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# 1. INTRODUCTION

## 1.1 Project Background

1.1.1 In 2002, the Environmental Protection Department (EPD) carried out the Outlying Islands Sewerage Master Plan Stage 2 Review (SMP Stage 2 Review), and completed the Preliminary Project Feasibility Study for Outlying Islands Sewerage Stage 2 (hereinafter referred to as "PPFS").

1.1.2 In February 2008, Drainage Services Department (DSD) commenced the Investigation Stage of "Upgrading of Cheung Chau and Tai O Sewage Collection, Treatment and Disposal Facilities" under Agreement No. CE 31/2007 (DS) by commissioning a consultant to carry out review on the conclusions and recommendations of the PPFS report, surveys, investigations, impact assessments, preliminary environmental review and preliminary design of the recommended works (hereinafter referred to as "Investigation Consultancy").

1.1.3 In December 2010, Drainage Services Department (DSD) commissioned Atkins China Limited (ACL) to undertake Design and Construction of Upgrading of Cheung Chau and Tai O Sewage Collection, Treatment and Disposal Facilities under Agreement No. CE 15/2010 (DS).

## 1.2 Background to this EIA

1.2.1 The Preliminary Environmental Review (PER) conducted during the Investigation Consultancy has identified the potential environmental issues, such as air quality, noise, water quality, waste management implication, land contamination, ecology, fisheries, cultural heritage, landscape and visual, arising from the sewerage upgrading works and the likely environmental mitigation measures required.

1.2.2 The PER has identified the designated project (DP) status of the Upgrading of Cheung Chau Sewage Collection, Treatment and Disposal Facilities components under the Environmental Impact Assessment Ordinance (EIAO).

1.2.3 An Environmental Impact Assessment (EIA) Study Brief No. ESB-212/2009 was issued to cover the upgrading of Cheung Chau Sewage Collection, Treatment and Disposal Facilities (hereinafter referred as the "Project"). According to Section 3.2.1 of the Study Brief No. ESB-212/2009, the scope of the EIA Study should cover the works elements listed in Section 1.2 (i) to (iv), which are:

- Expansion of the sewage treatment capacity and upgrading of the treatment level of the existing Cheung Chau Sewage Treatment Works (STW);
- Expansion of the pumping capacity of the existing Pak She Sewage Pumping Station (SPS) and construction of a new SPS at Kwun Yam Wan;
- Upgrading of some existing sewers and construction of some new sewers in various necessary locations in Cheung Chau; and
- Construction of effluent reuse facilities within the Cheung Chau STW.

1.2.4 This EIA Report provides the approach, findings and recommendations of the EIA Study and has followed the requirements of EIA Study Brief No. ESB-212/2009. This EIA Study covers the works items for the sewerage upgrading works that comprised of the DP components as well as non-DP components as part of the Environmental Review for the non-DP components. Environmental Permits (EPs) are required before the construction and operation of the DP components of the Project can commence. The DP and non-DP components of the Project are summarized in **Table 1.1**.

**Table 1.1 : Designated Project Status of the Project Components**

| Project Components | DP / Non-DP | Remarks |
|---|---|---|
| Upgrading of Cheung Chau Sewage Treatment Works | DP | Expected capacity exceeds 5000 $m^3$ per day and located within 200 m from the boundary of residential area. Therefore it is classified as a DP according to Schedule 2 Part 1 Item F.2 of the EIAO. |
| Upgrading of Pak She Sewage Pumping Station | DP | Existing capacity exceeds 2000 $m^3$ per day and is located less than 150 m from sensitive uses as stated in Schedule 2 Part 1 Item F.3(b) of the EIAO. The SPS has been in operation in 1984 which is before the enactment of the EIAO on 1 April 1998. It is a DP exempted under section 9(2) of the EIAO.<br>Proposed upgrading works under this Project include replacement of screw pumps, E&M equipments. No major civil works. |
| Construction of Kwun Yam Wan Sewage Pumping Station | Non-DP | Expected capacity would not exceed 2000 $m^3$ per day. |
| Sewers works | Non-DP | Sewers works would not fall partly or wholly within any of the sensitive areas as stated in Schedule 2 Part 1 Item Q.1 of the EIAO. |
| Effluent reuse facilities within the Cheung Chau STW | DP | Schedule 2 Part 1 Item F.4 of the EIAO |

## 1.3 Purpose and Approach of the EIA Study

1.3.1 The purpose of this EIA Study is to provide information on the nature and extent of environmental impacts arising from the construction and operation of the Project and its related activities. This information will contribute to decisions by the Director of Environmental Protection on:

- The overall acceptability of any adverse environmental consequences that are likely to arise as a result of the proposed Project;
- The conditions and requirements for the detailed design, construction and operation of the proposed Project to mitigate against adverse environmental consequences, as practicable; and
- The acceptability of residual impacts after implementation of the proposed mitigation measures.

1.3.2 This EIA Study has been conducted to achieve specific objectives in the EIA Study Brief No. ESB-212/2009. These specific objectives are:

(i) to describe the Project and associated works together with the requirements and environmental benefits for carrying out the Project and the types of designated projects to be covered by the Project;

(ii) to identify and describe elements of community and environment likely to be affected by the Project and/or likely to cause adverse impacts to the Project, including natural and man-made environment and the associated environmental constraints;

(iii) to provide information on the consideration of alternative options of the design, layout, location, scale and extent of the Project and the construction methods

with a view to avoiding or minimizing potential environmental impacts to environmentally sensitive areas and sensitive uses; to compare the environmental benefits and disbenefits of different options; to provide reasons for selecting the preferred option(s) and to describe the part environmental factors played in the selection of preferred option(s);

(iv) to identify and quantify emission sources (including air quality, noise, water quality and waste, etc. as appropriate) and determine the significance of impacts on sensitive receivers and potential affected uses;

(v) to identify and quantify any potential loss or damage and other potential impacts to ecology and fisheries resources, flora, fauna and natural habitats and to propose measures to mitigate these impacts;

(vi) to identify and quantify where possible any potential landscape and visual impacts and to propose measures to mitigate adverse impacts;

(vii) to identify any negative impacts on historical and archaeological resources and to propose measures to mitigate these impacts;

(viii) to identify any potential human health impacts and to propose measures to mitigate these impacts;

(ix) to propose provision of mitigation measures so as to minimize pollution, environmental disturbance and nuisance during construction and operation of Project;

(x) to investigate the feasibility, practicability, effectiveness and implications of the proposed mitigation measures;

(xi) to identify, predict and evaluate the residual environmental impacts (i.e. after practicable mitigation) and the cumulative effects expected to arise during the construction and operation phases of the Project in relation to the sensitive receivers and potential affected uses;

(xii) to identify, assess and specify methods, measures and standards, to be included in the detailed design, construction and operation of the Project which are necessary to mitigate these environmental impacts and cumulative effects and reduce them to acceptable levels;

(xiii) to investigate the extent of the secondary environmental impacts that may arise from the proposed mitigation measures and to identify constraints associated with the mitigation measures recommended in the EIA study, as well as the provision of any necessary modification; and

(xiv) to design and specify environmental monitoring and audit requirements to check the effective implementation of the recommended environmental protection and pollution control measures.

## 1.4 Structure of this EIA Study Report

1.4.1 The backgrounds, descriptions and justifications of this Project are provided in **Section 2**. The assessment results and recommended mitigation measures for each of the environmental parameters that have been identified are presented in the following sections:

- Section 3 – Air Quality
- Section 4 – Noise
- Section 5 – Water Quality
- Section 6 – Waste Management
- Section 7 – Land Contamination
- Section 8 – Ecology

- Section 9 – Fisheries
- Section 10 – Cultural Heritage
- Section 11 – Landscape & Visual
- Section 12 – Environmental Monitoring and Audit Requirements
- Section 13 – Implementation Schedule of Recommended Mitigation Measures
- Section 14 – Summary of Environmental Outcomes and Overall Conclusions

1.4.2 All quoted appendices and figures in this EIA are presented under separate covers, which are Volume 2 of 3 and Volume 3 of 3 respectively.

# 2. PROJECT DESCRIPTION

## 2.1 Location and Description of the Project

2.1.1 The works for this Project in Cheung Chau mainly comprises the following items and as shown in Layout Plan of **Figure 2.1**:

(a) Upgrading of the existing Cheung Chau STW;

(b) Upgrading of the existing Pak She SPS by increasing the pumping capacity; and

(c) Sewers works in Cheung Chau including upgrading/rehabilitation of the existing sewers at Cheung Chau and provision of new sewers to unsewered areas/villages including Tai Kwai Wan San Tsuen, Pak She San Tsuen, Nam She Tong, Fa Peng, Chi Ma Hang, Round Table Villages, Tai Shek Hau and Sin Yan Tseng, Tai Tsoi Yuen Kui, Ko Shan Tsuen and Lung Tsai Tsuen.

**Sewage Treatment Works**

2.1.2 Existing Cheung Chau STW is located at the western side of the Cheung Kwai Estate. It is currently a primary treatment works with design capacity of 4,000 $m^3$/d. Upon completion of the Project, it will be increased to a capacity of 9,800 $m^3$/d with secondary treatment level. A Membrane-bioreactor (MBR) type sewage treatment plant will be adopted.

2.1.3 Conventional secondary sewage treatment generally involves the biological degradation of organic content in the influent followed by secondary sedimentation to settle out the sludge from the aqueous activated sludge solution. Rather than employing sedimentation, an MBR system passes the aqueous activated sludge solution through membrane filtration to separate water from the sludge. The MBR systems can operate at a considerably higher mixed liquor suspended solids concentration and provide an effective and reliable barrier, therefore MBR system has smaller footprint, superior effluent quality and less sludge production over the conventional process. All the MBR modules will be placed in MBR tanks, which are covered and installed indoor.

2.1.4 The STW upgrading works will include construction of new treatment facilities and also effluent reuse facilities to reuse portion of the treated effluent for non-potable uses within STW. All the upgrading works will be constructed within the existing site boundary of Cheung Chau STW. Proposed general layout of the Cheung Chau STW and the Schematic Flow Diagram are shown in **Figure 2.2** and **Figure 2.4**, respectively.

**Sewage Pumping Station**

2.1.5 Existing Pak She SPS was commissioned in 1984 and is located at the junction of Pak She Praya Road and Ping Chong Road, opposite to the Cheung Chau Fire Station. It is currently equipped with three screw pumps (two duty and one standby) with existing pumping capacity of 29,376 $m^3$/d (340 L/s). Upon completion of the Project, it will be increased to a capacity of 42,336 $m^3$/d (490 L/s).

2.1.6 The upgrading works of Pak She SPS mainly include replacement of pumps with higher pumping capacity and other Electrical and Mechanical (E&M) equipments, minor modification of existing pump troughs. Dual power supply or standby power sources, and deodourizing units will be provided to the upgraded Pak She SPS.

2.1.7 There is an existing 750mm dia. emergency bypass at the Pak She SPS currently connected to the Cheung Chau typhoon shelter. Under this Project, the emergency

bypass from Pak She SPS will be diverted away from the typhoon shelter by constructing a 750mm dia. bypass pipe connecting from the existing overflow pipe of the SPS to downstream sewerage system as presented in **Figure 2.5**. No sewage emergency discharge from Pak She SPS into the Cheung Chau typhoon shelter would be anticipated after the upgrading works.

**Sewers works**

2.1.8 The proposed sewers works in Cheung Chau include:

(a) Upgrading of approximately 120 m long existing sewer of size 150 mm to 400 mm diameter;

(b) Rehabilitation of approximately 160 m long existing sewer of size 525 mm diameter;

(c) Construction of approximately 7,500 m long of new sewers with size 150 mm to 400 mm diameter in village areas by open cut method; and

(d) Construction of approximately 300 m long of new deep sewers with size Twin 400 mm to Twin 500 mm diameter along Cheung Chau Sports Road and Tung Wan Road by trenchless method.

2.1.9 Under Part I, Schedule 2 of the EIAO, the Project consists of the following designated projects:

(a) Upgrading of the existing Cheung Chau STW – under Item F.2 which is *Sewage Treatment Works with an installed capacity of more than 5,000 $m^3$/d and a boundary less than 200 m from the boundary of a residential area*;

(b) Upgrading of the existing Pak She SPS - under Item F.3 which is *Sewage Pumping Station with an installed capacity of more than 2,000 $m^3$/d and a boundary less than 150 m from the boundary of a residential area*; and

(c) Upgrading of the existing Cheung Chau STW – under Item F.4 which includes *an activity for the reuse of treated sewage effluent from a treatment plant*.

## 2.2 Need of the Project

**Existing Conditions**

2.2.1 There is no public sewerage system for some of the village houses currently in Cheung Chau. Sewage and greywater generated from most of these village houses are disposed of at septic tanks adjacent, where regular maintenance is needed. Sewage and greywater generated from some of the village houses is even directly discharged into surface drainage system.

2.2.2 Besides, the existing sewage treatment plant at Cheung Chau is a primary treatment facility and inadequate to cope with the population growth and future development within the catchments.

**Purpose and Objectives of the Project**

2.2.3 The Project is to improve the coastal water quality to the northwest of Cheung Chau by upgrading of existing sewers and provision of new sewers where practicable within the catchment, upgrading of the existing primary treatment plant to a secondary STW and expand the STW to cope with the population growth and future developments to improve the hygiene conditions at Cheung Chau.

## 2.3 Scenarios With and Without the Project

### Without Project

2.3.1 Most of the village houses will remain unsewered. Sewage will be disposed of at septic tanks and required to be cleared manually from time to time. Hygiene problems will continue to arise such as odour impacts. Improper maintenance of septic tanks will also cause problems such as overflow from septic tanks or soakaway pit, which would cause pollution to nearby areas and/or streams. Moreover, the sewage treatment plant will remain as primary treatment level and suffer from insufficient capacity to cope with increased sewage flows and loads in the future, and consequently deteriorate the coastal water quality.

### With Project

2.3.2 Public sewers will be provided to unsewered village houses as far as practicable. Hygiene problems arising from the use of septic tanks will be largely relieved. Moreover, the sewage treatment level will be upgraded from primary to secondary and the capacity of the STW will be expanded to cope with the population growth and future developments. Discharge of low quality effluent to the receiving water body will be reduced and hence will improve the coastal water quality of Cheung Chau.

## 2.4 Consideration of Alternative Design and Layout

2.4.1 Under the Investigation Stage, the proposed works for SPS in Cheung Chau include construction of a new Kwun Yam Wan SPS and upgrading of the existing Pak She SPS.

2.4.2 Kwun Yam Wan SPS was proposed under the conforming design for conveying sewage from Fa Peng and Chi Ma Hang, through the low spot area near Kwun Yam Wan, to the existing sewerage system at Cheung Chau Sports Road.

2.4.3 Due to the close proximity of the Kwun Yam Wan SPS and Kwun Yam Wan Beach, which is a Gazetted Beach, the proposed SPS will likely create adverse environmental impacts to beach visitors and swimmers during both construction and operation if impacts are not properly controlled. Moreover, the catchment of the SPS consists of village houses, squatter huts and a camp site, which contribute to a major population of the catchment, the design flow is relatively small and will fluctuate with peak flows only occurring at weekends from the camp sites. These flow conditions will create potential septicity problems, maintenance and operational difficulties to the Kwun Yam Wan SPS and its associated rising mains. In addition, the proposed SPS site will require land resumption, which adds to the uncertainties associated with this pumping scheme.

2.4.4 Alternatives to the construction of the Kwun Yam Wan SPS have been investigated:

(a) Reduced Sewerage Provision Option: sewerage works not provided to catchments upstream of the Kwun Yam Wan SPS;

(b) Exposed and Deep Sewers Option: construction of a section of 220 m long exposed gravity sewers along hillside and a section of 60 m long deep sewers with depth between 6 m to 15 m connecting to the existing sewerage at Cheung Chau Sports Road; and

(c) Deep Sewers Option: Construction of a section of 700 m long gravity sewers from the Kwun Yam Wan, of which 300 m long are at a depth of 4 m to 8 m (ground to invert level) along Cheung Chau Sports Road and Tung Wan Road, connecting to the existing sewerage at Praya Road. It is proposed that the

300 m long sewers along Cheung Chau Sports Road and Tung Wan Road to be constructed by trenchless technique.

2.4.5 Preliminary assessment on sewerage impact and construction methodology had been studied. Among the three alternatives mentioned above, Option (c) - Deep Sewer Option is recommended as an alternative to the Kwun Yam Wan SPS construction based on the extent of sewerage catchment, technical feasibility and ease of maintenance. The proposed layout of the Deep Sewer Option is shown in **Figure 2.3**.

2.4.6 The Deep Sewer Option will eliminate the Kwun Yam Wan SPS and serve the same catchment as that of the SPS scheme. The diversion of upstream sewage flows to the deep sewers will eliminate the need to upgrade the existing sewers along Cheung Chau Sports Road and Tung Wan Road (proposed under the Kwun Yam Wan SPS Option). With the introduction of trenchless construction method under the Deep Sewer Option, the extent of road opening works along the Cheung Chau Sports Road and Tung Wan Road could be reduced.

2.4.7 The major drawback of the Deep Sewer Option is the difficulty in maintenance due to the deeper sewer alignment beneath Cheung Chau Sports Road and Tung Wan Road. The gradient of the deep sewer is constrained by the existing invert level of the downstream connecting sewerage, and results in a slack gradient. However, by introducing the use of HDPE pipes and diversion of sewage flow from existing Nam She Tong SPS, a minimum velocity of 0.75 m/s could be reached along the sewers from Kwun Yam Wan to Cheung Chau town centre. Twin sewers would be provided to facilitate future maintenance. Rehabilitation of the trunk sewers along Praya Street is also proposed to enhance the hydraulic performance of the pipes.

2.4.8 **Table 2.1** provides the environmental benefits and dis-benefits of the proposed Kwun Yam Wan SPS Option and the Deep Sewer Option.

**Table 2.1 : Environmental Benefits and Dis-Benefits of Alternative Options**

| Options | Environmental Benefits | Environmental Dis-Benefits | Other Considerations |
|---|---|---|---|
| **Kwun Yam Wan SPS Option** | • Relatively shallower sewers and rising mains will be constructed along Tung Wan Road, which can be completed within a shorter duration. Hence nuisance to the sensitive receivers would be of shorter period. | • The proposed SPS may have potential adverse environmental impacts such as dust during construction; and emergency discharge, visual impacts and odour to the swimmers nearby during operation.<br>• Approximately 15% of the population served by the proposed SPS is contributed by two camp sites in Fa Peng (population is categorised as institution). This would contribute to about 32% sewage inflow to proposed sewage pumping station. As this flow from the camp sites would fluctuate significantly, potentially between zero flow during weekdays, to a high flow during holidays, this will create operation and maintenance problems to the proposed SPS and rising mains. Sewage would remain stored in the pumping station wet well and rising main until subsequent inflows reach the SPS before triggering the pump to operate, which may cause septicity issue.<br>• Open-trench excavation is required for proposed rising main and existing sewer upgrading works. Noise nuisance will affect all sensitive receivers along the entire works alignment. | • Construction difficulties will be encountered for the construction works at Kwun Yam Wan Beach area with limited space.<br>• The proposed Kwun Yam Wan SPS is located on private lot where land resumption and site clearance is required. |

| Options | Environmental Benefits | Environmental Dis-Benefits | Other Considerations |
|---|---|---|---|
| **Deep Sewer Option** | • Potential adverse environmental impacts (such as water quality of emergency discharge, visual and odour) to the swimmers in Kwun Yam Wan Beach can be eliminated.<br>• No operation and additional maintenance for the SPS is required.<br>• Excavation is only required at the working pit locations, hence localised construction nuisance to the sensitive receivers near the working pits only.<br>• Comparatively less excavated materials will be generated. | • Noise impacts at the pit locations during construction. | • Relatively more difficult in maintenance of the deep sewer.<br>• Diversion of upstream flow to the deep sewers so that no upgrading of existing sewers along Tung Wan Road and Praya Road is required. |

## 2.5 Consideration of Alternative Construction Methods and Sequences of Work

2.5.1 Trenchless construction techniques are proposed for the construction of pipes beneath Cheung Chau Sports Road and Tung Wan Road. Both trenchless techniques by Tunnel Boring Machine (TBM) and Hand-Shield Excavation – Segmental Method are feasible in Cheung Chau but as discussed below, the Segmental Method is more suitable for Cheung Chau.

2.5.2 TBM method for the construction of a single small diameter sewer is considered technically feasible in Cheung Chau. The major concern for TBM method is the heavy TBM equipment which creates transport logistical difficulties within Cheung Chau. Furthermore, the large equipment will also occupy large working space to house the slurry tank and electricity generator, which would be a nuisance to the public, in particular along Cheung Chau Sports Road and Tung Wan Road, which are busy. Construction of twin pipes is also considered impractical with TBM technique because separation distances between the pipe construction is necessary and results with the need to have larger corridor widths and larger construction areas, which is limited on Cheung Chau.

2.5.3 Segmental Method is a manual excavation method which involves a shield head to be launched into the ground. The erection of the pre-fabricated segmental rings is done within the shield head. The rock/spoil is excavated manually from the tunnel face and transferred to ground level to be disposed of offsite. Wastewater generated shall be properly treated by desilting tanks before discharged (similar to all other excavation works). Relatively smaller working space and smaller machines would be required for Segmental Method. It also enables twin gravity pipes to be laid within trenches. The major drawback for Segmental Method is the slow progress with excavation in rock, but it is expected that through multiple workfronts and proper sequencing of works, this programme implication would be resolved to not affect the overall Project completion.

2.5.4 **Table 2.2** provides the environmental benefits and dis-benefits of the Hand-Shield (Segmental Method) and the TBM construction Method.

**Table 2.2 : Environmental Benefits and Dis-Benefits of Alternative Construction Methods**

| Options | Environmental Benefits | Environmental Dis-Benefits |
|---|---|---|
| **Hand Shield Excavation (Segmental Method)** | • Less environmental nuisance to the public during construction as it requires much less working space when compared with TBM method.<br>• Launching pit size is about 2.5 m x 3 m.<br>• No slurry tank and electricity generator is required. | • Longer period of environmental disturbance at the workfronts due to slow construction progress: 1m per day in soil and 1m per 6 days in rock.<br>• Multiple workfronts and proper sequencing of works are required, which may give rise to more nuisance. |
| **TBM Method** | • Jacking head returns back to launching pit. Construction works can be speeded up and hence reducing the period of environmental disturbance. | • Nuisance to the public as large working space is required for placing the machine, the slurry tank and the electricity generator. The space required for launching pit is large. (Approx. 4-6m) |

## 2.6 Selected of Preferred Scenario

2.6.1 The Deep Sewer Option is recommended mainly because it eliminates the need of a new SPS which will have the potential to cause adverse environmental impacts to the nearby Kwun Yam Wan Beach.

2.6.2 The Hand Shield Excavation (Segmental Method) is recommended due to its smaller machine and less space required. To compensate for the slow progress, multiple workfronts and proper sequencing of works are required.

## 2.7 Effluent Reuse

2.7.1 The following non-potable effluent reuse elements are proposed for MBR treated effluent:

(a) Process cleaning water for: screens, grit classifier, membrane filter press, storm tanks, channels and tanks, floor wash down, etc.; and

(b) On-site toilet flushing.

2.7.2 200$m^3$/d of the treated effluent would be undergoing chlorination in the disinfection tank before being conveyed to the treated water storage tank for further distribution to the effluent reuse units within the STW. The quality of chlorinated effluent for effluent reuse in this Project is summarized in **Table 2.3**. This is the effluent reuse standards recommended in the proposed expansion of Shek Wu Hui STW for off-site toilet flushing and other non-potable uses. The recommended standards are more strengthened when compared with the treated effluent standard recommended for Ngong Ping STW, where the effluent is reused for off-site toilet flushing and other potential non-potable reuses (such as irrigation, water features, cooling towers, etc.).

**Table 2.3 : Effluent Reuse Standards**

| Water Quality Parameter | Unit | Ngong Ping STW Effluent Reuse Quality | Shek Wu Hui STW Effluent Reuse Quality | Recommended Effluent Reuse Quality for Cheung Chau STW |
|---|---|---|---|---|
| pH | - | Not specified | 6-9 | 6-9 |
| Residual Chlorine | mg/L | ≥ 0.5 | ≥ 1 | ≥ 1 |
| *E.Coli* | counts/100 ml | < 100 | Not detectable | Not detectable |
| Turbidity | NTU | ≤ 10 | ≤ 5 | ≤ 5 |
| Biochemical Oxygen Demand ($BOD_5$) | mg/L | ≤ 10 | ≤ 10 | ≤ 10 |
| Dissolved Oxygen | mg/L | ≥ 2 | ≥ 2 | ≥ 2 |
| Total Suspended Solid (TSS) | mg/L | ≤ 10 | ≤ 5 | ≤ 5 |
| Ammonia Nitrogen ($NH_3N$) | mg/L | ≤ 1 | ≤ 1 | ≤ 1 |
| Colour | Hazen Unit | ≤ 20 | ≤ 20 | ≤ 20 |
| Synthetic Detergents | mg/L | ≤ 5 | ≤ 5 | ≤ 5 |
| Threshold Odour Number (TON) | - | Not specified | ≤ 100 | ≤ 100 |

2.7.3 The schematic diagram of effluent reuse is presented in **Figure 2.4**. A chlorine dosing system in the form of sodium hypochlorite with contact time of about 30 minutes will be installed. The remaining portion of treated effluent without chlorination will be discharged via outfall. The chlorination process will cease when its quantity is monitored to reach a pre-set level to avoid over generation of chlorinated treated effluent. In-house monitoring would be performed by STW Operators at the discharge point to ensure the residual chlorine level in discharged effluent is less than 1mg/L as stated in the Technical Memorandum on Standards for Effluent Discharged into Drainage and Sewerage Systems, Inland and Coastal Water (TM) for Marine Waters of the Southern Water Control Zone.

2.7.4 Small amount of sodium hypochlorite solution (<250L) will be stored on-site. Such amount could be exempted from licensing requirements under the Dangerous Goods Ordinance (Cap 295) and is far less than that planned to be stored in the Stonecutters Island STW (1.8 million L of sodium hypochlorite) for the operation of the disinfection facilities in the Harbour Area Treatment Scheme (HATS), storage of which has been concluded to present an “acceptable” risk in the quantitative risk assessment of the approved EIA study for HATS.

2.7.5 Sodium hypochlorite is classified as a Category 4 poisonous substance under the Dangerous Goods Ordinance (Cap 295). They are not acutely toxic, flammable, or explosive substances, but hazardous gas would be generated if they were accidentally mixed with incompatible chemicals. Also, the use of these chemicals in the treated effluent reuse system would not constitute a potentially hazardous installation in accordance with EPD’s ProPECC PN 2/94 Potentially Hazardous Installation.

## 2.8 Human Health Impacts due to Effluent Reuse

2.8.1 The effluent reuse is expected to reduce the amount of potable water demand required for the on-site STW operation, thereby providing an environmental benefit. Since there is no off-site effluent reuse, no potential health impacts to general public on effluent reuse is anticipated.

2.8.2 The treated effluent is to undergo a chlorination treatment process before being conveyed to the point of storage and usage. Chlorination is to minimize bacterial growth and contamination during the water transmission. The recommended residual chlorine level in Shek Wu Hui STW is 1 mg/L for reducing odour and bacterial growth.

2.8.3 The process for the generation of chlorinated treated effluent will cease when its quantity is monitored to reach a pre-set level. In-house monitoring would be performed by STW Operators at the discharge point to ensure the residual chlorine level in discharged effluent is in compliance with the discharge requirements. No adverse water quality impacts are therefore anticipated from the normal operation of the effluent reuse system.

2.8.4 To avoid the potential health and hygiene problems associated with possible incorrect pipe connections, pipes for the treated effluent would be specially arranged to differentiate them from potable water pipes. For example, pipes for the treated effluent are colour-coded, clearly labelled with warning signs and notices, and/or sized differently, so that physical connection of the treated effluent pipes with potable water fittings would be unlikely. The effluent reuse system will also be provided with safe guard system to avoid arbitrarily contact from human. Appropriate provisions would also be incorporated into the operation and maintenance manual to prevent possible incorrect pipe connections. With proper preventative measures in place, health and hygiene impacts are not anticipated to occur during the normal operation of the effluent reuse system.

## 2.9 Project Implementation Programme

2.9.1 The tentative implementation schedule for different works packages is presented in **Table 2.4** below.

**Table 2.4 : Tentative Implementation Schedule for Different Works Packages**

| | Package 1<br>Cheung Chau STW and Pak She SPS upgrading | Package 2<br>Cheung Chau Sewers Works |
|---|---|---|
| EIA Endorsed | Nov 2013 | |
| Scheme Gazette under WPC(S)R | - | May 2014 |
| Scheme Authorization | - | Aug 2014 |
| Tender Gazette | May 2014 | Apr 2015 |
| Contract Commencement | Sep 2014 | Aug 2015 |
| Contract Completion | Mar 2019 | Mar 2019 |

## 2.10 Public Consultations

2.10.1 Project Profile had been prepared in December 2009 for application of Environmental Impact Assessment Study Brief under EIAO. No adverse comments had been received from the public.

2.10.2 Consultations had been conducted with Cheung Chau Rural Committee and Islands District Councilor regarding the proposed works under this Project. Three consultation meetings had been arranged in June 2011 and general supports on the Cheung Chau Sewerage Works were gained from the forum.

## 2.11 Project Interface / Concurrent Projects

2.11.1 Based on our review of the Investigation Stage and the latest information gathered during the Review Phase, the following interface projects in Cheung Chau have been identified:

(a) "Improvement of Fresh Water Supply to Cheung Chau - Design and Construction" undertaken by WSD Design Division;

(b) "Replacement and Rehabilitation of Water Mains Stage 3, Mains On Hong Kong and Islands – Investigation, Design and Construction" untaken by WSD CM Division;

(c) "Replacement and Rehabilitation of Water Mains Stage 4, Mains On Hong Kong and Islands – Investigation, Design and Construction" untaken by WSD CM Division; and

(d) "Improvement to Existing Roads and Drains in Cheung Chau Old Town, Remaining Engineering Works, Stage 3, Cheung Chau" undertaken by CEDD/HK&I.

2.11.2 The following discusses the potential interface issues between this Project's components and the projects mentioned in Section 2.11.1.

**Improvement of Fresh Water Supply to Cheung Chau - Design and Construction**

2.11.3 Based on the information provided by WSD, the captioned Agreement is currently under detailed design stage. Construction will commence in mid 2013 and complete in end 2015. There is potential interface with the sewers works proposed under this Project at Cheung Chau Tai Kwai Wan.

2.11.4 A short section of the land-based watermains at Tai Kwai Wan will be laid and connected to the existing trunk mains. Close liaison will be undertaken with the project proponent of the interfacing project to avoid concurrent works as far as possible. By avoiding concurrent works and given the short section of the land-based watermains and the small scale works involved, adverse cumulative environmental impact is not expected.

**Replacement and Rehabilitation of Water Mains Stage 3 and Stage 4, Mains on Hong Kong and Islands - Investigation, Design and Construction**

2.11.5 Based on the information provided by WSD, Stage 3 works have been completed by end 2012. No direct interface will be expected from the two projects.

2.11.6 The construction of Stage 4 works commenced in October 2012 and is anticipated for completion in end 2015. The potential interface with the sewers works under this Project is at Cheung Chau – Tai Shek Hau, Tung Koon San Tsuen, Round Table 2nd Village and Round Table 3rd Village.

2.11.7 Close liaison will be undertaken with the project proponent of the interfacing project to avoid concurrent works as far as possible. By avoiding concurrent works and given the short section of the land-based water main and the small scale works involved, adverse cumulative environmental impact is not expected.

**Improvement to Existing Roads and Drains in Cheung Chau Old Town, Remaining Engineering Works Stage 3, Cheung Chau**

2.11.8 Potential interface between the proposed sewerage, road and drainage works under CEDD project with this Project were identified mainly in Cheung Chau Town Centre, Hill Side Road, Kwun Yam Wan Road, Tai Shek Hau, Lung Tsai Tsuen, Ko Shan Tsuen and Pak She San Tsuen.

2.11.9 Based on the information provided by CEDD, Stage 3 is currently under detailed design stage and the construction programme could not be ascertained at time of this EIA Study. However, it has been agreed in principle with CEDD that any construction works under the two projects within a local area would be undertaken by only one party as far as practicable. By avoiding concurrent works involved, adverse cumulative environmental impact is not expected.

**Summary - Potential Interfacing Projects During Construction**

2.11.10 The interfacing projects that may have potential to cause cumulative construction impacts are summarized in **Table 2.5**.

**Table 2.5 : Interfacing Projects**

| Interfacing Project | Scheduled Construction Period | | Overlapping Months | Potential Cumulative Impacts |
|---|---|---|---|---|
| | Start | Complete | | |
| Improvement of Fresh Water Supply to Cheung Chau | Mid 2013 | End 2015 | 5 | Yes |
| Replacement and Rehabilitation of Water Mains Stage 3, Mains on Hong Kong and Islands | -- | End 2012 | -- | No |
| Replacement and Rehabilitation of Water Mains Stage 4, Mains on Hong Kong and Islands | Oct 2012 | End 2015 | 5 | Yes |
| Improvement to Existing Roads and Drains in Cheung Chau Old Town, Remaining Engineering Works, Stage 3, Cheung Chau | Construction programme not yet confirmed | | -- | -- |

2.11.11 Notwithstandingly, continuous liaison will be conducted with all works department and utilities companies to ensure adequate phasing with each concurrent project is taken into consideration, if interfacing does eventually occurs. Cumulative environmental impact will therefore be eliminated by proper scheduling of works to avoid concurrent works.

# 3. AIR QUALITY

## 3.1 Introduction

3.1.1 This section presents the assessment on the potential air quality impacts that are likely to be generated during the construction and operation phases of both the upgrading of the Cheung Chau STW and Pak She SPS and the sewers works of the Project. Appropriate mitigation measures were identified, where necessary, to mitigate the potential air quality impacts to acceptable levels.

3.1.2 This assessment has based on the criteria and guidelines for evaluation and assessment of air quality impacts as stated in Annexes 4 and 12 of the EIAO-TM and has covered the scope outlined in Section 3.4.1 of the EIA Study Brief.

## 3.2 Relevant Legislations, Standards & Guidelines

### Environmental Impact Assessment Ordinance

3.2.1 For construction dust impact assessment, Annex 4 of EIAO-TM stipulates an hourly average of Total Suspended Particulate (TSP) concentration of 500 $\mu g/m^3$ measured at 298K (25°C) and 101.325 kPa (1 atmosphere) should be met.

3.2.2 For odour impact assessment, Annex 4 of EIAO-TM stipulates an odour limit of 5 odour units based on an average time of 5 seconds at an air sensitive receiver should be met.

### Air Pollution Control Ordinance

3.2.3 Hong Kong's air quality is regulated through the Air Pollution Control Ordinance (Cap. 311) (APCO). The APCO specifies Air Quality Objectives (AQOs), which are the statutory limits for pollutants and the maximum allowable number of times that these may be exceeded over specified periods. These pollutants are defined as Criteria Pollutants (CP). The AQOs that have been defined for these CP are given in **Table 3.1**.

**Table 3.1 : Hong Kong Air Quality Objectives**

| Pollutant | Concentration ($\mu g/m^3$)(1) Averaging Period | | | | |
|---|---|---|---|---|---|
| | 1 Hour(2) | 8 Hours(3) | 24 Hours(3) | 3 Months(4) | 1 Year(4) |
| Sulphur Dioxide, $SO_2$ | 800 | - | 350 | - | 80 |
| Total Suspended Particulate, TSP | 500 (7) | - | 260 | - | 80 |
| Respirable Suspended Particulates, RSP(5) | - | - | 180 | - | 55 |
| Nitrogen Dioxide, $NO_2$ | 300 | - | 150 | - | 80 |
| Carbon Monoxide, CO | 30,000 | 10,000 | - | - | - |
| Photochemical Oxidants, (as ozone(6)) | 240 | - | - | - | - |
| Lead | - | - | - | 1.5 | - |

Notes:
1) Measured at 298 K and 101.325 kPa (one atmosphere).
2) Not to be exceeded more than 3 times per year.
3) Not to be exceeded more than once per year.
4) Arithmetic means.

5) Respirable Suspended Particulates means suspended particles in air with a nominal aerodynamic diameter of 10 μm or less.
6) Photochemical oxidants are determined by measurement of ozone only.
7) Hourly TSP limit is stipulated in the EIAO-TM.

3.2.4 The Government announced on 17 January 2012 the proposal to adopt the proposed new AQOs. The Air Pollution Control (Amendment) Bill 2013 has passed the Legislative Council and endorsed by Chief Executive on 18 July 2013. The Air Pollution Control (Amendment) Ordinance 2013 will come into operation on 1 January 2014. The proposed new AQOs are summarised in **Table 3.2** for reference only.

**Table 3.2 : Proposed New Air Quality Objectives for Hong Kong**

| Pollutant | Concentration (μg/m³) Averaging Period | | | | |
|---|---|---|---|---|---|
| | 10 Minutes | 1 Hour | 8 Hours | 24 Hours | 1 Year |
| Sulphur Dioxide, $SO_2$ | 500 (1) | -- | -- | 125 (1) | -- |
| Respirable Suspended Particulates (PM10) | -- | -- | -- | 100 (2) | 50 |
| Fine Suspended Particulates (PM2.5) | -- | -- | -- | 75 (2) | 35 |
| Nitrogen Dioxide, $NO_2$ | -- | 200 (3) | -- | -- | 40 |
| Carbon Monoxide, CO | -- | 30,000 (4) | 10,000 (4) | -- | -- |
| Ozone | -- | -- | 160 (2) | -- | -- |
| Lead | -- | -- | -- | -- | 0.5 |

Notes:
(1) Not to be exceeded more than 3 times per year
(2) Not to be exceeded more than 9 times per year
(3) Not to be exceeded more than 18 times per year
(4) No exceedances allowed

### Air Pollution Control (Construction Dust) Regulation

3.2.5 The APCO's subsidiary regulation Air Pollution Control (Construction Dust) Regulation defines notifiable and regulatory works activities that are subject to construction dust control.

Notifiable Works:

- Site formation;
- Reclamation;
- Demolition of a building;
- Work carried out in any part of a tunnel that is within 100 m of any exit to the open air;
- Construction of the foundation of a building;
- Construction of the superstructure of a building; or
- Road construction work.

Regulatory Works:

- Renovation carried out on the outer surface of the external wall or the upper surface of the roof of a building;
- Road opening or resurfacing work;

- Slope stabilization work; or
- Any work involving any of the following activities-
  - Stockpiling of dusty materials;
  - Loading, unloading or transfer of dusty materials;
  - Transfer of dusty materials using a belt conveyor system;
  - Use of vehicles;
  - Pneumatic or power-driven drilling, cutting and polishing;
  - Debris handling;
  - Excavation or earth moving;
  - Concrete production;
  - Site clearance;
  - or Blasting.

3.2.6 Notifiable works require that advance notice of activities to be given to EPD. The Regulation also requires the works contractor to ensure that both notifiable works and regulatory works will be conducted in accordance with the Schedule of the Regulation, which provides dust control and suppression measures.

**Air Pollution Control (Specified Process) Regulation**

3.2.7 The APCO provides licence control on certain polluting industrial processes known as "specified processes (SP)". The aim is to properly control and monitor the air pollution caused by the industries that have significant pollution potential. Through the terms and conditions of the licence, the owners of the premises used for the conduct of specified processes are required to use the best practicable means to prevent air pollution. Cement works such as concrete batching plant is classified as a specified process.

## 3.3 Baseline Environmental Conditions

3.3.1 Cheung Chau is situated at southeast of Lantau Island. It is a densely populated outlying island. Cheung Chau contains mostly developed areas including commercial uses, residential uses and community facilities.

3.3.2 The proposed sewage treatment upgrading works would be undertaken within the existing Cheung Chau STW which is located southwest of Tai Kwai Wan on Cheung Chau Island and adjacent to Pak Kok Tsui Road and Cheung Kwai Road. It is surrounded by the sea at three sides and Cheung Kwai Estate is located further to the east. Cheung Chau Slaughter House is located to the northwest of the Cheung Chau STW.

3.3.3 Buildings located in the immediate vicinity area of the existing Pak She SPS include Cheung Chau Fire Station, Cheung Chau Commercial Centre, an Electricity Sub-station, and low-rise residential buildings along Pak She Praya Road. The existing land uses in the vicinity of the proposed sewerage works are mainly developed areas comprise residential and commercial uses.

3.3.4 There is currently no EPD-operated air quality monitoring station located in Cheung Chau area. Historical air quality monitoring data from the nearest station, namely Tung Chung Air Quality Monitoring Station operated by EPD is taken to present the historical trend of the air quality condition near Cheung Chau area. **Table 3.3** summarizes the annual average concentrations of the air pollutants recorded at the Tung Chung Air Quality Monitoring Station from Year 2007 to Year 2011.

**Table 3.3 : Annual Average Concentration of Pollutants from Year 2007 to 2011 at EPD's Air Quality Monitoring Station (Tung Chung)**

| Pollutant | Annual Average Concentration (μg/m³) | | | | | 5-year average (used as background) |
|---|---|---|---|---|---|---|
| | Year 2007 | Year 2008 | Year 2009 | Year 2010 | Year 2011 | |
| RSP | 54 | 52 | 46 | 45 | 47 | 49 |
| $SO_2$ | 23 | 18 | 13 | 12 | 13 | 16 |
| $NO_2$ | 46 | 49 | 45 | 44 | 51 | 47 |
| TSP | 70 | 69 | 60 | 59 | 65 | 65 |
| $O_3$ | 40 | 41 | 47 | 44 | 44 | 43 |

Note:
Reference made to Air Quality in Hong Kong 2007-2011.

3.3.5 Odour patrol was conducted in areas near the Cheung Chau STW and Pak She SPS to review the existing background odour intensity of ambient air in the vicinity of the two sewage treatment facilities. The odour patrol exercise was conducted on 5th, 6th, 7th and 16th July 2012 summer time. During the odour patrol, the Cheung Chau STW and Pak She SPS were under normal operation and the temperature was generally higher than 30˚C. The weather conditions such as wind direction and wind speed were also recorded.

3.3.6 Based on the odour patrol survey results, sewage type odour was detected in areas close to the Cheung Chau STW and Pak She SPS. No sewage type odour was detected in other surveyed locations. Details of the odour survey methodology, locations and survey results are provided in **Appendix 3.1**.

3.3.7 In addition to the odour patrol, on-site odour sampling and laboratory olfactometry measurement for the existing odour condition in the areas near the Cheung Chau STW and Pak She SPS was carried out on 15 May 2013 to provide supplementary details on the existing odour conditions. Field measurements at selected air sensitive receivers near the Cheung Chau STW and Pak She SPS were conducted.

3.3.8 Based on the measurement results, the odour concentration at Cheung Chau Slaughter House (close to the Cheung Chau STW) was measured about 40 $OU_E/m^3$, whilst at locations close to Pak She SPS were measured to be in a range of 11 to 16 $OU_E/m^3$. Details of the odour measurement methodology and results are provided in **Appendix 3.1.**

## 3.4 Air Sensitive Receivers

3.4.1 The assessment area for air quality impact is defined by a distance of 500 m from the boundary of the project site. Within the assessment area, representative Air Sensitive Receivers (ASRs) have been identified for this assessment, in accordance with the Annex 12 of the EIAO-TM. Domestic premises, hotel, hostel, hospital, clinic, nursery, temporary housing accommodation, school, educational institution, office, factory, shop, shopping centre, home for the aged and recreational activity areas are classified as ASRs.

3.4.2 The ASRs in the vicinity of the proposed works site are identified for the assessment and the locations of these ASRs and their nearest horizontal separation from the proposed works are listed in **Table 3.4**. **Figure 3.1** to **Figure 3.16** show the locations of the ASRs.

**Table 3.4 : Representative Air Sensitive Receivers**

| ASR | Description of ASR | Nature of Use | Horizontal Distance to Nearest Works Area (m) | Nearest Works | Figure No. |
|---|---|---|---|---|---|
| TKST2 | No.4 Tai Kwai San Tsuen | Residential | 1 | Sewer | 3.1 |
| TKW2* | No.7, Tai Kwai Wan San Tsuen | Residential | 1 | Sewer | 3.1 |
| CSH1* | Chung Shak Hei Home for the Aged | Homes for the Aged | 1 | Sewer | 3.2 |
| CCC1* | No.109, Pak She San Tsuen | Residential | 2 | Sewer | 3.2 |
| CCC2* | No.67, Pak She San Tsuen | Residential | 1 | Sewer | 3.2 |
| CSH2* | Cheung Shun House | Residential | 82 | Cheung Chau STW | 3.3 |
| CCSH* | Cheung Chau Slaughter House | Slaughterhouse | 3 | Cheung Chau STW | 3.3 |
| CKH * | Cheung King House | Residential | 113 | Cheung Chau STW | 3.3 |
| FS* | Cheung Chau Fire Station | Government Quarter | 12 | Pak She SPS | 3.4 |
| CCA* | Cheung Chau Commercial Centre | Office | 6 | Pak She SPS | 3.4 |
| CCB* | Cheung Chau Commercial Centre | Office | 1 | Pak She SPS | 3.4 |
| PSSL* | No. 1A Pak She Second Lane | Residential | 35 | Pak She SPS | 3.4 |
| TKS | Block K, Tung Koon San Tsuen | Residential | 2 | Sewer | 3.5 |
| CCEP | No.7 Cheung Chau Electric Path | Residential | 1 | Sewer | 3.5 |
| CHR | No. 18, Chung Hok Road | Residential | 2 | Sewer | 3.6 |
| SW1 | 3A Golden Lake Garden | Residential | 5 | Sewer | 3.6 |
| THT | No.24 Tai Hing Tai Road | Residential | 5 | Sewer | 3.6 |
| SWR | No. 3A, Sai Wan Road | Residential | 1 | Sewer | 3.7 |
| ST | Block D Seaview Terrence | Residential | 5 | Sewer | 3.7 |
| SYT1 | No.2A Sin Yan Tseng | Residential | 2 | Sewer | 3.7 |
| SYT2 | No.37 Sin Yan Tseng | Residential | 1 | Sewer | 3.7 |
| P1 | No. 34 Praya Street | Residential | 9 | Sewer | 3.8 |
| TW1 | Cheng Chau Fisheries Joint Association Public School | Educational | 2 | Sewer | 3.8 |

| ASR | Description of ASR | Nature of Use | Horizontal Distance to Nearest Works Area (m) | Nearest Works | Figure No. |
|---|---|---|---|---|---|
| TW2 | No. 156, Tung Wan Road | Residential | 2 | Sewer | 3.8 |
| TW3 | No. 83, Tung Wan Road | Residential | 2 | Sewer | 3.8 |
| TSB | No. 107, Tai San Back Street | Residential | 1 | Sewer | 3.9 |
| TSB1 | No. 123 Tai San Back Street | Residential | 1 | Sewer | 3.9 |
| HSR1 | No.35, Hill Side Road | Residential | 1 | Sewer | 3.10 |
| TTY | No. 4, Tai Tsoi Yuen Road | Residential | 1 | Sewer | 3.10 |
| KKPS | Cheung Chau Church Kim Kong Primary School | Educational | 11 | Sewer | 3.10 |
| TG | House 10, Tinford Garden | Residential | 3 | Sewer | 3.10 |
| LTT | No. 9A, Lung Tsai Tsuen | Residential | 2 | Sewer | 3.10 |
| KL | No.49A, King Lau, Lung Tsai Tsuen | Residential | 3 | Sewer | 3.10 |
| LTT1 | Cheng Chau Alliance Church | Church | 1 | Sewer | 3.10 |
| LTT2 | No.35 Lung Tsai Tsuen Road | Residential | 1 | Sewer | 3.10 |
| P2 | No.41A Peak Road | Residential | 1 | Sewer | 3.10 |
| SJH | St. John's Hospital | Hospital | 6 | Sewer | 3.11 |
| CCS | Warwick Hotel | Hotel | 9 | Sewer | 3.11 |
| HPR | Hak Pai Road Sitting-out Area | Recreational area | 2 | Sewer | 3.12 |
| HC | Block 5, Herald Court | Residential | 4 | Sewer | 3.12 |
| KYW1 | No.31 Kwun Yam Wan Road | Residential | 7 | Sewer | 3.12 |
| CCS2 | Block G-H Fu Yuen | Residential | 1 | Sewer | 3.12 |
| HSR2 | No 22C, Hill Side Road | Residential | 2 | Sewer | 3.13 |
| PR1 | No.25B Peak Road | Residential | 2 | Sewer | 3.13 |
| PR2 | No.72A Peak Road | Residential | 4 | Sewer | 3.13 |
| KYW2 | No.46 Kwun Yam Wan Road | Residential | 2 | Sewer | 3.14 |
| MF1 | Caritas Ka Fai House | Residential | 2 | Sewer | 3.14 |
| FP1 | No.18 Fa Peng Road | Residential | 2 | Sewer | 3.15 |
| FP2 | Bethany Cottage and House | Residential | 2 | Sewer | 3.15 |

| ASR | Description of ASR | Nature of Use | Horizontal Distance to Nearest Works Area (m) | Nearest Works | Figure No. |
|---|---|---|---|---|---|
| GIC_1 [1] | G/IC Area near Pak Kok Tsui Road | G/IC | 23 | Cheung Chau STW | 3.3 |
| GIC_2 [1] | G/IC Area near Ping Chong Road | G/IC | 68 | Pak She SPS | 3.4 |
| GIC_3 [1] | G/IC Area adjacent Pak She Sewage Pumping Station | G/IC | 1 | Pak She SPS | 3.4 |
| PSSPS_DW [2] | North of Pak She Sewage Pumping Station | Public road | 3 | Pak She SPS | 3.4 |
| CCSTW_DW [2] | North of Cheung Chau Sewage Treatment Plant | Public road | 18 | Cheung Chau STW | 3.3 |

Notes:
ASR ID marked with * represents ASR located within the 500 m radius of the boundary of the Cheung Chau STW and Pak She SPS.
[1] The existing land-uses of these locations are storage area and open space. According the Cheung Chau Outline Zoning Plan (No. S/I-CC/5), they are zoned as Government / Institution and Community (G/IC) use which may be used for potential air sensitive use. These are considered planned ASRs.
[2] Reference locations as the downwind locations for the odour measurements near the Cheung Chau STW and Pak She SPS conducted on 15-May-2013. They are not considered as ASR and were included for the odour prediction assessment for reference only.

## 3.5 Identification of Pollution Sources

### Upgrading Works of Cheung Chau STW and Pak She SPS

3.5.1 The potential air quality impacts arising during construction phase would be dust nuisance. The major construction activities involved for the upgrading of the Cheung Chau STW that would be potential source of construction dust include site clearance, excavation, materials handling and wind erosion of stockpile on site. The construction works will be confined within the existing Cheung Chau STW boundary.

3.5.2 For a worst case scenario assessment of construction dust impacts, it is assumed that a concrete batching plant would be provided. According to the current design, the practical proposed concrete batching plant location is shown in **Figure 3.17**.

3.5.3 In view of the traffic-free nature of Cheung Chau, trucks hauling off site is not expected. Vehicular movement on-site will only be limited to the small scale "VV vehicle" and the number that would be in use is expected to be low.

3.5.4 According to the design information at the time of preparation of this EIA, the new MBR treatment facilities will be constructed first whilst the existing Cheung Chau STW will continue the normal operation. Sewage sludge from the STW will be disposed of via marine route as per the current operation thus no additional odour impacts would arise. Sewage will be diverted to the new MBR facilities upon its completion. The existing treatment facilities will then be decommissioned. There will be no demolition of existing septic tanks under the current design. If it is necessary to demolish the existing septic tank during the construction period, the sludge in the septic tank would be transferred to enclosed container following the same procedure with the regular maintenance works for septic works. Therefore,

no additional odour sources would be expected during the construction phase of the Cheung Chau STW upgrading works.

3.5.5 Upgrading of the Pak She SPS will involve replacement of pumps and other E&M equipments, and minor modification of existing pump troughs. Deodourizing units will also be provided to the upgraded Pak She SPS. Appropriate dust control measures should be implemented during the construction stage in accordance with the requirements in the Air Pollution Control (Construction Dust) Regulation. Dust control techniques should be considered to control dust to a level not exceeding the AQOs as well as the 1-hour TSP guideline level of 500 μg/m³. These measures include, but are not limited to, the following:

- Adoption of good site practices;
- Avoid practices likely to raise dust level;
- Frequent cleaning and damping down of stockpiles and dusty areas of the site;
- Covering the exposed areas with tarpaulin;
- Reducing drop height during material handling;
- Provision of wheel-washing facilities for site vehicles leaving the site;
- Regular plant maintenance to minimize exhaust emission; and
- Sweep up dust and debris at the end of each shift.

**Sewers Works**

3.5.6 The potential dust generating construction activities associated with the sewers works will mainly be localised excavation. It is expected that the sewers works will be carried out by sections. Under normal practice, the sewers would be constructed in section of about 20m to 30m at any one time and each work front would be separated by a clearance distance. With such a typical arrangement, construction works for each section could normally be completed in about 30 days, with each construction activity lasts for about 1.5 days to 9 days.

3.5.7 Given each section of the works would be small scale, localised, and short-term, it would not be useful to perform dust dispersion modelling for this type of transient dust generation activities. Dust suppression and control measures stipulated in the Air Pollution Control (Construction Dust) Regulation would be applied.

3.5.8 These measures include, but are not limited to, the following:

- Adoption of good site practices;
- Avoid practices likely to raise dust level;
- Frequent cleaning and damping down of stockpiles and dusty areas of the site;
- Covering the exposed areas with tarpaulin;
- Reducing drop height during material handling;
- Regular plant maintenance to minimize exhaust emission; and
- Sweep up dust and debris at the end of each shift.

**Cumulative Dust Impacts and Control Measures**

3.5.9 The following discusses the potential cumulative interface issues between concurrent projects as indicated in **Section 2.11**. Liaisons with each of the project proponents of these concurrent projects have been made in order to obtain the latest available information and details. The correspondences are shown in **Appendix 3.6**.

***Improvement of Fresh Water Supply to Cheung Chau - Design and Construction***

3.5.10 The construction activities of the fresh water supply project are located at Cheung Chau Tai Kwai Wan which potentially interface with the proposed sewers works in the same area for 3 months overlapping period. It is recommended that the construction of sewers at Tai Kwai Wan San Tsuen should be launched after the completion of the Project. The contractor should liaise with the correspondent party to ensure concurrent works are avoided as far as possible. By avoiding concurrent works, adverse cumulative dust impact is not expected to occur.

***Replacement and Rehabilitation of Water Mains Stage 3 and Stage 4, Mains on Hong Kong and Islands – Investigation, Design and Construction***

3.5.11 Based on the information provided by WSD, Stage 3 of this project has been completed. Construction of Stage 4 commenced in October 2012 and is anticipated for completion in 2015. Close liaison will be undertaken with the project proponent of the interfacing project to avoid concurrent works as far as possible. By avoiding concurrent works, the potential interface issues with this project are not expected to occur.

***Improvement to Existing Roads and Drains in Cheung Chau Old Town, Remaining Engineering Works, Stage 3, Cheung Chau***

3.5.12 Based on the best available information at time of preparation of this EIA, this project involves the construction of village sewer at Cheung Chau Town Centre, Hill Side Road, Kwun Yam Wan Road, Tai Shek Hau, Lung Tsai Tsuen, Ko Shan Tsuen and Pak She San Tsuen. Close liaison between the two project teams will be undertaken to ensure concurrent works are avoided as far as possible. By avoiding concurrent works and given the small scale works involved, adverse cumulative dust impact is not expected during construction.

3.5.13 In addition, proper mitigation measures as stipulated in the Air Pollution Control (Construction Dust) Regulation would be applied.

3.5.14 As a result, only minimal cumulative impacts from these potential concurrent construction works are anticipated. With the continual monitoring and review of dust impact in the area and close liaison with the contractors of these interfacing projects, adverse cumulative dust impact would not be anticipated.

**Operational Phase**

3.5.15 It is anticipated that odour impact from the sewers works would be negligible as the sewage collection system is a closed system. The potential air quality impacts during the operational phase will be the potential odour emissions from the upgraded Cheung Chau STW and the Pak She SPS.

## 3.6 Construction Dust Impact Assessment Methodology

**Air Dispersion Model**

3.6.1 The air pollutant concentrations were assessed in accordance with the Guidelines for Choice of Models and Model Parameters in Air Quality Assessment published by EPD. The extent of dust impacts arising from the construction phase have been predicted by using the Industrial Source Complex Short-Term 3 (ISCST3) model which has been developed and validated by the United States Environmental Protection Agency (USEPA) and accepted by EPD for regulatory applications.

**Emissions Factors**

3.6.2 The construction works at the Cheung Chau STW site have the potential to generate fugitive dust from various construction activities and these are included in the ISCST3 dispersion model, including:

- Traffic from Paved Road;
- Heavy Construction;
- Wind erosion;
- Material Construction; and
- Operation of the concrete batching plant.

3.6.3 Whilst emissions from the sewers works are expected to be low, the model has included the dust sources of sewers works located within the 500 m of the upgrading works of Cheung Chau STW and the Pak She SPS study area for the evaluation of the potential cumulative impacts.

3.6.4 The emission factors used for the prediction of construction dust emissions impacts were based on typical values referenced from USEPA Compilation of Air Pollution Emission Factors (AP-42), 5th Edition. The calculations of dust emission factors for different dust generating activities are detailed in **Appendix 3.2** and summarized below:

***Traffic from Paved Road***

Emission Factor = k(sL)^0.91* (W)^1.02 (reference: AP-42, Chapter 13.2.1)

| | | |
|---|---|---|
| Where | E : | particulate emission factor, g/veh-km |
| | k : | particulate size multiplier for particle size range and units of interest |
| | sL : | road surface silt loading, g/m$^2$ |
| | W : | average weight, ton |

***Heavy Construction***

Emission Rate = 1.2 tons arcs/arce/month of activities (reference: AP-42 Chapter 13.2.3.3)

***Wind Erosion***

Emission Factor = 0.85 Mg/ha/yr (reference: AP-42, Chapter 11.09 Table 11.9-4)

***Material Handling***

Emission factor = k (0.0016) x (U/2.2)^1.3 / (M/2)^1.4

| | | |
|---|---|---|
| Where | E : | Emission factor, g/megagram |
| | k : | Particulate size multiplier, k=0.74 as defined according to Table 2 of AP-42 Section 13.2.4 |
| | U : | Average wind speed at Cheung Chau from 2006 to 2010 (i.e. ~ 4.93m/s) |
| | M : | Material moisture content; Material handling at construction sites and stone quarrying, and the nature of these activities are similar.. The moisture content for a quarry is estimated between 0.3% and 1.1% according to Section 13.2.4 of AP-42. For conservative scenario, the minimum moisture content value (0.3%) is assumed for the construction sites. . |

***Unloading of Raw Material***

Emission factor = 0.0035 (kg/Mg) (reference: AP-42, Chapter 11.12, Table 11.12-1)

**Meteorological Data**

3.6.5 Meteorological data from Cheung Chau Automatic Weather Station provided by the Hong Kong Observatory for the year 2010 (the amount of valid data is more than 90 percent for this year) was used for the dispersion model. The following data were included:

- flow vector of wind;
- wind speed;
- air temperature;
- atmospheric Pasquill stability class; and
- morning mixing height and maximum mixing height recorded at King's Park.

**Assumptions**

3.6.6 The dust impact assessment has made the following assumptions:

- The study area is defined as "rural";
- dry depletion and gradual plume rise options were considered in the model run;
- A twelve-hour (07:00 to 19:00) working day during construction phase, of which a ten-hour operation 08:00 to 19:00 exclude 1 hour for lunch) for material handling and heavy construction activities;
- A twelve-hour (07:00 to 19:00) operation hours for concrete batching plant; and
- The minor VV vehicle movements on site were considered in the model as conservative approach, although it will only be minimal.

3.6.7 Watering of site areas with heavy construction operations, and of paved roads, is recommended to minimize construction dust generation as general good site practice during construction. **Table 3.5** shows the calculated dust removal efficiency at different time intervals between watering.

**Table 3.5 : Dust Removal Efficiency for Different Watering Frequencies**

| Time Between Watering (hour) | Dust Removal Efficiency (%) |
|---|---|
| 6 | 63.7 |
| 3 | 81.9 |
| 1.5 | 90.9 |

3.6.8 Based on **Table 3.5**, watering frequencies of heavy construction operations and paved roads are assumed to be 1.5 hours intervals for the heavy construction operation areas and for the paved roads.

3.6.9 According to the "Control of Open Fugitive Dust Sources" cited in AP 42 issued by USEPA, average dust control efficiency (in percent) can be estimated by equation 5-4 of the paper [c=100 – (0.8*p*d*t)/i] based on potential average hourly daytime evaporation rate for the construction site (p in mm/h), average hourly daytime traffic rate (d in veh/hr), watering intensity (in litre/$m^2$), and the time between applications of watering (t in hr). Based on "The Year's Weather – 2011" issued by Hong Kong Observatory, the total annual evaporation recorded in Hong Kong is 1476.7 mm (58.14 inches). The potential average hourly daytime evaporation rate is calculated by equation 5-5b of the USEPA's paper based on the mean annual pan evaporation in Hong Kong. The maximum hourly traffic flow is estimated to be 10 vehicles per hour, respectively (round-trip included). To adopt a conservative

approach, the peak hourly daytime traffic rate of 10 vehicles per hour is assumed for the dust control efficiency calculation. Based on these assumptions, a minimum 0.5 litres per $m^2$ of watering application intensity is required to achieve the target dust removal efficiency. Calculation details are provided in **Appendix 3.2.**

3.6.10 Watering of site areas with wind erosion will be implemented to minimize construction dust generation as general good site practice during construction. It is assumed the watering application intensity to be 1.5 litres per $m^2$ which can achieve the 90% dust removal efficiency. **Appendix 3.2** shows the calculation of the water amount and frequency of watering to achieve the dust removal efficiency to 90%.

3.6.11 Construction dust is the key air emission source during construction phase at above-ground works areas. According to Annex 4 of EIAO-TM, Total Suspended Particulates (TSP) is the air pollutant parameter for construction dust impact assessment. According to EPD's Air Quality Report 2011, the major sources of Respirable Suspended Particulates (RSP) include power generation and road traffic emissions which is not originated by construction activities. As such, RSP are not included in the construction dust impact assessment.

### Background TSP Concentration

3.6.12 For background TSP concentration, the 5-years (2007 to 2011) average annual TSP concentration of 64.6 $\mu g/m^3$ at Tung Chung Station was adopted. This is because Tung Chung is located on an outlying island which is of similar nature of Cheung Chau. The air quality data recorded at the Tung Chung Station is considered to be the most relevant data for Cheung Chau.

### Assessment Heights

3.6.13 The highest elevation of ASR identified (Cheung Kwai Estate) is about 30 m above ground level. Therefore, the assessment heights were taken as 1.5m (breathing level), 5m, 10m 15m, 20m and 25m above ground level.

### Selected ASR for Dispersion Modelling Assessment

3.6.14 All existing ASRs selected and described in **Table 3.4** were used for the dispersion modelling assessment.

## 3.7 Prediction of Construction Dust Impact

### Unmitigated Scenario

3.7.1 The worst case modelling results of 1-hour, 24-hour and annual TSP concentrations at all identified ASRs for the unmitigated scenarios are presented in **Table 3.6** and **Table 3.7** respectively. All the results presented in the tables have included 64.6$\mu g/m^3$ for background concentration. The predicted results show that the ASRs located close to the construction site and at low elevations would be impacted by elevated dust level if no mitigation measures are applied. Mitigation measures are required to be implemented to reduce the potential dust impacts.

**Table 3.6 : Predicted Worst-case 1-hour Average and 24-hour Average TSP Concentration at Different Level above Ground (Unmitigated)**

| ASR | Worst-case 1-hour Average TSP, $\mu g/m^3$ | | | | | | Worst-case 24-hour Average TSP, $\mu g/m^3$ | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 1.5m | 5m | 10m | 15m | 20m | 25m | 1.5m | 5m | 10m | 15m | 20m | 25m |
| TKST2 | **839.2** | **751.4** | **526.9** | 307.4 | 237.5 | 197.6 | 99.7 | 96.7 | 89.4 | 81.6 | 75.8 | 72.2 |
| TKW2* | **1000.3** | **857.7** | **526.9** | 308.0 | 251.9 | 198.6 | 112.2 | 107.1 | 95.2 | 84.4 | 77.4 | 73.3 |
| CSH1* | 282.2 | 272.9 | 246.3 | 209.3 | 170.2 | 135.3 | 82.6 | 81.0 | 77.4 | 73.9 | 71.4 | 69.5 |

| ASR | Worst-case 1-hour Average TSP, µg/m³ | | | | | | Worst-case 24-hour Average TSP, µg/m³ | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 1.5m | 5m | 10m | 15m | 20m | 25m | 1.5m | 5m | 10m | 15m | 20m | 25m |
| CCC1* | **1871.3** | **1242.8** | 382.5 | 249.1 | 196.8 | 179.6 | 139.9 | 113.7 | 90.1 | 85.0 | 80.5 | 77.0 |
| CCC2* | **2008.7** | **1587.4** | **756.5** | 426.7 | 309.0 | 213.2 | 151.0 | 133.1 | 98.1 | 81.3 | 75.9 | 71.8 |
| CSH2* | **2456.0** | **878.0** | **528.7** | 378.4 | 254.5 | 171.3 | 167.5 | 133.1 | 91.1 | 82.2 | 75.5 | 70.5 |
| CCSH* | **4597.5** | **1408.2** | **538.4** | 327.3 | **510.5** | **1481.5** | **440.3** | 194.1 | 120.9 | 103.3 | 163.0 | 150.3 |
| CKH * | **4517.1** | **1013.3** | **627.0** | 409.0 | 253.0 | 169.1 | 255.9 | 135.1 | 96.7 | 84.1 | 75.3 | 70.2 |
| FS* | **1196.3** | **903.0** | 392.0 | 197.8 | 187.0 | 174.4 | 119.5 | 105.1 | 81.9 | 72.6 | 71.1 | 70.2 |
| CCA* | **2038.2** | **1350.5** | 385.0 | 233.0 | 215.6 | 196.0 | 155.0 | 125.2 | 84.3 | 75.0 | 73.5 | 72.1 |
| CCB* | **1561.6** | **988.2** | 273.8 | 255.3 | 232.3 | 224.9 | 134.3 | 108.8 | 79.8 | 77.4 | 75.4 | 74.3 |
| PSSL* | **1214.1** | **891.0** | 374.7 | 184.9 | 176.1 | 165.7 | 119.8 | 106.1 | 82.8 | 72.5 | 70.6 | 69.8 |
| TKS | 144.3 | 143.5 | 140.9 | 136.9 | 131.6 | 125.4 | 70.9 | 70.8 | 70.5 | 70.0 | 69.4 | 68.9 |
| CCEP | 120.8 | 120.3 | 118.6 | 115.9 | 112.4 | 108.2 | 69.5 | 69.4 | 69.3 | 69.1 | 68.8 | 68.5 |
| CHR | 180.7 | 179.5 | 175.5 | 169.2 | 161.0 | 151.4 | 69.5 | 69.4 | 69.2 | 69.0 | 68.6 | 68.2 |
| SW1 | 126.0 | 125.4 | 123.4 | 120.1 | 115.9 | 110.9 | 68.9 | 68.8 | 68.6 | 68.3 | 67.9 | 67.4 |
| THT | 151.3 | 150.3 | 147.1 | 142.0 | 135.4 | 127.7 | 68.5 | 68.4 | 68.2 | 67.9 | 67.6 | 67.2 |
| SWR | 126.2 | 125.6 | 123.8 | 120.8 | 116.8 | 112.2 | 69.0 | 68.9 | 68.7 | 68.4 | 68.0 | 67.6 |
| ST | 151.7 | 150.8 | 148.2 | 144.0 | 138.5 | 132.0 | 71.5 | 71.4 | 71.0 | 70.5 | 69.9 | 69.2 |
| SYT1 | 119.8 | 119.3 | 117.6 | 114.9 | 111.4 | 107.2 | 68.4 | 68.4 | 68.2 | 67.9 | 67.6 | 67.2 |
| SYT2 | 138.4 | 137.8 | 135.8 | 132.6 | 128.4 | 123.3 | 70.4 | 70.3 | 70.0 | 69.7 | 69.2 | 68.6 |
| P1 | 180.2 | 172.6 | 151.2 | 126.6 | 112.4 | 98.9 | 69.4 | 69.2 | 68.9 | 68.4 | 67.9 | 67.4 |
| TW1 | 166.5 | 160.2 | 142.1 | 119.6 | 99.2 | 87.9 | 69.0 | 68.8 | 68.0 | 67.7 | 67.3 | 66.8 |
| TW2 | **629.1** | **589.0** | 477.0 | 343.6 | 229.9 | 153.2 | 88.1 | 86.5 | 81.8 | 76.2 | 71.5 | 69.3 |
| TW3 | 483.5 | 454.3 | 372.0 | 272.4 | 185.9 | 126.7 | 82.1 | 80.8 | 77.4 | 73.3 | 69.7 | 68.5 |
| TSB | 166.9 | 164.7 | 157.7 | 147.1 | 134.3 | 120.8 | 69.4 | 69.3 | 69.1 | 68.7 | 68.3 | 67.9 |
| TSB1 | 212.3 | 208.8 | 197.6 | 180.9 | 161.1 | 140.7 | 71.0 | 70.8 | 70.5 | 70.0 | 69.3 | 68.6 |
| HSR1 | 172.7 | 170.7 | 164.5 | 154.9 | 143.0 | 130.0 | 69.2 | 69.1 | 68.9 | 68.6 | 68.2 | 67.8 |
| TTY | 453.0 | 433.5 | 376.4 | 300.9 | 226.3 | 165.4 | 80.8 | 80.0 | 77.6 | 74.5 | 71.4 | 68.8 |
| KKPS | 204.0 | 197.7 | 179.1 | 153.7 | 127.3 | 104.6 | 70.5 | 70.2 | 69.5 | 68.4 | 67.3 | 66.4 |
| TG | 220.7 | 213.8 | 193.2 | 165.0 | 135.7 | 110.3 | 71.2 | 70.9 | 70.0 | 68.9 | 67.6 | 66.6 |
| LTT | 149.6 | 146.0 | 135.4 | 120.7 | 105.2 | 91.4 | 68.1 | 68.0 | 67.6 | 66.9 | 66.6 | 66.5 |
| KL | 139.1 | 137.9 | 134.0 | 128.0 | 120.5 | 112.1 | 67.9 | 67.9 | 67.7 | 67.6 | 67.3 | 67.0 |
| LTT1 | 128.7 | 127.6 | 124.0 | 118.4 | 111.5 | 104.0 | 67.8 | 67.8 | 67.7 | 67.5 | 67.3 | 67.1 |
| LTT2 | 132.5 | 131.4 | 127.7 | 122.1 | 115.1 | 107.3 | 67.8 | 67.7 | 67.6 | 67.4 | 67.2 | 67.0 |
| P2 | 403.4 | 388.2 | 343.0 | 281.3 | 217.3 | 162.0 | 78.7 | 78.1 | 76.2 | 73.7 | 71.0 | 68.7 |
| SJH | 163.9 | 158.9 | 144.4 | 125.3 | 106.5 | 91.1 | 68.9 | 68.7 | 68.1 | 67.3 | 66.5 | 66.1 |
| CCS | 185.5 | 180.1 | 163.8 | 141.7 | 118.9 | 99.4 | 69.8 | 69.5 | 68.9 | 67.9 | 67.0 | 66.2 |
| HPR | 302.7 | 294.3 | 268.9 | 232.9 | 193.7 | 157.3 | 74.7 | 74.3 | 73.3 | 71.8 | 70.1 | 68.6 |
| HC | 251.1 | 243.8 | 222.0 | 191.4 | 158.3 | 128.2 | 72.4 | 72.1 | 71.2 | 69.9 | 68.5 | 67.2 |
| KYW1 | 251.3 | 242.4 | 216.1 | 180.7 | 144.6 | 114.2 | 72.4 | 72.0 | 70.9 | 69.4 | 67.9 | 67.1 |
| CCS2 | 107.8 | 106.0 | 100.6 | 93.1 | 85.3 | 79.6 | 66.6 | 66.6 | 66.5 | 66.4 | 66.2 | 66.0 |
| HSR2 | 136.7 | 135.4 | 131.4 | 125.2 | 117.5 | 109.0 | 67.8 | 67.8 | 67.7 | 67.5 | 67.2 | 66.9 |
| PR1 | 141.4 | 140.1 | 136.2 | 130.1 | 122.4 | 113.8 | 67.8 | 67.7 | 67.6 | 67.3 | 67.1 | 66.9 |
| PR2 | 145.1 | 143.8 | 139.7 | 133.3 | 125.3 | 116.4 | 68.1 | 68.0 | 67.9 | 67.7 | 67.4 | 67.2 |
| KYW2 | 152.6 | 149.3 | 139.3 | 125.3 | 109.9 | 95.7 | 68.4 | 68.2 | 67.8 | 67.2 | 66.6 | 66.0 |
| MF1 | 136.4 | 133.9 | 126.1 | 115.2 | 103.0 | 91.5 | 67.7 | 67.6 | 67.2 | 66.8 | 66.3 | 65.8 |

| ASR | Worst-case 1-hour Average TSP, µg/m³ | | | | | | Worst-case 24-hour Average TSP, µg/m³ | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 1.5m | 5m | 10m | 15m | 20m | 25m | 1.5m | 5m | 10m | 15m | 20m | 25m |
| FP1 | 317.6 | 309.3 | 283.9 | 247.3 | 206.2 | 166.6 | 75.1 | 74.8 | 73.7 | 72.2 | 70.5 | 68.8 |
| FP2 | 287.4 | 280.2 | 258.4 | 226.8 | 191.0 | 156.4 | 73.9 | 73.6 | 72.7 | 71.4 | 69.9 | 68.4 |

Notes:
All the results presented in the table have included 64.6 µg/m³ for background TSP concentration.
Underlined and bold figure indicates exceedance of the relevant AQO.
ASR ID marked with * represents ASR located within the 500 m radius of the boundary of the Cheung Chau STW and Pak She SPS.

