Hongkong International Theme Parks Limited

REMEDIAL INVESTIGATION / REMEDIAL ALTERNATIVES EVALUATION AND REMEDIAL ACTION WORK PLAN

Cheoy Lee Shipyards Land Contamination Assessment

Hong Kong Disneyland
Penny's Bay Lantau Island, HKSAR

February 2002

Asia Pacific

Final Report

Appendix 4I

Remedial Investigation / Remedial Alternatives Evaluation and Remedial Action Work Plan prepared by IEC

REMEDIAL INVESTIGATION REPORT
REMEDIAL ALTERNATIVES EVALUATION
AND
REMEDIAL ACTION WORK PLAN

CHEOY LEE SHIPYARDS LAND CONTAMINATION ASSESSMENT

HONG KONG DISNEYLAND

PENNY'S BAY, LANTAU ISLAND

HONG KONG SPECIAL ADMINISTRATIVE REGION
OF THE PEOPLE'S REPUBLIC OF CHINA

TABLE OF CONTENTS

LIST OF FIGURES, TABLES AND APPENDICES

REMEDIAL INVESTIGATION
REMEDIAL ALTERNATIVES EVALUATION
AND
REMEDIAL ACTION WORK PLAN

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HONG KONG DISNEYLAND PROJECT

PENNY'S BAY, LANTAU ISLAND

HONG KONG SPECIAL ADMINISTRATIVE REGION OF THE PEOPLE'S REPUBLIC OF CHINA

PREPARED FOR

HONGKONG INTERNATIONAL THEME PARKS LTD.

EXECUTIVE SUMMARY

This document presents a Remedial Investigation (RI), Remedial Alternatives Evaluation (RAE), and Remedial Action Work Plan (RAW) for the Phase II Land Contamination Assessment of the former Cheoy Lee Shipyards (CLS) site at Penny's Bay on Lantau Island in the Hong Kong Special Administrative Region (HKSAR) of the Peoples Republic of China. This report was prepared by URS Corporation (URS) in association with BMT Asia Pacific Ltd. (BMT), collectively referred to as the Independent Environmental Consultant (IEC), for Hongkong International Theme Parks Ltd. (HKITP). The report was prepared in accordance with the agreed-upon approach between the HKSAR Government, The Walt Disney Company, and HKITP for addressing potential environmental contamination associated with the CLS site (hereafter "the agreed-upon approach").

The investigations reported herein were conducted in accordance with the RIWP dated May 2001, and its accompanying Field Sampling Plan and Quality Assurance Project Plan. The RIWP is the functional equivalent of the Contamination Assessment Plan (CAP) and the RI/RAE/RAW is the functional equivalent of the Contamination Assessment Report (CAR) and Remedial Action Plan (RAP) per Hong Kong environmental practice.

In accordance with the agreed-upon approach, environmental assessment and remediation at the CLS site shall be conducted pursuant to and in accordance with both appropriate U.S. environmental laws and Hong Kong environmental law and standards. This RI/RAE and RAW therefore have been prepared following both Hong Kong and applicable U.S. standards and guidelines.

The objectives of the RI are to:

- Identify sources of contamination beneath the CLS site

- Define the presence, nature, and concentrations of contaminants in soil and groundwater beneath the CLS site and delineate their vertical and lateral extent
- Evaluate the potential risks to human health and the environment posed by the identified subsurface contamination, and
- Recommend cleanup levels for contaminants present at concentrations that exceed appropriate institutional and risk-based criteria.

Site characterization data developed during the RI were used in the RAE to evaluate and recommend appropriate remedial measures to remedy contamination present at concentrations exceeding cleanup levels established for the site.

The objectives of the RAE and RAW are to:

- Identify remedial alternatives that will attain the cleanup levels established as part of the RI
- Evaluate the remedial alternatives with respect to applicability for use in Hong Kong
- Recommend the most cost-effective remedy for achieving the site cleanup levels in consideration of overall site development schedule constraints, and
- Present a summary of site environmental conditions, recommended cleanup standards, remedial action objectives and goals, remedial alternatives evaluation, and the selected remedy for soil contamination at the CLS site, along with justification for its selection.
- A further objective of the RAW is to outline remediation construction sequencing and design considerations for the selected remedy, soil confirmation sampling and post-remediation soil testing requirements, guidelines for reuse of treated soil, permitting issues, control measures, and site monitoring well closure/decommissioning requirements.

The scope of the RI included:

- Preparing the RIWP
- IEC oversight of the field work performed by Government contractors
- A geophysical survey in the southeastern portion of the site to identify potential locations of burn/waste pits
- Excavating, logging, photo documenting, and sampling a series of trenches to further evaluate potential burn/waste pits
- Drilling and sampling of exploratory borings to evaluate subsurface conditions throughout the site
- Installing, developing, sampling, and testing groundwater monitoring wells to evaluate site hydrogeology and potential impacts to groundwater quality
- Analyzing soil and groundwater samples for potential chemical contaminants and determination of soil physical properties
- Performing a Human Health and Ecological Risk Assessment (HHERA) to evaluate potential risks posed by chemical contaminants identified and to recommend risk-based cleanup levels; and

- Developing estimates of the volume, locations, and depths of contaminated soils exceeding site cleanup levels.

The scope of the RAE and RAW included:

- Identifying and evaluating applicable remedial approaches capable of attaining cleanup goals for the site.
- Selecting and recommending the most appropriate remedial approaches for the site, taking into consideration the overall program for site infrastructure development.
- Describing the selected site remedy(s) and outlining the various steps and procedures to be undertaken to achieve site remediation.
- Outlining control measures to be implemented to assure that remediation activities are completed in accordance with the selected remediation program.

Findings of the RI field and laboratory investigations reveal that soils at the CLS site have been impacted by various chemicals, including: metals (principally lead, copper, chromium, nickel and zinc with lesser impacts by arsenic and barium); petroleum hydrocarbons (TPH); semi-volatile organic compounds (SVOCs); dioxins, and to a lesser extent locally by cyanide and polychlorinated biphenyls (PCBs). Within the northwestern portion of the site (Area 1), soils have been impacted by metals (lead, chromium, copper, and nickel), petroleum hydrocarbons, and SVOCs both in the vicinity of buildings and external areas between buildings. The most significant impacts occur in the former plating shop (Building B), aluminum smelter (Building D), and foundry (Building L). In the central portion of the site (Area 2), impacts by metals, hydrocarbons, SVOCs, PCBs, and dioxins were found to occur. A significant portion of the impacted soil occurs along the northeastern margin of Area 2 associated with mounds of waste and debris and in buried burn/waste pits discovered in exploratory trenches. Impacts in the southeastern part of the site (Area 3) are related to past waste burning and disposal activities. A large number of burn/waste pits were exposed in this area of the site with impacts to soils and burn residues by dioxins and metals.

Estimated impacted soil volumes are summarized as follows:

Site Area	Estimated Volume (m^3)	Predominant Chemicals Present
1	10,000	Metals, TPH, SVOCs, limited dioxins
2	16,000	Metals, TPH, SVOCs, dioxins
3	61,000	Metals, TPH, SVOCs, dioxins
Total	87,000	

Impacted soil volumes by contaminant types are estimated as follows:

Contaminant Type(s)	Estimated Volume (m^3)
Metals only	48,000
TPH and/or SVOCs	700
Metals and TPH and/or SVOCs	8,300
Dioxins, metals, and TPH and/or SVOCs	30,000
Total Estimated Volume	87,000

Maps included with the RI portion of the report delineate areas and depths of soils impacted by chemicals exceeding screening and recommended cleanup levels.

Findings of the groundwater investigation reveal little impact to groundwater. The most significant occurrence of groundwater impact is associated with the former aluminum smelter (Building D), where a thin layer of floating hydrocarbon was discovered on the groundwater table in one well (MW-D06).

Findings of the Human Health and Ecological Risk Assessment indicate that, under existing baseline conditions, direct contact with chemicals detected in soil at the site would pose an unacceptable health risk to future park workers. Chemicals that contributed to risk levels above the target risk level of $1x10^{-5}$ include hexavalent chromium and dioxin in Area 1, PCBs and dioxins in Area 2, and chromium and dioxins in Area 3. In addition, several chemicals were present in soil at concentrations that exceeded ecological screening criteria.

The fate and transport modeling conducted for existing soil and groundwater concentrations indicate that migration of chemicals to the Water Recreation Centre (WRC) will most likely be insignificant when accounting for the migration pathway, chemical-specific properties, and the combined liner and fill section underneath the WRC.

Recommended cleanup levels for soil contamination at the CLS site were developed based on Hong Kong standards and the findings of the health risk assessment, in accordance with the agreed-upon approach. Recommended cleanup levels for chemicals detected at the site are presented in Table 8-1 and are summarized as follows:

- Petroleum hydrocarbons – Dutch 'B' Guideline values
  - $C_6 - C_{14}$ = 100 mg/kg
  - C_{15} and greater = 1,000 mg/kg
- SVOCs – Risk-based concentrations, as listed in Table 8-1
- Metals – Dutch 'B' Guideline values, as listed in Table 8-1
- Dioxins –
  - 1 µg/kg TEQ for dioxins in soils that will be covered with a minimum of 3m of clean fill soils, and
  - 0.1 µg/kg TEQ for dioxins in surface soils or where less than 3m of clean fill soil will be placed.

The IEC also developed recommended residual concentrations for treated soils returned to the site as fill, as follows:

- Petroleum hydrocarbons – Dutch 'B' Guideline values
- SVOCs – Risk-based concentrations, as listed in Table 8-1
- Metals – Universal Treatment Standard soluble concentrations in a TCLP extract, as described in Section 10.11, and

- Dioxins – 1.0 µg/kg TEQ for treated soils that will be placed beneath a minimum of 3m of clean fill, and 0.1 TEQ µg/kg for treated soils that will be placed with less than 3m of clean fill cover.

Available selected remedial approaches that could be applied at the CLS site were identified and evaluated during the RAE. The following remedial action alternatives were evaluated:

- Alternative 1 – No Action
- Alternative 2 – Onsite Cover of Impacted Soils
- Alternative 3 – Excavation and Entombment Within Lined Cell Beneath Engineered Cap
- Alternative 4 – Excavation and Offsite Landfill Disposal of Impacted Soils, and
- Alternative 5 – Excavation and Onsite or Offsite Treatment.

The Infrastructure Consultant (IC), Maunsell Consultants Asia Ltd. (MCAL), has conducted an evaluation of *ex situ* remedial technologies for non-dioxin impacted and dioxin-impacted soils as part of the *Environmental Impact Assessment Report (Final) for Decommissioning of Cheoy Lee Shipyards at Penny's Bay*. MCAL has recommended excavation and offsite treatment of impacted soils. Treatment methods recommended by MCAL include cement solidification of metals-impacted soils, biopile treatment of TPH and SVOC-impacted soils, and thermal desorption treatment of dioxin-impacted soils. Based upon the RAE, it is the IEC's opinion that the remediation approach recommended by MCAL can effectively meet the remedial action objectives and goals for the CLS site. The IEC therefore concurs with MCAL's selected remedy of excavation and treatment of metals-impacted soils by cement stabilization, TPH and SVOC-impacted soils by biopiling, and thermal treatment of dioxin-impacted soils by thermal desorption.

The RAW presents a summary of site environmental conditions, recommended cleanup standards, remedial action objectives and goals, remedial alternatives evaluation, and the recommended remedy for soil contamination at the CLS site. Also presented are discussions of engineering design and implementation considerations for the selected remedy, construction sequencing and implementation factors, soil confirmation sampling and post-remediation soil testing requirements, permitting considerations, monitoring and control measures and contingency plans, and site monitoring well closure/decommissioning requirements.

1.0 INTRODUCTION

1.1 BACKGROUND

This report presents a Remedial Investigation (RI), Remedial Alternatives Evaluation (RAE), and Remedial Action Work Plan (RAW) for the Phase II Land Contamination Assessment of the former Cheoy Lee Shipyards (CLS) site at Penny's Bay on Lantau Island in the Hong Kong Special Administrative Region (HKSAR) of the Peoples Republic of China. This report was prepared by URS Corporation (URS) in association with BMT Asia Pacific Ltd. (BMT), collectively referred to as the Independent Environmental Consultant (IEC), for Hongkong International Theme Parks Ltd. (HKITP). The report was prepared in accordance with the agreed-upon approach between the HKSAR Government, The Walt Disney Company, and HKITP for addressing potential environmental contamination associated with the CLS site (hereafter "the agreed-upon approach").

The investigations reported herein were conducted in accordance with the RIWP dated May 2001, and its accompanying Field Sampling Plan (FSP) and Quality Assurance Project Plan (QAPP), prepared by the IEC on behalf of HKITP. The RIWP provided the background, rationale, and a description of specific investigative tasks that were performed to evaluate potential land contamination at the former CLS site. The RIWP and its included FSP and QAPP also provided guidance to the HKSAR Government's Infrastructure Consultant (IC) and Site Investigation Contractor (SIC) responsible for implementing the field and laboratory investigations for the RI under IEC oversight.

The primary area addressed by this RI is the former location of the CLS facility, situated at the head of and along the eastern shore of Penny's Bay (Figure 1-1). The CLS site comprises approximately 18.7 hectares (46.2 acres) of primarily reclaimed land along the bay waterfront. CLS used the site for construction and repair of wooden, aluminum, and steel-hulled ships from 1963 until 2000. Historical operations at the CLS site, to the extent they are known, are discussed in Section 2.0 of this report.

1.2 OBJECTIVES

The objectives of the Remedial Investigation (RI) are to:

- Identify sources of contamination beneath the CLS site.
- Define the presence, nature, and concentrations of organic and inorganic contaminants in soil and groundwater beneath the CLS site and delineate their vertical and lateral extent.
- Evaluate the potential risks to human health and the environment posed by the identified subsurface contamination.
- Recommend cleanup levels for contaminants identified to be present at concentrations that exceed appropriate institutional and risk-based criteria.

The RI Report includes an evaluation of the nature and extent of contamination at the CLS site based upon data developed during the field and laboratory testing program. It also includes recommended cleanup levels based on intended site land use, applicable standards, and the findings of the evaluation of potential health and ecological risks posed by chemical constituents detected during the investigation.

Site characterization data developed during the RI are then used in the RAE to evaluate and recommend appropriate remedial measures to remedy contamination present at concentrations exceeding cleanup levels established for the site.

The objectives of the Remedial Alternatives Evaluation (RAE) and Remedial Action Work Plan (RAW) are to:

- Identify remedial alternatives that will attain the cleanup levels established as part of the RI.
- Evaluate the remedial alternatives with respect to applicability for use in Hong Kong.
- Select the most cost-effective remedy for achieving the site cleanup levels in consideration of overall site development schedule constraints.
- Present a summary of site environmental conditions, recommended cleanup standards, remedial action objectives and goals, remedial alternatives evaluation, and the selected remedy for soil contamination at the CLS site, along with justification for its selection.
- A further objective of the RAW is to outline remediation construction sequencing and design considerations for the selected remedy, soil confirmation sampling and post-remediation soil testing requirements, guidelines for reuse of treated soil, permitting issues, control measures, and site monitoring well closure/decommissioning requirements.

1.3 OVERVIEW OF PLANNED SITE DEVELOPMENT

The primary planned future use of the CLS site is for the construction of transportation-related infrastructure to support development of a large-scale International Theme Park (ITP) and Water Recreation Centre (WRC) on reclaimed land in Penny's Bay. The overall Penny's Bay site development plan is shown on Figure 1-2. The major project components located on or adjacent to the CLS site are as follows:

<u>Chok Ko Wan Link Road</u> – A 1.5-km long section of Chok Ko Wan Link Road will extend from the existing Yam O Interchange across Area 1 of the CLS site and then across the new reclamation at the head of Penny's Bay bordering the WRC on the north side. It will then re-enter the CLS site at the Penny's Bay Roundabout intersection with Highway P2 and extend easterly across the southeastern portion of Area 3. Chok Ko Wan Link Road will then exit the site and continue eastward to Na Tau Kwu Pak Wan along the eastern shore of Lantau Island.

<u>Highway P2</u> – This 4-km long elevated primary distributor road will extend from the Lantau Expressway at the Yam O Interchange across the current locations of Buildings D (Hull Molding, Pressing Workshop) and K (Fiberglass Hull Construction Workshop). It will then extend across a portion of the new reclamation at the head of Penny's Bay and re-enter the shipyard site at a point directly to the southeast of Building S (Yacht Building). It will then turn to a southerly direction across Area 3 of the site to a roundabout intersection with Chok Ko Wan Link Road located astride the current seaward margin of Area 3 of the CLS site.

<u>Resort Road</u> – A 3.5-km long district distributor road will provide access to the Park entrance. Resort Road (a.k.a. Entry Road) will continue southward from P2 Road at the Penny's Bay Roundabout and extend southerly onto the future reclamation east of the WRC.

Penny's Bay Rail Link – The rail line will exit a tunnel portal formed in the rock slope to the northeast of Building L (Foundry). It will bisect the site at grade and traverse the site just south of Building L (across the historical location of Building M (Rolling Mill) and continue across the locations of Buildings N (Saw Mill) and O (Vehicle Maintenance and Leather Dressing Stores) and onto the future reclamation bordering the WRC on the west.

Water Recreation Centre and Artificial Lake – An approximately 32 hectare (70 acre) Water Recreation Centre (WRC) with a 12 hectare (30 acre) artificial lake will be directly south of Highway P2 and west of the southward trending Park entrance road and Penny's Bay Rail Link. The WRC and multi-function artificial will lake will include water-based and land-based recreational facilities and ancillary facilities, and other essential and supporting services and facilities. The lake will be constructed upon reclaimed land within (former) Penny's Bay with a base elevation of +2.5 meters above Principal Datum (mPD). The lake will be constructed with a 1.5 millimeter- (mm) (60-mil) thick high density polyethylene (HDPE) liner and a rock/gravel protective cover.

WRC Arboretum – The WRC will include an Arboretum, consisting of footpaths and landscaped areas that will be constructed between Chok Ko Wan Link Road and Highway P2, overlying potions of Areas 2 and 3 of the CLS site.

Prior to infrastructure development, the existing CLS facilities will be decommissioned. Key elements of the decommissioning project will include:

- Demolition of existing structures at the CLS facility.
- Removal and appropriate disposal or other appropriate management of construction and demolition debris.
- Remediation of contaminated soil at the site.
- Slope improvements behind the CLS site.
- Placement of fill materials to raise the site grade. Based upon site drawings and cross-sections prepared by the Government's Infrastructure Consultant and by HKITP's Engineering Consultant, Mott Connell, the IEC understands that the site grade will be raised from an existing elevation of +3.5 to 4.3 mPD to a final elevation of +11 mPD prior to construction of the infrastructure elements described above.

1.4 ENVIRONMENTAL STANDARDS, GUIDELINES AND APPROACH

1.4.1 Relevant Standards

In accordance with the agreed-upon approach, environmental assessment and remediation at the CLS site shall be conducted pursuant to and in accordance with appropriate U.S. environmental laws and in compliance with Hong Kong environmental law. The parties have agreed that the IEC will analyze the sample results obtained by the Government's Infrastructure Consultant and recommend cleanup levels for the detected contaminants that are appropriate for a comparable recreational/theme park facility under applicable U.S. environmental law and Hong Kong law, taking into consideration conditions in Hong Kong and aspects of risk-based corrective action. As such, this RI/RAE and RAW have been prepared following both Hong Kong and applicable U.S. standards and guidelines.

1.4.2 Hong Kong Standards

The RI Site Investigation (SI) was conducted following the HKSAR Government Environmental Protection Department's (EPD's) *Practice Note for Professional Persons, Contaminated Land Assessment and Remediation* (ProPECC Note PN 3/94, March 1994) and EPD's *Guidance Notes for Investigation and Remediation of Contaminated Sites of Petrol Filling Stations, Boatyards, and Car Repairing/Dismantling Workshops* (EPD Report No. EPD/TR1/99, May 1999). 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* (1994) (the Dutch Guidelines) are used as reference criteria by the EPD for the classification of contaminated materials. The Dutch Guidelines are widely recognized and considered generally applicable on a global scale, and they are widely used as guidance for assessment of land contamination in Hong Kong. The Dutch Guidelines contain three levels of contaminant concentrations for soil and groundwater, referred to as 'A', 'B', and 'C'. Dutch Level 'A' implies soil or groundwater is unpolluted; Level 'B' implies potential pollution is present that requires further investigation and remediation; and Level 'C' implies a degree of pollution that requires remediation. EPD generally requires remediation for soil contamination that exceeds the Dutch 'B' Guidelines and typically uses the Dutch 'B' values as "bright line" cleanup for remediation of soil.

1.4.3 U.S. Standards

In the U.S. environmental investigations and remediation are conducted under guidance documents, directives, and various regulations promulgated by the U.S. Environmental Protection Agency (USEPA). Site investigations such as the RI/RAE Land Contamination Assessment for the CLS site are conducted in accordance with the USEPA document, *Guidance for Conducting Remedial Investigations and Feasibility Studies under CERCLA, Interim Final*, October 1988 (USEPA Report No. EPA/540/G-89/004). The Human Health Risk Assessment (HHRA) component of the RI is conducted following a variety of guidance documents, including the following USEPA publications and notices:

- Risk Assessment Guidance for Superfund, Volume 1, Human health Evaluation Manual (Part A) (EPA 540/1-89-002, 1989)
- Risk Assessment Guidance for Superfund, Volume 1, Supplemental Guidance for Standard Exposure Factors, Draft Final (OSWER Directive 9285.6-03, 1991)
- Guidance for Data Usability in Risk Assessment (USEPA Publication 9285.7, 1992)
- *Guidelines for Exposure Assessment* (Federal Register Notice 57(104): 22888-22938, 1992)
- Supplemental Guidance to RAGS: Calculating the Concentration Term (USEPA Publication 9285.081, 1992)
- Health Effects Assessment Summary Tables, Annual Update FY 1995 (Office of Solid Waste and Emergency Response, 1995)
- Health Effects Assessment Summary Tables, Annual FY 1997 (OHEA-ECAO-CIN-921, 1997)
- Exposure Factors Handbook (EPA/600/P-95/002Ba)
- *Soil Screening Guidance* (Office of Solid Waste and Emergency Response, 1996)

- U.S. Risk Assessment Guidance for Superfund, Volume I: Human Health Evaluation Manual (Part E, Supplemental Guidance for Dermal Risk Assessment (EPA/540/R-99/005, 1999)
- Integrated Risk Information System (IRIS) Substance File Database (USEPA, 2000)
- Additional guidance may be sought from various USEPA documents and directives. Among those relevant to the CLS site are the *USEPA Region IX Preliminary Remediation Goals (PRGs)* and the USEPA Office of Solid Waste and Emergency Response (OSWER) Directive 9200.4-26, *Approach for Addressing Dioxin in Soil at Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) Sites*, signed 13 April 1998.

U.S.-based practice generally does not utilize bright line remediation standards, such as the Dutch Guidelines, for directing remediation of contaminated soil. Rather, a risk-based corrective action (RBCA) approach is most commonly utilized, wherein an assessment is conducted of the potential human health and, if relevant, ecological risks to contaminants identified at a site taking into consideration planned land use and potential exposure pathways. A "Conceptual Site Model" (CSM) is used to identify potential exposure routes and pathways to chemicals of potential concern (COPCs). Exposure point concentrations are then estimated based upon a geostatistical evaluation of site contaminant data, and an estimate of health risk (in terms of probability of contacting cancer for carcinogenic chemicals) and hazard (for noncarcinogenic but toxic chemicals) is calculated for the potentially exposed population. These risk and hazard calculations are used to establish risk-based cleanup levels using the RBCA approach.

1.4.4 Integrated Approach

For this project, an integrated approach has been used that addresses both Hong Kong and U.S. based standards and approach to decision making regarding site remediation. For the first tier analysis, the Dutch 'B' Guidelines have been used to identify areas of the site that have been impacted by chemical contaminants above concentrations of concern. USEPA PRGs have been used for the few chemicals detected at the site that are not covered by in the Dutch Guidelines. A risk assessment was also conducted to evaluate potential risk and hazard associated with COPCs and to identify if any COPCs exist that would present an unacceptable level of risk at concentrations below their respective Dutch 'B' values.

According to these Hong Kong environmental guidelines, and the EPD's *Technical Memorandum on Environmental Impact Assessment Process* (Hong Kong EPD, 1997), prior to undertaking an environmental assessment of potential land contamination, a Contamination Assessment Plan (CAP) should be prepared and submitted to EPD for review and endorsement prior to implementation of the site investigation. Based on the endorsed CAP, the contamination assessment is then implemented and a Contamination Assessment Report (CAR) is prepared to document the findings of the investigation for review and approval by the EPD. If the site is found to be contaminated, a Remedial Action Workplan (RAP) should be developed to formulate the necessary remedial measures for site cleanup for review and agreement by the EPD.

Construction of the Hong Kong Disneyland theme park and related infrastructure will require decommissioning of the Cheoy Lee Shipyards. Because the decommissioning of a shipyard greater than 1 ha in size is a Designated Project under Schedule 2, Part II, Decommissioning Projects (Item 17) of the Environmental Impact Assessment Ordinance, Cap. 499, S.16 (EPD, 1997), an

Environmental Impact Assessment (EIA) must be conducted. The RIWP is a functional equivalent of the CAP and the RI is the functional equivalent of the Contamination Assessment Report (CAR) under Hong Kong environmental guidelines. The Remedial Alternatives Evaluation and Remedial Action Work Plan will satisfy the requirements for a RAP under Annex 19 of the Technical Memorandum on Environmental Impact Assessment Process.

1.5 OVERVIEW OF RI SCOPE OF WORK

The scope of the RI included:

- Preparing the RIWP, and its included FSP and QAPP, that describe in detail the scope of work and procedures to be followed for the field and laboratory investigations that were performed by Government contractors (see Section 1.7).
- IEC oversight of the field work performed by the Government contractors and interaction with the analytical testing laboratory contracted by the Government to perform laboratory testing of soil, groundwater, waste material, and QC blank samples.
- Conducting a geophysical survey in the southeastern portion of the site to identify potential locations of buried metallic debris that may be indicative of buried wastes, including buried drums. Approximately 24,700 linear meters (81,000 linear feet) of geophysical survey using detailed electromagnetic (EM) conductivity mapping and 13,300 linear meters (43,600 feet) of magnetic survey mapping was conducted. Approximately 1,200m (3,900 feet) of ground penetrating radar (GPR) profiling was then conducted for further delineation and assessment of potential buried waste and/or other materials in selected areas based on the EM and magnetic mapping.
- Excavating, logging, photo documenting, and sampling a series of 57 trenches, predominantly located in the southeastern part of the site, to assess conditions within and below debris and waste piles, and to explore geophysical anomalies or areas identified from aerial photographs as possible burn pit/waste disposal areas. Approximately 3,090 linear meters (10,140 linear feet) of trenches were excavated to a nominal depth of 4m (13 feet) below ground surface (bgs), logged, sampled, and subsequently backfilled.
- Drilling and sampling of 316 initial exploratory borings in potential source areas identified based on past shipyard operations, observations during site reconnaissance, aerial photograph interpretation, or other indications and in other areas of the site on a random basis. Based upon findings from these initial borings, 128 additional borings were recommended by the IEC and completed by the SIC (83 additional borings throughout the site, 22 additional borings in the vicinity of Building T, and 23 borings for installation of additional monitoring wells). Boring depths ranged from shallow hand-auger borings to a depth of 1.5m (5 feet) bgs to nominal depths of 4.6m (15 feet) bgs for mechanically drilled borings. Monitoring well borings were extended to a nominal depth of 4.6m (15 feet) below the groundwater table where possible based on location-specific conditions.
- Installing, developing, sampling, and testing groundwater monitoring wells to characterize the groundwater quality and geochemical characteristics within the various areas of the site. A total of 56 groundwater monitoring wells were completed as shallow, water table completions (33 initial wells and 23 additional wells).
- Analyzing soil, groundwater, and equipment blank samples using appropriate laboratory test methods in accordance with U.S. standards per USEPA's *Test Methods for Evaluating Solid Waste* (USEPA SW-846, Third Update, 1996).

