

Post Project Monitoring of Discharge into Victoria Harbour from Tolo Harbour Effluent Export Scheme (THEES)

1. Description of the Study

1.1. The Post Project Monitoring shall take into account the planned extension and upgrading of the Sha Tin and Tai Po treatment works and the findings of previous studies of relevance including the results from any other relevant monitoring programmes. The study shall principally comprise assessment of the following elements:

- 1.1.1. beneficial uses of the receiving waters and sensitive receivers within the study area, including Kai Tak Nullah, that may potentially be affected by the discharge;
- 1.1.2. dispersion of the effluent plume so as to establish the extent of and influences on the zone of influence. Determination of the zone of influence shall be based on a list of parameters to be proposed by the Project Proponent and agreed by the Director of Environmental Protection and shall include substances of interest such as Biochemical Oxygen Demand (and its interaction with Dissolved Oxygen), suspended solids, nutrients, *E.coli* and trace contaminants of concern;
- 1.1.3. impact of the treated effluent on the receiving water quality and compliance with the gazetted Water Quality Objectives;
- 1.1.4. impact on sediment deposition in Kai Tak Nullah and sediment resuspension, if any, in Kwun Tong Typhoon Shelter or Kowloon Bay, as appropriate arising from the treated effluent;
- 1.1.5. impact of the treated effluent discharge on the sediment quality within the receiving marine waters;
- 1.1.6. risk to human health associated with sensitive receivers in Kai Tak Nullah or Kowloon Bay as appropriate arising from the discharge of treated effluent;
- 1.1.7. ecotoxicological effects of the treated effluent;
- 1.1.8. likely effects of the treated effluent on marine ecology including benthos, commercial and aquaculture fisheries; and
- 1.1.9. impact on sensitive receivers other than those specifically covered above.

1.2. The monitoring requirements shall be proposed by the Project Proponent and agreed with the Director of Environmental Protection in such a way as to ensure that the study objectives are fully satisfied. The monitoring programme shall comprise the following components:

- 1.2.1. effluent quality monitoring;

- 1.2.2. water quality monitoring;
- 1.2.3. sediment quality monitoring;
- 1.2.4. benthic survey;
- 1.2.5. ecotoxicological assessment.

An indicative outline of the basic requirements of the above is suggested in Clauses 1.3 to 1.7 for the consideration of the Project Proponent.

1.3. Effluent Quality Monitoring (Indicative)

- 1.3.1. Two cycles of effluent sampling each of a full 24-hour period shall be conducted during both the wet and dry seasons over the field work period of one year to characterize the quality of the treated effluent (i.e. a total of four sampling cycles). Samples of the treated effluent shall be collected at appropriate time intervals over the 24-hour period and analysed for a range of variables to be agreed with the Director of Environmental Protection such as *E.coli*, Biochemical Oxygen Demand, suspended solids, volatile suspended solids, ammonia, total organic carbon, total nitrogen (soluble and particulate), total phosphorous (soluble and particulate), a suite of metals and other contaminants of concern. This sampling shall be performed to coincide with samples of effluent to be assessed for toxicity as described in Clause 1.7.

1.4. Water Quality Monitoring (Indicative)

- 1.4.1. Sampling for water quality monitoring shall be performed four times over the field work period of one year to give adequate coverage of different tidal states during both wet and dry seasons. The locations of the sampling stations (approximately 12 in number) shall be proposed by the Project Proponent, with justification, for the agreement of the Director of Environmental Protection prior to commencement of the field work. Samples shall be collected at surface and bottom of the water column at the selected locations and at times corresponding to two slack tide conditions during each survey.
- 1.4.2. Samples collected in accordance with Clause 1.4.1 above shall be analyzed for a range of water quality determinands to be agreed with the Director of Environmental Protection such as *E.coli*, Biochemical Oxygen Demand, suspended solids, ammonia, nitrite, nitrate, total nitrogen (soluble and particulate), total phosphorous (soluble and particulate), chlorophyll-a and other contaminants of concern. Dissolved oxygen, pH, salinity, temperature and turbidity shall also be measured at all of the selected water quality monitoring stations by vertical profiling at 0.5m depth intervals at the same time as the water samples are taken as described above.

