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Drainage Services Department

Agreement No. CE 43/2005 (EP)

Harbour Area Treatment Scheme (HATS) Stage 2A Environmental Impact Assessment Study - Investigation

Executive Summary

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1 INTRODUCTION

Project Background

1.1 Commissioned in the end of 2001, Stage 1 of Harbour Area Treatment Scheme (HATS) is currently collecting and treating 1.4 million m^3/d of sewage generated from Tsuen Wan, Kwai Tsing, Tseung Kwan O, the urban areas of Kowloon and northeastern Hong Kong Island. Water quality in the eastern and middle parts of Victoria Harbour has since improved considerably.

1.2 The remaining sewage from northern and western Hong Kong Island, which currently amounts to 450,000 m^3/d, however receives only screening and de-gritting prior to discharging into Victoria Harbour, exerting a negative effect on water quality. With the anticipated growth in population and business activities in the harbour area, water quality would deteriorate in the future unless the remainder of untreated sewage is also intercepted and treated, and the overall treatment level at Stonecutters Island to be raised by completing HATS Stage 2.

1.3 After taking into account the public's views collected through a five-month consultation in 2004, the Government is committed to proceeding with Stage 2 of HATS in two phases, namely Stage 2A and Stage 2B.

- Under Stage 2A, deep tunnels will be built to bring sewage from eight preliminary treatment works (PTW) in the northern and western areas of Hong Kong Island to Stonecutters Island Sewage Treatment Works (SCISTW). The eight existing preliminary treatment works (PTW) (at North Point, Wan Chai East, Central, Sandy Bay, Cyberport, Wah Fu, Aberdeen, and Ap Lei Chau respectively) on Hong Kong Island will be upgraded. The treatment works of the SCISTW will be expanded to provide centralized chemically enhanced primary treatment (CEPT) and disinfection for all sewage from the whole of the HATS catchment. Part of the Stage 2A disinfection facilities will be fast-tracked for completion in 2009 to achieve early improvement to the beach water quality in Tsuen Wan. This proposal is referred to as the "Advance Disinfection Facilities" (referred as ADF), and has been covered in a separate EIA study[1].

- Under Stage 2B, a new biological treatment plant on a site adjacent to SCISTW is proposed to treat all HATS flow. Planning for Stage 2B is in hand, with a view to completing it in time to suit actual sewage flow build up and water quality conditions.

1.4 This Environmental Impact Assessment (EIA) Study is concerned with HATS Stage 2A (the Project). The objectives of HATS Stage 2A are:

- To deal with the remaining sewage from Hong Kong Island which is discharged into the harbour virtually untreated
- To provide disinfection to all sewage from the whole HATS service area to protect our beaches from bacterial pollution
- To restore the Harbour to a healthier condition

1.5 On 27 February 2006, ENSR Asia (HK) Ltd. (formerly Maunsell Environmental Management Consultants Ltd.) was commissioned by the Drainage Services Department of the Hong Kong SAR Government to undertake the EIA Study of the Project. The purpose of the EIA Study is to provide information on the nature and extent of environmental impacts arising from the construction and operation of the Project and related activities that take place concurrently.

Need for the Project

1.6 Victoria Harbour is a precious natural asset of Hong Kong with tremendous socio-economic value. Rapid population growth in the past decades on both shores of Victoria Harbour resulted in water

[1] The objective of the ADF is to reduce the *E. coli* level in the CEPT effluent at SCISTW prior to discharge and hence facilitate early improvement to beach water quality. A separate EIA study - *Agreement No. CE 7/2005 (EP) HATS EIA Study for the Provision of Disinfection Facilities at Stonecutters Island STW - Investigation* was *approved* by EPD on 8 November 2007 (Approved EIA Register No.: AEIAR-113/2007). The ADF EIA Report is available at http://www.epd.gov.hk/eia/register/report/eiareport/eia_1342007/index.htm

quality deterioration from the discharge of untreated sewage into the Harbour. Stage 1 of HATS has brought about noticeable improvement to the water quality of the Victoria Harbour. Yet, sewage from the densely populated parts of Hong Kong Island (i.e., northern and southwestern districts) is only subject to preliminary treatment (i.e., screening and de-gritting) before discharging into the harbour. This preliminary treated sewage, coupled with the un-disinfected effluent from the SCISTW, is a source of the current water quality problems, particularly in the western part of the harbour including bathing beaches in the Tsuen Wan area.

1.7 HATS Stage 2A is needed to further improve the water quality of the Harbour, beyond those achieved in Stage 1. Generally, the benefits include:

- Prevent another 190 to 500 tonnes of sewage sludge (at commissioning and ultimate flow conditions respectively) from being dumped into the harbour each day
- Reduce toxic ammonia by 10% on average
- Reduce total inorganic nitrogen and phosphorus by 5% and 8% respectively
- Increase dissolved oxygen levels by 5%
- Facilitate the re-opening of the closed Tsuen Wan beaches

1.8 HATS Stage 2A will substantially improve the water quality conditions compared to the scenario of 'no HATS Stage 2A'. Improved harbour water quality will benefit society in many different ways, including for example, enhanced recreational opportunities, scenic quality, aesthetics, public health and safety, and ecological and fishery resources, as well as commercial activities. Besides, completion of Stage 2A, together with other sewerage programmes in the area, should enable the closed Tsuen Wan beaches to be re-opened at the earliest opportunity. Completion of Stage 2A would also provide a much-improved environment for marine life and possibility of staging water events.

