel between Cha Kwo Ling and South Apron of the former Kai Tak Airport. The project is located at > 6 km from the proposed desalination plant and submarine pipelines. The preliminary construction programme is anticipated between late 2015 and late 2020. According to the approved EIA, non-dredge method using tunnel boring machine would be adopted for the construction of Truck Road T2 and there will be no dredging and reclamation required. The potential water quality impact from the construction of Trunk Road T2 is expected to be minimal and no cumulative water quality impact is anticipated.

5.5 *BACKFILLING OF MARINE BURROW AREA AT EAST TUNG LUNG CHAU*

Based on our understanding, the captioned project would be stopped soon and there will be no more marine filling activity at the captioned facilities. A letter to CEDD has been issued to request for confirmation. CEDD's confirmation would be included in the water quality section of the EIA. As such, there will be not cumulative water quality impact from the captioned project.

6 MODEL SCENARIOS

The water quality modelling exercise will commence with the set-up of hydrodynamic baseline models (covering a complete spring/neap cycle for both the dry and wet seasons). It will be conducted with regard to two main components, construction phase and operation phase as detailed below.

- **Construction Phase**: the assessment will examine potential water quality impacts arising from dredging for the installation of one submarine outfall and the seawater intake, with the extent of seabed dredging of about 4,590 m^3 and 1,740 m^3 respectively;
- **Operation Phase**: the assessment will examine potential water quality impacts arising primarily from the effluent discharge from the desalination plant operation via the outfall.

Table 6.1 summarizes the proposed near-field and far-field modelling scenarios below:

Table 6.1 Proposed Far-field and Near-field Model Scenarios

Scenario ID	Project Phase	Project Activity	Model Year	Seasons
Far-field Delft3D Model				
C01	FLOW model for baseline	Baseline Model	Construction year	Wet Season
C02	FLOW model for baseline	Baseline Model	Construction year	Dry Season
C03	Sediment Plume Model (Delft-PART)	Outfall and intake construction	Construction year	Wet Season
C04	Sediment Plume Model (Delft-PART)	Outfall and intake construction	Construction year	Dry Season
O01	FLOW model for Operation (1)	Operation Model	Operation year	Wet Season
O02	FLOW model for Operation (1)	Operation Model	Operation year	Dry Season
O03	SS Model (Delft-PART)	Normal Operation	Operation year	Wet Season
O04	SS Model (Delft-PART)	Normal Operation	Operation year	Dry Season
O05	Iron (Delft-PART)	Normal Operation	Operation year	Wet Season
O06	Iron (Delft-PART)	Normal Operation	Operation year	Dry Season
Near-field CORMIX Model				
ND10	CORMIX for operation	Normal Operation	Operation year	Dry Season
ND50	CORMIX for operation	Normal Operation	Operation year	Dry Season
ND90	CORMIX for operation	Normal Operation	Operation year	Dry Season
NW10	CORMIX for operation	Normal Operation	Operation year	Wet Season
NW50	CORMIX for operation	Normal Operation	Operation year	Wet Season
NW90	CORMIX for operation	Normal Operation	Operation year	Wet Season

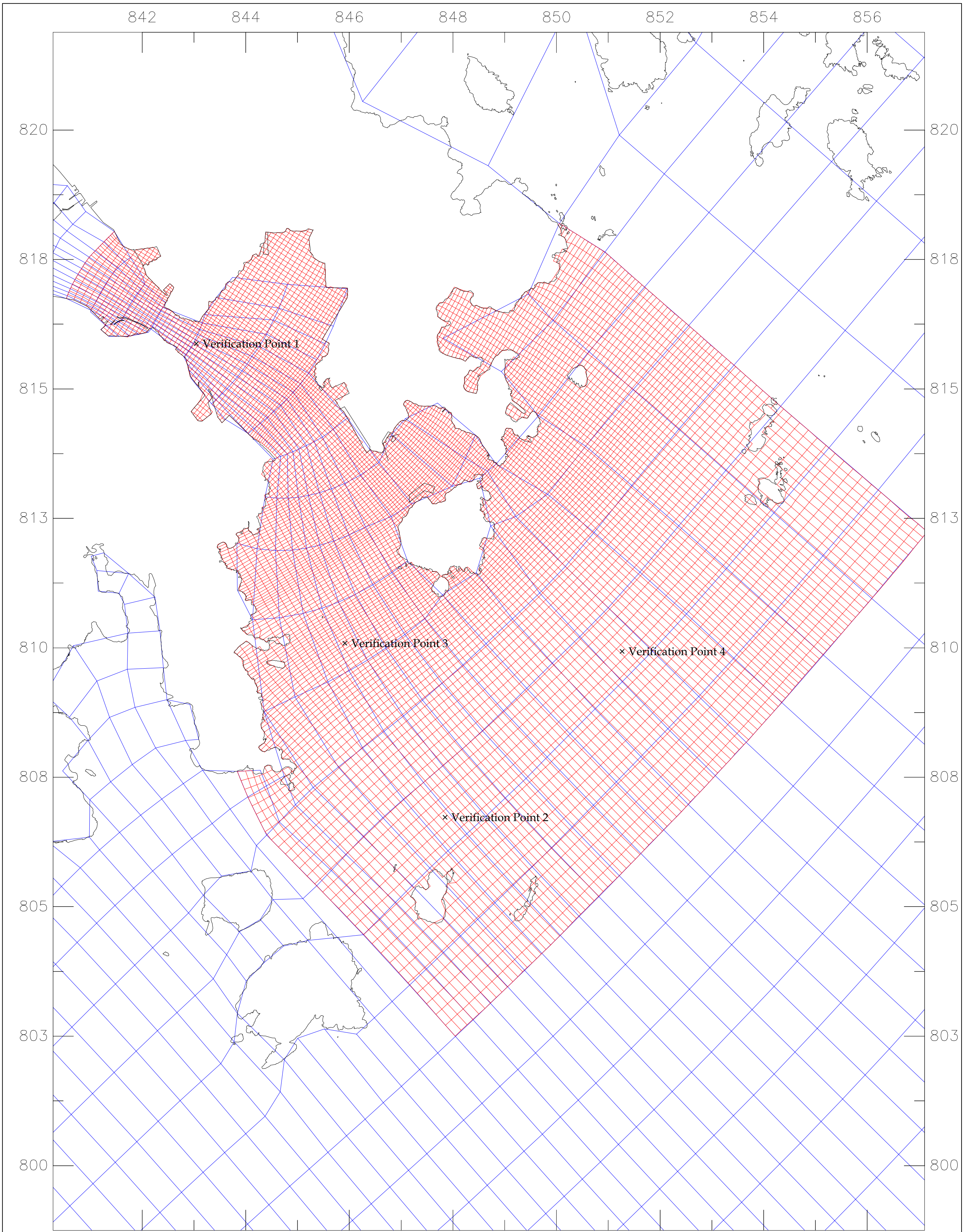
Note:

(1) Salinity will be specifically assessed for the compliance with Water Quality Objectives (WQOs) using the FLOW model results.

Annex A

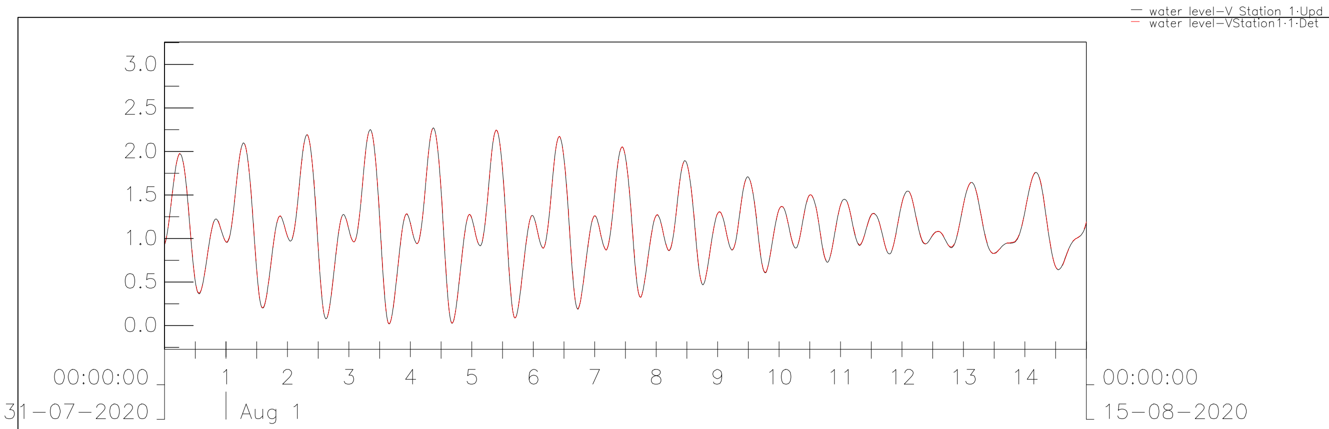
Delft3D FLOW Verification Plots

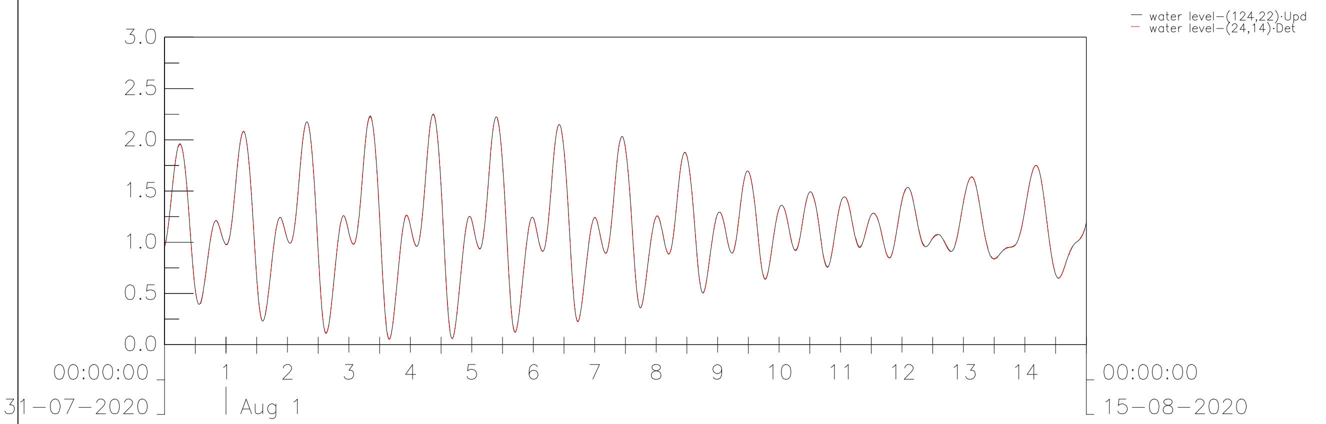
Location of
Verification Points

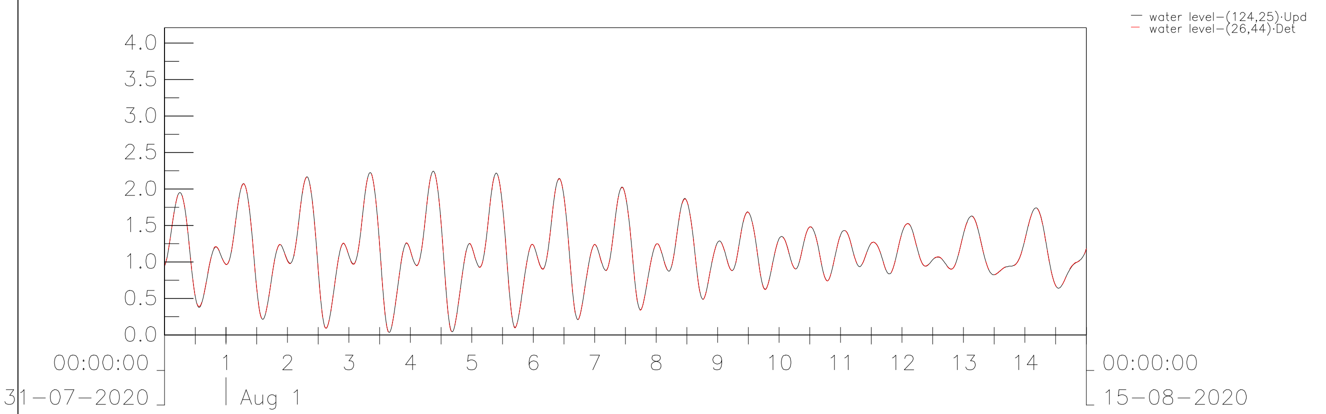


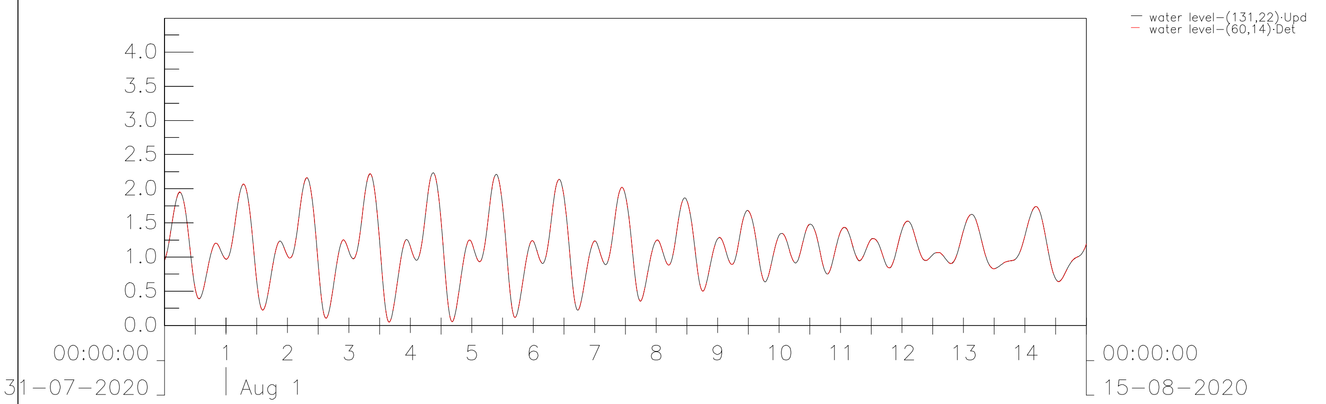
Desalination Plant at Tseung Kwan O – Feasibility Study Verification Points 1 to 4 Blue: Update Model; Red: Refine Model	Year 2020	Dry
	Annex A	
ERM HK Limited	GPP/Calibration	Grid.ssn