**Table 3.7 : Predicted Worst-case Annual Average TSP Concentration at Different Level above Ground (Unmitigated)**

| ASR | Worst-case Annual Average TSP, µg/m³ | | | | | |
|---|---|---|---|---|---|---|
| | 1.5m | 5m | 10m | 15m | 20m | 25m |
| TKST2 | 65.7 | 65.6 | 65.4 | 65.2 | 65.0 | 64.9 |
| TKW2* | 65.9 | 65.7 | 65.4 | 65.1 | 65.0 | 64.9 |
| CSH1* | 65.0 | 65.0 | 64.9 | 64.9 | 64.8 | 64.8 |
| CCC1* | 66.8 | 66.5 | 65.9 | 65.5 | 65.3 | 65.1 |
| CCC2* | 66.0 | 65.8 | 65.5 | 65.3 | 65.1 | 65.0 |
| CSH2* | 68.5 | 66.8 | 65.6 | 65.1 | 64.9 | 64.7 |
| CCSH* | **148.5** | **102.6** | 75.9 | 69.8 | 76.9 | 71.4 |
| CKH * | 69.5 | 67.5 | 66.0 | 65.3 | 64.9 | 64.8 |
| FS* | 65.4 | 65.2 | 65.0 | 64.9 | 64.8 | 64.8 |
| CCA* | 65.6 | 65.3 | 65.0 | 64.9 | 64.8 | 64.8 |
| CCB* | 65.7 | 65.3 | 65.1 | 64.9 | 64.9 | 64.8 |
| PSSL* | 65.3 | 65.2 | 65.0 | 64.9 | 64.8 | 64.8 |
| TKS | 64.9 | 64.9 | 64.9 | 64.9 | 64.9 | 64.8 |
| CCEP | 64.9 | 64.9 | 64.9 | 64.9 | 64.8 | 64.8 |
| CHR | 64.7 | 64.7 | 64.7 | 64.7 | 64.7 | 64.7 |
| SW1 | 64.8 | 64.8 | 64.8 | 64.7 | 64.7 | 64.7 |
| THT | 64.7 | 64.7 | 64.7 | 64.7 | 64.7 | 64.7 |
| SWR | 64.8 | 64.8 | 64.8 | 64.7 | 64.7 | 64.7 |
| ST | 64.8 | 64.8 | 64.8 | 64.8 | 64.8 | 64.8 |
| SYT1 | 64.7 | 64.7 | 64.7 | 64.7 | 64.7 | 64.7 |
| SYT2 | 64.8 | 64.8 | 64.8 | 64.8 | 64.7 | 64.7 |
| P1 | 64.7 | 64.7 | 64.7 | 64.7 | 64.7 | 64.7 |
| TW1 | 64.7 | 64.7 | 64.7 | 64.7 | 64.7 | 64.6 |
| TW2 | 64.8 | 64.8 | 64.8 | 64.7 | 64.7 | 64.7 |
| TW3 | 64.8 | 64.8 | 64.7 | 64.7 | 64.7 | 64.7 |
| TSB | 64.7 | 64.7 | 64.7 | 64.7 | 64.7 | 64.7 |
| TSB1 | 64.7 | 64.7 | 64.7 | 64.7 | 64.7 | 64.7 |
| HSR1 | 64.7 | 64.7 | 64.7 | 64.7 | 64.7 | 64.6 |
| TTY | 64.7 | 64.7 | 64.7 | 64.7 | 64.7 | 64.6 |
| KKPS | 64.7 | 64.7 | 64.7 | 64.6 | 64.6 | 64.6 |
| TG | 64.7 | 64.7 | 64.7 | 64.6 | 64.6 | 64.6 |
| LTT | 64.6 | 64.6 | 64.6 | 64.6 | 64.6 | 64.6 |
| KL | 64.6 | 64.6 | 64.6 | 64.6 | 64.6 | 64.6 |
| LTT1 | 64.7 | 64.7 | 64.6 | 64.6 | 64.6 | 64.6 |
| LTT2 | 64.6 | 64.6 | 64.6 | 64.6 | 64.6 | 64.6 |
| P2 | 64.7 | 64.7 | 64.7 | 64.7 | 64.6 | 64.6 |
| SJH | 64.7 | 64.7 | 64.7 | 64.7 | 64.6 | 64.6 |
| CCS | 64.7 | 64.7 | 64.6 | 64.6 | 64.6 | 64.6 |

| ASR | Worst-case Annual Average TSP, µg/m³ | | | | | |
|---|---|---|---|---|---|---|
| | 1.5m | 5m | 10m | 15m | 20m | 25m |
| HPR | 64.7 | 64.7 | 64.7 | 64.6 | 64.6 | 64.6 |
| HC | 64.7 | 64.7 | 64.7 | 64.7 | 64.6 | 64.6 |
| KYW1 | 64.7 | 64.7 | 64.7 | 64.7 | 64.7 | 64.6 |
| CCS2 | 64.6 | 64.6 | 64.6 | 64.6 | 64.6 | 64.6 |
| HSR2 | 64.7 | 64.7 | 64.6 | 64.6 | 64.6 | 64.6 |
| PR1 | 64.7 | 64.6 | 64.6 | 64.6 | 64.6 | 64.6 |
| PR2 | 64.6 | 64.6 | 64.6 | 64.6 | 64.6 | 64.6 |
| KYW2 | 64.6 | 64.6 | 64.6 | 64.6 | 64.6 | 64.6 |
| MF1 | 64.6 | 64.6 | 64.6 | 64.6 | 64.6 | 64.6 |
| FP1 | 64.7 | 64.7 | 64.7 | 64.7 | 64.7 | 64.6 |
| FP2 | 64.7 | 64.7 | 64.7 | 64.7 | 64.7 | 64.6 |

Note:
All the results presented in the table have included 64.6 µg/m³ for background TSP concentration.
ASR ID marked with * represents ASR located within the 500 m radius of the boundary of the Cheung Chau STW and Pak She SPS.

3.7.2 Concentration contour plots of the assessment results of the unmitigated scenario for the cumulative effect of construction activities within the 500 m boundary of Cheung Chau STW and Pak She SPS are presented in **Figure 3.18** to **Figure 3.35**.

**Mitigated Scenario**

3.7.3 Typical dust control methods include ground watering, equipment and vehicle watering, proper handling of material and stockpile. The assumptions of the dust removal efficiency achieved by dust control measures are provided in **Section 3.6.7** to **Section 3.6.10** above and detailed in **Appendix 3.2**.

3.7.4 The TSP concentrations are predicted with the proposed mitigation measures at the identified ASRs. TSP concentrations can be reduced significantly and the predicted results are shown in **Table 3.8** and **Table 3.9**.

3.7.5 From **Table 3.8**, the predicted maximum 1-hr TSP concentrations at CCSH are exceeding at 20m and 25m above ground level. As the height of CCSH building is below 20m, the exceedance values for CCSH are not applicable. The predicted TSP concentrations at all selected were found to be within the relative AQOs with the proposed mitigation measures incorporated.

**Table 3.8 : Predicted Worst-case 1-hour Average and 24-hour Average TSP Concentration at Different Level above Ground (Mitigated)**

| ASR | Worst-case 1-hour Average TSP, µg/m³ | | | | | | Worst-case 24-hour Average TSP, µg/m³ | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 1.5m | 5m | 10m | 15m | 20m | 25m | 1.5m | 5m | 10m | 15m | 20m | 25m |
| TKST2 | 279.7 | 257.9 | 200.7 | 143.2 | 106.6 | 97.4 | 73.7 | 72.9 | 71.2 | 69.3 | 67.8 | 66.8 |
| TKW2* | 176.6 | 163.9 | 132.7 | 103.6 | 96.0 | 88.4 | 71.5 | 71.0 | 69.8 | 68.5 | 67.3 | 66.5 |
| CSH1* | 103.8 | 102.5 | 98.8 | 93.4 | 87.3 | 81.4 | 67.4 | 67.2 | 66.8 | 66.3 | 65.9 | 65.6 |
| CCC1* | 255.0 | 205.4 | 134.6 | 112.0 | 98.2 | 91.9 | 72.5 | 70.5 | 69.3 | 68.1 | 67.4 | 66.9 |
| CCC2* | 283.4 | 243.2 | 160.6 | 120.6 | 105.6 | 92.3 | 74.9 | 73.1 | 69.6 | 67.4 | 66.6 | 66.1 |
| CSH2* | 302.5 | 242.9 | 446.4 | 310.5 | 158.0 | 103.4 | 77.9 | 76.2 | 82.0 | 76.0 | 70.7 | 67.7 |
| CCSH* | 485.4 | 186.8 | 108.6 | 145.7 | **510.5** | **1481.5** | 107.7 | 81.2 | 72.6 | 80.2 | 154.9 | 149.5 |
| CKH * | 478.3 | 251.4 | 203.0 | 158.5 | 114.1 | 99.2 | 84.6 | 75.4 | 70.9 | 68.9 | 67.4 | 66.4 |
| FS* | 192.3 | 161.1 | 112.4 | 110.9 | 137.6 | 140.5 | 70.8 | 69.4 | 67.3 | 67.2 | 68.3 | 68.4 |
| CCA* | 248.5 | 185.1 | 100.8 | 102.9 | 104.3 | 103.0 | 74.6 | 71.0 | 67.5 | 67.4 | 67.4 | 67.2 |
| CCB* | 217.1 | 160.9 | 117.9 | 126.2 | 207.3 | 224.9 | 73.5 | 69.7 | 68.4 | 68.5 | 71.4 | 72.0 |

| ASR | Worst-case 1-hour Average TSP, µg/m³ | | | | | | Worst-case 24-hour Average TSP, µg/m³ | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 1.5m | 5m | 10m | 15m | 20m | 25m | 1.5m | 5m | 10m | 15m | 20m | 25m |
| PSSL* | 170.9 | 146.9 | 106.7 | 99.5 | 114.0 | 115.3 | 70.5 | 69.1 | 67.1 | 66.7 | 67.3 | 67.3 |
| TKS | 83.9 | 83.7 | 83.1 | 82.1 | 80.8 | 79.4 | 66.2 | 66.2 | 66.1 | 66.0 | 65.8 | 65.7 |
| CCEP | 77.7 | 77.3 | 75.9 | 74.0 | 73.4 | 72.6 | 65.6 | 65.6 | 65.6 | 65.6 | 65.5 | 65.4 |
| CHR | 84.2 | 84.0 | 83.5 | 82.7 | 81.5 | 80.2 | 65.5 | 65.5 | 65.4 | 65.4 | 65.3 | 65.3 |
| SW1 | 78.7 | 78.6 | 78.2 | 77.6 | 76.8 | 75.8 | 65.3 | 65.3 | 65.2 | 65.2 | 65.2 | 65.1 |
| THT | 76.7 | 76.6 | 76.2 | 75.6 | 74.9 | 73.9 | 65.2 | 65.2 | 65.2 | 65.2 | 65.1 | 65.1 |
| SWR | 76.8 | 76.7 | 76.3 | 75.7 | 75.0 | 74.0 | 65.4 | 65.4 | 65.3 | 65.3 | 65.2 | 65.1 |
| ST | 77.7 | 77.6 | 77.2 | 76.6 | 75.8 | 74.9 | 65.8 | 65.7 | 65.7 | 65.6 | 65.4 | 65.3 |
| SYT1 | 74.9 | 74.8 | 74.5 | 74.1 | 73.5 | 72.7 | 65.3 | 65.3 | 65.3 | 65.2 | 65.1 | 65.1 |
| SYT2 | 75.7 | 75.6 | 75.3 | 74.9 | 74.2 | 73.5 | 65.6 | 65.6 | 65.5 | 65.4 | 65.3 | 65.2 |
| P1 | 79.3 | 79.0 | 78.1 | 77.1 | 76.2 | 74.9 | 65.3 | 65.3 | 65.3 | 65.2 | 65.2 | 65.1 |
| TW1 | 80.0 | 79.6 | 78.7 | 78.0 | 77.0 | 75.9 | 65.5 | 65.4 | 65.4 | 65.4 | 65.3 | 65.3 |
| TW2 | 128.2 | 125.5 | 118.0 | 109.0 | 100.5 | 93.0 | 67.3 | 67.1 | 66.8 | 66.4 | 66.1 | 65.8 |
| TW3 | 107.8 | 105.4 | 98.8 | 90.6 | 83.1 | 77.2 | 66.4 | 66.3 | 66.0 | 65.7 | 65.4 | 65.3 |
| TSB | 84.6 | 84.3 | 83.5 | 82.1 | 80.3 | 78.3 | 65.5 | 65.5 | 65.5 | 65.4 | 65.4 | 65.3 |
| TSB1 | 86.1 | 85.7 | 84.6 | 82.9 | 80.8 | 78.5 | 65.6 | 65.6 | 65.5 | 65.5 | 65.4 | 65.3 |
| HSR1 | 84.4 | 84.1 | 83.3 | 81.9 | 80.2 | 78.2 | 65.4 | 65.4 | 65.4 | 65.3 | 65.3 | 65.2 |
| TTY | 104.4 | 103.4 | 100.3 | 96.1 | 91.4 | 86.6 | 66.3 | 66.2 | 66.1 | 65.9 | 65.7 | 65.5 |
| KKPS | 81.5 | 80.8 | 78.9 | 76.3 | 73.5 | 71.1 | 65.3 | 65.3 | 65.2 | 65.1 | 65.0 | 64.9 |
| TG | 82.6 | 81.9 | 79.8 | 77.0 | 74.0 | 71.1 | 65.4 | 65.3 | 65.2 | 65.1 | 65.0 | 64.9 |
| LTT | 81.0 | 80.4 | 78.7 | 76.2 | 73.5 | 70.9 | 65.3 | 65.3 | 65.2 | 65.1 | 65.0 | 65.0 |
| KL | 80.1 | 79.9 | 79.2 | 78.2 | 76.8 | 75.3 | 65.3 | 65.3 | 65.2 | 65.2 | 65.2 | 65.1 |
| LTT1 | 77.3 | 77.2 | 76.7 | 76.0 | 75.1 | 74.0 | 65.2 | 65.2 | 65.2 | 65.2 | 65.2 | 65.1 |
| LTT2 | 78.7 | 78.5 | 77.9 | 77.0 | 75.8 | 74.5 | 65.2 | 65.2 | 65.2 | 65.2 | 65.1 | 65.1 |
| P2 | 101.6 | 100.1 | 95.5 | 89.2 | 82.5 | 76.5 | 66.1 | 66.1 | 65.9 | 65.6 | 65.3 | 65.1 |
| SJH | 80.0 | 79.8 | 78.9 | 77.5 | 75.8 | 74.6 | 65.3 | 65.3 | 65.3 | 65.2 | 65.2 | 65.2 |
| CCS | 88.5 | 87.8 | 85.7 | 82.4 | 78.7 | 74.9 | 65.6 | 65.6 | 65.5 | 65.4 | 65.2 | 65.1 |
| HPR | 103.0 | 102.5 | 101.0 | 98.6 | 95.3 | 91.3 | 66.2 | 66.2 | 66.1 | 66.0 | 65.9 | 65.7 |
| HC | 89.0 | 88.1 | 85.4 | 81.7 | 77.5 | 73.7 | 65.6 | 65.6 | 65.5 | 65.3 | 65.1 | 65.0 |
| KYW1 | 90.1 | 89.0 | 85.7 | 81.3 | 76.7 | 72.6 | 65.7 | 65.6 | 65.5 | 65.3 | 65.1 | 65.0 |
| CCS2 | 76.0 | 75.5 | 74.4 | 72.7 | 70.9 | 69.9 | 65.1 | 65.1 | 65.0 | 65.0 | 64.9 | 64.9 |
| HSR2 | 75.8 | 75.6 | 75.0 | 74.0 | 72.8 | 71.5 | 65.1 | 65.1 | 65.1 | 65.1 | 65.0 | 65.0 |
| PR1 | 81.5 | 81.2 | 80.3 | 79.0 | 77.4 | 75.5 | 65.3 | 65.3 | 65.3 | 65.2 | 65.1 | 65.1 |
| PR2 | 80.9 | 80.7 | 80.0 | 78.9 | 77.5 | 75.9 | 65.3 | 65.3 | 65.2 | 65.2 | 65.2 | 65.1 |
| KYW2 | 84.5 | 83.8 | 81.8 | 78.8 | 75.5 | 72.6 | 65.4 | 65.4 | 65.3 | 65.2 | 65.1 | 65.0 |
| MF1 | 81.3 | 80.7 | 79.0 | 76.5 | 73.7 | 71.8 | 65.3 | 65.3 | 65.2 | 65.1 | 65.0 | 65.0 |
| FP1 | 95.7 | 94.7 | 91.7 | 87.3 | 82.4 | 77.6 | 65.9 | 65.9 | 65.7 | 65.5 | 65.3 | 65.1 |
| FP2 | 91.5 | 90.7 | 88.1 | 84.4 | 80.2 | 76.1 | 65.7 | 65.7 | 65.6 | 65.4 | 65.3 | 65.1 |

Notes:
All the results presented in the table have included 64.6 µg/m³ for background TSP concentration.
ASR ID marked with * represents ASR located within the 500 m radius of the boundary of Cheung Chau STW and Pak She SPS.

**Table 3.9 : Predicted Worst-case Annual Average TSP Concentration at Different Level above Ground (Mitigated)**

| ASR | Worst-case Annual Average TSP, µg/m³ | | | | | |
|---|---|---|---|---|---|---|
| | 1.5m | 5m | 10m | 15m | 20m | 25m |
| TKST2 | 64.9 | 64.9 | 64.8 | 64.8 | 64.7 | 64.7 |
| TKW2* | 64.8 | 64.8 | 64.7 | 64.7 | 64.7 | 64.7 |
| CSH1* | 64.7 | 64.7 | 64.7 | 64.7 | 64.6 | 64.6 |
| CCC1* | 65.0 | 65.0 | 64.9 | 64.8 | 64.7 | 64.7 |
| CCC2* | 64.8 | 64.8 | 64.8 | 64.7 | 64.7 | 64.7 |
| CSH2* | 65.3 | 65.0 | 64.9 | 64.8 | 64.7 | 64.7 |
| CCSH* | 74.7 | 68.7 | 65.9 | 66.5 | 75.8 | 71.0 |
| CKH * | 65.4 | 65.1 | 64.9 | 64.8 | 64.7 | 64.7 |
| FS* | 64.8 | 64.7 | 64.7 | 64.7 | 64.7 | 64.7 |
| CCA* | 64.9 | 64.7 | 64.7 | 64.7 | 64.7 | 64.7 |
| CCB* | 65.0 | 64.7 | 64.7 | 64.7 | 64.7 | 64.7 |
| PSSL* | 64.8 | 64.7 | 64.7 | 64.7 | 64.7 | 64.7 |
| TKS | 64.7 | 64.7 | 64.7 | 64.7 | 64.7 | 64.7 |
| CCEP | 64.7 | 64.7 | 64.7 | 64.7 | 64.7 | 64.7 |
| CHR | 64.6 | 64.6 | 64.6 | 64.6 | 64.6 | 64.6 |
| SW1 | 64.6 | 64.6 | 64.6 | 64.6 | 64.6 | 64.6 |
| THT | 64.6 | 64.6 | 64.6 | 64.6 | 64.6 | 64.6 |
| SWR | 64.6 | 64.6 | 64.6 | 64.6 | 64.6 | 64.6 |
| ST | 64.6 | 64.6 | 64.6 | 64.6 | 64.6 | 64.6 |
| SYT1 | 64.6 | 64.6 | 64.6 | 64.6 | 64.6 | 64.6 |
| SYT2 | 64.6 | 64.6 | 64.6 | 64.6 | 64.6 | 64.6 |
| P1 | 64.6 | 64.6 | 64.6 | 64.6 | 64.6 | 64.6 |
| TW1 | 64.6 | 64.6 | 64.6 | 64.6 | 64.6 | 64.6 |
| TW2 | 64.6 | 64.6 | 64.6 | 64.6 | 64.6 | 64.6 |
| TW3 | 64.6 | 64.6 | 64.6 | 64.6 | 64.6 | 64.6 |
| TSB | 64.6 | 64.6 | 64.6 | 64.6 | 64.6 | 64.6 |
| TSB1 | 64.6 | 64.6 | 64.6 | 64.6 | 64.6 | 64.6 |
| HSR1 | 64.6 | 64.6 | 64.6 | 64.6 | 64.6 | 64.6 |
| TTY | 64.6 | 64.6 | 64.6 | 64.6 | 64.6 | 64.6 |
| KKPS | 64.6 | 64.6 | 64.6 | 64.6 | 64.6 | 64.6 |
| TG | 64.6 | 64.6 | 64.6 | 64.6 | 64.6 | 64.6 |
| LTT | 64.6 | 64.6 | 64.6 | 64.6 | 64.6 | 64.6 |
| KL | 64.6 | 64.6 | 64.6 | 64.6 | 64.6 | 64.6 |
| LTT1 | 64.6 | 64.6 | 64.6 | 64.6 | 64.6 | 64.6 |
| LTT2 | 64.6 | 64.6 | 64.6 | 64.6 | 64.6 | 64.6 |
| P2 | 64.6 | 64.6 | 64.6 | 64.6 | 64.6 | 64.6 |
| SJH | 64.6 | 64.6 | 64.6 | 64.6 | 64.6 | 64.6 |
| CCS | 64.6 | 64.6 | 64.6 | 64.6 | 64.6 | 64.6 |
| HPR | 64.6 | 64.6 | 64.6 | 64.6 | 64.6 | 64.6 |
| HC | 64.6 | 64.6 | 64.6 | 64.6 | 64.6 | 64.6 |
| KYW1 | 64.6 | 64.6 | 64.6 | 64.6 | 64.6 | 64.6 |
| CCS2 | 64.6 | 64.6 | 64.6 | 64.6 | 64.6 | 64.6 |
| HSR2 | 64.6 | 64.6 | 64.6 | 64.6 | 64.6 | 64.6 |
| PR1 | 64.6 | 64.6 | 64.6 | 64.6 | 64.6 | 64.6 |
| PR2 | 64.6 | 64.6 | 64.6 | 64.6 | 64.6 | 64.6 |
| KYW2 | 64.6 | 64.6 | 64.6 | 64.6 | 64.6 | 64.6 |
| MF1 | 64.6 | 64.6 | 64.6 | 64.6 | 64.6 | 64.6 |
| FP1 | 64.6 | 64.6 | 64.6 | 64.6 | 64.6 | 64.6 |
| FP2 | 64.6 | 64.6 | 64.6 | 64.6 | 64.6 | 64.6 |

Note:
All the results presented in the table have included 64.6 µg/m$^3$ for background TSP concentration.
ASR ID marked with * represents ASR located within the 500 m radius of the boundary of Cheung Chau STW and Pak She SPS.

3.7.6 Concentration contour plots of the assessment results of the mitigated scenario for the cumulative effect of construction activities within the 500 m boundary of Cheung Chau STW and Pak She SPS are presented in **Figure 3.36** to **Figure 3.53**. A typical dispersion model output file is shown in **Appendix 3.3.**

## 3.8 Operational Phase Odour Assessment Methodology

### Air Dispersion Model

3.8.1 The air pollutant concentrations were assessed in accordance with the Guidelines for Choice of Models and Model Parameters in Air Quality Assessment published by EPD. The potential odour emissions arising from the operation of the upgraded Cheung Chau STW and Pak She SPS were predicted by using the Industrial Source Complex Short-Term 3 (ISCST3) model.

### Emissions Inventory

#### *Cheung Chau Sewage Treatment Works*

3.8.2 Potential odour sources identified in the STW include the following:

Preliminary Treatment Unit:

- Inlet Works
- Coarse Screen
- Distribution Well and Equalisation Tank
- Fine Screen and Grit Chambers
- Storm Tank
- Flow Distribution Tank
- 1-2mm Fine Screen Channel
- Wet Well Before MBR Tank
- Pump House

MBR Treatment Unit:

- Anoxic Tank
- Aerobic MBR Tank

Sludge Treatment Unit:

- Sludge Holding Tank (Pre-thickener)
- Sludge Digester
- Sludge Holding Tank (Post-digester)
- Sludge Dewatering House

3.8.3 Based on the current design, the civil component of the total eight MBR units will be constructed. Six MBR units will be operated and two MBR units will be stand-by use. For planning the worst scenario, it is assumed in the odour impact assessment that total eight MBR units will be operated in full capacity.

3.8.4 The General Layout Plan of the Cheung Chau STW (**Figure 2.2**) shows the locations of these potential odour sources.

***Pak She Sewage Pumping Station***

3.8.5 Potential odour sources identified in the SPS mainly include the wet well, screw pump and screening area as shown in **Figure 3.54**.

**Emissions Rates**

3.8.6 The odour emission rates from Preliminary Treatment Unit and Sludge Treatment Unit of the Cheung Chau STW, and the Pak She SPS were referenced to the odour emission rates provided in the approved EIA of Harbour Area Treatment Scheme (HATS) Stage 2A (Appendix 3-2) (Register No. AEIAR-121/2008).

3.8.7 Odour measurement of air collected from an operative MBR sewage treatment facility in Hong Kong was conducted for estimating the odour emissions data of the aerobic MBR tank of the MBR treatment unit of the upgraded Cheung Chau STW. MBR Sewage Treatment Facility at Lo Wu Correctional Institution (LWCISTP) was chosen due to similar sewage condition and also using same MBR treatment facility. The correction of changes of surface flow rate under operation scenario of LWCISTP and Cheung Chau Sewage Treatment Works was adopted before the air modelling assessment. Details of the odour measurements at LWCISTP and the calculations of the odour emission rates are provided in **Appendix 3.4**.

**Meteorological Data and Assumptions**

3.8.8 Meteorological data from Cheung Chau Automatic Weather Station provided by the Hong Kong Observatory for the year 2010 was used for the dispersion model. .

**Selected ASR for Dispersion Modelling Assessment**

3.8.9 All ASRs selected and described in **Table 3.4** were used for the operational phase odour assessment. In addition, for odour concentration contour plots, assessment grid points were also included to cover the assessment area within 500 m from the Cheung Chau STW and Pak She SPS.

**Conversion of 1-Hour Average to 5-Second Average**

3.8.10 Odour impact assessment is based on a 5-second average level. Conversion of the ISCST3 modelled output from 1-hour average concentration to 5-second average is needed. The 1-hour average odour concentration is first converted to 3-minute average by the power law relationship which is related to the stability classes. For stability class A to F, multiplying factors of 2.23, 2.23, 1.7, 1.38, 1.31 and 1.31 respectively were applied. The 3-minutes averages were further converted to 5-second averages by applying a multiplying factor of 10 for those hours with atmospheric stability classes A to B, and a factor of 5 for those hours with stability classes C to F. This has made reference to the Guidelines for Choice of Models and Model Parameters in Air Quality Assessment.

## 3.9 Prediction of Odour Impact

**Unmitigated Scenario**

3.9.1 It should be noted that deodourizing units will be installed at the Cheung Chau STW and Pak She SPS. Thus, the “unmitigated scenario” prediction results, assuming no deodourizing units, are presented for comparison only. The predicted unmitigated cumulative odour levels at the selected ASRs are summarized in **Table 3.10**. The

predicted unmitigated odour concentration contour plots at 1.5m, 5m, 10m 15m, 20m and 25m above ground level are shown in **Figure 3.55** to **Figure 3.60**

**Table 3.10 : Predicted Worst-case 5-second Average Odour Concentration at Different Level above Ground (Unmitigated – for Comparison Only)**

| ASR | Predicted Worst-case Odour Concentration, 5-second Average Odour Units | | | | | |
|---|---|---|---|---|---|---|
| | 1.5m | 5m | 10m | 15m | 20m | 25m |
| TKST2 | 24.1 | 25.6 | 29.1 | 30.9 | 28.7 | 24.6 |
| TKW2* | 23.4 | 23.3 | 23.0 | 22.5 | 21.8 | 20.9 |
| CSH1* | 41.1 | 48.6 | 63.1 | 64.6 | 56.8 | 51.8 |
| CCC1* | 48.3 | 47.7 | 45.8 | 42.8 | 38.9 | 34.4 |
| CCC2* | 41.2 | 40.9 | 39.9 | 38.4 | 36.3 | 33.8 |
| CSH2* | 267.6 | 264.1 | 245.7 | 204.5 | 147.7 | 96.0 |
| CCSH* | 153.7 | 184.4 | 325.0 | 350.8 | 275.4 | 180.8 |
| CKH * | 229.1 | 226.1 | 257.9 | 279.3 | 196.2 | 158.8 |
| FS* | 49.0 | 50.3 | 63.4 | 95.3 | 100.6 | 86.8 |
| CCA* | 245.0 | 339.5 | 242.2 | 97.3 | 98.4 | 84.0 |
| CCB* | 61.4 | 60.8 | 58.6 | 55.1 | 54.9 | 47.0 |
| PSSL* | 47.3 | 49.9 | 66.2 | 100.2 | 103.3 | 90.2 |
| TKS | 16.5 | 16.6 | 16.9 | 16.7 | 15.8 | 14.1 |
| CCEP | 8.8 | 8.5 | 7.6 | 6.5 | 6.0 | 6.0 |
| CHR | 14.4 | 14.8 | 15.8 | 16.5 | 16.0 | 15.1 |
| SW1 | 13.4 | 13.1 | 12.2 | 10.6 | 9.1 | 8.4 |
| THT | 7.1 | 7.0 | 7.4 | 7.8 | 7.6 | 7.2 |
| SWR | 11.1 | 11.0 | 10.6 | 10.0 | 9.0 | 7.8 |
| ST | 9.1 | 9.1 | 9.2 | 9.3 | 9.0 | 8.4 |
| SYT1 | 9.6 | 9.4 | 8.7 | 7.9 | 7.0 | 6.3 |
| SYT2 | 7.6 | 7.3 | 6.6 | 5.7 | 5.7 | 5.7 |
| P1 | 11.6 | 12.0 | 12.9 | 13.3 | 12.5 | 11.9 |
| TW1 | 18.5 | 18.5 | 18.2 | 16.8 | 15.0 | 14.0 |
| TW2 | 17.8 | 18.3 | 19.5 | 19.7 | 18.3 | 17.3 |
| TW3 | 16.9 | 17.1 | 17.4 | 16.7 | 15.1 | 14.2 |
| TSB | 21.9 | 21.9 | 21.7 | 20.6 | 18.2 | 16.9 |
| TSB1 | 15.4 | 15.8 | 17.0 | 17.8 | 17.2 | 16.2 |
| HSR1 | 22.7 | 22.6 | 21.9 | 20.6 | 18.3 | 16.6 |
| TTY | 14.4 | 14.7 | 15.6 | 16.2 | 15.9 | 14.9 |
| KKPS | 8.5 | 8.2 | 7.4 | 6.3 | 5.0 | 4.3 |
| TG | 8.3 | 8.0 | 7.2 | 6.1 | 4.8 | 4.1 |
| LTT | 8.4 | 8.2 | 7.7 | 6.8 | 5.8 | 4.8 |
| KL | 18.2 | 18.0 | 17.3 | 15.9 | 14.0 | 12.5 |
| LTT1 | 12.3 | 12.4 | 12.4 | 12.1 | 11.2 | 10.3 |
| LTT2 | 16.7 | 16.5 | 15.8 | 14.6 | 12.8 | 11.5 |
| P2 | 8.1 | 7.8 | 7.0 | 6.0 | 4.8 | 4.0 |
| SJH | 13.6 | 13.5 | 13.1 | 12.1 | 10.7 | 10.1 |
| CCS | 17.2 | 16.9 | 16.1 | 14.5 | 12.5 | 11.6 |
| HPR | 19.6 | 19.6 | 19.4 | 18.8 | 17.4 | 15.9 |
| HC | 6.9 | 6.6 | 6.0 | 5.2 | 4.2 | 3.2 |

| ASR | Predicted Worst-case Odour Concentration, 5-second Average Odour Units | | | | | |
|---|---|---|---|---|---|---|
| | 1.5m | 5m | 10m | 15m | 20m | 25m |
| KYW1 | **8.4** | **8.1** | **7.3** | **6.2** | 4.9 | 4.5 |
| CCS2 | **7.8** | **7.5** | **6.8** | **5.8** | 4.6 | 3.9 |
| HSR2 | **9.2** | **9.1** | **8.8** | **8.5** | **8.0** | **7.2** |
| PR1 | **14.5** | **14.5** | **14.6** | **14.4** | **13.8** | **12.6** |
| PR2 | **19.6** | **19.4** | **18.6** | **17.2** | **15.1** | **13.5** |
| KYW2 | **12.3** | **12.1** | **11.4** | **10.3** | **8.8** | **7.8** |
| MF1 | **8.8** | **8.7** | **8.4** | **7.9** | **7.3** | **6.5** |
| FP1 | **5.4** | **5.2** | 4.7 | 4.1 | 3.4 | 2.7 |
| FP2 | **5.1** | 5.0 | 4.5 | 4.0 | 3.3 | 2.6 |
| GIC_1 [1] | **175.2** | **155.0** | **270.1** | **236.6** | **162.7** | **114.5** |
| GIC_2 [1] | **69.7** | **68.9** | **66.2** | **89.8** | **84.1** | **74.1** |
| GIC_3 [1] | **68.0** | **97.9** | **150.6** | **87.8** | **86.2** | **73.6** |
| PSSPS_DW [2] | **60.6** | **59.9** | **82.1** | **96.8** | **98.7** | **83.5** |
| CCSTW_DW [2] | **119.0** | **132.0** | **359.5** | **345.1** | **238.1** | **170.9** |

Note:
Underlined figure indicates exceedance of the assessment criteria stipulated in the EIAO-TM.
ASR ID marked with * represents ASR located within the 500 m radius of the boundary of Cheung Chau STW and Pak She SPS.

[1] The existing land-uses of these locations are storage area and open space. According the Cheung Chau Outline Zoning Plan (No. S/I-CC/5), they are zoned as Government / Institution and Community (G/IC) use which may be used for potential air sensitive use. These are considered planned ASRs.

[2] Reference locations as the downwind locations for the odour measurements near the Cheung Chau STW and Pak She SPS conducted on 15-May-2013. They are not considered as ASR and were included for the odour prediction assessment for reference only.

3.9.2 Without any odour removing measures, elevated odour levels were predicted.

3.9.3 Odour prediction was also conducted at two reference locations where odour measurements were conducted near the Cheung Chau STW (CCSTW_DW) and Pak She SPS (PSSPS_DW). These two locations (1.5m above ground level) were downwind locations from the Cheung Chau STW and Pak She SPS that were to capture a representative existing odour level. The odour modeling results of the unmitigated scenario at the two reference locations (at 1.5m above ground) were predicted to be 60.6 OU and 119.0 OU (PSSPS_DW and CCSTW_DW, respectively). These modeling results were based on an unmitigated scenario with the upgraded treatment facilities operation. In comparison with the odour measurement results at the two reference locations, PSSPS_DW and CCSTW_DW, that were 14 OU and 64 OU, respectively, the modeled results of the unmitigated scenario are higher. This is considered generally in order as the modeled scenario was based on higher treatment capacities, no deodourisation facilities and no covering structures, which is expected to have resulted a higher predicted odour level than the measurement results.

**Mitigated Scenario**

3.9.4 Based on the current design, the identified odour sources within the Cheung Chau STW would be enclosed and all the odour emissions from the enclosed sources would be ventilated to a deodourizing unit. The deodourizing unit is designed to be able to achieve an odour removal efficiency of 99% for Cheung Chau STW and 99% for Pak She Pumping Station. The design information of deodourizing unit is summarized in **Table 3.11**. The odour emission rate and odour removal efficiency in **Table 3.11** shall be verified during commission test and periodic performance tests.

**Table 3.11 : Design Information of Deodourizing Units (Mitigated)**

| | | Odour removal efficiency of deodourization unit | Number of emission point | Total emission area ($m^2$) | Emission Rate per emission point (with mitigation) (OU/s) |
|---|---|---|---|---|---|
| Cheung Chau STW | Room 1 – Preliminary Treatment Unit | 99% | 5 | 12 | 10.095 |
| | Room 2- Treatment Unit | 99% | 6 | 12.8 | 3.255 |
| | Room 3 – Sludge Treatment Unit | 99% | 2 | 3.5 | 36.199 |
| Pak She Pumping Station | | 99% | 1 | 3.5 | 3.808 |

3.9.5 The treated air would then be emitted at 2.5 m above ground level based on the current design information. The predicted maximum mitigated odour levels at the selected ASRs are summarized in **Table 3.12**. With the odour removing measures, predicted odour levels at all selected ASRs will be significantly reduced to meet the 5 odour units criteria.

3.9.6 The predicted mitigated odour concentration contour plots at 1.5m, 5m, 10m 15m, 20m and 25m above ground level are shown in **Figure 3.61** to **Figure 3.66**. A typical odour modelling output file is shown in **Appendix 3.5.**

**Table 3.12 : Predicted Worst-case 5-second Average Odour Concentration at Different Level above Ground (Mitigated)**

| ASR | Predicted Worst-case Odour Concentration, 5-second Average Odour Units | | | | | |
|---|---|---|---|---|---|---|
| | 1.5m | 5m | 10m | 15m | 20m | 25m |
| TKST2 | 0.2 | 0.3 | 0.3 | 0.3 | 0.3 | 0.2 |
| TKW2* | 0.2 | 0.2 | 0.2 | 0.2 | 0.2 | 0.2 |
| CSH1* | 0.4 | 0.5 | 0.6 | 0.6 | 0.6 | 0.5 |
| CCC1* | 0.5 | 0.5 | 0.5 | 0.4 | 0.4 | 0.3 |
| CCC2* | 0.4 | 0.4 | 0.4 | 0.4 | 0.4 | 0.3 |
| CSH2* | 2.7 | 2.6 | 2.5 | 2.0 | 1.5 | 1.0 |
| CCSH* | 1.5 | 1.8 | 3.3 | 3.5 | 2.8 | 1.8 |
| CKH * | 2.3 | 2.3 | 2.6 | 2.8 | 2.0 | 1.6 |
| FS* | 0.5 | 0.5 | 0.6 | 1.0 | 1.0 | 0.9 |
| CCA* | 2.5 | 3.4 | 2.4 | 1.0 | 1.0 | 0.8 |
| CCB* | 0.6 | 0.6 | 0.6 | 0.6 | 0.5 | 0.5 |
| PSSL* | 0.5 | 0.5 | 0.7 | 1.0 | 1.0 | 0.9 |
| TKS | 0.2 | 0.2 | 0.2 | 0.2 | 0.2 | 0.1 |
| CCEP | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 |
| CHR | 0.1 | 0.1 | 0.2 | 0.2 | 0.2 | 0.2 |
| SW1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 |
| THT | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 |
| SWR | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 |
| ST | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 |
| SYT1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 |
| SYT2 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 |

| ASR | Predicted Worst-case Odour Concentration, 5-second Average Odour Units | | | | | |
|---|---|---|---|---|---|---|
| | 1.5m | 5m | 10m | 15m | 20m | 25m |
| P1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 |
| TW1 | 0.2 | 0.2 | 0.2 | 0.2 | 0.2 | 0.1 |
| TW2 | 0.2 | 0.2 | 0.2 | 0.2 | 0.2 | 0.2 |
| TW3 | 0.2 | 0.2 | 0.2 | 0.2 | 0.2 | 0.1 |
| TSB | 0.2 | 0.2 | 0.2 | 0.2 | 0.2 | 0.2 |
| TSB1 | 0.2 | 0.2 | 0.2 | 0.2 | 0.2 | 0.2 |
| HSR1 | 0.2 | 0.2 | 0.2 | 0.2 | 0.2 | 0.2 |
| TTY | 0.1 | 0.1 | 0.2 | 0.2 | 0.2 | 0.1 |
| KKPS | 0.1 | 0.1 | 0.1 | 0.1 | 0.0 | 0.0 |
| TG | 0.1 | 0.1 | 0.1 | 0.1 | 0.0 | 0.0 |
| LTT | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.0 |
| KL | 0.2 | 0.2 | 0.2 | 0.2 | 0.1 | 0.1 |
| LTT1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 |
| LTT2 | 0.2 | 0.2 | 0.2 | 0.1 | 0.1 | 0.1 |
| P2 | 0.1 | 0.1 | 0.1 | 0.1 | 0.0 | 0.0 |
| SJH | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 |
| CCS | 0.2 | 0.2 | 0.2 | 0.1 | 0.1 | 0.1 |
| HPR | 0.2 | 0.2 | 0.2 | 0.2 | 0.2 | 0.2 |
| HC | 0.1 | 0.1 | 0.1 | 0.1 | 0.0 | 0.0 |
| KYW1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.0 | 0.0 |
| CCS2 | 0.1 | 0.1 | 0.1 | 0.1 | 0.0 | 0.0 |
| HSR2 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 |
| PR1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 |
| PR2 | 0.2 | 0.2 | 0.2 | 0.2 | 0.2 | 0.1 |
| KYW2 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 |
| MF1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 |
| FP1 | 0.1 | 0.1 | 0.0 | 0.0 | 0.0 | 0.0 |
| FP2 | 0.1 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| GIC_1 [1] | 1.8 | 1.6 | 2.7 | 2.4 | 1.6 | 1.1 |
| GIC_2 [1] | 0.7 | 0.7 | 0.7 | 0.9 | 0.8 | 0.7 |
| GIC_3 [1] | 0.7 | 1.0 | 1.5 | 0.9 | 0.9 | 0.7 |
| PSSPS_DW [2] | 0.6 | 0.6 | 0.8 | 1.0 | 1.0 | 0.8 |
| CCSTW_DW [2] | 1.2 | 1.3 | 3.6 | 3.5 | 2.4 | 1.7 |

Note:
ASR ID marked with * represents ASR located within the 500 m radius of the boundary of Cheung Chau STW and Pak She SPS.

[1] The existing land-uses of these locations are storage area and open space. According the Cheung Chau Outline Zoning Plan (No. S/I-CC/5), they are zoned as Government / Institution and Community (G/IC) use which may be used for potential air sensitive use. These are considered planned ASRs.

[2] Reference locations as the downwind locations for the odour measurements near the Cheung Chau STW and Pak She SPS conducted on 15-May-2013. They are not considered as ASR and were included for the odour prediction assessment for reference only.

3.9.7 No exceedances of odour level arising from the operation of the upgraded Cheung Chau sewage treatment facilities were predicted under the mitigated scenario.

## 3.10 Mitigation Measures

### Construction Phase

3.10.1 For the construction activities under the Project, the suitable requirements stipulated in the Air Pollution Control (Construction Dust) Regulation shall be implemented during the construction activities to minimise the dust impact. It is recommended that typical dust control methods including the following good site practices should also be incorporated during construction phase:

- Watering every 1.5 hours on active works areas and paved haul roads to reduce dust emissions by 90.9% (e.g. watering intensity at 0.5 litres/$m^2$. Actual application shall depend on the site condition and weather conditions).
- Watering every hour on unpaved areas and stockpiles of dusty materials (if no tarpaulin is provided) to reduce dust emissions by 90% (e.g. watering intensity at 1.5 litre/$m^2$ during the first hour, subsequent application at 0.2 litre/$m^2$. Actual application shall depend on the site condition and weather conditions).
- Use of regular watering, with complete coverage, to reduce dust emissions from exposed site surfaces and unpaved roads, particularly during dry weather.
- Use of frequent watering for particularly dusty construction areas and areas close to ASRs.
- Vehicle washing facilities should be provided at every vehicle exit point.
- Where a site boundary adjoins a road, streets or other areas accessible to the public, hoarding of not less than 2.4 m high from ground level should be provided along the entire length except for a site entrance or exit.
- Stockpiles of imported material kept on site shall be contained within hoarding, dampened and/or covered during dry and windy weather.
- Material stockpiled alongside trenches should be covered with tarpaulins.
- Open stockpiles shall be avoided or covered. Where possible, prevent placing dusty material storage piles near ASRs.
- Any excavated or stockpile of dusty material should be covered entirely by impervious sheeting or spayed with water to maintain the entire surface wet during the non-working hours.
- All dusty materials shall be sprayed with water prior to any loading, unloading or transfer operation so as to keep the dusty materials wet.
- Water sprays shall be used during the delivery and handling of sands aggregates and the like.
- All demolished items that may emit dust particles should be covered entirely by impervious sheeting or placed in an area sheltered on the top and the 3 sides within a day of demolition.
- Good site practices for Concrete batching plant:
  - Every stock of more than 20 bags of cement or dry pulverized fuel ash (PFA) should be cover entirely by impervious sheeting or placed in an area sheltered on the top and the sides.
  - Cement or dry PFA delivered in bulk should stored in a closed silo fitted with an audible high level alarm which is interlocked with the material filling line and no overfilling is allowed.
  - Loading, unloading, transfer, handling or storage of bulk cement or dry PFA should be carried out in a totally enclosed system or facility, and any vent or exhaust should be fitted with effective fabric filter or equivalent air

pollution control system (Maximum TSP emission factor of silos and mixing tower: 50 mg/$m^3$)

**Operational Phase**

3.10.2 The design of enclosing the odour sources of the upgraded Cheung Chau STW and Pak She SPS and the installation of deodorization units would readily reduce the potential odour impacts. Odour impacts after the upgrading works will be significantly reduced. The current design information of deodourizing units is summarized in **Table 3.13**.

**Table 3.13 : Design Information of Deodourizing Units (Mitigated)**

| | | Odour removal efficiency of deodorisation unit | Number of emission point | Total emission area ($m^2$) | Emission Rate per emission point (with mitigation) (OU/s) |
|---|---|---|---|---|---|
| Cheung Chau STW | Room 1 – Preliminary Treatment Unit | 99% | 5 | 12 | 10.095 |
| | Room 2- Treatment Unit | 99% | 6 | 12.8 | 3.255 |
| | Room 3 – Sludge Treatment Unit | 99% | 2 | 3.5 | 36.199 |
| Pak She Pumping Station | | 99% | 1 | 3.5 | 3.808 |

3.10.3 In addition, good housekeeping practices listed below should be followed to control odour emissions from the plant and these standard practices should be included in the plant operator manual:

- Screens should be cleaned regularly to remove accumulated organic debris;
- Grit and screening transfer systems should be flushed regularly with water to remove organic debris and grit;
- Grit and screened materials should be transferred to closed containers to minimize odour escape;
- Sludge should be frequently withdrawn from tanks to prevent the production of gases;
- Sludge should be transferred to closed containers; and
- Sludge containers should be flushed with water regularly.

## 3.11 Environmental Monitoring and Audit Requirements

**Construction Phase**

3.11.1 Mitigation Measures are recommended to reduce the dust impact to an acceptable level. With the implementation of the dust suppression measures stipulated in the Air Pollution Control (Construction Dust) Regulation and good site practices, construction dust impacts could be eliminated. Environmental monitoring and audit (EM&A) for air quality will be carried out during the construction period of Cheung Chau STW and Pak She SPS to ensure proper implementation of construction phase mitigation measures with consideration of practicability in local level.

3.11.2 Further details of the specific EM&A requirements for the construction activities of Cheung Chau STW and Pak She SPS are provided in the EM&A Manual, together with event action plans and procedures for complaints.

**Operational Phase**

3.11.3 All the odorous gas arising from the sewage would be collected and properly treated by deodorization unit with 99% odour removal efficiency for Cheung Chau STW and Pak She SPS. The predicted odour levels at the ASRs would comply with the EIAO-TM criterion. Odour monitoring and audit should be carried out during the commissioning stage to ensure the continuing effectiveness of the odour control measures. Details of monitoring and audit programme of odour due to the operation of Cheung Chau STW and Pak She SPS are presented in the EM&A Manual. Commissioning test of the deodorization unit is also a mandatory requirement to confirm the effectiveness of the odour removal efficiency is in compliance with the design criteria.

## 3.12 Conclusion

3.12.1 Dust generating activities were identified and evaluated. If unmitigated, construction of the Cheung Chau STW upgrade would have short term fugitive dust emissions impacts at the identified ASRs. Mitigation measures including watering of on-site construction area are expected to limit fugitive dust levels to acceptable levels. Provided proper implementation of mitigation measures is adopted, no unacceptable construction dust emissions impacts are anticipated. An EM&A programme will be implemented to ensure construction dust impacts are controlled to acceptable level.

3.12.2 During the operational phase of the Project, all the potential odour generating facilities would be enclosed by air-tight covers. Odourous gas generated from the Cheung Chau STW and Pak She SPS would be ventilated to the deodorization facility for treatment before discharge. The deodorization facility is designed to be able to achieve an odour removal efficiency of 99% for Cheung Chau STW and Pak She SPS. During sludge transportation, it is recommended that the sludge should be carried by enclosed container to avoid unacceptable odour nuisance. With proper mitigation measures incorporated into the design, odour impacts after the upgrading works will be significantly reduced, and no unacceptable odour impacts are anticipated. An EM&A programme will be implemented to ensure the continuing effectiveness of the odour control measures.

# 4. NOISE

## 4.1 Introduction

4.1.1 This section presents the assessment on the potential airborne noise impacts that are likely to be generated during the construction and operation phases of the both the upgrading of the Cheung Chau STW and Pak She SPS and the sewers works of the Project. Appropriate mitigation measures were identified to mitigate the potential noise impacts as far as practicable.

4.1.2 This assessment has based on the criteria and guidelines for evaluation and assessment of air quality impacts as stated in Annexes 5 and 13 of the EIAO-TM and has covered the scope outlined in Section 3.4.3 of the EIA Study Brief.

## 4.2 Relevant Legislations, Standards and Guidelines

4.2.1 Noise impacts have been assessed in accordance with the criteria and methodology given in the Technical Memoranda issued under the Noise Control Ordinance (NCO) and Environmental Impact Assessment Ordinance (EIAO).

4.2.2 The NCO provides the statutory framework for noise control. This defines statutory limits applicable to equipment used during the construction and operation phases of the proposed works in the study area. The NCO invokes four Technical Memoranda, which define the technical means for noise assessment:

- Technical Memorandum on Noise from Places other than Domestic Premises, Public Places or Construction Sites (IND-TM):
- Technical Memorandum on Noise from Construction Work in Designated Areas (DA-TM);
- Technical Memorandum on Noise from Construction Work other than Percussive Piling (GW-TM); and
- Technical Memorandum on Noise from Percussive Piling (PP-TM).

4.2.3 The NCO and the accompanying Technical Memoranda provide a mechanism for assessing noise levels and the statutory power to control noise.

### Construction Noise

4.2.4 Noise impact arising from general construction activities other than percussive pilling during the daytime period (0700-1900 hours of any day not being a Sunday or public holiday) shall be assessed against the noise standards given in Annex 5 of EIAO-TM, which is tabulated in **Table 4.1**.

**Table 4.1 : Noise Standards for Daytime Construction Activities**

| Noise Sensitive Uses | 0700 to 1900 hours on any day not being a Sunday or general holiday, Leq (30 min), dB(A) |
|---|---|
| Domestic premises, hotels and hostel | 75 |
| Educational institutions (normal teaching periods) | 70 |
| Educational institutions (examination periods) | 65 |

Notes:

1) The above noise standards apply to uses, which rely on opened windows for ventilation.
2) The above standards shall be viewed as the maximum permissible noise levels assessed at 1m from the external facade.
3) The above standards shall be met as far as possible. All practicable mitigation measures shall be exhausted and the residual impacts are minimized.

**Operational Noise**

4.2.5 Fixed noise sources associated with STW and SPS are controlled by Section 13 of the NCO. For the assessment of fixed noise sources, the area sensitivity rating (ASR) of the noise sensitive receivers (NSRs) will be determined in accordance with the IND-TM. Based on the ASR, the appropriate Acceptable Noise Levels (ANLs) can be determined.

4.2.6 The Acceptable Noise Level (ANL) is a function of the type of area within which the NSR is located, and the degree of the effect on the NSR of influencing factors such as major roads and industrial areas. According to the IND-TM, the ANLs for different Area Sensitivity Rating (ASR) of noise sensitive receivers (NSRs) are given in **Table 4.2**.

**Table 4.2 : Acceptable Noise Levels**

| Time Period | ASR A | ASR B | ASR C |
|---|---|---|---|
| All days during the evening (1900 to 2300 hours), and general holidays (including Sundays) during the day-time and evening (0700 to 2300 hours) | 60 | 65 | 70 |
| All days during the night-time (2300 to 0700 hours) | 50 | 55 | 65 |

4.2.7 More stringent criteria for fixed plant noise impacts recommended in Table 1A of the EIAO-TM for planning purposes are as follow:

- 5 dB(A) below the appropriate ANL set out in the IND-TM (the ANL–5 dB(A) criterion), or
- The prevailing background noise level where the prevailing background noise level is 5 dB(A) below the appropriate ANL (although during the operation the NCO will be the controlling legislation).

4.2.8 The above-mentioned second criterion would generally apply to areas with low ambient noise levels such as rural and suburban areas. In view of no major nearby noise sources such as road and rail traffic, noise sensitive receivers near Cheung Chau STW and Pak She SPS would be subject to low ambient noise levels which could be lower than the ANL-5dB(A) criterion. The type of area containing the STW and SPS is considered to be “Rural Area” that is not affected by any influencing factors (IF). This represents ASR ”A” with an ANL-5dB(A) criterion of 45 dB(A) for the nighttime (23:00 to 07:00 hours) and 55 dB(A) in the daytime and evening (07:00 to 19:00 hours, and 19:00 to 23:00 hours, respectively).

4.2.9 In order to determine the appropriate criteria for noise assessment, background noise measurements at representative sensitive receivers in the vicinity of the Cheung Chau STW and Pak She SPS were conducted in October 2011. For those sensitive receivers which were found to experience to prevailing noise levels lower than the ANL-5dB(A) criterion, fixed plant noise impact were assessed against the prevailing background noise levels.

4.2.10 In any event, the Area Sensitivity Rating assumed in this EIA Report is for indicative assessment only. Therefore, the Noise Control Authority shall determine noise impact from concerned fixed noise sources on the basis of prevailing legislation and practices being in force, and taking account of contemporary conditions/situations of adjoining land uses. Nothing in the EIA study shall bind the Noise Control Authority in the context of law enforcement against any of the fixed noise sources being assessed.

## 4.3 Description of the Existing Noise Environment

4.3.1 Cheung Chau is situated at southeast of Lantau Island. It is a densely populated outlying island. Cheung Chau contains mostly developed areas including commercial uses, residential villages and community facilities.

4.3.2 Cheung Chau is generally car-free except the common used transportation within the island by village vehicles called "VV vehicle" and the emergency vehicles. These are considered to be the dominant noise sources within the study area. There are also human noises arising from commercial activities centred near the ferry pier and Tung Wan Beach. The ambient noise level increases slightly with more tourist activities during weekends and festivals.

### Background Noise Measurements

4.3.3 Background noise measurements were conducted for the determination of noise criteria as discussed in **Section 4.2.8**.

4.3.4 Continuous free-field noise measurements were conducted in October 2011 to investigate the prevailing noise levels in the study areas. The noise measurement locations are shown in **Figure 4.1**. The noise measurements were conducted according to the operation period of the facilities, and therefore the noise results are considered to be representative to the background noise at the noise sensitive receivers.

4.3.5 The noise measurements were conducted using B&K Type 2238 Sound Level Meter (Type 1) and were calibrated using B&K Sound Level Calibrator Type 4231 with a calibration signal of 94.0 dB(A) at 1kHz. The measurements were conducted with reference to the calibration and measurement procedures as stated in the IND-TM. A summary of background noise measurement results is given in **Table 4.3**.

**Table 4.3 : Background Noise Measurement Results**

| Measurement Location | Measured Noise Level(1), $L_{eq(30\ min)}$ (daytime / nighttime), dB(A) | Area Sensitivity Rating (ASR) | ANL-5 dB(A) (daytime / nighttime), dB(A) | Recommended Operational Noise Assessment Criteria (daytime / nighttime), dB(A) |
|---|---|---|---|---|
| Near Cheung Chau STW - at Cheung Shun House | 53 / 54 | A | 55 / 45 | 53 / 45 |
| Near Pak She SPS - at Cheung Chau Fire Station | 56 / 53 | A | 55 / 45 | 55 / 45 |

Note:
(1) A façade correction of +3 dB(A) has been included.

## 4.4 Construction Noise Impact Assessment

### Noise Sources Identification

4.4.1 Key noise generating activities during the construction phase are summarized in **Table 4.4**.

**Table 4.4 : Summary of related Works Type**

| Works Type | Description of Works Type |
|---|---|
| Works Type 1 | Construction of Sewer (Open Cut Method) |
| Works Type 2 | Construction of Sewer (Trenchless Method) |
| Works Type 3 | Upgrading of Existing Sewer |
| Works Type 4 | Upgrading of Pak She Sewage Pumping Station |
| Works Type 5 | Upgrading of Cheung Chau Sewage Treatment Works |
| Works Type 6 | Rehabilitation of Existing Sewer |
| Works Type 7 | Temporary Concrete Mixing (within Cheung Chau STW) |

4.4.2 The works type and the various works stages involved are given in **Table 4.5** together with the estimated duration. No restricted hours works are expected to be required for the construction of the Project.

4.4.3 In collaboration with the design engineer and the Project Proponent and based on the findings from the Review Phase, an inventory of project specific powered mechanical equipment required has been developed for each works type which is considered to be appropriate and practical for completing works within the proposed works programme, and are detailed in **Appendix 4.1**. The associated worst-case sound power levels (SWLs) of the different works stages are also provided in **Table 4.5**.

4.4.4 Whilst it is possible that the future appointed contractor may propose a different plant inventory, this assessment has been undertaken on the anticipated plant to allow early identification of any potential noise problem and to ensure there are practicable and sufficient noise mitigation measures that can be implemented to alleviate adverse noise impacts. The contractor will be required to provide and implement sufficient direct noise mitigation measures based on the recommendation in this EIA to achieve acceptable noise levels on the nearby NSRs.

**Table 4.5 : Construction Activities Schedule**

| Works Stage | Construction Activities | Calculated Worst-case SWL, dB(A) |
|---|---|---|
| **Works Type 1 - Construction of Sewer (Open Cut Method)** | | |
| Stage 1 | Breaking up of road surface | 103 |
| Stage 2 | Excavation of soil material | 95 |
| Stage 3 | Steel fixing & concreting of manholes | 110 |
| Stage 4 | Laying of bedding material | 113 |
| Stage 5 | Backfilling and soil compaction | 102 |
| Stage 6 | Reinstatement of road surface | 113 |
| **Works Type 2 - Construction of Sewer (Trenchless Method) (Intervals between 2 manholes)** | | |
| Stage 1 | Excavation of Pits | 122 |
| Stage 2 | Jacking of pipes | 118 |
| Stage 3 | Steel fixing and concreting of manholes | 110 |
| Stage 4 | Reinstatement of road surface with bricks | No PME involved |

| Works Stage | Construction Activities | Calculated Worst-case SWL, dB(A) |
|---|---|---|
| **Works Type 3 - Upgrading of Existing Sewer** | | |
| Stage 1 | Breaking up of road surface | 103 |
| Stage 2 | Excavation of soil material | 95 |
| Stage 3 | Removal of existing sewers and laying of new sewers | 94 |
| Stage 4 | Steel fixing & concreting of manholes | 110 |
| Stage 5 | Laying of bedding materials | 113 |
| Stage 6 | Backfilling and soil compaction | 102 |
| Stage 7 | Reinstatement of road surface | 110 |
| **Works Type 4 - Upgrading of Pak She Sewage Pumping Station** | | |
| Stage 1 | Partial removal of existing structure | 122 |
| Stage 2 | Partial reconstruction of structures | 119 |
| Stage 3 | Replacement of E&M equipments | 112 |
| **Works Type 5 - Upgrading of Cheung Chau Sewage Treatment Works** | | |
| Stage 1 | Demolish the abandoned filter beds | 123 |
| Stage 2 | Modification and diversion of pipework | 123 |
| Stage 3 | Construction and upgrading of treatment facilities | 123 |
| Stage 4 | Construction of the new pump house | 123 |
| Stage 5 | Demolish of primary sedimentation tanks & sludge digestor | 122 |
| Stage 6 | Construction of the new storm tanks and workshop | 123 |
| **Works Type 6 - Rehabilitation of Existing Sewers (for 20 meters)** | | |
| Stage 1 | Rehabilitation of existing sewer | 104 |
| **Works Type 7 - Temporary Concrete Mixing** | | |
| Stage 1 | Operation of concrete mixer | 96 |

Notes:

1) The various stages involved for each work type will not be undertaken concurrently.
2) Note that works programme is subject to variables such as weather, conflicts with utilities, etc. and is variable upon these conditions.
3) "SWL" is the calculated worst-case total sound power level due to the operation of the plant inventory for that works stage based on the unmitigated scenario.

### Noise Sensitive Receivers

4.4.5 Representative noise sensitive receivers (NSRs), both existing and planned ones, within 300 m of the Project boundary were identified, according to the criteria set out in Annex 13 of EIAO-TM, observations from site visits and review of latest approved Cheung Chau Outline Zoning Plan (OZP) No. S/I-CC/5 and information available in the Statutory Planning Portal of the Town Planning Board (TPB).

4.4.6 NSRs located closest to the noise sources, i.e., the first layer of NSR, have been considered as the most critical locations. **Figure 4.2** to **Figure 4.15** show the locations of the NSRs. **Table 4.6** presents a summary of representative NSRs selected for the noise assessments and photographs of these NRSs are provided in **Appendix 4.2**.

**Table 4.6 : Representative Noise Sensitive Receivers (Construction Phase)**

| NSR | Description of NSR | Nature of Use | No. of Floor | Figure No. | Construction Phase Works Type that will Affect the NSR | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | 1 | 2 | 3 | 4 | 5 | 6 | 7 |
| TKST2 | No.4 Tai Kwai San Tsuen | Residential | 2 | 4.2 | √ | -- | -- | -- | -- | -- | -- |
| CSH1* | Chung Shak Hei Home for the Aged | Homes for the Aged | 2 | 4.3 | √ | -- | -- | -- | -- | -- | -- |
| CKH* | Cheung King House | Residential | 4 | 4.4 | -- | -- | -- | -- | √ | -- | √ |
| CSH2* | Cheung Shun House | Residential | 4 | 4.4 | -- | -- | -- | -- | √ | -- | √ |
| PSSL* | No. 1A Pak She Second Lane | Residential | 3 | 4.5 | -- | -- | -- | √ | -- | -- | -- |
| CCEP | No.7 Cheung Chau Electric Path | Residential | 3 | 4.6 | √ | -- | -- | -- | -- | -- | -- |
| ST | Block D Seaview Terrence | Residential | 3 | 4.8 | √ | -- | -- | -- | -- | -- | -- |
| SW1 | 3A Golden Lake Garden | Residential | 3 | 4.7 | √ | -- | √ | -- | -- | -- | -- |
| THT | No.24 Tai Hing Tai Road | Residential | 3 | 4.7 | √ | -- | √ | -- | -- | -- | -- |
| SYT1 | No.2A Sin Yan Tseng | Residential | 2 | 4.8 | √ | -- | -- | -- | -- | -- | -- |
| SYT2 | No.37 Sin Yan Tseng | Residential | 2 | 4.8 | √ | -- | -- | -- | -- | -- | -- |
| P1 | No. 34 Praya Street | Residential | 3 | 4.9 | -- | √ | -- | -- | -- | √ | -- |
| TW1 | Cheung Chau Fisheries Joint Association Public School | Educational | 2 | 4.9 | √ | √ | √ | -- | -- | -- | -- |
| TSB1 | No. 123 Tai San Back Street | Residential | 3 | 4.10 | √ | -- | -- | -- | -- | -- | -- |
| LTT1 | Cheung Chau Alliance Church | Church | 2 | 4.11 | √ | -- | -- | -- | -- | -- | -- |
| LTT2 | No.35 Lung Tsai Tsuen Road | Residential | 3 | 4.11 | √ | -- | -- | -- | -- | -- | -- |
| P2 | No.41A Peak Road | Residential | 3 | 4.11 | √ | -- | -- | -- | -- | -- | -- |
| KYW1 | No.31 Kwun Yam Wan Road | Residential | 2 | 4.12 | √ | -- | -- | -- | -- | -- | -- |
| CCS2 | Block G-H Fu Yuen | Residential | 3 | 4.12 | √ | -- | -- | -- | -- | -- | -- |
| PR1 | No.25 Peak Road | Residential | 2 | 4.13 | √ | -- | -- | -- | -- | -- | -- |
| PR2 | No.72 Peak Road | Residential | 2 | 4.13 | √ | -- | -- | -- | -- | -- | -- |
| KYW2 | No.46 Kwun Yam Wan Road | Residential | 3 | 4.14 | √ | -- | -- | -- | -- | -- | -- |
| MF1 | Caritas Ka Fai House | Residential | 2 | 4.14 | √ | -- | -- | -- | -- | -- | -- |
| FP1 | No.18 Fa Peng Road | Residential | 3 | 4.15 | √ | -- | -- | -- | -- | -- | -- |
| FP2 | Bethany Cottage and House | Residential | 3 | 4.15 | √ | -- | -- | -- | -- | -- | -- |

Notes:
NSR ID marked with * is located within the 300 m radius of the boundary of Cheung Chau STW and Pak She SPS
All representative NSRs identified are existing NSRs.
Works Type 1 - Construction of sewer (Open Cut Method).
Works Type 2 - Construction of sewer (Trenchless Method).
Works Type 3 - Upgrading of existing sewers.
Works Type 4 - Upgrading of Pak She Sewage Pumping Station.
Works Type 5 - Upgrading of Cheung Chau Sewage Treatment Works.
Works Type 6 - Rehabilitation of existing sewers.
Works Type 7 - Temporary Concrete Mixing.
Local ground mPD levels at the NSRs are shown on the respective Figure 4.2 to Figure 4.15.

**Construction Noise Impact Evaluation**

4.4.7 Construction noise impact will be assessed based on the following methodology:

- Locate the NSRs which would most likely be affected by noise from construction work;
- Determine the items of Powered Mechanical Equipment (PME) for each discrete construction activity, based on available information or agreed plant inventories;
- Assumptions for on-time percentage of certain PME have been made. The Project Proponent's design engineer confirmed that the assumption of on-time percentage and number of PME are considered to be practical in completing the works within the schedule;
- Calculate the distance attenuation and screening effects to NSRs from notional noise source. Under the Technical Memorandum on Noise from Construction work other than Percussive Piling (GW-TM), the distance attenuation will be determined by the following formula;
- Distance Attenuation in dB(A) = 20 Log D + 8 [where D is distance in metres];
- A +3 dB (A) façade correction is added to the predicted noise levels to account for the façade effect at each NSR;
- Calculate the unmitigated Predicted Noise Level ("PNL") and correct it for façade reflection to obtain the Corrected Noise Level ("CNL") at any NSRs;
- If necessary, re-select typical project-specific silenced equipment and other types of mitigation measure to address noise exceedance, e.g. noise barrier and calculate the mitigated noise impact; and
- Compare the mitigated CNL with the noise standards to determine acceptability and the need for further mitigation/ EM&A.

4.4.8 For a conservative approach to assessing the worst-case construction noise impacts, it was assumed that all the proposed PMEs for each construction work stage are operating concurrently. The predicted cumulative worst-case construction noise levels at the NSRs due to the construction activities of the upgrading of Cheung Chau STW and Pak She SPS are summarized in **Table 4.7**, while the impacts due to the construction activities of sewers works are presented in **Table 4.8**. Detailed calculations are provided in **Appendix 4.3**.

**Table 4.7 : Predicted Worst-case Cumulative Construction Noise Levels at Representative NSRs Affected by Upgrading of Cheung Chau STW and Pak She SPS - Unmitigated Scenario**

| NSR | Description of NSR | Predicted Worst-case Construction Noise Level of Works Type for Upgrading of Cheung Chau STW and Pak She SPS, dB(A) | | | |
|---|---|---|---|---|---|
| | | Works Type 4 | Works Type 5 | Works Type 7 | Total |
| CKH | Cheung King House | -- | **77** | 48 | **77** |
| CSH2 | Cheung Shun House | -- | **76** | 47 | **76** |
| PSSL | No. 1A Pak She Second Lane | **86** | -- | -- | **86** |

Notes:
Underlined bold figure (e.g. **77**) indicates an exceedance of the 75 dB(A) noise criteria.
Works Type 4 - Upgrading of Pak She Sewage Pumping Station.
Works Type 5 - Upgrading of Cheung Chau Sewage Treatment Works.
Works Type 7 - Temporary Concrete Mixing.

