Enclosed Water Bodies - Typhoon Shelters

- Rambler Channel (B1);
- Yau Ma Tei (B2);
- Causeway Bay (B3);
- To Kwa Wan (B4);
- Kwun Tong (B5);
- Aldrich Bay (B6);
- Sam Ka Tsuen (B7);
- Chai Wan (B8); and
- Aberdeen (B9).

Mariculture Zones

- Ma Wan (C1); and
- Tung Lung Chau (C2).

Gazetted Beaches

- Tung Wan (E1); and
- Ting Kau (E2 and E3).

4.2.5.2 After the completion of the SEKD, the existing TKWTS will no longer exist and a new marina will be built in Hoi Sham. The existing KTTS will be shifted towards the existing breakwaters at the typhoon shelter outlet. A portion of the new KTTS would be located in front of the end section of the disused airport runway. The new marina and KTTS are the water quality sensitive receivers for the 2016 scenario.

4.2.5.3 The reclamation affects the Kai Tak Nullah and Tsui Ping Nullah. The extended sections of these two nullahs will be built for flow diversion. These two nullahs are sensitive to the water quality changes due to the reclamation and the water quality in the nullahs has been assessed in this report.

4.2.5.4 The water quality changes in the SEKD area may have a direct impact on the seawater intake of the District Cooling System (DCS) for the SEKD. This seawater intake has been included as a water quality sensitive receiver when the SEKD is in place. **Drawing No. 22936/EN/191** shows the locations of these new sensitive receivers.

4.3 Assessment Methodology

4.3.1 *Introduction*

4.3.1.1 To assess the water quality impacts due to the SEKD, coastline configuration in year 2002 has been used as the baseline. Coastline configuration in year 2016 with and without the SEKD has been used for operational phase assessment. **Drawing Nos. 22936/EN/187** and **188** shows the 2002 and 2016 coastline configurations. Major reclamation and marine developments included in the modelling are indicated in the drawings. Comparisons of water quality have been made for the following scenarios:

- Between year 2016 without the project and year 2002;
- Between year 2016 with the project and year 2002; and
- Between year 2016 with the project and year 2016 without the project.

4.3.1.2 The flows and loads discharging into the Victoria Harbour would influence the water quality in the harbour. Implementation of the SSDS Stages II, III/IV or use of decentralised water treatment plants to reduce the pollution loads in the harbour is still uncertain at this stage. However, no matter which approach would be adopted, reduction in flows and loads entering the harbour is expected. In deriving the flow and load data for the 2016 scenario, the pollution load inventory compiled under the *Cumulative Impact Study* was used as the basis. It was assumed that SSDS Stages II, III/IV would be in place or decentralised water treatment plants would be built leading to the reduction in flows and loads entering the harbour.

4.3.2 *Hydrodynamic and Water Quality Modelling*

4.3.2.1 The proposed reclamation for the SEKD alters the shoreline in the southern part of Kowloon. This changes the hydrodynamic condition in Victoria Harbour. The changes in tidal flushing capacity would affect the dispersion of pollutants discharging from the urban areas in Kowloon Peninsula and Hong Kong Island. In addition to the Victoria Harbour WCZ, the water quality of the two adjacent WCZs (Eastern Buffer WCZ and Western Buffer WCZ) would also be affected.

4.3.2.2 The Delft3D suite of models, which have been developed by Delft Hydraulics, were used to provide a modelling platform for hydrodynamic and water quality modelling in this study. A detailed model with refined grids was developed based on the Updated model, which was calibrated and verified by Delft Hydraulics under the Agreement No. CE42/97, to simulate flow movement and water quality changes in the water body covered by the Victoria Harbour, Eastern Buffer and Western Buffer WCZs. A high grid resolution (less than 75m) was applied in the vicinity of the South East Kowloon reclamation area and a low grid resolution (more than 75m) was used in the remaining areas of the WCZs for hydrodynamic computations. The schematisation of the detailed model is presented in **Drawing No. 22936/EN/189**.

4.3.2.3 Water levels, current velocities and salinities generated by the Updated model provided the boundary conditions to the detailed model for hydrodynamic computations in the three WCZs. **Drawing No. 22936/EN/298** shows the open boundary definition adopted by the detailed model. The hydrodynamic modelling of the Updated model covered the outer regions of Pearl River Estuary, Macau, Lamma Channel and Mirs Bay. All major influences on hydrodynamics in the outer regions were therefore incorporated into the detailed model. The initial conditions for initiating the hydrodynamic computations of the detailed model were based on the computations by the Updated model.