Timeseries Plots at Verification Points - Wet Season

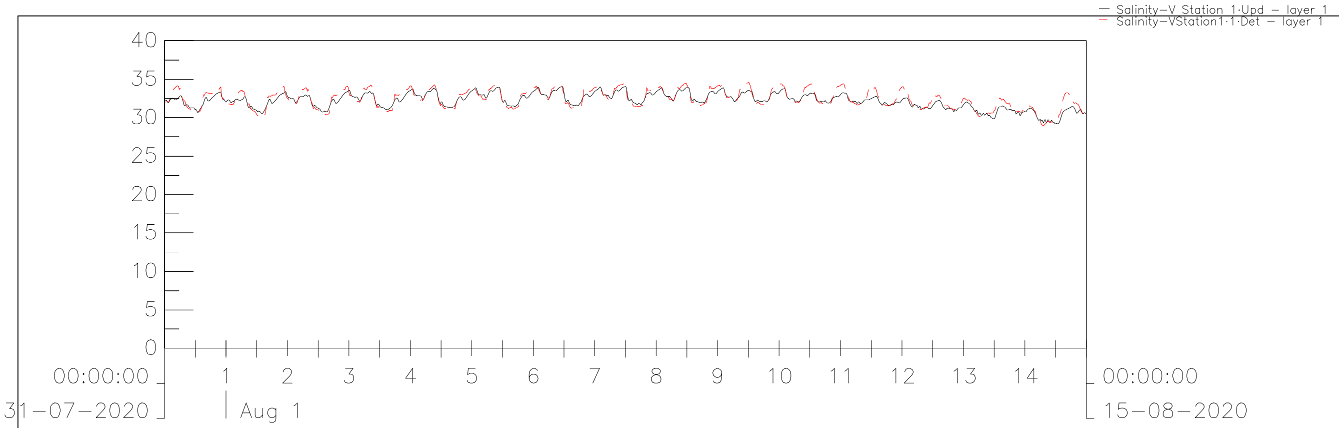


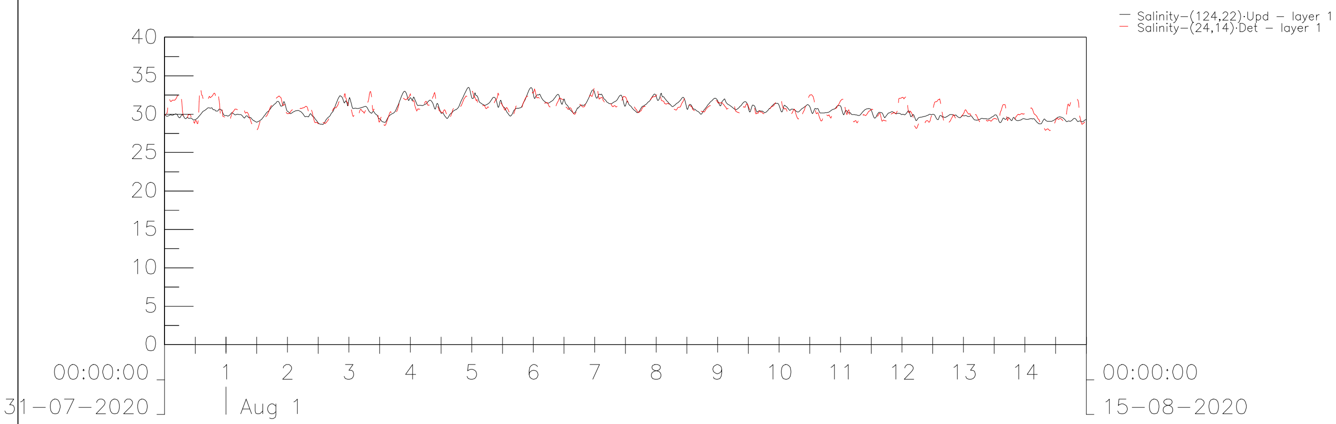


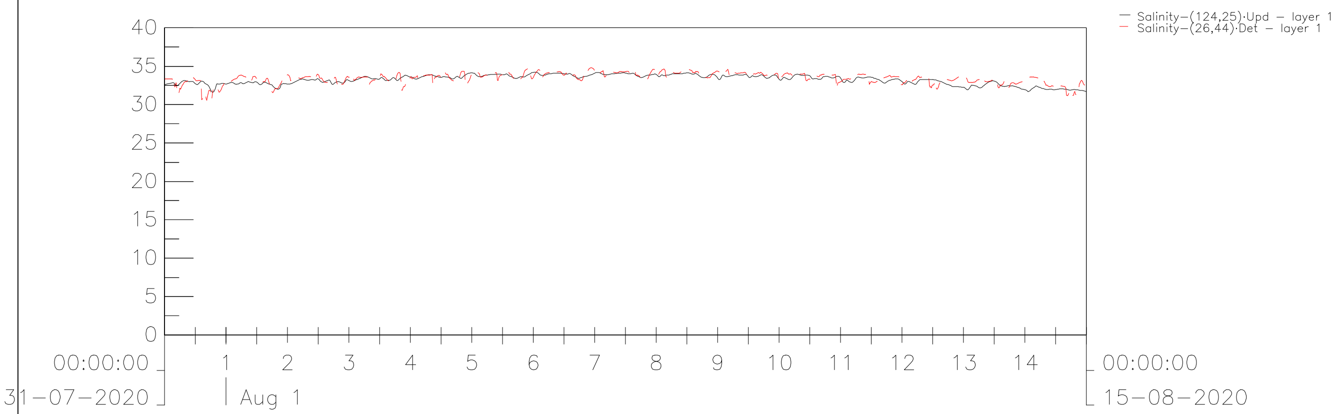


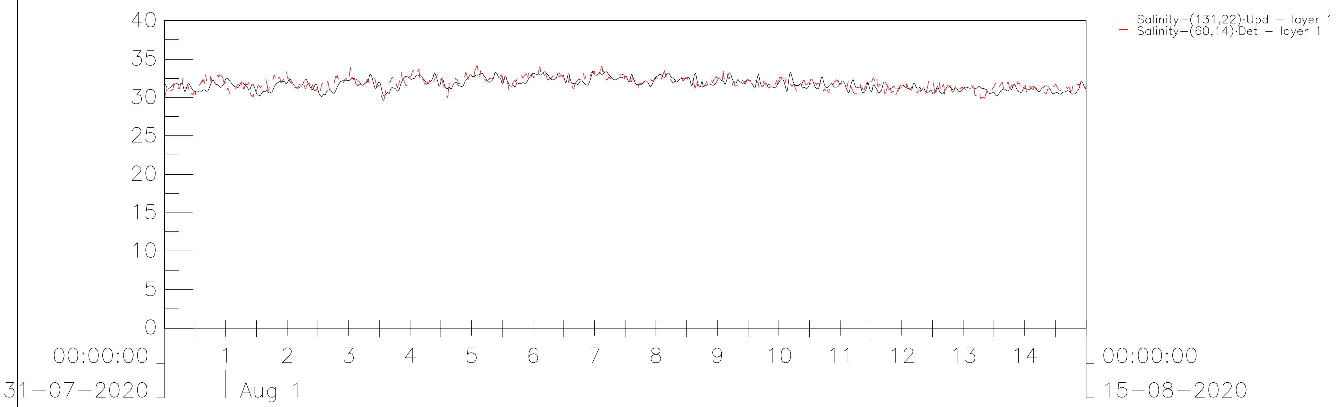


Desalination Plant at Tseung Kwan O – Feasibility Study Water Level · Dry Season (Black: Updated Model; Dashed Red: Refined Model) From top to bottom: Verification point 1 to 4	Year 2020	Dry
	Annex A	
ERM HK Limited	GPP/Verification	Ver.ssn

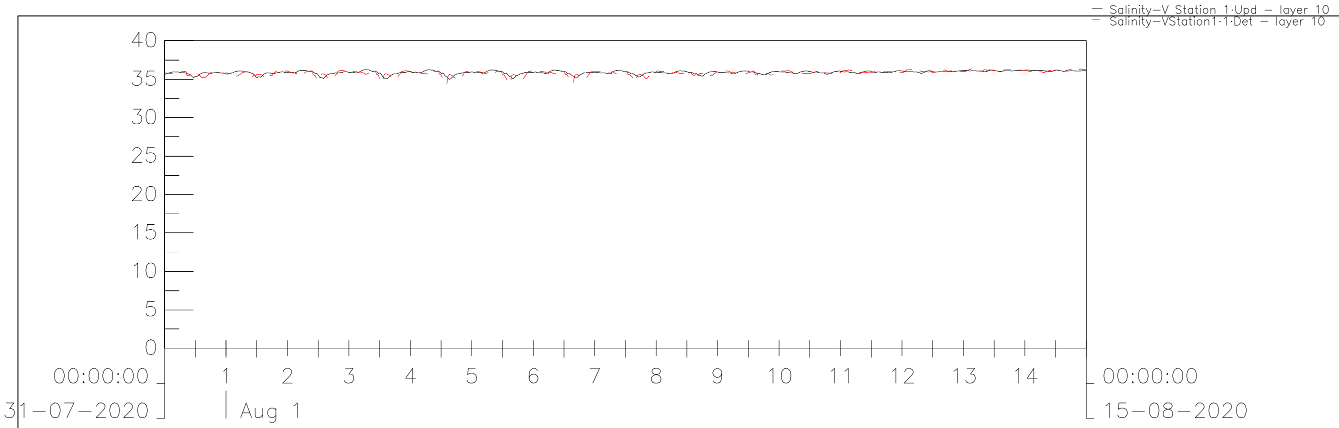


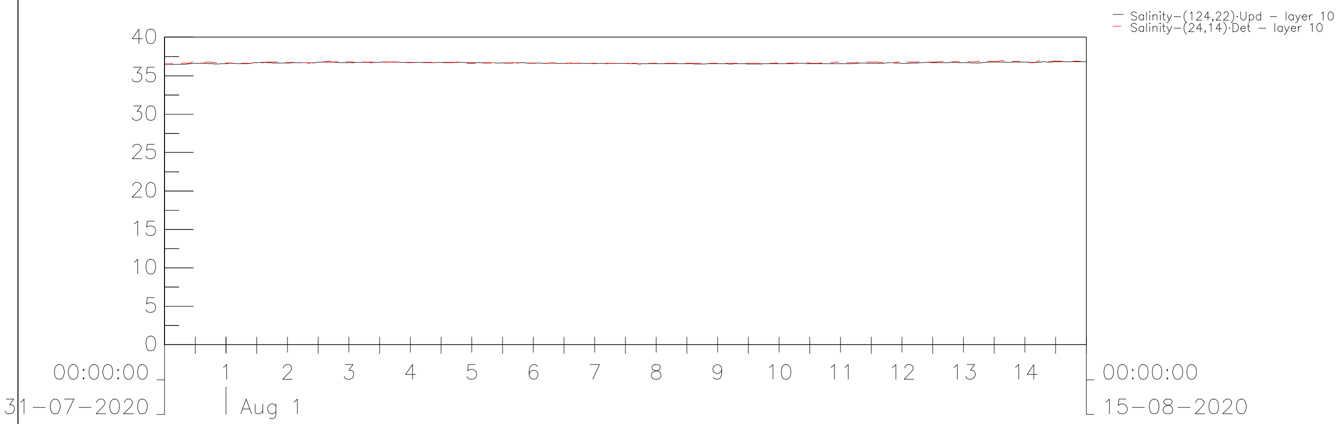


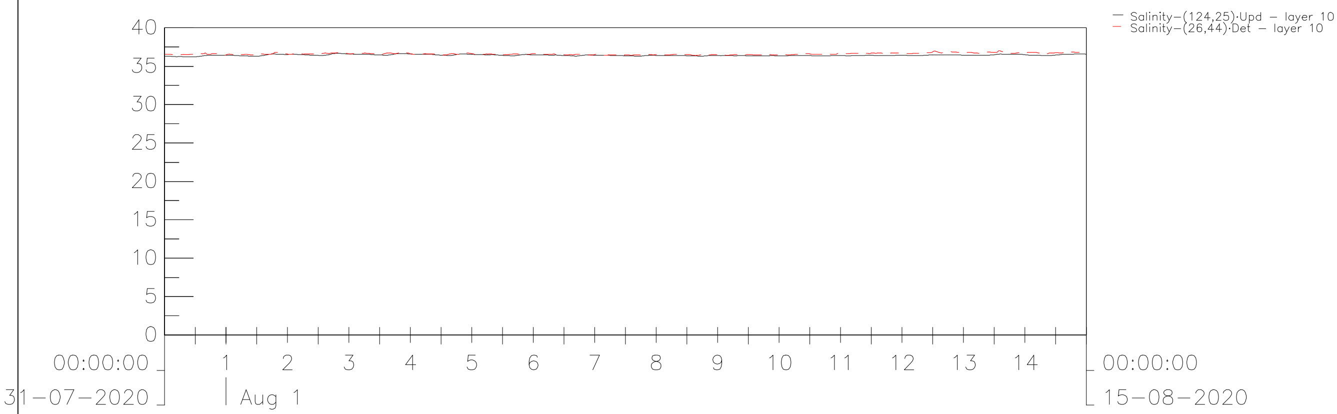


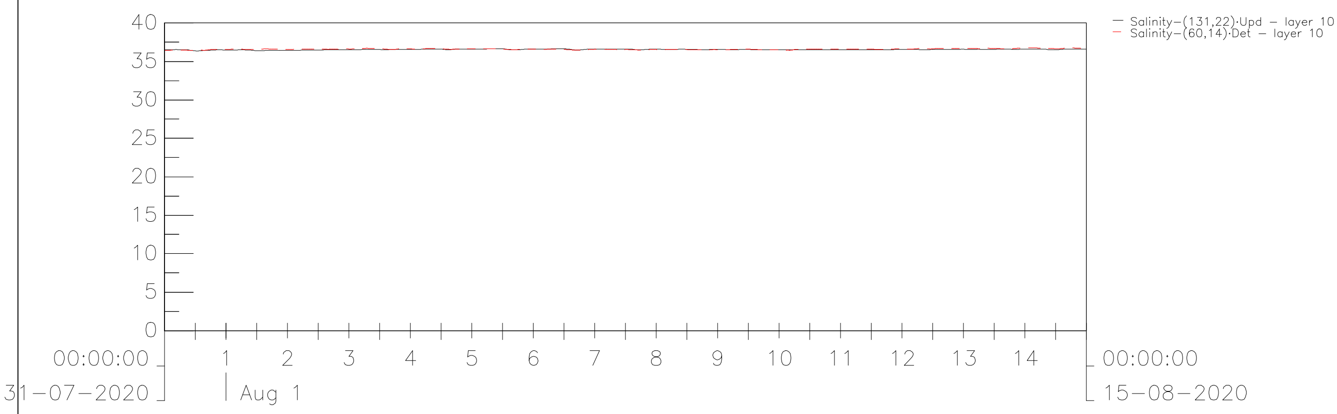


Desalination Plant at Tseung Kwan O – Feasibility Study Surface Salinity · Dry Season (Black: Updated Model; Dashed Red: Refined Model) From top to bottom: Verification point 1 to 4	Year 2020	Dry
	Annex A	
ERM HK Limited	GPP/Verification	Ver.ssn