1.9 The Harbour with improved water quality after Stage 2A will inevitably bring economic benefits to Hong Kong directly, and indirectly through the tourism industry. If HATS Stage 2A does not proceed, the water quality would resume a deteriorating trend in the near future as the population grows and development on both sides of the harbour continues. Hence, there is a need for maintaining sustained efforts to clean up the harbour through implementation of the remaining stage of HATS.

Project Scope

1.10 The scope of work for HATS Stage 2A includes:

- Upgrading of eight existing preliminary treatment works (PTWs) on Hong Kong Island
- Extension of the deep sewage conveyance system (SCS) to collect and transfer sewage from the eight PTWs to SCISTW for treatment and disposal
- Augmentation of the existing Chemical Enhanced Primary Treatment (CEPT) capacity at SCISTW from the present design capacity of 1.7million m^3/d to the ultimate design capacity (which is estimated at about 2.45million m^3/d based on the latest available planning information)
- Provision of disinfection to all HATS effluent before discharging into the harbour

1.11 **Figure 1** shows the general layout plan of HATS Stage 2A.

Consideration of Alternatives

1.12 In developing the HATS Stage 2A scheme, relative environmental benefits and dis-benefits of alternatives of SCS alignment, construction methods, treatment methods and sequence of works of the Project were evaluated.

Alternative SCS Alignment

1.13 Two major alternatives for the SCS alignment (**Figure 2** refers) were considered, including:

- *Option 1,* the initial scheme presented in the EIAO Study Brief, which was developed based on the schematic design produced under the "Environmental and Engineering Feasibility Assessment Studies in relation to the Way Forward of the HATS (EEFS)" commissioned by EPD in 2001.

- *Option 2*, a revised alignment developed for the SCS under Agreement No. CE 34/2005(DS), Harbour Area Treatment Scheme Stage 2A Sewage Conveyance System – Investigation, Design, and Construction.

1.14 The alignment under Option 2 could minimise impacts to the inland environmental sensitive receivers/historic structures by going offshore. It also minimises encroachment on private lots and thereby eliminates interfaces with private properties. This would result in the reduction of programming risk and hence duration of environmental impacts to the public. Since the tunnel alignment under Option 2 is only 0.5 km longer than the alignment of Option 1, increase of waste generation would not be a significant concern. On considering the relative environmental impacts of the tunnel alignments, Option 2 is preferred from an environmental perspective and is proposed for the Project.

Alternative Disinfection Technologies

1.15 The feasible sewage disinfection options for HATS are chlorination (with dechlorination) and UV radiation. Both chlorination/dechlorination (purchase of sodium hypochlorite and sodium bisulphite) and UV radiation were found to be environmentally acceptable for HATS. Water quality and ecological impacts could be controlled to well within established criteria in the Technical Memorandum of EIA Process for either option.

1.16 Although both disinfection options would be environmentally acceptable, it has been shown that neither is superior to the other on all environmental aspects. However, the chlorination option would be preferred in terms of cost, reliability, flexibility to cater for uncertainties, and ease of implementation. The detailed evaluation conducted under the *HATS EIA Study for the Provision of Disinfection Facilities at Stonecutters Island Sewage Treatment Works – Investigation (ADF EIA)* has concluded the adoption of chlorination with dechlorination as the disinfection technology for HATS.

Alternative Construction Methods

i) Sewage Conveyance System (SCS) and Effluent Conveyance system (ECS) at SCISTW

1.17 The key alternatives for construction of the SCS and ECS are:

- *Option 1* - Shallow sewer pipes (open trench excavation)
- *Option 2* - Deep tunnelling (trenchless method or "no dig" technology)

1.18 Deep tunnelling under Option 2 would be preferred from an environmental perspective because activities on the surface would be restricted to a relatively small number of production shafts and hence construction stage environmental impacts would be much lower than Option 1. Further, at these shaft locations, environmental noise, dust, and visual impacts could be effectively mitigated with a carefully designed enclosure.

1.19 With respect to alternative tunnel construction methods, the principal options are i) mechanical boring and ii) drill & blast. Both options would be environmentally acceptable, as demonstrated in relevant chapters of the EIA Report. The final selection will be made by the design-build contractor.

ii) PTW Upgrading and SCISTW Augmentation

1.20 There are a number of proposed facilities for the PTW upgrading and expansion of SCISTW which would require piling works, such as location for heavy mechanical equipment (e.g. pumps) in PTWs as well as new sedimentation tanks, sludge processing plant and upgraded disinfection facilities in SCISTW. The relative environmental impacts of the alternative piling methods (i.e. percussive vs. bored pile) were considered. From an environmental perspective, bored piling is preferred as it would

have lesser noise and vibration impacts compared to percussive piling.