**Table 4.8 : Predicted Worst-case Cumulative Construction Noise Levels at Representative NSRs Affected by sewers works- Unmitigated Scenario**

| NSR | Description of NSR | Predicted Worst-case Construction Noise Level of Works Type for sewers works, dB(A) | | | | |
|---|---|---|---|---|---|---|
| | | Works Type 1 | Works Type 2 | Works Type 3 | Works Type 6 | Total |
| TKST2 | No. 4 Tai Kwai San Tsuen | **108** | -- | -- | -- | **108** |
| CSH1* | Chung Shak Hei Home for the Aged | **108** | -- | -- | -- | **108** |
| CCEP | No.7 Cheung Chau Electric Path | **108** | -- | -- | -- | **108** |
| ST | Block D Seaview Terrence | **94** | -- | -- | -- | **94** |
| SW1 | 3A Golden Lake Garden | **94** | -- | **86** | -- | **95** |
| THT | No.24 Tai Hing Tai Road | **94** | -- | **82** | -- | **94** |
| SYT1 | No.2A Sin Yan Tseng | **102** | -- | -- | -- | **102** |
| SYT2 | No.37 Sin Yan Tseng | **108** | -- | -- | -- | **108** |
| P1 | No. 34 Praya Street | -- | **98** | -- | **73** | **98** |
| TW1 | Cheung Chau Fisheries Joint Association Public School | **102** | **102** | **99** | -- | **106** |
| TSB1 | No. 123 Tai San Back Street | **108** | -- | -- | -- | **108** |
| LTT1 | Cheung Chau Alliance Church | **108** | -- | -- | -- | **108** |
| LTT2 | No.35 Lung Tsai Tsuen Road | **108** | -- | -- | -- | **108** |
| P2 | No.41A Peak Road | **108** | -- | -- | -- | **108** |
| KYW1 | No.31 Kwun Yam Wan Road | **91** | -- | -- | -- | **91** |
| CCS2 | Block G-H Fu Yuen | **108** | -- | -- | -- | **108** |
| PR1 | No.25 Peak Road | **102** | -- | -- | -- | **102** |
| PR2 | No.72 Peak Road | **96** | -- | -- | -- | **96** |
| KYW2 | No.46 Kwun Yam Wan Road | **102** | -- | -- | -- | **102** |
| MF1 | Caritas Ka Fai House | **102** | -- | -- | -- | **102** |
| FP1 | No.18 Fa Peng Road | **102** | -- | -- | -- | **102** |
| FP2 | Bethany Cottage and House | **102** | -- | -- | -- | **102** |

Notes:
NSR ID marked with * is located within the 300 m radius of the boundary of the Cheung Chau STW and Pak She SPS but no line of sight to the site.
Underlined bold figure (e.g. **77**) indicates an exceedance of the 75 dB(A) noise criteria.
Noise criteria for TW1 (school) is 70 dB(A) during normal hours (65 dB(A) during examination periods).
Noise criteria for LTT1 is 70 dB(A) is a place of worship where unaided voice communication is required.
Works Type 1 - Construction of sewer (Open Cut Method).
Works Type 2 - Construction of sewer (Trenchless Method).
Works Type 3 - Upgrading of existing sewers
Works Type 6 - Rehabilitation of existing sewers

4.4.9 From **Table 4.7**, the predicted unmitigated worst-case construction noise levels at NSRs that will be affected by the upgrading of the Cheung Chau STW and Pak She

SPS will range from 76 dB(A) to 86 dB(A), which would exceed the EIAO-TM noise standards by up to 11 dB(A).

4.4.10 From **Table 4.8**, the predicted unmitigated worst-case construction noise levels at NSRs that will be affected by the sewers works will be up to 108 dB(A) which exceeds the EIAO-TM noise standards.

**Noise Mitigation Measures for Upgrading of Cheung Chau STW and Pak She SPS**

4.4.11 The construction noise assessment indicated that, in the absence of any mitigation measures, there would be exceedance of the construction noise criteria at some of the NSRs. Various mitigation options have thus been considered in accordance with the guidelines laid down in the *Environmental Impact Assessment Ordinance, Guidance Note No. 9/2010 "Preparation of Construction Noise Impact Assessment under the Environmental Impact Assessment Ordinance"* (GN 9/2010). It should be noted that the assumptions used in formulating mitigation measures and their practicality were based on the best available information from the preliminary design stage of the Project. Alternative mitigation proposals which could achieve the same noise reduction effect may be formulated in detailed design stage. Mitigation measures considered are discussed below:

***Good Site Practice***

4.4.12 Good site practice and noise management can significantly reduce the impact of construction site activities on nearby NSRs. The following mitigation measures should be followed during the construction:

- only well-maintained plant should be operated on-site and plant should be serviced regularly during the construction works;
- machines and plant that may be in intermittent use should be shut down between work periods or should be throttled down to a minimum;
- plant known to emit noise strongly in one direction should, where possible, be orientated to direct noise away from the NSRs;
- mobile plant should be sited as far away from NSRs as possible; and
- material stockpiles and other structures should be effectively utilized, where practicable, to screen noise from on-site construction activities.

***Adoption of Quiet PMEs and Site Hoardings Screening***

4.4.13 To reduce construction noise impact on the affected NSRs during the construction phase, quieter equipment shall be adopted as far as possible. **Table 4.9** shows the possible alternative quieter PME which are taken from BS:5228: Part 1:2009. These quieter PMEs are available in the market and have been successfully applied to other projects and have achieved noticeable noise reductions. The SWLs of quieter PMEs that are to be used for the works shall meet, or lower than, the values in **Table 4.9**.

**Table 4.9 : Quiet PME and Associated Sound Power Level**

| Description of PME | Equivalent Quiet PME | SWL, dB(A) |
|---|---|---|
| Generator | BS 5228 Table C4/77 | 88 |
| Poker, vibratory, hand-held | BS 5228 Table C4/34 | 97 |
| Breaker, excavator mounted (hydraulic) | BS 5228 Table C9/12 | 113 |
| Excavator | BS 5228 Table C4/65 | 99 |

| Description of PME | Equivalent Quiet PME | SWL, dB(A) |
|---|---|---|
| Tracked Mobile Crane | BS 5228 Table C4/50 | 99 |
| Vibratory Compactor | QPME EPD-00055 | 102 |
| Dumper | BS 5228 Table C4/3 | 104 |
| Air Compressor | BS 5228 Table D7/24 | 95 |
| Concrete Pump | BS 5228 Table C3/25 | 106 |
| Piling Rig | BS 5228 Table C3/14 | 111 |

4.4.14 Temporary site hoardings of 2.4 m high are recommended for the works at the Pak She SPS. The hoardings will be erected along the works boundary facing the NSRs. The PME involved in the works would be screened by the erected site hoardings. Without direct line of sight from the affected NSRs, a noise reduction of 10 dB(A) could be achieved provided that the hoardings have no openings or gaps and have a surface mass of at least 7 kg/$m^2$. Nonetheless, a -5 dB(A) screening correction for site hoardings has been applied as a more conservative approach.

4.4.15 It should be noted that the noise screening effect due to the temporary site hoardings noise barriers and the noise mitigation measures including phasing of the works adopter in this EIA Report are specific to this Project with considerations of specific works types, low-rise houses, specific design of temporary noise barriers in the form of site hoardings and screening without direct line sight between the NSRs and the PMEs. The measures and the noise screening effect should not be lightly applied to other project without careful considerations of the specific construction works, design of barriers and NSR's situations.

4.4.16 The predicted cumulative mitigated construction noise levels at the NSRs due to the construction activities for the upgrading of Cheung Chau STW and Pak She SPS will comply with the EIAO-TM noise standard. The predicted noise levels are summarized in **Table 4.10**. Detailed calculations are provided in **Appendix 4.5**.

**Table 4.10 : Predicted Maximum Construction Noise Levels at Representative NSRs Affected by upgrading of Cheung Chau STW and Pak She SPS- Mitigated Scenario (Quiet Plant and Site Hoardings)**

| NSR | Description of NSR | Predicted Maximum Construction Noise Level of Works Type for upgrading of Cheung Chau STW and Pak She SPS, dB(A) | | | |
|---|---|---|---|---|---|
| | | Works Type 4 | Works Type 5 | Works Type 7 | Total |
| CKH | Cheung King House | -- | 72 | 48 | 72 |
| CSH2 | Cheung Shun House | -- | 71 | 47 | 71 |
| PSSL | No. 1A Pak She Second Lane | 72 | -- | -- | 72 |

Notes:
Noise criteria = 75 dB(A).
Works Type 4 - Upgrading of Pak She Sewage Pumping Station.
Works Type 5 - Upgrading of Cheung Chau Sewage Treatment Works.
Works Type 7 - Temporary Concrete Mixing.

### Noise Mitigation Measures for Sewers Works

4.4.17 In view of the high noise exceedances at some NSRs due to the sewers works, mitigation measures are considered to be implemented at three levels, which

involves adoption of quiet PME and temporary noise barriers; good scheduling of works avoiding concurrent construction activities; and alternative construction method for excavation of soil. In addition, good site practice as described above for the upgrading of Cheung Chau STW and Pak She SPS should also be applied to reduce the impact of construction site activities on nearby NSRs.

***Level 1 Noise Mitigation Measures - Quiet PMEs and Temporary Noise Barrier***

4.4.18 Similar to the mitigation measures recommended for the upgrading of Cheung Chau STW and Pak She SPS, quiet PME and temporary noise barriers can be adopted as far as possible to reduce the noise impacts. Quiet PMEs and SWLs as provided in **Table 4.9** can be adopted for the sewers works.

4.4.19 For the construction of sewers, use of temporary noise barrier has been recommended for PMEs to alleviate the construction noise impacts. In general, temporary noise barrier located close to the noise generating part of the PME would reduce noise level of 5 to 10 dB(A) depending on the actual design with reference to GN 9/2010. The noise screening benefit for each plant considered in this assessment has been adopted as follow:

- Temporary noise barrier for stationary plant - assuming 10 dB(A) reduction on stationary plants;
- Temporary noise barrier for mobile plant - assuming 5 dB(A) reduction on mobile plants.

4.4.20 In general, temporary noise barrier material's surface mass in excess of 7 kg/m$^2$ is recommended. The contractor shall be responsible for design of the temporary noise barrier with due consideration given to the size of the PME and the requirement of intercepting the line of sight between the NSRs and PME. Although the sewers works areas within village area are limited, contractors are recommended to adopt temporary noise barrier as far as practicable to minimize noise impact at lower floors of NSRs. **Table 4.11** summarizes the assumed noise reduction achieved by the temporary noise barrier for certain PMEs. Detailed mitigated plant inventory is presented in **Appendix 4.4**.

**Table 4.11 : Noise Mitigation Measures for Certain PME**

| Description of PME | Proposed Mitigation Measures | Assumed Noise Reduction, dB(A) |
|---|---|---|
| Backhoe (mini) | Noise Barrier (Mobile) | 5 |
| Breaker, hand-held, mass>10kg and <20kg | Noise Barrier (Stationary) | 10 |
| Generator | Noise Barrier (Stationary) | 10 |
| Poker, vibratory hand-held | Noise Barrier (Stationary) | 10 |
| Bar bender and cutter (electric) | Noise Barrier (Stationary) | 10 |
| Vibratory compactor | Noise Barrier (Stationary) | 10 |
| Breaker, excavator mounted (hydraulic) | Noise Barrier (Mobile) | 5 |
| Piling, earth auger, auger | Noise Barrier (Stationary) | 10 |
| Hoist (electric) | Noise Barrier (Stationary) | 10 |
| Excavator | Noise Barrier (Mobile) | 5 |
| Dumper | Noise Barrier (Mobile) | 5 |
| Submersible Pump | Noise Barrier (Stationary) | 10 |

| Description of PME | Proposed Mitigation Measures | Assumed Noise Reduction, dB(A) |
|---|---|---|
| Rock Drill, hand-held (pneumatic) | Noise Barrier (Stationary) | 10 |
| Air Compressor | Noise Barrier (Stationary) | 10 |
| Ventilation Fan | Noise Barrier (Stationary) | 10 |
| Grout Mixer | Noise Barrier (Stationary) | 10 |
| Grout Pump | Noise Barrier (Stationary) | 10 |
| Winch (electric) | Noise Barrier (Stationary) | 10 |
| Grinder, hand held (electric) | Noise Barrier (Stationary) | 10 |

4.4.21 The predicted mitigated construction noise levels at the representative NSRs are summarized in **Table 4.12** and detailed in **Appendix 4.5**.

**Table 4.12 : Predicted Maximum Construction Noise Levels at Representative NSRs Affected by sewers works - with Level 1 Mitigation Measures**

| NSR | Description of NSR | Predicted Worst-case Construction Noise Level of Works Type for sewers works, dB(A) | | | | |
|---|---|---|---|---|---|---|
| | | Works Type 1 | Works Type 2 | Works Type 3 | Works Type 6 | Total |
| TKST2 | No. 4 Tai Kwai San Tsuen | **88** | -- | -- | -- | **88** |
| CSH1* | Chung Shak Hei Home for the Aged | **88** | -- | -- | -- | **88** |
| CCEP | No.7 Cheung Chau Electric Path | **88** | -- | -- | -- | **88** |
| ST | Block D Seaview Terrence | 74 | -- | -- | -- | 74 |
| SW1 | 3A Golden Lake Garden | 74 | -- | 66 | -- | 75 |
| THT | No.24 Tai Hing Tai Road | 74 | -- | 62 | -- | 74 |
| SYT1 | No.2A Sin Yan Tseng | **82** | -- | -- | -- | **82** |
| SYT2 | No.37 Sin Yan Tseng | **88** | -- | -- | -- | **88** |
| P1 | No. 34 Praya Street | -- | **84** | -- | 60 | **84** |
| TW1 | Cheung Chau Fisheries Joint Association Public School | **82** | **88** | **79** | -- | **89** |
| TSB1 | No. 123 Tai San Back Street | **88** | -- | -- | -- | **88** |
| LTT1 | Cheung Chau Alliance Church | **88** | -- | -- | -- | **88** |
| LTT2 | No.35 Lung Tsai Tsuen Road | **88** | -- | -- | -- | **88** |
| P2 | No.41A Peak Road | **88** | -- | -- | -- | **88** |
| KYW1 | No.31 Kwun Yam Wan Road | 71 | -- | -- | -- | 71 |
| CCS2 | Block G-H Fu Yuen | **88** | -- | -- | -- | **88** |
| PR1 | No.25 Peak Road | **82** | -- | -- | -- | **82** |
| PR2 | No.72 Peak Road | **76** | -- | -- | -- | **76** |
| KYW2 | No.46 Kwun Yam Wan Road | **82** | -- | -- | -- | **82** |
| MF1 | Caritas Ka Fai House | **82** | -- | -- | -- | **82** |
| FP1 | No.18 Fa Peng Road | **82** | -- | -- | -- | **82** |

| NSR | Description of NSR | Predicted Worst-case Construction Noise Level of Works Type for sewers works, dB(A) | | | | |
|---|---|---|---|---|---|---|
| | | Works Type 1 | Works Type 2 | Works Type 3 | Works Type 6 | Total |
| FP2 | Bethany Cottage and House | **82** | -- | -- | -- | **82** |

Notes:
NSR ID marked with * is located within the 300 m radius of the boundary of the Cheung Chau STW and Pak She SPS but no line of sight to the site.
Underlined bold figure (e.g. **77**) indicates an exceedance of the 75 dB(A) noise criteria.
Noise criteria for TW1 (school) is 70 dB(A) during normal hours (65 dB(A) during examination periods).
Noise criteria for LTT1 is 70 dB(A) is a place of worship where unaided voice communication is required.
Works Type 1 - Construction of sewer (Open Cut Method).
Works Type 2 - Construction of sewer (Trenchless Method).
Works Type 3 - Upgrading of existing sewers.
Works Type 6 - Rehabilitation of existing sewers.

4.4.22 With the adoption of quiet PMEs and temporary barrier, noise exceedances were still predicted at most sensitive receivers during construction of the sewers works.

***Level 2 Noise Mitigation Measures - Good Scheduling of Works***

4.4.23 For NSRs which would be affected by more than one Works Type of the sewers works, good scheduling of works is recommended to further mitigate the potential construction noise impacts.

4.4.24 NSR P1 and NSR TW1 will be affected by more than one Works Type of the sewers works. Level 2 noise mitigation measures by considering good scheduling of works were proposed. It is recommended to avoid carrying out concurrent Works Type near these NSRs.

4.4.25 During construction phase of sewers works, the contractor should liaise with the NSR TW1 (Cheung Chau Fisheries Joint Association Public School) to obtain the examination schedule and avoid noisy construction activities during the school examination period.

4.4.26 By avoiding concurrent Works Type, noise exceedances were still predicted at NSRs P1 and TW1 due to individual Works Type. Further mitigation measures were considered.

***Level 3 Noise Mitigation Measures - Hand Digging for Excavation***

4.4.27 Further mitigation measures were considered for the soil excavation works of constructing sewer (open cut method) and upgrading of the existing sewer. Provided the site condition is allowed, the contractor should avoid the use of PME as far as possible and adopt hand digging method. If hand digging method is adopted, the maximum sound power level associated with the excavation works can be reduced from 89 dB(A) to 80 dB(A) (sum of sound power level of water pump and generator). Since digging will occupy most of the time during the excavation works, avoid the use of PME would reduce the noise impacts on the NSRs. However, the use of hand digging method for excavation should be considered with all relevant factors taken into account, such as site condition, work duration, extent of excavation, liaison with residents etc. Although the employment of hand digging method would further reduce the mitigated sound levels, it would otherwise prolong the construction period and thereby nuisance to the public. Therefore, the overall

merits or demerits of this mitigation measure must be carefully assessed on a case-by-case basis under the prevailing situation on site.

**Cumulative Impact**

4.4.28 The following discusses the potential cumulative interface issues between concurrent projects as indicated in **Section 2.10**.

***Improvement of Fresh Water Supply to Cheung Chau - Design and Construction***

4.4.29 The construction activities of the fresh water supply project are located at Cheung Chau Tai Kwai Wan which potentially interface with the proposed sewers works in the same area for 15 months overlapping period. It is recommended that the construction of sewers at Tai Kwai Wan San Tsuen should be launched after the completion of the Project. The contractor should liaise with the correspondent party to ensure concurrent works are avoided as far as possible. By avoiding concurrent works, adverse cumulative noise impact is not expected to occur.

***Replacement and Rehabilitation of Water Mains Stage 3 and Stage 4, Mains on Hong Kong and Islands – Investigation, Design and Construction***

4.4.30 Based on the information provided by WSD, Stage 3 of this project will be completed before the construction phase of this Project. Construction of Stage 4 commenced in October 2012 and is anticipated for completion in 2015. Close liaison will be undertaken with the project proponent of the interfacing project to avoid concurrent works as far as possible. By avoiding concurrent works, the potential interface issues with this project are not expected to occur.

***Improvement to Existing Roads and Drains in Cheung Chau Old Town, Remaining Engineering Works, Stage 3, Cheung Chau***

4.4.31 There are potential concurrent construction activities within Cheung Chau Area. Based on the best available information, this project involves the construction of village sewer at Cheung Chau Town Centre, Hill Side Road, Kwun Yam Wan Road, Tai Shek Hau, Lung Tsai Tsuen, Ko Shan Tsuen and Pak She San Tsuen. Close liaison between the two project teams will be undertaken to ensure concurrent works are avoided as far as possible. By avoiding concurrent works and given the small scale works involved, adverse cumulative noise impact is not expected during construction.

**Residual Noise Impact**

***Upgrading of Cheung Chau STW and Pak She SPS***

4.4.32 The predicted mitigated construction noise levels at NSRs due to the construction activities for upgrading of the Cheung Chau STW and Pak She SPS were found to be within the EIAO-TM noise criteria. With appropriate implementation of the noise mitigation measures, residual noise impacts due to the construction activities for upgrading of the Cheung Chau STW and Pak She SPS are expected to be insignificant.

***Sewers Works***

4.4.33 Practical noise abatement measures, such as the use of quieter PME, scheduling of works avoiding the concurrent of noise activities and the use of temporary noise barriers, have been considered for the construction of sewers works where

practicable. However, exceedances of the daytime construction noise criterion are still predicted at some NSRs which are located very close to the construction and upgrading work of village sewers.

4.4.34 All reasonably practicable mitigation measures are, therefore, considered to have been proposed but some residual noise impacts will still remain. Residual impacts related to the sewers works are further discussed in below.

4.4.35 The construction noise assessment results were based on the worst case scenario where the notional sources were assumed. The actual residual exceedances would be limited on to the time period when the construction work is being carried out adjacent to these NSRs. In practice, the PME will progress along the working area of each section. Once the PMEs move on along the working area within each section and further from the NSRs, the noise impacts will be less and only last for a short period.

4.4.36 The construction of sewer is unavoidable. Under normal practice, the sewers would be constructed in section of about 20m to 30m at any one time and each work front would be separated by a clearance distance. The anticipated noise impact would be localized. With such a typical arrangement, construction works for each section could normally be completed in about 30 days, with each noisy construction activity lasts for about 1.5 days to 9 days. The duration of the residual noise impacts is hence short-term only. Having said that, longer sections of sewer construction may be adopted in less sensitive locations to suit site condition, construction method and/or works sequence/programme.

4.4.37 The extent and duration of the predicted residual impacts of Works Type 1 construction of sewer (open cut method) during different construction stages are summarized in **Table 4.13**. Details of the construction noise calculation for each works stage for the construction of sewer (open cut method) are provided in **Appendix 4.6**.

**Table 4.13 : Predicted Residual Impact of Works Type 1 Construction of Sewer (Open Cut Method) at the Representative NSRs**

| NSR | Description of NSR | Predicted Residual Noise Impacts due to different Construction Stages, dB(A) | | | | | |
|---|---|---|---|---|---|---|---|
| | | Stage 1 | Stage 2 | Stage 3 | Stage 4 | Stage 5 | Stage 6 |
| | | Duration | | | | | |
| | | 1.5 days | 9 days | 6 days | 2.5 days | 8 days | 3 days |
| TKST2 | No. 4 Tai Kwai San Tsuen | **88** | **84** | **80** | **83** | **84** | **80** |
| CSH1 | Chung Shak Hei Home for the Aged | **88** | **84** | **80** | **83** | **84** | **80** |
| CCEP | No.7 Cheung Chau Electric Path | **88** | **84** | **80** | **83** | **84** | **80** |
| SYT1 | No.2A Sin Yan Tseng | **82** | **78** | 74 | **77** | **78** | 74 |
| SYT2 | No.37 Sin Yan Tseng | **88** | **84** | **80** | **83** | **84** | **80** |
| TW1 | Cheung Chau Fisheries Joint Association Public School | **82** | **78** | **74** | **77** | **78** | **74** |
| TSB1 | No. 123 Tai San Back Street | **88** | **84** | **80** | **83** | **84** | **80** |
| LTT1 | Cheung Chau Alliance Church | **88** | **84** | **80** | **83** | **84** | **80** |
| LTT2 | No.35 Lung Tsai Tsuen Road | **88** | **84** | **80** | **83** | **84** | **80** |
| P2 | No.41A Peak Road | **88** | **84** | **80** | **83** | **84** | **80** |
| CCS2 | Block G-H Fu Yuen | **88** | **84** | **80** | **83** | **84** | **80** |
| PR1 | No.25 Peak Road | **82** | **78** | 74 | **77** | **78** | 74 |
| PR2 | No.72 Peak Road | **76** | 72 | 68 | 71 | 72 | 68 |
| KYW2 | No.46 Kwun Yam Wan Road | **82** | **78** | 74 | **77** | **78** | 74 |
| MF1 | Caritas Ka Fai House | **82** | **78** | 74 | **77** | **78** | 74 |
| FP1 | No.18 Fa Peng Road | **82** | **78** | 74 | **77** | **78** | 74 |
| FP2 | Bethany Cottage and House | **82** | **78** | 74 | **77** | **78** | 74 |

Notes:
Underlined bold figure (e.g. **77**) indicates an exceedance of the 75 dB(A) noise criteria.
Noise criteria for TW1 (school) is 70 dB(A) during normal hours (65 dB(A) during examination periods).
Noise criteria for LTT1 is 70 dB(A) is a place of worship where unaided voice communication is required.
Works Stage 1 - Breaking up of road surface (SWL: 93 dB(A)).
Works Stage 2 - Excavation of soil material (SWL: 89 dB(A)).
Works Stage 3 - Steel fixing and concreting of manholes (SWL: 85 dB(A)).
Works Stage 4 - Laying of bedding material (SWL: 88 dB(A)).
Works Stage 5 - Backfilling and soil compaction (SWL: 89 dB(A)).
Works Stage 6 - Reinstatement of road surface (SWL: 85 dB(A)).

4.4.38 For NSRs TW1 and P1, maximum construction noise impacts were predicted due to Works Type 2 construction of sewer (trenchless method). The extent and duration of the predicted residual impacts of Works Type 2 construction of sewer (trenchless method) during different construction stages at these two NSRs are summarized in **Table 4.14**. For pit excavation (Stage 1), the worst case residual noise impacts will be associated with the use of hydraulic breaker for breaking up the concrete surface at grade. This work would be of short duration only. The rest of the excavation works below grade will require hydraulic breaker only if rock is encountered which is on occasional case only. However, the excavation works will be below ground, the

construction noise level associated with the pit excavation by hydraulic breaker below grade will be less. For the pipe jacking activities (Stage 2) of Works Type 2, trenchless method, the predicted residual noise impacts would occur at the working pit only. The contractor can plan theirs works to locate the working pits further away from the NSRs. Details of the construction noise calculation for each works stage for the construction of sewer (trenchless method) are provided in **Appendix 4.6**.

**Table 4.14 : Predicted Residual Impact of Works Type 2 Construction of Sewer (Trenchless Method) at NSRs TW1 and P1**

| NSR | Description of NSR | Predicted Residual Noise Impacts due to different Construction Stages, dB(A) | | |
|---|---|---|---|---|
| | | Stage 1 | Stage 2 | Stage 3 |
| | | Duration | | |
| | | 5 days | 7 days | 30 days |
| TW1 | Cheung Chau Fisheries Joint Association Public School | **88** | **88** | 65 |
| P1 | No. 34 Praya Street | **84** | **84** | 61 |

Notes:
Underlined bold figure (e.g. **77**) indicates an exceedance of the 75 dB(A) noise criteria.
Noise criteria for TW1 (school) is 70 dB(A) during normal hours (65 dB(A) during examination periods).
Works Stage 1 - Excavation of pits by breaker (SWL: 108 dB(A)). This relates to the breaking up of concrete surface at grade at the pit by hydraulic breaker. Excavation below grade will require hydraulic breaker only if rock is encountered which is on occasional case only.
Works Stage 2 - Jacking of pipes (SWL: 108 dB(A)). The pits close to the two NSRs are receiving pits where the PME will be deployed after the break-through at that point. This is the worst case if rock drill is used. Predicted noise level would be less if no rock is encountered.
Works Stage 3 - Steel fixing and concreting of manholes (SWL: 85 dB(A)).
Reinstatement of road surface is by using bricks. No PME will be involved.

4.4.39 NSR TW1 will be affected by Works Type 3 upgrading of existing sewer. The extent and duration of the predicted residual impacts of Works Type 3 upgrading of existing sewer during different construction stages at NSR TW1 are summarized in **Table 4.15**. In view of the predicted residual noise impacts, the contractor should liaise closely with the school to plan their works to avoid examination periods and to avoid teaching periods as far as practicable, e.g. during school break. In doing so, this residual noise impacts at NSR TW1 due to Works Type 3 will be eliminated. Details of the construction noise calculation for each works stage for Works Type 3 are provided in **Appendix 4.6**.

**Table 4.15 : Predicted Residual Impact of Works Type 3 Upgrading of Existing Sewer at NSR TW1**

| NSR | Description of NSR | Predicted Residual Noise Impacts due to different Construction Stages, dB(A) | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | | Stage 1 | Stage 2 | Stage 3 | Stage 4 | Stage 5 | Stage 6 | Stage 7 |
| | | Duration | | | | | | |
| | | 1.5 days | 9 days | 5 days | 6 days | 2.5 days | 8 days | 3 days |
| TW1 | Cheung Chau Fisheries Joint Association Public School | **79** | **75** | **75** | **71** | **74** | **75** | **71** |

Notes:
Underlined bold figure (e.g. **77**) indicates an exceedance of the 70 dB(A) noise criteria during normal teaching hours.
Noise criteria for TW1 (school) is 65 dB(A) during examination periods.
Works Stage 1 - Breaking up of road surface (SWL: 93 dB(A)).
Works Stage 2 - Excavation of soil material (SWL: 89 dB(A)).
Works Stage 3 - Removal of existing sewers and laying of new sewers (SWL: 89 dB(A)).
Works Stage 4 - Steel fixing and concreting of manholes (SWL: 85 dB(A)).
Works Stage 5 - Laying of bedding material (SWL: 88 dB(A)).
Works Stage 6 - Backfilling and soil compaction (SWL: 89 dB(A)).
Works Stage 7 - Reinstatement of road surface (SWL: 85 dB(A)).

4.4.40 Based on the above, the predicted residual impacts are considered to be temporary and reversible. The geographic extent of the impacts are confined to small works areas and considered to be localised, not of international and regional importance. Furthermore, the mitigation measures proposed will reduce the levels of impacts. As such, the residual impacts associated with the construction phase exceedances for the sewers works would be short-term and considered acceptable provided appropriate mitigation measures are implemented.

## 4.5 Operational Noise Impact Assessment

### Noise Sources Identification

4.5.1 Potential operational fixed plant noise impact will be associated with the upgrading of Cheung Chau STW and Pak She SPS. Both Cheung Chau STW and Pak She SPS are existing operative facilities and installed with noise generating equipment. After the upgrading works the equipment inventory will be similar to the existing ones, which would be sewage pumps, ventilation fans, deodourizing fans, mechanically raked fine screen and blower. The noisy equipment inventory at both Cheung Chau STW and Pak She SPS, based on the design at the time of preparation of this EIA, are provided in **Table 4.16**. The typical Sound Power Levels (SWL) associated with these equipments are also provided. **Figure 4.16** shows the general location of noisy equipment for Cheung Chau STW.

**Table 4.16 : Major Noise Generating Equipment (Operational Phase)**

| Location | Equipment | No. of Units | Typical Sound Power Level, dB(A) | Sub-total Sound Power Level, dB(A) |
|---|---|---|---|---|
| **Pak She Sewage Pumping Station** | | | | |
| Plant Room | Submersible pump (Ref. 1) | 2 | 85 | 88 |
| | Exhaust fan (Ref. 2) | 2 | 79 | 82 |
| | Mechanically raked fine screen (Ref. 3) | 2 | 89 | 92 |
| Deodourizing Units | Deodourizing fan (Ref. 4) | 1 | 85 | 89 |
| **Cheung Chau Sewage Treatment Works** | | | | |
| Preliminary Treatment Units | Submersible pump (Ref. 1) | 10 | 85 | 95 |
| | Mechanically raked fine screen (Ref. 3) | 3 | 89 | 96 |
| | Deodourizing fan (Ref. 4) | 4 | 85 | 95 |
| | Exhaust fan (Ref. 2) | 14 | 79 | 90 |

| Location | Equipment | No. of Units | Typical Sound Power Level, dB(A) | Sub-total Sound Power Level, dB(A) |
|---|---|---|---|---|
| MBR Equipment Unit (Part 1) | Mechanically pump (Ref. 5) | 9 | 92 | 108 |
| | Deodourizing fan (Ref. 4) | 2 | 85 | 92 |
| | Exhaust fan (Ref. 2) | 8 | 79 | 88 |
| MBR Equipment Unit (Part 2) | Mechanically pump (Ref. 5) | 9 | 92 | 108 |
| | Deodourizing fan (Ref. 4) | 2 | 85 | 92 |
| | Exhaust fan (Ref. 2) | 4 | 79 | 85 |
| Sludge Treatment Unit | Submersible pump (Ref. 1) | 2 | 85 | 88 |
| | Deodourizing fan (Ref. 4) | 2 | 85 | 92 |
| | Exhaust fan (Ref. 2) | 6 | 79 | 87 |
| Air Blower Room | Blower (Ref. 6) | 7 | 85 | 93 |
| | Exhaust fan (Ref. 2) | 4 | 79 | 85 |
| Existing Outfall Pumping Station and Header Tank | Mechanical pump (Ref. 5) | 12 | 92 | 109 |
| | Deodourizing fan (Ref. 4) | 4 | 85 | 91 |
| | Exhaust fan (Ref. 2) | 14 | 79 | 90 |

Notes:
Only noisy equipments are included in the table. Other equipments which do not have significant noise emissions are not included.
(Ref. 1) SWL referenced to CNP283.
(Ref. 2) SWL referenced to approved EIA of Harbour Area Treatment Scheme (HATS) Stage 2A (EIA-148/2008) and Good Practices on Ventilation System Noise Control based on the flow rate of 1,300m$^3$/hr.
(Ref. 3) SWL referenced to the approved EIA Report on Tai Po Sewage Treatment Works Stage V (EIA-097/2004).
(Ref 4) SWL of plant refers to Good Practices on Ventilation System Noise Control based on the flow rate of 17,000 m3/hr and 125 Pa.
(Ref 5) SWL of plant refer to Good Practices on Pumping System Noise Control based on the horsepower of pumpset 20 hp at 1800 rpm.
(Ref 6) SWL of plant refers to the tender specification for Shatin STW Stage 3 Upgrading and approved EIA of Harbour Area Treatment Scheme (HATS) Stage 2A (EIA-148/2008).

4.5.2 Standby equipment would only be used in case of failure or maintenance of duty units. Therefore, concurrent operation of both duty and standby equipment will not occur under the normal operation. It is anticipated that the maximum sound power levels during operation would be under the full operation of all duty equipment which are given in **Table 4.16**.

**Noise Sensitive Receivers**

4.5.3 Representative first tier NSRs closest to the Pak She SPS and Cheung Chau STW were selected for predicting the noise impacts during the operational phase. These would represent the worst case scenario in predicting noise impacts. Other NSRs further away from these NSRs are expected to be less affected by comparison. **Table 4.17** shows the selected representative NSRs for the operational phase fixed plant noise assessment for the operation of Pak She SPS and Cheung Chau STW. All selected NSRs for the operational noise impact assessment are existing NSRs. Based on the information available at the time of the preparation of this EIA, there

are no planned NSRs that are in a location closer to the Pak She SPS and Cheung Chau STW than those identified existing NSRs.

**Table 4.17 : Representative Noise Sensitive Receivers (Operational Phase)**

| NSR | Description of NSR | Nature of Use | No. of Floor | Figure No. | Approximate Nearest Horizontal Separation (m) | |
|---|---|---|---|---|---|---|
| | | | | | Cheung Chau STW | Pak She SPS |
| PSSL | No. 1A Pak She Second Lane | Residential | 3 | 4.5 | No direct line of sight | 58 |
| CKH | Cheung King House | Residential | 4 | 4.4 | 65 | No direct line of sight |
| CSH2 | Cheung Shun House | Residential | 4 | 4.4 | 81 | No direct line of sight |

### Operational Noise Impact Evaluation

4.5.4 All identified noisy equipment of Pak She SPS and Cheung Chau STW would be confined within the existing site boundary and housed inside the SPS and STW building structure. For the assessment of the worst-case unmitigated operational noise, it was assumed that all duty equipments would be operated at the same time and located outdoor without cover. The predicted noise levels during operation phase at the identified NSRs are shown in **Table 4.18** and detailed in **Appendix 4.7**.

**Table 4.18 : Predicted Worst-case Maximum Operational Noise Levels at Representative NSRs - Without Mitigation Measures**

| NSR | NSR Description | Predicted Unmitigated Noise Level, dB(A) | Night-time Noise Criterion, dB(A) | Day-time Noise Criterion, dB(A) |
|---|---|---|---|---|
| CKH | Cheung King House | 69 | 45 | 53 |
| CSH2 | Cheung Shun House | 68 | 45 | 53 |
| PSSL | No. 1A Pak She Second Lane | 55 | 45 | 55 |

4.5.5 From **Table 4.18**, the predicted worst-case unmitigated noise levels due to the operation of Cheung Chau STW would exceed the noise criteria at all time, and it would exceed the night-time noise criterion due to the operation of the Pak She SPS.

### Possible Noise Mitigation Measures and Mitigated Impacts

4.5.6 The assessment assumed that all the noisy equipments for the SPS and STW are located outdoor without covering. In real terms, the equipments are designed to be installed inside the respective building structures. A reduction of 20 dB(A) can be achieved if the building enclosure are built using suitable material such as concrete with surface density of 25 kg/m$^2$.

4.5.7 The use of acoustic louver on ventilation fans can provide significant reduction in noise level. It is recommended to provide acoustic louver with a minimum noise reduction of 10 dB(A) for ventilation fans at the discharge point.

4.5.8 The recommended mitigation measures for the equipment used for the operation of Pak She SPS and Cheung Chau STW and the proposed noise reduction are summarized in **Table 4.19**.

**Table 4.19 : Proposed Noise Mitigation Measures for Equipments during Operation**

| Location | Equipment | Mitigation Measures | Noise Reduction |
|---|---|---|---|
| **Pak She Sewage Pumping Station** | Submersible pump | enclosed inside SPS building structure | -20 dB(A) |
| | Mechanically raked fine screen | enclosed inside SPS building structure | -20 dB(A) |
| | Deodourizing fan | enclosed inside SPS building structure | -20 dB(A) |
| | Exhaust fan | Provide acoustic louver at discharge point | -10 dB(A) |
| **Cheung Chau Sewage Treatment Works** | Submersible pump | enclosed inside treatment unit building structure | -20 dB(A) |
| | Mechanically raked fine screen | enclosed inside STW building structure | -20 dB(A) |
| | Deodourizing fan | enclosed inside STW building structure | -20 dB(A) |
| | Exhaust fan | Provide acoustic louver at discharge point | -10 dB(A) |
| | Blower | enclosed inside STW building structure | -20 dB(A) |
| | Mechanical pump | enclosed inside STW building structure | -20 dB(A) |

4.5.9 By incorporating the recommended noise mitigation measures, the predicted worst-case mitigated noise levels at identified NSRs due to the operation of Cheung Chau STW and Pak She SPS would comply with the noise criteria at all time. The predicted noise levels at representative NSRs are summarized in **Table 4.20** and detailed in **Appendix 4.8**.

**Table 4.20 : Predicted Maximum Operational Noise Levels at Representative NSRs - With Mitigation Measures**

| NSR | NSR Description | Predicted Mitigated Noise Level, dB(A) | Night-time Noise Criterion, dB(A) | Day-time Noise Criterion, dB(A) |
|---|---|---|---|---|
| CKH | Cheung King House | 45 | 45 | 53 |
| CSH2 | Cheung Shun House | 44 | 45 | 53 |
| PSSL | No. 1A Pak She Second Lane | 42 | 45 | 55 |

4.5.10 The maximum sound power level of equipment would be specified in the tender specification to ensure the operational noise impact complying with relevant noise criteria. The supplier of equipment should guarantee the specified SWLs including the characteristics of tonality, impulsiveness and intermittency, if any. If necessary, the suppliers should apply attenuation measures (e.g. use of silencers) to achieve the recommended noise levels during the detailed design stage.

### Residual Impact

4.5.11 Provided that the maximum SWL of equipment is met through appropriate design and the recommended noise mitigation measures are adopted, the residual noise impacts due to the operation of the upgraded Cheung Chau STW and Pak She SPS are expected to be insignificant.

## 4.6 Environmental Monitoring and Audit Requirements

### Construction Phase

4.6.1 With the adoption of appropriate noise mitigation measures, construction noise levels caused by upgrading of Cheung Chau STW and Pak She SPS at all representative NSRs would comply with the EIAO-TM daytime noise criteria of 75 dB(A). It was envisaged that the residual impact at the NSRs will be significantly reduced with appropriate mitigation measures being incorporated. Nonetheless, it is recommended that environmental monitoring and audit (EM&A) for construction noise be carried out throughout the construction period for upgrading of Cheung Chau STW and Pak She SPS to ensure proper implementation of construction phase mitigation measures with consideration of practicability in local levels. Details of the specific EM&A requirements are detailed in the EM&A Manual.

4.6.2 Localised and short period residual impacts during construction of the sewers works were predicted. As such, it is recommended that construction phase EM&A is undertaken as part of the contract requirements. Details of the EM&A programme will be included as Particular Specifications of the works contract documents.

### Operational Phase

4.6.3 Operational noise impacts from fixed plant of the Cheung Chau STW and Pak She SPS can be effectively mitigated by implementing noise control treatment at source. Results of assessment indicate that the predicted impacts are within the EIAO-TM requirements. EM&A during operational phase is not required. In order to ensure compliance of the operational airborne noise impacts with the relevant noise standards, the requirement for carrying out a noise commissioning test for all major fixed noise sources should be included in the tender document.

## 4.7 Conclusion

4.7.1 Construction noise assessment has been conducted for the upgrading of Cheung Chau STW and Pak She SPS, and the sewers works. Assessment results indicate that with proper implementation of recommended mitigation measures, the predicted noise levels at the NSRs due to the construction activities for upgrading of Cheung Chau STW and Pak She SPS will comply with the EIAO-TM noise standard.

4.7.2 There would be noise exceedances at some NSRs due to the construction activities for the sewers works. Mitigation measures have been recommended to reduce the associated construction noise impacts. Residual impacts of construction phase have been evaluated and considered the impacts are temporary and reversible. Construction phase EM&A is recommended to be undertaken for the sewers works to minimize the impacts as far as practicable.

4.7.3 Operational noise impacts from fixed plant of the Cheung Chau STW and Pak She SPS can be effectively mitigated by implementing noise control treatment at source. Results of assessment indicate that the predicted impacts are within the EIAO-TM requirements.

# 5. WATER QUALITY IMPACT

## 5.1 Introduction

5.1.1 This section presents the results of water quality impact assessment associated with the construction and operation phases of both the Cheung Chau STW and Pak She SPS upgrading works and the sewers works of the Project.

5.1.2 The assessment covered the scope outlined in Section 3.4.4 of the EIA Study Brief, and was based on the criteria and guidelines stated in Annexes 6 and 14 of the EIAO-TM for evaluation and assessment of water quality impacts. Recommended mitigation measures were provided, where necessary, to minimize the identified water quality impacts, if any, to acceptable levels.

## 5.2 Relevant Legislations, Standards & Guidelines

### Environmental Impact Assessment Ordinance (EIAO)

5.2.1 The Environmental Impact Assessment Ordinance (EIAO) provides a legislative framework to safeguard the environment by reducing and minimizing adverse environmental impacts from designated projects.

5.2.2 Annexes 6 and 14 of the EIAO – TM specify the general and project-specific criteria, and guidelines for water quality impact assessment.

### Practice Note for Professional Persons

5.2.3 The Practice Note for Professional Persons (ProPECC Note PN1/94) on construction site drainage provides guidelines on good practice for dealing with discharges from construction sites. This note is applicable to this study for control of site runoff and wastewater generated during the construction phase of the Project.

5.2.4 The assessment will follow this practical note to recommend mitigation measures to minimize the potential water quality impact arising from construction activities.

### Water Pollution Control Ordinance & Water Quality Objectives

5.2.5 The Water Pollution Control Ordinance (WPCO) (Cap. 358) enacted in 1980 is the principal legislation to safeguard the water quality in Hong Kong. Under the WPCO, the Hong Kong waters are divided into 10 Water Control Zones (WCZs). Water Quality Objectives (WQOs) are specified for each of the 10 WCZs, respectively. The WQOs set the limits for different water quality parameters for maintaining the integrity of aquatic system within each of the WCZs.

5.2.6 The effluent discharge from the Cheung Chau STW has the potential to impact the marine water quality conditions in the Southern WCZ and adjacent areas. The WQOs for the Southern WCZ are listed in **Table 5.1**.

**Table 5.1 : Summary of Water Quality Objectives for Southern WCZ**

| Parameter | Water Quality Objective | Sub-Zone |
|---|---|---|
| Aesthetic Appearance | • There should be no objectionable odours or discolouration of the water.<br>• Tarry residues, floating wood, articles made of glass, plastic, rubber or of any other substances should be absent.<br>• Mineral oil should not be visible on the surface.<br>• Surfactants should not give rise to a lasting foam.<br>• There should be no recognisable sewage-derived debris.<br>• Floating, submerged and semi-submerged objects of a size likely to interfere with the free movement of vessels, or cause damage to vessels, should be absent.<br>• The waters should not contain substances which settle to form objectionable deposits. | Whole zone |
| Bacteria | • Annual geometric mean level of Escherichia coli not to exceed 610 cfu/100mL for secondary contact recreation subzones and fish culture zones.<br>• Geometric mean level of E.coli of all samples collected from March to October exclusive not to exceed 180 per 100mL for bathing beaches. | • Secondary Contact Recreation Subzones & Fish Culture Zones<br>• Bathing Beach Subzones |
| Dissolved Oxygen (DO) | • Bottom dissolved oxygen not less than 2 mg/L for 90% of samples;<br>• Depth-averaged dissolved Oxygen not less than 4 mg/L for 90% of samples. | Whole zone |
| pH | In the range 6.5 - 8.5, change due to waste discharge not to exceed 0.2. | Whole zone |
| Temperature | Change due to waste discharge not to exceed 2°C. | Whole zone |
| Salinity | Change due to waste discharge not to exceed 10% of natural ambient level. | Whole zone |
| Suspended solids (SS) | Waste discharge not to raise the natural ambient level by 30% nor cause the accumulation of suspended solids which may adversely affect aquatic communities. | Marine waters of the whole zone |
| Ammonia | Annual mean of un-ionized ammonia nitrogen not to exceed 0.021 mg/L, calculated as the arithmetic mean. | Whole zone |
| Nutrients | Annual mean depth-averaged total inorganic nitrogen (TIN) not to exceed 0.1mg/L. | Whole zone |
| Toxins | Not to be present at levels producing significant toxic effect. | Whole zone |

**Technical Memorandum on Effluents Discharge Standard**

5.2.7 Effluent discharges are subject to control under the WPCO. The Technical Memorandum (TM) on Standards for Effluents Discharged into Drainage and Sewerage Systems, Inland and Coastal Waters, issued under Section 21 of the WPCO, sets limits for permissible effluent discharges based on the types of receiving waters (foul sewers, storm water drains, inland and coastal waters).

5.2.8 The effluent standards are intended to control the physical, chemical and microbial quality of effluent, and vary with the effluent flow rate. The TM effluent standards relevant to this study are summarized in **Table 5.2**.

**Table 5.2 : Standards for Effluent Discharge into Marine Waters of the Southern Water Control Zone**

| Flow rate ($m^3$/day) Determinant | ≤10 | >10 & ≤200 | >200 & ≤400 | >400 & ≤600 | >600 & ≤800 | >800 & ≤1000 | >1000 & ≤1500 | >1500 & ≤2000 | >2000 & ≤3000 | >3000 & ≤4000 | >4000 & ≤5000 | >5000 & ≤6000 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| pH (pH units) | 6–10 | 6–10 | 6–10 | 6–10 | 6–10 | 6–10 | 6–10 | 6–10 | 6–10 | 6–10 | 6–10 | 6–10 |
| Temperature (°C) | 45 | 45 | 45 | 45 | 45 | 45 | 45 | 45 | 45 | 45 | 45 | 45 |
| Colour (lovibond units) (25mm cell length) | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |
| Suspended solids | 500 | 500 | 500 | 300 | 200 | 200 | 100 | 100 | 50 | 50 | 40 | 30 |
| BOD | 500 | 500 | 500 | 300 | 200 | 200 | 100 | 100 | 50 | 50 | 40 | 30 |
| COD | 1000 | 1000 | 1000 | 700 | 500 | 400 | 300 | 200 | 150 | 100 | 80 | 80 |
| Oil & Grease | 50 | 50 | 50 | 30 | 25 | 20 | 20 | 20 | 20 | 20 | 20 | 20 |
| Iron | 20 | 15 | 13 | 10 | 7 | 6 | 4 | 3 | 2 | 1.5 | 1.2 | 1 |
| Boron | 6 | 5 | 4 | 3.5 | 2.5 | 2 | 1.5 | 1 | 0.7 | 0.5 | 0.4 | 0.3 |
| Barium | 6 | 5 | 4 | 3.5 | 2.5 | 2 | 1.5 | 1 | 0.7 | 0.5 | 0.4 | 0.3 |
| Mercury | 0.1 | 0.1 | 0.1 | 0.001 | 0.001 | 0.001 | 0.001 | 0.001 | 0.001 | 0.001 | 0.001 | 0.001 |
| Cadmium | 0.1 | 0.1 | 0.1 | 0.001 | 0.001 | 0.001 | 0.001 | 0.001 | 0.001 | 0.001 | 0.001 | 0.001 |
| Other toxic metals individually | 2 | 1.5 | 1.2 | 0.8 | 0.6 | 0.5 | 0.32 | 0.24 | 0.16 | 0.12 | 0.1 | 0.1 |
| Total toxic metals | 4 | 3 | 2.4 | 1.6 | 1.2 | 1 | 0.64 | 0.48 | 0.32 | 0.24 | 0.2 | 0.14 |
| Cyanide | 1 | 0.5 | 0.5 | 0.5 | 0.4 | 0.3 | 0.2 | 0.15 | 0.1 | 0.08 | 0.06 | 0.04 |
| Phenols | 0.5 | 0.5 | 0.5 | 0.3 | 0.25 | 0.2 | 0.13 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 |
| Sulphide | 5 | 5 | 5 | 5 | 5 | 5 | 2.5 | 2.5 | 1.5 | 1 | 1 | 0.5 |
| Total residual chlorine | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |
| Total nitrogen | 100 | 100 | 80 | 80 | 80 | 80 | 50 | 50 | 50 | 50 | 50 | 50 |
| Total phosphorus | 10 | 10 | 8 | 8 | 8 | 8 | 5 | 5 | 5 | 5 | 5 | 5 |
| Surfactants (total) | 30 | 20 | 20 | 20 | 15 | 15 | 15 | 15 | 15 | 15 | 15 | 15 |
| *E.Coli* (count/100 mL) | 4000 | 4000 | 4000 | 4000 | 4000 | 4000 | 4000 | 4000 | 4000 | 4000 | 4000 | 4000 |

Notes:
(1) All units in mg/L unless otherwise stated; and
(2) All figures are upper limits unless otherwise indicated.

## Assessment Criteria for Specific Sensitive Receivers

### *Water Supplies Department's Water Quality Criteria*

5.2.9 Water Supplies Department (WSD) has specified a set of water quality criteria for flushing seawater intakes. The WSD parameters relevant to this EIA are shown in **Table 5.3** along with their target limits.

**Table 5.3 : WSD Water Quality Standards for Flushing Water Intakes**

| Parameter (in mg/L unless otherwise stated) | WSD Target Limit |
|---|---|
| Colour (Hazen Unit) | < 20 |
| Turbidity (NTU) | < 10 |
| Threshold Odour Number (odour unit) | < 100 |
| Ammonical Nitrogen | < 1 |
| Suspended Solids (SS) | < 10 |
| Dissolved Oxygen (DO) | > 2 |
| Biochemical Oxygen Demand (BOD) | < 10 |
| Synthetic Detergents | < 5 |
| *E.Coli* (no. / 100 ml) | < 20,000 |

### *Assessment Criterion for Cooling Water Intake*

5.2.10 The assessment criterion to address the impact on cooling water intakes is a limit of 40 mg/L for suspended solids (SS).

### *Assessment Criteria for Corals*

5.2.11 The assessment criteria for corals are based on both the sedimentation rate and WQO for SS. A 3-dimensional hydrodynamic and water quality mathematical model was used in the EIA to predict the SS concentrations in receiving waters.

5.2.12 With reference to studies by (Pastorok & Bilyard, 1985) and (Hawker & Connel, 1992) on coral reef communities, the recommended sedimentation rate for providing sufficient protection and avoiding unacceptable impacts to corals is less than 0.1 kg/m$^2$/day.

5.2.13 The WQO for SS specifies that human activities or waste discharges shall not raise the ambient SS level by 30% and shall not affect aquatic communities. The ambient SS concentrations at each of the identified WSRs were determined using the latest field data collected at the EPD's marine water monitoring stations located near the WSRs. The level of increase in SS due to the Project was predicted by a mathematical modelling approach.

## 5.3 Assessment Methodology

### Key Issues

5.3.1 Main water quality issues related to the construction and operational phases of the Project include:

- Construction site runoff;
- Wastewater generated from general construction activities;
- Sewage effluent generated by the workforce;
- Emergency discharge of sewage from the SPS and STW;
- Accidental spillage of chemicals; and
- Discharge of effluent from the upgraded STW into the marine water.

5.3.2 During the construction phase, runoff and potential wastewater releases from construction sites are the major issues related to water quality impact.

5.3.3 During the operational phase, water quality impact is mainly related to the effluent discharge from the upgraded Cheung Chau STW. A key concern is that the effluent discharge may affect the quality of waterbodies at the nearby water quality sensitive receivers.

5.3.4 Impacts could also occur in case of emergency discharge of wastewaters resulting from unexpected events such as interruption of power supply or damage to the effluent pipeline. The emergency discharge may cause substantially higher pollutant levels in receiving waters than the normal operational condition.

5.3.5 The mathematical modelling approach was used in this study to predict and assess the potential water quality impact. The Delft3D suite of models with capabilities of 3-dimensional hydrodynamic and water quality simulation was adopted to quantify the impacts in line with the modelling requirements listed in Appendix D of the EIA Study Brief No. ESB-212/2009. Details on the modelling approach are provided in **Appendix 5A** of this report.

5.3.6 The study area for water quality impact assessment mainly includes the Southern WCZ as required in the EIA Study Brief. Adjacent areas in other WCZs were evaluated where appropriate.

### Construction Phase

5.3.7 Potential sources of water quality impact under the construction phase include:

- Construction site runoff;
- Wastewater generated from general construction activities;
- Sewage effluent generated by workforce; and
- Accidental spillage of chemicals.

5.3.8 Water quality impact assessment for the construction phase covered all the identified potential sources, and followed the criteria and guidelines for water pollution evaluation as stated in Annexes 6 and 14 of the EIAO – TM. Mitigation measures were proposed on the basis of ProPECC Note for Construction Site Drainage to ensure that any effluent discharge would comply with the WPCO criteria.

**Operational Phase**

***Effluent from Cheung Chau STW***

5.3.9 During the operational phase, a major concern is the discharge of treated effluent from Cheung Chau STW into the marine water. To address the concern, the Delft3D model with 3-dimensional capability was used to simulate the effects of the effluent discharge on water quality conditions of the marine environment.

***Emergency Discharge***

5.3.10 The Cheung Chau STW is located in the vicinity of Cheung Chau Wan (Cheung Chau Typhoon Shelter) and Tai Kwai Wan. The Pak She SPS to be upgraded is located near Cheung Chau Wan (Cheung Chau Typhoon Shelter). In case of an operational failure, overflow of raw sewage from the STW could impose a higher level of water quality impact to nearby water sensitive receivers compared to the normal operating condition. On the other hand, emergency overflow of raw sewage from the Pak She SPS would be diverted into the Cheung Chau STW for treatment prior to discharge into the marine water. The main concern about the emergency discharge in this EIA is overflow of raw sewage from the Cheung Chau STW.

5.3.11 The potential impact of emergency discharge was assessed using the 3-dimensional water quality model, Delft3D. The existing submarine outfall and emergency discharge of Cheung Chau STW is shown in **Figure 5.1a**.

***Scenario Runs***

5.3.12 According to the project development programme indicated in the EIA Study Brief, the Cheung Chau STW was tentatively scheduled to be completed in early 2019. The time horizon for water quality impact assessment was therefore set at the year of 2019 and the assessment was conducted for the following scenarios:

- Scenario 1 – Year 2019 without the proposed upgrading of the Cheung Chau STW (baseline condition);
- Scenario 2 – Year 2019 with the proposed upgrading of the Cheung Chau STW (normal operation of the upgraded STW); and
- Scenario 3 – Emergency bypass of untreated sewage from the Cheung Chau STW (STW failure).

5.3.13 Scenario 1 represents the baseline condition in 2019 without the Cheung Chau STW upgrading works. The purpose of Scenario 1 is to evaluate the environmental conditions that would be expected in absence of the proposed Project. Scenario 2 represents the normal operation of the Cheung Chau STW after the Project is commissioned in 2019. Scenario 3 is to assess the impact from emergency discharge of untreated sewage in case of temporary shutdown of Cheung Chau STW due to the failure of power supply or other incidents.

5.3.14 As the overflow of raw sewage from the Pak She SPS would be diverted to the Cheung Chau STW for treatment prior to discharge, and the worst emergency discharge from the Cheung Chau STW is assessed in Scenario 3, it is not necessary to carry out additional modelling work for the Pak She SPS emergency discharge.

**Evaluation of Mitigation Measures**

5.3.15 Appropriate mitigation measures were identified where necessary to mitigate the potential water quality impact to an acceptable level for both the construction and operational phases of the Project.

**Residual Water Quality Impacts**

5.3.16 With the implementation of recommended mitigation measures, the residual water quality impact was assessed to examine the potential impact to water sensitive receivers in the study area.

**Model Development**

5.3.17 Computer modelling approach was adopted to assess the potential impact on marine water quality associated with the Project. The Delft3D suite of models, namely Delft3D-FLOW and Delft3D-WAQ, developed by Delft Hydraulics, was used as the platform for hydrodynamic and water quality modelling, respectively. Delft3D is a state-of-the-art computer program that simulates three-dimensional flow and water quality processes and is capable of handling interactions between different hydrodynamic and water quality processes.

5.3.18 The existing regional model "Update Model" developed for Hong Kong marine waters was applied in this study to simulate the effects of the proposed Cheung Chau STW works on hydrodynamics and water quality. The Update Model is a fully calibrated and verified model developed under Update on Cumulative Water Quality and Hydrological Effect of Coastal Developments and Upgrading of Assessment Tool Study (1998) by EPD based on the Delft3D suite of models.

5.3.19 The grid size of the existing Update Model near the Project site is in the order of about 300 m. To cover the local areas near the proposed Project, a fine grid model with finer grids was specifically set up for the Cheung Chau Project to carry out hydrodynamic and water quality simulations. The grid size of the fine grid model was set to be less than 75 m near the discharge outfall to meet the modelling requirements specified in the Study Brief.

5.3.20 The fine grid model was linked to the regional Update Model for continuity of model input conditions. Open boundary conditions of the fine grid model were transferred from the Update Model. That is, modelling was first carried out using the regional Update Model, and the output from the Update Model at the interface with the local fine grid model was used as the boundary conditions for input to the local fine grid model. The cumulative effects from the Pearl River estuary were accounted for in the Update Model, which covers the entire Hong Kong waters and the Pearl River estuary. Details on the model development are provided in **Appendix 5A** of this report.

**Pollution Loading**

***Scenario 1 – Baseline Condition***

5.3.21 **Table 5.4** shows the pollutant loads into the marine water under the baseline condition without upgrading of the Cheung Chau STW. Details on the pollutant load calculation are illustrated in **Appendix 5B**.

**Table 5.4 : Baseline Pollutant Loads from Existing Cheung Chau STW Effluent**

| Flow ($m^3/d$) | BOD (kg/d) | TSS (kg/d) | *E. coil* (CFU/d) | NH3-N (kg/d) | TKN (kg/d) | Org-N (kg/d) |
|---|---|---|---|---|---|---|
| 8,817 | 797 | 571 | $2.56x10^{15}$ | 97 | 194 | 97 |

***Scenario 2 - Normal Operation of Upgraded Cheung Chau STW***

5.3.22 Upon commissioning, the upgraded Cheung Chau STW is expected to discharge a reduced amount of pollutants into the marine water due to the implementation of upgraded facilities and improved treatment efficiencies of the STW. The proposed quality of the treated effluent from the upgraded Cheung Chau STW is as follows:

- Flow ($m^3/d$): 9,800
- BOD (mg/L): 20
- TSS (mg/L): 30
- NH3-N (mg/L): 5
- TN (mg/L): 10
- *E. coil* (CFU/100ml): 1,000

5.3.23 The pollutant loads from the upgraded Cheung Chau STW effluent into the marine water under the normal operational condition are summarized in **Table 5.5**.

**Table 5.5 : Projected Pollutant Loads from Upgraded Cheung Chau STW Effluent under Normal Operational Condition**

| Flow ($m^3/d$) | BOD (kg/d) | TSS (kg/d) | *E. coil* (CFU/d) | $NH_3$-N (kg/d) | TKN (kg/d) | $NO_3$ (kg/d) |
|---|---|---|---|---|---|---|
| 9,800 | 196 | 294 | $9.80\times10^{10}$ | 49 | 73.5 | 24.5 |

***Scenario 3 – Emergency Discharge of Untreated Sewage from Cheung Chau STW***

5.3.24 In case of operational failure of the Cheung Chau STW, raw sewage would bypass the wastewater treatment unit and be directly discharged into the marine water as an emergency discharge. The STW emergency discharge loads are shown in **Table 5.6**.

**Table 5.6 : Projected Pollutant Loads from Upgraded Cheung Chau STW under Emergency Discharge of Untreated Sewage**

| Flow ($m^3/d$) | BOD (kg/d) | TSS (kg/d) | *E. coil* (CFU/d) | $NH_3$-N (kg/d) | TKN (kg/d) | Org-N (kg/d) |
|---|---|---|---|---|---|---|
| 9,800 | 1881.6 | 1636.6 | $5.68\times10^{15}$ | 186.2 | 323.4 | 137.2 |

**Data Collection**

5.3.25 To assess the existing water quality conditions in the study area, the most recently published monitoring data collected at the EPD marine water monitoring stations near the proposed Project site were compiled and reviewed.

5.3.26 The compiled information include water quality monitoring data collected from 2006 to 2010 at the EPD marine water quality monitoring station, SM12, and Cheung Chau Typhoon Shelter water monitoring station, ST1, in the Southern WCZ. Water quality data monitored at the Tung Wan and Kwun Yam Wan beaches were also used in the EIA study.

## 5.4 Study Area and Sensitive Receivers

5.4.1 The study area for this EIA study is shown in **Figure 5.1** and **Figure 5.2**. It covers the Cheung Chau Island and its surrounding areas to have a sufficient aerial coverage of potentially affected marine waters. Identified water sensitive receivers (WSRs) in the study area that could be potentially affected by the Cheung Chau STW works include the following:

- bathing beaches including Cheung Chau Tung Wan, Kwun Yam Wan, Tai Kwai Wan, Tai Long Wan, and Yi Long Wan;
- secondary contact recreational zones;
- recreation and tourism related uses;
- coastal protection areas;
- natural coastal shore, water courses, and natural streams and rivers in and near Cheung Chau;
- Cheung Chau Typhoon Shelter;
- areas of ecological or conservation value in Cheung Chau;
- habitats of marine mammals (e.g. Finless Porpoise and Chinese White Dolphin);
- marine benthic communities;
- intertidal habitats;
- corals;
- fish spawning and nursery grounds and fish culture zones; and
- sea water intakes.

5.4.2 Potential adverse impacts on the above WSRs due to the proposed Cheung Chau Upgrading Project were evaluated in this EIA study.

## 5.5 Baseline Water Quality

5.5.1 To assess the existing water quality conditions in the study area, the most recently published monitoring data collected at the EPD marine water monitoring stations near Cheung Chau were compiled and reviewed.

5.5.2 The data collected at the EPD marine water quality monitoring station, SM12, and Cheung Chau Typhoon Shelter water monitoring station, ST1, in the Southern WCZ were used to represent the baseline water quality conditions of the study area. The station, SM12, is close to the project site and is considered to reflect the typical condition and trend of baseline water quality in Adamasta Channel, west of Cheung Chau Island. Data monitored at the Cheung Chau Typhoon Shelter reflect the local baseline water quality condition in the typhoon shelter area. The latest water quality data for the Tung Wan and Kwun Yam Wan beaches were also reviewed. The collected water quality data are presented in **Table 5.7** to **Table 5.10**.