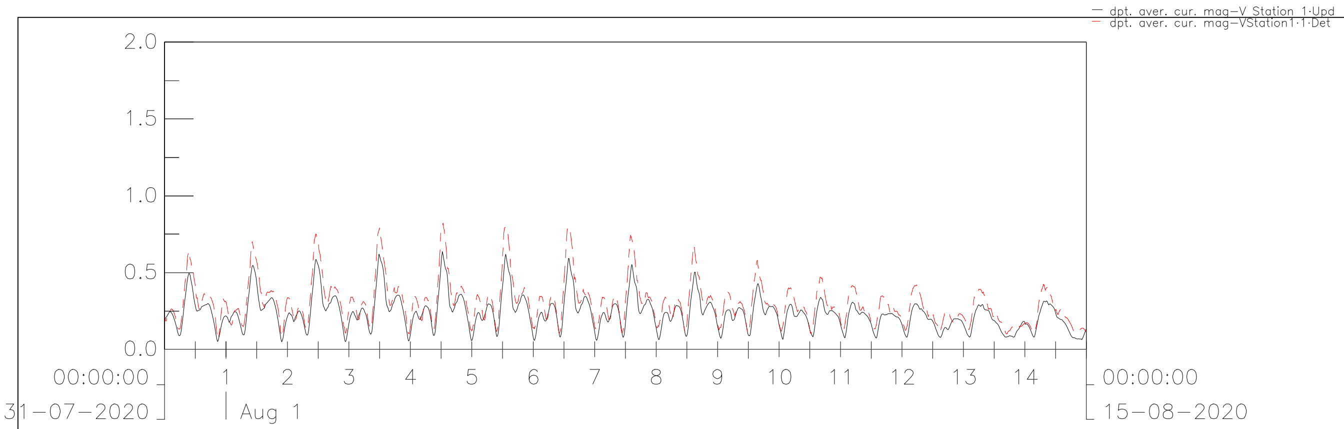


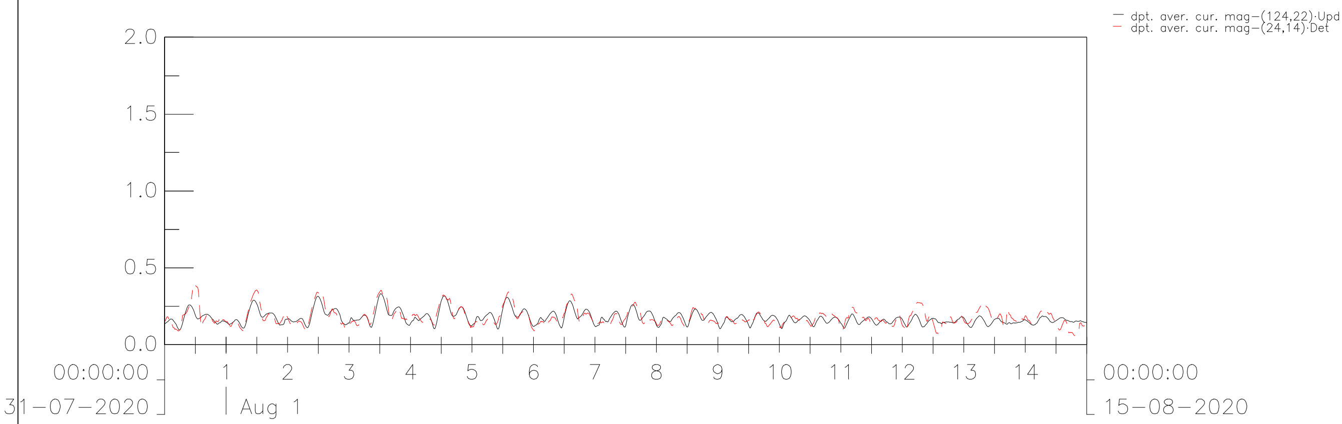


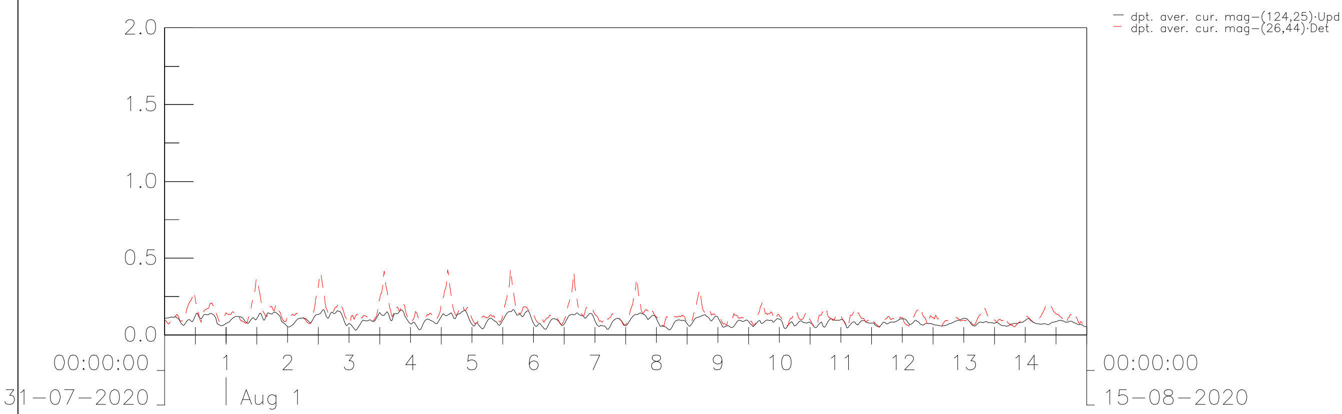


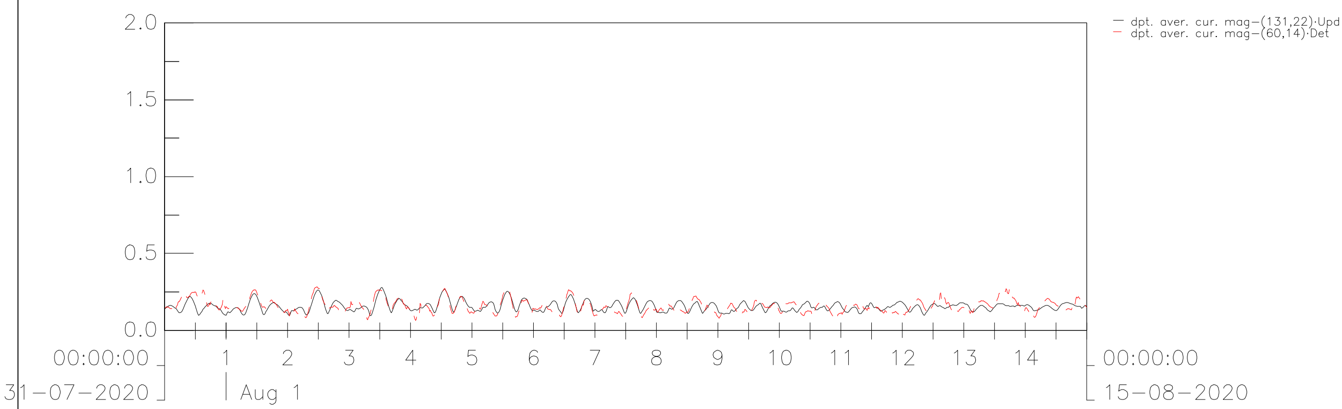


Desalination Plant at Tseung Kwan O – Feasibility Study Bottom Salinity · Dry Season (Black: Updated Model; Dashed Red: Refined Model) From top to bottom: Verification point 1 to 4	Year 2020	Dry
	Annex A	
ERM HK Limited	GPP/Verification	Ver.ssn

