2 DESCRIPTION OF THE PROJECT

2.1 PROJECT REQUIREMENTS

2.1.1 The main objective of this Project --upgrading and reconstructing the existing Peng Chau Sewage Treatment Works (STW) is to provide sufficient treatment capacity and adequate treatment levels to meet the demand of the projected catchment from Peng Chau as to minimise the water quality impact and the associated odour nuisance due to the untreated discharge.

2.1.2 The Project involves the construction of a secondary treatment works incorporating nitrification, de-nitrification and disinfection facilities. Emergency overflow outfall, storm tanks and a submarine outfall, which will extend with a short distance offshore from the boundary of the STW site are also to be constructed. At present, the Project is in preliminary design stage.

2.2 PUBLIC CONSULTATIONS

2.2.1 Various consultations were carried out between December 2003 and February 2004 to solicit the public views and support on the proposed STW Upgrade. The consulted parties included the Peng Chau/Discovery Bay Area Committee, Peng Chau Fishermen Association (PCFA), Green Peng Chau Association (GPCA), resident representatives of Sea Crest Villa and Islands District Council (IDC). Summary of the consultations are presented in **Table 2-1**.

Table 2-1 Summary of Public Consultations

Date of Consultation	Consulted Parties	Key Concerns and Suggestions of the Consulted Parties	Project Proponent's/ Study Team's Responses	Overall Views on the Project
17 December 2003	Peng Chau/Discovery Bay Area Committee	The environmental impact arising from the project should be acceptable.	There will be no unacceptable environmental impact from the Project if mitigation measures were implemented.	Support
6 January 2004	Peng Chau Fishermen Association	The north-west coast of Tai Lei Island might be a better location for the outfalls.	A desktop review was conducted on the outfall location suggested by PCFA. It was found in the review that the originally proposed south-west direction was the preferred option.	Support
13 January 2004	Green Peng Chau Association	The stakeholders expressed their concern that the effluent from the outfalls might have impact on nearby marine ecology, such as the *hippocampus kuda*, a species of seahorse, which was found in a dive survey conducted in the vicinity of Tai Lei Island in 2001.	As suggested by Oceanway Corporation Limited, who conducted the 2001 dive survey, the *hippocampus kuda* found was not a protected species and it could be found in other marine area in Hong Kong. Unlike sessile marine organisms, seahorse would swim away from affected area and the potential impact on seahorse is thus considered insignificant. In addition, based on the experience of the diving team, the proposed south-west direction was the location with least impact to nearby marine ecology.	Support
15 January 2004	Resident Representatives of Sea Crest Villa	The appearance of the STW should be improved.	The future appearance of the STW will be improved.	Support
9 February 2004	Islands District Office	The stakeholders expressed their concern on the potential impact on the marine environment around Peng Chau and Discovery Bay. And the appearance of the proposed STW should be aesthetic.	There will be no unacceptable impact to the marine environment arising from the Project if mitigation measures were implemented. The appearance of the proposed STW will be aesthetic	Support

Please refer to **Appendix 2A** for the details of the public consultations.

2.3 PROJECT LOCATION

2.3.1 The proposed Peng Chau STW Upgrade Project site and its general environs fall within the Peng Chau Outline Development Plan (ODP) D/I-PC/2 (July 2000) and Peng Chau Outline Zoning Plan (OZP) (S/1-PC/4) gazetted in August 2003. The proposed Project will be carried out on Tai Lei Island and Tai Lei Bridge. Submarine outfall construction will be carried out in the marine area to the southwest of Tai Lei Island.

2.3.2 The immediate surroundings of Peng Chau STW on Tai Lei Island consist of mainly government facilities, including a refuse transfer station and its associated pier, storage place for liquefied petroleum gas cylinders, and a temporary storage area occupied by the Highways Department. To the south of Tai Lei Island a public pier is located. The rest of Tai Lei Island has been zoned for Green Belt area (**Figure 2-1**).

2.3.3 Residential developments are concentrated on the Peng Chau Island and the closest one is a private medium density residential development Sea Crest Villa. A helipad has been proposed and will be constructed to the north-western shore of Peng Chau Island. To the south of Sea Crest Villa is a landscaped promenade along the seafront and an open area. Further south to the open area a comprehensive residential development area and a commercial complex are planned but the implementation schedules are not definite. To the immediate east of the planned comprehensive residential area is another planned comprehensive development area (CDA) with no definite development schedule. Two public housing developments, namely Kam Peng Estate and Peng Lai Court, are located to the south of the proposed CDA. Restaurant and other commercial facilities are mainly in the central and south-western portion of the island. There are few tourist spots and employment generating developments on the island. The remaining part of Peng Chau has scattered, low density village housing. Peng Chau is accessible by ferries from Hong Kong Island and Mui Wo on Lantau Island. It is also accessible by Kai-to ferries from Discovery Bay.

2.4 FUTURE ENVIRONMENTAL CONDITIONS WITHOUT IMPLEMENTATION OF THE PROPOSED PROJECT

2.4.1 The existing Peng Chau STW was designed in 1980s' to provide secondary wastewater treatment and disinfection to the wastewater collected from Peng Lai Court and Kam Peng Estate. The design capacity of the existing Peng Chau STW is based on the population of 1,500 with an average dry weather flow (ADWF) of 450 m^3/d. The sewerage systems serving Kam Peng Estate and Peng Lai Court are separate stormwater and domestic sewers and only domestic wastewater is directed into the existing plant for secondary treatment and disinfection. The design peak flow of the existing STW is 1,350 m^3/d (3 ADWF), and rotating biological contactors (RBC) are used as secondary treatment units.

2.4.2 Wastewater from rest of Peng Chau households is discharged into the combined drainage system and then into the marine waters without treatment. Due to poor dispersion characteristics of marine water in the area, the discharge of untreated wastewater leads to deteriorating of water quality and is the major water pollution

source to the highly sensitive marine environment such as the secondary contact recreational zone and the coral communities located to the northeast of Tai Lei Island.

2.4.3 The capacity of the existing STW is far short of the requirement for the future flows and loads from Peng Chau. It is expected marine water quality will further deteriorate if no proper sewage treatment is provided.

2.5 ENVIRONMENTAL BENEFIT AND DIS-BENEFIT OF THE PROPOSED STW UPGRADE

2.5.1 To cater for the identified problem, an upgrade of the existing STW is needed. Construction of village sewerage to collect and transfer wastewater from the majority of Peng Chau households to the Peng Chau STW has been implemented by the Drainage Services Department under Package H works of Outlying Islands Sewerage Stage 1 Phase 2. The works was started in September 2002 and is scheduled to be completed in mid 2005. It is planned in the ultimate sewage master plan that storm drains would eventually be separated from the sewage networks. However, due to the constraints and difficulties in modification and separation of the existing system in the congested and old household neighbourhood, it is unlikely that complete separation of the two systems would be achieved prior to the commencement of the upgrade of Peng Chau STW. It is anticipated that wastewater entering the upgraded facility would gradually increase and the influent would be of combined stormwater and domestic wastewater characteristics in the early stage of upgraded STW operation. Taking into account the characteristics of combined influent, the proposed STW upgrade would be designed to produce effluent meeting discharge criteria.

2.5.2 The major environmental benefits gained from the implementation of the Project would be the long-term improvement of water quality in the surrounding sensitive marine environment by substantially reducing the total organic and nitrogen loads into the marine water, as well as by facilitating dilution and dispersion of effluent through submarine outfall.

2.5.3 Although an overall improvement of long term water quality is anticipated, impacts due to construction and operation of the STW upgrade components as well as the submarine outfalls with respect to air quality, noise, water quality, waste management and marine ecology may occur. The acceptability of these environmental impacts is assessed in this report.

2.6 SCOPE OF WORKS

2.6.1 Two working phases are recommended and the detailed scopes are:

i. Phase 1 Works:

(a) construction of a new STW adjacent to the existing STW comprising secondary treatment with nitrification, de-nitrification and disinfection;

(b) construction of two new submarine outfalls;

(c) provision of de-odourization facilities;

(d) provision of associated sludge treatment facilities;

(e) extension of inlet pumping mains; and

(f) construction of equalisation tank.

ii. Phase 2 Works:

(a) demolition of the existing treatment facilities;

(b) construction of sludge drying bed; and

(c) construction of remaining works.

Flow Considerations

2.6.2 It was stipulated in the OISMP Stage 2 Review (EPD, 2002) that the future Peng Chau population forecast would be 11,000 and the projected average dry weather flow (ADWF) is 3,250 m^3/d. After the commencement of the Project, however, a different approach for population estimation was adopted by the Planning Department to replace the original Upon Full Development (UFD) approach, for which 100% occupancy rate of Peng Chau Island was assumed. A new approach Planned Population (PP), applied the natural occupancy rate of the Peng Chau Island for population projection and the projected population is lower. The estimated Peng Chau population by using PP approach was 6,200 at year 2011, and the respective ADWF was calculated to be 1,580 m^3/d.

2.6.3 This report is to assess the environmental impact of preliminary design of the Peng Chau STW Upgrade and submarine outfall for 6,200 population scenario with an ADWF of 1,580 m^3/d.

2.7 OUTFALL CONSIDERATIONS

2.7.1 The Outlying Islands SMP for Peng Chau under package D included the construction of a pumping station at Peng Chau and the laying of a submarine pipeline to link with the sewerage system at Discovery Bay for the export of sewage to Siu Ho Wan Sewage Treatment Works on Lantau Island.

2.7.2 Some post SMP issues were raised after the Outlying Island SMP Study. For Peng Chau, the scope and programme for the Lantau port development is no longer likely to be the same as that originally envisaged. The Peng Chau export proposal was reviewed in light of the latest port development proposals as well as the identified problems associated with arranging connection to the Discovery Bay sewerage system.

