Drainage Services Department

**Agreement No. CE29/2001 Outlying Islands Sewerage Stage 1 Phase 1 Ngong Ping Sewage Treatment Works and Sewerage Investigation, Design and Construction**

# Environmental Assessment Report for Tung Wan Option

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## Environmental Assessment Report for Tung Wan Option

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## APPENDICES

# 1. INTRODUCTION

## 1.1 Background

The scheme as recommended by Outlying Island (OI) Sewerage Master Plan (SMP) is to collect and treat the sewage in Ngong Ping to tertiary standard. The effluent is then conveyed to Tai O for ultimate disposal at the mouth of Tai O creek as shown in **Drawing No. 23400/EN/082**.

Apart from the discharge point at Tai O flood control pumping station, which has been covered in the Environmental Impact Assessment (EIA) recently completed for the Project, the possibility of conveying the effluent for disposal at Tung Wan downstream of Shek Pik Reservoir is raised. This alternative option has been identified earlier as a second choice as compared to the current selected Tai O route. This Report provides an environmental assessment on this alternative Tung Wan route.

## 1.2 Description of Tung Wan Option

This disposal alternative is to re-route the originally proposed effluent pipeline from Ngong Ping STW to Tung Wan jetty as shown in **Drawing No. 23400/EN/082**. The route of the effluent pipeline under this option involves the laying of effluent pipe from Ngong Ping STW along Ngong Ping Road and Shum Wat Road. At the junction of Shum Wat Road and Keung Shan Road, the effluent pipe will turn to the south of Keung Shan Road towards Shek Pik Reservoir Road. The whole section of Keung Shan Road is within the water gathering ground. The effluent pipe will attach to the existing jetty at Tung Wan by some mounting brackets for effective discharging into the sea.

A flow monitoring chamber, for detection of possible leakage of effluent, is proposed to be located adjacent to the existing Shek Pik Sewage Treatment Works (STW) at the Northwest corner of the Shek Pik Prison. The size of the chamber would be approximately 3.5m x 6.5m.

## 1.3 Key Environmental Issues associated with this Option

The construction of effluent pipeline along Keung Shan Road and Shek Pik Reservoir Road may cause some dust, noise and visual impacts to the local village residents at Tai Long Wan, the users of barbecue site and visitors travelling along Keung Shan Road. The pipe laying work may also affect the nearby sensitive habitats and biota as well as any sites of cultural heritage in the vicinity of the pipeline.

As the effluent pipe can be attached to the existing jetty at Tung Wan by mounting brackets for discharging into the sea. Therefore, all construction works will be land-based and no dredging or reclamation will be required. The potential sources of construction water quality impacts are limited to the construction site runoff and wastewater from land-based construction activities. During the operational phase, the Ngong Ping exported effluent discharges may affect the receiving water body at Tung Wan and the nearby water quality and ecological sensitive receivers.

The key environmental issues associated with the Tung Wan route are air quality, noise, water quality, waste management implications, visual and landscape impact, cultural heritage impact and ecology impact. This report provides environmental assessment for the Tung Wan route and has been written in 10 sections with this section providing a broad introduction.

Section 2 Air Quality

Section 3 Noise

Section 4 Water Quality

Section 5 Waste Management Implications

Section 6 Landscape and Visual

Section 7 Ecology

Section 8 Fisheries

Section 9 Cultural Heritage

Section 10 Conclusions

# 2. AIR QUALITY

It is expected that the works related to the pipe laying works for Tung Wan route would be carried out section by section. The dust generated from each section of the pipe laying works would be of small scale, localised, and short-term. In order to ensure that dust emission is minimised during the construction phase of the project, relevant dust control requirements set out in the *Air Pollution Control (Construction Dust) Regulation* should be met. The site agent of the Contractor is required to adopt dust reduction measures while carrying out construction works. In particular, the mitigation measures listed in Section 3.6 of the main EIA report for the original Tai O scheme should be adopted where applicable. With the implementation of effective dust control measures, adverse dust impacts from the construction works of the project would not be expected.

# 3. NOISE

## 3.1 Noise Sensitive Receivers

Noise sensitive receivers (NSRs) were identified with reference to Annex 13 of the EIAO-TM. **Table 3.1** and **Drawing No. 23400/EN/0095** present the summary of identified noise sensitive receivers along the Tung Wan route and their likely impact.

**Table 3.1 Identified NSRs along Tung Wan Route and Preliminary Screening of Potential Impacts**

| Sensitive Receivers | Within Assessment Area and Likely Affected by | | | |
|---|---|---|---|---|
| | Construction of the Proposed Ngong Ping Sewerage System | Construction of the Proposed Effluent Export Pipeline | Construction & Operation of the Proposed Sewage Treatment Plant | Drawing Ref. |
| Staff Quarters A of Shek Pik Prison | N/A | Likely | N/A | 23400/EN/095 |
| Village House B of Shek Pik Prison | N/A | Likely | N/A | 23400/EN/095 |

| Sensitive Receivers | Within Assessment Area and Likely Affected by | | | |
|---|---|---|---|---|
| | Construction of the Proposed Ngong Ping Sewerage System | Construction of the Proposed Effluent Export Pipeline | Construction & Operation of the Proposed Sewage Treatment Plant | Drawing Ref. |
| | | | | |
| Staff Quarters 1 of Shek Pik Prison | N/A | Likely | N/A | 23400/EN/095 |
| Staff Quarters 2 of Shek Pik Prison | N/A | Likely | N/A | 23400/EN/095 |
| Staff Quarters 3 of Shek Pik Prison | N/A | Likely | N/A | 23400/EN/095 |
| Staff Quarters 4 of Shek Pik Prison | N/A | Likely | N/A | 23400/EN/095 |
| Staff Quarters 5 of Shek Pik Prison | N/A | Likely | N/A | 23400/EN/095 |
| Staff Quarters 6 of Shek Pik Prison | N/A | Likely | N/A | 23400/EN/095 |
| Staff Quarters 7 of Shek Pik Prison | N/A | Likely | N/A | 23400/EN/095 |
| Staff Quarters 8 of Shek Pik Prison | N/A | Likely | N/A | 23400/EN/095 |
| Staff Quarters 9 of Shek Pik Prison | N/A | Likely | N/A | 23400/EN/095 |

Note: N/A Not Applicable.

## 3.2 Assessment methodology

Assessment methodology will follow that adopted for the main EIA report for the Tai O scheme. An inventory of powered mechanical equipment was developed for the purpose of assessing the potential construction noise impacts under the main EIA report and is given in **Appendix 3A** for easy reference.

## 3.3 Evaluation of Impact

The nature of work would be in progress manner and so the impact to the nearby NSRs along the effluent pipeline would be transient. The predicted construction noise levels for construction of effluent pipeline along Tung Wan route are shown in **Table 3.2**. With the use of quiet plant and temporary noise barriers, 3 out of 11 identified NSRs were within construction noise limit of 75 dB(A) for domestic premises and no residual impact would be expected. Eight no. of NSRs (Staff Quarters 2 –9 of Shek Pik Prison) could not comply with construction noise limit of 75 dB(A) with the use of quiet plant and temporary noise barriers.

**Table 3.2 Construction Noise Impact due to the Construction of Effluent Export Pipeline (Drawing Ref: 23400/EN/095)**

| Nearest NSR | Distance from site boundary | Noise Criteria dB(A) | Predicted Noise Level (dB(A)) under worst-case | | |
|---|---|---|---|---|---|
| | | | Unmitigated scenario | Mitigation Level 1 | Mitigation Level 2 |
| Staff Quarters A northwest to Shek Pik Prison | 16 m | 75 | 93 | 78 | 73 |
| Staff Quarters B northwest to Shek Pik Prison | 28 m | 75 | 88 | 73 | 68 |

| Nearest NSR | Distance from site boundary | Noise Criteria dB(A) | Predicted Noise Level (dB(A)) under worst-case | | |
|---|---|---|---|---|---|
| | | | Unmitigated scenario | Mitigation Level 1 | Mitigation Level 2 |
| Staff Quarters 1 of Shek Pik Prison | 19 m | 75 | 92 | 77 | 72 |
| Staff Quarters 2 of Shek Pik Prison | 2 m | 75 | 113 | 98 | 93 |
| Staff Quarters 3 of Shek Pik Prison | 6 m | 75 | 102 | 87 | 82 |
| Staff Quarters 4 of Shek Pik Prison | 4 m | 75 | 106 | 91 | 86 |
| Staff Quarters 5 of Shek Pik Prison | 7 m | 75 | 100 | 85 | 80 |
| Staff Quarters 6 of Shek Pik Prison | 7 m | 75 | 100 | 85 | 80 |
| Staff Quarters 7 of Shek Pik Prison | 7 m | 75 | 100 | 85 | 80 |
| Staff Quarters 8 of Shek Pik Prison | 7 m | 75 | 100 | 85 | 80 |
| Staff Quarters 9 of Shek Pik Prison | 7 m | 75 | 100 | 85 | 80 |

Note:
Mitigation Level 1 Use of quiet plant
Mitigation Level 2 Use of quiet plant and use of movable and temporary noise barriers

It can be seen from **Table 3.2** above, even with Mitigation Level 2 in place, there would be residual impact of 5 to 18 dB(A) at the NSRs of staff quarters of Shek Pik prison. Since all practicable mitigation measures on PME have been exhausted, it is recommended to adopt Level 3 mitigation measures (i.e. manual construction methods) in front of Staff Quarters 2 to 9 which are close to the proposed pipeline, so as to minimize the noise impacts as it is not practicable to use noise barriers in work areas with limited space. With the use of manual construction methods for these NSRs, no residual impacts are expected.

## 3.4 Noise Mitigation Measures

The proposed mitigation measures for construction noise are arranged in an increasing level of efforts. The following are mitigation levels:

Mitigation Level 1 Use of quiet plant.

Mitigation Level 2 Use of quiet plant and movable noise barriers.

Mitigation Level 3 Use of manual construction methods in front of Staff Quarters 2 to 9.

Adopt administrative measures to inform and, if necessary, liaise with the residents of Staff Quarters of Shek Pik Prison on the construction schedule and work locations before the start of any construction work.

For construction of effluent export pipeline for the Tung Wan route, mitigation level 2 with the use of quiet plant and movable noise barrier should be adopted. Mitigation level 3 with the use of manual construction methods are recommended in front of Staff Quarters 2 to 9 which are close to the proposed pipeline where it may not be practical to use noise barriers. It is also

recommended that the contractor should inform and, if necessary, liaise with the residents of the staff quarters of Shek Pik Prison on the construction schedule and work locations before starting any construction work within that area. Noise mitigation measures as detailed in Section 4.5 of the main EIA report for the Tai O scheme should be followed where applicable throughout the construction phase.

# 4. WATER QUALITY

Potential sources of water quality impacts from land-based construction activities are likely to be construction site runoff, sewage from workforce, accidental spillage of chemicals and wastewater from various construction activities, including groundwater collected from excavations. It is however anticipated that the construction phase of Tung Wan route would not cause water pollution problem after undertaking all required measures proposed in Section 5.4 of the main EIA report for the Tai O Scheme.

The assessment of operational impact on Tung Wan water quality due to the proposed effluent discharges was carried out with CORMIX near field models. The main purpose of using the near-field model is to investigate the effluent plume and water quality condition of the receiving water body at the potential outfall locations. The operational phase water quality assessment is presented in the subsequent sections.

## 4.1 Water Quality Sensitive Receivers and Beneficial Uses

The export effluent will be of high quality and the potential impacts on the water quality would be localised. The assessment will be based on the discharge via an effluent pipeline at the existing jetty in Tung Wan. The main water quality sensitive receivers will be the marine mammals (i.e. Finless Porpoise and Chinese White Dolphin) near Tung Wan. Based on the sightings distribution data from AFCD, these sensitive receivers are represented by Stations FP, MP and 12 shown on **Drawing No. 23400/EN/083**.

The shorelines along both sides of Tung Wan are gazetted secondary recreational subzones and are thus considered to be sensitive receivers. The non-gazetted Tai Long (Sai) Wan at the western side of the bay near Chung Chau is also considered as a water quality sensitive receiver.

The potential South Lantau Marine Park/Marine Reserve near Fan Lau and the Marine Park at Soko Islands as well as the closest gazetted beach are several km away from the site. The impacts of this Project would be minimal on this distant area.

## 4.2 Effluent Quality

The sewage treatment process of the Ngong Ping STW will be designed to meet the minimum effluent quality standard as specified in the DSD Consultancy Brief (**Table 4.1**).

**Table 4.1 Minimum Effluent Quality Standards**

| WQ Parameter | Minimum Effluent Standard |
|---|---|
| Biochemical Oxygen Demand (BOD) mg/L | 10 (95 %ile) |
| Suspended Solids (SS), mg/L | 15 (95 %ile) |
| Ammonia Nitrogen ($NH_3$), mg/L | 1 (annual average) |
| Total Inorganic Nitrogen (TIN), mg/L | 7 (annual average) |
| *E. coli*, cfu/100 mL | 100 (geometric mean) |

## 4.3 Water Quality Objectives (WQO)

Tung Wan is located within the Southern Water Control Zone (WCZ) and the corresponding WQOs for the parameters of concern are listed in **Table 4.2**.

**Table 4.2 Water Quality Objectives for the Southern Water Control Zone**

| Parameters | General Marine Waters | Secondary Contact Recreation |
|---|---|---|
| *E. coli* | Not specified | Annual geometric mean not to exceed 610 per 100mL |
| Depth Average Dissolved Oxygen (DO) | Not less than 4 mg/L for 90% samples | |
| pH value | To be in the range 6.5-8.5. Change due to human activity not to exceed 0.2 | |
| Salinity | Change due to human activity not to exceed 10% of natural ambient level | |
| Suspended Solids (SS) | Human activity not to raise the natural ambient level by 30% nor cause the accumulation of suspended solids which may adversely affect aquatic communities | |
| Unionised Ammonia (UIA) | Annual mean not to exceed 0.021 mg/L | |
| Nutrients/Total Inorganic Nitrogen (TIN) | Not to be present in quantities that cause excessive algal growth. Annual mean depth average inorganic nitrogen not to exceed 0.1 mg/L | |

## 4.4 Background / Ambient Condition

Hydrodynamics

Hydrodynamic conditions were collected at six stations in Tung Wan which are Stations 6, 7, 8, 9, 10 and 12 shown on **Drawing No. 23400/EN/083**. The data were collected on 25 to 26 July 2002 and 1 to 2 August 2002 during the wet season.

