2 PROJECT DESCRIPTIONS

2.1 Project Scope

2.1.1 Po Toi O is located in the southern part of Sai Kung District, next to Clear Water Bay. Around the bay is a small settlement called Po Toi O village, which is not served by public sewerage. The location of Po Toi O can be found in **Figure 1-1**.

2.1.2 The proposed sewerage Project comprises the following works:

i. Provision of village sewerage to the unsewered areas of Po Toi O. The works involve construction of about 800m of gravity sewers and 400m of rising mains;
ii. Construction of a local sewage treatment plant (STP) with Average Dry Weather Flow (ADWF) of about 139m^3/day; and
iii. Construction of a submarine outfall of about 385m in length.

2.1.3 This is an environmental enhancement project that aims to improve environmental hygiene of the Po Toi O area.

2.2 Need of the Project

Existing Conditions

2.2.1 Po Toi O is located in the southern part of Sai Kung District. It is a small bay area in the shape of a "sack" surrounded by sloping topography. There are small numbers of stilt houses, village houses, seafood restaurants and a temple mainly along the coast and some on the hilly terrain, while a few fish rafts on the bay waters as fish farms. The village is currently not served by public sewerage and the sewage in the area is treated using septic tanks and/or soakaway system (STS).

Purpose, Objectives and Environmental Benefits

2.2.2 Provision of proper sewerage system to unsewered villages is a general government policy. Without centralized public sewage treatment facility, villagers have to regularly desludge the STS to maintain the cleaning performance and to avoid overflow of sewage. However, the desludging process may bring along potential hygiene and odour issues. Under the Port Shelter Sewerage Master Plan (SMP), Drainage Services Department (DSD) has proposed sewerage works at Po Toi O. In addition to improving local hygiene conditions and removing associated odour problem, the provision of sewerage is a preventive measure to avoid potential environmental problems due to insufficient desludging or structural defect of the STS. This can also relieve villagers' burden to maintain their STS (e.g. desludging).

2.2.3 The proposed sewerage consists of a local sewage treatment plant (STP), gravity sewers, rising mains and a submarine outfall. It is designed to collect and treat the sewage and wastewater from the communities in the Po Toi O village for final disposal offshore. In the Sai Kung District Council meetings over the past five years, the residents of Po Toi O generally welcomed the proposal.

Scenarios with and without the Project

Without the Project

2.2.4 As mentioned in **Sections 2.2.1 - 2.2.2**, wastewater generated in Po Toi O is treated by STS. Hygiene and associated odour concerns may arise during desludging of the STS. Also, ineffective treatment or overflow of sewage from unmaintained STS may result in leakage of raw or partially treated sewage into nearby water bodies (e.g. sea and streams). Water pollution may affect villagers and the fish culture zone. These potential hygiene and environmental problems cannot be fully rectified without proper collection and treatment of sewage.

With the Project

2.2.5 Upon completion of the Project, sewage from the villagers will be conveyed to Po Toi O STP for centralized treatment and the treated effluent will be discharged through a submarine outfall to a good dispersion point in Clearwater Bay. The environmental hygiene in the Po Toi O area is expected to improve and the pollution risk due to insufficient desludging will be eliminated. Also, villagers will be free from routine maintenance of the STS.

2.3 Consideration of Alternative Design and Layout

Design and Layout of STP

2.3.1 Po Toi O Sewage Treatment Works will adopt membrane bioreactor technology (MBR) for sewage treatment. This technology allows a smaller footprint than that for a conventional STP. To further minimize the STP footprint, most of the tanks and equipment (e.g. equalization tank, MBR tank and screens) will be placed 10m underground. This can also minimize emissions of odour generated from the treatment processes. A single storey building of 5m high will be constructed above ground to minimize landscape and visual impacts on the surrounding village and hilly scenery. The layout of the STP is shown in **Appendix 2.1**.

Location of STP

2.3.2 In order to identify a feasible location for placing the proposed STP, four locations in the vicinity of Po Toi O were studied under *Agreement No. CE 65/2006(DS)*. A plan showing the locations of four studied sites (namely Sites 1 – 4) and the sensitive receivers in the vicinity is provided in **Figure 2-1**.

- Site 1 – Shore to the North of Po Toi O Village
- Site 2 – Within Po Toi O Village in front of Hung Shing Temple
- Site 3 – Shore to the South of Po Toi O Village
- Site 4 – Cut Slope to the South of Po Toi O Village

2.3.3 All four studied locations are considered based on the land requirement of the proposed STP, and they are technically feasible from the drainage, sewerage and structural points of view. They have also been reviewed in terms of accessibility,

environmental impacts, public concerns, and current zonings in OZP (zoning of Po Toi O area is shown in **Figure 10-2**). As given by **Figure 10-2**, land of sufficient size in the proximity of the Po Toi O Village is either zoned as Conservation Area or Costal Protection Area. A small piece of land zoned as "Open Space" is sandwiched by Fairway Vista and Po Toi O Village. However, it is not considered for placing the proposed STP due to the following reasons: (1) This area is located on high altitude (+23.1 mPD). An extra pumping station has to be constructed to pump the sewage from village houses at lowland to the STP; (2) This area is surrounded by and is adjacent to residential houses, and thus prone to adverse environmental constraints as Site 2 (unacceptable noise and visual impacts plus odour nuisance in operational phase, see **Section 2.3.5** for details); (3) the size of "Open Space" is too small to accommodate the proposed STP.

2.3.4 **Site 1** is located at the shore to the north of Po Toi O. Site 1 was not selected for the proposed STP due to two main reasons: (1) inaccessibility for maintenance in operational phase and (2) objection from village representatives due to high construction and operational environmental impacts. Site 1 cannot be accessible by maintenance vehicles and hence maintenance of the STP becomes infeasible. Also, this land is zoned as "Coastal Protection Area". In general, this zoning intends to conserve, protect and retain the natural coastline and the sensitive coastal natural environment, and to deter against development. Dredging and reclamation works required in site formation work for the proposed STP will damage rocky shore lined with corals. In addition, this will cause water deterioration that affects fish culture zone in Po Toi O bay, corals along coastline and species of conservation importance amphioxus in the Po Toi O bay channel seabed (see **Figure 2-2**). Furthermore, the house behind Site 1 may be prone to odour nuisance in the operational phase.