2.7.3 The Review Study carried out for the Outlying Island SMP in 2002 identified problems and issues associated with the combined sewerage systems, and capacity of the treatment and disposal systems. The Review Study further recommended that "provided that nitrification is incorporated, a relatively short outfall from any of the potential treatment sites will suffice. Short outfalls would be in close proximity to recreational waters and the available dilution is not sufficient to satisfy the bathing

water criteria or the secondary contact recreation WQO unless the effluent is disinfected." The Review Study also indicated a short outfall of about 40m from the upgraded STW would be adequate.

Current Discharging Conditions at Peng Chau Island

2.7.4 Currently the effluent from Peng Chau STW is discharged at the existing seawall located to the south of Tai Lei Island. However, the current discharges only take into account the treated sewage effluent from areas served by sewerage system. For areas where sewerage systems are not connected, wastewater is discharged directly to sea, causing some odour problem in the vicinity of the ferry pier. Debris, silt and grease were also observed on the water surface.

Discharging at Seawall vs. Submarine Outfall

2.7.5 Discharging of treated effluent into marine water bodies, may produce high level of wastewater dilution if the discharge location is carefully sited and the outfall properly designed. The momentum of the jet discharge and the buoyancy arising from the density difference between effluent and marine waters, would result in rising of sewage effluent plume and entraining the surrounding ambient water, thus diluting the sewage plume.

2.7.6 According to Annex 6 of EIAO-TM, "*It is not always necessary to meet all water quality criteria in all areas to protect the integrity of the aquatic environment*", the Authority under the WPCO may allow for the receiving water quality not to meet water quality criteria. These areas include water near the sewage outfall discharge, which are subjected to greater impacts and are called mixing zones. A mixing zone is therefore a region of a water body where initial dilution of a pollution input takes place and where water quality criteria can be exceeded.

2.7.7 The requirements of mixing zones, as stated in the Water Quality Handbook that "the area or volume of an individual mixing zone or group of mixing zones be limited to an area or volume as small as practicable that will not interfere with the designated uses or the established community of aquatic life in the segment for which the uses are designated, and the shape be a simple configuration that is easy to locate in the body of water and avoids impingement on biologically important areas, and the shore hugging plumes should be avoided." (USEPA, 1984)

2.7.8 Considerations were given to discharging of treated effluent at the seawall to achieve a desirable dilution to the discharged effluent. Seawall discharge in general, if is positioned lower than the average seawater level of the water receiving body, is subject to seawater intrusion. If it is positioned higher than the average seawater level, the advantages of ambient water entrainment through plume rising and dilution from the surrounding seawater cannot be achieved. Given the poorly flushed marine waters around Peng Chau, discharge of effluent through seawall would likely to produce shore hugging plume where mixing is incomplete. As indicated in the Water Quality Handbook (USEPA 1984), this kind of plume should be avoided, particularly for long-term continuous discharge.

2.7.9 Discharge through submarine outfall, however, is often referred as a marine treatment of the wastewater. Where complete mixed plumes can always be achieved in submarine outfall, depending on the ambient conditions, siting and configurations, it is more preferred than seawall discharge in terms of effluent dispersion characteristics. Thus seawall discharge would not be further considered in this Project.

Proposed Locations of Submarine Outfall

2.7.10 In viewing of the geographical conditions of Tai Lei Island, four options of submarine outfall and emergency overflow, representing and covering four areas of Tai Lei Island marine waters, were considered and are presented in **Figure 2-2**. Based on available information, the proposed four outfalls location options would not impose adverse impacts on water quality and marine ecology (including the coral community) in the surrounding environment provided that proper mitigation measures are in place. These four options are all environmental acceptable and they will be further examined for the most favourable option.

2.7.11 The bathymetry contours in Figure 2-2 is only indicative. Depths are measured in meters and are reduced to Chart Datum, which is approximately the Lowest Astronomical Tide. Each option consists of one submarine outfall and an adjacent emergency overflow alignment.

2.7.12 The bathymetry of the area approximately 40m from the seashore of Tai Lei Island, is about 2m. Submarine outfall length of 40m at 2m bathymetry was adopted for evaluation of each option. Descriptions of four alternative outfall options are given below:

(a) Option A

This outfall is located to the southwest area of Peng Chau STW, with the same orientation as the proposed outfall in the PPFS stage. The outfall points towards the channel between Tai Lei Island and Discovery Bay of Lantau. Scattered live coral colonies are found in the outcrop boulder to the southwest of Tai Lei Island (**Figure 8-3**). Potential impacts from this option to the marine sensitive receiver will be addressed in later section.

(b) Option B

This outfall is located to the northwest area of Peng Chau STW, in the vicinity of the pier for transporting refuse. The terrestrial components of alignments would pass through natural habitats of intertidal area. Disturbance of terrestrial and intertidal habitats are likely to occur. The area is composed of mainly non-ecological important dead coral skeleton but some small patches of corals were identified in the marine ecological surveys conducted for this Project.

(c) Option C

Option C is located to the eastern side of Tai Lei Island. The outfall is located in the small channel between Tai Lei Island and Peng Chau Island. The terrestrial components would pass through other properties on Tai Lei Island such as LPG storage yard and refuse collection point. The marine component is proposed next to

areas where scattered and rich live corals are found in the vicinity. Live corals found in these areas are of low abundance but with relatively high species richness.

(d) Option D

Option D is located to the south of Tai Lei Island, parallel to the southern pier. Scattered corals colonies are found around the small outcrop boulder located to the southwest of Tai Lei Island. This site falls within the proposed typhoon shelter for Peng Chau (See Figure 1-1). The implementation schedule of the proposed typhoon shelter, however, is not definite. The presence of typhoon shelter in this area would further decrease the water movement to the south Tai Lei Island.

2.8 SELECTION OF THE PREFERRED OUTFALL LOCATION

2.8.1 The option selection processes were documented in the initial assessment of this Project. Comparisons have been made with respect to the identified environmental issues with reference to the latest marine ecological survey results in the area (details are shown in Chapter 8), as well as engineering and land issue constraints for each option. A summary of the comparisons for all four options is provided in **Table 2-2**.

2.8.2 Qualitative comparison of potential environmental impacts of the four proposed submarine outfall alignment are summarised below:

Option A: This option would have the least air quality impact, noise impact and waste management implication during construction phase due to short terrestrial outfall component. Dredging activities for outfall construction may pose potential impact on the small isolated coral colonies found in the vicinity. No terrestrial ecological impact is anticipated. Due to the shelter of rocky areas of northwest of Tai Lei, the dispersion characteristic in the area is likely worse than Option B but better than Options C and D.

Option B: This option would involve long terrestrial outfall components where higher impacts on air quality, noise, waste management implication and terrestrial and intertidal ecology during construction phase are expected. Despite that better effluent dispersion characteristic can be achieved in this area, the marine ecological survey conducted for this Project revealed that small patches of live coral colonies are found in the vicinity. The marine ecological impact is anticipated to be better than Option C but worse than Options A and D.

Option C: This option would have long terrestrial outfall components on the formed lands. Higher impact on waste management implication than short terrestrial outfall options A and D. This option is closest to the residential areas of Peng Chau Island and higher construction noise and air quality impacts are expected. The marine ecological environment in the area is highly sensitive due to the presence of live coral communities of low abundance and relatively high species richness.

Table 2-2 Impacts Summary for Four Outfall Options

		Option A –South West Tai Lei	Option B –North West Tai Lei	Option C – East of Tai Lei	Option D – South of Tai Lei
Environmental Issues					
Air Quality	Construction Phase	Potential dust impact from short terrestrial outfall. Same potential impact as Options B and D.	Construction of terrestrial outfall alignment mostly by tunnelling through the northern rocky shore. Same potential impact as Options A and D.	Greatest potential fugitive dust impact due to long terrestrial outfall alignment.	Potential impact from short terrestrial outfall. Same potential impact as Options A and D.
	Operation Phase	The outfall component would not give rise to operational phase air quality impact such as odour. No difference in operational air quality is anticipated among 4 proposed options.	The outfall component would not give rise to operational phase air quality impact such as odour. No difference in operational air quality is anticipated among 4 proposed options.	The outfall component would not give rise to operational phase air quality impact such as odour. No difference in operational air quality is anticipated among 4 proposed options.	The outfall component would not give rise to operational phase air quality impact such as odour. No difference in operational air quality is anticipated among 4 proposed options.
Noise Impact	Construction Phase	Potential impact from short terrestrial outfall. Same potential impact as Option D.	Construction of terrestrial outfall alignment mostly by tunnelling through the northern rocky shore, longer construction period, more Powered Mechanical Equipment involved. Less impact than Option C but greater than Options A and D.	Longest terrestrial outfall alignment would likely to have longest construction period. Outfall location is closest to NSR, greatest potential impact.	Potential impact from short terrestrial outfall. Same potential impact as Option A.
	Operation Phase	The outfall component would not give rise to operational phase noise impact. No difference in operational noise impact is anticipated among 4 proposed options.	The outfall component would not give rise to operational phase noise impact. No difference in operational noise impact is anticipated among 4 proposed options.	The outfall component would not give rise to operational phase noise impact. No difference in operational noise impact is anticipated among 4 proposed options.	The outfall component would not give rise to operational phase noise impact. No difference in operational noise impact is anticipated among 4 proposed options.