The survey on 25 to 26 July 2002 was conducted on a large range (spring) tide whereas the survey on 1 to 2 August 2002 took place on a semidiurnal small range (neap) tide. During the flood periods in both spring and neap tides, the currents in general flowed strongly towards the west across the mouth of Tung Wan with the highest speeds recorded of around 0.8 m/s, becoming steadily weaker closer to the shore. There was a reversal for the ebb tides, i.e. the currents in general flowed towards the east across the mouth of the bay, becoming gradually weaker towards the shore. At location close to Station 6 (see **Drawing No. 23400/EN/083**), near the proposed effluent discharge location, currents were in general very weak during all the survey periods, mostly around 0.1 m/s, without a well defined direction.

Water Quality

The wet season water quality surveys were conducted on 4 separate days in August 2002 (two separate days in spring tides and two separate days in neap tides). Each survey covered both mid-flood and mid-ebb periods. Therefore, a total of 8 sampling events were undertaken as shown in **Table 4.3**.

**Table 4.3 Water Sampling Programme**

| Event | Sampling Dates | State of Tide | Remarks |
|---|---|---|---|
| 1 | 9 Aug 02 | mid-flood | Wet season spring tide |
| 2 | 9 Aug 02 | mid-ebb | |
| 3 | 15Aug 02 | mid-flood | Wet season neap tide |
| 4 | 15Aug 02 | mid-ebb | |
| 5 | 23 Aug 02 | mid-flood | Wet season spring tide |
| 6 | 23 Aug 02 | mid-ebb | |
| 7 | 30 Aug 02 | mid-flood | Wet season neap tide |
| 8 | 30 Aug 02 | mid-ebb | |

During each sampling event, water samples were collected at 14 locations (Stations 1 to 12, MP and FP) as shown on **Drawing No. 23400/EN/083.** At each sampling station, water samples were taken at 3 water depths, namely, 1m below water surface, mid-depth and 1m above seabed, except where the water depth less than 6m, the mid-depth station was omitted. Where the water depth was less than 3m, samples were collected at one mid-depth station only. Consequently, a total of 283 samples were collected within Tung Wan for laboratory analysis for pH, Salinity, DO, *E.coli*, BOD, SS, $NH_3$ and TIN. It is considered that these 283 samples represent replicate measurements of the wet season condition of Tung Wan. For each parameter of concern, the 5% highest and 5% lowest values of the 283 measurements were discarded and the "average" of the remaining 90% measurements were adopted as the ambient level for the purpose of water quality modelling. The adopted values for ambient conditions are presented in **Table 4.4**.

Only the wet season survey results are included in this assessment as the wet season scenarios are considered more critical. The dry season survey results are attached in **Appendix 4B** as supplementary information.

**Table 4.4 Background Marine Water Quality Conditions**

| Depth Average Concentration (in mg/L except for *E.coli* in cfu/100mL and Salinity in ppt) | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| **PH** | **Salinity** | **DO** | ***E.coli*** | ***BOD*** | **SS** | **$NH_3$** | **UIA[1]** | **TIN** |
| 8.15 | 26 | 5.6 | 8 | 2.3 | 10.5 | 0.1 | 0.0075 | 0.5 |

Note: 1. Value is not from field measurements but was calculated from the measured ambient $NH_3$ level.

The ambient nutrient level of 0.5 mg/L for TIN is higher than the WQO of 0.1 mg/L. It should however be noted that the ambient TIN level of 0.5 mg/L represent the wet season condition (i.e. worst case) and therefore cannot be directly compared with the WQO because the WQO of ≤0.1 mg/L for TIN is an annual average. As stated in the EPD's publication: Marine Water Quality in Hong Kong 2000, under the influence of the Pearl River flow, nitrogen and phosphorus nutrients in the Southern WCZ exhibited an increasing gradient from east to west. The three EPD routine monitoring stations closest to Tung Wan are NM8, SM13 and SM20 which are still at least several km away from Tung Wan. Station NM8 is located in the marine open water north of Tai O near the western Lantau and SM13 is located near Cheung Sha to the south of Lantau. Station SM20 is located near Soko Islands south of Tung Wan. The TIN concentrations at SM20 ranged

from 0.07 to 0.44 with an annual mean of 0.18 mg/L. The TIN concentrations at NM8 measured by EPD during June to August 1999 (wet season) ranged from 1.03 mg/L to 1.2 mg/L with a mean value of 1.12 mg/L and the measured data during January to December 2000 at SM13 ranged from 0.09 mg/L to 0.47 mg/L with a mean value of 0.2 mg/L. It is considered that the TIN data collected in Tung Wan under the present study during August 2002 with an average value of 0.5 mg/L are within a reasonable range as compared to the EPD routine monitoring data.

The ammonia nitrogen ($NH_3$) concentrations, again, cannot be directly compared with the WQO as the WQO of ≤0.021 mg/L is an annual average and is for unionized ammonia (UIA) rather than $NH_3$. It was predicted that roughly 7.54% of the $NH_3$ within the water column of Tung Wan near the proposed discharge location may be present in an unionised state. Therefore, the ambient UIA level is considered to be roughly 0.0075 mg/L as discussed in Section 2.6 below (see **Table 4.6**). The predicted UIA value of 0.0075 mg/L is considered low as compared to the annual mean WQO of ≤0.021 mg/L.

From **Table 4.4**, the ambient levels for pH, DO and *E.coli* were well within the WQOs. The average levels of BOD and SS are 2.3 mg/L and 10.5 mg/L respectively.

It should be stressed that the wet season conditions presented in **Table 4.4** represent the worst case. The dry season survey results for selected parameters are presented in **Appendix 4B** and are compared with the wet season survey results. It can be seen from the appendix that the dry season water quality condition in Tung Wan was considerably better than that for the wet season.

## 4.5 Model Setup

The main purpose of using the near-field model was to investigate the initial dilution that can be achieved within a relatively short distance from the effluent discharge location. The modelling results give information on the length of the initial dilution zone, spreading width and dilution along the plume trajectory. The CORMIX model was applied for this purpose. The modelling was carried out for the wet season only as the wet season scenarios are considered more critical. Two model runs have been included in the near-field modelling exercises for the wet season:

- During spring flood condition; and
- During neap ebb condition.

The spring flood and neap ebb conditions already represent 2 extreme tidal conditions (i.e. the largest and smallest ranges of tidal elevations respectively). As supported by the modelling results as presented in the subsequent sections, the effects of these 2 modelling scenarios on the effluent plume are similar. It is therefore believed that there would not be any significant deviation on the assessment results for other tidal conditions of the wet season. The two proposed modelling scenarios are considered sufficient for the purpose of this assessment.

The duration of initial mixing is expected to be short and the flow dynamic can be treated as a steady state condition. It is considered that when determining the input data for the near-field model, more weight should be given to area close to the discharge location. The bathmetry close to the discharge point (i.e. Stations 6) was adopted for model input. The shoreline nearest to the discharge location is quite far away (more than 160 m away), it is considered that there would not be any significant boundary effect from the shoreline on the near-field mixing region. For the purpose of near-field modelling, it is assumed that, on flood tides, the currents would flow towards the west, whereas on ebb tides, the currents would flow towards the east. The average

current speed of 0.3 m/s measured at the 4 inner stations (Stations 6, 8, 9 and 10 as shown on Drawing No. 23400/EN/083) was adopted. The model parameters for the two modelling scenarios are shown in Table 4.5. The flow of effluent discharge of 34.2 L/s was adopted in the model which is a very conservative assumption representing the peak flow on weekends and holidays. For the majority of the year (on normal weekdays), the estimated flow would only be 17.64 L/s. It is anticipated that there could be up to 60% further reduction in the volume of effluent discharge with the implementation of the effluent reuse scheme which is currently being considered under a separate study.

**Table 4.5 Model Parameters for the Tung Wan Near Field Model**

| **Run** | **1** | **2** |
|---|---|---|
| State of tide | Spring Flood | Neap Ebb |
| Water Level, mPD | 1.5 | 1.3 |
| Water depth[1], m | 5 | 4.8 |
| Invert of discharge, mPD | -1.146 | -1.146 |
| Flow Rate of Discharge, $m^3$/sec | 0.0342 | |
| Size of discharge port | 200mm $\phi$ | |
| Wind Speed[1], m/sec | 2 | |
| Current Speed, m/sec | 0.3 | |
| Salinity, ppt | 25.1 | 28.0 |

Note:
1. Wind speed of 2m/s was used as recommended by CORMIX for conservative design.

## 4.6 Implications for WQOs

Methodology

To compare the modelled data with the WQOs, the concentration of a particular contaminant at the edge of the initial zone was calculated by:

$$C\ idz = \frac{C\ background\ (Dilution - 1)}{Dilution} + \frac{C\ effluent}{Dilution}$$

Where

C idz is the concentration of the contaminant at the edge of the near field (and is the concentration to be compared with the WQOs,
C background is the background or ambient concentration without the discharge,
C effluent is the concentration in the effluent and
Dilution is the dilution of the wastewater in the near-field at particular distances from discharge point.

The implications for WQOs for the parameters of concern are discussed in the subsequent paragraphs. The model output files are attached in **Appendix 4A**.

pH

[1] The CORMIX model does not support the condition where height of the discharge point above the seabed bottom exceeds one third of the local ambient water depth. Therefore, a lower local ambient water depth of 3.78 m and 3.45 m are used for spring flood and neap ebb scenarios respectively instead of the actual water depth of 5 m and 4.8 m. This is considered a conservative approach as a greater depth near the discharge location would in principal result in a greater dilution effect.

The pH of the effluent would be within the range specified in the WQO. The WQO for pH is that the discharge should not cause a change of 0.2 pH value. The small quantity of treated effluent from Ngong Ping is not expected to alter the pH of seawater at and near the discharge point mainly because of the strong buffering capacity of seawater.

Salinity

The WQO for salinity is that any discharge should not raise the ambient level by 10%. From the near-field model results, the salinity concentration in the wet season would achieve the WQO within 2.9 m and 2.6 m downstream from the discharge point for spring flood and neap ebb scenarios respectively.

DO

The WQO for DO is >4mg/L expressed as an annual 90 percentile. The BOD of the effluent is low after tertiary treatment and would not affect the DO concentration in the near-field. Assuming the DO concentration in the effluent is 1 mg/L, the receiving water would achieve the WQO within 0.8m from the discharge point. Given that tertiary treatment is incorporated and the effluent will be conveyed via a steep effluent pipeline to the vicinity of Tung Wan, it is unlikely that its DO concentration at the discharge point would be as low as 1 mg/L.

SS

The WQO for SS is that any discharge should not raise the ambient level by 30%. From the near-field model results, the SS concentration would achieve the WQO within 0.3 m from the discharge point for both spring flood and neap ebb scenarios.

Ammonia

The WQO is for unionized ammonia (UIA) rather than ammonia nitrogen. The proportion of ammonia nitrogen in unionized form depends on the pH, temperature and salinity of the receiving waters. Higher pH, higher temperature and lower salinity lead to higher concentrations of UIA for a given concentration of ammonia nitrogen. The predicted UIA are presented in **Table 4.6** below.

**Table 4.6 Predicted Wet Season UIA Concentrations in the Effluent and Ambient Water**

| | PH | Salinity (ppt) | Temp (°C) | $NH_3$ (mg/L) | %UIA | UIA (mg/L) |
|---|---|---|---|---|---|---|
| Effluent | 7 | 2 | 20 | 1 | 0.38% | 0.0038 |
| Ambient | 8.15 | 26 | 27.56 | 0.1 | 7.54% | 0.0075 |

The UIA level of both the effluent and the ambient water would be well within the WQO. The discharge would therefore achieve the WQO directly irrespective of the initial dilution achieved. As the predicted UIA level in the effluent would be considerably lower than the UIA level of the ambient water into which it will discharge, and the water quality (in terms of UIA) in the vicinity of the discharge location would in fact be improved by the Project.

*E.coli*

The existing ambient level of 8 cfu/100mL was very low as compared to WQO for *E.coli* of ≤10 cfu/100mL for secondary contact recreation. The effluent concentration would be 100

cfu/100mL which is more than six times lower than the WQO. Again, as the *E.coli* level of both the effluent and the ambient water would be well within the WQO, the discharge would therefore achieve the WQO directly irrespective of the initial dilution achieved.

From the near-field model results, at a distance 2 m downstream from the discharge point, the *E.coli* level would increase to 29 cfu/100mL for spring flood scenario and to 20 cfu/100mL for neap ebb scenario which were well below the WQO of ≤610 cfu/100mL. It should be noted that the presented results did not take into account the natural decay of bacteria in the ambient water. It is therefore expected that the actual increases caused by the effluent discharge would be smaller than those predicted by the model.

TIN

The discharge from Ngong Ping STW would contain about 7mg/L on average of TIN which is more than 10 times higher than the ambient concentration of 0.5 mg/L. The predicted TIN levels at various distances downstream from the discharge location are summarised in **Table 4.7**. At a distance 5 m downstream from the discharge point, the TIN level would increase to 0.66 mg/L for spring flood scenario and to 0.65 mg/L for neap ebb scenario. At a distance 200m downstream from the discharge point, the predicted increases would only elevate the background levels by less than 4%. This is considered to represent a small increase.

The nearest ecological sensitive receiver would be the Finless Porpoise and Chinese White Dolphin which were observed to utilize the offshore areas rather than within the Tung Wan Bay (more than 1600m away from the discharge point). The nearest gazetted beach is at least 2000 m away from the discharge location. The non-gazetted beach Tai Long Wan is also more than a 1000 m away from the discharge location. The effluent discharge would contribute negligible increase (<0.4%) to the background concentration within 500 m away the discharge point. It is therefore considered that the impact from the TIN plume would be localised and it is not expected that there would be any adverse impact on the nearby identified sensitive receivers.