- Analyzing soil samples for determination of soil physical properties to facilitate transport modeling for the risk assessment and to support the remedial alternatives evaluation.
- Performing a Human Health and Ecological Risk Assessment (HHERA) to evaluate potential risks posed by COPCs identified based upon findings of the RI field and laboratory investigation and to recommend risk-based cleanup levels, as appropriate, for the site taking into account Hong Kong standards and the risk-based corrective action approach.
- Developing estimates of the volume, locations, and depths of contaminated soils exceeding site cleanup levels.
- Preparing a draft and final RI Report presenting the findings and conclusions of the RI.

1.6 OVERVIEW OF RAE AND RAW SCOPE OF WORK

The scope of work for the RAE and preparation of the RAW included:

- Reviewing information regarding volumes of contaminated media and chemical contaminants at the site.
- Identifying applicable remedial technologies and process options capable of attaining cleanup goals for the site for the various contaminants identified and volumes of contaminated media, and initial screening of these technologies and processes based on the criteria of:
- Effectiveness,
- Implementability,
- Availability in Hong Kong, and
- Relative cost, taking into account Hong Kong environmental laws and practice regarding hazardous waste and contaminated media disposal.
- Selecting and recommending the most appropriate remedial approaches for the site, taking into consideration the overall program for site infrastructure development.
- Describing the selected site remedy(s) and outlining the various steps and procedures to be undertaken to achieve site remediation.
- Outlining control measures to be implemented to assure that remediation activities are completed in accordance with the selected remediation program.

1.7 REMEDIAL INVESTIGATION ROLES AND RESPONSIBILITIES

Implementation of the RI involved participation by a number of organizations and agencies of the Government. The overall program for Penny's Bay Infrastructure Development to support construction of the Hong Kong Disneyland Project is administered under the Works Bureau and Civil Engineering Department (CED) of the Government of the HKSAR.

The IEC was retained by HKITP. The IEC was responsible for developing the RIWP that prescribes the scope of field and laboratory testing to be undertaken to complete the SI. The FSP and QAPP elements of the RIWP specified in detail the methods and protocols that were used to conduct the field investigations, collect, package and handle soil and groundwater samples, and analytical protocols for analysis of the samples.

The RI field and laboratory investigations were carried out under the supervision of CED's Infrastructure Consultant (IC), Maunsell Consultants Asia Ltd. (MCAL). Actual field work (trial pits, borings, trenches, and monitoring well installation) were carried out by the Site Investigation Contractor (SIC), Vibro HK Pty Ltd. (Vibro). Minimum requirements for qualifications and experience of field personnel conducting and documenting the field investigation were specified in the RIWP, and the IEC reviewed qualifications and approved personnel functioning in this capacity. Through the IC (MCAL), the SIC was responsible for preparing final logs of borings and trial pits/trenches, which were reported separately by the SIC. The SIC was directly responsible for sample collection and for the custody and integrity of all samples collected until transferred, under chain-of-custody, to the analytical laboratory.

ALS Technichem HK Ltd., a Hong Kong Laboratory Accreditation Scheme (HOKLAS)-accredited analytical laboratory was contracted by CED to perform chemical analytical testing of soil and groundwater samples collected during the RI. The RIWP specified that all chemical testing shall be in accordance with USEPA *Test Methods for Evaluating Solid Waste* (USEPA SW-846, Third Update, 1996). The IEC retained the services of an independent laboratory, Australian Laboratory Services, Australia for analysis of a limited number of duplicate samples for quality control (QC) purposes.

During implementation of the RI field investigation, the IEC monitored full and proper implementation of the scope of work for the Site Investigation outlined in the RIWP by the IC and SIC. The IEC's oversight role included:

- Providing regular observation and monitoring of field work conducted by the IC and SIC to make sure that all field activities associated with the RI were being conducted according to the protocols presented in the RIWP, or approving deviations from specified protocols;
- Evaluating field and analytical data as they became available and making recommendations for changes to the scope of field work, including additional drilling, trenching, monitoring well installation, and sampling, as necessary based on interim findings, to meet the project objectives; and
- Collecting and analyzing an appropriate number of split samples by an independent laboratory for QC purposes.

The IEC evaluated and interpreted the field and laboratory data developed during the RI Site Investigation to evaluate the presence, nature, and extent of contamination at the CLS site and prepared this RI/RAE and RAW Report. The IEC was also responsible for conducting the HHERA and for recommending cleanup levels for the site consistent with planned land use and considering both U.S. and Hong Kong environmental standards. Based upon these findings, the IEC conducted an evaluation of remedial approaches and recommended the preferred remedial approach in the RAW.

2.0 SITE HISTORICAL INFORMATION

2.1 SITE LAND USE

2.1.1 Overview

The most detailed information available regarding site land use and former operations at the CLS site at Penny's Bay is contained in the *Final Environmental Impact Assessment Report for Lantau Port Development – Stage 1, Reclamation for Shipyard at To Kau Wan, North Lantau, EIA for Operational Phase* prepared by Binnie Consultants Limited (BCL, October 1995). This document includes an evaluation of operations conducted at the CLS site as of 1995 as a baseline for activities that would be conducted at the new site at To Kau Wan. The following descriptions are extracted from this document.

According to BCL, Cheoy Lee Shipyards Limited established their Penny's Bay shipyard in 1963 on reclaimed land leased from the Government. Over the years of operation, the CLS site was expanded, with additional land reclamation to the southeast of the original site. CLS' shipbuilding business consisted of three main activities: fiberglass or glass-reinforced plastic (GRP) boat manufacture, metal (usually steel or aluminum) boat manufacture, and boat repair and maintenance. Historically, CLS manufactured wooden-hull boats, and the sawmill operations and building were present until plant operations ceased. CLS' boat-building operations included complete fabrication from raw materials to the finished product, which minimized purchase of components from other suppliers.

Ships and boats fabricated at the CLS site ranged from small launches to ocean-going yachts, passenger ferries, tugs, and luxury pleasure craft. Vessels up to 80m (260 feet) in length were constructed at the site.

The boat repair and maintenance aspect of Cheoy Lee's business included general repair of boat hulls and superstructures, shot blasting of boat hulls, re-painting, and the repair, or removal for renovation, of marine engines.

The Penny's Bay Shipyard layout evolved over time and was modified to suit changing demand. CLS increased the size of the shipyard land area with further reclamation by quarrying the adjacent hillside to provide the materials for reclamation. According to the Final EIA Report by BCL (1995), the reclaimed area used by CLS at the time the EIA was prepared totaled approximately 14 hectares (34.6 acres), of which about 4.2 hectares (10.4 acres) was occupied by buildings, 2.1 hectares (5.2 acres) for storage of fiberglass boat molds, and 7.5 hectares (18.5 acres) of open areas and roads for access, cranes, storage, maneuvering, slipways and open-air boat fabrication.

The layout of the shipyard as documented by BCL in November 1994 is shown on Figure 2-1, together with approximate building sizes and areas by type of use. (Note that some of the building dimensions shown on the BCL figure reproduced as Figure 2-1 are not consistent with computer aided design (CAD) drawings of the site provided to the IEC and measurements of some buildings by the IEC.)

2.1.2 Shipbuilding Processes and Activities

This section presents a general explanation of the processes and activities undertaken at the CLS site. Chemical/hazardous materials usage aspects of these processes are discussed in more detail in Section 2.2.

All goods and materials were delivered to CLS by sea and unloaded by wharf crane; there was no road access to the site during its operation. "Dangerous Goods" used in shipbuilding processes were stored at the north end of the shipyard in a designated building located away from 'hot' processes involving high temperatures or chemical reaction. These "Dangerous Goods" included toxic chemicals, caustics, organic compounds and highly flammable materials.

"Dry Goods", including inert materials used in shipbuilding (glass-fiber sheets used for fiberglass boat manufacture, screws, bolts, metal and some non-flammable chemicals and paints), were classified as non-dangerous goods.

Foundry, casting and smelting activities utilized furnaces to heat, melt and mold metals for fabrication of boat fittings and components. The shipyard had an electric furnace capable of operating temperatures 1,350 to 1,650 °C (at different places in their report, BCL cite 1,350 °C and 1,650 °C as the operating temperature of the induction furnace, hence the range shown), a milling furnace, and an aluminum smelter. There were also small specialty furnace units for casting of items such as propellers.

Plating activities conducted at the site included electroplating and anodizing. Final polishing activities were also conducted in association with plating operations.

Metalwork, metal sheet fabrication, and shot-blasting activities were associated with production of metal-hulled boats. Large metal sections were welded together to form the vessel. Shot blasting was a specialized activity in which iron shot was fired at metal faces to remove surface layers such as paint or rust, exposing a clean surface for painting. Because of the dust and dross generated, shot blasting required a single-use segregated area.

Fabrication of fiberglass boats occupied the greatest site building area. Fabrication of fiberglass boats first involved constructing a mold for the hull. A full-scale mock-up of the boat was made using timber so that a mold could be made around it. The mold pieces were made around the vessel mock-up using glass-reinforced fiber sheets and resin. The mold was then assembled from individual pieces. Boats were fabricated inside the assembled mold using glass-reinforced fiber sheets and resin.

Once the boat or large sections were complete, they were extracted from the mold and transported to a finishing building. The molds were retained since they represented a capital asset that could be used again. In the finishing building, the boat was completed by installing the marine engine and related running gear, adding fixtures, fittings, and furnishings, and then painting. The completed vessel was then transported by crane from the finishing building to a slipway for launching.

Metal boat finishing took place in the open-air, where metal plates were welded together to fabricate the vessel. Metal vessels were then finished and painted in a similar manner to fiberglass vessels.

2.1.3 Layout of Facilities

BCL divided the shipyard into four broad geographical areas according to the different stages of boat fabrication. BCL designated these area one, area two, area three, and area four. The facilities layout as of November 1994 is shown on Figure 2-1. Numbers shown in parentheses ( ) in the following summary are keyed to the facilities shown on Figure 2-1.

The first area was situated the head of Penny's Bay, partially on reclaimed land, and consisted of storage (6), office and administration (7), and general preparation facilities. Two rail-mounted cranes (17) used for unloading of goods were located adjacent to the 150-meter (500-foot) long seawall in this area.

The shipyard canteen (1) and watchman's quarters (3) were located at the northern end of area one, together with the Dangerous Goods Store (2). Several buildings in this area were compartmentalized with diverse activities taking place under one roof. Dry goods storage (6, 7a, and 13), offices (7b) and document archives (8b) were located on the western side of area one, with small-scale activities such as aluminum smelting (8a), die-casting (9a) and small-piece fiberglassing (10) located in the center of the area. The eastern sector was composed of a machine shop (4), a lost wax store (5), a timber mill (15), the foundry (12), and two large, open-plan steel frame buildings for fiberglass boat mold production (11 and 16). The plating and anodizing shop, pipe roller, laboratory, and offices (14) were also located in this area. A metal stamping building (18) was located along the eastern edge of this area.

The second area is located to the south of area one and was used primarily for metalwork preparation (20 and 21), shot blasting (23), and open-air metal boat fabrication. Three mold manufacturing-related buildings were located to the east (25, 26 and 27). Twin slipways for boat launching were also located in this area.

Three large buildings (28, 31 and 32) characterized the third area, located to the south of area two. Final assembly of fiberglass boats was conducted in these buildings, including plumbing, joinery, painting and other finishing activities. A solvent still (discussed in Section 2.2.9) was located to the rear of Building 31 in this area adjacent to a stormwater channel. Mobile cranes were used along the seafront for transportation and launching of finished boats. A specialist launching dock was located in this area.

The fourth area was located to the south of the launching dock and was used for mold storage and for boat repair and maintenance. Burn pits and waste disposal activities occurred in area of the site.

2.1.4 Site Drainage, Sewage Disposal and Water Supply

Stormwater from the surrounding drainage basin is collected and channeled through stormwater culverts across the reclamation and into Penny's Bay. Locations of three storm drains are shown on Figure 2-1. Runoff from buildings was generally discharged by down pipes into channels surrounding each building before being collected in open channels which discharge into the sea. The shipyard also relied on sheet discharge across the reclamation into the bay. CLS reportedly collected and stored part of the runoff from the surrounding drainage basin in a reservoir within one of the stormwater culverts to act as an emergency, non-potable water supply. This supply was also used in certain fabrication processes where the quality of the water was not important.

CLS reportedly imported all potable water to the site, as there was no connection to a piped potable water supply.

Seawater was used for fire-fighting services. A small seawater pumping station (22) was used to provide a pressurized water supply to the fire services main and associated hydrants.

Sewage treatment and disposal from the shipyard was governed by a Water Pollution Control Ordinance Section 23A License to discharge into Hong Kong waters. CLS's Penny's Bay operation was licensed by EPD for three discharge points. Sewage was reportedly discharged to the bay after treatment in a septic tank to separate solids. BCL noted that very little wastewater was discharged by the CLS operation. This statement is not consistent with the IEC's observations that a network of drainage channels apparently was used to collect and transport process wastes from various shipbuilding areas, as well as for surface runoff and runoff from buildings to the bay.

2.2 HAZARDOUS MATERIALS USAGE

Presented below is a description of CLS operations and hazardous material usage at the time of BCL's EIA review. BCL's summary of operations at the CLS Penny's Bay site was based on their observations in October and November 1994 and information obtained by BCL representatives during a meeting with Mr. Lo Shu Yang and Mr. Martin Lo, Owner/Directors and Production Manager at the CLS facility. Information presented in this section is largely from the EIA document supplemented by observations by the IEC during site reconnaissance in March 2001. It should be noted that at the time of the IEC's reconnaissance, shipbuilding operations had ceased, and CLS had moved its operations offsite to a new facility located on the Pearl River at Dou Men, 100 km (60 miles) from Hong Kong in mainland China.

2.2.1 Refueling Station

A boat fueling station was located near the jetty at the main site entrance. Other fueling stations were situated near the boat launching slipways. These stations were used to dispense marine diesel fuel to vessels. The potential for leakage and spillage of fuel into the environment existed at these areas.

2.2.2 Fiberglass (GRP) Ship Mold Production and GRP Shipbuilding

One of CLS's major businesses was production of glass reinforced plastic (GRP) boats, commonly referred to as fiberglass boats. The boats were made by building up layer upon layer of fiberglass cloth into a fiberglass mold and applying an epoxy-resin mixture. The GRP molds were made by laying fiberglass cloth over a wooden replica of the intended boat hull and applying epoxy resin. For shipbuilding, a layer of resin was first applied to the mold, called a gel coat, which formed the exterior surface of the hull and provided a smooth protective layer for the GRP laminate. This gel coat was usually colored with dye. Fiberglass cloth was then layered into the mold and resin applied to produce a laminate. The boat hull was constructed through multiple applications of fiberglass cloth and resin.

The GRP used for construction of molds, boat hulls, and superstructures consisted of woven glass-fiber cloth embedded in a polyester resin. The resin used was unsaturated polyester resin with a styrene monomer that was polymerized by the addition of methyl ethyl ketone peroxide (MEKP) catalyst.

Chemicals that were used in GRP ship and mold production included:

- Styrene
- Polyester resin
- MEKP
- Acetone, and
- Dyes.

2.2.3 Steel Ship Making

Construction of steel ships was carried out in a large open yard near the slipways. Fabrication of metal plates was conducted in two large open sheds near the slipways and a third shed behind the shot-blasting building. Historically, CLS constructed metal ships from raw materials and had a rolling shed to produce steel sheets. These steel sheets were then primed using various metal-based paint primers containing either lead or zinc. More recently, the rolling shed was removed and CLS bought most of their steel plates pre-cut and pre-primed.

Chemicals used in steel ship construction included:

- Metal-containing primers, and
- Thinners.

2.2.4 Laboratory

An onsite laboratory was present in Building 14 that was used to measure the quality of metals formed in the foundry and to monitor the quality of solutions and effluent from the electroplating and anodizing operations. BCL reported that the quantities of chemicals used were very small. A chemical inventory was not provided.

2.2.5 Foundry

CLS operated a large foundry onsite, which consisted of one large electrical induction furnace that operated at up to 1,650 °C, three smaller diesel oil-fired crucible furnaces, and several large diesel oil-fired annealing furnaces housed in a single open-plan building. This building was also used for sand molding and centrifugal molding (for ships propellers). In another building located between the machine shops and the foundry there was a lost wax molding area that also had a small diesel oil-fired crucible furnace used to melt copper and bronze. A small crucible furnace was also located in another nearby shed and used for die-casting.

Slag from the steel furnace was reportedly collected in steel drums for disposal. Slag from other metals, such as copper, was collected and sold for recycling to China.

The main metals used included iron, steel, aluminum and bronze. It is likely that chromium, nickel, and molybdenum were also used in production of stainless-steel alloys. Iron and steel were used in the production of the steel ships, and bronze was used to manufacture propellers and fittings. Aluminum was used for the manufacture of various fittings.

Almost all of the metal parts used in CLS' ship construction were made onsite from raw materials. CLS employed three main processes for metal molding – the lost wax process, sand molding using fine "Zirconite Sand", and die-casting. The lost wax process was used for aluminum, copper and bronze, and sand molding was used for iron and steel; die-casting was used for aluminum. Raw metals (e.g. steel, aluminum, copper) were either imported or obtained from onsite scrap. All scrap metal was reportedly recycled and the final quality of the metal checked by the in-house laboratory. Wax and sand were also reportedly recycled where possible.

Chemicals and other materials used in the foundry areas included:

- Metals
- Diesel oil for fuel
- Zirconite sand
- Bentonite clay, and
- Wax.

2.2.6 Electroplating and Anodizing

CLS had both an electroplating and an anodizing operation that were housed in separated areas of the same building (14). The open middle area of the building was used for polishing and finishing the plated and anodized metals. The laboratory was located at the far end, next to the electroplating room. The plating process was used for non-aluminum metals and usually involved either chromium or nickel plating. Aluminum was anodized.

As part of the nickel plating process, thin layer of copper was first applied to non-copper-based metals. The metal parts were first polished and then degreased by placing in a tank of sodium hydroxide solution. Degreased metal parts were then placed in an alkaline electrolysis bath to remove any oxides before being soaked in dilute sulfuric acid. The metal parts were then rinsed with water before introduction to the electrolysis-plating bath containing a solution of copper cyanide, sodium cyanide, and sodium carbonate for primary electroplating with a thin layer of copper. After primary electroplating, metal parts were rinsed to remove the copper cyanide solution, which was then recycled. After cleaning, metal parts were placed in the nickel-plating tank containing a concentrated solution of nickel sulfate and nickel chloride together with a commercial brightening agent. When plating was completed to the required thickness, the plated parts were removed, washed and sent for polishing.

The chromium plating process was similar to nickel plating, in that all non-copper-based metals were first copper plated before chromium plating occurred. Metal items were washed, cleansed, and copper plated. Copper-plated metal items were then placed as the anode in a chromic acid tank that was connected to the cathode. The bath contained a hot solution of chromic acid in concentrated sulfuric acid. When plating was completed to the required thickness, the plated parts were removed, washed and sent for polishing.

For the anodizing process, aluminum items were first polished and cleaned and were then "activated" in dilute nitric acid, washed with water, and oxidized in a solution of phosphoric acid. The parts were connected to the cathode and a thin layer of aluminum oxide would build up on the surface. After oxidizing, aluminum parts were washed in water and may have been "sealed" by placing in a bath of nickel sulfate, although this reportedly was not a common process at CLS. Anodized aluminum parts may have then been colored using various organic dyes before being final rinsed and dried.

Chemicals reportedly used in the plating and anodizing process included:

- Copper cyanide
- Sodium cyanide
- Sodium hydroxide
- Sodium carbonate
- Nickel sulfate
- Nickel chloride
- Boric acid
- Chromic acid
- Sulfuric acid
- Phosphoric acid, and
- Nitric acid.

Various other chemicals may have been used, such as trisodium phosphate of sodium carbonate, during the alkali wash, or ammonia to neutralize the wastewater.

Of the chemicals listed above, cyanide and hexavalent chromium are of concern due to their known acute toxicity. Other chemicals used were either very corrosive, such as acids and alkalis, or toxic, such as nickel or copper solutions. BCL reported that plating and anodizing operations were carried out as a batch process and that all of the plating and acid baths did not discharge waste into the drainage system but were either continually topped up with fresh chemicals or, when the potency of the solution fell below that required, poured into a container for disposal.

The waste discharges from each of the washing processes were reportedly collected in a large underfloor "diffuser" before being discharged to the drainage system. The drainage discharge reportedly was monitored for pH. nickel, copper, iron. cyanide and phosphorus by the in-house laboratory so as to comply with the discharge regulations specified in CLS' Water Pollution Control Ordinance License.

2.2.7 Metal Stamping Shop

CLS operated eight metal stamping machines in a shed next to the die-casting shed. Metal parts were stamped out from sheet metal, which was either brought in or made onsite. Any remaining waste metal or off-cuts were recycled in the foundry.

2.2.8 Paint Shop

All GRP ships were either spray painted or hand painted depending upon the application requirements and the part of the ship being painted. Spray painting was carried out under cover in a special painting shed, which was open at one end for ventilation and to aid drying. Hand painting was also carried out in a covered ventilated shed or out in the open at the steel ship construction area.

Many different finishes were used on ships including polyurethane finishes, non-slip deck paint, and various other finishes, varnishes, and wood preservatives.

A primer was applied before paint application. This primer varied depending upon the type of material used in construction. Different primers were used for GRP, aluminum, and steel vessels. The most commonly used primer on the GRP vessels was zinc based, although primers for other vessels may have been lead based. After applying the primer, a polyurethane or epoxy-based paint was usually applied.

Anticorrosion antifouling paints were applied to portions of the hull below the water line. These paints usually contained copper impregnated in a slow dissolving epoxy resin. During use, when the hull was below the water line, the copper slowly leaked out to prevent marine organisms from attaching themselves to the hull.

For special purposes, such as large steel ships, tributyltin (TBT) antifouling paint was used. This is a highly toxic antifouling agent that has been highly regulated. The regulations governing the use of these compounds in Hong Kong are included in *Environmental Legislation and Guidelines* of Chapter 1. A license must be obtained for each usage, purchase, and storage of TBT.

Chemicals and solvents used in association with painting of vessels included:

- Tribuyltin
- Lead, zinc, and copper
- Toluene
- Xylenes
- Cellosolve acetate (2-ethoxyethylethanoate or 2-ethoxyethly acetate), the main ingredient of modified polyester resin used as a polyurethane topcoat
- Diisobutyl ketone
- Butyl acetate, and
- Methyl ethyl ketone.

2.2.9 Solvent Recycling

CLS operated a small distillation solvent recycling system for recovery of xylene, toluene and acetone. The solvent mixture was placed in a container encased in an oil bath. The oil bath was heated electrically which in turn heated and boiled the solvent mixture. As the solvents boiled, the vapor was carried away from the original solution through a water-cooled column. The vapor then condensed as it passed along this column, and the resultant distillate liquid was collected in a separate vessel. As different solvents have different boiling points, they could be separated from one another by collecting the distillate at the various boiling point temperatures associated with that solvent.

Chemicals and wastes associated with the solvent recycling operation included:

- Acetone
- Toluene
- Xylenes
- Potentially any other solvents used in the operations at the CLS site
- Solvent still sludge and solid wastes, and
- PCBs (from the oil bath).

2.2.10 Machine Shop

Metal workshops were present in two areas. A small shed was used for stamping steel, and a larger building (4) was used for machining metal parts using lathes, mills and drill presses. The floors of the machine shop were concrete. Cooling water and cutting oils were used with various machining operations.

Chemicals and materials used in association with the machine shop included:

- Various metal parts and shavings/cuttings
- Cutting and lubricating oils, and
- Potentially solvents for cleanup of parts and machinery.

2.2.11 Dangerous Goods Storage

Dangerous goods were stored in a special locked, ventilated and environmentally controlled storage facility separated from other buildings. There were six separate rooms for storage of MEKP, paints, xylene, oxygen, sulfuric acid, and acetylene, respectively. This storage facility was separated from other buildings and equipped with appropriate fire extinguishers.

2.2.12 Metal Finishing/Shot Blasting

Shot blasting of steel was conducted in an open shed that could be closed off during blasting with a heavy cloth to prevent dust and shot from escaping. The shot used was a mixture of irregular silica and iron slag.

Chemicals/materials potentially used or generated in the shot-blasting area include:

- Silica and iron slag, and

- Paint chips/residue containing lead, zinc, copper, and possibly tributyltin.

2.2.13 Repair Works

Repair work was carried out in the area southeast of the launching dock. A variety of operations took place in this area, including engine overhauling, hull scraping, painting, bilge cleaning, and many others. Boat hulls were scraped for repainting, resulting in paint flakes potentially containing heavy metals associated with antifouling paints (lead, copper, zinc, and tributyltin). The hulls were then repainted with antifouling paints.

Engine oils were changed and engines overhauled. Oil was reportedly recovered and recycled either by using it as an anticorrosive agent in ships' rudders or by sending it offsite to an oil recycling company. The bilges of boats were cleaned using household detergents, and the waste was disposed of either into the sea or into drains (which drain to the sea). The bilge waste contained oil and possibly phosphates and carbonates from detergents.

Chemicals potentially used or generated in the repair works area included:

- Paint chips/residue containing lead, zinc, copper, and possibly tributyltin
- Solvents
- Paints
- Used engine oil
- Detergents, and
- Pesticides (for rodent control).

2.2.14 Solid Waste Storage

Solid waste was stored in either large steel drums or in a special waste storage area situated near the solvent recycling plant. Used steel drums were stored in various places, depending upon available space, for disposal or recycling either as raw steel for the foundry or as waste containers.

2.3 AERIAL PHOTOGRAPH INTERPRETATION

The IEC reviewed and interpreted a number of historic aerial photographs during preparation of the RIWP to better understand the site history, as well as relevant work practices. Photographs were obtained from the Aerial Photograph Library of the Hong Kong Government Survey and Mapping Office and span the years of operation of Cheoy Lee Shipyards. A summary of observations and list of aerial photographs reviewed were included as Table 1 of the RIWP, and copies of low altitude aerial photographs are included as Figures 4A through 4D of the RIWP.

The original CLS site at the head of Penny's Bay was first formed in the early 1960s. Land reclamation to create the second area of the site is inferred to have been completed by the late 1960s. The southeastern section of the site was reclaimed over a period starting in the late 1960s/early 1970s and continuing to the early 1980s. Throughout this period, there is no clear indication in the aerial photographic record of how wastes were handled within the CLS operations. This, however, appears to change once vehicle access was gained to the southeastern portion of the site in 1983/84. The first indications of land disposal activities were observed on the aerial photographs during this time frame. From that time forward, and up to and including the time of the IEC's site reconnaissance in March 2001, it appears that CLS used the southeastern part of the site for waste disposal.

2.4 IEC SITE RECONNAISSANCE OBSERVATIONS

The IEC performed site reconnaissance of the CLS site on three occasions to support preparation of the RIWP. CLS had ceased operations prior to the IEC's site visits and virtually all of the equipment, supplies, materials, and other shipbuilding facilities had been relocated to CLS' new facility. The only operations still active were in the main foundry building, where minor smelting of scrap metal for resource recovery purposes was occurring. CLS personnel onsite were engaged in collecting and salvaging remaining usable materials and scrap. These materials were seen being loaded onto barges or vessels for transport offsite. Personnel knowledgeable of CLS' operations at the site were not available for interview, nor were site facility plans, process descriptions, material and chemical inventories, Material Safety Data Sheets (MSDSs), waste disposal and/or waste recycling records, or other records and information that would be helpful to achieve a more complete understanding of CLS' operations and chemical usage at the site. The IEC therefore relied on information from the BCL report referenced in the previous section and inference of past operations based on its observations and past experience for preparation of the RIWP and FSP.

