1. Water Quality Modelling

1.1 Hydrodynamic Model Coupling

1.1.1 The Delft3D suite of modelling tools is used to conduct the hydrodynamic simulations, the Delf3D-FLOW module was used to conduct the operational phase hydrodynamic. Whereas the Delft3D-WAQ module was sued to conduct the water quality assessments of this Project. The hydrodynamic outputs from the model were coupled into the water quality module for water quality simulation. The hydrodynamic forcing including averaged fresh water flow, wind, initial conditions and boundary conditions for the dry and wet seasons were applied separately in the corresponding hydrodynamic simulation.

1.2 Reclamation Assumptions

1.2.1 Dredging would be required during the reclamation works using a grab dredger. According to the latest engineering design, an estimated total of 30,000m3 of sediments would need to be dredged, the total duration of dredging works is estimated to be completed within 10 days. However, to assume for the worst-case scenario in case the construction programme would need to be condensed, the estimated dredging rate of 5,000m3 per day was adopted, assuming that dredging works would need to be completed within 6 days. **Table 1** summaries the assumptions adopted to estimate the sediment release rate used for model input, it should be noted that the calculated "Release Rate per Workfront" shall be used for model input. Additionally, a silt curtain with a SS reduction rate of 45% shall be deployed during dredging works as an enhancement measure.

Table 1 Sediment Release Rate Assumptions[1]

Work Type	Total Dredging Volume	Total Working Days	Working Duration/Day[2]	Production Rate	Loss rate[4]	Workfront[3]	Release Rate per Workfront	Release Rate per Workfront (with Mitigation by Silt Curtain)
	m^3	Days	Hours	m^3/day	kg/m^3	No.	g/s	g/s
Dredging	30,000	6	12	5,000	20	1	2,315	1,273

Assumptions:
[1] Marine mud encountered at the reclamation site is localised.
[2] Working hours per day is 12 hours (07:00 - 19:00).
[3] Only one workfront would be operating at any given time.
[4] The sediment loss rate using a grab dredger of 20kg/m^3 is referenced from previously approved EIA Reports of nearby projects including the Expansion of Hong Kong International Airport into a Three-Runway System (AEIAR-233/2014), and Hong Kong-Zhuhai-Macau Bridge Boundary Crossing Facility (AEIAR-145/2009).

1.2.2 The following formula was adopted to calculate the "Release Rate per Workfront" value estimated in **Table 1**, which will be adopted for the "Base Case" scenarios:

Release Rate per Workfront (g/s) =

Production Rate (m^3/day) x Loss Rate (g/m^3) ÷ Working Duration/Day (s) =

5,000 m^3/day x 20,000g/m^3 ÷ 43,200s =

2,315 g/s

1.2.3 The deployment of a silt curtain is recommended throughout the duration of the reclamation works as a water quality enhancement measure, the sediment Release Rate per Workfront with the deployment of a silt curtain is calculated using the formula below, and would be adopted in the "Enhanced Case" scenarios:

Enhanced Release Rate per Workfront (g/s) =

Release Rate per Workfront (g/s) x [1 - silt curtain reduction rate (%)] =

2,315 g/s x (1 - 45%) =

1,273 g/s

1.3 Modelling Scenarios

1.3.1 According to the latest engineering design, only one workfront would be operating at any given time, hence to simulate the water quality effect from the movement of the workfront throughout the dredging works, two different locations of dredging discharge were modelled. In addition, both sediment release rates calculated in **Section 1.2** will be adopted for the water quality modelling scenarios.

1.3.2 The construction phase water quality modelling scenarios are summarised in **Table 2** below:

Table 2 Construction Phase Water Quality Modelling Scenarios

Scenario	Adopted Release Rate (g/s)	Sediment Discharge Location	Purpose
Scenario WQ01a – "Base Case 1"	2,315	Next to shoreline	To simulate the water quality impacts from dredging at a location next to the shoreline without deploying a silt curtain.
Scenario WQ01b – "Base Case 2"	2,315	Further away from shoreline	To simulate the water quality impacts from dredging at a location further away from the shoreline without deploying a silt curtain.
Scenario WQ02a – "Enchanced Case 1"	1,273	Next to shoreline	To simulate the water quality impacts from dredging at a location next to the shoreline with a silt curtain deployed.