		Option A –South West Tai Lei	Option B –North West Tai Lei	Option C – East of Tai Lei	Option D – South of Tai Lei
Water Quality	Construction Phase	Live coral colonies are found in the northeast (NE) and in the seabed of outcrop boulder to the southwest (SW) of Tai Lei. The former colonies are of low abundance but relatively high species richness and with a higher coral coverage. Coral in the southwest are present in small isolated patches and are anticipated to be less significant than the NE colonies. This option is closest to the SW colonies but farthest away from the NW colonies. The overall dredging impacts may be the smallest among four options.	Closer to live corals colonies in Tai Lei NE. Higher potential dredging impact than Option A and Option D but less than Option C.	Alignment closest to a relatively large is of live coral communities. Greatest potential impact due to re-deposition of suspended solids from dredging. Greater potential impact than Options A, B and D.	This option, located between Option A and Option C, would have larger potential impact on corals than Option A but less than Option C.
	Operation Phase	Dispersion and dilution characteristics worst than Option B.	Better dispersion and dilution characteristics than Options A, C and D.	Effluent discharge would likely have impact upon the live coral communities. Poor dispersion and dilution conditions of surrounding marine water.	Poor dispersion and dilution characteristics at the proposed location. Worse flushing conditions encountered after implementation of Peng Chau typhoon shelter. Discharge at typhoon shelter is not recommended.
Waste Management Implications	Construction Phase	Short terrestrial outfall component. Impact not significant. Same potential impact as Option D.	Relatively long terrestrial outfall. Impact not significant but more excavated waste than Option A and Option D.	Relatively long terrestrial outfall. Impact not significant but more excavated waste than Option A and Option D.	Short terrestrial outfall component. Impact not significant. Same potential impact as Option A.
	Operation Phase	The outfall component would not give rise to operational phase waste management implications No difference is anticipated among 4 proposed options.	The outfall component would not give rise to operational phase waste management implications No difference is anticipated among 4 proposed options.	The outfall component would not give rise to operational phase waste management implications No difference is anticipated among 4 proposed options.	The outfall component would not give rise to operational phase waste management implications No difference is anticipated among 4 proposed options.

		Option A –South West Tai Lei	**Option B –North West Tai Lei**	**Option C – East of Tai Lei**	**Option D – South of Tai Lei**
Ecology (marine and terrestrial)	Construction Phase	Live coral colonies are found in the northeast (NE) and in the seabed of outcrop boulder to the southwest (SW) of Tai Lei. The former colonies are of low abundance but relatively high species richness and with a higher coral coverage. Coral in the southwest are present in small isolated patches and are anticipated to be less significant than the NE colonies. This option is closest to the SW colonies but farthest away from the NW colonies. The overall dredging impacts may be the smallest among four options. No natural terrestrial habitat along the alignment, no impact is anticipated.	Closer to live corals colonies in Tai Lei NE. Higher potential dredging impact than Option A and Option D but less than Option C. Hill slope and natural intertidal zone are located along the terrestrial alignment. Greatest impact on intertidal and terrestrial ecology.	Alignment closest to a relatively large are of live coral communities. Greatest potential impact due to re-deposition of suspended solids from dredging. Greater potential impact than Options A, B and D. No natural terrestrial habitat along the alignment, no impact is anticipated.	Farthest from live coral area compared with other options. Least potential impacts are anticipated. No natural terrestrial habitat along the alignment, no impact is anticipated.

		Option A –South West Tai Lei	Option B –North West Tai Lei	Option C – East of Tai Lei	Option D – South of Tai Lei
	Operation Phase	Coral colonies in small isolated patches are found in the vicinity. Less potential impact than Option C and Option B due to outfall discharge. Higher potential impact than Option D. The outfall component would not give rise to terrestrial ecological impacts during operational phase. No difference in operational terrestrial ecological impact is anticipated among 4 proposed options.	Best dispersion and dilution characteristics are anticipated among four proposed options. Larger and more abundant isolated coral patches than Option A are found in the vicinity. Higher potential operational impact than Option A and Option D but less than Option C. The outfall component would not give rise to terrestrial ecological impacts during operational phase. No difference in operational terrestrial ecological impact is anticipated among 4 proposed options.	Effluent discharge would likely have impact upon the live coral communities. The greatest marine ecological impact. The outfall component would not give rise to terrestrial ecological impacts during operational phase. No difference in operational terrestrial ecological impact is anticipated among 4 proposed options.	Farthest from live coral area compared with other options. Least potential impacts are anticipated. The outfall component would not give rise to terrestrial ecological impacts during operational phase. No difference in operational terrestrial ecological impact is anticipated among 4 proposed options.
Cultural Heritage	Construction Phase	No cultural heritage site of interest is found. No impact.	No cultural heritage site of interest is found. No impact.	No cultural heritage site of interest is found. No impact.	No cultural heritage site of interest is found. No impact.
	Operation Phase	No cultural heritage site of interest is found. No impact.	No cultural heritage site of interest is found. No impact.	No cultural heritage site of interest is found. No impact.	No cultural heritage site of interest is found. No impact.
Engineering Constraints		No apparent engineering constraints are identified for Option A.	This option appeared to be technically unsound with a pipe through rocky hills. Regions beyond the natural intertidal zone where dead coral skeletons were identified. Construction of submarine outfall through these shallow skeleton area is difficult as compared with other options.	The location of outfall is very close to live coral areas, which would pose difficulties in avoiding them during construction. In addition, this option would have the longest terrestrial pipeline component, passing through other existing properties.	No apparent engineering constraints are identified for this option.

	Option A –South West Tai Lei	Option B –North West Tai Lei	Option C – East of Tai Lei	Option D – South of Tai Lei
Land Issue Constraints	No apparent land issue constraints are identified for Option A.	No apparent land issue constraints are identified for Option B.	The terrestrial component of outfall would be laid on other existing properties on the eastern Tai Lei.	This option is located at the planned typhoon shelter area by CED. The implementation schedule of typhoon shelter is not definite. Should the typhoon shelter be implemented, submarine outfall would need to be relocated.

Option D: This option would have the least air quality impact, noise impact and waste management implication during construction phase due to short terrestrial outfall component. No terrestrial ecological impact and least marine ecological impact are anticipated. However, the area is poorly flushed. The area has been proposed for Peng Chau typhoon shelter and worse flushing conditions would be encountered after implementation of typhoon shelter. Discharge at typhoon shelter is not recommended.

2.8.3 Based on the environmental considerations, Option A is the most feasible and the most preferred site compared with other options. Table 2-2 also provides the comparison of engineering and land issue constraints among four options. Option A also has the least apparent engineering and land issue constraints. Thus option A is considered the most preferred option with respect to all compared issues.

2.9 FURTHER CONSIDERATIONS OF OUTFALL AND EMERGENCY OVERFLOW

2.9.1 The dispersion characteristic of a short submarine outfall as specified in the Study Brief was evaluated in the initial assessment stage of the EIA study. It was recommended that a longer outfall would provide more adequate dilutions to the water quality parameters of concern from STW discharge especially nitrogen species such as unionised ammonia and total inorganic nitrogen. The proposed outfalls locations are shown in **Figure 2-3** with bathymetry contours from the geophysical survey under the same Project. Although short outfall discharge is not recommended for long term continuous discharge, it is proposed to be constructed for emergency overflow in case of failure of treatment works units or submarine outfall.

2.9.2 The proposed configurations of Peng Chau STW submarine outfall and emergency overflow outfall (subject to refinement at the detailed design stage) are shown in **Table 2-3**. Detail information on water quality impact is provided in Chapter 5.

Table 2-3 Configurations of STW and Emergency Overflow Outfall

Configurations	STW Outfall	Emergency Overflow Outfall
Approximate Pipe Length (m)	100	40
Minimum Discharge Depth (m)	8	3
No. of Risers	2	1
No. of Jet per Riser	4	N.A.
Riser Separation (m)	10	N.A.
Jet Diameter (mm)	100	250

2.10 SUBMARINE OUTFALL CONSTRUCTION METHOD

2.10.1 Two submarine outfall construction methods, namely the open trench method and horizontal directional drilling (HDD), have been considered for this Project. HDD method is relatively environmental friendly as the operation is conducted underground for most of the time. Besides, the construction impact is mainly located on the land-base drilling site and less water quality impact from dredging is anticipated. However, this method is more expensive and less flexible in the routing. On the contrary, open trench method is much cheaper and straightforward, but it may cause the release of the fine sediment, temporary effect to the benthic community and nearby sensitive receivers if no proper mitigation measures are implemented.

2.10.2 Further investigation on the environmental and engineering feasibility, as well as the cost of the two proposed method revealed that open trench method is more feasible based on the following reasons:

(a) The proposed outfall and emergency overflow outfall are quite short (100m and 40m respectively). Therefore, it is not a cost-effective option to employ HDD method.

(b) Based on the geological investigation data, the proposed profile of the outfalls will go through Grade V rock. This is not practicable for HDD construction method as it is designed to drill through better Grade of rock. As such, drilling is still required.

(c) There is a minimum curvature requirement of the HDD alignment. Based on the GI results, the HDD alignment has to be reasonably deep and stop inside the rock layer at the end of the 100m outfall. To retrieve the head and construct the risers, open cut is still required at this end.

(d) As major dredging is still required for the HDD option, the environmental advantages of HDD over open trench method is diminished to very marginally.

2.10.3 In view of the above issues, open trench method is recommended for construction of submarine outfalls. Detailed water quality assessment is provided in Chapter 5. Mitigation measures are recommended as necessary.

2.11 CONSIDERATIONS OF TREATMENT TECHNOLOGIES

2.11.1 To achieve a desirable effluent water quality as specified in the OISMP with stringent nitrogen concentration as well as bacteria reduction, the most important components in the Peng Chau STW Upgrade are technologies of secondary treatment units and disinfection units. Selection and review of these technologies have been conducted and are summarised below:

Secondary/Biological Treatment Technology

2.11.2 Several biological treatment technologies were considered in the Working Paper of Treatment Technology Review, and are as follows:

- Oxidation Ditch (OD);
- Sequencing Batch Reactor (SBR);
- Rotating Biological Contactor (RBC);
- Biological Aerated Filter (BAF);
- Conventional Activated Sludge System (CAS); and
- Membrane Bioreactor (MBR)

2.11.3 These biological treatment technologies were evaluated against the following criteria and the best two technologies were brought forward for further detailed life cycle analysis. The evaluation criteria are:

- Operation and Maintenance Cost and Requirement;
- Capital Cost;
- Requirement of Pretreatment and/or Secondary Sedimentation;
- Reliability;
- Ability to handle wide flow and load variations;
- Simplicity and Ease of Operation;
- Ability to Utilise Existing Peng Chau STW Facilities;
- Ease of Expansion;
- Size of Required Footprint;
- Ability of Nitrification/Denitrification; and
- Capability of Producing Effluent Meeting Discharge Criteria

2.11.4 Summary of evaluation is shown in **Table 2-4**. Among the six technologies, the two most preferred treatment technologies are Sequential Batch Reactor (SBR) and Membrane Bioreactor (MBR) as these are easy to expand, reliable, able to handle widely varying flow and relatively small footprint requirement. Oxidation ditch (OD) and rotating biological contactor (RBC) and conventional activated sludge system (CAS) are not further considered due to the undesirable footprint requirement. Biological aerated filter (BAF), though is capable of handling wide load variation, producing high quality effluent and requiring small footprint, is not preferred for its lack of local operating experience.