At the time of the IEC's site observations, the CLS site was heavily littered with refuse and scrap. General housekeeping at the site appears to have been very poor since CLS relocated its facilities, and scrap materials and waste had been stockpiled at various locations onsite. It is apparent that little care had been given to proper waste management practices, and there were numerous locations seen where waste materials (resins, metal slag, hydrocarbon and potentially other residues from drums, paints and possibly thinning agents, and refuse) had been discharged directly to the ground surface.

The IEC's observations of individual site areas are summarized below. Building locations are referenced to Figure 2-2. For purposes of site description and depiction on detailed site maps, the CLS site has been divided into three areas: Area 1 (Figure 6-1) consists of the northern part of the site that was the original CLS facility; Area 2 (Figure 6-2) includes the central part of the site that was formed by land reclamation following initiation of shipbuilding operations by CLS within Area 1; and Area 3 (Figure 6-3) includes the southeastern portion of the site, which is located on the most recent plot of reclaimed land. More detailed sketch maps of selected buildings are included as Figures 6-4 (Building B), 6-5 (Building D) and 6-6 (Building L). Note that the IEC designations Area 1, 2, and 3 differ from the designations area one through four used by BCL (1995) in their review of site operations.

2.4.1 Area 1

Building A – Company Store

This building is approximately 9 by 46m (30 by 150 feet) in size and appears to have been used for dry goods storage, including various boat/ship fittings and components. CLS workers were using the building as a gathering/break room at the time of the IEC's reconnaissance. Remnants of ships upholstery items and other materiel were noted on the floor. Visual evidence for environmental concerns was not noted in this building.

Building B – Plating, Anodizing and Laboratory

As described by BCL, this building was used by CLS for metals electroplating and anodizing; it also housed a small quality control testing laboratory and an office. The building is approximately 19 by 67m (62 by 220 feet) in size. A sketch map of the plating shop is shown on Figure 6-4.

Plating and anodizing operations apparently occurred in separate rooms within the building. Evidence was observed for the former presence of either an old plating line or some type of conveyer system along most of the length of the eastern part of the building. This area was described by BCL as a redundant pipe roller. Staining and pitting of the concrete floor was evident in this portion of the building, and yellow powder, which was subsequently determined to have a high concentration of chromium and hexavalent chromium, was observed on the floor of the building.

Plating operations apparently occurred in the room adjacent to the laboratory along the eastern side of the building. There was significant evidence of pitting and corrosion of the floor and walls in this area, and green staining of the crumbling walls was observed. The floor in the main plating room had what appeared to be a shallow drainage channel cut into the concrete. This drainage channel led to a grated drain, which in turn exited the building and joined the perimeter drain system, ultimately leading to a storm drain and the bay. Etching and staining of the walls suggest that a highly corrosive environment once existed in this portion of the building. Anodizing operations reportedly occurred in a small room in the northeastern corner of the building. The floor in this portion of the building appeared pitted and corroded.

A large, oil-cooled electrical transformer was observed on the northwestern exterior corner of the plating building. Light oil staining was observed on the side of the building associated with this transformer; however, staining was not evident on the ground surface adjacent to the transformer.

The exterior area adjacent to the east side of building B, especially opposite the vehicle maintenance shed (Building P), was observed to have apparent hydrocarbon staining associated with vehicle maintenance operations and dismantling. There was also a considerable amount of debris in this area, and 208-liter (55-gallon) drums and 19-liter (5-gallon) buckets were stored in this area of the site.

Building C – Warehouse

The warehouse (Building 6 on Figure 2-1 and Building C on Figure 2-2) was reported by BCL to have been used for dry goods storage. The building is approximately 9 by 46m (30 by 150 feet) in size and contains a mezzanine level of steel construction over approximately one-half of the building. The building appeared to have a fairly new roof and floor, suggesting it had been remodeled. The only indication of potential chemical usage noted within this warehouse building was a green stain on the base of the eastern wall of the building. Other indications of potential environmental concerns were not noted during the IEC's reconnaissance.

Building D – Hull Molding and Pressing Workshop, Aluminum Smelter

Building D (Buildings 7, 8, 9 and 10 on Figure 2-1) is a large multi-use building that has been compartmentalized with interior walls separating different use areas. The building was originally two separate buildings with an intervening open-air passageway. The passageway was subsequently roofed over and a concrete floor placed to create one building. Overall, the building is approximately 43 by 46m (140 by 150 feet) in size. A sketch map of Building D is shown on Figure 6-5.

The eastern part of the building was previously used for storage and an office area. Features of environmental concern were not noted in this part of the building.

The second bay from the eastern side of the building (designated by BCL as structure 8 on Figure 2-1) contained an aluminum smelter in the rear, document storage area in the middle, and an office in the front part of the building. Features of an environmental concern were not noted in the storage and office area of this part of the building. The smelter area at the rear was observed to contain a crucible furnace with a hood and venting system that were very heavily stained with soot-like residue. The floor of the building had an accumulation of dark gray to black, greasy soot and silty residue that appeared to be 5 to 15 cm (2 to 6 inches) thick. The walls of this part of the building also appeared to be stained with dark gray to black soot and residue from past operations. The furnace was apparently fueled with diesel fuel, and an aboveground diesel tank was observed mounted on the wall adjacent to the furnace. In general, the work area contained a considerable amount of stained and potentially contaminated debris.

The central part of Building D, which was formerly a passageway, was used for die-casting and metal stamping. There was evidence from floor bolts that heavy machinery, such as punch presses, were formerly located in this part of the building. There were also accumulations of waste materials and scrap outside the building that include metal scraps from pressing and stamping operations. A small furnace was present in this part of the building; its former use is unknown. Minor oil staining was present in this area of the building. The building was seen to contain a passageway leading to the adjacent aluminum smelter area; this passageway had staining and soot residue similar to that described in the smelter area. The middle part of this portion of the building was reportedly used as a mess area, and the front part was reportedly an open area. Indications of impacts from former operations were not visually evident in this part of the building.

The western part of this building (Structure 10 on Figure 2-1) was reported by BCL to have been used for small-scale fiberglassing and pipe storage. This large, open-bay building has an overhead track hoist system that likely was used to lift and move boat or mold components. The building has a concrete floor that was littered with refuse, but stains were not observed on the floor. A locked electrical room is present at the rear of the building adjacent to the northwest corner. This electrical room was energized at the time of the IEC's site reconnaissance and is a CLP substation serving the CLS facility. The IEC did not have access to this part of the building.

The area to the rear of the building, especially adjacent to the eastern portion of the building, was littered with metal debris, metal stamping chad, and other trash and debris. There was evidence of staining by apparent hydrocarbons in this area. This staining is also evident on low-altitude aerial photographs of the site from 1991.

Building E & F – Security Guards Quarters and Staff Canteen

This approximately 6 by 32-meter (20 by 105-foot) building served as the site security guards quarters and a staff canteen for resident CLS staff. Since this is the current residence for the site watchman, it was not accessed during the IEC's reconnaissance. Visual observations of the area surrounding the building did not indicate the presence of environmental concerns.

Building G – Worker's Canteen

This building served as the kitchen and dining area for the CLS workers. At the time of the IEC's site visit, the kitchen area was being used for food preparation to provide meals for the staff engaged in materials salvage activities at the site. The kitchen and dining areas appeared to be generally clean and orderly. Aside from potential food wastes and oil and grease associated with cooking oils, impacts were not anticipated in this portion of the site.

Building H – Dangerous Goods Stores

Building H consists of two parts. There is a row of six 3m square (10 by 10 foot) concrete-constructed dangerous goods lockers along one side and a partially depressed larger storage area that measures approximately 9 by 10m (30 by 35 feet) to the rear.

The dangerous goods lockers were constructed with walls on the order of 30-cm (1-foot) thick and a 0.5-meter (1.5-foot) high door sill that provided secondary containment. Each locker was observed to have a halon-type fire extinguisher mounted on the underside of the roof. The lockers were labeled as containing, from east to west, MEKP, paints, oxygen (O_2), paints, sulfuric (presumably sulfuric acid), and acetylene. With the exception of the sulfuric acid locker, which was pitted and corroded, the floors of the lockers appeared to be in good condition.

The building to the rear has an elevated loading dock approximately 1m (3.3 feet) above ground level with stairs leading down approximately 2.5m (8 feet) to a concrete floor. The room was observed to be equipped with an air-conditioning system. A roof-mounted track appears to have had a crane system to aid in moving drums into and out of the storage room. Empty drums in the room indicate it had been used to store fiberglass resins. There were several indications that resins had been spilled on the concrete floor.

Building I – Machine Shop

The machine shop is approximately 18 by 32m (60 by 105 feet) in size and consists of two bays. The northern bay of the machine shop contained what appeared to be two diesel fuel-fired crucible furnaces. The southern bay contained a tool and parts storage room and another open area of unknown past use. The BCL report indicated this part of the building was used for stamping steel. This area of the building may also have been used for fabrication or assembly of various components. Indications of environmental impact were not visibly apparent in this part of the building other than etching of the floor at one location.

There is evidence in the former machine shop area for anchorage of machining equipment. Photos of this area from the 1994 BCL report show lathes in this part of the building. One drill press was seen in this area. It is likely that milling machines were also used in parts machining operations. The concrete floor in the machine shop showed evidence of staining from cutting oils and lubricants, and metal chips from machining operations were scattered about the floor. The two crucible furnaces appeared to be in very good condition, suggesting little use. There was apparent staining in the vicinity of the furnaces, and the metal walls of this area of the building were badly rusted and corroded. Piping leading to the building wall suggests an exterior fuel source.

Building J – Lost Wax Store

According to the BCL report, lost wax molding was a process that involved creating a replica of the intended item and packing it in fine inert sand. The wax was then melted and poured off and molten metal poured into the mold in its place. The lost wax store is a small, approximately 9 by 18-meter (30 by 60-foot) two-story building located adjacent to the machine shop and foundry. A small crucible furnace was observed in the northwest corner of the building, with considerable staining of the concrete floor and corrosion of the building columns. In the rear central part of the building, there was an approximately 3 by 5-meter (10 by 16-foot) room with a low, 1.7-meter (5.5-foot) high roof that may have been used for curing of molds. This interior room was vented to the outside of the building. Along the eastern wall there were three apparent dip tanks with 190 to 380 liter (50 to 100-gallon) capacities.

A lean-to shed was observed along the eastern exterior side of the building surrounded by a large number of drums and rubbish/debris. While some of the drums appeared to be empty, some contained liquids or solids of an unknown nature. Drums were noted with the label Triklone. Triklone is a trade name for specially stabilized trichloroethylene, a halogenated hydrocarbon solvent that was formerly widely used in industry as a degreasing solvent. There was also an accumulation of what appeared to be slag on the ground adjacent to the northwestern corner of the building and piles of metal scrap in the area near its southwestern corner. This area of the site also had a large number of bags of sand and bentonite that had been broken open and the contents spread on the ground. A spring seep was present along the margin of the site behind this area resulting in standing water and muddy conditions.

There was evidence for recent spillage of what appears to be an oil material at the southeastern corner of the building. The material was odorous and reddish in color.

The second floor of the building appeared to have been used for storage. The only materials seen on the second floor were welding electrodes.

Building K – Fiberglass Hull Construction Workshop

This large building is approximately 43 by 46m (140 by 150 feet) in size and was formerly used for laying up of fiberglass boat hulls. It has an open-plan construction with interior columns supporting the roof and a concrete floor. Although there was considerable refuse and debris littering the floor, indications of releases or chemical spills were not visibly evident during the IEC's site reconnaissance.

Building L – Foundry

The foundry building is approximately 18 by 46m (60 by 150 feet) in size and is a large, open-bay building. A sketch map of the foundry building is shown on Figure 6-6. Interior columns support the roof, and there is a beam/rail system that runs down the axis of the building for moving of heavy objects. The interior walls of the foundry building and visible roof components appeared to be stained with an accumulation of soot. Foundry equipment observed within this building included a large induction furnace for production of stainless steel, three smaller, diesel-fueled crucible furnaces, and three large annealing furnaces. There was also what appeared to be a burn pit within the foundry building.

The induction furnace was located in the northern part of the building. A covered pit that was reported by an employee to be a slag pit was present within the floor in front of the induction furnace. He indicated that when the pit was filled the slag was removed and disposed. CLS employees have stripped salvageable materials from the furnace electrical room, which is located in the extreme eastern part of the building. There was no evidence of oil-cooled transformers in this room but virtually all equipment had been removed at the time of the IEC's site visit.

Three crucible furnaces were located along the western side of the building near the northwestern corner. The furnaces were operating at the time of the IEC's site visit. The three furnaces were fueled by diesel fed from an aboveground tank mounted on the exterior of the building. There was a pit behind the crucible furnaces approximately 0.9m (3 feet) deep with considerable apparent hydrocarbon staining on the concrete pit floor. Staining was observed on the ground in the vicinity of the aboveground tank, and there was a row of 25 208-liter (55-gallon) fuel drums stacked on their sides along the side of the building directly over an open drainage system. No secondary containment was provided.

Three annealing furnaces were observed in the foundry building – one was situated near the door at the southeastern corner, and the other two were located near the door near the northwestern corner of the building. Another possible furnace was observed near the southern corner of the building. All three annealing furnaces were fueled with diesel fed from aboveground tanks adjacent to the furnaces, and staining was evident in the area the tanks. A fuel source was not evident near the possible furnace near the southern corner of the building.

A pit approximately 2m (6.5 feet) across was observed near the center of the building that has been used for a burn pit. Burned wood and ashes were visible in the pit. It is not known whether this pit was used as part of foundry operations or for burning of refuse.

The floor of the building appeared to be concrete; however, dark gray to brown sand covered the floor in almost all parts of the building. There were drums containing slag metal at several places within the building, most notably in the southern portion of the building adjacent to the door. There were also many sand casting box molds within the building that were being used by CLS employees to cast items from aluminum being recovered from other parts of the site and recycled.

Two large sand pits were observed within the floor of the building. The largest pit was located along the east central part of the building. It measured approximately 2.4m wide by 18m long (8 by 60 feet) and was estimated to be deeper than 1m (3.3 feet). The very northern part of this pit was open to a depth of 0.9m (3 feet) and had sand and water at its base. The remaining portion of the pit was filled with dark grayish brown fine sand that had been used for sand casting of various parts. The second and smaller pit was located near the southwestern corner of the building and measured approximately 2.4 by 4.9m (8 by 16 feet) in size; its depth is not known. Adjacent to the smaller pit to the south there was an open pit that was formerly the location of another furnace. This furnace had been removed; there was no visible indication of staining or other impacts in the pit.

Outside the building on the north side there was a large accumulation of waste materials and metal debris, including drums. Near the northeastern corner at the rear of the building two features were observed that are interpreted to be cooling towers.

A scrap yard area was present adjacent to the foundry on the western side with a large accumulation of metal debris, old castings, batteries, battery plates, wire, and other waste materials. Some of the material was contained in bins and drums and other materials were scattered on the ground. Several rusted-out drums were noted in this area containing stainless-steel silverware stampings, lead battery plates, and other materials. An open-hearth furnace was also noted in this area that BCL (1995) reported was used for burning wire from insulation. Across the drainage channel from the area adjacent to Building L, a pile of burned wire was observed where it appears that workers had burned insulation from wire. This entire area of the site had very poor housekeeping, and there were indications of staining possibly from petroleum hydrocarbon releases and from metals slag materials.

Building M – Former Rolling Mill

The area shown on Figure 2-2 as Building M is a former building location. Apparently, Building M was formerly used for rolling of metal sheets for fabrication of steel-hulled vessels. This building was removed sometime prior to 1991. The area has been used as a scrap yard, and there was a very large accumulation of scrap materials, similar to those described above along the west side of the foundry building, in this area of the site. The scrap materials extended beyond the former location of the rolling mill building to the site boundary marked by the drainage channel that borders the site.

A large accumulation of old 208-liter (55-gallon) drums was observed within the area west and southwest of the former location of the rolling mill, and continuing to the vicinity of the metal stamping building (Building N on Figure 2-2). Many of these drums were noted to contain residual liquids when first observed on 6 March 2001. By the final day of the IEC's site reconnaissance on 9 March 2001, these drums had been crushed by a tracked vehicle and residual liquids were observed to have spilled and pooled on the ground surface.

Building N – Metal Stamping Building (a.k.a. Hammer Room)

The metal stamping building is a small, approximately 9 by 14-meter (30 by 45-foot) building that contained a remnant foundation from heavy machinery. The concrete floor of this building was strewn with litter and debris. There was a small locked room (to which the IEC did not gain access) near the northeastern corner of the building that appeared to contain a furnace or oven. This was evidenced by a large stack on the exterior of the building at this location. It is not clear from available evidence and information what activities occurred in this building.

There was a large amount of waste metallic debris, rubbish, and old drums surrounding this building. In the area adjacent to the building to the north, a hydrocarbon-like crust was apparent on the ground surface, potentially the result of spills or releases.

There was evidence of very recent dumping of granular and chunky metallic slag wastes on the ground southeast of this building.

Building O – Sawmill and Molding Shed

This large, approximately 24 by 73-meter (80 by 240-foot) building has a wall down its long axis that divided the sawmill on the west from the molding shed on the east. This building was identified as the Specialist Fiberglass Hull Construction Building by BCL (1995, Figure 2-1). The molding shed was observed to be a large open building with a small office in its northwest corner. The building had a concrete floor with rails for support of vessel hull supports. No staining or other evidence of impacts were noted during the IEC's reconnaissance.

The sawmill consisted of a large open bay with several saw pits in the floor. The wood milling equipment had been removed from the room prior to the IEC's site reconnaissance, with only minor saw parts and band-saw blades remaining. Staining or other evidence of impacts was not noted during the IEC's reconnaissance.

Building P – Leather Dressing, Stores, and Vehicle Maintenance Shed

This building, located adjacent to the sawmill, is approximately 15 by 37m (50 by 120 feet) in size. The vehicle maintenance shed occupied the northwestern corner of the building in an area roughly 6 by 15m (20 by 50 feet) in size. The vehicle maintenance shed and area outside the shed and extending the length of Building P had abundant visible evidence of impact. There was significant dark hydrocarbon-like staining, apparently from used motor oil, vehicle parts of all types, batteries and broken batteries, old 208-liter (55-gallon) drums, and a large amount of rubbish and debris. The interior of the vehicle shed had apparent hydrocarbon staining and contained many batteries and vehicle parts. This was one of the most visibly impacted areas of the site observed by the IEC.

The leather dressing and stores part of the building is a two-story building that appears to have been used for manufacture and storage of vessel upholstery. Only minor staining was evident on the floor of the building. Indications of significant impact were not visibly evident.

Fueling and Loading Area Along Seawall

There was an area adjacent to the seawall at the southeast ends of Buildings A, B, P, and O being used by CLS at the time of the IEC's site visit for staging of materials being salvaged and for loading of these materials onto barges for offsite shipment. Numerous drums were observed opposite Building B. This is believed to be one of the vessel fuelling locations noted by BCL. Apparent hydrocarbon staining was observed in this area.

2.4.2 Area 2

Building R – Fiberglass Boat Finishing (Yacht Building)

This large open-plan building is approximately 47 by 47m (154 by 154 feet) in size and has a very high roof and a roof drain system connected to the perimeter drain system. With the exception of only minor debris and left-behind equipment, the building was empty. There were minor occurrences of spilled fiberglass resin noted on the concrete floor. Other than this minor spillage, there were no visible indications of environmental concerns in this building.

Building S – Boat Finishing (Yacht Building)

Building S is a high-roofed open building, approximately 43 by 70m (140 by 230 feet) in size that was used for fiberglass boat building. This large open-plan building had a row of offices, tool crib, or specialty rooms along both sides of the long side of the building on the ground floor and a mezzanine level above the rooms. The central part of the building was observed to be concrete floored and open. The building was littered with rubbish and debris, and the CLS personnel onsite were using this bay for temporary storage of waste materials, including pallets of cans of paint and other boat-building materials, drums, and other materials.

At the time of the IEC's site reconnaissance there was evidence of spillage of fiberglass resin on the floor of the building. There were also very strong odors evidencing recent spillage or disposal of liquid paint and solvent wastes to the drain system in a hallway near the southeastern side of the building. There was a large amount of old paint cans, buckets, and drums on the ground along the entire southeastern side of this building, and paint waste paint had been disposed to the ground surface.

There was also a large amount of refuse and debris, including what appeared to be plating vats, piled up near the large opening along the northeast side of the building. It was apparent that CLS personnel had been using this part of the site as a temporary staging area for shipyard wastes.

Building T – Boat Finishing and Painting Building

This building is compartmentalized and is approximately 33 by 70m (100 by 230 feet) in overall size. This multi-purpose building was used for painting and drying of shipbuilding components and yachts, yacht finishing and plumbing, and joinery. There was a paint bay approximately 10m (33 feet) in width along the northwestern edge of the building and a paint room to the rear of this area and extending partially along the rear of the building. Various cans of paint and paint reducers were observed in this part of the building. Contents included toluene, ethyl acetate, cellosolve acetate, methylene chloride, and Butanox HBO-50 containing MEK peroxide in a phthalate plasticizer. A washout basin was observed in this paint bay that drains to the building drainage system, thence to Penny's Bay. The building floor was sloped so as to drain to the building perimeter drainage system. It was evident that paint was directly disposed to this drainage system based on a thick accumulation paint stains on the metal grate of the perimeter drainage system.

The adjacent 12-meter (40-foot) wide bay was apparently used for painting large yachts. This bay had an elaborate drying system with a series of air ducts to exhaust air from the bay.

The remaining 47-meter (154-foot length) of the building contained seven bays for vessel fitting. There were no walls separating these bays. At the rear of the bays there was a series of caged rooms that may have been used as offices or for storage of fittings and other material. A second level may have been used for additional storage or for offices. To the rear of this part of the building there was an area that was used for storage of piping. This storage area was open and covered by an awning. The area to the rear of the building had a considerable amount of debris and rubbish.

Solvent Still Area

To the northeast of Building T adjacent to a concrete lined drainage channel there was a solvent still that had been used to distill and thereby recycle used solvents. All that remains from the still was a concrete pad surrounded by stressed vegetation and soil with a fine-grained dark brown crust. On the opposite (northern) side of the drainage channel a fiberglass cooling tower was present that was apparently part of the distillation system.

Building U – Fire Suppression Pump House

This small building is located adjacent to the seawall near the slipway in the central part of the site. The building housed a diesel powered engine and pump for firefighting purposes. The pump and compressor have been partly disassembled and are in pieces. Very dark hydrocarbon-like staining was present on the concrete floor of the building. Apparent hydrocarbon stained soil was evident outside the building on the northeast side, as well as the residual piping and connections for what was likely an exterior fuel storage tank.

Building V – Mold Lofting Room, Paint Booth, and Mold Mock-up Building

Building V is a large, divided, multi-use building that measures approximately 41 to 44 by 70m (135 to 145 by 230 feet). The wider eastern portion and the central part of the building were used for layout of full-scale vessel design drawings for constructing hull and superstructure molds. The floor of this part of the building was raised plywood that was painted so allow design layout using chalk. The actual building floor was not visible due to presence of this raised floor. Features of concern or evidence of environmental impacts were not noted in this part of the building.

The western part of the building consisted of a large double-bay open building that reportedly was used for construction of wood mold mock-ups. This part of the building contained a large paint spray booth located in the rear of the building and vented to the rear exterior of the building. The paint room was very dusty from paint residues and, because IEC personnel did not have respiratory protective equipment, the IEC did not enter this part of the building. Paints and solvents were not observed. The main area of this portion of the building was observed to have a concrete floor containing floor drains. Various electrical connections were seen. There were no visible indications of potential impacts from past operations in this portion of the building.

Building W – Welding/Metal Workshop

Building W is an approximately 25 by 25-meter (82 by 82-foot) open building, separated down the middle into two bays, that was used for welding and metal works. The floor of this building had exposed earth; there was no evidence seen that the building had a concrete floor. It was evident that activities conducted within this building included welding, grinding, and steel fabrication. A transformer room was observed within the building; all of the electrical equipment had been removed. There were no oil-cooled transformers seen, and it is not known whether they formerly were present.

A great deal of trash was observed within this building area and in the surrounding exterior area. There were no obvious stains on the floor suggesting hydrocarbon releases, however there were indications of metals debris associated with welding and grinding activities. Other than the trash and metals debris, there were no visible indications of impact in this building at the time of the IEC's site visit.

Building X – Shot-blasting Building

The shot-blasting building is approximately 11m wide by 26m long (35 by 85 feet) and located adjacent to the welding/metal workshop. According to information included in the BCL report, shot blasting was a specialized activity in which iron shot was fired at metal faces, presumably using compressed air, to remove surface layers such as paint or rust, exposing a clean surface for finishing. BCL also described the material used for shot blasting as a mixture of irregular silica and iron slag about 1 mm in diameter. This is consistent with the IEC's observation that the ground within and in the vicinity of the shot-blasting building had a yellowish-brown rusty crust on the surface.

The exterior area of the shot-blasting building was observed to contain a large amount of refuse and debris.

Building Y – Metal Workshop/Hull Finishing Building

Building Y is a large open-ended building measuring approximately 19 by 58m (63 by 190 feet). At the time of the IEC's visit, there were welding rods and oxy/acetylene controls present within the building indicating its use for welding and fabrication of steel-hulled vessels. The floor within the building was observed to be concrete. Apart from limited rubbish and debris, the building was vacant, and there were no visible indications of staining or other impacts.

Near the southern end of the building an open excavation was present approximately 4 by 5m (13 by 16 feet) in size and up to about a meter (3.3 feet) deep. The concrete floor has been removed from this area and an excavation with an irregular floor conducted. There was no indication of staining or impact to the soils exposed in the excavation. The purpose of the excavation is not known.

Building Z – Metal Boat/Metal Sheet Fabrication Building

Building Z appears very similar to Building Y. It is approximately 19 by 43m (62 by 140 feet) in size and open at both ends. The building had an office-like enclosure or tool crib at one end. The floor of the building was concrete, and there were steel plates covering areas of the floor. Steel rails were present on the outer sides of the building about 2m (6.5 feet) inward of building walls. These steel rails are believed to be tracks for wheeled vessel support systems during assembly operations. There were holes, in some locations covered with steel plates, to allow welding cables or other lines to pass under the rails.

The floor in Building Z had accumulations of what appeared to be clay pellets and metal slag. Because much of the floor was covered with steel plates, it was not possible for the IEC to observe the condition of the floor beneath the plates. Other than the slag and clay pellets, there were no stains or other visible indications of impact within this building.

Slipway and Boat Launch

Within Area 2 a boat slipway (launch ramp) was located adjacent to the pump house (Building U) with an elevated ramp north of the slipway near the northern end of Building Y. Beneath an awning at the head of this ramp there were foundations from what are inferred to have been a launching cable and pulley system. There were not visible indications of impact in this area.

Between the slipway and Building T to the southeast, four pairs of linear support structures were observed that apparently were used to support large overhead cranes during outdoor assembly of large vessels. These are clearly evident on low-altitude 1991 aerial photographs of the site. The IEC infers that hull assembly operations in this area of the site would have involved welding, grinding, and chipping activities. Painting may have also occurred in this area. The area was overgrown with weeds and the ground surface was obscured. Although visible indications of impact were not evident, as noted, the ground surface was largely obscured.

Evidence of fueling operations in this area of the site was not noted during the IEC's site visit. Based on information contained in the BCL report, CLS reportedly conducted fueling of vessels near the boat launching slipways.

