7 WATER QUALITY

7.1 Introduction

7.1.1 This chapter provides a detailed assessment of the potential water quality impacts associated with the advance works; the construction of the proposed housing development and infrastructural work and operational phase of the development. The key focus will be to identify discharges that, if uncontrolled, may cause adverse impacts on identified water sensitive receivers. Where appropriate, mitigation measures will be proposed to ensure that all residual impacts are in compliance with the applicable Legislation, Guidelines and Technical Memoranda.

7.2 Assessment Criteria

7.2.1 Marine Water Quality

7.2.1.1 The proposed site is located at the western end of Hong Kong Island and is immediately adjacent to the East Lamma Channel. The East Lamma Channel falls into the Western Buffer Water Control Zone which was declared in 1993. Therefore, Water Quality Objectives (WQOs) for this WCZ are adopted as criteria for the purposes of this assessment. The relevant WQOs are given in Table 7.1A and Table 7.1B.

Table 7.1A Water Quality Objectives – Western Buffer Water Control Zones

Parameters	Criterion	Beneficial Use
Suspended Solids	Waste discharges shall neither cause the natural ambient level to be raised by more than 30% nor give rise to accumulation of suspended solids which may adversely affect aquatic communities.	Marine waters
Dissolved Oxygen	Waste discharges shall not cause the level of dissolved oxygen to fall below 4 mg/L (depth averaged) for 90% of the sampling occasions during the whole year. The dissolved oxygen concentration should not be less than 2mg/L within bottom 2m of seabed for 90% of the sampling occasions during the whole year.	Marine subzone except FCZ Marine waters
pH	The pH of water should be within the range of 6.5-8.5 units. Changes due to waste discharges should not exceed 0.2 pH units.	Marine waters except bathing beaches subzone
Nutrients	Annual depth averaged total inorganic nitrogen not to exceed 0.4mg/L.	Marine waters
Ammonical Nitrogen	Annual mean not to exceed 0.021mg/L	Whole zone

Table 7.1B Water Quality Objectives Based on the Beneficial Uses of the Receiving Waters

Parameter	*Criterion*	*Beneficial Uses*
Dissolved Oxygen	The dissolved oxygen concentration at the cooling water intake point should not be less than 2mg/L.	BU6a – Cooling Water
E Coli	The E-coli level should not exceed 20,000 cfu/100ml for 90% of the sampling occasions during the whole year.	BU6b – Flushing Water

7.2.2 WSD standards for Flushing Water

7.2.2.1 For pumping seawater for use in domestic toilet flushing, WSD has its own water quality standards at seawater intake points. WSD standards are as follows:

Parameter	Standard
Suspended solid	<10 (mg/L)
Dissolved Oxygen	>2 (mg/L)
Ammonical Nitrogen	<1 (mg/L)
E-coli	<20,000 per 100mL
BOD5	<10
Synthetic Detergents	<5
Colour (H.U.)	<20
Turbidity (N.T.U.)	<10
Threshold Odour No.	<100

Amongst these parameters, it is anticipated that the major impacts arising from the construction and operation of the Telegraph Bay Development (TBD) project will be the elevation in the SS, E-Coli, BOD5 and NH4-N levels and decrease in DO level in the receiving water, i.e., East Lamma Channel. Due to the nature of the work, it is highly unlikely that this project will cause any coloration and odour problem. Hence, this assessment focuses on the potential alteration in concentrations of the key parameters.

7.3 Sensitive Receivers

7.3.1 The water sensitive receivers (WSR) that could potentially be affected by the proposed housing and infrastructural work at Telegraph Bay are presented in Figure 7.1 and include :

- Stream originating to the north of Kong Sin Wan Village, flows across the site to discharge into the East Lamma Channel, (referred to as "Northern Stream" hereafter);
- Stream which flows into Waterfall Bay, i.e. Site 5 (referred to as "Southern Stream" hereafter);
- Marine waters and marine life around the site and in East Lamma Channel, including coral found to the north and north-east of Lamma Island (reference to the Binnie 1994);
- Queen Mary Hospital seawater intake at Sha Wan Drive (SR10); WSD seawater intakes at Wah Fu Estate;
- Storm drain outfalls in the vicinity of the site including Waterfall Bay, coastline along Sandy Bay, at Wah Fu and Wah Kwai Estate;
- The existing sewage outfall for the sewage treatment work at Sandy Bay and Wah Fu Estate;
- The three as-built stormwater outfalls (by CED as part of the reclamation work) in the development area (for protecting the water quality at the WSD seawater intake, the stormwater outfall locates near the proposed WSD pumping station at Site 4, i.e., outfall no. 7 as indicated in Figure 7.1, has been made abandoned); and
- The as-built salt water intake (as part of the CED reclamation work) for the proposed WSD pumping station at the southern end of the reclamation (near Site 4).

7.3.2 According to a recent survey conducted by ERM (HK) Ltd., on behalf of the Agriculture

and Fisheries Department, the most important spawning and nursery grounds are located in the southern and eastern waters of Hong Kong. These areas include Sharp Island, Basalt Island, Ninepin Islands, Waglan Islands and South Cheung Chau. In particular the Port Shelter region and the inshore waters of the northeast New Territories were identified as nursery areas of high value species. Picnic Bay, Long Harbour, Sharp Island and south Cheung Chau were areas identified as having high abundance of juvenile fish. These findings, therefore, indicate that the coastal waters adjacent to Telegraph Bay are not a significant fish nursery area.

7.4 Description of the Environmental Baseline Conditions

7.4.1 Marine Water Quality

7.4.1.1 EPD routine monitoring data for station WM1 and WM2 were made available. Existing ambient marine water quality in the area was established based on the data obtained for 1996 and November 1998 for these stations. The monitoring locations are shown in Figure 7.2. Table 7.2 summarises the key monitoring data. A review of the data indicates that:

- *Dissolved oxygen (DO).* The routine EPD monitoring data indicates that the DO level at the surface and the bottom were between 4.7 mg/L to 8.7 mg/L and 2.9 mg/L to 8.1 mg/L, respectively. These results indicate full compliance with both the WSD standard for flushing water and the DO WQO for cooling water. The 4 mg/L WQO for the depth-averaged DO were only satisfied in 1996 and in 1997. More than 10% of the samples collected from both stations in 1998 had DO content less than 4 mg/L. It implies the WQO cannot be achieved in 1998 and indicates there is a new source. Apparently, the non-compliance was ere recorded in the October and November 1998 monitoring data. This suggests that the water quality in the area is affecting by a new source of pollution. From the past three years (1996 to 1998) data, it was found that 90% of the samples collected have DO level greater than 3.7 mg/L and 3.4 mg/L;

- *pH.* This was within the WQO range of 6.5 to 8.5 throughout the monitoring period;

- *Suspended solids (SS).* The recorded SS levels fluctuate throughout the monitoring period. The fluctuations in SS levels could be attributed to scouring of sediments by natural ocean currents. The annual mean depth-averaged levels were below 10 mg/L, i.e., the SS standard for WSD flushing water. By comparing the data, a decreasing trend was observed over the past three years;

- *Total Inorganic Nitrogen (TIN).* Full compliance with the WQO for TIN was recorded at both monitoring stations;

- *E-Coli.* There is no secondary contact subzone in the vicinity of the site therefore, the data is compared against the WQO for cooling water use. The recorded E-Coli levels were well below the standard set for cooling water use. The WSD flushing water E-coli standard is also met;

- *BOD_5.* The annual mean BOD_5 was consistently between 0.5 mg/L to 0.8 mg/L with the depth-averaged maximum levels being well below the WSD flushing water standard (5 mg/L);

- *NH4-N.* Annual NH4-N levels at both stations ranged from 0.09 mg/L to 0.13 mg/L.