Alternative Sequences of Construction

1.21 With respect to sequence of construction works for PTW and SCISTW, the alternatives are:

- *Option 1* - Constructing the SCS drop shafts at the same time as the main PTW upgrading works and the new and upgrading works elements on the SCISTW site
- *Option 2* - Phased construction of the SCS drop shaft and PTW upgrading works, and phased construction of the new and upgrading works elements on the SCISTW site

1.22 Option 2 (phased construction) would have lower noise and dust impacts as it would have less construction activities on site at a given time. This would achieve compliance with the relevant environmental criteria (e.g., construction noise) and therefore it is preferred from an environmental perspective.

2 PROJECT DESCRIPTION

Overview of Proposed Scheme for HATS Stage 2A

2.1 The operational philosophy of HATS Stage 2A is similar to HATS Stage 1 with the addition of disinfection. That is, sewage from the catchments will be:

- Firstly, screened and de-gritted at the PTWs to remove large solid objects and sediments, so as to protect the downstream sewer tunnels from blockage or excessive sedimentation
- Then, discharged into the SCS, which consists of sewer tunnels or pipelines to convey the screened/de-gritted sewage to SCISTW
- Finally, treated and disinfected at SCISTW, to a level suitable for discharge via a submarine outfall system into the sea

2.2 Sludge drawn from the sedimentation process will be dewatered in SCISTW, and then transported offsite for final treatment and/or disposal in accordance with Government's strategy for sewage sludge management. The solid residues (screened debris and grits) from the PTW will be removed by trucks to landfill for disposal.

Preliminary Treatment Works

2.3 Eight existing PTWs on northern and western Hong Kong Island (**Figure 1** refers), including North Point, Wan Chai East, Central, Sandy Bay, Cyberport, Aberdeen, Wah Fu, and Ap Lei Chau would be upgraded/modified to meet design treatment and flow requirements. Principally, the major upgrading works at most of the PTWs would include replacement or installation of the following:

- Mechanical screens of various sizes
- Pumps
- Grit traps
- Compactors
- Deodorising units
- Control system and expert system

2.4 Construction works would be carried out in phases in order to minimize environmental impacts and provide space for SCS construction and normal PTW operation. Conventional construction plant and equipment would be used for the PTW upgrading works.

Sewage Conveyance System

2.5 SCS would be constructed to bring sewage discharged from the PTWs via drop shaft into the deep

tunnels and then conveyed to the SCISTW. The proposed alignment is about 21 km long and at a depth of about 70m to 160m below sea level. The longitudinal-section of the SCS is shown in **Figure 3**. In general, the SCS includes 7 main tunnel sections (J, K, L, M, N, P and Q), 16 vertical shafts (6 temporary production shaft and 10 permanent drop/riser shafts), and up to 3 sewage transfer pumping stations and two ancillary seawater pumping stations at strategic locations in the SCS. To facilitate the SCS construction, 20 temporary/permanent sites are required for shaft construction or as supporting areas for temporary stockpile/storage during construction stage.

2.6 Either mechanical boring or "drill and blast" would be used to excavate the main tunnel sections, depending on the anticipated ground conditions and other site-specific considerations (e.g., construction logistics, proximity to sensitive receivers, etc). The shafts would be constructed using conventional techniques, i.e., mechanical excavation of the near surface softer materials and blasting/mechanical boring for the deeper harder rock materials. For construction of sewage transfer/seawater pumping stations, conventional construction plant and equipment would be used. Non-percussive piling method would be used if piling is required.

Expansion of SCISTW

2.7 Augmentation of the existing SCISTW (**Figure 4** refers) to meet design flow and treatment performance requirements includes:

- Construction of a new influent pump station to lift the sewage from the SCS to surface
- Expansion of the existing chemically enhanced primary treatment (CEPT) facilities to cater for the additional flows, increase present design capacity of 1.7 million m^3/d to the ultimate design capacity (which is estimated at about 2.45 million m^3/d based on latest available planning information)
- Upgrading of the interim disinfection facilities (also known as the Advance Disinfection Facilities (ADF), which are scheduled to complete by end of 2009) to cater for the ultimate design flows and the disinfection requirements
- Expansion of the existing sludge processing facilities to cater for additional sludge volumes associated with the additional sewage flows
- Construction of a new effluent tunnel to convey treated and disinfected effluent to the existing outfall system
- Construction of a new odour treatment system
- Ancillary facilities

2.8 Construction of the effluent tunnel would be by either mechanical boring or "drill and blast". Other elements would be constructed largely using conventional construction plant and equipment, for which the choice of equipment would aim to reduce environmental impacts.

Project Programme

2.9 Noting that the discharge of un-disinfected sewage effluent from SCISTW is contributing to unsatisfactory beach water quality at the Tsuen Wan beaches, the Government has proposed to advance the provision of part of the permanent disinfection facilities under HATS Stage 2A. The construction works for ADF have been scheduled to commence in April 2008 for completion in end 2009.

2.10 Construction of the remaining works of Stage 2A (i.e. excluding ADF) is planned to start in 2009 and the whole of Stage 2A should be completed and commissioned by 2014.

3 KEY FINDINGS OF THE ENVIRONMENTAL IMPACT ASSESSMENT

Air Quality

Construction Phase

3.1 Major construction activities that are potential sources of construction dust in the study area include soil excavation activities at work sites, construction of shafts and wind erosion of open sites. Construction dust levels were assessed at 53 representative air sensitive receivers (ASR) near the 8 PTWs and the SCISTW. These ASRs included residential and commercial buildings, clinics, schools, institutions, community and recreational facilities and open space. With the implementation of mitigation measures specified in the Air Pollution Control (Construction Dust) Regulation, dust nuisance at these ASRs would not be expected. An EM&A programme was recommended for the construction phase to verify that the dust criteria would be satisfied at the ASRs.

