Chapter 7

WATER QUALITY IMPACT ASSESSMENT

7. WATER QUALITY

Introduction

7.1 In connection with the development of constructing an international theme park and associated infrastructures at North Lantau, the former shipyard, Cheoy Lee Shipyard (CLS), at the inner part of Penny's Bay will be decommissioned. Potential environmental impacts arising from the CLS decommissioning were only broadly discussed under the Northshore Lantau Development Feasibility Study (NLDFS) EIA (Schedule 3).

7.2 This section presents the potential water quality impacts associated with the shipyard decommissioning and associated decontamination works. Key concerns relate to the potential release of the contaminated groundwater to the nearby marine waters, and the effluent discharges from land based demolition/ construction and soil remediation activities.

7.3 As explained in the precedent chapter, contaminated soils found within the CLS site will be excavated and treated in on-site and off-site facilities. Land transportation of contaminated soil to the off-site treatment facility would be proposed and therefore no marine water quality impact in association with the marine transportation is envisaged. The Project is of land based and will not involve any dredging of sediment or sediment transportation, no impacts associated with the sediment quality issue are expected.

7.4 The impacts of filling works have been addressed in the Theme Park EIA Report and will not be addressed in this EIA Report.

Environmental Legislations, Standards and Evaluation Criteria

7.5 The criteria for evaluating water quality impacts in this EIA Study include:

- *Technical Memorandum on Environmental Impact Assessment Process (Environmental Impact Assessment Ordinance) (EIAO-TM);*
- *Water Pollution Control Ordinance (WPCO);*
- *Hong Kong Planning Standards and Guidelines (HKPSG);*
- *Practice Note for Professional Persons (ProPECC), Construction Site Drainage (PN 1/94);*
- *Technical Memorandum on Standards for Effluents Discharged into Drainage and Sewerage Systems, Inland and Coastal Waters (TM-ES); and*
- *Heavy Metals Standards as stipulated in UK Water Quality Standards for Coastal Surface Water([1]).*

([1]) Environmental Quality Standards and Assessment Levels for Coastal Surface Water (from HMIP (1994) Environmental Economic and BPEO Assessment Principals for Integrated Pollution Control). *(Source: Environmental Impact Assessment Study for Disposal of Contaminated Mud in the East Sha Chau Marine Borrow Pit, by ERM, January 1997).*

Environmental Impact Assessment Ordinance (EIAO), Cap. 499, S.16

7.6 This Project comprises two Designated Projects under Schedule 2 of the EIAO. The EIAO-TM was issued by the EPD under Section 16 of the EIAO. It specified the assessment method and criteria that were followed in this Study. Reference sections in the EIAO-TM provide the details of assessment criteria and guidelines that are relevant to the water quality assessment, including:

- Annex 6 – Criteria for Evaluating Water Pollution;
- Annex 14 – Guidelines for Assessment of Water Pollution.

Water Quality Objectives

7.7 The Water Pollution Control Ordinance (Cap. 358) provides the major statutory framework for the protection and control of water quality in Hong Kong. According to the Ordinance and its subsidiary legislation, Hong Kong waters are divided into ten Water Control Zones (WCZs). Corresponding statements of Water Quality Objectives (WQOs) are stipulated for different water regimes (marine waters, inland waters, bathing beaches subzones, secondary contact recreation subzones and fish culture subzones) in the WCZs based on their beneficial uses. The CLS site and To Kau Wan site are located within the Southern and North Western WCZs, respectively. The corresponding WQOs are summarised in Tables 7.1 and 7.2.

Table 7.1 Summary of Water Quality Objectives for the Southern WCZ

Parameters	Objectives	Sub-Zone
Offensive Odour, Tints	Not to be present	Whole zone
Visible foam, oil scum, litter	Not to be present	Whole zone
E. coli	Not to exceed 610 per 1000mL, calculated as the geometric mean of all samples collected in one calendar year	Secondary contact recreation subzones, fish culture subzones and bathing beach subzones
	Not to exceed 180 per 100mL, calculated as the geometric mean of all samples taken at least 3 times in a calendar month at intervals of between 3 and 14 days from March to October inclusive in one calendar year	(L.N. 453 of 1991)
Dissolved Oxygen (DO) within 2 m of the seabed	Not less than 2.0mg/L for 90% of samples	Marine waters
Depth-averaged DO	Not to fall below 4.0 mg/L for 90% of samples caused by waste discharges	Marine water excepting fish culture subzones
	Not less than 5.0 mg/L for 90% of samples	Fish culture subzones
Dissolved Oxygen	Not less than 4.0 mg/L for 90% of samples	Inland waters
pH	To be in the range of 6.5 – 8.5, change due to waste discharges not to exceed 0.2.	Marine waters excepting bathing beach subzones; Mui Wo (A), Mui Wo (B), Mui Wo (C), Mui Wo (E) and Mui Wo (F) subzones.
	To be in the range of 6.0 – 9.0.	Mui Wo (D) subzone and other inland waters
	To be in the range of 6.0 – 9.0 for 95% of samples, change due to waste discharges not to exceed 0.5.	Bathing beach subzones
Salinity	Change due to waste discharges not to exceed 10% of ambient	Whole zone
Temperature	Change due to waste discharge not to exceed 2°C	Whole zone
Suspended solids	Not to raise the ambient level by 30% caused by waste discharges	Marine waters

Parameters	Objectives	Sub-Zone
	Annual median not to exceed 20 mg/L due to waste discharges	Mui Wo (A), Mui Wo (B), Mui Wo (C), Mui Wo (E) and Mui Wo (F) subzones.
	Annual median not to exceed 25 mg/L due to waste discharges	Mui Wo (D) subzone and other inland waters
Ammonia	Annual mean not to exceed 0.021 mg/L as unionised form	Whole zone
Nutrients	Not to cause excessive growth of algae or other aquatic plants	Marine waters
	Annual mean depth-averaged inorganic nitrogen not to exceed 0.1 mg/L	Marine waters
BOD_5	Not to exceed 5 mg/L due to waste discharges	Inland waters
Chemical Oxygen Demand	Not to exceed 30 mg/L due to waste discharges	Inland waters
Dangerous substances	Not to attain such levels as to produce significant toxic effects in humans, fish or any other aquatic organisms due to waste discharges	Whole zone
	Not to put a risk to any beneficial uses of the aquatic environment due to waste discharges	Whole zone

Table 7.2 Summary of Water Quality Objectives for the North Western WCZ

Parameters	Objectives	Sub-Zone
Offensive Odour, Tints	Not to be present	Whole zone
Colour	Not to exceed 30 Hazen units, due to waste discharges	Tuen Mun (A) and Tuen Mun (B) subzones and water gathering ground subzones
	Not to exceed 50 Hazen units, due to waste discharges	Tuen Mun (C) subzone and other inland waters
Visible foam, oil scum, litter	Not to be present	Whole zone
E. coli	Not to exceed 610 per 100mL, calculated as the geometric mean of all samples collected in one calendar year	Secondary contact recreation subzones
	To be less than 1 per 100mL, calculated as the running median of the most recent 5 consecutive samples taken at intervals of between 7 and 21 days.	Tuen Mun (A) and Tuen Mun (B) subzones and water gathering ground subzones
	Not to exceed 1000 per 100mL, calculated as the running median of the most recent 5 consecutive samples taken at intervals of between 7 and 21 days.	Tuen Mun (C) subzone and other inland waters
	Not to exceed 180 per 100mL, calculated as the geometric mean of all samples taken at least 3 times in a calendar month at intervals of between 3 and 14 days from March to October inclusive in one calendar year	Bathing beach subzones
Dissolved Oxygen (DO) within 2 m of the seabed	Not less than 2.0mg/L for 90% of samples	Marine waters
Depth-averaged DO	Not to fall below 4.0 mg/L for 90% of samples caused by waste discharges	Marine water
Dissolved Oxygen	Not less than 4.0 mg/L for 90% of samples	Tuen Mun (A) and Tuen Mun (B) and Tuen Mun (C) subzones, water gathering ground subzones and other inland waters
pH	To be in the range of 6.5 – 8.5, change due to waste discharges not to exceed 0.2.	Marine waters excepting bathing beach subzones
	Not to exceed the range of 6.5 – 8.5 due to waste discharges.	Tuen Mun (A) and Tuen Mun (B) and Tuen Mun (C) subzones, water gathering ground subzones
	To be in the range of 6.0 – 9.0	Other inland waters
	To be in the range of 6.0 – 9.0 for 95% of samples, change due to waste discharges not to exceed 0.5.	Bathing beach subzones
Salinity	Change due to waste discharges not to exceed 10% of ambient	Whole zone

Parameters	Objectives	Sub-Zone
Temperature	Change due to waste discharge not to exceed 2°C	Whole zone
Suspended solids	Not to raise the ambient level by 30% caused by waste discharges	Marine waters
	Annual median not to exceed 20 mg/L due to waste discharges	Tuen Mun (A) and Tuen Mun (B) and Tuen Mun (C) subzones, water gathering ground subzones
	Annual median not to exceed 25 mg/L due to waste discharges	Other inland waters
Ammonia	Annual mean not to exceed 0.021 mg/L as unionised form	Whole zone
Nutrients	Not to cause excessive growth of algae or other aquatic plants	Marine waters
	Annual mean depth-averaged inorganic nitrogen not to exceed 0.3 mg/L	Castle Peak Bay subzone
	Annual mean depth-averaged inorganic nitrogen not to exceed 0.5 mg/L	Marine waters excepting Castle Peak Bay subzone
BOD_5	Not to exceed 3 mg/L due to waste discharges	Tuen Mun (A) and Tuen Mun (B) and Tuen Mun (C) subzones, water gathering ground subzones
	Not to exceed 5 mg/L due to waste discharges	Inland waters
Chemical Oxygen Demand	Not to exceed 15 mg/L due to waste discharges	Tuen Mun (A) and Tuen Mun (B) and Tuen Mun (C) subzones, water gathering ground subzones
	Not to exceed 30 mg/L due to waste discharges	Inland waters
Toxin	Not to cause the toxins in water to attain such levels as to produce significant toxic, carcinogenic, mutagenic or teratogenic effects in humans, fish or any other aquatic organisms due to waste discharges	Whole zone
	Not to cause a risk to any beneficial uses of the aquatic environment due to waste discharges	Whole zone
Phenol	Not to present in such quantities as to produce a specific odour, nor to exceed 0.05mg/L as C_6H_5OH	Bathing beach subzones
Turbidity	Not to reduce light transmission substantially from the normal level due to waste discharges	Bathing beach subzones

Hong Kong Planning Standards and Guidelines (HKPSG)

7.8 *The Hong Kong Planning Standards and Guidelines (HKPSG), Chapter 9 (Environment)*, provides additional information on regulatory guidelines against water pollution for sensitive uses such as aquaculture and fisheries zones, bathing waters and other contact recreational waters.