2.3.5 **Site 2** is located at the residential area (Village Zone) of Po Toi O where construction is easier due to less site constraints. However, Site 2 cannot be accessed by maintenance vehicles, making maintenance of STP infeasible. In addition, houses in the vicinity of Site 2 may be prone to odour nuisance in the operational phase. Moreover, village representatives objected the construction of the STP near their village houses, and in particular, they strongly opposed the construction of the STP in front of "Hung Shing Temple 洪聖宮". In this connection, Site 2 was not selected for the proposed STP.

2.3.6 **Site 3** is located at the shore to the south of Po Toi O Village. Similar to Site 1, this land is zoned as "Coastal Protection Area" where development is generally against. Release of suspended solids from dredging and reclamation works for site formation for the proposed STP is also detrimental to the fish culture zone and marine wildlife. In addition, village representatives also objected construction of the proposed STP in Site 3 due to visual impact. In this connection, Site 3 was not selected for the proposed STP.

2.3.7 **Site 4** is located at the slope above Po Toi O Chuen Road and to the east of Site 3. This land is zoned as "Conservation Area". This zoning intends to protect and retain the existing natural landscape, ecological or topographical features of the area for conservation, educational and research purposes and to separate natural environment such as Country Park from adverse effects of development. Nevertheless, **Site 4** is

furthest away from residence in Po Toi O and thus bringing the least odour concern during operation of the STP. In addition, as the Site is located uphill, construction works are less likely to cause severe water pollution like Site 1 and Site 3 do. The village representatives supported the proposed STP to be located at this location. In view of the above, Site 4 was selected for the proposed STP.

2.3.8 The STP can either be constructed on the slope next to Po Toi O Chuen Road or further uphill. The latter option is not preferred due to a number of disadvantages. Further upslope is a natural, undisturbed shrubland. Establishment of an access road for maintenance vehicles will bring substantial vegetation clearance. Also, sewage has to be pumped uphill to the STP and this incurs additional operational cost and is not environmentally friendly in the long run. On the other hand, part of the slope next to Po Toi O Chuen Road is a cut slope, which is a disturbed habitat. By placing the STP on the cut slope, maintenance vehicles could easily gain access the site and thus vegetation clearance can be minimized. In addition, the cut slope is at a lower altitude and less energy will be required for pumping.

2.3.9 On the cut slope, the STP was primarily designed next to a seasonal stream W2 in the Project Profile (**Figure 2-1** refers). It was later shifted southward to create a buffer from W2 and also from the residences as this reduces potential odour impact and operational noise concerns. In addition, the STP is kept at a reasonable distance from the village so that the rising mains and gravity sewers will not be unnecessarily long. After the above amendment, this was adopted as the preferred Site in this EIA (**Figure 1-1** refers).

Summary of Site Selection for STP

2.3.10 Building the STP in the village area will cause odour nuisance, unacceptable noise and visual impacts on the nearby residence. The narrow strip of coastal protection area has to be reclaimed to provide sufficient land to accommodate a STP. The construction process will inevitably destroy the coastal habitat and bring significant elevation in suspended solids in water, affecting fish culture zone and marine wildlife (e.g. corals and amphioxus).

2.3.11 Construction of STP within conservation area is the only viable option as ecological impact can be minimized by choosing an already disturbed habitat (a cut slope). Without marine works, water quality, marine ecological and fisheries impacts can be avoided. Noise and odour nuisances are reduced by locating the STP away from village area. View of the STP from residence can be partially screened by embedding the plant in rock slope.

2.3.12 A comparison table showing the impacts of the four sites is shown in **Table 2-1**.

Table 2-1: Summary of Site Selection Process for Sewage Treatment Plant (Undesirable items are underlined)

Impact	Site 1	Site 2	Site 3	Site 4 (Preferred Site)
Zoning in OZP	Coastal Protection Area	Village Zone	Coastal Protection Area	Conservation Area
Operation and Maintenance consideration	**Unacceptable.** There is no vehicle access to Site 1. Maintenance vehicles cannot gain access to the STP. Maintenance activities such as sludge removal, replacement/ repair of E&M parts become **infeasible**. Site 1 is subject to tidal effect especially during typhoon, which would pose a threat to the E&M equipment of the STP and thus risk plant breakdown.	**Unacceptable.** There is no vehicle access to Site 2. Maintenance vehicles cannot gain access to the STP. Maintenance activities such as sludge removal, replacement/ repair of E&M parts become **infeasible**.	**Undesirable.** Maintenance vehicles can gain access to Site 3 via Po Toi O Chuen Road. Maintenance activities such as sludge removal, replacement/ repair of E&M parts become **feasible**. However, Site 3 is subject to tidal effect especially during typhoon, which would pose a threat to the E&M equipment of the STP and thus risk plant breakdown.	**Acceptable.** Maintenance vehicles can gain access to Site 4 via Po Toi O Chuen Road. Maintenance works are **feasible**.
Ecological & Water Quality Impacts	**Considerable impact**. As dredging and reclamation are required, impacts on water quality, marine ecology and coral communities are expected. Furthermore, existing coastline will be broken.	**Acceptable impact**. The STP will be built on developed land.	**Considerable impact.** As dredging and reclamation are required, impacts on water quality, marine ecology and coral communities are expected. Furthermore, existing coastline will be broken.	**Acceptable impact**. Shrubland habitat and one common plant species of conservation importance will be lost (*Gnetum luofuense*, a climbing plant that has low transplantation success due to difficulty in making root ball on rock slope and its twining nature). However, impacts on water quality, coastline, marine ecology and coral communities can be avoided.
Air & Noise Impacts	**Unacceptable noise impact and prone to odour nuisance** as Site 1 is near existing residential houses.	**Unacceptable noise impact and prone to odour nuisance** as Site 2 is near existing residential houses.	**Insignificant odour nuisance and noise impact** due to sufficient distance from residence.	**Insignificant odour nuisance and noise impact** due to sufficient distance from residences.
Visual Impact	**Unacceptable adverse visual impact.** Site 1 breaks the existing coastline and block the seaview of residential houses behind and in Fairway Vista.	**Unacceptable adverse visual impact.** Site 2 is sandwiched between residential houses and in front of "洪聖宮".	**Unacceptable adverse visual impact.** Site 3 breaks the existing coastline and causes moderate visual impact on the residential houses near Site 3.	**Acceptable visual impact.** Site 4 is mainly embedded in existing slope, causing minimal impact on existing residential houses.
Local Opinion	**Objected** by village representatives due to its visual impact at seashore.	**Strongly objected** by village representatives due to its visual impact on "洪聖宮" and proximity to residential houses.	**Objected** by village representatives due to its visual impact at seashore and its close proximity to residential houses.	**Supported** by village representatives.