The results indicates that the WQO for marine waters could not be met but the WSD flushing water standard was achieved over the past three years.

7.4.1.2 In summary, the available monitoring results show that marine water quality in the East Lamma Channel in general complied with the WQOs except NH4-N and full compliance with WSD flushing water standards was achieved. In fact, the key pollutant levels in East Lamma Channel water are well below the WSD seawater intake standard.

Table 7.2 Summary of EPD Marine Water Monitoring Data

Parameter		WM1			WM2		
		1996	1997	1998*	1996	1997	1998*
DO	Surface	6.4 (4.7–8.1)	6.6 (4.7–11.1)	6.5 (3.5–8.2)	6.1 (4.4–8.5)	6.4 (5.0–9.2)	6.0 (3.5–7.6)
[mg/L]	Bottom	5.5 (2.9–7.2)	5.8 (2.7–8.0)	5.4 (2.2–8.7)	5.7 (3.3–8.5)	5.5 (3.6–7.0)	5.3 (2.5–8.0)
	Depth-averaged	10% - 3.7 mg/L 90% - 7.24 mg/L			10% - 3.4 mg/L 90% - 7 mg/L		
pH		8.0 (7.8–8.3)	7.8 (6.8–8.2)	7.7 (7.0–8.2)	8.1 (7.8–8.3)	7.8 (7.2–8.2)	7.9 (7.5–8.2)
SS	[mg/L]	4.8 (3.0–8.1)	4.3 (2.2–7.2)	3.9 (2.7–4.8)	7.5 (2.6–14.6)	5.9 (2.5–12.3)	5.4 (1.9–11.2)
TIN	[mg/L]	0.19 (0.04–0.38)	0.21 (0.11–0.43)	0.24 (0.12–0.44)	0.25 (0.14–0.40)	0.30 (0.18–0.42)	0.25 (0.14–0.39)
BOD5	[mg/L]	0.6 (0.4-1.1)	0.6 (0.2-1.6)	0.71 (0.34-1.1)	0.56 (0.27-1.39)	0.5 (0.1-1.9)	0.79 (0.23-1.36)
E-Coli	[cfu/100ml]	188 (56–1333)	201 (35–634)	65 (14–170)	111 (13–1167)	251 (21–1327)	345 (40–1869)
NH4-N	[mg/L]	0.08 (0.01–0.26)	0.08 (0.03–0.13)	0.09 (0.04–0.17)	0.08 (0.02–0.16)	0.13 (0.03–0.28)	0.12 (0.04–0.18)

Source: EPD Routine Monitoring Data was used to establish the ambient marine water quality for the past three years.

*Note : * Data for 1998 were calculated based on the EPD monitoring results obtained upto November 1998.*

7.4.2 Freshwater Quality and Ecology

7.4.2.1 Ecological field surveys were conducted in September 1998 to investigate both the intertidal and freshwater stream habitats present in the vicinity of the site. The survey areas covered the intertidal zones of East Lamma Channel, the "Northern Stream" and the "Southern Stream".

7.4.2.2 The findings of the survey indicate that the Northern Stream is currently being impacted by external pollution sources and soap-like foam was observed on the stream surface. Moreover, the unusual presence of certain marine (salt water) species was also observed in the upstream location of a "freshwater stream". A second site survey was carried out to identify the potential sources of pollution and it was observed that the foam appears to originate from the Queen Mary Hospital discharge pipe (foam was seen downstream of the discharge). Spot checks on salinity have also been undertaken at different locations in the Northern Stream to attempt to explain the observation of marine species in the stream. It was found that the stream is most likely being affected by the discharge from the Li Shu Fan Building, (Medical School, HKU). This is based on a spot check (refractometer) of salinity at the discharge point which exhibited a concentration of 16 ppt.

7.4.2.3 During the site visit, it was found that a USD officer was spraying an oil /petrol mix into the Southern Stream" for mosquito control. Although the Southern Stream is not under the EPD routine monitoring program, it is found that the diversity of the freshwater species in this stream is high indicating that the water quality in the stream is good. No rare or endangered species were identified in the area. The species present in these streams are described in more detail in Chapter 9.

7.4.3 Marine Sediment Quality

7.4.3.1 The project will not require any reclamation or seawall construction, although there is a need to carry out minor dredging work for the construction of the submarine outfall for the proposed sewage treatment plant. This section provides a general discussion on the sediment quality in the area.

7.4.3.2 As part of this study, a sediment investigation has been conducted by Geotechnical Engineering Office (GEO) of the Civil Engineering Department (CED) in June and July 1998. Two marine boreholes were drilled as part of the marine site investigation work, and only the sediments obtained from borehole, TBM2, as shown in Figure 7.2, were analysed chemically. Sediment samples were taken at various depths and the laboratory analysis results are tabulated in Table 7.3A. The analysis results are compared against the sediment grading criteria, which was reproduced in Table 7.3B.

Table 7.3A Marine sediment laboratory results

Depth (m)	Cd [mg/kg]	Cr [mg/kg]	Cu [mg/kg]	Hg [mg/kg]	Ni [mg/kg]	Pb [mg/kg]	Zn [mg/kg]	Grading
0-0.1	<0.5	41	39	<0.4	21	38	110	A
0.9-1.0	<0.5	28	20	<0.4	16	39	85	A
1.9-2.0	<0.5	33	10	<0.4	20	20	75	A
2.9-3.0	<0.5	31	<10	<0.4	19	20	71	A
5.75-5.85	<0.5	31	10	<0.4	17	26	67	A

Table 7.3B Sediment Contamination Criteria for Marine Disposal (mg kg^{-1} dry weight)

Classification	Cd	Cr	Cu	Hg	Ni	Pb	Zn
Class A	0.0-1.0	0-50	0-55	0.0-0.8	0-35	0-65	0-150
Class B	1.0-1.5	50-80	55-65	0.8-1.0	35-40	65-75	150-200
Class C	>1.5	>80	>65	>1.0	>40	>75	>200

Class A : Uncontaminated material, for which no special dredging, transport or disposal methods are required beyond those which would normally be applied for the purpose of ensuring compliance with the EPD's Water Quality Objectives, or for the protection of sensitive receptors near the dredging or disposal areas.

Class B : Moderately contaminated material, which requires special care during dredging and transport, and which must be disposed of in a manner which minimises the loss of pollutants either into solution or by re-suspension.

Class C : Seriously contaminated material, which must be dredged and transported with great care, which cannot be dumped in the gazetted marine disposal grounds and which must be effectively isolated from the environment upon final disposal.