**Table 5.7 : Water Quality Monitoring Results at SM12 from 2006 to 2010**

| Parameter | 2006 | 2007 | 2008 | 2009 | 2010 | Average |
|---|---|---|---|---|---|---|
| Temperature (°C) | 24.2 | 24.1 | 23.0 | 24.3 | 23.7 | 23.9 |
| | (18.0 - 28.1) | (19.4 - 27.9) | (13.7 - 28.9) | (16.4 - 28.9) | (16.7 - 28.6) | |
| Salinity (ppt) | 31.2 | 31.3 | 29.5 | 30.7 | 29.9 | 30.5 |
| | (24.8 - 33.1) | (27.1 - 33.6) | (14.9 - 32.9) | (25.6 - 33.3) | (23.1 - 33.4) | |
| DO (mg/L) (Depth-average) | 7.3 | 7.1 | 6.8 | 6.3 | 7.0 | 6.9 |
| | (6.1 - 9.2) | (5.2 - 9.7) | (4.5 - 9.8) | (5.3 - 8.0) | (5.4 - 8.6) | |
| DO (mg/L) Bottom | 7.3 | 6.9 | 6.6 | 6.2 | 6.5 | 6.7 |
| | (5.8 - 9.6) | (5.6 - 8.8) | (3.0 - 9.7) | (5.0 - 8.0) | (4.7 - 7.9) | |
| pH | 8.1 | 8.2 | 8.1 | 8.1 | 8.0 | 8.1 |
| | (7.9 - 8.3) | (7.5 - 8.9) | (7.7 - 8.3) | (7.9 - 8.5) | (7.7 - 8.3) | |
| Secchi Disc Depth (m) | 1.5 | 1.5 | 1.8 | 2.0 | 2.1 | 1.8 |
| | (0.4 - 2.1) | (1.0 - 2.2) | (1.0 - 3.2) | (1.0 - 3.3) | (1.1 - 3.5) | |
| Turbidity (NTU) | 15.7 | 12.9 | 13.5 | 9.7 | 5.0 | 11.4 |
| | (4.9 - 27.7) | (4.2-20.5) | (8.8-21.9) | (1.7-23.5) | (1.8 - 9.5) | |
| SS (mg/L) | 7.8 | 7.7 | 11.6 | 13.1 | 6.5 | 9.3 |
| | (2.3-14.9) | (2.1 - 18.7) | (2.8-21.0) | (2.3-36.0) | (1.5 - 14.2) | |
| $BOD_5$ (mg/L) | 0.8 | 1.4 | 0.7 | 1.0 | 1.1 | 1.0 |
| | (0.2 - 2.2) | (0.1 - 3.4) | (0.2 - 1.8) | (0.3 - 2.2) | (0.4 - 2.2) | |
| $NH_4$ (mg/L) | 0.06 | 0.09 | 0.07 | 0.049 | 0.070 | 0.068 |
| | (0.02 - 0.14) | (0.03 - 0.16) | (0.02 - 0.21) | (0.020 - 0.120) | (0.030 - 0.163) | |
| $NH_3$-N (mg/L) | 0.004 | 0.007 | 0.004 | 0.003 | 0.003 | 0.004 |
| | (0.001 - 0.009) | (0.001 - 0.028) | (<0.001 - 0.018) | (0.001 - 0.007) | (<0.001 - 0.009) | |
| $NO_2$ (mg/L) | 0.031 | 0.034 | 0.041 | 0.033 | 0.038 | 0.035 |
| | (0.002 - 0.086) | (0.009 - 0.081) | (0.006 - 0.160) | (0.013 - 0.120) | (0.006 - 0.088) | |
| $NO_3$ (mg/L) | 0.12 | 0.131 | 0.194 | 0.140 | 0.178 | 0.153 |
| | (<0.01 - 0.42) | (0.051 - 0.280) | (0.019 - 0.940) | (0.052 - 0.303) | (0.029 - 0.477) | |
| TIN (mg/L) | 0.22 | 0.25 | 0.31 | 0.22 | 0.29 | 0.26 |
| | (0.03 - 0.52) | (0.12 - 0.44) | (0.07 - 1.31) | (0.13 - 0.36) | (0.07 - 0.61) | |
| TKN (mg/L) | 0.23 | 0.30 | 0.27 | 0.21 | 0.22 | 0.25 |
| | (0.14 - 0.32) | (0.15 - 0.63) | (0.15 - 0.46) | (0.13 - 0.28) | (0.13 - 0.32) | |
| TN (mg/L) | 0.38 | 0.47 | 0.51 | 0.38 | 0.44 | 0.44 |
| | (0.22 - 0.72) | (0.29 - 0.98) | (0.19 - 1.56) | (0.26 - 0.55) | (0.20 - 0.78) | |
| $PO_4$-P mg/L) | 0.01 | 0.014 | 0.016 | 0.011 | 0.013 | 0.013 |
| | (<0.01 - 0.03) | (0.004 - 0.027) | (0.004 - 0.028) | (<0.002 - 0.026) | (0.003 - 0.030) | |
| TP (mg/L) | 0.04 | 0.04 | 0.03 | 0.03 | 0.03 | 0.03 |
| | (0.02 - 0.06) | (0.02 - 0.09) | (0.02 - 0.05) | (<0.02 - 0.05) | (<0.02 - 0.04) | |
| Silica (mg/L) | 0.86 | 0.9 | 1.3 | 0.81 | 0.90 | 0.95 |
| | (0.1 - 2.4) | (0.1 - 1.4) | (0.1 - 4.9) | (0.15 - 1.50) | (0.21 - 2.00) | |
| Chlorophyll-a (µg/L) | 7.3 | 11.8 | 3.5 | 5.3 | 7.9 | 7.2 |
| | (1.8 - 25.7) | (1.0 - 46.0) | (1.2 - 10.4) | (1.6 - 17.3) | (1.3 - 27.3) | |
| *E.Coli* (count/100mL) | 26 | 25 | 21 | 36 | 43 | 30 |
| | (1 - 580) | (2 - 290) | (2 - 200) | (1 - 2600) | (1 - 840) | |
| Fecal Coliforms (count/100mL) | 63 | 54 | 43 | 79 | 93 | 66 |
| | (1 - 1500) | (2 - 490) | (3 - 480) | (3 - 3500) | (2 - 2100) | |

**Table 5.8 : Water Quality Monitoring Results at ST1 from 2006 to 2010**

| Parameter | 2006 | 2007 | 2008 | 2009 | 2010 | Average |
|---|---|---|---|---|---|---|
| Temperature (°C) | 24.1 | 24.0 | 23.1 | 23.8 | 23.7 | 23.7 |
| | (18.4 - 27.7) | (19.4 - 28.2) | (16.2 - 28.9) | (16.1 - 29.4) | (16.7 - 29.5) | |
| Salinity (ppt) | 31.8 | 31.6 | 29.4 | 30.7 | 29.7 | 30.6 |
| | (29.1 - 32.9) | (26.7 - 33.4) | (21.9 - 33.1) | (27.0 - 33.3) | (22.2 - 33.1) | |
| DO (mg/L) (Depth-average) | 6.7 | 6.4 | 6.8 | 6.2 | 6.9 | 6.6 |
| | (5.7 - 7.8) | (5.4 - 7.9) | (5.2 - 10.0) | (4.7 - 7.5) | (6.1 - 8.8) | |
| DO (mg/L) Bottom | 6.9 | 6.3 | 6.8 | 6.3 | 5.7 | 6.4 |
| | (5.7 - 8.2) | (5.4 - 7.3) | (4.7 - 9.9) | (4.6 - 7.4) | (0.8 - 7.8) | |
| pH | 8.1 | 8.1 | 8.1 | 8.1 | 8.0 | 8.1 |
| | (8.0 - 8.3) | (7.6 - 8.9) | (8.0 - 8.2) | (7.9 - 8.4) | (7.7 - 8.3) | |
| Secchi Disc Depth (m) | 1.6 | 1.8 | 2.2 | 2.0 | 2 | 1.9 |
| | (1.4 - 1.8) | (1.0 - 2.5) | (1.1 - 3.1) | (1.0 - 2.5) | (1.5 - 2.6) | |
| Turbidity (NTU) | 14.3 | 11.5 | 9.5 | 7.2 | 4.5 | 9.4 |
| | (5.0-25.2) | (4.2 - 15.1) | (7.2 - 15.0) | (3.3 - 10.9) | (1.9 - 8.1) | |
| SS (mg/L) | 7.7 | 5.0 | 6.1 | 6.5 | 5.1 | |
| | (2.8-19.1) | (1.9 - 7.1) | (2.1 - 12.0) | (4.4 - 9.9) | (2.7 - 9.4) | |
| $BOD_5$ (mg/L) | 1.1 | 1.4 | 1.1 | 1.2 | 1.6 | 1.3 |
| | (0.2 - 2.6) | (0.6 - 3.0) | (0.7 - 1.8) | (0.3 - 2.1) | (0.7 - 2.3) | |
| $NH_4$ (mg/L) | 0.09 | 0.11 | 0.08 | 0.08 | 0.067 | 0.085 |
| | (0.04 - 0.13) | (0.07 - 0.15) | (0.04 - 0.14) | (0.039 - 0.153) | (0.034 - 0.15) | |
| $NH_3$-N (mg/L) | 0.005 | 0.008 | 0.004 | 0.004 | 0.003 | 0.005 |
| | (0.002 - 0.008) | (0.001 - 0.027) | (0.002 - 0.006) | (0.002 - 0.008) | (0.001 - 0.006) | |
| $NO_2$ (mg/L) | 0.025 | 0.022 | 0.024 | 0.017 | 0.034 | 0.024 |
| | (0.002 - 0.072) | (0.011 - 0.033) | (0.007 - 0.057) | (0.010 - 0.034) | (0.007 - 0.069) | |
| $NO_3$ (mg/L) | 0.10 | 0.116 | 0.181 | 0.124 | 0.159 | 0.136 |
| | (0.01 - 0.20) | (0.090 - 0.167) | (0.033 - 0.465) | (0.065 - 0.280) | (0.051 - 0.33) | |
| TIN (mg/L) | 0.22 | 0.25 | 0.29 | 0.22 | 0.26 | 0.25 |
| | (0.05 - 0.36) | (0.19 - 0.31) | (0.08 - 0.63) | (0.17 - 0.34) | (0.13 - 0.4) | |
| TKN (mg/L) | 0.25 | 0.31 | 0.29 | 0.23 | 0.24 | 0.26 |
| | (0.21 - 0.28) | (0.25 - 0.47) | (0.24 - 0.35) | (0.13 - 0.31) | (0.18 - 0.37) | |
| TN (mg/L) | 0.38 | 0.44 | 0.50 | 0.37 | 0.44 | 0.43 |
| | (0.21 - 0.51) | (0.37 - 0.64) | (0.28 - 0.78) | (0.28 - 0.55) | (0.23 - 0.57) | |
| $PO_4$-P (mg/L) | 0.016 | 0.016 | 0.018 | 0.014 | 0.013 | 0.015 |
| | (0.003 - 0.026) | (0.003 - 0.028) | (0.006 - 0.039) | (<0.002 - 0.022) | (0.003 - 0.026) | |
| TP (mg/L) | 0.04 | 0.04 | 0.04 | 0.03 | 0.03 | 0.04 |
| | (0.03 - 0.04) | (0.04 - 0.05) | (0.02 - 0.05) | (0.02 - 0.04) | (0.02 - 0.04) | |
| Silica (mg/L) | 0.8 | 0.7 | 1.0 | 0.76 | 0.68 | 0.79 |
| | (0.1 - 1.3) | (0.3 - 1.0) | (0.1 - 3.1) | (0.09 - 1.37) | (0.09 - 1.47) | |
| Chlorophyll-a (µg/L) | 6.7 | 14.2 | 5.3 | 0.55 | 10 | 7.35 |
| | (1.5 - 22.7) | (2.1 - 52.7) | (1.4 - 9.8) | (1.9 - 12.5) | (0.9 - 27) | |
| *E.Coli* (count/100mL) | 45 | 110 | 79 | 80 | 63 | 75 |
| | (2 - 200) | (14 - 240) | (19 - 270) | (32 - 290) | (15 - 150) | |
| Fecal Coliforms (count/100mL) | 150 | 390 | 260 | 210 | 220 | 246 |
| | (5 - 1000) | (68 - 1000) | (77 - 1100) | (50 - 1000) | (32 - 530) | |

**Table 5.9 : Beach Water Quality Monitoring Results at Cheung Chau Tung Wan from 2006 to 2010**

| Parameter | 2006 | 2007 | 2008 | 2009 | 2010 | Average |
|---|---|---|---|---|---|---|
| Temperature (°C) | 25.8 | 26.0 | 25.7 | 26.4 | 25.9 | 26.0 |
| | (16.9 - 30.9) | (17.6 - 29.8) | (17.0 - 29.6) | (19.5 - 31.0) | (18.0 - 31.0) | |
| Salinity (ppt) | 27.7 | 28.9 | 27.7 | 29.0 | 28.5 | 28.4 |
| | (18.9 - 32.3.) | (22.3 - 32.7) | (15.2 - 31.4) | (23.7 - 32.7) | (22.5 - 33.1) | |
| DO (mg/L) | 6.8 | 6.8 | 7.0 | 6.9 | 6.9 | 6.9 |
| | (5.1 - 9.1) | (5.5 - 8.6) | (6.0 - 8.3) | (5.5 - 8.6) | (5.9 - 8.3) | |
| pH | 8.1 | 8.2 | 8.3 | 8.4 | 8.4 | 8.3 |
| | (7.9 - 8.1) | (7.9 - 8.6) | (8.0 - 8.8) | (8.1 - 8.7) | (8.2 - 8.9) | |
| Turbidity (NTU) | 4.4 | 5.3 | 7.9 | 6.7 | 4.2 | 5.7 |
| | (1.6 - 13.6) | (1.2 - 18.2) | (4.4 - 20.1) | (2.8 - 16.4) | (1.5 - 9.9) | |
| *E.Coli* (count/100mL) | 37 | 21 | 15 | 17 | 12 | 20 |

**Table 5.10 : Beach Water Quality Monitoring Results at Cheung Chau Kwun Yam Wan from 2006 to 2010**

| Parameter | 2006 | 2007 | 2008 | 2009 | 2010 | Average |
|---|---|---|---|---|---|---|
| Temperature (°C) | 25.7 | 25.9 | 25.6 | 26.4 | 25.7 | 25.9 |
| | (16.6-31.3) | (17.9 - 29.8) | (17.0 - 29.3) | (19.5 - 30.4) | (18.0 - 31.0) | |
| Salinity (ppt) | 27.7 | 28.7 | 27.4 | 28.7 | 28.3 | 28.2 |
| | (19.6-32.3) | (21.7 - 32.7) | (15.0 - 31.4) | (23.4 - 32.6) | (21.7 - 33.1) | |
| DO (mg/L) | 6.9 | 6.9 | 7.0 | 6.8 | 6.8 | 6.9 |
| | (5.6-9.6) | (4.7 - 8.9) | (6.0 - 8.5) | (5.6 - 9.7) | (5.6 - 8.0) | |
| pH | 8.1 | 8.2 | 8.3 | 8.4 | 8.4 | 8.3 |
| | (7.9-8.4) | (7.7 - 8.7) | (7.9 - 8.8) | (8.1 - 8.7) | (8.1 - 8.9) | |
| Turbidity (NTU) | 4.3 | 5.1 | 8.3 | 7.2 | 3.8 | 5.7 |
| | (1.6-11.5) | (1.2 - 16.2) | (4.1 - 32.0) | (3.1 - 19.5) | (1.3- 10.1) | |
| *E.Coli* (count/100mL) | 13 | 9 | 10 | 9 | 8 | 10 |

5.5.3 Water quality data collected at majority of the marine water monitoring stations show that total inorganic nitrogen (TIN) frequently exceeds the water quality objective (WQO) for TIN. The TIN level at SM12 has been consistently higher than the WQO limit since 2006. The TIN concentration at the Cheung Chau shelter (ST1) is similar to that at SM12, and is also in non-compliance with the WQO.

5.5.4 The pH level monitored from 2006 to 2010 was in full compliance with the WQO at the Adamasta Channel (SM12) and the Cheung Chau Typhoon Shelter (ST1). From 2006 to 2010, pH at Tung Wan ranged from 7.9 to 8.9 and varied from 7.7 to 8.9 at Kwun Yam Wan, which is close to the WQO range of 6.5-8.5.

5.5.5 Salinity ranged from 23.1 to 33.4 ppt for SM12 and 22.2 to 33.1 ppt for ST1 in 2010. Salinity conditions at these two locations were very close. The annual average salinity remains to be stable since 2006. Salinity at the Tung Wan and Kwun Yam Beaches was in a similar range from 22.5 to 33.1 and 21.7 to 33.1, respectively in 2010. The annual average salinity levels at the two gazetted beaches were very close.

5.5.6 Depth-averaged DO ranged from 6.1 to 8.8 mg/L and 5.4 to 8.6 mg/L at ST1 and SM12, respectively, in 2010. The DO levels have been within the WQO limits since

2006 without a significant annual variation. The bottom DO monitored in 2010 at ST1 showed a wider range of 0.8-7.8 mg/L than the range of 4.7-7.9 mg/L at SM12. The lower DO levels occurred at Cheung Chau Shelter (ST1) might be influenced by human activities. DO levels at Tung Wan and Kwun Yam Wan varied from 5.9-8.3 mg/L and 5.6-8.0 mg/L in 2010, respectively, and were in compliance with the WQOs for DO. No significant changes in the annual average DO since 2006 were detected at the two beaches.

5.5.7 SS concentration monitored in 2010 ranged from 2.7 to 9.4 mg/L at ST1 in the Cheung Chau Typhoon Shelter and 1.5 to 14.2 mg/L at SM12 in Adamasta Channel. The slightly smaller range of SS concentration in the typhoon shelter might be attributable to less tidal disturbance inside the typhoon shelter. A similar pattern of SS variation was also observed in other years since 2006 that ST1 has a smaller range of SS variation than SM12.

5.5.8 *E.coli* levels at SM12 were fairly low in 2006 to 2010, which were in good compliance with the WQO for *E.coli*. The *E.coli* levels at the typhoon shelter (ST1) were relatively higher than those at SM12, but still in compliance with the WQO. The relatively higher *E.coli* levels at ST1 might be attributable to sewage generation in the typhoon shelter area.

5.5.9 For the Tung Wan and Kwun Yam Wan beaches, *E.coli* levels monitored in 2006 to 2010 were fairly low as shown in **Table 5.9** and **Table 5.10**, indicating a low risk to the public health.

## 5.6 Water Quality Impact Assessment

### Construction Phase

#### *Site Runoff*

5.6.1 Site runoff from construction sites that are subject to excavation or earth works might lead to surface erosion and would carry high sediment concentrations. Without any control, sediments in runoff might be discharged to adjacent marine waters near the Cheung Chau STW, the Cheung Chau Typhoon Shelter, and the Tung Wan and Kwun Yam Wan areas through drainage channels. If this was the case, it had the potential to cause increased concentrations of suspended solid in local waters and reduce light penetration into the water, which might affect aquatic organisms.

5.6.2 However, it should be noted that all the construction works are land-based and no works will be carried out in the marine or intertidal environment. Effluents from these construction sites, including any site runoff into the drainage channels, are controlled to comply with the WPCO. The relevant water pollution control and mitigation measures as recommended in ProPECC Note (PN1/94) for Construction Site Drainage are required to be implemented, and any effluents have to meet the WPCO standards. With the implementation of good site practice and the precautionary measures, polluting effluents from the construction sites are avoided and adverse water quality impact on the marine environment is not anticipated.

#### *General Construction Activities*

5.6.3 Wastewaters generated from general construction activities may contain high SS concentrations and a certain amount of grease and oil. Nonetheless, potential impact due to such site wastewater discharges can be minimized if good construction and site management practices are implemented to ensure that litter, fuels, and solvents would not enter public drainage systems. With implementation

of good management practices, no adverse impact is expected to occur to drainage systems and receiving waters.

5.6.4 The upgrading works of the Cheung Chau STW will not involve marine dredging activities and marine based construction works. Release of sediments and contaminants from the sea bed into the water column would not occur during the construction phase of the Project. The potential impact of the Cheung Chau STW Upgrading Project on sediment quality is not anticipated to be significant.

***Domestic Sewage from Workforce***

5.6.5 Domestic sewage generated from the workforce during the construction phase would be forbidden to be directly discharged into public drainage systems or adjacent waterbodies. Portable chemical toilets would be provided at the construction sites as necessary. Wastewater generated from site office would be discharged to public foul sewers or collected in temporary storage tanks. With a good control of domestic sewage, no adverse water quality impact from the workforce swage is anticipated to occur.

***Accidental Spillage of Chemicals***

5.6.6 Accidental spillage and illegal disposal of chemicals would cause soil contamination, which could potentially impose groundwater pollution. It could also impose pollution to nearby drainage channels or waterbodies through leaching to surface water. The Code of Practice on Packaging, Labelling and Storage of Chemical Wastes published under the Waste Disposal Ordinance would be used as a guideline for handling chemical wastes. The disposal of chemical wastes would be conducted following the rules stipulated in the Waste Disposal Ordinance.

5.6.7 With effective controls through good operation and management practices, no adverse impact is anticipated to occur to water quality due to the accidental spillage of chemicals from construction activities.

***Operational Phase***

***Scenario 1 - Baseline Condition***

5.6.8 Associated construction works is scheduled to commence in 2014 and to be completed in early 2019. Simulated marine water quality for 2019 with the existing Cheung Chau STW discharge was used as the baseline water quality condition for assessing the potential impact arising from the operation of the upgraded Cheung Chau STW.

5.6.9 The simulated baseline water quality results for 2019 at locations where the WSRs were identified are summarized in **Table 5.11** and **Table 5.12** for dry and wet seasons, respectively.

**Table 5.11 : Baseline Water Quality (Scenario 1) at Identified WSRs in Dry Season**

| Location | DO (mg/L) | Bottom DO (mg/L) | TIN (mg/L) | UIA (mg/L) | SS (mg/L) | $BOD_5$ (mg/L) | *E.Coli* (count/100mL) |
|---|---|---|---|---|---|---|---|
| **WQO** | **>4** | **>2** | **<0.1** | **<0.021** | **Change <30%** | **<10 (WQC)** | **< 610 cfu/100mL** |
| C1 | 6.4 | 6.3 | 0.12 | 0.002 | 3.9 | 0.1 | 6 |
| C2 | 6.4 | 6.3 | 0.12 | 0.002 | 3.9 | 0.1 | 6 |
| C3 | 6.2 | 6.2 | 0.12 | 0.002 | 4.0 | 0.1 | 1 |
| C4 | 6.2 | 6.2 | 0.12 | 0.002 | 4.0 | 0.1 | 2 |
| C5 | 6.2 | 6.2 | 0.12 | 0.002 | 3.9 | 0.1 | 1 |
| C6 | 6.3 | 6.3 | 0.12 | 0.002 | 4.0 | 0.1 | 1 |

| Location | DO (mg/L) | Bottom DO (mg/L) | TIN (mg/L) | UIA (mg/L) | SS (mg/L) | $BOD_5$ (mg/L) | *E.Coli* (count/100mL) |
|---|---|---|---|---|---|---|---|
| **WQO** | **>4** | **>2** | **<0.1** | **<0.021** | **Change <30%** | **<10 (WQC)** | **< 610 cfu/100mL** |
| C7 | 6.4 | 6.4 | 0.11 | 0.002 | 4.1 | 0.1 | 2 |
| C8 | 6.3 | 6.2 | 0.12 | 0.002 | 4.0 | 0.1 | 1 |
| C9 | 6.3 | 6.1 | 0.12 | 0.002 | 4.0 | 0.1 | 1 |
| C10 | 6.4 | 6.3 | 0.11 | 0.002 | 4.1 | 0.1 | 5 |
| C11 | 6.5 | 6.5 | 0.11 | 0.002 | 4.1 | 0.2 | 15 |
| C12 | 6.3 | 6.2 | 0.12 | 0.002 | 4.1 | 0.1 | 1 |
| C13 | 7.3 | 7.3 | 0.07 | 0.001 | 4.5 | 0.7 | 391 |
| C14 | 6.7 | 6.7 | 0.10 | 0.002 | 4.2 | 0.3 | 7 |
| C15 | 6.6 | 6.6 | 0.11 | 0.002 | 4.2 | 0.3 | 5 |
| B1 | 6.5 | 6.4 | 0.11 | 0.002 | 3.9 | 0.1 | 10 |
| B2 | 6.5 | 6.5 | 0.11 | 0.002 | 3.9 | 0.1 | 36 |
| B3 | 6.3 | 6.2 | 0.11 | 0.002 | 3.9 | 0.1 | 1 |
| B4 | 6.2 | 5.8 | 0.12 | 0.002 | 3.9 | 0.1 | 1 |
| B5 | 7.4 | 7.4 | 0.07 | 0.001 | 4.5 | 0.8 | 265 |
| B6 | 6.6 | 6.6 | 0.11 | 0.001 | 4.1 | 0.2 | 16 |
| B7 | 6.7 | 6.6 | 0.10 | 0.001 | 4.2 | 0.2 | 9 |
| B8 | 6.4 | 6.3 | 0.11 | 0.002 | 4.1 | 0.1 | 52 |
| B9 | 6.3 | 6.1 | 0.11 | 0.002 | 4.1 | 0.2 | 3 |
| ST1 | 6.5 | 6.3 | 0.13 | 0.003 | 4.8 | 0.6 | 80 |
| ST2 | 6.3 | 6.2 | 0.11 | 0.002 | 4.1 | 0.1 | 1 |
| FP1 | 6.3 | 6.2 | 0.11 | 0.002 | 4.0 | 0.1 | 47 |
| S1 | 6.3 | 6.2 | 0.11 | 0.002 | 3.9 | 0.1 | 29 |
| S2 | 6.2 | 6.2 | 0.11 | 0.002 | 4.0 | 0.1 | 1 |
| S3 | 6.3 | 6.2 | 0.11 | 0.002 | 4.0 | 0.1 | 1 |
| CW1 | 6.2 | 6.1 | 0.11 | 0.002 | 3.9 | 0.1 | 1 |
| MH1 | 6.2 | 6.2 | 0.11 | 0.002 | 4.0 | 0.1 | 1 |
| F1 | 6.7 | 6.7 | 0.10 | 0.002 | 4.2 | 0.3 | 7 |
| M1 | 6.9 | 6.9 | 0.09 | 0.001 | 4.3 | 0.4 | 15 |
| M2 | 6.7 | 6.7 | 0.10 | 0.001 | 4.2 | 0.2 | 37 |
| U1 | 6.4 | 6.3 | 0.11 | 0.002 | 4.0 | 0.1 | 4 |
| SM5 | 6.3 | 6.2 | 0.11 | 0.002 | 3.9 | 0.1 | 1 |
| SM6 | 6.3 | 6.2 | 0.11 | 0.002 | 4.0 | 0.1 | 1 |
| SM7 | 6.2 | 6.1 | 0.12 | 0.002 | 4.0 | 0.1 | 1 |
| SM9 | 6.3 | 6.3 | 0.12 | 0.002 | 4.0 | 0.1 | 1 |
| SM11 | 6.6 | 6.5 | 0.11 | 0.002 | 4.1 | 0.2 | 4 |
| SM12 | 6.4 | 6.2 | 0.11 | 0.002 | 4.1 | 0.1 | 24 |
| SM13 | 6.5 | 6.4 | 0.11 | 0.002 | 4.1 | 0.2 | 14 |
| SM17 | 6.3 | 6.3 | 0.11 | 0.002 | 4.0 | 0.1 | 1 |
| SM18 | 6.3 | 6.2 | 0.11 | 0.002 | 4.0 | 0.1 | 1 |
| Average | 6.4 | 6.4 | 0.11 | 0.002 | 4.1 | 0.2 | 25 |
| Max | 7.4 | 7.4 | 0.13 | 0.003 | 4.8 | 0.8 | 391 |
| Min | 6.2 | 5.8 | 0.07 | 0.001 | 3.9 | 0.1 | 1 |

Note:
(1) Numbers in shade exceed WQO standards.

**Table 5.12 : Baseline Water Quality (Scenario 1) at Identified WSRs in Wet Season**

| Location | DO (mg/L) | Bottom DO (mg/L) | TIN (mg/L) | UIA (mg/L) | SS (mg/L) | $BOD_5$ (mg/L) | *E.Coli* (count/100mL) |
|---|---|---|---|---|---|---|---|
| **WQO** | **>4** | **>2** | **<0.1** | **<0.021** | **Change <30%** | **<10 (WQC)** | **< 610 cfu/100mL** |
| C1 | 5.7 | 5.5 | 0.21 | 0.005 | 5.0 | 0.7 | 43 |
| C2 | 5.7 | 5.5 | 0.21 | 0.005 | 5.0 | 0.7 | 43 |
| C3 | 5.6 | 5.3 | 0.21 | 0.005 | 5.0 | 0.6 | 0 |
| C4 | 5.6 | 5.4 | 0.20 | 0.005 | 4.8 | 0.6 | 1 |
| C5 | 5.4 | 5.3 | 0.21 | 0.005 | 4.8 | 0.6 | 1 |
| C6 | 5.8 | 5.4 | 0.19 | 0.005 | 4.9 | 0.7 | 1 |
| C7 | 5.8 | 5.5 | 0.19 | 0.005 | 5.0 | 0.8 | 5 |
| C8 | 5.7 | 5.4 | 0.20 | 0.005 | 5.0 | 0.7 | 3 |
| C9 | 5.7 | 5.4 | 0.20 | 0.005 | 5.0 | 0.7 | 8 |
| C10 | 5.8 | 5.3 | 0.19 | 0.005 | 5.1 | 0.8 | 5 |
| C11 | 5.8 | 5.5 | 0.20 | 0.005 | 5.1 | 0.8 | 7 |
| C12 | 5.8 | 5.3 | 0.20 | 0.005 | 4.9 | 0.7 | 29 |
| C13 | 5.2 | 5.0 | 0.20 | 0.006 | 5.1 | 1.0 | 182 |
| C14 | 5.6 | 5.0 | 0.20 | 0.006 | 5.1 | 0.9 | 7 |
| C15 | 5.7 | 5.2 | 0.20 | 0.005 | 5.1 | 0.8 | 13 |
| B1 | 5.6 | 5.3 | 0.20 | 0.005 | 5.0 | 0.7 | 18 |
| B2 | 5.6 | 5.3 | 0.20 | 0.005 | 5.0 | 0.7 | 38 |
| B3 | 5.8 | 5.3 | 0.20 | 0.005 | 4.9 | 0.7 | 1 |
| B4 | 5.8 | 5.4 | 0.20 | 0.005 | 4.8 | 0.7 | 0 |
| B5 | 5.0 | 4.6 | 0.19 | 0.006 | 5.2 | 1.0 | 100 |
| B6 | 5.9 | 5.3 | 0.21 | 0.005 | 5.2 | 0.7 | 10 |
| B7 | 5.9 | 5.4 | 0.21 | 0.005 | 5.1 | 0.7 | 12 |
| B8 | 5.7 | 5.4 | 0.22 | 0.005 | 5.1 | 0.7 | 3 |
| B9 | 5.7 | 5.3 | 0.22 | 0.005 | 5.0 | 0.7 | 1 |
| ST1 | 5.9 | 5.5 | 0.23 | 0.005 | 5.3 | 0.8 | 65 |
| ST2 | 6.0 | 5.4 | 0.20 | 0.005 | 4.9 | 0.7 | 17 |
| FP1 | 5.7 | 5.3 | 0.22 | 0.005 | 5.1 | 0.7 | 25 |
| S1 | 5.6 | 5.2 | 0.21 | 0.005 | 5.0 | 0.7 | 10 |
| S2 | 5.4 | 4.8 | 0.22 | 0.005 | 5.0 | 0.6 | 0 |
| S3 | 5.6 | 5.3 | 0.21 | 0.005 | 4.9 | 0.6 | 0 |
| CW1 | 5.7 | 5.2 | 0.21 | 0.005 | 4.9 | 0.6 | 0 |
| MH1 | 5.5 | 5.0 | 0.21 | 0.005 | 5.0 | 0.6 | 0 |
| F1 | 5.6 | 5.0 | 0.20 | 0.006 | 5.1 | 0.9 | 7 |
| M1 | 5.5 | 4.9 | 0.20 | 0.006 | 5.1 | 0.9 | 8 |
| M2 | 5.9 | 5.4 | 0.21 | 0.005 | 5.1 | 0.7 | 23 |
| U1 | 5.9 | 5.6 | 0.21 | 0.005 | 5.0 | 0.7 | 63 |
| SM5 | 5.8 | 5.3 | 0.20 | 0.005 | 4.9 | 0.7 | 1 |
| SM6 | 5.5 | 5.1 | 0.21 | 0.005 | 5.0 | 0.6 | 0 |
| SM7 | 5.6 | 5.3 | 0.20 | 0.005 | 4.9 | 0.6 | 0 |
| SM9 | 5.8 | 5.5 | 0.19 | 0.005 | 4.9 | 0.7 | 1 |
| SM11 | 5.8 | 5.3 | 0.20 | 0.005 | 5.0 | 0.8 | 8 |
| SM12 | 5.8 | 5.4 | 0.22 | 0.005 | 5.1 | 0.7 | 96 |
| SM13 | 5.8 | 5.3 | 0.22 | 0.005 | 5.2 | 0.7 | 0 |
| SM17 | 5.5 | 4.9 | 0.23 | 0.004 | 5.1 | 0.5 | 0 |

| Location | DO (mg/L) | Bottom DO (mg/L) | TIN (mg/L) | UIA (mg/L) | SS (mg/L) | $BOD_5$ (mg/L) | *E.Coli* (count/100mL) |
|---|---|---|---|---|---|---|---|
| **WQO** | **>4** | **>2** | **<0.1** | **<0.021** | **Change <30%** | **<10 (WQC)** | **< 610 cfu/100mL** |
| SM18 | 5.3 | 4.8 | 0.22 | 0.005 | 5.0 | 0.5 | 0 |
| Average | 5.7 | 5.3 | 0.21 | 0.005 | 5.0 | 0.7 | 19 |
| Max | 6.0 | 5.6 | 0.23 | 0.006 | 5.3 | 1.0 | 182 |
| Min | 5.0 | 4.6 | 0.19 | 0.004 | 4.8 | 0.5 | 0 |

Note:
(1) Numbers in shade exceed WQO standards.

***Scenario 2 – Normal Operation of Upgraded Cheung Chau STW***

5.6.10 The simulated water quality concentrations at the identified WSRs under Scenario 2 of normal operation of the upgraded STW are summarized in **Table 5.13** and **Table 5.14** for dry and wet seasons, respectively.

5.6.11 **Figures 5C-3** to **5C-16** in **Appendix 5C** illustrate the aerial distributions (contour plots) of selected water quality parameters of concern including the 90% depth-averaged DO, 90% bottom DO, TIN, SS, UIA, *E.coli* and $BOD_5$ to compare the difference between Scenario 1 (baseline) and Scenario 2 (normal operation of the upgraded STW). The time-series model results are also presented in **Figures 5C-17** to **5C-106** in **Appendix 5C** for comparing water quality conditions between the baseline and normal operation scenarios.

5.6.12 Incremental changes in concentration of the water quality parameters between Scenario 2 and Scenario 1 are presented in **Table 5.15** and **Table 5.16** for the identified WSRs.

**Table 5.13 : Water Quality under Normal Operation (Scenario 2) at Identified WSRs in Dry Season**

| Location | DO (mg/L) | Bottom DO (mg/L) | TIN (mg/L) | UIA (mg/L) | SS (mg/L) | $BOD_5$ (mg/L) | *E.Coli* (count/100mL) |
|---|---|---|---|---|---|---|---|
| **WQO** | **>4** | **>2** | **<0.1** | **<0.021** | **Change <30%** | **<10 (WQC)** | **< 610 cfu/100mL** |
| C1 | 6.4 | 6.3 | 0.12 | 0.002 | 3.9 | 0.1 | 1 |
| C2 | 6.4 | 6.3 | 0.12 | 0.002 | 3.9 | 0.1 | 1 |
| C3 | 6.2 | 6.2 | 0.12 | 0.002 | 4.0 | 0.1 | 1 |
| C4 | 6.2 | 6.2 | 0.12 | 0.002 | 4.0 | 0.1 | 2 |
| C5 | 6.2 | 6.2 | 0.12 | 0.002 | 3.9 | 0.1 | 1 |
| C6 | 6.3 | 6.3 | 0.12 | 0.002 | 4.0 | 0.1 | 1 |
| C7 | 6.4 | 6.4 | 0.11 | 0.002 | 4.1 | 0.1 | 2 |
| C8 | 6.3 | 6.2 | 0.12 | 0.002 | 4.0 | 0.1 | 1 |
| C9 | 6.3 | 6.1 | 0.12 | 0.002 | 4.0 | 0.1 | 1 |
| C10 | 6.4 | 6.3 | 0.11 | 0.002 | 4.1 | 0.1 | 5 |
| C11 | 6.5 | 6.5 | 0.11 | 0.002 | 4.1 | 0.2 | 15 |
| C12 | 6.3 | 6.2 | 0.12 | 0.002 | 4.1 | 0.1 | 1 |
| C13 | 7.3 | 7.3 | 0.07 | 0.001 | 4.5 | 0.7 | 391 |
| C14 | 6.7 | 6.7 | 0.10 | 0.002 | 4.2 | 0.3 | 7 |
| C15 | 6.6 | 6.6 | 0.11 | 0.002 | 4.2 | 0.3 | 5 |
| B1 | 6.5 | 6.4 | 0.11 | 0.002 | 3.9 | 0.1 | 1 |
| B2 | 6.5 | 6.5 | 0.11 | 0.002 | 3.9 | 0.1 | 1 |
| B3 | 6.3 | 6.2 | 0.11 | 0.002 | 3.9 | 0.1 | 1 |
| B4 | 6.2 | 5.8 | 0.12 | 0.002 | 3.9 | 0.1 | 1 |
| B5 | 7.4 | 7.4 | 0.07 | 0.001 | 4.5 | 0.8 | 265 |

| Location | DO (mg/L) | Bottom DO (mg/L) | TIN (mg/L) | UIA (mg/L) | SS (mg/L) | $BOD_5$ (mg/L) | *E.Coli* (count/100mL) |
|---|---|---|---|---|---|---|---|
| **WQO** | **>4** | **>2** | **<0.1** | **<0.021** | **Change <30%** | **<10 (WQC)** | **< 610 cfu/100mL** |
| B6 | 6.6 | 6.6 | 0.11 | 0.001 | 4.1 | 0.2 | 15 |
| B7 | 6.7 | 6.6 | 0.10 | 0.001 | 4.2 | 0.2 | 9 |
| B8 | 6.4 | 6.3 | 0.11 | 0.002 | 4.1 | 0.1 | 1 |
| B9 | 6.3 | 6.1 | 0.11 | 0.002 | 4.1 | 0.2 | 1 |
| ST1 | 6.6 | 6.4 | 0.11 | 0.002 | 4.5 | 0.4 | 29 |
| ST2 | 6.3 | 6.2 | 0.11 | 0.002 | 4.1 | 0.1 | 1 |
| FP1 | 6.3 | 6.2 | 0.11 | 0.002 | 4.0 | 0.1 | 3 |
| S1 | 6.3 | 6.2 | 0.11 | 0.002 | 3.9 | 0.1 | 1 |
| S2 | 6.2 | 6.2 | 0.11 | 0.002 | 4.0 | 0.1 | 1 |
| S3 | 6.3 | 6.2 | 0.11 | 0.002 | 4.0 | 0.1 | 1 |
| CW1 | 6.2 | 6.1 | 0.11 | 0.002 | 3.9 | 0.1 | 1 |
| MH1 | 6.2 | 6.2 | 0.11 | 0.002 | 4.0 | 0.1 | 1 |
| F1 | 6.7 | 6.7 | 0.10 | 0.002 | 4.2 | 0.3 | 7 |
| M1 | 6.9 | 6.9 | 0.09 | 0.001 | 4.3 | 0.4 | 15 |
| M2 | 6.7 | 6.7 | 0.10 | 0.001 | 4.2 | 0.2 | 36 |
| U1 | 6.4 | 6.3 | 0.11 | 0.002 | 4.0 | 0.1 | 1 |
| SM5 | 6.3 | 6.2 | 0.11 | 0.002 | 3.9 | 0.1 | 1 |
| SM6 | 6.3 | 6.2 | 0.11 | 0.002 | 4.0 | 0.1 | 1 |
| SM7 | 6.2 | 6.1 | 0.12 | 0.002 | 4.0 | 0.1 | 1 |
| SM9 | 6.3 | 6.3 | 0.12 | 0.002 | 4.0 | 0.1 | 1 |
| SM11 | 6.6 | 6.5 | 0.11 | 0.002 | 4.1 | 0.2 | 4 |
| SM12 | 6.4 | 6.2 | 0.11 | 0.002 | 4.1 | 0.1 | 1 |
| SM13 | 6.5 | 6.4 | 0.11 | 0.002 | 4.0 | 0.1 | 1 |
| SM17 | 6.3 | 6.3 | 0.11 | 0.002 | 4.0 | 0.1 | 1 |
| SM18 | 6.3 | 6.2 | 0.11 | 0.002 | 4.0 | 0.1 | 1 |
| Average | 6.4 | 6.4 | 0.11 | 0.002 | 4.1 | 0.2 | 19 |
| Max | 7.4 | 7.4 | 0.12 | 0.002 | 4.5 | 0.8 | 391 |
| Min | 6.2 | 5.8 | 0.07 | 0.001 | 3.9 | 0.1 | 1 |

Note:
(1) Numbers in shade exceed WQO Standards.

**Table 5.14 : Water Quality under Normal Operation (Scenario 2) at Identified WSRs in Wet Season**

| Location | DO (mg/L) | Bottom DO (mg/L) | TIN (mg/L) | UIA (mg/L) | SS (mg/L) | $BOD_5$ (mg/L) | *E.Coli* (count/100mL) |
|---|---|---|---|---|---|---|---|
| **WQO** | **>4** | **>2** | **<0.1** | **<0.021** | **Change <30%** | **<10 (WQC)** | **< 610 cfu/100mL** |
| C1 | 5.7 | 5.5 | 0.20 | 0.005 | 5.0 | 0.7 | 1 |
| C2 | 5.7 | 5.5 | 0.20 | 0.005 | 5.0 | 0.7 | 1 |
| C3 | 5.6 | 5.3 | 0.21 | 0.005 | 5.0 | 0.6 | 1 |
| C4 | 5.6 | 5.4 | 0.21 | 0.005 | 4.8 | 0.6 | 1 |
| C5 | 5.4 | 5.3 | 0.22 | 0.005 | 4.8 | 0.6 | 1 |
| C6 | 5.8 | 5.4 | 0.20 | 0.005 | 4.9 | 0.7 | 1 |
| C7 | 5.8 | 5.5 | 0.19 | 0.005 | 5.0 | 0.8 | 3 |
| C8 | 5.7 | 5.4 | 0.20 | 0.005 | 5.0 | 0.7 | 1 |
| C9 | 5.7 | 5.4 | 0.20 | 0.005 | 5.0 | 0.7 | 1 |
| C10 | 5.8 | 5.3 | 0.19 | 0.005 | 5.1 | 0.8 | 4 |

| Location | DO (mg/L) | Bottom DO (mg/L) | TIN (mg/L) | UIA (mg/L) | SS (mg/L) | $BOD_5$ (mg/L) | *E.Coli* (count/100mL) |
|---|---|---|---|---|---|---|---|
| **WQO** | **>4** | **>2** | **<0.1** | **<0.021** | **Change <30%** | **<10 (WQC)** | **< 610 cfu/100mL** |
| C11 | 5.8 | 5.5 | 0.19 | 0.005 | 5.1 | 0.8 | 2 |
| C12 | 5.8 | 5.3 | 0.20 | 0.005 | 4.9 | 0.7 | 1 |
| C13 | 5.2 | 5.0 | 0.19 | 0.006 | 5.1 | 1.0 | 181 |
| C14 | 5.5 | 5.0 | 0.19 | 0.006 | 5.1 | 0.9 | 4 |
| C15 | 5.7 | 5.2 | 0.19 | 0.005 | 5.1 | 0.8 | 4 |
| B1 | 5.6 | 5.3 | 0.20 | 0.005 | 5.0 | 0.7 | 1 |
| B2 | 5.6 | 5.3 | 0.20 | 0.005 | 5.0 | 0.7 | 1 |
| B3 | 5.8 | 5.3 | 0.21 | 0.005 | 4.9 | 0.7 | 1 |
| B4 | 5.8 | 5.4 | 0.20 | 0.005 | 4.8 | 0.7 | 1 |
| B5 | 5.0 | 4.6 | 0.19 | 0.006 | 5.2 | 1.0 | 100 |
| B6 | 5.9 | 5.3 | 0.22 | 0.005 | 5.2 | 0.7 | 10 |
| B7 | 5.9 | 5.4 | 0.21 | 0.005 | 5.1 | 0.7 | 12 |
| B8 | 5.7 | 5.4 | 0.22 | 0.005 | 5.1 | 0.7 | 1 |
| B9 | 5.7 | 5.3 | 0.22 | 0.005 | 5.0 | 0.7 | 1 |
| ST1 | 6.0 | 5.6 | 0.21 | 0.005 | 5.2 | 0.8 | 8 |
| ST2 | 6.0 | 5.4 | 0.19 | 0.005 | 4.9 | 0.7 | 1 |
| FP1 | 5.6 | 5.3 | 0.22 | 0.005 | 5.1 | 0.7 | 1 |
| S1 | 5.6 | 5.2 | 0.21 | 0.005 | 5.0 | 0.7 | 1 |
| S2 | 5.4 | 4.8 | 0.22 | 0.005 | 5.0 | 0.6 | 1 |
| S3 | 5.6 | 5.3 | 0.21 | 0.005 | 4.9 | 0.6 | 1 |
| CW1 | 5.7 | 5.2 | 0.21 | 0.005 | 4.9 | 0.6 | 1 |
| MH1 | 5.5 | 5.0 | 0.22 | 0.005 | 5.0 | 0.6 | 1 |
| F1 | 5.5 | 5.0 | 0.19 | 0.006 | 5.1 | 0.9 | 4 |
| M1 | 5.5 | 4.9 | 0.19 | 0.006 | 5.1 | 0.9 | 7 |
| M2 | 5.9 | 5.4 | 0.21 | 0.005 | 5.1 | 0.7 | 23 |
| U1 | 5.9 | 5.5 | 0.21 | 0.005 | 5.0 | 0.7 | 8 |
| SM5 | 5.8 | 5.3 | 0.21 | 0.005 | 4.9 | 0.7 | 1 |
| SM6 | 5.5 | 5.0 | 0.22 | 0.005 | 5.0 | 0.6 | 1 |
| SM7 | 5.6 | 5.3 | 0.21 | 0.005 | 4.9 | 0.6 | 1 |
| SM9 | 5.8 | 5.5 | 0.20 | 0.005 | 4.9 | 0.7 | 1 |
| SM11 | 5.8 | 5.3 | 0.19 | 0.005 | 5.0 | 0.8 | 1 |
| SM12 | 5.8 | 5.4 | 0.22 | 0.005 | 5.1 | 0.7 | 1 |
| SM13 | 5.8 | 5.3 | 0.23 | 0.005 | 5.2 | 0.7 | 1 |
| SM17 | 5.5 | 4.9 | 0.23 | 0.004 | 5.1 | 0.5 | 1 |
| SM18 | 5.3 | 4.8 | 0.23 | 0.005 | 5.0 | 0.5 | 1 |
| Average | 5.7 | 5.3 | 0.21 | 0.005 | 5.0 | 0.7 | 9 |
| Max | 6.0 | 5.5 | 0.23 | 0.006 | 5.2 | 1.0 | 181 |
| Min | 5.0 | 4.6 | 0.19 | 0.004 | 4.8 | 0.5 | 1 |

Note:
(1) Numbers in shade exceed WQO standards.

**Table 5.15 : Incremental Changes in Water Quality from Scenario 1 (Baseline) to Scenario 2 (Normal Operation) at Identified WSRs in Dry Season**

| Location | DO (mg/L) | Bottom DO (mg/L) | TIN (mg/L) | UIA (mg/L) | SS (Percentage) | $BOD_5$ (mg/L) | *E.Coli* (count/100mL) |
|---|---|---|---|---|---|---|---|
| C1 | 0.0 | 0.0 | 0.00 | 0.000 | 0% | 0.0 | -5 |
| C2 | 0.0 | 0.0 | 0.00 | 0.000 | 0% | 0.0 | -5 |
| C3 | 0.0 | 0.0 | 0.00 | 0.000 | 0% | 0.0 | 0 |
| C4 | 0.0 | 0.0 | 0.00 | 0.000 | 0% | 0.0 | 0 |
| C5 | 0.0 | 0.0 | 0.00 | 0.000 | 0% | 0.0 | 0 |
| C6 | 0.0 | 0.0 | 0.00 | 0.000 | 0% | 0.0 | 0 |
| C7 | 0.0 | 0.0 | 0.00 | 0.000 | 0% | 0.0 | 0 |
| C8 | 0.0 | 0.0 | 0.00 | 0.000 | 0% | 0.0 | 0 |
| C9 | 0.0 | 0.0 | 0.00 | 0.000 | 0% | 0.0 | 0 |
| C10 | 0.0 | 0.0 | 0.00 | 0.000 | 0% | 0.0 | 0 |
| C11 | 0.0 | 0.0 | 0.00 | 0.000 | 0% | 0.0 | 0 |
| C12 | 0.0 | 0.0 | 0.00 | 0.000 | 0% | 0.0 | 0 |
| C13 | 0.0 | 0.0 | 0.00 | 0.000 | 0% | 0.0 | 0 |
| C14 | 0.0 | 0.0 | 0.00 | 0.000 | 0% | 0.0 | 0 |
| C15 | 0.0 | 0.0 | 0.00 | 0.000 | 0% | 0.0 | 0 |
| B1 | 0.0 | 0.0 | 0.00 | 0.000 | 0% | 0.0 | -9 |
| B2 | 0.0 | 0.0 | 0.00 | 0.000 | 0% | 0.0 | -35 |
| B3 | 0.0 | 0.0 | 0.00 | 0.000 | 0% | 0.0 | 0 |
| B4 | 0.0 | 0.0 | 0.00 | 0.000 | 0% | 0.0 | 0 |
| B5 | 0.0 | 0.0 | 0.00 | 0.000 | 0% | 0.0 | 0 |
| B6 | 0.0 | 0.0 | 0.00 | 0.000 | 0% | 0.0 | -2 |
| B7 | 0.0 | 0.0 | 0.00 | 0.000 | 0% | 0.0 | -1 |
| B8 | 0.0 | 0.0 | 0.00 | 0.000 | 0% | 0.0 | -51 |
| B9 | 0.0 | 0.0 | 0.00 | 0.000 | 0% | 0.0 | -2 |
| ST1 | 0.1 | 0.1 | -0.03 | -0.001 | -5% | -0.2 | -51 |
| ST2 | 0.0 | 0.0 | 0.00 | 0.000 | 0% | 0.0 | 0 |
| FP1 | 0.0 | 0.0 | 0.00 | 0.000 | 0% | 0.0 | -44 |
| S1 | 0.0 | 0.0 | 0.00 | 0.000 | 0% | 0.0 | -28 |
| S2 | 0.0 | 0.0 | 0.00 | 0.000 | 0% | 0.0 | 0 |
| S3 | 0.0 | 0.0 | 0.00 | 0.000 | 0% | 0.0 | 0 |
| CW1 | 0.0 | 0.0 | 0.00 | 0.000 | 0% | 0.0 | 0 |
| MH1 | 0.0 | 0.0 | 0.00 | 0.000 | 0% | 0.0 | 0 |
| F1 | 0.0 | 0.0 | 0.00 | 0.000 | 0% | 0.0 | 0 |
| M1 | 0.0 | 0.0 | 0.00 | 0.000 | 0% | 0.0 | 0 |
| M2 | 0.0 | 0.0 | 0.00 | 0.000 | 0% | 0.0 | 0 |
| U1 | 0.0 | 0.0 | 0.00 | 0.000 | 0% | 0.0 | -3 |
| SM5 | 0.0 | 0.0 | 0.00 | 0.000 | 0% | 0.0 | 0 |
| SM6 | 0.0 | 0.0 | 0.00 | 0.000 | 0% | 0.0 | 0 |
| SM7 | 0.0 | 0.0 | 0.00 | 0.000 | 0% | 0.0 | 0 |
| SM9 | 0.0 | 0.0 | 0.00 | 0.000 | 0% | 0.0 | 0 |
| SM11 | 0.0 | 0.0 | 0.00 | 0.000 | 0% | 0.0 | 0 |
| SM12 | 0.0 | 0.0 | 0.00 | 0.000 | 0% | 0.0 | -23 |
| SM13 | 0.0 | 0.0 | 0.00 | 0.000 | 0% | 0.0 | -13 |
| SM17 | 0.0 | 0.0 | 0.00 | 0.000 | 0% | 0.0 | 0 |

| Location | DO (mg/L) | Bottom DO (mg/L) | TIN (mg/L) | UIA (mg/L) | SS (Percentage) | $BOD_5$ (mg/L) | *E.Coli* (count/100mL) |
|---|---|---|---|---|---|---|---|
| SM18 | 0.0 | 0.0 | 0.00 | 0.000 | 0% | 0.0 | 0 |
| Average | 0.0 | 0.0 | 0.00 | 0.000 | 0% | 0.0 | -6 |
| Max | 0.1 | 0.1 | 0.00 | 0.000 | 0% | 0.0 | 0 |
| Min | 0.0 | 0.0 | -0.03 | -0.001 | -5% | -0.2 | -51 |

Notes:
(1) All absolute differences were calculated as Scenario 2 minus Scenario 1.
(2) SS was evaluated by percentage difference: (Scenario 2-Scenario1) / Scenario 1 × 100%.

**Table 5.16: Incremental Changes in Water Quality from Scenario 1 (Baseline) to Scenario 2 (Normal Operation) at Identified WSRs in Wet Season**

| Location | DO (mg/L) | Bottom DO (mg/L) | TIN (mg/L) | UIA (mg/L) | SS (Percentage) | $BOD_5$ (mg/L) | *E.Coli* (count/100mL) |
|---|---|---|---|---|---|---|---|
| C1 | 0.0 | 0.0 | 0.00 | 0.000 | 0% | 0.0 | -42 |
| C2 | 0.0 | 0.0 | 0.00 | 0.000 | 0% | 0.0 | -42 |
| C3 | 0.0 | 0.0 | 0.00 | 0.000 | 0% | 0.0 | -1 |
| C4 | 0.0 | 0.0 | 0.00 | 0.000 | 0% | 0.0 | 0 |
| C5 | 0.0 | 0.0 | 0.00 | 0.000 | 0% | 0.0 | 0 |
| C6 | 0.0 | 0.0 | 0.00 | 0.000 | 0% | 0.0 | 0 |
| C7 | 0.0 | 0.0 | 0.00 | 0.000 | 0% | 0.0 | -2 |
| C8 | 0.0 | 0.0 | 0.00 | 0.000 | 0% | 0.0 | -2 |
| C9 | 0.0 | 0.0 | 0.00 | 0.000 | 0% | 0.0 | -7 |
| C10 | 0.0 | 0.0 | 0.00 | 0.000 | 0% | 0.0 | -1 |
| C11 | 0.0 | 0.0 | 0.00 | 0.000 | 0% | 0.0 | -5 |
| C12 | 0.0 | 0.0 | 0.00 | 0.000 | 0% | 0.0 | -28 |
| C13 | 0.0 | 0.0 | 0.00 | 0.000 | 0% | 0.0 | 0 |
| C14 | 0.0 | 0.0 | 0.00 | 0.000 | 0% | 0.0 | -3 |
| C15 | 0.0 | 0.0 | 0.00 | 0.000 | 0% | 0.0 | -9 |
| B1 | 0.0 | 0.0 | 0.00 | 0.000 | 0% | 0.0 | -17 |
| B2 | 0.0 | 0.0 | 0.00 | 0.000 | 0% | 0.0 | -37 |
| B3 | 0.0 | 0.0 | 0.00 | 0.000 | 0% | 0.0 | 0 |
| B4 | 0.0 | 0.0 | 0.00 | 0.000 | 0% | 0.0 | -1 |
| B5 | 0.0 | 0.0 | 0.00 | 0.000 | 0% | 0.0 | 0 |
| B6 | 0.0 | 0.0 | 0.00 | 0.000 | 0% | 0.0 | 0 |
| B7 | 0.0 | 0.0 | 0.00 | 0.000 | 0% | 0.0 | 0 |
| B8 | 0.0 | 0.0 | 0.00 | 0.000 | 0% | 0.0 | -2 |
| B9 | 0.0 | 0.0 | 0.00 | 0.000 | 0% | 0.0 | 0 |
| ST1 | 0.1 | 0.1 | -0.02 | 0.000 | -2% | -0.1 | -57 |
| ST2 | 0.0 | 0.0 | 0.00 | 0.000 | 0% | 0.0 | -16 |
| FP1 | 0.0 | 0.0 | 0.00 | 0.000 | 0% | 0.0 | -24 |
| S1 | 0.0 | 0.0 | 0.00 | 0.000 | 0% | 0.0 | -9 |
| S2 | 0.0 | 0.0 | 0.00 | 0.000 | 0% | 0.0 | -1 |
| S3 | 0.0 | 0.0 | 0.00 | 0.000 | 0% | 0.0 | -1 |
| CW1 | 0.0 | 0.0 | 0.00 | 0.000 | 0% | 0.0 | -1 |
| MH1 | 0.0 | 0.0 | 0.00 | 0.000 | 0% | 0.0 | -1 |
| F1 | 0.0 | 0.0 | 0.00 | 0.000 | 0% | 0.0 | -3 |
| M1 | 0.0 | 0.0 | 0.00 | 0.000 | 0% | 0.0 | -1 |

| Location | DO (mg/L) | Bottom DO (mg/L) | TIN (mg/L) | UIA (mg/L) | SS (Percentage) | $BOD_5$ (mg/L) | *E.Coli* (count/100mL) |
|---|---|---|---|---|---|---|---|
| M2 | 0.0 | 0.0 | 0.01 | 0.000 | 0% | 0.0 | 0 |
| U1 | 0.0 | 0.0 | 0.00 | 0.000 | 0% | 0.0 | -55 |
| SM5 | 0.0 | 0.0 | 0.00 | 0.000 | 0% | 0.0 | 0 |
| SM6 | 0.0 | 0.0 | 0.00 | 0.000 | 0% | 0.0 | -1 |
| SM7 | 0.0 | 0.0 | 0.00 | 0.000 | 0% | 0.0 | -1 |
| SM9 | 0.0 | 0.0 | 0.00 | 0.000 | 0% | 0.0 | 0 |
| SM11 | 0.0 | 0.0 | 0.00 | 0.000 | 0% | 0.0 | -7 |
| SM12 | 0.0 | 0.0 | 0.00 | 0.000 | 0% | 0.0 | -95 |
| SM13 | 0.0 | 0.0 | 0.00 | 0.000 | 0% | 0.0 | -1 |
| SM17 | 0.0 | 0.0 | 0.00 | 0.000 | 0% | 0.0 | -1 |
| SM18 | 0.0 | 0.0 | 0.00 | 0.000 | 0% | 0.0 | -1 |
| Average | 0.0 | 0.0 | 0.00 | 0.000 | 0% | 0.0 | -10 |
| Max | 0.1 | 0.1 | 0.01 | 0.000 | 0% | 0.0 | -1 |
| Min | 0.0 | 0.0 | -0.02 | 0.000 | -2% | -0.1 | -95 |

Notes:
(1) All absolute differences were calculated as Scenario 2 minus Scenario 1.
(2) SS was evaluated by percentage difference: (Scenario 2-Scenario1) / Scenario 1 × 100%.

5.6.13 Under the normal operation condition, predicted concentrations of depth-averaged DO (90%) range from 6.2 to 7.4 mg/L in dry season and from 5.0 to 6.0 mg/L in wet season, which are both in compliance to the WQO for DO. The bottom DO concentration (90%) ranges from 5.8 to 7.4 mg/L in dry season and from 4.6 to 5.5 mg/L in wet season, respectively, which are also both in compliance to the WQO. At the Cheung Chau Typhoon Shelter (ST1), the DO concentration was simulated to be slightly higher than the baseline condition for both dry and wet seasons (higher by 0.1mg/L for both the depth-averaged and the bottom DO concentrations). No significant changes in DO concentration at the other WSRs were predicted as indicated in **Table 5.15** and **Table 5.16.** Overall, the upgraded Cheung Chau STW was predicted to result in a certain level of improvement in DO concentration near the Project area. No adverse impact is expected to occur with respect to DO concentration.

5.6.14 The baseline TIN ranges from 0.07 to 0.12 mg/L in dry season and from 0.19 to 0.23 mg/L in wet season at the identified WSRs as shown in **Table 5.13** and **Table 5.14**, which both exceed the WQO standard of 0.1 mg/L. This indicates that the background TIN concentration in the southern WCZ has already been experiencing non-compliance to the TIN WQO.

5.6.15 With the commissioning of the upgraded Cheung Chau STW, TIN concentration in Cheung Chau Wan at ST1 was predicted to be lower by 0.03 mg/L in dry season and by 0.02 mg/L in wet season (indicating an improvement in water quality). As indicated in **Table 5.15** and **Table 5.16**, an overall reduction in TIN concentration near the Project area was predicted, and no significant water quality changes in terms of TIN were simulated at the other WSR locations.

5.6.16 The simulated UIA concentration ranges from 0.001 to 0.002 mg/L in dry season and from 0.004 to 0.006 mg/L in wet season, which are both in compliance to the WQO. Compared to the baseline condition, the upgraded Cheung Chau STW would result in a decrease in UIA concentration by 0.001 mg/L in dry season near Cheung Chau Wan (ST1). As indicated in **Table 5.15** and **Table 5.16**, no significant changes in UIA concentration were predicted at the other WSRs. The

results indicate that no adverse impacts are likely to occur to the UIA concentration of receiving waters.

5.6.17 SS concentration varies from 3.9 to 4.5 mg/L in dry season and from 4.8 to 5.2 mg/L in wet season, respectively. A decrease by 5% in SS level was predicted for dry season and by 2% for wet season near Cheung Chau Wan at ST1. The predicted SS level is in compliance with the WQO. No significant changes in SS level were predicted at the other identified WSRs. No adverse water quality impacts were predicted to occur to the SS level after commissioning of the upgraded Cheung Chau STW.

5.6.18 $BOD_5$ was simulated to range from 0.1 to 0.8 mg/L in dry season and from 0.5 to 1.0 mg/L in wet season, respectively, which are below the WQO of 10 mg $BOD_5$/L for water intakes. $BOD_5$ was predicted to decrease near Cheung Chau Wan at ST1 by 0.2 mg/L in dry season and by 0.1mg/L in wet season, respectively after commissioning of the upgraded Cheung Chau STW. No significant changes in $BOD_5$ concentration were simulated at the other WSR locations. No adverse water quality impact was predicted to occur to the $BOD_5$ concentration in the marine water after commissioning of the upgraded Cheung Chau STW.

5.6.19 Predicted *E.coli* levels range from 1 to 391 cfu/100mL in dry season and from 1 to 181 cfu/100mL in wet season, which are compliant to the WQO of 610 cfu/100mL for *E.coli*. Compared to the baseline condition, the upgraded Cheung Chau STW would result in a decrease in the *E.coli* level at a number of locations including SM12 (Water Monitoring Station), ST1 (Cheung Chau Wan), FP1 (south to Cheung Chau), S1 (Spawning Nursery Grounds south of Cheung Chau), B1 (Tung Wan) and B2 (Kwun Yam Wan). Reduced *E.coli* levels were also predicted at other locations including Yi Long Wan, Hei Ling Chau (C12).

5.6.20 Generally, an improvement in water quality in terms of *E.coli* was predicted in the vicinity of Cheung Chau Island under the both dry and wet weather conditions. The improvement is mainly attributable to the enhanced treatment efficiency of the upgraded STW, which would significantly reduce the *E.coli* loading to the marine water. No adverse water quality impacts are anticipated to occur as far as *E.coli* is concerned under the normal operation of the upgraded Cheung Chau STW.

5.6.21 Overall, upon commissioning of the upgraded Cheung Chau STW, a relative improvement in water quality is expected to occur to the marine water near the Project area. The proposed Upgrading Project would result in a reduction in concentrations of a number of water quality parameters including TIN, UIA, SS, $BOD_5$ and *E.coli,* and would result in a certain level of improvement in DO concentration (by approximately 0.1 mg/L) near the Project area. Predicted differences (benefit) with the upgrading of the Cheung Chau STW are as follows for different water quality parameters: TIN concentration was predicted to be lower by 0.03 mg/L in dry season and by 0.02 mg/L in wet season; UIA concentration lower by 0.001 mg/L; SS level lower by 5% in dry season and by 2% in wet season; BOD5 lower by 0.2 mg/L in dry season and by 0.1 mg/L in wet season; and E. coli level lower at a number of locations including SM12 (Water Monitoring Station), ST1 (Cheung Chau Wan), FP1 (south to Cheung Chau), S1 (Spawning Nursery Grounds south of Cheung Chau), B1 (Tung Wan) and B2 (Kwun Yam Wan). Reduced E. coli levels were also predicted at other locations including Yi Long Wan, Hei Ling Chau (C12). No significant changes to water quality were predicted at the other WSR locations. No adverse water quality impacts are therefore anticipated to result from the normal operation of the upgraded Cheung Chau STW.

***Scenario 3 - Emergency Discharge of Untreated Sewage from STW***

5.6.22 Emergency discharge is a provisional situation for operation of the STW regardless of this upgrading works. The past operational record by DSD shows it normally takes about 6 hours to resume to the normal operation of a STW in case of an operational failure. A 6-hour period of emergency discharge was therefore simulated to assess the impact of emergency discharge of untreated sewage from the Cheung Chau STW. In general, a neap tide is expected to result in higer concentrations in the discharge outfall area, whereas a spring tide would result in a larger extent of the impact area due to higher tidal current speeds during the spring tide. Sensitive receivers at South Lantau, e.g. Chi Ma Wan, Cheung Sha Fish Cultural Zone, are one of the issues to look into for the emergency discharge assessment.

5.6.23 To cover different conditions of tidal movement, the potential impact of emergency discharge was assessed for the following six scenarios:

- Scenario 3a – emergency discharge occurs at beginning of a flood tide during the neap tide cycle in dry season (for consideration of the maximum concentration near the discharge outfall in dry season);
- Scenario 3b – emergency discharge occurs at beginning of a flood tide during the neap tide cycle in wet season (for consideration of the maximum concentration near the discharge outfall in wet season);
- Scenario 3c – emergency discharge occurs at beginning of a flood tide during the spring tide cycle in dry season (for consideration of the maximum aerial extent of impact in dry season);
- Scenario 3d – emergency discharge occurs at beginning of a flood tide during the spring tide cycle in wet season (for consideration of the maximum aerial extent of impact in wet season);
- Scenario 3e – emergency discharge occurs at beginning of an ebb tide during the spring tide cycle in dry season (for consideration of the maximum aerial extent of impact in dry season);
- Scenario 3f – emergency discharge occurs at beginning of an ebb tide during the spring tide cycle in wet season (for consideration of the maximum aerial extent of impact in wet season).

5.6.24 The purpose of Scenarios 3a and 3b is to evaluate the maximum emergency impact to local areas near the discharge outfall, e.g Cheung Chau Wan. The ebb tide flows away from Cheung Chau Island to the south-west direction and would result in a smaller impact than the flood tide to near field areas, such as Cheung Chau Wan.

5.6.25 The purpose of Scenarios 3c, 3d, 3e and 3f is to evaluate the maximum aerial impact to some sensitive receivers at South Lantau, e.g. Chi Ma Wan, Cheung Sha Fish Cultural Zone under both flood and ebb tide conditions.

***Scenario - 3a, 3b***

5.6.26 **Figures 5C-107** to **5C-206** in **Appendix 5C** show time-series plots for depth-averaged 90% DO, bottom 90% DO, SS, UIA, *E.Coli* and $BOD_5$ concentrations at the identified WSRs for emergency discharge (Scenario 3) from the upgraded Cheung Chau STW in comparison to the baseline condition (Scenario 1) under the both dry and wet seasons.

5.6.27 The locations of ST9 and ST10 are close to the Cheung Chau STW discharge outfall. As shown in **Figures 5C-156** and **5C-166** of **Appendix 5C**, the UIA

concentration at ST10 increases slightly right after the emergency discharge, and the peak UIA level is up to 0.0018 mg/L (in comparison to the baseline level of 0.002 mg/L) in dry season, and 0.0058 mg/L (baseline is 0.0059 mg/L) in wet season. Nonetheless, the predicted UIA concentrations during the emergency discharge are still below the baseline levels during both dry and wet seasons. The impact of the Cheung Chau STW emergency discharge is short in duration and not significant with respect to UIA.

5.6.28 At more distant locations of B8 (Yi Long Wan), B9 (Tai Long Wan), S1 (Cheung Chau Spawning Nursery Grounds), FP1 (South of Cheung Chau) and SM12 (Adamasta Channel), the magnitude of impact on UIA from the Cheung Chau STW emergency discharge is significantly smaller than that at ST9 and ST10. The simulated UIA concentrations in these locations are at the same level as the baseline condition for both dry and wet seasons and the impact of emergency discharge on UIA is insignificant at these locations.

5.6.29 Similar to UIA, the potential impact of the Cheung Chau STW emergency discharge on *E.coli* is limited to local areas (such as ST9, ST10 and U1) as shown in **Figures 5C-136** and **5C-142** in **Appendix 5C**. The *E.Coli* level would increase sharply at ST9 to a peak up to 10,000 cfu/100ml (baseline peak is about 15,000 cfu/100ml) in dry season, and to a peak up to 5,000 cfu/100ml in wet season (baseline peak for the wet season is in the range of 6,000 cfu/100ml as well). On the other hand, the *E.Coli* concentration would decrease sharply from its peak and return to its normal background level in less than 12 hours after the emergency discharge is ceased.

5.6.30 Apart from the local area (such as at ST9, ST10 and U1), no obvious changes to the *E.Coli* level were predicted to occur at other more distant locations such as at ST1 (Cheung Chau typhoon shelter), C1 (Tung Wan), C2 (Kwun Yam Wan), C12 (South of Hei Ling Chau), B8 (Yi Long Wan), B9 (Tai Long Wan), S1 (Cheung Chau Spawning Nursery Grounds), and F1 (Cheung Sha Wan Fish Culture Zone). **Figures 5C-133** and **5C-143** in **Appendix 5C** show that the potential impact of the STW emergency discharge on Cheung Sha Wan Fish Culture Zone (F1) is insignificant. As shown in **Table 5.4** and **Table 5.6**, the emergency discharge loading from the upgraded Cheung Chau STW (Scenario 3) is higher than, but still in the same order of magnitude as the baseline loading (Scenario 1). Given that the upgraded STW is expected to result in an improvement of overall water quality in local areas near the Project site compared to the existing baseline condition, and given that the duration of emergency discharge last only about 6 hours, it is anticipated that the potential impact due to the Cheung Chau STW emergency discharge is temporary and short lived.

***Scenario - 3c, 3d, 3e, 3f***

5.6.31 Four typical scenarios 3c, 3d, 3e, 3f were simulated to assess the maximum extent of impact during the spring tide cycle for both the flood and ebb tide conditions.

5.6.32 **Figures 5C-208** and **5C-214** show that the emergency discharge would result in a sharp increase in the *E.Coli* level in the local area (Observation point U1) during a flood tide. The peak value at U1 is up to 2,000 cfu/100mL in dry season and 7,000 cfu/100mL in wet season. On the other hand, the *E.Coli* level would decrease quickly from its peak and return to its normal background level in about 10 hours after the emergency discharge is ceased. At more distant locations such as SM12 (EPD routine monitoring station), B1 (Tung Wan), B8 (Yi Long Wan), B9 (Tai Long Wan), C15 (Chi Ma Wan Peninsula) and F1 (Cheung Sha Wan Fish Culture Zone), the emergency discharge was predicted to have minimal influence in both dry and wet seasons as shown in **Figures 5C-207** to **5C-218.**

5.6.33 Similar to the flood tide condition, a sharp increase in the *E.Coli* level is expected in the local area near the emergency discharge outfall during an ebb tide as shown in **Figures 5C-220** and **5C-226** (Observation points ST1 and U1). The peak value at U1 was simulated to reach up to 900 cfu/100mL in dry season and 5,000 cfu/100mL in wet season. The peak value at ST1 is up to 12,000 cfu/100mL in dry season and 5,000 cfu/100mL in wet season. Nonetheless, the *E.Coli* level would decrease quickly from its peak and return to its normal background level in about 12 hours after the emergency discharge is ceased. **Figures 5C-219** to **5C-230** show that the emergency discharge would impose a minimal influence at more distant locations such as SM12 (EPD routine monitoring station), B1 (Tung Wan), B8 (Yi Long Wan), B9 (Tai Long Wan), C15 (Chi Ma Wan Peninsula) and F1 (Cheung Sha Wan Fish Culture Zone) under both the dry and wet season conditions.

5.6.34 The above four scenarios 3c, 3d, 3e, 3f show that the impact of emergency discharge would be limited only to local areas. The potential impact would disappear rapidly and sharp concentration of water quality variables such as *E.Coli* would return to their normal levels in less than 12 hours after the emergency discharge is ceased. Impact to more distant WSRs would be extremely small and insignificant.

**Water Quality Impact on Cooling Water Intake at Lamma Island**

5.6.35 As shown in **Table 5.13** and **Table 5.14**, the commissioning of the upgraded Cheung Chau STW would not result in a significant change to water quality conditions in vicinity of the sea water intake at Lamma Island at CW1, SM5, and SM6 and SM7. The SS level at the intake location was simulated to be in the range of 3 to 5 mg/L, which is in compliance with the criteria of 40 mg SS/L for cooling water intakes. It is not anticipated that adverse water quality impact would occur at the sea water intake at Lamma Island.

**Impact to Corals**

5.6.36 As indicated in **Table 5.15** and **Table 5.16**, changes in sediment concentration at the proximity of the identified coral sites are negligible near Stations of C1 to C15. No adverse impact on corals is predicted to result from the upgrading of the Cheung Chau STW.

**Cumulative Impacts**

5.6.37 Concurrent projects that are expected to be constructed or operated in the same period of time include:

- Improvement of fresh water supply to Cheung Chau;
- Replacement and Rehabilitation of Water Mains Stage 3, Mains On Hong Kong and Islands – Investigation, Design and Construction;
- Replacement and Rehabilitation of Water Mains Stage 4, Mains On Hong Kong and Islands – Investigation, Design and Construction;
- Improvement to Existing Roads and Drains in Cheung Chau Old Town, Remaining Engineering Works, Stage 3, Cheung Chau;
- Development of a 100MW Offshore Wind Farm in Hong Kong;
- Harbour Area Treatment Scheme (HATS) Stage 2A;
- Hong Kong - Zhuhai - Macao Bridge Hong Kong Link Road Tuen Mun Chek Lap Kok Link;

- New Contaminated Mud Marine Disposal Facility at Airport East / East Sha Chau Area Mud pits at North Brothers;
- Hong Kong - Zhuhai - Macao Bridge Hong Kong Boundary Crossing Facilities;
- Integrated Waste Management Facility at Shek Kwu Chau; and
- Upgrading of Tai O Sewage Collection, Treatment and Disposal Facilities (354DS – Outlying and Sewerage Stage 2).

5.6.38 Based on the results of relevant EIA studies, cumulative impacts by the concurrent projects listed above were concluded to be insignificant. Water quality impacts from the listed projects are limited to respective local areas near each project site. Given that the Cheung Chau STW Upgrading Project is sufficiently distant away from the listed project locations, it is anticipated that the potential cumulative water quality impacts due to the additive impacts from these projects and the Cheung Chau STW Upgrading Project would be insignificant.

5.6.39 The concurrent projects include the proposed works "Upgrading of Tai O Sewage Collection, Treatment and Disposal Facilities (354DS – Outlying and Sewerage Stage 2)". As the sewerage works in Tai O is expected to have insignificant impact to marine water quality at Cheung Chau, the cumulative water quality impact from the Tai O STW works and the Cheung Chau STW works is anticipated to be negligible, provided that the recommended mitigation measures are properly implemented during construction.

## 5.7 Water Pollution Mitigation and Management

### Construction Phase

5.7.1 The practices outlined in ProPECC PN 1/94 Construction Site Drainage should be adopted to minimize the potential water quality impacts from site runoff and other construction activities. The mitigation measures should cover, but not be limited to, the following practices:

- Perimeter channels are to be installed in works areas to intercept runoff at the site boundary prior to the commencement of any earthworks. Surface runoff should be discharged into storm drains via sand/ silt removal facilities with an adequate capacity;
- Works programme should be designed to minimize works areas to reduce soil exposure and site runoff;
- Silt removal facilities, channels and manholes should be maintained and cleaned regularly to ensure their proper functions;
- Works programme should be carefully planned to minimize the scale of soil excavation during the rainy season;
- Earthworks surfaces should be well compacted and subsequent permanent works or surface protection measures should be carried out immediately;
- All vehicles should be washed before they leave the construction site to avoid earth, mud, and debris being carried off from the site. Wash-water should be treated to remove sand and silt at least on a weekly basis to ensure the continued efficiency of the washing facility;
- Open stockpiles of construction materials on site should be covered with tarpaulin or similar fabric materials during storms;
- For sections of sewer mains that need to be laid underneath water courses with the open cut method, site works should be carried out during the dry season with a temporary drainage diversion; and

- Any construction works along Hak Pai Road immediately by the Kwun Yam beach and Cheung Chau Tung Wan beach should be avoided during the swimming season.

5.7.2 With implementation of the above measures, construction site runoff is not anticipated.

***General Construction Activities***

5.7.3 Good site practices should be adopted to regularly clean the construction sites to avoid rubbish, debris and litter from entering to nearby water bodies.

5.7.4 Wastewaters generated from construction activities may contain high SS concentrations and possibly a certain amount of grease and oil. Good construction and site management practices should be implemented to ensure that litter, fuels, and solvents would not enter the public drainage systems.

***Sewage Arising from Workforces***

5.7.5 Domestic sewage generated by the workforce on construction sites should be collected and disposed of to the STW for proper treatment. Portable toilets should be provided by the Contractor, where necessary, to handle sewage from the workforce. The Contractor should also be responsible for waste disposal.

***Spillage of Chemicals***

5.7.6 Illegal disposal of chemicals should be strictly prohibited. Registration to EPD as a Chemical Waste Producer is required if chemical wastes are generated and need to be disposed of. Disposal of chemical wastes should be carried out in compliance with the Waste Disposal Ordinance (WDO). The Code of Practice on Packaging, Labelling and Storage of Chemical Wastes published under the WDO should be used as a guideline for handling chemical wastes.

