12 LAND CONTAMINATION

12.1 INTRODUCTION

12.1.1 An existing shipyard, Cheoy Lee Shipyards, Ltd. (CLS),to be decommissioned, is located within the Study Area and scope of the NLDFS. Consequently, the NLDFS EIA comprises Schedule 3 level coverage of the environmental impacts arising from the CLS shipyard decommissioning, although access to undertake site investigation works at the CLS site was not available as part of the NLDFS EIA, due to its present operation and private ownership.

12.1.2 To allow the Theme Park and associated developments EIA to 'stand alone' the relevant land contamination section of the NLDFS EIA is included within this Theme Park and associated developments EIA, although it is not strictly a requirement of the Theme Park Study Brief.

12.1.3 Additionally, the decommissioning of a shipyard comprises a Designated Project under Schedule 2 of the EIAO. Thus a separate and subsequent EIA Study will be commissioned by CED before the decommissioning of the CLS occurs. This subsequent decommissioning EIA, which, due to access requirements can only commence after the site has become available, will include detailed site investigation and formulation of appropriate methods and procedures, if required, to decontaminate the shipyard site. CED presently expect this decommissioning EIA to be completed and submitted under the EIAO to DEP for approval in 2002. More importantly, this decommissioning EIA will need to be approved under the EIAO, and an Environmental Permit issued by the DEP before any decommissioning or construction work can commence in the former CLS shipyard area. In order to provide limited quantitative information to the extent possible, a preliminary sampling programme was conducted along a stream bed discharging from the south-eastern boundary of the CLS site. The results are discussed in *Section 12.6* below.

12.1.4 At this stage, property access for site specific investigations for the CLS site in Penny's Bay has not been obtained, therefore, information on the potential land contamination within the CLS site was based upon on-site observations, interviews with various site operators and regulatory personnel, and review of available documentation. As only limited soil sampling and analysis has been conducted adjacent to the property boundary (see discussion below), very little quantitative information regarding the level of potential contamination of the shipyard site is available at this stage. However, the evaluation of impacts and selection of appropriate cleanup technologies of the NLDFS EIA, reported herein, has been performed using standard and appropriate industry guidelines and EPD approved methodologies for the particular contaminating land uses identified in this CLS site. CED have committed more specific soil and groundwater sampling and analysis will be performed at a later stage, when site access is available, and remediation after the Schedule 2 decommissioning EIA will overcome any potential problems and mitigate any contamination. This Section, therefore, provides the potential environmental issues associated with land contamination from the CLS site and was developed as a result of the desktop research and limited site observations performed for the NLDFS EIA Study. The Section also previews areas for further assessment in subsequent of the studies, where appropriate.

12.2 STATUTORY REQUIREMENTS AND EVALUATION CRITERIA

12.2.1 Assessments of land contamination and the potential impacts are guided by the EPD's document note Professional Persons Environmental Consultative Committee Practice Note 3/94 - Contaminated Land Assessment and Remediation (ProPECC PN 3/94), the Technical Memorandum on Environmental Impact Assessment Process (EIAO), and the 1999 Guidance Notes for Investigation and Remediation of Contaminated Sites of: Petrol Filling Stations, Boatyards, and Car Repair/Dismantling Workshops (Guidance Notes). In accordance with these documents, the assessment evaluation should:

- provide a clear and detailed account of the present use of the land in question and the relevant past land use history, in relation to possible land contamination;
- identify those areas of potential contamination and associated impacts, risks or hazards; and
- as required, submit a plan to evaluate the actual contamination conditions for soil and/or groundwater.

12.2.2 Under the ProPECC PN 3/94 note and the Guidance Notes, and in the absence of any formal legislation requiring cleanup of soil and groundwater contamination in Hong Kong, the "Dutch Ministry of Housing, Planning and Environmental Soil and Groundwater Standards" (the Dutch Guidelines) (1994) are used as reference criteria by the EPD for the classification of contaminated materials. It should be noted that the Dutch Guidelines, whilst widely recognised and generally applicable on a global scale, are not enforceable standards in Hong Kong. In the Netherlands, the Dutch Guidelines were developed in the specific case where the drinking water supply is sourced entirely from groundwater. Hence, the Dutch Guidelines are very strict in regard to some specific contaminants, but must be viewed in the relative context of the Hong Kong situation.

12.2.3 Under the EIA Ordinance, *Annex 19: Guidelines for Assessment of Other Impacts*, consideration shall be given to a number of potentially contaminating historical land uses, including oil installations, shipyards/boatyards, car repairing and dismantling, power plants and gas works. If these land uses are identified, then the applicant is required to generate a Contamination Assessment Plan (CAP).

12.2.4 In this Section, a review of the proposed development is provided with indications, as appropriate to the level of assessment conducted, for any further investigations that may be required.

12.3 EXISTING ENVIRONMENTAL SENSITIVE RECEIVERS

12.3.1 Based upon the generally remote and undeveloped locations that comprise the Study Area, sensitive receivers to potential land contamination are identified as the current land users (who are engaged in potentially land contaminating activities), construction workers and future users of the site, including the proposed Water Recreation Centre.