4.3.2.4 The computations of hydrodynamic and water quality were separated to increase the efficiency of the overall model performance. The hydrodynamic outputs from the detailed model were used as inputs for the water quality simulation. The coupling of the hydrodynamic and water quality modules formed a water quality framework capable of predicting the water quality condition in the three WCZs.

4.3.2.5 The water quality module of the detailed model incorporated the transport of substances and associated water quality processes. The water body covered by the WCZs was divided into homogeneous segments. The module allowed physical transport, chemical/biological reactions, or accumulation of substances in the segments to calculate the concentrations of the substances. The regional Updated model for water quality computations provided information for specifying boundary conditions of the detailed model.

4.3.2.6 The purposes of the water quality modelling was to investigate the changes in water quality condition in the WCZs and check for compliance with the WQO requirements during the construction and operational phases of the SEKD. The water quality parameters used for water quality impact assessment mainly include:

- Depth-averaged dissolved oxygen;
- Bottom dissolved oxygen;
- Depth-averaged total inorganic nitrogen;
- Depth-averaged free (unionised) ammonia;
- Depth-averaged geometric mean *E. coli*; and
- Depth-average suspended solids.

4.3.2.7 Representative indicator points were selected for assessment of water quality changes. These indicator points covered all the existing and future water quality sensitive receivers. Some of the indicator points were at the same locations as EPD's routine monitoring stations to check for WQO compliance. **Drawing Nos. 22936/EN/033** and **191** show these indicator points.

Pollution Load Inventory

4.3.2.8 The changes in hydrodynamic and water quality conditions in the vicinity of the reclamation areas and Victoria Harbour would occur after the formation of sea walls. The SEKD reclamation is scheduled to commence in late 2002 and the entire development is expected to complete in 2016. Years 2002 and 2016 have been selected as the base year and the assessment year. When the KTAC reclamation commences, the existing KTAC and part of the KTTS will be reclaimed. The pollution load inventory has been prepared for years 2002, 2003 and 2016 with and without SEKD to assess the potential water quality impacts due to the reclamation. The pollution load inventory has been compiled based on the following studies:

1. *Update on Cumulative Water Quality and Hydrological Effect of Coastal Development and Upgrading of Assessment Tool* (Agreement No. CE42/97) – *Pollution Load and Flow Data HKSAR* (Cumulative Impact Study); and
2. *Review of Central and East Kowloon Sewage Master Plan (Agreement No. 25/98) – Working Paper No. 1 Surveys (Supplementary Report)*, (Central and East Kowloon SMP Study).

2002 Flow and Load Inventory

4.3.2.9 The Central and East Kowloon SMP Study provided the dry weather flow and load data in the Tsim Sha Tsui (TST), Northern and Central Kowloon (NCK), Northern East Kowloon (NEK), and South East Kowloon (SEK) Sewerage Catchment Areas (SCAs) for year 1999. Discharges from these SCAs were covered by the oufalls for North-south Kowloon and East Kowloon.

4.3.2.10 To compile the pollution load inventory for year 2002, it was assumed that the flows and loads for year 2002 in the SEKD area were the same as those for year 1999. The dry weather flows and loads for outfalls within North-south Kowloon and East Kowloon were updated using the 1999 flow and load data obtained from the Central and East Kowloon SMP Study. Rainfall flow and load data from the Cumulative Impact Study were included to give the total flows and loads. The flows and loads for the remaining outfalls were assumed the same as those derived from the Cumulative Impact Study for year 2002. The same approach was adopted to derive both the dry and wet season flow and load data. SSDS Stage I was assumed to be in place in compiling the 2002 flow and load inventory.

2003 Flow and Load Inventory

4.3.2.11 The 2003 flow and load inventory has been used for the interim assessment for the KTAC reclamation. The flow and load data for year 2003 in North-south Kowloon and East Kowloon areas were assumed the same as those for year 2002. There were some changes in storm outfall locations in the SEKD area. SSDS Stage I was assumed to be in place for the year 2003 scenario.