7.4.3.3 In accordance with EPD *Technical Circular TC-1-1-92 Classification of Dredged Sediments for Marine Disposal*, the marine mud near the submarine outfall area is classified as Grade A (i.e., uncontaminated) and no special disposal methods are required.

7.4.4 Site Hydrology

7.4.4.1 The major part of the site (Site 1 to Site 4) was formed in 1989 by reclaiming the bay between the headlands of Telegraph Bay and Waterfall Bay. The reclaimed land has remained undeveloped since the completion of the reclamation and is currently heavily vegetated with trees, shrubs and grass. An open space with sparse vegetation is found at the southern end of the reclamation (i.e. Site 4). The existing reclamation ground level is at approximately 4 metres PD.

7.4.4.2 The Waterfall Bay site (Site 5) is located on a hillside with an existing base level which varies with the topography and is estimated to be between 25.1 mPD and 49.7 mPD.

7.4.4.3 The Northern Stream, which originates to the north of Kong Siu Wan Tsuen, merges with the Kong Sin Wan Tsuen nullah. The nullah then flows to the surface body, which is located at the northern end of the reclamation, and subsequently into an as-built twin box culvert which discharges into the East Lamma Channel. All wastewater generated by the Kong Siu Wan Village is now being directed to the nullah. Two water bodies are found within the site (reclaimed area). They will be filled during the advance (surcharging) works and a new underground box culvert will be constructed across Site 1 during the advance works stage for the conveyance of the water in the Kong Sin Wan Nullah to East Lamma Channel.

7.4.4.4 Under the Telegraph Bay reclamation program (which was completed in 1989), three outfall pipes, one twin cell box culvert (as mentioned above) and one submarine outfall have been constructed through the seawall. These together with the new box culvert channel (to be built as part of this study) will form the basis for the future drainage works for the proposed Telegraph Bay Development.

7.4.4.5 In addition to these drainage works, a salt water intake culvert was also constructed through the seawall near the southern end of the reclamation for the future WSD seawater pumping station seawater intake.

7.5 Assessment Methodology

7.5.1 To assess the potential impacts upon the water quality and the associated risks to the marine environment, a comprehensive desktop study covering the following aspects have been carried out.

1. Identification of both the WSRs and uses which may be impacted by the proposed work, as well as the assessment criteria to be complied with. (This has already been discussed above in Sections 7.2 and 7.3).

2. Identification of potential sources of wastewater and water quality impacts to be generated during the construction phase. This involves the compilation of a wastewater stream inventory for the infrastructure and proposed housing construction, as well as the definition of those activities that have the potential to impact upon water quality.

3. Identification of wastewater generating activities during the operational phase. This includes the characteristics of wastewaters being generated, its location within the site, volume of the wastewater arising (where available), and typical chemical characteristics of the wastewater generated.

4. Assessment of the potential impacts upon the identified WSRs and uses, taking into account sources of impacts and physical characteristics. In addition, the need for permits, treatment and disposal options have been identified.

5. On the basis of the impact assessment, guidance has been provided on actions/remedial measures that need to be implemented to reduce impacts to acceptable levels. This will identify the need for discharge permits, segregation, treatment, etc, and provide guidance on best site management practices.

6. Evaluation of the residual impacts and identify the requirements for Environmental Monitoring & Audit (EM&A).

7.6 Construction Phase Impacts

7.6.1 Source of Impacts

7.6.1.1 The construction work can be divided into two phases : the construction of advance works and the main construction works. The advance works is estimated to last for 20 months and involves the surcharging, construction of a box culvert, site levelling work and excavation works. The advance works will be commenced in October 1999 and finished in July 2001.

7.6.1.2 The second phase, i.e. the "main construction work" is expected to be completed within 42 months starting from January 2001. The population uptake of the proposed development is expected to be around year 2004/2005. During the main construction phase, the temporary quay deck, the access roads, sewage treatment work (including the submarine outfall), schools, drainage as well as the residential blocks will be constructed. This involves foundation piling, building works, superstructure installation, drainage works and roadwork.

7.6.1.3 The major impacts upon the water quality will be the siltation problem generated by the different construction works. Due to the nature / size of the works, the impacts are considered to be near-field. The existing water quality may be impacted by the following construction activities.

7.6.1.1 Surcharging Work

7.6.1.1.1 In order to affect the required compaction, the existing site level will have to be surcharged by up to 5 metres of fill. This involves the placement of approximately 630,000 cubic metres of fill material. Both public fill and sandfill will be used for the surcharging work. Approximately 330,000 m^3 of the imported fill material will be removed after the surcharging period. Potential impacts that may arise from the surcharging will be related to the loss of fill material during the fill unloading and subsequent loading operations.

7.6.1.2 Construction of Box Culvert

7.6.1.2.1 The surface water body located at the northern end of the reclamation will be filled and therefore, a new underground box channel will have to be constructed during the advance works to provide the required drainage connection between the Kong Sin Wan Nullah and the existing culvert outlet in the seawall. The work will involve the excavation of a 374 m long (approx.) trench and the placement of the box culvert into the trench and then backfilling. The impacts will likely be limited to the dust generated during the excavation and the backfilling activities.

7.6.1.3 Construction of Quay Deck

7.6.1.3.1 Marine based access would be used for the transport / disposal of material during the first two years of the main construction period prior to the completion of the two access roads. Two quay decks will be constructed, one at each side of the existing pier. This will involve minor marine pilling activities. These quay decks are temporary structure and are intended to provide marine access to the site prior to the completion of the road access. They will be removed around 2003 when the road access is available. The pile removal is likely to be by the vibration - extraction method.

7.6.1.4 Marine Dredging for the Construction of the Submarine Outfall

7.6.1.4.1 For the construction of the sewage submarine outfall, approximately 4000 m^3 of marine mud will need to be dredged. Dredging of the seabed will disturb the bottom sediment and may lead to the re-suspension of sediment. Moreover, the dredged materials will require proper disposal. It is estimated that the dredging and pipelaying work for submarine outfall will start in May 2001 and end in January 2003 (Refer to Appendix 2.1).

7.6.1.5 Construction of Southern Access

7.6.1.5.1 Construction of the Southern Access Road involves excavation along the hilltop beside Waterfall Bay. The excavation work may create a silt deposition problem with respect to the Southern Stream which is located close to the proposed access road alignment. However, the proposed realignment of the Southern Stream will move it away from the construction area and reduce the likelihood of any significant impacts.

7.6.1.6 Realignment of the Southern Stream

7.6.1.6.1 In order to fulfil the Transport Department's requirements for an acceptable road curve radius, part of the Southern Stream will have to be realigned. The proposed realignment of the stream is shown in Figure 7.3. By doing so, the total length of the Southern Stream will be shortened. The work required will involve the excavation of a 100 m long x 6 m wide x 2 m deep trench (estimated size) and the placing of the appropriate lining (e.g. gabion).

7.6.1.7 General Construction Activities and Workforce

7.6.1.7.1 Water quality may also be affected throughout the construction period by the following:

- wash water from dust suppression activities, wheel washing facilities and bore piling (high suspended particulate load);

- domestic sewage and waste generated by work force (e.g. canteen and sanitary facilities);
- construction wastes generated on site being washed off-site by the surface runoff;
- run-off and erosion from site surfaces, earth working areas, material stockpiles and drainage channels; and
- accidental fuel/chemical/oil spillages from vehicle and plant usage and maintenance.