12.3.2 As detailed in *Section 2* above, the Theme Park and associated developments include reclamation and development of a number of areas including the Penny's Bay reclamation which includes the broader Penny's Bay area. The developments in Penny's Bay area will involve the construction and operation of PBRL, Road P2, and the western section of the Chok Ko Wan Link Road, and a Theme Park, with associated ancillary facilities and developments, existing and reclaimed land. Some land based excavation and grading works

will be required for the construction of the railway and roadways. These projects are of concern as there may be interphasing with any potentially contaminated soil underlying the CLS site, and hence the potential to impact sensitive receivers.

12.4 ASSESSMENT METHODOLOGY

12.4.1 The objective of this land contamination study is to identify and screen any concerns with respect to potential soil and groundwater contamination for the CLS site.

12.4.2 The following methodology has been adopted:

- preliminary review of the current and historical land uses to evaluate the likely level of potential for any soil and ground contamination;
- description of the likely nature of any potential contamination, supplemented, where available, with specific quantitative data from a limited sampling programme;
- a preliminary review of potential environmental impacts or health concerns arising as a result of the development or during future use of the land, as a result of exposure to potentially contaminated materials; and
- overview of typical mitigation measures.

REFERENCE SOURCES

12.4.3 During this study reference to the following sources of information was made:

- Outline Development Plan (P1884/D2/D (21 January 2000);
- Hong Kong Ordinance Survey maps and North East Lantau Port Outline Zoning Plans (S/I-NELP/4, February 1998) for the Study Area;
- Draft North-East Lantau Outline Zoning Plan (Ref: *S/I-NEL/5*, dated 13 August 1999);
- Hong Kong Geological Survey *Solid and Superficial Geology Series,* Map 10, Silver Mine Bay (1986);
- selected aerial photographs held at the Government Lands Department;
- correspondence with various Government Departments, including the EPD, EPD Local Control Office (LCO, Urban West & Islands), Planning Department, and Civil Engineering Department (CED);
- *Lantau Port & Western Harbour Development Studies, Addendum C, Cheoy Lee Shipyard Reprovisioning*, Final Report, April 1993;
- reviewing existing data from ERM audit reports performed previously for CLP Power, and performing site visits and interviewing site management at the Penny's Bay Gas Turbine Plant (GTP);
- performing several site visits and interviewing site management at the CLS site; and
- subsequently performing a limited soil sampling and analysis exercise at the CLS site boundary.

12.4.4 It should be noted that a separate Contamination Assessment Plan (CAP) was generated as an earlier part of the NLDFS EIA. However, no on-site investigation works could be conducted due to the CLS site access limitations. The CAP may be reviewed in conjunction with the future CLS site Schedule 2 EIA.

12.4.5 Selected stereoscopic pairs of aerial photographs were reviewed for specific information on the site developments and land use. The primary concern this land contamination assessment was land use changes in the Penny's Bay area, where the CLS site is located.

Aerial photographs reviewed, with specific details for this location, are presented in *Table 12.4a*.

Table 12.4a - Aerial Photograph Review - Penny's Bay Area

Date	Photographs	Height	Key Issues
7 Nov 1998	A48861 / A48862 A48932 / A 48933 A48934	5,000 ft	No changes from 1997; current CLS and neighbouring CLP Power Gas Turbine Plant (GTP) operations noted.
15 Aug 1997 10 Sept 1997	A45575 / A45576 A45577 A46039 / A46040	2,000 ft 4,000 ft	"Current" refuse pit noticeable in SE corner of property, with evidence of burning of waste.
24 Apr 1996 12 Oct 1996	A42362 / A42361 CN 14753 / CN14752	2,000 ft 5,000 ft	Former, smaller refuse pit #3 noted at SE corner of site in April 1996, near edge of seawall; Pit #3 no longer visible in October 1996, when "current" refuse pit excavated.
23 Jun 1993	A34904 / A34903	2,500 ft	CLP Power GTP is built. Small ditch or pit (#2) noted along SE seawall, apparently for refuse disposal.
12 May 1992	A31057 / A31058 (oblique photos)	6,000 ft	Above ground storage tanks (ASTs) installed at neighbouring CLP GTP as construction continues; some storage of construction materials in vacant SE portions of the CLS site.
24 Oct 1991	A28671 / A28672 A28673 / A28674	2,000 ft	Concrete batching activities at the lot on southeast corner of site. CLP GTP site under construction; Evidence of possible refuse disposal or surface pile of burned refuse in SE portion of site.
6 Dec 1990	A24941 / A24942	4,000 ft	Construction in Progress at CLP GTP. Adjacent portions of SE corner of CLS site used for quarry and sand/gravel batching plant. Additional expansion of hull and mould storage area in SE portion of site.
6 Dec 1985	A03956 / A03957	4,000 ft	First evidence of storage of ship hulls and moulds along SE portion of site. Neighbouring CLP site still vacant.
22 Nov 1984	57254 / 57255	6,000 ft	Most of SE portion of site area still vacant. Slipways built into seawall at CLS site.
7 Dec 1978	23958 / 23959	4,000 ft	All reclamation work appears completed, with increased number of CLS buildings and development of seawall. Quarry activity and piles of sand/gravel along SE portion; neighbouring CLP site vacant and undeveloped. Evidence of refuse dumping at edge of reclamation on SE portion of site (in former stream drainage area).
13 Dec 1964	2614 / 2615	12,500 ft	Most of seawall and small reclamation at head of Penny's Bay completed; Increased number of warehouse buildings indicates CLS business operations underway.
25 Jan 1963	4663 / 4664	3,900 ft	Most of Penny's Bay area is not reclaimed; original shoreline exists, however, at least six CLS warehouse buildings noted at head of Bay on small reclaimed portion.
22 Jan 1962	F42/642-97 F42/642-96	N/A	Construction of seawall jetty at very head of Penny's Bay, with marine reclamation/filling underway. New warehouse building in place.
1954	V81A/RAF/553-72 V81A/RAF/553-73	N/A	No reclamation noted. Original Penny's Bay shoreline is present and untouched.
Note: No aerial photos available for 1995-94, 1989-85, 1983-80, 1975, 1970, 1969, 1968, 1967, 1964			