Practice Note

7.9 A practice note for professional persons was issued by the EPD to provide guidelines for handling and disposal of construction site discharges. The *ProPECC PN 1/94 "Construction Site Drainage"* provides good practice guidelines for dealing with ten types of discharge from a construction site. These include surface runoff, groundwater, boring and drilling water, bentonite slurry, water for testing and sterilisation of water retaining structures and water pipes, wastewater from building constructions, acid cleaning, etching and pickling wastewater, and wastewater from site facilities. Practices given in the ProPECC PN 1/94 should be followed as far as possible during construction to minimise the water quality impact due to construction site drainage.

Technical Memorandum

7.10 Besides setting the WQOs, the WPCO controls effluent discharging into the WCZ through a licensing system. The *Technical Memorandum on Standards for Effluents Discharged into Drainage and Sewerage Systems, Inland and Coastal Waters (TM-ES)* was issued under Section 21 of the WPCO that gives guidance on the permissible effluent discharges based on the type of receiving waters (foul sewers, storm water drains, inland and coastal waters). The limits control the physical, chemical and microbial quality of effluents. Wastewater and sewage from the shipyard decommissioning and decontamination activities should comply with the standards for effluents discharged into the foul sewers, inshore waters or marine waters of the Southern, North Western and Western Buffer WCZs, as shown in Table 10b of the TM-ES.

Heavy Metal Standards

7.11 Since there is no existing legislative standard or guideline for individual heavy metal contents in marine waters, the *UK Water Quality Standards for Coastal Surface Water* is adopted as assessment criteria. The standards of the relevant heavy metals (such as arsenic, cadmium, chromium, copper, lead, nickel and zinc) are listed in the following table.

Table 7.3 UK Water Quality Standards

Heavy Metals	Water Quality Standards (µg/L)
Arsenic	65
Cadmium	2.5
Chromium	15
Copper	5
Lead	25
Nickel	30
Zinc	40

Description of the Environment

Existing Marine Water Quality

7.12 There are two routine EPD water quality monitoring stations located in the vicinity of the CLS site (Southern WCZ) and the To Kau Wan site (North Western WCZ). In addition, water quality data of three routine monitoring stations as included in the monitoring programme for Penny's Bay Reclamation Phase 1 are also made reference. The locations of the reference routine monitoring stations are shown in Figure 7.1. A summary of water quality data for each of the stations is presented in Table 7.4.

Table 7.4 Routine Water Quality Monitoring Data in the Vicinity of the Project Area

WQ Parameter	CLS Site			To Kau Wan Site	
	SM10	**G2**	**G4**	**NM1**	**G6**
Temperature (°C)	23.4 (16.3 - 27.2)	23.6 (17.4 – 29.1)	23.6 (17.2 – 29.9)	23.6 (18.2 - 26.8)	23.6 (17.6 – 30.0)
Salinity (ppt)	30.2 (26.9 - 33.4)	31.0 (13.1 – 37.3)	30.8 (18.6 – 37.3)	29.3 (21.9 - 32.5)	30.4 (6.0 – 38.3)
Dissolved Oxygen (mg L^{-1})	**4.0 (3.2 - 7.2)**	6.4 (3.5 - 9.2)	6.7 (3.5 – 12.6)	**3.5 (3.2 - 8.4)**	6.5 (3.6 – 10.5)
Dissolved Oxygen Bottom (mg L^{-1})	4.3 (3.9 - 7.2)	6.0 (2.8 – 9.3)	6.3 (3.7 – 11.1)	2.9 (2.7 - 8.3)	5.9 (2.9 – 10.0)
5-Day Biochemical Oxygen Demand (mg L^{-1})	0.9 (0.1 - 1.8)	--	--	0.9 (0.2 - 2.0)	--
Suspended Solids (mg L^{-1})	6.9 (4.1 - 9.9)	13.8 (3.7 – 47.8)	21.4 (2.7 – 115.9)	4.0 (1.1 - 6.7)	14.0 (3.2 – 51.0)
Total Inorganic Nitrogen (mg L^{-1})	**0.27 (0.14 - 0.43)**	--	--	0.43 (0.24 - 0.66)	--
Unionised Ammonia (mg L^{-1})	0.003 (0.001 - 0.009)	--	--	0.005 (0.002 - 0.007)	--
E.coli (cfu $100mL^{-1}$)	9 (2 - 300)	--	--	110 (6 - 570)	--

Notes:
1. Data from EPD (1999) Marine Water Quality in Hong Kong in 1998 and Penny's Bay Reclamation Phase 1 EM&A data from September 2000 to August 2001.
2. Data presented are depth averaged, except as specified.
3. Data presented are annual arithmetic means except for *E. coli* which are geometric means.
4. Data enclosed in brackets indicate the ranges.
5. Boldface type indicates non-compliance with the WQOs.

7.13 The data indicated that there were non-compliances with the WQO for depth averaged dissolved oxygen at stations SM10 and NM1, despite the compliance with the bottom dissolved oxygen WQO. This revealed a deterioration from the data collected in 1997, which showed compliance with both depth averaged and bottom dissolved oxygen WQOs. However it might not be the case that the DO levels measured in G2, G4 & G6 show the compliance with WQO. Therefore, it is premature to conclude that the dissolved oxygen concentrations in the study area are deteriorating based on the 1998 data alone.

7.14 The total inorganic nitrogen WQO is exceeded at Station SM10. The exceedance of the total inorganic nitrogen WQO at Station SM10 has been recorded for the last ten years. It is worth noting that the WQO for total inorganic nitrogen is not exceeded at Station WM4, even though the average concentration is higher than that at Station SM10. This is because of the different WQO for total inorganic nitrogen in the Western Buffer WCZ, which is higher compared with that of the Southern WCZ.

7.15 The WQO for *E. coli* at Station SM10, which is in a Secondary Contact Recreation Subzone, was achieved and also satisfied the WQO for bathing beaches. Station NM1 is somewhat influenced by sewage effluent discharges, as shown by higher *E. coli* concentrations. This is possibly because this station is in one of the main flow paths between the waters of Victoria Harbour and will therefore receive dilute discharges of sewage from this areas.

7.16 The data for temperature, salinity and dissolved oxygen show a wide variation, which indicates seasonal changes. These are most pronounced at Station NM1, which is the station most influenced by the discharges from the Pearl River estuary.

Groundwater Quality at Cheoy Lee Shipyard

7.17 As part of this EIA study, contaminant testing of groundwater samples collected within the CLS site was undertaken. The groundwater samples were collected between July and October 2001, which is a wet season in Hong Kong. Most of the contaminated soils were found to be at top 2m layer and the water table in wet season is generally high (1-3m below grade). It means the groundwater system will have more contacts with the contaminated soil and the contaminant concentration in the groundwater can be expected to be higher in the wet season. Therefore, the testing results can represent a worst-case scenario.

7.18 A risk assessment has been carried out to assess whether the groundwater concentrations pose any risk to the site future users. The details of the assessment are presented in the Land Contamination Section of the EIA report. It was found that the observed groundwater concentrations are below risk-based standards. The following discussion focuses on the potential impact of groundwater migration/ discharge to the marine environment.

7.19 From the testing results, it is noted that heavy metals and total petroleum hydrocarbons (TPH) are the dominant chemicals identified in the groundwater samples. Table 7.5 shows the comparison of the identified heavy metals in the groundwater samples with the UK surface water quality standards. Figures 7.2a to 7.2c give locations of groundwater samples having exceedances of metal levels.

Table 7.5 Comparison of Identified Heavy Metals in the Groundwater Samples with the UK Water Quality Standards

Heavy Metals	Concentration in groundwater (μg/L)			No. of groundwater samples exceeded UK standard / Total No.	UK Surface Water Quality Standards (μg/L)
	Range	Average	Median		
Arsenic	<10 – 38	11	10	0 / 63	65
Cadmium	<0.2 - 17.8	1.0	0.2	4 / 63	2.5
Chromium	<0.1 – 67	2.0	0.1	1 / 63	15
Copper	<1 – 1187	**27**	1	17 / 63	5
Lead	<1 - 2254	**49**	1	2 / 63	25
Nickel	<1 - 7200	**120**	2	4 / 63	30
Zinc	<10 - 1200	**105**	31	25/ 63	40

Note : Boldface type indicates non-compliance with the UK Surface WQ Standard.

7.20 Although high levels of heavy metal were found in the groundwater samples, they are regarded as isolated events given the much lower median levels. Therefore for the purpose of this assessment, the average levels have been used for comparison. The average copper, lead, nickel and zinc levels in groundwater is found to exceed the corresponding UK Surface Water Quality Standards by 5.4, 2.0, 4.0 and 2.6 times respectively. However, such direct comparisons between groundwater concentration and surface water quality standards are used for screening purpose only. This is because as groundwater slowly seeps into the marine environment via drainage channels, it is subject to dilution processes in the channel where the metal concentration will be reduced by 88 times (refer Section 7.56 for the calculation of the dilution factor) before entering to the marine water.

7.21 Maximum TPH concentration of 0.4 mg/L was determined in the groundwater samples. Risk-based approach has been adopted to evaluate the groundwater contamination to confirm the acceptable risk level for the future site users. It is noted that there are no statutory marine water quality standards for TPH, BTEX and other toxic parameters. Their insignificant impacts on the marine water quality can be inferred by the fact that their concentrations in marine water would be well below the analytical detection limits (25μg/L for TPH and 6μg/L for BTEX) once the dilution effect (dilution by 88 times) is taken into account. (Refer Section 7.56 for the calculation of the dilution factor of 88).