2.4.3 Area 3

Building Q – Boat Repair Building and Area

This small building is located at the southeastern area of the site adjacent to two parallel slips for docking of vessels. CLS reportedly performed maintenance and repair of vessels in this area of the site. At the time of the IEC's site reconnaissance, the area consisted of a small, approximately 11-meter square (36 by 36-foot) building, several storage sheds, and a long rectangular building or shipping container apparently used for storage. Materials observed stored in the sheds included various paints and solvents used in boat maintenance and refinishing. CLS reportedly performed paint chipping in preparation for painting, including hull scraping for paint removal and application of bottom antifouling paints in this area of the site. There was abundant staining of the ground in this work area by both paint residues and apparent hydrocarbons.

At the seaward edge of the building a concrete pad was observed where engine or other mechanical equipment maintenance and repair apparently occurred. The concrete in this area and surrounding soil were both heavily stained with apparent dark hydrocarbons. A covered drain opening was present in the concrete pad that appears to have been used for disposal of liquids. This drain opening is only a few meters from the seawall and appears to drain to the bay.

The exterior area surrounding the boat repair building and extending at least 60m (200 feet) southeast from the boat slip and 60m (200 feet) inland from the seawall was littered with refuse, debris, and old paint cans and five-gallon buckets. Staining by what appeared to be hydrocarbons and paints was locally evident in this area.

Hull Mold Storage Area

CLS used the outdoor area extending from the base of the hills behind Building S southeastward to the fence line shown on Figure 2-2 to store fiberglass hull molds. Based upon review of aerial photographs taken in 1991, more than 125 molds of various sizes and configurations were stored in this area of the site. At the time of the IEC's site reconnaissance, all of the molds had been broken into fragments of various sizes and spread around the ground surface. The presence of this fiberglass debris made it extremely difficult to walk through the area and observe the ground conditions.

Along the northeast margin of this area, particularly opposite Building S and continuing northwestward to the area behind Building R, a large number of debris piles were observed. This debris consisted of various refuse, metal, and fiberglass materials mixed with soil that had been bulldozed up against the base of the slope at the rear margin of the site. Some of the debris and waste piles in this area were noted to be several meters (up to 10 feet) in height.

Southeastern Portion of CLS Site/Former Lay Down Area

The very southeastern portion of the CLS site was separated from the former mold storage area by a chain-link fence. This area was largely vacant at the time of the IEC's site visit. A row of five concrete slabs was observed along the rear of the area parallel to the hillslope, extending from the fence line to the creek that bounds the area to the southeast. Based on the low-altitude 1991 aerial photographs, these concrete pads were for temporary buildings present during construction of the CLP Penny's Bay power generation facility.

During the first day of the IEC's site reconnaissance, a large open trench was observed in the southeast portion of this area. The trench had considerable vegetative growth at its base and along its slopes, indicating it had not been recently excavated. Four 208-liter (55-gallon) drums were noted by the IEC adjacent to the edge of the trench on 6 March 2001. On the afternoon of 8 March 2001, the IEC observed a CLS work crew motoring in the direction of the trench in a flatbed truck loaded with 208-liter (55-gallon) drums and pallets of 19-liter (5-gallon) buckets, boxes, and other containers. Approximately 20 minutes later, the IEC observed the flatbed truck returning to the main part of the site; the drums and pallets were absent.

Upon inspection of the trench, the IEC observed that the four 208-liter (55-gallon) drums were no longer visible, and there was an accumulation of fresh soil in the base of the trench beneath where the drums had formerly been located. The materials observed on the flatbed truck had been placed on the ground near the trench. An IEC representative entered the trench and dug into the fresh soil in the trench, exposing the end of one of the drums. The IEC reported these observations to the EPD the following morning. The materials placed near the trench on 8 March were removed by CLS workers on 9 March and stockpiled within Building S. The IEC did not observe removal of the drums from the trench, but understands that EPD supervised their removal. This occurrence provides clear evidence that waste disposal has occurred, on at least one occasion, in this portion of the CLS site. Low-altitude oblique aerial photographs taken of the site in August 1999 clearly show the presence of the trench in this area of the site at that time, indicating it was open from at least August 1999 until March 2001. Whether other disposal activities occurred during this 19-month period is unknown.

There were spoils piles and large debris and refuse piles in the vicinity of the trench. These piles consisted of a variety of materials, including metal and fiberglass debris, crushed drums, wood, and other materials. The debris was weathered, indicating it has been present for a considerable period of time.

3.0 SITE SETTING AND PHYSICAL CHARACTERISTICS

3.1 PHYSICAL SETTING

The physical setting of the CLS site is very straightforward. As detailed previously, the site consists of approximately 18.7 hectares (46.2 acres) of almost entirely reclaimed land located along the shore of Penny's Bay on Lantau Island. It is bounded on its southern and southwestern perimeters by a rock-armor seawall (and Penny's Bay), and by cut rock and/or heavily vegetated slopes along its northern and northeastern boundaries. A concrete drainage channel (to drain the slopes and a number of ephemeral streams) also extends the entire length of the northeastern boundary in both the original site area (Buildings A through P) and behind the more recently reclaimed southeastern portion of the site (northeast perimeter from Building S to CLP site boundary). Localized rock outcropping is also present along this same boundary. The southeastern end of the site is bounded by a stream that flows between the Cheoy Lee site and the CLP site, while the extreme northwestern edge of the site (at the northernmost tip of Penny's Bay) is adjacent to a sandy beach area and an old village site. There is a single major concrete drainage channel, which drains the stream that enters the site to the northeast of Building V (Mold Lofting Room, Paint Booth and Mold Mock-up Building). The channel cuts the site diagonally and drains into the bay via the slip between Buildings S and T (Yacht Buildings).

The entire usable site area is essentially flat and varies in elevation between 3.9 to approximately 5.0m (13 to 16 feet). The ground surface in the heavily trafficked areas outside of the buildings is primarily sandy with varying degrees of gravel, while that in the storage or less utilized areas is quite heavily vegetated. The current level of vegetation is clearly related to the decrease in activities on the CLS site over the last couple of years. From its inception in 1963, the site has not had direct road access and all major movement of materials and people to and from the site has been by sea. Throughout the history of the site an overland footpath has been in existence connecting the site to the Yam O area to the north.

3.2 CLIMATOLOGY

The site, like all of Hong Kong, is subject to two distinct seasons, a dry and wet season. The dry season extends from October until March, while the rainy season extends from April until September. A review of Hong Kong Observatory rainfall statistics between 1961 and 1990 indicates that average rainfall for the wet season is upwards of 180 cm (71 inches). The average number of days with rainfall in excess of 25 mm (1 inch) over the same period is 22 days.

3.3 GEOLOGY AND HYDROGEOLOGY

3.3.1 Geology

The following geological site description is freely adapted from the following Geotechnical Engineering Office of the Hong Kong Civil Engineering Department publications: *Geology of North Lantau Island and Ma Wan*, Hong Kong Geological Survey Sheet Report No. 4 (1995) and *Geology of Lantau District*, Hong Kong Geological Survey Memoir No. 6 (1995).

Geologically, the North Lantau area is situated in a complex zone of intrusive igneous rocks on the boundary between two contrasting structural domains. The rocks in the area are composed dominantly of Mesozoic, Upper Jurassic granites and volcanics that are intruded by strongly ENE-WSW oriented porphyritic rhyolite dike swarms. Based on simplified information, the Penny's Bay area is predominantly characterized by minor intrusive rocks (dikes) of Mesozoic age, which are comprised of feldspar and quartz porphyritic rhyolites, as well as porphyritic microgranites and fine-grained granites. The only remaining occurrences of the original volcanics are the isolated bands of coarse-ash crystal tuffs of the Yim Tin Tsai Formation located to the north of Penny's Bay, in the vicinity of Yam O. Observations made during the IEC's site reconnaissance (March 2001) confirm the presence of the quartz-rich dikes in the rock slopes above the northeastern boundary of the site.

As detailed above, the geology of the Lantau District is dominated by igneous rocks of Late Jurassic age. The major structural features of the district also date from this period. The area is characterized by a northeast-trending fold and fault zone and includes structurally complex basement terranes. Based on aerial photograph interpretation, the Geological Survey has identified a series of regularly spaced northwest-trending photolineaments along the length of Lantau Island, as well as a set of northeast-trending photolineaments that are inferred to be one set of faults. It is believed that the northwest and northeast-trending faults may have been active conjugate structures. Near Yam O, the northwest-trending fault through Penny's Bay and the northeast trending Yam O–Pui O fault define a triangular block of rhyolite dikes from which Tsuen Wan Volcanic Group rocks are largely absent. In adjacent blocks volcanic rocks are dominant although many rhyolite dikes intrude them.

The CLS site is composed almost entirely of reclaimed land. Prior to reclamation and fill placement, extensive sandy beach deposits occurred along the sheltered northeastern shore of Penny's Bay. This is clearly evident in predevelopment aerial photographs circa 1954. These beach deposits were integrated into the reclamation and are currently well below ground level. Onsite observations during the site reconnaissance indicate that the materials utilized in the reclamation range in gradation between silt and sand-sized fines to rock boulders. The relative percentages of either likely vary considerably depending upon the source and gradation of materials used for reclamation area, and depth within the fill deposits.

Findings of the geophysical investigation conducted in Area 3 of the site indicate the presence of a cut rock platform adjacent to and extending from the cut slope in the central part of Area 3. This area was characterized by lower ground conductivities and a low frequency distribution of magnetic sources. Exploratory trenches in this part of Area 3 confirm the presence of shallow bedrock in the central part of the area.

3.3.2 Hydrogeology

Based on the scope of work outlined in the RIWP, 33 monitoring wells were initially installed in Areas 1, 2 and adjacent to Building Q in Area 3. These wells were supplemented by an additional 23 wells installed in Areas 2 and 3 at locations selected by the IEC based upon observations made during the trenching program. In total, 56 monitoring wells were installed and sampled at the CLS site as part of the RI.

Hydrogeological Observations

Factors Influencing Water Level Readings

The groundwater monitoring wells were installed over the 5-month period from July to November 2001. The installation sequence followed the natural progression of the soil investigation, with the wells in Area 1 being completed in July and August, Area 2 in August and September, and the post-trenching wells in Area 3 in October and November. Due to the time lapse between the well installations/monitoring in the three areas, there are no synoptic monitoring data available that can be utilized to provide an accurate picture of groundwater flow across the entire site. Additionally, the groundwater level measurements obtained do not take into account potential tidal effects and the resultant temporal variation tidal changes would introduce to the measured levels. As such, even readings from adjacent wells taken at different times of the same day must be used with care. In addition to the tidal effects, the following factors also have likely influenced the groundwater level measurements to such a degree that it is not possible to establish a meaningful site-wide interpretation of groundwater levels and groundwater flow.

Seasonal Rainfall: The annual rainfall total for 2001 (based on measured rainfall at the Hong Kong Observatory) was 3,091.8 mm, the fourth wettest year on record. A total of 1,083.6 mm of rainfall was recorded in June 2001 alone, three times the June average and the highest recorded rainfall for the month on record. It was warmer and drier than usual in August, October and even more so in November, with only 4.3 mm of rainfall recorded, one-eighth the November monthly average of 35.1mm. The total monthly rainfall figures for 2001 are presented in the following table:

Month	Total Rainfall (mm)	Month	Total Rainfall (mm)	Month	Total Rainfall (mm)
Jan	47.6	May	162	Sept	563
Feb	10.9	Jun	1,083	Oct	11
Mar	56.3	Jul	656	Nov	4.3
Apr	133	Aug	319	Dec	44.6

Year 2001 Total: 3,091.8 mm
Normal: 2,241.3 mm

Spring Discharge: The presence of a spring behind Building J meant that there was continuous surface flow and ponding of groundwater and local surface discharge around Buildings H, I, and J and at the back of Buildings K and L within Area 1. High water tables are evident in this area in both the dry and wet seasons, as reflected by the ponding behind the buildings. Observations during the site exploration program indicate that the situation was likely exacerbated due to the unseasonably high rainfall during June through August, and the resulting surface run-off from the cut slope at the rear of the area.

Backfilling of the Tidal Lake between CLS and New Reclamation: Penny's Bay was a natural marine embayment before placement of fill soils associated with reclamation activities to support Penny's Bay infrastructure development. Sequential fill placement transformed part of the bay into a tidal lake. Placement of fill across the mouth of Penny's Bay essentially created a dam, which resulted in creation of a tidal lake during the months of May and June 2001. Reclamation advanced from the mouth of Penny's Bay towards CLS, and by mid-September, the lake was completely backfilled. As a result, the box culvert/storm water drain that dissects Area 2 was dammed and filled completely with water. A similar damming situation occurred in the old dock/slipway areas on the boundary between Areas 2 and 3. The mouth to the docks was dammed and a 4-5m deep pool of water was trapped. The water level in the box culvert gradually subsided by the end of November, but natural overland flow from the cut slope to the docks kept the water level high in these 'pools'.

As a result of both the damming and the dry conditions of October and November, it is expected that localized water levels in a number of the wells installed in October and November will be artificially high. This is reflected by the water levels measured in monitoring wells AW-01 through AW-09A, where differences between these and adjacent wells installed and measured previously range between 0.3 and 3.0m. Another hydrogeological effect related to the reclamation was the eventual loss of tidal influence within a number of wells located close to the seawall. This is well illustrated through the downward trend in the measured water levels in Monitoring Wells B24, OB2, OB4, U2a, AW-10, 11, 13, 15, 17, and 22.

Existing Open Pit – Mid Area 3: The excavated pit located in the central portion of the lower half of Area 3 (within the old fenced-in area) appears to directly influence the water levels in downgradient Monitoring Wells AW-14, 16A, and to a lesser extent 18. Water level measurements in these wells taken during the beginning of November indicate significantly lower water level elevations than measured in adjacent wells. This corresponded to almost dry conditions in the excavation. As such, the pit may act as a groundwater sink during dry conditions and possibly as a recharge source during wet season conditions.

Groundwater Flow

A summary of the groundwater level data as reported in the *Draft RIWP Fieldwork Reports* (Volume 1, Part 2, Appendix H, Volume 2, Part 1, Appendix H (September 2001) and Volume 4, Part 1, Appendix H (December 2001)) prepared by Vibro (H.K.) Limited, is summarized in Table 3-1. The following subsections present the IEC's observations and interpretations of these data relative to groundwater occurrence and flow directions in the three areas of the CLS site.

Area 1

Area 1 comprises the northwestern section of the site and includes Buildings A through P. As detailed previously, the 17 groundwater monitoring wells in Area 1 were completed during the months of July and August 2001. At this time, the effects of the reclamation on groundwater flows was at a minimum and, as such, the available data are likely representative of the natural subsurface flow conditions for this area of the site. Site-related factors that must be considered when evaluating the groundwater flow data include: 1) the drainage channel that runs below the cut slopes along the northern and eastern boundaries of Area 1; 2) the stormwater drain located in front of Building D that runs parallel to Building P and discharges directly into Penny's Bay; and 3) the tidal effects generated within the area as a result of the high degree of sea frontage (southern and western area boundaries).

Based upon these data, a groundwater high is inferred to occur in the vicinity of Monitoring Well OB-05, located in the northeast corner of Area 1. Groundwater elevations in this well were consistently greater than 3.8 mPD, which is higher than the actual ground elevation at the two adjacent Wells B-J07 (3.59 mPD) and B-L37 (3.40 mPD), respectively. This likely explains the wet conditions in this part of the site that exist in both the dry and wet seasons. A steep flow gradient is interpreted to exist between the wells located along the northeastern boundary (Wells OB-05 and B-L37) and those located downgradient to the southwest (Wells B-J07, B-L34 and B-L06). This gradient, however, rapidly flattens across the center of the site (in the vicinity of Buildings K and D) towards the western site boundary (Buildings C and B). The gradient is interpreted to then steepen towards the center of the site (east of Building B and west of Building P) with the apparent flow direction following that of the subsurface storm drain towards the southern boundary seawall.

Area 2

Area 2 represents the central portion of the site and extends from just north of Building Z to the northern edge of the slip adjacent to Building S. The original 14 groundwater monitoring wells were installed in this area during August and September 2001. An additional 6 monitoring wells (AW-01C, 2, 3, 4, 5 and 8) were installed during October and November 2001 following completion of the Area 2 and 3 trenching investigation. The available area-specific groundwater monitoring data were generated during two different monitoring programs, and as such, represent both pre-reclamation (prior to the infilling of the "tidal lake") and post-reclamation conditions. However, during the second round of monitoring only the newly installed wells were measured, and consequently no direct comparisons can be made from the two datasets. The primary site-related features that should be considered when evaluating the groundwater data are the major drainage channel that essentially bisects the area and enters the sea between Buildings T and S, as well as the tidal effects likely encountered due to the significant seawall frontage. The channel is constructed of concrete and originates in the northernmost corner of Area 2 where it drains a stream that enters the site at this location. Secondary features that should also be considered are the slips located within the Area 2 seawall that were dammed as a result of fill placement for the reclamation the central area of the site.

As is the case in Area 1, the highest groundwater elevations in Area 2 occur in the north-northeast corner of the area. This corresponds to the site edge closest to the cut rock slopes, as well as where the channelized stream enters the site. In general terms, on the western side of the concrete stream channel, the groundwater flow emulates the flow pattern of the stream moving from the northeast corner to the seawall. There appear to be localized controlling factors (i.e., tidal effects, or perhaps increased permeability in the strata due to tidal flushing) within Area 2, as the groundwater flow approaches the seawall. These are illustrated by the reduced water level elevations measured for Wells B-T01, B-S04 and B-S08, which are all in close proximity to the seawall. Flow on the eastern side of the concrete channel is contributed to by a separate catchment that is controlled by the local hillside geology.

The set of groundwater measurements taken for the Area 2 wells completed following the Area 2 and 3 trenching program (in October and November 2001) highlight a significantly different groundwater flow regime than that described above. Comparison between Wells OB-22 from the original program and adjacent Well AW-05 from the post-trenching program indicates an increase in groundwater level of more than 2m. Given the relative differences in groundwater measurements in these two nearby wells, it is clear that the two data sets are not comparable. The reason for the large difference is likely related to the damming within the system caused by the final infilling of the bay. Clearly the natural flow regime was disrupted, and as such, significant localized mounding occurred. This condition would likely exist until a new flow equilibrium is established within the system. It is unlikely that the newly established regime would be the same as that which existed prior to the reclamation.

Area 3

Area 3 represents the section of the CLS site that extends from the slipway adjacent to Building S in a southeasterly direction to the stream adjacent to the CLP Power Station. It is bounded by the cut slope on the east and formerly by the seawall along Penny's Bay on the west. There were two monitoring wells installed in Area 3 during the first week of September 2001, Wells B-Q01 and B-Q05; 17 additional were installed as part of the post-trenching program during October and November. Site-related factors that may impact the groundwater level readings include the subsurface cut-rock platform which underlies the central portion of the area, the slipways located adjacent to Building Q, the excavated pit located in the southwestern end of the area, as well as the potential tidal effects associated with the significant seawall frontage.

Wells B-Q01 and Q05 provide data from September 2001. These water level data (1.55 mPD and 1.65 mPD, respectively) indicate that the levels were similar to those recorded on the opposite side of the slipways within Area 2 in Well B-S08. As noted previously, there is no correlation between the water level readings from the wells installed prior to the final infilling of the bay and those installed afterwards. However, it appears from the data that the most pronounced effects from the infilling are seen in those wells located closest to the slipways and Area 2 (i.e., Wells AW-06 (3.39 mPD), AW-07 (3.27 mPD) and AW-09A (4.76 mPD)). The measured water levels clearly decrease in a southwesterly direction, with the lowest levels being recorded in the most southerly portion of Area 3. Accepting the variation introduced by the infilling of the bay and the excavated pit, the general trend of flow in Area 3 is from the cut slope on the east of the site to the (former) bay on the west. There is a small variation to this on the southernmost end of the site where some of the flow does migrate in the direction of the stream that separates the site from the CLP site.

4.0 LAND CONTAMINATION ASSESSMENT

4.1 GEOPHYSICAL SURVEY

A geophysical survey was conducted in the southeastern portion of the property, including the southeastern part of Area 2 and all of Area 3 to assess the subsurface for buried waste materials, including drums and waste disposal/burn pits. The geophysical survey was implemented by EGS (Asia) Ltd. under the technical supervision of Cosine Ltd. Geophysical Consultants (Cosine) and was administrated by MCAL. The survey was conducted in two phases between 27 April and 26 May 2001 (first phase) and 28 July and 13 August 2001 (second phase). The second survey phase was required to allow clearing of soil and debris piles, broken boat hull molds, vehicles, refuse, and other waste materials from the site to allow access for the survey crew and remove articles that might cause interference with the survey. Technical details of the survey methods, interpretation, and findings are included in the *Final Report on Geophysical Investigation*, November 2001, prepared by Cosine and issued by MCAL.

The geophysical survey covered an area approximately 565m (1,850 feet) long by up to 140m (460 feet) wide extending from the existing seawall northeastward to the base of the hillside bordering the site. The northwestern half of the survey area is reclaimed land over former bay sediments, while the central part of the survey area consists of a large cut-rock platform, which was formed by quarrying at the time of reclamation, and a peripheral margin of reclaimed land. The southeastern part of the survey area is also reclaimed land that overlies a former small coastal inlet. Prior to conducting the surveys, the survey area was set out with a local grid system to facilitate geophysical profiling in a direction perpendicular to the long dimension of the seawall. Reference tie-in to the Hong Kong metric grid system is provided in Cosine's report.

The objectives of the geophysical survey were to locate potential buried debris, wastes, and burn pits that may contain hazardous chemicals. Information from the geophysical survey findings was then used to establish locations for exploratory trenches to allow direct observation of inferred waste materials and obtain representative samples for laboratory testing. Owing to the large area over which waste disposal/burning activities potentially may have occurred during shipbuilding operations at the site, use of geophysical methods allowed focusing of the trenching investigation and a reduced level of effort than would otherwise have been required to evaluate environmental conditions in this part of the site.

Three geophysical methods were used to perform the surveys: detailed electromagnetic (EM) ground conductivity mapping with In-phase and Quadrature at two effective depths of penetration, detailed total magnetic field mapping, and ground penetrating radar (GPR) profiling over selected magnetic and electromagnetic targets identified from the first two survey methods. The methods used are capable of locating ferrous materials, such as buried drums, and non-ferrous materials, such as plastic containers, as well as soils with anomalous conductivity associated with introduction of contaminants. Approximately 24,700 linear meters (81,000 feet) of EM survey and 13,300 linear meters (43,600 feet) of magnetic survey were conducted. The aggregate GPR traverses totaled approximately 1,200m (3,900 feet). Details of the survey methods and data reduction and interpretation are provided in the *Infrastructure for Penny's Bay Development, Engineering Design and Construction, Geophysical*

Investigation Final Report, November 2001, prepared on behalf of MCAL by Cosine for the CED of the HKSAR under Agreement No. CE 68/99.

4.2 SOIL BORINGS AND SAMPLING

The SIC implemented a program of subsurface exploration using a combination of shallow soil borings and trial pits and deeper soil borings to investigate subsurface conditions and obtain representative soil samples for laboratory testing. The subsurface exploration program was developed by the IEC and described in detail in the RIWP and the FSP. The RIWP and FSP were incorporated into the CAP approved by EPD.

Appropriately qualified environmental scientists, approved by the IEC, technically supervised the drilling and sampling program, prepared logs of borings, and packaged and labeled samples for environmental testing. An IEC representative was present onsite during field investigations to assure that the work was done in accordance with the RIWP and FSP and to approve any field changes to the manner in which the investigations were carried out.

4.2.1 Hand-Auger Borings/Trial Pits

Borings designed with shallow target depths of 1.5m were advanced using an AMS hand-auger, equipped with either an 8.25 or 12.7-cm (3.25 or 5-inch) diameter auger bit. The diameter of bit used depended upon the *in situ* conditions encountered. The hand auger was operated by two-man teams employed by the SIC, under direct supervision of experienced environmental scientists.

The auger was advanced by exerting downward pressure while at the same time rotating the 'T-bar' handle clockwise. Soil cuttings removed from the hole were piled to the side and later used to backfill the boring. Excess soil not used as backfill was double bagged and stored undercover pending a decision on disposal.

In most cases, two attempts were made to complete a boring. If the hand auger was refused at any point above the designated terminal depth, the hole was abandoned and a second boring attempt made at an adjacent location. If refusal occurred on the second attempt, the boring location was abandoned altogether.

The target sampling depths in all hand-auger borings were 0.15m, 0.75m and 1.5m bgs. Once a target sampling depth was reached, the auger and cuttings were removed from the hole, and a slide-hammer sampler was lowered into the boring for sample collection. In most cases, if more than 75 blows of the slide hammer were required to cut a sample, the slide-hammer sampler was removed and the hole advanced a further 20 cm. The split-spoon sampler was then reintroduced, and if it met with refusal a second time, the sampling interval was abandoned. If possible, the boring was then further advanced to the next sampling interval; if not. the boring location was abandoned.

The decision to relocate and make a second attempt at a refused boring was primarily determined by the progress made with the first attempt. For example, if drilling was refused between the 0.75 and 1.5m sampling intervals, provided the 0.15 and 0.75m samples were collected and elevated volatile organics readings were not recorded using a photo-ionization detector (PID), the boring generally was abandoned. An exception was made where the 1.5m sample could not be collected in several neighboring hand-auger borings, such as in Buildings H, I, and L. It was not possible to collect more than half of the 1.5m samples in borings from these buildings, so rotary drill rigs were used to redrill and complete most of these abandoned borings.

A breakdown of the hand-auger drilling program is presented in the following table:

	HA Completions	HA Completions on 2nd Attempt	HA Borings Completed by Rotary	Subtotal
Original Program				
Area 1	51	6	21	78
Area 2	1		2	3
Area 3		2	3	5
Subtotal	52	8	26	86
Additional Borings				
Area 1		1		1
Area 2				
Subtotal		1		1
TOTAL	52	9	26	87

In total, 61 of 87 planned shallow borings were completed using hand-auger methods; the remaining 26 shallow borings were completed using rotary drilling methods to reach terminal depth.

Although a cable detector was used prior to spudding all borings, trial pits were necessary to confirm the orientation of underground services/infrastructure at four locations. Trial pits were excavated by SIC employees using shovels, under supervision of experienced environmental scientists. The supervisor logged the trial pits, and slide hammer samples were collected from the sidewalls at designated sampling intervals per the RIWP and as per the methodology described below in Section 4.2.2. The maximum depth of the trial pits was 1.2m.

4.2.2 Slide-Hammer Sampling

Slide-hammer sampling was performed using an AMS slide hammer. The sampling bit consisted of a 15.25-cm (6-inch) long, 3.8-cm (1.5-inch) diameter stainless-steel sampling sleeve enclosed within a 4.5-cm (1.75-inch) diameter stainless-steel housing and cutting shoe. The sampling bit was screwed to the slide hammer prior to collection of each sample. Collection of all samples was conducted under the direct supervision of experienced environmental scientists. Hand augers, samplers and sample sleeves were thoroughly decontaminated prior to collection of each sample in accordance with the RIWP.

After sampling, the slide hammer was brought to the surface, and the soil in the cutting shoe was immediately sealed in a plastic airtight, zip-lock bag. The contents of the bag were then manually mixed and placed in direct sunlight for approximately 10 minutes to allow volatile organic compounds (VOCs) in the soil to volatilize. The zip-lock bag was then pierced with the tip of the PID, and a total organic vapor reading recorded on a PID log sheet.

According to the RIWP, if a PID measurement was two times greater than the background, the boring was to be advanced to the next sampling interval. Given that the onsite background reading was 0.0

ppm, the onsite IEC representative directed that a trigger concentration of 30 ppm be used for this criterion.