**Table 4.7 Summary of Predicted TIN Levels**

| Flow Scenario | Tide Status | Ambient Level (mg/L) | Distance Downstream from the Discharge Point | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | 5m | 20m | 50m | 100m | 200m | | 500m | |
| | | | TIN Level (mg/L | TIN Level (mg/L | TIN Level (mg/L) | TIN Level (mg/L) | TIN Level (mg/L) | % Increase | TIN Level (mg/L) | % increase |
| Peak flow rate adopted in the main EIA report (34.2 L/s) | Spring Flood | 0.5 | 0.659 | 0.638 | 0.609 | 0.560 | 0.520 | 3.94% | 0.502 | 0.31% |
| | Neap Ebb | | 0.652 | 0.587 | 0.573 | 0.546 | 0.518 | 3.56% | 0.501 | 0.28% |
| Reduced flow rate with implementation of the effluent reuse scheme (13.68 L/s) | Spring Flood | 0.5 | 0.641 | 0.613 | 0.569 | 0.528 | 0.506 | 1.24% | 0.501 | 0.14% |
| | Neap Ebb | | 0.666 | 0.553 | 0.541 | 0.521 | 0.505 | 1.09% | 0.500 | 0.03% |

As discussed in Section 4.5, the effluent flow rate of 34.2 L/s adopted in the main EIA report is very conservative. With the implementation of the effluent reuse scheme, it is expected that there would be roughly 60% reduction in effluent flow rate (thus pollution load) from the Project discharge into Tung Wan. It is predicted that, with the effluent reuse scheme, the elevation in the background TIN level would be further reduced to <1.5% and <0.2% at a distance 200 m and 500 m respectively downstream from the discharge point (see **Table 4.7**). These increases are considered negligible.

## 4.7 Summary of Near-Field Model Results

The near-field model predicted that salinity, DO and SS concentrations would achieve the WQO within a very short distance (less than 3 m away from the discharge location). The *E.coli* would achieve the WQO irrespective of the initial dilution as the *E.coli* concentration of both the effluent and the ambient water would be within ranges specified in the WQO. The pH at and near the Tung Wan discharge point is dependence on the buffering capacity of the seawater which is usually very high. Therefore, the pH of Tung Wan at and near the discharge point is highly unlikely to change with the addition of small quantity of effluent from Ngong Ping.

In terms of UIA, the effluent quality would be better then the existing quality of the water into which it will discharge, and therefore, the UIA concentration would not be deteriorated by the Project irrespective of the initial dilution achieved.

Though the TIN concentration in the effluent would be more than 10 times higher than the ambient level, the impact of the TIN plume is however considered very small and localised. The TIN plume would not affect any bathing beaches nearby and areas with ecological importance in the vicinity of the Tung Wan bay.

Conclusion

It is concluded that the Ngong Ping discharge would not adversely affect the water quality and the areas with ecological importance in Tung Wan and vicinity.

## 4.8 Routine Maintenance Programme

It is recommended a routine maintenance programme be carried out to ensure that the outfall discharge point would not be plugged because of the low flow volume from Ngong Ping. Manholes will be provided along the pipeline to deal with clogging and other maintenance requirements.

# 5. WASTE MANAGEMENT IMPLICATIONS

An estimate of the total volume of excavated material likely to be generated from the Tung Wan option is given in **Table 5.1**. Data for the Tai O option is also included in the table for comparison.

**Table 5.1 Types and Quantities of Construction Waste for Main Trunk Sewer and Effluent Export Pipeline**

| Construction Package | Expected Time Frame | Route | Excavated Spoil ($m^3$) | Excavated Spoil to be Reused Onsite ($m^3$) | Excavated Spoil for Disposal ($m^3$) | Imported Fill Material ($m^3$) |
|---|---|---|---|---|---|---|
| Ngong Ping main trunk sewer and effluent export pipeline | Mar 03-Apr 05 | Tung Wan | 17,800 | 5,000 | 12,800 | 0 |
| | | Tai O[1] | 19,000 | 5,200 | 13,800 | 0 |

Note: 1. Volume as reported in the main EIA for Tai O scheme

The volume of excavated material generated from the main trunk sewer and effluent pipeline required for disposal would be about 12,800 $m^3$. The mitigation measures as proposed in Section 6.5 of the main EIA report will be adopted for the Tung Wan route. No adverse waste impact is anticipated with proper mitigation measures in place.

# 6. LANDSCAPE AND VISUAL

There would be potential visual impacts during construction phase to barbecue and camp sites users and visitors travelling along Keung Shan Road. It is expected that the works related to the pipe laying works for Tung Wan route would be carried out section by section. The visual impacts generated from each section of the pipe laying works would be of small scale, localised, and short-term. No permanent landscape and visual impacts are expected for the buried pipeline during operational phase.

# 7. ECOLOGY

## 7.1 Introduction

This section summarizes the findings of ecological surveys for and assesses the potential ecological impacts of the Tung Wan route. The survey period covered both the dry and wet seasons in 2002. Survey methods followed those employed for the main EIA carried out from July 2001 to April 2002.

The Study Area was defined as the area 500 m on either side of the original proposed alignment from the junction between Keung Shan Road and Ngong Ping Road to Tung Wan. The lower section of the original proposed route was realigned slightly toward the west in late November 2002 (**Drawing No. 23400/E/096**). The study area for the original alignment therefore cannot cover the area within 500m on the west side of the revised alignment. However, the revised alignment section is located on urbanised/disturbed habitat, and it is not anticipated that there would be any adverse ecological impact due to the change of the proposed alignment. Also, due to the tight programme schedule, the study area for ecology follows that of the original alignment.

## 7.2 Methodology

*Habitat and vegetation survey*

A habitat map of the Study Area was prepared using the latest (2001) government aerial photos and ground truthing. Surveys were undertaken on 30 July, 27 September, and 29 November 2002. Each representative habitat type was surveyed on foot. Plant species encountered in each habitat type and their relative abundance were recorded with special attention to rare or protected species. Photographs of each habitat type were taken. Nomenclature of plant species and their conservation status followed Xing *et al.* (2000). The habitat map was digitised using ArcView GIS software.

*Mammal survey*

The Study Area was searched for evidence of mammal activity, in the form of scats, burrows, footprints and other traces. These were plotted onto the habitat plans and investigated in further detail where required. Burrows were examined closely to determine whether they were in current use. Mammal nomenclature follows Reels (1996) and Wilson and Reeder (1992). Surveys were undertaken during the wet season on 27 September 2002. Signs of mammals were also noted during the night survey on 9 August and 29 November 2002.

*Bird survey*

The bird surveys were undertaken in all major habitat types using quantitative (point counts) and qualitative methods. For the point count method, a total of twenty minutes were spent counting birds at each point. All birds seen or heard within 30 m of each point count location were counted and identified to species where possible. Ornithological nomenclature follows Viney *et al.* (1996). All bird species seen or heard outside sampling points but within the Study Area were also recorded. Evidence of breeding such as nests, recently fledged juveniles and habitat utilization was recorded. Surveys were undertaken on 10 July, 9 August, 30 September and 29 November 2002.

*Amphibian and reptile survey*

Reptiles and amphibians were recorded during a night survey by direct observation and active searching in potential concealed locations such as in leaf litter, under stones and logs. Auditory detection of species-specific vocalisations were used to survey frogs and toads. Surveys were undertaken on 9 August and 29 November 2002. A day time survey was also performed in 30 September 2002 to recorded species encountered.

*Insects (dragonflies, damselflies and butterflies) survey*

The abundance of adult butterfly, dragonfly and damselfly fauna was investigated quantitatively (using the point count method) and qualitatively (direct observation/active searching) in all major habitat types within the Study Area. Any butterfly, dragonfly and damselfly seen within 20 m from the points was identified and counted. A total of five minutes was spent counting butterflies, dragonflies and damselflies at each point. Identification of Odonates follows Wilson (1997) and identification of butterflies follows Walthew (1997). Surveys of butterfly and dragonfly were undertaken on 16 August and 30 September 2002.

*Aquatic Fauna*

Aquatic fauna surveys were conducted by direct observation, active search, and sample collection. Methods were used depending upon the conditions of the sites and the responses of the target species.

Surveys were undertaken on the hillside along both sides of Keung Shan Road near the Shek Pik Reservoir. Stream fish surveys were undertaken on 15 August 2002. Aquatic invertebrate surveys were conducted on 26 August 2002 for wet season and 15 November 2002 for dry season.

*Marine/Coastal Surveys*

Intertidal surveys were conducted on 26 August and 2 October 2002 for wet season and 15 November 2002 for dry season. Most of the shoreline within the Study Area remained natural except the section of seawall adjacent to the pier. Two natural coastal habitat types within the Study Area were identified during the surveys, i.e. sandy shore and rocky shore.

The rocky shores located at the outer part of the bay were surveyed by quadrat method at three tidal levels, low, mid and high. At each tidal level, five quadrats (25 cm x 25 cm) were placed randomly to assess the abundance and distribution of flora and fauna. All animals found in each quadrat were identified and recorded to species level so that density (individuals per $m^2$) could be determined.

Soft shores were surveyed qualitatively by active searching along the coastline. Special attention was paid to horseshoe crabs, both adult and juvenile. Any horseshoe crabs encountered were identified to species, counted and their locations recorded.

Subtidal benthos surveys were performed on 2 October 2002. Six sampling stations were established in the subtidal zone of Tung Wan Bay (**Drawing Nos. 23400/EN/096** and **23400/EN/097**) to survey marine soft bottom benthic fauna. Three replicates of 0.1 $m^2$ grab samples of the seabed substrate were collected from each of the six benthos sampling stations (total of 18 grab samples) using a van Veen grab. Samples were sieved using a 0.5mm sieve. Collected organisms were preserved in 5% formalin for identification to the lowest practicable taxonomic level using a binocular dissecting microscope.

Species diversity H' and evenness J were calculated for pooled data from each set of three replicates, using the formulae:

$$H' = -\Sigma ( Ni / N ) \ln ( Ni / N )$$ **(Shannon and Weaver 1963); and**

$$J = H' / \ln S$$ **( Pielou 1966),**

where S is the total number of species in the sample, N is the total number of individuals, and Ni is the number of individuals of the $i^{th}$ species. Species diversity and evenness were calculated and compared among the stations.

## 7.3 Survey Results

### Terrestrial Ecology

*Habitat and Vegetation*

The field surveys identified that the Study Area is covered by a variety of terrestrial habitats including plantation, grass-shrubland, stream, reservoir, backshore and urbanized area. Plantation was the dominant habitat type recorded within the Study Area.

**Table 7.1 Habitat types recorded within the study area**

| Habitat | Area (ha) | No, of plant species recorded |
|---|---|---|
| Plantation | 204.9 | 146 |
| Woodland | 2.5 | 74 |
| Grass-shrubland | 77.6 | 79 |
| Reservoir | 39.4 | Not applicable |
| Urbanized Area | 20.6 | 18 |
| Stream | ca. 4.6 km | Not applicable |
| Coastline/Backshore | ca. 2.1 km | 22 |

*Plantation:* A substantial portion of the Study Area was covered by plantation. Plantations were mainly composed of exotic species. The most common trees planted were *Acacia confusa*, *Lophostemon conferta* and *Pinus elliotii*. Plantation along Keung Shan Road mostly formed a pure, dense stand with little undergrowth. Plantation on steep hillslopes was young, with an open canopy and ferns and grasses dominating the understorey. Plantation on the east side of Keung Shan Road was on less severe terrain and had a comparatively diverse understorey. One locally common but protected shrub species, *Pavetta hongkongensis*, and one uncommon tree species, *Celtis timorensis*, was found in this habitat.

*Woodland*: A patch of woodland was recorded in a ravine at the northern part of the study area. This woodland was covered in the main EIA for Tai O option. The woodland had similar composition to the surrounding grass-shrubland but with proportionally more tree species including *Schefflera octophylla, Sterculia lanceolata, and Ficus hispida*. The woodland could be considered as young (<15yrs) and had moderate diversity.

*Grass-Shrubland*: Grass-Shrubland was mainly located on hillsides at higher elevations and on the hydroseeded engineering slope along roads. Grass-shrublands were of various heights, ranging from 0.5 m to 2 m, dominated by *Dicranopteris linearis, Baeckea frutescens*, and *Rhodomyrtus tomentosa*. Grasses including *Ischaemum* spp. and *Cymbopogon* sp. were also abundant in grass-shrubland of younger age. Grass-shrubland was considered to have low to moderate diversity, and was subject to fire disturbance.

During the wet season surveys, three orchid species, *Arundina graminifolia*, *Spathoglottis pubescens*, and *Habenaria linguella* were recorded on grassy cut slopes of Ngong Ping Road. The orchid family (Orchidaceae) is protected under Forestry Regulations. These species are however commonly found (the former two) or of restricted distribution (the latter) in grassland in Hong Kong (Siu 2000).

*Stream*: All the streams are small and are indeed remnants of the upper reaches of streams that existed before the construction of the Shek Pik Reservoir. These small streams mainly cut across plantations within the study area. All streams were channelled at the sections crossed by Keung Shan Road. For the plant species recorded along the stream habitat readers are referred to the plant species lists for the plantation habitat.

*Reservoir*: Shek Pik Reservoir was constructed during the 1960s. The waterbody was surrounded by plantation habitat, while the reservoir itself was void of vegetation.

*Coastline/Backshore:* The backshore community behind the sandy beaches at Tung Wan was modified and disturbed due to the presence of Shek Pik Prison and the Sha Tsui Detention Centre. A few individual mangrove associates *Exoecaria agallocha, Clerodendrum inerme*, and typical backshore species including *Hibiscus tiliaceus, Pandanus tectorius*, and *Ipomoea pre-capre* were recorded.

*Urbanised Area:* This man-made habitat mainly included Shek Pik Prison and Sha Tsui Detention Centre and existing road alignment. Except a few plantation species including *Acacia confusa* and *Casuarina equisetifolia*, this habitat was void of vegetation and was of little ecological value.

*Mammal survey*

The only mammal species recorded within the Study Area during the wet season night survey was Japanese Pipistrelle *Pipistrellus abramus*. Five individuals were seen in plantation near Shek Pik Reservoir. The Japanese Pipistrelle is protected by the Wild Animals Protection Ordinance but is widespread and common in Hong Kong (Ades 1999). No additional mammal species was recorded during the dry season night survey.

*Birds*

A total of 20 species were recorded during systematic surveys conducted in wet season and November 2002 of dry season (**Appendix 7B**). All species recorded at sampling points are common and widespread in Hong Kong except Chestnut Bulbul *Hemixos castanonotus* (Carey *et al.* 2001). Chestnut Bulbuls are mainly found in older forests in Hong Kong (*ibid.*). No sign of

breeding was observed. Both bird abundance and species richness were highest in plantation, and lowest in shrub-grassland and stream (**Table 7.2**).