4.3.2.12 In addition to the option for temporary diversion of the Kai Tak Nullah and Jordan Valley Box Culvert to the boundary between the KTAC and KTTS, flow diversion to the Kowloon Bay water may be one of the options when the KTAC reclamation commences. The nullah diversion would adopt the shortest route to discharge the flow into the open water and the temporary discharge point would be close to TKWTS. A fall back option has been proposed to extend the discharge point further to the south away from the typhoon shelter. In case where the modelling results for the shortest discharge route option indicate a significant deterioration of water quality in TKWTS, the fall back option could provide an alternative to minimise the water quality impacts.

2016 Flow and Load Inventory

4.3.2.13 The flows and loads entering Victoria Harbour would be reduced when implementing the SSDS Stages II, III/IV or adopting decentralised wastewater treatment plants to provide a higher level of wastewater treatment. Both options aim to improve the water quality in the Hong Kong waters.

4.3.2.14 In this study, it was assumed that the remaining stages of SSDS would be in place to provide a more realistic representation of the reduction in flows and loads in the harbour for the 2016 scenario. The flow and load data for year 2012 adopted in the Cumulative Impact Study were used as the basis for deriving the flow and load data for year 2016 in the present study. As the Kai Tak Nullah discharge is influenced by the THEES, the effluent discharge standards that would be adopted after the upgrading of the Sha Tin Sewage Treatment Works and Tai Po Sewage Treatment Works were used to prepare the pollution load inventory for year 2016. The pollution load inventory also incorporated the new outfall locations in the SEKD area due to relocation and reconnection of some of the existing outfalls.

4.3.2.15 Details of the flow and load calculation and the numerical data are presented in *Technical Note on Flow and Load Inventory*.

4.3.3 *Thermal Plume Modelling*

4.3.3.1 The WAQ module of Delft3D was used to simulate thermal plume (excess temperature) from the district cooling water discharges. Prominent features such as temperature and salinity effects on buoyancy, tidal flow condition, locations of the cooling water intake and discharge, and surface heat loss were considered in the modelling exercise. Due to the higher temperature of the cooling water, the buoyancy effects will rise the thermal plume to the water surface. Discharges of cooling water from the DCS would be at a level close to the water surface. Therefore, no attempt was made to determine the initial plume geometry and dilution characteristics within the initial mixing zone.

4.3.3.2 The temperature process simulated by the WAQ module of Delft3D is based on the heat exchange coefficient by Sweers (1976)[1]. The coefficient is function of wind speed and temperature, and is calculated during the simulation. The water quality impacts as a result of the use of chemicals (biocide and chlorine) to control scaling, fouling and corrosion in the district cooling water system have been assessed using the detailed model.

Modelling Inputs for Cooling Water Discharge

4.3.3.3 The DCS with a single centralised cooling system pumping station for seawater intake at mid-runway of the disused airport and a single chiller plant room in close proximity to seashore at mid-runway would be used to serve all phases of the SEKD. **Drawing No. 22936/EN/191** shows the seawater intake point and cooling water discharge point of the preferred scheme of DCS. The input data for cooling water discharge include:
Discharge flow rate : 6 m^3/s
Temperature excess : 7 ^{o}C above ambient water temperature

4.3.3.4 The value of 6 m^3/s represents the peak discharge flow rate, which has been derived for the preferred scheme of DCS. Elevation of temperature after the DCS is approximately 7 ^{o}C above the intake seawater temperature. The discharge flow rate may vary for the wet season

[1] Sweers, H. E. (1976). A monogram to estimate the heat exchange coefficient at the air-water interface as a function of wind speed and temperature; a critical survey of some literature. Journal of Hydrology, 30.

and the dry season due to differences in the seawater temperature. Use of the peak discharge flow rate represents the worst case scenario.

4.3.3.5 The substantial discharge rate at the discharge point, abstraction of seawater at the intake point and thermal effects of the cooling water discharge have been included in the hydrodynamic simulations of the detailed model. The subsequent water quality simulations have fully incorporated the dynamics of the cooling water discharge.

4.3.3.6 The chemical used for the seawater treatment would be sodium hypochlorite generated using electrochlorinators in the seawater pump house. The treatment is a continuous process to control growth of micro-organism. The discharge concentration of residual chlorine would be 0.5 mg/L. No decay of chlorine was assumed in the modelling.