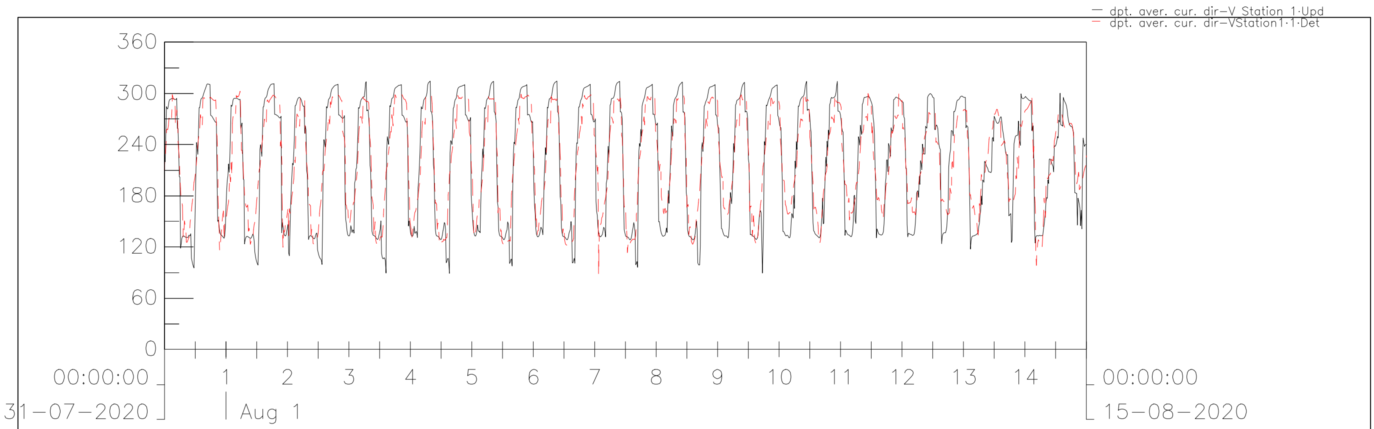


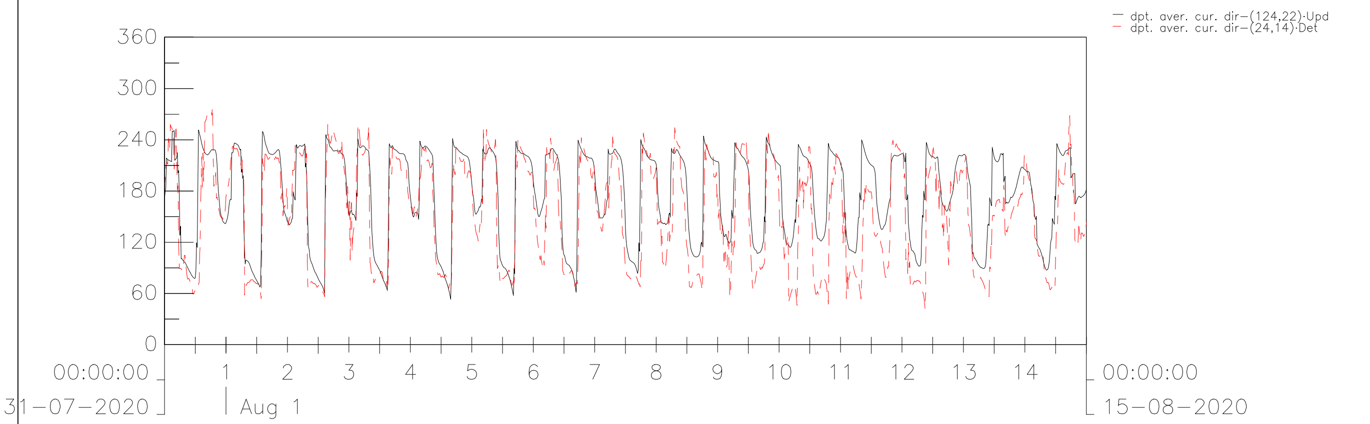


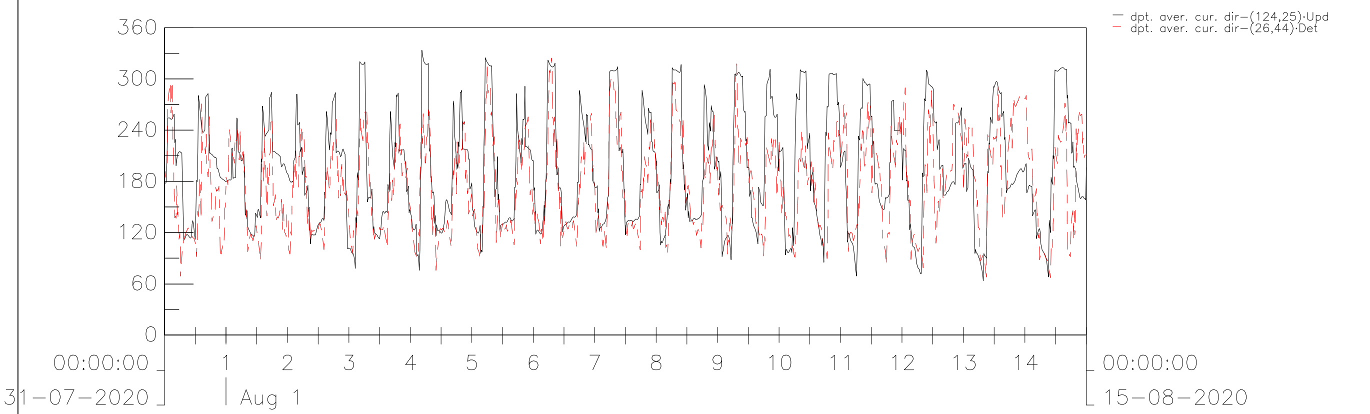


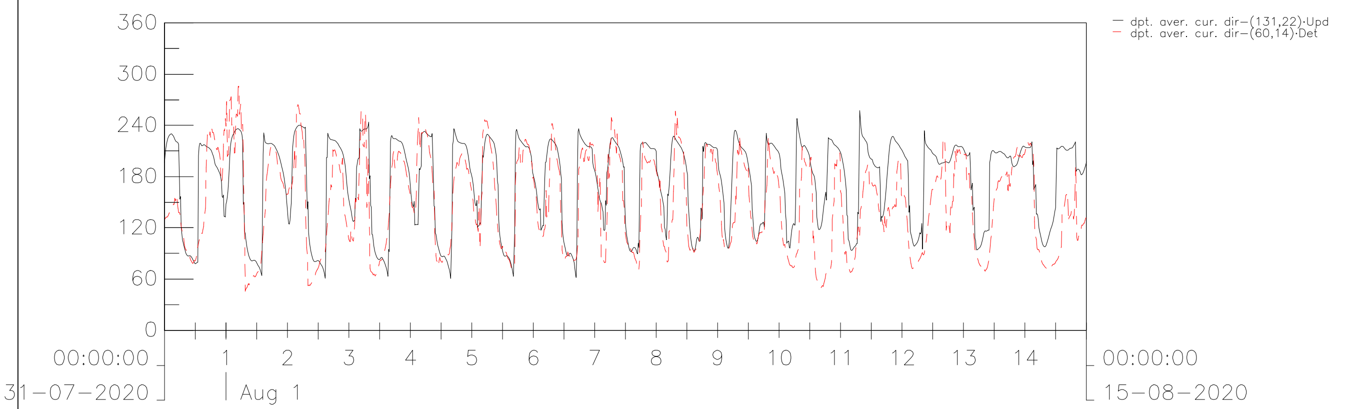


Desalination Plant at Tseung Kwan O — Feasibility Study Current Magnitude · Dry Season (Black: Updated Model; Dashed Red: Refined Model) From top to bottom: Verification point 1 to 4	Year 2020	Dry
	Annex A	
ERM HK Limited	GPP/Verification	Ver.ssn

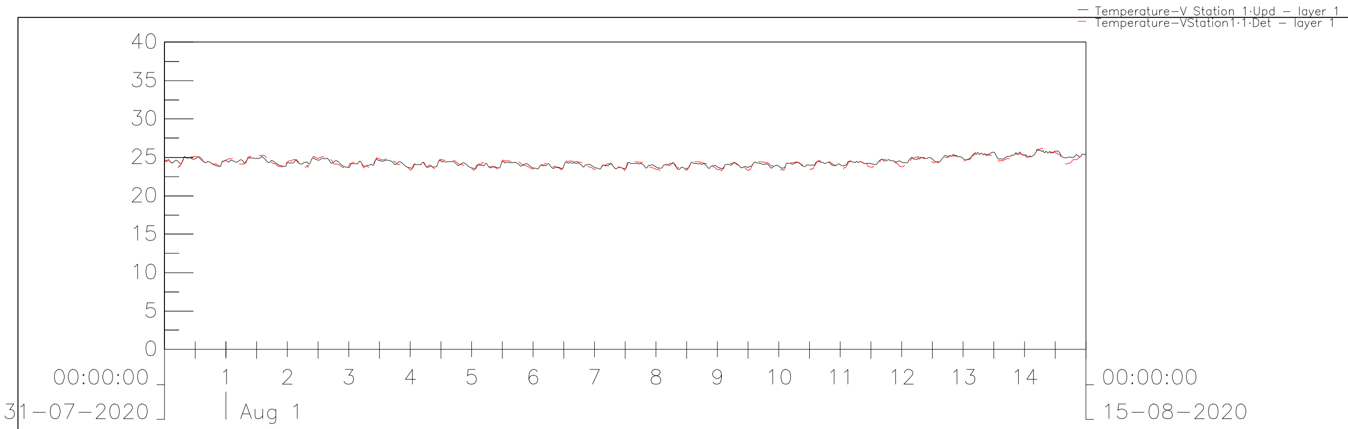


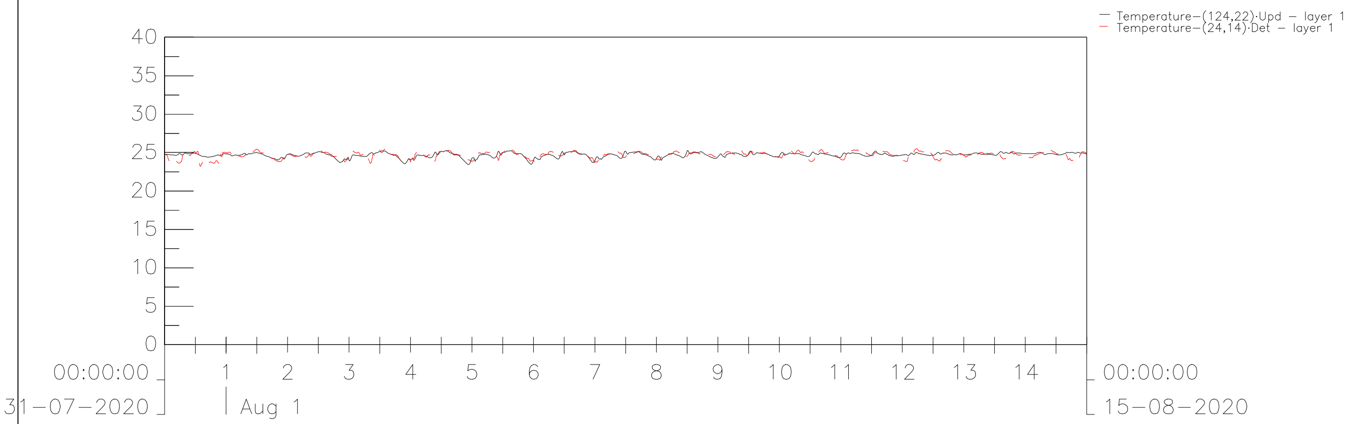


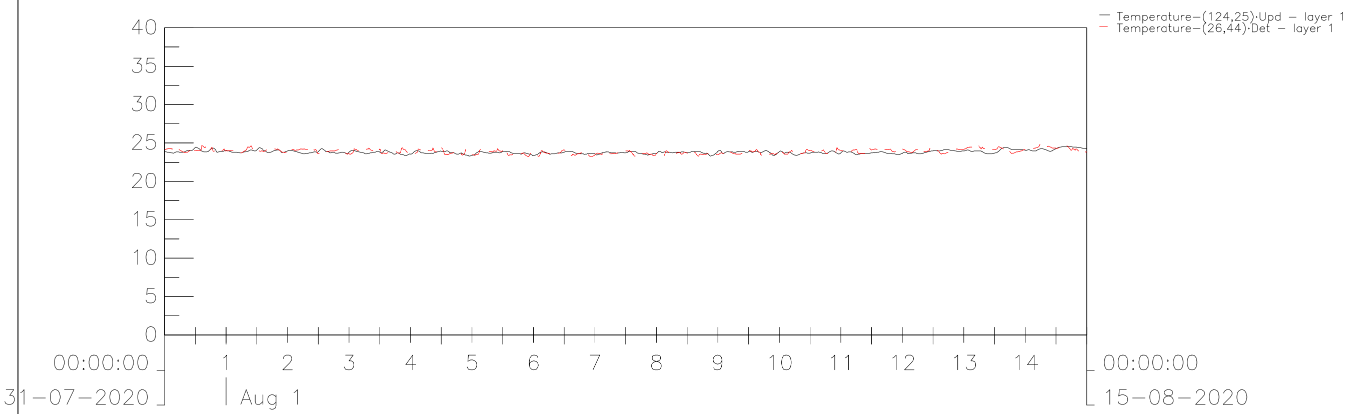


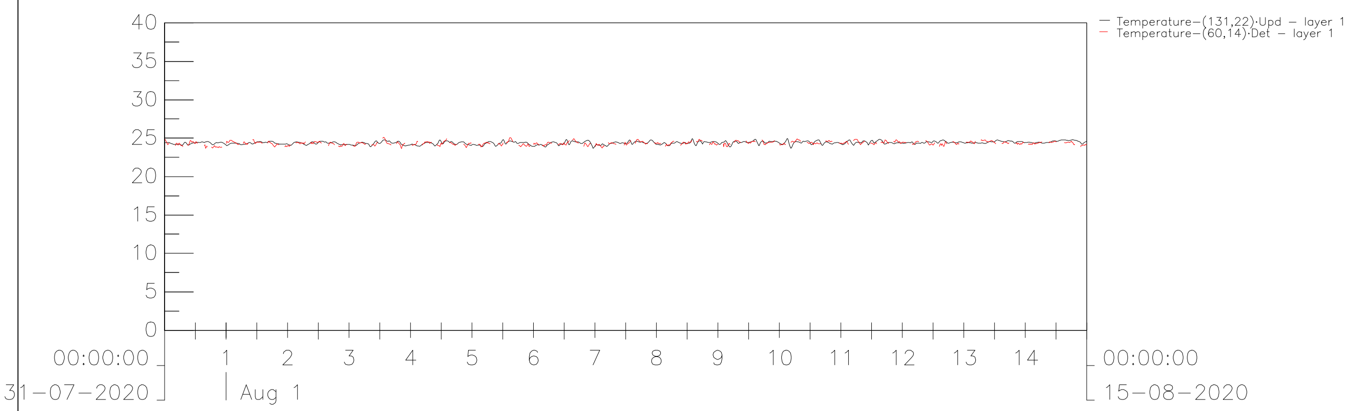


Desalination Plant at Tseung Kwan O – Feasibility Study Current Direction · Dry Season (Black: Updated Model; Dashed Red: Refined Model) From top to bottom: Verification point 1 to 4	Year 2020	Dry
	Annex A	
ERM HK Limited	GPP/Verification	Ver.ssn









Desalination Plant at Tseung Kwan O – Feasibility Study

Surface Temperature · Dry Season (Black: Updated Model; Dashed Red: Refined Model)

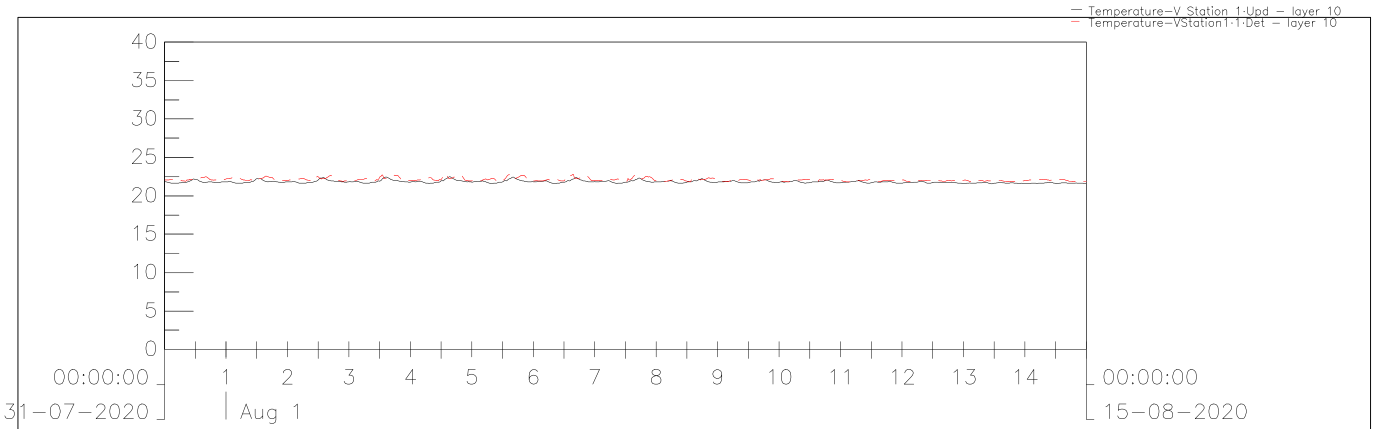
From top to bottom: Verification point 1 to 4