Operational Phase

3.2 Odour emission from the PTWs and SCISTW would be the main concern during the operation phase. Air dispersion modelling was conducted to simulate the potential odour impacts of the SCISTW and the PTWs on the representative ASRs. Odour sources in the SCISTW include the distribution channel, flocculation tanks, primary sedimentation tanks, drop shafts of the sedimentation tanks, effluent weirs, overflow chamber, flow distribution chamber and dewatered sludge. Odour sources at the PTWs include the solids handling areas. Based on modelling results, the recommendation was to properly enclose or cover all the identified odour sources in the PTWs and SCISTW, with the foul air drawn through deodorization units and discharged after treatment. Good house keeping (regular cleansing schedule) should be conducted to minimize odour generation from the PTWs and SCISTW. With the proposed mitigation, the residual odour levels at the ASRs were predicted to comply well with the odour criterion. Odour monitoring in the form of odour patrol was also recommended to be carried out during the operation phase to verify that the odour criterion is met at the ASRs.

Airborne Noise

Construction Phase

3.3 The EIA has predicted the cumulative construction noise impacts of the Project during normal daytime working hours. The predicted unmitigated noise levels would range from 56 to 89 dB(A) at the 29 representative Noise Sensitive Receivers (NSRs). These NSRs included residential and commercial buildings, clinics, schools, institutions, and community and recreational facilities near the 8 PTWs and SCISTW. With the use of quiet power mechanical equipment, movable barriers and acoustic mats for construction tasks under the Project, the noise levels at all representative NSRs except N1 (i.e. Madam Chan Wai Chow Memorial School) during the examination periods would comply with the construction noise standards.

3.4 Assessing against the noise standard of 65 dB(A) during examination periods, the predicted noise level at NSR N1 would exceed the noise standard by up to 5 dB(A). However, the school has been noise insulated with air conditioners and, by keeping the windows closed during construction activities, noise impacts at the indoor environment could be avoided. Notwithstanding this, particularly noisy construction activities were recommended to be scheduled during the summer vacation period as far as practicable.

3.5 An indicative assessment was undertaken for possible construction activities within the tunnel and bottom of shaft during restricted hours. The predicted construction noise levels at representative NSRs during restricted hours would comply with the corresponding noise limits, provided that the ventilation fans and motors of gantry at the production shafts of Sandy Bay PTW would be properly housed and the silencers would be installed at outlet and inlet of the enclosure for ventilation fans. It should be noted that the results of the construction noise impact assessment for restricted hours are for indicative purposes, the Noise Control Authority will process any Construction Noise Permit (CNP) application

based on the Noise Control Ordinance (NCO) and the relevant technical memoranda in addition to considering the contemporary situations / conditions.

3.6 A construction noise EM&A programme was recommended to check the compliance of the noise criteria during normal daytime working hours.

Operation Phase

3.7 The noise impact associated with the operation of the Project was assessed. For newly proposed equipment without any mitigation, the predicted noise levels at all 29 representative NSRs except 5 near the Sandy Bay PTW (N12, N13, N14, N15a, N15b), 2 near the Cyberport PTW (N16, N17) and one near the Wah Fu PTW (N20) would comply with the night-time planning noise criteria. The noise levels at these affected NSRs would exceed the planning noise criterion by 1 to 13 dB(A). For cumulative noise impact, the predicted noise levels at all representative NSRs except N13, N15a and N15b would comply with the night-time ANL. The cumulative noise level at N13, N15a and N15b would exceed the night-time ANL of 50 dB(A) by up to 8 dB(A).

3.8 To mitigate the noise impact at the affected NSRs, acoustic louvers have been proposed for air supply fans/extraction fans of transfer pumping stations and ventilation fans of deodourization unit at Sandy Bay PTW, Cyberport PTW and Wah Fu PTW. Besides, it is recommended that the maximum allowable sound power level (SWL) of each new transformer at Sandy Bay PTW shall be limited to 89 dB(A) during the detailed design stage. With such proper designs, the predicted noise levels at all representative NSRs would comply with both the night-time ANL and night-time planning noise criteria. No residual operation noise impact arising from the Project is anticipated.

3.9 Proper designs of PTWs, SCISTW and disinfection facilities would control the potential noise impact at noise sensitive receivers within acceptable levels, operational noise monitoring would not be necessary.

Groundborne Noise

Construction Phase

3.10 Potential groundborne noise impacts would arise mainly from rock breaking activities and tunnel boring by Tunnel Boring Machine (TBM) during tunnel/shaft construction of this Project. Eleven sensitive receivers were identified, consisting of residential and institutional buildings, school, hospital and community facilities ranging from 86 m to 343 m in slant distance from the nearest tunnel. The Le Meridien Hotel in Cyberport would have the shortest slant distance to the nearest tunnel and was selected as the worst affected sensitive receiver to groundborne noise impact. The assessment results indicated that the predicted impacts at the Le Meridien Hotel would be within the statutory requirements and no mitigation measure would therefore be required.