5.7.7 Oils and fuels should only be used and stored in designated areas that have pollution prevention facilities.

**Operational Phase**

***Cheung Chau STW***

5.7.8 Emergency discharge of raw sewage from the STW may be needed in case of failure of electrical power supply or treatment units. Under the circumstances of a possible emergency discharge, the STW operator should immediately notify the relevant governmental departments, such as EPD, LCSD and DSD. The STW operator should maintain a good line of communication with various parties involved in an emergency discharge event.

5.7.9 Standby facilities for the main treatment units and standby pumps, accessories/ equipment parts should be installed to avoid the occurrence of an emergency discharge. Storm Tanks would also be incorporated to provide temporary storage of flow under extremely high flow conditions and hence reduce the chance of emergency bypass. Dual power supply or standby power sources should also be implemented to minimize the possibility of power failure. It is expected that with the above mitigation measures, the chance of emergency discharge of untreated effluent is small.

5.7.10 A contingency plan should be developed to deal with the occurrence of an emergency discharge during the operation of the STW.

***Sewage Overflow from the SPS***

5.7.11 Although the emergency overflow of raw sewage from the Pak She SPS would be diverted into the Cheung Chau STW for treatment prior to discharge into the marine water, mitigation measures would still be recommended to reduce the possibility of an emergency bypass of sewage from the Pak She SPS:

- A standby pump is already provided and will continue to be provided after the upgrading to cater for breakdown and maintenance of duty pumps to reduce the chance of occurrence of sewage bypass;
- A backup power supply would be provided to secure electrical power supply; and
- Regular maintenance and checking of equipment should be carried out to prevent equipment failure.

***Contingency Plan***

5.7.12 A contingency plan each for the Cheung Chau STW and the Pak She SPS respectively, should be developed to deal with emergency discharge. The contingency plan should include the following:

- Locations of the sensitive receivers in vicinity of the emergency discharge;
- A list of relevant governmental bodies to inform of and to ask for assistance in the event of an emergency discharge, including key contact persons and telephone numbers;
- Reporting procedures required in the event of an emergency discharge;
- Responsibility and procedure for clean-up of the affected water body/sensitive receivers after the emergency discharge; and
- Procedures listing the most effective means in rectifying the breakdown of the pumping station to minimize the discharge duration.

## 5.8 Residual Impacts

5.8.1 With effective controls through good operation and management practices, no adverse water quality impact is anticipated to occur during the construction phase of both the upgrading works for the Cheung Chau STW and Pak She SPS and the sewers works under this Project.

5.8.2 For the operational phase, water quality in the study area is expected to be in compliance with the WQOs under the normal operation of the upgraded Cheung Chau STW (Scenario 2) with the exception for TIN, based on the modelling and analysis results. Given that the background TIN level in the Southern WCZ is already higher the WQO for TIN, the upgraded Cheung Chau STW was not predicted to impose additional adverse impacts to water quality conditions of the receiving marine environment.

5.8.3 In general, the results of model simulation indicate that the upgraded Cheung Chau STW would result in an improvement of water quality conditions in vicinity of the Project area. Lower concentrations of the key water quality parameters including UIA, TIN, *E.Coli*, SS and $BOD_5$ in areas near the Project site are expected. This is mainly attributable to the improved treatment efficiency of upgraded facility and better quality of the upgraded Cheung Chau STW effluent, resulting in a reduction in pollutant loads into the marine water. The predicted pollutants level during normal operation of the upgraded Cheung Chau STW generally in compliance with WQO for the Southern Water Control Zones except the TIN content, where the background TIN concentration has already exceeded the standard as specified in the WQO.

5.8.4 The simulation results show that the impact of emergency discharge of Cheung Chau STW would be limited only to the local areas. The potential impact would disappear rapidly and sharp concentration of water quality variables such as *E.Coli* would return to their normal levels in less than 12 hours after the emergency discharge is ceased. Impact to more distant WSRs would be extremely small and insignificant.

5.8.5 Upgrading of the Pak She SPS will reduce the chance of sewage overflow from the SPS and eliminate any direct emergency discharge to marine waters. Adverse water quality impacts due to this upgrading works is not anticipated.

## 5.9 Environmental Monitoring and Audit Requirements

5.9.1 The need for EM&A activities during the construction and operation phases of the Project was identified in this EIA study. Details of the EM&A requirements are provided in a separate EM&A manual.

## 5.10 Conclusion

5.10.1 Overall, no significantly adverse impacts from the effluent discharge of the upgraded Cheung Chau STW are anticipated at the identified water sensitive receivers in the study area. An overall improvement in water quality is expected for marine waters near the Project site, as a result of the enhanced coverage of sewer systems to collect raw sewage on Cheung Chau and the improved treatment efficiency of the upgraded Cheung Chau STW.

# 6. WASTE MANAGEMENT IMPLICATION

## 6.1 Introduction

6.1.1 This section identifies the types of wastes that are likely to be generated during the construction and operation phases of both the upgrading of the Cheung Chau STW and Pak She SPS and the sewers works of the Project, and evaluates the potential environmental impacts that may result from these wastes.

6.1.2 The primary waste arising will be generated during the construction phase would mainly be construction and demolition (C&D) materials from the works. During the operational phase, general refuse and sewage sludge are expected to be generated from the Cheung Chau STW and Pak She SPS. Mitigation measures and good site practices, including waste handling, storage and disposal, are recommended with reference to the applicable waste legislation and guidelines.

6.1.3 This assessment has based on the criteria and guidelines stated in Annexes 7 and 15 of the EIAO-TM for evaluation and assessment of waste management implications and has covered the scope outlined in Section 3.4.5 of the EIA Study Brief.

## 6.2 Relevant Legislations, Standards & Guidelines

6.2.1 In carrying out this assessment, reference has been made to the following relevant Hong Kong legislations governing waste management and disposal:

- The Waste Disposal Ordinance (Cap. 354) and subsidiary legislation such as the Waste Disposal (Chemical Waste) (General) Regulation and Waste Disposal (Charges for Disposal of Construction Waste) Regulation that set out requirements for the storage, handling and transportation of all types of wastes.
- Environmental Impact Assessment Ordinance (Cap. 499), Technical Memorandum on Environmental Impact Assessment Process (EIAO-TM), Annexes 7 and 15;
- Public Health and Municipal Services Ordinance (Cap. 132) – Public Cleansing and Prevention of Nuisance Regulation – control of disposal of general refuse; and
- Land (Miscellaneous Provisions) Ordinance (Cap. 28).

6.2.2 Other relevant documents and guidelines that are applicable to waste management and disposal in Hong Kong include:

- Development Bureau Technical Circular (Works) (TC(W)) No. 6/2010, Trip Ticket System for Disposal of Construction & Demolition Materials;
- Development Bureau TC(W) No. 8/2010 Enhanced Specification for Site Cleanliness and Tidiness;
- ETWB TC(W) No. 19/2005, Environmental Management on Construction Sites;
- ETWB TC(W) Nos. 22/2003 and 22/2003A, Additional Measures to Improve Site Cleanliness and Control Mosquito Breeding on Construction Sites;
- ETWB TC(W) No. 33/2002, Management of Construction and Demolition Material Including Rock;
- Works Bureau TC No. 12/2002, Specification Facilitating the Use of Recycled Aggregates;

- Works Bureau TC Nos. 25/99, 25/99A and 25/99C, Incorporation of Information on Construction and Demolition Material Management in Public Works Sub-committee Papers; and
- Works Bureau TC No. 2/93, Public Dumps.

**Waste Management**

6.2.3 The Waste Disposal Ordinance (WDO) prohibits the unauthorised disposal of wastes. Construction waste is defined as any substance, matter or thing that is generated from construction work and abandoned, whether or not it has been processed or stockpiled before being abandoned, but does not include any sludge, screenings or matter removed in or generated from any desludging, desilting or dredging works. Under the WDO, wastes can be disposed of only at designated waste disposal facilities.

6.2.4 Under the WDO, the Chemical Waste (General) Regulation 1992 provides regulations for chemical waste control, and administers the possession, storage, collection, transport and disposal of chemical wastes. EPD has also issued a guideline document, the Code of Practice on the Packaging, Labelling and Storage of Chemical Wastes (1992), which details how the contractor should comply with the regulations on chemical wastes.

6.2.5 Public Cleansing and Prevention of Nuisance Regulation provides control on illegal tipping of wastes on unauthorised (unlicensed) sites.

6.2.6 The Land (Miscellaneous Provisions) Ordinance provides control on dumping of public fill. The inert portion of construction waste (also called public fill) may be taken to public fill reception facilities which are operated by the Civil Engineering and Development Department (CEDD). The Land (Miscellaneous Provisions) Ordinance requires that dumping licences be obtained by individuals or companies who deliver public fill to public filling areas. The CEDD issues the licences under delegated powers from the Director of Lands.

6.2.7 Under the licence conditions, public fill reception facilities will only accept inert earth, soil, sand, rock, boulder, rubble, brick, tile, concrete, asphalt, masonry or used bentonite. In addition, in accordance with Development Bureau Technical Circular (Works) (TC(W)) No. 6/2010, the Public Fill Committee will advise on the acceptance criteria (e.g. no mixing of construction waste, nominal size of the materials less than 250mm, etc) for disposal of construction and demolition (C&D) materials at public fill facilities.

**Construction and Demolition (C&D) Material**

6.2.8 The current policy related to the disposal of C&D materials is documented in the Works Branch TC No. 2/93, 'Public Dumps'. C&D materials that are wholly inert, namely public fill, should not be disposed of to landfill, but taken to public filling areas, which usually form part of reclamation schemes.

6.2.9 Under the Waste Disposal (Charges for Disposal of Construction Waste) Regulation, enacted in January 2006, construction waste delivered to a landfill for disposal must not contain more than 50% by weight of inert material. Construction waste delivered to a sorting facility for disposal must contain more than 50% by weight of inert material, and construction waste delivered to a public fill reception facility for disposal must consist entirely of inert materials.

6.2.10 The ETWB TC(W) No. 19/2005 "Environmental Management on Construction Sites" includes procedures on waste management requiring contractors to reduce the C&D materials to be disposed of during the course of construction. The ETWB TC(W) No.

33/2002, "Management of Construction and Demolition Material Including Rock" to enhance the management of C&D materials, and to minimize its generation at source, submission of C&D Material Management Plan (C&DMMP) is not required for less than 50,000 $m^3$ C&D materials from Designated Projects and less than 300,000 $m^3$ from non-Designated Projects. Under ETWB TC(W) No. 19/2005, the contractor is required to prepare and implement an Environmental Management Plan (EMP) and the Waste Management Plan becomes part of the EMP.

**Chemical Waste**

6.2.11 Under the Waste Disposal (Chemical Waste) (General) Regulations, all producers of chemical waste must register with EPD and treat their wastes, either utilising on-site plant licensed by EPD, or arranging for a licensed collector to transport the wastes to a licensed facility. The regulation also prescribes the storage facilities to be provided on site, including labelling and warning signs, and requires the preparation of written procedures and training to deal with emergencies such as spillages, leakages or accidents arising from the storage of chemical wastes.

## 6.3 Assessment Methodology

6.3.1 The assessment of potential waste management implications includes the following tasks:

- Estimation of the types and quantities of waste arising;
- Evaluation of potential impacts from the handling, collection, transportation and disposal of waste; and
- Proposal of mitigation measures for the waste management.

## 6.4 Construction Phase Waste Generation and Potential Impacts

**Waste Arisings**

6.4.1 The construction activities to be carried out under the Project include:

- trench excavation of pipe laying;
- modification works of Pak She SPS (mechanical and electrical installations);
- removal of surface and sub-surface materials unsuitable as fill;
- cutting and installation of new pipelines; and
- upgrading of Cheung Chau STW.

6.4.2 These construction activities will generate a variety of wastes which includes:

- C&D materials;
- site clearance wastes;
- chemical wastes; and
- general refuse.

6.4.3 During the construction phase of the upgrading of Cheung Chau STW, the sludge handling arrangements would remain the same, which is to be disposed of to Cheung Chau Refuse Transfer Station daily by v-v vehicles. Based on the current design, installation of temporary sludge handling arrangements is considered unnecessary thus no temporary waste management implications regarding the sludge handling are expected.

6.4.4 No special nor hazardous wastes are expected to be generated during the construction phase of the project.

6.4.5 The nature of each type of waste to be arisen and an evaluation of the potential environmental impacts associated with generation, handling, storage and transport of the waste are provided as below.

**C&D Materials**

6.4.6 C&D materials would be generated from the excavation works for the sewer construction, modification works of Pak She SPS and upgrading works of Cheung Chau STW. The total quantity of C&D materials generated from the works is estimated to be approximately 52,333$m^3$. The quantity of inert C&D materials to be generated from excavation (soil, rock, sand and concrete) is estimated to be approximately 52,221$m^3$ while the quantity of non-inert C&D materials (C&D waste) generated is estimated to be approximately 112$m^3$.

6.4.7 To minimize the net amount of inert C&D materials generated from the Project, the inert C&D materials will be re-used on-site as far as possible. It is estimated that approximately 35,054$m^3$ of inert C&D materials will be reused on-site as backfill materials.

6.4.8 The estimated quantity of inert C&D materials to be disposed of will be 17,167$m^3$. Final destinations of the inert C&D materials will be determined to the availability of public filling facilities and are subject to the agreement with CEDD.

6.4.9 The volume of C&D materials generated from the modification works of the Pak She SPS is 278$m^3$. Thus, it is will not have adverse impacts to landfills and public filling facilities

6.4.10 The breakdown of the amount of C&D materials are summarized in **Table 6.1**.

**Table 6.1 : Summary of Estimated C&D Materials Generation**

| Type of Construction | Total C&D Materials ($m^3$) | Inert C&D Materials (e.g. soil, rock, concrete) ($m^3$) | Non-inert C&D Materials ($m^3$) | Backfilling Volume ($m^3$) | Volume of inert C&D Materials to be Disposed of ($m^3$) |
|---|---|---|---|---|---|
| Sewers | 13,561 | 13,561 | 0 | 13,431 | 130 |
| Modification Works of SPS | 282 | 278 | 4 | 134 | 144 |
| Upgrading of Cheung Chau STW | 38,490 | 38,382 | 108 | 21,489 | 16,893 |
| Total | 52,333 | 52,221 | 112 | 35,054 | 17,167 |

6.4.11 Provided proper management for C&D materials and adoption of good site practices are implemented, it is anticipated that the impacts due to C&D materials arising from the Project would be insignificant.

6.4.12 Inert and non-inert C&D waste materials will be sorted on-site and disposed of properly. Based on the current design information, it is planned to use barges to transport the C&D waste materials from the barging point of Cheung Chau STW to the designated disposal facilities once per day. Proper management of C&D materials and good site practice will be implemented to minimise the potential environmental impacts.

**General Refuse**

6.4.13 The construction workforce will generate a small amount of general refuse such as waste papers, plastic packaging and possibly food wastes. Such refuse will be collected on-site on a regular basis, separately from C&D materials by an appropriate waste collector to be employed by the contractor.

6.4.14 Prior to disposal off-site, such wastes will have to be temporarily put in suitably covered storage areas/bins where they will have to be regularly cleaned and maintained to avoid attracting vermin and pests. With proper on-site handling and storage as well as regular disposal of the wastes, no adverse impacts are envisaged.

**Chemical Waste**

6.4.15 The maintenance and servicing of construction plant and vehicles may generate a small amount of chemical wastes such as waste oil/grease, spent solvents/detergents, empty fuel/lubricant drums, used oil filters and scrap batteries. The volume of chemical waste to be generated is difficult to estimate at this stage. It will depend on the total number of plant or vehicles to be used on-site and the frequency of maintenance. However, with consideration of the nature of the project, it is expected that the volume of chemical waste to be generated would be small. Should proper handling, storage and disposal of chemicals are implemented, no unacceptable environmental impacts are anticipated.

## 6.5 Operational Phase Waste Generation and Potential Impacts

**Waste Arisings**

6.5.1 During the operational phase of the project, wastes to be generated include screenings and chemical wastes from the Pak She SPS and Cheung Chau STW, silts and debris from the maintenance of sewers, general refuse from the office of the Cheung Chau STW and dewatered sludge.

6.5.2 The screenings from Pak She SPS and Cheung Chau STW, silt and debris from the maintenance of sewers and general refuse from the STW will be properly stored in a covered container and disposed of daily to Cheung Chau Refuse Transfer Station by a reputable waste collector employed by the operators to reduce the potential pest, odour and litter impacts. The estimated volume of waste to be generated from screening is about 80$m^3$ per month.

6.5.3 The grits collected from grit chamber of Cheung Chau STW will be stored in covered containers and disposed to Cheung Chau Refuse Transfer Station. The estimated volume of grits to be generated is approximately 4.5$m^3$ per month.

6.5.4 The dewatered sludge generated from the sewage treatment process will be the main stream of waste during the operation of the Cheung Chau STW. According to the design capacity of the upgraded STW, the average quantity of dewatered sludge is about 100$m^3$ per month.

6.5.5 The maintenance works of Pak She SPS and Cheung Chau STW will generate a small amount of chemical wastes which will be collected by a license collector and disposed of properly following standard practices.

6.5.6 Deodourizers will be provided in the upgraded Cheung Chau STW and Pak She SPS. The chemicals used in the deodourizers (e.g. granulated activated carbon (GAC)) have to be replaced regularly to ensure the odour removal efficiency. The handling, storage and disposal of the used chemicals will follow the Waste Disposal (Chemical Waste) (General) Regulation.

6.5.7 No special nor hazardous wastes are expected to be generated during the operation of the project.

6.5.8 Mitigation and control measures to minimise the potential environmental impacts generated from the waste management is provided in the following section.

## 6.6 Mitigation Measures

### Construction Phase

6.6.1 Adverse impacts from waste management are not expected, provided that good site practices are strictly followed. Recommendations for good site practices during the construction activities include:

- The Contractor shall prepare a Waste Management Plan (WMP) in accordance with the requirements set out in the ETWB TCW No. 19/2005, Waste Management on Construction Site, for the Engineer's Representative approval. The WMP shall include monthly and yearly Waste Flow Tables that indicate the amounts of waste generated, recycled and disposed of (including final disposal site);
- The Contractor's waste management practices and effectiveness shall be audited by the Engineer's Representative on regular basis;
- The Contractor shall provide training for site staff for the concept of site cleanliness and appropriate waste management procedures, including waste reduction, reuse and recycling;
- Sufficient waste disposal points and regular collection of waste shall be provided;
- Trucks with covering for the open-box bed and enclosed container shall be used to minimise windblown litter and dust during transportation of waste;
- Regular cleaning and maintenance programme for drainage systems, pumps and oil interceptors;
- Separation of chemical wastes for special handling and appropriate treatment at a Chemical Waste Treatment Facility (CWTF);
- Encourage collection of aluminium cans, paper and plastic bottles by providing separate labelled bins to enable these wastes to be segregated from other general refuse generated by the workforce;
- Segregation and storage of different types of waste in different containers, skips or stockpiles to enhance reuse or recycling of materials and their proper disposal;
- A recording system for the amount of wastes generated, recycled and disposed (including disposal sites) should be proposed; and
- Plan and stock construction materials carefully to minimise amount of waste generated and avoid unnecessary generation of waste.

### *C&D Materials*

6.6.2 With good site management it can reduce the over-ordering of C&D materials such as concrete and mortars. Alternatives such as steel frameworks and plastic fencing can be considered to increase the chances for reuse.

6.6.3 In order to minimise the potential environmental impacts resulting from collection and transportation of C&D materials for off-site disposal, the excavated materials comprising fill materials should be reused on-site as backfilling materials as far as practicable.

6.6.4 C&D waste, such as wood, plastic, steel and other metals should be reused or recycled and, as a last resort, disposed of to Cheung Chau Refuse Transfer Station. A suitable area should be designated within the site for temporary stockpiling of C&D materials and to facilitate the sorting process. In order to monitor the disposal of C&D materials at the designated public fill reception facility and landfill and to control fly-tipping, a trip ticket system should be included. Reference can be made to Development Bureau Technical Circular (Works) (TC(W)) No. 6/2010 for details.

6.6.5 The C&D materials to be disposed of at public filling reception facilities shall be materials only consist of brick, concrete, cement plaster, soil and inert building debris. The materials shall be free from plastics, chemical waste, industrial metals and other materials that are considered unsuitable at the facility.

***General Reuse***

6.6.6 General refuse should be stored in enclosed bins or compaction units separate from C&D materials. A reputable waste collector should be employed by the Contractor to remove general refuse from the site regularly, separately from C&D materials. An enclosed and covered area is preferred to reduce the occurrence of 'wind blown' light materials. In addition, a sufficient number of enclosed bins shall be provided on site for containment of general refuse to prevent visual impacts and nuisance to the sensitive surrounding.

***Chemical Wastes***

6.6.7 For the disposal of chemical wastes produced at the construction site, the Contractor is required to register with the EPD as a Chemical Waste Producer and to follow the requirements stated in the Code of Practice on the Packaging, Labelling and Storage of Chemical Wastes. Good quality containers compatible with the chemical wastes should be used. Appropriate labels should be securely attached on each chemical waste container indicating the chemical characteristics of the chemical waste, such as explosives, flammable, oxidizing, irritant, toxic, harmful, corrosive, etc. The Contractor shall also use a licensed waste collector engaged to transport and dispose of the chemical wastes in accordance with the Waste Disposal (Chemical Waste) (General) Regulation.

***Sewage***

6.6.8 Chemical toilets to be provided on-site shall be regularly cleaned and the night-soil collected and transported by a licensed contractor to a Government Sewage Treatment Works facility for disposal.

**Operational Phase**

6.6.9 The major waste generated during the operational phase will be screenings, silt and debris, grits and dewatered sludge. The screenings, silt and debris and grits are considered similar in nature to general refuse and will be disposed of Cheung Chau Refuse Transfer Station regularly by a reputable waste collector to reduce pest, odour and litter impacts. As the project will be commissioned in 2019, it is expected that dewatered sludge will be disposed of at Sludge Treatment Facilities regularly,

6.6.10 For chemical waste generated during the operational phase, the handling procedures and disposal method are the same as those presented in **Section 6.6.7**.

6.6.11 **Table 6.2** provides a summary of the various types of waste to be generated during the construction and operational phases of the Project and the corresponding handling and disposal methods.

**Table 6.2 : Summary of Waste Handling Procedures and Disposal Routes**

| Waste Type | Handling | Disposal |
|---|---|---|
| **Construction** | | |
| C&D Materials | Where possible should be reused on-site. If off-site disposal is required, separate into:<br>• Non-inert C&D waste.<br>• Inert C&D materials. | • Non-inert C&D waste to strategic landfill.<br>• Inert C&D materials (Public fill) to Public Filling Reception Facilities. |
| Chemical Wastes | Recycle on-site or by licensed companies. Store on-site within suitably designed containers. | CWTF |
| General Refuse | Provide on-site refuse collection facilities. | Employ a reputable hygiene company for collection and disposal of general refuse to landfill sites. |
| **Operation** | | |
| Screenings, Silt and Debris from Operation and Maintenance | Off-site disposal required | Cheung Chau Refuse Transfer Station |
| Grits | Off-site disposal required | Cheung Chau Refuse Transfer Station |
| Dewatered Sludge | Off-site disposal required | Sludge Treatment Facilities |
| Chemical Waste | Off-site disposal required | CWTF |

## 6.7 Residual Impacts

6.7.1 Waste management implication has been discussed in this section. By following relevant regulations and statutory requirements, and with proper implementation of good practice and recommended mitigation measures as in Section 6.6, no unacceptable residual impacts are expected to occur during the construction and operation of the Project.

## 6.8 Environmental Monitoring and Audit Requirements

6.8.1 The assessment has concluded that proper handling, storage, collection, transportation and disposal of waste materials generated during construction and operation of the Project will not give rise to any significant impacts to nearby sensitive receivers.

6.8.2 It is recommended that during the construction phase, site inspections and supervisions of waste management procedures and auditing of the effectiveness of implemented mitigation measures should be undertaken on a regular basis (e.g. weekly as a minimum). These tasks shall be scheduled in the WMP to be prepared by the Contractor, and a summary of the site audit findings shall be presented in the EM&A reports.

6.8.3 No EM&A requirement is considered necessary during the operational phase.

## 6.9 Conclusion

6.9.1 The construction activities associated with the proposed works will generate a variety of wastes including site clearance waste, C&D materials, chemical waste and general refuse. With the implementation of good site practice and recommended mitigation measures, there would be no adverse environmental impacts.

6.9.2 Major wastes to be generated from the operation of the STW include screenings, silt and debris, grits and dewatered sludge. Provided proper handling procedures and disposal method are adopted, no unacceptable environmental impacts are anticipated.

# 7. LAND CONTAMINATION

## 7.1 Introduction

7.1.1 This section presents the appraisal of the baseline situation for the land lots within the Study Area due to their past or present land uses history, which could be a potential of contaminated land issue, and the assessment on the implications of land contamination associated with both the upgrading of the Cheung Chau STW and Pak She SPS and the sewers works of the Project.

7.1.2 This assessment has based on the guidelines for evaluation and assessment of potential contaminated land as stated in Section 3.1 of Annex 19 of the EIAO-TM and has covered the scope outlined in Sections 3.4.5.3 and 3.4.5.4 of the EIA Study Brief.

## 7.2 Relevant Legislation, Standards & Guidelines

7.2.1 According to Annex 19 of the EIAO-TM, if a site with historical land uses which have the potential to cause or have caused land contamination, a Contamination Assessment Plan (CAP) has to be submitted as part of the EIA Report to the EPD for endorsement prior to conducting a contamination assessment of the site. The land contamination assessment results should be documented in a Contamination Assessment Report (CAR). If land contamination is confirmed, a Remediation Action Plan (RAP) should be prepared and submitted with the CAR as a combined report for EPD approval. Upon the approval of the CAR/RAP, the site shall be cleaned up the contamination according to the approved RAP prior to any development or redevelopment of the site. The preparation of CAP, CAR and RAP shall be prepared in accordance with the relevant standards and guidelines issued by EPD.

7.2.2 EPD has issued three publications in relation to the land contamination assessment. They are:

- Guidance Note for Contaminated Land Assessment and Remediation (Guidance Note);
- Guidance Manual for use of Risk-based Remediation Goals (RBRGs) for Contamination Land Management (Guidance Manual); and
- Practice Guide for Investigation and Remediation of Contaminated Land (Practice Guide).

7.2.3 The Guidance Note for Contaminated Land Assessment and Remediation set out the requirements for proper assessment and management of potentially contaminated sites, provide guidelines on how site assessment should be conducted and suggest practical remedial measures that can be adopted for the clean-up of a contaminated site.

7.2.4 The Guidance Manual provides the background of the use of RBRGs and presents instructions for comparison of soil and groundwater data to the RBRGs.

7.2.5 The Practice Guide outlines the process for conducting land contamination assessment and remediation in Hong Kong and presents the standard investigation methods and remediation strategies for the range of potential contaminated sites and contaminants typically encountered in Hong Kong.

## 7.3 Assessment Methodology

7.3.1 In order to identify land lots / sites within the Study Area that are potential contaminated sites and evaluate the land contamination impacts, the following approach was adopted for the land contamination assessment:

- Desktop study to review the current and historical land uses and identify any potential contaminative land uses within the Study Area; and
- Site reconnaissance to identify the existing land uses and confirm the general environmental conditions associated with each of the identified sites.

7.3.2 In addition, the following sources of information have been collected and reviewed:

- Aerial photographs from Lands Department taken between 1924 - 2011;
- Acquisition of information related to potential land contamination from the Environmental Compliance Division of EPD, Fire Services Department (FSD) and Lands Department (LD); and
- Records and photographs from site reconnaissance.

7.3.3 Potential contaminants and their associated potential hazardous risks to the land users and surrounding environment would be evaluated with reference to the EPD's Guidance Note, Guidance Manual and Practice Guide.

## 7.4 Baseline Environmental Condition

7.4.1 As described in **Section 2**, the Project includes the upgrading the existing sewers construction of new sewers for some of village houses, upgrading the existing Pak She SPS and Cheung Chau STW. The Study Areas cover Tai Kwai San Tsuen, Cheung Kwai Estate, Round Table 2nd and 3rd Villages, Lutheran Village, Pak She San Tsuen, Nam She Tong, Fa Peng, Lung Tsai Tsuen, Ko Shan Tsuen and Tai Shek Hau in Cheung Chau. These areas are composed of low-rise residential buildings, recreation facilities and vegetated areas. The present land uses that give rise to potential concerns for land contamination include a scrap recycling workshop, shipyards and machinery repairing workshops for ships along Ping Chong Road and Pak She Praya Road. **Figure 7.1** shows the locations of these potential contaminated sites.

## 7.5 Site History

7.5.1 Historical aerial photographs (as listed in **Table 7.1**) available in the Survey and Mapping Office at Lands Department were reviewed to identify the potential contaminated sites.

**Table 7.1 : Historical Aerial Photos Reviewed for Cheung Chau**

| Year | Height (Feet) | Photograph Reference No. |
|---|---|---|
| 1924 | NA | 16 |
| 1945 | 2000 | 4161 |
| 1956 | 16700 | 0187 |
| 1963 | 3900 | 4171, 4180 |
| 1968 | NA | 953 |
| 1973 | 6000 | 3755 |
| 1977 | 4000 | 18327 |
| 1980 | 5000 | 29188 |
| 1982 | 4000 | 45916 |
| 1984 | 5200 | 57247 |

| Year | Height (Feet) | Photograph Reference No. |
|---|---|---|
| 1986 | 2000 | A04100, A04101 |
| 1988 | 1000 | A12493 |
| 1990 | 1000 | A20328, A20330 |
| | 2000 | A20681 |
| 1992 | 3500 | A33458, A33464, A33480 |
| 1996 | 3500 | A43432 |
| 1998 | 4000 | A47752 |
| 2000 | 4000 | A50738 |
| 2002 | 4000 | CW39820 |
| 2006 | 4000 | CW72380, CW73717 |
| 2007 | 6000 | CS06215, CS06270 |
| 2008 | 6000 | CS12301, CS12495 |
| 2009 | 6000 | CS26911, CS27087 |
| 2010 | 6000 | RS01455, RS05125 |
| 2011 | 3000 | CW89340, CW89559 |

7.5.2 The review of available historical aerial photographs indicates that Cheung Chau consists of mainly village houses and vegetation areas. The oldest aerial photograph for Cheung Chau was taken in 1924. It shows that there were residential houses along the areas of Tung Wan and Cheung Chau Wan. The present area of Cheung Kwai Estate located north of Cheung Chau Wan was green land in the 1924 aerial photograph. The existing machinery repairing workshops for ships, shipyards, scrap recycling workshop and Cheung Chau STW sites were not reclaimed at the time. Since 1970's, village houses began to increase on the island. In the 1980's, reclamation works began at the exiting machinery repairing workshops area and along the southern coastline of Cheung Chau Wan. Cheung Kwai Estate and a few shipyards along Ping Chong Road were found in the 1984 aerial photograph. In the 1990 aerial photograph, it was found that there were more shipyards and machinery repairing workshops for ships along Ping Chong Road. The scrap recycling workshop along Ping Chong Road was also observed in the 1990 aerial photograph. **Figures 7.2** to **7.8** show the aerial photographs of 1924, 1977, 1980, 1984, 1990, 1996 and 2011 for Cheung Chau.

## 7.6 Review of Environmental Information from the Government

7.6.1 Information regarding historical records of chemical spillage, violations of environmental regulations and licences / permits was requested from the FSD and the Regional Office (South) of EPD for a review. The correspondences are provided in **Appendix 7.1**.

7.6.2 **Table 7.2** lists the chemical waste producers registered under the Waste Disposal (Chemical Waste) (General) Regulation within the vicinity of the Project.

**Table 7.2 : Records of Registration of Chemical Waste Producer**

| Name of Registered Waste Producers | Address | Business Type |
|---|---|---|
| Chung Shak Hei (C.C) Home for the Aged Ltd. | Pak She, Cheung Chau, HK | Elderly Service |
| Cheung Chau Government Secondary School | 5B School Road, Outlying Island, NT | Education |
| Hop Lee Construction Company - Kam Kong Primary School | Cheung Chau Church Kam Kong Primary School, 1 Peak Road West, Outlying Island, N.T. | Construction |
| ST John Hospital - Dispensary/Pathology Laboratory/ X-Ray Department | Hospital Road, Cheung Chau, NT | Hospital |
| Fire Services Department | Cheung Chau Fire Station, 1 Ping Chong Road, Cheung Chau | Fire Station |
| Water Supplies Department | Tai Kwai Wan San Tsuen, N.T. | Provision of water supplies and attendant services |
| Buddhist Wai Yan Memorial College | Buddhist Wai Yan Memorial College, 25 Tai Hing Tai Road, Outlying Island, NT | Education |

7.6.3 According to the information provided by EPD, there is no record of chemical spillage in the past within the Study Area.

7.6.4 **Table 7.3** lists dangerous goods stores within the Study Area.

**Table 7.3 : Records of Registration of Dangerous Goods Stores**

| Location of Registrant | Type of Dangerous Goods | Method of Storage |
|---|---|---|
| Shek Kau Chau | Diesel | Licensed dangerous goods Store on G/F |
| Cheung Chau Hospital Road | Oxygen cylinders | Licensed dangerous goods store on G/F |

7.6.5 According to the information provided by FSD, there is no record for spillage or leakage of dangerous goods at the above listed dangerous good stores.

## 7.7 Identification of Sensitive Receivers

7.7.1 Construction workers may be exposed to contaminated soils during the construction stage. The main exposure routes for construction workers are accidental direct ingestion of contaminated soils through poor hygiene and eating, or through direct contact with contaminants during excavation works.

7.7.2 During the operational phase of the Project, the maintenance workers for the sewerage system are the sensitive receivers.

## 7.8 Identification and Evaluation of Potential Impacts

7.8.1 The site reconnaissance was undertaken on 28 October 2011. Based on site observations, the majority of the proposed sewers works are along public and vehicular access roads. There were no potential contaminated sites identified within the proposed construction areas of sewers and Cheung Chau STW. However, there are machinery repairing workshops for ships and scrap recycling workshop in the vicinity of the Pak She SPS. Access to these potential contaminated sites could not be granted and observations were made outside the sites. It was found that the potential contaminated sites are paved with concrete. Oil stains next to the oil drums were observed at some of the potential contaminated sites. As the upgrading Pak She SPS would not involve any excavation works within the contaminated sites, the construction workers would not have a direct contact of the potential contaminated soils. Therefore, no potential land contamination impacts are anticipated and no further site investigation is required.

7.8.2 Both Cheung Chau STW and Pak She SPS were built on a reclaimed land and operation in the mid 1980's (**Figure 7.5**). Power supplier has been provided for Cheung Chau STW and Pak She SPS and no fuel, chemical or dangerous goods is used for its operation. Therefore, no contaminated soils underneath Cheung Chau STW and Pak She SPS sites are anticipated.

7.8.3 The details of the current and historical land uses of the potential contaminated areas are summarized in **Table 7.4**.

**Table 7.4 : Potentially Contaminated Sites Identified in the Vicinity of the Project Area**

| Location | Current Land Use | Historical Land Use | Potential Contamination Impact on the Project Area | Need for Further Site Investigation |
|---|---|---|---|---|
| Pak She Praya Road and Ping Chong Road | Machinery repairing workshops and a scrap recycling workshop | The site is a reclaimed land and appears to be machinery repairing workshops and a scrap recycling workshop since 1990. | Oil stains next to oil drums were observed on the concrete paved area for some of the workshops.<br>The upgrading of Pak She SPS would not involve excavation works within the contaminated site. Therefore, the construction workers would not have direct contact with the potential contaminated soils. | No |

7.8.4 The operation of the upgraded Cheung Chau STW, Pak She SPS and existing sewers would not cause land contamination. Therefore, there would be no land contamination impacts on the maintenance workers for the sewerage system.

## 7.9 Residual Impacts

7.9.1 No potential land contamination sites are located within the construction areas of the proposed upgrading works and sewer alignment, the upgraded Cheung Chau STW and Pak She SPS. No unacceptable residual impact is anticipated during the construction and operation of the Project.

## 7.10 Environmental Monitoring and Audit Requirements

7.10.1 There are no EM&A requirements for land contamination.

## 7.11 Conclusion

7.11.1 The land contamination assessment was undertaken by reviewing historical and current land uses and site reconnaissance. Based on the findings of the site appraisal, there were potential contaminated sites at the Shipyard and the Machinery Repairing and Recycling Workshops for Ship. However, as there are no excavation works within the contaminated sites, no potential contaminated soils would be disturbed. The unacceptable impacts of land contamination are not expected during the construction phase of the Project.

7.11.2 The operation of the Project is not potential contaminated land use. No operational contamination impacts are anticipated.

# 8. ECOLOGY

## 8.1 Introduction

8.1.1 This section presents the assessment of potential ecological impacts resulting from both the upgrading of the Cheung Chau STW and Pak She SPS and the sewers works of the Project. Literature review and ecological field surveys were undertaken to establish the ecological baseline for the evaluation of the ecological importance of habitats and flora/fauna species potentially affected by the proposed works. The magnitude of potential ecological impacts arising from the proposed works was assessed and necessary mitigation is recommended.

8.1.2 This assessment has based on the criteria and guidelines stated in Annexes 8 and 16 of the EIAO-TM for evaluation and assessment of terrestrial and marine ecological impacts and has covered the scope outlined in Section 3.4.6 and Appendix F of the EIA Study Brief ESB–212/2009.

## 8.2 Relevant Legislations, Standards & Guidelines

8.2.1 The local relevant regulations, legislation and guidelines for the protection of species and habitats of ecological importance include the following:

- Technical Memorandum for the Environmental Impact Assessment Ordinance (Cap 499) (EIAO-TM);
- EIAO Guidance Note No. 6/2010;
- EIAO Guidance Note No. 7/2010;
- EIAO Guidance Note No. 10/2010;
- EIAO Guidance Note No. 11/2010;
- Hong Kong Planning Standards and Guidelines Chapter 10 (HKPSG);
- Forests and Countryside Ordinance (Cap 96) and its subsidiary legislation the Forestry Regulations;
- Wild Animals Protection Ordinance (Cap 170);
- Protection of Endangered Species of Animals and Plants Ordinance (Cap 586);
- Country Parks Ordinance (Cap 208);
- Marine Parks Ordinance (Cap 476);
- Town Planning Ordinance (Cap 131);
- PRC Regulations and Guidelines;
- IUCN Red List Categories and Criteria;
- China Red Data Book of Endangered Species; and
- The Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES).

8.2.2 Annex 16 of the EIAO-TM sets out the general approach and methodology for assessments of ecological impacts arising from a project or proposal, to allow a complete and objective identification, prediction and evaluation of the potential ecological impacts. Annex 8 recommends the criteria that can be used for evaluating ecological impacts.

8.2.3 EIAO Guidance Note No. 6/2010 clarifies the requirements of ecological assessments under the EIAO. EIAO Guidance Note No. 7/2010 provides general guidelines for conducting ecological baseline surveys in order to fulfil requirements stipulated in the EIAO-TM. EIAO Guidance Note No. 10/2010 and EIAO Guidance

Note No. 11/2010 outline the methodologies for ecological field surveys on various terrestrial and marine faunal groups.

8.2.4 Chapter 10 of the HKPSG covers planning considerations relevant to conservation. This chapter details the principles of conservation, the conservation of natural landscape and habitats, historic buildings, archaeological sites and other antiquities. It also addresses the issue of enforcement. The appendices list the legislation and administrative controls for conservation, other conservation related measures in Hong Kong and Government departments involved in conservation.

8.2.5 The Forests and Countryside Ordinance (Cap 96) prohibits felling, cutting, burning or destroying of trees and live plants in forests and plantations on Government land. Related subsidiary Regulations prohibit the picking, felling or possession of listed rare and protected plant species. The list of protected species in Hong Kong, which comes under the Forestry Regulations, was last amended on 11 June 1993 under the Forestry (Amendment) Regulation 1993 made under Section 3 of the Forests and Countryside Ordinance.

8.2.6 Under the Wild Animals Protection Ordinance (Cap 170), designated wild animals are protected from being hunted, whilst their nests and eggs are protected from destruction and removal. All birds and most mammals are protected under this Ordinance. The Second Schedule of the Ordinance that lists all the animals protected was last revised in June 1992.

8.2.7 The Protection of Endangered Species of Animals and Plants Ordinance (Cap 586) was enacted to align Hong Kong to control regime with the Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES). With effect from 1 December 2006, it replaces the Animals and Plants (Protection of Endangered Species) Ordinance (Cap 187). The purpose of the Protection of Endangered Species of Animals and Plants Ordinance is to restrict the import and export of species listed in CITES Appendices so as to protect wildlife from overexploitation or extinction. The Ordinance is primarily related to controlling trade in threatened and endangered species and restricting the local possession of them.

8.2.8 The Country Parks Ordinance (Cap 208) provides for the designation and management of Country Parks and Special Areas. Country Parks are designated for the purpose of nature conservation, countryside recreation and outdoor education. Special Areas are reserved generally for the purpose of nature conservation.

8.2.9 The amended Town Planning Ordinance (Cap 131) provides for the designation of coastal Protection Areas, Sites of Special Scientific Interest (SSSI), Green Belt or other specified uses that promote conservation or protection of the environment, e.g., Conservation Areas. The authority responsible for administering the Town Planning Ordinance is the Town Planning Board.

8.2.10 The enactment of Marine Parks Ordinance (Cap 476) laid the milestone of marine conservation in Hong Kong. This Ordinance provides for designation, control and management of marine parks and marine reserve.

8.2.11 The Peoples' Republic of China (PRC) is a Contracting Party to the United Nations Convention on Biological Diversity of 1992. The Convention requires signatories to make active efforts to protect and manage their biodiversity resources. The Government of the Hong Kong SAR has stated that it will be "committed to meeting the environmental objectives" of the Convention (PELB 1996). In 1988 the PRC ratified the Wild Animal Protection Law, which lays down basic principles for protecting wild animals. The Law prohibits killing of protected animals, controls hunting, and protects the habitats of wild animals, both protected and non-protected. The Law also provides for the creation of lists of animals protected at the state level,

under Class I and Class II. There are 96 animal species in Class I and 156 in Class II. Class I provides a higher level of protection for animals considered to be more threatened.

8.2.12 The International Union for Conservation of Nature and Natural Resources (IUCN) Red List of Threatened Species provides taxonomic, conservation status and distribution information on taxa that have been evaluated using the IUCN Red List Categories and Criteria. This system is designed to determine the relative risk of extinction, and the main purpose of the IUCN Red List is to catalogue and highlight those taxa that are facing a higher risk of global extinction. The IUCN Red List also includes information on taxa that are either close to meeting the threatened thresholds or that would be threatened were it not for an ongoing taxon-specific conservation programme.

8.2.13 China Red Data Book of Endangered Species is a joint publication of China National Environmental Protection Agency (NEPA) and the Endangered Species Scientific Commission, PRC (ESSC). The first four volumes of this series cover China's vertebrates (i.e. aves, pisces, amphibia, reptilian and mammalia). The criteria of categories of species included in these volumes are 'extinct', 'extirpated', 'endangered', 'vulnerable', 'indeterminate' and 'rare'. These categories are basically based on the criteria set out by the IUCN Species Survival Commission (IUCN-SSC) for its global Red List. However, there are some important differences. The category "Extirpated" includes those species which experts believe have been lost from China, although they may be secure in the other countries. The use of the category "Rare" has been discontinued by the IUCN-SSC, however, it is used here for those species that have always been rare in China but are not necessary to be vulnerable or endangered.

8.2.14 CITES is an international agreement between governments. It aims to ensure that international trade in specimens of wild animals and plants does not threaten their survival. Roughly 5,000 species of animals and 28,000 species of plants are protected by CITES against over-exploitation through international trade. They are listed in the three CITES Appendices, in which the species are grouped according to how threatened they are by international trade. Appendix I lists species that are the most endangered and are threatened with extinction. Appendix II lists species that are not necessarily now threatened with extinction but that may become so unless trade is closely controlled. And Appendix III is a list of species included at the request of a Party that already regulates trade in the species and that needs the cooperation of other countries to prevent unsustainable or illegal exploitation.

## 8.3 Assessment Methodology

8.3.1 Existing information about the ecological condition within the Study Area were reviewed. This included but not limited to "EIA-065/2001 – 132KV Supply Circuit from Pui O via Chi Ma Wan Peninsula via Sea Crossing towards Cheung Chau"; "Extension of Existing Landfills and Identification of Potential New Waste Disposal Sites – Final SEA Report (Part B: South Cheung Chau Island Landfill"; and "Improvement of Fresh Water Supply to Cheung Chau". Reviewed literature is listed in **Section 1.5.1** of **Appendix 8.1**.

8.3.2 According to the EIA Study Brief No. ESB–212/2009, ecological field surveys were carried out to fill the information gap identified from reviewed literatures. Field surveys for terrestrial and freshwater ecology, with a 4-month duration, were conducted between May and August 2011 to cover the wet season. The full ecological baseline survey report is attached in **Appendix 8.1**, and results of key findings are summarized in this chapter.

8.3.3 The marine elements of the Project, including the construction of a new SPS at Kwun Yam Wan, which had once been described in the Project Profile, were omitted in the design process during the present EIA study to avoid and minimise impacts. All proposed works elements are now land-based and no marine works will be involved under the Project. Given that there will be no direct impact on intertidal or subtidal habitat and the beneficial effects on marine water quality would be brought by the Project as illustrated in the water quality assessment, assessment on marine ecology would focus on indirect impacts and the assessment results are likely positive. After reviewing all available literatures on baseline information for marine ecology, in particular to marine mammals, benthic communities, intertidal habitats, and corals as stipulated in the Study Brief, it was found that the information, of which the literatures include some recently approved EIA studies in the area, is up-to-date and sufficient for the assessment purposes. Therefore, field surveys for marine ecology were not conducted.

8.3.4 **Table 8.1** summarizes the methodology of habitat mapping, flora and fauna surveys carried out in terrestrial and freshwater habitats in the Study Area of Cheung Chau. Details of survey methodology are described in **Section 1.6** of **Appendix 8.1**.

**Table 8.1 : Summary of the Methodology for Ecological Baseline Surveys**

| Survey Type | Brief Methodology | Survey Period |
|---|---|---|
| Habitat and Vegetation | Habitat mapping and vegetation identification through ground truthing in major habitats. | Monthly from May to August 2011 |
| Bird | Quantitative (point count and transect count method) and qualitative (recorded within the Study Area) survey including day and night surveys covering the wet season. | Monthly from May to August 2011 |
| Mammal | Quantitative (active searching along the survey transect) and qualitative (recorded within Study Area); including day and night surveys covering the wet season. | Monthly from May to August 2011 |
| Herpetofauna | Quantitative (active searching along the survey transect) and qualitative (recorded within Study Area); including day and night surveys covering the wet season. | Monthly from May to August 2011 |
| Butterfly | Quantitative (point count and transect count method) and qualitative (recorded within Study Area) survey; including only day-time surveys covering the wet season. | Monthly from May to August 2011 |
| Odonates (i.e. Dragonfly & Damselfly) | Quantitative (point count and transect count method) and qualitative (recorded within Study Area) survey; including only day-time surveys covering the wet season. | Monthly from May to August 2011 |
| Freshwater Aquatic Assemblage | Active searching in freshwater streams,; using hand net and kick sampling; including only day-time surveys in the wet season. | Two times in July and August 2011 |

## 8.4 Description of Existing Ecological Baseline Conditions

### Terrestrial and Aquatic Ecology

8.4.1 Habitats recorded within the Study Area included young woodland, plantation, shrubland, grassland, stream, agricultural land/orchard, developed area/village and coastal area (**Figures 1.3a-d** and **1.4a-b** of **Appendix 8.1**). Details of existing

ecological baseline conditions for terrestrial and aquatic ecology from reviewed literature are described in **Sections 1.3 - 1.5** of **Appendix 8.1**. Details of findings from ecological field surveys are described in **Section 1.7** of **Appendix 8.1**. Based on the ecological field surveys, it is concluded that the habitats recorded included young woodland, plantation, shrubland, grassland, stream, agricultural land/orchard, developed area/village and coastal area. The ecological value of young woodland was considered to be moderate to high. The ecological value of shrubland, stream and developed area/village was considered to be low to moderate. And that of plantation, grassland, agricultural land/orchard and coastal area was considered to be low. The sites of Cheung Chau STW and Pak She SPS where the upgrading works would be performed are classified as Village/Developed Area.

**Marine Ecology**

8.4.2 As stipulated in the EIA Study Brief (clause 3.4.6.2), the assessment area for marine ecological impact assessment shall be the same as the assessment area for water quality impact assessment. The water quality assessment has identified water quality sensitive receivers (WSRs) within the Southern Water Control Zone and adjacent areas, and the simulated water quality results in these WSRs due to the effluent discharge from upgraded Cheung Chau STW under different scenarios were presented to assess the potential water quality impact. The locations and distributions of these WSRs were presented in **Figure 5.1** and **5.2**. Within the coverage of these WSRs, several recognized sites of conservation importance were found, including Sham Wan SSSI. There are also some important intertidal habitats within the coverage of these WSRs, such as corals previously recorded in Cheung Chau and the nearby islands (Ping Chau, Lantau and Lamma), Finless Porpoise habitat to the south of Cheung Chau, mangroves and seagrass beds in Lantau, and horseshoe crab sites. The marine ecological assessment would thus follow the coverage of the WSRs and focus on the recognized sites of conservation importance as well as species and habitats within, including benthic communities, intertidal habitats, coral communities (**Figure 8.1** referred) and marine mammals (**Figure 8.2** referred). Sites and habitats outside the coverage are far away from the Project Site due to the vast size of the Southern Water Control Zone, and impacts to these sites and habitats would be unlikely given that there will be no marine works involved in the present Project.

**Marine Mammals**

8.4.3 Only two marine mammal species, the Chinese White Dolphin (*Sousa chinensis*, also known as Indo-Pacific humpback dolphin,) and Finless porpoise (*Neophocaena phocaenoides*) are resident to Hong Kong. Finless Porpoise is protected locally by the Wild Animals Protection Ordinance (Cap 170). It is also categorized as 'Vulnerable' by the IUCN Red List of Threatened Species, and 'Appendix I' in the CITES. According to Hung (2013), from 2012-2013 Finless Porpoise were mainly sighted in the southern waters of Hong Kong (**Figure 8.2**). The important porpoise habitats during 2004-2012 were located to the south of Tai A Chau near Shek Kwu Chau, the waters between these two islands, the sourth-western and eastern side of Lamma Island during the dry season and around Po Toi Islands during the wet season . When comparing the porpoise distribution in 2012-13 with those from the past five years (i.e. 2007-2008 annual survey to 2011-2012 annual survey), the area between Shek Kwu Chau and the Soko Islands have been consistently utilized by finless porpoises since 2007-2008. But temporal changes in distribution were also found. Finless porpoises were regularly sighted between Cheung Chau and Shek Kwu Chau during this period, the sightings of porpoises were increased in 2012-13 among the past six-year records. However, the sighting maps during from 2007-

2008 annual survey to 2012-2013 annual survey also reveal that finless porpoise sightings near southern half of Cheung Chau were less frequent than its adjacent areas including waters between Shek Kwu Chau and Soko Islands and waters around south Lamma Island. The coastal waters at northern half of Cheung Chau, where the existing STW and existing outfall are located, is not considered important for marine mammals.

8.4.4 Chinese White Dolphin also protected locally by the Wild Animals Protection Ordinance (Cap. 170) and under the Protection of Endangered Species of Animals and Plants Ordinance (Cap 586). It is listed as "Near Threatened" in the IUCN Red List of Threatened Species, and listed in the CITES Appendix I. In mainland, it is listed as a "Grade 1 National Key Protected Species". In Hong Kong, Chinese White Dolphins concentrate in the more estuarine-influenced waters, i.e. all the waters of western Hong Kong. They are present commonly year-round in the waters north and west of Lantau, and also occur seasonally or in small numbers to the south and east of Lantau Island, as well as in southern Deep Bay and to the west of Lamma Island. They are not present in the waters to the east of Lamma Island, except for occasional wanderings. From 2012-2013, Chinese White Dolphins were sighted throughout waters around Lautau and Deep Bay (Hung 2013). Habitat use patterns of dolphins from 2008-12 revealed that their highest densities areas included the west coast of Lantau, around Lung Kwu Chau, near the northeast corner of airport, Kau Ling Chung and Yam O. Waters around Cheung Chau however are not dolphins' important habitats. In the 2012-2013 annual marine mammal monitoring survey, there was no sighting recorded around Cheung Chau, and the nearest sighting was Soko Islands (*ibid*). When reviewing the dolphin results from 2006 to 2013, basically there was no dolphin sighting around Cheung Chau during this duration, except one single sighting on the southeast side of the island in 2006-2007 survey (Hung 2013).

**Benthic Communities**

8.4.5 Except in eastern and southern shores where the shallow subtidal habitat is rocky and coral-encrusted, the majority of subtidal seabed of Hong Kong is soft and comprises an admixture of sand and mud. The detailed composition of the soft sediment varies from place to place and is one of the main factors that determines the type of bottom dwelling (benthic) organisms which inhabits the sediment. Soft sediments support a wide range of bottom-dwelling (benthic) communities and standing crops, and have been long recognized as valuable feeding areas as they are major food source for demersal fishery (AFCD website).

8.4.6 A study of benthic assemblages throughout Hong Kong was undertaken by Shin and Thompson (1982). The study concluded that the western waters of Hong Kong supports assemblages that are polychaete dominated (over 80%). Results from 2001 territorial-wide marine benthic survey (CCPC 2002), the eastern and southern waters are more homogeneous (evenness) in benthic composition and diversity, which reflect relatively higher ecological importance as compared with the other regions. However, no species of conservation importance is recorded.

8.4.7 According to the EIA Study for the CLP cable circuit project (Mott 2001), it was suggested that the benthic assemblages between Chi Ma Wan and Cheung Chau (i.e. Admasta Channel) supported relatively low ecological value assemblages.

8.4.8 Soft-bottom seabed habitat offshore to east Cheung Chau was investigated by grab sampling during the EIA study for "Improvement of Fresh Water Supply to Cheung Chau" (BV 2010), and the results revealed that no species of conservation importance was found in the area. 59 taxon were recorded among the 268 benthic organisms collected, including 8 Phyla. Shannon-Wiener Diversity Index ranged

from 1.75 to 3.30, while Pielou's Evenness index ranged from 0.76 to 0.96. Infauna diversity was relatively low, and all the species recorded occurred frequently in Hong Kong.

**Intertidal Habitats**

8.4.9 As described in the study for EIA-065/2001 – "132 KV Supply Circuit from Pui O via Chi Ma Wan Peninsula via Sea Crossing towards Cheung Chau" (CLP 2001), the majority of the coastal areas on Cheung Chau have been reclaimed and lined with vertical artificial seawalls. This is particularly obvious on the western shores at the populated central portion of the island. Within the Study Area, the coastlines near Sai Wan, Cheung Chau Wan and Cheung Chau Typhoon Shelter are all dominated by artificial seawalls.

8.4.10 Rocky shores and sandy shores are present along the coastline of the Study Area. Typical exposed rocky shore communities consist of periwinkles, barnacles and limpets. Encrusting algae are common in low intertidal zone (William 2003). Typical sandflat communities consist of numerous epifauna and infauna organisms such as burrowing crabs, gastropods, bivalves and worms (Chan and Caley 2003).

8.4.11 During the EIA study for "Improvement of Fresh Water Supply to Cheung Chau" (BV 2010), intertidal surveys were performed on Cheung Chau at 8 locations at Tai Kwai Wan covering artificial seawalls, rocky shores and sandy shores. One of the survey locations was on the artificial seawalls of the existing STW under the Project. It was found that no species of conservation importance was recorded during the survey in intertidal habitats (neither hard nor soft shore habitats). On rocky shores, dominant species included Rock oyster *Saccostrea cucullata*, Acorn barnacle *Tetraclita squamosa*, Stalked barnacle *Capitulum mitella*, and Black mussel *Septifer virgatus*. All these species are common and abundant species on typical rocky shore habitats. On sandy shores, however, only Ghost crab *Ocypode* sp. and Clam *Donax* sp. were recorded, which are also common and typical fauna of sandy beaches. While on artificial seawalls, species composition was similar with those on rocky shores, but the diversity and abundance of intertidal fauna were relatively much lower. (*ibid*)

**Coral Communities**

8.4.12 Corals were previously reported in Cheung Chau at some locations away from urbanized areas, for examples the headlands at the northeast and southeast of Cheung Chau. Hard coral communities have been identified in the waters of Tung Wan Tsai (Coral Beach) (Chan *et al*. 2005; AFCD 2004), which is approximately 750 m from the closest works area. Families including Siderastreidae, Mussidae, Faviidae and Poritidae have been previously recorded at Tung Wan Tsai (Chan *et al*. 2005). Octocorals *Dendronephthea*, *Guaiagorgia*, *Stereonephthea* and a presently undescribed species of nephtheid soft coral have also been recorded (AFCD 2004). Moreover, siderastreid *Psammocora superficialis*, ahermatypic dendrophylliids *Balanophyllia*, *Tubastraea* and *Dendrophyllia* spp., soft corals (gorgonians) *Euplexaura* and *Echinomuricea*, and corallimorpharian *Discosoma* have been reported by AFCD (2004) at Tung Wan Tsai and to the east of Kwun Yam Wan Beach. In other locations closer to the urbanized areas, no significant coral record was reported. During the EIA study for "Improvement of Fresh Water Supply to Cheung Chau", dive survey was conducted at a small reclamation headland at Kwu Yam Wan, but no coral was recorded. In Hong Kong, coral communities are protected under Protection of Endangered Species of Animals and Plants Ordinance (Cap 586).

## 8.5 Evaluation of Habitats and Species of Ecological Importance

8.5.1 The ecological importance of the habitats and wildlife identified within the Assessment Area during the surveys are evaluated in accordance with the EIAO-TM Annex 8 criteria, and presented in **Tables 8.2** - **8.9**. The ecological value of young woodland was considered to be moderate to high. The ecological value of shrubland, stream and developed area/village was considered to be low to moderate. And that of plantation, grassland, agricultural land/orchard and coastal area was considered to be low.

**Table 8.2 : Ecological Evaluation of Young Woodland within Study Area of Cheung Chau**

| Criteria | Young Woodland |
|---|---|
| Naturalness | Semi-natural dominated by native plants. |
| Size | Large patches of young woodland were found in the hilly northern (behind Tai Kwai Wan San Tsuen), south-western (in the vicinity of Cheung Chau Public Cemetery) and south-eastern (i.e. Fa Peng) parts of the Study Area, with an overall area of approximately 78.4 ha (37.6% of the total Study Area). |
| Diversity | Moderate to high floral diversity (100 plant species recorded) with moderate structural complexity.<br>Moderate faunal diversity. |
| Rarity | Bird species of conservation importance included Black Kite *Milvus migrans*, Crested Goshawk *Accipiter trivirgatus*, Chinese Goshawk *Accipiter soloensis*, Emerald Dove *Chalcophaps indica*, Greater Coucal *Centropus sinensis* and Chinese Hwamei *Garrulax canorus*. |
| Re-creatability | Habitat characteristics and species composition are relatively natural although not mature enough. In the absence of disturbance, it would take 15 - 20 years for the young woodland to be re-created. |
| Fragmentation | The north patch is largely continuous, while the close canopy of the southern patches is often opened or chopped by built-ups. |
| Ecological Linkage | Not functionally links to any highly valued habitat in close proximity; but may provide roosting sites for different fauna. Largely fell within the Green Belt zone. |
| Potential Value | With a moderate to high potential value to become mature woodland if given sufficient time and protection from disturbances. |
| Nursery / Breeding Ground | Nil. |
| Age | 15 – 20 years. |
| Abundance / Richness of Wildlife | Moderate to high for birds and butterflies; low for the other fauna groups. |
| **Overall Ecological Value** | **Moderate to high.** |

**Table 8.3 : Ecological Evaluation of Plantation within Study Area of Cheung Chau**

| Criteria | Plantation |
|---|---|
| Naturalness | Manmade habitat, dominated by exotic trees and shrubs. |
| Size | The total area of this habitat is approximately 9.5 ha (4.6% of the total Study Area). |
| Diversity | Low floral diversity (18 plant species recorded) with low structural complexity.<br>Low faunal diversity. |
| Rarity | One bird species of conservation importance, Black Kite *Milvus migrans*. |
| Re-creatability | For the plantation woodland along northern hillsides, it would take about 10 years for the trees to be re-created.<br>For the plantation in close proximity of urban environments, habitat characteristics and species composition are relatively easy to be re-created. |

| Criteria | Plantation |
|---|---|
| Fragmentation | Largely fragmented and isolated except for the northern plantation woodland along hill slopes. |
| Ecological Linkage | Not functionally linked to any highly valued habitat in close proximity. |
| Potential Value | Generally low, but low to moderate for the plantation woodland in north to become young woodland with native species as dominant plants if given sufficient time and protection from disturbances. |
| Nursery/ Breeding Ground | Nil. |
| Age | 10 years. |
| Abundance/ Richness of Wildlife | Low for all fauna groups. |
| **Overall Ecological Value** | **Low.** |

**Table 8.4 : Ecological Evaluation of Shrubland within Study Area of Cheung Chau**

| Criteria | Shrubland |
|---|---|
| Naturalness | Semi-natural habitats mainly covered by native species. |
| Size | Patches were recorded within the Study Area with an overall area of approximately 16.0 ha (7.7% of the total Study Area). |
| Diversity | Moderate diversity of plants (67 species) with moderate structural complexity.<br>Moderate faunal diversity. |
| Rarity | Bird species of conservation importance included Black Kite *Milvus migrans*, Greater Coucal *Centropus sinensis* and Chinese Hwamei *Garrulax canorus*. |
| Re-creatability | In the absence of disturbance, it would take 5 - 10 years for the shrubland to be re-created. |
| Fragmentation | Relatively fragmented, in particular to those patches surrounded by the developed areas. |
| Ecological Linkage | Not functionally linked to any highly valued habitat, bordering young woodland in close proximity. Largely fell within the Green Belt zone. |
| Potential Value | Low to moderate to become mature shrubland and then young woodland if given sufficient time and protection from disturbance. |
| Nursery/ Breeding Ground | Nil. |
| Age | 5 – 10 years. |
| Abundance/ Richness of Wildlife | Moderate for butterflies and birds, low for the other fauna groups. |
| **Overall Ecological Value** | **Low to moderate** |

**Table 8.5 : Ecological Evaluation of Grassland within Study Area of Cheung Chau**

| Criteria | Grassland |
|---|---|
| Naturalness | Natural succession would be frequently impeded by disturbances such as hill fires. |
| Size | The total area of this habitat is approximately 6.9 ha (6.9% of the total Study Area). |
| Diversity | Relatively low diversity of plants (37 species) with low structural complexity.<br>Low faunal diversity. |
| Rarity | No flora or fauna species of conservation importance were found in this habitat. |
| Re-creatability | Readily re-creatable. |
| Fragmentation | Concentrated in the northern hilly areas, generally not fragmented. |

| Criteria | Grassland |
|---|---|
| Ecological Linkage | Not functionally linked to any highly valued habitat, bordering young woodland and shrubland located at lower levels. Largely fell within the Green Belt zone. |
| Potential Value | Subject to practice of management and level of disturbance (e.g. hill fires). |
| Nursery/ Breeding Ground | Nil. |
| Age | Very young. |
| Abundance/ Richness of Wildlife | Low for all fauna groups. |
| **Overall Ecological Value** | **Low.** |

**Table 8.6 : Ecological Evaluation of Stream within Study Area of Cheung Chau**

| Criteria | Stream |
|---|---|
| Naturalness | Stream at Shui Hang: generally natural.<br>Stream at Fa Peng: may receive excessive fertilizer from nearby farmlands in upstream section. |
| Size | Total area of this habitat is 0.3 ha, accounting for 0.1% of the total Study Area (in terms of length, 159.9m for the stream at Shui Hang and 476.3 m for the stream at Fa Peng). |
| Diversity | Moderate diversity of plants (32 species) given its small area.<br>Low to moderate diversity of amphibian species, low diversity of other fauna. |
| Rarity | No flora or fauna species of conservation importance were found in this habitat. |
| Re-creatability | Low re-creatability, the characteristic of natural stream banks and stream bed could be recreated through the incorporation of ecologically friendly stream design, but the ecological value / functions will be less when compared with natural stream. |
| Fragmentation | Not applicable. |
| Ecological Linkage | Not functionally linked to any highly valued habitat. Nevertheless, banks of the Shui Hang river integrated into the young woodland in close proximity. |
| Potential Value | Moderate in general if provided with sufficient time, deduction in fertilizer input and protection from disturbance, etc. |
| Nursery / Breeding Ground | Nil. |
| Age | Not applicable. |
| Abundance / Richness of Wildlife | Low to moderate for freshwater assemblage, low for the other fauna groups. |
| **Overall Ecological Value** | **Low to moderate.** |

**Table 8.7 : Ecological Evaluation of Agricultural Land/Orchard within Study Area of Cheung Chau**

| Criteria | Agricultural Land / Orchard |
|---|---|
| Naturalness | Man-made habitat actively cultivated in most area except some small plots in the agricultural land near Self Help Care Village. |
| Size | Two patches of agricultural lands often associated with small sized orchards were found located within the valley east of the Self Help Care Village as well as in the lowland area below Ming Fai Road in Fa Peng, with an overall area of approximately 1.6 ha (0.8% of the total Study Area). |
| Diversity | Moderate diversity of crop plant species, in particular in the Fa Peng Agricultural land.<br>Low fauna diversity. |
| Rarity | One bird species of conservation importance, Black Kite *Milvus migrans*. |

| Criteria | Agricultural Land / Orchard |
|---|---|
| Re-creatability | Readily re-creatable. |
| Fragmentation | Relatively fragmented given the small size of the two patches. |
| Ecological Linkage | Surrounded by young woodland, but not functionally linked to any highly valued habitat. |
| Potential Value | Highly depending on the management practice of land owners, i.e. wet agricultural land often has higher ecological value due to the comparatively high diversity of fauna it supports. |
| Nursery/ Breeding Ground | Nil. |
| Age | Not applicable. |
| Abundance/ Richness of Wildlife | Low to all fauna groups. |
| **Overall Ecological Value** | **Low** |

**Table 8.8 : Ecological Evaluation of Developed Area/Village within Study Area of Cheung Chau**

| Criteria | Developed Area / Village |
|---|---|
| Naturalness | Man-made habitat dominated by ornamental trees and fruit trees. |
| Size | The largest habitat within the Study Area with an overall area of approximately 85.6 ha (41.1% of the total Study Area). |
| Diversity | Moderate to high floral diversity (136 plant species recorded).<br>Moderate faunal diversity. |
| Rarity | No flora species of conservation importance, but one OVT (Chinese Banyan *Ficus microcarpa*, Registration No.: LCSD Is/4) found outside the Pak Tai Temple.<br>Bird species of conservation importance included Black Kite *Milvus migrans* and Emerald Dove *Chalcophaps indica*.<br>One reptile species of conservation importance, Chinese Cobra *Naja atra*, found in front of a village house along Fa Peng Road. |
| Re-creatability | Readily re-creatable. |
| Fragmentation | Largely continuous and concentrated in the central part of the Study Area, some village houses or other rural settlements scattered in the northern and southern hilly areas. |
| Ecological Linkage | Not functionally linked to any highly valued habitat, but bordering nearly all of the other habitats within the Study Area. |
| Potential Value | Low. |
| Nursery / Breeding Ground | Nil. |
| Age | Not applicable. |
| Abundance / Richness of Wildlife | Moderate to high for birds, moderate for butterflies and herpetofauna, low for the other fauna groups. |
| **Overall Ecological Value** | **Low to moderate.** |

**Table 8.9 : Ecological Evaluation of Coastal (Intertidal) Area and Marine Area within Study Area of Cheung Chau**

| Criteria | Coastal (Intertidal) Area | Marine Area |
|---|---|---|
| Naturalness | Rocky shore: largely natural, with a minor proportion of artificial seawalls.<br>Sandy shore: disturbed by beach activities and littering.<br>Seawalls are artificial. | Natural in general but disturbed by human activities. |
| Size | Total area of this habitat is 10.0 ha (4.8% of the total Study Area). | NA |
| Diversity | Low in plant species diversity (20 plant species recorded) and structural complexity.<br>Low in fauna diversity. | Diversity and evenness of the benthic composition were relatively high in the southern and eastern Hong Kong waters, but a low diversity on benthic communities was recorded in east Cheung Chau. |
| Rarity | One bird species of conservation importance, Black Kite *Milvus migrans*. | No species of conservation importance was found in benthic habitat; while Finless porpoises are recorded in the southern waters of Hong Kong, ranging from southwest Lantau to the west to Po Toi and Ninepins areas to the east. The Assessment Area also covers some habitats of Chinese White Dolphins, but only sporadic sighting records around Cheung Chau. |
| Re-creatability | Difficult to be re-created except artificial seawalls. | Difficult to be re-created. |
| Fragmentation | Located continuous along the periphery of the Study Area. | The habitat is not fragmented. |
| Ecological Linkage | Not functionally linked to any highly valued habitat in close proximity. Rocky shore mainly bordering young woodland and shrubland, while sandy shore mainly bordering developed area/village. | The habitat is generally linked with the open sea and is not functionally linked to any high value habitat in a significant way |
| Potential Value | Low. | Low. |
| Nursery/Breeding Ground | Nil. | Nil. |
| Age | NA | NA |
| Abundance /Richness of Wildlife | Low for all fauna groups. | Low for benthic fauna groups, relatively high for Finless Porpoise during winter and spring months. |
| **Overall Ecological Importance** | **Low** | Moderate due to vicinity of the Finless Porpoises habitat range. |

8.5.2 A list and evaluation of the species of conservation importance recorded during ecological baseline surveys within the Study Area, according to the EIAO-TM, are given in **Table 8.10**. Seven fauna species were considered of conservation importance, including Black Kite *Milvus migrans*, Crested Goshawk *Accipiter trivirgatus*, Chinese Goshawk *Accipiter soloensis*, Emerald Dove *Chalcophaps indica*, Greater Coucal *Centropus sinensis*, Hwamei *Garrulax canorus* and Chinese Cobra *Naja atra*. The locations of these species of conservation importance, whenever available, are presented in **Figures 1.3a** - **1.3d** of **Appendix 8.1**.

8.5.3 Marine fauna of conservation importance including Finless porpoises and hard corals were addressed from literature reviews, and are evaluated in **Table 8.10**.

8.5.4 Black Kite, Greater Coucal and Chinese Cobra occur in a variety of habitats. Chinese Goshawk is mainly found in lightly wooded areas and marshes. Crested Goshawk and Emerald Dove are mainly found in woodland. Hwamei is mainly found in woodland and hillsides with thick scrub cover.