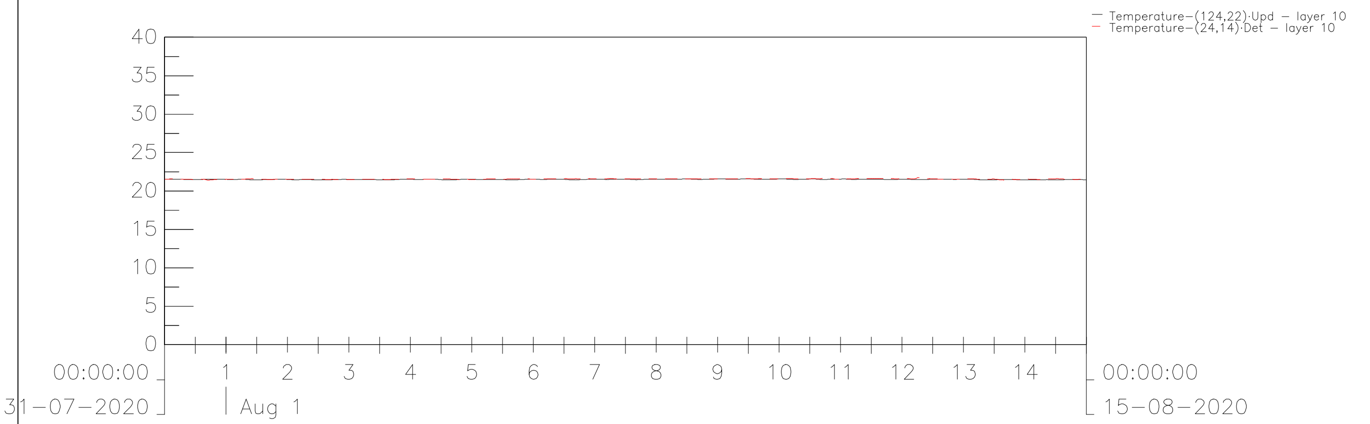
Year 2020 | Dry

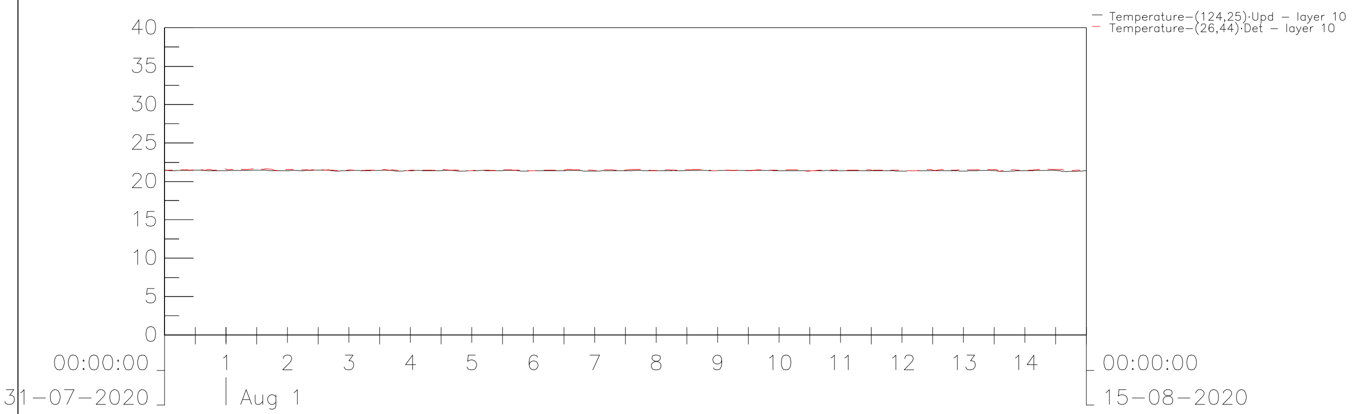
Annex A

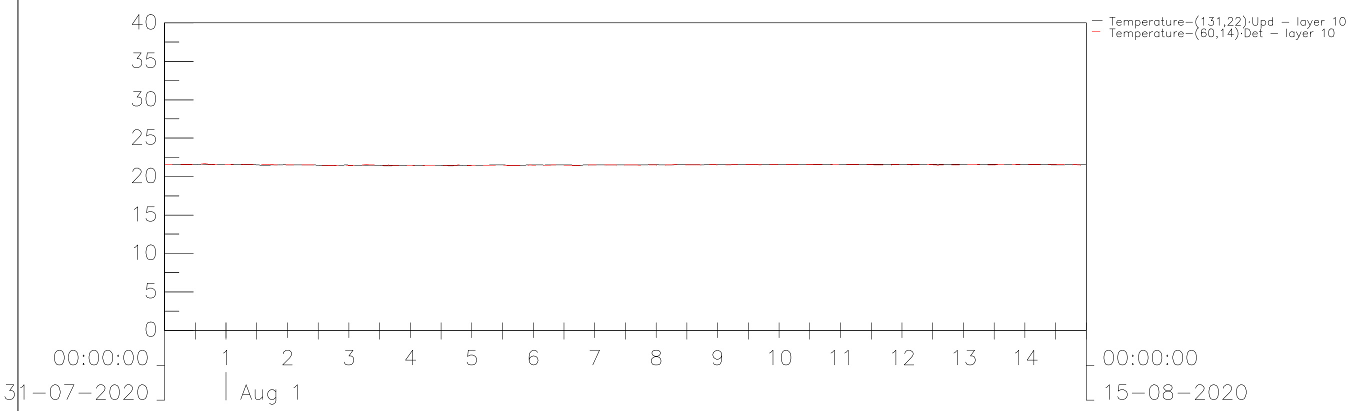
ERM HK Limited

GPP/Verification | Ver.ssn



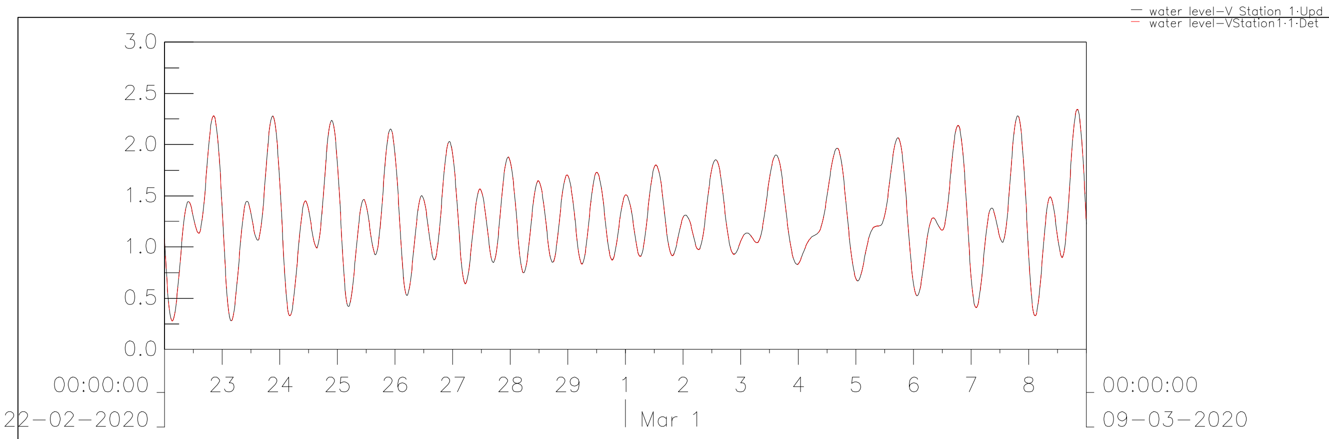


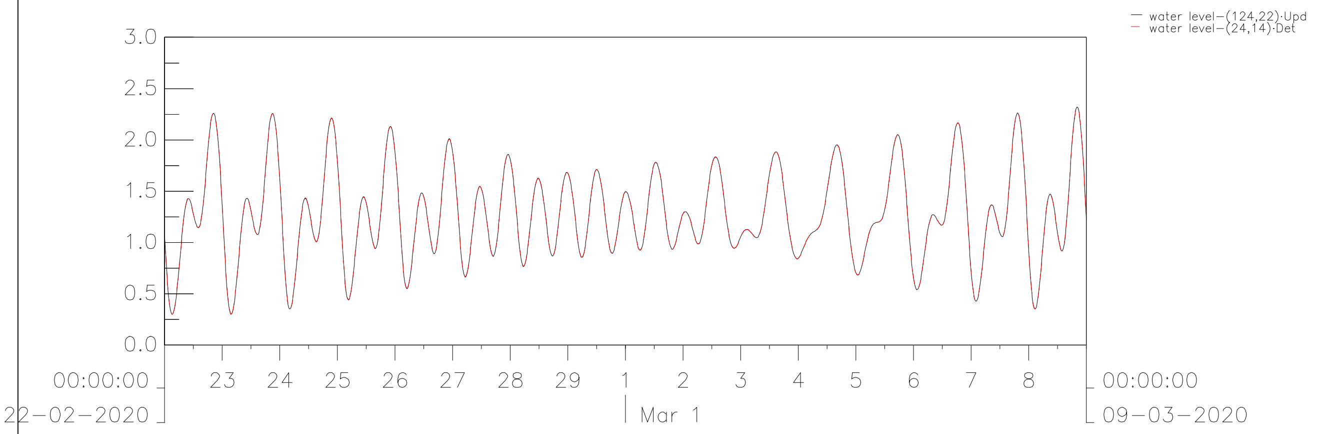


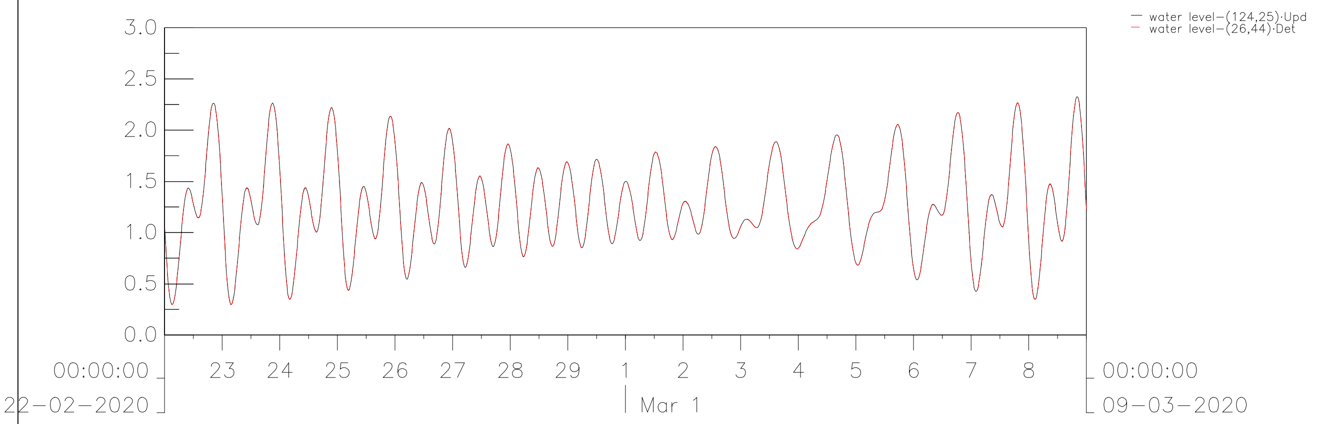


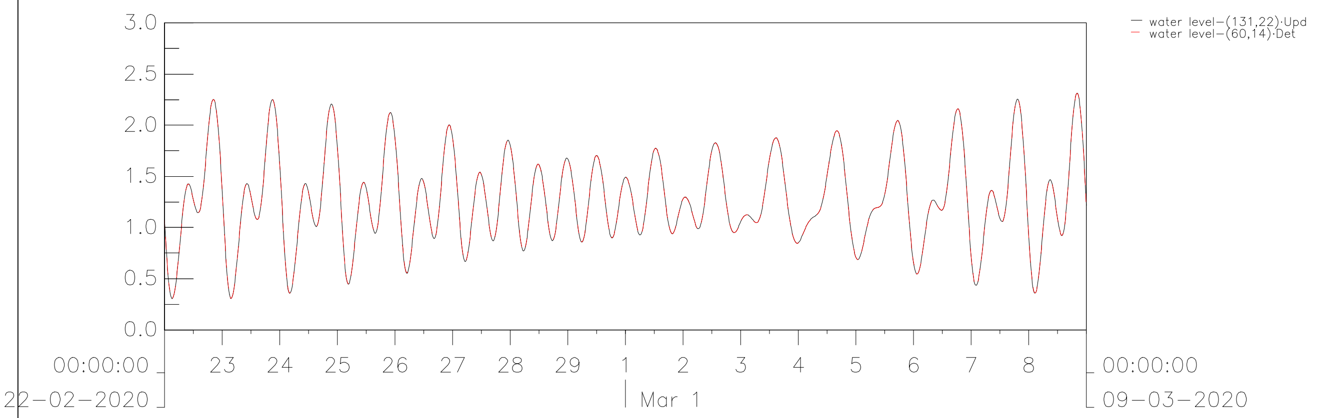
Desalination Plant at Tseung Kwan O – Feasibility Study Bottom Temperature · Dry Season (Black: Updated Model; Dashed Red: Refined Model) From top to bottom: Verification point 1 to 4	Year 2020	Dry
	Annex A	
ERM HK Limited	GPP/Verification	Ver.ssn