4.3.3.7 Biocides would also be used to protect the pipework against corrosion and biofouling. The proposed biocide is C-Treat-6, 30% tallow 1,3-propylene diamine. The dosing rate of C-Treat-6 would be 1 hour per week and the discharge concentration of the biocide would be less than 2 mg/L to minimise the harmful effect on the aquatic life. The suggested decay rate for C-Treat-6 is 64% (decayed amount) in 8 days.

4.3.3.8 During the detailed design stage of the project, it is recommended to explore ways to reduce the use of chlorine and biocide so as to keep the residual chlorine and biocide in the discharge at low levels. This can minimise the potential impacts to the aquatic life. To further protect the aquatic life, the discharge residual chlorine should not be more than 0.3 mg/L and the biocide concentration should be lower than 2 mg/L, wherever practicable.

Assessment Criteria for Cooling Water Discharge

4.3.3.9 The WQO for temperature change due to human activity in the Victoria Harbour WCZ specified that the variation in temperature should not exceed 2 ^{o}C. This limiting value was used as the criteria for assessing the increase in ambient water temperature due to the cooling water discharge.

4.3.3.10 There is no WQO for residual chlorine. As the residual chlorine concentration above 0.02 mg/L would be harmful to the aquatic life, a lower value of 0.01 mg/L of residual chlorine was adopted as the assessment criteria. The USEPA standard adopted the same value for residual chlorine in the receiving water.

4.3.3.11 With reference to the paper "Environmental Management of Coastal Cooling Water Discharges in Hong Kong" by Ma et al. (1998)[2], an interim maximum permissible concentration for C-Treat-6 in the ambient water was recommended to be 0.1 mg/L. The intermittent nature of the discharge was taken into account in determining this limiting value. This value was used as the assessment criteria in the present modelling exercise.

4.3.4 *Sediment Plume Modelling*

4.3.4.1 The reclamation in South East Kowloon would involve dredging and filling activities. In view of the high pollution levels of the sediments in the reclamation areas, the reclamation programme has been planned to minimise the volume of sediments to be dredged. Sediment dredging would mainly be carried out at the locations where tunnels, sea walls, breakwaters and Earth Bund are to be constructed. This reduces the water quality impacts due to sediment plume dispersion.

[2] S. W. Y. Ma, C. S. W. Kueh, G. W. L. Chiu, S. R. Wild, and J. Y. Yip (1998). Environmental Management of Coastal Cooling Water Discharges in Hong Kong. Water Science Technology, Vol. 38, No. 8-9, pp 267-274.

4.3.4.2 The SEKD will be carried out in phases and the early start of the reclamation would be at KTAC commencing in late 2002. The final stage of reclamation would be the Cha Kwo Ling reclamation, which is expected to complete by end of 2013. The schedule of the SEKD reclamation is included in **Table 4.7**. The water quality changes during the construction phase of the project are related on the construction sequence in particular the reclamation phasing and stormwater diversion. Drawings (**Drawing Nos. 22936/IM/620** to **624**, **611** to **615** and **630** to **633**) showing the construction sequence are included for easy reference. The estimated volumes of dredging and filling are presented in **Tables 4.8** and **4.9**. **Drawing Nos. 22936/EN/192** and **020** show the dredging and filling zones.

4.3.4.3 Fill material from both marine and land sources would be used for reclamation. Potential sources of public fill are from the Anderson Road, Choi Wan, Jordan Valley housing development sites and Chai Kwo Ling mining site. The components of public fill would comprise of rock and hard artificial material. Most of the proposed reclamation areas would be reclaimed using public fill. For the sea wall construction, fill material from a land source is considered more suitable.

4.3.4.4 Marine sand fill would be imported from marine borrow areas. The application of sand fill will be mainly for provision of sand blanket in the reclamation areas and at foundations for major marine structures. The construction of D4 Tunnel would use cut and cover method. To impose less earth pressure onto the lateral support wall and to minimise wall deflection and ground settlement of the tunnel, marine sand fill would be used in the D4 Tunnel area. The foundations for breakwaters and sea walls would also be filled with marine sand. Large rocks would be placed on the top of the marine sand layer to form the breakwaters and sea walls.