7.22 Apart from the detectable level of heavy metals and TPH in the groundwater samples, the pH of the groundwater samples is in a range of 6.1-8.1 pH units, which comply with the pH standard of 6-10 pH units as stipulated in the TM-ES.

Water Sensitive Receivers

7.23 The shipyard decommissioning and decontamination activities at CLS site and To Kau Wan site may potentially affect water quality in Penny's Bay and the neighbouring waters. The Theme Park EIA report has assessed several water sensitive receivers of the potential impact, which include the broad designations of gazetted and non-gazetted bathing beaches, water intakes, fish culture zones. sites of ecological interest and recreational areas. Figure 7.3 gives locations of existing sensitive receivers. In addition, an artificial lake at the Water Recreation Centre at Penny's Bay (Figure 7.4), which is located immediate adjacent to the CLS site, will be built after the CLS decommissioning, the potential water quality impact on the operation of the planned Water Recreation Centre is a concern in this study. For the purpose of this assessment, the following water sensitive receivers have been identified.

- **Gazetted Bathing Beaches:** Gemini, Hoi Mei Wan, Casam, Lido, Ting Kau, Approach, Tung Wan (Ma Wan), Silvermine Bay;
- **Non-Gazetted Beaches:** Dragon and Discovery Bay;
- **Fish Culture Zones:** Ma Wan (South and North); and
- **Recreational Uses:** Discovery centre at Sze Pak Wan and the artificial lake of the future Water Recreation Centre at Penny's Bay.

7.24 It is known that the temporary drainage channel immediately adjacent to the southern boundary (seawall) of the CLS will have been filled up at the time of CLS decommissioning. Potential impact will be on future drainage channel to the north of the CLS site. During the decommissioning work, there will be no direct discharge from site drainage or groundwater drawn from CLS into the marine water. In concluding insignificant impact to the nearby marine water via the drainage channel, water quality in the drainage channel has to be compared and complied with the relevant marine water quality standard.

Assessment Methodology

7.25 The objective of the water quality impact assessment is to identify and evaluate the potential source of water pollution associated with the decommissioning and decontamination of the shipyard. Criteria and guidelines for evaluating and assessing water pollution as stated in Annexes 6 and 14 of the EIA-TM have been adopted for the present study in order to address all assessment objectives specified in the section 3.5.3 of EIA Study Brief.

Identification of Water Quality Impacts

Building Demolition

7.26 Surface runoff and site discharges are the only sources that pose potential water quality impact during the building demolition.

7.27 Precipitation that falls on unpaved lands and areas with the topsoil exposed during the demolition will wash away soil particles. Such surface runoff and stormwater overflows with high levels of suspended solids if directly discharged into water bodies or via the drainage channel would lead to a water quality impact. Wastewater resulting from wheel washing of site vehicles at site entrances would also pose a potential water quality impact if not adequately controlled.

7.28 Effluent discharge from temporary site facilities shall be controlled to prevent direct discharge to the neighbouring marine waters and storm drains. Such wastewater may include sewage effluent from toilets.

Slope Improvement

7.29 There will be improvement works on the slope behind CLS. Earthworks from slope cutting and soil nailing may impact the adjacent stream course by introducing debris and suspended solids. Surface runoff primarily laden with sediments may also enter into the stream.

Soil Remediation

7.30 Upon recommendations in the chapter of the "Land Contamination Assessment", contaminated soil at CLS will be excavated and treated either on-site or in an off-site facility at TKW dependent on the contaminant of concern.

<u>At Cheoy Lee Site</u>

7.31 The remediation works involved in CLS will be the soil excavation work and treatment of metal contaminated soil by solidification. Potential water quality impacts will be expected from the following sources.

Excavation and Dewatering

7.32 Excavations of contaminated soil will be required for the decontamination works. Where such excavation takes place below the water table in the contaminated areas within the shipyard, dewatering may be required in order to facilitate excavation. Groundwater pumped out if discharged directly into local drains or drainage channels may impose adverse water quality impact to the marine water.

7.33 The subsequent construction works for the foundations of the Chok Ko Wan Link Road (CKWLR), Road P2 and the Penny's Bay Rail Link (PBRL) may however require dewatering. However, these are beyond the scope of this EIA which focus on the decommissioning work.

Groundwater Seepage

7.34 Potential water quality impact may arise from groundwater seeping directly into the marine water, indirectly via drainage channels adjacent to CLS site into the marine water and into the artificial lake of the future water recreation centre.

Operation of the Solidification Facility

7.35 Cement solidification is a remediation method for the treatment of metal-contaminated soil. During the cement solidification process, cement, water and other additive(s) (such as fly ash, lime, soluble silicates, and clays) are added to the contaminated soils to form solid block. Mixing of contaminated soils and cement/water/other additive(s) would introduce potential leaching of contaminants, if water addition is not well controlled. There will be temporary stockpiles of metal contaminated soils with quantity up to 24,000m^3 at CLS site pending the construction of solidification facility. The temporary stockpiling that lasts for approximately seven months is unavoidable because excavation works will advance before the commencement of the solidification facility for making room for the facility and gauging with the Project programme. Runoff from the stockpile may impact the nearby water course if not controlled.

Decontamination Water and Wastewater from Wheel Washing

7.36 After excavating and handling the dioxin-contaminated soil at CLS, excavators/ backhoes and dump trucks are to be decontaminated by steam cleaning. Such decontamination water that may carry dioxin poses water quality impact if discharged without prior treatment. Wastewater from the wheel washing bay at the site entrance is also potentially contaminated and may pose the similar water quality impact.

<u>At To Kau Wan Site</u>

7.37 Potential water quality impacts are associated with the construction and operation of the remediation plant at To Kau Wan.

Construction of Soil Remediation Plants

7.38 Possible sources of water quality impact during construction of the remediation plant include;

- Surface runoff of elevated levels of suspended solids as a result of precipitation and wheel washing water,

- Wastewater from temporary site facilities, such as toilets and site canteens, and
- Uncontained spillage water from plant servicing facilities being contaminated with oil and other petroleum products.

Operation of Soil Remediation Plants

7.39 Decontamination processes, viz. biopiling, thermal desorption and cement solidification will be carried out in the To Kau Wan decontamination site.

7.40 Biopiling is a bioremediation method for the restoration of the contaminated soils with organic compounds. By using microorganisms to degrade the contaminants in soil, biopiles transform hazardous/toxic materials into harmless elements such as water, carbon dioxide, and other innocuous products. On forming the biopile, trucks holding the TPH contaminated soil from CLS would directly unload at the biopile area, therefore there will be no temporary stockpiles nor associated water quality impacts. Leachate resulting from rain percolation in case that the biopiles are not fully covered and from biodegradation product would be a concern to the underlying soil, groundwater system and water bodies if not properly controlled.

7.41 Thermal desorption process employs high temperature to volatilise or vaporise, but not to destroy, dioxin from the contaminated soils. On commencing the Project, dioxin-contaminated soils at CLS will be transported to and temporarily stored at TKW in a purpose-built concrete bin pending the construction and commissioning of the thermal desorption facility. Leachates and runoff from the storage bin if not properly drained and controlled may result in a potential water quality impact to the underlying soil, groundwater system and adjacent water bodies. Soil loading and unloading activities for the thermal desorber and the transport operations within site may pose a source of spilled soil, which in contact with rainwater may lead to contaminated runoff. This contaminated runoff may impact the water bodies adjacent to TKW if not properly drained and treated. Thermal desorption process would create condensate, which will be concentrated and contained for disposal. The condensate drums will be stored in accordance with the *Waste Disposal (Chemical Waste)(General) Regulation* with proper spill containment measures. Should there be any accidental spillage, the soil of the affected area will be excavated and treated on-site as CLS soil. Water quality impacts arising from the operation of the thermal desorption is therefore not expected.

7.42 Cement solidification will be the last treatment procedure for mixed contaminated soils after treated by biopiling or thermal desorption. During the cement solidification process, cement, water and other additive(s) (such as fly ash, lime, soluble silicates, and clays) are added to the contaminated soils to form solid block. Mixing of contaminated soils and cement/water/other additive(s) would introduce potential leaching of contaminants, if water addition is not well controlled.

Decontamination Water and Wastewater from Wheel Washing

7.43 Dump trucks after unloading are to be decontaminated and wheel washed before exiting TKW site. Such decontamination water that may carry dioxin poses water quality impact if discharged without prior treatment. Wastewater from the wheel washing bay at the site entrance is also potentially contaminated and may pose the similar water quality impact.

To Kau Wan Decommissioning

7.44 Upon completion of the soil remediation, the soil treatment facility at TKW will be decommissioned and removed off the site. As of a demolition site, surface runoff will be the only source that poses potential water quality impact during the TKW decommissioning.

Evaluation of Water Quality Impacts

Building Demolition

7.45 The potential impacts arising from surface runoff and site discharges can be readily controlled by appropriate on-site measures. The *ProPECC PN 1/94 "Construction Site Drainage"* recommends good site practices for dealing with various discharges from a construction site. With the implementation of recommended site practices, no adverse impacts on the surface waters are expected. Given that all buildings have been provided with temporary roofing, generation of contaminated surface runoff as a result of precipitation is not possible.

Slope Improvement

7.46 The potential sources of water quality impacts arising from the slope works can be readily mitigated by implementation of appropriate on-site measures as recommended in the *ProPECC PN 1/94 "Construction Site Drainage"*, no adverse water quality impact is expected on the identified water quality sensitive receivers.

Soil Remediation

<u>At Cheoy Lee Site</u>

Excavation and Dewatering

7.47 During excavation, all exposed pits shall be whenever possible backfilled immediately or covered. Direct soil loading from the excavator onto the dump truck shall be the priority practice. Where it is unavoidable to have transient soil piles pending collection by dump trucks, the transient piles shall be bottom-lined, bunded and covered during rain events with impervious membrane. As such, it is unlikely that the surface runoff is contaminated. Therefore, the surface runoff after sedimentation can be safely discharged into the local drainage.

7.48 As contaminants with levels higher than the screening levels for risk assessment are found in the groundwater, direct discharge of groundwater collected from the dewatering process during excavation of contaminated soil shall not be practised. It is recommended that the groundwater be recharged back into the ground in the vicinity of the extraction point as per the scheme proposed in the section "Land Contamination Assessment". The recharge scheme has taken into account of avoiding the migration of contaminants caused by the locally high groundwater level at the recharge location. Furthermore the recharge locations shall be distant from the culvert or the shore. Therefore adverse water quality impacts are not expected.