1.5. Sediment Quality Monitoring (Indicative)

- 1.5.1. Sediment sampling shall be performed four times over the field work period of one year to give adequate coverage of both wet and dry seasons. The sampling locations (approximately 12 in number) and analysis of sediment samples to be conducted shall be agreed with the Director of Environmental Protection. Analysis shall include determinands such as percentage of silt/ clay, pH, acid volatile sulphides, total volatile solids, total organic carbon, ammonia, total nitrogen, total phosphorous, a suite of metals and other contaminants of concern identified in the treated effluent, if any.
- 1.6. Benthic Survey (Indicative)
 - 1.6.1. Benthic sampling shall be conducted four times over the field work period of one year, in parallel with the sediment sampling described in Clause 1.5.1 above, using the same monitoring stations except those along Kai Tak Nullah. The benthos collected shall be identified to the lowest taxonomic level and the benthic community structure determined.
- 1.7. Ecotoxicological Assessment (Indicative)
 - 1.7.1. The Project Proponent shall propose, with full scientific justification, for the approval of the Director of Environmental Protection and undertake a programme of ecotoxicological assessment to determine the toxicity of the treated effluent and the toxicity of the receiving marine water. All ecotoxicological samples shall be fully characterized physically and chemically. The list of determinands shall be proposed by the Project Proponent and agreed with the Director of Environmental Protection but shall include ammonia, sulphide, a suite of heavy metals, Polychlorinated Biphenyls, a suite of Polynuclear Aromatic Hydrocarbons and a suite of organochlorine pesticides. The test organisms used for the toxicity tests shall include representative species of the local environment, preferably including common species of fish cultured locally. The Project Proponent's attention is drawn to the conditions under the Water Pollution Control Ordinance discharge licence for THEES requiring the Drainage Services Department (DSD) to undertake routine sampling and testing for characterization of the treated effluent. The Project Proponent shall coordinate the works required under Clauses 1.3.1 and 1.7.1 and liaise with DSD properly in order to minimize duplication of effort and expenditure for sampling and testing related to this Assignment.
- 1.8. The existence of any pollution gradients away from the point of discharge shall be established for parameters and trace contaminants of concern pertaining to water quality and sediment quality.
- 1.9. Water Quality and Plume Dispersion Models
 - 1.9.1. Modelling software

- 1.9.1.1. The modelling software shall be capable of accurately simulating stratification and salinity transport in three dimensions within the model area.
- 1.9.1.2. The modelling software shall contain hydrodynamic, water quality and particle dispersion modules. The hydrodynamic and water quality modules shall have proven successful applications locally and overseas.
- 1.9.1.3. The hydrodynamic and water quality modules shall strictly conserve mass at all levels.

1.9.2. Model details – Calibration and Validation

- 1.9.2.1. No field data collection is required for the purposes of model calibration for this study. However, before commencement of this study, the models shall have been properly calibrated and validated in the Western Harbour and Victoria Harbour with the field data collected from studies which may include, inter alia:
 - Hydraulic and Water Quality Studies in Victoria Harbour (1987)
 - Port and Airport Development Strategy - Enhancement of WAHMO Mathematical Models (1990)
 - Strategic Sewage Disposal Scheme Stage II - Oceanic Outfall, Oceanographic Surveys and Modelling (1992)
 - Update on Cumulative Water Quality and Hydrological Effect of Coastal Developments and Upgrading of Assessment Tool (1998)
 - EPD’s routine monitoring data
 - Tidal data from HK Observatory, Macau and relevant Mainland Authorities.
- 1.9.2.2. Tidal elevation data shall be calibrated and validated in both frequency and time domain manner.
- 1.9.2.3. For the purposes of calibration and validation, the model shall simulate not less than 15 days of real tide sequence (excluding model spin up) in both dry and wet seasons with due consideration for the time required to establish initial conditions.
- 1.9.2.4. The hydrodynamic models must be calibrated to the following criteria:

<u>Criteria</u>	<u>Level of fitness with field data</u>
• tidal elevation (root mean square)	< 8 %
• maximum phase error at High Water and Low Water	<20 minutes
• maximum current speed deviation	< 25 %
• maximum phase error at peak speed	< 20 minutes
• maximum direction error at peak speed	< 15 degrees