Table 4.7 Schedule of the SEKD Reclamation

Location	Expected Period of Reclamation
Hoi Sham (Earth Bund)	late 2002 - mid 2004
Hoi Sham Phase 1 Stage 1	early 2006 - end 2007
Hoi Sham Phase 1 Stage 2	early 2007 - end 2008
Hoi Sham Phase 1 Stage 3	end 2008 - early 2010
Hoi Sham Phase 2	mid 2009 - end 2010
Western Arm of New KTTS	mid 2002 - end 2004
Eastern Arm of New KTTS	early 2005 - end 2006
KTTS	mid 2006 - mid 2009
KTTS (a strip along existing seawall)	mid 2009 - early 2011
Cha Kwo Ling	late 2011 - end 2013
KTAC	late 2002 - mid 2006

Table 4.8 Estimated Volume of Dredged Material

Location	Dredge Zone	Volume of Contaminated Sediment to be Dredged ($x10^4$ m^3)	Volume of Uncontaminated Sediment to be Dredged ($x10^4$ m^3)	Total Volume to be Dredged ($x10^4$ m^3)
Hoi Sham (Earth Bund)	1	6.8	4.0	10.8
Hoi Sham (Phase 1 Stage 2)	4	4.8	7.4	12.2
Hoi Sham (Phase 1 Stage 1 - D4 Tunnel)	5	6.4	7.6	14.0
Hoi Sham (Phase 1 Stage 3)	7	7.7	9.8	17.5
Hoi Sham (Phase 2)	8	7.8	5.6	13.4
Western Arm of New KTTS	2	33.8	0	33.8
Eastern Arm of New KTTS	3	42.0	21.2	63.2
KTTS (along existing seawall)	6	8.4	11.9	20.3
Cha Kwo Ling	9	3.4	4.8	8.2
Hoi Sham (Phase 2 – Marina)	10	6.8	4.6	11.4

Table 4.9 Estimated Volume of Marine Sand Fill and Public Fill

Location	Volume of Marine Sand Fill ($x10^6$ m^3)	Volume of Public Fill ($x10^6$ m^3)	Volume of Public Fill for Surcharge ($x10^6$ m^3)
Hoi Sham/Hoi Sham Reclamation	1.37 (44%)	5.96 (45%)	4.10 (43%)
Marina at Hoi Sham	0.11 (3%)	-	-
KTAC Reclamation	0.59 (19%)	2.96 (22%)	2.50 (27%)
KTTS Reclamation	1.0 (32%)	4.05 (30%)	2.50 (27%)
Cha Kwo Ling Reclamation	0.06 (2%)	0.41 (3%)	0.30 (3%)
Total	3.13	13.38	9.4

4.3.4.5 Modelling of sediment transport during dredging and filling was based on the Delft3D-WAQ module. The hydrodynamic condition was generated using the detailed model for hydrodynamic computations and was applied for sediment plume modelling. The processes of settling of sediment particles and exchange of sediment particles between the water column and the seabed governed the sediment transport. Sediment deposition and erosion would occur when the bed shear stress is below or above the critical shear stress. The deposition rate and erosion rate were calculated using the following equations:

(1) Bed Shear Stress (τ) < Critical Shear Stress for Deposition (τ_d = 0.05 Pascal)
Deposition rate = $V_s C_b (1 - \tau / \tau_d)$
Where: V_s = settling velocity (= 2 m/day); and C_b = bottom layer SS concentration

(2) Bed Shear Stress (τ) > Critical Shear Stress for Erosion (τ_e = 0.4 Pascal)
Erosion rate = $R_e (\tau / \tau_e - 1)$
Where: R_e = erosion coefficient (= 0.0002 kg/m^2/s).

Sediment Loss due to Dredging

4.3.4.6 It was assumed that close grab dredgers would be used for sediment dredging in the SEKD reclamation. The most common grab size in the Hong Kong fleet is approximately 8m^3 in capacity. The dredging is assumed to be continuous. Based on the *Kellett Bank Study*[3], the rate of production for contaminated sediment dredging using grab dredgers (8m^3 grab capacity) was 31,250m^3/week, assuming 150 working hours each week. The hourly production rate was calculated as 208.3m^3/hr. This production rate has been adopted to estimate the sediment loss during contaminated sediment dredging in the SEKD.