Timeseries Plots at Verification Points - Dry Season

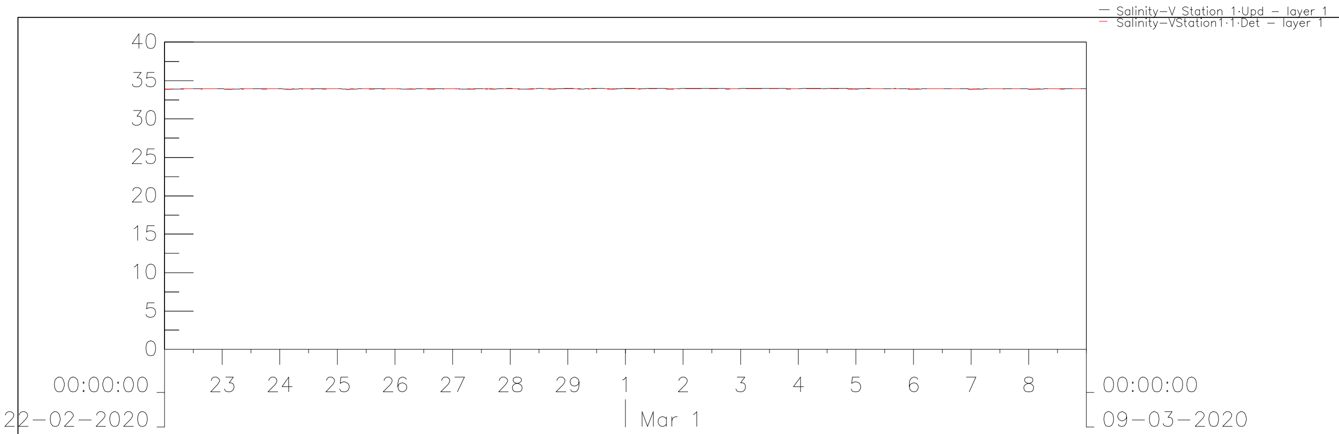


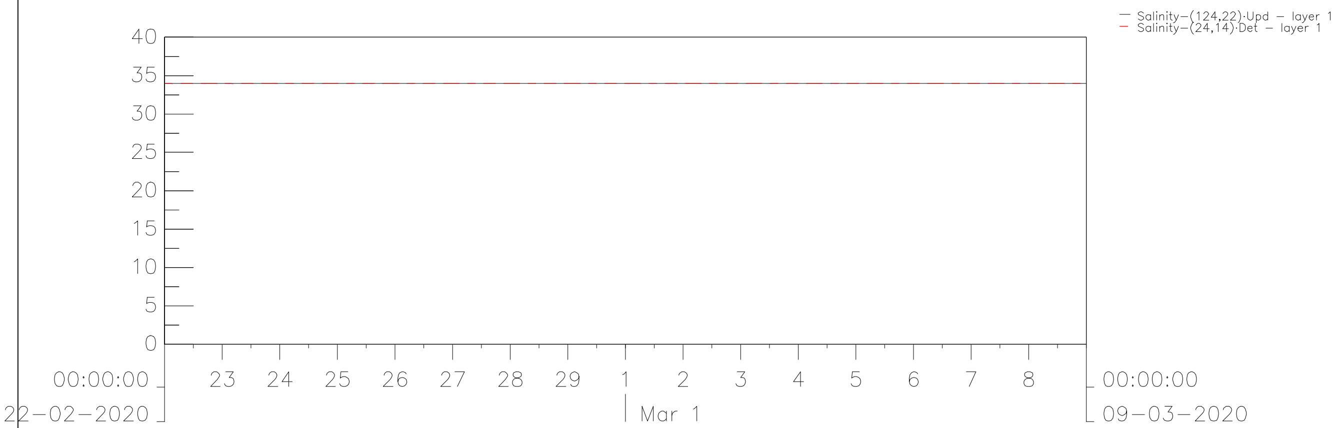


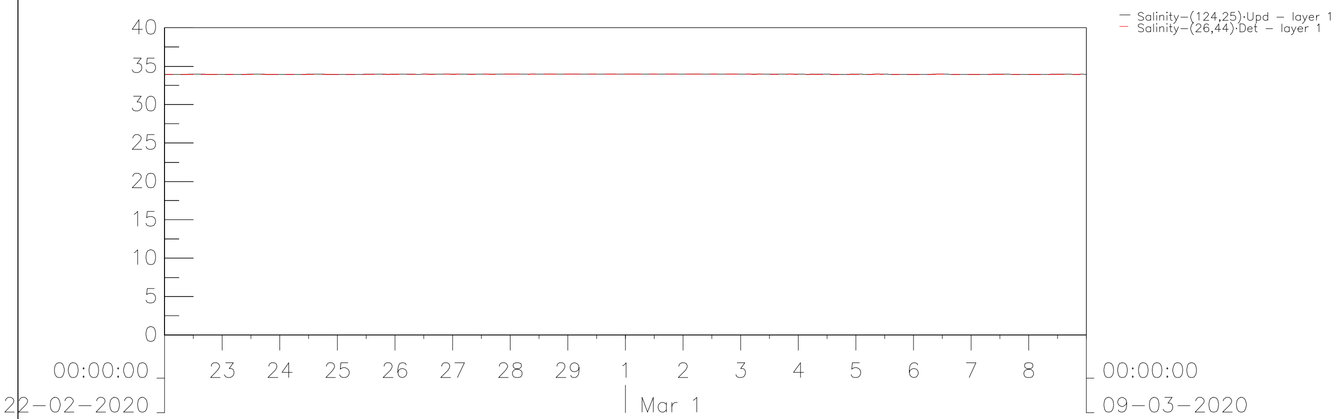


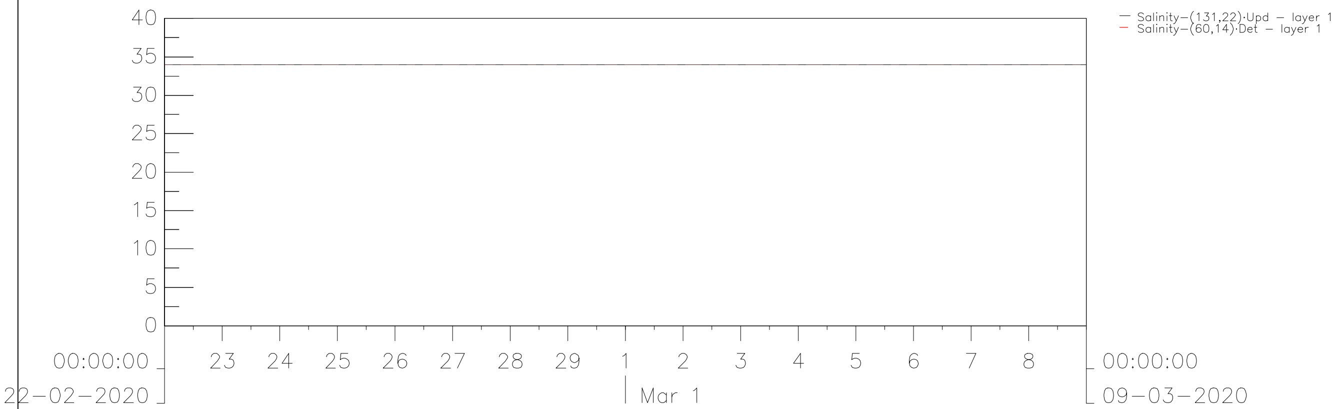


Desalination Plant at Tseung Kwan O – Feasibility Study Water Level · Dry Season (Black: Updated Model; Dashed Red: Refined Model) From top to bottom: Verification point 1 to 4	Year 2020	Dry
	Annex A	
ERM HK Limited	GPP/Verification	Cal.ssn

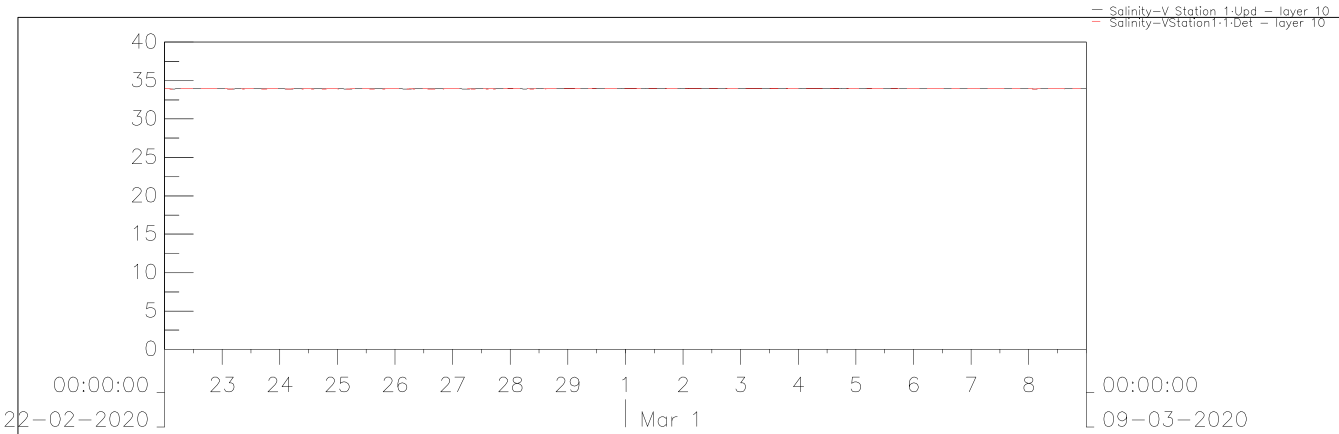


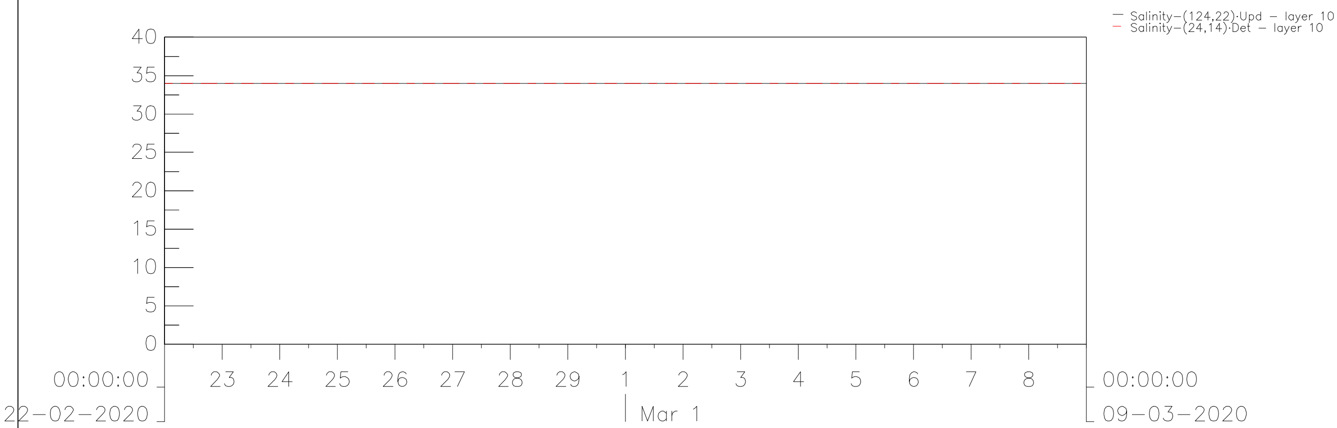


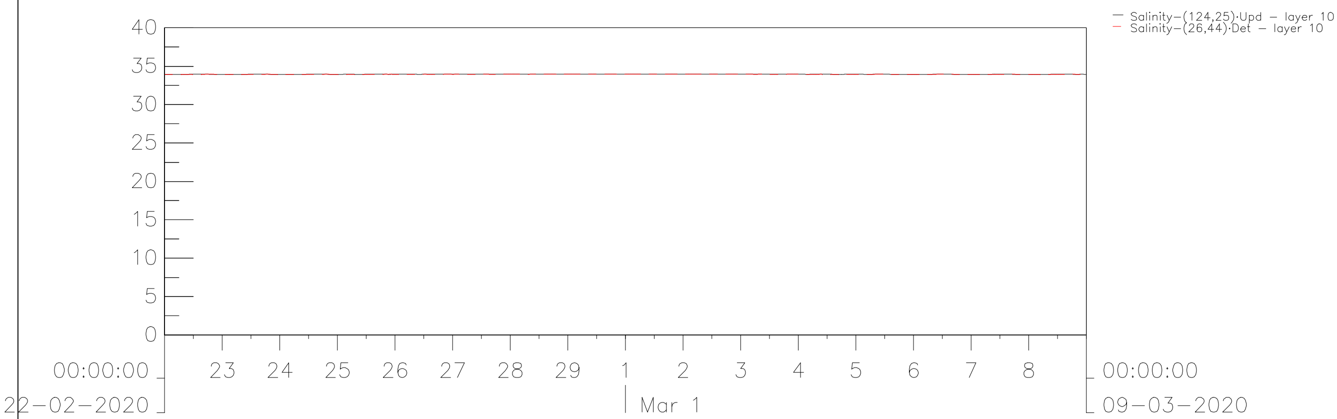


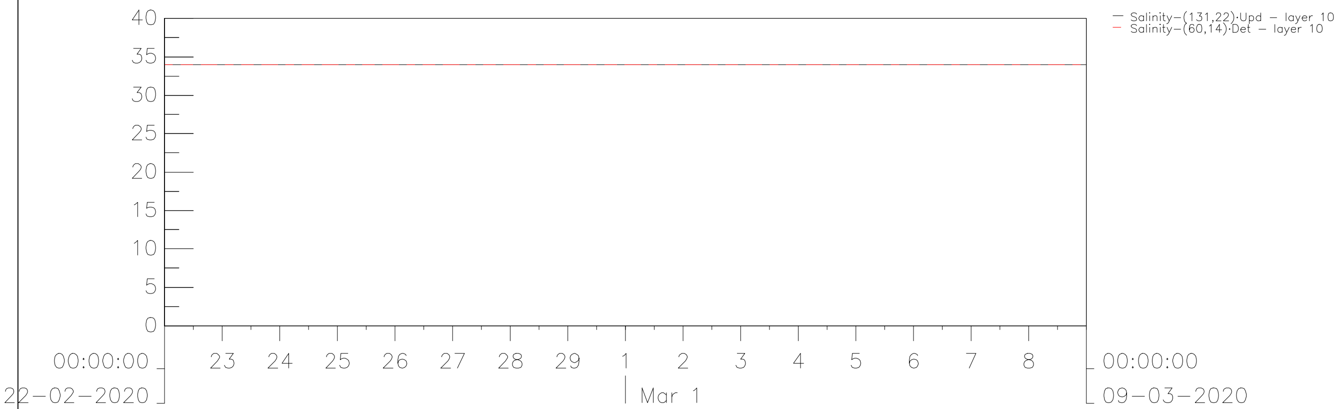


Desalination Plant at Tseung Kwan O – Feasibility Study Surface Salinity · Dry Season (Black: Updated Model; Dashed Red: Refined Model) From top to bottom: Verification point 1 to 4	Year 2020	Dry
	Annex A	
ERM HK Limited	GPP/Verification	Ver.ssn