Table 2-4 Evaluation of Secondary Treatment Processes

Criteria	OD	SBR	RBC	BAF	CAS	MBR
Operation and Maintenance Cost and Requirement	Low	Low	Moderate	Highly dependent on instrumentation and controls, high O&M cost and requirement.	High operation and maintenance cost and requirement.	High. Energy requirement is high. Regular replacement of membrane is needed.
Capital Cost	High capital cost due to large footprint	low	Low	High	High capital cost due to larger footprint	High
Requirement of Pretreatment and /or secondary sedimentation	Screens and Secondary clarifier are needed	Only screens are required.	Screens, Primary and secondary clarifiers are required.	Fine screens and primary clarifier are required.	Screens, primary and secondary clarifiers are required.	Fine screens are required.
Reliability	Reliable	Reliable	Performance varied with flow rate and temperature.	Average	Reliable	Reliable
Ability to handle wide flow and load variations	Sludge bulking is likely from low food to mass ratio.	Yes	Difficult	Average	Average	Yes
Simplicity and Ease of Operation	Simple and easy to operate	Simple and easy	Simple and easy	Lack of local operating experience	Simple and easy to operate	Lack of local operating experience
Ability to Utilise Existing Peng Chau STW Facilities	No	No	Yes. The secondary treatment process of the existing STW is also RBC.	No	No	Yes. MBR can be placed within the existing facility
Ease of Expansion	Difficult	Easy, scalable	Moderate	Moderate	Moderate	Easy
Size of Required Footprint	Large	Medium	Large	Small	Large	Small
Ability of Nitrification/ Denitrification	Yes	Yes	No	Yes	Yes	Yes
Capable of Producing Effluents Meeting Discharge Criteria	Yes	Yes	No	Yes	Yes	Yes

2.11.5 Further life cycle analysis of the most preferred systems were carried out by using a generous discounted and inflation rates, a project cycle of 15 years showed that **SBR** option is financially favourable than the MBR option.

Disinfection Technology

2.11.6 Disinfection is the destruction of pathogenic microorganisms. Chlorination, Ultraviolet radiation (UV) and ozonation are the typical disinfection processes adopted in STW.

2.11.7 Among these three technologies, ozonation is not further considered, as it is not cost effective for a small plant with relatively low flow such as Peng Chau STW Upgrade. Chlorination and Ultraviolet radiation (UV) are the most widely used disinfection methods in Hong Kong and they are further considered and evaluated.

2.11.8 Chlorine, as a form of hypochlorite, is a common disinfectant used for chlorination. It is an effective, inexpensive and readily available disinfectant. However, chlorination generates by-products if not properly controlled and they would cause some detrimental impacts to human and marine fauna at high dosage. These by-products include trihalomethanes (THMs), chloramines and haloacetic acids. The concentration of these by-products in the chlorinated effluent can be reduced by lowering the total residual chlorine (TRC) through dechlorination, thereby reducing the toxicity of effluent.

2.11.9 UV radiation is a physical disinfection process and is one of the proven disinfection methods. No harmful effluent by-products would be produced. UV disinfection units require less space than chlorination facilities. However, the recurrent cost of UV is significantly higher than that of chlorination. As flow variation for the Peng Chau STW upgrade is anticipated to be large, substantial operation and maintenance issues may occur when the units are required to be switched on and off frequently.

2.11.10 **Table 2-5** provides the evaluation of the two disinfection technologies.

Table 2-5 Evaluation of Chlorination and UV Radiation

Criteria	Chlorination	UV Radiation
Total Cost (capital and recurrent)	Low	High
Ability to achieve disinfection standards	Yes	Yes
Footprint Size	Larger	Smaller
Implications due to large flow variations	More flexible and can better cope with the flow variation	More difficult on operation and maintenance to meet the flow changes
Environmental impacts	Effluent from the plant is relatively small and the potential water quality impact can be mitigated through dechlorination	Insignificant environmental impacts with proper handling of spent UV lamps

2.11.11 Both chlorination and UV radiation are proven disinfection processes. At this stage there is no enough information to conclude which one is a preferred option in terms of effectiveness, footprint size as well as environmental impacts. In view of the requirement and nature and low design flow of the plant, chlorination is therefore selected as the disinfection process for this project. Besides, chlorination is relatively inexpensive. A detailed life cycle analysis was conducted and a brief summary is provided in **Appendix 2B**.

2.11.12 Chlorination may be provided by using either chlorine gas or sodium hypochlorite solution. Gaseous chlorine has been rejected as an option, based on safety considerations and potential difficulties with shipping and handling. Sodium hypochlorite has been used successfully in many large cities around the world and is a proven disinfection agent. Therefore, a sodium hypochlorite system has been selected for disinfection.

2.11.13 The desktop assessment for environmental impacts of disinfected effluent with dechlorination is conducted in Chapter 5 – Water Quality Impacts.

2.12 SEWAGE TREATMENT SCHEME FOR PENG CHAU UPGRADE

2.12.1 In addition to the secondary treatment and disinfection processes, namely the Sequencing Batch Reactor (SBR) and chlorination, respectively, together with preliminary treatment units, equalization units, sludge treatment units and outfall components are designed and details of the recommended treatment method are provided in **Appendix 2C** and the treatment system is further evaluated in **Appendix 2D**. The preliminary layout plan of the proposed Peng Chau STW Upgrade is shown in **Figure 2-4a** to **2-4b**. The existing landscape environment surrounding Peng Chau STW is shown in **Figure 2-4c**. Landscape design proposal and the external finishes of the STW Upgrade are provided in **Figure 2-4d**. The three dimensional photomontages are illustrated in **Figure 2-5a** and **Figure 2-5b. Figure 2-5c** and **Figure 2-5d** illustrate respectively the cross-sectional view and the perspective view of the upgraded facility. The preliminary construction programme is provided in **Figure 2-6**.

2.13 POTENTIAL ENVIRONMENTAL IMPACTS FROM OTHER PROJECTS IN THE AREA

2.13.1 There are a few ongoing and planned projects in the vicinity of the Project. Cumulative environmental impacts on sensitive receivers identified for the Upgrade of Peng Chau STW may be exerted from these projects during the construction and/or operation phase. The work scopes and implementation programme schedules of these projects are summarised below.

(a) Potential Port Development East of Peng Chau: As stated in EPD's Outlying Islands Sewerage Master Plan Stage 2 Review (SMP 2002) (EPD, 2002a), the potential port development remains on the current Draft North-East Lantau Outline Zoning Plan. The proposed port development area extends from the NE coast of Lantau to Siu Kau Yi Chau and Kau Yi Chau. An EIA study has

been performed under the Northshore Lantau Development Feasibility Study and potential water quality impacts were evaluated. The SMP 2002 has considered the findings from the Northshore Lantau EIA and recommended a short submarine outfall for the Peng Chau Upgrading Project. The later EIA scope developed for Peng Chau Upgrading Project has excluded the location of potential port development as water quality assessment area (1km from the STW) since the port development has already been taken into account.

(b) Remaining Works for Construction of Footpath along Pak Wan, Peng Chau: This project is being carried out by the Home Affairs Department (HAD). It was commenced in December 2002 and is anticipated to complete in mid 2004, which is prior to the start of construction of Peng Chau STW Upgrade. Thus, the footpath project is unlikely to have cumulative impact on the sensitive receivers.

(c) Reconstruction of Peng Chau Public Pier: The public pier located in central Peng Chau was reconstructed. The reconstruction works were commenced in May 2002 and was completed in January 2004. It is anticipated that this reconstruction work would not have any cumulative environmental impacts with the proposed Peng Chau STW Upgrade.

(d) The CED is also planning to build a typhoon shelter to provide some 40-ha anchorage and mooring area at the southwest side of Peng Chau. It involves the erection of navigation lights and warning signboards and construction of a breakwater, navigation channels, landing facilities, boat landing steps at each light beacon and a water-selling kiosk. The location is shown in **Figure 2-7**. It is stated in SMP 2002 that the proposed typhoon shelter might be required by 2016. However, based on the recent information received from the Marine Department and CED, no definite implementation schedule for typhoon shelter has been set.

(e) Outlying Islands Sewerage Stage 1 Phase 2- Construction of Village Sewerage at Peng Chau and Cheung Chau Phase 1 (Package H). This is an in-house project of DSD. Package H consists of the construction of about 1.7-km of sewers, 400m of twin 250mm rising mains, a new sewage pumping station and temporary pump pit to replace the existing Kam Peng Estate sewage pumping station (which will also be demolished under Package H) and rehabilitation of some 300m of existing sewers (Figure 2-7). Construction of Package H was started in September 2002 and is scheduled to complete in mid 2005 followed by a one-year maintenance period. The construction period of this project partially overlaps with Peng Chau STW Upgrade construction.

(f) Peng Chau Helipad. This project is to be carried out by the Civil Engineering Department (CED) to construct a helipad in Peng Chau for transporting residents to the urban area for medical treatment in case of emergency. The proposed helipad and associated access road will be constructed by reclamation. The location of the selected site is shown in Figure 2-7. The construction period of Peng Chau Helipad is scheduled to begin in March 2005 and end in February 2006. The construction period falls within the Peng Chau STW's Upgrade construction schedule.

2.13.2 In viewing of the projects above, only the last three projects may have cumulative environmental impacts on the sensitive receivers identified for construction and/or operation phase of Peng Chau STW Upgrade Project. The potential impacts, if any, are described in the subsequent sections.