4.3.4.7 The reclamation areas would be close to residential blocks. It was assumed that the allowable working hour would be from 7 a.m. to 7 p.m. with a total of 12 working hours each day for carrying out the construction work. There would be 6 working days per week. The weekly rate of production for the SEKD was calculated to be approximately 15,000m^3 (=208.3m^3/hr x 12hr/day x 6day/week).

4.3.4.8 Rates of sediment release during dredging have been reviewed and developed in a number of studies. The sediment loss rate is influenced by water depth, current speed and sediment characteristics. The range of sediment loss rate for close grab dredgers was reported to be between 11 and 20 kg/m^3 (Kirby and Land 1991[4], Environment Canada 1994[5]). Bray et al. (1997)[6] reported that sediment release from grab dredgers would well exceed 20 kg per cubic meter of dredged sediment. It was recommended in the *Kellett Bank Study* that a sediment loss rate of 25kg/m^3 would be more appropriate for modelling the grab dredging operations. The recommended value takes into account the occasional failure to close the grab. By adopting

[3] Environmental Impact Assessment: Dredging an Area of Kellett Bank for Reprovisioning of Six Government Mooring Buoys – Working Paper on Design Scenarios, ERM, 1998.
[4] Kirby, R., and Land, J. M., (1991). The Impact of Dredging – A Comparison of Natural and Man-Made Disturbances to Cohesive Sedimentary Regimes. Proc. CEDA-PIANC Conference, Amsterdam. Central Dredging Association, The Netherlands.
[5] Environment Canada (1994). Environmental Impacts of Dredging and Sediment Disposal. Development Section, Environmental Protection Branch, Environment Canada, Quebec and Ontario Branch, Cat. No. EN 153-39/1994E.
[6] Dredging – A Handbook for Engineers, 2nd Edition, R. N. Bray, A. D. Bates, and J. M. Land, John Wily & Sons, Inc., 1997.

the same unit loss rate, the sediment loss rate with the sediment production rate of 15,000m^3/week for this study would be **1.45kg/s** per dredger (= 15,000m^3/wk / 72(wk/hr) / 3600(hr/sec) x 25kg/m^3).

Sediment Loss due to Filling

4.3.4.9 It was assumed that bottom split trailer hopper dredger with a capacity of 5000m^3 would be used to carry out the sand filling activities. Filling is assumed to be a 10-minute per 3-hour cycle. Release of fine particles from disposal operations using bottom dump trailer may vary depending on the dumping material and site condition. Bokuniewicz et al. (1978)[7] reported that the loss rate for disposal of sandy, marine and river silt at water depths 14 to 46m was about 1%. In the study of Sustar and Wakeman (1977)[8], the loss rates of bottom dump trailer ranged from 1 to 5% for silt and clay. A higher sediment loss rate of 5% is assumed for the present study.

4.3.4.10 The calculation of sediment loss rate for sand filling is detailed below:
Dry density = 1600 kg/m^3
Fine portion = 20%
Portion of fines lost during filling (marine sand) = 5%
Capacity of the bottom split trailer hopper dredger = 5000 m^3
Dry solids released per filling event = 5000 m^3 x 1600 kg/m^3 = 8000 ton.
Release of fine portion = 8000 ton x 20% = 1600 ton
Fines lost to suspension = 1600 ton x 5% = 80 ton
Total discharge time = 10 min
Loss rate of fines = 80 ton / 10 min = 133 kg/s
The estimated loss rate for sand filling for a release duration of 10 minutes is 133 kg/s.

4.3.4.11 Public fill would be used in most of the reclamation areas. The fine content of public fill varies in a wide range depending on the components of public fill. The percentage of fine portion would be as high as 40%. The filling operation would be carried out from bottom dumping barges with a capacity of 1500 m^3. Assuming that the bulk density of public fill is 2000 kg/m^3 and the total quantity of fines lost to suspension is 5%, the estimated loss rate for public fill for a release duration of 5 minutes would be approximately 200 kg/s. The filling frequency is about one every 54 minutes.