**Table 7.2 Bird communities in each type of habitats in the Study Area**

| Habitat | Bird density (birds $ha^{-1}$) | Species richness (species $point^{-1}$) |
|---|---|---|
| Plantation | 23.0 | 2.7 |
| Stream | 7.4 | 1.3 |
| Shrub-grassland | 5.6 | 1.0 |
| Sandy shore | 5.6 | 1.0 |

An additional 18 species were recorded between sampling points in the Study Area (**Appendix 7C**). This included 3 endangered species, Reef Egret *Egretta sacra*, Osprey *Pandion haliaetus* and Greater Coucal *Centropus sinensis*, and 1 rare species Short-tailed Bush Warbler *Urosphena squameiceps*. All three are Class 2 Protected Animals of PRC, and Osprey is listed in Appendix 2 of CITES (Zheng and Wang 1998). Reef Egret and Osprey were recorded in Shek Pik Reservoir, and these two species are mainly maritime (Carey *et al.* 2001). Greater Coucals are found a wide range of habitats, and is common in Hong Kong (*ibid.*). Short-tailed Bush Warbler is found in woodland and shrubland (*ibid.*).

*Amphibian and reptiles survey*

Four species of amphibians were recorded in the Study Area during the wet season night survey. These were the Asian Common Toad *Bufo melanostictus*, Gunther's Frog *Rana guentheri*, Brown Tree Frog *Polypedates megacephalus* and Asiatic Painted Frog *Kaloula pulchra*. All were recorded in plantations, and are common and widely distributed in Hong Kong (Lau and Dudgeon 1999). No additional amphibian species was recorded during the dry season night survey.

Six species of reptiles were recorded in the Study Area. These were the Red-eared Slider *Trachemys scripta*, Chinese Gecko *Gekko chinensis*, Changeable Lizard *Calotes versicolor*, Long-tailed Skink *Mabuya longicaudata*, Reeves' Smooth Skink *Scincella reevesii* and Mock Viper *Psammodynastes pulverulentus*. All were recorded in plantations. All except Mock Viper are common and widely distributed in Hong Kong (Karsen *et al.* 1998). Mock Viper is generally uncommon in Hong Kong. This species inhabits hilly areas, including shrubland and grassland (*ibid.*). No additional reptile species was recorded during the dry season night survey.

*Insects (dragonflies, damselflies and butterflies) survey*

Six species of dragonfly were recorded within the Study Area (**Appendix 7D**). All are common and widespread in Hong Kong (Wilson 1997). No additional dragonfly species was recorded between sampling points within the Study Area. Abundance of dragonflies was highest in plantation while species richness was highest in stream and sandy shore (**Table 7.3**).

**Table 7.3 Dragonfly communities in each type of habitats in the Study Area**

| Habitat | Dragonfly density (dragonflies $ha^{-1}$) | Species richness (species $point^{-1}$) |
|---|---|---|
| Plantation | 13.0 | 0.5 |
| Stream | 11.1 | 1.0 |
| Shrub-grassland | 11.1 | 0.5 |

| Habitat | Dragonfly density (dragonflies $ha^{-1}$) | Species richness (species $point^{-1}$) |
|---|---|---|
| Sandy shore | 0.0 | 1.0 |

Fourteen species of butterfly were recorded within the Study Area (**Appendix 7E**). All except Dark Evening Brown *Melanitis phedima* are common and widespread in Hong Kong (Wilson 1997). This species is mainly found in woodlands (Wu 1988). Both abundance and species richness of butterflies were highest in plantation (**Table 7.4**).

A total of 13 butterfly species were recorded between sampling points in the Study Area (**Appendix 7F**). This included 3 uncommon species – Yellow Pansy *Junonia hierta*, Red Admiral *Vanessa indica* and Mapwing *Cyrestis thyodamas*. All were recorded in plantations and are inhabitants of woodlands (Wu 1988).

**Table 7.4 Butterfly communities in each type of habitat in the Study Area**

| Habitat | Bird density (butterflies $ha^{-1}$) | Species richness (species $point^{-1}$) |
|---|---|---|
| Plantation | 16.7 | 1.7 |
| Stream | 11.1 | 1.0 |
| Shrub-grassland | 11.1 | 1.0 |
| Sandy shore | 5.6 | 0.5 |

*Aquatic Fauna*

All fish species recorded were identified in the field, and the number of individuals seen was also noted. A total of 6 fish species (including 26 captured individuals) were recorded in the streams (**Table 7.5**). All species found were native to Hong Kong.

Surveys were undertaken in eastern hillside of Keung Shan beside the Shek Pik Reservoir. All the streams are small streams running in a narrow "V" shaped rocky valleys, which belong to the upper course of the branches of the same stream system previously running along the valley before the construction of the Shek Pik Reservoir. The study area, especially along the streams, has rarely been disturbed and well covered with vegetation.

The existing populations of freshwater fishes found in the streams belong to the native upstream species. Distribution of every species are distinctly aggregated and restricted in some riffles with gentle flows or the pools with sandy bottom. Number of individuals (including all species) found in each riffle or pool is less than 30 in average except some pools with size larger than 2m in diameter and 0.5m in depth.

**Table 7.5 Stream fish species recorded within the Study Area**

| No | Individuals Recorded | | | Abundance |
|---|---|---|---|---|
| | Scientific Name | Status | | |
| *1.* | *Liniparhomaloptera disparis disparis* Lin, 1934 | | *Cap.* | +++ |
| *2.* | *Pseudogastromyzon myersi* Herre, 1932 | | *Cap.* | +++ |
| *3.* | *Oreonectes platycephalus* Günther, 1868 | | *Cap.* | +++ |
| *4.* | *Schistura fasciolata* (Nichols & Pope, 1927) | | *Cap.* | +++ |
| *5.* | *Silurus cochinchinensis* Valenciennes, 1840 | *Obs.* | | ++ |
| *6.* | *Rhinogobius duospilus* (Herre, 1935) | | *Cap.* | +++ |

*+ = less than 5 individuals; ++ = 5-10 individuals; +++ = more than 10 individuals*

*Cap. =Captured ; Obs. = Observed ; Int. = Introduced species*

Aquatic invertebrates dominated by crustaceans and insects. A total of 5 species (2 species of crustaceans, two species of insects and one species on molluscs) were recorded. All aquatic invertebrates recorded are all common and widespread in Hong Kong. Though the Mountain crab *Nanhaipotamon hongkongensis* is an endemic species, it is not rare in Hong Kong.

All the three freshwater crabs, *Cryptopotamon anacoluthon*, *Nanhaipotamon hongkongense* and *Somanniathelphusa zanklon*, found in Hong Kong are endemic. Among the three species, *Cryptopotamon anacoluthon* is most common, and usually occurs at greater abundance in Hong Kong. The mountain crab *Nanhaipotamon hongkongense* is usually found in, or close to, upland streams with clean water in Hong Kong. *Somanniathelphusa zanklon* belongs to a different family (Parathelphusidae) to the above two species. This crab is usually found in lowland habitats such as rice fields, irrigation ditches, flooded furrows and slow-flowing streams and rivers (Dudgeon and Corlett 1994).

One species of shrimps, Atyid shrimp *Caridina cantonensis* was recorded. *Caridina cantonensis* was in high abundance inside small pools in the streams. The genus *Caridina* belongs to the Family Atyidae, Infraorder Caridea. The Atyidae has the first two pairs of pereiopods (walking legs) chelate and is characterized by well-developed tufts of setae for the collection of food. *Caridina* spp. are tiny animals with the body length around 2 cm. They are detritivores feeding mainly on leaf litter from riparian vegetation. Members of this genus are usually found in mountain streams with clean water. In Hong Kong at least three species of this genus have been reported, namely, *Caridina cantonensis*, *Caridina apodosis* and *Caridina serrata*. *Caridina cantonensis* is the commonest one, and can be found in various locations throughout Hong Kong.

The two insects found are also common water insects in Hong Kong. Both are carnivorous, feeding on other aquatic invertebrates, tadpoles or even fish fry (Hill 1982; Hill & Cheung 1988). One individual of suspected Coleoptera larvae was recorded. Abundant Litter Cockroach *Opisthoplatia orientalis* were observed along the edges of the streams.

Besides the aquatic invertebrates, abundant tadpoles of unknown species (possibly Gunther's Frog *Rana guentheri*), and one individual on Chinese Waterside Skink *Tropidophorus sinicus* were observed during the aquatic fauna surveys.

The streams generally remain in the same conditions in both wet and dry seasons. The abundance of each aquatic fauna recorded was also similar, with the exception for Water skater which was not found in dry season survey.

**Table 7.6 Aquatic invertebrates recorded within the Study Area**

| Common name | Scientific name | Relative Abundance* | |
|---|---|---|---|
| | | Wet season | Dry season |
| Mountain crab | Nanhaipotamon hongkongensis | + | + |
| Atyid shrimp | *Caridina* cf *cantonensis* | +++ | +++ |
| Backswimmer | *Notonecta* sp. | ++ | + |
| Water skater | *Gerris* sp. | + | \ |
| Freshwater snail | *Brotia hainanensis* | ++ | ++ |

*Relative abundance: +++ abundant; ++ common; + occasional

## Marine and Intertidal Ecology

*Intertidal Fauna*

The natural rocky shore in Tung Wan is not of typical slope topography as in most other coastlines. Instead, it is composed of a platform within tidal level and a cliff on the landward side. Normal zonation pattern in most rocky shores in Hong Kong thus is not clear in Tung Wan.

Intertidal fauna recorded during the rocky shore surveys were all common species widespread in Hong Kong, including Rock oyster *Saccostrea cucullata*, Barnacle *Tetraclita squamosa*, Stalked barnacle *Pollicepes mitella*, Limpet *Cellana grata*, and Star limpet *Patelloida saccharina*. The abundance of those common fauna was not high at Tung Wan. No rare or protected species was recorded during the survey.

**Table 7.7 Number of individuals and density of intertidal organisms recorded during the survey.**

| Taxa | High-intertidal Zone | | | | | | Mid-intertidal Zone | | | | | | Low-intertidal Zone | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Quadrat | | | | | | Quadrat | | | | | | Quadrat | | | | | |
| | 1 | 2 | 3 | 4 | 5 | (No./ $m^2$) | 1 | 2 | 3 | 4 | 5 | (No./ $m^2$) | 1 | 2 | 3 | 4 | 5 | (No./ $m^2$) |
| **Crustaceans** | | | | | | | | | | | | | | | | | | |
| Stalked barnacle *Pollicepes mitella* | 0 | 0 | 0 | 0 | 0 | **0** | 0 | 0 | 0 | 0 | 0 | **0** | 25 | 5 | 37 | 29 | 2 | **78.4** |
| *Tetraclita squamosa* | 0 | 0 | 0 | 0 | 0 | **0** | 0 | 0 | 0 | 0 | 0 | **0** | 5 | 9 | 0 | 4 | 5 | **18.4** |
| **Gastropods** | | | | | | | | | | | | | | | | | | |
| *Littorina scabra* | 35 | 31 | 42 | 37 | 53 | **158.4** | 16 | 24 | 31 | 29 | 19 | **95.2** | 0 | 0 | 0 | 0 | 0 | **0** |
| Limpet *Cellana grata* | 0 | 0 | 0 | 0 | 0 | **0** | 0 | 0 | 0 | 0 | 0 | **0** | 0 | 0 | 2 | 0 | 1 | **2.4** |
| Star limpet *Patelloida saccharina* | 0 | 0 | 0 | 0 | 0 | **0** | 0 | 0 | 0 | 0 | 0 | **0** | 5 | 15 | 9 | 21 | 18 | **54.4** |
| | 1 | 2 | 3 | 4 | 5 | **% cover** | 1 | 2 | 3 | 4 | 5 | **% cover** | 1 | 2 | 3 | 4 | 5 | **% cover** |
| **Bivalve** | | | | | | | | | | | | | | | | | | |
| *Saccostrea cucullata* | 0 | 0 | 0 | 0 | 0 | **0** | 0 | 0 | 0 | 0 | 0 | **0** | 20 | 25 | 25 | 20 | 40 | **26** |

The majority of the surface of the artificial seawall is covered by concrete and void of any fauna. Only on the surface of large-sized rocks near low tidal level, Limpet *Cellana grata* was observed, but also in low density.

On sandy shore, only burrows which were suspected to have been built by Ghost crabs were found. No other intertidal fauna was found. No horseshoe crabs were recorded during the surveys.

No signs or tracks of horseshoe crabs were recorded within the Study Area during the surveys for the present project.

Horseshoe crabs, three species of which occur in the South China Sea, are thought to be at risk from over-harvesting and loss of habitat (Huang *et al.* 1998).Three species of Horseshoe crabs occur in HKSAR waters: *Tachypleus tridentatus*, *T. gigas* and *Carcinoscorpius rotundicauda* (Chiu & Morton 1999). These represent all species known from the South China Sea, and three of four species known worldwide. The conservation status of the three Indo-Pacific species is listed as "Data Deficient" by IUCN, indicating that existing knowledge is insufficient to determine whether they are threatened or endangered. Horseshoe crabs have been identified as species of potential conservation concern in the HKSAR. Currently, Ha Pak Nai in Deep Bay, together with San Tau near Tung Chung and Shui Hau in South Lantau, are regarded as nursery sites for horseshoe crabs (Chiu & Morton 1999).

The conditions of intertidal habitat generally remain in the same in both wet (August and October 2002) and dry (November 2002) seasons. The abundance and diversity of fauna found were also similar. No rare species were recorded in both seasons.

*Marine Fauna*

A total of 303 individuals form 43 species were collected at the six sites. The species composition, individual number, biomass, total abundance, species richness, species diversity and species richness are shown in Table 7.8 below.