Groundwater Seepage

7.49 There are essentially three main concerns with regard to the seepage of CLS groundwater, i.e. seepage of groundwater to the artificial lake of the future water recreation centre; direct seepage of groundwater to the marine water and seepage of groundwater to the marine water indirectly via the nearby surface channels.

Impact on the Artificial Lake

7.50 As mentioned in the NLDFS EIA report, potential migration of any residual contamination or impact to the proposed artificial lake at the Water Recreation Centre is a concern. However, no adverse water quality impact is expected on the artificial lake of the planned Water Recreation Centre because:

- the artificial lake (planned water surface at about +7.35 mPD) will have a hydraulic head above that of CLS site (average water table level at about +2.50mPD measured from the SI boreholes), migration of the contaminated groundwater from the CLS site (lower level) to the artificial lake (higher level) is therefore not expected;
- the artificial lake will be constructed offshore and away from the CLS site, by first dredging the sediment from the relevant part of Penny's Bay, followed by placement of a impermeable HDPE liner. This liner, whilst designed to hold the freshwater in, will also prevent against subsurface contaminant infiltration provided that the liner integrity is maintained; and
- under the present EIA study, appropriate remediation actions are recommended in the Land Contamination Assessment section and shall be implemented to clean up the contamination to acceptable levels, hence removing a source of contaminating water.

Direct Impact to the Marine Water

7.51 The contaminated site in CLS is an inland site and will be approximately 1.5km from the nearest future seawall at the Penny's Bay reclamation. This makes it highly unlikely for any groundwater to directly leach to the marine water.

Indirectly impact to the Marine Water via Surface Channels

7.52 The groundwater from the CLS site seeping via the nearby surface channels into the marine water is a concern in this study. The temporary drainage channel located immediately adjacent to the existing southern seawall of CLS site will no longer be a receiver because it will have been filled at the time of CLS decommissioning.

7.53 No seepage of CLS groundwater into the future drainage channel to the north of the site is expected. It is because after the decommissioning, CLS site will be filled to a level at about 7 to 8 m above the existing ground level before constructing the future drainage channel. This increase of ground level would effectively isolate the CLS groundwater (at about 3m below the existing ground level) from the bottom of the future drainage channel (at 4m above the existing ground level given 3m depth of the channel).

7.54 In an unexpected case that the CLS groundwater can reach the future drainage channel, the very slow seepage rate of groundwater and subsequent dilution of the groundwater in the channel confer no adverse impact to the marine water.

7.55 According to the Darcy's empirical law([2]), the seepage velocity (v) of the groundwater within the site can be expressed as follows:

$$v = k\, i\, /\, n,$$

where k is the coefficient of permeability, i is hydraulic gradient and n is the porosity of soil.

7.56 With reference to the groundwater sampling data collected in wet season, the maximum hydraulic gradient was determined to be about 10^{-2} and the averaged porosity of soil within the site was about 40%. Silty and clayey sand were found to be dominant within the CLS site, and therefore the coefficient of permeability was assumed to be about 10^{-5} m/s. Based on the above equation, the calculated seepage velocity of the groundwater within the site was 2.5×10^{-7} m/s, which is extremely slow to transport the contaminants into the marine waters.

7.57 Assuming that the seepage velocity of the groundwater from the CLS site to the drainage channel is same as that within the CLS site, and that the total contact area of the future drainage channel with respect of the groundwater seepage is 3,180 m^2 (i.e. ~1,060m long by ~3m deep), the calculated seepage rate of the contaminated groundwater is $7.95 \times 10^{-4} m^3/s$. As the flow rate of the waters in the drainage channel is assumed 0.07 m^3/s, there is a dilution effect of about 88 on the contaminants in the water column in the drainage channel.

7.58 As discussed in Section 7.20, the average heavy metal concentration in the groundwater exceeds the UK Water Quality Standards by no more than 5.4 times. Taking into account of the dilution effect, the heavy metal concentrations in the waters of the drainage channel as a result of groundwater seepage would comply with the UK Water Quality Standards. Considering that the contribution of heavy metal level from seeped groundwater is at least 22 times (for nickel) less than the UK Water Quality Standards , which are insignificant, associated adverse impacts to the coastal sensitive receivers and the marine biota including Chinese White Dolphin and fish are not envisaged.

7.59 In summary, the water quality of the waters in the drainage channel complies with the water

([2]) R.F. Craig, Soil Mechanics, 6th edition, E & F N Spon (an imprint of Chapman & Hall) quality standards and thus no adverse water quality impact associated with the discharge of the waters from the drainage channel to the marine waters is anticipated. The water quality of the identified water sensitive receivers in the vicinity of the CLS site would also comply with the relevant water quality guidelines.

Operation of the Solidification Facility

7.60 It would be recommended that temporary stockpiles of metal contaminated soil be lined with impervious sheet, bunded and covered by impermeable sheeting pending receipt by the solidification facility. With the implementation of these mitigation measures, contaminated runoff and leachate would be minimised in quantity. During the solidification process, excessive addition of water is avoided. This would eventually eliminate the possibility of leachate generation from the facility. Further, taking into account of the dust reduction measures, the solidification facility will be housed in a shed that prevents contaminated runoff. All contaminated runoff and leachate shall be treated together with the decontamination water and wheel wash water in the centralised wastewater treatment unit before being discharged. Taking the above considerations, no adverse water quality impact is expected during the solidification process.

Decontamination Water and Wastewater from Wheel Washing

7.61 It would be the required site practice not to directly discharge the decontamination water and the potentially contaminated wheel washing water into the surface channel or nearby water bodies. All decontamination water and wheel washing water would be regarded contaminated and diverged to a centralised wastewater treatment unit where flocculation/ sediment and activated carbon filtering processes would be deployed. Metal contaminants would be flocculated out with the aid of precipitating agents and TPH would be removed by activated carbons. Dioxin at large is hydrophobic and will remain adhering to soil particles that would be settled out during sedimentation while the last bit of aqueous phase dioxin would be removed in the polishing activated carbon filter. Any contaminants and pollutants are in the effluent shall be treated before discharged into local drainage channel. Therefore significant water quality impact is not expected.

<u>At To Kau Wan Site</u>

Construction of Soil Remediation Plants

7.62 The potential sources of water quality impacts arising from the construction of remediation plant at TKW can be readily mitigated by implementation of appropriate on-site measures as recommended in the *ProPECC PN 1/94 "Construction Site Drainage*", no adverse water quality impact is expected on the identified water quality sensitive receivers.

Operation of Soil Remediation Plants

Biopiling

7.63 As recommended in the chapter of "Land Contamination Assessment", concrete perimeter bund and impermeable floor sheeting shall be constructed respectively around and underneath the biopile. With the floor sheeting and bund in place, any biopile leachate would be contained and migration of leachate out of the biopiling area is not likely. In operation, low impermeability sheeting shall be employed to cover the biopile after formation and during rains. This avoids contaminated runoff as a result of the rainwater washing over the biopile and leaching of the biopile by the rainwater. It is also proposed that a centralised wastewater treatment unit employing flocculation/ sedimentation and activated carbon filtering processes be constructed to treat all biopile leachate before being discharged into local sewers or drainage channels. With the implementation of mitigation measures, adverse water quality impacts on the nearby water quality sensitive receivers are not expected.

Thermal Desorption

7.64 Pending the construction and commissioning of the thermal desorption plant, dioxin-contaminated soils from CLS will be temporarily stored in a purpose-built concrete bin. The storage bin shall be sheltered and bottom-lined. No rainwater washing over the soil is expected. A sump shall be in place to diverge and collect any leachate from the soil stack and subsequently the leachate will be treated in the centralised wastewater treatment unit before discharging. To prevent contaminated runoff from migrating out of the thermal desorption plant, the boundary of the plant shall be bunded and runoff collected for treatment at the centralised wastewater treatment unit. It is proposed that the runoff from the first 30 minutes of a rainstorm be regarded as contaminated and collected (rainwater in the first 30 minutes would have sufficiently washed away the soil remains and any runoff after first 30 minutes will be considered as uncontaminated). Given maximum hourly rainfall to the record of Hong Kong Observatory of 109.9mm and plant area of 3,280m^2, the maximum volume of contaminated runoff collected during the first 30 minutes of a rainstorm will be 180m^3. Aqueous product resulting from the thermal desorption is to be recharged into the process to quench and rehumidify the thermally-treated soil. Non-aqueous condensate (containing dioxin and TPH) being the end product of the thermal desorption, shall be properly stored in sealable leak-proof containers subject to transporting to CWTC for treatment. With the implementation of the mitigation measure and process practice, no adverse water quality impact arising from the soil storage and thermal desorption plant is envisaged.

Solidification

7.65 Any metal contaminant left over in soil after biopiling and thermal desorption treatment will be dealt with by solidification. During the process, excessive addition of water is avoided. This would eventually eliminate the possibility of leachate generation from the facility. Further, taking also the dust reduction consideration, the solidification facility will be housed in a shed that prevents contaminated runoff. As such, no adverse water quality impact is expected during the solidification process.

Decontamination Water and Wastewater from Wheel Washing

7.66 It would be site practice not to directly discharge the decontamination water and the potentially contaminated wheel washing water into the surface channel or nearby water bodies. All decontamination water and wheel washing water shall be diverged to a centralised wastewater treatment unit where the contaminants and pollutants in the effluent shall be treated before discharged into local drainage channel. Therefore significant water quality impact is not expected.

To Kau Wan Decommissioning

7.67 The potential sources of water quality impacts arising from the TKW decommissioning can be readily mitigated by implementation of appropriate on-site measures as recommended in the *ProPECC PN 1/94 "Construction Site Drainage"*, no adverse water quality impact is expected on the identified water quality sensitive receivers.