4.3.4.12 When carrying out the filling activities using bottom dumping barges or trailer dredgers, a patch of high concentration of fine particles would be generated in the water column. The fine particles would be transported away from the filling location by the currents. In case where the sediment plume modelling results indicate significant exceedances of SS levels at the sensitive receivers, mitigation measures should be adopted to minimise the potential impact. A mitigated scenario of using suction trailer to place marine sand through the suction arm down to the seabed would be considered. This method minimises the loss of fine particles during the filling and is likely to be applicable for sand filling at breakwater locations, i.e. eastern and western arms of KTTS. The sediment loss rate for trailer dredgers[9] is about 3 kg/m^3. Over a 2-hour period for each filling event, the estimated loss rate of fine particles for the mitigated scenario would be **2.1 kg/s** (= 3 kg/m^3 x 5000 m^3 / 2 hrs). However, this method may not be suitable for filling of public fill. Mitigation measures including provision of silt curtains and filling behind sea wall would be considered.

[7] Bokuniewicz, H. J, et al., (1977). Field Study of the Mechanics of Placement of Dredged Material at Open Water Sites. Technical Report D-78-7, prepared by Yale University for USACE, WES, Vicksburyg, Mississippi.
[8] Sutar, J. F., and Wakeman, T., (1997). Dredge Material Study, San Francisco Bay and Esturary – Main Report. US Army Engineer District, San Francisco, Ca.
[9] Tang Lug Chau DGA EIA, Tsuen Wan Bay Further Reclamation, Agreement No. CE 26/94.

Proposed Modelling Scenarios

4.3.4.13 Three scenarios have been considered in sediment plume modelling based on the reclamation programme. **Table 4.10** summarises the details. The proposed scenarios cover the situations where most of the dredging and filling activities are carried out at the same time. **Drawing No. 22936/EN/216** shows the location plan for dredging and filling operation.

4.3.4.14 The key concern of dredging and filling is the increase in SS levels in the ambient water and release of contaminants from the sediment particles. The WQO for SS defined that there should be no exceedance of 30% of the ambient level due to human activities. This criterion was used for assessment of sediment plume dispersion. A conservative tracer has been added in the sediment plume modelling exercise to give an estimate of the dilution around the dredging sites.

Table 4.10 Modelling Scenarios for Sediment Plume Modelling

Scenario	Location of Sediment Loss	Dredge / Reclamation Zone	Activity	Sediment Release Rate (kg/s)
1	S1	Dredge Zone 1	Dredging at Hoi Sham (Earth Bund)	1.45 kg/s (1 close grab dredger)
	S2	Dredge Zone 2	Dredging at western arm of the new KTTS	2.9 kg/s (2 close grab dredger)
	S3	Reclamation Zone 2A	Filling at KTAC	200 kg/s for 5 minutes (1 bottom dumping barge)
2	S4	Dredge Zones 4	Dredging at Hoi Sham (Phase 1 Stage 2)	1.45 kg/s (1 close grab dredger)
	S5	Dredge Zone 5	Dredging at Hoi Sham (D4 Tunnel)	1.45 kg/s (1 close grab dredger)
	S6	Dredge Zone 3	Filling at eastern arm of KTTS	133 kg/s for 10 minutes (1 trailer dredger for sand filling)
3	S7	Reclamation Zone 1E	Filling at Hoi Sham (Phase 1 Stage 2)	200 kg/s for 5 minutes (1 bottom dumping barge)
	S8	Reclamation Zone 3A	Filling at KTTS	200 kg/s for 5 minutes (1 bottom dumping barge)
	S9	Dredge Zone 8	Dredging at Hoi Sham Phase 2	1.45 kg/s (1 close grab dredger)

Notes:
1. Use of close grab dredgers for sediment dredging (8 m^3 close grab dredger) and the dredging would be continuous between 0700 and1900;
2. It was assumed that bottom split trailer hopper dredger with a capacity of 5000m^3 would be used for filling in Hoi Sham. The filling rate is assumed to be a 10-minute per 3-hour cycle. Bottom dumping barge with a capacity of 1500m^3 would be used for filling at KTAC and KTTS; and
3. Daily production rates: sediment dredging = 2500m^3/day, sandfilling and filling of public fill = 20000m^3/day.

4.3.5 *Extended Channel Water Quality Modelling*

4.3.5.1 In view of the tidal range/intrusion in the development area and the widths of the Kai Tak Nullah and Tsui Ping Nullah, the extended sections of these two nullahs were included in the detailed model and were represented by suitably defined model grids. The section of the Kai Tak Nullah included in the model were extended from the coastline (after reclamation) upstream to the mean high water mark at +2.5mPD.