Operation Phase

3.11 No groundborne noise generating activity was anticipated during the operation phase of the Project.

Water Quality

Construction Phase

3.12 General construction works for the Project would be land-based except seawall re-construction at the Aberdeen PTW. No dredging would be required for the Project. The fine content in the fill material during seawall re-construction at the Aberdeen PTW should be negligible. Key water quality issues associated with land-based construction would include the impacts from site run-off, sewage from workforce, accidental spillage and discharges of wastewater from various construction activities. With well maintained site drainage and the implementation of good site practices, impacts would be controlled to comply with the Water Pollution Control Ordinance (WPCO) standards. No unacceptable

water quality impact would therefore be expected.

3.13 Temporary bypass of screened sewage via seawall or submarine outfalls of individual PTWs would be required during the construction stage. The associated water quality impact would be short-term and the water quality would return to the normal condition after the sewage bypass period. No insurmountable water quality impact would be expected.

Operation Phase

3.14 The water quality impacts during operation of the Project were assessed using the Delft3D model. Impacts were assessed over a series of one-year simulation periods. The assessment area included the Victoria Harbour, Western Buffer, Eastern Buffer, Junk Bay, Northwestern, and Southern Water Control Zones. Sensitive receivers within the assessment area identified for water quality impact assessment included cooling water intakes, flushing water intakes, fish culture zones, beaches, sites of special scientific interest, marine parks, marine reserves, seagrass beds, artificial reefs, corals, the Chinese White Dolphin and Green Turtle nesting grounds.

3.15 The water quality modelling results showed that the Project would not cause any adverse impact on the marine water quality and on the identified sensitive receivers during normal operations of the SCISTW. The total residual chlorine from the chlorination/dechlorination disinfection process would meet the criterion set for the edge of the zone of initial dilution, with a large safety margin. Whole effluent toxicity tests showed that the chlorination/dechlorination disinfection process did not introduce additional toxic effects to the test organisms. The model predicted that implementation of Stage 2A would improve the water quality in the receiving water (including the area close to the SCISTW outfall) for all the selected water quality parameters as compared to the baseline (without Stage 2A) condition. A Post Project Monitoring (PPM) programme was proposed to confirm the model predictions made in this EIA.

3.16 Overflow at PTW may occasionally occur only during heavy storm events and the extent of impact was considered minor. Mitigation measures, including dual power supply, standby pumps, treatment units and equipment, would be provided at SCISTW and PTWs to minimize the occurrence of emergency discharge. In case of power outage of the dechlorination plant, the uninterruptible power supply (UPS) system to be provided would switch the power supply of the sodium bisulphite dosing pump to a backup battery almost instantaneously, allowing continuous dosage of sodium bisulphite for at least half an hour so that sufficient time can be provided for shutting down the chlorination plant to avoid the possibility of discharge of chlorinated effluent. An emergency contingency plan has been formulated to minimise the impact of emergency discharges and facilitate subsequent management of the emergency. An event and action plan and a detailed EM&A programme are recommended to collect water quality information and to mitigate the potential impact due to emergency discharge. The monitoring results shall be employed to identify areas for any further necessary mitigation measures to avoid, rectify and eliminate environmental damage associated with the Project. No insurmountable water quality impact would be expected from the temporary sewage discharges.

Human Health and Ecological Risk Assessment

3.17 Risk assessments were conducted to assess potential adverse human health and ecological effects that may result from exposure to toxic substances from the HATS effluent. The findings were summarized in three categories: risk to human health, risk to aquatic life and risk to marine mammals.

Risk to Human Health

3.18 Results of Human Health Risk Assessment revealed that potential risk/hazard impact due to chlorination by-products (CBPs) and other contaminants present in the chlorinated/dechlorinated (C/D) HATS effluent would be negligible and acceptable under established assessment criteria in all Project Scenarios.

Risk to Aquatic Life

3.19 According to the findings of Ecological Risk Assessment – Aquatic Life, the potential risk to aquatic life due to CBPs present in C/D HATS effluent would be lower than the risk screening value. Since the calculated risk is below the screening value, it would indicate that use of chlorination would not present an unacceptable risk and no further investigation would be required. For cumulative risk assessment, which included both CBPs and other pollutants present in the C/D HATS effluent, the results showed a potential hazard that was in the same order as that of the ambient marine water, indicating that the effluent would not cause significant additional toxicity to the ambient condition.

3.20 Results of whole effluent toxicity test on C/D effluent were used to supplement the ecological risk assessment and to determine whether the C/D effluent would induce adverse effects to aquatic life. The results complied with the established toxicity criteria at the edge of both the zone of initial dilution (ZID) and the mixing zone in all Project Scenarios. Therefore, the potential risk of C/D effluent on aquatic life would be minimal and acceptable.

Risk to Marine Mammals

3.21 Results of Ecological Risk Assessment – Marine Mammals showed that the calculated risk to marine mammals due to CBPs and other pollutants present in C/D HATS effluent were lower than the risk screening value. This indicated that the Project would not pose an unacceptable risk and no further investigation would be required. Cumulative risk assessment revealed that CBPs and other pollutants present in the C/D HATS effluent would also pose negligible and acceptable risk in all Project Scenarios.