Summary of Potential Water Quality Impacts

7.68 In summary, the likely water quality impacts arising from the different stages of the Project is tabulated below.

Table 7.6 Potential Water Quality Impacts Arising from the Project

Project Stage	Source of water quality impacts	Pollutants/ Contaminants of Concern
Building Demolition at CLS	1. Surface runoff & stormwater overflow	1. Sand and Silt
Slope Improvement	1. Surface runoff & stormwater overflow	1. Sand and Silt
Soil Remediation at CLS	1. Runoff during building demolition phase 2. Groundwater from dewatering during excavation 3. Groundwater seepage 4. Decontamination water and wheel washing water	1. Sand and Silt 2. Silt, metals, TPH and other contaminants found in CLS soil 3. metals, TPH and other contaminants found in CLS soil 4. Sand/ silt, TPH and dioxin found in CLS soil
Soil Remediation at TKW	1. Surface runoff & stormwater during construction phase 2. Runoff from thermal desorption plant, leachate from biopiles/ storage bins and decontamination/ wheel washing water during operation phase	1. Sand and silt 2. Metals, TPH and dioxin found in CLS soil
TKW decommissioning	1. Surface runoff & stormwater overflow	1. Sand and Silt

Mitigation of Environmental Impacts

Building Demolition

7.69 Mitigation measures are required to prevent and minimise the adverse water quality impacts from the surface runoff and site discharge during the CLS decommissioning. The details of the recommended mitigation measures are summarised in the following sections.

Surface Runoff

7.70 Catchpits and perimeter channels shall be constructed in advance of site formation works and earthworks. Surface runoff from the construction sites shall be directed into storm drains via adequately designed wastewater treatment facilities such as sand traps, silt traps and sediment basins. Channels, earth berms or sand bag barriers shall be provided on site to properly direct stormwater to such facilities.

7.71 Silt removal facilities, channels and manholes shall be maintained and the deposited silt and grit shall be removed regularly, at the onset of and after each rainstorm to ensure that these facilities are functioning properly at all times.

7.72 Open stockpiles of demolition materials on site shall be avoided or where unavoidable covered with tarpaulin or similar fabric during rainstorms. Measures shall be taken to prevent the washing away of construction materials, soil, silt or debris into any drainage system.

7.73 Manholes (including any newly constructed ones) shall always be adequately covered and temporarily sealed so as to prevent silt, construction materials or debris from getting into the drainage system.

<u>Wheel Washing Water</u>

7.74 All vehicles and plant shall be cleaned before they leave the construction site to ensure that no earth, mud or debris is deposited by them on roads. A wheel washing bay shall be provided at every site exit and wash-water shall have sand and silt settled out or removed before being discharged into storm drains. In any case, discharge of wheel wash water shall be minimised and recycled where possible. The section of construction road between the wheel washing bay and the public road shall be paved with backfill to reduce vehicle tracking of soil and to prevent surface runoff from entering public road drains.

<u>Wastewater from Site Facilities</u>

7.75 Should the use of chemical toilets be necessary then these shall be provided by a licensed contractor, who will be responsible for appropriate disposal and maintenance of these facilities.

<u>Storage and Handling of Oil, Other Petroleum Products and Chemicals</u>

7.76 All fuel tanks and chemical storage areas shall be provided with locks and be sited on sealed areas. The storage areas shall be surrounded by bunds with a capacity equal to 110% of the storage capacity of the largest tank to prevent spilled oil, fuel and chemicals from reaching the receiving waters. The Contractors shall prepare guidelines and procedures for immediate clean-up actions following any spillages of oil, fuel or chemicals.

<u>Wastewater Treatment Facilities</u>

7.77 Sufficient wastewater treatment facilities shall be provided to treat the surface runoff and wheel wash water to the discharge standards as stipulated in the *Technical Memorandum on Standards for Effluents Discharged into Drainage and Sewerage Systems, Inland and Coastal Waters.* In addition, discharge licence under the *Water Pollution Control Ordinance* shall be obtained for any discharge of treated runoff and wheel wash water to the environment.

Slope Improvement

7.78 Mitigation measures as recommended in sections 7.70 to 7.77 shall be implemented.

Soil Remediation

At Cheoy Lee Site

Excavation and Dewatering

7.79 During excavation, all exposed pits shall be whenever possible backfilled immediately or covered and bunded. Further, all excavated soils shall be loaded into dump truck directly but where it is unavoidable to transiently pile up soils next to the excavation pit, the transient pile shall be bottom-lined and covered with impervious membrane during rain event in order to avoid generation of the contaminated runoff.

7.80 Final surfaces after excavation shall be well compacted and the subsequent permanent work or surface protection shall be carried out as soon as practical after the final surfaces are formed to prevent erosion caused by rainstorms. Appropriate intercepting channels and partial shelters shall be provided where necessary to prevent rainwater from collecting within the trenches or footing excavations. The contractor shall develop contingency plans for capture and control of any runoff prior to backfill during runoff-producing rainfall events.

7.81 Groundwater drawn from the dewatering process during excavation and rainwater collected within the trenches or excavation pits shall be pumped out and recharged back the ground in the vicinity. The recharge scheme as recommended in the chapter of "Land Contamination Assessment" shall be followed.

Groundwater Seepage

7.82 Given that the water quality impact arising from the seepage of contaminated groundwater into the adjacent drainage channel is insignificant, no mitigation measure is considered necessary in this respect.

Operation of the Solidification Facility

7.83 The designated stockpiling area before incepting contaminated soils shall be concrete-paved or lined with impervious floor membrane and shall have its perimeter constructed of a concrete bund in order to avoid any contaminated leachate from migrating out of the area. Temporary stockpiles upon formation shall be immediately covered with impermeable cover to stop precipitation from washing the contaminated soil thus generating contaminated runoff. The contractor shall formulate contingency plans for the runoff collection and control.

7.84 The solidification facility shall be sheltered and area of soil unloading/ loading shall be provided with shed to avoid contaminated runoff. Excessive addition of water during the process shall be avoided during the process.

7.85 As an additional measure, Any pit used for solidification area shall be shallower than the water table to minimize the leaching of the contaminated soils. And a impermeable membrane/sheet shall be placed at the bottom of any solidification pit during the solidification process.

Decontamination Water and Wastewater from Wheel Washing

7.86 During soil excavation, dump trucks or excavators shall be decontaminated before they leave the site to ensure that no contaminated earth, mud or debris is deposited by them on roads. A wheel washing bay shall be provided at every site exit that equipped with an adequately sized centralised wastewater treatment unit. The wastewater treatment unit shall deploy flocculation/ sedimentation and activated carbon filtering by which processes sands/ silts with dioxin cohered are to be settled out and other soil contaminants in wheel washes and decontamination water removed. The polluting parameters in effluent shall be with compliance of TM discharge standards and dioxin in effluent shall be cleared of to an undetectable range before the effluent being discharged into the storm drains. The installation and operation of the wastewater treatment unit shall be licensed and subject to the effluent monitoring as required under the *Waste Disposal Ordinance*. In any case, discharge of wheel wash water shall be minimised and recycled where possible. The section of construction road between the wheel washing bay and the public road should be paved with backfill to reduce vehicle tracking of soil and to prevent surface runoff from entering public road drains.

At To Kau Wan

Construction of Soil Remediation Plants

7.87 Mitigation measures as recommended in sections 7.70 to 7.77 shall be implemented.

Operation of Soil Remediation Plants

7.88 Mitigation measures are required at the To Kau Wan site to minimize the potential water quality impacts during the decontamination process. The dioxin-contaminated soils and the liquid end products shall be properly stored . Non-dioxin contaminated soils shall be stored in earth bunds and covered by impermeable membranes to prevent wind erosion and exposure to rain. An impermeable base and drainage system shall also be required to collect the contaminated leachate.

Biopiling

7.89 Impermeable liner shall be placed at the bottom of the biopiles and leachate collection sump shall be constructed along the perimeter of the biopiles to prevent leachate from contaminating the underlying soil/groundwater. Concrete bund shall be constructed along the perimeter of biopiles to prevent the runoff coming out from the contaminated soil. All leachate collected shall be treated in a centralised wastewater treatment unit. The wastewater treatment unit shall deploy flocculation/ sedimentation and activated carbon filtering by which processes sands/ silts and other soil contaminants in wheel washes and decontamination water removed. The polluting parameters in effluent shall be with compliance of TM discharge standards before the effluent being discharged into the storm drains. The installation and operation of the wastewater treatment unit shall be licensed and subject to the effluent monitoring as required under the *Waste Disposal Ordinance*.

7.90 Biopiles after formation and during rain shall be covered by anchored low permeability geotextiles to prevent contaminated runoff. It is proposed that the exposed biopile section at any time shall not be more than 5m in length.

Thermal Desorption

7.91 The storage bin for the dioxin-contaminated soils shall be sheltered and bottom lined to prevent generation of contaminated runoff. The storage bin shall be equipped with leachate sump to collect any leachate from the soil stack and subsequently the leachate will be treated in the centralised wastewater treatment unit before discharging. Concrete bund and adequately sized sump shall be constructed at the perimeter of thermal desorption plant to collect any runoff within the plant to cater occasionally very heavy downpour during the remediation period. The runoff from the desorption plant during the first 30 minutes of a rainstorm shall be considered to be contaminated. The contaminated runoff shall be collected and treated in the centralised wastewater treatment unit. The wastewater treatment work shall contain sedimentation, filters, coagulation/ flocculation unit and activated carbon adsorption. The treatment plant will be subject to the effluent monitoring requirement under the *Waste Disposal Ordinance*. All non-aqueous condensates from the thermal desorption processes shall be stored in sealable, leak-proof containers for off-site disposal. The aqueous phase of the condensate shall be used to quench the thermally-treated soil and rehumidify it to reach a specified moisture content. Excessive aqueous product shall be treated in the wastewater treatment unit before discharged. No direct discharge of excessive aqueous product into the local drains or drainage channel shall be allowed.

Solidification

7.92 The solidification facility shall be sheltered and area of soil unloading/ loading shall be provided with shed to avoid contaminated runoff. Excessive addition of water during the process shall be avoided during the process.

7.93 As an additional measure, any pit used for solidification area shall be shallower than the water table to minimize the leaching of the contaminated soils. And an impermeable membrane/sheet shall be placed at the bottom of any solidification pit during the solidification process.

To Kau Wan Decommissioning

7.94 Mitigation measures as recommended in sections 7.70 to 7.77 shall be implemented.

Cumulative Environmental Impacts

7.95 During the demolition and excavation at CLS that will take around 6-7 months, the period is comparatively short and also no major impacts were found in the assessment, cumulative water quality impact added on the Penny's Bay area is considered insignificant.