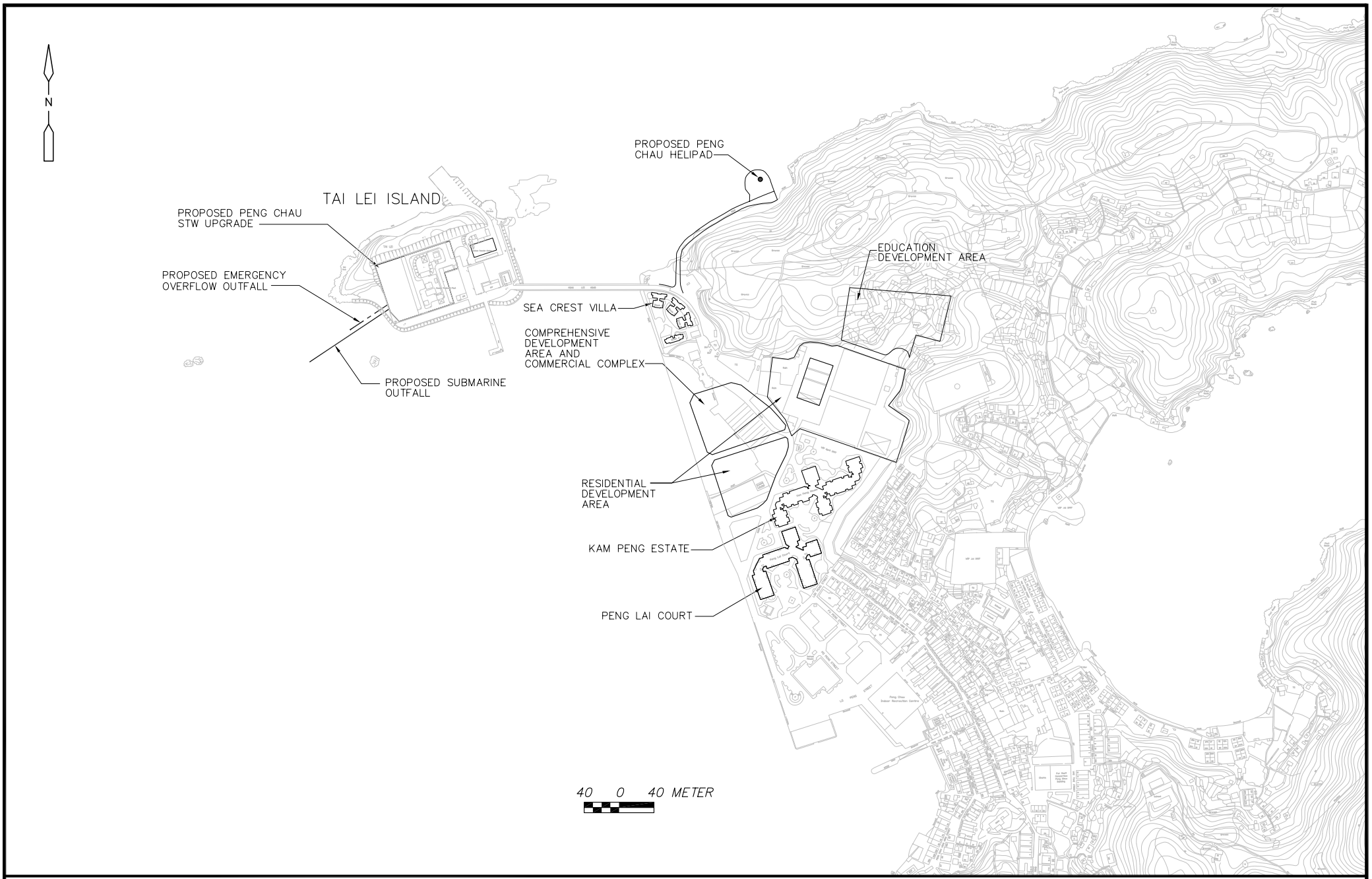

Figure 2-1

Surrounding Environment of Peng Chau Sewerage Treatment Works

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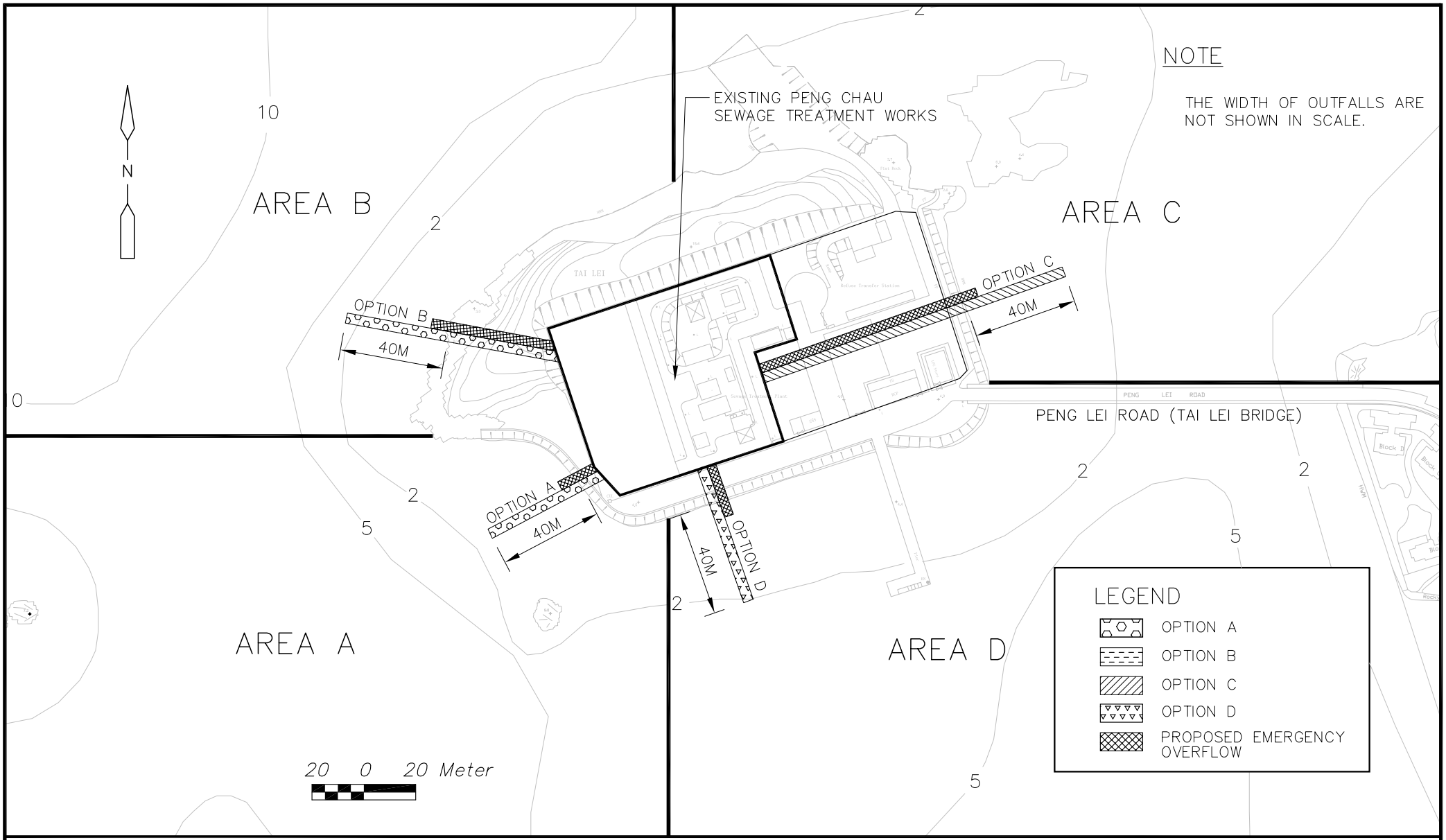