12.5 IDENTIFICATION OF ENVIRONMENTAL IMPACTS

POTENTIAL SOURCES OF IMPACT

12.5.1 The sources of impacts are the potentially contaminating land uses within the Study Area.

12.5.2 The CLP Penny's Bay GTP is located at the eastern side of Penny's Bay. This GTP was commissioned in 1992 with a generating capacity of 300 MW and serves as a peak load and emergency back-up facility for the HKIA, Tung Chung and the future developments along NLH and the Study Area. A smaller electricity substation, near Sham Shui Kok, is part of CLP's electricity distribution system and is directly connected to Penny's Bay GTP. A series of power lines run from the substation to Discovery Bay and Tung Chung. However, the CLP operations are not judged to be a serious concern (see further discussion in *Section 12.5.2* below).

12.5.3 The primary land use of concern for this land contamination assessment comprises the shipyard and associated maintenance activities at the CLS site, located on the north and eastern shores of Penny's Bay. The main operations of the CLS site are constructing and repairing glass-reinforced plastic (GRP) and fibreglass yachts and boats, and steel hulled ships up to approximately 80 m in length. Such related activities include metal and foundry works, some vehicle maintenance work, and waste disposal activities, and each of these activities has the potential of causing land contamination (*Figure 12.5a*). Shipyards and related activities have been identified by the EPD's ProPECC PN 3/94 note and Guidance Notes (1999), as land uses with the potential for contamination, and specific guidelines have been developed for the assessment and remediation of such industries. The typical contaminants associated with historic shipyard activities, which are known to occur at CLS, are summarised in *Table 12.5a*.

Table 12.5a - Potential Contaminants Associated with Historical Shipyard Land Use

Historical Use	Potential Site Contaminants	Comments
Ship hull and structural woodworking operations	resins, thinners, wood preservatives and treatment chemicals (possibly including such as creosote, arsenic trioxide, and chlorophenols), paints	• possible localised spillage's
Open scrap and equipment yard, metal foundries, metal workshops	heavy metals and grinding swarf (lead, cadmium, copper, nickel, zinc, TBT) and cutting oils, possible acids and paints, solvents, and electroplating effluents	• possible localised spillage's • fuel storage tanks
Ship and hull construction, maintenance, repair and machining works	petroleum fuel storage, including benzene, toluene, ethyl benzene and xylene (BTEX), polycyclic aromatic hydrocarbons (PAHs), acids, solvents and degreasants, antifouling paints (TBT), scrap metals and grinding swarf, asbestos, anticorrosive compounds	• spillage's from maintenance and dismantling equipment • grinding swarf and sandblasting discharges • grease and oils on slipways • localised areas of contamination • possible presence of storage tanks
Miscellaneous chemical storage yards and areas	fuel and chemical storage, solvents, thinner, resins, paints and pigments, PAHs	• localised or general spillage • open storage areas
Waste disposal / burn pits	residual amounts of resins, paints, thinners or solvents, fuels, wood preservatives and other treatment chemicals, heavy metals	• uncontrolled burning activities • localised areas of contamination

12.5.4 A description of general hazardous properties of compounds which are or may have been used or stored in the various areas described is presented in *Table 12.5b*.

Table 12.5b - General Properties of Hazardous Substances Potentially Found in Shipyards

Typical Material	General Hazardous Properties
Petroleum hydrocarbons and BTEX	• can be toxic by inhalation, ingestion and contact • concentrations may be flammable
Oils, oily wastes	• can be toxic by contact or ingestion • concentrations may be flammable
Thinners, organic solvents, degreasants, and wood preservatives	• toxic by contact, inhalation and ingestion • concentrations may be flammable
Heavy metals (including arsenic, mercury, copper, chromium, lead, zinc, and TBT)	• can be toxic by ingestion and contact • most are toxic to fish, plants, and marine plants (copper) • specific precautions may be required in relation to monitoring and dust control in site formation works
Acids and alkalis	• toxic and harmful by contact • corrosive to metal, concrete
Polycyclic aromatic hydrocarbons (PAHs)	• toxic by contact and ingestion

12.5.5 Localised spillage's of any of these potential contaminants may impact the surrounding soil or groundwater, and may cause negative impacts to sensitive receivers, including humans involved in future construction activities.

POTENTIAL IMPACTS

12.5.6 The potential impacts from contaminated soil and groundwater are identified as follows:

- health risks to site workers;
- disposal of contaminated soil, where required;
- contaminated groundwater disposal, where required; and
- potential health risks to future users of the site.