**Table 8.10 : Evaluation of Species of Conservation Importance recorded within Study Area of Cheung Chau during Ecological Baseline Surveys**

| Species | Location and Activities (if any) | Protection Status | Distribution | Commonness in HK |
|---|---|---|---|---|
| **Birds*** | | | | |
| Black Kite *Milvus migrans* | Flew over or perched at young woodland, plantation, shrubland, agricultural land/orchard, developed area/village and coastal area of the Study Area. | Appendix II of CITES; Class II Protected Animal of PRC; Protected under Protection of Endangered Species of Animals and Plants Ordinance (Cap. 586). | Found in a wide variety of coastal and inland habitats, including small islands, sea-coasts, intertidal mudflat, fish ponds, reservoirs, landfills and grassy hillsides at all altitudes; East Eurasia. | Common and widespread. Resident and Winter Visitor |
| Crested Goshawk *Accipiter trivirgatus* | Flew over the young woodland in the north of the Study Area. | Appendix II of CITES; Class II Protected Animal of PRC; Listed as 'Rare' in China Red Data Book; Protected under Protection of Endangered Species of Animals and Plants Ordinance (Cap. 586). | Widespread in the forest and mature woodlands of the New Territories in Hong Kong, widespread in PRC. | Locally uncommon resident |
| Chinese Goshawk *Accipiter soloensis* | Flew over the young woodland in the north of the Study Area. | Appendix II of CITES; Class II Protected Animal of PRC; Protected under Protection of Endangered Species of Animals and Plants Ordinance (Cap. 586). | Breeds in Ussuriland, Korea, and much of China, and winters from southeast China through Indochina, the Philippines and Indonesia to New Guinea. In Hong Kong, previously recorded in Tsim Bei Tsui, Kadoorie Farm and Botanic Garden, and Tai Po Kau | Uncommon passage migrant in Hong Kong. |
| Emerald Dove *Chalcophaps indica* | Flew through the developed area and finally perching at the young woodland near Ping Chong Road during the survey. | Listed at 'Vulnerable' in China Red Data Book | South Asia and Australia. Favours thick woodland and good secondary growth. | Scarce resident in Hong Kong |
| Greater Coucal *Centropus sinensis* | Calling heard at several spots in young woodland and shrubland | Class II Protected Animal of PRC; Listed as 'Vulnerable' in China Red Data Book. | Resident throughout the Oriental region, apart from Taiwan, the Philippines and Sulawesi; Found in many types of habitats in Hong Kong. | Common and widespread resident in Hong Kong. |

| Species | Location and Activities (if any) | Protection Status | Distribution | Commonness in HK |
|---|---|---|---|---|
| Hwamei *Garrulax canorus* | Calling heard in young woodland and shrubland. | Appendix II of CITES. | North Indo-China to China and South China; Found in woodland and hillsides with thick scrub cover. | Common breeding resident in Hong Kong |
| **Reptile** | | | | |
| Chinese Cobra *Naja atra* | Found in front of a village house along Fa Peng Road. | Appendix II of CITES; Listed as 'Vulnerable' in China Red Data Book; Protected under Protection of Endangered Species of Animals and Plants Ordinance (Cap. 586). | Usually occurs in different kinds of habitat such as woodlands, shrublands, grasslands and mangroves. | Unclear |
| **Marine Fauna** | | | | |
| Finless porpoise *Neophocaena phocaenoides* | Recorded in southeast and southwest Cheung Chau, but not within their important habitats | WAPO | Can be found in the southern and eastern waters of Hong Kong | NA |
| Chinese White Dolphin | Only sporadic sightings near Cheung Chau | WAPO | Mainly in West Lantau and North Lantau, | NA |
| Hard corals | Eastern Cheung Chau | Cap 586 | Mainly grow along the northeastern and eastern shores, form communities in shallow coaster water. | Common |

Note:
* All birds in Hong Kong are protected under the Wild Animals Protection Ordinance (Cap 170).

## 8.6 Impact Identification

8.6.1 The Project will comprise the expansions, improvement and upgrading of the existing sewerage system at Cheung Chau. The extent of the Project Site is shown in **Section 2** and **Figures 1.1** - **1.2** of **Appendix 8.1**. Major project elements include:

- new gravity village sewers for 9 villages and Cheung Chau Town Centre; and
- upgrading of Cheung Chau STW and Pak She SPS.

8.6.2 All the sewers will be constructed along existing road and paths within developed area using open-cut method. A section of the deep sewer alignment will run along Ming Fai Road. Currently there is a footbridge on Ming Fai Road near Kwun Yam Wan Beach, which spans across a stream (i.e. Fa Peng Stream) and leaves the streambed unmodified. The sewer alignment will cross Fa Peng Stream through this existing footbridge and thus it will be elevated above the stream and therefore the stream will not be directly encroached.

8.6.3 Upgrading works of the SPS and sewage treatment work will take place within the existing structure located within developed area/village. Construction of SPS will take place within developed area/village.

8.6.4 The potential ecological impacts caused by the project are identified and evaluated in the following sections.

## 8.7 Impact Evaluation

### Construction Phase

#### *Direct Impact – Habitat Loss*

8.7.1 The proposed project will only cause temporary loss of about 3 ha of developed area/village for both options. There will be no loss of intertidal habitat or coral communities as no marine works are proposed. No important habitat or species of conservation importance will be lost to the proposed project. A summary of habitat loss is provided in **Table 8.11**.

8.7.2 Removal of existing vegetation and trees will be required during site formation for the STW upgrading works. Plant species associated with developed area/village habitat are all common species; no species of conservation importance will be affected.

8.7.3 No important habitat or species of conservation importance listed in **Table 8.10** will be lost to or affected by the proposed project. Losses of habitats and their associated flora and fauna are considered minor impacts due to the limited ecological importance and temporary nature.

**Table 8.11 : Estimated Habitat Loss Caused by the Project**

| Items | Estimated habitat loss (ha) (Developed area/village only) |
|---|---|
| Proposed Sewers* | 1.18 |
| Proposed upgrading of Cheung Chau STW | 1.59 |
| Proposed upgrading of Pak She SPS | 0.03 |
| Deep Sewer | 0.15 |
| Temporary Works Area | 0.14 |
| Total | 3.09 |

Note:
* gravity sewer + rising main, assuming a 2m works boundary during construction

#### *Indirect Impact – Disturbance*

8.7.4 Indirect construction impacts include disturbance of flora and fauna due to noise and dust during construction. Noise and dust will mainly affect areas adjacent to the works areas, which are mostly developed area/village. Fauna inhabiting this type of habitat are likely to be disturbance tolerant. Disturbance during construction phase will be short-term and localised. Due to the temporary and localized nature of the impacts, potential impacts to flora and fauna are ranked as minor. Dispersion of dust and noise generated during construction can be minimized by good site practice. Should the Deep Sewer Option be selected, trenchless construction method is recommended to reduce the extent of road opening works.

#### *Indirect Impact - Site Runoff*

8.7.5 In the present proposed Project, all construction works are minor in scale and would take place within proposed working area. With the implementation of adequate mitigation measures at construction sites and provision of sediment removal

facilities, it is anticipated that site runoff would not occur. The adjacent marine waters (mainly near the Cheung Chau STW, the Cheung Chau Typhoon Shelter, and the Tung Wan and Kwun Yam Wan areas) are not identified as of special ecological or conservation value. Good site practice and precautionary measures will be implemented to avoid the potential impact due to runoff.

8.7.6 Finless Porpoises, Chinese White Dolphins, and coral communities were recorded at the marine environment. Considering that the Project is localised in nature, all works are terrestrial based. The potential impacts are further reduced significantly since the original proposed SPS in Kwun Yam Wan is removed. Therefore, potential impacts on this marine fauna are considered to be **minor**. With the implementation of site runoff control and good site practice, potential impact on water quality hence coral communities should not arise.

8.7.7 The concentration of suspended sediment fluxes naturally in the marine environment, and fish has developed some adaptative behaviours (e.g. clearing of gills, swimming to clear area) to tolerate changes in suspended solid and polluted drainage water. With the implementation of adequate construction site drainage and provision of sediment removal facilities, potential impact of unacceptable water quality should not arise. The potential impacts to the aquatic invertebrate and fish are considered to be **insignificant**.

***Indirect impact – Accidental Spillage of Chemicals***

8.7.8 For marine ecology, as the adjacent marine waters are not identified as of special ecological or conservation value, and there is no marine works under the Project, there would not be any associated marine traffic, and no increase in the risk of chemical spillage from vessels. For terrestrial ecology however, there is still an increased risk of small-scale oil or chemical (construction works solvent) spills from the construction sites during the construction phase. As all construction works are minor in scale and would take place within proposed working area, with the implementation of adequate construction site practices and management, it is anticipated that the chemical spillage of significant scale would not occur. Because of the small volumes of such materials involved, this risk is considered **insignificant**.

**Operation Phase**

***Direct Impact - Permanent Habitat Loss***

8.7.9 The sewers will be underground and the SPS is built on existing developed area/village. There will be no permanent loss of important habitat.

***Indirect Impact - Water Quality Changes (normal operation)***

8.7.10 The water quality parameters (including annual 90% depth-average DO, 90% bottom DO, TIN, SS, UIA, *E.coli* and $BOD_5$) in the identified WSRs during the baseline conditions (i.e. the operation of the existing STW) and the normal operation of the upgrade STW were presented in Section 5.6 and compared. It was found that incompliance of the TIN will occur in both the dry and wet seasons under the baseline condition as well as the normal operation. But the incremental difference between the two scenarios indicated improvements (increase of DO, and reductions in TIN, UIA, SS, and $BOD_5$ and *E.coli*) in both dry and wet seasons. Upon completion of the upgrading works, a relative improvement of water quality is expected to occur to marine waters near the Cheung Chau area, especially near the Cheung Chau Wan area. Reductions in concentrations of a number of water quality parameters including DO, TIN, UIA, SS, $BOD_5$ and *E.coli* were predicted. No adverse water quality impact is anticipated under the normal operating conditions of

the upgraded Cheung Chau STW. An improvement on water quality and thus positive impacts to aquatic ecology will be anticipated. Under this project, no effluent with disinfection will be discharged to the sea. As stated in **Section 2.7**, there is a proposed effluent reuse scheme for a portion of treated effluent under the Project. Only the portion of treated effluent which will be reused under this scheme, i.e. 200$m^3$/day, will be processed by chlorination in a separated disinfection tank before being conveyed for reuse within the STW. All effluent discharged via outfall, i.e. the remaining portion of treated effluent not for reuse purposes, would not go through chlorination process. As the reused effluent and the discharged effluent will be separated and the chlorination is limited to the reused portion, there will be no chlorine going into the sea with the discharges. Therefore, there will be no water quality impact associated with disinfection activities.

***Indirect Impact - Water Quality Changes (Emergency Discharge from STW)***

8.7.11 In case of operational failure of the Cheung Chau STW, raw sewage might bypass the wastewater treatment unit and be directly discharged into the marine water. Water quality assessment assesses the scenario of the STW emergency discharge in case of the STW operational failure. Emergency discharge might cause deterioration in water quality and adverse impact on aquatic and intertidal communities. The water quality results indicated that the impact from emergency discharge of untreated effluent from the upgraded STW would be insignificant for majority of the study area in terms of DO, TIN, UIA, SS, $BOD_5$ and *E.coli* concentrations. (see **Section 5.6.24**). There will be no adverse incremental difference at all WSRs related to corals (C1 to C15) during the dry season (see **Table 5.15, Section 5.6.34**). Decrease of *E.coli* was observed in these WSRs (C1 to C15) in wet season (see **Table 5.16**). In general, the adverse impact on water quality is expected not significant during the emergency discharge of untreated sewage from the STW. No adverse impact is anticipated either to long term water quality conditions of the marine receiving water. With regular maintenance and checking of plant equipment, chances of occurrence of the incident will be very low. The potential ecological impacts to aquatic and marine ecology will be temporary in nature and is anticipated to be **Insignificant**. As there will be no adverse impact on the WSRs around Cheung Chau and in the vicinity, there will be no adverse impacts on other marine ecological resources farther away including Sham Wan SSSI, Finless Porpoise habitat to the south of Cheung Chau, mangroves and seagrass beds in Lantau, and horseshoe crab sites.

***Indirect Impact - Water Quality Changes (Emergency Discharge from SPS)***

8.7.12 Sewage overflow may occur if pumps fail or if there is an interruption to the electrical supply powering the pumps. Sewage overflow may enter the nearby watercourse and intertidal habitat, causing deterioration in water quality and adverse impact on aquatic and intertidal communities. Corals are recorded at Tung Wan Tsai and Kwun Yam Wa of east side of Cheung Chau, while the two sewage pumping stations are located on the west side of Cheung Chau. The overflow of raw sewage from Pak She SPS will be diverted to the Cheung Chau STW for normal treatment. In case of operational failure of the Cheung Chau STW, raw sewage might bypass the wastewater treatment unit and be directly discharged into the marine water. Water quality assessment assesses the scenario of the STW emergency discharge in case of the STW operational failure. The simulated concentrations near the STW will increase sharply right after the emergency discharge. Potential impact of the Cheung Chau STW emergency discharge on water quality was predicted to occur only to limited local areas close to the STW discharge outfall. The impact of the emergency discharge will last for a short duration, decreases rapidly from its peak,

impact returns to the normal background level in less than 12 hours after the emergency discharge is ceased. No adverse impact is anticipated either to long term water quality conditions of the marine receiving water. With regular maintenance and checking of plant equipment, chances of occurrence of the incident will be very low. With the implementation of contingency plan and remedial measures, the potential ecological impacts to aquatic and marine ecology will be temporary in nature and is anticipated to be **insignificant**. Similarly, as there will be no adverse impact on the WSRs around Cheung Chau and in the vicinity, there will be no adverse impacts on other marine ecological resources farther away.

***Indirect Impact – Noise and Other Disturbance generated by Operation Activities***

8.7.13 Noise might be generated during the operation stage (e.g. operation of machines inside the SPS and STW). It is however anticipated that noise from the proposed Project would be of low level (as its operation only involves machines confined within buildings) and only the immediately adjacent areas are concerned. The pumping stations and the STW are not close to any terrestrial natural habitats sensitive to noise disturbance, and thus the potential impact would be **insignificant**. For impacts on marine fauna, the potential is even more remote as those facilities are all land-based.

## 8.8 Impact Avoidance and Mitigation Measures

8.8.1 The marine elements of the Project, including the construction of a new SPS at Kwun Yam Wan, which had once been described in the Project Profile, were omitted in the design process during the present EIA study to avoid and minimise impacts. All proposed works elements will be land-based and no marine works will be involved under the Project. Direct impact on intertidal or subtidal habitat will be avoided.

8.8.2 Deep Sewer Option as described in Section 2.4 is proposed to replace the construction of Kwun Yam Wan SPS for conveying sewage from Fa Peng and Chi Ma Hang. Potential adverse marine ecological impacts due to the construction and operation of Kwun Yam Wan SPS can be eliminated.

8.8.3 The 6 nos. of affected trees will be transplanted as far as possible. Compensatory planting in accordance with ETWB TCW 3/2006 - Tree Preservation would be implemented to fully compensate for the tree and vegetation loss if transplanting of trees is not feasible or not preferable. Mitigation measures on potential landscape impacts will be addressed in **Section 11**.

8.8.4 The overall ecological impact is ranked as minor, and other than environmental protection measures and good site practice proposed in air, water, noise and waste chapters, no specific ecological mitigation is required.

## 8.9 Residual Impacts

8.9.1 Due to small scale, temporary nature and limited ecological value of habitat affected, the residual impact is short term and minimal, and considered acceptable. Similar habitats will be created upon completion of works. In long term, there will be an overall improvement in water quality for marine waters near the Project site as a result of the upgrading works, hence a positive effect on the habitat for the marine ecology.

## 8.10 Environmental Monitoring and Audit Requirements

8.10.1 Given the limited sizes of the works areas, the ecological value of the habitats affected by the works areas is limited, no specific ecological monitoring is required during construction phase. Weekly site inspection should be carried out by the environmental team to ensure the implementation of mitigation measures and proper site practice proposed to safeguard air and water quality as well as noise impacts.

## 8.11 Conclusion

8.11.1 The Project will only temporarily affect small sizes of habitat of limited ecological value habitats. No important habitat or optimal habitats of fauna species of conservation importance will be lost to the Project. Affected trees will be transplanted. The overall ecological impact is ranked as minimal and the long term effect is positive with respect to marine ecology as a result of the improvement in marine water quality due to the upgrading works.

8.11.2 Besides good site practices, no other major mitigation measure for ecology is required. With the regular site inspection performed by the Environmental Team, no specific ecological monitoring programme is needed.

## 8.12 References


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# 9. FISHERIES

## 9.1 Introduction

9.1.1 This section presents the assessment on the fisheries impacts associated with the upgrading of the Cheung Chau STW and Pak She SPS and the sewers works of the Project. This assessment comprises three major parts: establishment of baseline conditions, evaluation and assessment of fisheries impact Appropriate mitigation measures were identified, where necessary, to mitigate the potential impacts.

9.1.2 This assessment has based on the criteria and guidelines for evaluation and assessment of fisheries impacts as stated in Annexes 9 and 17 of the EIAO-TM and has covered the scope outlined in Section 3.4.7 of the EIA Study Brief.

## 9.2 Relevant Legislations, Standards & Guidelines

9.2.1 HKSAR Ordinances and Regulations which are relevant to this study include the following:

- The Environmental Impact Assessment Ordinance (Cap. 499) and the associated TM;
- Fisheries Protection Ordinance (Cap. 171) and its subsidiary legislation, the Fisheries Protection Regulations;
- Marine Fish Culture Ordinance (Cap. 353) and associated subsidiary legislation; and
- Water Pollution Control Ordinance (Cap. 358) and its supporting regulations and statements.

## 9.3 Study Area and Sensitive Receivers

9.3.1 In accordance with the EIA study brief, the assessment area generally covers the Southern Water Control Zone (WCZ) and includes any other areas likely to be impacted by the Project. Special attention has been given to the fishing activities and fishing spawning and nursery grounds within the assessment area and the Cheung Sha Wan Fish Culture Zone.

## 9.4 Methodology for Baseline Establishment and Assessment

9.4.1 Existing information available from relevant studies/surveys regarding the Assessment Area was reviewed. A review of Government and private sector reports, independent Government published literature and academic studies was undertaken to determine the existing conditions of fisheries in the Assessment Area, and to identify practices, areas and species of potential fisheries importance which may be affected by the Project. This review included but was not limited to the following:

- Port Survey 2006;
- Agriculture, Fisheries and Conservation Department (AFCD) latest annual report 2009/2010 and website; and
- Other relevant reports from private sectors or Government.

9.4.2 Port Survey is the most comprehensive fisheries study conducted by AFCD every few years. Different from the approach adopted in previous Port Surveys in which Hong Kong waters were divided into “Fishing Areas” of various sizes, a uniform grid of 720 ha cell size was overlaid on Hong Kong’s waters for Port Survey 2006 and the fisheries related information (e.g. production, vessel number, catch value) was presented in several categories. The fisheries resources within the assessment

area were evaluated based upon the information from Port Survey. The results of Port Survey 2006 are available on AFCD website.

9.4.3 AFCD's annual report and website provide the most updated information on the development and trend in Hong Kong fisheries. The latest annual fisheries production is also provided.

9.4.4 Based on the review results, the assessment identified data gap and determine if there is any need for field surveys. If field surveys are considered necessary, the assessment would recommend appropriate methodology, duration and timing for the field surveys.

9.4.5 Impacts are assessed in the absence of mitigation. The construction and operational phase impacts on fisheries resources have been assessed individually, then cumulatively, in combination with other existing, committed and proposed developments.

## 9.5 Description of Physical Environment Background

9.5.1 A detailed description of the physical marine conditions is presented in the Water Quality Assessment and the key aspects are summarized below. The assessment area of present Project is located in the Southern Water Control Zone, which stretches from Hong Kong Island south to Lantau Island and faces the South China Sea (EPD 2010).

9.5.2 In 2010, the Southern WCZ attained an overall 67% compliance with the WQOs. Although full compliance with the WQOs for NH3 and *E. coli* was achieved in 2010, there was a decrease in total inorganic nitrogen (TIN) compliance rate due to the higher TIN levels recorded mainly in the summer months from June to September. This could be related to the heavy rainfalls recorded in the Pearl River Delta area in the same period (EPD 2010).

9.5.3 In Hong Kong, the commercial marine fishing industry is divided into capture and culture fisheries. Further details of these resources are discussed below.

### Capture Fisheries

9.5.4 In 2012, the fishing industry produced an estimated 155,230 tonnes of fisheries produce valued at about $2 317 million. The industry consists of some 4 000 fishing vessels and 8 800 local fishermen (AFCD 2013a).

9.5.5 The top 10 families/groups captured in Hong Kong were Carangidae (e.g. Scad), mixed shrimp, Siganidae (e.g. rabbitfish), mixed squid, Sciaenidae (e.g. Croaker), mixed crab, Mugilidae (e.g. Mullet), Clupeidae (e.g. Sardine), Sparidae (e.g. Seabream) and Engraulidae (e.g., Anchovy) (AFCD 2013a).

9.5.6 AFCD Port Survey provides the most comprehensive information on capture fisheries in Hong Kong waters, including fishing operation and fisheries production (adult fish and fish fry).

9.5.7 The Port Survey consisted of an interview programme. About 36% of the local fishing fleet which accounted for all homeports (places at which local fishing vessels are based) and vessel types was interviewed. Particulars such as vessel length, type and its homeport of the fishing vessels were recorded and information about their fishing operations and fisheries production in Hong Kong waters was collected during the interviews. Cheung Chau is one of the main homeports in Hong Kong (AFCD 2013a).

9.5.8 According to the Port Survey 2006, the water bodies near Po Toi, Ninepin Group and Tap Mun have the highest fisheries production (adult fish) (600-1000 kg/ha)

(**Figure 9.1**). The overall adult fish production surrounding Cheung Chau was comparatively lower and at medium level, with two northern grids of Cheung Chau at 200-400 kg/ha and the two southern grids at 400-600 kg/ha. Fisheries production from vessels exceeding 15m in length was 100-200 kg/ha and 200-400kg/ha in the northern and southern waters of Cheung Chau, respectively; while the production from vessels below 15m were lower (from 50-100 kg/ha to 100-200kg/ha) than the production from vessels larger than 15m. It should be noted that the vessels exceeding 15m usually include many trawlers. As a ban on trawling activities in Hong Kong waters has been in effective from 31 December 2012, those trawlers would not able to operate in the waters surrounding Cheung Chau anymore. The fisheries production from vessels over 15m, which contributed more for the total fisheries production in the waters around Cheung Chau, would decrease, and so would the total fisheries production. It is thus expected that the current fisheries production in the waters surrounding Cheung Chau would be much lower than those reported in the Port Survey 2006.

9.5.9 In Hong Kong, fish fry production has become very limited throughout Hong Kong waters. This fisheries activity was only operated in a few locations in the eastern Hong Kong waters (**Figure 9.2**) (AFCD 2013a). There was no significant fish fry collection in the entire Fisheries Assessment Area. .

9.5.10 The value of fisheries production in the waters to the west of Cheung Chau was regarded as moderate value (HK$2,000-HK$5,000 /ha/yr). Waters to the east and to the south of Cheung Chau were generally higher, having moderate - high value (HK$5,000-HK$10,000 /ha/yr) (**Figure 9.3**) (AFCD 2013a).

**Marine Fish Culture**

9.5.11 In Hong Kong, aquaculture includes marine fish culture, pond fish culture and oyster culture. In 2012 production from the aquaculture sector was 3,697 tonnes value at $181 million which was 2% in weight and 7% in value of the total fisheries production (AFCD 2013b).

9.5.12 Marine Fish culture involves rearing of marine fish from fry or fingerlings to marketable size in cages suspended by floating rafts usually in sheltered coastal areas. The species cultured changed gradually over the recent years depending on the availability of imported fry mainly from the Mainland, Thailand, Philippines or Indonesia. Common species under culture include green grouper, brown-spotted grouper, giant grouper, Russell's snapper, mangrove snapper, goldlined seabream, star snapper and red drum (AFCD 2013b).

9.5.13 There are four Fish Culture Zones (FCZ) within the Southern WCZ study area. The two FCZ located in Sok Kwu Wan and Lo Tik Wan in eastern Lamma Island and the FCZ located in Po Toi are too remote (over 10 km) from the Project Area and are not expected to be impacted by the Project. The closest FCZ is located at Cheung Sha Wan near Chi Ma Wan, which is about 2.7 km from the Project Site (**Figure 9.4**) (AFCD 2013b).

9.5.14 The latest information (31 Jan 2009) from AFCD indicates that the Cheung Sha Wan FCZ consists of 134 licensed rafts with a total licensed area of 20,302 $m^2$ (9.4% of total gazetted area in HK). No figure is available on fish production at this FCZ, although the estimated total local production of marine culture fish in 2008 was about 1,370 tonnes valued at HK$82 million (B & V 2009).

**Spawning and Nursery Areas**

9.5.15 The Southern Hong Kong waters (including South Lantau and Cheung Chau) were previously identified in 1998 as important fisheries spawning ground for high value

commercial species (**Figure 9.5**). These waters were also identified as important nursery ground for a number of commercial juvenile fish and crustacean species (ERM 1998, 2006) (**Figure 9.6**).

9.5.16 In summary, there are some fisheries resources in the waters surrounding Cheung Chau, including fishing grounds, fisheries species spawning and nursery grounds, and Fish Culture Zone. The Cheung Sha Wan FCZ (represented by WER F1) and the fisheries species spawning and nursery grounds as well as the fishing grounds (represented by WSR S1, S2, and S3) are considered as fisheries sensitive receivers when assessing the potential impacts from the Project, particularly potential water quality impact. Assessment below will address the potential impacts on these fisheries resources.

## 9.6 Environmental Impacts to Fisheries

### Construction Phase - Direct Impacts

9.6.1 The proposed Project includes sewers works and upgrading of the existing Cheung Chau STW and Pak She SPS. All works would be land- based, and would involve 1) the laying of sewers along and underneath existing roads and footpaths, and 2) the construction / upgrading of the existing Cheung Chau STW and Pak She SPS (subject to the final design) within developed area. The alignments and footprints of all elements under this Project would be land-based, and no marine components such as submarine outfall are included. As such no works would be carried out in the marine or intertidal environment.

9.6.2 No direct impacts have been identified during the construction phase. No loss of fishing ground as well as spawning and nursery area of fishes is expected. The impacts of construction and operation phases were evaluated in **Table 9.1**.

### Construction Phase - Indirect Impacts

9.6.3 All the construction works are land-based and no works will be carried out in the marine or intertidal environment. If there were no control on the construction sites, increased sedimentation due to construction site runoff might lead to a short-term increase in suspended solid, which may be gradually settled in the vicinity of the coastal area. It should be noted that the concentration of suspended sediment fluxes naturally in the marine environment, and fish has developed some adaptative behaviours (e.g. clearing of gills, swimming to clear area) to tolerate changes in suspended solid and polluted drainage water. The nearest Fish Culture Zone to Cheung Chau is Cheung Sha Wan FCZ which is about 2.5 km to the north of the northern end of Cheung Chau and approximately 4km from the Project Area. It is also sheltered from Cheung Chau by a headland on Chi Ma Wan Peninsula. Even if there were sediments from site runoff, it is very unlikely that they would disperse to this FCZ.

9.6.4 It should be noted that all effluents from the construction sites, including the site runoff, are controlled under the WPCO. The relevant water pollution control and mitigation measures are required to be implemented, and no polluting effluents are allowed to enter into the marine waters. With the implementation of good site practice and precautionary measures, potential impact due to site effluents is avoided, and thus adverse impact on fishery resources is not anticipated.

### Operation Phase - Direct Impacts

9.6.5 No direct impact is expected to arise during operation phase under the normal operation of the proposed sewerage works.

**Operation Phase - Indirect Impacts**

***Indirect Impact - Water Quality Changes (Normal Operation)***

9.6.6 Currently there is no public sewerage system for most of the village houses in Cheung Chau. Sewage from these village houses is mainly treated in septic tanks, sewage and greywater generated from some of the village houses is even directly discharged into surface drainage system. Besides, there is existing combined sewerage and drainage system in Cheung Chau. Sewage would contaminate the stormwater and discharge into the sea without being treated. The Project aims at upgrading and expanding the sewage collection, treatment and disposal facilities to cover unsewered areas and to cope with future developments. Moreover, separation of the existing combined sewerage system is to be included in the design as far as possible. With the implementation of the Project, public sewers will be provided to all village houses as far as possible. Combined sewerage system will be separated as far as possible. Moreover, the sewage treatment level will be upgraded from primary treatment to secondary treatment. Contamination to the receiving water will be reduced and hence improve the water quality of Cheung Chau as well as the Southern WCZ., hence resulting in better habitat quality for fisheries resources, including fishing ground, spawning ground and nursery ground for commercial species, and the Cheung Sha Wan FCZ.

9.6.7 The water quality parameters (including annual 90% depth-average DO, 90% bottom DO, TIN, SS, UIA, *E.coli* and $BOD_5$) in the identified WSRs during the baseline conditions (i.e. the operation of the existing STW) and the normal operation of the upgrade STW were presented in **Section 5.6** and compared. It was found that incompliance of the TIN will occur in both the dry and wet seasons under the baseline condition as well as the normal operation. But the incremental difference between the two scenarios indicated improvements (increase of DO, and reductions in TIN, UIA, SS, and $BOD_5$ and *E.coli*) in both dry and wet seasons. Upon completion of the upgrading works, a relative improvement of water quality is expected to occur to marine waters near the Cheung Chau area, especially near the Cheung Chau Wan area. Reductions in concentrations of a number of water quality parameters including DO, TIN, UIA, SS, $BOD_5$ and *E.coli* were predicted. In Cheung Sha Wan Fish Culture Zone (WSR F1), there will be a reduction of *E.coli* (-3 count/100ml) during the wet season (see **Table 5.16**). No adverse water quality impact is anticipated under the normal operating conditions of the upgraded Cheung Chau STW. For the spawning and nursery grounds, there will be a reduction in *E.coli* in both dry season (-28 count/100ml, see **Table 5.15**), and in wet season (-9 count/100ml, see **Table 5.16**) in WSR S1, and a minor decrease in both WSR S2 and S3 in wet season (-1 count/100ml, see **Table 5.16**). An improvement on water quality and thus positive impacts to fisheries will be anticipated. And the maintenance of the facilities would not have marine water quality impact as all components are land-based. No operation phase indirect impact under normal operation was identified.

***Indirect Impact - Water Quality Changes (Emergency Discharge from Cheung Chau STW)***

9.6.8 In case of operational failure of the Cheung Chau STW, raw sewage might bypass the wastewater treatment unit and be directly discharged into the marine water. Water quality assessment assesses the scenario of the STW emergency discharge in case of the STW operational failure. The simulated concentrations near the STW will increase sharply right after the emergency discharge. Potential impact of the Cheung Chau STW emergency discharge on water quality was predicted to occur only to limited local areas close to the STW discharge outfall. The impact of the

emergency discharge will last for a short duration, decreases rapidly from its peak, impact returns to the normal background level in less than 12 hours after the emergency discharge is ceased. No adverse impact is anticipated either to long term water quality conditions of the marine receiving water. With regular maintenance and checking of plant equipment, chances of occurrence of the incident will be very low. The potential impacts to fisheries resources will be temporary in nature and is anticipated to be **insignificant**. As there will be no significant adverse impact on the WSRs around Cheung Chau and in the vicinity, there will be no significant adverse impacts on other fisheries resources farther away including fishing grounds and important spawning grounds.

***Indirect Impact - Water Quality Changes (Emergency Discharge from Pak She SPS)***

9.6.9 Sewage overflow may occur if pumps fail or if there is an interruption to the electrical supply powering the pumps. The overflow of raw sewage from Pak She SPS will be diverted to the Cheung Chau STW for normal treatment. The worst scenario of STW failure has been assessed in Scenario 3. There will not be significant adverse impact caused in Cheung Chau typhoon shelter. Similarly, as there will be no significant adverse impact on the WSRs around Cheung Chau and in the vicinity, there will be no significant adverse impacts on other fisheries resources farther away including fishing grounds and important spawning grounds.

## 9.7 Mitigation Measures

9.7.1 The works involves land-based construction works only, and water pollution control measures and good site practices will be adopted to avoid impacts to nearby water bodies. In long term, there will be a positive effect on the water quality after the upgrading works and hence improvement in the marine habitat quality for fisheries resources. To this end, no unacceptable impact on fishing resources is identified, and no mitigation measure and monitoring programme would be required.

## 9.8 Residual Impacts

9.8.1 Evaluation of the fisheries impacts is provided in **Table 9.1**. In summary, no significant adverse fisheries impacts are anticipated. No residual impact is expected after implementing standard site practices.

**Table 9.1 : Evaluation of Fisheries Impact**

| Evaluation Criteria | Evaluation of Fisheries Impact |
|---|---|
| Nature of impact | All works would be terrestrial based and no works would be carried out in the marine environment. No direct impacts have been identified during the construction phase. With implementation of the measures outlined in ProPECC PN 1/94 Construction Site Drainage, indirect water quality impact during construction phase is not anticipated. The habitat quality for fisheries resources is expected to improve during the operation phase of this Project. |
| Size of affected area | The affected area from the indirect water quality impact is expected to be localised, small scale and in the vicinity of the works area. |
| Loss of fisheries resources / production | The waters surrounding Cheung Chau are ranked as moderate importance in comparison to other areas in Hong Kong in terms of fisheries production (including spawning and nursery ground) and value. No direct loss of fishing resource / production is expected. Indirect impact is expected to be insignificant with the implementation of construction site water quality mitigation measures. |

| Evaluation Criteria | Evaluation of Fisheries Impact |
|---|---|
| Destruction and disturbance of nursery and spawning grounds | The waters of Cheung Chau was previously identified in 1998 as important fisheries spawning ground for high value commercial species. With the implementation of site drainage measures, adverse water quality impact is not expected. The potential indirect water quality impact on the spawning and nursery grounds is anticipated to be negligible, their influence on fisheries resources / production is therefore insignificant. |
| Impact on fishing activity | No impact to the fishing activity is expected due to the absent of marine works or disturbance of the seabed. |
| Impact on aquaculture activity | With the implementation of proper construction site drainage system to contain and treat site runoff and wastewater prior to discharge, no adverse water quality impact is expected to the Cheung Sha Wan FCZ which is located over 2 km away from the Project Site. |

## 9.9 Environmental Monitoring and Audit Requirements

9.9.1 The quality of effluent discharge of the STW will be monitored by STW operators for compliances with the proposed effluent discharge standards. No specific fisheries EM&A programme would be required during the construction phase of the Project.

## 9.10 Conclusion

9.10.1 A literature review has been conducted to establish the fisheries baseline condition of the assessment area and assessment of potential impacts conducted in accordance with the EIAO-TM requirements. All works would be land-based and no works would be carried out in the marine or intertidal environment. With proper implementation of water pollution control measures and good site practices, no direct or indirect impacts have been identified during the construction phase. Once upon completion of this Project, the habitat quality for fisheries resources is expected to improve.

## 9.11 References


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- Environmental Protection Department (EPD) 2010. Marine Water Quality in Hong Kong in 2010. The Government of the Hong Kong Administrative Region, Hong Kong
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# 10. CULTURAL HERITAGE

## 10.1 Introduction

10.1.1 This section presents the assessment on the cultural heritage impacts during the construction and operation phases of the both the upgrading of the Cheung Chau STW and Pak She SPS and the sewers works of the Project. Cultural heritage resources were identified and the potential direct and indirect impacts from proposed works on these resources were assessed. Appropriate mitigation measures were identified, where necessary, to mitigate the potential impacts.

10.1.2 This assessment has based on the criteria and guidelines for evaluation and assessment of cultural heritage impacts as stated in Annexes 10 and 19 of the EIAO-TM and has covered the scope outlined in Section 3.4.9 of the EIA Study Brief.

## 10.2 Relevant Legislations, Standards & Guidelines

10.2.1 Legislation, Standards, Guidelines and Criteria relevant to the consideration of Cultural Heritage impacts under this study include the following:

- Antiquities and Monuments Ordinance;
- Environmental Impact Assessment Ordinance;
- Hong Kong Planning Standards and Guidelines;
- Technical Memorandum on Environmental Impact Assessment Process;
- Guidelines for Cultural Heritage Impact Assessment; and
- Development Bureau Technical Circular (Works) No. 6/2009: Heritage Impact Assessment Mechanism for Capital Works Projects.

### Antiquities and Monuments Ordinance

10.2.2 The Antiquities and Monuments Ordinance (the Ordinance) provides the statutory framework to provide for the preservation of objects of historical, archaeological and paleontological interest. The Ordinance contains the statutory procedures for the Declaration of Monuments. The proposed monument can be any place, building, site or structure, which is considered to be of public interest by reason of its historical, archaeological or paleontological significance.

10.2.3 Under Section 6 and subject to sub-section (4) of the Ordinance, the following acts are prohibited in relation to certain monuments, except under permit:

- To excavate, carry on building works, plant or fell trees or deposit earth or refuse on or in a proposed monument or monument; and
- To demolish, remove, obstruct, deface or interfere with a proposed monument or monument.

10.2.4 The discovery of an Antiquity, as defined in the Ordinance must be reported to the Antiquities Authority (the Authority), or a designated person. The Ordinance also provides that, the ownership of every relic discovered in Hong Kong after the commencement of this Ordinance shall vest in the Government from the moment of discovery. The Authority on behalf of the Government may disclaim ownership of the relic.

10.2.5 No archaeological excavation may be carried out by any person, other than the Authority and the designated person, without a licence issued by the Authority. A licence will only be issued if the Authority is satisfied that the applicant has sufficient scientific training or experience to enable him to carry out the excavation and search

satisfactorily, is able to conduct, or arrange for, a proper scientific study of any antiquities discovered as a result of the excavation and search and has sufficient staff and financial support.

10.2.6 It should also be noted that the discovery of an antiquity under any circumstances must be reported to the authority, i.e. the Secretary for Development or designated person. The authority may require that the antiquity or supposed antiquity is identified to the authority and that any person who has discovered an antiquity or supposed antiquity should take all reasonable measures to protect it.

**Environmental Impact Assessment Ordinance**

10.2.7 The EIAO was implemented on 1 April 1998. Its purpose is to avoid, minimise and control the adverse impact on the environment of designated projects, through the application of the EIA process and the Environmental Permit (EP) system.

**Hong Kong Planning Standards and Guidelines**

10.2.8 Chapter 10 of the HKPSG details the planning principles for the conservation of natural landscape and habitats, historical buildings and archaeological sites. The document states that the retention of significant heritage features should be adopted through the creation of conservation zones within which uses should be restricted to ensure the sustainability of the heritage features. The guidelines state that the concept of conservation of heritage features, should not be restricted to individual structures, but should endeavour to embrace the setting of the feature or features in both urban and rural settings.

10.2.9 The guidelines also address the issue of the preparation of plans for the conservation of historical buildings, archaeological sites and other antiquities. It is noted that the existing Declared Monuments and proposed Monuments be listed in the explanatory notes of Statutory Town Plans and that it be stated that prior consultation with AMO is necessary for any redevelopment or rezoning proposals affecting the Monuments and their surrounding environments.

10.2.10 It is also noted that planning intention for non-statutory town plans at the sub-regional level should be include the protection of monuments, historical buildings, archaeological sites and other antiquities through the identification of such features on sub-regional layout plans. The appendices list the legislation and administrative controls for conservation, other conservation related measures in Hong Kong, and Government departments involved in conservation.

**Technical Memorandum on Environmental Impact Assessment Process**

10.2.11 The general criteria and guidelines for evaluating and assessing impacts to Sites of Cultural Heritage are listed in Annexes 10 and 19 of the Technical Memorandum on Environmental Impact Assessment Process (EIAO-TM). It is stated in Annex 10 that all adverse impacts to Sites of Cultural Heritage should be kept to an absolute minimum and that the general presumption of impact assessment should be in favour of the protection and conservation of all Sites of Cultural Heritage. Annex 19 provides the details of scope and methodology for undertaking Cultural Heritage Impact Assessment, including baseline study, impact assessment and mitigation measures.

**Guidelines for Cultural Heritage Impact Assessment**

10.2.12 This document, as issued by the Antiquities and Monuments Office, outlines the specific technical requirement for conducting terrestrial archaeological and built heritage impact assessments and is based upon the requirements of the Technical

Memorandum for Environmental Impact Assessment. It includes the parameters and scope for the Baseline Study, specifically desk-based research and field evaluation. There are also included guidelines encompassing reporting requirements and archive preparation and submission in the form of Guidelines for Archaeological Reports and Guidelines for the Handling of Archaeological Finds and Archives.

10.2.13 The prerequisite conditions for conducting impact assessment and mitigation measures are presented in detail, including the prediction and evaluation of impacts based upon five levels of significance (Beneficial, Acceptable, Acceptable with Mitigation Measures, Unacceptable and Undetermined). The guidelines also state that preservation in totality must be taken as the first priority and if this is not feasible due to site constraints or other factors, full justification must be provided.

10.2.14 Mitigation measures will be proposed in cases with identified impacts and shall have the aim of minimising the degree of adverse impact and also where applicable providing enhancement to a heritage site through means such as enhancement of the existing environment or improvement to accessibility of heritage sites. The responsibility for the implementation of any proposed mitigation measures must be clearly stated with details of when and where the measures will be implemented and by whom.

**Development Bureau Technical Circular (Works) No. 6/2009: Heritage Impact Assessment Mechanism for Capital Works Projects**

10.2.15 The Technical Circular (TC) contains the procedures and requirements for assessing heritage impact arising from the implementation of new capital works projects. It is stated in the document that the works agent will provide a checklist to the AMO of any heritage sites (as defined in the TC) situated within or within the vicinity of the project boundary (usually to be defined as not more than 50 metres measured from the nearest point of the project boundary, including works areas).

10.2.16 The identification of the heritage sites should be undertaken at the earliest possible stage, preferably as part of the Technical Feasibility Statement. If the works boundary cannot be defined at this stage, the checklist should be provided as soon as the project boundary has been defined. Upon receipt of the above information from the works agent, the AMO will determine if the proposed project will affect the heritage value of any heritage site and decide the necessity of conducting an HIA based upon the submitted information.

10.2.17 If an HIA is required, the works agent shall submit a proposal for the scope of the HIA for AMO approval. Once the scope has been approved it will be the responsibility of the works agent to conduct the HIA.

## 10.3 Archaeological Impact Assessment

### Study Area and Sensitive Receivers

10.3.1 There are a few of known sites of archaeological interest on Cheung Chau which intersect with the proposed works. **Figure 10.2** to **Figure 10.4** show the locations of the sites of archaeological interests in relation to the proposed impact areas; the inset location for each site of interest on Cheung Chau can be seen on **Figure 10.1**. The below descriptions are indicative of the potential for further archaeological materials and deposits in the identified areas:

***Tung Wan Site of Archaeological Interest (AM96-0752) (Figure 10.2)***

10.3.2 The site was marked on the HKASoc Map as site no. 87 by W. Schofield using the symbol of prehistoric remains.

10.3.3 A number of archaeological works were undertaken between 1982 and 2011 with very limited success in locating stable archaeological deposits or even finds:

- 1982 Site inspection of deep trenches for house foundations at the northern end of the tombolo was carried out by AMO; no archaeologically meaningful stratigraphy was observed (Peacock & Nixon 1986)
- 1986 Inspection of areas cleared for construction; no artefacts or other archaeological remains were found (Peacock & Nixon 1986)
- 2001 Two test pit excavations undertaken for a small house development site at San Hing Back Street; no significant cultural layers but a small amount of abraded pottery sherds were found (AMO 2001)
- 2002 Excavation of two test pit (19sq metres) ahead of small house construction off Pak She Street conducted in 2002 revealed prehistoric pottery (including Bronze Age fragments) and stone tools although the author concluded that no significant archaeological remains were present (Au 2002).
- 2002 Four test pit excavations undertaken as part of small house development; two cultural layers (Middle and Late Neolithic) were recorded in two of the test pits (Au 2002). A rescue excavation in Pak She Street prior to the construction of two shops was conducted as follow up. The results indicated a fill layer with few archaeological finds and with a thickness up to 130cm. The wall sections collapsed before sterile soils were recorded and the report therefore suggested that earlier cultural layers/ remains might survive in the non-excavated layers (Au 2002).
- 2007 AMO conducted two test pit excavations ahead of a small house redevelopment at Pak She Street. No archaeological material was recorded.
- 2008 Archaeological Watching Brief programme undertaken during rehabilitation and replacement of water mains on Cheung Chau (and Tai O); a total of six small pits were monitored to a maximum depth of 1.2m. No significant archaeological materials were found (ERM 2007).
- 2011 Surface scan and seven test pit excavations were conducted as part of improvement to existing roads and drains in Cheung Chau Old Town. The excavators suggest that in the southwest of the Tung Wan Site of Archaeological Interest in situ archaeological deposits may exist based on the results of this archaeological survey and previous archaeological excavations. The test pit excavations were conducted in three areas (two north and one south more or less in the middle of the site of interest) no significant archaeological materials were found (HKIA 2011). The authors concur that the testing programme was limited and presents a limited view.

***Tai Kwai Wan Site of Archaeological Interest (AM77-0038) (Figure 10.3)***

10.3.4 Historic kilns and prehistoric materials were first recorded in 1937 by W. Schofield (Peacock & Nixon 1986). In 1968, an archaeological excavation in the form of two test pits was carried out in the southern end of the raised beach by J. Hayes. Coarse pottery sherds, soft red pottery sherds and fragments of polishing stone and stone adze were unearthed. Two test pits were excavated in the middle of the site by W. Meacham in 1974 revealing a cultural deposit to 110cm. In 1978, a series of test pit excavations were conducted by W. Meacham in different areas of the sand bar, part of which was scheduled for development. Materials of at least five periods (Mid-Neolithic, Late Neolithic, Early Bronze Age, Tang and Qing dynasties) were identified in the 1974 and 1978 excavations. A two-phase rescue excavation was conducted by Dr. S. Bard between 1978 and 1979 prior to a road construction project. A total of five test pits were excavated with the discovery of Late Neolithic

cultural layer in all test pits. Some Tang dynasty kiln debris and Qing burials were also identified (AMO files).

10.3.5 In 1995, an investigation was carried out prior to a large scale residential development project. Three test pits were placed at the back of the sand bar (areas with previously identified archaeological deposits were excluded). No archaeological materials or features were found (AMO 1995). The site was further investigated by the Institute of Cultural Relics and Archaeology of Guangdong Province during the 1997 Territory-wide survey. No cultural materials were identified in field walking. The report suggested that the original cultural remains were severely disturbed due to development (Guangdong Institute 1997).

***Sai Wan Site of Archaeological Interest (AM77-0039) (Figure 10.4)***

10.3.6 Sai Wan Archaeological Site comprises of two sites previously known as 'Care Village' and 'Sai Wan' in the Hong Kong Archaeological Survey (Peacock & Nixon 1986). This hill slope site was discovered by W. Meacham in 1974 and two test pit excavations carried out in 1977 yielded no less than 1100 prehistoric coarse ware and chalky ware sherds.

10.3.7 More prehistoric surface finds were collected in the 1982 site visit as part of the Hong Kong Archaeological Survey (Peacock & Nixon 1986). The site was further investigated in the 1997-1998 Territory-wide Survey when a total of eight auger hole test were conducted. Prehistoric cultural layers and sherds dated to Southern Song period were identified (Guangdong Institute 1997).

***Cheung Chau Rock Carving (AM77-0017) (Figure 10.2)***

10.3.8 This prehistoric rock carving is located next to Warwick Hotel and was first discovered in 1970 by the geologist Dr. C. Peng. The Rock Carving covers about 50square centimetre and is in three separate series engraved in flowing lines interspersed by animal-mask shapes and is reminiscent of the Po Toi Rock Carvings. It was declared a monument in 1982.

**Assessment of Potential Impacts**

10.3.9 In this EIA report, the areas of archaeological interest based upon the finalised design of the proposed alignments have been identified and the scope for the archaeological watching brief programme has been reviewed by the Antiquities and Monuments Office (AMO).

10.3.10 A summary for the assessment of archaeological potential for each area of archaeological interest or with new alignments can be found in **Table 10.1** below.

**Table 10.1 : Summary for the Assessment of Archaeological Potential within Project**

| Areas of Impact | Archaeological Potential of the Areas | Assessment of Archaeological Potential | Scope |
|---|---|---|---|
| **Proposed Sewers Works - Village Sewers in Cheung Chau** | | | |
| *Tai Kwai Wan San Tsuen*<br>*(Figures 10.5 to 10.6)* | This modern village is located along very steep slopes, with thin soil cover and outcrop of bedrock. As well, the proposed alignments are located on existing footpaths with disturbance from previous utilities. | No archaeological potential | No further action |
| *Pak She San Tsuen*<br>*(Figures 10.6 and 10.8)* | Although this study area encroaches slightly into Tung Wan Archaeological Site, all of the proposed alignments are located on existing footpaths along steep slopes or steps, with thin soil cover and outcrop of bedrock. In addition, there are extensive impacts from previous utility groundworks. | Very low archaeological potential | No further action |
| *Nam She Tong*<br>*(Figures 10.13 and 10.16)* | Although this study area is situated within the boundary of Tung Wan Archaeological Site, all of the proposed alignments are located on existing footpaths and some of these alignments are located along steep slopes or steps, with thin soil cover and outcrop of bedrock. As well, there are extensive impacts from previous utility groundworks.<br>In addition, Kwun Yam Wan area was investigated during 1997 Territory-wide survey. No surface finds were identified and auger test was not feasible. The survey therefore suggested that the archaeological potential of this area is extremely low (Guangdong Institute 1997). | No archaeological potential | No further action |

| Areas of Impact | Archaeological Potential of the Areas | Assessment of Archaeological Potential | Scope |
|---|---|---|---|
| *Cheung Chau Rock Carving (Nam She Tong study area)* (Figure 10.15) | Recognized archaeological significance (Declared Monument)<br>Cheung Chau Rock Carving was declared a monument in 1982. It is located in close proximity of the proposed works - approximately 6m from the proposed sewers alignment. | It is recommended that a buffer zone be provided to ensure that the Declared Monument and its environs are not infringed upon during the construction works.<br>In order to better protect the Rock Carving and its environs the buffer zone will include Hak Pai Road and the nearby open space (see extent of buffer zone on Figure 10.15). Within the buffer zone, construction works as well as storage of construction materials are not allowed. Erection of temporary fencing/barriers to demarcate the buffer zone is not required.<br>In addition, access to the rock carving should be maintained and directional signage should be erected or installed at appropriate location(s) near the rock carving to facilitate visitors to access the rock carving during the construction phase.<br>In addition, periodic monitoring of the declared monument is recommended. It is recommended to conduct inspection of the site every 3 months during the construction phase. Inspection record supplemented with the site photos showing the condition of the overall declared monument should be submitted to AMO for record purposes.<br>Finally, an archaeological watching brief programme is proposed for the area at the foot of the rock carving (see Figure 10.15) to assess potential deposits associated with the rock carving. | |
| *Fa Peng (Figures 10.18 and 10.19)* | Proposed alignments are located on existing footpaths along steep slopes, with thin soil cover and outcrop of bedrock and disturbance from utilities. | No archaeological potential. | No further action |
| *Tai San Street , Tai San Back Street, Chung Hing Street and Chung Hing Back Street (Figures 10.10, 10.12,10.13, 10.14)* | In 2001, an archaeological investigation in the form of two test pits was conducted at San Hing Back Street. No significant cultural layers but a small amount of abraded pottery sherds and some postholes were identified (AMO 2001). Another investigation was carried out in 2002 at Chung Hing Back Street and Tai San Back Street. Four test pits were excavated with the discoveries of two cultural layers (Middle and Late Neolithic) in two of the test pits (Au 2002). | One alignment is located in close proximity of Chung Hing Back Street where significant finds were discovered in 2002. It is deemed that this small alignment has high archaeological potential.<br>There are other sewers alignments located within area of archaeological interest, including the area near the Cheung Chau Fisheries Joint Association Public School which remains of high archaeological potential. | Archaeological Watching Brief of alignments within boundary of Tung Wan Site of Archaeological Interest; marked on Figures 10.10, 10.12 to 10.14. |

| Areas of Impact | Archaeological Potential of the Areas | Assessment of Archaeological Potential | Scope |
|---|---|---|---|
| *Ko Shan Tsuen (Figure 10.14)* | Ko Shan Tsuen is a relatively new village with extensive utility disturbance. New development on the hillock resulted in modification of the landscape and rocky surface shows. | No archaeological potential | No further action |
| *Lung Tsai Tsuen*<br>*(Figures 10.14 and 10.17)* | Although the study area is located in close proximity of Tung Wan Archaeological Site, the current proposed alignments are either located on existing footpaths of solid geology (granite), steps, steep slopes, or have extensive impacts from previous utility groundworks. | No archaeological potential | No further action |
| *Shui Hang (Round Table 2nd Village and Round Table 3rd Village)*<br>*(Figures 10.09 and 10.11)* | All of the proposed alignments are located on existing footpaths with disturbance from previous utility works. Although the study area is located in close proximity of Tung Wan Archaeological Site, the geology is totally different – the current study area is located along steep slopes, with thin soil cover and outcrop of bedrock. | No archaeological potential | No further action |
| *Tai Shek Hau*<br>*(Figures 10.10 and 10.14)* | The proposed alignment is located along the main road within Tinford Garden, with extensive disturbance from utility groundworks. | No archaeological potential | No further action |

| Areas of Impact | Archaeological Potential of the Areas | Assessment of Archaeological Potential | Scope |
|---|---|---|---|
| **Proposed Sewers Works - Deep Sewer Scheme in Cheung Chau** | | | |
| *Tung Wan Road (Figure 10.12)* | Although the proposed works will largely take place in an area of high archaeological potential, the sewer upgrade works will take place entirely within the corridor of the existing sewers at deep depths. | Kwun Yam Wan Pumping station is deleted from the design, and the construction method employed at Tung Wan Road is modified to trenchless deep gravity sewer at depths of 6 to 8m. | Archaeological Watching Brief of the manhole excavations which are marked on Figure 10.12. |

### Archaeological Works during Construction Phase

10.3.11 An Archaeological Watching Brief during construction phase is recommended for the sections of the sewers works highlighted in **Table 10.1**. In accordance with the requirements under the Antiquities and Monuments Ordinance the works have to be undertaken by a professional archaeologist who has to apply for licence for excavate and search for Antiquities. The granting of such licence by the Antiquity Authority may take up to 8 weeks after submission of the application form and the required information.

10.3.12 In order to create a specification tailored to this particular project, it was necessary to devise a means of calculating the numbers of Archaeological Watching Brief visits per section of alignment, where 'section' can nominally be taken to mean a length of sewer alignment between two manholes. Past experience has shown that engineering work of this kind tends to be conducted on the basis of short sections of alignment between two manholes. Although the lengths of alignment between manholes vary somewhat, this is nevertheless a meaningful basis upon which to decide the monitoring schedule. With this in mind, two levels of Archaeological Watching Brief frequency were matched to two different levels of archaeological potential associated with disturbed areas of moderate archaeological potential and 100% monitoring of cultural layers of high or moderate (with minimal disturbance) archaeological potential. Wherever practicable, the archaeologist conducting such Archaeological Watching Briefs should ensure that site visits provide adequate coverage of the works area in question (i.e. they are reasonably evenly distributed along the alignment).

10.3.13 Each monitoring visit should nominally be of a day's duration and would typically involve observation, finds collection and recording as specified in **Appendix 10.1**.

10.3.14 Should significant findings be identified during the archaeological watching brief, additional archaeological resources will be provided in the form of additional/extended visits to ensure that appropriate recording and retrieval is accomplished prior to the continuation of engineering groundworks. Upon discovery of any artefact or archaeological feature in the course of other excavation works during the construction stage, the AMO will be notified immediately for site inspection, on site discussion with the AMO will be arranged to agree on further actions required.

### Archaeological Watching Brief Scope

10.3.15 The methodology for conducting an Archaeological Watching Brief programme is appended in **Appendix 10.1. Table 10.2** below presents a summary of the proposal

for further archaeological works to be conducted for the sewers works during the construction phase:

**Table 10.2 : Proposed Further Archaeological Works during Construction Phase**

| Areas of Impact | Archaeological Potential | Type of Archaeological Investigation / Protection | Scope |
|---|---|---|---|
| **Proposed Sewers Works - Village Sewers in Cheung Chau** | | | |
| Tai San Street , Tai San Back Street, Chung Hing Street and Chung Hing Back Street (Figures 10.10, 10.12, 10.13, 10.14) | High archaeological potential<br><br>Moderate archaeological potential | Archaeological Watching Brief (within boundary of Tung Wan Site of Archaeological Interest) | Archaeological Watching Brief area covers all marked alignments within Figures 10.10, 10.12, 10.13, 10.14.<br><br>100% monitoring is required for the proposed sewer at Chung Hing Street (Figure 10.10) due to its known high archaeological potential.<br><br>100% monitoring is proposed for the proposed sewer near the Cheung Chau Fisheries Joint Association Public School (Figure 10.12).<br><br>Due to the moderate archaeological potential which is based on previous findings and level of existing impacts, one visit per four sections monitoring frequency is proposed (Figures 10.10, 10.12, 10.13, 10.14). |
| Cheung Chau Rock Carving<br><br>(Figure 10.15) | Declared Monument | Archaeological Watching Brief | Archaeological Watching Brief area is marked on Figure 10.15.<br><br>Due to its proximity to a Declared Monument, one visit per four sections monitoring frequency is proposed (Figure 10.15). |

| Areas of Impact | Archaeological Potential | Type of Archaeological Investigation / Protection | Scope |
|---|---|---|---|
| Cheung Chau Rock Carving<br>(Figure 10.15) | Declared Monument | Protective measures | A buffer zone including the rock carving and its immediate environs and Hak Pai Road and the nearby open space (see Figure 10.15). Within the buffer zone, construction works as well as storage of construction materials are not allowed. Erection of temporary fencing/barriers to demarcate the buffer zone is not required. The rock carving should be maintained and directional signage should be erected or installed at appropriate location(s) near the rock carving to facilitate visitors to access the rock carving during the construction phase. It has to be noted however that the access to the rock carving will not be blocked as the works area does not encroach upon the access or immediate environs of the rock carving. The directional signage can only be erected on the fencing at the edge of construction works area which is locate more than 10m from the entrance to the rock carving. |

| Areas of Impact | Archaeological Potential | Type of Archaeological Investigation / Protection | Scope |
|---|---|---|---|
| **Proposed Sewers Works - Deep Sewer Scheme in Cheung Chau** | | | |
| Tung Wan Road (Figure 10.12) | Moderate to high archaeological potential | Archaeological Watching Brief of the manhole excavations | Archaeological Watching Brief area at Manhole nos. 24-28 is marked on Figure 10.12.<br>Despite the moderate potential of the area a 100% monitoring of the manholes until sterile soils are reached is recommended. The manhole areas are relatively small and will be excavated by hand. |

### Protective Measures for Cheung Chau Rock Carving

10.3.16 Since the proposed works area is at a distance of at least 6m from the Rock Carving, and the constructor is not allowed under the contract to carry out any works outside of the designated works area, it is anticipated that the impact to the Rock Carving and its buffer zone is minimal. It is however recommended that during the construction phase a buffer zone be provided to ensure that the Declared Monument and its environs are not infringed upon during the construction works.

10.3.17 In order to better protect the Rock Carving and its environs the buffer zone will include Hak Pai Road and the nearby open space (see **Figure 10.15**). Within the buffer zone, construction works as well as storage of construction materials are not allowed. Erection of temporary fencing/barriers to demarcate the buffer zone is not required.

10.3.18 In addition, access to the rock carving should be maintained and directional signage should be erected or installed at appropriate location(s) near the rock carving to facilitate visitors to access the rock carving during the construction phase. It has to be noted however that the access to the rock carving will not be blocked as the works area does not encroach upon the access or immediate environs of the rock carving. The directional signage can only be erected on the fencing at the edge of construction works area which is locate more than 10m from the entrance to the rock carving.

10.3.19 In addition, periodic monitoring of the declared monument is recommended. It is recommended to conduct inspection of the site every 3 months during the construction phase. Inspection record supplemented with the site photos showing the condition of the overall declared monument should be submitted to AMO for record purposes.

### Residual Environmental Impacts

10.3.20 No archaeological potential will be affected by the upgrading of Cheung Chau STW and Pak She SPS.

10.3.21 For the sewers works, Archaeological Watching Brief programme will be conducted and protective measures for the Cheung Chau Rock Carving will be undertaken during construction. The operation of the sewers will have no cultural heritage impact on archaeological areas of interest on Cheung Chau.

**Environmental Monitoring and Audit Requirements**

***Archaeological Watching Brief Programme***

10.3.22 Archaeological Watching Brief programme is recommended during the construction of the sewers works at Tai San Street, Tai San Back Street, Chung Hing Street and Chung Hing Back Street, Ko Shan Tsuen and Tung Wan Road. Archaeological Watching Brief should be undertaken by a qualified archaeologist, who must apply for a licence under the Antiquities and Monuments Ordinance (Cap. 53) from the Antiquity Authority before the commencement of archaeological fieldwork. The Archaeological Watching Brief programme and scope has been stated in **Section 10.3.15**.

***Provision of Buffer Zone***

10.3.23 It is recommended that a buffer zone be provided to ensure that the Declared Monument and its environs are not infringed upon during the construction works.

10.3.24 In order to better protect the Rock Carving and its environs a buffer zone is required which includes Hak Pai Road and the nearby open space (see **Figure 10.15**). Within the buffer zone, construction works as well as storage of construction materials are not allowed. Erection of temporary fencing/barriers to demarcate the buffer zone is not required. In addition, access to the rock carving should be maintained and directional signage should be erected or installed at appropriate location(s) near the rock carving to facilitate visitors to access the rock carving during the construction phase.

10.3.25 In addition, periodic monitoring of the declared monument is recommended. It is recommended to conduct inspection of the site every 3 months during the construction phase. Inspection record supplemented with the site photos showing the condition of the overall declared monument should be submitted to AMO for record purposes.

10.3.26 For auditing purposes the Independent Environmental Checker (IEC) must ensure that the above periodic monitoring is conducted properly and that the information from the site inspection is delivered promptly to the Engineer and the AMO. The IEC will also be responsible for advising on any necessary proactive action and also for checking on the effectiveness of any corrective measures that have been employed.

**Conclusions**

10.3.27 The Study identified that the proposed sewers works will impact on areas with potential for archaeological material and deposits. Due to level of existing impacts and surface conditions of the study area, namely under concrete paths, an Archaeological Watching Brief programme is recommended for sewers excavation impacts within Tung Wan Site of Archaeological Interest and nearby the Cheung Chau Rock Carving. The Archaeological Watching Brief programme scope has been stated in **Section 10.3.15**.

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## 10.4 Built Heritage Impact Assessment

### Study Area and Sensitive Receivers

10.4.1 The Study Area for the built heritage survey will include all resources within 50 metres of the proposed works. There is one Declared Monument in the project Study Area, but as it is a rock carving it is classified as a site of archaeological interest and has been included as part of the AIA for this project. There are no Government Historic Sites in Cheung Chau. There are 18 Graded Historic Buildings located in the current project Study Area and a brief background is provided below:

***Yuk Hui Temple (CC-14), Pak She Street, Tung Wan (Grade 1) (Figure 10.23)***

10.4.2 It is a Taoist temple built in 1783 for the worship of Yuen Tin Sheung Tai and is also known as the Pak Tai temple. It is a Qing Vernacular style building with a two hall main building and two side chambers. The façade contains a porch with two platforms at each end. Unique features of the temple are the granite columns on the porch and the two pairs of granite lions and incense burner in the open courtyard. The building underwent renovations in 1822, 1838, 1858, 1903 and 2002.

***Cheung Chau Police Station (CC-37), No. 4 Police Station Path (Grade 2) (Figure 10.27)***

10.4.3 The police station was built in 1913 and replaced an earlier station constructed in 1899 on Tai Sun Street. The move was precipitated by a raid on the former police station by pirates in which three Indian constables were murdered. The police station was closed down during the Japanese Occupation and resumed its function in 1947. It is a rectangular complex consisting of three interconnected blocks. The main block is Neo-Classical Colonial in style and the two side wings and new annex block are of Modernist style.

***No. 91 Lai Chi Yuen (CC-38A) (Grade 2) (Figure 10.27)***

10.4.4 This is the northern end unit in the block and the exact year of construction could not be traced, but the Land registry started in 1905. The land ownership changed several times, and the building is now used as a home for the elderly. The building consists of a 2 storey tenement structure which is rectangular in shape and elongated with narrow façade and rear wall. The kitchen is an extension at the rear of the building. The building has a flat roof with ornamental parapet. Other architectural features include: classical style columns, moulded cornices and ornamental balustrades. The style of architecture is Neo-Classical with Chinese Eclectic overtones.

***No. 92 Lai Chi Yuen (CC-38B) (Grade 2) (Figure 10.27)***

10.4.5 This is the middle unit in the block and the exact year of construction could not be traced, but the Land registry started in 1905. The land ownership changed several times, and the building is now used as a home for the elderly. The building consists of a 2 storey tenement structure which is rectangular in shape and elongated with

narrow façade and rear wall. The kitchen is an extension at the rear of the building. The building has a flat roof with ornamental parapet. Other architectural features include: classical style columns, moulded cornices and ornamental balustrades. The style of architecture is Neo-Classical with Chinese Eclectic overtones.

***No. 93 Lai Chi Yuen (CC-38C) (Grade 2) (Figure 10.27)***

10.4.6 This is the southern end unit in the block and the exact year of construction could not be traced.but the Land registry started in 1905. The land ownership changed several times, and the building is now used as a home for the elderly. The building consists of a 2 storey tenement structure which is rectangular in shape and elongated with narrow façade and rear wall. The kitchen is an extension at the rear of the building. The building has a flat roof with ornamental parapet. Other architectural features include: classical style columns, moulded cornices and ornamental balustrades. The style of architecture is Neo-Classical with Chinese Eclectic overtones.

***Hung Shing Temple (CC-29), Chung Hing Street, Cheung Chau Wan (Grade 2) (Figure 10.28)***

10.4.7 The temple was built in the 18th year of the Jiaqing Reign of the Qing Dynasty (1813) and was built for the worship of the Hung Shing Deity. It is a Qing Vernacular building in style with a two hall and one courtyard plan. The courtyard between the entrance and main halls has been covered. It is constructed of green bricks with granite columns with pitched roofs with wooden support structures and clay tiles. The main roof ridge has sets of Shiwan ceramic figures in good condition.

***No. 18 Tai San Street (CC-32) (Grade 2) (Figure 10.28)***

10.4.8 Currently a two storey building, but originally built as a one storey building in 1921 and used as the Cheung Chau Public Free School and the Kung So Communal Hall. After WWII it became a grocery shop and an extra floor was added in the 1950's. It is a two hall one courtyard plan building and the courtyard originally open has been covered with a flat roof.

***Cheung Chau Government Secondary School, Old Block (CC-35) Grade 2 and Caretakers Residence (CC-36) (Grade 2) No. 5B, School Road (Figure 10.28)***

10.4.9 The original school was known as the Cheung Chau Anglo- Chinese School that was established at another location on Cheung Chau in 1908. The first permanent school building was constructed at the present site in 1928. The school was used by the Japanese during the occupation as their military headquarters. The school reopened in 1945. The old block of the school is an L-shaped two-storey red brick building of Neo-Classical style.

***Cheung Chau Theatre (CC-45), San Hing Back Street (Grade 3) (Figure 10.27)***

10.4.10 The theatre was built in 1931, the theatre ran over seventy years before it was closed down in 1990s. Chinese and Western movies, sometimes mimes, were shown in the theatre. In the 1930s, mimes were popular in Hong Kong, and interpreters were hired to explain the content. The Theatre only showed one show in the daytime and two shows at night. With its collective memory provided, the theatre was used as a shooting scene in a local movie named "Just One Look" in 2001. The building is Chinese Eclectic in style and constructed of concrete, bricks and rocks in its walls and columns with a pitched roof of black tiles.

***Tin Hau Temple (CC-20) Chung Hing Street (Tai Shek Hau) (Grade 2) (Figure 10.25)***

10.4.11 The temple is a two-hall structure to worship Tin Hau, the deity of the sea. A bell made in A.D.1772 is found in the temple, indicating the temple is over 200 years old.

***Tin Hau Temple (CC-13) near Pak She San Tsuen (Grade 2) (Figure 10.21)***

10.4.12 The temple is a two-hall structure to worship Tin Hau, the deity of the sea. The construction date of the temple is unknown. However, a bronze dated to A.D.1767 was found in the temple. Thus, the temple was built before 1767. According to the tablets found in the temple, the temple was renovated in 1889 and 1968. The inscriptions on the four-leg vessel in front of the temple recorded the existence of Cheung Chau Market in A.D.1785.

***Cheung Chau Fong Pin Hospital (CC-30) (Grade 3) (Figure 10.28)***

10.4.13 The hospital was established in A.D.1872 by Cai Liang, a merchant from Dongguang, to provide free medical and burial service. The original name was Tsai-lau-sor. A cemetery was constructed next to Tsai-lau-sor in A.D.1873 for the burial service. In 1915, Tsai-lau-sor was expanded and renamed to Fong Pin Hospital. Two renovations were undertaken in 1938 and 1951. The Hospital is made up of a motley collection of old village houses built in various styles with features derived from traditional Chinese Vernacular and Colonial architecture which can be classified as Chinese Eclectic. Some of the buildings are single-storey and some are two storey. The gabled front entrance has a porch supported by round columns. One of the structures is a simple two-storey courtyard house with an atrium for admission of light and ventilation. Historic relics include tablets and stone plaques with inscriptions.

***St. John Hospital (CC-51), Cheung Chau Hospital Road (Grade 3) (Figure 10.30)***

10.4.14 The original English name of the hospital was “The Haw Par Hospital” as the main benefactors of the construction were Mr. Aw Boon Haw and Mr. Aw Boon Par. The hospital was constructed between 1932 and 1943. It was originally built as a missionary hospital, but after the Second World War it was maintained by the government to serve as a local rural hospital. It is a three storey building built in a symmetrical E shaped plan and is Neo-Classical with Chinese influence in style.

***No. 233 Tai San Back Street (CC-39A) (Grade 3) (Figure 10.27)***

10.4.15 Probably built before the Second World War by Yu Lin-gui, a local gentry who was well known in the Cheung Chau District Community, the two-storey tenement situated at Nos. 233, 234 & 242 Tai San Back Street reveals the village fabric in Cheung Chau which sustains distinctive character of both Chinese and Western architecture. The tenement is now shared by two to three families of Yu clan. The architectural styles incorporate Chinese and Western features.

***No. 234 Tai San Back Street (CC-39B) (Grade 3) (Figure 10.27)***

10.4.16 Probably built before the Second World War by Yu Lin-gui, a local gentry who was well known in the Cheung Chau District Community, the two-storey tenement situated at Nos. 233, 234 & 242 Tai San Back Street reveals the village fabric in Cheung Chau which sustains distinctive character of both Chinese and Western architecture. The tenement is now shared by two to three families of Yu clan. The architectural styles incorporate Chinese and Western features.

***No. 242 Tai San Back Street (CC-39C) (Grade 3) (Figure 10.27)***

10.4.17 This is a modern replacement structure.

***Entrance Gate together with the enclosing walls of Nos. 233, 234 and 242 Tai San Back Street (CC-40) (Grade 3) (Figure 10.27)***

10.4.18 The enclosing walls and elaborately decorated gateway (with pedimented gate posts and arched central feature) surround the residential units and courtyard. It is likely that the walls and gate are of similar age to the structures.

**Other Built Heritage Resources**

10.4.19 In addition to the above cited historical buildings, 54 other historical structures (including buildings, graves, shrines and gates) were recorded in the original built heritage field survey and reconfirmed by a site visit undertaken on November 12th 2011. The catalogue for the recorded items has been included in **Appendix 10.2** (with updated information from the original field survey).