7.6.1.7.2 At this time, it is impossible to quantify the volume of the wastewater generated by the general construction activities as this depends on the Contractor's practices. However, the contractor will have a statutory obligation to meet the requirements of the on-site discharge license. As such, they will be required to size / construct the treatment systems accordingly so that the effluents generated are treated to the levels specified in the license prior to discharge. Site runoff and process waters typically have a high suspended solids content prior to treatment.

7.6.1.7.3 Domestic sewage generated on site would likely include canteen or kitchen wastewater, as well as sanitary wastes. The amount of sewage to be generated would depend on the number of workers employed. As a conservative estimate, the number of workers has been assumed to be 500 which amounts to a sewage generation rate of about 30 m^3/day. (assume a domestic wastewater arising of 60 litres/per person/ per day (*Watson Hawksley 1989)*). This wastewater will be characterized by high biochemical oxygen demand (BOD), ammonia, oil and grease, and faecal bacteria counts.

7.6.1.7.4 The rainfall related surface water run-off was estimated based on the Rational Method as detailed in ("*Stormwater Drainage Manual*" published by DSD in 1994). For a 10 year return storm, the gross estimates of stormwater runoff from the construction site is 0.97 m^3/s. The full set of calculations is attached in Appendix 7.1.

7.6.1.7.5 During the construction phase, solvents/lubricants/fuel will be utilised on-site for vehicle and plant maintenance. The required chemicals will be handled and stored on site as detailed in Section 7.6.3.4. With a well planned spill/leakage management plan, the impacts upon the surrounding waters can be minimised in case of accidental spillage.

7.6.1.7.6 The majority of the proposed development site at Telegraph Bay is located within a reclamation area with the exception of Site 1 (undeveloped scrub land, residential) and Site 5 (Waterfall Golf Driving Range). The golf driving range located at Site 5 is the only known, non residential land use to have been identified within the development area. Site 5 is currently being used as a golf driving range. The facility consists of two driving ranges with one at each platform level. It is estimated that only 1/3 of the area (approximately) is covered by maintained grass. The remaining area is occupied by buildings, hardstanding, car parking spaces, concrete roadway or undeveloped. Pesticides / herbicides are used for the grass maintenance, however it is understood from the appointed maintenance contractor that these are applied sparingly, only when needed (approximately once per every four months) i.e. Application is kept to a minimum since the area is used by the public. The natures of these argochemicals are such that they will either be bound to the soils, bio-degraded or immobilised. After the closure of the driving range, there will be no more application of fertilisers / herbicides and it is considered highly unlikely that significant concentrations would be present or remain on site. In view of the very small dosage and the nature of the chemical, it is unlikely that they will cause any contamination to the freshwater quality during the construction and operation phases. More details regarding the land contamination issue for the golf driving range are given in Chapter 8.

7.6.1.8 *Off-Site Works Area*

7.6.1.8.1 Due to the limited access to the study site, off-site work areas are required in the early stage of the work. The provision of these areas enable the contractors involved in the TBD works to store materials, such as steel bars, cement and equipment, delivered by road for transit onto barges for onward delivery to Telegraph Bay. The proposed off-site works areas include the area on the seaward side of the road junction of Sandy Bay Road and Sha Wan Drive (WA1) and the seafront area at Lee Nam Road between Ap Lei Chau Sewage Treatment Plant and Wang Kwong Sand and Quarry Ltd (WA2). Figures 2.5 to 2.6 show the location of the proposed off-site works area. The transportation of materials and workers will be by derrick lighter barges and passenger boats. One derrick lighter barge and two passenger boats will be running between each work site and Telegraph Bay. Each vessel is expected to make approximately three round trips per day.

7.6.1.8.2 The off-site works areas will serve as a cargo working area for loading, unloading and temporary storage of materials. The major potential impact from the off-site work areas operation will be the loss of fine materials during transportation. However, given the fact that all the cement will be packed in sealed package, loss of fine particulate to the sea during handling/transport is unlikely to occur. Consequently, the impacts upon the water quality is anticipated to be minimal. Besides, there is also a requirement for the temporary storage of fuel/lubricants/solvents in these areas. These materials are generally stored in drum and provided that proper storage procedures (as detailed in Section 7.6.3.4) are followed, the potential for leakage and impacts are low.

7.6.2 Evaluation of Potential Impacts

7.6.2.1 Surcharging

7.6.2.1.1 The loss of fill material during transfer from the barge to the shore may lead to an increase in the suspended solid levels in the water. However, through the use of a closed grab and other appropriate measure, it is envisaged that there will be only minor losses of fill material.

7.6.2.2 Construction of the Box Culvert Channel

7.6.2.2.1 The works involve excavation of a trench, placing of a box culvert into the trench and backfilling. It is anticipated that the major source of impact will be from the trench excavation. The main part of the trench will be completed first before joining to the target bodies at the two ends (i.e., Kong Sin Wan Nullah and the existing culvert outlet). Given the way the excavation works is to be carried out, the trench will actually be isolated with no water flowing in it under normal circumstances. Minor impacts may occur during heavy rainfall and / or the final stage - drainage connection. These however, will be localised and temporary.

7.6.2.3 Quay Deck Construction

7.6.2.3.1 The piling works required for the construction of the quay deck will likely lead to the suspension of fine material which, if uncontrolled, will lead to a rise in the suspended solid level in the water around the quay deck area. The pile removal activities may also slightly

disturb the bottom sediments. However, due to the relatively short construction / demolition period, the impact will likely be localised and temporary. No long term deterioration in the water quality is expected.

7.6.2.4 Marine Dredging for the Construction of the Submarine Outfall

7.6.2.4.1 Marine sediments may be disturbed during the dredging activities leading to the resuspension of sediment into the water column. Moreover, the dredged marine mud may be lost during handling and/or transportation to the disposal site. The preliminary laboratory test results indicate that the muds are unlikely to be contaminated. In view of this, it is envisaged that the most significant impact would be a temporary rise in SS level in the surrounding water.

7.6.2.5 Construction of Southern Access

7.6.2.5.1 The main concern related to the southern access construction will be the deposition of the fine particulates (generated during excavation) into the Southern Stream. However, by realigning the stream prior to the commencement of the roadwork construction, the stream is unlikely to be impacted by the access road construction.

7.6.2.6 Realignment of Southern Stream

7.6.2.6.1 The excavation of the trench for the stream realignment, if not conducted carefully, may lead to sedimentation in the stream. Consequently, it may impact upon the flora and fauna of the Southern Stream during the construction stage. However, these potential impacts can be controlled by adopting proper work methods / mitigation measures as mentioned in Section 7.6.3.3.

7.6.2.6.2. The realignment of the stream may lead to a loss in the freshwater habitat. The associated ecological impacts and the remedial measures to be taken will be discussed in Chapter 9. The change in the stream alignment may alter the flow regime which in turn will affect the hydrology of the stream. The design of the stream realignment must minimise any significant alteration of the natural stream hydraulic regime.