In most cases, two 15-cm long, 5-cm diameter stainless-steel sleeves (referred to as U50's) of soil were collected from each sampling depth. Once removed from the sampler and inspected for staining, odors, or other indications of impact, the exposed ends of the stainless-steel sampling tubes were quickly covered with Teflon sheeting, then a layer of Parafilm, and finally fitted with tight-fitting, plastic end caps. This method of sealing the sample involved a slight variation to that described in the FSP. The FSP specified that the end cap be fitted and then sealed with Parafilm. The Parafilm used on site was pre-cut into approximately 10 cm squares and was therefore not suitable for wrapping the outside of the sample tubes. A secure seal was achieved by placing the Parafilm square beneath the end cap; this method was adopted for the entire sampling program with the approval of the onsite IEC representative. Each sample tube was identified with an adhesive label detailing the boring ID, sample number, depth and collector.

Once labeled, the samples were immediately placed in ice chests containing blue ice and maintained in a chilled state at 4°C until delivered under chain-of-custody to ALS Technichem (HK). All samples were delivered to the laboratory the same day they were collected.

4.2.3 Rotary Borings

One Sedidrill 500 track-mounted rig and seven Longyear LY38 skid-mounted rotary drilling rigs were used to complete the rotary borings. Rotary borings were drilled using H (115-mm diameter), P (140-mm diameter) and U (194-mm diameter) casing equipped with tungsten carbide cutting shoes. Cuttings were cleaned from the hole by a combination of hand auger and light cable tool percussive techniques. The drilling rigs were operated by two-man teams employed by the SIC, under direct supervision of experienced environmental scientists. In general, rotary drilling was used to complete holes greater than two meters in target depth. Rotary wash boring was undertaken in two borings, B-D23 and AW-1c only – in B-D23 in an attempt to prevent heaving sands from lifting the casing, and in AW-1c to help speed up the drilling.

Rotary drilling commenced on 7 July 2001 and was completed 17 November 2001. The following table details the number of borings completed by rotary boring per area:

	Rotary Completions on 1st Attempt	Rotary Completions on Redrill	HA Borings Completed by Rotary	Subtotal
Original Program				
Area 1	119	5	21	145
Area 2	88	7	2	97
Area 3	10		3	13
Subtotal	217	12	26	255
Additional Borings				
Area 1	40			40
Area 2	37	6		43
Subtotal	77	6		83
AB-T Borings				
Area 2	17	5		22
AW Borings				
Area 2	5	1		6
Area 3	14	3		17
Subtotal	19	4		23
TOTAL	330	27	26	383

A total of 383 borings were advanced and sampled using rotary drilling techniques, 26 of which were spudded by hand-auger but need completion with rotary drilling due to difficult drilling conditions.

4.2.4 Split-Spoon Sampling

The uniform target sampling depths for all rotary borings were 0.15, 0.75, 1.50, 3.00 and 4.50m (approximately 0.5, 2.5, 5, 10, and 15 feet) bgs. The actual depth of sampling commenced 8 cm above the nominal target sampling depth and continued to 8 cm below the nominal target sampling depth. Sampling was performed using both slide-hammer and split-spoon samplers. When sampling the 0.15 and 0.75m intervals, the weight applied by the hammer on the unsupported split-spoon sampler was hazardous to the drilling crews. Therefore, as a matter of safety, the slide-hammer sampler was used for sampling the 0.15m and many of the 0.75m intervals.

The split spoon sampler comprised two 125-mm (5-inch) long, 64-mm (2.5-inch) diameter (U64) stainless-steel sampling sleeves fitted inside a stainless-steel waste barrel and cutting shoe. To collect a sample, the split-spoon sampler was attached to drive rods, lowered to the sampling interval, and driven with the use of the drill-rig hammer.

Where refusal occurred at a sampling interval, the split-spoon sampler was removed, and drilling was continued for 20 cm before another sampling attempt was made. If the second sampling attempt was refused, the interval was abandoned and drilling continued to the next sampling depth. If refusal occurred twice at the terminal sampling depth, the boring was abandoned.

After the sampler had been driven to the desired depth, it was carefully removed, detached from the drive rods and placed on a work table. The cutting shoe and waste barrel were removed, allowing the split spoon to be separated using a clean sampling knife. Sealing of the exposed ends of the sample tubes was performed as per the method described for the samples collected with the slide-hammer

(Section 4.2.2). Each sample tube was identified with an adhesive label detailing the boring ID, sample number, depth and collector.

Soil in the cutting shoe was immediately sealed in a plastic airtight, zip-lock bag to be analyzed with a PID meter as per methodology described in Section 4.2.2.

As was the case for the slide-hammer sampling protocol, if the PID measurement exceeded 30 ppm, the boring was advanced to the next sampling interval. If a PID reading greater than 30 ppm was recorded in the sample collected from the terminal sampling interval, the boring was advanced another 1.5m and another sample collected. This approach was followed until samples recorded a total volatile organic reading lower than 30 ppm.

After each sampling attempt, the split-spoon sampler was decontaminated at the nearest decontamination station in accordance with the procedures outlined in the RIWP. All persons involved in sample collection wore new latex gloves when handling each piece of sampling equipment. Once samples were collected and stored in iceboxes, all gloves were disposed of as per the investigative derived waste handling procedures described in the RIWP.

4.3 EXPLORATORY TRENCHING

Exploratory trenches were advanced using a track-mounted excavator and supervised and documented by experienced environmental scientists. In total, approximately 7,385m^3 of soil was excavated from approximately 3,090 linear meters (10,140 linear feet) of exploratory trenches. The following table provides a breakdown of the length of trenches and volume of soil excavated in Areas 1, 2 and 3 of the site:

AREA 1

Trench ID	Total Length (m)	Volume Excavated (m^3)
T 1	16	14
IEC-T38	5	7
TOTAL	21	21

AREA 2

Trench ID	Total Length (m)	Volume Excavated (m^3)
T 2	17	8
T 3	12	11
T 4	18	16
T 5	22	20
T 6	12	11
T 7	17	20
T 8	22	16
T 9	15	13
T 10	16	14
T 11	16	16
Sub Total	167	145
IEC-T1	90	247
IEC-T2	116	288
IEC-T3	95	114
IEC-T4	35	83
IEC-T5	224	520
IEC-T6	55	114
Sub Total	615	1,366
TOTAL	782	1,510

AREA 3

Trench ID	Total Length (m)	Volume Excavated (m^3)
T12 & T13	25	19
T 14	5	9
Sub Total	30	28
IEC-T7	100	264
IEC-T8	175	450
IEC-T9	101	277
IEC-T10	14	43
IEC-T11	56	169
IEC-T12	146	381
IEC-T13	23	49
IEC-T14	68	251
IEC-T15	43	70
IEC-T16	30	72
IEC-T17	10	26
IEC-T18	84	258
IEC-T19	94	271
IEC-T20	242	673
IEC-T21	87	209
IEC-T22	115	355
IEC-T23	69	184
IEC-T24	47	92
IEC-T25	44	128
IEC-T26	50	161
IEC-T27	23	47
IEC-T28	31	75
IEC-T29	46	124
IEC-T30	70	193
IEC-T31	61	171
IEC-T32	19	39
IEC-T33	64	194
IEC-T34	20	69
IEC-T35	51	153
IEC-T36	125	382
IEC-T37	148	351
Sub Total	2,256	5,827
TOTAL	2,286	5,855

NOTE: Trench T12 and T13 have been included together because they form one T-shaped trench but were labeled separately because they were excavated as two separate transects.

Trenching of the debris piles at the base of the cut slope in Areas 1 and 2 commenced on 16 July 2001. The location of the 11 trenches (T1 to T11) planned for the debris piles were marked out in the field by the IC and SIC under the supervision of the IEC. Trenching of the debris piles commenced on 16 July and was completed on 1 August 2001. The table below contains the relevant specifications and findings pertaining to the debris pile trenches:

Trench ID	Date Commenced	Date Completed	Length (m)	Mean Depth (m)	Water Table (m bgs)	Visual Observations of Impact
T1	01-Aug-01	01-Jul-01	16.0	1.0	Dry	Waste Dump – small dump of scrap metal, wood & plastic
T2	17-Jul-01	17-Jul-01	16.7	0.5	0.06	None observed
T3	17-Jul-01	17-Jul-01	11.8	1.2	Dry	Waste Dump – small dump of scrap metal and wood
T4	19-Jul-01	19-Jul-01	18.2	1.0	Dry	Waste Dump – several corroded drums on backside of debris pile
T5	21-Jul-01	21-Jul-01	22.2	1.0	Dry	Waste Dump – wood debris and scrap metal
T6	23-Jul-01	23-Jul-01	12.1	1.2	Dry	Waste Dump – buried electric cables
T7	27-Jul-01	27-Jul-01	16.5	1.0	Dry	Waste Dump – buried metal pipe
T8	26-Jul-01	26-Jul-01	22.0	0.7	Dry	Waste Dump – dark soil containing scrap metal
T9	28-Jul-01	28-Jul-01	14.6	1.2	Dry	None observed
T10	30-Jul-01	30-Jul-01	16.0	1.1	Dry	Waste Dump – buried waste wood pile
T11	31-Jul-01	31-Jul-01	16.0	1.2	Dry	Waste Dump – buried discarded clothing soaked with viscous red paint, scrap metal, tires, solvent odor

At each of the 11 trench locations, a minimum of two soil samples was collected; one from within the debris pile and one from beneath the debris pile. Additional samples were collected based on the environmental scientist's findings and after the location was verified by the onsite IEC representative.

Sampling was performed by driving the slide-hammer sampler into the sidewall of the trench at the appropriate depth. PID measurements, sample preservation, storage and decontamination methodology were performed as previously described in Section 4.2.2.

Prior to completion of the geophysics program, shallow trenches, T12, T13 and T14 were excavated in Area 3 to verify preliminary geophysical data. Details of the three verification trenches are provided in the table below:

Trench ID	Date Commenced	Date Completed	Length (m)	Mean Depth (m)	Water Table (m bgs)	Visual Observations of Impact
T12	24-Jul-01	24-Jul-01	14.80	0.80	Dry	None observed
T13	24-Jul-01	24-Jul-01	12.50	1.00	Dry	None observed
T14	24-Jul-01	24-Jul-01	4.80	2.00	Dry	Waste Dump – buried 44 gal drum filled with foam and epoxy resin (extremely odorous), scrap metal

Two slide-hammer samples were collected from the sidewalls of Trenches T12 and T13 as per the methodology detailed in Section 4.2.2. Samples were not collected from Trench T14.

Trenching of the burn pit/waste disposal sites in Areas 2 and 3 was commenced once MCAL and the IEC had reviewed the final geophysical data and delineated areas to be excavated. The first trench in this area, IEC-T9 (1-10), was excavated on 21 August 2001 and the last, IEC-T38 (1-2), was backfilled on 8 October 2001. Pertinent information regarding these trenches and relevant findings are summarized in Table 4-1.

The surveying contractor first surveyed in the locations of the trenches in the burn pit/waste disposal areas within Areas 2 and 3 of the site. Three track-mounted excavators were used to dig the trenches to first encountered groundwater, which on average was between 3 and 4m bgs in this area of the site. In visibly contaminated areas, an extra bucket or two was excavated below the water table in an attempt to delineate the vertical extent of impacted materials.

Trenches were excavated in approximately 20m sections. The trench was first opened to the water table in order for the environmental scientist to visually assess the sidewalls for the presence of contamination. If the sidewalls appeared 'clean', the excavator exhumed a bucket of soil from the capillary fringe and, a sample was collected by driving the slide-hammer into the sediment contained within the bucket. In apparently clean trenches, a sample was collected from the capillary fringe every 15m (50 linear feet).

Once the trench had been geologically logged, sketched and photographed, the trench was backfilled to approximately 1m bgs, so another slide-hammer sample could be collected. A fresh face was exposed and the slide hammer driven into the sidewall at approximately 0.6m bgs, directly above the sample collected from the capillary fringe. The excavator then backfilled the trench and continued with the next section or moved to the decontamination station.

A slightly different methodology was adopted for trenches that were visibly impacted. If an impacted side-wall was excavated in the first 20m of trench, trenching continued until the lateral extent of the apparently impacted area was exposed. This allowed the supervising scientist to more accurately select sampling locations than if just 20m of side-wall was exposed. The trench was opened to the water table, and deeper if the impacted soils appeared to extend below this level.

Apparently unimpacted sections of the trench were sampled as per methodology described above. At a minimum, one pair of slide-hammer samples was collected from the impacted strata. One sample was collected from the most visually impacted materials exposed, and another from apparently non-impacted soil below the impacted materials. If the impacted/clean soil horizon could not be determined or was beneath the water table, the closest point below the area of impact was sampled. Additional impacted soil samples were also collected, using the same methodology, at the discretion of the supervising scientist. Backfilling of the trenches was performed as previously described.

After each use, all sampling equipment was decontaminated at the nearest decontamination station. Once an impacted section of trench was excavated, if the trench was not to be terminated at that point, the backhoe bucket was decontaminated, under the same protocol as the sampling equipment, before proceeding with the next section.

Trench logs providing side-wall sketches, soil descriptions, sampling details, trench dimensions and trench orientations as well as trench photographs are provided in the SIC's *RIWP Fieldwork Report, Volumes 3, 4 and 5*.

4.4 GROUNDWATER INVESTIGATION

The RIWP originally planned for the installation of 34 monitoring wells throughout Areas 1, 2 and 3 of the site, with the provision that, after review of soil chemistry and geophysical data, more wells may be proposed bringing the total number to 50 to 75 wells. Of the 34 wells initially planned, 33 were installed. MW-OB31 was abandoned at 10m bgs due to heaving sands preventing the setting of casing and cleaning out of the boring.

In the first week of October 2001, instruction was given by the IEC to install an additional 23 monitoring wells adjacent to trench locations in Areas 2 and 3. All 23 wells were successfully installed. A summary table of completed wells is provided below:

	Area 1	Area 2	Area 3	Planned but not Completed
Originally Planned and Completed	17	14	2	MW-OB31
Additional Wells Completed	0	6	17	
Total Wells Completed	17	20	19	

4.4.1 Drilling and Soil Sample Collection

Rotary drilling rigs were used to advance boreholes for installation of groundwater monitoring wells using the same methods described in Section 4.2.3. Soil samples were collected from 0.15, 0.75 and 1.5m bgs and at 1.5m intervals thereafter to the total depth of the borings. The IEC selected 29 borings (12 from Area 1, 11 from Area 2, and six from Area 3) from which soil samples were collected at depths ranging from 0.75m to 4.6m bgs for analysis of physical properties. The resultant data were used in the evaluation of the fate and mobility of chemical species in support of the risk assessment. These soil samples were analyzed for the following physical parameters:

- Moisture content
- Bulk and grain density
- Effective and air filled porosity

- Total organic carbon, and
- Permeability and hydraulic conductivity.

4.4.2 Monitoring Well Construction

Monitoring wells were constructed from 88-mm (3.5-inch) OD, 75-mm (3-inch) ID, flush-joint, threaded Schedule 40 PVC blank casing and slotted screen. The screen slot size on all wells was 0.5 mm (0.20 inches), with the exception of MW-B24, which was constructed with 1.0-mm (0.40-inch) screen.

Prior to installing the monitoring well screen and casing, the boreholes were reamed to provide and minimum 50 mm annulus around the casing.

Centralizers were placed at the top and bottom of the screened intervals prior to installation. Sand traps screwed to the base of the screened interval were designed to be 30 cm long. However, because the SIC could only obtain sand traps 1m in length, most monitoring wells were completed with a 1m sand trap. The extra 70 cm of sand trap provided by the 1m lengths became very useful because of the high silt content of sediments and the high percentage of fines drawn into the well during development.

As specified in the RIWP, monitoring wells were to be completed 4.6m below the water table. Due to very slow drilling progress, drilling refusal or heaving sands, some monitoring wells were completed above this depth. At several locations, drilling was refused above the water table, in which case, the location was abandoned and a nearby suitable location was selected by the onsite IEC representative. As a general guideline, wells were only completed if there was greater than 2m of screen below the water table. In order to satisfy this criterion, wells MW-N3, AW-1c and AW-9a were completed without sand traps in order to maximize the length of screened section below the water table.

The sand pack was constructed with Monterey #2/12 equivalent sand. A 5-cm diameter tremie pipe was used to install the sand pack in first three wells completed, MW-B24, MW-I11, and OB-6. However, a combination of slightly moist sand and the small diameter of the tremie pipe made installing the sand pack with the tremie pipe very difficult. For the other 53 wells, the tremie pipe was replaced in favor of pouring the sand into the well annulus. The sand pack was slowly poured down the annulus in measured volumes, and a weighted fiberglass tape was used to ensure no bridging occurred. The supervisor recorded the number of sand bags used for the sand pack.

Once the sand pack was in place, each well was surged for five minutes across every meter of well screen constructed below the water table. As surging invariably reduced the level of the sand pack, additional sand was added to maintain the desired level of sand pack above the well screen. Although it was optimal to construct the well with 0.6m of sand pack above the well screen, restrictive *in situ* conditions meant that this was sometimes not achieved.

Monitoring wells were completed in general accordance with the provisions outlined in the FSP component of the RIWP. However, because of drilling refusal and/or shallow water table conditions in portions of the site (predominantly Areas 1 and 2), construction details were modified for some wells with the approval of the onsite IEC representative. Well completion specifications for each well are included in Volumes 1, 2 and 4, Parts 2, 1 and 1 respectively, of the SIC's *Site Investigation Report* and *RIWP Fieldwork Report*.

All monitoring wells were completed with a steel standpipe that was cemented in place using a 5% bentonite/cement surface seal. The standpipe was fitted with a locking cap and the top of the casing fitted with a press-fit well cap that could be accessed and removed from within the standpipe.

4.4.3 Groundwater Elevation and Field Monitoring

The water table depth was measured in all monitoring wells to the nearest ±3 mm (±0.01 foot) below the top of each casing, using an electronic water level sounder or in the case of MW-D6, an interface probe. Both water level measuring apparatus were decontaminated prior to use on each well.

The total depth of each well was measured by lowering a decontaminated weighted tape to the bottom of the well. The total depth was recorded to the nearest ±3 mm (±0.01 foot).

4.4.4 Monitoring Well Development

Once installed, each monitoring well was left to stabilize for at least 48 hours prior to development. Immediately prior to development, the depth to groundwater was measured using an electronic water level sounder or if immiscible hydrocarbon product was encountered, as was the case in Well MW-D6, an interface probe. The water measuring equipment was decontaminated prior to use on the next well.

Development was performed with a bailer and surge block until a minimum of five well volumes of groundwater had been removed from each well and the temperature, pH, conductivity and turbidity of the removed water had stabilized. Groundwater parameters from the first 33 wells (Table 5 if the RIWP) were measured with the following equipment:

- TPS WP80D pH meter
- YSI 85D meter for temperature, redox, conductivity and dissolved oxygen, and
- Hach turbidity meter.

Groundwater parameters from the additional wells (AW1c to AW-23) were measured with the following equipment:

- YSI 600XLM pH, temperature, redox, conductivity and dissolved oxygen meter, and
- Hach turbidity meter.

Groundwater parameters were recorded on development, purging and sampling logs. Groundwater produced during development was stored in watertight 55-gallon drums and labeled pending review of analytical results.

4.4.5 Groundwater Purging and Sampling

Immediately after removing the well cap, a PID was used to measure the presence organic vapors within the well casing. The PID reading was followed by a water level measurement using either an electronic water level sounder or interface probe. The water measuring equipment was decontaminated prior to use on the each well.

In all monitoring wells, field parameters pH, temperature, redox potential, specific conductance and dissolved oxygen were measured prior to purging using the same equipment listed above in Section 4.4.4.

The onsite IEC representative selected 24 monitoring wells from which groundwater samples were collected for geochemical analysis. The 24 wells were chosen for their proximity to specific site operations, potential source areas, natural recharge areas, areas of lithologic interest and field observations of groundwater conditions.

Three samples were discarded due to contamination by the laboratory, therefore geochemical data for only 21 wells was reported. The geochemical sample from MW-P8 was collected pre-purging by using a new, disposable HDPE bailer. Geochemical samples for the other wells were collected pre-purging, directly from the Grundfos MP1 submersible pump discharge hose.

After measuring the groundwater elevation, groundwater was purged using low-flow purging methods and the aforementioned Grundfos pump. During purging, the water level was constantly monitored with an electronic water level sounder to ensure drawdown did not exceed 30 cm. All wells installed yielded sufficient volumes so as not to exceed this criterion.

All wells were purged until the pH, temperature, electrical conductivity, turbidity and dissolved oxygen had stabilized to within 10% and until the turbidity was maintained at less than 10 nephelometric turbidity units (NTU's). Groundwater parameters were recorded, and purged groundwater was stored as per the methodology used in the well development phase (Section 4.4.4). The same groundwater monitoring equipment used in the development phase (Section 4.4.4) was used to perform the groundwater monitoring in the purging phase.

In response to poor turbidity results using the bailer and the ability of the Grundfos pump to provide a flow rate as low as 0.1 L/min, the IEC onsite representative approved sampling of groundwater directly from the pump rather than from HDPE bailer. Therefore, all groundwater samples analyzed for this project were sampled directly from the pump discharge line under low-flow conditions.

All groundwater samples were collected into new, pre-cleaned laboratory-supplied sampling containers appropriate for the analytical method and containing the appropriate preservatives. Care was taken to ensure minimal aeration of the samples and that no headspace occurred in the sample containers. Samples were labeled appropriately with site name, monitoring well number, date and time of collection, sampler's initials and preservatives used.

The submersible pump as well as all equipment used in the development, purging and sampling stages was disassembled and decontaminated following its use in each well.

4.5 ANALYTICAL TESTING PROGRAM

A comprehensive analytical testing program for soil and groundwater matrices was developed and described as part of the RIWP. The analytical program was developed to test soil and groundwater samples for potential chemical contaminants based upon the nature of materials and chemicals used by CLS at the site. In addition, analyses were conducted for soil physical properties and groundwater *in situ* properties to aid in evaluating contaminant fate and transport.

Primary chemical testing was performed by ALS Technichem (HK) Ltd. (ALS HK) under contract to CED and administrated by MCAL. ALS is a Hong Kong Laboratory Accreditation Scheme (HOKLAS)-accredited analytical testing laboratory. Testing for dioxin compounds was subcontracted by ALS to AgriQuality New Zealand Limited (AgriQuality), a New Zealand-accredited testing laboratory, and to Maxxam Analytics Inc. of Waterloo, Ontario, Canada (Maxxam). Maxxam holds numerous certifications and accreditations, including accreditation by the Canadian Association of Environmental Analytical Laboratories and ISO 9002 certification. MCAL provided first-tier oversight of ALS HK's laboratory activities. The IEC interacted with ALS HK as necessary to assure that the analytical work was carried out in accordance with the RIWP. In addition, as described in Section 5.3, the IEC conducted data validation for the laboratory testing results to assure that the data meet the Data Quality Objectives identified in the RIWP.

In addition to the primary sample analyses, approximately 10 percent of the total number of samples collected were analyzed as quality control (QC) samples. Five percent of these QC samples were collected by the SI Contractor and analyzed by ALS HK as field replicates. An additional five percent of the field replicates were provided to a second independent laboratory, Australian Laboratory Services Pty. Ltd. (ALS Aus) of Queensland, Australia, for analysis as "check samples". ALS HK and ALS Aus worked independently on the project to assure that ALS Aus' check sample analyses were not influenced by communication with ALS HK.

Soil matrix samples were collected from soil borings, boreholes advanced for installation of additional monitoring wells, trial pits and trenches. Groundwater samples were collected from monitoring wells, as well as a limited number of samples collected from trench excavations. The following types and numbers of soil and groundwater analyses were conducted as part of the RI, including both primary samples, duplicate samples, and QC samples:

4.5.1 Soil Samples

- 1,896 samples for 18 total metals, including: antimony (Sb), arsenic (As), barium (Ba), beryllium (Be), cadmium (Cd), total chromium (Cr), cobalt (Co), copper (Cu), lead (Pb), mercury (Hg), molybdenum (Mo), nickel (Ni), selenium (Se), silver (Ag), thallium (Tl), tin (Sn), vanadium (V), and zinc (Zn) by USEPA Method 6020 and 7471A.
- 585 samples for hexavalent chromium (Cr^{VI}) by USEPA Method 7196A.
- 706 samples for tributyltin (TBT) by Gas Chromatography/Mass Spectrometry (GC/MS).
- 1,933 samples for soil hydrogen ion content (pH) by APHA 4500+.
- 763 samples for cyanide by USEPA Method 9012A and 335.2.

- 863 samples for volatile organic compounds (VOCs) by EPA Method 5035B/8260B.
- 944 samples for semi-volatile organic compounds (SVOCs) by EPA Method 3510C/8270C.
- 2,024 samples for total petroleum hydrocarbons (TPH) with carbon-chain breakdown from C_6 to C_{36} by USEPA Method 5035B/3510C/8015 Modified.
- 94 samples for polychlorinated biphenyls (PCBs) by USEPA Method 3510C/8082.
- 51 samples for chlorinated pesticides and herbicides by USEPA Methods 8081A and 8151A.
- 208 samples for polychlorinated dibenzodioxins and polychlorinated dibenzofurans (dioxins) by USEPA Method 8290.
- 31 samples for organic carbon by a laboratory-specific method.

4.5.2 Water Samples

- 202 samples for 18 total metals, including: antimony (Sb), arsenic (As), barium (Ba), beryllium (Be), cadmium (Cd), total chromium (Cr), cobalt (Co), copper (Cu), lead (Pb), mercury (Hg), molybdenum (Mo), nickel (Ni), selenium (Se), silver (Ag), thallium (Tl), tin (Sn), vanadium (V), and zinc (Zn) by USEPA Method 6020 and 7471A.
- 150 samples for hexavalent chromium (Cr^{VI}) by USEPA Method 7196A.
- 149 samples for TBT by GC/MS.
- 104 samples for pH by APHA 4500+.
- 91 samples for cyanide by USEPA Method 9012A and 335.2.
- 297 samples for VOCs by EPA Method 8260B.
- 137 samples for SVOCs by EPA Method 8270C.
- 154 samples for TPH with carbon-chain breakdown by USEPA Method 8015 Modified.
- 57 samples for PCBs by USEPA Method 8082.
- 44 samples for dissolved methane by Method RSK-175.
- 13 samples for dioxins by USEPA Method 8290.
- 35 samples for general water quality parameters including ammonia, bicarbonate as $CaCO_3$, carbonate as $CaCO_3$, total alkalinity as $CaCO_3$, chloride, nitrate, nitrite, sulfide, sulfate, and total dissolved solids (TDS) by USEPA Methods 160.1, 300.0, 310.1, 350.2, 353.2, 375.4, 376.2, and SM4500CL.

In addition groundwater within each of the monitoring wells was monitored *in situ* using a YSI 600 Series Field Monitoring System, or equivalent, for the following field parameters prior to purging:

- Dissolved oxygen
- Redox potential
- Specific conductance, and
- pH.

5.0 RI DATA EVALUATION

5.1 QUALITY ASSURANCE AND QUALITY CONTROL MEASURES

The Quality Assurance and Quality Control (QA/QC) Program was implemented in accordance with the Quality Assurance Project Plan (QAPP) that was presented as Appendix B to the RIWP. Quality control samples collected in the field included trip blanks, field duplicate samples, and equipment/field/rinseate blanks, as described in the FSP and QAPP. The data for the various blanks were reviewed as part of the laboratory data review.

5.2 REVIEW OF FIELD DATA COLLECTION PROCEDURES

Throughout the RI field investigation, an IEC representative was present onsite to review and observe field procedures used by the SIC, as described in Section 4.0 of the *Draft RIWP Fieldwork Report*. In addition, the onsite IEC representative provided clarification regarding requirements of the RIWP, FSP and QAPP, if need arose, and provided direction and approval regarding sampling locations, redrilling of borings, and other similar matters requiring field decisions. Where actual procedures deviated from those described in the RIWP, such as abandoning a refused boring, increasing the PID trigger concentration, or changing a laboratory analytical procedure, the deviations were approved by the IEC field representative.