Scenario	Adopted Release Rate (g/s)	Sediment Discharge Location	Purpose
Scenario WQ02a – “Enchanced Case 2”	1,273	Further away from shoreline	To simulate the water quality impacts from dredging at a location further away from the shoreline with a silt curtain deployed.

1.3.3 Based on the latest information, the dredging works of Road P1 (Tai Ho Wan – Sunny Bay Section) may overlap with that of the Project, to deduce the cumulative water quality impacts of both projects, its release rates are included the construction phase water quality model:

- Release rate of 3,420 g/s without silt curtains adopted for scenarios WQ01a-b
- Enhanced release rate (i.e. single silt curtain deployed) of 1,881 g/s adopted for scenarios WQ02a-b

1.3.4 The locations of the assumed dredging works at Tsing Lung Tau for Route 11 and Sham Shui Kok for Road P1 are shown in **Figure 1** and **Figure 2** respectively.

Figure 1 Dredging Locations at Tsing Lung Tau

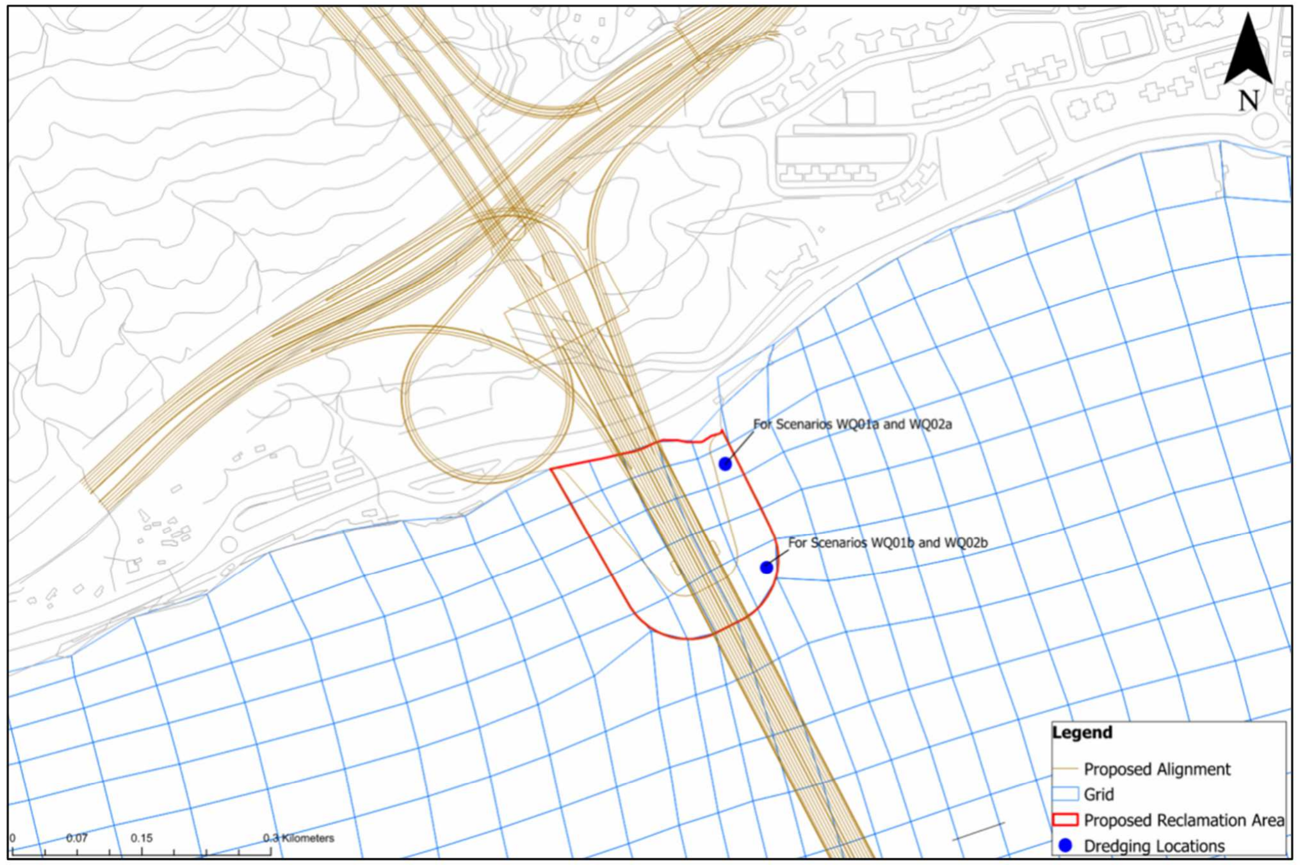
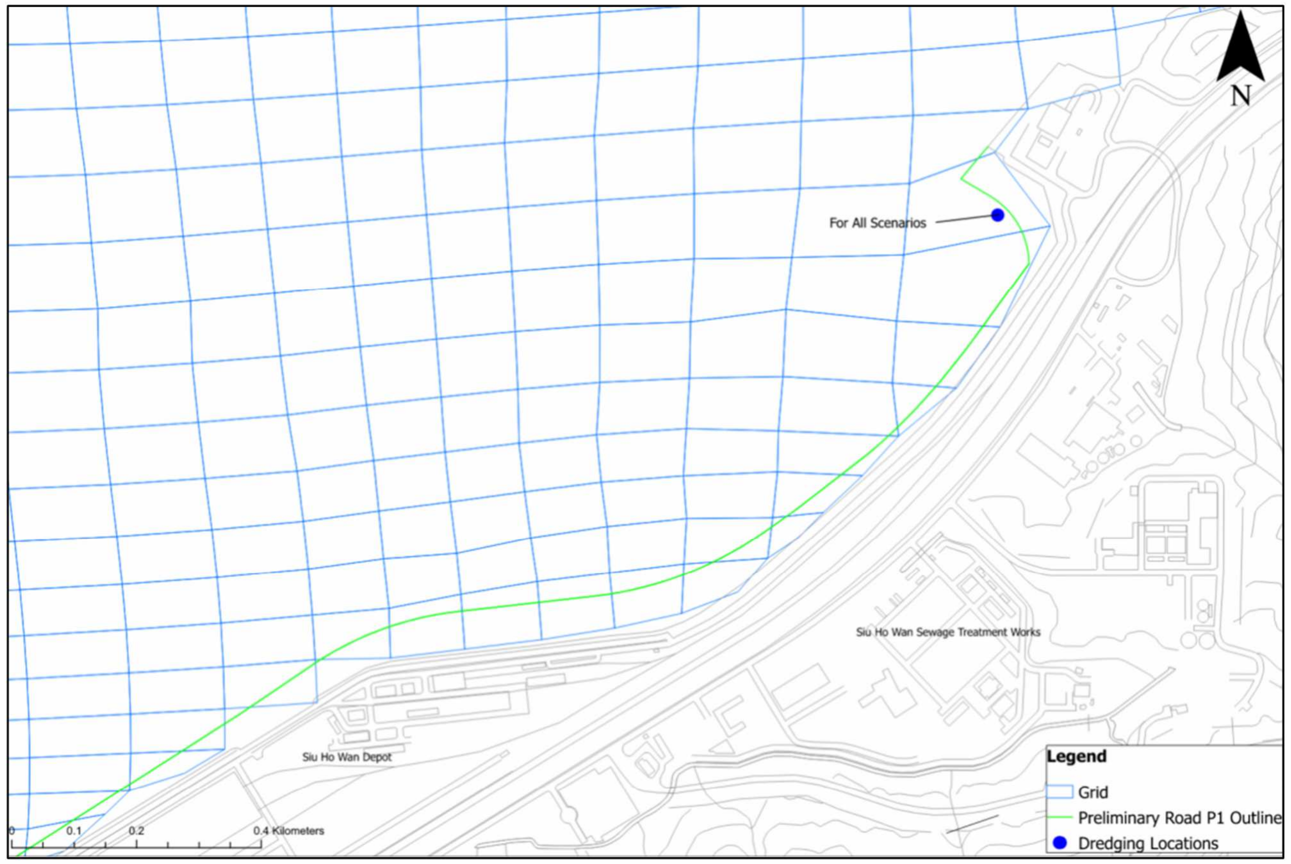


Figure 2 Dredging Location at Sham Shui Kok



1.4 Modelling Parameters

<u>Input Parameters</u>

1.4.1 The following key modelling parameters on sedimentation and erosion of suspended solids were adopted for the construction phase water quality modelling, which was referenced from the approved EIA Report for Expansion of Hong Kong International Airport into a Three-Runway System (AEIAR-185/2014). The parameters are summarised under **Table 3** below.