Health Risk to Site Workers

12.5.7 Site construction workers may become exposed to contaminated soils and groundwater during earth moving operations and the construction of the roadway foundations or any underground services. The main exposure routes for site construction workers is direct ingestion of contaminated materials, either through poor hygiene and eating or smoking on site, or through direct contact with potentially toxic or harmful contaminants in soils or sediments.

Disposal of Contaminated Soils

12.5.8 In the event that any contaminated soils are identified during ground development works or further environmental investigations, they may require disposal as part of the construction programme. Otherwise, prior agreement will need to be reached with EPD to ensure that these materials are properly mitigated or dealt with appropriately, i.e. as part of the remediation under the Schedule 2 EIA of the CLS site. It should be noted that landfill space is seriously limited in Hong Kong, therefore landfill disposal of contaminated soil should only be considered as a last resort. Any contaminated soils which are excavated may require off site disposal at an appropriate site which is licensed to accept 'contaminated'

soils, or reused as fill after treatment/ remediation. The actual type(s) and concentration of contaminants will determine the actual disposal requirement, following agreement of the proper disposal option with the Waste Facilities Management Group of the EPD.

Contaminated Groundwater Disposal

12.5.9 Where excavations take place below the water table in areas identified as being contaminated, there will be a need to dewater the operations for safety and construction purposes. Where dewatering takes place through layers of contaminated material or where any contaminated soil is being excavated and/or dewatered, the water may become contaminated, requiring appropriate handling and disposal. Depending on the level of contamination encountered, and subject to the agreement of the EPD, groundwater will need to be remediated, or more likely disposed of in an appropriate manner and to ensure compliance with the Water Pollution Control Ordinance (WPCO).

Potential Health Risks to Future Users of the Site

12.5.10 No contaminated soil is likely to remain *in situ* after remediation to the agreed upon clean up standard and the satisfaction of EPD. Therefore, during the operational phase of the works, there is considered no potential for impact associated with any contaminated soil at the site following development of the PBRL, P2 Road or the Chok Ko Wan Link Road. In addition, maintenance workers or workers who may be commissioned to perform maintenance or alterations to the above road or railways or the Water Recreation Centre at a later stage will, therefore, not come into contact with any such materials. However, as mentioned above, the CLS shipyard site will be subject to a separate Schedule 2 EIA for decommissioning, and all contamination will be remediated or effectively mitigated so as to prevent any potential negative impact. Where there is any question of the potential for any residual contamination to migrate or impact to the proposed artificial lake at the Water Recreation Centre, it should be noted that the artificial lake will be constructed offshore and away from the shipyard site, by first dredging the marine sediment from the relevant part of Penny's Bay to a depth of 1 m, followed by placement of an HDPE liner. This liner, whilst designed to hold the freshwater in, will also help mitigate against subsurface contaminant infiltration assuming the liner integrity is maintained. The site will be remediated, under the direction of the subsequent Schedule 2 CLS EIA, to the extent that any former CLS site land contamination will not adversely affect the lake.

12.6 ASSESSMENT OF ENVIRONMENTAL IMPACTS

REVIEW OF HISTORIC AND CURRENT LAND USES

12.6.1 A review of historical maps and selected historical aerial photos in the Penny's Bay indicates that the majority of the proposed development of concern will be on land which has primarily been previously undeveloped, or recently reclaimed land developed for the CLS shipyard use or the CLP Penny's Bay GTP.

Historical Land Uses

12.6.2 The Penny's Bay area was developed by reclamation in the late 1960s to early 1970s. The main operations at the CLS facility are and have always been constructing and repairing ships, including steel hulled, fibreglass, and glass-reinforced plastic (GRP) vessels. Based

on discussions with site management, the main operations appear to have changed little since the initial development of the property in 1960 and growth through the 1960s. The operations and number of workers employed have always been based on market demand.

12.6.3 According to CLS site management, there have been no other uses of the property throughout its history except for ship building and repair operations. The plating operations are no longer used (parts are now reportedly purchased from outside suppliers) and the practice of using tributyl tin in antifouling paints and compounds was terminated in 1995 and is no longer carried out at the site.

Evaluation of Impacts

12.6.4 As a result of the fact that there has been very little industrial usage of land within the Study Area other than the CLP GTP and the CLS site, overall historical contamination concerns are considered to be limited.

12.6.5 There is no expected environmental impact from the CLP facility. Based upon interviews with CLP Power Hong Kong Limited management, and our understanding of the results of two previous environmental audits performed at the Penny's Bay GTP in 1996 and 1998 as part of the CLP Power Generation Business Group's environmental policy, the GTP facility complies with all appropriate legislation and does not have any negative environmental issues in relation to land contamination. There have been no spill incidents or accidents reported at the site.

12.6.6 The main focus of potential concern, therefore, relates to the CLS site, which will be decommissioned. The contamination concerns would only arise if any historical leakage's or spillage's have migrated through to areas where works or workers might interphase with the soil. However, correspondence with various government authorities revealed that there is generally little information available on the site relating to land contamination.

12.6.7 Correspondence with the Planning Department (*(6) in LI/D/LP/23 Pt.6*) indicated there was no information regarding land contamination in the files of the CLS site. The EPD Local Control Office (Urban West and Islands) indicated in correspondence (*EP 742/974/0024 I*) that, in relation to the CLS site, their office had:

- no record of contamination incident;
- no record of known spillage accident, uncontrolled or illegal dumping;
- no record of illegal dumping site (flytipping blackspot); and
- no record of Water Pollution Control Ordinance (WPCO) and Waste Disposal Ordinance (WDO) prosecution.