The RI field investigations were conducted in substantial accordance with the provisions of the RIWP, FSP, and QAPP. Where field conditions necessitated deviations from the provisions of the plans, the onsite IEC representative pre-approved those field deviations.

The following sections summarize field QA/QC procedures implemented during the RI field investigation.

5.2.1 Field Data

All field observations made regarding drilling and sample collection were recorded by qualified, experienced and approved environmental scientists in page-numbered field log books. Information recorded in the log books included:

- Site location reference
- Field conditions
- Relevant boring ID
- Name of supervisor
- Field team members names and relevant responsibilities
- Changes in personnel and/or responsibilities
- Date and time of observation or activity
- Deviations from procedures described in the FSP or QAPP
- Sample information including type, ID, location/depth sampled

- Type of sample collected and equipment used
- In the case of trenching, basic sketch marked with relevant depth and length measurements, geological description and general observation notes; and
- PID measurements.

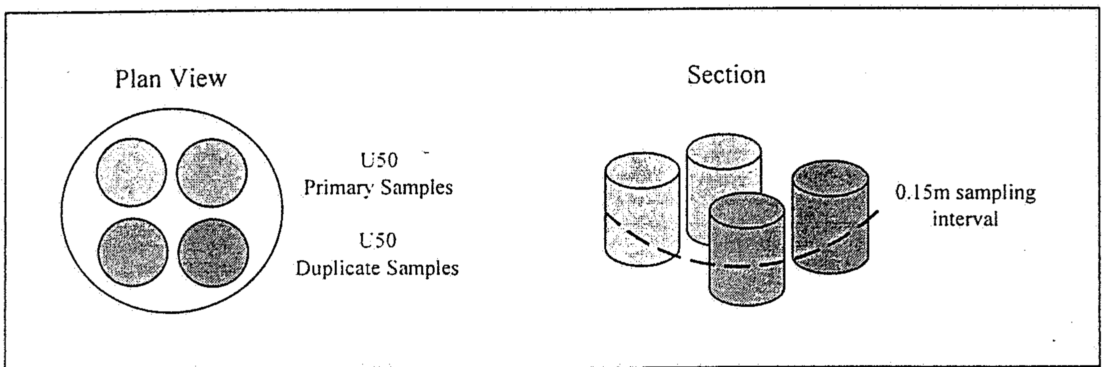
Further, each supervisor used a digital camera to visually record site conditions prior to, and at the completion of, each boring, and photos were taken of each sample collected.

Upon completion of each boring/trench, supervisors constructed a borehole/trench log and submitted the log to the SIC for review and electronic reproduction. Borehole/trench logs, produced with the information required by the FSP (Section A.6.2), are included in the SIC's *Site Investigation Report* and *RIWP Fieldwork Report.*

5.2.2 Field Duplicates and Field Splits

Field duplicate and field split samples were collected to evaluate sampling and analytical precision. The RIWP stipulated that soil samples totaling 5% of the number of primary samples collected were to be submitted to the laboratory as 'Duplicate' samples and another 5% were to be submitted as 'Field Splits'. The duplicate samples were labeled as 'QC' samples and were analyzed in Hong Kong, and the field splits, labeled as 'IEC' samples, were analyzed by an independent laboratory in Australia.

Purely for sample accuracy and ease of sampling, U50 duplicate and field split soil samples (QC and IEC samples) were most often collected from the 0.15m interval, as depicted in the following figure.



By performing the sampling at the surface, all four sample tubes were collected from the same interval, providing a high degree of accuracy. In some instances, duplicates were collected from the 0.75m interval.

5.2.3 Chain of Custody Documentation

At the end of each day, each supervisor completed Chain-of-Custody (COC) forms for the samples they collected that day. IC onsite personnel checked each COC form before relinquishing the samples to ALS. The onsite IEC representative also performed a random double check of the COCs. At days end, samples, with accompanying COC forms, were collected from the site by ALS HK and transported in iceboxes to the lab for analysis.

5.2.4 Equipment Decontamination Protocol

Once a boring or trench was completed, all equipment used in completing that boring/trench, including drilling and sampling equipment, hand auger, the backhoe bucket etc., was decontaminated prior to use on the next location. After every sample was collected, the sampling equipment, such as the slide-hammer sampler, split-spoon sampler and all associated parts were subjected to the same decontamination protocol. Decontamination stations were set up around the site to facilitate this process whereby a large wastewater holding tank was used to collect decontamination fluids. All equipment was either steam cleaned or hand washed in a non-phosphate cleaning solution, double-rinsed in potable water and final rinsed with deionized water then air dried.

5.2.5 Field Equipment Blanks

At the beginning of the sampling program in late June 2001, as per QAPP, one field equipment blank was collected for every 20 samples collected. However, by mid July 2001 there were six drill crews working and an excessive number of equipment blanks were being submitted for analysis. As a result, the IEC amended the number of equipment blanks required to two per day; these blanks were randomly selected by IC site staff from two independent drilling crews.

5.2.6 Trip Blanks

A trip blank, consisting of a 40 ml vial of distilled/carbon-free water, accompanied each cooler of sample containers from the site to the laboratory. The laboratory supplied the trip blanks.

5.2.7 PID Calibration

Prior to commencement of work each day, each PID was calibrated to isobutylene span gas at 100 ppm in air. Calibration was performed by ALS Lab Technicians and recorded on calibration log sheets. The PIDs used on site were equipped with lamps having energy of at least 10.6 eV.

5.2.8 Calibration of Groundwater Field Monitoring Equipment

As required by HOKLAS, calibration of all groundwater field monitoring equipment was performed in two steps. Each instrument was first calibrated to a standard solution; this calibration was then checked against a another standard solution with the same concentration but made by a different manufacturer.

Monitoring of groundwater field parameters was performed using the following equipment:

- TPS WP80D pH meter
- YSI 85D meter for temperature, redox potential, conductivity and dissolved oxygen
- YSI 600XLM for pH, temperature, redox potential, conductivity and dissolved oxygen; and
- Hach turbidity meter.

The following table lists the brands and composition of standards used in the calibration of each instrument:

Parameter	Calibration Standard Made By		Standard Composition
	1st Check	2nd Check	
pH	RDH	Merck	Calcium carbonate
			Phosphate buffer
			Sodium and potassium salt
Turbidity	RDH	Merck	Hydrazine sulfate
			Hexmethylenetetramine
Redox	Disposed if fail to comply	RDH	Ferrous ammonium sulfate
			Ferric ammonium sulfate
			Sulfuric acid
			Potassium ferrocyanide
			Potassium ferricyanide
			Potassium chloride
Conductivity	RDH	Merck	Potassium chloride
DO	Air calibration: 100% saturated - RDH	--	Alkaline-azide-iodide
			Sulfuric acid

Prior to groundwater monitoring and/or sampling, ALS HK staff performed all calibration under the supervision of an experienced environmental scientist. The results of each calibration were recorded on a calibration log.

5.3 LABORATORY DATA VALIDATION

Laboratory data from the RI were reviewed to evaluate whether the data are of sufficient quality to support project data quality objectives (DQOs) for characterization of the nature and extent of contamination and to support the risk assessment. The data review focused on two specific DQOs:

- To determine if the data were of acceptable quality (i.e., the data are not rejected), and
- To determine if any of the data reported at or above the Dutch 'B' Guideline values were impacted by sample contamination problems reflected by blank contamination.

Based on these two specific DQOs, most results of quality control samples indicate appropriate sample collection and handling procedures, and suggest little matrix interference for the samples analyzed.

The laboratory data were reviewed for the quality of data reported in the following areas:

- Holding times (except dioxin/furan data)
- Blanks
- Laboratory control samples

- Laboratory duplicate samples
- Matrix spike/matrix spike duplicates, and
- Surrogates (as applicable).

Findings of the IEC's review of these criteria resulted in the identification of the following data quality issues:

- 2-Butanone, 1,2,3,7,8-PentaCDD, 1,2,3,4,6,7,8-HeptaCDD, and 2,3,7,8-TetraCDF were detected in associated laboratory method blanks. Consequently, sample results which were greater than the Dutch 'B' values for 2-butanone in 36 primary soil samples were qualified as anomalous (U). In addition, the reported results for 1,2,3,7,8-PentaCDD in two primary soil samples, 1,2,3,4,6,7,8-HeptaCDD in one primary soil sample, and 2,3,7,8-TetraCDF in one primary soil sample were qualified as anomalous (U).
- TPH in the carbon chain range C_{19}-C_{22}, chromium, di-n-butyl phthalate, molybdenum, nickel, tributyltin, vanadium, and zinc were detected in laboratory method blanks. Consequently, sample results that were greater than the Dutch 'B' values for carbon chain C_{19}-C_{22} in one primary aqueous sample, chromium in 27 primary and three duplicate soil samples, di-n-butyl phthalate in one primary aqueous sample, molybdenum in two primary aqueous samples, nickel in two primary aqueous samples, tributyltin in three primary soil samples, vanadium in two primary aqueous samples, and zinc in eight primary aqueous samples and 16 primary and two duplicate soil samples were qualified as anomalous (U).
- Due to holding time issues, the data for PCBs in three aqueous blanks, for hexavalent chromium in two aqueous blanks and one primary aqueous sample, and for tributyltin in seven aqueous blanks, two primary aqueous samples, and eight primary soil samples were qualified as rejected (R).
- The data for PCBs in one primary soil sample and tributyltin in 113 primary and seven duplicate soil samples were qualified as rejected (R) due to very low surrogate recoveries.
- The data for 1,2,3,4,7,8-HexaCDD in three primary soil samples, 1,2,3,4,7,8-HexaCDF in one primary sample, and for 1,2,3,4,6,7,8-HeptaCDF in two primary soil samples were qualified as rejected (R) due to very low internal standard/surrogate recoveries.
- Due to matrix spike recovery issues, the data for tributyltin in eight primary soil samples were qualified as rejected (R).

The results of the data review were documented on data review checklists in the project file. Data validation flags have been added to those data that did not meet acceptance criteria.

Based on the validation performed more than 99 percent of the data are useful in characterizing the nature and extent of contamination at the site and to support the human health and ecological risk assessments for the site. Data qualified as anomalous (U) should be considered a non-detect, given the adjusted reporting limit. Data reported as rejected (R) are not used for site evaluation. Qualified data are presented along with all the data results in PDF files included on a CD in Appendix A.

5.4 DATA MANAGEMENT

Analytical sample data were received via e-mail in an electronic data deliverable (EDD) from the contracted laboratories. The EDD for all laboratories was produced in Microsoft Excel. Once received, it was imported by means of a custom import algorithm into a relational database system constructed on a Microsoft FoxPro platform. This algorithm screens the data for structural, format, and common data errors and does not allow data to be imported until any errors detected are resolved. The data were then segregated into primary and quality control data (i.e., field duplicates, equipment blanks, trip blanks, and field blanks).

A data quality review was performed on the analytical data, which included comparing the data received electronically with the data received in a hardcopy format. Discrepancies between the two formats were resolved and qualifiers applied to the data were manually entered into the electronic data repository. Any changes to the data or applied qualifiers were then reviewed for proper entry.

The data were then subjected to risk and statistical analysis, compared to regulatory criteria, selected and formatted for reporting. All analyses, calculations, and comparisons were checked for accuracy. Security was maintained throughout the process. All procedures adhered to those submitted in the project QAPP.

6.0 NATURE AND EXTENT OF CONTAMINATION

6.1 SOIL SCREENING LEVELS

As described in Section 1.4, environmental assessment and remediation at the CLS site shall be conducted in accordance with both Hong Kong environmental law and standards and appropriate U.S. environmental laws and risk-based corrective action approach. The RI has been conducted using an integrated approach that addresses both Hong Kong and U.S.-based standards and approach to decision making regarding site remediation.

6.1.1 Initial Screening Levels

Dutch 'B' Guidelines

For the initial evaluation and interpretation of the nature and extent of contamination at the site, the Dutch 'B' Guidelines have been used to identify areas of the site that have been impacted by chemical contaminants above concentrations of concern. The Dutch 'B' Guidelines are recommended by EPD as general guidelines in Hong Kong to determine if soils are contaminated at levels that require remediation (*Practice Note for Professional Persons, Contaminated Land Assessment and Remediation* [ProPECC Note PN 3/94, March 1994]). The Dutch 'B' Guidelines are conservative values that are considered "good for all uses" with respect to planned land use. As the EPD generally requires remediation of soil contamination above the Dutch 'B' Guidelines, and since the agreed-upon approach requires that both Hong Kong and U.S.-based standards shall apply, the Dutch 'B' Guidelines are the primary screening tool used for the RI data evaluation. For detected chemicals for which there are applicable Dutch 'B' Guidelines, these values were used in preference over other standards or guidance. Dutch 'B' values are shown in Table 6-1.

USEPA Region IX PRG Values

For chemicals detected at the CLS site that are not included in the Dutch 'B' Guidelines, such as hexavalent chromium and tributyltin, we have used USEPA Region IX Residential Preliminary Remediation Goals (PRGs). PRG values are useful risk-based tools for evaluating and cleaning up contaminated sites. They are based on "standard" exposure factors to estimate concentrations of contaminants in soil that are considered protective of humans, including sensitive receptors, over a lifetime exposure. As such, they are conservative values that are considered protective of human health and the environment based upon residential land use and a level of risk of one-in-a-million (1 x 10^{-6}) or a noncarcinogenic hazard quotient of one (1). Residential PRG values were chosen rather than values presented for industrial land use, consistent with the conservative nature of the Dutch 'B' Guidelines "good for all uses" philosophy. Applicable PRG values are shown in Table 6-1.

Screening Levels for Dioxins

For dioxins, which have been detected associated with burn pit residues at the CLS site, two values were considered: 1.0 microgram per kilogram (µg/kg, equivalent to 1 part per billion, ppb) and 0.1 µg/kg (equivalent to 100 parts per trillion, ppt) of dioxin "toxicity equivalents" (TEQs). TEQs are derived from toxicity equivalency factors (TEFs) of individual dioxin compounds in relation to that for 2,3,7,8 tetrachlorodibenzo-p-dioxin (TCDD), which is the most toxic and potent carcinogen among dioxin congeners. These TEFs range from 0.001 to 1.0. The TEQ for a given sample result is calculated by multiplying the concentrations of the various congeners detected in the sample by their respective TEF and summing the results. To be consistent with health risk assessment practice, a value of one-half the reporting limit is used for congeners not detected in samples that contain other detected dioxin congeners.

The 1.0 µg/kg value is based upon USEPA Office of Solid Waste and Emergency Response (OSWER) Directive 9200.4-26, *Approach for Addressing Dioxin in Soil at Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) and Resource Conservation and Recovery Act (RCRA) Sites*, April 13, 1998. In this Directive, the USEPA recommends a value of 1.0 µg/kg dioxin TEQs as a PRG or starting point for setting cleanup levels for residential exposures, unless extenuating site-specific circumstances or more stringent applicable or relevant and appropriate requirements (ARARs) indicate a more conservative value is warranted. This 1.0 µg/kg value equates to a 2.5×10^{-4} risk level, which is slightly above the upper end of the risk range of 1×10^{-6} to 1×10^{-4} normally considered acceptable for risk management decisions. The 2.5×10^{-4} risk level equates to an excess cancer risk of 2.5 in 10,000, as compared to risks of 1 in 1,000,000 to 1 in 10,000 that equate to the 1×10^{-6} to 1×10^{-4} acceptable risk range. The IEC understands that EPD has professed in recent meetings an initial preference for following the USEPA OSWER Directive 9200.4-26 cleanup value of 1.0 µg/kg for sites in Hong Kong.

The IEC also considered a cleanup level of 0.1 µg/kg TEQs, or 100 ppt, based on more recent information from USEPA. As noted in OSWER Directive 9200.4-26, the USEPA is conducting a comprehensive reassessment of the toxicity of dioxin and dioxin-like compounds that represents an Agency-wide effort to evaluate all the available information about dioxins. The results of the reassessment indicate that dioxin may be approximately 10 times more toxic and carcinogenic than originally estimated, resulting in an approximate ten-fold increase in the cancer slope factor (USEPA Office of Research and Development, Washington D.C., Information Sheet 2, *Dioxin: Scientific Highlights from Draft Reassessment (2000)*, May 25, 2001 Update). Based upon the IEC's communication with USEPA toxicologists, USEPA is now considering using the higher (i.e., more conservative) slope factor for dioxins. This would result in an approximate order-of-magnitude lower recommended cleanup level nearer to 0.1 µg/kg TEQ, or 100 ppt dioxin TEQ. This more conservative stance was confirmed in communications with the USEPA Region IX Regional Toxicologist responsible for establishing USEPA Region IX PRGs and USEPA Superfund Headquarters personnel. The OSWER Directive states that EPA should review Records of Decision (RODs) or Action Memoranda promptly after release of the dioxin reassessment report and, if necessary, make changes to cleanup requirements for sites cleaned up to 1 µg/kg TEQs based on the 1998 OSWER Directive. The IEC understands USEPA is now evaluating the significance of sites that were remediated using the 1.0 µg/kg cleanup level with respect to dioxin reassessment and is considering lowering the cleanup level for residential land use based on the new cancer slope factor.

Considering the direction that USEPA is moving with regard to dioxin cleanup guidelines, and in full consideration of EPD's general recommendations, the IEC has adopted a dioxin soil screening level of 0.1 µg/kg TEQ (100 ppt) for evaluation of the nature and extent of contamination. This 0.1 µg/kg screening level corresponds to an approximate 1×10^{-5} risk level using the old cancer slope factor and a risk of approximately 1×10^{-4} based on the higher cancer slope factor. In selecting this dioxin soil screening level, the IEC notes that a 1×10^{-5} risk level is commonly used in the U.S. as a safe exposure level or cleanup level in risk-based environmental decisions. In fact, California's Safe

Drinking Water and Toxic Enforcement Act defines "no significant risk" as an exposure corresponding to a 1×10^{-5} risk level. This level of risk is consistent with the conservative nature of the Dutch 'B' Guidelines and USEPA Region IX PRG values used as screening levels for other COPCs.

6.1.2 Health-Risk Based Values

As part of this RI, the IEC has also conducted a health risk assessment to establish risks posed by COPCs detected at the site under existing site conditions and considering placement of fill soils at the site prior to development of the infrastructure elements described in Section 1.3. Findings of the risk assessment are presented in Section 7 of this report. As discussed in Section 7, under baseline conditions risks associated with exposure to COPCs that exceed their respective Tier 1 screening levels would result in an unacceptable risk to potential receptors.

6.2 SUMMARY OF FIELD OBSERVATIONS REGARDING PRESENCE OF IMPACTS FROM FORMER SHIPBUILDING OPERATIONS

6.2.1 Organic Vapor Monitoring

Organic vapors were monitored using PIDs as described in Section 4.2. If a PID reading exceeded 30 ppm, drilling was continued to the next sampling interval. Tabulated below is a list of samples that registered PID readings in excess of 30 ppm.

Boring/Trench ID	Sample Depth Range (m bgs)	Sample Date	VOC Concentration by PID (ppm)
Boring D1	1.85 – 2.04	13 July 01	49.5
	2.04 – 2.14	13 July 01	54.2
Boring D4	1.64	13 July 01	147.0
Boring D5	1.47 – 1.63	13 July 01	151.0
Boring D6	0.98 – 1.03	6 Aug 01	132.0
	1.72 – 1.77	6 Aug 01	117.0
Boring D8	0.31 – 0.34	12 Jul 01	53.1
	0.80 – 0.83	12 Jul 01	123.0
	1.62 – 1.62	12 Jul 01	77.7
	2.0 – 1.02	12 Jul 01	47.1
Boring D25	1.65 – 1.75	7 Sept 01	87.7
Trench IEC-T19 (5-6)	1.3	22 Sept 01	54.1
Trench IEC-T20 (5-6)	3.5	26 Sept 01	120.0
Trench IEC-T21 (3-4)	1.4	29 Sept 01	60.0
Trench IEC-T22 (3-4)	1.1	21 Sept 01	40.7
Trench IEC-T33 (3-4)	4.6	15 Sept 01	60.0
Trench IEC-T37 (5-6)	0.8	18 Sept 01	60.4

Boring samples with elevated organic vapor concentrations relative to the field-adjusted criterion of 30 ppm were all collected from within or immediately adjacent to the aluminum smelter room at the rear of Building D (Area 1). As documented in the RIWP, this area of Building D had significant apparent hydrocarbon staining and a coating of dark grayish black material. A hydrocarbon sheen was noted on the water table in the vicinity of this room, and up to a 3 mm-thick layer of floating hydrocarbon product was observed and measured in Well B-D26. Strong hydrocarbon-like odors were noted in each of the borings in this area of the site.

Trench samples with PID readings in excess of 30 ppm were all collected from within or immediately adjacent to burn pits. In all cases, elevated PID readings were accompanied by a strong hydrocarbon odors.

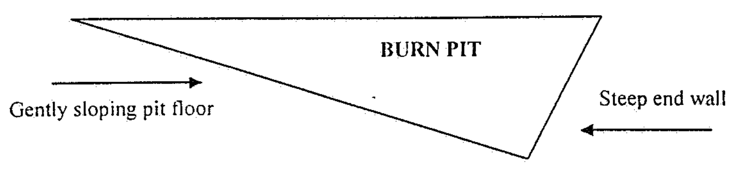
6.2.2 Burn Pits

The trenching program exposed many burn pits in Areas 2 and 3 of the site, some up to 36m in length (IEC-T3 (1-8)) and greater than 4m deep (IEC-T19 and T20). Burn pits had an almost uniform composition containing predominantly brown, dark brown, dark gray and black soil and ash mixed with smaller percentages of waste materials, including:

- Waste metal scrap such as corroded 44-gallon drums, machined filings, discarded metal boat parts, metal 'rope-like' cable, electrical cable, and metal piping
- Marine batteries
- Discarded cloth and clothing
- Corrugated asbestos sheeting
- Various chemicals and paints occurring in the form of burnt 'honeycomb-like' balls, some of which were colored and odorous
- Plastic sheeting
- Audio tape
- Wood
- Clay building bricks
- Fiberglass matting, and/or
- Rubber tires.

Many of the pits appeared to be purposely excavated with most having a gently sloping base and one steep end wall, typical of bucket excavated holes.

General Shape of Burn Pits



It was also common for pits to have a broad 'V-shaped' base, such as exposed in IEC-T22 (3-4). Another construction variation is evidenced by the burn pit exposed in Trench IEC-T3 (1-8), which was apparently created as a shallow (<1m bgs) 'flat-bottomed' pit, then covered with a thin (<10 cm) cover of apparently clean fill.

It appeard as though the aforementioned waste was simply dumped or pushed into the pits, ignited, then covered with fill material.

6.2.3 Waste Pits

Construction of additonal pits or lateral extension of existing burn pits also appears to have been a method of waste disposal in Areas 2 and 3. The waste in these pits did not appear to be burned. Trench IEC-T13 (1-2) intersected a 1.8m deep pit apparently constructed specifically for disposal of waste scrap metal and steel cables. Moreover, a 0.5m-thick layer of black sandy gravel containing aluminum plate and other waste metal filings was exposed between 0.7 and 1.1m bgs in trench IEC-T31 (5-6). This waste material, which appears similar to casting sand seen in Building L, appeared to have been dumped in a specifically constructed pit and then buried beneath a layer of apparently clean fill material. Other waste pits contained predominantly clay bricks (IEC-T12 (5-6)), wood (IEC-T34 (1-2)) and general site waste including fiberglass (IEC-T36 (5-6)).

6.3 GEOPHYSICAL INVESTIGATION FINDINGS IN AREA 3

Cosine classified geophysical targets identified from interpretation and reduction of the survey data into three main categories based on conductivity and their ferrous (magnetic) properties: ferrous, non-ferrous metallic, and non-metallic. Each category was then further subdivided into three categories based on electrical conductivity measurements: low, mean, and high ground conductivity. This resulted in definition of nine categories of ground conditions. These categories are shown on Drawing 13 to Cosine's final report (Appendix B), with color-coding and patterns used to differentiate different interpreted sources.

The geophysical ground conductivity survey results are indicative of former site topography prior to land reclamation within Area 3 of the site. Ground conductivities are lowest in the central part of the area over the cut bedrock platform and against the cut slope along the northeast margin of the site. Conductivities increase toward the bay due to increased salinity of groundwater and in the northwestern and southeastern part of the area over the reclaimed former marine areas. The frequency and distribution of magnetic sources, identified from the magnetics survey, are consistent with this interpretation of former topography, with the greatest number of magnetic detections in reclaimed fill areas and along the periphery of the cut platform area around the former coastline.

Cosine interpreted the results of the geophysical survey to subdivide the site into a number of source zones. A total of 13 groups of sources were identified and described in Cosine's report. These groups of sources are shown on Drawing 13 (Appendix B). Some of these sources were due to buried infrastructure elements, such as buried cables and pipes, while others were inferred to be potential buried waste materials. Findings of the geophysical survey were used to select exploratory trench locations, and many of the identified geophysical targets proved out to be due to buried metallic debris and burn pits where waste materials were burned and later buried.

6.4 SOIL CONTAMINATION

Findings of the RI field and laboratory investigations reveal that soils at the CLS site have been impacted by various COPCs, including: metals (principally lead, copper, chromium, nickel and zinc with lesser impacts by arsenic and barium); petroleum hydrocarbons; semi-volatile organic compounds (SVOCs); dioxins, and to a lesser extent locally by cyanide and polychlorinated biphenyls (PCBs). A summary table containing all analytical results for all soil samples analyzed is included on a CD attached as Appendix A to this document. Analytical results of samples from Areas 1, 2, and 3 of the site with one or more analytes that exceed the screening criteria discussed in Section 6.1 above are presented in Tables 6-2, 6-3, and 6-4 and summarized in the following sections.

6.4.1 Area 1

Soil in Area 1 has been impacted by various COPCs at concentrations exceeding screening criteria, including metals (principally lead, chromium, copper, and nickel), hydrocarbons, and SVOCs. Chemical compounds exceeding Dutch 'B' Guidelines were detected in multiple buildings from Area 1, including Buildings B, D, I, J, L, M, N, O, and P (Table 6-2). The most significant impacts occur in Buildings B (metals, including hexavalent chromium, and cyanide), D (fuel hydrocarbons, SVOCs, and metals), and L (metals). The locations of all investigative borings and wells within Area 1 are identified on Figure 6-1 with a shaded symbol to indicate sample locations where COPC(s) exceeded screening criteria. A shaded triangular interior pattern within a circle is used to indicate classes of COPCs exceeding screening criteria at each location indicated.

Metals

In general, metals impacts within Area 1 are shallow, occurring in the upper ½ to 1m of soil. However, metals impacts beneath Building B, the former plating and anodizing building, occur to depths of greater than 3m, and metals impacts to approximately 2m were identified in portions of and adjacent to Buildings J, L, and M. In addition, copper was detected in a number of borings advanced between buildings at concentrations in excess of Dutch 'B' Guidelines. The source of the copper found in these areas is unknown. The following table summarizes the specific metals, that exceeded Dutch 'B' and/or PRGs, and the maximum concentration detected.