Table 3 Input Parameters for Construction Phase Water Quality Modelling

Parameter	Value
Settling velocity	0.5mm/s (input as 43.2m/day in the model)
Critical stress for deposition	0.2N/m^2
Critical stress for erosion	0.3N/m^2
Minimum depth in which deposition can take place	0.1m

Simulation Period

1.4.2 The timeframe presented in **Table 4** below was adopted for dry season and wet season water quality simulations respectively. The adopted timeframe covered the maximum estimated filling period of 1 week. It should be noted that the 1st month of each season's simulation period is excluded from the results to allow for the model spin-up.

Table 4 Simulation Periods for Dry and Wet Season

Season	Modelling Timeframe
Dry Season	1st January → 1st May
Wet Season	1st May → 1st September

Assessment Parameters

1.4.3 In order to assess the overall water quality impacts induced by the reclamation works associated with the construction phase of the Project, the following parameters were assessed:

- Suspended solids concentration;
- Sedimentation rate;
- Dissolved oxygen depletion; and
- Contaminant release from disturbed sediment.

1.4.4 Suspended solids concentration and sedimentation rate can be deduced directly from the model's output files, however dissolved oxygen depletion and contaminant release from disturbed sediment would require further calculations, details are discussed below.

1.5 Dissolved Oxygen Depletion (DO_{Dep})

1.5.1 The extent of DO_{Dep} as a result of a sediment plume induced by dredging activities is a function of the sediment oxygen demand of the sediment, its concentration in the water column, and the rate of oxygen replenishment. The amount of DO_{Dep} is calculated using the following formula which has been referenced from the EIA Report of Tung Chung New Town Extension:

$$DO_{Dep}\ (mg/L) =$$

$$SS\ Concentration\ (kg/m3) \times Chemical\ Oxygen\ Demand\ (mg/kg) \times Daily\ Oxygen\ Uptake\ Factor \times 0.001$$

1.5.2 As discussed, the SS concentration is deduced from the water quality model output, whereas the chemical oxygen demand is referenced from the nearest sediment quality monitoring station data published by EPD in 2021. The nearest sediment quality monitoring station from the reclamation area is Pearl Island (NS2), and the chemical oxygen demand measured at this station is 13,000mg/kg, this value is adopted for the DO_{Dep} calculations. The daily oxygen uptake factor is set at 1.0 to assume a worst case scenario.

1.6 Contaminant Release from Disturbed Sediment

1.6.1 The concentration of contaminants release from reclamation site to WSRs can be estimated by the following equation:

$$C(x) = q/(Dx\omega\pi^{0.5}).$$

Where: C(x) = concentration at distance x from the source (mg/L);

q = sediment loss rate;

D = water depth (m);

x = distance from source(m); and

ω = diffusion velocity (=0.01 m/s).

1.6.2 This equation calculates the concentration along the centreline of a plume through solving an advection-diffusion equation for a continuous line source, which is appropriate for calculating the concentrations of contaminant release for the dredging works at Tsing Lung Tau. This is because the equation assumes a continuous line source of sediment, which is an appropriate approximation of the sediment lost to suspension during grab dredging. However, this equation is limited to areas where the tides are uni-directional for each phase of the tidal cycle, hence it is still applicable for assessing the contamination concentrations dispersion at Tsing Lung Tau considering the current flows at the general direction of the coastline (i.e. east to west and vice-versa).

1.6.3 Similar approach has been adopted in previous approved EIA studies including Tung Chung New Town Extension (AEIAR-196/2016), Hong Kong - Zhuhai - Macao Bridge Hong Kong Boundary Crossing Facilities (AEIAR-145/2009), Hong Kong - Zhuhai - Macao Bridge Hong Kong Link Road (AEIAR-144/2009), 132 KV Supply Circuit from Pui O via Chi Ma Wan Peninsula via Sea Crossing towards Cheung Chau (AEIAR-051/2002), and Construction of an International Theme Park in Penny's Bay of North Lantau together with its Essential Associated Infrastructures (AEIAR – 032/2000). The dilution factor is estimated by assuming the radius of initial release as 10m. The calculation of sediment contaminant release would only be applied to ecologically-related observation points, and beaches.