## Table 7.8 Benthos recorded during the benhtic survey and Species diversity (*H'*) &Evenness (*J'*).

| Taxa | Station | | | | | | Total |
|---|---|---|---|---|---|---|---|
| | A | B | C | D | E | F | |
| **NEMERTEA** | | | | | | | |
| *Nemertean* sp. | | 1 | 1 | 1 | | 1 | 4 |
| **ANNELIDA** | | | | | | | |
| **Polychaeta** | | | | | | | |
| ***Amaeana trilobata*** | | 1 | | | | | 1 |
| *Aricidea* sp. | | 1 | | | | | 1 |
| *Asychis* sp. | 6 | 4 | 1 | 1 | | 3 | 15 |
| *Auchenoplax* sp. | | | | | 2 | | 2 |
| *Caulleriella* sp. | 1 | 3 | | | | | 4 |
| ***Cirratulus filiformis*** | | | | 1 | | | 1 |
| *Glycera alba* | 4 | 5 | 2 | 4 | 4 | 3 | 22 |
| *Glycinde kameruniana* | | 1 | 2 | | 1 | | 4 |
| *Loimia medusa* | 1 | | | | | 1 | 2 |
| *Lugia* sp. | | 1 | | | | | 1 |
| ***Lumbrineris nagae*** | | | | | | | |
| *Lumbrineris* sp. | | 1 | 2 | | 1 | | 4 |
| ***Magelona crenulifrons*** | 6 | 7 | 1 | 1 | 1 | | 16 |
| *Mediomastus californiensis* | | 2 | 8 | 9 | 3 | 1 | 23 |
| *Minuspio cirrifera* | | | | 1 | | | 1 |
| *Myriochele* sp. | 1 | | | | | | 1 |
| ***Nephtys oligobranchia*** | 1 | | | | | 3 | 4 |
| *Ophelina grandis* | | 1 | | | | | 1 |
| *Orbinia* sp. | | 5 | 1 | | 4 | 3 | 13 |
| *Paraleiocapitella* sp. | | 2 | 5 | 7 | 3 | 1 | 18 |
| ***Paraprionospio pinnata*** | 11 | 13 | 3 | 11 | 13 | 7 | 58 |
| *Pholoe minuta* | | | | 1 | | | 1 |
| *Phyllodoce malmgreni* | | 1 | | | 1 | | 2 |
| *Polydora maculata* | 1 | | | | 1 | | 2 |
| *Praxillella gracilis* | | | 1 | 3 | | | 4 |
| *Prionospio malmgreni* | 9 | 4 | 4 | 1 | 3 | 5 | 26 |
| *Pseudomalacoceros cantabra* | | 1 | | | | | 1 |
| *Sigambra robusta* | | 1 | | | | | 1 |
| *Terebellides stroemi* | | | | 1 | | | 1 |
| *Tharyx marioni* | 5 | 4 | 4 | 1 | 8 | 4 | 26 |
| Trichobranchidae | 1 | | | | | 4 | 5 |
| **Oligochaeta** | | | | | | | |
| *Oligochaete* sp. | | | 3 | | | | 3 |
| **MOLLUSCA** | | | | | | | |
| **Bivalvia** | | | | | | | |
| Corbulidae | | | | 1 | | | 1 |
| Solenidae | | | | 2 | | | 2 |
| Tellinidae | | 1 | | 3 | | | 4 |
| Veneridae | | | | 1 | | | 1 |
| **Gastropoda** | | | | | | | |
| ***Oliva mustellina*** | | | | | | 1 | 1 |

| Taxa | Station | | | | | | Total |
|---|---|---|---|---|---|---|---|
| | A | B | C | D | E | F | |
| **CRUSTACEA** | | | | | | | |
| **Amphipoda** | | | | | | | |
| Amphipod sp.1 | | | | | | 1 | 1 |
| **Decapoda** | | | | | | | |
| *Alpheus* sp. | | | | | | 1 | 1 |
| ***Metapenaeus ensis*** | | | | | 1 | | 1 |
| *Xenophthalmus pinnotheroides* | | 1 | 2 | 2 | | | 5 |
| **PHORONIDA** | | | | | | | |
| ***Phoronis australis*** | 1 | | | | | | 1 |
| **Echinodermata** | | | | | | | |
| Ophiuroidea | | | | | | | |
| Amphiuridae | 4 | 3 | 2 | 4 | 2 | 2 | 17 |
| | | | | | | | |
| **Biomass (g)** | 0.15 | 0.92 | 0.622 | 2.03 | 0.09 | 1.871 | 5.683 |
| **Individual no.** | 52 | 64 | 42 | 56 | 48 | 41 | 303 |
| **Species no.** | 14 | 23 | 16 | 20 | 15 | 16 | 43 |
| | | | | | | | |
| Species diversity ***H'*** | 2.3 | 2.8 | 2.6 | 2.6 | 2.3 | 2.6 | |
| **Evenness *J*** | 0.16 | 0.12 | 0.16 | 0.13 | 0.15 | 0.16 | |

Grab sampling was carried out to establish benthic baseline conditions and to assess the importance of the existing benthic communities close to and outside the sewer alignment and outfall . Grab sampling stations were established both in locations close to the outfall, and in locations away from the outfall. Stations E were located very close to the proposed outfall. Station A, B and C were at outer shore, while Stations D, E and F were located at inner shore.

For the Shannon-Weiner index ($H'$), a value of < 1 indicates low diversity, 1-2 indicates moderate diversity and a value of > 2 indicates higher diversity. The benthos species diversity ($H'$) was high at all stations. The value ranging from 2.3 to 2.8. The lowest H' was recorded at Site A and E, which are still over 2, while the highest at Site B.

The evenness index reflects how similar the abundance values for each species are within an assemblage. For example, a value of 1 indicates that all species occur in equal abundance whereas a value close to zero indicates that one species has very high abundance and the other species are recorded at very low abundance. The mean value of the evenness ($J'$) recorded in the six sites ranged from 0.12 to 0.16. The evenness indices indicate that benthic organisms recorded within the sites were patchily distributed.

Five major taxa (Phylum) were recorded. Annelids, especially Polychaetes, dominated at all stations (over 87%, 264 over 303 individuals). Phoronida ranked the second in terms of abundance (17 individuals). Nine Molluscs and eight Crustacean were recorded in all samples, but contributed to a significant portion of the total biomass. No rare species were recorded in the samples collected.

The total number of species recorded was highest at Sites B (23 species), which is located away from the outfall location, while lowest at Site A (14 species).

Benthic infauna were dominated by polychaetes (in terms of individual number) and crabs & molluscs (in terms of biomass). Though high species diversity were recorded in all stations, the

abundance and biomass of infauna at all sampling points were not high (Abundance < 64 individuals, and biomass < 2g.) No species of conservation concern was recorded in the benthos surveys.

Dive surveys commissioned by AFCD in 2001 revealed that there were no hard coral colonies in the vicinity of the outfall location including Tung Wan, Tai Long Wan to the west of Tung Wan, and also the coastline to the east of Tung Wan up to Shek Lam Chau. Dominant benthic organisms include bryozoan, coralline algae, Green mussel (*Perna* sp.), and Sea urchins (*Temnopleurus* sp. and *Anthocidaris* sp.). These marine organisms are all common and widespread in Hong Kong. No species of conservation concern were recorded during the surveys.

Established coral communities of any size are regarded as important habitat types in Hong Kong as defined in Annex 8 of EIAO-TM. Hard corals, however, are vulnerable and prefer clear oceanic water. The western waters of Hong Kong are not suitable for coral colonisation due to the lower salinity and higher turbidity. According to findings of recent studies commissioned by AFCD, corals also occur in western side of Hong Kong including areas like Peng Chau, Hei Ling Chau and Cheung Chau. They are found in shallow water along the coastline. The coverage of corals in this region is low (less than 5%, and is the lowest compared with other regions in Hong Kong. Instead of forming coral communities, they exist as sparse isolated patches, composed of extremely tolerant and hardy species. The corals here represent a small subset of those present in the east, where corals are much more diverse and abundant.

Tung Wan is not a site regularly used by both residential cetaceans in Hong Kong, i,e, Chinese White Dolphin and Finless Porpoise. Indeed, based on AFCD's sighting records accumulated since 1995, there is only a single record of Chinese White Dolphin so far inside the embayment between Pak Kok and Shek Lam Chau, which covers Tung Wan and Tai Long Wan. The data showed that Chinese White Dolphin in South Lantau more often utilise the coastal waters near Fan Lau, while Finless Porpoise sightings spread over a large area of the south Lantau waters but none comes close to Tung Wan.

Chinese White Dolphin is protected by law in the Hong Kong Special Administrative Region (HKSAR). It is a CITES Appendix I species and a Class I protected species in Mainland China.

## 7.4 Evaluation of Habitats and Species

*Habitat Evaluation*

The ecological importance of the habitats identified was evaluated against the criteria in Annex 8 of the *EIAO TMEIA*. This evaluation is presented in **Tables 7.9 – 7.15**.

**Table 7.9 Evaluation of Plantation within the Study Area**

| Criteria | Discussion |
|---|---|
| Naturalness | Low to moderate, human created habitat but with natural recolonisation. |
| Size | The total size of this habitat is approximately 204.9ha. |
| Diversity | High plant species diversity but partly contributed by exotic/landscaping species, low to moderate diversity for fauna. |

| Criteria | Discussion |
|---|---|
| Rarity | Two rare bird species Chestnut Bulbul and Short-tailed Bush Warbler, and one Class 2 Protected Animals of PRC Greater Coucal. One uncommon snake Mock Viper. One protected bat species Japanese Pipistrelle. Four uncommon butterfly species Dark Evening Brown, Yellow Pansy, Red Admiral and Mapwing. One protected but common shrub species (*Pavetta hongkongensis*) and one uncommon tree species (*Celtis timorensis*). |
| Re-creatability | This habitat can be readily re-created. |
| Fragmentation | Less fragmented. |
| Ecological Linkage | Mostly within and very close to the Lantau South Country Park. |
| Potential value | Hillside plantation can develop into mature woodland upon management including thinning and weeding. Limited potential for roadside and landscaping plantation. |
| Nursery/Breeding Ground | Plantation in the Study Area can provide breeding habitats for birds and butterflies. |
| Age | Young. |
| Abundance/Richness of Wildlife | Moderate. |
| Overall Ecological Value | **Moderate.** |

## Table 7.10 Evaluation of Grass-shrubland within the Study Area

| Criteria | Discussion |
|---|---|
| Naturalness | Natural, occasionally with planted species. Subject to high level of human disturbance |
| Size | Large continuous patch on upper hillslopes within the Study Area. The total size of this habitat is approximately 77.6ha. |
| Diversity | Moderate plant species diversity, low fauna diversity. |
| Rarity | Protected but not rare plant species *(Arundina graminifolia, Spathoglottis pubescens, and Habenaria linguella)* recorded. |
| Re-creatability | This habitat can be re-created, but some native species are not commercially available. |
| Fragmentation | Fragmented. |
| Ecological Linkage | Partly within and very close to Lantau South Country Park |
| Potential value | Moderate, become secondary woodland over time, but limited by fire disturbance. |
| Nursery/Breeding Ground | No record of significant nursery or breeding ground during the surveys. |
| Age | Young. |
| Abundance/Richness of Wildlife | Low to moderate wildlife richness and abundance. |
| Overall Ecological Value | **Low.** |

## Table 7.11 Evaluation of Woodland within the Study Area

| Criteria | Discussion |
|---|---|
| Naturalness | Natural, occasionally with planted species. Subject to high level of human disturbance |
| Size | Small continuous patch on upper hillslopes within the Study Area. The total size of this habitat is approximately 2.5 ha. |
| Diversity | Moderate plant species diversity, low fauna diversity. |
| Rarity | No rare fauna species recorded |
| Re-creatability | This habitat can be re-created, but some native species are not commercially available. |
| Fragmentation | Fragmented. |
| Ecological Linkage | Very close to Lantau South Country Park which has rich and rare flora. |
| Potential value | Moderate, become mature secondary woodland over time, but limited by fire disturbance. |
| Nursery/Breeding Ground | No record of significant nursery or breeding ground during the surveys. Shrublands in the Study Area can provide breeding habitats for birds and butterflies. |
| Age | Young. |
| Abundance/Richness of Wildlife | Low to moderate wildlife richness and abundance. |

| Criteria | Discussion |
|---|---|
| Overall Ecological Value | **Moderate .** |

## Table 7.12 Evaluation of Streams within the Study Area

| Criteria | Discussion |
|---|---|
| Naturalness | Natural at upper reach, intercepted by catchwater at middle or lower reaches. |
| Size | The total length of the freshwater streams is about 4.6 km. |
| Diversity | Los to moderate fauna diversity. |
| Rarity | No rare species were recorded. An endemic crab was found. |
| Re-creatability | Difficult to be re-created. |
| Fragmentation | Not applicable. |
| Ecological Linkage | Not functionally linked to any highly valued habitat in close proximity. |
| Potential value | Medium, The diversity could maintain if undisturbed. |
| Nursery/Breeding Ground | No record of significant nursery or breeding ground during the surveys. |
| Age | Not applicable. |
| Abundance/Richness of Wildlife | Low to moderate |
| Overall Ecological Value | **Low to moderate** |

## Table 7.13 Evaluation of Shek Pik Reservoir within the Study Area

| Criteria | Discussion |
|---|---|
| Naturalness | Low to moderate, human created habitat. |
| Size | The total size of this habitat is approximately 39.4ha. |
| Diversity | Low |
| Rarity | Two Class 2 Protected Animals of PRC: Reef Egret *Egretta sacra* and Osprey *Pandion haliaetus* |
| Re-creatability | This habitat can be readily re-created. |
| Fragmentation | Isolated. |
| Ecological Linkage | Not functionally linked to any highly valued habitat in close proximity. |
| Potential value | Low. |
| Nursery/Breeding Ground | Limited as breeding ground for wildlife. |
| Age | About 30 years |
| Abundance/Richness of Wildlife | The abundance and richness of wildlife recorded were low. |
| Overall Ecological Value | **Low.** |

## Table 7.14 Evaluation of Urbanised Area within the Study Area

| Criteria | Discussion |
|---|---|
| Naturalness | Low. Heavily disrupted and disturbed by human activities. |
| Size | The total size of this habitat is approximately 20.6ha. |
| Diversity | Low in terms of both flora and fauna diversity |
| Rarity | Neither rare nor protected species recorded during the surveys. |
| Re-creatability | This habitat can be readily re-created. |
| Fragmentation | Isolated |
| Ecological Linkage | Not functionally linked to any highly valued habitat in close proximity. |
| Potential value | Low. |
| Nursery/Breeding Ground | Limited as breeding ground for wildlife due to high human disturbance. |
| Age | No information but considered irrelevant. |

| Criteria | Discussion |
|---|---|
| Abundance/Richness of Wildlife | The abundance and richness of wildlife recorded were low. |
| Overall Ecological Value | **Low.** |