7.6.2.7 Wastewater generated from the General Construction Activities and Workforce

7.6.2.7.1 Unmitigated site runoff could lead to localized incidents of increased suspended solids, oil and grease content, turbidity, BOD levels and nutrient enrichment in the East Lamma Channel. This may result in reduced light penetration and dissolved oxygen content that would locally decrease the assimilative capacity of the receiving waters for various organic and inorganic pollutants. This, in turn, could lead to toxic effects upon the marine biota. The potential also exists for site-generated debris and rubbish, such as packaging and used construction materials, entering the water column and result in floating refuse which would reduce the aesthetic quality of the receiving water body. These impacts, however can be controlled by implementing appropriate site management measures.

7.6.2.7.2 Any required chemicals will be handled and stored on site as detailed in Section 7.6.3.4. Through the implementation of appropriate storage and handling procedures, the risk of accidental chemical losses to the environment is very low.

7.6.3 Mitigation Measures

7.6.3.1 Dredging and Surcharging

7.6.3.1.1 Pollution avoidance measures for the dredging, transportation and dumping of dredged material and the transportation of fill material should include the following:

- Vessels should be sufficiently sized to allow adequate water clearance between the vessel bottom and the sea bed at all states of the tide to ensure that undue turbidity is not generated by turbulence from vessel movement or propeller wash;
- Excess material should be cleaned from the decks and exposed fittings of barges and dredgers before the vessel is moved;
- Loading of barges and dredgers should be controlled to prevent splashing of dredged/fill material to the surrounding water and barges should not be filled to a limit which would cause overflow of material or polluted water during loading or transportation;
- Adequate freeboard shall be maintained on barges to ensure that decks are not washed by wave action; and
- The works should not cause visible foam, scum, oil, grease, litter or other objectionable matter to be present on the water within the dredging, barging area or disposal area.

7.6.3.1.2 On top of the above measures, the contractor commissioning the dredging work shall also implement the following measures:

- Dredging operations should be performed in order to minimise any adverse impacts to identified sensitive receivers. Where appropriate, silt curtains should be utilised to minimise sediment migration during dredging, or to protect specific water intakes;
- Minimise disturbance to the seabed during dredging and disposal activities;
- Barges and dredgers should be fitted with tight seals to their bottom opening to prevent leakage of materials. Vessels used for disposal should be capable of rapid-discharge bottom dumping at the designated marine disposal site;
- Pipe leakages should be repaired promptly and plant should not be operated with leaking pipes;
- Prevent discharge of dredged material except at approved locations; and
- The use of closed grab dredging techniques to minimise sediment losses and leakage of dredged material during lifting and dumping activities.

7.6.3.2 Construction of the Southern Access

- The realignment of the Southern Stream should be completed prior to the commencement of the construction work to avoid silt deposition into the stream; and

- Proper mitigation as suggested below for controlling the construction wastewater should be followed to prevent site runoff from flowing into the stream.

7.6.3.3 Realignment of the Southern Stream

7.6.3.3.1 The excavation of the stream (or trench) should be carried out in the following manner:

- Prevent the flow in the Southern Stream from entering into the trench during construction;
- Diversion of the Southern Stream shall only be done after the completion of the new channel;
- As far as practical, excavation shall be started at the downstream location and worked upward to eliminate the chance for impacting the Southern Stream; and
- Use of submersible pump to empty the trench if filled with rainwater. The water shall be directed to pass through silt traps / sedimentation basin prior discharge;

7.6.3.3.2 The realignment shall be designed to:

- Maintain the natural stream environment as far as practicable; e.g. by lining with gabion; and
- avoid any significant changes in the flow hydraulics.

7.6.3.4 General Construction Wastewater

7.6.3.4.1 A surface water management plan comprised of the following will be implemented to control the potential water quality impacts created from the proposed construction activities. The strategy is to recover and reuse as much wastewater/site runoff as practicable so as to minimise the need for discharge to the ocean. The planned measures include:

A. Surface runoff

(i) Works should be programmed to avoid the rainy season whenever possible to minimise storm runoff. If work during rainy seasons cannot be avoided, precautions should be taken to prevent soil erosion;

(ii) The site should be kept clean and tidy with construction materials and waste being stored such that they are not washed off-site;

(iii) Channels or earth bunds should be constructed to direct the surface runoff to silt traps or sedimentation basin;

(iv) Perimeter channels should be constructed at site boundaries to stop the storm runoff from washing across the site;

(v) Dykes or embankments for flood protection should be positioned around critical earthwork areas;

(vi) The drainage channels should be connected to sand or silt traps and sediment basins. The silt traps should be designed as per the guidelines given in Appendix A1 of ProPECC PN 1/94. Sedimentation basins should be configured so as to provide sufficient time for the suspended solids to settle out. Baffles should be provided in the basins to reduce water velocity, promote settling and prolong the residence time of the runoff. The "cleaned" water should be pumped back for further on site dust suppression and vehicle washing as far as practicable. These facilities should be regularly desilted to maintain their effectiveness. Excess water, following treatment, should be discharged to the stormwater drainage system;

(vii) Surface runoff from areas likely to be contaminated with oil or fuel, e.g. vehicle or plant parking areas, equipment refuelling areas should be directed to an oil separator prior to entering the general site drainage stream;

(viii) Stockpiles of construction materials on site should be covered with tarpaulins or similar fabric to prevent surface erosion. Minimisation of stockpiling in the wet season will reduce the chance of silt laden surface runoff from entering the ocean;

(ix) Silt removal facilities should be checked and the deposited silt and grit should be removed regularly to ensure these facilities are in good working condition and to prevent blockages;

(x) Prohibited substances, as specified in the Technical Memorandum for Standards for Effluents into Drainage and Sewerage Systems, Inland and Coastal Waters, should be avoided on site;

(xi) The "clean" stormwater runoff should be directed to the stormwater drainage system which discharges directly to the ocean. Stormwater runoff from potentially contaminated areas should be diverted to the silt traps or petrol interceptor for treatment prior to discharge;

(xii) The vehicle washing area should be drained into a settlement basin to settle out the suspended solid before discharging to storm water drains. The waters should be recycled on site whenever possible; and

(xiii) The volume of water used for dust suppression purposes should be minimised as far as practicable; and an alternative soil holding agent should be considered. A wheel wash basin be used to minimize the water usage / wash water generated from direct hosing. The basin should be refilled as required and the wash water from the basin either reused for road watering or pumped to the on-site settling tanks for treatment.

B. Spillage, Oil and Solvents

(i) Any spillage should be cleaned up immediately and the resulting contaminated absorbent material properly managed. Spills should be contained to avoid spreading and contaminating the water resources;

(ii) Oil and fuels should be used and stored in designated areas. All fuel tanks and storage areas should be provided with locks and be sited on sealed areas, within bunds of a capacity equal to 110% of the storage capacity of the largest tank;

(iii) Maintenance and storage areas should be covered and equipped with pollution prevention measures. The drainage of these areas should be directed to a petrol interceptor prior connecting to storm water drains to remove the oil and grease; and

(iv) Any spent oil should be collected and stored and disposed of in accordance with the Waste Disposal Ordinance.