Impact	Site 1	Site 2	Site 3	Site 4 (Preferred Site)
Construction Cost and Difficulties	**High.** Involve excavation of rock mass under the seashore, dredging and reclamation works.	**Lowest**. Involve excavation of rock mass underground.	**High**. Involve excavation of rock mass under the seashore and dredging and reclamation works.	**High**. Involve excavation of rock slope and rock mass underground, and provision of retaining structure.
Fisheries Impact	**Unacceptable**. 111m to the existing fish culture zone. Would cause adverse impact during the dredging works	**Minimal impact** as the STP is on developed land.	**Unacceptable**. 86m to the existing fish culture zone. Would cause adverse impact during the dredging works	**Minimal impact** as the STP is on slope.

Need of Submarine Sewage Outfall and Dredging

2.3.13 According to the Technical Memorandum of the Water Pollution Control Ordinance, no new effluent will be allowed within 200m of the seaward boundaries of a marine fish culture zone, or within 100m of the landward boundaries.

2.3.14 For the discharge of treated effluent from the sewage treatment plant, a 200m long pipeline was initially proposed to be laid along the rocky shore to discharge treated effluent near shore (see **Figure 2-2**). However, local residents strongly objected any construction works along the natural shoreline during the consultation process. Furthermore, as there is a large natural slope along the shoreline, substantial slope stabilization works will be required for construction and future maintenance of the proposed pipeline. Therefore, the treated effluent has to be discharged by a submarine outfall and diffuser.

2.3.15 Although this alternative will involve minor dredging, no slope stabilization works are required and this is more acceptable to local residents. Also, ecological impact will be minimized by placing the diffuser at outer Po Toi O bay to avoid Amphioxus habitat as explained in **Section 2.3.21**. Minor dredging is required for installing the diffuser at seabed. The water quality impact related to dredging will be minimized by fully enclosing the dredging area within cofferdam.

2.3.16 The submarine outfall directs effluent from rising mains on land to the diffuser in seabed. The alignment of submarine outfall must go straight towards the proposed diffuser location. Curved alignment will increase resistance to effluent flow, prolonging the time for discharge. This may also cause settlement of particles in effluent at turning point. Also, unnecessary curvature will increase construction difficulty. Thus straight horizontal alignment is adopted.

2.3.17 The submarine outfall will be constructed by Horizontal Directional Drill (HDD) as explained in **Section 2.4.6**. The drill head will penetrate the ground at the coast, drill underneath the seabed and emerge from the seabed at the proposed diffuser location. By adopting this construction method, no dredging is required along the submarine outfall alignment. Water deterioration, impacts on marine ecology and fisheries as well as generation of marine sediment due to dredging operation will be significantly minimized. The works will involve a dredging barge stationed next to the cofferdam. With localized dredging operation, disturbance to marine traffic and safety can be minimized.

2.3.18 Three diffuser location options are formulated and illustrated in **Figure 2-2**:

- Option 1 – Near rocky shore (Design in Project Profile)
- Option 2 – Mouth of Po Toi O Bay
- Option 3 – Outer Po Toi O Bay

2.3.19 For **Option 1**, the diffuser location was designed based on the shortest permissible distance from Po Toi O Fish Culture Zone (200m). It is located right next to the rocky shore where corals were later recorded during the course of EIA Study (see **Figure 2-2** for location of corals). Construction works will likely damage the rocky

shore and the corals. Also, the water depth was far too shallow (about 3m) for the installation of the diffuser as it may be damaged by boats cruising or anchoring in the waterway.

2.3.20 For **Option 2**, the diffuser is located at the mouth of Po Toi O Bay, about 141m away from Option 1, and is about 226 m away from Po Toi O Fish Culture Zone. Coral surveys confirmed that no coral was recorded away from shore in waters near the central part of Po Toi O Bay channel. As the water current is expected to be higher at the outer Po Toi O channel with a much larger water body in Clearwater Bay, the dispersion of the treated effluent should be much improved, reducing potential water quality, marine ecological and fisheries impacts. Furthermore, greater water depth (about 5m) would provide sufficient clearance for marine vessel movements. However, subsequent benthic survey recorded species of conservation importance, Amphioxus, at the diffuser location.

2.3.21 For **Option 3**, the diffuser is located at the outer part of Po Toi O Bay, about 239m and 110m away from Options 1 and 2 respectively, and is about 326 m away from Po Toi O Fish Culture Zone. Additional benthic survey did not record any Amphioxus or other species of conservation importance (e.g. coral) at this location. This new diffuser option is even further away from the Po Toi O bay and the mariculture zone. The water is over 10m deep, further improving navigation safety and effluent dispersion. The starting point of submarine outfall is slightly shifted to the east when compared with Options 1 and 2 as a larger works area for placing HDD equipment was found necessary.