- maximum salinity deviation < 2.5 ppt

1.9.3. Model details – Simulation

- 1.9.3.1. The Project Proponent is required to undertake model runs to simulate the actual conditions to help ascertain and predict the impact of the discharge on the receiving waters. The water quality modelling results shall be qualitatively explainable, and any identifiable trend and variations in water quality shall be reproduced by the model. The water quality model shall simulate and take account of the interaction of dissolved oxygen, phytoplankton, organic and inorganic nitrogen, phosphorus, silicate, biochemical oxygen demand, temperature, suspended solids, air-water exchange and benthic processes. It shall also simulate salinity transport and *E.coli* dispersion. Salinity results simulated by hydrodynamic models and water quality models shall be demonstrated to be consistent.
- 1.9.3.2. The models shall at least cover the Victoria Harbour, Ma Wan Channel, Kap Shui Mun, Western Harbour (bounded in the South by Green Island and Peng Chau) and Tathong Channel to incorporate all major influences on hydrodynamic and water quality.
- 1.9.3.3. Model grid around the Ma Wan Channel, Kap Shui Mun, Rambler Channel, Lei Yue Mun and the Kwun Tong Typhoon Shelter shall be less than 75 m. In general, grid size at the area shall be less than 400 m in open waters and less than 75 m around sensitive receivers. The grid schematisation shall be agreed with the Director of Environmental Protection. All models shall either be dynamically linked to a far field model or form part of a larger model by gradual grid refinement.
- 1.9.3.4. The Project Proponent shall install all modelling results and display software on the Government's computers.

1.9.4. Modelling assessment

- 1.9.4.1. Scenarios to be modelled shall cover various stages of implementation of the THEES including any future expansion or upgrading of the Sha Tin and Tai Po treatment works being considered. Corresponding pollution loads, bathymetry and coastline shall be adopted in the model set up.
- 1.9.4.2. Hydrodynamic and water quality models shall be run to simulate 15 days (excluding model spin up) of real tide sequence.
- 1.9.4.3. The models shall be used to help ensure cost effective design of the field monitoring programme and to help establish the extent of and influences on the zone of influence.

- 1.9.4.4. The models shall be used to facilitate the assessment of the impact of the treated effluent discharge on the receiving environment in order to ensure that the study objectives are fully satisfied.
- 1.10. Dye Tracer Surveys, if necessary shall be conducted during wet and dry seasons in post-commissioning period, both on a flood tide and an ebb tide, to assess the behaviour of the effluent plume from the discharge points and to quantify the actual dilution under both stratified and non-stratified water columns.
- 1.11. The monitoring programme shall maintain a degree of flexibility to allow the incorporation of the findings based on the monitoring results obtained as the study progresses. Therefore, the location and number of monitoring stations, number of samples and replicates, and types of tests and analyses will be subject to continual review by the Project Proponent and amendment as necessary. Accordingly, upon direction from the Director of Environmental Protection, resources for the monitoring programme may be redeployed, reduced or increased within the study area.
- 1.12. The Project Proponent shall propose and arrange field sampling and survey, if required, to characterize other major pollutant inputs to Kai Tak Nullah and Kwun Tong Typhoon Shelter.
- 1.13. The Project Proponent shall assess the potential impacts of the treated effluent on marine ecology including benthos, commercial and aquaculture fisheries based on the water quality, sediment quality, benthic survey and ecotoxicological assessment in Clauses 1.4 to 1.7 above and assessment of the available data in respect of the water and sediment quality.
- 1.14. The Project Proponent shall take account of, and distinguish, impacts arising as a consequence of the discharge of treated effluent from THEES, as distinct from those arising from other pollution sources and anthropogenic activities.

2. Recommendations

- 2.1. The Project Proponent shall make recommendations with respect to the need for improvement to the operation of THEES.
- 2.2. The Project Proponent shall make recommendations with respect to the requirements for, and methodologies to be employed in the course of, future monitoring programmes or supplementary investigations to quantitatively assess and predict future performance of THEES and its impact on the environment.
- 2.3. The Project Proponent shall prepare a M&A Manual for long term monitoring of the performance of the outfall to ensure acceptability of the impacts of the effluent discharge on the receiving environment.