C. On-Site Effluent Generation (Foul and Grey Waters)

(i) Chemical toilets should be positioned at appropriate locations across the site. There should be no direct discharge of foul water off-site.

(ii) Grey waters, which in this case would be food preparation/wash-up waters, should pass through a grease trap prior to discharge to the environment. It must be noted that a WPCO licence is required for discharging these process waters and the sewage must be in compliance with the standards put forth in the TMSE.

7.6.4 Residual Impacts

7.6.4.1 Through the adoption of proper mitigation measures during the dredging of marine mud for the submarine outfall construction and the surcharging work, any potential impacts will be

minimized. Therefore, no significant impacts upon the East Lamma Channel are expected.

7.6.4.2 The construction and demolition of the quay deck may create short term impacts on marine water quality. However, the situation will be restored once the work is finished. By proper phasing of the work, the impacts can be further minimised.

7.6.4.3 The realignment of the Southern Stream will eliminate the impacts upon the stream caused by the construction work. The final realignment shall be determined in detail in a later stage in aiming to avoid significant alteration to the flow regime.

7.6.4.4 The discharge from the site is subject to the control of the WPCO. A Discharge License must be obtained prior to the commencement of construction. The license will specify the maximum allowable limits for the parameters of concern in the discharge. As stated previously, the contractor is obliged to comply with the standards set out in the license. The implementation of the aforementioned mitigation measures and water management plan will aid him in doing so. However, the contractor will still be responsible for the design, operation and performance of any on-site treatment systems.

7.6.4.5 During prolonged or excessive wet weather periods, even after implementing the precautions detailed in Appendix A2 of ProPECC PN 1/94, discharges of waters high in suspended solids may occur. However, given the temporary nature of such events, the actual water quality impacts within the East Lamma Channel would be minimal.

7.6.4.6 No significant water quality impacts are expected at either of the two off site work areas.

7.6.4.6 Overall, it is anticipated that any impacts will be minor, temporary and localised if the identified mitigation measures are properly applied. Moreover, no significant impacts upon the existing seawater intakes, drain outfalls or either the marine or fresh water ecology are predicted.

7.7 Cumulative Water Quality Impact From Route 7

7.7.1 Although the proposed alignment of Route 7 has not been finalised, it is considered that some reclamation will be required for constructing the section around the Waterfall Bay headland. The impacts upon the nearby water sensitive receivers arising from the proposed reclamation will be studied under the Route 7 EIA study. The study will also make recommendations on the mitigation measures.

7.7.2 Based on the alignment given in the "Route 7 Feasibility Study Final Report", Route 7 will be at-grade and situated on reclaimed land (reclaimed under the Telegraph Bay Reclamation Project). No major marine work or excavation work is expected. The sources of pollutants will therefore likely be limited to the site-runoff generated during general construction work. The implementation of the mitigation measures as detailed in Section 7.6.3.4 will help control the water quality impacts to an acceptable level.

7.8 Operational Phase

7.8.1 Source of Impacts

7.8.1.1 The primary source of wastewater associated with the operational phase will be the sewage generated by the residential development and commercial activities. Until the

commissioning of the Strategic Sewage Disposal Scheme (SSDS) Stage III/IV (aim to be in operation in year 2007), municipal sewage from the development will be directed to the proposed sewage treatment plant, where it is treated, prior to discharge into the East Lamma Channel. The residual impacts arising from the discharge of the treated effluent are considered to be the main water quality issue during the operational phase.

7.8.1.2 Other minor sources of impact may include runoff (washwater) from the Public Transport Interchange (PTI) and carpark areas. As these areas are covered, the runoff will be limited to the washwater generated during the facility maintenance. This runoff water may entrain fuel / oil and any dirt and rubbish from on the ground surface.

7.8.1.3 The planning intention of the G/IC Site is for the accommodation of a school and a sewage treatment works. The sewage treatment works (STW) will be an enclosed structure and hence, the only surface runoff will be from the facility parking spaces.

7.8.2 Evaluation of Potential Impact

7.8.2.1 Treated Sewage "Outfall"

Sewage Treatment Plant

7.8.2.1.1 The proposed sewage treatment system will receive a daily peak and equalized flow of approximate 204 litres/sec and 179 litres/sec, respectively. The sewage treatment plant consists of three stages: Preliminary Treatment (i.e. bar screen and detritor), Chemically Enhanced Primary Treatment (CEPT) and Disinfection.

7.8.2.1.2 After the preliminary treatment (screening), the sewage is diverted to the CEPT system. It is equalised in the Screened Sewage Storage Tank prior to being pumped to Rapid Mixing Tank where a coagulant chemical, such as ferric chloride of alum is added. The sewage will then flow to the Flocculation Tank for flocculant dosing, e.g. Magnifloc 1011, and then the Sedimentation Tank for solid/liquid separation. After these processes, the CEPT treated sewage is stored in the Effluent Balancing Tank from where it is pumped to the ground floor disinfection contact tank. A disinfectant solution will be injected into the sewage during pumping. The residence time of the sewage in the disinfection tank will be sufficient for disinfection to take place.

Effluent Sewage Quality:

7.8.2.1.3 The major contaminants found in the sewage are SS, BOD, E-Coli and inorganic nitrogen. It is estimated that a removal efficiency of 50% for SS and 50% for BOD respectively can be achieved by the use of the CEPT. With the employment of the ozone disinfection system together with the natural die-off, the E-Coli concentration can be reduced from 10^8 cfu/100ml to 10,000 cfu/100ml. The effluent water quality is estimated to have :

Parameter	Concentration
SS	125 mg/L
BOD	125 mg/L
E-coli	10000 cfu / 100mL
Inorganic Nitrogen	25 mg/L (same as influent)

A sensitive test by assuming the removal rate of BOD at 35% efficiency in the CEPT is conducted at Chapter 6. The effluent level for BOD is equal to 162.5 mg/L. According to

Section 6.7.2, the critical dilution factor of 137 is for the pollutant of total inorganic nitrogen. It is therefore, expected that the water quality impact arising from this BOD concentration is insignificant.

7.8.2.1.4 The flow rate of the outfall is estimated to be 179 l/s.

Dilution Dispersion models

7.8.2.1.5 The dilution effect of the sewage disposal to the East Lamma Channel via the proposed outfall has been studied and the results have been presented in Chapter 6. The size and extent of the mixing zone regions have been simulated through the use of the computer model "CORMIX". Inorganic Nitrogen has been chosen for the assessment purpose because it is the critical pollutants (as it requires the maximum dilution factor amongst the other pollutants). This model is designed for the analysis, prediction, and design of conventional aqueous pollutant discharges into diverse water bodies.

7.8.2.1.6 The proposed submarine outfall is approximately 300 m long. The proposed outfall location is indicated in Chapter 6 – Figure 6.2. The size of the mixing zones for the dilution of Inorganic Nitrogen have been simulated for three different current speeds : 0.5m/s (fast flow) , 0.35 m/s (medium flow) and 0.1 m/s (slow flow) under three water density profile conditions. The full set of model results are presented in Section 6.7.2.