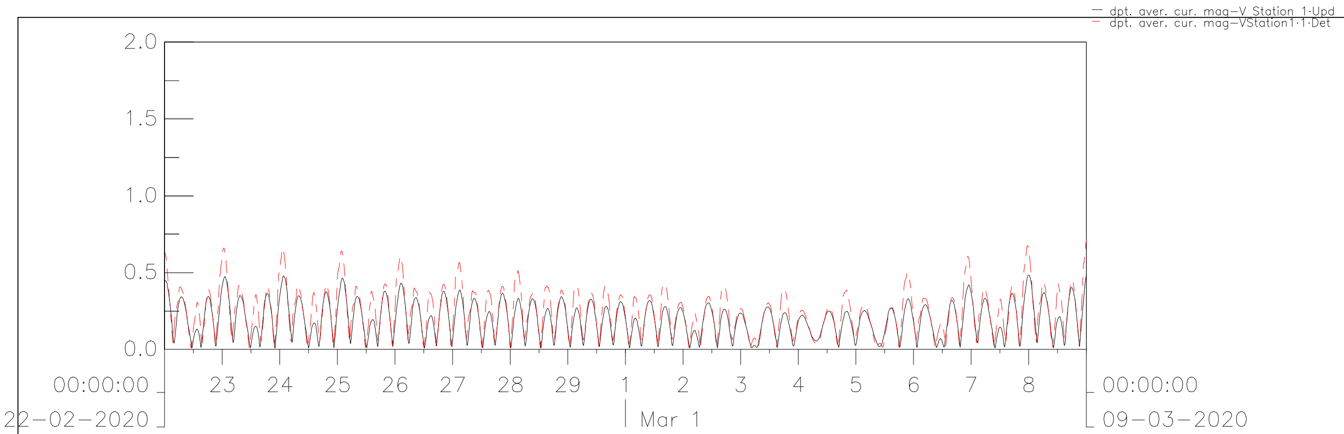


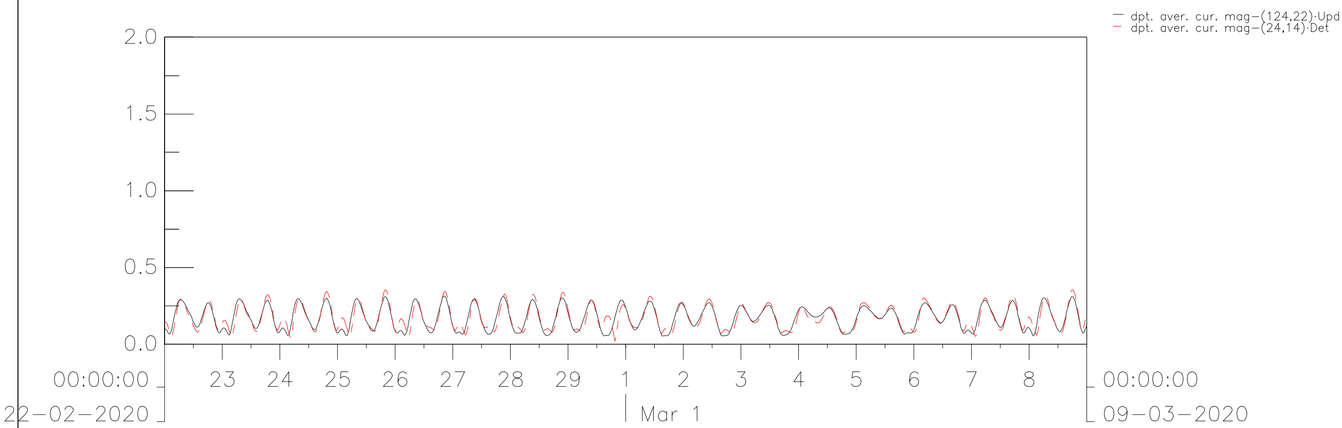


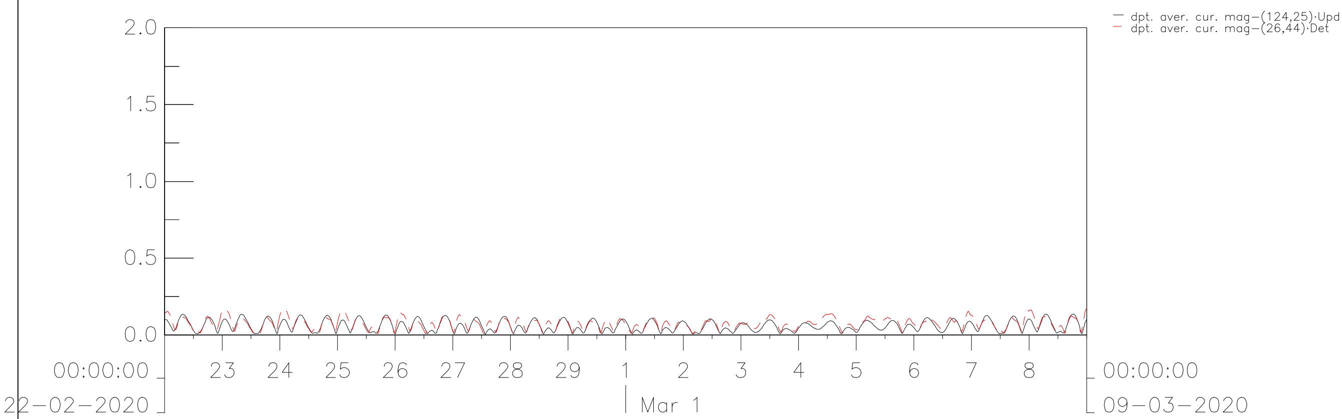


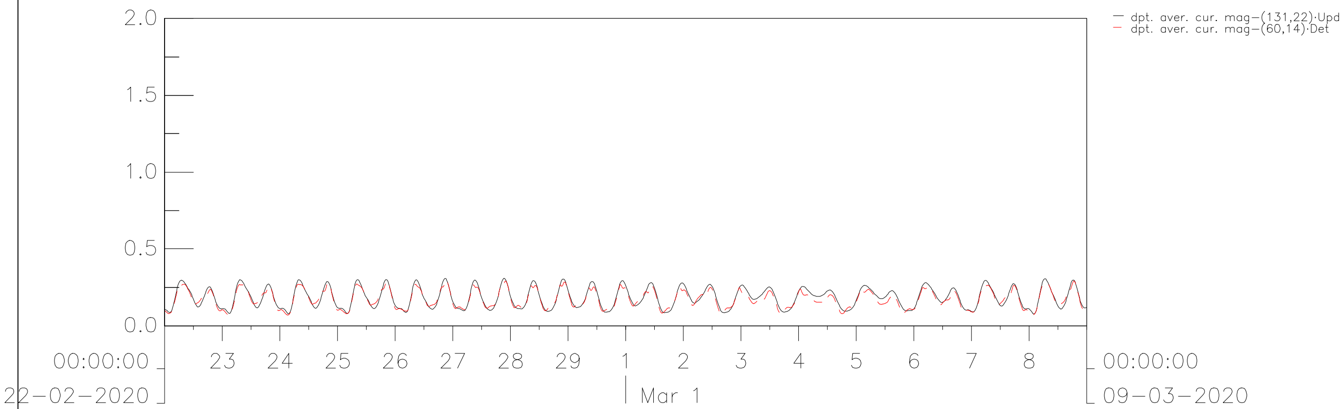


Desalination Plant at Tseung Kwan O − Feasibility Study Bottom Salinity · Dry Season (Black: Updated Model; Dashed Red: Refined Model) From top to bottom: Verification point 1 to 4	Year 2020	Dry
	Annex A	
ERM HK Limited	GPP/Verification	Ver.ssn

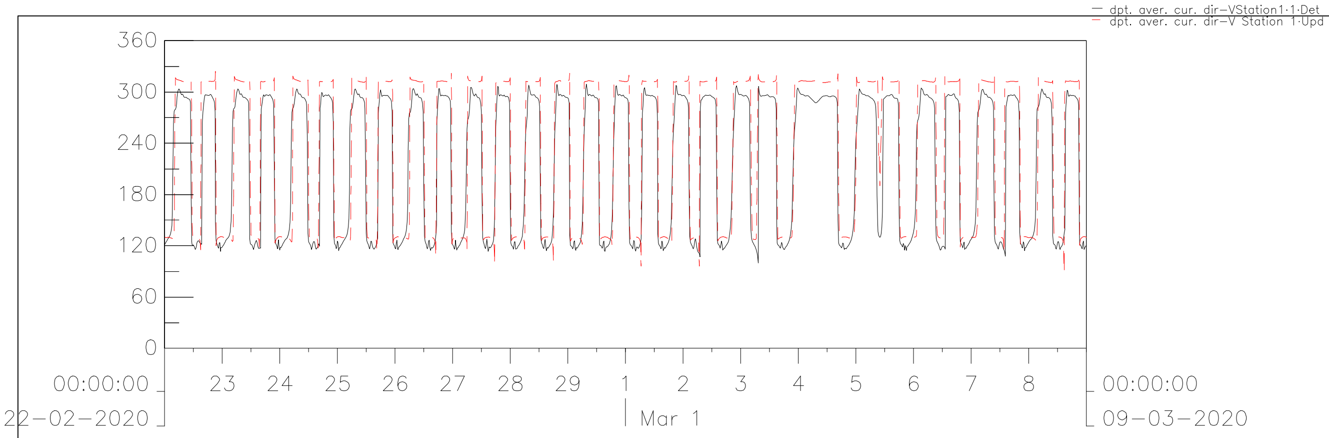


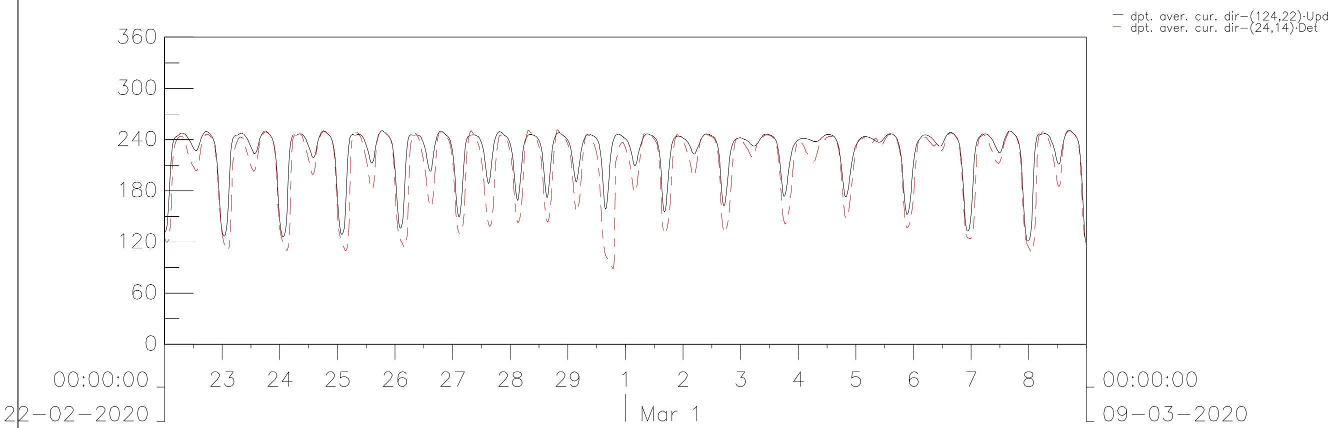


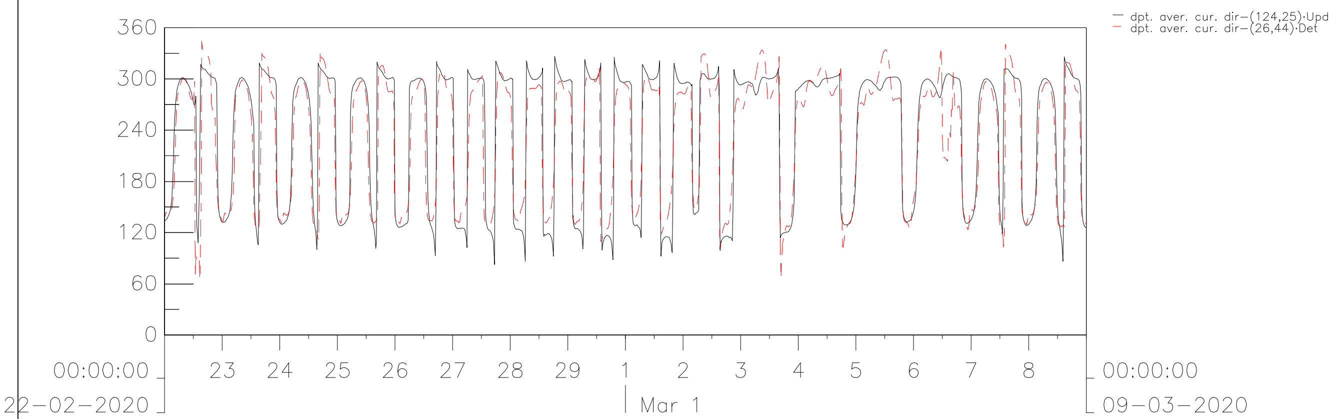


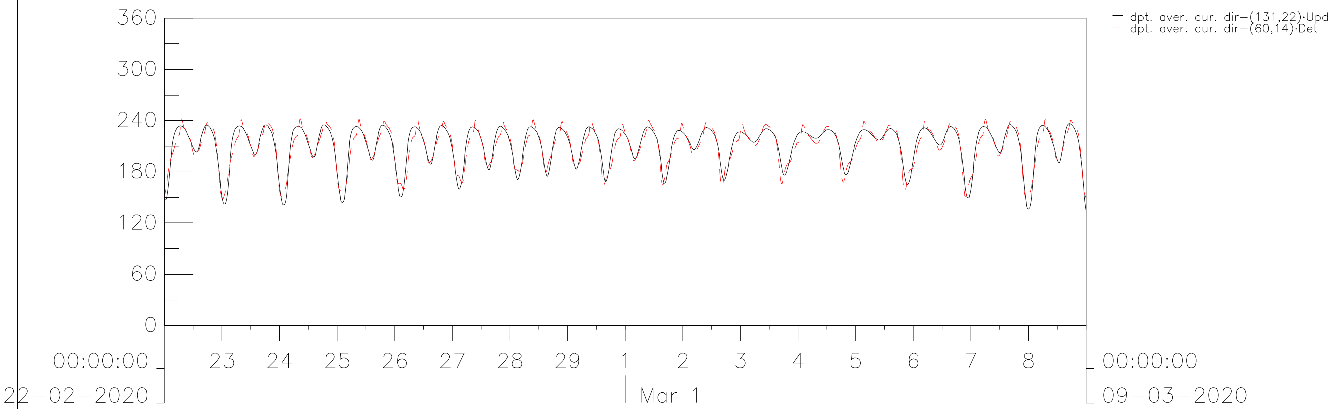


Desalination Plant at Tseung Kwan O – Feasibility Study Current Magnitude · Dry Season (Black: Updated Model; Dashed Red: Refined Model) From top to bottom: Verification point 1 to 4	Year 2020	Dry
	Annex A	
ERM HK Limited	GPP/Verification	Ver.ssn