2.3.22 Although the construction cost for Option 3 will be higher than the other two due to longer submarine outfall, Option 3 is selected as the preferred option due to smaller impact on water quality (better effluent dispersion), marine ecology (no coral and amphioxus) and marine traffic safety (deep water depth). The environmental benefits and dis-benefits and other considerations of each option are summarized below:

Table 2-2: Summary of Site Selection Process for Diffuser

	Option 1 (Design in Project Profile)	**Option 2**	**Option 3 (Preferred design)**
Location	Diffuser near rocky shore within PTO channel	Diffuser at the mouth of PTO bay	Diffuser at the outer part of PTO bay
Water Depth	3m	5m	10m
Length of SO	192m	285m	385m
Benefits	Lower cost due to shorter SO	Smaller impact on coral	Smaller impact on coral and amphioxus
		Better water dispersion	Better water dispersion
		Better marine traffic safety	Better marine traffic safety

	Option 1 (Design in Project Profile)	**Option 2**	**Option 3 (Preferred design)**
Dis-benefits	Impact on coral	Impact on amphioxus	Highest cost due to longer SO and deeper water
	Shallow water depth affecting marine traffic safety	Higher cost due to longer SO	

* STP: Sewage Treatment Plant, SO: Submarine Outfall

Gravity Sewer and Rising Mains Alignment

2.3.23 The gravity sewer and rising mains will be laid along the footpath between residences. The rising mains will eventually be connected to the submarine outfall at the rocky shore. Therefore, the alignment of the pipelines will be determined by the selected STP and residence locations.

Duration of Effluent Discharge

2.3.24 In response to the worry raised by the locals on drifting of treated effluent back to the Po Toi O bay under flood tide condition, an option on effluent discharge only during ebb tide was considered. Due to the difficulty in operation with varying tidal periods, the discharge was assumed to occur every 12.4 hours, the approximate tidal period, under the control of a timer. The treated effluent would be stored inside the plant between discharges.

2.3.25 However, this method was considered not cost-effective or practical due to the following considerations:

(1) The water quality model showed that the water quality would be similar to that under normal discharge scenario, i.e. continuous discharge right after treatment.

(2) *E. coli* in effluent may propagate during storage. Additional disinfection would be required before discharge, incurring extra operation cost. Also, the contact time may not be sufficient to ensure that the concentration can meet the discharge standard.

(3) The tide can be irregular at times, resulting in insufficient tidal flow.

Emergency Plant Breakdown

2.3.26 In case the sewage treatment plant (STP) breakdowns due to power or equipment failure, the following actions were considered:

- Option 1: Discharge of untreated sewage along a channel next to the STP directly into the bay
- Option 2: Discharge of untreated sewage through the submarine outfall
- Option 3: Removal of untreated sewage by tankers to other STP

2.3.27 For the first two options, the major water quality impact during emergency discharge is elevation of *E. coli* concentration.

2.3.28 **Option 1** is a typical provision in sewage treatment plants in Hong Kong by quickly removing sewage before overflowing inside the plants. However, the discharge location is located within 200m of the seaward boundaries of Po Toi O Fish Culture Zone, which does not satisfy TM of WPCO mentioned in **Section 2.3.13**. Also, water quality model results found that *E. coli* in sewage would be trapped within the Po Toi O bay. Although the impact is temporary, significant elevation in bacterial content in water may contaminate the fish in Po Toi O fish culture zone.

2.3.29 **Option 2** should have smaller impact than Option 1 has as the discharge point is further away from fish culture zone. Stronger water current and deeper water depth at the mouth of Po Toi O bay also allow better dispersion and dilution of sewage. However, this option is highly undesirable as the pipe is only 280mm in diameter and has a sagging profile. Particles in the raw sewage would settle and accumulate at the lowest point if raw sewage was to be discharged through the pipe. Desilting this pressurized main would be very difficult due to its inaccessibility at the landward side. On the other hand, constructing another emergency submarine disposal pipe of similar length (385m) would be expensive and not cost effective, not to mention that the said problem remains unresolved.

2.3.30 **Option 3** is practical and chosen as the preferred option. As the average dry weather flow (ADWF) of PTO STP would be small (about 139m^3/day), it is possible to deploy tankers to transport away the sewage to Tseung Kwan O Preliminary Treatment Works (TKO PTW) (or other nearby STW) in case of plant failure.

2.3.31 Emergency storage of 4-hour ADWF (23.19m^3) will be provided in the PTO STP. In case of plant failure, three 12m^3 sewage tankers will be called in to transport the sewage from PTO STP to TKO PTW. Each tanker will take different travel routes to reduce the risk of delay due to traffic jam. The tanker arrangement is as follows:

Table 2-3: Tanker Away Arrangement

Tanker	Source	Potential Route	Arrival Time	Duty
A	DSD's tanker which stationed at Sai Kung Sewage Treatment Works	Sai Kung STW → Hiram's Highway → Clearwater Bay Road → Tai Au Mun Road → Po Toi O STP	1.5 hours from plant failure	Transport sewage from PTO STP to TKO PTW
B	DSD Sewage Treatment Division Term Contractor, required to arrive in 2 hours in contract	Shatin STW* → Route 9 → Tate's Cairn Tunnel → Clearwater Bay Road → Tai Au Mun Road → Po Toi O STP	2.5 hours from plant failure	Transport sewage from PTO STP to TKO PTW

Tanker	Source	Potential Route	Arrival Time	Duty
C	DSD District Term Contractors (any 1 of the 3 districts), required to arrive in 1.5 hours in contract	Kwun Tong Preliminary Treatment Works* → Tseung Kwan O Road → Clearwater Bay Road → Tai Au Mun Road → Po Toi O STP	2.5 hours from plant failure	Standby at PTO STP, to be on duty if Tanker A/B breaks down or encounters traffic delay

* Typical location where term contractor's tankers are stationed

2.3.32 The distance between PTO STP and TKO PTW is about 12.1km or 18-minute travel distance. Including sewage loading and unloading time, each tanker is assumed to take 2 hours round trip. Tankers A and B will work in shift to continuously remove sewage from PTO STP. If one of the tankers fails to arrive at PTO STP on time, Tanker C will come in to ensure that at least two tankers will be operating. An operation drill prior to future operation will be conducted to confirm that the time estimates are achievable at peak hours.