**Prediction of Impacts (Construction and Operational Phases)**

***Sewers Works – Village Sewers***

10.4.20 The proposed works will consist of the laying of pipes between 150mm - 525mm in diameter. It is expected that the depths of excavation will range between 0.6m to 3.3m. This project does not include connection of the sewerage system to any structures and no direct impacts to structures will occur as a result of the construction activities. A tapping sewer (a short pipe for future sewerage connection) will be designed and constructed within government lands as practicable as possible up to the lot boundary/front gate of the village houses.

10.4.21 Indirect impacts from construction related activities, such as concrete breaking and excavation works may occur if conducted in the vicinity of built heritage structures. This distance that required attention will be defined as 20 m from the proposed works area.

10.4.22 Heritage resources in close proximity (i.e. less than 5 metres from the proposed works areas) may be damaged by contact with machinery during the works as well as vibration impacts and buffer zones should be provided. As there may be insufficient room for provision of adequate buffer zones, protective covering for the exterior surfaces of these structures should also be provided.

10.4.23 It should be noted that a study area for the built heritage survey has been set at 50 m. The purpose for this is to ensure that if there are any minor alterations to sewers alignments at a later stage, heritage resources will already have been identified and impacts assessment and mitigation if required can be undertaken on an individual basis.

10.4.24 The proposed construction works areas are in close proximity to a number of shrines, temples and village entrance gates and access to these structures may be restricted by the presence of works areas. As mentioned above, no direct impacts to structures will result from the proposed works, however, indirect impacts may occur to any historical ground surface coverings, such as granite paving stones, slabs and steps that are located along the proposed alignment. No such surfaces were identified during the field survey, however, if any surfaces (not visible at the ground surface level) are encountered during the construction works, the alignment should be altered to avoid damaging the surface or if this is not feasible the material should

be removed during the excavation process and reinstated upon completion of the works.

10.4.25 As the alignments are to be situated on existing footpaths there is no predicted impact to cultural landscape features such as fung shui woods and ponds.

10.4.26 The sewers alignments will be located underground and will not cause any adverse impacts during the operational phase.

***Sewers Works – Trenchless Sewers***

10.4.27 The construction method for trenchless excavation consists of excavation of manholes and extraction of material from underground brought to the surface through the manhole shafts. It is expected that the underground excavation method will be undertaken by Hand-Shield Excavation – Segmental Method. The proposed depth of the trenchless sewer alignment is 6 to 8 metres. The proposed trenchless sewers will be located at Tung Wan Road and Cheung Chau Sports Road. The construction works have the potential to damage built heritage resources through ground borne vibration.

***Upgrading of Existing STW and SPS***

10.4.28 It is proposed to upgrade existing STW and Pak She SPS to improve the processing capacity. The proposed works will occur within the existing facilities and impacts during the construction works, if applicable will be indirect and will arise from ground borne vibration. As the STW and SPS buildings are currently in place and will not alter the existing environment, no impacts are predicted to occur during the operational phase.

**Built Heritage - Impacts Evaluation and Mitigation Measures (Construction Stage)**

***Sewers Works***

10.4.29 The impacts arising from the construction of sewers works and the recommended mitigation will be presented in **Table 10.3** and **Table 10.4**. It should be noted that the alignments in the vicinity of all Graded Historic Buildings have been designed to provide the maximum feasible distance between the resource and the proposed works.

10.4.30 Although no historical ground surface covering, such as granite paving slabs were identified as being directly impacted during the survey, there is potential for such surfaces to exist under modern covering. If any such surfaces are encountered during the construction works there is potential that they may be damaged or destroyed. If any surfaces (not visible at the ground surface level) are encountered during the construction works, the alignment should be altered to avoid damaging the surface or if this is not feasible the material should be removed during the excavation process and reinstated upon completion of the works.

10.4.31 The following mitigation recommendations will be carried out for resources as required from the findings of the impact assessment presented in **Table 10.3** and **Table 10.4**. The description below will provide the detailed requirements for each of the mitigation actions and will be abbreviated in the tables by the letters shown in brackets.

*Condition Survey (CS)*

10.4.32 A condition survey must be carried out by qualified building surveyor or engineer in advance of works for Graded Historic Buildings and structures and Nil Grade heritage structures that may be affected by ground borne vibration. The Condition Survey Report should contain descriptions of the structure, identification of fragile elements, an appraisal of the condition and working methods for any proposed monitoring and precautionary measures that are recommended.

10.4.33 The condition survey report for Graded Historic Buildings must be submitted to AMO before construction activities commence. The contractor must implement the approved monitoring and precautionary measures.

*Vibration Monitoring (VM)*

10.4.34 Vibration monitoring should be undertaken during the construction works to ensure that safe levels of vibration are not exceeded. A maximum level of 5mm/s for Grade 1, 7.5mm/s for Grades 2 and 3 Historic Buildings and 15 mm/s for Nil Grade heritage structures should be adopted. It should be noted that the condition survey report should highlight if the limit should be lowered after the detailed study of the condition of the building. A monitoring schedule should be included in the condition survey report. The location of proposed monitoring point on the building should avoid damaging the historic fabric and approved by the owner.

*Provision of Buffer Zones (BZ)*

10.4.35 A buffer zone should be provided to separate the building from the construction works. The buffer zone should be clearly marked out by temporary fencing. The buffer zone should be at least 1 metre unless site restrictions make this unfeasible. In this case the buffer zone should be made as large as the site restrictions allow.

*Provision of Protective Covering (PC)*

10.4.36 Protective covering in the form of plastic sheeting placed on a movable fence should be provided for external walls and surfaces of historical buildings and structures in close proximity to works areas, i.e. areas where a buffer zone alone cannot provide protection from equipment and works activities.

*Safe Public Access (SPA)*

10.4.37 Any proposed works in close proximity to buildings or structures used by the public for religious, ritual or funerary purposes, such as shrines, ancestral halls, temples and graves have the potential to create an unsafe environment for members of the public. The contractor must ensure that safe public access, through provision of clearly marked paths separated from the construction works areas is provided for any such affected cultural heritage structure.

**Table 10.3 : Assessment of Impacts and Mitigation Recommendations for Graded Historic Buildings in Cheung Chau (Sewers Works)**

| Recorded Resource | Grade | Cat Ref | Description of Construction Works | Minimum Distance to Works | Impact Assessment | Mitigation(1) |
|---|---|---|---|---|---|---|
| Yuk Hui Temple | 1 | (CC14) | Sewer and manhole | 45m | Based on distance to the proposed works no adverse impacts are expected. | No mitigation required. |
| Cheung Chau Police Station | 2 | (CC37) | Sewer and manhole | 38m | Based on distance to the proposed works no adverse impacts are expected. | No mitigation required. |
| No. 91 Lai Chi Yuen | 2 | (CC38A) | Sewer and manhole | 18m | The structure may be damaged by ground borne vibration. | The Alert, Alarm and Action (AAA) vibration limit will be set at 5/6/7.5 mm/s. (CS, VM) |
| No. 92 Lai Chi Yuen | 2 | (CC38B) | Sewer and manhole | 18m | The structure may be damaged by ground borne vibration. | The Alert, Alarm and Action (AAA) vibration limit will be set at 5/6/7.5 mm/s. (CS, VM) |
| No. 93 Lai Chi Yuen | 2 | (CC38C) | Sewer and manhole | 18m | The structure may be damaged by ground borne vibration. | The Alert, Alarm and Action (AAA) vibration limit will be set at 5/6/7.5 mm/s. (CS, VM) |
| Hung Shing Temple | 2 | (CC29) | Sewer and manhole | 10m | The structure may be damaged by ground borne vibration. | The Alert, Alarm and Action (AAA) vibration limit will be set at 5/6/7.5 mm/s. (CS, VM) |
| No. 18 Tai San Street | 2 | (CC32) | Sewer, manhole and tapping pipe | Close proximity | Direct impacts to the exterior walls may occur during the construction works through contact with digging equipment and machinery. Indirect impacts may arise from ground borne vibration. | The Alert, Alarm and Action (AAA) vibration limit will be set at 5/6/7.5 mm/s.<br>Any damage to exterior walls will be repaired with finishes which match with the existing finish. If matching material is not readily available, the closest possible substitute will be sourced by the contractor and AMO will be contacted for comment on the material. (CS, VM, BZ, PC) |

| Recorded Resource | Grade | Cat Ref | Description of Construction Works | Minimum Distance to Works | Impact Assessment | Mitigation(1) |
|---|---|---|---|---|---|---|
| Cheung Chau Government Secondary School, Caretakers Residence | 2 | (CC36) | Sewer and manhole | 20m | The structure may be damaged by ground borne vibration. | The Alert, Alarm and Action (AAA) vibration limit will be set at 5/6/7.5 mm/s. (CS, VM) |
| Cheung Chau Government Secondary School, Old Block | 2 | (CC35) | Sewer and manhole | 40m | Based on distance to the proposed works no adverse impacts are expected. | No mitigation required. |
| Tin Hau Temple, Chung Hing Street | 2 | (CC20) | Sewer and manhole | 10m | The structure may be damaged by ground borne vibration. | The Alert, Alarm and Action (AAA) vibration limit will be set at 5/6/7.5 mm/s. (CS, VM) |
| Tin Hau Temple, Pak She Tsuen | 2 | (CC13) | Sewer and manhole | Close proximity | Direct impacts to the exterior walls may occur during the construction works through contact with digging equipment and machinery. Indirect impacts may arise from ground borne vibration.<br>Safe public access to the temple may be restricted by the construction works. | The Alert, Alarm and Action (AAA) vibration limit will be set at 5/6/7.5 mm/s.<br>Any damage to exterior walls will be repaired with finishes which match with the existing finish. If matching material is not readily available, the closest possible substitute will be sourced by the contractor and AMO will be contacted for comment on the material. (CS, VM, BZ, PC, SPA) |
| Cheung Chau Fong Pin Hospital | 3 | (CC30) | Sewer and manhole | 15m | The structure may be damaged by ground borne vibration. | The Alert, Alarm and Action (AAA) vibration limit will be set at 5/6/7.5 mm/s. (CS, VM) |
| St. John Hospital | 3 | (CC51) | Sewer and manhole | 8m | The structure may be damaged by ground borne vibration. | The Alert, Alarm and Action (AAA) vibration limit will be set at 5/6/7.5 mm/s. (CS, VM) |
| No. 233 Tai San Back Street | 3 | (CC39A) | Sewer and manhole | 20m | The structure may be damaged by ground borne vibration. | The Alert, Alarm and Action (AAA) vibration limit will be set at 5/6/7.5 mm/s. (CS, VM) |
| No. 234 Tai San Back Street | 3 | (CC39B) | Sewer and manhole | 20m | The structure may be damaged by ground borne vibration. | The Alert, Alarm and Action (AAA) vibration limit will be set at 5/6/7.5 mm/s. (CS, VM) |

| Recorded Resource | Grade | Cat Ref | Description of Construction Works | Minimum Distance to Works | Impact Assessment | Mitigation(1) |
|---|---|---|---|---|---|---|
| No. 242 Tai San Back Street | 3 | (CC39C) | Sewer and manhole | 20m | The structure is a modern replacement; no impacts. | No mitigation required. |
| Gate and Enclosing Walls of Nos. 233, 234 and 242 Tai San Back Street | 3 | (CC40) | Proposed sewer and manholes | 20m | The remaining historical structures may be damaged by ground borne vibration. | The Alert, Alarm and Action (AAA) vibration limit will be set at 5/6/7.5 mm/s. (CS/VM) |
| Cheung Chau Theatre | 3 | (CC45) | Sewer and manhole | 35m | The theatre though in poor condition is a concrete structure and the distance is considered sufficient that no adverse impacts will arise from the construction works. | No Mitigation required. |

Note: (1) CS – Condition Survey
VM – Vibration Monitoring
BZ – Buffer Zone
PC – Provision of Protective Covering
SPA – Safe Public Access

**Table 10.4 : Assessment of Impacts to Non-Graded Historic Structures on Cheung Chau (Sewers Works)**

| Recorded Resource | Type | Cat Ref | Description of Construction Works | Minimum Distance to Works | Impact Assessment | Mitigation Recommendations (1) |
|---|---|---|---|---|---|---|
| Shrine beside Pak Kok Tsuen Road | Shrine | CC01 | There are no proposed alignments in the vicinity of the shrine | N/A | No impacts. | No mitigation required. |
| Grave near No. 21 Tai Kwai Wan San Tsuen | Grave | CC02 | Sewer and manhole | 18 m | The structure may be damaged by ground borne vibration. | The vibration limit will be set at 15 mm/s. (CS, VM) |
| Grave beside No. 5A Tai Kwai San Tsuen | Grave | CC03 | Sewer and manhole | Close proximity | Direct impacts to the grave may occur during the construction works through contact with digging equipment and machinery.<br>The structure may be damaged by ground borne vibration.<br>Safe public access to the grave may be restricted by the construction works. | The vibration limit will be set at 15 mm/s. (CS, VM, BZ, PC, SPA) |
| Cheung Chau Christian Cemetery | Cemetery | CC04 | Sewer and manhole | Close proximity | The construction works are outside of the cemetery grounds and no impacts are expected. | No mitigation required. |
| Grave behind No. 108 Pak She San Tsuen | Grave | CC05 | Sewer and manhole | Close proximity | The grave has been abandoned and there is a government notice that it will be removed in the near future. | No mitigation required. |

| Recorded Resource | Type | Cat Ref | Description of Construction Works | Minimum Distance to Works | Impact Assessment | Mitigation Recommendations (1) |
|---|---|---|---|---|---|---|
| No. 107 Pak She San Tsuen | VH | CC06 | Sewer, manhole and tapping pipe | Close proximity | Direct impacts to the building may occur during the construction works through contact with digging equipment and machinery.<br>The structure may be damaged by ground borne vibration. | The vibration limit will be set at 15 mm/s. (CS, VM, BZ, PC) |
| No. 103 Pak She San Tsuen | VH | CC07 | Sewer, manhole and tapping pipe | Close proximity | Direct impacts to the building may occur during the construction works through contact with digging equipment and machinery.<br>The structure may be damaged by ground borne vibration. | The vibration limit will be set at 15 mm/s. (CS, VM, BZ, PC) |
| No. 57 Pak She San Tsuen | VH | CC08 | Sewer, manhole and tapping pipe | Close proximity | Direct impacts to the building may occur during the construction works through contact with digging equipment and machinery.<br>The structure may be damaged by ground borne vibration. | The vibration limit will be set at 15 mm/s. (CS, VM, BZ, PC) |
| No. 56 Pak She San Tsuen | VH | CC09 | Sewer, manhole and tapping pipe | Close proximity | Direct impacts to the building may occur during the construction works through contact with digging equipment and machinery.<br>The structure may be damaged by ground borne vibration. | The vibration limit will be set at 15 mm/s. (CS, VM, BZ, PC) |

| Recorded Resource | Type | Cat Ref | Description of Construction Works | Minimum Distance to Works | Impact Assessment | Mitigation Recommendations (1) |
|---|---|---|---|---|---|---|
| No. 48 Pak She San Tsuen | VH | CC10 | Sewer, manhole and tapping pipe | Close proximity | Direct impacts to the building may occur during the construction works through contact with digging equipment and machinery.<br>The structure may be damaged by ground borne vibration. | The vibration limit will be set at 15 mm/s. (CS, VM, BZ, PC) |
| No. 30 Pak She San Tsuen | VH | CC11 | Sewer, manhole and tapping pipe | Close proximity | Direct impacts to the building may occur during the construction works through contact with digging equipment and machinery.<br>The structure may be damaged by ground borne vibration. | The vibration limit will be set at 15 mm/s. (CS, VM, BZ, PC) |
| No. 24 Pak She San Tsuen | VH | CC12 | Sewer, manhole and tapping pipe | Close proximity | Direct impacts to the building may occur during the construction works through contact with digging equipment and machinery.<br>The structure may be damaged by ground borne vibration. | The vibration limit will be set at 15 mm/s. (CS, VM, BZ, PC) |
| Shrine south of No.1, Block A, Round Table 2nd Village | Shrine | CC15 | Sewer and manhole | 12m | The structure may be damaged by ground borne vibration. | The vibration limit will be set at 15 mm/s. (CS, VM) |
| Shrine north of Block J of Tung Koon San Tsuen | Shrine | CC16 | Sewer and manhole | 18m | The structure may be damaged by ground borne vibration. | The vibration limit will be set at 15 mm/s. (CS, VM) |

| Recorded Resource | Type | Cat Ref | Description of Construction Works | Minimum Distance to Works | Impact Assessment | Mitigation Recommendations (1) |
|---|---|---|---|---|---|---|
| Shrine southwest of No.39 Lutheran Village | Shrine | CC17 | Sewer and manhole | Close proximity | Direct impacts to the shrine may occur during the construction works through contact with digging equipment and machinery.<br>The structure may be damaged by ground borne vibration.<br>Safe public access to the shrine may be restricted by the construction works. | The vibration limit will be set at 15 mm/s. (CS, VM, BZ, PC, SPA) |
| Grave south of Lutheran Village | Grave | CC18 | Sewer and manhole | 20m | The structure may be damaged by ground borne vibration. | The vibration limit will be set at 15 mm/s. (CS, VM) |
| Boundary stone next to a footpath at the end of the uphill stairs south of Golden Lake Garden | Boundary Stone | CC19 | Sewer and manhole | Close proximity | The boundary stone may be damaged by construction works through contact with digging equipment and machinery. | The vibration limit will be set at 15 mm/s. (CS, VM, BZ, PC) |
| Grave west of No.139B Middle Hill Road | Grave | CC21 | Sewer and manhole | 10m | The structure may be damaged by ground borne vibration. | The vibration limit will be set at 15 mm/s. (CS, VM) |
| Well south of No.5B Tai Shek Hau | Well | CC22 | Sewer and manhole | 25m | No adverse impacts are expected. | No mitigation required. |
| No.30A Ko Shan Tsuen | VH | CC23 | Sewer and manhole | Close proximity | Direct impacts to the building may occur during the construction works through contact with digging equipment and machinery.<br>The structure may be damaged by ground borne vibration. | The vibration limit will be set at 15 mm/s. (CS, VM, BZ, PC) |

| Recorded Resource | Type | Cat Ref | Description of Construction Works | Minimum Distance to Works | Impact Assessment | Mitigation Recommendations (1) |
|---|---|---|---|---|---|---|
| No.73B Chung Hing Back Street | VH | CC24 | Sewer and manhole | 18m | The structure may be damaged by ground borne vibration. | The vibration limit will be set at 15 mm/s. (CS, VM) |
| No.78 Chung Hing Back Street | VH | CC25 | Sewer and manhole | 10m | The structure may be damaged by ground borne vibration. | The vibration limit will be set at 15 mm/s. (CS, VM) |
| Fuk Tak Koon (near No.101 Chung Hing Back Street) | Shrine | CC26 | Sewer and manhole | 8m | The structure may be damaged by ground borne vibration. | The vibration limit will be set at 15 mm/s. (CS, VM) |
| No.94 Chung Hing Back Street | VH | CC27 | Sewer and manhole | 30m | No adverse impacts are expected. | No mitigation required. |
| Shrine east of No.125 Chung Hing Back Street | Shrine | CC28 | Sewer and manhole | Close proximity | Direct impacts to the shrine may occur during the construction works through contact with digging equipment and machinery.<br>The structure may be damaged by ground borne vibration.<br>Safe public access to the shrine may be restricted by the construction works. | The vibration limit will be set at 15 mm/s. (CS, VM, BZ, PC SPA) |
| East Section of No.15 Tai San Back Street | VH | CC31 | Sewer, manhole and tapping pipe | Close proximity | Direct impacts to the shrine may occur during the construction works through contact with digging equipment and machinery.<br>The structure may be damaged by ground borne vibration. | The vibration limit will be set at 15 mm/s. (CS, VM, BZ, PC) |

| Recorded Resource | Type | Cat Ref | Description of Construction Works | Minimum Distance to Works | Impact Assessment | Mitigation Recommendations (1) |
|---|---|---|---|---|---|---|
| Gate of the Fong Pin Yuen Hospital east of No.111C Tai San Back | Arch | CC33 | Sewer and manhole | 15m | The structure may be damaged by ground borne vibration. | The vibration limit will be set at 15 mm/s. (CS, VM) |
| Wong Chung Ying Tong at No.31 Tai San Back Street | Ancestral Hall | CC34 | Sewer and manhole | 14m | The structure may be damaged by ground borne vibration. | The vibration limit will be set at 15 mm/s. (CS, VM) |
| Nos. 1, 2 and 3 Tung Wan Road | VH | CC41 | Deep sewer by trenchless excavation (manhole) | Close proximity | Direct impacts to the structure may occur during the construction works through contact with digging equipment and machinery.<br>The structure may be damaged by ground borne vibration. | The vibration limit will be set at 15 mm/s. (CS, VM, BZ, PC) |
| Shrine east of No.157 San Hing Back Street | Shrine | CC42 | Deep sewer by trenchless excavation (manhole) | 12m | The structure may be damaged by ground borne vibration. | The vibration limit will be set at 15 mm/s. (CS, VM) |
| No.157 San Hing Back Street | VH | CC43 | Deep sewer by trenchless excavation (manhole) | Close proximity | Direct impacts to the structure may occur during the construction works through contact with digging equipment and machinery.<br>The structure may be damaged by ground borne vibration. | The vibration limit will be set at 15 mm/s. (CS, VM, BZ, PC) |

| Recorded Resource | Type | Cat Ref | Description of Construction Works | Minimum Distance to Works | Impact Assessment | Mitigation Recommendations (1) |
|---|---|---|---|---|---|---|
| Shrine west of No.81 Hok Loo Lane | Shrine | CC44 | Deep sewer by trenchless excavation (manhole) | Close proximity | Direct impacts to the shrine may occur during the construction works through contact with digging equipment and machinery.<br>The structure may be damaged by ground borne vibration.<br>Safe public access to the shrine may be restricted by the construction works. | The vibration limit will be set at 15 mm/s. (CS, VM, BZ, PC,SPA) |
| Shrine near the Sitting-out Area of Afternoon Beach | Shrine | CC46 | Sewer and manhole | Close proximity | Direct impacts to the shrine may occur during the construction works through contact with digging equipment and machinery.<br>The structure may be damaged by ground borne vibration.<br>Safe public access to the shrine may be restricted by the construction works. | The vibration limit will be set at 15 mm/s. (CS, VM, BZ, PC,SPA) |
| Shrine west of Shui Yuek Temple | Shrine | CC47 | Sewer and manhole | 17m | The structure may be damaged by ground borne vibration. | The vibration limit will be set at 15 mm/s. (CS, VM) |
| Gate west of Shui Yuek Temple | Gate | CC48 | Sewer and manhole | 15m | The structure may be damaged by ground borne vibration. | The vibration limit will be set at 15 mm/s. (CS, VM) |
| Shrine west of Shui Yuek Temple | Shrine | CC49 | Sewer and manhole | 18 m | The structure may be damaged by ground borne vibration. | The vibration limit will be set at 15 mm/s. (CS, VM) |
| Shui Yuet Temple at Kwun Yam Wan | Temple | CC50 | Sewer and manhole | 20m | The structure may be damaged by ground borne vibration. | The vibration limit will be set at 15 mm/s. (CS, VM) |

| Recorded Resource | Type | Cat Ref | Description of Construction Works | Minimum Distance to Works | Impact Assessment | Mitigation Recommendations (1) |
|---|---|---|---|---|---|---|
| Boundary Stone Near the east wall of St John Hospital | Boundary Stone | CC52 | Sewer and manhole | 25m | No adverse impacts are expected. | No mitigation required. |
| Grave northwest of Cheung Chau Sports Ground | Grave | CC53 | Sewer | Close proximity | Direct impacts to the grave may occur during the construction works through contact with digging equipment and machinery.<br>The structure may be damaged by ground borne vibration.<br>Safe public access to the grave may be restricted by the construction works. | The vibration limit will be set at 15 mm/s. (CS, VM, BZ, PC, SPA) |
| Pavilion South of No. 14A Fa Peng Road) | Pavilion | CC54 | Sewer and manhole | 9m | The structure may be damaged by ground borne vibration. | The vibration limit will be set at 15 mm/s. (CS, VM) |
| Shrine next to the gate of No.15 Fa Peng Road | Shrine | CC55 | Sewer and manhole | Close proximity | Direct impacts to the shrine may occur during the construction works through contact with digging equipment and machinery.<br>The structure may be damaged by ground borne vibration.<br>Safe public access to the shrine may be restricted by the construction works. | The vibration limit will be set at 15 mm/s. (CS, VM, BZ, PC, SPA) |
| Gwai Yuen Jing She Nunnery at No.15 Fa Peng Road | Nunnery | CC56 | Sewer and manhole | 15m | The structure may be damaged by ground borne vibration. | The vibration limit will be set at 15 mm/s. (CS, VM) |

| Recorded Resource | Type | Cat Ref | Description of Construction Works | Minimum Distance to Works | Impact Assessment | Mitigation Recommendations (1) |
|---|---|---|---|---|---|---|
| Tao Yuen, Main House and Annex Block at No. 14 Fa Peng Road | VH | CC57 | Sewer and manhole | 12m | The structure may be damaged by ground borne vibration. | The vibration limit will be set at 15 mm/s. (CS, VM) |
| Christian Zheng Sheng School at No.4 Fa Peng Road | School | CC58 | Sewer and manhole | 10m | The structure may be damaged by ground borne vibration. | The vibration limit will be set at 15 mm/s. (CS, VM) |
| No.26 Ko Shan Tsuen | VH | CC59 | Sewer and manhole | 10m | The structure may be damaged by ground borne vibration. | The vibration limit will be set at 15 mm/s. (CS, VM) |
| No.27 Ko Shan Tsuen | VH | CC60 | Sewer and manhole | Close proximity | Direct impacts to the building may occur during the construction works through contact with digging equipment and machinery.<br>The structure may be damaged by ground borne vibration. | The vibration limit will be set at 15 mm/s. (CS, VM, BZ, PC) |
| No.38 Ko Shan Tsuen | VH | CC61 | Sewer and manhole | Close proximity | Direct impacts to the building may occur during the construction works through contact with digging equipment and machinery.<br>The structure may be damaged by ground borne vibration. | The vibration limit will be set at 15 mm/s. (CS, VM, BZ, PC) |
| East of No.2 Hi Shi Road | VH | CC62 | Sewer, manhole and tapping pipe | 12 m | The structure may be damaged by ground borne vibration. | The vibration limit will be set at 15 mm/s. (CS, VM) |

| Recorded Resource | Type | Cat Ref | Description of Construction Works | Minimum Distance to Works | Impact Assessment | Mitigation Recommendations (1) |
|---|---|---|---|---|---|---|
| No. 27 Lung Tsai Tsuen | VH | CC63 | Sewer and manhole | 10m | The structure may be damaged by ground borne vibration. | The vibration limit will be set at 15 mm/s. (CS, VM) |
| No. 61 Lung Tsai Tsuen | VH | CC64 | Sewer and manhole | Close proximity | Direct impacts to the building may occur during the construction works through contact with digging equipment and machinery.<br>The structure may be damaged by ground borne vibration. | The vibration limit will be set at 15 mm/s. (CS, VM, BZ, PC) |
| No.50 Lung Tsai Tsuen | VH | CC65 | Sewer and manhole | 20m | The structure may be damaged by ground borne vibration. | The vibration limit will be set at 15 mm/s. (CS, VM) |
| No.54 Lung Tsai Tsuen | VH | CC66 | Sewer and manhole | 6m | The structure may be damaged by ground borne vibration. | The vibration limit will be set at 15 mm/s. (CS, VM) |
| No.61A Lung Tsai Tsuen | VH | CC67 | Sewer | Close proximity | Direct impacts to the building may occur during the construction works through contact with digging equipment and machinery.<br>The structure may be damaged by ground borne vibration. | The vibration limit will be set at 15 mm/s. (CS, VM, BZ, PC) |
| No.25D Lung Tsai Tsuen | VH | CC68 | Sewer | Close proximity | Direct impacts to the building may occur during the construction works through contact with digging equipment and machinery.<br>The structure may be damaged by ground borne vibration. | The vibration limit will be set at 15 mm/s. (CS, VM, BZ, PC) |

Note: (1) CS – Condition Survey
VM – Vibration Monitoring
BZ – Buffer Zone
PC – Provision of Protective Covering
SPA – Safe Public Access

***Upgrading of Cheung Chau STW***

10.4.38 One built heritage resource has been identified in the vicinity of the STW; a modern concrete shrine (CC-01) (**Figure 10.22**), which is located approximately 45 metres from the STW site. Based upon the distance and nature of the resource (a concrete box structure with no fragile architectural features, no adverse impacts are expected during the construction phase and no mitigation will be required.

***Upgrading of the Pak She SPS***

10.4.39 No built heritage resources have been identified in the vicinity of the Pak She SPS and no built heritage resources will be affected by the proposed works. No mitigation measures will be required.

**Built Heritage – Impacts Evaluation and Mitigation Measures (Operational Stage)**

***Sewers Works***

10.4.40 No impacts have been identified for the operational phase and no mitigation will be required.

***Upgrading of Cheung Chau STW***

10.4.41 The upgrading works will occur within the STW site and will not alter the external environmental setting. No impacts have been identified and no mitigation will be required.

***Upgrading of the Pak She SPS***

10.4.42 No impacts have been identified for the operational phase and no mitigation will be required.

**Built Heritage – Residual Environmental Impacts**

10.4.43 Based on the assessment above, no adverse impacts have been identified and no mitigation will be required.

**Built Heritage - Environmental Monitoring and Audit Requirements**

10.4.44 No specific mitigation measures are required for the works of upgrading Cheung Chau STW and Pak She SPS under this Project. Monitoring and preventive measures for the sewers works will be recommended as part of the environmental monitoring and audit requirements. The recommended measures are described as follow:

***Condition Survey***

10.4.45 The requirements for the condition survey have been highlighted in **Sections 10.4.32** and **10.4.33**. Condition survey will be required for all highlighted Graded Historic Buildings and Non-Graded Historic Structures as shown in **Table 10.3** and **Table 10.4** respectively.

***Vibration Monitoring***

10.4.46 The requirements for vibration monitoring have been highlighted in **Section 10.4.34** in this report. The condition survey report will confirm the Graded Historic Buildings

and Non-Graded Historic Structures that will require vibration monitoring during the construction works.

***Provision of Buffer Zone***

10.4.47 The requirements for provision of buffer zone are highlighted in **Section 10.4.35** of this report. Resources requiring buffer zone are shown in **Table 10.3** and **Table 10.4**.

**Protective Covering**

10.4.48 The requirements for protective covering have been highlighted in **Section 10.4.36**. Resources requiring protective covering are shown in **Table 10.3** and **Table 10.4**.

**Safe Public Access**

10.4.49 The requirements for safe public access have been highlighted in **Section 10.4.37**. Resources requiring measures for safe public access are shown in **Table 10.3** and **Table 10.4**.

**Conclusion**

10.4.50 The construction and operation of the sewerage works will not cause any insurmountable impacts. Monitoring and preventative measures have been recommended. Adverse impact is not anticipated if the measures are being implemented properly.

# 11. LANDSCAPE & VISUAL IMPACT

## 11.1 Introduction

11.1.1 This section assesses the potential landscape and visual impacts arising from the proposed construction and upgrading of the sewage collection, treatment and disposal facilities, together with the mitigation measures proposed to alleviate the impacts.

11.1.2 This assessment has based on the criteria and guidelines stated in Annexes 10 and 18 of the EIAO-TM and EIAO Guidance Note No. 8/2010 for evaluating and assessing landscape and visual impacts and has covered the scope outlined in Section 3.4.8 of the EIA Study Brief.

## 11.2 Project Summary

11.2.1 The proposed works under the Project comprises the following items and as shown in Layout Plan of **Figure 2.1**:

(a) Upgrading of the existing Cheung Chau Sewage Treatment Works (STW) to secondary treatment level with design capacity of 9,800 $m^3$/day ;

(b) Upgrading of the existing Pak She Sewage Pumping Station (SPS) by increasing the pumping capacity of 42,336 $m^3$/d (490 L/s);

(c) Sewers works in Cheung Chau including upgrading/rehabilitation of the existing sewers at Cheung Chau and provision of new sewers to unsewered areas/villages including Tai Kwai Wan San Tsuen, Pak She San Tsuen, Nam She Tong, Fa Peng, Chi Ma Hang, Round Table Villages, Tai Shek Hau and Sin Yan Tseng, Tai Tsoi Yuen Kui, Ko Shan Tsuen and Lung Tsai Tsuen.

11.2.2 Under Part I, Schedule 2 of the EIAO, the Project consists of the following designated projects:

(a) Upgrading of the existing Cheung Chau STW – under Item F.2 which is *Sewage Treatment Works with an installed capacity of more than 5,000 $m^3$/d and a boundary less than 200m from the boundary of a residential area* **(item 11.2.1(a))**;

(b) Upgrading of the existing Pak She SPS - under Item F.3 which is *Sewage Pumping Station with an installed capacity of more than 2,000 $m^3$/d and a boundary less than 150m from the boundary of a residential area* **(item 11.2.1(b))**; and

(c) Upgrading of the existing Cheung Chau STW – under Item F.4 which includes *an activity for the reuse of treated sewage effluent from a treatment plant* **(item 11.2.1(a))**.

11.2.3 The proposed works at Cheung Chau and proposed general layout plan of the Cheung Chau STW are shown in **Figure 2.1** and **Figure 2.2**.

### Sewers Works

11.2.4 The proposed sewers works will be laid underground along the existing carriageway, footpaths and paved tracks. The construction works will be carried out section by section in a local area with a short period of time, in order to reduce the disturbance to the surrounding areas and nearby residents. The works area will be reinstated to its original conditions. Landscape and visual impact during construction and operation stage of the sewers is considered to be negligible.

**Sewage Pumping Station**

11.2.5 The proposed upgrading of the existing Pak She SPS will include replacement of pumps with higher pumping capacity and other E&M equipment, diversion of existing emergency bypass away from typhoon shelter and minor modification of existing pump troughs. All the works will be either constructed within the existing superstructure of Pak She SPS or would be reinstated to its original conditions. Landscape and visual impact during construction and operation stage is therefore considered to be negligible.

11.2.6 As discussed in **Section 2 - Project Description**, an alternative scheme with construction of a section of deep gravity sewer has been proposed. As such, the proposal of construction of Kwun Yam Wan SPS will no longer exist, landscape and visual impact arising from the SPS at the adjacent Kwun Yam Beach will be avoided.

**Sewage Treatment Works**

11.2.7 The proposed upgrading of the Cheung Chau STW will take place within the boundary of the existing Cheung Chau STW. Landscape and visual impact during construction and operation stage will be assessed in the following sections.

## 11.3 Review of Planning and Development Control Framework

11.3.1 A review of the existing and planned development framework for the proposed works and their surroundings has been considered, in order to identify any issues within the neighbouring planned land uses, and therefore to identify potential sensitive receivers, and to ensure a high compatibility between the proposed project and the surroundings.

11.3.2 According to approved Cheung Chau Outline Zoning Plan No. S/I-CC/5, the existing Cheung Chau STW is located in the area zoned as “Other Specified Uses (Sewage Treatment Works)”. Zones with “Government, Institution or Community (G/IC)”, Residential (Group A) (R(A))”, “Green Belt (GB)”, “Costal Protection Area (CPA)”, “Open Space (O)”, “Village Type Development (V)”, and “Other Specified Uses (OU)” are found within the assessment area.

11.3.3 The Cheung Chau STW is located in a zone which is intended to be designated land for sewage treatment works. According to the Schedule of Uses of the relevant OZP, any new development, or addition, alteration and/or modification to or redevelopment of an existing building shall be with a maximum building height of 2 storeys (10m), or the height of the existing building, whichever is the greater. Planning application to the Town Planning Board under section 16 of the Town Planning Ordinance may be required if the proposed STW cannot fulfil the specified requirements.

11.3.4 According to the Notes of the relevant OZP, the proposed sewerage works shall be always permitted. Thus no conflict to the relevant planning and development control framework.

## 11.4 Relevant Legislations, Standards & Guidelines

11.4.1 The following Environmental Legislation and Standards are considered:

- Approved Cheung Chau Outline Zoning Plan (OZP) No. S/I-CC/5 and the Town Planning Ordinance;
- EIAO, Annexes 10 and 18 of EIAO Technical Memorandum and EIAO Guidance Note No. 8/2010 – Preparation of Landscape and Visual Impact Assessment under the Environmental Impact Assessment Ordinance;

- The Forests and Countryside Ordinance (Cap 96)
- The Forestry Regulations – made under Section 3 of The Forests and Countryside Ordinance (Cap 96), and Government General Regulation 740;
- ETWB TCW No. 3/2006 - Tree Preservation;
- ETWB TCW No. 5/2005 - Protection of natural streams/rivers from adverse impacts arising from construction works;
- ETWB TCW No. 29/2004 - Registration of Old and Valuable Trees, and Guidelines for their Preservation;
- ETWB TCW No. 14/2004 - Maintenance of Stormwater Drainage Systems and Natural Watercourses;
- ETWB TCW No. 2/2004 - Maintenance of Vegetation and Hard Landscape Features;
- ETWB TCW No. 7/2002 - Tree Planting in Public Works;
- DSD Technical Circular No. 9/2006 - Vetting Committee on Aesthetic Design of Pumping Station Buildings, and Guidelines on Aesthetic Design of Pumping Station Buildings; and
- Hong Kong Planning Standards and Guidelines, Chapter 4 - Recreation, Open Space & Greening, and Chapter 10 – Conservation.

## 11.5 Landscape and Visual Impact Assessment Methodology

11.5.1 The landscape and visual impacts are assessed separately for the construction phase and operation phase. The methodologies to assess landscape and visual impacts are described in the following sections.

### Methodology of Assessment of Landscape Impacts

11.5.2 The assessment of landscape impacts involves the following procedures:

- Identification of Baseline Landscape Resource (LR) and Landscape Character Area (LCA): A desktop research study on aerial photos and topographical maps, followed by site visit and photo-taking, is conducted to identify the baseline LR and LCA found within the study boundary, which is within 500m from the proposed site as presented in **Figure 11.1**.

11.5.3 Landscape Resource (LR) considered including: natural and secondary woodland; amenity planting; scrubland and grassland; natural topography; significant planning designation, e.g. Country Park or Green Belt; and heritage or cultural features.

11.5.4 Physical components related to the visual amenity, cultural association and heritage value of the Landscape Character Area (LCA) are considered, elements including: land use; public use of land; extent of vegetation; age of landscape; cultural, heritage and religious elements; scale and type of buildings; pattern of settlement; location and topography; and extent of natural compare to man-made.

- Assessment of “Sensitivity” of LR and LCA: The “Sensitivity” of LR and LCA is assessed based on the factors including (i) whether the resource is common or rare; (ii) whether it is considered to be of local, regional, national or global importance; (iii) whether there are any statutory or regulatory limitations/requirements relating to the resource; (iv) the quality of the resource; (v) the maturity of the resource, and (vi) the ability of the resource to accommodate changes. The sensitivity of LR and LCA is rated as high, medium or low:
  - High - Important components of landscape of particularly distinctive character susceptible to relatively small changes.

  - Medium - A landscape of moderately valued characteristics reasonably tolerant of change.
  - Low - A relatively unimportant landscape, the nature of which is largely tolerant to change.
- Assessment of "Magnitude of Change" for landscape impacts: The "Magnitude of Change" is assessed based on the factors including (i) the physical extent of impact; (ii) the landscape context of impact and (iii) the timescale of impact. The magnitude of change is rated as large, intermediate, small and negligible:
  - Large – Notable permanent change in the landscape characteristics over an extensive area ranging to very intensive changes over a more limited area.
  - Intermediate – Moderate change in a localised area.
  - Small – Virtually imperceptible change or temporary change.
  - Negligible – Virtually no change in the area.

11.5.5 Assessment of "Impact Significance Threshold before Mitigation" for landscape impacts: The degree of significance of the landscape impacts is determined based on the "Sensitivity" and "Magnitude of Change" for various LR and LCA, as shown in **Table 11.1**. The degree of significance is divided into four thresholds:

- Substantial – Adverse or beneficial and reversible or irreversible impact where the proposal would cause significant deterioration or improvement in existing landscape quality.
- Moderate – Adverse or beneficial and reversible or irreversible impact where the proposal would cause noticeable deterioration or improvement in existing landscape quality.
- Sight – Adverse or beneficial and reversible or irreversible impact where the proposal would cause a barely perceptible deterioration or improvement in existing landscape quality.
- Insubstantial – No discernible change in the existing landscape quality.

**Table 11.1 : Matrix for Impact Significance Threshold before Mitigation**

| Magnitude of Change | Sensitivity | | |
|---|---|---|---|
| | High | Medium | Low |
| Large | Substantial | Substantial / Moderate | Moderate / Slight |
| Intermediate | Substantial / Moderate | Moderate | Moderate / Slight |
| Small | Moderate / Slight | Moderate / Slight | Slight / Insubstantial |
| Negligible | Insubstantial | Insubstantial | Insubstantial |

11.5.6 Identification of Potential Mitigation Measures: The potential measures to be implemented during the construction and operation phases are proposed in order to minimize unavoidable adverse impacts and/or to generate beneficial long-term impacts.

11.5.7 Identification of "Residual Impact Significance Threshold after Mitigation" for landscape impacts: The accumulative influence to LR and LCA after full implementation of the proposed mitigation measures is reviewed.

**Methodology of Assessment of Visual Impacts**

11.5.8 The assessment of visual impacts involves the following procedures:

11.5.9 Identification of zone of visual influence/visual envelope and visually sensitive receivers groups (VSRs): Visual envelop is the viewshed formed by natural/man-made features such as ridgeline or building blocks. The VSRs are those within the visual envelope whose views will be affected by the proposed works. **Figure 11.3** presents the extent of the visual envelop and the identified VSRs**.**

11.5.10 Assessment of "Sensitivity" of VSRs: The "Sensitivity" of VSRs is assessed based on the factors including (i) value and quality of existing views; (ii) availability and amenity of alternative views; (iii) type and estimated number of receiver population; (iv) duration or frequency of view; and (v) degree of visibility.

11.5.11 The sensitivity of VSRs is rated as high, medium or low:

- High – The VSR is highly sensitive to any change in their viewing experience.
- Medium – The VSR is moderately sensitive to any change in their viewing experience.
- Low – The VSR is only slightly sensitive to any change in their viewing experience.

11.5.12 Assessment of "Magnitude of Change" for visual impacts: The "Magnitude of Change" is assessed based on the factors including (i) compatibility of the proposed project with the surrounding landscape; (ii) duration of impacts during construction and operation stages; (iii) scale of impact and distance of the source of impact from the viewer; (iv) reversibility of impact; and (v) potential blockage of the view. The magnitude of change is rated as large, intermediate, small and negligible:

- Large – The VSR would suffer a major change in their viewing experience.
- Intermediate – The VSR would suffer a moderate change in their viewing experience.
- Small – The VSR would suffer a small change in their viewing experience.
- Negligible – The VSR would suffer no discernible change in their viewing experience.

11.5.13 Assessment of "Impact Significance Threshold before Mitigation" for visual impacts: The degree of significance of the visual impacts is determined based on the "Sensitivity" and "Magnitude of Change" for the VSRs, as shown in **Table 11.1**. The degree of significance is divided into four thresholds:

- Substantial – Adverse or beneficial and reversible or irreversible impact where the proposal would cause significant deterioration or improvement in existing visual quality.
- Moderate – Adverse or beneficial and reversible or irreversible impact where the proposal would cause noticeable deterioration or improvement in existing visual quality.
- Sight – Adverse or beneficial and reversible or irreversible impact where the proposal would cause a barely perceptible deterioration or improvement in existing visual quality.
- Insubstantial – No discernible change in the existing visual quality.

11.5.14 Identification of Potential Mitigation Measures: The potential measures to be implemented during the construction and operation phases are proposed in order to minimize unavoidable adverse impacts and/or to generate beneficial long-term

impacts. The responsible agencies for the funding, implementation, management and maintenance of the mitigation measures have been identified.

11.5.15 Identification of "Residual Impact Significance Threshold after Mitigation" for visual impacts: The accumulative influence to VSRs after full implementation of the proposed mitigation measures is reviewed.

## 11.6 Existing Landscape and Visual Baseline

### Landscape Baseline – Landscape Resources (LR)

11.6.1 Existing Landscape Resource (LR) are identified within the study boundary, which is within 500m from the proposed site. The locations of the LRs are shown in **Figure 11.1** and are summarized in **Table 11.2**. Photographic records of LRs are shown in **Figure 11.4** to **11.6**.

11.6.2 During the Ecological Baseline Survey conducted in May - August 2011, no rare or protected plant species and no species of conservation interest was found. Only one tree listed in the Registered Old and Valuable Trees is found at Pak Tai Temple Sitting-out Area (LCSD Is/4), which is located within the 500m Study Area but far away from the proposed Cheung Chau STW upgrading works. Existing trees conditions and tree schedule for the trees at the development site (i.e. Cheung Chau STW) have been extracted from the Tree Survey Report under "Agreement No. CE31/2007(DS) Upgrading of Cheung Chau and Tai O Sewage Collection, Treatment and Disposal Facilities – Investigation" and appended in **Appendix 11.1**.

11.6.3 Sensitivity of LRs with relatively more important landscape character including coast, and marine (i.e. LR4, LR5) are considered as "High". Sensitivity of LRs of landscaping nature including vegetation, shrubland, young woodland, vegetated slopes and residential area with plants/vegetations in common species (i.e. LR2, LR3, LR6) are considered as "Medium". Since it is identified in the Tree Survey that an existing tree (T822) within LR1 is with over 1 criteria of Old and Valuable Trees requirements under ETWB Technical Circular 29/2004, the sensitive of LR1 is rated as high. The summary of sensitivity of each LRs is presented in **Table 11.2**.

**Table 11.2 : Description of Identified Landscape Resource (LR)**

| ID | Landscape Feature | Dominant Tree Species | Sensitivity |
|---|---|---|---|
| LR1 | Vegetation within existing Cheung Chau STW | There are currently 18 nos. of existing trees in overall height from 2.5m to 8m, trunk diameter from 90mm to 1,100mm and average crown spread from 2.5m to 13m. They are mainly Ficus elastic, Ficus microcarpa, Macaranga tanarius and Psidium guajava, which are common species. Existing tree T822 (Ficus microcarpa) with trunk diameter of 1,100mm satisfies at least one of the Old and Valuable Trees requirements under ETWB Technical Circular 29/2004. | High |
| LR2 | Shrubland | Patches of shrubland were found bordering the young woodland as a temporary stage in the natural succession towards the latter. These shrublands have a moderate level of structural complexity and were mainly covered by native species with an average height ranging from 1.5 to 3 m. The understorey species were highly variable, from ferns (e.g. Cyclosorus parasiticus and Lygodium japonicum), herbs (e.g. Wedelia trilobata, Rhynchelytrum repens, Peperomia pellucidal and Dactyloctenium aegyptium) to climbers (e.g. Cassytha filiformis, Cocculus orbiculatus and Morinda umbellata), whilst woody climbers (e.g. Desmos chinensis), shrubs (e.g. Ilex asprella, Psychotria asiatica, Phyllanthus cochinchinensis and Sageretia thea) and small scattered trees (e.g. Rhus succedanea and Sterculia lanceolata) formed the canopy. | Medium |
| LR3 | Young Woodland | Large patches of young woodland, where a total of 100 plant species were recorded, is dominated by native trees including Mallotus paniculatus, Microcos paniculata and Sterculia lanceolata. They are estimated to be an age of 15 to 20 years, with an average canopy height of 4m to 10m. | Medium |
| LR4 | Coast | Common coastal plant species such as Clerodendrum inerme, Pandanus tectorius and Portulaca sp., and some landscaping trees, including Erythrina speciosa and Terminalia catappa, were found planted along the periphery where the coastal area meets the inland developed area. Coastal rock/boulders were also found. | High |
| LR5 | Marine | Seawater body and waterfront character such as breakwaters at the west of the island. | High |
| LR6 | Vegetated Slope and Vegetation within Residential Development | Vegetated slope with planted trees and shrubs in close proximity of the residential buildings of Cheung Kwai Estate and along Cheung Kwai Road. | Medium |

### Landscape Baseline – Landscape Character Area (LCA)

11.6.4 Existing Landscape Character Area (LCA) are identified within the study boundary, which is within 500m from the proposed site. The locations of the LCAs are shown in **Figure 11.2** and are summarized in **Table 11.3**. Photographic records of LCAs are shown in **Figure 11.4** to **11.6**.

11.6.5 Sensitivity of LCAs with relatively more important landscape character including natural coastal area and marine (i.e. LCA8, LCA9) are considered as “High”. Sensitivity of LCAs of landscaping nature and natural character including shrubland, hillside, medium-rise residential and village with plants/vegetations in common species (i.e. LCA2, LCA4, LCA5, LCA6) are considered as “Medium”. Other LCAs

with relatively unimportant landscape character and the nature of which is largely tolerant to change, including institutional, transportation corridor, industrial and artificial coastal area (i.e. LCA1, LCA3, LCA7, LCA10) are considered as "Low". The sensitivity of each LCAs is presented in **Table 11.3**.

**Table 11.3 : Description of Identified Landscape Character Area (LCA)**

| ID | Landscape Character Area | Description | Sensitivity |
|---|---|---|---|
| LCA1 | Institutional | Government institutions and public utilities such as Cheung Chau STW, Cheung Chau Slaughter House, Pak She SPS, Cheung Chau Fire Station and Cheung Chau North Sub-station. Common plant species were found in the open spaces, private and public gardens. | Low |
| LCA2 | Shrubland | Shrubland at the south of Cheung Chau STW. | Medium |
| LCA3 | Transportation Corridor | Footpath and paved access road such as Cheung Kwai Road, Pai Chong Road, Ping Chong Road, Pak She Praya Road etc. | Low |
| LCA4 | Medium-rise Residential | Medium-rise residential zone with commercial and retail uses as well as public open space, such as Cheung Kwai Estate. Vegetation includes amenity planting alongside carriageways and footpath. | Medium |
| LCA5 | Village | Village areas including Tai Kwai Wan San Tsuen, Siu Kwai Wan, Pak She San Tsuen, along Pak She Street and Pak She Praya Road. They consist typically grouped village houses, separated by narrow footpaths at hillside/upland. At the periphery of the villages there are sitting areas, and sometimes scattered vegetation, woodland or shrubs, which typically consists of scattered mature trees, e.g. Acacia confusa, Murraya paniculata, Macaranga tanarius and Casuarina equisetifolia. Pak Tai Temple is also located within the village area. | Medium |
| LCA6 | Hillside | They are mainly hillside plantation area, which located around the village areas of Tai Kwai Wan San Tsuen and Pak She San Tsuen. They are essentially natural areas comprising of wooded and grassland slopes. The uplands form scenic backdrop surrounding the village areas and are important visual resources. | Medium |
| LCA7 | Industrial | Industrial zone along Pai Chong Road and Ping Chong Road, which are mainly shipyard, ice factory and open storage area. | Low |
| LCA8 | Marine | Seawater body and waterfront character such as breakwaters at the west of the island. | High |
| LCA9 | Natural Coastal Area | Natural coastal area along Cheung Kwai Road. | High |
| LCA10 | Artificial Coastal Area | Artificial coastal area adjacent to Cheung Chau STW. | Low |

### Visual Baseline

11.6.6 Five VSRs are identified within the visual envelop as presented in **Figures 11.3** to **11.6** with description as below:

***VSR1 - Cheung Kwai Road***

11.6.7 These VSRs comprise mainly transient passers including residents living in the northern part of Cheung Chau, including Cheung Kwai Estate, Tai Kwai Wan San

Tsuen and Scenic Garden, and occasional travellers from elsewhere. The views of Cheung Chau STW from Cheung Kwai Road are occasionally blocked by trees in particular at the northern part of the Cheung Kwai Road. These VSRs are easily distracted by the sea view along the beach which is considered of high amenity value, the sensitivity of these VSRs is considered to be Medium.

***VSR2 - Cheung Kwai Estate***

11.6.8 Cheung Kwai Estate is located at hillside, with approximately 12m above the Cheung Chau STW. Due to the level difference resulted from the sloped topography and the screening of the existing vegetation, the expanded Cheung Chau STW would not likely to block the views from VSR2. These VSRs are also easily distracted by the sea view which is considered of high amenity value, the sensitivity of these VSRs is considered to be Medium.

***VSR3 - Adamasta Channel***

11.6.9 Residents/travellers/visitors travelling to Cheung Chau by ferry will be able to see the Cheung Chau STW from a far distance. The duration of view is considered short and these VSRs can have alternative views on other features of the Cheung Chau Island. The sensitivity of these VSRs is considered to be Medium.

***VSR4 - Shrine***

11.6.10 A shrine is found located near the intersection of Pak Kok Tsui Road and Cheung Kwai Road, which is set in a wooded area beside a small boulder and close to the edge of the road. The shrine is probably worshipped by the villagers of Cheung Kwai Estate, and the number of worshiper is expected to be small. The worshipper may experience glimpses through the gaps between heavily planted trees. While worshiping, the worshipers normally stand in front of the shine where the Cheung Chau STW would be at the back of these VSRs. The sensitivity of these VSRs is considered to be Low.

***VSR5 – Beach adjacent to Siu Kwai Wan***

11.6.11 These VSRs could have a clear view of the Cheung Chau STW. Alternative sea views along the beach (which is not a gazetted beach) and on the northern side of the Cheung Chau Island are available. Since the degree of visibility of the Cheung Chau STW to these VSRs is high, the sensitivity of these VSRs is considered to be High.

11.6.12 **Table 11.4** summarizes the identified VSRs and their sensitivity to change.

**Table 11.4: Assessment of Sensitivity of identified VSRs**

| VSR | Value and quality of existing views | Availability and amenity of alternative views | Type and estimated number of receiver population | Duration or frequency of view | Degree of visibility | Sensitivity (Low, Medium, High) |
|---|---|---|---|---|---|---|
| VSR1 | Low quality of view along the existing Cheung Chau STW with little visual mitigation measures | High amenity sea view and tree view available | Many | Short term views that change as the VSR moves along the path | Medium | Medium |
| VSR2 | Low quality of view along the existing Cheung Chau STW with little visual mitigation measures | High amenity sea view and tree view available | Many | Long term views | Medium | Medium |
| VSR3 | Low quality of view of the existing Cheung Chau STW with little visual mitigation measures | High availability of alternative views along Cheung Chau coastal | Many | Very short term views as the VSR moves around the area by ferry | Medium | Medium |

| VSR | Value and quality of existing views | Availability and amenity of alternative views | Type and estimated number of receiver population | Duration or frequency of view | Degree of visibility | Sensitivity (Low, Medium, High) |
|---|---|---|---|---|---|---|
| VSR4 | Medium quality of view of the existing Cheung Chau STW with heavy trees screenings | Medium alternative views on the adjacent trees and the Shrine | Very Few | Short term views that change as the VSR moves around the area | Low | Low |
| VSR5 | Medium quality of view across the existing Cheung Chau STW with less structures that enable views to the mountains behind | High amenity sea view and coastal view available | Few | Medium term views | High | High |

## 11.7 Landscape and Visual Impact Assessment

### Landscape Impacts - Construction Phase

11.7.1 The potential sources of landscape impacts in the construction phase include:

- Removal of existing vegetation and tree transplanting;
- Construction of site access;
- Demolition of existing treatment units;
- Excavation and construction of the new treatment units and plant rooms;
- Temporary stockpiling of excavated materials and construction materials; and
- Temporary storage of construction plants and equipment.

11.7.2 The upgrading of the Cheung Chau STW will take place within the boundary of the existing Cheung Chau STW. There would be impact on the vegetation within the existing STW (LR1 and LCA1) due to the construction works as listed out in **Section 11.7.1** within the construction period (approximately 4.5 years). As the treatment plants will be arranged to minimize disturbance to existing trees, e.g. treatment units designed to be outside the spread of existing tree T822, the magnitude of change on topography and landform as a landscape resource for LR1 and LCA1 during construction is considered to be “Intermediate”.

11.7.3 The proposed STW works would have no direct impact on all other landscape resources and landscape character areas located outside of the existing STW site, on the consideration that the construction works will be confined within the existing boundary of STW, and of temporary nature. Therefore, the magnitude of change for LR2 to LR6 and LCA2 to LCA10 during construction is considered to be “Negligible”.

### Landscape Impacts - Operation Phase

11.7.4 The potential sources of landscape impact during the operation phase would be related to the following visible above-ground structures:

- Existing administration building;
- Existing sludge dewatering house;
- New preliminary treatment units, odour control room and pump house;
- Plant room above MBR tanks;
- New sludge digesters, sludge holding tanks and air blower room; and
- New transformer room, switch room and standby generator room.

11.7.5 During operation, the magnitude of impact to the vegetation within the STW (i.e. LR1) is considered as small. As the upgrading of the STW would be operated within the existing STW site, which the treatment facilities are already exist, no direct impact would be expected on all other landscape resources and landscape character areas located outside of the existing STW site. Therefore the magnitude of impact to all the LRs and LCAs other than the existing site (i.e. LR2 to LR6 and LCA1 to LCA10) during operation is considered to be “Negligible”.

11.7.6 The sensitivity, the magnitude of change before mitigation, impact significant threshold before mitigation, recommended mitigation measures and residual impact significance threshold after mitigation (Day 1 and Year 10) for the LRs and LCAs on landscape impacts are shown in **Table 11.5**.

**Table 11.5: Significance of the Landscape Impacts in the Construction and Operation Phases**

| Landscape Resources / Landscape Character Areas | | Sensitivity (Low, Medium or High) | Magnitude of Change before Mitigation (Negligible, Small, Intermediate or Large) | | Impact Significance Threshold before Mitigation (Insubstantial, Slight, Moderate or Substantial) (3) | | Recommended Mitigation Measures(1) | Residual Impact Significance Threshold after Mitigation (Insubstantial, Slight, Moderate or Substantial)(2,3) | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | Construction | Operation | Construction | Operation | | Construction | Operation (Day 1) | Operation (Year 10) |
| LR1 | Vegetation within existing CCSTW | High | Intermediate | Small | Moderate | Moderate | CM-2, CM-3, OM-1, OM-2 | Slight | Insubstantial *(beneficial as there will be more trees than existing)* | Insubstantial *(beneficial as there will be more trees than existing)* |
| LR2 | Shrubland | Medium | Negligible | Negligible | Insubstantial | Insubstantial | N/A | N/A | N/A | N/A |
| LR3 | Young Woodland | Medium | Negligible | Negligible | Insubstantial | Insubstantial | N/A | N/A | N/A | N/A |
| LR4 | Coast | High | Negligible | Negligible | Insubstantial | Insubstantial | N/A | N/A | N/A | N/A |
| LR5 | Marine | High | Negligible | Negligible | Insubstantial | Insubstantial | N/A | N/A | N/A | N/A |
| LR6 | Vegetated Slope and Vegetation within Residential Development | Medium | Negligible | Negligible | Insubstantial | Insubstantial | N/A | N/A | N/A | N/A |
| LCA1 | Institutional | Low | Intermediate | Negligible | Moderate | Insubstantial | CM-2, CM-3, OM-1, OM-2 | Slight | N/A | N/A |
| LCA2 | Shrubland | Medium | Negligible | Negligible | Insubstantial | Insubstantial | N/A | N/A | N/A | N/A |
| LCA3 | Transportation Corridor | Low | Negligible | Negligible | Insubstantial | Insubstantial | N/A | N/A | N/A | N/A |

| Landscape Resources / Landscape Character Areas | | Sensitivity (Low, Medium or High) | Magnitude of Change before Mitigation (Negligible, Small, Intermediate or Large) | | Impact Significance Threshold before Mitigation (Insubstantial, Slight, Moderate or Substantial) (3) | | Recommended Mitigation Measures(1) | Residual Impact Significance Threshold after Mitigation (Insubstantial, Slight, Moderate or Substantial)(2,3) | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | Construction | Operation | Construction | Operation | | Construction | Operation (Day 1) | Operation (Year 10) |
| LCA4 | Medium-rise Residential | Medium | Negligible | Negligible | Insubstantial | Insubstantial | N/A | N/A | N/A | N/A |
| LCA5 | Village | Medium | Negligible | Negligible | Insubstantial | Insubstantial | N/A | N/A | N/A | N/A |
| LCA6 | Hillside | Medium | Negligible | Negligible | Insubstantial | Insubstantial | N/A | N/A | N/A | N/A |
| LCA7 | Industrial | Low | Negligible | Negligible | Insubstantial | Insubstantial | N/A | N/A | N/A | N/A |
| LCA8 | Marine | High | Negligible | Negligible | Insubstantial | Insubstantial | N/A | N/A | N/A | N/A |
| LCA9 | Natural Coastal Area | High | Negligible | Negligible | Insubstantial | Insubstantial | N/A | N/A | N/A | N/A |
| LCA10 | Artificial Coastal Area | Low | Negligible | Negligible | Insubstantial | Insubstantial | N/A | N/A | N/A | N/A |

Notes:
(1) Recommendation on landscape and visual mitigation measures are described in Section 11.8.
(2) Residual impacts are discussed in Section 11.9.
(3) All impacts are adverse and irreversible unless otherwise stated.

**Visual Impacts**

11.7.7 The visual impacts to the VSRs during construction and operation phases of the Cheung Chau STW are generally due to the sources as described in **Section 11.7.1** and **11.7.4**.

11.7.8 The magnitude of change for each of the VSRs is shown in **Table 11.6**.

11.7.9 Based on the "Sensitivity of VSRs" as listed in **Table 11.4** and "Magnitude of Change" as listed in **Table 11.6**, the impact significant threshold before mitigation, recommended mitigation measures and residual impact significance threshold after mitigation (Day 1 and Year 10) for the VSRs are shown in **Table 11.7**.

**Table 11.6: Magnitude of Change of VSRs in the Construction and Operation Phases**

| VSR | Compatibility of the proposed development with the surrounding landscape | Scale of the development | Reversibility of change | Viewing distance (m) | Potential blockage of view | Duration of Impact | | Magnitude of Change BEFORE Mitigation (Negligible, Small, Intermediate, Large) | |
|---|---|---|---|---|---|---|---|---|---|
| | | | | | | Construction | Operation | Construction | Operation |
| VSR1 | Low, the view of the site is generally open sea | Small, the development located within the existing Cheung Chau STW site | Irreversible | 25 - 600 | Slight blockage of view to the mountains behind | Temporary | Permanent | Small | Small |
| VSR2 | Low, the view of the site is generally open sea | Small, the development located within the existing Cheung Chau STW site | Irreversible | 50 - 250 | Negligible blockage of view due to the high level of the VSRs | Temporary | Permanent | Negligible | Negligible |
| VSR3 | Medium, the view of the site is generally coastal area with developments adjacent | Small, the development located within the existing Cheung Chau STW site | Irreversible | over 350 | Negligible blockage of view due to far distant viewing | Temporary | Permanent | Negligible | Negligible |
| VSR4 | Low, the view of the site is generally green landscape | Negligible, only minimal developments within the viewing angles | Irreversible | 20 | No blockage of view due to negligible developments from the view angle | Temporary | Permanent | Negligible | Negligible |
| VSR5 | Low, the view of the site is generally open sea | Small, the development located within the existing Cheung Chau STW site | Irreversible | 130 - 300 | Slight blockage of view to the mountains behind | Temporary | Permanent | Small | Small |

**Table 11.7: Significance of the Visual Impacts in the Construction and Operation Phases**

| Visual Sensitive Receivers | Sensitivity (Low, Medium, High) | Magnitude of Change before Mitigation (Negligible, Small, Intermediate, Large) | | Impact Significance Threshold before Mitigation (Insubstantial, Sight, Moderate, Substantial) | | Recommended Mitigation Measures(1) | Residual Impact Significance Threshold after Mitigation (Insubstantial, Sight, Moderate, Substantial)(2,3) | | |
|---|---|---|---|---|---|---|---|---|---|
| | | Construction | Operation | Construction | Operation | | Construction | Operation (Day 1) | Operation (Year 10) |
| VSR1 | Medium | Small | Small | Slight | Slight | CM-1, CM-4, CM-5, CM-6, OM-1, OM-2 | Slight | Slight | Slight |
| VSR2 | Medium | Negligible | Negligible | Insubstantial | Insubstantial | N/A | Insubstantial | Insubstantial | Insubstantial |
| VSR3 | Medium | Negligible | Negligible | Insubstantial | Insubstantial | N/A | Insubstantial | Insubstantial | Insubstantial |
| VSR4 | Low | Negligible | Negligible | Insubstantial | Insubstantial | N/A | Insubstantial | Insubstantial | Insubstantial |
| VSR5 | High | Small | Small | Moderate | Moderate | CM-1, CM-4, CM-5, CM-6, OM-1, OM-2 | Slight | Slight | Slight |

Notes:
(1) Recommendation on landscape and visual mitigation measures are described in Section 11.8.
(2) Residual impacts are discussed in Section 11.9.
(3) All impacts are adverse and irreversible unless otherwise stated.

## 11.8 Recommended Mitigation Measures

11.8.1 The proposed mitigation measure for landscape and visual impacts in both the construction and operation phases are listed in **Table 11.8** and **Table 11.9**, respectively. Implementation agents and management/maintenance agents of the proposed mitigation measures are also identified.

11.8.2 The mitigation measures during construction will be implemented from the commencement of the works and shall be applied for the entire duration of the construction period. The mitigation measures during operation will be constructed or built up during the construction stage. Management and maintenance for all mitigation measures will follow ETWB TCW No. 2/2004 Maintenance of Vegetation and Hard Landscape Features.

11.8.3 The existing trees would be preserved as far as possible. Existing trees conditions were recorded by the Tree Survey carried out under "Agreement No. CE 31/2007 (DS) Upgrading of Cheung Chau and Tai O Sewage Collection, Treatment and Disposal Facilities – Investigation" in March and April 2009. There are totally 18 nos. of existing trees in the site of Cheung Chau STW. During the course of preliminary design under the Project, effort had been made to adjust the location, layout and dimensions of treatment facilities in order to avoid affecting to the existing trees. With the updated proposed STW layout developed, 6 nos. of trees are in direct conflict with the proposed STW upgrading works, and are proposed to be transplanted within the area of the STW boundary or to be fell with compensatory planting. The other 12 nos. of trees will be retained. The tree conditions and tree schedule is shown in **Appendix 11.1**. Preliminary landscape design plan is shown in **Appendix 11.2** for reference. However, this preliminary landscape design plan may be subject to change during detailed design stage when updated tree survey data is obtained for the preparation of tree removal application. The technical feasibility of tree transplanting such as machinery, logistic, tree nursery etc. would also be further considered. As a general principle, compensatory planting would be implemented to fully compensate for the tree and vegetation loss if transplanting of trees is not feasible or not preferable. The total number of compensatory tree planted in the project area shall not be less than 1:1 ratios by new trees in terms of quality and quantity, i.e. the total numbers and the aggregated girth size of compensatory trees within the site and off-site should not be less than that of the tree(s) to be felled. The required numbers and locations of compensatory trees would be determined and agreed with Government during the tree removal application process under ETWB TCW 3/2006 - Tree Preservation.

**Table 11.8: Proposed Mitigation Measures during Construction Phase**

| Landscape and Visual Impact Mitigation Measures | | Implementation Agent | Management/ Maintenance Agent |
|---|---|---|---|
| CM-1 | Visual Screen/Hoarding<br>Decorative hoarding or boundary fence for construction sites shall be considered, and designed to be compatible to the surroundings. | Contractors | Contractors |

| | Landscape and Visual Impact Mitigation Measures | Implementation Agent | Management/ Maintenance Agent |
|---|---|---|---|
| CM-2 | Protection to Existing Trees within Works Areas<br><br>All existing trees which are not in direct conflict with the proposed works will be retained. The existing trees proposed to be retained shall be properly maintained and protected by means of fencing to prevent vehicular or pedestrian intrusion that may potentially damage tree canopies, trunks and root zones. Detailed tree protection specifications shall be allowed and included in the Contract Specification, which specifying the tree protection requirement, submission and approval system, and tree monitoring system. For trees with high preservation value, individual tree assessments and continuous tree monitoring reports shall be provided by a certified Arborist, Landscape Architect or related professional during construction. All retained trees shall be recorded photographically at the commencement of contract.<br><br>Root pruning to the retained trees should be prohibited. Retained trees should be well-preserved by setting up a tree protection zone throughout the construction period for protecting the retained trees from damages.<br><br>To maximize protection to existing trees and ground vegetation, construction contracts may designate “No-intrusion Zone” to various areas within the site boundary with rigid and durable fencing for each individual no-intrusion zone. The contractor should close monitor and restrict the site working staff not to enter the “no-intrusion zone”, even for non-direct construction activities and storage of equipment. | DSD and Contractors | DSD and Contractors |
| CM-3 | Tree Transplanting<br><br>Existing trees to be affected shall be directly transplanted to the proposed tree receiving sites, or to temporary tree nurseries alternatively. Temporary tree nurseries may be set up for the transplanted tree and proposed trees at an early stage to allow small trees to grow during the construction stage. By the time when planting area becomes available, trees have been mature and required minimal pruning and suffer much less damage during transplanting. The construction programme should also allow sufficient time for root pruning and root ball preparation prior to transplanting, if necessary, and transplanting operations to be carried out in planting season.<br><br>Tree pruning such as topping, lion tailing would be prohibited as far as possible. Also, frequent keep watering would be necessary for transplanting trees. The proposed tree preservation measures during construction would be carried out and approved by the competent persons. | Contractors | Contractors |

| Landscape and Visual Impact Mitigation Measures | | Implementation Agent | Management/ Maintenance Agent |
|---|---|---|---|
| CM-4 | Construction Light<br>Security floodlight for construction areas shall be controlled, such as equipped with adjustable shield, frosted diffusers and reflective covers, at night to avoid excessive glare to the nearby areas and residents. Other security measures shall also be considered to minimize the visual impacts by construction light. | Contractors | Contractors |
| CM-5 | Dust and Erosion Control for Exposed Soil<br>Excavation works and demolition of existing building blocks shall be well planned with precautions to suppress dust. Exposed soil shall be covered or watered often. Areas that are expected to be left with bare soul for a long period of time after excavation shall be properly covered with suitable protective fabric. Suitable drainage shall be provided around construction sites to avoid discharge of contaminants and sediments into sensitive water-based habitats. | Contractors | Contractors |
| CM-6 | Reinstatement of Works Areas<br>The affected works areas shall be properly reinstated to the satisfaction of relevant government departments. | Contractors | Contractors |

**Table 11.9: Proposed Mitigation Measures during Operation Phase**

| Landscape and Visual Impact Mitigation Measures | | Implementation Agent | Management/ Maintenance Agent |
|---|---|---|---|
| OM-1 | Architectural and Landscape Design<br>The appearance of the proposed structures shall be properly designed, including a careful selection of material, colour and texture, so as to fit into the existing suburban, natural to semi-natural surroundings. The aesthetic design of the proposed structures will follow the requirements in the Guidelines on Aesthetic Design of Pumping Station Buildings and submitted to Vetting Committee on Aesthetic Design of Pumping Station Buildings (VCAB) for approval in accordance with DSD TC No. 9/2006, and circulated to ASD for comment in accordance with ETWB TCW No. 8/2005. Sufficient planting shall be considered and provided around the boundary fence of the proposed buildings for screening. Buffer planting will also be considered during the detailed design. | DSD | DSD |

| Landscape and Visual Impact Mitigation Measures | | Implementation Agent | Management/ Maintenance Agent |
|---|---|---|---|
| OM-2 | Establishment Period<br>A 12-month establishment period for the soft landscape works shall be allowed in the main contract for contractor to carry out routine horticultural operations, including watering, pruning, weeding, pest control, replacement of dead plants etc. to ensure healthy establishment of new planting during a 12 month establishment period. This period can also serves as a kind of warranty/guarantee on the quality of the plants supplied and installed by the contractor. Monthly monitoring during the first year of establishment period is recommended. | DSD and Contractors | DSD and Contractors |

## 11.9 Residual Impacts

11.9.1 Before applying any mitigation measures, the landscape and visual impact during construction and operation to the identified LRs, LCAs and VSRs are generally ranged as “Insubstantial”, “Slight” and “Moderate” as shown in **Table 11.5** and **Table 11.7**.