Summary of Metals Exceedances
Area 1

COPC	Number of Samples Analyzed	Dutch 'B' Guideline (mg/kg)	Number of Samples Exceeding Dutch 'B' Guideline	USEPA Residential PRG (mg/kg)	Number of Samples Exceeding PRG	Maximum Detected Concentration (mg/kg)	Sample with Maximum Concentration
Antimony	702	Na		31	1	66.6	B-L26/0.0-0.16m/1
Arsenic	702	30	3	0.39	523	54.4	AB15/0.78-0.93m/3
Barium	702	400	3	5,400		1,100	OB-5/0.15-0.25m/1
Cadmium	702	5	4	37		18.1	B-L24/0.0-.016m/1
Chromium	702	250	17	210	19	2,670	B-B23/0.13-0.29m/1
Cobalt	702	50	2	4,700		70.3	B-L25/0.0-0.13m/1
Copper	702	100	56	2,900	3	7,680	AB-25/0.08-0.23m/2
Hexavalent Chromium	208	na		30	7	392	AB-14/0.05-0.30m/1
Lead	702	150	31	400	18	26,300	B-L26/0.0-0.16m/1
Nickel	702	100	39	1,600	1	1,780	B-B24/0.68-0.83m/3
Tin	702	50	1	47,000		139	B-N2/0.07-0.22m/1

Summary of Metals Exceedances Area 1							
COPC	Number of Samples Analyzed	Dutch 'B' Guideline (mg/kg)	Number of Samples Exceeding Dutch 'B' Guideline	USEPA Residential PRG (mg/kg)	Number of Samples Exceeding PRG	Maximum Detected Concentration (mg/kg)	Sample with Maximum Concentration
Zinc	702	500	16	23,000		9,090	AB-25/0.08-0.23m/2

Hydrocarbons and Semi-Volatile Organic Compounds

Soils containing hydrocarbons in excess of Dutch 'B' Guidelines were detected beneath several buildings, including Buildings D, I, L, N, and P; as well as in roadways. The most significant hydrocarbon impacts occur beneath Building D, where soil and groundwater have been impacted by fuel hydrocarbons. In addition, soils in Area 1 contained a number of SVOCs including naphthalene, 2-methylnaphthalene, dibenz(a,h)anthracene, phenanthrene, and benzo(a)pyrene at concentrations in excess of either Dutch 'B' values or PRGs. The following table summarizes the detections of hydrocarbons and SVOCs that exceeded Dutch 'B' and/or PRG standards.

Summary of TPH and SVOC Exceedances Area 1							
COPC	Number of Samples Analyzed	Dutch 'B' Guideline (mg/kg)	Number of Samples Exceeding Dutch 'B' Guideline	USEPA Residential PRG (mg/kg)	Number of Samples Exceeding PRG	Maximum Detected Concentration (mg/kg)	Sample with Maximum Concentration
2-Methylnaphthalene	312			56	1	60.7	B-D4/1.45-1.61m/6
Benzo(a)pyrene	312	1		0.062	10	0.552	B-L31/0.0-0.16m/1
Dibenz(a,h)anthracene	312			0.062	2	0.089	B-D25/1.40-1.65m/5
Phenanthrene	312	10	4	3,700		21.6	B-D6/1.37-1.62m/4
Naphthalene	694	5	4	56		20.8	B-D6/1.37-1.62m/4
Carbon Chain => C_{15}	787	1,000	37			22,700	AB-39/1.35-1.60m/5
Carbon Chain C_6 - C_{14}	787	100	27			7,030	B-D4/1.45-1.61m/6

Dioxins

There is one small area east of Building L, at the base of the slope across a concrete-lined drainage channel, where dioxins were detected in association with a location formerly used to burn plastic insulation from wire. The near surface sample collected from Boring B-M06 contained approximately 6 µg/kg TEQ of dioxins.

Summary of Dioxin Exceedances
Area 1

COPC	Number of Samples Analyzed	Dutch 'B' Guideline(mg/kg)	Number of Samples Exceeding Dutch 'B' Guideline	IEC Adopted Screening Level (µg/kg)	Number of Samples Exceeding Screening Level	Maximum Detected Concentration (µg/kg)	Sample with Maximum Concentration
Total I-TEQ with 1/2 RL	11	na	na	0.1	1	6.0	B-M6 / 0.00-0.16/1&2

6.4.2 Area 2

Various COPCs, including metals, hydrocarbons, SVOCs, PCBs, and dioxins have impacted soils within Area 2. Environmental impacts revealed in Area 2 appear to be associated with operations in portions of Buildings R, S, T, W, X, Y, and Z; areas adjacent to several buildings; and in waste disposal mounds and pits located east of Buildings S and T (Table 6-3).

A significant portion of the impacted soil occurs along the northeastern margin of Area 2, where field observations and/or geophysical anomalies indicated the presence or possible presence of buried waste. A number of trenches (T2 through T10 and IEC-T1 through IEC-T6) were advanced in Area 2 to explore the subsurface for buried waste. Buried waste and buried burn pits were discovered in a number of trenches, and analytical testing of samples collected from the trenches indicated the presence of elevated concentrations of heavy metals, hydrocarbons, and dioxins (see Section 6.6). The locations of all investigative borings, wells, trenches, and burn pits (as interpreted by the SIC, Vibro) within Area 2 are shown on Figure 6-2 with a shaded symbol to indicate sample locations where COPC(s) exceeded screening criteria. A shaded triangular interior pattern within a circle is used to indicate classes of COPCs exceeding screening criteria at each location indicated.

Metals

Soils containing metals at concentrations in excess of Dutch 'B' Guidelines occur within and/or adjacent to Buildings R, S, T, V, and W; in roadways; and in several trench locations. The most significant metals impacts occur in trenches and borings advanced in the open area north and northeast of Buildings S and T. In general, metals impacts associated with the buildings and roads are shallow, occurring in the upper meter of soil. However, metals impacts in the trenches occur to depths of greater than 2.5m. The following table summarizes the specific metals detected which exceeded screening levels and the maximum concentration detected.

Summary of Metals Exceedances
Area 2

COPC	Number of Samples Analyzed	Dutch 'B' Guideline (mg/kg)	Number of Samples Exceeding Dutch 'B' Guideline	USEPA Residential PRG (mg/kg)	Number of Samples Exceeding PRG	Maximum Detected Concentration (mg/kg)	Sample with Maximum Concentration
Arsenic	540	30		0.39	251	24.8	T8/0.25m/1
Barium	540	400	16	5,400		3,290	T9/1.17m/1
Cadmium	540	5	6	37		12.9	IEC-T2(1-8)/2.5m/7
Chromium	540	250	8	210	10	672	T8/0.25m/1

Summary of Metals Exceedances
Area 2

COPC	Number of Samples Analyzed	Dutch 'B' Guideline (mg/kg)	Number of Samples Exceeding Dutch 'B' Guideline	USEPA Residential PRG (mg/kg)	Number of Samples Exceeding PRG	Maximum Detected Concentration (mg/kg)	Sample with Maximum Concentration
Cobalt	540	50	3	4,700		67.8	T8/0.25m/1
Copper	540	100	55	2,900	16	27900	IEC-T2(1-8)/2.5m/7
Lead	540	150	28	400	21	4,630	IEC-T2(4-5)/1.0m/21
Nickel	540	100	14	1,600		728	IEC-T2(6-7)/0.3m/31
Tin	540	50	9	47,000		232	IEC-T2(1-8)/2.5m/7
Zinc	540	500	22	23,000		6,840	IEC-T2(1-8)/2.5m/7

Hydrocarbons and Semi-Volatile Organic Compounds

Soils containing hydrocarbons and SVOCs in excess of Dutch 'B' and/or PRG values were detected beneath several buildings; including Buildings S, T, V, W, and Z; as well as in several trenches (T-5, T-10, and IEC-T1). The following table summarizes the detections of hydrocarbons and SVOCs, which exceeded Dutch 'B' and/or PRG screening values.

Summary of TPH and SVOC Exceedances
Area 2

COPC	Number of Samples Analyzed	Dutch 'B' Guideline (mg/kg)	Number of Samples Exceeding Dutch 'B' Guideline	USEPA Residential PRG (mg/kg)	Number of Samples Exceeding PRG	Maximum Detected Concentration (mg/kg)	Sample with Maximum Concentration
Benzo(a)anthracene	286			0.62	6	1.67	B-Y4/0.08-0.23m/1
Benzo(a)pyrene	286	1	4	0.062	20	1.90	SD-21/0.80-0.94m/3
Benzo(b)fluoranthene	286			0.62	7	2.38	SD-21/0.80-0.94m/3
Bis(2-ethylhexyl) phthalate	286			35	1	46.0	B-S8/0.08-0.23m/1
Dibenz(a,h)anthracene	286			0.062	8	0.657	SD-21/0.80-0.94m/3
Indeno(1,2,3-cd)pyrene	286			0.62	6	1.51	SD-21/0.80-0.94m/3
Styrene (VOC)	269	5	1	1,700		6.30	T11/0.31m/1
Carbon Chain => C_{15}	579	1,000	11			14,200	T5/0.96m/3
Carbon Chain C_6 - C_{14}	579	100	5			2,280	B-S8/0.08-0.23m/1

Dioxins

Dioxins were detected in nine of the 22 samples analyzed from Area 2. The dioxins occur in the eastern corner of this area of the site where burn pits were found in exploratory trenches. The following table summarizes results of dioxin testing in Area 2, including the number of analyses, number of results exceeding the IEC adopted screening value of 0.1 µg/kg, and location of the maximum concentration detected.

Summary of Dioxin Exceedances Area 2							
COPC	Number of Samples Analyzed	Dutch 'B' Guideline(mg/kg)	Number of Samples Exceeding Dutch 'B' Guideline	IEC Adopted Screening Level (µg/kg)	Number of Samples Exceeding Screening Level	Maximum Detected Concentration (µg/kg)	Sample with Maximum Concentration
Total I-TEQ with 1/2 RL	22	na	na	0.1	8	3.0	IEC-T2(1-8) /2.5 /7 & 8

6.4.3 Area 3

Soils within in Area 3 have been impacted by various COPCs, including metals, hydrocarbons, and dioxins (Table 6-4). The majority of Area 3 was not formerly used for shipbuilding operations; rather, it apparently was used for disposal of wastes generated at the CLS facility. This is evident from the large number of burn pits and buried wastes that were uncovered in exploratory trenches excavated at the site. The SIC, Vibro, documented in detail the presence of these waste materials and burn pits extending to depths up to 4.8 meters. The extent of burn pits observed and documented by Vibro is indicated by a cross-hatched pattern on Figures 6-3 and 6-9.

A majority of the impacted soil in Area 3 occurs in buried waste disposal pits located in the southeastern half of the area. A number of trenches (IEC-T7 through IEC-T37) were advanced in Area 3 to explore the subsurface for buried waste. Buried waste and buried burn pits were discovered in a number of trenches, and analytical testing of samples collected from the trenches indicated the presence of elevated concentrations of heavy metals, hydrocarbons, and dioxins. A summary of observations of materials exposed in burn and waste pits is provided in Sections 6.2.2 and 6.2.3, above, and observations in individual trenches are summarized in Table 4-1.

The locations of all investigative borings, wells, trenches, and burn pits (as interpreted by the SIC, Vibro) within Area 3 are shown on Figure 6-3 with a shaded symbol to indicate sample locations where COPC(s) exceeded screening criteria. A shaded triangular interior pattern within a circle is used to indicate classes of COPCs exceeding screening criteria at each location indicated.

Metals

The following table summarizes the specific metals that exceeded Dutch 'B' and PRG values, and the maximum concentration detected in Area 3. Metals impacts in soils occur to depths in excess of 3m associated with the burn and waste pits. In addition, metals were found at concentrations exceeding the screening values in numerous samples collected from outside of identified burn pit areas within the upper meter of soil.

Summary of Metals Exceedances
Area 3

COPC	Number of Samples Analyzed	Dutch 'B' Guideline (mg/kg)	Number of Samples Exceeding Dutch 'B' Guideline	USEPA Residential PRG (mg/kg)	Number of Samples Exceeding PRG	Maximum Detected Concentration (mg/kg)	Sample with Maximum Concentration
Antimony	545			31	5	340	IEC-T20(5-6)/2.0m/13
Arsenic	545	30	5	0.39	286	114	IEC-T13(7-8)/2.4m/5
Barium	545	400	25	5,400		4,660	IEC-T20(3-4)/3.9m/5
Cadmium	545	5	11	37	1	118	IEC-T20(5-6)/2.0m/13
Chromium	545	250	22	210	26	5,390	IEC-T20(7-8)/4.5m/1
Cobalt	545	50	13	4,700		328	IEC-T9(8-9)/1.91m/17
Copper	545	100	97	2,900	39	28,100	IEC-T9(8-9)/1.91m/17
Hexavalent Chromium	253			30	1	30.4	IEC-T20(7-8)/4.5m/1
Lead	545	150	89	400	42	21,100	IEC-T20(5-6)/2.0m/13
Molybdenum	545	40	5	390	1	599	IEC-T9(8-9)/1.91m/17
Nickel	545	100	52	1,600	1	1,790	IEC-T9(8-9)/1.91m/17
Tin	545	50	18	47,000		3,650	IEC-T20(5-6)/2.0m/13
Zinc	545	500	64	23,000	3	35,700	IEC-T20(5-6)/2.0m/13

Hydrocarbons and Semi-Volatile Organic Compounds

The following table summarizes hydrocarbons and SVOCs detected in samples from Area 3 that exceeded Dutch 'B' and/or PRG values.

Summary of TPH and SVOC Exceedances
Area 3

COPC	Number of Samples Analyzed	Dutch 'B' Guideline (mg/kg)	Number of Samples Exceeding Dutch 'B' Guideline	USEPA Residential PRG (mg/kg)	Number of Samples Exceeding PRG	Maximum Detected Concentration (mg/kg)	Sample with Maximum Concentration
Benzo(a)pyrene	276	1		0.062	7	0.547	IEC-T12(1-2)/1.8m/7
Benzo(b)fluoranthene	276			0.62	1	0.660	IEC-T12(1-2)/1.8m/7
Bis(2-ethylhexyl) phthalate	276			35	1	563	IEC-T20(5-6)/2.0m/13
Dibenz(a,h)anthracene	276			0.062	3	0.169	B-Q15/0.24-0.39m/1
Hexachlorobenzene	276			0.30	1	1.00	B-Q15/0.24-0.39m/1
Indeno(1,2,3-cd)pyrene	276			0.62	1	0.669	IEC-T12(1-2)/1.8m/7
Phenol	276	1	1	37,000		1.30	B-Q15/0.24-0.39m/1
Carbon Chain => C_{15}	546	1,000	13			82,900	IEC-T20(5-6)/2.0m/13
Carbon Chain C_6 - C_{14}	546	100	9			5,580	IEC-T20(5-6)/2.0m/13

Dioxins

Dioxins were detected at concentrations in excess of the IEC adopted screening value of 0.1 µg/kg in 27 of 145 samples analyzed from Area 3. The dioxins occur in burn pits exposed in exploratory trenches. The following table summarizes results of dioxin testing in Area 3 with the number of analyses, PRGs, number of detections exceeding the IEC adopted screening value of 0.1 µg/kg, and location of the maximum concentration detected.

Summary of Dioxin Exceedances
Area 3

COPC	Number of Samples Analyzed	Dutch 'B' Guideline (mg/kg)	Number of Samples Exceeding Dutch 'B' Guideline	IEC Adopted Screening Level (µg/kg)	Number of Samples Exceeding Screening Level	Maximum Detected Concentration (µg/kg)	Sample with Maximum Concentration
Total I-TEQ with 1/2 RL	145	na	na	0.1	27	109	IEC-T37(6-5)/0.8/6

6.5 GROUNDWATER CONTAMINATION

Groundwater is not used as a potable water source in Hong Kong. As such, there are no specific cleanup levels specified for groundwater contamination. In practice, the Dutch 'B' groundwater values are used as screening levels to identify contaminant concentrations of potential concern. These incidents of contamination are then reviewed more closely and evaluated on a risk basis. Within Hong Kong this is a relatively straightforward exercise, as no formal risk assessment guidelines currently exist, and sites are evaluated on a case-by-case basis. Consistent with this process, a conceptual site model has been established and a formal risk assessment conducted to evaluate the level of risk, if any, associated with the detected groundwater contamination concentrations. The full risk assessment is presented in Chapter 7 of this report.

In light of the above, it is clear that any requirements for groundwater decontamination will be based on the findings of the risk assessment. However, in order to understand the relative extent of groundwater contamination across the site, the following sections present an area-by-area discussion groundwater investigation findings. A summary groundwater analytical results with detections exceeding Dutch 'B' values is included as Table 6-5.

6.5.1 Area 1

As defined previously, Area 1 comprises the original CLS site prior to any of the subsequent expansions. As such, it has the longest production history of the three site areas. Review of the data obtained from the 17 monitoring wells in Area 1 indicates the following:

Metals and Other Inorganic Contamination

Only localized groundwater contamination appears to exist in Area 1. In fact, only one well (MW-B24, located in the former electroplating area) exhibited metals contamination in excess of Dutch 'C' criteria. A groundwater sample from this was well had a nickel concentration of 7,200 µg/L, as well as concentrations of copper, zinc and chromium in excess of the Dutch 'B' criteria. It is interesting to note that none of the contaminants in this well were detected at levels above the Dutch 'B' criteria in either the adjacent (MW-B34) or downgradient (MW-OB02) wells. In terms of other occurrences of metals contamination, there were four other wells (MW-OB05, J07, D06 and B34) that exhibited barium concentrations in excess of the Dutch 'B' criteria.

Ammonia was detected in Well MW-OB02 at a concentration in excess of 9.0 mg/L. This is likely related to the Cheoy Lee office septic system, which although never located, must be in the vicinity of Building B where offices were located.

Organics Contamination

Hydrocarbon contamination was observed at low concentrations in a number of wells within Area 1. These include Wells MW-J07, L34, L06, D06, OB06, B24, B34, and P08. A review of the site reconnaissance information presented in the RIWP indicates that the likely hydrocarbon origins are as follows:

- MW-J07 – Spills related to the fuel supply for the small kiln area located in the northeast corner of Building I.
- MW-L34 and L06 – Spills related to the fuel supply for the foundry and adjacent fuel drum storage area located along western wall (exterior) of Building L.
- MW-D06 – Spills related to the fuel supply for the small kiln area located in the northwest section of Building D.
- MW-OB06 – Potentially could be related to dumping of waste fuels in the stormwater sewer adjacent to the well.
- MW-B34 and P08 – Spills related to vehicle maintenance, refueling and fuel storage activities which took place adjacent to both Buildings B and P. MTBE was also noted to be present in MW-B34, which is likely related to a gasoline release from the drum storage area adjacent to Building B. A low concentration of naphthalene was also detected in MW-B34, which, as a light weight PAH, is also likely related to the fuels or vehicle oils.

Based on a review of the borehole soil logs, only the area in the vicinity around MW-D06 appears to be impacted by petroleum hydrocarbon contamination at a level that may require some remediation. Floating product was reportedly observed in some of the boreholes in the vicinity of MW-D06, and there was a 3 mm layer of floating product measured in MW-D06 prior to its development. However, based on hydrocarbon analyses of post-development and post-purge groundwater samples, the overall concentrations in groundwater appear to be relatively low. It therefore appears that minimal solubilization of hydrocarbons into the groundwater has occurred and, as such, it is likely that the majority of the hydrocarbon impact is in the soils above the water table underlying Building D.

6.5.2 Area 2

Area 2 represents the central area of the site. Twenty monitoring wells were installed in Area 2, fourteen under the original RIWP program and six additional wells following the trenching program. A thorough review of the data indicates that groundwater contamination in excess of Dutch 'C' criteria was not detected for samples from any of the 20 wells.

Metals and Other Inorganic Contamination

Four wells exhibited metals-related groundwater contamination in excess of the Dutch 'B' criteria. These include AW-05 (zinc), AW-02 (zinc and barium), MW-S04 (zinc) and MW-S08 (molybdenum). Each occurrence of metals impact appears to be localized, as there is no appearance of similar levels of contamination in adjacent or downgradient wells.

Ammonia was detected in three wells (MW-U2A, OB13, and S08). There is no clear indication of the likely source of ammonia, nor are the impacted wells in close proximity to each other. The potential exists that it is related to septic system discharge or sanitary practices at the site. As such, ammonia impact is considered to be localized in the area of the individual wells.

Organics Contamination

Hydrocarbon contamination was observed in only one well (MW-OB11). The likely source of this contamination is unclear, although review of aerial photographs indicates that it may be related to the ship launching pulley system which historically was located to the west of the well location.

6.5.3 Area 3

Area 3 represents the section of the site southeast of the slipways adjacent to Building S. The central portion of Area 3 was formerly used as a large hull mold storage area, while the portion to the south was used historically as a construction staging area for the CLP Power plant, as well as a waste disposal area by CLS. There were 19 monitoring wells installed in Area 3. Two were installed as part of the original RIWP program, while the remaining 17 were installed based upon observations made during the Area 3 trenching program. None of the groundwater samples exhibited contamination in excess of compounds covered by the Dutch 'C' criteria, although two incidents of dioxin/furan contamination were observed. It should be noted that there is no applicable standard in Hong Kong for dioxin/furan, although the Region IX PRG for 2,3,7,8-TCDD in tap (potable) water is 4.5×10^{-7} µg/L or 0.45 pg/L.

Metals

Six wells exhibited metals-related groundwater impact in excess of the Dutch 'B' criteria. These include Wells MW-Q05 (zinc), MW-Q01 (zinc), AW-12 (barium), AW-13 (molybdenum), AW-16A (barium), and AW-20 (molybdenum). With the exception of the two zinc occurrences in MW-Q01 and Q05, which are both likely related to the maintenance/storage activities in and around Building Q, each occurrence of metal impact appears to be localized, as there is no appearance of similar levels of contamination in adjacent or downgradient wells.

Ammonia was detected in well AW-11, while tributyltin (TBT) was present in two wells (Wells AW-10 and 16). While there is no clear indication of the likely ammonia source, the TBT is likely due to the waste disposal/burning activities undertaken within in burn pits upgradient of the two wells.

Organics Contamination

Hydrocarbon contamination was observed in only one well (AW-18). The source of this contamination is unclear although review of aerial photographs indicates that it may be related to the CLP construction staging activities, which were located on this section of Area 3.

Dioxins were detected in groundwater samples from two wells within the burn pit area of Area 3 (AW-11 and AW-23). In both wells, individual dioxin congeners were not detected above reporting limits, and the TCDD TEQ value would be zero ignoring ½ reporting limit concentrations. Dioxin detections were limited to total Penta CDD, Penta CDF, Tetra CDD, and Tetra CDF (Table 6-5 and Appendix A). Dioxin detections in groundwater were isolated to the two wells, both of which were located adjacent to or downgradient of burn pits detected during the trenching program that had significant dioxin levels in soils/burn pit residues. The source of the dioxin is interpreted to be waste burning which took place in the burn pit located adjacent to and upgradient of each of the respective wells.

Review of field records reveals that the groundwater samples were not filtered in the field. Dioxins have a strong tendency to sorb to fine soil particles (organic solids are the primary site and to a lesser extent mineral solids). Given the low solubility of dioxins in water (19.3 ng/L @ 25° C for 2,3,7,8-TCDD) the likelihood of wide spread solubilization of dioxins seems very low. As such it is likely that the dioxins detected in samples from these two wells were related to colloidal or finely suspended particles within the groundwater samples.

There were no other organic contaminants detected in the samples from either Well AW-11 or AW-23, and metals were not reported above Dutch 'B' levels. Only ammonia was reported from Well AW-11 at a concentration slightly above its Dutch 'B' level.

No other wells adjacent to or upgradient of these wells exhibit dioxin contamination. As such, the occurrence is localized to the two wells, which also suggests that the source is localized to the adjacent burn-pit. Thus, lack of other contaminants in water samples from these two wells suggests that groundwater impacts in this area are not significant and are most likely due to sorbing of dioxins to fine organic or mineral solids within the water samples.

6.6 LATERAL AND VERTICAL EXTENT OF IMPACT EXCEEDING SOIL SCREENING LEVELS

The lateral and vertical extent of soils impacted by COPCs at concentrations that exceed Dutch 'B' Guidelines, USEPA PRGs, or 0.1 μg/kg dioxin TEQs in Areas 1, 2, and 3 of the CLS site, respectively are shown on the Conservative Excavation Plan on Figures 6-7, 6-8, and 6-9. Also shown on Figures 6-8 and 6-9 are areas that the SIC has interpreted to represent burn pits based on observations from exploratory trenches. The IEC has reviewed logs of trenches prepared by the SIC, and based on the documentation presented in the logs, we have only minor differences in interpretation from the interpreted locations of burn pits shown on these figures. These minor differences do not materially affect the interpretation of the lateral extent of impact in Areas 2 and 3 of the site.

The boundaries of impacted areas identified were established from the areal distribution of sample analytical results exceeding screening values. The evaluation of these data was conducted differently for Areas 1 and 2 from that used for Area 3. For Areas 1 and 2, where adjacent nearby borings indicate chemical concentrations exceeding relevant values, the intervening area between adjoining sample locations was included within the excavation area. The boundary between contaminated and non-impacted areas was generally chosen based on one-half the distance between a sample location with the exceeding value and the nearest sample location with chemical concentrations below the screening value. This ½-distance method generally was used where the distance between adjacent borings exceeded 10m (33 feet). In cases where adjacent borings were less than 10m apart (for example within some of the Buildings within Area 1), the boundary was drawn next to the closest non-impacted sample location. For instances where an isolated sample result exceeded screening levels, the boundary was arbitrarily drawn about 5m (16 feet) from the sample point producing a 10 by 10-m (33 by 33-foot) box around the impacted sample location. For Area 3, the entire portion of the area in which burn pits were found is identified for excavation, primarily due to the presence of dioxins with lesser influence by metals and hydrocarbons.

Conservatively estimated depths of impacted soils, based on results from the RI borehole and trench sampling, are indicated on Figures 6-7, 6-8, and 6-9 using various patterns. The type of pattern indicates the estimated depths of impact within each patterned area.

Chemical test results indicate that most of the impacted soils from Areas 1 and 2 (Figures 6-7 and 6-8) are contaminated by metals, principally copper and lead, and hydrocarbons at concentrations that exceed Dutch 'B' Guidelines. Chemical data indicate that impacted soils from burn pits within Area 3 (Figure 6-9) are impacted by dioxins at concentrations up to 109 µg/kg TEQ and metals.

6.7 ESTIMATED VOLUMES OF IMPACTED SOIL

The IEC has estimated soil volumes that exceed Dutch 'B' Standards, USEPA PRGs, or dioxin soil screening levels discussed above, as indicated on Figures 6-7, 6-8, and 6-9. It is important to note that these soil volume estimates area based on data from the site RI field and laboratory investigation. Even though the RI field and laboratory investigations were comprehensive, the distribution of sample locations and soil sample volumes analyzed are extremely small in comparison to the estimated areas and volumes of soil to be excavated. As a consequence, these volume estimates are "best estimates" based upon the site characterization data. It should also be noted that the volume estimates are in-place volumes. Upon excavation, bulking of up to 30% by volume may be expected, depending on the gradation of materials.

Estimated areas, volumes, and mass of soil (rounded to two significant figures) that may exceed Dutch 'B' or other relevant standards by site area are as follows:

Area 1:
Surface Area = 11,000 square meters
Average Depth = 0.9 meters
Soil Volume = 10,000 cubic meters
Soil Mass = 18,000 metric tons

Area 2:
Surface Area = 11,000 square meters
Average Depth = 1.4 meters
Soil Volume = 16,000 cubic meters
Soil Mass = 29,000 metric tons

Area 3: Surface Area = 21,000 square meters
Average Depth = 2.9 meters
Soil Volume = 61,000 cubic meters
Soil Mass = 110,000 metric tons

Totals: Surface Area = 43,000 square meters
Soil Volume = 87,000 cubic meters
Soil Mass = 157,000 metric tons

These volume estimates may be further subdivided by contaminant type or types. Estimated soil volumes in cubic meters, to two significant figures, by the soil contaminant type(s) are as follows:

Contaminant Type(s)	Estimated Volume (m^3)
Metals only	48,000
TPH and/or SVOCs	700
Metals and TPH and/or SVOCs	8,300
Dioxins, Metals, and TPH and/or SVOCs	30,000
Total Estimated Volume	87,000

These estimates are subject to the same uncertainties as noted above for contaminated soil volumes by area. The volume estimates for dioxin-impacted soil are subject to the greatest uncertainty. For characterization purposes, the IEC has assumed that all of the burn pit materials are potentially impacted by dioxins. This is supported by the distribution of dioxin analytical results with respect to interpreted burn pit locations. We have used a general approximation of the surface area of the identified burn pits from the map prepared by the SIC and an average depth of burn pit materials of 3m (10 feet), even though burn pit materials were locally encountered as deep as 4.8m (16 feet) below grade. Based on the available information, it is the IEC's judgment that is a "best estimate" of the in-place volume of impacted soils by contaminant type(s).