2.3.33 **Appendix 5.5** shows the fluctuation of sewage volume in PTO STP in case plant failure occurs during peak sewage flow (6pm). With continuous removal of sewage by tankers in rotation, the highest quantity stored in the plant will be 17.24m^3, which is well below the emergency storage capacity (23.19m^3). With about 6m^3 storage buffer, the chance of having sewage volume exceeding the storage capacity is very low. No overflow of sewage from the PTO STP is anticipated.

2.3.34 Each tanker will deliver 12m^3 sewage from PTO STP to TKO PTW. Based on DSD's past experience, it takes 15 minutes to unload all sewage, the average flow rate will be 12m^3/15 minutes/60 seconds = 0.013m^3/s, which is far below the design capacity of TKO PTW (5.55m^3/s) [1]. No overloading of TKO PTW is anticipated.

2.3.35 Considering the project scale, risk of emergency condition, construction difficulties and cost, the following provisions are the most appropriate and practical mitigation measures in case of plant/power failure:

- Delivery of an emergency generator to PTO STP within 4 hours from plant failure
- Provision of dual power by CLP;
- Provision of a supervisory control and data acquisition system (SCADA), which signals to the operation and maintenance personnel for emergency attendance in case of plant failure;
- Provision of a standby pump and screen at the PTOSTW;
- Provision of emergency storage of 4-hr ADWF sewage retention time;

1 Maunsell Consultants Asia Ltd. 2005. Further Development of Tseung Kwan O Feasibility Study (Application No. EIA-111/2015) Ch. 6 Sewerage and Sewage Treatment. [online] Available at: http://www.epd.gov.hk/eia/register/report/eiareport/eia_1112005/HTML/EIA/HTML/Volume%201/Sec_6%20Sewerage.htm. Last Accessed: 23 March 2016.

- Arrangement of tankers for removing incoming sewage to other sewage treatment plants for treatment continuously to ensure sufficient buffer for emergency storage.

2.3.36 Based on these provisions, emergency discharge of raw sewage is not expected, and thus no adverse impact on water quality, marine ecology or fisheries due to emergency discharge is anticipated.

Capacity of the Sewage Treatment Plant

2.3.37 The sewage treatment plant was planned to treat the sewage from both Po Toi O and Tai Wong Kung in Project Profile stage. Nevertheless, since establishing a pipeline system to cover Tai Wong Kung is not cost effective, Tai Wong Kung will not be served by this Project. Therefore, the average dry weather flow (ADWF) of the STP decreases from 220m^3 in the Project Profile to about 139 m^3 per day in the current design.

2.4 Consideration of Alternative Construction Methods

Sewage Treatment Plant

2.4.1 The proposed sewage treatment plant will be constructed on a cut slope with hard bed rock. Rock breaking by hydraulic breakers and stabilization by bored piling are common construction methods. Drilling of bored piles has the advantage of less noise and vibration generation. Driven piles are not adopted due to existence of rock layer. Blasting of bed rock is not considered due to safety concern.

Gravity Sewer and Rising Mains

2.4.2 Gravity sewer and rising mains will be laid along the footpath in Po Toi O. Open trench excavation involves excavation, pipe laying and backfilling, the most common method for pipe laying in shallow ground layer. As there are different existing underground utilities located along the footpath in Po Toi O, trenchless method is considered risky for pipe laying in shallow ground layer.

2.4.3 As mentioned in **Section 2.3.1**, all sewage treatment processes will be conducted in the basement level. Sewage will flow along the gravity sewers to the basement of STP. Between Po Toi O Village and STP, the gravity sewers will be deep underground. Open trench method requires extensive excavation works and cause disturbance to the existing footpath and carriageway, and therefore this is not recommended. On the other hand, trenchless method will be adopted in this section to drill through the hard rock layer.

Submarine Outfall

2.4.4 Submarine outfall conveys treated effluent from the rising mains in Po Toi O Village to the diffuser at the outer part of Po Toi O Bay. Two construction methods have been considered:

- Option 1: Open dredging
- Option 2: Horizontal Directional Drill

2.4.5 For **Option 1**, the traditional construction method will use open dredging to create a trench for pipe laying and then backfill. Dredging will release marine sediment within Po Toi O bay. The semi-enclosed geography will hinder dispersion of suspended solid and cause water quality impact on the fish culture zone, coral and amphioxus within the bay. Contaminants in marine sediment may also dissolve in water. Furthermore, occupation of dredging barge and tugboat at the narrow channel at the mouth of Po Toi O bay will affect movement of fishing vessels and boats.

2.4.6 **Option 2** Horizontal Directional Drilling (HDD) involves a drill head that penetrates underground from the shore until reaching the location of diffuser. No dredging or disturbance of surface sediment is required, minimizing water quality, marine ecology, fisheries and marine traffic impacts. Therefore, this option is selected as the preferred method.

2.4.7 The following table summarizes the benefits and dis-benefits of HDD and dredging for submarine outfall construction.

Table 2-4: Summary of Selection Process for Construction Works of Submarine Outfall

	Option 1	Option 2
Method	Open Dredging	HDD
Benefits	Lower cost	No disturbance of seabed surface and thus no release of SS
	Faster Programme	No disturbance to FCZ, coral or amphioxus
		No obstruction of marine traffic and thus safer
Dis-benefits	Adverse water quality deterioration, fisheries and marine ecological impacts	Higher cost
	Affect marine traffic along Po Toi O channel and also navigation safety	Longer programme

	Option 1	Option 2
Impact Duration	Throughout dredging works and effect of water pollution will last until SS get diluted and settled	Not anticipated
Impact Severity	High	Low

Diffuser

2.4.8 At the end of the submarine outfall on the seaward side, dredging of 1,200m^3 marine sediment is required for installation of the diffuser. Two construction methods have been considered:

- Option 1: Open Dredging
- Option 2: Dredging within Fully Enclosed Cofferdam

2.4.9 **Option 1** involves traditional open dredging, which may result in elevation in SS and sedimentation rate at the FCZ, corals and amphioxus. This option is not chosen given the sensitivity of these sensitive receivers to water deterioration.