11.9.2 Impact of “Slight” and “Moderate” is considered as non-ideal situations, and mitigation measures are recommended. The potential residual landscape and visual impacts during construction and operation after mitigation are also provided in **Table 11.5** and **Table 11.7**.

11.9.3 By introducing mitigation measures, the residual landscape and visual impact levels will be lowered down to “Slight” and “Insubstantial” during construction stage and operation stage.

11.9.4 Existing and planned setting in four stages (existing condition, proposed development without mitigation, proposed development with mitigation on Day 1 and proposed development with mitigation in Year 10) from VSR 1 to VSR 5 are shown in **Figure 11.7** to **Figure 11.11** respectively.

## 11.10 Conclusion

11.10.1 Landscape and visual impact assessment has been carried out for the proposed upgrading of the Cheung Chau STW to be carried out within the boundary of the existing Cheung Chau STW.

11.10.2 The proposed new and upgrading of sewers will mainly be laid underground along the existing carriageway, footpaths and paved tracks. The construction works will be carried out section by section in a local area with a short period of time, in order to reduce the disturbance to the surrounding areas and nearby residents. The works area will be reinstated to its original conditions. Landscape and visual impact during construction and operation stage of the sewers is considered to be negligible.

11.10.3 LRs, LCAs and VSRs are identified within the study area to assess the landscape and visual impacts arising from the proposed upgrading of the Cheung Chau STW. Impact significance and mitigation measures are recommended and discussed. After mitigation, residual landscape and visual impacts are considered to be “Slight” and “Insubstantial”. With reference to the criteria defined in Annex 10 of the EIAO-TM, landscape and visual impacts in the construction and operation phases arising from the proposed works will be considered as acceptable.

# 12. ENVIRONMENTAL MONITORING AND AUDIT REQUIREMENTS

## 12.1 Introduction

12.1.1 This section provides a summary of the requirements of the environmental monitoring and audit (EM&A) for the upgrading of the Cheung Chau STW and Pak She SPS (DP component) and the sewers works (non-DP component) based on the findings of this EIA study.

12.1.2 The objectives of conducting the EM&A programme for the Project are as follows:

- To provide a database against which any short or long-term environmental impacts of the Project can be determined;
- To provide an early indication should any of the environmental control measures or practices fail to achieve the acceptable standards;
- To monitor the performance of the Project and the effectiveness of mitigation measures;
- To verify the environmental impacts predicted in this EIA;
- To determine project compliance with regulatory requirements, standards and government policies;
- To take remedial action if unexpected problems or unacceptable impacts arise; and
- To provide data to enable an environmental audit.

12.1.3 The following section summarizes the recommended EM&A requirements for the Project. Details of the specific requirements for the upgrading of the Cheung Chau STW and Pak She SPS (DP component of the Project) and the sewers works (non-DP component of the Project) are provided in the EM&A Manual prepared in accordance with Annex 21 of the EIAO-TM.

## 12.2 Air Quality

### Construction Phase

12.2.1 The predicted TSP results show that exceedance of recommended TSP levels would occur if no mitigation measures are undertaken. Mitigation Measures are therefore needed to reduce the dust impact to an acceptable level. With the implementation of the dust suppression measures stipulated in the Air Pollution Control (Construction Dust) Regulation and good site practices, no adverse construction dust impacts would be expected. Nevertheless, it is recommended that environmental monitoring and audit (EM&A) for air quality be carried out during the construction period to ensure proper implementation of construction phase mitigation measures with consideration of practicability in local level.

12.2.2 Further details of the specific EM&A requirements of the Project are detailed in the EM&A Manual, together with event action plans and procedures for complaints.

### Operational Phase

12.2.3 All the odorous gas arising from the sewage would be collected and properly treated by deodorization unit with 99% odour removal efficiency for Cheung Chau STW and Pak She SPS. The predicted odour levels at the ASRs would comply with the EIAO-TM criterion. Odour monitoring and audit should be carried out during the commissioning stage to ensure the continuing effectiveness of the odour control measures. Details of monitoring and audit programme of odour due to the operation

of Cheung Chau STW and Pak She SPS are presented in the EM&A Manual. Commissioning test of the deodorization unit is also a mandatory requirement to confirm the effectiveness of the odour removal efficiency is in compliance with the design criteria.

## 12.3 Noise

### Construction Phase

12.3.1 With the adoption of appropriate noise mitigation measures, construction noise levels caused by construction works of the upgraded Cheung Chau STW and Pak She SPS at all representative NSRs would comply with the EIAO-TM daytime noise criteria of 75 dB(A). It was envisaged that there would be no adverse residual impact at the NSRs. Nonetheless, it is recommended that environmental monitoring and audit (EM&A) for construction noise be carried out throughout the construction period of the upgrading of Cheung Chau STW and Pak She SPS to ensure proper implementation of construction phase mitigation measures with consideration of practicability in local levels.

12.3.2 Residual impacts during the construction of the sewers works were predicted. As such, it is recommended that construction phase EM&A is also undertaken for the sewers works to minimize the impacts as far as practicable. It is noted that during the construction process, episodes of high noise levels may occur and it will be the function of the EM&A process to identify these events and take the necessary action such as, for example, temporarily adjustment of the number of plant to be used or an equivalent measure as necessary. Further details of the specific EM&A requirements are detailed in the EM&A Manual.

### Operational Phase

12.3.3 Operational noise impacts from fixed plant of the Cheung Chau STW and Pak She SPS can be effectively mitigated by implementing noise control treatment at source. Adverse operation noise impacts are not anticipated. EM&A during operational phase is not required. In order to ensure compliance of the operational airborne noise impacts with the relevant noise standards, the requirement for carrying out a noise commissioning test for all major fixed noise sources should be included in the tender document.

## 12.4 Water Quality

### Construction Phase

12.4.1 With effective controls through good operation and management practices, no adverse water quality impact is anticipated to occur during the construction phase of both the upgrading works for the Cheung Chau STW and Pak She SPS and the sewers works of the Project.

### Operational Phase

12.4.2 For the operational phase, water quality in the study area is expected to be in compliance with the WQOs under the normal operation of the upgraded Cheung Chau STW (Scenario 2) with the exception for TIN, based on the modelling and analysis results. Given that the background TIN level in the Southern WCZ is already higher the WQO for TIN, the upgraded Cheung Chau STW was not predicted to impose additional adverse impacts to water quality conditions of the receiving marine environment.

## 12.5 Waste Management

### Construction Phase

12.5.1 The assessment has concluded that proper handling, storage, collection, transportation and disposal of waste materials generated during construction and operation of the Project will not give rise to any significant impacts to nearby sensitive receivers.

12.5.2 It is recommended that during the construction phase, site inspections and supervisions of waste management procedures and auditing of the effectiveness of implemented mitigation measures should be undertaken on a regular basis (e.g. weekly as a minimum). These tasks shall be scheduled in the WMP to be prepared by the Contractor, and a summary of the site audit findings shall be presented in the EM&A reports.

### Operational Phase

12.5.3 No EM&A requirement is considered necessary during the operational phase.

## 12.6 Land Contamination

### Construction Phase

12.6.1 The land contamination assessment was undertaken by reviewing historical and current land uses and site reconnaissance. Based on the findings of the site appraisal, there were potential contaminated sites in the vicinity of the proposed upgrading works at the Pak She SPS. However, as there are no excavation works in the potential contaminated sites, no potential contaminated soils would be disturbed. The impacts of land contamination are not expected during the construction phase of the Project. There are no EM&A requirements for land contamination.

### Operational Phase

12.6.2 The operation of the Project is not potential contaminated land use. No operational contamination impacts are anticipated. There are no EM&A requirements for land contamination.

## 12.7 Ecology

### Construction Phase

12.7.1 Given the limited sizes of the works areas, the ecological value of the habitats affected by the works areas is limited, no specific ecological monitoring is required during construction phase.

### Operational Phase

12.7.2 No adverse ecological impacts would be expected as a result of the implementation of the Project during operational phase. Thus, no specific EM&A programme during the operational phase is required.

## 12.8 Fisheries

### Construction Phase

12.8.1 Since no unacceptable impact on fishing resources is identified, no specific fisheries EM&A programme would be required during the construction phase of the Project.

### Operational Phase

12.8.2 No adverse fisheries impacts would be expected as a result of the implementation of the Project during operational phase. Thus, no specific EM&A programme with respect to fisheries during the operational phase is required.

## 12.9 Cultural Heritage

### Built Heritage

12.9.1 No adverse impacts on any built heritage resources would be expected from the works of upgrading of Cheung Chau STW and Pak She SPS. No specific EM&A programme for the upgrading of Cheung Chau STW and Pak She SPS is required.

12.9.2 The construction of sewers works may have potential indirect impacts to the built heritage resources. Monitoring and preventive measures for the sewers works will be recommended as detailed in the EM&A Manual. The recommended measures are described as follow:

#### *Condition Survey*

12.9.3 The requirements for condition survey have been highlighted in **Sections 10.4.32** and **10.4.33**. A condition survey will be required for all highlighted Graded Historic Buildings and Non-Graded heritage structures as shown in **Table 10.3 and Table 10.4** respectively.

#### *Vibration Monitoring*

12.9.4 The requirements for vibration monitoring have been highlighted in **Section 10.4.34**. The condition survey report will confirm the Graded Historic Buildings and Non-Graded heritage structures that will require vibration monitoring during the construction works.

#### *Provision of Buffer Zone*

12.9.5 The requirements for provision of buffer zone have been highlighted in **Section 10.4.35**. Resources requiring buffer zone are shown in **Table 10.3** and **Table 10.4**.

#### *Protective Covering*

12.9.6 The requirements for protective covering have been highlighted in **Section 10.4.36**. Resources requiring protective covering are shown in **Table 10.3** and **Table 10.4**.

#### *Safe Public Access*

12.9.7 The requirements for safe public access have been highlighted in **Section 10.4.37**. Resources requiring safe public access are shown in **Table 10.3** and **Table 10.4**.

### Archaeology

12.9.8 No archaeological potential will be affected by the upgrading of Cheung Chau STW and Pak She SPS.

12.9.9 For the construction of sewers works, Archaeological Watching Brief programme and provision of buffer zone will be recommended as detailed in the EM&A Manual.

#### *Archaeological Watching Brief Programme*

12.9.10 Archaeological Watching Brief programme at Tai San Street, Tai San Back Street, Chung Hing Street and Chung Hing Back Street, Ko Shan Tsuen and Tung Wan

Road. Archaeological Watching Brief should be undertaken by a qualified archaeologist, who must apply for a licence under the Antiquities and Monuments Ordinance (Cap. 53) from the Antiquity Authority before the commencement of archaeological fieldwork.

12.9.11 Should significant findings be identified, additional archaeological resources should be provided in the form of additional or extended visits to ensure that appropriate recording and retrieval is accomplished prior to the continuation of engineering groundworks. Upon discovery of any artefact or archaeological feature in the course of other excavation works during the construction stage, the AMO will be notified immediately for site inspection, on site discussion with the AMO will be arranged to agree on further actions required.

***Provision of Buffer Zone***

12.9.12 A buffer zone should be provided to ensure that the declared monument and its environs are not infringed upon during the construction works. In order to better protect the Rock Carving and its environs a buffer zone is required which includes Hak Pai Road and the nearby open space. Within the buffer zone, construction works as well as storage of construction materials are not allowed. Erection of temporary fencing/barriers to demarcate the buffer zone is not required. In addition, access to the rock carving should be maintained and directional signage should be erected or installed at appropriate location(s) near the rock carving to facilitate visitors to access the rock carving during the construction phase.

12.9.13 In addition, periodic monitoring of the declared monument is recommended. It is recommended to conduct inspection of the site every 3 months during the construction phase. Inspection record supplemented with the site photos showing the condition of the overall declared monument should be submitted to AMO for record purposes.

**Operational Phase**

12.9.14 No adverse impacts on any cultural heritage resources would be expected as a result of the implementation of the Project during operational phase. Thus, no specific EM&A programme with respect to cultural heritage during the operational phase is required.

## 12.10 Landscape and Visual

**Construction Phase**

12.10.1 During the construction phase of the Project, some of the existing trees and vegetation would be disturbed. A number of on-site landscape mitigation measures are recommended to minimise the potential landscape and visual impacts. With the implementation of the recommended mitigation measures, the landscape and visual impacts are considered to be negligible.

12.10.2 Regular audits should be carried out to ensure all the recommended landscape and visual mitigation measures would be effectively implemented and audited by the Environment Team during construction phases of the Project. The EM&A will comprise audit of the tree transplanting, compensatory planting and planting establishment through site audit programme.

**Operational Phase**

12.10.3 Operational stage EM&A during the operational phase will comprise audit of the implementation of the landscape plan in the form of site inspection.

# 13. IMPLEMENTATION SCHEDULE OF MITIGATION MEASURES

## 13.1 Introduction

13.1.1 The implementation schedules for the recommended mitigation measures for each environmental aspect covered in this EIA are given in as appropriate.

**Table 13.1 : Implementation Schedule of Recommended Mitigation Measures - Air Quality**

| EIA Ref. | Recommended Environmental Protection Measures/ Mitigation Measures | Objectives of the recommended measures & main concerns to address | Who to implement the measures? | Location / Timing of implementation of Measures | | | What requirements or standards for the measures to achieve? |
|---|---|---|---|---|---|---|---|
| | | | | D | C | O | |
| **Construction Phase (Upgrading Works of Cheung Chau STW and Pak She SPS (DP Component))** | | | | | | | |
| S.3.5.5 | Appropriate dust control measures should be implemented during the construction stage in accordance with the requirements in the Air Pollution Control (Construction Dust) Regulation. Dust control techniques should be considered to control dust to a level not exceeding the AQOs as well as the 1-hour TSP guideline level of 500 µg/m³. These measures include, but are not limited to, the following:<br>• Adoption of good site practices;<br>• Avoid practices likely to raise dust level;<br>• Frequent cleaning and damping down of stockpiles and dusty areas of the site;<br>• Covering the exposed areas with tarpaulin;<br>• Reducing drop height during material handling;<br>• Provision of wheel-washing facilities for site vehicles leaving the site;<br>• Regular plant maintenance to minimize exhaust emission; and<br>• Sweep up dust and debris at the end of each shift. | Air Quality (fugitive dust) Control during Construction Phase | Contractors | | √ | | Annex 4 and Annex 12 of EIAO -TM, Air Pollution Control (Construction Dust) Regulation |
| S.3.10.1 | All the dust control measures as recommended in the Air Pollution Control (Construction Dust) Regulation, where applicable, should be implemented. Typical dust control measures include: | Air Quality (fugitive dust) Control during Construction Phase | Contractors | | √ | | Annex 4 and Annex 12 of EIAO -TM, Air Pollution Control (Construction Dust) Regulation |

| EIA Ref. | Recommended Environmental Protection Measures/ Mitigation Measures | Objectives of the recommended measures & main concerns to address | Who to implement the measures? | Location / Timing of implementation of Measures | | | What requirements or standards for the measures to achieve? |
|---|---|---|---|---|---|---|---|
| | | | | D | C | O | |
| S.3.10.1 | Watering every 1.5 hours on active works areas and paved haul roads to reduce dust emissions by 90.9% (e.g. watering intensity at 0.5 litres/$m^2$. Actual application shall depend on the site condition and weather conditions). | Air Quality (fugitive dust) Control during Construction Phase | Contractors | | √ | | EIA, Annex 4 and Annex 12 of EIAO -TM, Air Pollution Control (Construction Dust) Regulation |
| S.3.10.1 | Watering every hour on unpaved areas and stockpiles of dusty materials (if no tarpaulin is provided) to reduce dust emissions by 90% (e.g. watering intensity at 1.5 litre/$m^2$ during the first hour, subsequent application at 0.2 litre/$m^2$. Actual application shall depend on the site condition and weather conditions). | Air Quality (fugitive dust) Control during Construction Phase | Contractors | | √ | | EIA, Annex 4 and Annex 12 of EIAO -TM, Air Pollution Control (Construction Dust) Regulation |
| S.3.10.1 | Use of regular watering, with complete coverage, to reduce dust emissions from exposed site surfaces and unpaved roads, particularly during dry weather | Air Quality (fugitive dust) Control during Construction Phase | Contractors | | √ | | Annex 4 and Annex 12 of EIAO -TM, Air Pollution Control (Construction Dust) Regulation |
| S.3.10.1 | Use of frequent watering for particularly dusty construction areas and areas close to ASRs | Air Quality (fugitive dust) Control during Construction Phase | Contractors | | √ | | Annex 4 and Annex 12 of EIAO -TM, Air Pollution Control (Construction Dust) Regulation |
| S.3.10.1 | Vehicle washing facilities should be provided at every vehicle exit point | Air Quality (fugitive dust) Control during Construction Phase | Contractors | | √ | | Annex 4 and Annex 12 of EIAO -TM, Air Pollution Control (Construction Dust) Regulation |

| EIA Ref. | Recommended Environmental Protection Measures/ Mitigation Measures | Objectives of the recommended measures & main concerns to address | Who to implement the measures? | Location / Timing of implementation of Measures | | | What requirements or standards for the measures to achieve? |
|---|---|---|---|---|---|---|---|
| | | | | D | C | O | |
| S.3.10.1 | Where a site boundary adjoins a road, streets or other areas accessible to the public, hoarding of not less than 2.4 m high from ground level should be provided along the entire length except for a site entrance or exit | Air Quality (fugitive dust) Control during Construction Phase | Contractors | | √ | | Annex 4 and Annex 12 of EIAO -TM, Air Pollution Control (Construction Dust) Regulation |
| S.3.10.1 | Stockpiles of imported material kept on site shall be contained within hoarding, dampened and/or covered during dry and windy weather | Air Quality (fugitive dust) Control during Construction Phase | Contractors | | √ | | Annex 4 and Annex 12 of EIAO -TM, Air Pollution Control (Construction Dust) Regulation |
| S.3.10.1 | Material stockpiled alongside trenches should be covered with tarpaulins | Air Quality (fugitive dust) Control during Construction Phase | Contractors | | √ | | Annex 4 and Annex 12 of EIAO -TM, Air Pollution Control (Construction Dust) Regulation |
| S.3.10.1 | Open stockpiles shall be avoided or covered. Where possible, prevent placing dusty material storage piles near ASRs | Air Quality (fugitive dust) Control during Construction Phase | Contractors | | √ | | Annex 4 and Annex 12 of EIAO -TM, Air Pollution Control (Construction Dust) Regulation |
| S.3.10.1 | Any excavated or stockpile of dusty material should be covered entirely by impervious sheeting or spayed with water to maintain the entire surface wet during the non-working hours | Air Quality (fugitive dust) Control during Construction Phase | Contractors | | √ | | Annex 4 and Annex 12 of EIAO -TM, Air Pollution Control (Construction Dust) Regulation |

| EIA Ref. | Recommended Environmental Protection Measures/ Mitigation Measures | Objectives of the recommended measures & main concerns to address | Who to implement the measures? | Location / Timing of implementation of Measures | | | What requirements or standards for the measures to achieve? |
|---|---|---|---|---|---|---|---|
| | | | | D | C | O | |
| S.3.10.1 | All dusty materials shall be sprayed with water prior to any loading, unloading or transfer operation so as to keep the dusty materials wet | Air Quality (fugitive dust) Control during Construction Phase | Contractors | | √ | | Annex 4 and Annex 12 of EIAO -TM, Air Pollution Control (Construction Dust) Regulation |
| S.3.10.1 | Water sprays shall be used during the delivery and handling of sands aggregates and the like | Air Quality (fugitive dust) Control during Construction Phase | Contractors | | √ | | Annex 4 and Annex 12 of EIAO -TM, Air Pollution Control (Construction Dust) Regulation |
| S.3.10.1 | All demolished items that may emit dust particles should be covered entirely by impervious sheeting or placed in an area sheltered on the top and the 3 sides within a day of demolition | Air Quality (fugitive dust) Control during Construction Phase | Contractors | | √ | | Annex 4 and Annex 12 of EIAO -TM, Air Pollution Control (Construction Dust) Regulation |

| EIA Ref. | Recommended Environmental Protection Measures/ Mitigation Measures | Objectives of the recommended measures & main concerns to address | Who to implement the measures? | Location / Timing of implementation of Measures | | | What requirements or standards for the measures to achieve? |
|---|---|---|---|---|---|---|---|
| | | | | D | C | O | |
| S.3.10.1 | Good site practices for concrete batching plant<br>Every stock of more than 20 bags of cement or dry pulverized fuel ash(PFA) should be cover entirely by impervious sheeting or placed in an area sheltered on the top and the sides.<br>Cement or dry PFA delivered in bulk should stored in a closed silo fitted with an audible high level alarm which is interlocked with the material filling line and no overfilling is allowed.<br>Loading, unloading, transfer, handling or storage of bulk cement or dry PFA should be carried out in a totally enclosed system or facility, and any vent or exhaust should be fitted with effective fabric filter or equivalent air pollution control system (Maximum TSP emission factor of Silos and Mising Tower: 50mg/$m^3$) | Air Quality (fugitive dust) Control during Construction Phase | Contractors | | √ | | Annex 4 and Annex 12 of EIAO -TM, Air Pollution Control (Construction Dust) Regulation<br>Best Practical Means for Cement Works (Concrete Batching Plant) BPM 3/2(93) |

| EIA Ref. | Recommended Environmental Protection Measures/ Mitigation Measures | Objectives of the recommended measures & main concerns to address | Who to implement the measures? | Location / Timing of implementation of Measures | | | What requirements or standards for the measures to achieve? |
|---|---|---|---|---|---|---|---|
| | | | | D | C | O | |
| **Construction Phase (Sewers Works (non-DP Component))** | | | | | | | |
| S.3.5.8 | Appropriate dust control measures should be implemented during the construction stage in accordance with the requirements in the Air Pollution Control (Construction Dust) Regulation. Dust control techniques should be considered to control dust to a level not exceeding the AQOs as well as the 1-hour TSP guideline level of 500 µg/m³. These measures include, but are not limited to, the following:<br>• Adoption of good site practices;<br>• Avoid practices likely to raise dust level;<br>• Frequent cleaning and damping down of stockpiles and dusty areas of the site;<br>• Covering the exposed areas with tarpaulin;<br>• Reducing drop height during material handling;<br>• Regular plant maintenance to minimize exhaust emission; and<br>• Sweep up dust and debris at the end of each shift. | Air Quality (fugitive dust) Control during Construction Phase | Contractors | | √ | | EIA, Air Pollution Control (Construction Dust) Regulation |
| S.3.10.1 | All the dust control measures as recommended in the Air Pollution Control (Construction Dust) Regulation, where applicable, should be implemented. Typical dust control measures include: | Air Quality (fugitive dust) Control during Construction Phase | Contractors | | √ | | EIA, Air Pollution Control (Construction Dust) Regulation |
| S.3.10.1 | Use of regular watering, with complete coverage, to reduce dust emissions from exposed site surfaces and unpaved roads, particularly during dry weather | Air Quality (fugitive dust) Control during Construction Phase | Contractors | | √ | | EIA, Air Pollution Control (Construction Dust) Regulation |

| EIA Ref. | Recommended Environmental Protection Measures/ Mitigation Measures | Objectives of the recommended measures & main concerns to address | Who to implement the measures? | Location / Timing of implementation of Measures | | | What requirements or standards for the measures to achieve? |
|---|---|---|---|---|---|---|---|
| | | | | D | C | O | |
| S.3.10.1 | Use of frequent watering for particularly dusty construction areas and areas close to ASRs | Air Quality (fugitive dust) Control during Construction Phase | Contractors | | √ | | EIA, Air Pollution Control (Construction Dust) Regulation |
| S.3.10.1 | Stockpiles of imported material kept on site shall be contained within hoarding, dampened and/or covered during dry and windy weather | Air Quality (fugitive dust) Control during Construction Phase | Contractors | | √ | | EIA, Air Pollution Control (Construction Dust) Regulation |
| S.3.10.1 | Material stockpiled alongside trenches should be covered with tarpaulins | Air Quality (fugitive dust) Control during Construction Phase | Contractors | | √ | | EIA, Air Pollution Control (Construction Dust) Regulation |
| S.3.10.1 | Open stockpiles shall be avoided or covered. Where possible, prevent placing dusty material storage piles near ASRs | Air Quality (fugitive dust) Control during Construction Phase | Contractors | | √ | | EIA, Air Pollution Control (Construction Dust) Regulation |
| S.3.10.1 | Any excavated or stockpile of dusty material should be covered entirely by impervious sheeting or spayed with water to maintain the entire surface wet during the non-working hours | Air Quality (fugitive dust) Control during Construction Phase | Contractors | | √ | | EIA, Air Pollution Control (Construction Dust) Regulation |
| S.3.10.1 | All dusty materials shall be sprayed with water prior to any loading, unloading or transfer operation so as to keep the dusty materials wet | Air Quality (fugitive dust) Control during Construction Phase | Contractors | | √ | | EIA, Air Pollution Control (Construction Dust) Regulation |
| S.3.10.1 | Water sprays shall be used during the delivery and handling of sands aggregates and the like | Air Quality (fugitive dust) Control during Construction Phase | Contractors | | √ | | EIA, Air Pollution Control (Construction Dust) Regulation |
| **Operational Phase (Upgrading Works of Cheung Chau STW and Pak She SPS (DP Component))** | | | | | | | |

| EIA Ref. | Recommended Environmental Protection Measures/ Mitigation Measures | Objectives of the recommended measures & main concerns to address | Who to implement the measures? | Location / Timing of implementation of Measures | | | What requirements or standards for the measures to achieve? |
|---|---|---|---|---|---|---|---|
| | | | | D | C | O | |
| S.3.10.2 | The design of enclosing the odour sources of the upgraded Cheung Chau STW and Pak She SPS and the installation of deodorization units would readily reduce the potential odour impacts. Adverse odour impact from the upgraded Cheung Chau STW and Pak She SPS is not anticipated. The current design information of deodourizing units is summarized in **Table 3.13 of EIA** | Odour control during operation phase | DSD and Contractors | √ | √ | √ | EIA |
| S.3.10.3 | In addition, good housekeeping practices listed below should be followed to control odour emissions from the plant and these standard practices should be included in the plant operator manual:<br>• Screens should be cleaned regularly to remove accumulated organic debris;<br>• Grit and screening transfer systems should be flushed regularly with water to remove organic debris and grit;<br>• Grit and screened materials should be transferred to closed containers to minimize odour escape;<br>• Sludge should be frequently withdrawn from tanks to prevent the production of gases;<br>• Sludge should be transferred to closed containers; and<br>• Sludge containers should be flushed with water regularly | Odour Control during Operation Phase | DSD and Contractors | √ | √ | √ | EIA |

**Table 13.2 : Implementation Schedule of Recommended Mitigation Measures – Noise**

| EIA Ref. | Recommended Environmental Protection Measures / Mitigation Measures | Objectives of the recommended measures & main concerns to address | Who to implement the measures? | Location / Timing of implementation of Measures | What requirements or standards for the measures to achieve? |
|---|---|---|---|---|---|
| **Construction Phase (Upgrading Works of Cheung Chau STW and Pak She SPS (DP Component))** | | | | | |
| S.4.4.12 | Only well-maintained plant should be operated on-site and plant should be serviced regularly during the construction works. | Noise control during construction | Contractors | At all construction areas of the site during the entire construction period | EIA, Contractual requirements |
| S.4.4.12 | Machines and plant that may be in intermittent use should be shut down between work periods or should be throttled down to a minimum. | Noise control during construction | Contractors | At all construction areas of the site during the entire construction period | EIA, Contractual requirements |
| S.4.4.12 | Plant known to emit noise strongly in one direction should, where possible, be orientated to direct noise away from the NSRs. | Noise control during construction | Contractors | At all construction areas of the site during the entire construction period | EIA, Contractual requirements |
| S.4.4.12 | Mobile plant should be sited as far away from NSRs as possible. | Noise control during construction | Contractors | At all construction areas of the site during the entire construction period | EIA, Contractual requirements |
| S.4.4.12 | Material stockpiles and other structures should be effectively utilized, where practicable, to screen noise from on-site construction activities. | Noise control during construction | Contractors | At all construction areas of the site during the entire construction period | EIA, Contractual requirements |

| EIA Ref. | Recommended Environmental Protection Measures / Mitigation Measures | Objectives of the recommended measures & main concerns to address | Who to implement the measures? | Location / Timing of implementation of Measures | What requirements or standards for the measures to achieve? |
|---|---|---|---|---|---|
| S.4.4.13 | Use of quiet plant (PME):<br>• Generator<br>• Poker, vibratory, hand-held<br>• Breaker, excavator mounted (hydraulic)<br>• Excavator<br>• Tracked Mobile Crane<br>• Vibratory Compactor<br>• Dumper<br>• Air compressor<br>• Concrete Pump<br>• Pilling Rig | Noise control during construction | Contractors | At all construction areas of the site during the entire construction period | EIA, Contractual requirements |
| S.4.4.14 | Temporary site hoardings of 2.4 m high are recommended for the works at the Pak She SPS. The hoardings will be erected along the works boundary facing the NSRs. The PME involved in the works would be screened by the erected site hoardings. Without direct line of sight from the affected NSRs, a noise reduction of 10 dB(A) could be achieved provided that the hoardings have no openings or gaps and have a surface mass of at least 7 kg/m$^2$. Nonetheless, a -5 dB(A) screening correction for site hoardings has been applied as a more conservative approach. | Noise control during construction | Contractors | At Pak She SPS during the entire construction period | EIA |
| S.4.4.23 | For NSRs which would be affected by more than one Works Types, good scheduling works is recommended to minimize the cumulative construction noise impacts due to different Works Types. | Noise control during construction | Contractors | Construction areas near the specified locations during the construction period | EIA, Contractual requirements |

| EIA Ref. | Recommended Environmental Protection Measures / Mitigation Measures | Objectives of the recommended measures & main concerns to address | Who to implement the measures? | Location / Timing of implementation of Measures | What requirements or standards for the measures to achieve? |
|---|---|---|---|---|---|
| S.4.4.29 | In order to prevent potential cumulative construction noise impacts to NSRs, the works at Tai Kwai Wan San Tsuen are recommended to be scheduled to avoid concurrent works at the areas near Tai Kwai Wan of the Improvement of Fresh Water Supply to Cheung Chau project. | Noise control during construction | DSD and Contractors | Construction areas near the specified locations during the construction period | EIA, Contractual requirements |
| S.4.4.30 | The contractor shall liaise with "Replacement and Rehabilitation of Water Mains Stage 4, Mains on Hong Kong and Islands – Investigation, Design and Construction"" contractors so as to avoid undertaking works concurrently with the works when they are in the close proximity as far as practicable. | Noise control during construction | DSD and Contractors | Construction areas near the specified locations during the construction period | EIA, Contractual requirements |
| S.4.4.31 | The contractor shall liaise with Improvement to Existing Roads and Drains in Cheung Chau Old Town, Remaining Engineering Works Stage 3 works contractors so as to avoid undertaking works concurrently with the works when they are in the close proximity as far as practicable. | Noise control during construction | DSD and Contractors | Construction areas near the specified locations during the construction period | EIA, Contractual requirements |
| **Construction Phase (Sewers Works (non-DP Component))** | | | | | |
| S.4.4.18 | Quieter equipment shall be adopted as far as possible. | Noise control during construction | Contractors | At all construction areas of the site during the entire construction period | EIA, Contractual requirements |

| EIA Ref. | Recommended Environmental Protection Measures / Mitigation Measures | Objectives of the recommended measures & main concerns to address | Who to implement the measures? | Location / Timing of implementation of Measures | What requirements or standards for the measures to achieve? |
|---|---|---|---|---|---|
| S.4.4.20 | Noise barrier in the form of site hoarding shall be used for the following PMEs where practicable:<br>• Backhoe (mini)<br>• Breaker, hand-held, mass>10Kg and <20Kg<br>• Generator<br>• Poker, vibratory hand-held<br>• Bar Bender and cutter (electric)<br>• Vibratory compactor<br>• Breaker, excavator mounted (hydraulic)<br>• Pilling, Rig<br>• Hoist (electric)<br>• Excavator<br>• Dumper<br>• Submersible Pump<br>• Rock Drill, hand-held (pneumatic)<br>• Air Compressor<br>• Ventilation Fan<br>• Grout Mixer<br>• Grout Pump<br>• Winch (electric)<br>• Grinder, hand held (electric) | Noise control during construction | Contractors | At all construction areas of the site close to identified NSRs during the entire construction period | EIA, Contractual requirements |
| S.4.4.20 | The barrier / enclosure material's surface mass shall be in excess of 7kg/$m^2$. | Noise control during construction | Contractors | At all construction areas of the site during the entire construction period | EIA, Contractual requirements |
| S.4.4.23 | Good scheduling of works is recommended to further mitigate the potential construction noise impacts. | Noise control during construction | Contractors | At all construction areas of the site during the entire construction period | EIA, Contractual requirements |

| EIA Ref. | Recommended Environmental Protection Measures / Mitigation Measures | Objectives of the recommended measures & main concerns to address | Who to implement the measures? | Location / Timing of implementation of Measures | What requirements or standards for the measures to achieve? |
|---|---|---|---|---|---|
| S.4.4.12 | Only well-maintained plant should be operated on-site and plant should be serviced regularly during the construction works. | Noise control during construction | Contractors | At all construction areas of the site during the entire construction period | EIA, Contractual requirements |
| S.4.4.12 | Machines and plant that may be in intermittent use should be shut down between work periods or should be throttled down to a minimum. | Noise control during construction | Contractors | At all construction areas of the site during the entire construction period | EIA, Contractual requirements |
| S.4.4.12 | Plant known to emit noise strongly in one direction should, where possible, be orientated to direct noise away from the NSRs. | Noise control during construction | Contractors | At all construction areas of the site during the entire construction period | EIA, Contractual requirements |
| S.4.4.12 | Mobile plant should be sited as far away from NSRs as possible. | Noise control during construction | Contractors | At all construction areas of the site during the entire construction period | EIA, Contractual requirements |
| S.4.4.12 | Material stockpiles and other structures should be effectively utilized, where practicable, to screen noise from on-site construction activities. | Noise control during construction | Contractors | At all construction areas of the site during the entire construction period | EIA, Contractual requirements |
| S.4.4.23 | For NSRs which would be affected by more than one Works Types, good scheduling works is recommended to minimize the cumulative construction noise impacts due to different Works Types. | Noise control during construction | Contractors | Construction areas near the specified locations during the construction period | EIA, Contractual requirements |

| EIA Ref. | Recommended Environmental Protection Measures / Mitigation Measures | Objectives of the recommended measures & main concerns to address | Who to implement the measures? | Location / Timing of implementation of Measures | What requirements or standards for the measures to achieve? |
|---|---|---|---|---|---|
| S.4.4.25 | The Contractor shall liaise with the schools that are located near the works sites regarding their examination period and schedule the noisy works to avoid the examination period as far as possible. | Noise control during construction | Contractors | At construction areas near schools during the entire construction period | Annex 5 and Annex 13 of EIAO-TM |
| S.4.4.27 | For the soil excavation works, the contractor shall avoid the use of PME as far as possible and adopting hand digging method to reduce the noise impacts if the site condition is allowed. | Noise control during construction | Contractors | At construction areas of constructing sewer (open cut method) and upgrading of existing sewer during the entire construction period. | EIA, Contractual requirements |
| S.4.4.29 | In order to prevent potential cumulative construction noise impacts to NSRs, the works at Tai Kwai Wan San Tsuen are recommended to be scheduled to avoid concurrent works at the areas near Tai Kwai Wan of the Improvement of Fresh Water Supply to Cheung Chau project. | Noise control during construction | DSD and Contractors | Construction areas near the specified locations during the construction period | EIA, Contractual requirements |
| S.4.4.30 | The contractor shall liaise with “Replacement and Rehabilitation of Water Mains Stage 4, Mains on Hong Kong and Islands – Investigation, Design and Construction”” contractors so as to avoid undertaking works concurrently with the works when they are in the close proximity as far as practicable. | Noise control during construction | DSD and Contractors | Construction areas near the specified locations during the construction period | EIA, Contractual requirements |

| EIA Ref. | Recommended Environmental Protection Measures / Mitigation Measures | Objectives of the recommended measures & main concerns to address | Who to implement the measures? | Location / Timing of implementation of Measures | What requirements or standards for the measures to achieve? |
|---|---|---|---|---|---|
| S.4.4.31 | The contractor shall liaise with Improvement to Existing Roads and Drains in Cheung Chau Old Town, Remaining Engineering Works Stage 3 works contractors so as to avoid undertaking works concurrently with the works when they are in the close proximity as far as practicable. | Noise control during construction | DSD and Contractors | Construction areas near the specified locations during the construction period | EIA, Contractual requirements |
| **Operational Phase (Upgrading Works of Cheung Chau STW and Pak She SPS (DP Component))** | | | | | |
| S.4.5.6<br>S.4.5.7<br>S.4.5.8 | All the noisy pumps, mechanically raked fine screen, deodourization fans and blowers are to be enclosed in building structures. Acoustic louvers are to be implemented to all exhausted fans. | Noise Control | DSD | Cheung Chau STW | Annex 5 of EIAO-TM, NCO; Good Practices on Ventilation Systems Noise Control; Good Practices on Pumping Systems Noise Control |

| EIA Ref. | Recommended Environmental Protection Measures / Mitigation Measures | Objectives of the recommended measures & main concerns to address | Who to implement the measures? | Location / Timing of implementation of Measures | What requirements or standards for the measures to achieve? |
|---|---|---|---|---|---|
| S.4.5.8 | The recommended mitigation measures for the operation of SPS and STW and the proposed noise reduction are listed below:<br><br>*Pak She Sewage Pumping Station*<br><br>• Submersible pump – enclosed inside SPS building structure(-20 dB(A))<br>• Mechanically raked fine screen – enclosed inside SPS building structure(-20 dB(A))<br>• Deodourization fan – enclosed inside SPS building structure(-20 dB(A))<br><br>*Cheung Chau Sewage Treatment Works*<br><br>• Submersible pump – enclosed inside treatment unit building structure (-20 dB(A))<br>• Mechanically raked fine screen – enclosed inside STW building structure (-20 dB(A))<br>• Deodourization fan – enclosed inside STW building structure (-20 dB(A))<br>• Exhaust fan – provide acoustic louver at discharge point(-10 dB(A))<br>• Blower – enclosed inside STW building structure (-20 dB(A))<br>• Mechanical pump – enclosed inside STW building structure (-20 dB(A)) | Noise Control | DSD | Cheung Chau STW | EIA |

**Table 13.3 : Implementation Schedule of Recommended Mitigation Measures - Water Quality**

| EIA Ref. | Recommended Environmental Protection Measures/ Mitigation Measures | Objectives of the recommended measures & main concerns to address | Who to implement the measures? | When to implement the measures? | | | What requirements or standards for the measures to achieve? |
|---|---|---|---|---|---|---|---|
| | | | | D | C | O | |
| **Construction Phase (Upgrading Works of Cheung Chau STW and Pak She SPS (DP Component) and Sewers Works (non-DP Component))** | | | | | | | |
| S.5.7.1 | Practices outlined in ProPECC PN 1/94 Construction Site Drainage are recommended, as highlighted below:<br>• Perimeter channels are to be installed in works areas to intercept runoff at the site boundary prior to the commencement of any earthworks. Surface runoff should be discharged into storm drains via sand/ silt removal facilities with an adequate capacity;<br>• Works programme should be designed to minimize works areas to reduce soil exposure and site runoff;<br>• Silt removal facilities, channels and manholes should be maintained and cleaned regularly to ensure their proper functions;<br>• Works programme should be carefully planned to minimize the scale of soil excavation during the rainy season;<br>• Earthworks surfaces should be well compacted and subsequent permanent works or surface protection measures should be carried out immediately;<br>• All vehicles should be washed before they leave the construction site to avoid earth, mud, and debris being carried off from the site. Wash-water should be treated to remove sand and silt at least on a weekly basis to ensure the continued efficiency of the washing facility; | Water Quality Control | Contractors | | √ | | • WPCO;<br>• TM –Effluent Standards for Effluents Discharged into Drainage and Sewerage Systems, Inland and Coastal Water |

| EIA Ref. | Recommended Environmental Protection Measures/ Mitigation Measures | Objectives of the recommended measures & main concerns to address | Who to implement the measures? | When to implement the measures? | | | What requirements or standards for the measures to achieve? |
|---|---|---|---|---|---|---|---|
| | | | | D | C | O | |
| (cont…) | • Open stockpiles of construction materials on site should be covered with tarpaulin or similar fabric materials during storms;<br>• For sections of pipes that need to be laid underneath water courses with the open cut method, site works should be carried out during the dry season with a temporary drainage diversion; and;<br>• Any construction works along Hak Pai Road immediately by the Kwun Yam beach and Cheung Chau Tung Wan beach should be avoided during the swimming season. | Water Quality Control | Contractors | | √ | | • WPCO;<br>• TM –Effluent Standards for Effluents Discharged into Drainage and Sewerage Systems, Inland and Coastal Water |
| S.5.7.2 and S.5.7.3 | Mitigations Measures for General Construction Activities:<br>• Good site practices should be adopted to regularly clean the construction sites to avoid rubbish, debris and litter from entering to nearby water bodies; and<br>• Good construction and site management practices should be implemented to ensure that litter, fuels, and solvents would not enter the public drainage systems. | Water Quality Control | Contractors | | √ | | • WPCO;<br>• TM –Effluent Standards for Effluents Discharged into Drainage and Sewerage Systems, Inland and Coastal Water |

| EIA Ref. | Recommended Environmental Protection Measures/ Mitigation Measures | Objectives of the recommended measures & main concerns to address | Who to implement the measures? | When to implement the measures? | | | What requirements or standards for the measures to achieve? |
|---|---|---|---|---|---|---|---|
| | | | | D | C | O | |
| S.5.7.4 | Domestic sewage generated by workforce would be collected and discharged to the STW for proper treatment. Portable toilets should be provided by the Contractor, where necessary, to handle sewage from the workforce. The Contractor should also be responsible for waste disposal. | Water Quality Control | Contractors | | √ | | • WPCO;<br>• TM –Effluent Standards for Effluents Discharged into Drainage and Sewerage Systems, Inland and Coastal Water |
| S.5.7.5 and S.5.7.6 | Mitigations Measures for Spillage of Chemicals:<br>• Registration to EPD as a Chemical Waste Producer if chemical wastes are generated and need to be disposed of;<br>• Illegal disposal of chemicals should be strictly prohibited; and<br>• Oils and fuels should only be used and stored in the designated area which has polluting prevention facilities. | Water Quality Control | Contractors | | √ | | • WPCO;<br>• TM –Effluent Standards for Effluents Discharged into Drainage and Sewerage Systems, Inland and Coastal Water |

| EIA Ref. | Recommended Environmental Protection Measures/ Mitigation Measures | Objectives of the recommended measures & main concerns to address | Who to implement the measures? | When to implement the measures? | | | What requirements or standards for the measures to achieve? |
|---|---|---|---|---|---|---|---|
| | | | | D | C | O | |
| **Operational Phase (Upgrading Works of Cheung Chau STW and Pak She SPS (DP Component))** | | | | | | | |
| S.5.7.7 | The STW operator should maintain a good line of communication with various parties involved in an emergency discharge event. | Water Quality Control | DSD | | | √ | • WPCO;<br>• TM –Effluent Standards for Effluents Discharged into Drainage and Sewerage Systems, Inland and Coastal Water |
| S.5.7.8 | • Standby facilities for the main treatment units and standby pumps, accessories/ equipment parts should be provided.<br>• Storm Tanks would also be incorporated to provide temporary storage of flow under extremely high flow conditions.<br>• Dual power supply or standby power sources should also be provided for Cheung Chau STW. | Water Quality Control | DSD | √ | | | • WPCO;<br>• TM –Effluent Standards for Effluents Discharged into Drainage and Sewerage Systems, Inland and Coastal Water |

| EIA Ref. | Recommended Environmental Protection Measures/ Mitigation Measures | Objectives of the recommended measures & main concerns to address | Who to implement the measures? | When to implement the measures? | | | What requirements or standards for the measures to achieve? |
|---|---|---|---|---|---|---|---|
| | | | | D | C | O | |
| S.5.7.9 | • A contingency plan should be developed to deal with the occurrence of an emergency discharge during the operation of the STW. | Water Quality Control | Contractors | | | √ | • WPCO;<br>• TM –Effluent Standards for Effluents Discharged into Drainage and Sewerage Systems, Inland and Coastal Water |
| S.5.7.10 | • Standby pump and backup power supply should be provided for Pak She SPS and will continue to be provided after the upgrading to cater for breakdown and maintenance of duty pumps to reduce the chance of occurrence of sewage bypass;<br>• A backup power supply would be provided to secure electrical power supply; and<br>• Regular maintenance and checking of equipment should be carried out to prevent equipment failure. | Water Quality Control | DSD | | | √ | • WPCO;<br>• TM –Effluent Standards for Effluents Discharged into Drainage and Sewerage Systems, Inland and Coastal Water |

| EIA Ref. | Recommended Environmental Protection Measures/ Mitigation Measures | Objectives of the recommended measures & main concerns to address | Who to implement the measures? | When to implement the measures? | | | What requirements or standards for the measures to achieve? |
|---|---|---|---|---|---|---|---|
| | | | | D | C | O | |
| S.5.7.11 | A contingency plan should be developed to deal with the emergency discharges the contingency plan should include the following:<br>• Locations of the sensitive receivers in vicinity of the emergency discharge;<br>• A list of relevant governmental bodies to inform of and to ask for assistance in the event of an emergency discharge, including key contact persons and telephone numbers;<br>• Reporting procedures required in the event of an emergency discharge;<br>• Responsibility and procedure for clean-up of the affected water body/sensitive receivers after the emergency discharge; and<br>• Procedures listing the most effective means in rectifying the breakdown of the pumping station to minimize the discharge duration. | Water Quality Control | DSD | | | √ | • WPCO;<br>• TM –Effluent Standards for Effluents Discharged into Drainage and Sewerage Systems, Inland and Coastal Water |

**Table 13.4 : Implementation Schedule of Recommended Mitigation Measures - Waste Management Implication**

| EIA Ref. | Recommended Environmental Protection Measures/ Mitigation Measures | Objectives of the recommended measures & main concerns to address | Who to implement the measures? | When to implement the measures? | | | What requirements or standards for the measures to achieve? |
|---|---|---|---|---|---|---|---|
| | | | | D | C | O | |
| **Construction Phase (Upgrading Works of Cheung Chau STW and Pak She SPS (DP Component) and Sewers Works (non-DP Component))** | | | | | | | |
| S.6.6.1 | The Contractor shall prepare a Waste Management Plan in accordance with the requirements set out in the ETWB TCW No. 19/2005, Waste Management on Construction Site, for the ER's approval. The WMP shall include monthly and yearly Waste Flow Tables that indicate the amounts of waste generated, recycled and disposed of (including final disposal site). | Waste management during construction | Contractors | | √ | | ETWB TCW No. 19/2005, Waste Management on Construction Sites |
| S.6.6.1 | The Contractor's waste management practices and effectiveness shall be audited by the Engineer's Representative on regular basis. | Waste management during construction | DSD | | √ | | Waste Disposal Ordinance |
| S.6.6.1 | The Contractor shall provide training for site staff concept of site cleanliness and appropriate waste management procedures, including waste reduction, reuse and recycling. | Waste management during construction | Contractors | | √ | | Waste Disposal Ordinance |
| S.6.6.1 | Sufficient waste disposal points and regular collection of waste shall be provided. | Waste management during construction | Contractors | | √ | | Waste Disposal Ordinance |
| S.6.6.1 | Trucks with covering for the open-box bed and enclosed container shall be used to minimise windblown litter and dust during transportation of waste. | Waste management during construction | Contractors | | √ | | Waste Disposal Ordinance |
| S.6.6.1 | Regular cleaning and maintenance programme for drainage systems, pumps and oil interceptors. | Waste management during construction | Contractors | | √ | | Waste Disposal Ordinance |

| EIA Ref. | Recommended Environmental Protection Measures/ Mitigation Measures | Objectives of the recommended measures & main concerns to address | Who to implement the measures? | When to implement the measures? | | | What requirements or standards for the measures to achieve? |
|---|---|---|---|---|---|---|---|
| | | | | D | C | O | |
| S.6.6.1 | Separation of chemical wastes for special handling and appropriate treatment at a Chemical Waste Treatment Facility (CWTF). | Waste management during construction | Contractors | | √ | | Waste Disposal (Chemical Waste) (General) Regulation |
| S.6.6.1 | Encourage collection of aluminium cans, paper and plastic bottles by providing separate labelled bins to enable these wastes to be segregated from other general refuse generated by the workforce. | Waste management during construction | Contractors | | √ | | Waste Disposal Ordinance |
| S.6.6.1 | Segregation and storage of different types of waste in different containers, skips or stockpiles to enhance reuse or recycling of materials and their proper disposal. | Waste management during construction | Contractors | | √ | | Waste Disposal Ordinance |
| S.6.6.1 | A recording system for the amount of wastes generated, recycled and disposed (including disposal sites) should be proposed. | Waste management during construction | Contractors | | √ | | Waste Disposal Ordinance |
| S.6.6.1 | Plan and stock construction materials to minimise amount of waste generated and avoid unnecessary generation of waste. | Waste management during construction | Contractors | | √ | | Waste Disposal Ordinance |
| S.6.6.2 | Alternatives C&D materials such as steel frameworks and plastic fencing can be considered to increase the chances for reuse. | Waste management during construction | Contractors | | √ | | Waste Disposal Ordinance |
| S.6.6.3 | In order to minimise the potential environmental impacts resulting from collection and transportation of C&D materials for off-site disposal, the excavated materials comprising fill materials should be reused on-site as backfilling materials as far as practicable. | Waste management during construction | Contractors | | √ | | Waste Disposal Ordinance |

| EIA Ref. | Recommended Environmental Protection Measures/ Mitigation Measures | Objectives of the recommended measures & main concerns to address | Who to implement the measures? | When to implement the measures? | | | What requirements or standards for the measures to achieve? |
|---|---|---|---|---|---|---|---|
| | | | | D | C | O | |
| S.6.6.4 | C&D waste, such as wood, plastic, steel and other metals should be reused or recycled and, as a last resort, disposed of to landfill sites. A suitable area should be designated within the site for temporary stockpiling of C&D materials and to facilitate the sorting process. In order to monitor the disposal of C&D materials at the designated public fill reception facility and landfill and to control fly-tipping, a trip ticket system should be included. Reference can be made to Development Bureau Technical Circular (Works) (TC(W)) No. 6/2010 for details. | Waste management during construction | Contractors | | √ | | Development Bureau Technical Circular (Works) (TC(W)) No. 6/2010,<br>Waste Disposal Ordinance |
| S.6.6.5 | The C&D materials to be disposed of at public filling reception facilities shall be only materials consist of brick, concrete, cement plaster, soil and inert building debris. The materials shall be free from plastics, chemical waste, industrial metals and other materials that are considered unsuitable at the facility. | Waste management during construction | Contractors | | √ | | Waste Disposal Ordinance |
| S.6.6.6 | General refuse should be stored in enclosed bins or compaction units separate from C&D materials. A reputable waste collector should be employed by the contractor to remove general refuse from the site regularly, separately from C&D materials. An enclosed and covered area is preferred to reduce the occurrence of 'wind blown' light materials. In addition, a sufficient number of enclosed bins shall be provided on site for containment of general refuse to prevent visual impacts and nuisance to the sensitive surrounding. | Waste management during construction | Contractors | | √ | | Waste Disposal Ordinance |

| EIA Ref. | Recommended Environmental Protection Measures/ Mitigation Measures | Objectives of the recommended measures & main concerns to address | Who to implement the measures? | When to implement the measures? | | | What requirements or standards for the measures to achieve? |
|---|---|---|---|---|---|---|---|
| | | | | D | C | O | |
| S.6.6.7 | For the disposal of chemical wastes produced at the construction site, the Contractor is required to register with the EPD as a Chemical Waste Producer and to follow the requirements stated in the Code of Practice on the Packaging, Labelling and Storage of Chemical Wastes. Good quality containers compatible with the chemical wastes should be used. Appropriate labels should be securely attached on each chemical waste container indicating the chemical characteristics of the chemical waste, such as explosives, flammable oxidizing, irritant, toxic, harmful, corrosive, etc. The Contractor shall also use a licensed waste collector engaged to transport and dispose of the chemical wastes in accordance with the Waste Disposal (Chemical Waste) (General) Regulation. | Waste management during construction | Contractors | | √ | | Waste Disposal (Chemical Waste) (General) Regulation |
| S.6.6.8 | Chemical toilets to be provided on-site shall be regularly cleaned and the night-soil collected and transported by a licensed contractor to a Government Sewage Treatment Works facility for disposal. | Waste management during construction | Contractors | | √ | | Waste Disposal Ordinance |
| **Operational Phase (Upgrading Works of Cheung Chau STW and Pak She SPS (DP Component))** | | | | | | | |
| S.6.6.9 | The major waste generated during the operational phase will be screenings, silt and debris, grits and dewatered sludge. The screenings, silt and debris and grits are considered similar in nature to general refuse and will be disposed of at landfill sites regularly by a reputable waste collector to reduce pest, odour and litter impacts. As the project will be commissioned in 2019, it is expected that dewatered sludge will be disposed of at Sludge Treatment Facilities regularly. | Waste management during construction | DSD | | | √ | Waste Disposal Ordinance |

| EIA Ref. | Recommended Environmental Protection Measures/ Mitigation Measures | Objectives of the recommended measures & main concerns to address | Who to implement the measures? | When to implement the measures? | | | What requirements or standards for the measures to achieve? |
|---|---|---|---|---|---|---|---|
| | | | | D | C | O | |
| S.6.6.10 | For chemical waste generated during the operational phase, the handling procedures and disposal method are the same as those presented in Section 6.6.7 of EIA. | Waste management during construction | DSD | | | √ | Waste Disposal (Chemical Waste) (General) Regulation |

**Table 13.5 : Implementation Schedule of Recommended Mitigation Measures - Land Contamination**

| EIA Ref. | Recommended Environmental Protection Measures/ Mitigation Measures | Objectives of the recommended measures & main concerns to address | Who to implement the measures? | When to implement the measures? | | | What requirements or standards for the measures to achieve? |
|---|---|---|---|---|---|---|---|
| | | | | D | C | O | |
| **Construction Phase** | | | | | | | |
| N/A | None specific | N/A | N/A | N/A | | | N/A |
| **Operational Phase** | | | | | | | |
| N/A | None specific | N/A | N/A | N/A | | | N/A |

**Table 13.6 : Implementation Schedule of Recommended Mitigation Measures - Ecology & Fisheries**

| EIA Ref. | Recommended Environmental Protection Measures/ Mitigation Measures | Objectives of the recommended measures & main concerns to address | Who to implement the measures? | When to implement the measures? | | | What requirements or standards for the measures to achieve? |
|---|---|---|---|---|---|---|---|
| | | | | D | C | O | |
| **Construction Phase** | | | | | | | |
| N/A | None specific | N/A | N/A | N/A | | | N/A |
| **Operational Phase** | | | | | | | |
| N/A | None specific | N/A | N/A | N/A | | | N/A |

**Table 13.7 : Implementation Schedule of Recommended Mitigation Measures - Cultural Heritage**

| EIA Ref. | Recommended Environmental Protection Measures/ Mitigation Measures | Objectives of the recommended measures & main concerns to address | Who to implement the measures? | When to implement the measures? | | | What requirements or standards for the measures to achieve? |
|---|---|---|---|---|---|---|---|
| | | | | D | C | O | |
| **Construction Phase (Sewers Works (non-DP Component))** | | | | | | | |
| S.10.3.15, S.10.3.22 | Undertake an archaeological watching brief programme at Tai San Street, Tai San Back Street, Chung Hing Street and Chung Hing Back Street, Cheung Chau Rock Carving and Tung Wan Road. Note: Archaeological Watching Brief should be undertaken by a qualified archaeologist, who must apply for a licence under the Antiquities and Monuments Ordinance (Cap. 53) from the Antiquity Authority before the commencement of archaeological fieldwork. | Identification, retrieval and recording of potential archaeological material and deposits. | DSD and Contractors | | √ | | EIAO-TM and Antiquities and Monuments Ordinance |
| S.10.3.16 to S.10.3.19 and S.10.3.23 to S.10.3.26 | Since the proposed works area is at a distance of at least 7m from the Rock Carving, and the constructor is not allowed under the contract to carry out any works outside of the designated works area. Buffer zone should be provided to ensure that the Declared Monument and its environs are not infringed upon during the construction works.<br>Within the buffer zone, construction works as well as storage of construction materials are not allowed. Erection of temporary fencing/barriers to demarcate the buffer zone is not required.<br>In addition, access to the rock carving should be maintained and directional signages should be erected or installed at appropriate location(s) near the rock carving to facilitate visitors to access the rock carving during the construction phase.<br>In addition, periodic monitoring of the declared monument is recommended. It is recommended to conduct inspection of the site every 3 months during the construction phase. Inspection record supplemented with the site photos showing the condition of the overall declared monument should be submitted to AMO for | Prevention of damage to the rock carving from contact with equipment and machinery during the construction works. | DSD and Contractors | | √ | | EIAO-TM and Antiquities and Monuments Ordinance |

| EIA Ref. | Recommended Environmental Protection Measures/ Mitigation Measures | Objectives of the recommended measures & main concerns to address | Who to implement the measures? | When to implement the measures? | | | What requirements or standards for the measures to achieve? |
|---|---|---|---|---|---|---|---|
| | | | | D | C | O | |
| | record purposes.<br>For auditing purposes the Independent Environmental Checker (IEC) must ensure that the above periodic monitoring is conducted properly and that the information from the site inspection is delivered promptly to the Engineer and the AMO. | | | | | | |
| S.10.4.32 to S.10.4.33 | Condition survey must be carried out by qualified building surveyor or engineer in advance of works for Graded Historic Buildings and structures and Nil Grade heritage structures that may be affected by ground borne vibration.<br>The condition survey report for Graded Historic Buildings must be submitted to AMO before construction activities commence. The contractor must implement the approved monitoring and precautionary measures. | Records of the existing structures, identification of fragile elements, and recommend monitoring and precautionary measures if necessary | DSD and Contractors | | √ | | EIAO-TM |
| S.10.4.34 | Conduct vibration monitoring on structures as stated in the requirements of the condition survey report. | Prevention of damage from ground borne vibration during the construction phase. | DSD and Contractors | | √ | | EIAO-TM |
| S.10.4.35 | A buffer zone should be provided to separate the building from the construction works. The buffer zone should be clearly marked out by temporary fencing. The buffer zone should be made as large as the site restrictions allow. | Prevention of damage to heritage structures | DSD and Contractors | | √ | | EIAO-TM |

| EIA Ref. | Recommended Environmental Protection Measures/ Mitigation Measures | Objectives of the recommended measures & main concerns to address | Who to implement the measures? | When to implement the measures? | | | What requirements or standards for the measures to achieve? |
|---|---|---|---|---|---|---|---|
| | | | | D | C | O | |
| S.10.4.36 | Provision of protective covering for external surfaces of heritage structures that are situated 5 m or closer to construction works. | Prevention of damage to heritage structures from contact with equipment and machinery during the construction works | DSD and Contractors | | √ | | EIAO-TM |
| S.10.4.37 | Provision of safe public access to temples, shrines, ancestral halls and any other heritage buildings and structures for public use that are 5 m or closer to construction works. | To ensure the safety of members of the public when using heritage structures during the construction works | DSD and Contractors | | √ | | EIAO-TM |
| **Operational Phase** | | | | | | | |
| N/A | None specific | N/A | N/A | N/A | N/A | N/A | N/A |

**Table 13.8 : Implementation Schedule of Recommended Mitigation Measures - Landscape & Visual**

| EIA Ref. | Recommended Environmental Protection Measures/ Mitigation Measures | Objectives of the recommended measures & main concerns to address | Who to implement the measures? | When to implement the measures? | | | What requirements or standards for the measures to achieve? |
|---|---|---|---|---|---|---|---|
| | | | | D | C | O | |
| **Construction Phase (Upgrading Works of Cheung Chau STW (DP Component))** | | | | | | | |
| Table 11.8 | Visual Screen/Hoarding<br>Decorative hoarding or boundary fence for construction sites shall be considered, and designed to be compatible to the surroundings. | To minimise the potential visual impacts | Contractors | | √ | | N/A |

| EIA Ref. | Recommended Environmental Protection Measures/ Mitigation Measures | Objectives of the recommended measures & main concerns to address | Who to implement the measures? | When to implement the measures? | | | What requirements or standards for the measures to achieve? |
|---|---|---|---|---|---|---|---|
| | | | | D | C | O | |
| Table 11.8 | Protection to Existing Trees within Works Areas<br><br>All existing trees which are not in direct conflict with the proposed works will be retained. The existing trees proposed to be retained shall be properly maintained and protected by means of fencing to prevent vehicular or pedestrian intrusion that may potentially damage tree canopies, trunks and root zones. Detailed tree protection specifications shall be allowed and included in the Contract Specification, which specifying the tree protection requirement, submission and approval system, and tree monitoring system. For trees with high preservation value, individual tree assessments and continuous tree monitoring reports shall be provided by a certified Arborist, Landscape Architect or related professional during construction. All retained trees shall be recorded photographically at the commencement of contract.<br><br>Root pruning to the retained trees should be prohibited. Retained trees should be well-preserved by setting up a tree protection zone throughout the construction period for protecting the retained trees from damages.<br><br>To maximize protection to existing trees and ground vegetation, construction contracts may designate “No-intrusion Zone” to various areas within the site boundary with rigid and durable fencing for each individual no-intrusion zone. The contractor should close monitor and restrict the site working staff not to enter the “no-intrusion zone”, even for non-direct construction activities and storage of equipment. | Landscape mitigation measures | DSD and Contractors | √ | √ | | EIA, Annex 10 and Annex 18 of EIAO-TM |

| EIA Ref. | Recommended Environmental Protection Measures/ Mitigation Measures | Objectives of the recommended measures & main concerns to address | Who to implement the measures? | When to implement the measures? | | | What requirements or standards for the measures to achieve? |
|---|---|---|---|---|---|---|---|
| | | | | D | C | O | |
| Table 11.8 | Tree Transplanting<br>Existing trees to be affected shall be directly transplanted to the proposed tree receiving sites, or to temporary tree nurseries alternatively. Temporary tree nurseries may be set up for the transplanted tree and proposed trees at an early stage to allow small trees to grow during the construction stage. By the time when planting area becomes available, trees have been mature and required minimal pruning and suffer much less damage during transplanting. The construction programme should also allow sufficient time for root pruning and root ball preparation prior to transplanting, if necessary, and transplanting operations to be carried out in planting season.<br>Tree pruning such as topping, lion tailing would be prohibited as far as possible. Also, frequent keep watering would be necessary for transplanting trees. The proposed tree preservation measures during construction would be carried out and approved by the competent persons. | Landscape mitigation measures | DSD and Contractors | √ | √ | | EIA, Annex 10 and Annex 18 of EIAO-TM |
| Table 11.8 | Construction Light<br>Security floodlight for construction areas shall be controlled, such as equipped with adjustable shield, frosted diffusers and reflective covers, at night to avoid excessive glare to the nearby areas and residents. Other security measures shall also be considered to minimize the visual impacts by construction light. | To reduce the night-time glare effect to the surrounding environs. | Contractors | | √ | | EIA, Annex 10 and Annex 18 of EIAO-TM |

| EIA Ref. | Recommended Environmental Protection Measures/ Mitigation Measures | Objectives of the recommended measures & main concerns to address | Who to implement the measures? | When to implement the measures? | | | What requirements or standards for the measures to achieve? |
|---|---|---|---|---|---|---|---|
| | | | | D | C | O | |
| Table 11.8 | Dust and Erosion Control for Exposed Soil<br>Excavation works and demolition of existing building blocks shall be well planned with precautions to suppress dust. Exposed soil shall be covered or watered often. Areas that are expected to be left with bare soul for a long period of time after excavation shall be properly covered with suitable protective fabric. Suitable drainage shall be provided around construction sites to avoid discharge of contaminants and sediments into sensitive water-based habitats. | To minimise the disturbance to existing landscape resources and minimise the impacts on the visual amenity of the area | Contractors | | √ | | EIA, Annex 10 and Annex 18 of EIAO-TM |
| Table 11.8 | Reinstatement of Works Areas<br>The affected works areas shall be properly reinstated to the satisfaction of relevant government departments. | Landscape mitigation measures | Contractors | | √ | | EIA, Annex 10 and Annex 18 of EIAO-TM |
| **Operational Phase (Upgrading Works of Cheung Chau STW (DP Component))** | | | | | | | |
| Table 11.9 | Architectural and Landscape Design<br>The appearance of the proposed structures shall be properly designed, including a careful selection of material, colour and texture, so as to fit into the existing suburban, natural to semi-natural surroundings. The aesthetic design of the proposed structures will follow the requirements in the Guidelines on Aesthetic Design of Pumping Station Buildings and submitted to Vetting Committee on Aesthetic Design of Pumping Station Buildings (VCAB) for approval in accordance with DSD TC No. 9/2006, and circulated to ASD for comment in accordance with ETWB TCW No. 8/2005. Sufficient planting shall be considered and provided around the boundary fence of the proposed buildings for screening. Buffer planting will also be considered during the detailed design. | To ensure the proposals are integrated with the existing landscape and visual content, and avoid cluster effect. | DSD | √ | | √ | EIA, Annex 10 and Annex 18 of EIAO-TM |

| EIA Ref. | Recommended Environmental Protection Measures/ Mitigation Measures | Objectives of the recommended measures & main concerns to address | Who to implement the measures? | When to implement the measures? | | | What requirements or standards for the measures to achieve? |
|---|---|---|---|---|---|---|---|
| | | | | D | C | O | |
| Table 11.9 | Establishment Period<br><br>A 12-month establishment period for the soft landscape works shall be allowed in the main contract for contractor to carry out routine horticultural operations, including watering, pruning, weeding, pest control, replacement of dead plants etc. to ensure healthy establishment of new planting during a 12 month establishment period. This period can also serves as a kind of warranty/guarantee on the quality of the plants supplied and installed by the contractor. Monthly monitoring during the first year of establishment period is recommended. | The planting proposal seeks to compensate for the predicted tree loss resulting from the construction of the proposed works, visually integrate the proposals within its existing landscape framework and provide an improved visual amenity for future users. | DSD and Contractors | | | √ | EIA, Annex 10 and Annex 18 of EIAO-TM |

Notes:
D – Design, C – Construction, O - Operation
BD – Building Ordinance
ETWB TCW – Environmental and Transport Works Bureau Technical Circular
HKPSG – Hong Kong Planning Standards and Guidelines
EIAO-TM – Technical Memorandum on Environmental Impact Assessment Process
TPO – Town Planning Ordinance
WBTC – Works Bureau Technical Circulars

# 14. SUMMARY OF ENVIRONMENTAL OUTCOMES AND OVERALL CONCLUSIONS

## 14.1 Key Environmental Outcomes

14.1.1 The key environmental outcomes of the Upgrading of Cheung Chau Sewage Collection, Treatment and Disposal Facilities are summarized below.

14.1.2 **Environmental benefits of the Project and the environmental protection measures recommended:** The sewage treatment level of the Cheung Chau STW will be upgraded from primary to secondary and the capacity will be expanded to cope with the population growth and future developments. Discharge of low quality effluent to the receiving water body will be reduced and hence will improve the coastal water quality of Cheung Chau. Furthermore, hygiene problems within the catchment areas arising from the use of septic tanks will be largely relieved with provision of public sewers to currently unsewered villages, where practicable.

14.1.3 **Population and environmentally sensitive area protected:** The marine waters near the Project site are protected by the improved treatment standard and treatment capacity of the Cheung Chau STW and the elimination of overflow from Pak She SPS. The residential areas and village houses which are currently unsewered are also protected by provision of new sewers under this Project.

14.1.4 **Environmentally friendly designs recommended:** The Deep Sewer Option instead of Kwun Yam Wan SPS would reduce impacts arising from the construction of a new SPS adjacent to Kwun Yam Wan Beach and the need of private land resumption. Hand Shield construction method would be proposed for the deep sewers construction to reduce the extent of road opening works along Tung Wan Road and Cheung Chau Sports Road. For Cheung Chau STW and Pak She SPS, the provision of standby parts and standby power sources improve the reliability of the sewage treatment and disposal system, while the provision of deodorizing units could reduce the possible odour impact to adjacent sensitive receivers. In the design of Cheung Chau STW, non-potable reuse of treated effluent within the STW site will be proposed to reduce the consumption of potable water. Energy efficiency measures such as adoption of solar panel, skylight and natural ventilation, etc. will also be explored to reduce energy consumption. The facilities of the upgraded Cheung Chau STW are so arranged as to minimize disturbance to the existing trees within the STW and more trees will be planted within the upgraded STW to enhance greenings and improve the visual appearances.

14.1.5 **Key environmental problems avoided:** Potential deterioration of effluent quality of the existing Cheung Chau STW due to ageing problem of the facilities will be avoided by the proposed upgrading of the sewage treatment level and increasing the existing capacity of the STW. The hygiene problems arising from the use of septic tanks will also be largely relieved by the provision of public sewers to currently unsewered village, where practicable. Furthermore, potential sewage overflow to Cheung Chau receiving water body will be eliminated by the proposed upgrading works for Pak She SPS.

14.1.6 **Compensation areas:** There is no significant habitat loss as a consequence of the Project. Thus no specific compensation areas are required.

## 14.2 Overall Conclusions

14.2.1 The EIA Report has provided an assessment of the potential environmental impacts associated with the Project. All environmental issues including air quality, noise, water quality, waste management, land contamination, ecology, fisheries, cultural

heritage and landscape and visual have been undertaken in accordance with the EIA Study Brief (No. ESB-212/2009).

14.2.2 The nature and extent of different environmental impacts arising from the construction and operation of the Project have been addressed and quantified in the previous sections. In addition, a summary of assessment findings of these individual issues is provided at the end of each section. Appropriate mitigation measures have also been recommended for incorporation into the design, construction and operation phases of the Project for compliance of relevant environmental legislation and standards. The Implementation Schedules of the recommended mitigation measures are provided in **Section 13**.

14.2.3 In conclusion, the Project would provide an overall improvement in water quality for marine waters near the Project site. It would comply with environmental legislation and standards with the implementation of the recommended mitigation measures and good site practice. An EM&A programme has also been recommended to be implemented before and during the construction and operation phases of the Project to check the implementation and effectiveness of the recommended mitigation measures.