**Table 7.15 Evaluation of Marine Habitats within the Study Area**

| Criteria | Discussion | |
|---|---|---|
| | Intertidal | Marine |
| Naturalness | Moderate. Most of the intertidal habitats within the Study Area remain natural, except the section of artificial seawall located near the pier. | Natural. |
| Size | The total size of this habitat is about 1500m in length, of which approximately 3200 m is artificial seawall. | The entire Tung Wan Bay |
| Diversity | Low, even on the natural section. | Low. |
| Rarity | Neither rare nor protected species recorded during the surveys. | Neither rare nor protected species recorded during the benthic surveys. There were sightings of Chinese White Dolphin in the sea areas outside Tung Wan Bay. |
| Re-creatability | Difficult to be re-created. | Difficult to be re-created. |
| Fragmentation | Fragmented. | Not fragmented. |
| Ecological Linkage | Not functionally linked to any highly valued habitat in close proximity. | Not functionally linked to any highly valued habitat in close proximity. |
| Potential value | Low. | Low to moderate |
| Nursery/Breeding Ground | No record of significant nursery or breeding ground was found during the surveys. | No record of significant nursery or breeding ground was found during the surveys. |
| Age | No information but considered irrelevant. | N/A |
| Abundance/Richness of Wildlife | The abundance and richness of wildlife recorded were low. | The abundance and diversity of wildlife were low to moderate |
| Overall Ecological Value | **Low.** | **Low to Moderate** |

*Species Evaluation*

The list and evaluation of the flora and fauna species of conservation concern recorded within the Study Area, according to the TMEIAP, are given in **Tables 7.16** and **7.17**:

**Table 7.16 Evaluation of flora species of conservation concern recorded within the Study Area**

| Species | Common Name | Growth Form | Location | Protection Status | Distribution | Rarity |
|---|---|---|---|---|---|---|
| *Celtis timorensis* | - | Tree | Plantation near reservoir road | Not protected | Tung Chung, Aberdeen, Shek O | Restricted |
| *Pavetta hongkongensis* | | Shrub | Plantation near reservoir road | Protected | Secondary woodland | Common |
| *Arundina chinense* | Bamboo Orchid | Herb | Grass-shrubland on hydroseeded slope along road | Protected | Ting Kau, Sai Kung, Hong Kong Island | Very common |
| *Spathoglottis pubescens* | Buttercup Orchid | Herb | Grass-shrubland on hydroseeded slope along road | Protected | Shing Mun | Very common |

| Species | Common Name | Growth Form | Location | Protection Status | Distribution | Rarity |
|---|---|---|---|---|---|---|
| *Habenaria linguella* | - | Herb | Grass-shrubland on hydroseeded slope along road | Protected | | Restricted |

## Table 7.17 Evaluation of fauna species of conservation concern recorded within the Study Area

| Common Name | Species | Location | Protection Status | Distribution | Rarity |
|---|---|---|---|---|---|
| Japanese Pipistrelle | *Pipistrellus abramus* | Plantation near Shek Pik Reservoir | All bats are protected in Hong Kong | Widespread in Hong Kong | Common |
| Chinese White Dolphin | *Sousa chinensis* | Waters southwest of Tung Wan | All cetaceans are protected in Hong Kong<br>Class I Protected Animal in PRC, Appendix I of CITES | Concentrated in western Hong Kong water | Not uncommon in western Hong Kong water |
| Greater Coucal | *Centropus sinensis* | Plantation near Shek Pik Reservoir | All birds are protected in Hong Kong, Class 2 Protected Animal of PRC, "vulnerable" in China Red Data Book | Widespread in Hong Kong | Common |
| Reef Egret | *Egretta sacra* | Shek Pik Reservoir | All birds are protected in Hong Kong, Class 2 Protected Animal of PRC and rare in China Red Data Book | Hong Kong's coastal areas | Common |
| Osprey | *Pandion haliaetus* | Shek Pik Reservoir | All birds are protected in Hong Kong, Class 2 Protected Animal of PRC and Appendix II of CITES | Hong Kong's coastal areas | Uncommon |
| Chestnut Bulbul | *Hemixos castanonotus* | Plantation near Shek Pik Reservoir | All birds are protected in Hong Kong | Old woodlands or plantations | Rare |
| Short-tailed Bush Warbler | *Urosphena squameiceps* | Plantation near Shek Pik Reservoir | All birds are protected in Hong Kong | Woodland | Rare |
| Mock Viper | *Psammodynastes pulverulentus* | Plantation near Shek Pik Reservoir | - | Widespread throughout Hong Kong | Uncommon |
| Dark Evening Brown | *Melanitis phedima* | Plantation near Shek Pik Reservoir | - | Widespread throughout Hong Kong | Uncommon |
| Yellow Pansy | *Junonia hierta* | Plantation near Shek Pik Reservoir | - | Sporadically distributed throughout Hong Kong | Uncommon |
| Red Admiral | *Vanessa indica* | Plantation near Shek Pik Reservoir | - | Widespread throughout Hong Kong | Uncommon |
| Mapwing | *Cyrestis thyodamas* | Plantation near Shek Pik Reservoir | - | Widespread throughout Hong Kong | Uncommon |

## 7.5 Impact Identification and Assessment

Evaluation of ecological impacts is based on the following criteria described in Annex 8 of the Technical Memorandum on Environmental Impact Assessment Process:

Habitat quality;

Species;

Size/abundance;

Duration of potential impact; and

Magnitude of potential impact

The primary EIA requirement is for compilation and analysis of data, followed by assessment of impacts using TM guidelines. Impacts are assessed with reference to Annexes 8 and 16 of the Technical Memorandum of the EIA Ordinance. Discrete project impacts and cumulative impacts are assessed, mitigation plans are developed to reduce impacts to acceptable levels, and ecological monitoring and audit programmes specified as needed.

*Construction Stage*

*Site Formation*

Construction of the sewerage pipelines and the temporary works area would cause a temporary loss of 0.37 ha of urbanised areas and 0.29 ha of plantation habitat (Table 7.18). The sewers will be buried underneath the existing road which will be reinstated after construction. The temporary works area will also be reinstated to its original condition after completion of construction. Due to the limited area and low ecological importance of the habitat to be lost, the impact is considered minimal. No habitat of high ecological value would be lost to the project. Species of ecological importance recorded during field surveys would not be affected.

As the proposed discharge point is located at the tip of jetty pier at Tung Wan, no dredging or reclamation is required for the proposed project. There would be no marine site formation works.

**Table 7.18 Potential loss of habitat (ha) to the Tung Wan Route**

| Habitat Type | Sewerage pipelines | Temporary works area |
|---|---|---|
| **Temporary loss** | | |
| Urbanised Areas | 0.35 | 0.02 |
| Plantation | | 0.29 |
| | | |
| **Permanent Loss** | | |
| Urbanised/Disturbed | -* | - |

* sewerage pipeline will be underground, and road surface will be reinstated.

*Noise and Disturbance*

Noise and visual disturbance may occur during site formation and construction, potentially affecting the distribution and behaviour of fauna in the adjacent habitats. Due to the small scale of works required for pipeline deployment and the temporary and localised nature of disturbance, potential impacts to fauna from this source are ranked as minor.

*Construction Dust*

Dust generated during construction may affect surrounding vegetation including the orchid species recorded within the study area. However, due to the commonness and opportunistic nature of the orchids species recorded and the small scale of works required for pipeline deployment, and provided that good site practice is performed, this indirect impact is ranked as minor.

*Surface Runoff*

Potential impacts to aquatic ecology during the construction phase would mainly arise from sedimentation due to surface runoff. Elevated suspended solids levels caused by site runoff could increase the suspended solids load in the water bodies, and could decrease dissolved oxygen levels. A lower oxygen level would affect sessile species, whilst vagile species would tend to temporarily avoid the area. The result could be a temporary reduction in aquatic life abundance.

For the present proposed project, however, the potential for sedimentation would be low. As mentioned above, all streams within the study area have been channelled at the sections crossed by roads. No construction works would thus be conducted at the bottoms or banks of natural streams, for which the potential of creating sedimentation from surface runoff would be much higher. Urbanised ground surface such as concrete road facilitates a more effective control of runoff during construction. Except the limited areas needed to be excavated, surface of other areas will remain intact and the soil beneath remains undisturbed.

In the proposed project, runoff should not be discharged into streams or marine water. Site runoff should be desilted, to reduce the potential for suspended sediments, organics and other contaminants to enter stream and marine environment. Caution must be taken to prevent runoff from entering the streams where sewers cross streams. This impact is ranked as minor.

***Summary of Construction Impacts***

Potential impacts of project construction are summarised in **Table 7.19.**

**Table 7.19 Construction-stage Impacts.**

| Activity | Receiver | Potential Impacts | Nature of Impacts | Severity | Mitigation Recommended |
|---|---|---|---|---|---|
| Site formation | Habitats and species associated (urbanised/disturbed) | Total loss of flora and habitats within site formation boundary. Loss of habitats for fauna | Temporary, reversible, small scale, limited species affected | Minimal | No (except reinstatement of temporary works area to its original conditions) |
| Noise and disturbance | Sensitive wildlife species on adjacent habitats | Changes in distribution, activity patterns | Temporary, reversible, small scale, limited species affected | Minor | Good site practice |
| Construction dust | Vegetation | Inhibition of vegetation growth | Temporary, reversible, small scale, limited species affected | Minor | Good site practice |

| Activity | Receiver | Potential Impacts | Nature of Impacts | Severity | Mitigation Recommended |
|---|---|---|---|---|---|
| Surface runoff | Marine and stream fauna | Changes in distribution, and/or activity patterns of associated fauna | Reversible, small scale, limited species affected | Minor | Good site practice. Prevention of runoff to streams and marine habitats, desilt runoff |

*Operation Stage*

Operational phase impacts would arise from discharge of treated effluent. As detailed in Water Quality Assessment sections, the effluent will be of high quality (tertiary treatment) and the potential impacts on water quality would be very localised. Within a short distance (less than 3m away from the discharge point), the level of salinity, DO, SS concentration, *E.coli* concentration, pH, and UIA would achieve the WQO. Some parameters such as pH value and *E.coli* concentration in the effluent will be as low as those in the ambient condition and within ranges specified in the WQO. Some other parameters such as UIA would be even better than the exiting quality of the water into which it will discharge. It is not expected that the water quality inside Tung Wan for these parameters of concern would be degraded by the Project.

Only TIN concentration in the effluent would be significant higher than both the ambient TIN level and the WQO (more than 10 times higher than the ambient level). However, even for TIN, the impact is considered very small and localised. The increases in the outer Tung Wan bay would be expected to be small, and would be negligible in the waters further away. Since there are no hard coral colonies in Tung Wan bay and the use of the bay by cetaceans is minimal (only one record of Chinese White Dolphin), the increase of TIN inside the bay would not have adverse impacts on any hard corals or cetaceans. The negligible increase outside the bay would also have no impacts on marine life in the south Lantau waters. The two potential Marine Parks near Fan Lau and at Soko Islands, and the horseshoe crab nursery site in Shui Hau, are several km away from Tung Wan and the impacts from this Project on them would be minimal. The overall operation phase impact on water quality is also minimal.

***Summary of Operation Impacts***

Potential impacts of project operation are summarised in **Table 7.20**.

**Table 7.20 Operation-stage Impacts.**

| Activity | Receiver | Potential Impacts | Nature of Impacts | Severity | Mitigation Recommended |
|---|---|---|---|---|---|
| Changes in water quality in Tung Wan Bay and in the vicinity | Marine ecosystems | Changes of nutrient levels in sea water | Long-term | Minimal | No |

*Cumulative Impacts*

Currently there is no other major project proposed in the areas along the sewer alignment and the sea areas near Tung Wan Bay. No cumulative impacts on terrestrial or marine ecology would arise.

## 7.6 Mitigation Measures

The TM (Annex 16) and the TC require that mitigation of ecological impacts be sought in the following order of priority: (1) avoid, (2) minimise, (3) compensate on-site and (4) compensate off-site. At each stage, residual impacts should be re-assessed to determine whether there is a need to proceed to the next stage of mitigation. The following measures are proposed to mitigate the impacts discussed in the preceding section.

*Construction Stage*

Measures should be taken to avoid runoff to streams and the sea. Site runoff should be desilted to reduce the potential for suspended sediments, organics and other contaminants to enter the local freshwater or marine environment.

*Operational Stage*

Sewage pipelines will be underground and changes in marine water quality will be minimal. No ecological mitigation measures are required.

## 7.7 Residual Impacts

Short-term and localised disturbance at urbanised areas of little ecological importance during construction phase will be the only impact, and this is predicted to be minor. No residual impacts would be anticipated if the mitigation measures recommended above are implemented.

## 7.8 Monitoring and Audit

No ecological monitoring programmes are proposed for the present project during both construction and operation phases. Monitoring and audit activities designed to detect impacts to water quality in operation phase will also serve to protect marine ecology.

## 7.9 Conclusions

Limited impacts on terrestrial and marine ecology were predicted from the construction of the Tung Wan Option. The proposed project would only affect existing road or developed area, and the disturbance would be short-term. Provided that good practice for controlling surface runoff is employed and enforced, no residual impacts are anticipated.

During operational stage, the high level of treatment would prevent any adverse impacts to the water quality in Tung Wan Bay.

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# 8. FISHERIES

## 8.1 Introduction

This section reviews existing information on fisheries in the vicinity of Tung Wan, describing fisheries impacts associated with construction and operation of the proposed project. It also proposes mitigation measures, if necessary, to reduce negative impacts within acceptable levels and assesses the need for fisheries monitoring.

## 8.2 Relevant Legislation and Guidelines

Hong Kong SAR Government ordinances, regulations and guidelines relevant to the consideration of fisheries and mariculture under this study include the following:

Fisheries Protection Ordinance (Cap. 171) and associated subsidiary legislation;

Marine Fish Culture Ordinance (Cap. 353) and associated subsidiary legislation; and

Environmental Impact Assessment Ordinance (Cap. 499) and associated Technical Memorandum on Environmental Impact Assessment Process (the EIA TM).

The assessment in this chapter is conducted in accordance with the guidelines set forth in the EIAO- TM, particularly Annexes 9 and 17. The EIAO- TM guidelines provide a systematic method for fisheries impact assessment.

## 8.3 Study Methodology

The commercial fisheries in Hong Kong is composed of capture fisheries and culture fisheries, which includes mariculture and pond culture. For the present proposed project, there is no fishpond or other pond for aquaculture within the terrestrial study area for ecology, i.e. the area 500 m on either side of the original proposed alignment from junction between Keung Shan Road and Ngong Ping Road to Tung Wan. The closet mariculture site to Tung Wan is the Cheung Sha Wan FCZ which is approximately 12km away from Tung Wan. It is separated from Tung Wan by the landmass of south Lantau, and outside the area covered by the water quality assessment for Tung Wan option given above in this report. No impacts on culture fisheries are anticipated in this project, the fisheries impact assessment is therefore concentrated in capture fisheries.