12.6.8 The LCO also indicated that spent lubricating oil, spent solvent, and waste fuel oil were stored at the CLS site. This was confirmed by the EIA Study Team's observation.

12.6.9 Review of the Chemical Waste Producer Registration (*WPN 3881-973-C2269-03,* dated 15 September 1994) indicated that the CLS facility may generate waste spent solvents and lubricating oils.

12.6.10 January 1999 correspondence (*(17) in FSD/PG43/790/77 (XIV)*) from the Fire Services Department (FSD) indicated that there was no Dangerous Goods (DG) License for the CLS site, and that there was no occurrence of fire or chemical spillage incident in the last three years.

12.6.11 The CLS site was noted to maintain a Discharge License (*EP742/973/0001 I*, dated 25 September 1997) under the WPCO, for discharge of effluent from the canteen and toilets, electroplating workshop, and maintenance of vessels. Treatment facilities listed under the Discharge License include the following: a septic tank and soakaway system; pH adjustment, heavy metal removal and cyanide destruction; and suspended solid and oil and grease removal.

Current Land Uses

12.6.12 The CLS facility is located on Lot 22 in DD 356, and occupies an area of 18.7 ha. Other than the neighbouring Penny's Bay GTP operated by CLP Power, there is no other development in the area. District Lands Office (Islands) confirmed that the adjacent Chok Ko Wan Village has been vacated after the clearance exercise conducted by DLO/ Tsuen Wan in January 1998, under the project of Lantau Port Development Phase I (*DLO=s Ref. (14) in DLO/IS 26/41 Pt.9 IS dated 28 November 1998*). Access to the CLS site is currently by boat only.

12.6.13 The main operations at the CLS facility are constructing and repairing ships, including steel hulled, fibreglass, and glass-reinforced plastic (GRP) vessels. The site layout (*Figure 12.5a*) presently includes a number of wet and dry dock berths, workshops and storage areas. There are approximately two dozen buildings at the site, including:

- a canteen and small dormitory;
- dangerous goods storage building;
- resins storage room (refrigerated);
- metal foundry building;
- two metal workshops;
- two steel fabrication shops;
- one mould design workshop;
- three moulding workshops;
- three storage warehouses;
- an office and storage building;
- vehicle maintenance workshop and area;
- saw mill;
- woodworking shop;
- two boat building shops; and
- sand blasting building.

12.6.14 In addition, mould and hull storage occupies a large area of vacant land on the southeast portion of the CLS property.

12.6.15 During the EIA Study Team’s December 1998 CLS site walkthrough, many of the workshop areas were noted to have unpaved, dirt floors, most notably the foundry building and metal work shops. Waste disposal was observed to be into large, unlined pits excavated in the ground near the southeastern edge of the site, in an area of open land (*Figure 12.5a*). The waste disposal pits were also noted to contain an extensive range of solid wastes, including tyres and drums, and the materials appeared to be burned. In addition, at least 100 old, empty drums were stored in at least two outside locations (*Figure 12.5a*), reportedly awaiting pickup for recycling. Many of the drums were on their sides, and none of the drums were stored within any containment area. A number of the drums were noted to be old and rusty, indicating a possible lengthy time of storage.

Evaluation of Impacts

12.6.16 Detailed quantitative studies of the CLS property not been undertaken, due to access limitations. However, a limited, preliminary assessment was made of five soil samples from the land adjacent to the south-eastern property boundary (see discussion below). The typical contaminants associated with shipyard land use activities generally include hydrocarbons and fuels, solvents, and heavy metals from plating activities, metal work or grinding and anti-fouling paints (such as copper, lead and tributyl tin). The potential impacts may arise from localised spillage's and these contaminants may cause negative impact to sensitive receivers, including humans, during construction works or during the operational phase. A description of general hazardous properties of typical compounds which may have been used or stored at shipyard sites is presented in *Table 12.6a* below.

12.6.17 It should be noted that almost all of the CLS facility, including the portions of the site where the waste disposal pits are located, is on reclaimed land adjacent to Penny's Bay. As such, the depth to groundwater at portions of the site are expected to be no greater than approximately 2 m. Where contamination is present (i.e. oils or fuel from past spills), this immiscible material is not expected to migrate through the groundwater interface or vertically to any great extent. Likewise, given the area of reclamation and the somewhat narrow area of land at the base of the steep hills, and the higher permeability of reclamation fill the horizontal migration of any contamination is not expected to be extensive. Lastly, as portions of the CLS property have been used for different, distinct shipyard activities, the contamination, where encountered, may be localised rather than regional.