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Figure 2-2

Proposed Submarine Outfall and Emergency Overflow Outfall Options

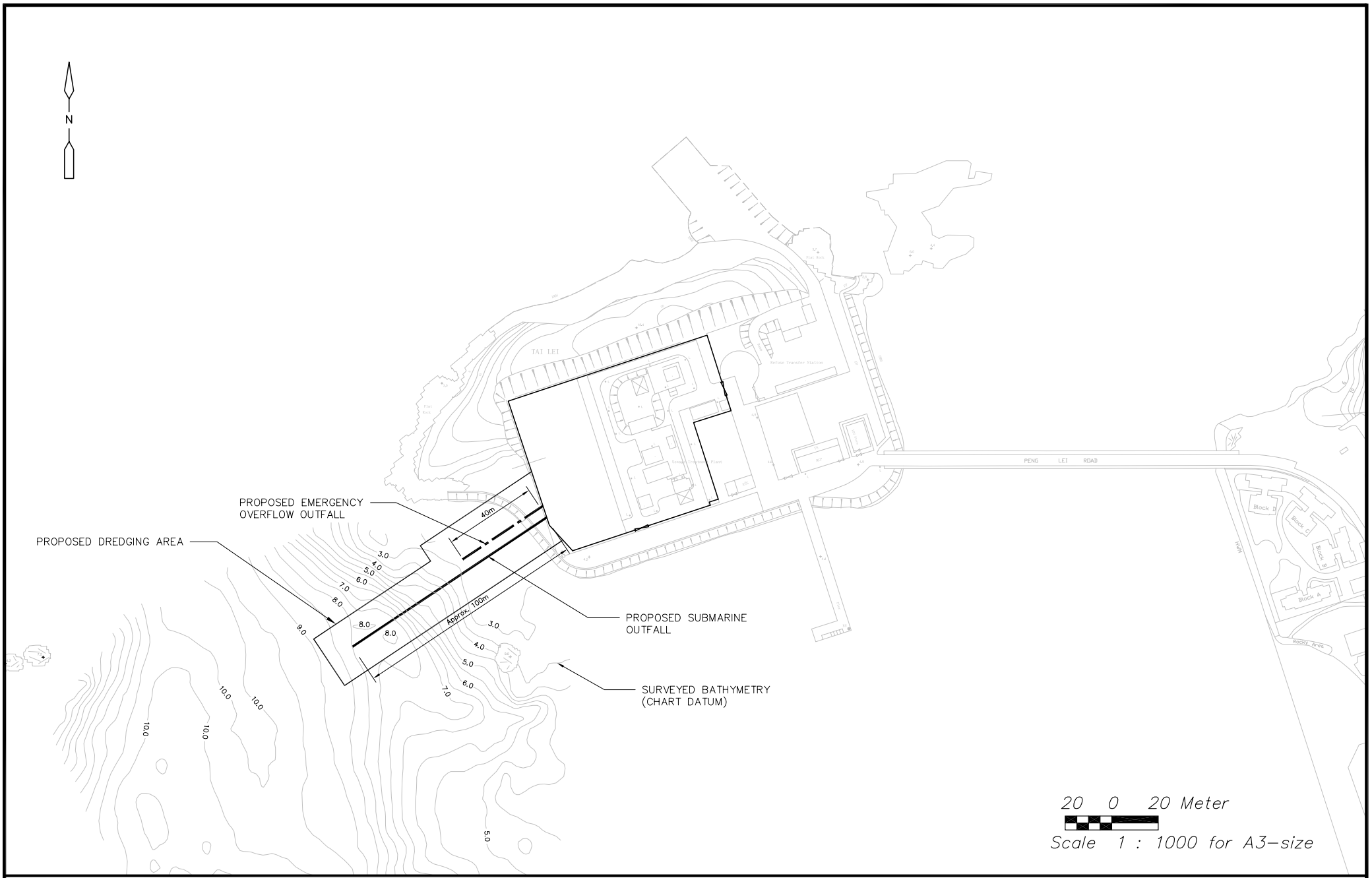

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Figure 2-3

Proposed Submarine and Emergency Overflow Outfall Locations

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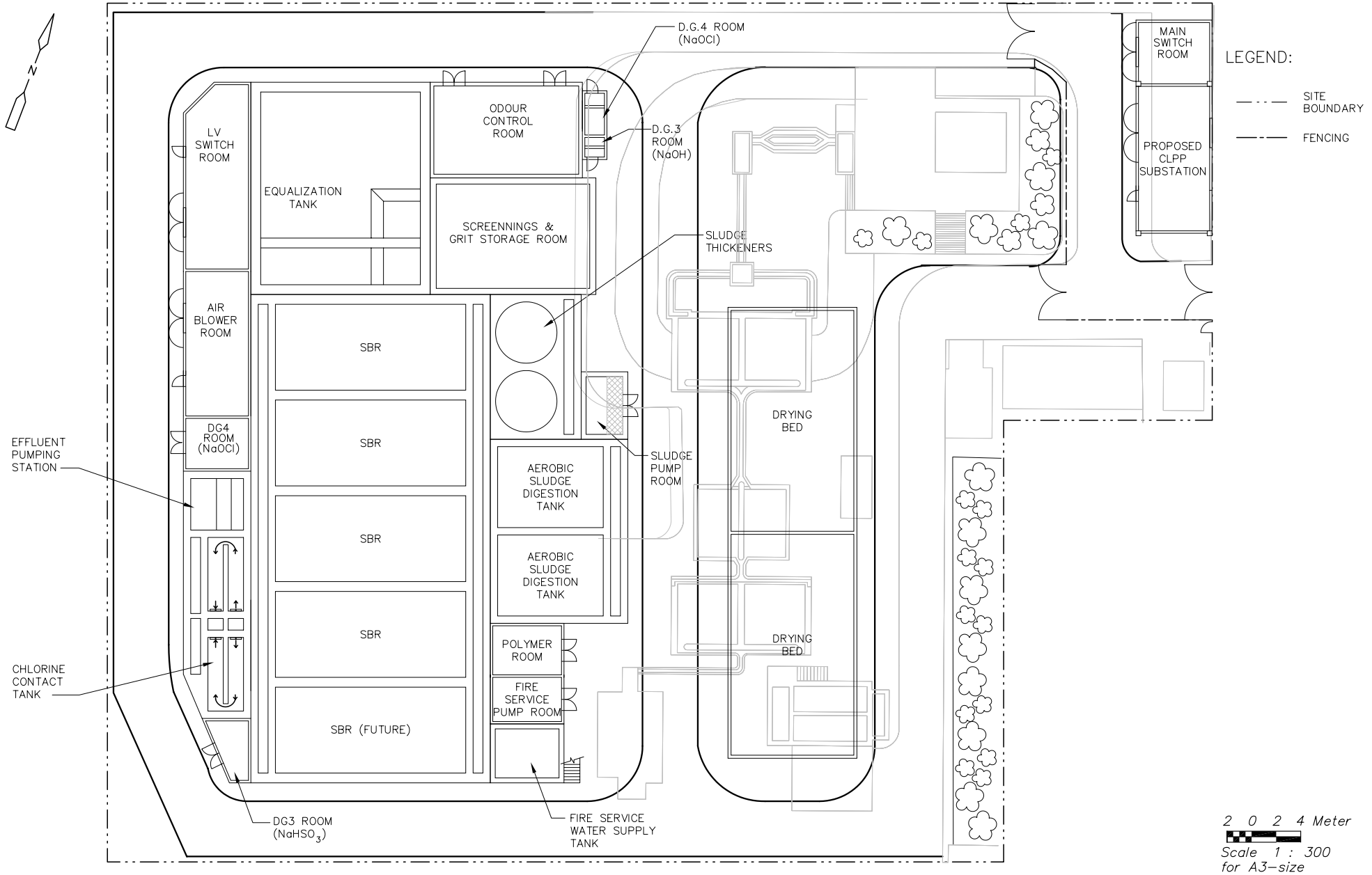

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Figure 2-4a
General Layout for Proposed Peng Chau STW Upgrade
- Ground Floor Plan

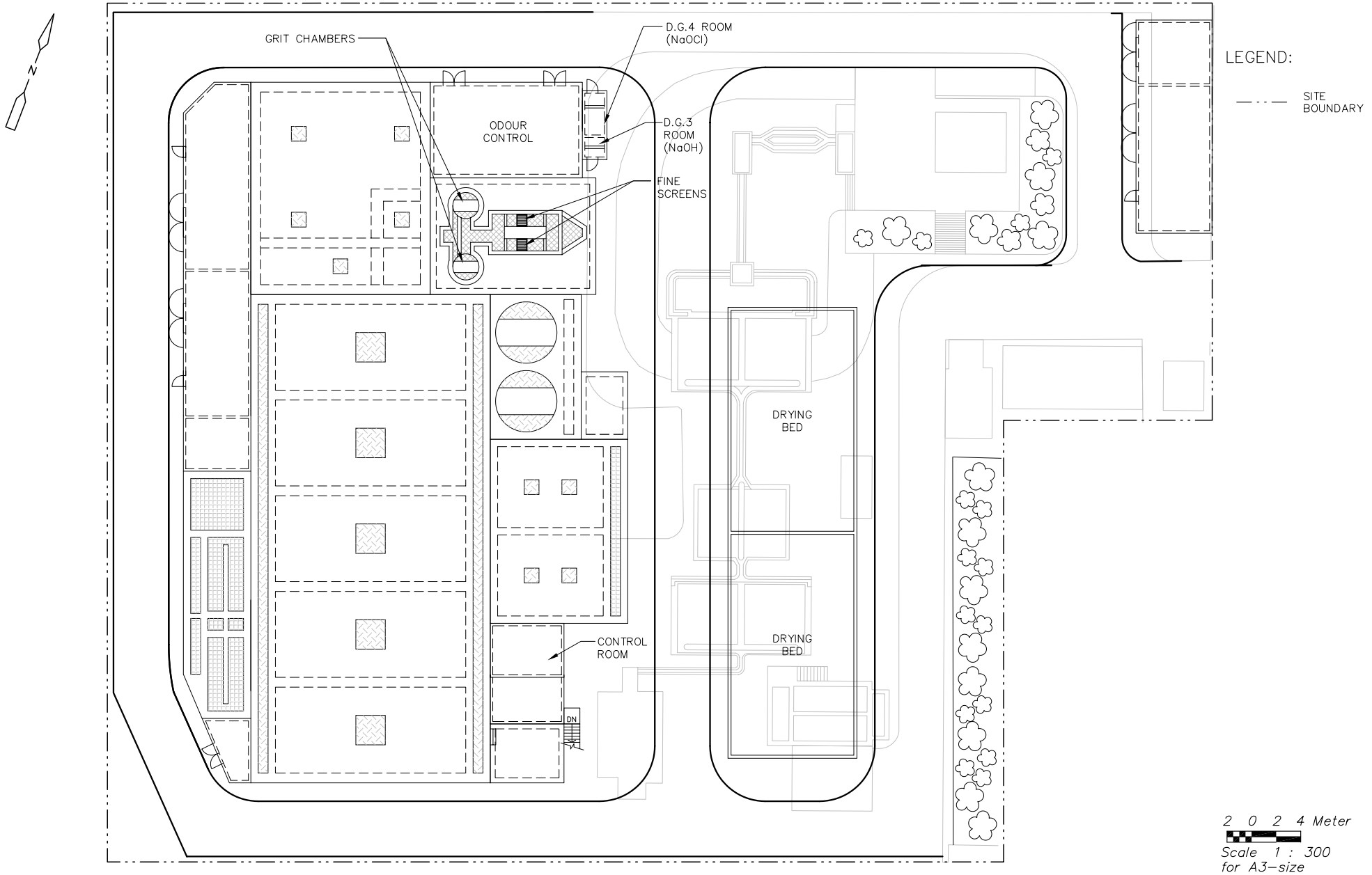

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Figure 2-4b
General Layout for Proposed Peng Chau STW Upgrade
- Roof Floor Plan

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Figure 2-4c
Existing Landscape Environment
Surrounding Peng Chau STW