2.4.10 **Option 2** involves dredging within fully enclosed cofferdam by a dredger barge anchored outside. No release of sediment into marine waters outside the cofferdam is expected. Only minor disturbance of seabed is required during erection of the cofferdam.

2.4.11 The following table summarizes the benefits and dis-benefits of open and enclosed dredging for diffuser construction.

Table 2-5: Summary of Selection Process for Construction Works of Diffuser

	Option 1	Option 2 (Preferred Option)
Method	Open Dredging	Dredging within Fully Enclosed Cofferdam
Benefits	Lower cost	Minor disturbance of seabed during cofferdam erection. No release of SS during dredging
	Faster Programme	No disturbance to FCZ, coral or amphioxus during dredging
Dis-benefits	Moderate water quality, fisheries and marine ecological impacts	Higher cost
		Longer programme
Impact Duration	Throughout dredging works and effect of water pollution will last until SS get diluted and settled	Short term release of SS during cofferdam erection. No water quality impact is expected during dredging
Impact Severity	High	Low

2.5 Consideration of Alternative Work Sequences

2.5.1 Construction work will be divided into three major parts:

(1) sewage treatment plant (STP),

(2) gravity sewers and rising mains and

(3) submarine outfall and diffuser installation.

2.5.2 The construction works are expected to commence in mid-2017 for completion in 2021 with one more year for defect correction. The proposed programme, which may be subject to amendment, is listed in **Appendix 2.2**.

2.5.3 After site clearance, the construction works for STP will commence. To minimize cumulative noise impact, pipe laying will be carried out after completion of the major noise emission works (i.e. excavation of STP). Due to topography of the area, pipe laying will progress from Po Toi O Village near the coast to Fairway Vista uphill. There will be three concurrent work zones, each of about 100m apart to reduce cumulative noise impact. The submarine outfall will be constructed near completion of civil works on the STP, and this will be followed by the diffuser installation.

2.6 Selection of Preferred Scenario

Selected Site and Construction Method

2.6.1 In summary, selection of the locations and construction methods for the sewage treatment plant, submarine outfall and diffuser have considered the following constraints:

- Current zonings in OZP
- Accessibility
- Distances from sensitive receivers, e.g. village houses, fish culture zone
- Presence of corals, amphioxus or other species of conservation importance
- Effluent dispersion effect
- Marine traffic safety
- Public concerns

2.6.2 The preferred scenario is summarized below:

Table 2-6: Summary of Preferred Scenario

Component	Location	Existing Condition	Construction Method
Sewage Treatment Plant (STP)	Cut Slope next to Po Toi O Chuen Road	Shrubland	Excavation and Bored Piling
Gravity Sewers/ Rising Mains	Between STP and Po Toi O Village	Cut slope/ Paved road	Trenchless/ Open Trench Excavation
	Po Toi O Village	Concrete paved footpath	Open Trench Excavation
Submarine Outfall	Along Po Toi O Bay channel	Below seabed	Horizontal Directional Drill (HDD)
Diffuser	Outer PTO Bay	Seabed with no record of corals/amphioxus	Dredging in fully enclosed cofferdam

2.6.3 The preferred scenario has the following environmental benefits comparing to other options:

- Avoid destruction of coral-lined rocky shore and a major amphioxus habitat by shifting the diffuser location away from shore and in seabed without amphioxus
- Minimize terrestrial ecological impact by placing the STP on a cut slope, which is an ecologically less sensitive habitat
- Minimize visual impact by embedding the STP into existing cut slope
- Minimize water quality, marine ecological and fisheries impact by (1) having no dredging works for constructing submarine outfall, and (2) confining dredging works for diffuser within four-side enclosed cofferdam
- Minimize odour and noise nuisance by keeping sufficient buffer distance between the STP and village houses (>59m)

2.6.4 In addition to the benefits mentioned above, the following measures will also be implemented to minimize environmental impacts:

- minimize the footprint and mass of STP by constructing most of the STP underground
- minimize noise disturbance to nearby noise sensitive receivers by installing noisy plant equipment underground
- provide appropriate façade treatment (e.g. adopting recessive colours on STP wall that blend in with the natural tones of the landscape backdrop), compensatory tree planting and vertical greening

Normal Operation

2.6.5 Sewage from Po Toi O will be collected through the gravity sewer to Po Toi O STP for MBR treatment. Treated effluent will be pumped through the submarine outfall underground and discharged at a diffuser at the outer part of Po Toi O Bay. The ADWF is designed at 139m^3/day.

Emergency Plant Breakdown during Operation

2.6.6 The PTO STP cannot operate in case of power or equipment failure. The SCADA system in the PTO STP will signal to the operation and maintenance personnel for emergency attendance. Standby pumps and screens will be provided at the PTO STP. According to the performance pledge of CLP, electricity provision will be restored within 2 hours after fault outage. Also, DSD's future term contractor should be able to deliver an emergency generator to the STP within 4 hours in case of plant failure.

2.6.7 If the plant cannot be restored immediately, the in-coming sewage will be temporarily stored at a capacity of 4-hour ADWF volume. Tankers will be deployed to continuously transport the sewage to Tseung Kwan O Preliminary Treatment Works (or other nearby STW) for treatment. This can continuously maintain sufficient buffer for emergency storage (details available in **Sections 2.3.30 - 2.3.35**). The above measures are the most appropriate and practical mitigation measures in case of plant/power failure considering the project scale, risk of emergency condition, construction difficulties and cost. Emergency discharge of untreated sewage is not expected.