3.22 According to the risk assessment results, the Project would not cause unacceptable risk to human health and ecological resources. Therefore, the Project was considered environmentally acceptable in terms of risks/impacts to human health and marine ecological resources.

Waste Management Implications

Construction Phase

3.23 Wastes generated during construction of the Project would include construction and demolition (C&D) materials from the tunnel excavation and shaft sinking for the SCS, expansion works at SCISTW as well as upgrading works of the PTWs (including seawall demolishing and re-construction works at Aberdeen) and demolition of the CEPT complex next to the Cyberport PTW after commissioning of HATS Stage 2A. Construction of the SCS would produce by far the largest quantity of C&D materials compared to other activities, estimated to be 791,600 m^3. Since approximately 84% of this material is rock, 78,000 m^3 would be recycled in form of aggregate for backfilling and 366,600 m^3 would be delivered to the Lam Tei Quarry. Approximately 336,200 m^3 of inert C&D materials would be disposed of to public fill reception facilities. The remaining C&D waste would be disposed of to landfill.

3.24 Waste management will be the Contractor's responsibility to ensure that all wastes produced during the construction of the Project are handled, stored and disposed of in accordance with good waste management practices, EPD's regulations and requirements. The recommended mitigation measures will form the basis of the site Waste Management Plan to be developed by the Contractor at the commencement of the construction phase.

Operation Phase

3.25 Wastes generated during the operation phase would comprise of approximately 61 m^3/day of screenings and grit from the upgraded PTWs and approximately 1,078 tons/day of sludge from the expanded SCISTW. The screenings and grit would be disposed of at landfill as is the current practice. The sludge would be taken to the centralized sludge treatment facility, planned for commissioning in 2012, two years before the commissioning of this Project. To minimize potential odour impact during the transport of sludge, marine transport was recommended as the preferred option. However, transport by trucks would be necessary during inclement weather. The sludge tanks on these trucks

would be required to install rubber seals to maintain air tightness and steel plates at the bottom of the unloading to prevent leakage, which should mitigate potential odour impact during road transport.

3.26 These identified waste arisings are to be handled, transported and disposed of using the recommended methods and that good site practices are to be strictly followed. No unacceptable environmental impacts would be anticipated during the construction and operation of the Project.

Terrestrial Ecology

3.27 Ecological surveys conducted under this Project identified seven types of terrestrial habitats within the Assessment Areas, including developed area, wasteland, woodland, plantation, shrubland, grassland and watercourse. All the identified habitats were found to have generally low ecological values (ranging from very low to low), except the natural woodland habitat which is of moderate / moderate to high ecological value. These natural woodlands were located at North Point, Sandy Bay, Cyberport, Wah Fu, Aberdeen, Ap Lei Chau and Stonecutters Island. There were two sites of conservation importance, the Pok Fu Lam Country Park and the coincided Pok Fu Lam Reservoir Catchment Area Site of Special Scientific Interest (SSSI), falling partly within the Assessment Area recorded. However, the Country Park / SSSI and most of the natural woodlands were located on upland area and far away from the proposed project works, potential ecological impact on these habitats and the associated wildlife should be minimal.

3.28 Three faunal species of conservation interest, including Black Kite, Common Buzzard and Pallas's Squirrel, were recorded in the Assessment Areas during recent surveys. All were recorded outside the project boundary and therefore no direct impact resulting from construction works would be expected.

3.29 The key direct impacts on terrestrial ecological resources from the Project would be habitat loss on 18.6 ha of developed area and 4.5 ha of wasteland. These habitats were ranked as very low in ecological value and supported no floral or faunal species of conservation importance. Only removal of individual trees located within the footprint of the proposed development would result and most of the affected trees were common species of low ecological value. No protected species or other flora of conservation interest would be directly affected under this Project. Tree transplantation and compensatory planting would mitigate such impact and no adverse direct ecological impacts would result.

3.30 Other indirect disturbance to the nearby habitats and associated wildlife during the construction phase of the Project would be temporary and minimised with the proposed mitigation measures in place, including noise mitigation measures and good site practice. No direct or indirect ecological impact would occur during the operation of the project..

Marine Ecology

3.31 A literature review of previous studies and EIA reports was initially conducted to establish the baseline conditions of the Assessment Area. In areas that were identified to be directly impacted by the project, i.e. Aberdeen PTW, ecological surveys (intertidal and dive surveys) were conducted to gather up to date, detailed information on the baseline condition of the affected site. The assessment of potential impacts was then conducted in accordance with the EIAO TM requirements.

3.32 Indirect impacts on water quality may result from site run-off, sewage from workforce, accidental spillage and discharges of wastewater associated with land based construction activities. If all the recommended good site practice and mitigation measures are implemented properly then no significant adverse impact on water quality would be expected.

3.33 A small area of seawall (approx.50m) would be demolished and reconstructed at the Aberdeen PTW site to complete the construction works. As confirmed by dive surveys, the subject site supported very limited marine life. Only 3 colonies of a common hard coral species (*Oulastrea crispata*), all in small size (3 to 5cm) and of low coverage were found in the potentially affected areas. All were attached to moveable boulders < 50cm diameter and thus feasible for translocation. Coral translocation and post translocation monitoring is proposed to minimise the adverse impacts on these corals.