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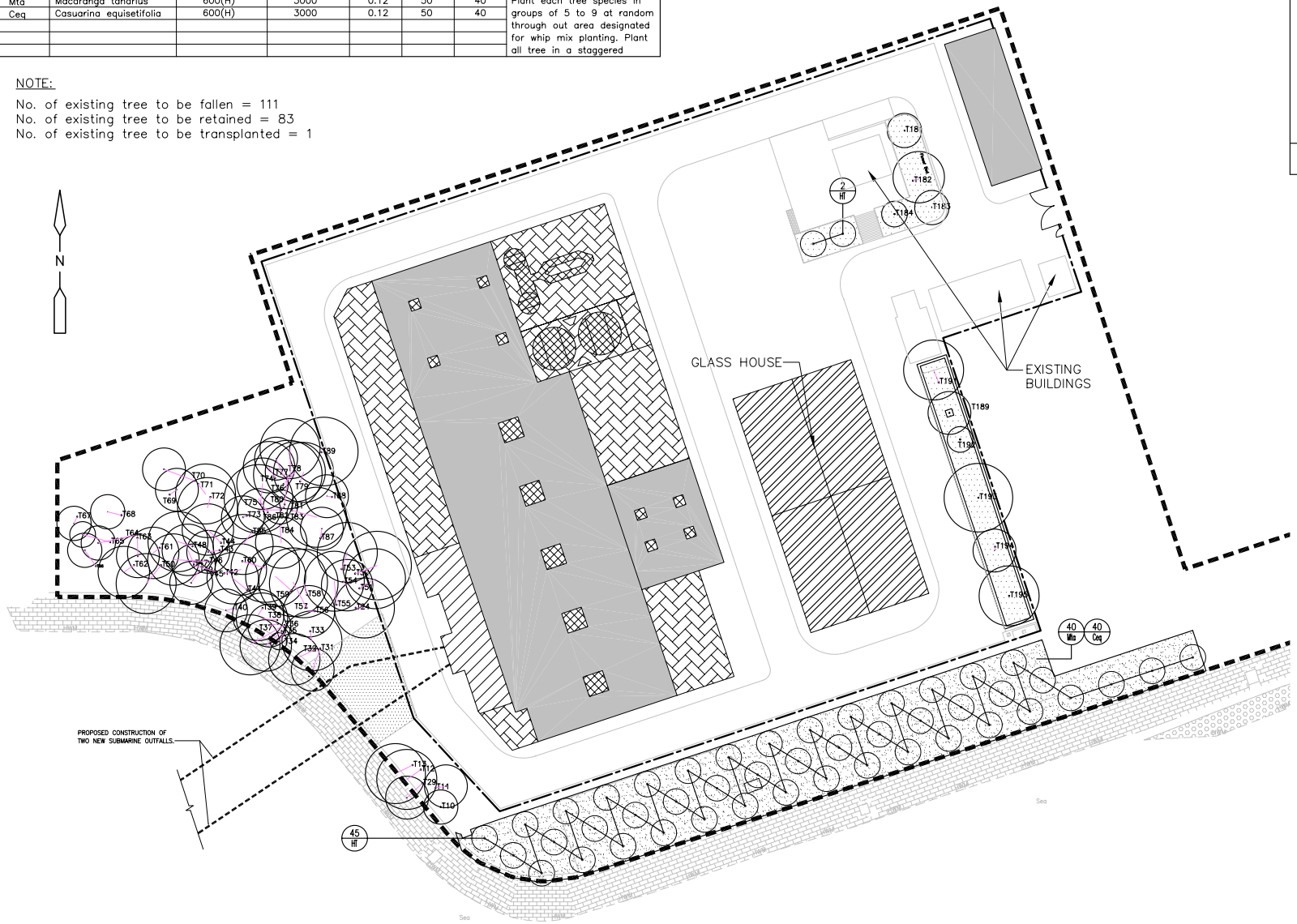
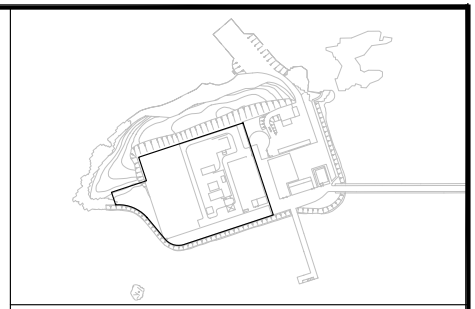
Planting Schedule
Tree Planting

Code	Botanical name	Specification	Spacing (mm)	No./m^2	% MIX	Quantity	Comment
HT	Hibiscus tiliaceus	Heavy Standard	As Shown	As Shown	–	47	
Whip Mix Planting							
Mta	Macaranga tanarius	600(H)	3000	0.12	50	40	Plant each tree species in groups of 5 to 9 at random through out area designated for whip mix planting. Plant all tree in a staggered
Ceq	Casuarina equisetifolia	600(H)	3000	0.12	50	40	

NOTE:

No. of existing tree to be fallen = 111
No. of existing tree to be retained = 83
No. of existing tree to be transplanted = 1





KEY PLAN

LEGEND:

- SITE BOUNDARY
- EXISTING TREE TO BE RETAINED
- PROPOSED HEAVY STANDARD SIZE TREE PLANTING
- HYDROSEEDING
- HYDROSEEDING & WHIP PLANTING
- TRANSPLANTED TREE FINAL LOCATION
- TREE SURVEY BOUNDARY
- EXTERNAL WALL/ROOF OF BUILDINGS TO BE PAINTED IN WHITE/LIGHT COLOUR TO MATCH WITH THE EXISTING BUILDINGS
- PROPOSED ROOF WITH WATER-PROOFING
- TREATMENT UNIT TO BE COVERED BY CHEQUER PLATE
- TREATMENT UNIT TO BE COVERED BY GRATING

5 0 5 Meter

Scale 1 : 500 for A3-size

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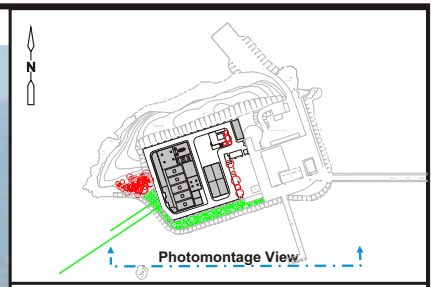
Figure 2-4d
Landscape Design Proposal
and External Finishes of Peng Chau STW Upgrade



KEY PLAN

Existing View from South of Tai Lei Island

Future View from South of Tai Lei Island without Landscape Treatment

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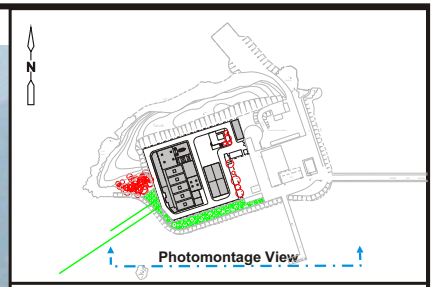
Figure 2-5a
Photomontage of the Peng Chau STW
(Sheet 1 of 2)



KEY PLAN

Future View from South of Tai Lei Island with Landscape Treatment at day 1 of the operation stage

Future View from South of Tai Lei Island with Landscape Treatment at year 10 of the operation stage

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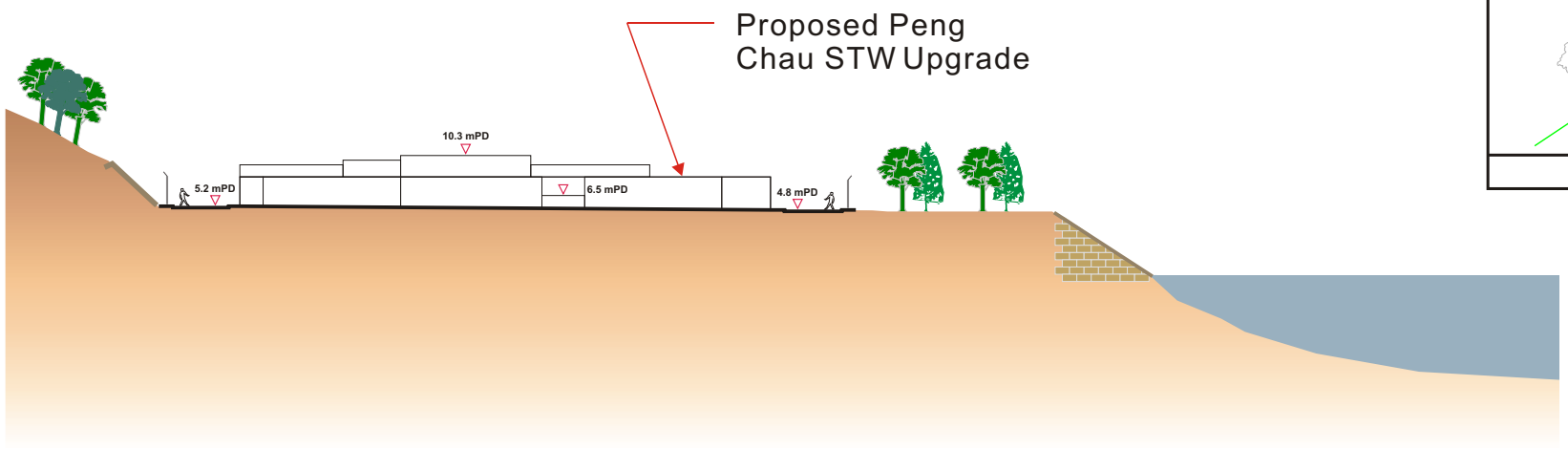
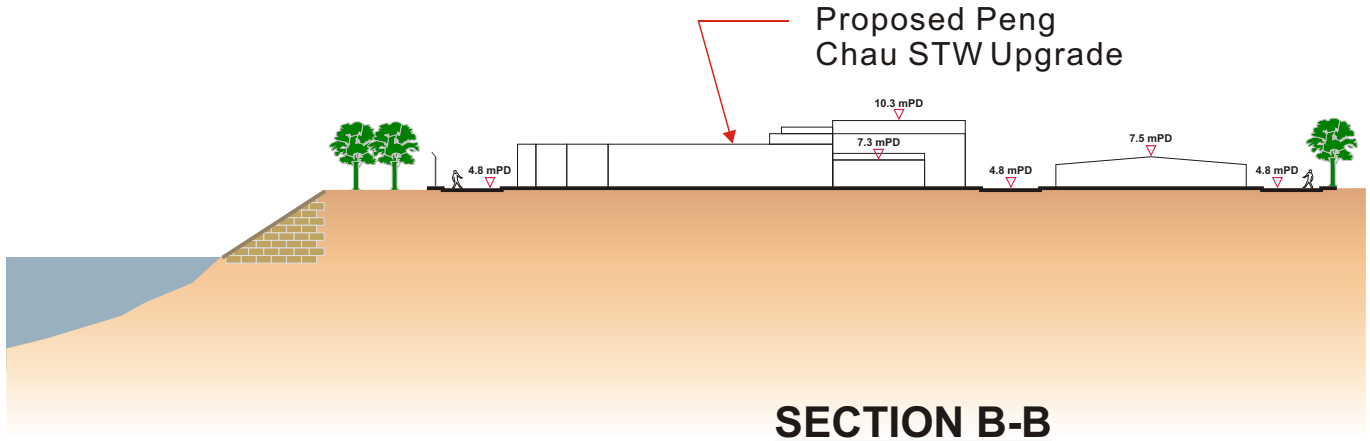
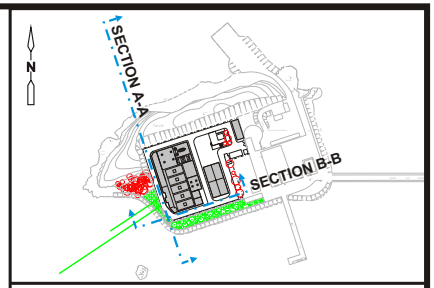
Figure 2-5b
Photomontage of the Peng Chau STW
(Sheet 2 of 2)