4.3.5.2 Assessment of water quality impacts in the Kai Tak Nullah was based on pollution loads and flows from the THEES and the other storm drain discharges taken from the current Review of Central and East Kowloon SMP Study. For the Tsui Ping Nullah, pollution loads and flows were mainly based on the Central and East Kowloon SMP Study. **Tables 4.11** and **4.12** summarise the effluent standards for the existing and upgraded Sha Tin Sewage Treatment Works and Tai Po Sewage Treatment Works. The effluent standards provided information to estimate the contribution of flows and loads by the sewage treatment works to the Kai Tak Nullah.

Table 4.11 Existing Effluent Discharge Standards for Sha Tin and Tai Po STWs

Parameters	Sha Tin STW	Tai Po STW
Flow (m^3/d)	220,000 (wet season), 190,000 (dry season)	89,000 (wet season), 75,000 (dry season)
BOD (mg/L)	20 (95%ile), 40 (maximum)	20 (95%ile), 40 (maximum)
SS (mg/L)	30 (95%ile), 60 (maximum)	30 (95%ile), 60 (maximum)
Total-N (mg/L)	25 (95%ile), 50 (maximum)	25 (95%ile), 50 (maximum)

Notes:
1. The flows presented in the table are the average daily flows for the Sha Tin and Tai Po STWs; and
2. There is no disinfection of the discharged effluent.

Table 4.12 Effluent Discharge Standards for the Upgraded Sha Tin and Tai Po STWs

Parameters	Sha Tin STW	Tai Po STW
Flow (m^3/d)	350,000	130,000
BOD (mg/L)	20 (95%ile), 40 (maximum)	20 (95%ile), 40 (maximum)
SS (mg/L)	30 (95%ile), 60 (maximum)	30 (95%ile), 60 (maximum)
E. coli (count/100mL)	1000 (monthly geometric mean), 15,000 (95%ile)	1000 (monthly geometric mean), 15,000 (95%ile)
NH_3-N (mg/L)	5 (annual average), 10 (maximum)	5 (annual average), 10 (maximum)
Total-N (mg/L)	20 (95%ile), 35 (maximum)	20 (95%ile), 35 (maximum)

Notes: The flows presented in the table are the designed flow rates for the upgraded Sha Tin and Tai Po STWs.

4.4 Identification, Prediction and Evaluation of Potential Impacts

4.4.1 The key issues pertinent to water pollution that would arise during the construction and operational phases of the proposed SEKD are listed as follows:

Construction Phase

- Changes in coastline configurations that affect the hydrodynamic and water quality conditions in the harbour and the water quality sensitive receivers;
- Nullah and box culvert diversion;
- Dredging and filling;
- Construction site runoff;
- Wastewater and sewage generated from construction activities;
- Ground Improvement; and
- Groundwater discharge during dewatering.

Operational Phase

- Sewage generated from the SEKD;
- Presence of the SEKD reclamation;
- Discharges from storm drains and sewage outfalls/nullahs;
- Water quality in the extended sections of diverted nullahs;
- Cooling water discharges; and
- Storm and Emergency Overflows.

4.4.2 *Construction Phase Water Quality Impacts*

Changes in Coastline Configurations

4.4.2.1 Reclamation will be carried out in KTAC, KTTS and Hoi Sham for the revised scheme of SEKD. The hydrodynamic condition in the vicinity of the proposed developments is likely to be affected by the new reclamation. Upon the completion of the whole SEKD reclamation, the current speeds within Victoria Harbour would be changed. The physical presence of the SEKD alters the flow patterns in the vicinity of the developments and would cause impacts on the discharges through the Victoria Harbour channel. The changes in hydrodynamic condition influence the water quality within the Assessment Area causing impacts to the nearby sensitive receivers.

2002 Base Year

4.4.2.2 The hydrodynamic condition in the Victoria Harbour, Western Buffer and Eastern Buffer WCZs for year 2002 was simulated to provide the baseline data for comparison with the future developments. **Drawing Nos. 22936/EN/152** and **153** show the flow patterns in Victoria Harbour for both the dry and wet seasons. The drawings illustrate the hydrodynamic condition in the harbour prior to the SEKD. The flow patterns showed higher current speeds in the central part of the Victoria Harbour channel. The flow condition near the development area