2.7 Details of Selected Construction Methods

2.7.1 Details of selected construction method from **Section 2.4** are shown below:

Sewage Treatment Plant

2.7.2 The proposed STP is one-storey high, with the top level at about 5m above ground. The basement is about 10m below ground comprising two levels. A retaining structure will be constructed to reinforce the slope behind the proposed STP.

2.7.3 During the construction, a temporary platform will be erected on the existing slope for the construction of a bored pile wall. Then the slope will be cut down to the level of the Po Toi O Chuen Road. Temporary lateral support will be constructed and the land will be further excavated to make room for the STP.

2.7.4 After the STP is built, E&M and building services installations will commence. Run-in and run-out for sludge tank will also be constructed. All pumps and plant equipment will be placed inside the building.

Gravity Sewers and Rising Mains

2.7.5 The proposed gravity sewers and rising mains will be constructed by open trench excavation and trenchless method.

2.7.6 For gravity sewers or rising mains to be placed less than or equal to 3.5m deep underground, open trench excavation will be adopted. The works area will be surrounded by temporary barriers. Trenches will be excavated by hand held tools and lateral support will be provided to prevent collapse. After pumping out groundwater, gravity sewers and/or rising mains will be placed in segments. The trench will be backfilled with the excavated soil and the works area will be reinstated.

2.7.7 For gravity sewers to be placed deeper than 3.5m underground, trenchless method will be adopted. The works area will be surrounded by temporary barriers. Jacking pit and receiving pits will be excavated and the sewer will be installed by heading method. The pits will be backfilled with excavated soil and the works area will be reinstated.

2.7.8 Drilling with chemical agent will be considered as far as practicable in the construction phase according to local situation.

Submarine Outfall & Diffuser Installation

2.7.9 Horizontal directional drilling (HDD) will be used to construct submarine outfall. On the landward side, a 7m deep entry pit will be excavated within sheet piles at the rocky shore above the high water mark. On the seaward side, a 10m x 50m fully enclosed cofferdam will be constructed around receiving pit by sheetpiles.

2.7.10 During the HDD process, the HDD drill rig will be inserted into the entry pit and drill through the rock layer below the sea. A small drill head will be used to form a small pilot hole on the first run. The drill head will emerge from the sea bottom at the receiving pit within the cofferdam. Pre-reaming process will be carried out using a larger drill head until the designed hole size is formed. A sleeve of 600 mm diameter will be installed encasing the rising mains, followed by connection and installation of the pre-casted diffuser ($<5m^2$ in area). When the works are completed, the entry pit and receiving pit will be backfilled to the original level. The sheet piles will then be extracted. Rocks that are temporarily removed for HDD works will be laid back onto the rocky shore for reinstatement.

2.7.11 Water protection measures are implemented during HDD and dredging inside cofferdam. Bentonite will be used as drilling liquid in HDD. Cuttings in bentonite will be extracted out for disposal and the reconditioned bentonite will be reused for drilling process. No wastewater will be generated.

2.7.12 After erection of cofferdam, the water inside will be pumped out and stored in a sedimentation tank of the barge for settling the suspended solids. The water will be treated up to the requirement in the Wastewater Discharge License for discharge. The marine sediment will be dredged by a dredger barge anchored outside the cofferdam.

The removed sediment will be stored in a sealed compartment of the dredger barge. No release of marine sediment outside the cofferdam is anticipated. The dredger barge, tug boat and barge for material storage will occupy around 1,020m^2 of sea area.

2.8 Public Consultation

2.8.1 Before the commencement of this EIA Study, the Sai Kung District Council and local residents had been consulted on the proposal for providing sewerage system to the un-sewered Po Toi O area. Although residents of Po Toi O generally welcomed the proposal during the Sai Kung District Council meetings over the past five years, they were worried about the secondary impact of the treated effluent. Environmental concerns and their solutions are summarized in **Table 2-7**.

2.8.2 During the course of this EIA Study, a public consultation was conducted to present the preferred layout to local communities, including residents from Po Toi O Village and Fairway Vista, mariculturists and fishermen, Sai Kung District Council and Green Groups. In general, all stakeholders welcomed the Project as it can bring benefits to the community. However, environmental concerns (e.g. water quality impact, odour impact, noise impact) were also brought out. Environmental concerns and their solutions are summarized in **Table 2-7**.

Table 2-7 Summary of Environmental Concerns with Solutions

	Environmental Concerns	Solutions
(a)	Potential adverse impact of the effluent on the Clear Water Bay First Beach and Second Beach	The effluent will be discharged at outer Po Toi O Bay with deep water depth (10m). Great depth and fast water flow result in sufficient dispersion and dilution of effluent. According to **Chapter 5 – Water Quality Impact Assessment**, the water quality in Clear Water Bay First Beach and Second Beaches will only have negligible changes. No adverse impact is anticipated.
(b)	Impact of the treatment plant on the fishery industry in Po Toi O	The effluent will be discharged at outer Po Toi O Bay, 326m away from Po Toi O Fish Culture Zone. In case of plant failure, sewage will be tankered away for treatment. No discharge of untreated sewage is anticipated that may result in significant deterioration of water quality in the FCZ. According to **Chapter 8 – Fisheries Impact Assessment**, normal operation of the STP will only bring insignificant impact on fisheries (including culture fishery in Po Toi O).
(c)	*E. coli* and micro-organisms would be trapped in the sack-like Po Toi O bay	The effluent will be discharged at outer Po Toi O Bay via a 385m long submarine outfall, such that the great depth and fast water flow can provide sufficient dispersion and dilution of the treated effluent already meeting the treatment standard. No