3.34 Water quality impact modelling results indicated that the potential impact zone would be restricted to the Victoria Harbour and Western Buffer Water Control Zones (WCZs). No significant impacts on ecological resources outside these two WCZs are expected.

3.35 The existing SCISTW outfall location was chosen in an area with low ecological value. No significant adverse impacts on marine ecological communities would be anticipated, considering that:

- Improvement in water quality with reduction in *E. coli* levels in Western Buffer WCZ and Western Victoria Harbour WCZ;
- Only localized and small changes in total residual chlorine (TRC), chlorination by-products (CBPs) and Dissolved Oxygen (DO) around the existing SCISTW outfall;
- No unacceptable ecological risk on marine mammal and marine life in relation to acute and chronic effects;
- Water quality criteria for unionized ammonia would be met at the edge of the zone of initial dilution (ZID) and would be out of the normal distribution range of dolphins, porpoises and green turtles;
- Unionized ammonia levels would be improved in the Northwestern, Western Buffer and Victoria Harbour WCZ;
- Oxygen depletion would be minimal and highly localized around the SCISTW outfall;
- Improved DO levels in the Victoria Harbour, Eastern Buffer and Junk Bay WCZs;
- Highly localised salinity and temperature changes would not have adverse impacts on the ecological habitats identified;
- Increases in the levels of Total Inorganic Nitrogen (TIN) and Orthophosphate predicted would not be significant enough to have direct impacts on identified ecological communities;
- There was no documented data on the specific conditions leading to harmful algal blooms (HABs) and they have been documented in polluted and un-polluted water. Increases in nutrient levels during discharge of CEPT effluent would be unlikely to trigger HAB events;
- TIN and Orthophosphate levels have increased in the Assessment Area since the implementation of HATS Stage 1, but no increase in the number of HAB events has been observed;
- Water quality modelling predicted little difference in levels of TIN and Orthophosphate with or without the implementation of the project. Additionally, with the implementation of HATS Stage 2B, phosphate discharge would be reduced; and
- Western Buffer WCZ and western Victoria Harbour WCZ, the areas affected by the effluent, generally support low to moderate ecological resources.

3.36 Emergency discharge of sewage effluent at PTW and SCISTW may occur during periods of heavy rain when inflow exceeds the capacity of the system or as a result of power/equipment failure. This would result in a rise in the level of *E. coli* in the receiving water body and thus a subsequent deterioration in water quality which would potentially cause adverse impacts to marine ecological resources. Water quality modelling predicted no adverse impact on water quality parameters such as nutrients and DO by emergency discharges. In addition, it was predicted that increases in the level of suspended sediment resulting from emergency discharges would not exceed the assessment criteria at coral sites. Water quality was also predicted to return to normal condition 1 to 2 days after emergency discharges. Due to the highly transient nature of potential emergency discharges and the ability of marine organisms to naturally resist pathogenic strains of *E. coli* as documented in literature, no insurmountable impact on water quality is predicted to result from emergency discharges.

Fisheries

3.37 The existing SCISTW outfall location was chosen in an area where fisheries resources were considered to be of low value. No adverse impact on fisheries resources would be anticipated, considering that:

- The project would result in improvement in water quality with reduction in *E. coli* levels in Western Buffer WCZ and western Victoria Harbour WCZ;
- Only localized and small changes in TRC, CBPs and DO around the existing SCISTW outfall would occur.
- No exceedance of unionized ammonia levels, which could be toxic to fish, were predicted.

- Oxygen depletion would be minimal and highly localized.
- Water quality modelling predicted little difference in levels of TIN and Orthophosphate with or without the implementation of the project.
- TIN and Orthophosphate levels have increased in the Assessment Area since the implementation of HATS Stage 1, but no increase in the number of HAB events has been observed.
- There was no documented data on the specific conditions leading to HABs and they have been documented in polluted and un-polluted water. Increases in nutrient levels during discharge of sewage effluent would be unlikely to trigger HAB events.
- Water quality objectives would be met at Ma Wan FCZ

3.38 As there would be no adverse impacts on fisheries resources from the proposed disinfection or discharge of effluent, no specific mitigation measure for fisheries would be required.

Landscape and Visual Impact

3.39 The proposed scheme and associated works under this Project are mainly located in the areas zoned as Other Specified Use (OU) and Government, Institution or Community (GIC) while the sites for the proposed PTW upgrading works are mainly within OU zone. Mitigation measures would be applied to avoid the adverse landscape and visual impacts in consideration with the surrounding environment.

3.40 Based on the tree survey carried out under this Project, approximately 376 trees would be affected due to the proposed construction works of the Project. No potential LCSD Champion Trees or Registered Old and Valuable Trees were found either in existing PTWs/SCISTW or temporary works areas. There were no rare species or endangered specie but common species identified only. All the trees with high amenity value which are unavoidably affected by the works would be transplanted. Based on the proposed works, trees would be planted within the site and works areas to compensate for the loss of the existing trees. Roof greening and vertical greening would be adopted where possible for the provision of more greening to enhance the landscape quality. In the landscape impact assessment, with the proposed mitigation measures to be implemented, the overall residual impacts on existing trees would be considered as slight in Wan Chai East PTW and Aberdeen PTW. The impacts on the rest of the PTWs remain insubstantial.