7.96 Yam O reclamation will be on-going during the remediation work at TKW. Since all possible effluents, viz the leachate and contaminated runoff from the TKW site, shall be treated and their quality be monitored before discharged, no significant cumulative water quality impact imposed by the setting up and operation of TKW soil remediation plants is expected.

Residual Environmental Impacts

7.97 No adverse residual environmental impacts were predicted to occur during the demolition and decommissioning of the CLS and decontamination works conducted at the To Kau Wan site provided that the recommended mitigation measures, including those detailed in the remediation action plan, are implemented. The mitigation measures were specified as a series of 'best practice' methods of working and appropriate treatment/remediation methods for the contaminated soil found within the shipyard site.

Conclusions

Demolition and Excavation at Cheoy Lee Shipyard

7.98 Potential adverse water quality impacts from the shipyard demolition and excavation would primarily be from the contaminated groundwater (including seepage and dewatering), potentially contaminated surface runoff and from and sewage effluent generated by the construction workforce. However, no unacceptable water quality impact on the nearby sensitive receivers was identified.

7.99 A number of mitigation measures during demolition and excavation were specified to reduce the potential adverse impacts to acceptable levels and no residual impact was anticipated. No water quality monitoring of any potentially contaminated surface runoff to be discharged during demolition and excavation at CLS is recommended. Furthermore, site audit is recommended to ensure that the recommended mitigation/remediation measures and 'best practice' site procedures are being implemented.

Slope Works behind Cheoy Lee Shipyard

7.100 As part of the slope work, slope cutting and soil nailing may impact the water quality of the nearby watercourses. Same for the demolition and excavation work at CLS, site mitigation measures were specified to reduce the potential adverse impacts to acceptable levels and no residual impact was anticipated. No water quality monitoring was recommended but site audit is recommended to ensure that the recommended mitigation/remediation measures and 'best practice' site procedures are being implemented.

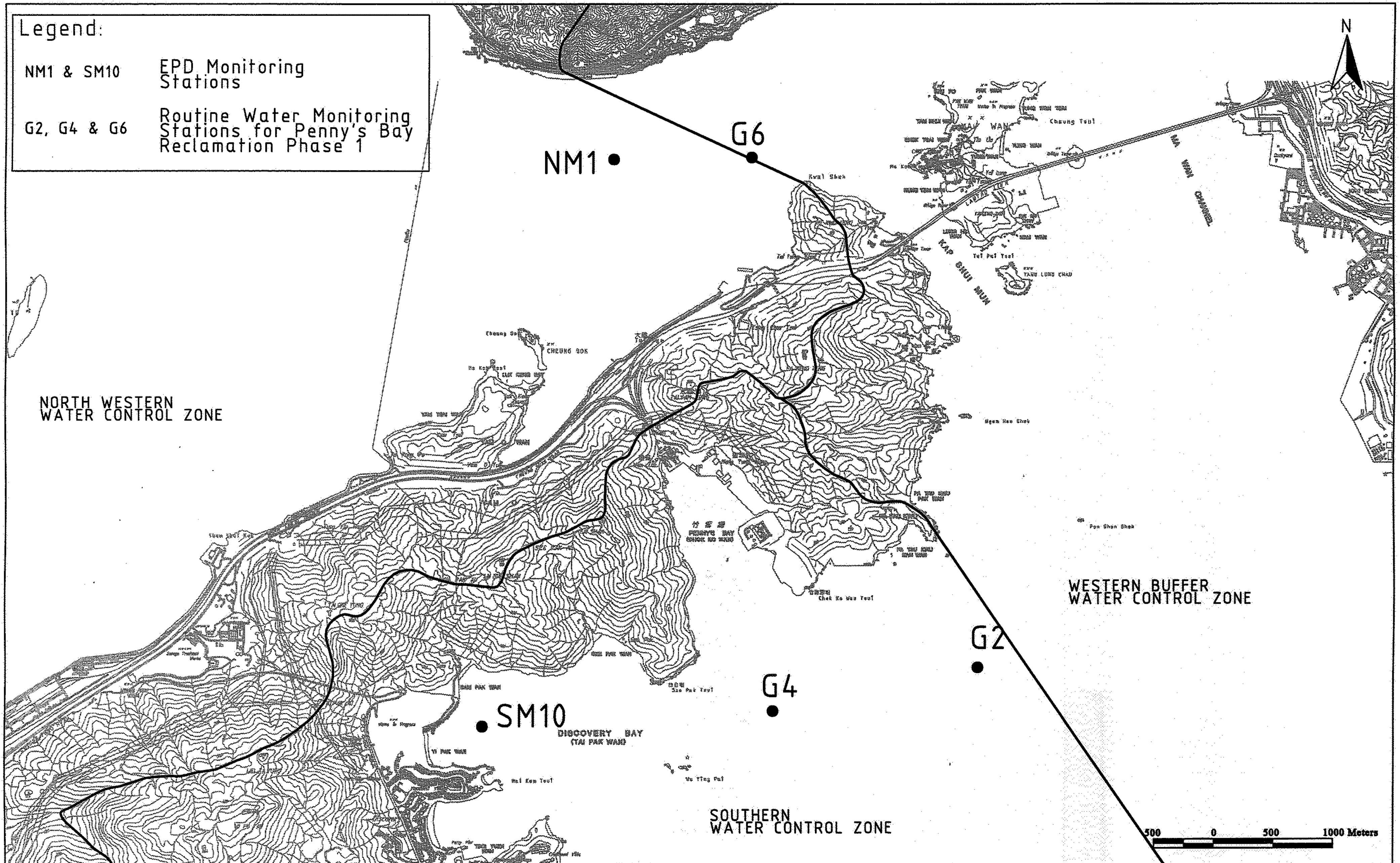
Soil Remediation at To Kau Wan

7.101 Biopile, solidification and thermal desorption are the processes conducted at the To Kau Wan decontamination site. Potential water quality impact would be arising from the leachate from contaminating the underlying soil/groundwater, surface runoff and the leakage of contaminated waters to surroundings. Significant impact is not envisaged where the leachate shall be treated before discharged.

7.102 As a number of mitigation/remediation measures and 'best practice' site procedures are being undertaken, water quality impacts associated with the decontamination works is expected to be insignificant and no residual impact is anticipated.

Potential Impact on the Planned Water Recreation Centre

7.103 As the artificial lake at the Water Recreation Centre is located at an elevation higher than the CLS site, and there is an impermeable liner at the bottom of the lake and most of the contaminants in the CLS site have been clean up, migration of the contaminated groundwater from the CLS site to the artificial lake is not expected. Therefore, no adverse water quality impact or residual impact is anticipated.



Title	Scale	Project No.
Agreement No. CE 68/99 Infrastruture for Penny's Bay Development - Engineering Design and Construction Decommissioning of Cheoy Lee Shipyard **Locations of Reference Routine Water Quality Monitoring Stations**	As Shown	R06100
	Date Feb 2002	**Figure No.** 7.1

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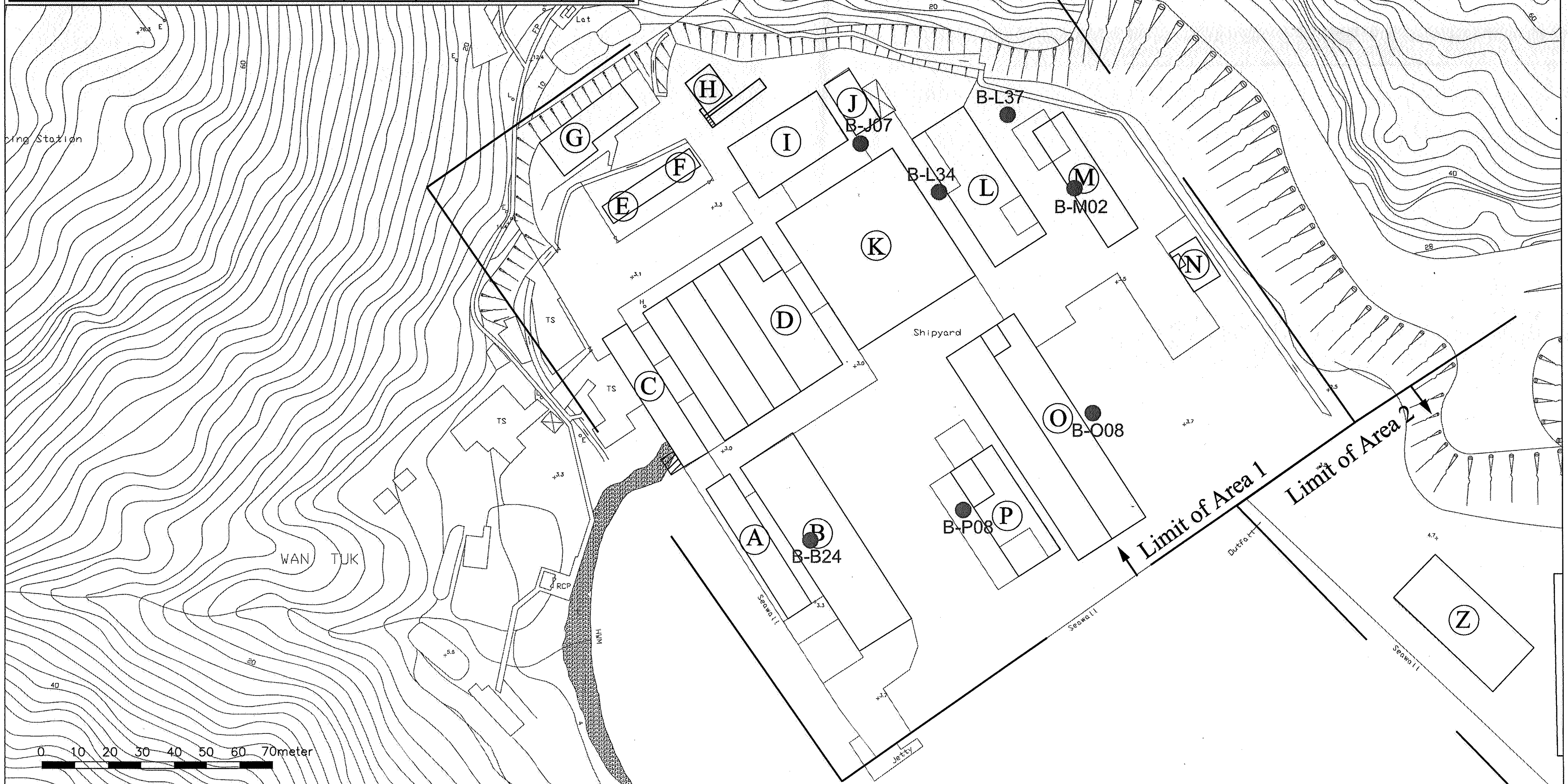
GW Sampling Location	Metal Conc (ug/L)						
	As	Cd	Cr	Cu	Pb	Ni	Zn
B-L34	<10	<0.2	1	<1	<1	<1	53
B-B24	<10	0.5	67	58	<1	7200	250
B-J07	<10	<0.2	<0.1	<1	<1	1	70
B-L37	<10	5.5	1	<1	5	4	99
B-M02	<10	0.7	<0.1	<1	1	2	97
B-O08	<10	0.5	<0.1	1	1	1	64
B-P08	<10	7.7	2	1	1	2	<10