	Environmental Concerns	Solutions
		discharge of untreated sewage will be permitted in case of plant failure. According to **Chapter 5 – Water Quality Impact Assessment**, no substantial change in *E. coli* is expected during normal operation of the STP.
(d)	Water quality impact from dredging works and effluent discharge on fish culture zone	Construction of the submarine outfall by Horizontal Directional Drilling eliminates the need for dredging, except for the diffuser location. At the diffuser location, since all dredging and backfilling works will be conducted within a fully enclosed, water-tight cofferdam, no water quality impact is expected due to these works. According to **Chapter 5 – Water Quality Impact Assessment**, once the Project is in operational phase (i.e. discharging treated effluent), no substantial change in the water quality around Po Toi O Fish Culture Zone is expected.
(e)	Landscape and visual impact due to construction of sewage treatment plant	The STP is designed with a small building mass by constructing most of the structure underground. This can minimize construction work site. The STP will have non-reflective finishes and recessive colours that blend in with natural tones of landscape backdrop. Tree and shrub planting and vertical greening will be provided to screen the building. These can minimize landscape and visual impact in operational phase. According to **Chapter 10 – Landscape and Visual Impact Assessment**, the impact will be acceptable in construction phase if mitigation measures are implemented properly, such as erecting decorative mesh screens or construction hoardings and/or temporary noise barriers around works areas in visually unobtrusive colours.
(f)	Odour impact from public sewer and operation of sewage treatment plant	Public sewer will have U-shaped water trap for preventing odour leak. During operation of STP, sludge removal will be conducted within STP building, which is equipped with filters with over 99.5% odour removal efficiency. According to **Chapter 3 – Air Quality Impact Assessment**, odour impact is anticipated to be acceptable in operation phase.
(g)	Noise generated from pumps during operation	Most plant equipment will be placed underground and enclosed within the sewage treatment plant. According to **Chapter 4 – Noise Impact Assessment**, operational noise impact is anticipated to be acceptable.

	Environmental Concerns	Solutions
(h)	Ecological impact on coral communities	The location of diffuser will be installed away from the coast grown with corals. Dredging works in construction phase will be fully enclosed within cofferdam, preventing leakage of suspended solids that may affect coral communities. According to **Chapter 7 – Marine Ecology Impact Assessment** no direct impact on coral communities is anticipated.

2.9 Concurrent Projects

2.9.1 There may be two potential concurrent projects in the area, i.e.

- Roundabout near the minibus terminal;
- Fish culture zone (FCZ) dredging and relocation

2.9.2 During the course of the study, CEDD has confirmed that there was no programme for the fish culture zone dredging and relocation. There was also no information on when the roundabout would be constructed.

2.10 Environmental Benefits

Environmental Enhancement Project by Nature

2.10.1 The proposed sewerage works in Po Toi O is an environmental enhancement project by nature. It aims to improve environmental hygiene in the Po Toi O area through replacement of septic tanks/soakaway systems (STS) in Po Toi O area by public sewerage system. Sewage will be properly collected, treated by MBR up to effluent discharge standard of Port Shelter Water Control Zone and discharged via submarine outfall at a diffuser installed at seabed in outer Po Toi O Bay.

Various Green Measures in the Project
(Mainly by Avoidance and Minimization of Potential Impacts)

2.10.2 Po Toi O has scenic seashore and is embraced by hilly terrain overgrown with shrubs and trees. Village settlements along the shore and fish farming in the bay give Po Toi O a unique rural landscape. This EIA Study has identified and fully considered the potential constraints imposed by this special environ, and has developed a number of green initiatives at this planning stage. In addition to improving environmental hygiene in the Po Toi O area, this Project targets to achieve environmental friendliness in sewerage, construction and operation designs. The green measures and the associated environmental benefits of this Project are summarized as follows:

Green Measures in Sewerage System Design

- **Minimization of loss of ecologically sensitive habitats** by locating the STP on a cut slope (disturbed shrubland) and laying gravity sewers and rising mains along existing footpath as far as possible (developed area);

- **Avoidance of destruction of coral-lined rocky shore and major amphioxus habitat** by shifting the treated effluent discharge location over 100m away from the coral-lined shore and species of conservation importance (amphioxus);
- **Minimization of fisheries impact** by discharging the treated effluent at about 326m away from fish culture zone;
- **Maximizing effluent dispersion** by placing the diffuser on seabed at >10m depth and at outer Po Toi O bay where current flow is fast;
- **Minimization of the footprint of the STP** by constructing most of the STP structure underground and adopting a less land demanding sewage treatment technology (MBR);
- **Minimization of odour and noise nuisance** by keeping sufficient buffer distance between the STP and village houses;
- **Minimization of visual impact** by embedding the STP into existing cut slope;
- **Maintenance of visual entity with surrounding undisturbed landscape** by provision of appropriate façade treatment (e.g. adopting recessive colours on STP wall that blend with the natural tones of the landscape backdrop), compensatory tree planting and vertical greening;
- **Avoidance of impact on built heritage resources** (e.g. Grade 3 historic building Hung Sing Temple) by laying gravity sewers and rising mains away from their footprint;

Green Measures in Construction Design

- **Avoidance of open dredging** to minimize water quality, marine ecological and fisheries impact by adopting (1) horizontal directional drilling for submarine outfall below seabed and (2) enclosed dredging within cofferdam for diffuser;
- **Avoidance of concurrent construction activities** by designing separate work programme for noisy works (carrying out rock breaking works for STP prior to laying of gravity sewer and rising mains and drilling for submarine outfall). Also, adopt three workfronts during pipe laying in village, each of short section and at least 100m away from each other.

Green Measures in Operation Design

- **Improvement of environmental hygiene and removal of associated odour nuisance in the Po Toi O area** by eliminating the need of desludging STS;
- **Avoidance of emergency discharge of raw sewage into waterbodies** by a number of designed arrangements in case of emergency plant failure, such as notification to operator by SCADA system, provision of standby equipment in the STP, provision of sufficient capacity of emergency storage of incoming sewage and provision of tankers for continuous removal of sewage to other STP for treatment.
- **Minimization of odour nuisance from STP** by provision of odour removal system of 99.5% efficiency in the STP;
- **Minimization of noise disturbance from STP** by storing noisy plant equipment underground.