3.41 For the visual impact assessment in the construction phase, there would still be some moderate adverse visual impact on the Visual Sensitive Receivers (VSRs) adjacent or close to the Project sites after implementation of the proposed mitigation measures. Residual impacts on VSRs further away from the PTWs and works areas would become slight to insubstantial. During the operation stage, with mitigation measures in place, there would still be slight adverse visual impact at day 1 after commissioning of the Project except some VSRs at North Point, Wan Chai, Central, Sandy Bay, Ap Lei Chau and Stonecutters Island which would experience moderate visual impacts. With the implementation of mitigation measures after 10 years during operation, the residual impacts on most of the VSRs would become insignificant except the VSRs at the above mentioned areas which would experience slight residual visual impact.

3.42 Overall, the residual landscape and visual impacts of the proposed development were considered to be acceptable with mitigation measures implemented during construction and operation phases.

Hazard to Life

Assessment for Potential Hazardous Installations (PHIs)

3.43 A hazard assessment was carried out for the proposed work sites at Aberdeen and Ap Lei Chau which are located within the consultation zone of two respective Potential Hazardous Installations (PHI), namely the Hong Kong & China Gas Company's Gas Holder (PHI No. H4) and the Shell LPG Transit Depot/Bulk Domestic Supply (PHI No. H5).

3.44 The potential hazards associated with all aspects of the construction and operation of the Project were

assessed. The overall risks posed by the activities of the Project were considered acceptable with the implementation of all safety measures recommended.

Construction Phase

3.45 The construction activities of the tunnels and PTWs upgrading works were identified and assessed. No significant increased risk level from works at both Aberdeen and Ap Lei Chau sites would be introduced in the vicinity of gas holder and gas pipework with the implementation of safety measures and close monitoring procedures for construction activities which may cause vibration and ground settlement during construction phase.

3.46 In addition, the requirements of the Gas Safety Ordinance Cap.51 and subsidiary regulations and the Electrical and Mechanical Services Department (EMSD)'s Code of practice on Avoiding Danger from Gas Pipe would be followed to ensure safety of works in the vicinity of gas pipework.

Operation Phase

3.47 The operational activities of the upgraded PTWs would be very similar to the existing one and both Aberdeen and Ap Lei Chau treatment works would not introduce addition risk factor to the nearby PHIs. Hence, the operations of Project would not increase the PHI risk level during operation phase.

Assessment for Overnight Explosives Storage

3.48 There would be no overnight explosives storage proposed for the Project. No hazard assessment for overnight storage of explosives was required in this Study.

Assessment for Disinfection Facilities

3.49 Hazard to life impact associated with the proposed disinfection facilities at SCISTW was quantitatively assessed, with consideration of identified precautionary measures / operation procedures that would minimize the risks associated with the chemicals related operations. The individual risk and societal risk associated with the chemicals used during operations were found to be acceptable in accordance with the risk guidelines stipulated in the Annex 4 of the EIAO TM. Hence, the hazard to life impact due to the Project would be acceptable.

Cultural Heritage

Marine Archaeology

3.50 No marine works would be required under this Project, except reconstruction of small part of the seawall near the Aberdeen PTW to facilitate the PTW upgrading works. As indicated in the old as-constructed drawings**,** the Aberdeen seawall area was dredged in 1970s and the seabed was already disturbed at that time. The current proposed construction works would only disturb the artificial seawall structure but not down to the level of the existing undisturbed seabed. Further, tunnel construction works would also not disturb the seabed as elevation of the tunnels would be deep underground below rockhead with average depth of ~100m below ground . Hence, potential impact on marine archaeological deposits from this Project would not be anticipated and no marine archaeology impact assessment on the seabed was therefore required.

Built Heritage

3.51 Built heritage impact assessment identified heritage buildings and structures on Stonecutters Island and also on Hong Kong Island that may be affected by groundborne vibration during the construction phase

of the Project. It was determined that the maximum vibration level should be limited to 25 mm/s and monitoring of vibration levels should be undertaken during blasting for tunnel, shafts, effluent conveyance system and disinfection facilities in the vicinity of the buildings/structures to confirm compliance with the vibration limits. There would be no impact to built heritage resources during the operation phase.

Environmental Monitoring and Audit

3.52 Environmental monitoring and audit (EM&A) requirements for the Project have been specified in an EM&A Manual. The EM&A Manual contains details of proposed baseline and compliance monitoring programmes, implementation schedule of the environmental protection / mitigation measures, EM&A reporting procedures and complaint handling procedures.

4 OVERALL CONCLUSION

4.1 The findings of this EIA Study have determined the likely nature and extent of environmental impacts predicted to arise from the construction and operation phases of the Project. The EIA has, where appropriate, identified precautionary design and mitigation measures to achieve compliance with environmental legislation and standards.

4.2 Overall, the EIA Study for the proposed HATS Stage 2A predicted that the Project, with the implementation of the proposed precautionary design and mitigation measures for construction and operation phases, would comply with all applicable environmental standards and legislation. This EIA has also demonstrated the acceptability of the residual impacts from the Project. EM&A mechanisms have been recommended, where necessary, to verify the accuracy of the EIA predictions and the effectiveness of recommended precautionary design and mitigation measures.