Table 12.6a - General Properties of Hazardous Substances Potentially Found at Shipyards

Typical Material	General Hazardous Properties
Petroleum hydrocarbons (including benzene, toluene, xylenes, and ethyl benzene - BTEX)	Can be toxic by inhalation, ingestion and contact Concentrations may be flammable
Oils, oily wastes	Can be toxic by contact Concentrations may be flammable
Thinners, solvents, degreasers	Toxic by contact, inhalation and ingestion
Heavy Metals (including copper, zinc, chromium, and lead); mercury; tributyl tin	Can be toxic by ingestion and contact Most are toxic to fish, plants, and marine plants (especially copper) Specific precautions may be required in relation to monitoring and dust control in site formation works
Acids (batteries)	Toxic and harmful by contact Corrosive to metal, concrete
Polycyclic Aromatic Hydrocarbons (PAHs)	Toxic by contact and ingestion

12.6.18 In the absence of full access to the shipyard site, a limited sampling and analysis programme was performed on 2 February 2000, with collection of five selected soil samples from a stream bed discharging along the southeastern property line of the CLS site.

12.6.19 A total of five samples were collected by the EIA Study Team and submitted to the LAM Geotechnics Limited Environmental Laboratory under chain of custody and analysed for the following parameters:

- total petroleum hydrocarbons (TPH) as gasoline and diesel;
- volatile organic compounds (VOCs);
- semivolatile organic compounds (SVOCs);

- priority pollutant heavy metals (13 metals);
- total cyanide;
- polychlorinated biphenyls (PCBs); and
- tributyl tin (TBT).

12.6.20 The chemical analysis results indicated that low levels of TPH as gasoline were detected in two samples, S-2 (0.12 μg/kg) and S-3 (0.13 μg/kg). The other three samples were not detected at a laboratory detection limit (DL) of 0.10 μg/kg. No concentrations of any TPH as diesel were detected in the five samples at the laboratory's detection limit (1.0 mg/kg).

12.6.21 No concentrations of any of 36 specific volatile organic compounds (VOCs) were detected in any of the five samples at the laboratory's specific DL for that particular compound.

12.6.22 No concentrations of any of 15 specific semivolatile organic compounds (SVOCs), analysed as polycyclic aromatic hydrocarbons (PAHs), were detected in any of the five samples at the laboratory's specific DL for that particular compound.

12.6.23 Analysis for heavy metal compounds indicated low concentrations of 12 specific metal compounds. There were no concentrations of cadmium or silver detected. Table 12.6b presents the results of the metals analysis.

Table 12.6b - Results of Heavy Metals Analysis (all results in mg/kg)

Parameter	S-1	S-2	S-3	S-4	S-5	Dutch Guideline Values
Cadmium (Cd)	<0.2	<0.2	<0.2	<0.2	<0.2	1 / 5 / 20
Chromium (Cr)	2.1	6.2	2.7	3.0	3.5	100 / 250 / 800
Nickel (Ni)	1.4	3.4	<1	1.4	<1	50 / 100 / 500
Copper (Cu)	15	11	5.9	6.4	2.7	50 / 100 / 500
Lead (Pb)	40	180	66	49	29	50 / 150 / 600
Zinc (Zn)	39	67	29	44	70	200 / 500 / 3,000
Mercury (Hg)	<0.1	<0.1	0.2	<0.1	<0.1	0.5 / 2 / 10
Arsenic (As)	2.2	2.5	1.3	1.3	1.2	20 / 30 / 50
Silver (Ag)	<1	<1	<1	<1	<1	N/A
Barium (Ba)	8.4	16	11	38	3.8	200 / 400 / 2,000
Tin (Sn)	<1	1.4	1.0	1.1	<1	20 / 50 / 300
Molybdenum (Mo)	<1	1.0	<1	1.2	<1	10 / 40 / 200
Cobalt (Co)	2.1	22	1.6	1.9	1.3	20 / 50 / 300

Note: mg/kg = milligrams per kilogram.

N/A = There are no specific Dutch Guideline Values for this metal.

12.6.24 As detailed above in the ProPECC PN 3/94 Note, the Dutch Guidelines (1994) are used as reference criteria by the EPD for the classification of contaminated soils. It should be noted that the Dutch Guidelines, whilst widely recognised and generally accepted on a global scale, are not enforceable standards in Hong Kong. In the Netherlands, the Dutch Guidelines (which were revised again in 1995) are enforceable standards whereby contaminants are subdivided into categories, dependent upon the various concentrations. For the purposes of this investigation, soil samples are classified according to the older version of the Dutch Guidelines as follows:

- "A" Values are characteristic of clean, uncontaminated soils;
- "B" Values imply that some form of pollution is present and further investigation may be required; and
- "C" Values imply significant pollution and some intervention or cleanup would be required.

12.6.25 Almost all of the detected metal compounds were noted to be below the respective Dutch "A" Value concentrations, which would imply clean, uncontaminated soil. Only the concentration of lead detected in sample S-2 (180 mg/kg) exceeded the respective Dutch "B" Value of 150 mg/kg. None of the samples exceeded a specific "C" Value, which would indicate significant pollution.

12.6.26 The chemical analyses did not detect any concentrations in excess of the laboratory's respective DLs for total cyanide (at 2 mg/kg), polychlorinated biphenyls (at 10 μg/kg for each of seven specific PCB compounds), or tributyl tin (at 40 μg/kg), in any of the five samples.

12.6.27 With the exception of *Section 6* above, which details sediment quality analysis results and potential contaminated sediment issues in Penny's Bay, no other assessment of soil or groundwater conditions has been performed at the CLS site at this time, due to access limitations. Therefore, there is no *in situ* data to assess the exact type, extent or severity of possible contamination on-site. Thus, the scale of any potential impacts can only be estimated at this stage. However, contamination, where encountered, may be limited in extent as described above.