7.8.2.1.7 From the results of the dilution models, it is found that the largest mixing zone has an area of 96m (length) x 210m (width) which does not extend to any water sensitive receivers nearby nor to the coral community found along the northern and north-eastern shores of Lamma Island. The predicted mixing zone area for the worst scenario is illustrated in Chapter 6 – Figure 6.9.

7.8.2.2 Wash Water From PTI / Carpark Cleaning

7.8.2.2.1 The wash water is expected to contain a relatively high amount of dirt or debris and also a small amount of hydrocarbons (i.e. oil and fuel). However, because the PTI / carpark area drainage systems are equipped with petrol interceptors and grit traps, no impacts from these discharges are anticipated.

7.8.2.3 Surface Runoff From Parking Spaces in G/IC Site

7.8.2.3.1 The contaminants found in the surface runoff from the G/IC site open parking spaces is likely to be limited to the dust and trace quantity of fuel/lubricants. It is unlikely that the surface runoff will cause any significant water quality impacts.

7.8.3 Residual Impacts

7.8.3.1 The initial dilution modelling results indicate that the suspended solids and E-coli will be diluted very rapidly after being discharged into the ocean. It is found that the largest mixing zone (with an area of 96m x 210m) will not extend to either the identified coral community nor any of the seawater intakes or storm drains outfall locations. Therefore, no adverse impacts are predicted.

7.8.3.2 In order to validate the effluent dilution modelling results, and to ensure that no impacts result as a result of the proposed sewage discharge, a sewage outfall monitoring program is

recommended. It is anticipated that six (6) monitoring points will be required, with both control and impact sampling locations being included. The provisional sampling points will be positioned as detailed in Figure 11.1, although these are subject to agreement with EPD. Water quality Action and Limit Levels will be prepared in conjunction with EPD after the baseline monitoring program is complete. It is anticipated that impact monitoring will be carried out three times per week at each sampling location. The monitoring requirements have been outlined in Chapter 11. A standalone EM&A manual will also be produced to cover the details of sampling and analysis specifications, including the required protocol and QA/QC procedures.

7.9 Conclusions

7.9.1 Available data suggested that existing water quality in East Lamma Channel is generally in good condition. The laboratory test results suggested that the marine sediments in the area are uncontaminated.

7.9.2 During the construction phase, if uncontrolled, contaminated surface runoff from the construction site could enter East Lamma Channel. As a mitigation measure, it has been proposed to implement a water pollution control plan to minimise the impact of construction runoff on the aquatic environment. Through the implementation of the recommended mitigation measures and management practices, it is anticipated that the impacts upon the sensitive receivers including the freshwater streams, will be temporary and minimal.

7.9.3 By the adoption of proper mitigation measures during the dredging of marine mud for submarine outfall construction and surcharging work, the disturbance to the marine bed and loss of dredged and fill material can be minimised. Therefore, no significant impacts upon the East Lamma Channel and corals to the North of Lamma Island arising from these activities is expected.

7.9.4 The construction / demolition of quay deck may create short term impacts on the marine water quality and the situation will be restored once the work is finished. By proper phasing of the piling and demolition work, the impacts can be further controlled. Given the physical separation between the quay deck and corals, the impacts upon the corals from the quay deck construction will be insignificant as the majority of the pollutants would be well dispersed / diluted before reaching it.

7.9.5 By the realigning the Southern Stream prior to the commencement of the southern access construction, the impacts upon the stream will be minimal provided that the design of the proposed stream alignment shall aim to avoid significant alteration to the stream flow hydraulic.

7.9.6 The discharge from the site is subject to the control of the WPCO. A Discharge License must be obtained prior to the commencement of construction and the operation of the proposed sewage treatment plant. The license will specify the maximum allowable limits for the parameters of concern in the discharge. As stated previously, the contractor / the proponent of the sewage treatment plant is obliged to comply with the standards set out in the license. The implementation of the afore-mentioned mitigation measures and water management plan during the construction stage will aid him in doing so. However, the contractor will still be responsible for the design, operation and performance of any on-site treatment systems.

7.9.7 During prolonged or excessive wet weather periods, even after implementing the

precautions detailed in Appendix A2 of ProPECC PN 1/94, discharges of waters high in suspended solids may occur. However, given the temporary nature of such events, the actual water quality impacts within the East Lamma Channel would be minimal.

7.9.8 It is anticipated that any impacts will be minor, temporary and localised if the identified mitigation measures are properly applied. It is envisaged that there will be no significant impact on the existing seawater intakes, drain outfalls and on both marine and fresh water ecology.

7.9.9 During operation, the dilution model results indicate that even the largest mixing zone (with an area of 96m x 210m) will not reach the coral community nor any of the seawater intakes or storm drains outfall locations. The related impacts are therefore considered to be negligible.

7.9.10 On top of the discharge monitoring (as part of the discharge license requirements), routine water quality monitoring will also be required to ensure the nearby water sensitive receivers are not impacted by the construction works (except the barging activities for the advance works) and by proposed submarine sewage outfall (during operation).

7.9.10 An environmental monitoring and audit programme will be prepared in conjunction with the EIA Report for the project. It will specify the environmental monitoring and audit requirements to be conducted during construction and operation

7.10 References

Binnie (Dec 1994) for CED Fill Management Study – Phase IV Coastal Ecology Surveys – Lamma Channel Underwater Ecological Survey Draft Report

Materialab (1998) Laboratory Testing Report for Infrastructural Works for Housing Development at Telegraph Bay

EPD Technical Circular TC-1-1-92 Classification of Dredged Sediments for Marine Disposal

Watson Hawksley (1989) Sewage Strategy Study: Appendices – Part 1 for EPD.

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EPD (1994) Practical Note for Professional Persons on Construction Site Drainage (ProPECC PN1/94)