Title

Agreement No. CE 68/99 Infrastructure for Penny's Bay Development - Engineering Design and Construction - Decomission of CLS

Locations of Groundwater Samples with Metal Contaminants Exceeded UK Surface Water Quality Standards (Area 1)

Scale	As Shown
Date	Feb 2002
Project No.	R06100
Figure No.	7.2a

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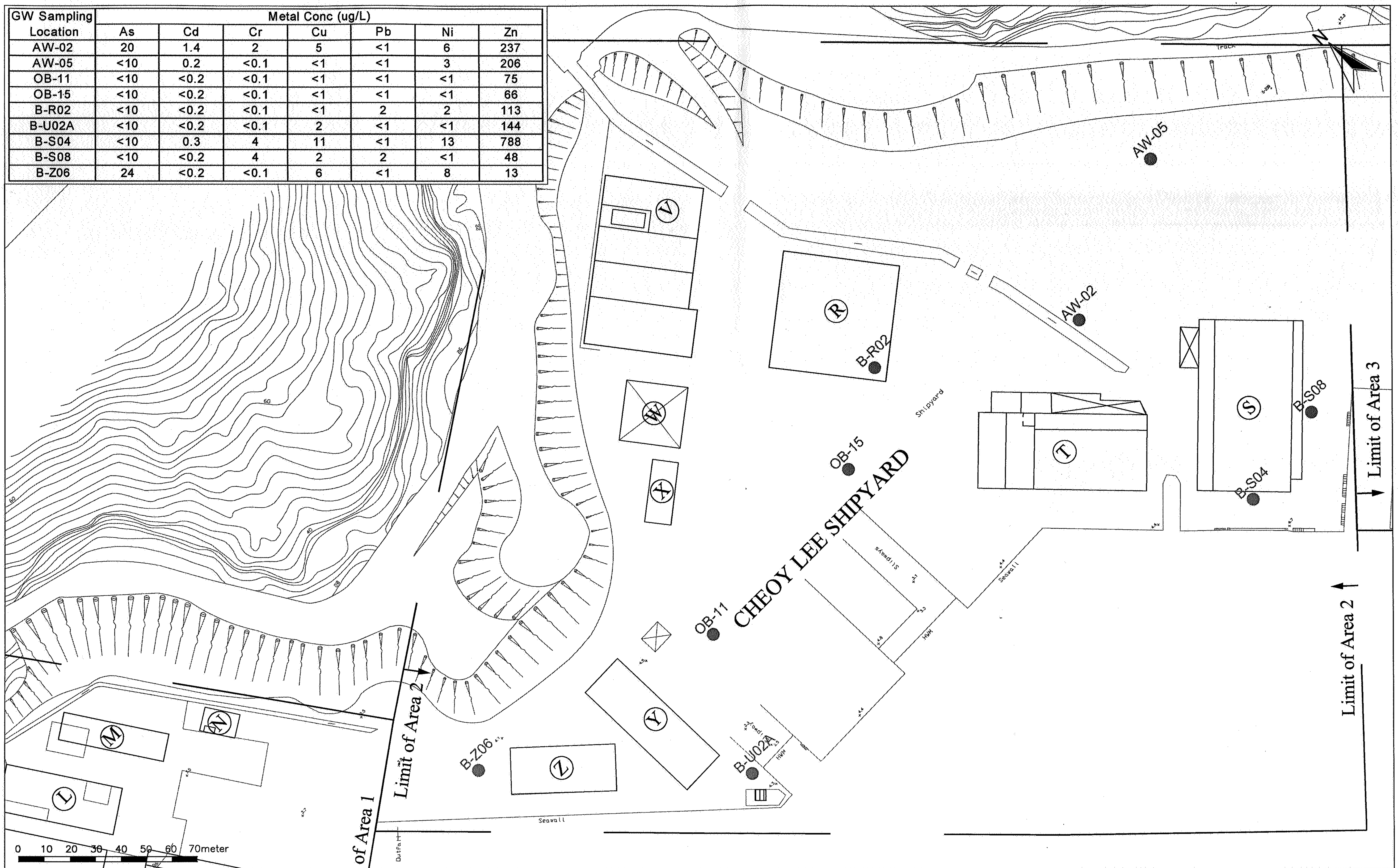
GW Sampling Location	Metal Conc (ug/L) As	Cd	Cr	Cu	Pb	Ni	Zn
AW-02	20	1.4	2	5	<1	6	237
AW-05	<10	0.2	<0.1	<1	<1	3	206
OB-11	<10	<0.2	<0.1	<1	<1	<1	75
OB-15	<10	<0.2	<0.1	<1	<1	<1	66
B-R02	<10	<0.2	<0.1	<1	2	2	113
B-U02A	<10	<0.2	<0.1	2	<1	<1	144
B-S04	<10	0.3	4	11	<1	13	788
B-S08	<10	<0.2	4	2	2	<1	48
B-Z06	24	<0.2	<0.1	6	<1	8	13



Title

Agreement No. CE 68/99 Infrastructure for Penny's Bay Development - Engineering Design and Construction - Decomission of CLS

Locations of Groundwater Samples with Metal Contaminants Exceeded UK Surface Water Quality Standards (Area 2)

Scale: As Shown	Project No. R06100
Date: Feb 2002	Figure No. 7.2b

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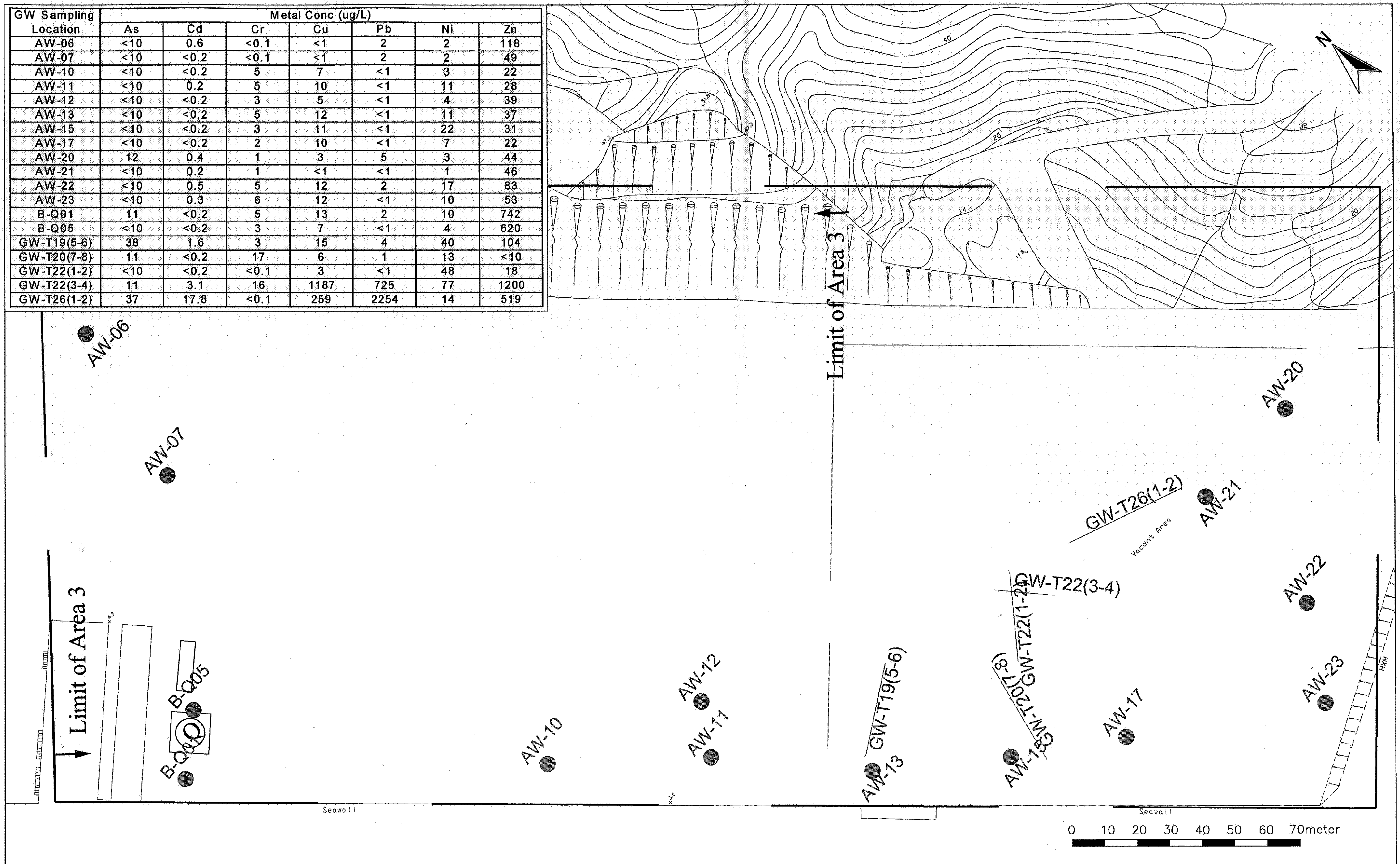
GW Sampling Location	Metal Conc (ug/L)						
	As	Cd	Cr	Cu	Pb	Ni	Zn
AW-06	<10	0.6	<0.1	<1	2	2	118
AW-07	<10	<0.2	<0.1	<1	2	2	49
AW-10	<10	<0.2	5	7	<1	3	22
AW-11	<10	0.2	5	10	<1	11	28
AW-12	<10	<0.2	3	5	<1	4	39
AW-13	<10	<0.2	5	12	<1	11	37
AW-15	<10	<0.2	3	11	<1	22	31
AW-17	<10	<0.2	2	10	<1	7	22
AW-20	12	0.4	1	3	5	3	44
AW-21	<10	0.2	1	<1	<1	1	46
AW-22	<10	0.5	5	12	2	17	83
AW-23	<10	0.3	6	12	<1	10	53
B-Q01	11	<0.2	5	13	2	10	742
B-Q05	<10	<0.2	3	7	<1	4	620
GW-T19(5-6)	38	1.6	3	15	4	40	104
GW-T20(7-8)	11	<0.2	17	6	1	13	<10
GW-T22(1-2)	<10	<0.2	<0.1	3	<1	48	18
GW-T22(3-4)	11	3.1	16	1187	725	77	1200
GW-T26(1-2)	37	17.8	<0.1	259	2254	14	519