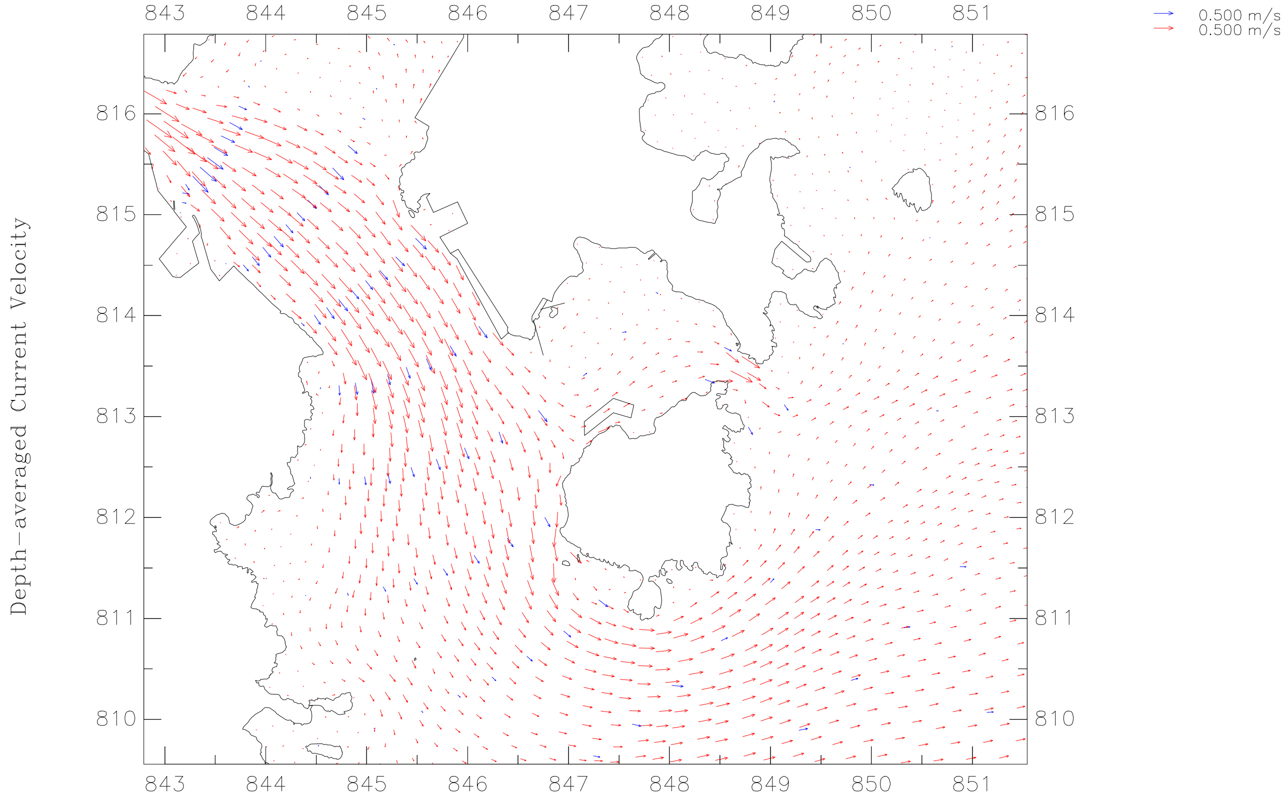


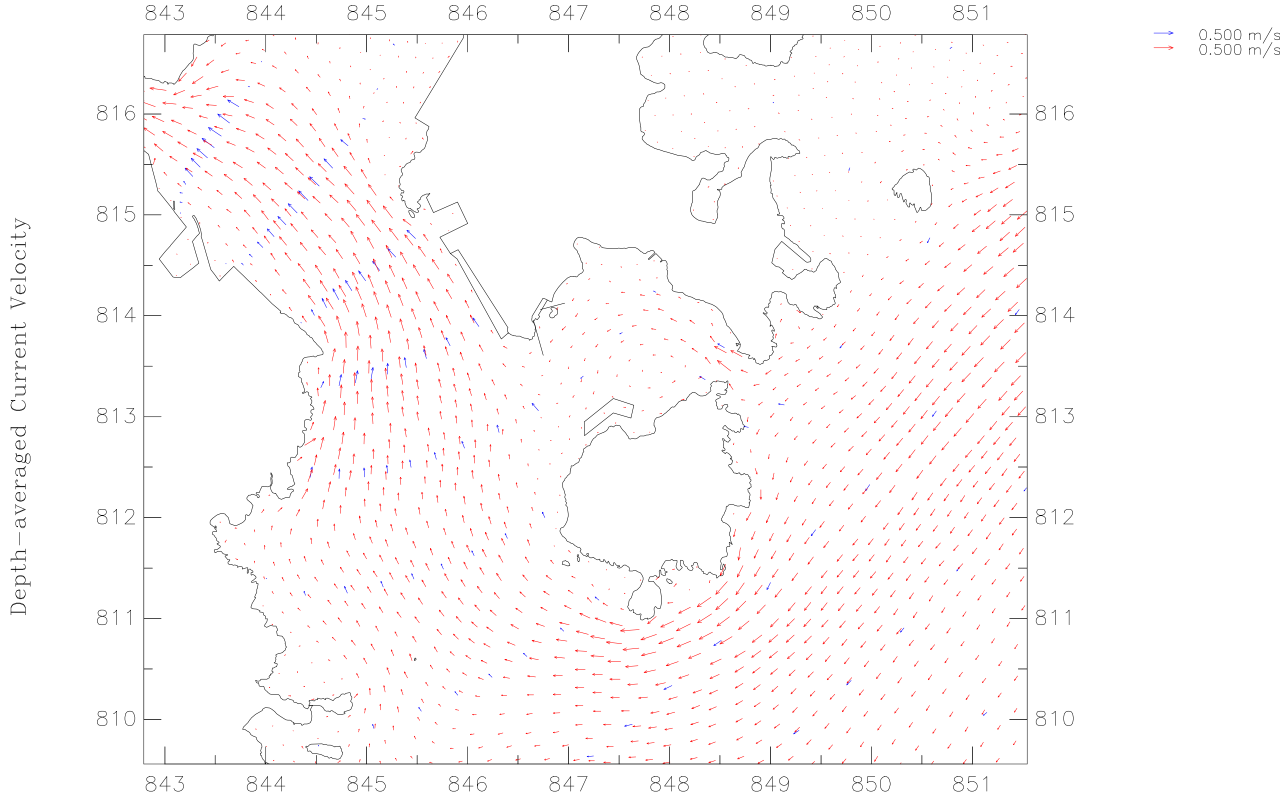




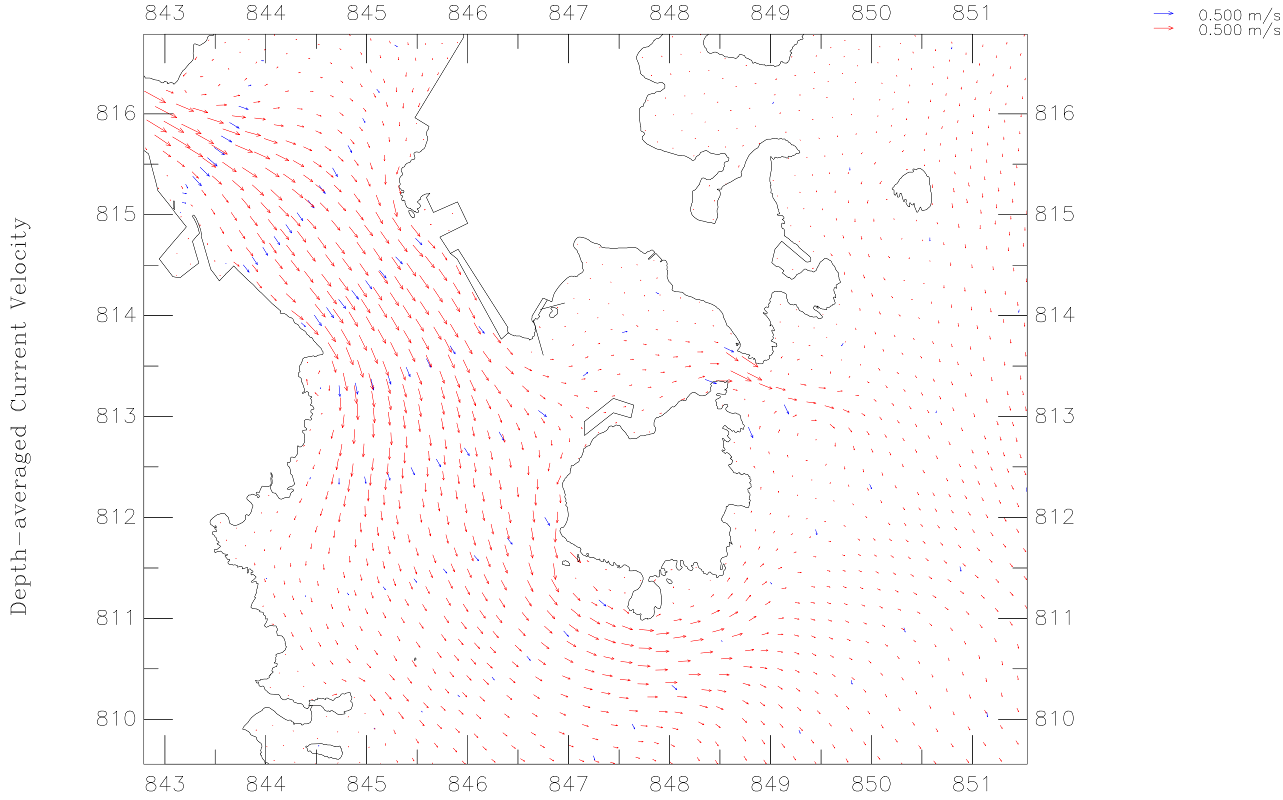
Desalination Plant at Tseung Kwan O – Feasibility Study Current Direction · Dry Season (Black: Updated Model; Dashed Red: Refined Model) From top to bottom: Verification point 1 to 4	Year 2020	Dry
	Annex A	
ERM HK Limited	GPP/Verification	Ver.ssn

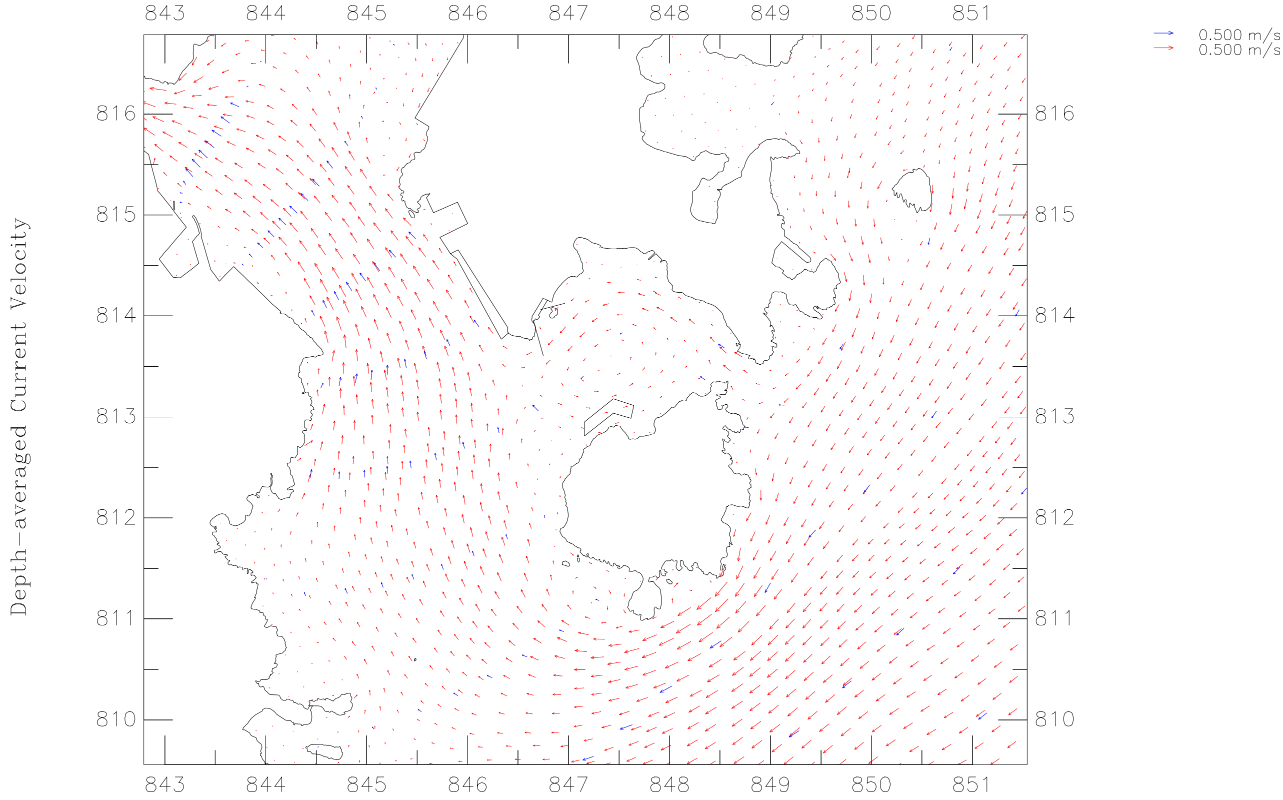
Current Vector Plots
for Mid-Ebb and Mid-Flood
- Wet Season and Dry Season





Desalination Plant at Tseung Kwan O – Feasibility Study Depth-averaged Current Velocity for Wet Season Top: mid-Ebb; Bottom: Mid-Flood; Blue: Updated Model; Red: Refined Model	Year 2020	Wet
ERM HK Limited	GPP/Calibration	Vector.ssn





Desalination Plant at Tseung Kwan O – Feasibility Study Depth-averaged Current Velocity for Dry Season Top: mid-Ebb; Bottom: Mid-Flood; Blue: Updated Model; Red: Refined Model	Year 2020	Dry
ERM HK Limited	GPP/Calibration	Vector.ssn