For the purposes of fisheries impact assessment, the assessment area for fisheries is defined as the sea area covered by 4 fishing areas in and near Tung Wan (see **Drawing No. 23400/EN/098**), i.e. Tong Fuk (Fishing Area 12), Shek Pik (Fishing Area 13), Fan Lau (Fishing Area 14), and Soko Islands (Fishing Area 26).

A literature review was conducted to determine the baseline conditions of fisheries within the Assessment Area and to identify areas and species of potential fisheries importance. The review included Government and private sector reports, as well as unpublished information, including the following:

Port Survey 96/97 conducted for AFD (AFD 1998);

AFCD Annual Report 1999/2000 (AFCD 2001); and

Port Survey 96/97 (AFD 1998) provides the most updated data and statistics on inshore fisheries in Hong Kong. It was consulted to assess capture fisheries impacts. It was considered that the information gathered was sufficient for assessment purposes.

## 8.4 Baseline Conditions

As explained in Section 8.3, there is no Fish Culture Zone, nor other aquaculture site, within or near the assessment area. The four fishing areas are the only sites of fisheries importance within the assessment area.

Recent detailed data on HKSAR capture fisheries in the assessment area were taken from the Port Survey 96/97 (AFD 1998). The assessment area covers four Fishing Areas, i.e. Tong Fuk (Fishing Area 12), Shek Pik (Fishing Area 13), Fan Lau (Fishing Area 14), and Soko Islands (Fishing Area 26). The sewer alignment falls within Fishing Area 13 (Shek Pik).

Fishing Area 13 is compared here with Fishing Areas 12 (Tong Fuk), 14 (Fan Lau), and 26 (Soko Islands). Data on capture fisheries include fish production and economic values as reported in the Port Survey 96/97. These statistics are shown in **Table 8.1**.

The combined area of these four Fishing Areas is 5,769.78 hectares, or 3.17 % of the total fishing area in Hong Kong. Approximately 80% vessels fished in the four fishing areas are

small-sized vessels (less than 15m in length). The average value of catch per ha for the whole assessment area was slightly higher than the Hong Kong average (2064.94 vs 1,892.12), while catches of adult fish (tonnes per ha) were lower than the Hong Kong average (72.99 vs 97.26). This indicates that the assessment area was not of high importance both in terms of quantity and value of catch.

Although value per hectare in Fishing Area 13 was the highest among the four Fishing Areas, its ranking among all fishing areas in Hong Kong was not very high (94$^{th}$). Fishing Area 13 was also the most productive Fishing Area in the Assessment Area on the basis of adult fish caught per hectare.

The average value of catch per ha in Area 13 (and Fishing Area 26) was higher than the Hong Kong average. Catches of adult fish (tonnes per ha) for Fishing Area 13 were also higher than the Hong Kong average. However, in terms of total catch and total value of catch, Fishing Area 13 was much lower than those of Fishing Area 26 (Soko Islands). No fry capture operations have been reported from any of Fishing Area 13.

As shown in **Table 8. 1**, the area of Fishing Area 13 accounts for 0.39% of the total fishing area of Hong Kong, and the adult fish catches recorded from these waters account for 0.52% of the catch of the Hong Kong fishery. The catches account for only 0.52% of the value of the Hong Kong fishery, demonstrating that the Fishing Area 13 is not of high importance in terms of production and value.

Out of 189 fishing areas in Hong Kong waters, Fishing Area 13 was ranked by the 96/97 Port Survey as 94$^{th}$ in terms of production value per ha, 77$^{th}$ in terms of adult fish production per ha. Except the adult fish production in Shek Pik, all four Fishing Areas in the assessment area were ranked close to 100th in Hong Kong in both production value per ha and adult fish production per ha.

The nearest fishing homeport to the site is at Cheung Chau, about 15 km east of the proposed outfall. Fishing grounds cover most of the open waters around the alignment, except for shipping fairways which are important for the marine traffic between Hong Kong and Macau. The Port Survey 96/97 reported that Fishing Area 13 was fished by about 85 vessels of up to 15 m, and by about 17 vessels over 15 m in length.

Within HKSAR waters, the highest yields for local fisheries were mainly derived from the eastern and northeastern coasts as indicated in the AFD Port Survey 96/97. While the western waters, including south Lantau, were comparatively less productive.

As reported in the Port Survey 96/97 (AFD 1998), the catches of adult fish and the total value from the Southern Lantau sector were ranked the seventh out of the 12 fishing sectors in Hong Kong, while the catches of fry were ranked the tenth. These figures demonstrate that the Southern Lantau sector which covers Fishing Areas 12, 13, 14, and 26 is not of high importance to capture fishing operations in Hong Kong.

In summary, on the basis of their ranking, and records of fisheries operations in the waters surrounding the alignment and also within the whole south Lantau, indicate that the area is not of high importance to the Hong Kong fishery.

## Table 8.1 Data on HKSAR Capture Fisheries in the Assessment Area (source: AFD 1998)

| Fishing Area (No.) | Fishing Area | Area (ha) | Number of vessels fishing the area | Annual catch of adult fish (kg) | Catch of adult fish per ha (kg) | Ranking for adult fish (of 210 HKSAR fishing areas) | Annual catch of fry (tails) | Catch of fry per ha (tails) | Ranking for fry (of 210 HKSAR fishing areas) | Value of annual catch (HK$) | Average value of catch per ha (HK$) | Ranking for value (of 210 HKSAR fishing areas) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 12 | Tong Fuk | 899.16 | 103.7 | 75,409.85 | 83.87 | 104 | 7,661.29 | 8.52 | 81 | 1,695,012.99 | 1,885.10 | 110 |
| 13 | Shek Pik | 704.64 | 101.3 | 92,758.27 | 131.64 | 77 | \ | \ | \ | 1,795,874.58 | 2,548.63 | 94 |
| 14 | Fan Lau | 1,067.61 | 89.9 | 77,181.01 | 72.29 | 109 | \ | \ | \ | 1,365,132.91 | 1,278.68 | 129 |
| 26 | Soko Islands | 3,098.37 | 209.9 | 175,772.62 | 56.73 | 122 | \ | \ | \ | 7,058,242.91 | 2,278.05 | 99 |
| | Assessment Area (4 fishing areas) | 5,769.78 | 504.8 | 421,121.75 | 72.99 | --- | 7,661.29 | 1.33 | --- | 11,914,263.39 | 2,064.94 | --- |
| | Hong Kong | 181,790.97 | 2,618.5 | 17,681,242.73 | 97.26 | --- | 6,383,436.76 | 35.11 | --- | 343,969,862.58 | 1,892.12 | --- |

## 8.5 Sensitive receivers

Sensitive receivers for fisheries impact assessment are the four Fishing Areas at and near Tung Wan. This includes commercial fisheries resources (adult fish and invertebrates harvested for market) and fish and invertebrates serving as prey for commercial species.

## 8.6 Fisheries importance

Except for the adult fish catch in Fishing Area 13, which ranked 77$^{th}$, four Fishing Areas inside the Assessment Area, ranked close to 100$^{th}$ out of the 189 fishing areas in Hong Kong, in terms of adult fish catch and total value. Among the four fishing areas, only Fishing Area 12 (Tong Fuk) produces fish fry. There is no record of fish fry production from Fishing Area 13.

## 8.7 Impact Assessment

The primary EIA requirement is for compilation and analysis of data, followed by assessment of impacts using TM guidelines. Assessment of fisheries impacts will be based on the following criteria described in Annex 9 of the Technical Memorandum on Environmental Impact Assessment Process:

Nature of impact;

Size of affected area;

Loss of fisheries resources/production;

Destruction and disturbance of nursery and spawning grounds;

Impact on fishing activity; and

Impact on aquaculture activity.

Impacts are generally ranked as "minor", "moderate" or "severe". The ranking assigned varies based on the criteria listed above. The major factors giving rise to a given ranking are noted in the text.

*Construction Phase Impacts*

Part of the proposed alignment and the outfall are located inside the Shek Pik fishing area. That the proposed alignment lies mainly along the roadway would greatly reduce the potential for impacts, and the need for mitigation.

No dredging or dredging will be carried out for the Project and this will minimise the potential for impacts, and the need for mitigation.

The following construction activities are potential sources of negative impacts to fisheries:

Construction site runoff;

Wastewater from various construction activities, including groundwater collected from excavations;

*Construction site runoff*

Construction site runoff may adversely affect water quality in nearby water bodies if uncontrolled. Elevated suspended solids levels caused by site runoff could increase the suspended solids load in the water column, and could decrease dissolved oxygen (DO) levels. A lower DO level would affect stationary species, whilst mobile species would tend to temporarily avoid the area. The result could be a temporary reduction in fish production and fishing activity.

In the present project, however, impacts would not be serious as the majority of construction works would be conducted in terrestrial areas far away from the coastline. Furthermore, the alignment mostly lies on existing roads or urbanised areas. Control of site runoff would be much easier in these kinds of areas than on natural ground surface. The above impacts would also be short-term, localised, and temporary. This impact is ranked as minor.

For wastewater from construction activities, the nature of impacts and the control methods are similar with those of site runoff. It is also ranked as minor.

The only works conducted in sea area would be the establishment of a section of sewer pipeline along the pier. The pipeline would be constructed beneath the existing pier. No marine works would be required for the pipeline and the outfall construction. Therefore impacts on water quality or fisheries would not be expected.

*Operational Phase Impacts*

During the operational phase, the discharges of the exported effluent may affect the water quality in the receiving water body and the nearby water quality sensitive receivers.

In the present case, however, the export effluent will be of high quality (see water quality assessment sections). The pollution loading discharged from Ngong Ping STW would be small given the small population served, and the potential impacts on the water quality would be localized and minimal.

As detailed in Water Quality Assessment sections, within a short distance (less than 3m away from the discharge point), the level of salinity, DO, SS concentration, *E.coli* concentration, pH, and UIA would achieve the WQO. Some parameters such as pH value and *E.coli* concentration in the effluent will be as low as those in the ambient condition and within ranges specified in the WQO. Some other parameters such as UIA would be even better than the exiting quality of the water into which it will discharge. It is not expected that the water quality inside Tung Wan for these parameters of concern would be degraded by the Project.

Only TIN concentration in the effluent would be significant higher than both the ambient TIN level and the WQO (more than 10 times higher than the ambient level). However, even for TIN, the impact is considered very small and localised. The increases in the outer Tung Wan bay would be expected to be small, and would be negligible in the waters further away.

The negligible increase outside the bay would also have no impacts on marine life in the south Lantau waters. The overall operation phase impact on water quality and fisheries would be minimal.

**Table 9.1 Evaluation of fisheries impacts in accordance with EIAO-TM Annex 9**

| Impacts | Criteria | | | | | |
|---|---|---|---|---|---|---|
| | **Nature of impact** | **Size of affected area** | **Loss of fisheries resources/ Production** | **Destruction and disturbance of nursery and spawning grounds** | **Impact on fishing activity** | **Impact on aquaculture activity** |
| Construction phase | | | | | | |
| Construction phase water quality | Potential temporary impacts from construction site runoff and wastewater. | The entire fisheries assessment area | Production ranks close to the middle in comparison to other areas in Hong Kong in terms of catch weigh and value. | Provided that the site management and practices are strictly enforced, no impact on nursery and spawning grounds would be caused. | The fishing grounds within the Assessment Area would be potentially affected. | N/A |
| Operation phase | | | | | | |
| Operation phase water quality | Change of water quality. | The entire fisheries assessment area. | Production ranks close to the middle in comparison to other areas in Hong Kong in terms of catch weigh and value. | No impact on nursery and spawning grounds would be caused. | The fishing grounds in the Assessment Area would be potentially affected. | N/A |

*Cumulative Impacts*

No cumulative impacts were identified as no intertidal or marine works would be required in the sewerage project, and there is no other development projects in the vicinity.

*Mitigation Measures*

Mitigation of construction phase and operation phase impacts was proposed according to the ranking of the potential impacts.

As stipulated in water quality assessment section of this report, to minimise the water quality impacts from construction site runoff and various construction activities, the practices outlined in ProPECC PN 1/94 Construction Site Drainage should be adopted.

For the operation phase, as stipulated in water quality assessment section, the effluent will be of high quality and the pollution loading discharged from Ngong Ping STW would be very small. It is not anticipated that the proposed discharge from the project would result in significant impacts on the receiving water bodies, including Tung Wan Bay and the nearby waters. No mitigation measures are required for the water quality during the operational phase.

*Residual Impacts*

Provided that all the mitigation measures during construction phase for water quality are strictly enforced, no residual impacts would be expected on the fisheries in Tung Wan Bay and the nearby waters.

Due to the level of treatment and the small additional loading during the operational phase, no operation phase impacts would be expected on fisheries.

## 8.8 Fisheries Monitoring

No marine work will be carried out during the construction phase. The only potential fisheries impact will be associated with the construction site runoff. Provided that all the mitigation measures during construction phase for water quality are strictly enforced, no residual impacts would be expected on the fisheries in Tung Wan Bay and the nearby waters. No fisheries monitoring programme would be needed.

## 8.9 Monitoring and Audit

Impacts of the project would be monitored through an environmental monitoring and audit (EM&A) programme on water quality that is specified in the EM&A Manual. The development of a monitoring and audit programme to assess the effects of the proposed project on commercial fisheries is not considered necessary.

## 8.10 Conclusion

No major construction phase impacts are anticipated from the project. During the operation phase, only very minor changes in water quality parameters in the Tung Wan Bay would occur. For the operation phase, as stipulated in water quality assessment section, the effluent will be of high quality and it is not anticipated that the proposed discharge would result in significant impacts on the receiving water bodies, including Tung Wan Bay and the nearby waters. Due to the high level of treatment and small additional pollution loading from the Project, no impacts would be expected on fisheries during operational phase. During construction phase, the main source of impacts on fisheries would be from site runoff, as well as wastewater from construction activities. Provided that all the mitigation measures during construction phase for water quality are strictly enforced, no residual impacts would however be expected on the fisheries in Tung Wan Bay and the nearby waters.

## 8.11 Reference

AFCD. 2001. *Agriculture and Fisheries Department Annual Report 1999/2000.* Agriculture and Fisheries Department, Government of Hong Kong Special Administrative Region.

AFD 1998. *Port Survey 1996/1997.* Agriculture and Fisheries Department, Government of Hong Kong Special Administrative Region.