Title			
Agreement No. CE 68/99 Infrastructure for Penny's Bay Development - Engineering Design and Construction - Decomission of CLS Locations of Groundwater Samples with Metal Contaminants Exceeded UK Surface Water Quality Standards (Area 3)	Scale: As Shown Date: Feb 2002	Project No. R06100 Figure No. 7.2c	Maunsell MAUNSELL ENVIRONMENTAL MANAGEMENT CONSULTANTS LTD

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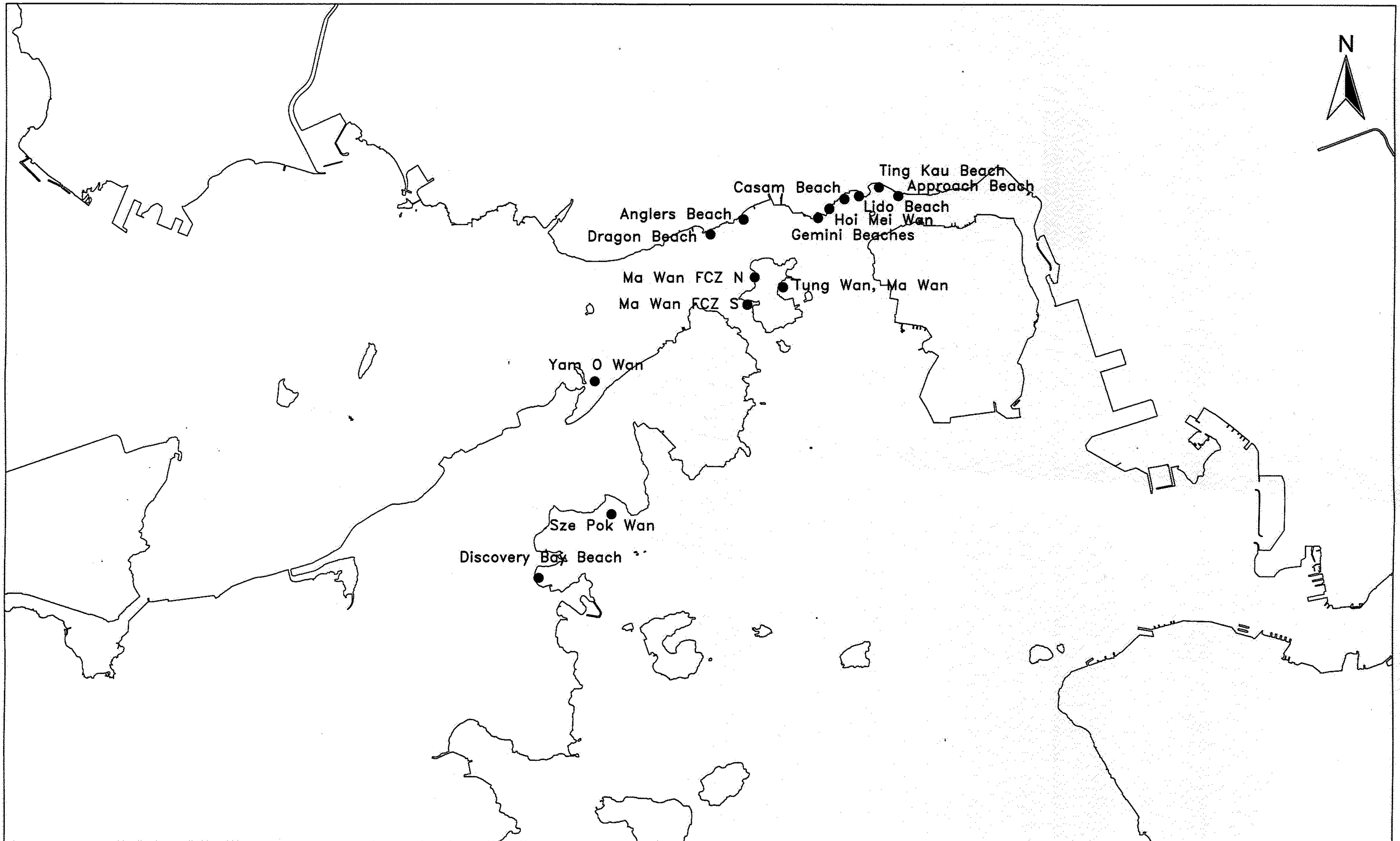

Title	Agreement No. CE 68/99 Infrastrusture for Penny's Bay Development - Engineering Design and Construction Decommissioning of Cheoy Lee Shipyard Locations of Water Quality Sensitive Receivers	Scale 1 : 100000	Project No. R06100	Maunsell MAUNSELL ENVIRONMENTAL MANAGEMENT CONSULTANTS LTD
		Date Feb 2002	Figure No. 7.3	

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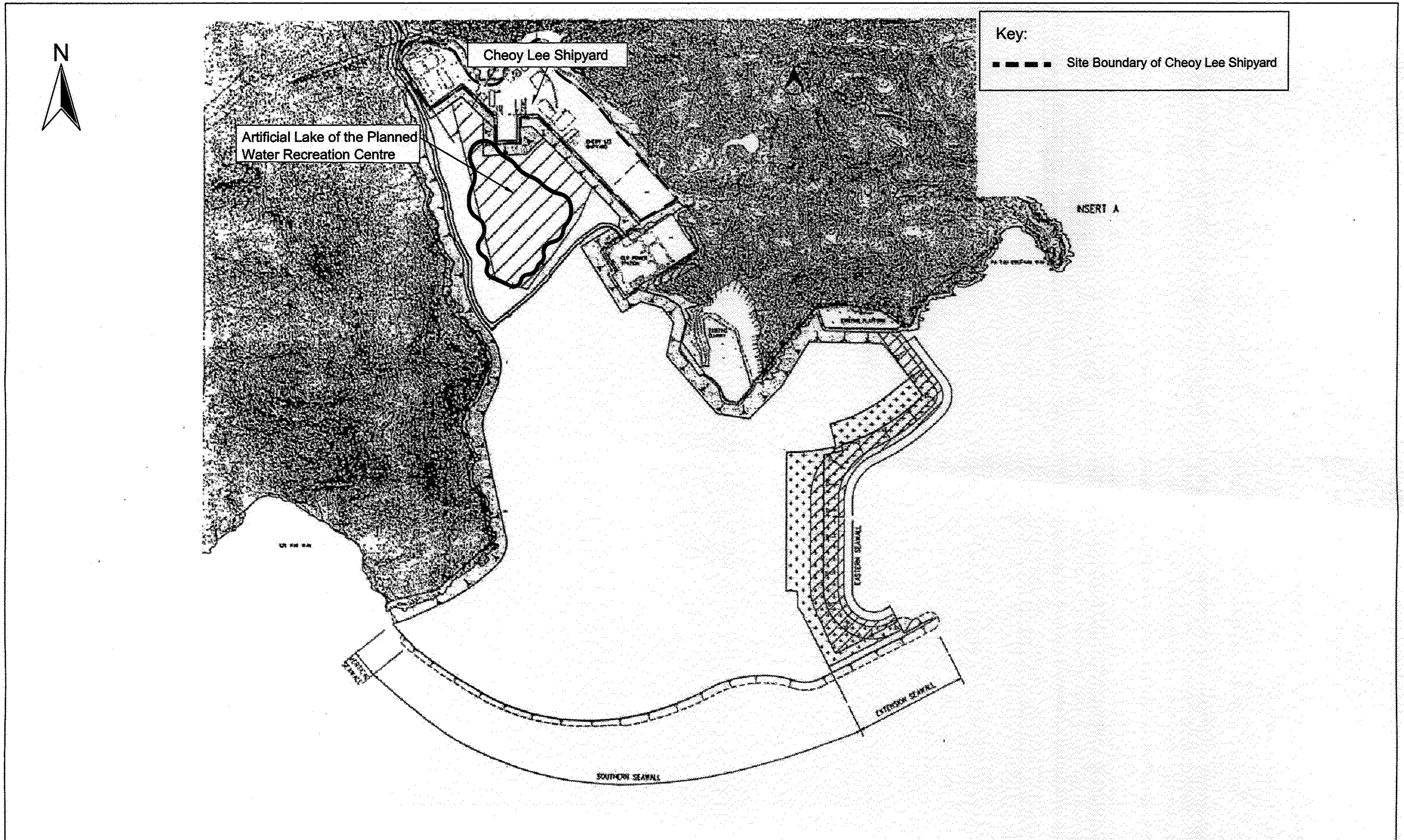

Title			
Agreement No. CE 68/99 Infrastructure for Penny's Bay Development - Engineering Design and Construction Decommissioning of Cheoy Lee Shipyard Location of the Planned Water Recreation Centre at Penny's Bay	Scale N.T.S.	Project No. R06100	Maunsell MAUNSELL ENVIRONMENTAL MANAGEMENT CONSULTANTS LTD
	Date Feb 2002	Figure No. 7.4	

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