12.7 MITIGATION OF ADVERSE ENVIRONMENTAL IMPACTS

12.7.1 The mitigation of adverse impacts, where required, is expected to be relatively straightforward, and will follow existing procedures and established protocols. The selection and implementation of remediation, if required, will be made in accordance with the EPD's *Guidance Notes* document, which outlines the general process as follows.

SELECTION OF A REMEDIATION METHOD

12.7.2 There are many options available for the remediation of contaminated sites. However, taking into consideration the characteristics of contaminated sites, including shipyards in Hong Kong, the following methods may be the more practical options suitable for use in smaller target sites such as the CLS facility:

- recovery trenches or wells;
- soil venting;
- air sparging; and
- controlled excavation and disposal.

12.7.3 Detailed descriptions of these three methods are given in the EPD's 1999 *Guidance Notes* document. *Table 12.7.a* below summarises the applicability of these methods for the CLS site and their characteristics.

Table 12.7a - Comparison of Remediation Methods

Method	Principal Use	Level of Expertise Required
Recovery Trenches or Wells	Removal of leaked oil that floats on top of groundwater; a prerequisite if leaked oil is found; used in conjunction with other remediation methods	Moderate

Method	Principal Use	Level of Expertise Required
Soil Venting/Air Sparging	Soil venting for unsaturated zone soil; air sparging for groundwater; removes volatile chemicals, also promotes bioremediation	High
Excavation/Disposal	Shallow contamination, one-off excavation and contaminant removal, addresses all contaminants. Pretreatment of excavated soil prior to disposal may be required.	Little
Source: EPD's *Guidance Notes for Investigation and Remediation of Contaminated Sites of: Petrol Filling Stations, Boatyards, Car Repair/Dismantling Workshops* (1999).		

12.7.4 The presented remedial measures are not the only available general technologies for shipyard sites. Additional methods include *in-situ* immobilization of contaminants and containment of contaminants. The selection of an appropriate methodology will depend upon a number of factors, as these particular technologies may only be applicable in certain special cases. In addition, the measures will be developed in consultation with EPD during the Schedule 2 decommissioning EIA. This decommissioning EIA will need to be approved under the EIAO, and an environmental permit issued by the DEP before any decommissioning or construction work can commence in the CLP site.

12.7.5 In Hong Kong, there is a serious limitation of available landfill space for disposal of contaminated materials. Therefore, the EPD suggest that *in-situ* remediation methods should be adopted wherever possible, and excavation and disposal to landfill should always be the last resort which should be used only when *in-situ* remediation is proved to be not feasible and there is very localized contamination and the quantity of contaminated soil for landfilling is small.

12.7.6 Acceptance of disposal of contaminated soil and landfill also depends on the degree of contamination of soil and the nature of the contamination. Special approval has to be obtained from EPD for disposal to landfill. In some cases, contaminated soil must be pretreated or stabilized before landfill disposal, so as to avoid impacting the biological treatment systems. According to the EPD's *Guidance Notes* document, the following factors should be considered when evaluating the different remediation methods and selecting the most suitable one for a site:

- degree and extent of the contamination;
- anticipated future uses of the site;
- nature of the contaminants;
- soil characteristics; and
- time available for remediation.

12.7.7 Information on the above factors is usually documented in the Contamination Assessment Report (CAR) prepared during the site investigation stage, and forwarded to EPD for approval. As detailed above, access has not been granted for the CLS site, so no detailed on-site assessment has been completed. However, limited data collected in February from immediately off-site indicates that five selected samples from that specific location are not contaminated.

REMEDIATION ACTION PLAN

12.7.8 Upon review of the appropriate remediation technology, a Remediation Action Plan (RAP) should be developed in conjunction with the Contamination Assessment Report (CAR). The RAP provides a summary of the site conditions, the contamination, and a proposal and commitment by the project proponent to provide remediation of the site. The EPD's suggested outline of a RAP is shown in *Table 12.7b*. The RAP should be submitted to and approved by the EPD prior to implementation of any remedial technology. The RAP would also serve as a record for the project proponent's use in future monitoring of the remediation progress.

Table 12.7b - Outline of a Typical Remediation Action Plan (RAP)

Section and Title	Description
Introduction	Outline the location of the site. The owner of operator or person responsible should also be mentioned.
Nature of Operation	Describe generally the present and past operations on site and the main contaminated area(s).
Description of Extent of Contamination	Describe the extent of contamination at the site. A figure showing the distribution of the contamination and areas requiring remediation action should be included.
Objectives of Remediation Action Plan	State the objectives of the Remediation Action Plan.
Design and Operation of Remediation	Outline the type of system to be used for remediation including a list of requirement and sketches of the proposed remediation system. If any special approval has to be obtained from EPD, it should be identified here.
Implementation Programme	Set out an implementation schedule with the appropriate actions and milestones for the completion of various activities. The criteria to be used to assess the effectiveness of the remediation activities should be included in this section.