SECTION A-A
(View from West)



SECTION B-B
(View from South)



KEY PLAN

10m

Vertical Scale
Horizatical Scale

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Figure 2-5c
Cross-sectional View of
Proposed Peng Chau STW Upgrade

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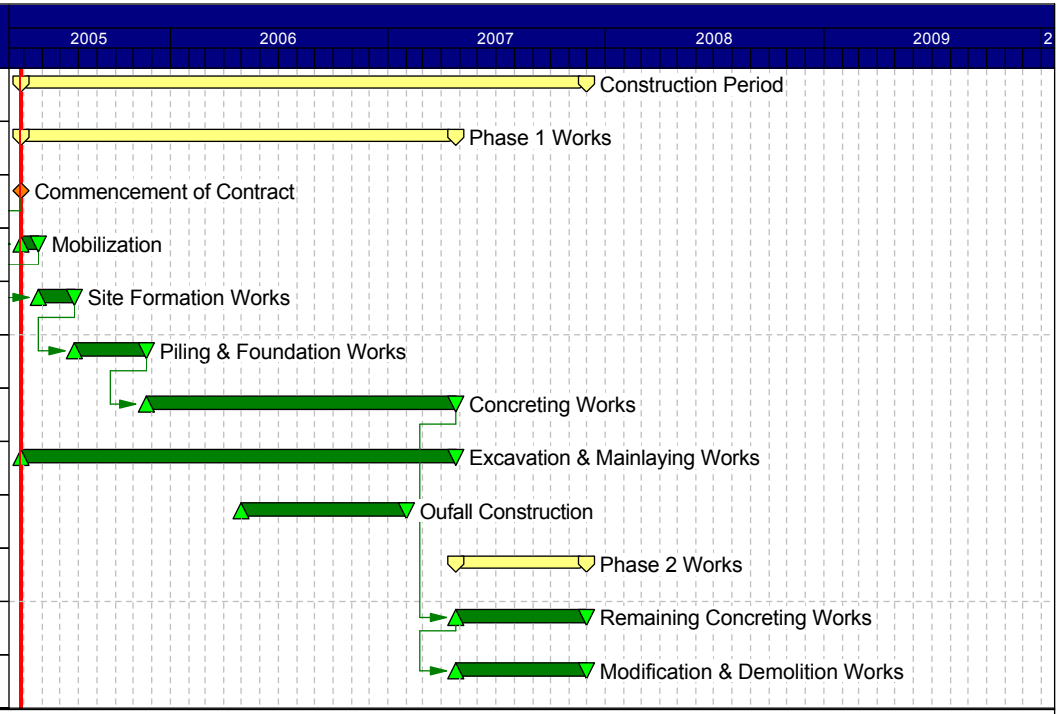
Figure 2-5d
Perspective Drawing of
the Proposed Peng Chau STW Upgrade

Activity ID	Description	Dur	Scheduled Start	Scheduled Finish
1000	**Construction Period**	**949 ***	**04/26/05**	**11/30/07**
1100	**Phase 1 Works**	**730 ***	**04/26/05**	**04/25/07**
1110	Commencement of Contract	0	04/26/05	
1140	Mobilization	30	04/26/05	05/25/05
1120	Site Formation Works	60	05/26/05	07/24/05
1130	Piling & Foundation Works	120	07/25/05	11/21/05
1040	Concreting Works	520	11/22/05	04/25/07
1150	Excavation & Mainlaying Works	730	04/26/05	04/25/07
1160	Oufall Construction	276	05/01/06 *	01/31/07
1200	**Phase 2 Works**	**219 ***	**04/26/07**	**11/30/07**
1210	Remaining Concreting Works	219	04/26/07	11/30/07
1220	Modification & Demolition Works	219	04/26/07	11/30/07



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Start date	04/26/05
Finish date	11/30/07
Run date	08/12/04
Page number	1A
Company name	CDM International Inc.

Agreement No. CE83/2001 (DS)
Peng Chau STW Upgrade

Preliminary Construction Works Programme

Figure 2-6

- **Early start point**
- **Early finish point**
- **Early bar**
- **Summary bar**
- **Summary point**
- **Start milestone point**
- **Finish milestone point**

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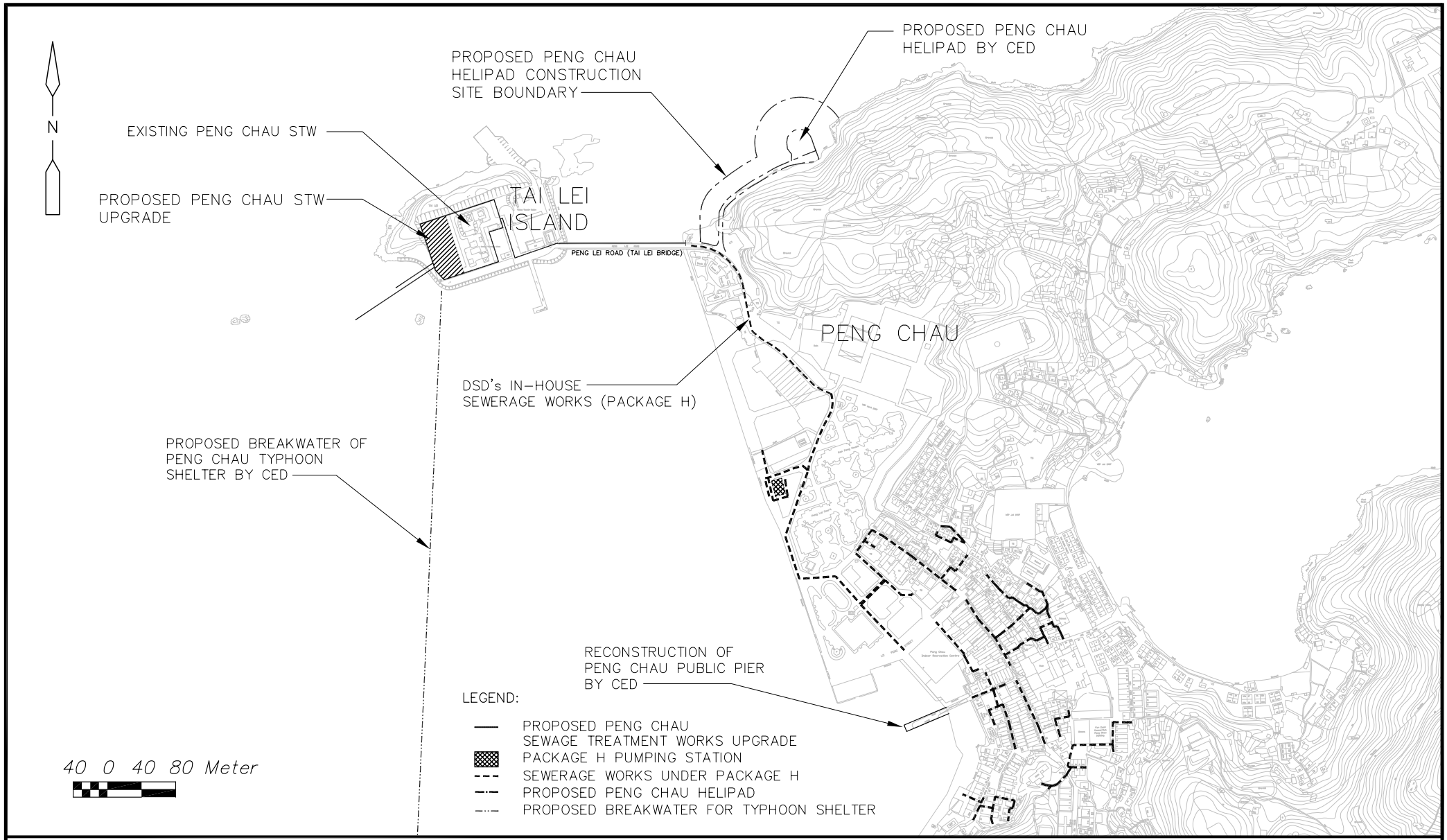

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Figure 2-7

Projects in the Vicinity of the Proposed Peng Chau STW Upgrade