# 9. CULTURAL HERITAGE

## 9.1 Introduction

The objectives of the cultural heritage assessment were to identify all the sites of cultural heritage in the study area, including historic buildings and structures, pre-war graves, landscape features and archaeological sites, and to recommend appropriate mitigation measures for those identified heritage sites with significant historical, archaeological and architectural values. The assessment methodology used for the Tung Wan assessment followed those adopted for the main EIA report for the Tai O scheme.

## 9.2 Assessment Methodology

### *Built Heritage Features*

Built heritage features dated to pre-war were recorded with written description, photographs, and location mapping. The identification of historical buildings were based on the inscriptions recording the history of the buildings, dated or datable artefacts associated with the buildings, stylistic characteristics of the building structure and construction material such as bricks and tiles. Besides, interviews with local residents and culture specialist were carried out and local written record were collected.

Special attention were paid to three aspects of the built heritage features in the evaluation of their significance:

- special type of the historical buildings such as temple, clan shrine, school or complex compounds;
- artistic decoration on historical buildings such as wall painting, brick carving and ceramic sculpture; and
- the size and distribution plan of historical buildings in group.

On the basis of field survey, an inventory of built heritage features in the study area was compiled in **Appendix 9A – 1**. Categories in the tables included location information, physical characteristics of various aspects, dating, historical references and additional observation.

### *Land Archaeology*

The investigation of archaeological sites in the assessment area was carried out through two phases: desktop study and field survey.

The desktop study examined all available written documents concerned with previously discovered archaeological sites or artefacts in the works area, in order to find informative clues to identify the archaeological potential. Besides, graphic data such as aerial photos, topographic maps, and old maps were also collected and analysed to identify landform and features meriting close attention.

The field surveys were carried out using three methods: field walking, auger drilling and test pit excavation. Field walking covered those areas within and close to the boundary of the proposed alignment. Besides collecting and quantifying artefacts left on the surface, special

attention were paid to the landforms and features to locate potential site settings, and to terrace walls and face cuttings on slopes revealing deposit layers.

Auger drilling is an effective way to reveal soil type and stratigraphy of natural and cultural deposits in a large area. Due to the topographic condition of the works area, most of the 71 augers were applied in the area surrounding the Shek Pik Prison and the low terrace just beyond the Tung Wan beach. Generally, each auger was drilled to the sterile layer unless there were large roots and rocks in the soil or the water level was high. The data from augering in the works were tabulated in the Auger Record as **Appendix 9A – 2**.

Test pit excavation is the most reliable way to determine the dating and nature of an archaeological site. Within the boundary of the proposed alignment, 7 test pits were excavated. Besides, one face cut was also made during the survey. In general, each test pit was dug to the sterile layer. Data from test pit excavation and slope face cutting were recorded in **Appendix 9A – 3**.

Cultural relics collected from surface and retrieved from test pit excavation were tabulated on the basis of material types and recorded in **Appendix 9A - 4**.

## 9.3 Desktop Study of the Works Area

### *Geographic Setting*

The proposed Effluent Export Pipeline – Tung Wan Option is distributed in the western part of the Lantau Island. The alignment initiates in the north connecting the original alignment on the down slope of Ngong Ping, then stretching down along Keung Shan Road to Shek Pik in the south on the hills from 200 metres to 100 metres high. Finally the alignment extends in the lowland along the northern and eastern sides of Shek Pik Prison, ending in the water of Tung Wan (**Appendix 9B – 1, 9B – 4**).

In the hill area along the alignment, the solid rock base was generally formed during the ancient geological period of the Mesozoic Era. The present topography of the hill area was shaped from the late Pleistocene to early Holocene and covered by slope deposits in the form of reddish weathered clay. The geology of the lowland and bay area is relatively more sophisticated, including fill, alluvium, estuarine deposits and beach deposits that were all formed up during the Holocene (**Appendix 9B – 2**).

The landscape of the works area, especially that in the middle and southern sections of the alignment, has been dramatically changed since the 1950s. The aerial photo taken in 1924 (**Appendix 9C – 1**) and the map made in 1957 (**Appendix 9B – 3**) clearly indicate that the valley from Shek Pik to Tung Wan, now occupied by Shek Pik Reservoir and Shek Pik Prison, was originally cultivated fields between the hill slopes.

### *Historical Review*

The Gazette of Lantau Island written in the 1950s verifies the changes of landscape mentioned above. This document records that the Shek Pik Village was first established at the hill foot in the Shek Pik area by the Tsui clan immigrated from Dongguan of Guangdong Province, then a new village was developed at Chung Hau. Besides, the villagers also built a Yeung Hau Temple at the old village and a Hung Shing Temple at the new village (**Appendix 9A – 1**) [1].

The description of the local history has been found on the stone tablet nearby the Shek Pik Reservoir recording the background of the construction of the reservoir. According to the

inscription, the villages in the Shek Pik area were established as early as 400 years ago during the Ming dynasty in the Chinese history, and before the construction of the reservoir, the villagers with nine clan names basically relied on an agricultural economy (**Appendix 9C – 2 – 1**).

### *Archaeological Review*

The Tung Wan Archaeological Site is located on the sand banks in the eastern side of Tung Wan, over 300 metres away from the southern end of the proposed alignment. This archaeological site was first excavated in the 1930s, then a series of excavations were conducted on the site by the Hong Kong Society of Archaeology in the 1980s. The findings from this site are mainly Neolithic and Bronze Age remains, including lithic and ceramic relics and archaeological features related to house structures and a workshop of stone tools, but kilns and other relics of historical periods have also been discovered from the site [2 - 6].

In summary, the potential of identifying sites of cultural heritage in the northern part of the proposed alignment is very low due to the geographic setting in this area. Old villages of late historical periods originally existed in the Shek Pik area but all the sites of cultural heritage, except the Rock Carving and Hung Shing Temple, have all been destroyed by the constructions of Shek Pik Reservoir, Shek Pik Prison and other associated facilities since the 1950s. The beach area at Tung Wan within and close to the alignment may have some archaeological potential because its location is close to the Tung Wan Archaeological Site and sharing similar geographic characteristics.

## 9.4 Division of the Works Area

For the convenience of marking the survey work for cultural heritage assessment, the proposed alignment is divided into six sections (**Appendix 9B – 4**). **Appendices 9B-5** to **9B-8** show the locations of auger holes and text pits applied for the project. It should be noted that these appendices are intended to show the rough locations of the auger holes and text pits for indicative purpose only. The size of auger holes and test pits shown on these appendices are not to scale.

Section 1 and Section 2 cover the northern part of the works area. This area is basically a hilly area around 200 metres high and the proposed alignment stretches along Keung Shan Road, with rocky cliffs on one side and densely vegetated steep slopes on the other (**Appendix 9C – 3**). Because of the geographic setting in this area, it was difficult to find a spot to apply augers and only two augers were eventually drilled in Section 2 (**Appendix 9B – 5**).

Section 3 and Section 4 are relatively flatter than the first two sections, stretching along the western side of Shek Pik Reservoir (**Appendix 9C – 4**). A series of augers were applied along the alignment in the two sections wherever a relatively flat area was found with soil deposit and not covered by rocks. A test pit T7 was also plotted in Section 4 (**Appendix 9B – 6, 9B – 7**).

Section 5 was the focus of the archaeological survey and most of the auger and test pits were allocated in this area (**Appendix 9B – 8**). This area can be further divided into two parts. The first part is the lowland area along the road to the north of Shek Pik Prison (**Appendix 9C – 5 – 1**). The second one is the area surrounding a small mound overseeing the Tung Wan beach. A new office compound of the Agriculture, Fishery and Conservation Department (AFCD) was being constructed on the mound facing the bay (**Appendix 9C – 5 – 2, 3, 4**).

## 9.5 Built Heritage in the Works Area

The survey did not identify any unknown built heritage sites in the works area but only recorded two known heritage features, the Rock Carving at Shek Pik and the Hung Shing Temple at Chung Hau (**Appendix 9A – 1, 9B – 8**).

According to the Gazette of Lantau Island mentioned above, Hung Shing Temple at Chung Hau was built at the location of the new Shek Pik Village; the accurate dating of this temple was unavailable but it should be no later than the late Qing dynasty or the early 20th century.

The Hung Shing Temple is a structure with three rooms in the front row and one in the back row. It is built with brick walls from the base to the top and covered by both flat and curved tiles on pitched roofs (**Appendix 9C – 7 – 1, 2, 3** and **5**). The temple is now severely damaged. The roof on the front left room is collapsed, all the rooms are piled with modern garbage and the surrounding space is also being used as storage place (**Appendix 9C – 7 – 1, 4**). The temple however is probably still being worshiped by some locals, judging from the offerings to a small shrine inside the temple (**Appendix 9C – 7 – 6**).

The distance between the Hung Shing Temple at Chung Hau and the proposed alignment is around 50 metres. As in the situation of the Rock Carving, it would not be affected by the Project either directly or indirectly.

## 9.6 Archaeological Survey in the Works Area

### *Augering*

None of the 71 augers applied during the archaeological survey, except one, has retrieved any relics or detected any cultural layers in the works area (**Appendix 9A – 2**). Auger K66 in Section 5 in front the AFCD Office is the exception with its yielding of blue-and-white sherds. The excavation of Test Pit T1 at the same location indicates, however, that the archaeological relics are mixed with modern garbage in the same contexts.

### *Test Pit Excavation*

Seven test pits were excavated during the survey. Out of the seven pits, five were allocated in Section 5 surrounding the small mound facing Tung Wan. The reason for this allocation was that a piece of geometric sherd (**Appendix 9C – 10 – 2**) was collected on the surface just in front of the AFCD Office, and an interview with the construction workers revealed that the sherd was unearthed from a yellowish clay layer in the middle of the compound yard. Because this geometric sherd was an important clue leading to the identification of potential Bronze Age deposit but the survey team was not allowed to enter the yard to conduct a survey, a series of augers and five test pits therefore were allocated around the mound just outside the office compound.

The excavation of five test pits at the above location did not identify any undisturbed cultural deposits. T1 and T2 in front of the AFCD Office shared the same deposit layers, which were mixed slope debris and beach deposit (**Appendix 9A – 3, 9B – 9 – 1, 9B – 9 – 2, 9C – 8 -1** and **9C – 8 – 2**). T1 yielded some ceramic pieces but they were all mixed with modern remains in three layers (**Appendix 9C – 11**). T3, T4 and T5 on the western side of the mound revealed only natural deposits under the surface (**Appendix 9B – 9 – 3, 9B – 9 – 4, 9B – 10 – 1, 9C – 8 – 3, 9C – 8 – 4** and **9C – 9 – 1**). A slope face cut FC1 was also made at the same location on the top of the mound but revealed only natural deposits (**Appendix 9B – 10 – 4, 9C – 9 – 4**).

Test Pit T6 was allocated in the woods to the north of Shek Pik Prison and it reached a cement layer right underneath the surface layer (**Appendix 9B – 10 – 2, 9C – 9 – 2**). T7 was placed on the high terrace on the western side of Shek Pik Reservoir and it verified the result of augering that only natural deposits were formed at this location (**Appendix 9B – 10 – 3, 9C – 9 – 3**).

### *Cultural Relics*

The number of cultural relics collected from the survey is small (**Appendix 9A – 4**). Three stone pieces and two ceramic pieces were collected from the surface (coded with the letter X) at Tung Wan and dated to the Neolithic period and Bronze Age. One geometric sherd was collected in front of the AFCD Office as mentioned above, all other relics were collected along the seashore in the eastern part of Tung Wan, including a stone adze (**Appendix 9C – 10 – 1**), a stone flake (**Appendix 9C – 10 – 3**) and a round pounding tool (**Appendix 9C – 10 – 4**) and a black coarse ware sherd (**Appendix 9C – 10 – 5**). These relics were probably rushed out from the Tung Wan Archaeological Site.

All the cultural relics from test pit excavation were retrieved from T1, including broken and heavily worn pieces of glazed and unglazed stoneware, white and coloured porcelain, blue-and-white porcelain and red tile. As mentioned above, these relics were co-existing with modern garbage like glass in the same contexts (**Appendix 9C – 11**).

### *Archaeological Item*

The Rock Carving at Shek Pik, probably dated to the Bronze Age around 2500 years ago, is a declared monument. This feature is protected by iron rails on the outside and cannot be touched by the visitors. But it is obviously lack of maintenance and now largely covered by tree branches (**Appendix 9C – 6**). The Rock Carving is located over 400 metres away from the proposed alignment therefore would not be affected by the Project.

## 9.7 Conclusion

The survey team has found no sites of cultural heritage within the boundary and in the vicinity of the proposed Tung Wan alignment, the Project therefore would not cause direct or indirect adverse impact to cultural heritage in the study area.

## 9.8 References

(1) 筏可方丈編印：《大嶼山志》(香港：民國第一丁酉初秋，1957)，頁16 - 17。

(2) William Meacham ed., *An Archaeological Site at Shek Pik: Excavation Report and Related Papers by Walter Schofield (1888 – 1968)* (Hong Kong Archaeological Society Journal Monograph 1, July 1975).

(3) 區家發、鄧聰、佟寶銘、孫德榮：〈香港石壁東灣新石器時代遺址〉，*Journal of the Hong Kong Archaeological Society*, Vol. XII (1986 – 88), pp. 45 – 69.

(4) J. R. Crawford, "A Report on the Excavation of a Kiln Site at Tung Wan (Shek Pik)", *Journal of the Hong Kong Archaeological Society*, Vol. XII (1986 – 88), pp. 70 – 77.

(5) J. R. Crawford, "A Report on the Kiln Debris at Tai Kwai Wan, Tung Wan and Sha Po Tsuen", *Journal of the Hong Kong Archaeological Society*, Vol. XII (1986 – 88), pp. 78 - 99.

(6)
鄧聰：〈考古學與香港古代史重建〉，見於周佳榮、劉詠聰主編：《當代香港史研究》
(香港：三聯書店，1994)，頁305 - 331。

## 10. CONCLUSION

This Environmental Assessment Report has identified potential environmental impacts from the Tung Wan route of various nature including air quality, noise, water quality, waste management, landscape and visual, ecology and fisheries, culture heritage. The results of various assessments indicate that there would not be any insurmountable environmental impacts resulted from the Tung Wan route as the alignment will be mainly on the existing road with little disturbance on the surrounding habitats. It was also concluded that the Ngong Ping discharge would not adversely affect the water quality and the areas with ecological importance in Tung Wan and vicinity.

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