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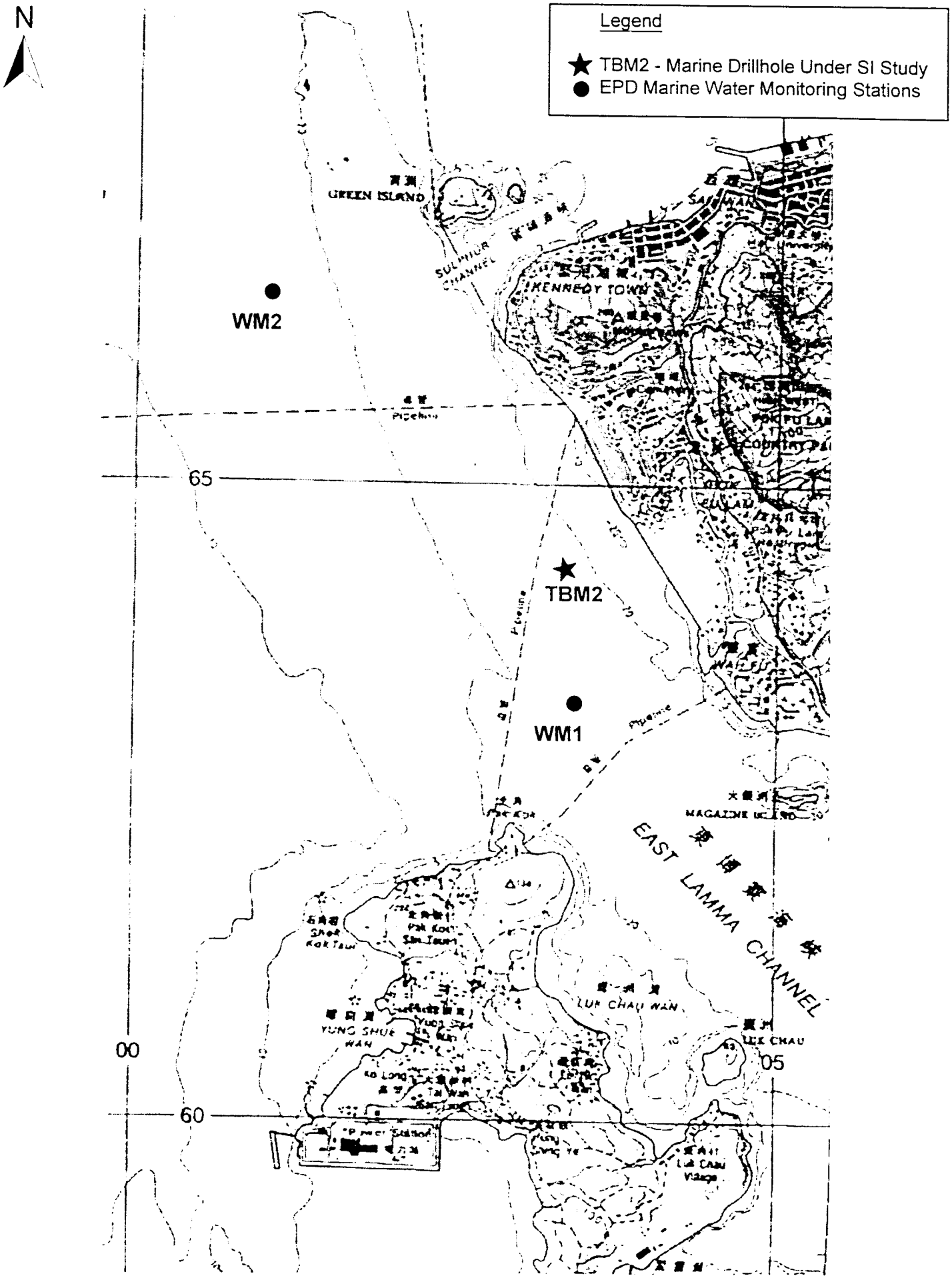
Figures



AGREEMENT NO. CE 92/97 INFRASTRUCTURAL WORKS FOR HOUSING DEVELOPMENT AT TELEGRAPH BAY - ENGINEERING FEASIBILITY STUDY

EPD Routine Marine Monitoring Stations

TERRITORY DEVELOPMENT DEPARTMENT, HONG KONG

HONG KONG ISLAND AND ISLANDS DEVELOPMENT OFFICE

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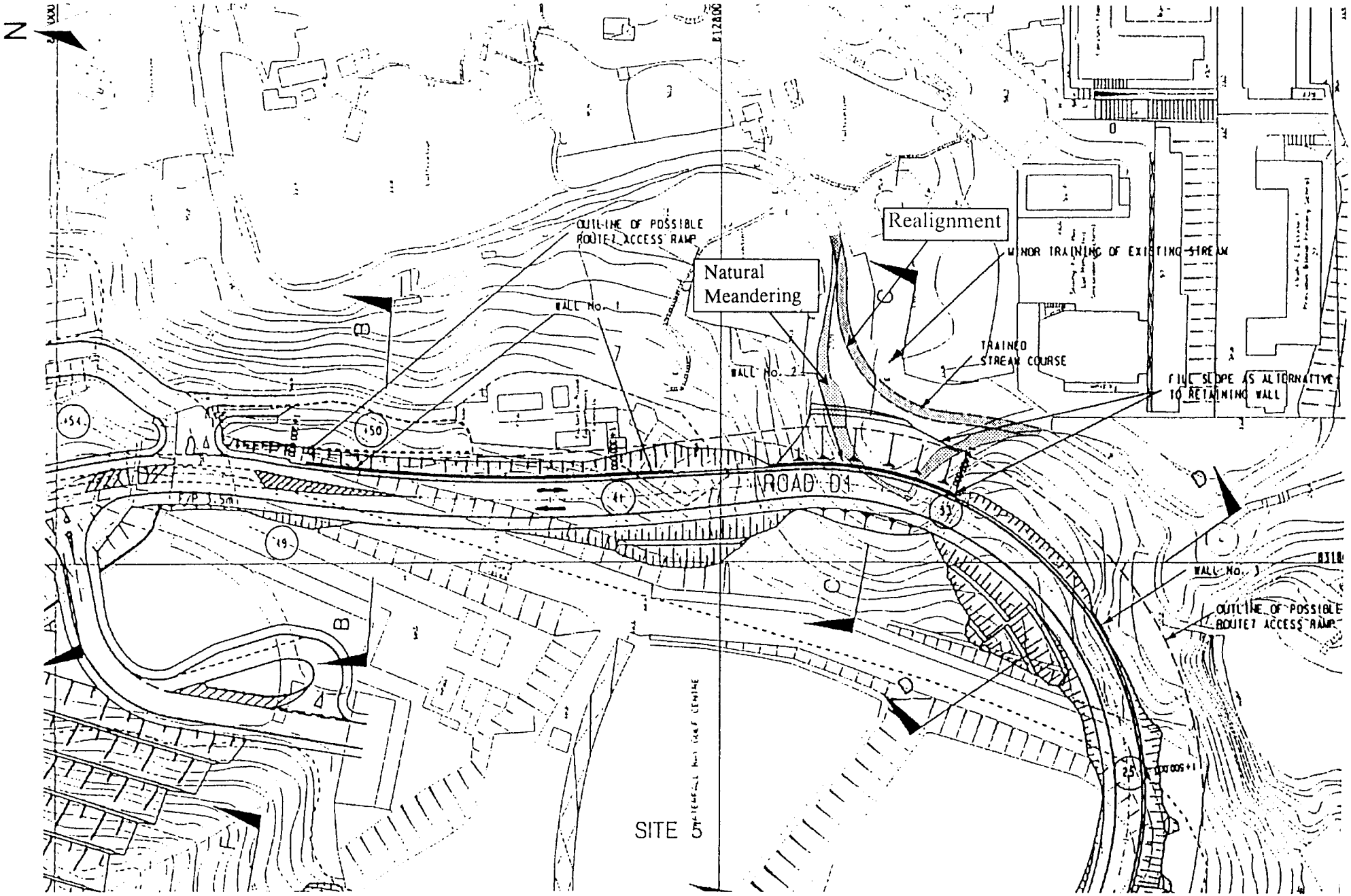

AGREEMENT NO. CE 92/97 INFRASTRUCTURAL WORKS FOR HOUSING DEVELOPMENT AT TELEGRAPH BAY - ENGINEERING FEASIBILITY STUDY

Realignment of Southern Stream

TERRITORY DEVELOPMENT DEPARTMENT, HONG KONG

HONG KONG ISLAND AND ISLANDS DEVELOPMENT OFFICE

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