IMPLEMENTATION OF REMEDIAL MEASURES

12.7.9 Implementation of the Remediation Action Plan can start once the CAR and RAP submissions are approved by the EPD. The essential steps involved in remedial programme are detailed in the EPD's *Guidance Notes* document. EPD's *Guidance Notes* document is developed to provide general guidance for the project programme on the major steps involved. In all cases contaminated soil remediation, treatment or disposal of must be managed in an environmentally sound manner, including compliance with all relevant legislation and Government requirements. The health and safety measures to be adopted during remediation work are also described in the EPD's *Guidance Notes* document. In the case of the shipyard site, the measures will be developed in consultation with EPD during the Schedule 2 decommissioning EIA. This decommissioning EIA will need to be approved under the EIAO, and an environmental permit issued by the DEP before any remediation or construction work can commence in the CLS site.

Other General Measures During Construction Phase

12.7.10 As stated above, it is considered unlikely that contaminated land issues will be a concern during either the construction or operation of the NLDFS development, as remediation will be performed as part of the Schedule 2 EIA for decommissioning of the CLS site before any remediation or construction at the CLS site. However, as a precaution, it is recommended that standard good practice measures are implemented during any works during the construction phase to minimise any potential exposure to contaminated soils or groundwater. These measures include:

- The use of bulk earth-moving excavator equipment will minimise construction workers' potential contact with contaminated materials;
- Exposure to any contaminated materials may be minimised by the wearing of appropriate clothing and personal protective equipment such as gloves (when interacting directly with contaminated material), providing adequate hygiene and washing facilities and preventing smoking and eating during such activities;
- Vehicles containing any contaminated materials should be suitably covered to limit potential dust emissions or contaminated wastewater run-off, and truck bodies and tailgates should be sealed to prevent any discharge during transport or during wet conditions;
- Only licensed waste haulers should be used to collect and transport any contaminated material to an appropriate disposal site and procedures should be developed to ensure that illegal disposal of wastes does not occur;
- The necessary waste disposal permits should be obtained, as required, from the appropriate authorities, in accordance with the *Waste Disposal Ordinance (Cap 354)*, *Waste Disposal (Chemical Waste) (General) Regulation (Cap 354)*, as required;
- Records of the quantities of wastes generated and disposed of should be maintained; and
- In accordance with good construction practice, silt traps should be used to reduce the impact to drainage caused by suspended solids (SS) arising from disturbed ground, or any construction materials such as cement and gravel. Groundwater should be disposed of in accordance with the *WPCO*.

12.7.11 Based upon the lack of any documented previous spill incidents, and the fact that the construction in this area of the Study will be performed after a separate decommissioning Schedule 2 EIA study and remediation (if required) is completed, the potential for future negative land contamination impacts are not expected.

RESIDUAL ENVIRONMENTAL IMPACTS

12.7.12 Due to access restrictions, residual environmental impacts cannot be fully assessed at this time. However, given that the CLS facility will undergo a separate Schedule 2 EIA decommissioning study, and that remediation will be employed to EPD satisfaction, the potential for residual impacts or future land contamination concerns will be minimal.

CONCLUSIONS

12.7.13 To allow the Theme Park and associated developments EIA Study to be a 'stand alone' assessment, the relevant land contamination section of the NLDFS EIA was included within this EIA, although it is not strictly a requirement of the Study Brief. In order to provide quantitative information to the limited extent possible, a preliminary sampling programme was conducted along a stream bed discharging from the southeastern boundary of the CLS site. The results of five soil samples indicated that, whilst low concentrations of total petroleum hydrocarbons (as gasoline) and 11 heavy metal compounds were detected in some samples, the concentrations were not a major concern. Almost all of the detected

metal compounds were noted to be below the respective Dutch "A" Value concentrations, which would imply clean, uncontaminated soil. As appropriate remediation will be performed for the CLS site before construction of the Theme Park road and rail elements, future potential negative land contamination impacts are judged to be minimal. Remediation works will be required to meet the EPD's standards. The NLDFS assessment will be verified by CED in a separate *EIAO* Schedule 2 EIA for the CLS site. Thus, it is considered that there will be no potential residual negative impacts and no insurmountable constraints associated with the future use of the site for the Theme Park and associated developments.

12.8 IMPACTS SUMMARY

12.8.1 The potential land contamination impacts have been summarised in *Table 12.10a* as follows.

Table12.9a - Impact Summary Table

Issue	Construction Impact	Operational Impact
Assessment Points	Cheoy Lee Shipyard Site	N/A
Relevant Criteria	Remediation in accordance with the future, Schedule 2 Decommissioning EIA for CLS (This decommissioning EIA will need to be approved under the EIAO); All works to be conducted under the EPD-approved Contamination Assessment Plan (CAP) for the Cheoy Lee Shipyard, and will be completed to the satisfaction of EPD; Reference will be made to the EPD's *ProPecc Note PN 3/94*, *Annex 19* of the EIAO, and the EPD's 1999 Document *Guidance Notes for Investigation and Remediation of Contaminated Sites of: Petrol Filling Stations, Boatyards, and Car Repair/Dismantling Shops.*	N/A
Potential Impacts	Land contamination caused by historical shipyard activities	None expected, as the site will be mitigated to the satisfaction of EPD
Mitigation Measures	To be developed in conjunction with EPD during the Schedule 2 decommissioning EIA. This decommissioning EIA will need to be approved under the EIAO, and an Environmental Permit issued by the DEP before any construction work can commence in the shipyard area.	None required
Residual Impacts	None expected	None expected
Environmental Acceptability	Acceptable	Acceptable