7.0 HUMAN HEALTH AND ECOLOGICAL RISK ASSESSMENT

A Baseline Risk Assessment was conducted to evaluate the current condition of the site based on the RI results. The baseline risk assessment presents the results of the evaluation of potential human health and ecological risks associated with chemicals found within the soil and groundwater beneath the site. The risk assessment addresses potential exposures to onsite theme park workers and park visitors as well as ecological receptors.. Potential exposures to chemicals detected in surface and shallow soils have been evaluated for the direct contact pathways as well inhalation of volatile chemicals in outdoor air and fugitive dust. For all soils and groundwater, the potential for chemicals to migrate from the subsurface to groundwater and then to the WRC has also been evaluated.

7.1 BASELINE RISK ASSESSMENT APPROACH

The overall approach used in the risk assessment is based on current USEPA guidance (USEPA, 1989; 1992; 1993, 1997b,c,e; 1999a,b; 1999c). The risk assessment is a predictive tool used to assess the potential human health and ecological risks associated with releases of site-related chemicals. This information is used in the remedial decision-making process to determine if further evaluation or remediation is warranted.

A tiered approach has been used in developing the risk assessment for the site. In Tier 1, conservative risk-based screening criteria were used to estimate exposure and risk to the COPCs selected for the site. In addition to risk-based criteria, ambient or background concentrations have been considered for those chemicals that are naturally occurring (e.g. heavy metals such as arsenic, nickel, barium). The screening criteria were used to determine if chemicals or investigation areas at the site warrant further evaluation. If estimated cancer risks and noncancer hazards are below the screening target risk or hazard index, no further action was recommended. If areas exceed the Tier 1 cleanup standards, then more site-specific cleanup standards, or Tier 2 cleanup standards, can be calculated for the chemicals that contribute the most to risk.

For risk assessment purposes the site was divided into the three areas, Area 1, Area 2 and Area 3, discussed earlier in this report. This was to facilitate an understanding of potential health risks in terms of operational history, chemical distribution or land-use considerations. By dividing up the site, those areas of the site that clearly do not pose a risk can be removed from further evaluation.

In Tier 2, a more detailed risk assessment was conducted for those areas and chemicals that did not get screened out in the Tier 1 screening. In addition, those pathways not addressed in the Tier 1 screening criteria (fish ingestion, surface water exposures for human exposures) were evaluated in the detailed risk assessment.

7.2 DATA REVIEW AND EVALUATION

An initial step in the risk assessment process is an evaluation of available data to: 1) characterize the site, 2) develop a data set for use in the risk assessment, and 3) identify media-specific COPCs.

7.2.1 Data Review

Data considered in the risk assessment include only the data collected during the RI as discussed in Section 5. The RI data that were deemed acceptable through the data validation process were carried forth into the risk assessment.

As presented in Sections 5 and 6, many chemicals have been detected in soil and groundwater at the site. Tables 7-1 and 7-2 present statistical summary tables of the soil and groundwater data collected during the RI.

7.2.2 Data Adequacy for Baseline Risk Assessment

For the Baseline Risk Assessment, site data must be available to support the characterization of contaminant levels for the depth intervals and media relevant to transport processes and exposure pathways. The sampling program implemented in the RI for soil and groundwater was designed to provide data to meet the needs of the Baseline Risk Assessment.

The soil sampling program was designed to characterize VOCs, SVOCs, PCBs, dioxins and metals for soils in the top 3 to 4 meters. Because a portion of the soil sampling effort was focused on the areas where contamination is most likely, the resulting data set is likely to be inherently conservatively biased for estimating exposure concentrations in local areas (i.e. exposure areas, surrounding a given set of samples). Where the data are focused on particular suspected hot spots, rather than distributed uniformly over the exposure area, including the hot spots, they will likely produce a conservatively biased estimate of exposure point concentration, and therefore a conservative estimate of risk.

7.2.3 Identification of Chemicals of Potential Concern

The hazard identification section of a risk assessment entails identifying the chemicals that will be carried through the risk assessment as COPCs. USEPA risk assessment guidance (USEPA, 1989) presents a methodology for identifying which detected chemicals should be included in a quantitative risk evaluation. These are defined by USEPA as chemicals potentially related to the site whose data are of sufficient quality for use in a quantitative risk assessment (USEPA, 1989). USEPA guidance states that the list of chemicals should include all chemicals that were:

- Positively detected in at least one sample
- Detected above levels of the same chemicals found in associated blank samples
- Tentatively identified but may be associated with the site based on historical information
- Transformation products of detected chemicals, and
- Detected above naturally occurring levels (background).

As discussed in Section 5, the existing site data were evaluated in terms of quality and usability in the RI and risk assessment. All data determined to be of sufficient quality were carried forward into the risk assessment.

All chemicals detected in soils and groundwater at the site were included as COPCs in the risk assessment. For those chemicals that are naturally occurring (e.g. heavy metals such as arsenic, nickel, barium) ambient or background concentrations have been considered in the risk characterization section of the risk assessment.

7.3 EXPOSURE ASSESSMENT

The objective of the exposure assessment is to estimate the magnitude, frequency, duration, and routes of current and reasonably anticipated future exposure to COPCs associated with the site. The exposure assessment is based on receptor scenarios that define the conditions of exposure to site-related COPCs. These scenarios are summarized in the Conceptual Site Models (CSM) presented on Figures 7-1 and 7-2. The CSM represents the current understanding of the sources of COPCs, the means by which they are released and transported within and among media, and the exposure pathways and routes by which they may contact potential receptors.

In order for an exposure pathway to be complete, the following four elements must be present:

- A source and mechanism of chemical release
- A retention or transport medium
- A point of contact between the human receptor and the medium, and
- A route of exposure for the potential human receptor at the contact point.

There must be a complete exposure pathway from the source of chemicals in the environment (i.e., from soil, air, or groundwater) to receptors in order for chemical intake to occur. If all exposure pathways are incomplete, no chemical intake occurs and hence, no health effects are associated with site-related COPCs.

This section describes the receptors and exposure pathways evaluated in the risk assessment. In addition, the methodology for calculating exposure point concentrations (EPCs) is discussed.

7.3.1 Conceptual Site Model

The CSM identifies potential chemical sources, release mechanisms, transport media, routes of chemical migration through the environment, exposure media, and potential receptors. The risk assessment considers the current and the anticipated future use of the site. Receptors that may currently or in the future be potentially exposed to site-related chemicals are then identified to help assess the likelihood and extent of their potential exposures.

A general CSM for the risk assessment for both human and ecological receptors was developed based on current and planned future uses of the site. The general CSM was constructed based on a review of the available site information regarding the site setting and chemical distribution in environmental media. The general CSM, presented as Figures 7-1 and 7-2, represents the current understanding of the sources of COPCs, the means by which they are released and transported within and among media, and the exposure pathways and routes by which they may contact human receptors. The major components of the CSM are discussed below.

As discussed in Section 1.3, the Phase II project area includes the land area of the former CLS site at the head of Penny's Bay. Portions of the shipyard and power plant situated to the southeast of the shipyard are located on reclaimed land. The future development plans within the Phase II project include portions of the Chok Ko Wan Link Road, Road P2, an arboretum, and tree farm and a part of the rail line that will serve the Hong Kong Disneyland theme park and hotel complex. A manmade lake and water recreation center (WRC), parking areas, and theme park facilities will be situated on newly reclaimed land in what is formerly Penny's Bay.

Current development plans call for a substantial section of fill to be placed on the former shipyard. Site development plans reviewed by the IEC indicate that final site grade for the CLS site area are at +11mPD. Based on current site elevations of +3.5 to 4.3mPD, on the order of 7m of fill will be placed at the site to support infrastructure development. This fill section will essentially eliminate potential direct contact to chemicals in soil for both human and ecological receptors. However, in keeping with a baseline risk assessment, the risk evaluation was conducted on the current or baseline condition of the site.

Human Health

Due to the planned uses of the former shipyard as an arboretum as well as transportation infrastructure for the park, both theme park visitors and workers may be exposed to chemicals detected in soils and groundwater at the site. Workers could be exposed to contaminated soil through incidental ingestion, dermal contact, and inhalation of chemicals in vapors or dust. Direct contact exposures to groundwater could occur to theme park workers but was not considered a significant pathway since worker activities would not likely include handling groundwater.

The potential also exists for chemicals present in soil and groundwater beneath the CLS site to migrate and impact the manmade lake at the WRC. The current configuration of the site includes significant storm water control and collection features that will eliminate the potential for contaminated soil to enter the lake via runoff. Therefore this pathway was not considered in the risk assessment.

Contaminated groundwater could potentially diffuse upward through the lake bottom and liner and introduce chemicals into overlying lake water. Once these chemicals enter the lake water they then become available for contact via recreational, irrigation, or mariculture use of the lake water. Contaminated groundwater migration to the open sea is considered an incomplete pathway due to the relatively low chemical concentrations detected in groundwater and the large distance from the CLS to the post-development sea wall. The nearest potential receptor point for potential impacts is the channel that is planned along the west side of the WRC. However, it will be constructed on fill and be at a grade that would preclude groundwater seepage into the channel water.

Proposed uses of the lake include recreational boating and fishing, and planned uses of the lake water include irrigation for the theme park. Receptors potentially at risk would include children and adults using the lake for recreational purposes, was well as workers associated with the use of lake water for irrigation purposes. Potential human exposures pathways to lake water include dermal contact and incidental ingestion. Inhalation of vapors is considered an insignificant pathway due to the low concentrations of volatiles detected in soil and groundwater at the site and the significant amount to of dilution that would occur in outdoor air. In addition, potential human exposure may occur via ingestion of contaminated fish if fishing is allowed.

Ecological

Ecological CSMs show potential exposure pathways from abiotic media (e.g., soil or surface water) through the various trophic levels of the terrestrial and aquatic ecosystems. Numerous wildlife species (mammals, birds, and aquatic organisms) potentially occur at the site. These species were categorized into functional groups for use as receptors in the CSM. The ecological CSM is based on existing site data, selected functional groups, and receptor organisms. CSMs trace the movement of chemical contamination from various sources through abiotic (i.e., non-living) media to the biotic components of the system, the eventual ecological organisms that may be adversely affected by the COPCs. CSMs illustrate the potential exposure of ecological receptors but are not meant to illustrate ecological risk since risk incorporates both exposure and toxicity of contaminants to the receptors.

The ecological CSM for the is presented on Figure 7-2 and includes the following elements:

- The Exposure Pathway column describes the exposure media and the pathway from the abiotic media to the ecological receptors.
- The term "Incidental Ingestion" applies to wildlife that ingest some soil while in the process of feeding. "Ingestion" includes consumption of food items that have accumulated COPCs from the abiotic exposure media.
- "Direct Contact" applies primarily to aquatic organisms that are evaluated on the basis of concentrations in the exposure media (i.e., surface water). Other receptors may have direct contact with other exposure media (e.g.; surface soil), but any evaluation can be only qualitative.
- The "Exposed Receptors" column lists the primary receptors exposed to COPCs. It is assumed that there is no direct exposure of ecological receptors to soils deeper than 2m or to groundwater. There maybe exposure through contact or ingestion of irrigation water, but those exposure pathways can only be evaluated qualitatively. Finally, exposure of ecological receptors to subsurface vapors is highly unlikely due to the subsurface location of the pathway, and exposure and potential risk from vapor inhalation cannot be evaluated due to an absence of a recognized methodology.
- Filled-in squares or circles in the "Pathway Complete" column denote that the exposure is assumed to be complete, and a quantitative evaluation of the exposure and potential risk to the receptor can be performed.

While these potential pathways exist under current site (baseline) conditions, it is important to note that the planned site development will interdict exposure of ecological receptors to contaminants in soil at the CLS site. Placement of fill to raise the site grade, as described in Section 1.3, will result in a physical barrier between ecological receptors and contaminated soil. The potential groundwater migration pathway is evaluated in the following section of the risk assessment for both human and ecological receptors.

7.3.2 Contaminant Fate and Transport/Exposure Point Concentration Estimation

Soil Exposure Point Concentrations (EPCs)

Estimates of chemical concentrations at points of potential human exposure are necessary for evaluating chemical intakes by potentially exposed individuals. Development of long-term EPCs from short-term monitoring data includes an underlying assumption about the representativeness of the monitoring data, both temporally and spatially, to simulate the current and future exposure conditions for a receptor traversing a particular region at the site.

To simulate a receptor's spatial and temporal integration exposure, USEPA (1992c) defines the concentration used to estimate the reasonable maximum exposure (RME) as the 95 percent upper confidence limit (95 UCL) of the arithmetic mean or the maximum observed concentration, whichever is lower. The arithmetic mean reflects the assumption that exposure is averaged by the receptor as they traverse an area over time. The intent of the RME scenario is to focus the assessment on a conservative exposure that is within the range of exposures. In general, the determination of "reasonable" is based on professional judgment as well as EPA recommendations. EPCs for exposures to shallow soil were defined as the maximum concentration in the Tier 1 evaluation and the 95 UCL of the arithmetic mean or the maximum observed concentration (which ever is lower) for the Tier 2 evaluation. For potential migration of chemicals from subsurface soil and groundwater to the WRC, the maximum detected concentration was used to model contaminant transport as discussed in the following section.

Surface Water Exposure Point Concentrations

Chemicals detected in soil and groundwater were evaluated with respect to future impacts to the WRC. Surface water concentrations that may occur in the WRC after development were estimated using several fate and transport modeling equations that are presented in this section. Appendix C presents more detailed information regarding the modeling. Table 7-3 presents the predicted surface water concentrations associated with both soil and groundwater contamination.

Intermedia Transfers of COPCs to the Water Recreation Centre

When chemicals move from one environmental medium (e.g., groundwater) to another (e.g., surface water) the chemical movement is referred to as an intermedia transfer. To evaluate potential EPCs at the WRC, intermedia transfers were mathematically modeled using quantitative evaluations of transfer rates between the relevant environmental media. The chemical flux rates into receiving environmental media were evaluated using mass transport and mixing models. For each COPC, intermedia transfer factors (ITFs) were developed from mass-balance principles and used to estimate EPCs. The operational definitions of each ITF are defined below.

$$ITF = \left(\frac{C_{exposure}}{C_{source}} \right)$$

where,

$C_{exposure}$ = Exposure point concentration (also called EPC; units vary depending on which exposure medium is considered),

C_{source} = Source medium concentration (units vary depending on which source medium is considered).

For each of the respective source media and exposure media evaluated in this assessment, ITFs are defined as follows.

$$ITF_{soil \rightarrow lake} = \left(\frac{C_{lake\text{-}soil}}{C_{soil}} \right)$$

The ITF defining the relationship between C_{soil} and $C_{lake\text{-}soil}$ was evaluated using three steps: 1) evaluate potential migration of COPCs from soil to groundwater, 2) evaluate groundwater mixing and lateral transport to the lake, and 3) evaluate upward diffusion of groundwater chemicals into the lake and subsequent mixing.

$$ITF_{groundwater \rightarrow lake} = \left(\frac{C_{lake\text{-}GW}}{C_{groundwater}} \right)$$

The ITF defining the relationship between $C_{groundwater}$ and $C_{lake\text{-}GW}$ was evaluated with two steps: 1) evaluate groundwater lateral transport to the lake, and 2) evaluate upward diffusion of groundwater chemicals into the lake and subsequent mixing. The procedures that were used to perform each element of this evaluation are described in the following sections and explained in detailed in Appendix C.

Potential Migration of COPCs from Soil to Groundwater

Potential rates of chemical leaching from soil to groundwater were evaluated by considering two factors: 1) chemical concentrations in soil pore water that may leach, and 2) the net infiltration rate of rainfall. A groundwater mixing model was used to quantitatively evaluate the propensity for leachate concentrations to attenuate by mixing with ambient groundwater. Each calculation procedure is summarized below. Only those chemicals that were detected in soil at a prevalence of greater than 5% were carried forward in the analysis.

Chemical concentrations in soil pore water were evaluated using equilibrium chemical partitioning relationships according to soil-water distribution coefficients (Kd values). For each site area, the maximum detected soil COPC concentration was divided by a chemical-specific Kd value. Sources of Kd values for metals included USEPA's Soil Screening Levels Guidance (USEPA, 2000) and, for metals not included in that reference, a compendium published by EPRI (1988). For organics, Kd values were obtained from the USEPA Region IX physical/chemical properties database for PRGs (USEPA, 2001b) and, as a secondary source, by estimating the Kd from the product of the organic carbon partition coefficient (Koc) and organic carbon content (foc). [Note: Koc values were developed by regression of Kow values obtained from an online database (http://esc.syrres.com/efdb.htm) using methods presented by Schwartzenbach et al. (1993).]

The net infiltration rate was estimated using the following equation:

Net infiltration = rainfall – evapotranspiration – runoff

For purposes of completing this calculation, annual average rainfall for Hong Kong was 2.22 m/yr (2,220 mm/yr), evapotranspiration was 1.02 m/yr (2.8 mm/day), and runoff was conservatively estimated at 50%. The calculated net infiltration was 0.09 m/yr.

Groundwater Mixing and Lateral Transport to The Lake

The Summers model (Summers et al., 1980; USEPA, 1989b) groundwater mixing equation was used to calculate the estimated groundwater concentrations beneath each site area that may result from leachate infiltration. Groundwater concentrations are calculated with the Summers model using a relationship between volumetric groundwater flow, the COPC mass released, and the volume of infiltrating (i.e., recharge) water.

According to USEPA (2001b), TCDD released to soil is not expected to leach. As a rule, the amount of TCDD detected more than 8 cm below the surface has been approximately 1/10 or less than that detected within the upper 8 cm of the soil column. Tests conducted by the USDA determined that vertical movement of 2,3,7,8-TCDD did not occur in a wide range of soil types. Soil cores collected from roadsides in Times Beach, Missouri in 1985, which had been sprayed with waste oils containing TCDD in the early 1970s, indicated that most of the TCDD had remained in the upper 15 cm of soil. A mean log K_{oc} of 7.39 was determined for ten dioxin-contaminated soils from New Jersey and Missouri.

Several classes of large molecular weight hydrophobic organic chemicals are generally recognized to have extremely limited mobility in groundwater. These include polycyclic aromatic hydrocarbons (PAHs), polychlorinated biphenyls (PCBs), and dioxins (and structurally similar dibenzofurans). For example, the distribution coefficient (K_d) for TCDD can be calculated at a value of 2×10^4. For sand fill, the equivalent retardation factor (R) for dioxin is about 145,000 (see Appendix C). Groundwater flow rate toward the lake was estimated at about 30 m/yr. The time period for groundwater to travel 125m to the lake then is about 4 years. The retarded dioxin solute groundwater flow rate toward the lake (under the influence of sorption) would be $30/145{,}000 = 5 \times 10^{-5}$ m/yr. Thus, the travel time for dioxin to reach the lake would be $(125\text{m})/(5 \times 10^{-5}\ \text{m/yr}) = 600{,}000$ years.

The octanol-water partition coefficient (K_{ow}) is an important indicator of the mobility of organic chemicals in soils. Values of K_{ow} for PAHs range from 2.2×10^3 to 1.7×10^7; for TCDD (a common dioxin compound) the K_{ow} is 4.3×10^6. For PCBs, reported K_{ow} values range from 2.3×10^3 to 3.1×10^6. The coefficient K_{ow} has been shown to be linearly related to the organic carbon partition coefficient K_{oc} (Schwartzenbach et al., 1993; USEPA, 1996) and the relationship $K_d = f_{oc} \times K_{oc}$ can be used to estimate K_d values for chemicals like PAHs and PCBs based on K_{ow} and soil organic carbon content (f_{oc}). Using this approach, retardation factors for typical PAHs and PCBs were estimated at 84 and 88, respectively (see Appendix C). Using the same assumptions that were used to evaluate potential dioxin transport, travel times for PAHs and PCBs to reach the lake would be 350 years and 360 years, respectively.

Since time periods beyond 300 years from present are considered past the planned lifetime of the WRC, and chemical fate and transport evaluation results indicate that no PAHs, PCBs, or dioxins/dibenzofurans migrating in groundwater will reach the bottom of the lake before 350 years, quantitative evaluation of future exposures would be highly speculative. Absent a viable exposure scenario, large molecular weight organic chemicals were not considered to represent a complete exposure pathway for receptors at the WRC.

Upward Diffusion of Groundwater Chemicals into The Water Recreation Centre's Artificial Lake And Subsequent Mixing

Potential mass transfer of COPCs from groundwater into lake water at the Water Recreation Centre was evaluated by modeling diffusion across the HDPE liner installed beneath the lake. Diffusion calculations were performed using Fick's law (Crank, 1956). The "box model" for evaluating chemical concentrations that result from mixing of chemicals transferred into a control volume is applied widely in health risk assessments (ASTM, 2000; USEPA, 1997d). For this project, a box model was used to estimate the average concentration in lake water that could result from soil and groundwater COPC mass flux across the HDPE liner. The equations used to perform the intermedia transfer modeling and the related human exposure assessment for this HHRA are presented in Appendix C.

Upward Diffusion of Sediment Chemicals into The Artificial Lake

Potential mass transfer of COPCs from sediment into lake water at the Water Recreation Centre was evaluated as part of the IEC's Phase RI. As part of the risk assessment performed for that study, time-dependant diffusion across the lake's HDPE liner was modeled using a one-dimensional solution to Fick's law (Crank, 1956). The Phase I study diffusion calculations were based in part on input parameters reflecting fill thickness, which are now variable due to mud waves formed during placement of the fill. For this project, the same box model that was used for evaluating upland soil and groundwater impacts was applied to estimate the average concentration in lake water that could result from sediment COPC mass flux across the HDPE liner. The modeling performed for this study does not require specifying the fill thickness. It assumes that sediment chemicals that dissolve into groundwater are in direct contact with the underside of the HDPE liner providing a conservative estimate of predicted lake water chemical concentrations.

For each of the respective source media and exposure media evaluated in this assessment, ITFs are defined as follows.

$$ITF_{sediment \rightarrow lake} = \left(\frac{C_{lake\text{-}GW}}{\left(\frac{C_{sediment}}{K_d} \right)} \right)$$

The ITF defining the relationship between $C_{groundwater}$ and $C_{lake\text{-}GW}$ was evaluated with two steps: (1) evaluate sediment-groundwater partitioning and (2) evaluate upward diffusion of groundwater chemicals into the lake and subsequent mixing. The procedures that were used to evaluate upward diffusion and mixing are described in Appendix C.

The results of the analysis are presented in Appendix C. Predicted concentrations from the underlying sediment were below Tier 1 screening criteria and/or resulted in cancer risk or noncancer hazard index estimates below target levels established for the site.

7.4 TIER 1 EVALUATION

As discussed in Section 7.1, a tiered risk assessment approach has been used for the site. In Tier 1, conservative screening values from published literature were used to evaluate chemicals detected in soil at the site. In addition, surface water concentrations were estimated using fate and transport modeling to predict the migration of chemicals from soil and groundwater to the WRC. These predicted concentrations were then compared to screening ecological criteria for surface water and were used as input in the equations to estimate dose and risk for human receptors.

7.4.1 Human Health

Soil

For exposures to soil, the Tier 1 screening criteria were based on the Region IX Preliminary Remedial Goals (PRGs) (USEPA, 2000a) for residential land use. Residential PRGs were selected to allow for the evaluation of use of the land under no future restrictions. If chemicals were detected below the residential PRG, then that chemical could be eliminated from further consideration in the risk assessment, especially given that the intensity of exposure would be much less for park visitors or workers that what is represented in the PRGs. The following pathways were evaluated in the Tier 1 screening:

- Incidental ingestion of soil
- Dermal contact
- Inhalation of fugitive dust in outdoor air, and
- Inhalation of volatile chemicals in outdoor air.

These pathways are considered the most relevant for the types of exposure that may occur to chemicals in site soils. Table 7-4 presents the Tier 1 Screening Criteria for chemicals that have been detected historically at the site.

The PRGs do not address potential exposure to surface water via incidental ingestion, dermal contact, or the fish ingestion pathway. These pathways were evaluated in the Tier 2 evaluation presented in Section 7.5.

The results of the Tier 1 evaluation are presented in Table 7-4. As shown in Table 7-4, several chemicals in each area of the site exceeded PRG values and were carried into the Tier 2 evaluation.

7.4.2 Ecological

Soil

Screening benchmarks for soil (mg/kg) were selected from one of three published sources or from calculated risk-based concentrations. These Tier 1 Ecological Screening Levels are shown in Table 7-5. Soil PRGs available from *Preliminary Remediation Goals for Ecological Endpoints* (Efroymson et al., 1997a) are shown along with the endpoint that PRG is based on. Alternative soil benchmark sources included published values from *Toxicological Benchmarks for Screening Contaminants of Potential Concern for Effects on Terrestrial Plants* (Efroymson et al., 1997b) and *Toxicological Benchmarks for Contaminants of Potential Concern for Effects on Soil and Litter Invertebrates and*

Heterotrophic Processes (Efroymson et al., 1997c). Alternative screening numbers also include no observed adverse effects level (NOAEL) risk-based concentrations (RBCs) calculated for soil from readily available sources for chemicals without a soil PRG or applicable benchmark from the three Efroymson et al. (1997a,b,c) documents listed above.

These calculated benchmarks were back-calculated from literature-based NOAEL doses (milligrams per kilogram bodyweight per day - mg/kg-bw/day) for avian and mammalian receptors as listed in the "source and endpoint" column of the soil screening benchmark table. Receptor- and chemical-specific data, including NOAEL doses, body weight, food ingestion rate, bioaccumulation, and bioconcentration factors were used in the calculation of these NOAEL soil RBC values as shown in Appendix C. Sources of these data include: USEPA (1993) and Sample et al. (1996), among others. Details of these calculations are described in Appendix C – Calculation of Alternative Soil Screening Values.

Screening levels in the analysis of soil chemistry results were based on: soil PRGs (Efroymson et al., 1997a), other available published soil screening values for terrestrial plants and soil invertebrates (Efroymson et al., 1997b,c), or NOAEL RBCs calculated for soil from readily available sources. These screening values were used to assess potential areas of soil contamination that may warrant further testing and/or a more refined analysis of potential risk. Table 7-5 presents the results of the Tier 1 screening for ecological receptors for Areas 1, 2, and 3. Most metals, as well as a few SVOCs, dioxins, pesticides, and VOCs, exceed the Tier 1 screening values.

Surface Water

Screening benchmarks for surface water (µg/L) were selected from one of two sources – *Preliminary Remediation Goals for Ecological Endpoints* (Efroymson et al., 1997a) or *National Recommended Water Quality Criteria – Correction* (USEPA, 1999a). If benchmarks were available from both sources for a chemical, the lower of the two benchmarks was chosen as the selected screening value.

Surface water PRGs (Efroymson et al., 1997a) and NAWQC (National Ambient Water Quality Criteria) (USEPA, 1999d) were used as initial screening levels in the analysis of surface water chemistry modeling results. Surface water concentrations were modeled from soil concentrations and from groundwater concentrations. Table 7-6 presents the results of the Tier 1 screening for ecological receptors in lake surface water. For metals and organics with applicable screening values, no modeled surface water concentrations based on either soil or groundwater concentrations exceed the Tier 1 screening values.

7.5 TIER 2 EVALUATION RESULTS

As discussed above, a Tier 2 evaluation for human health exposures was conducted for those chemicals that exceed Tier 1 standards and for the surface water pathway, typically not addressed in a Tier 1 standards analysis. The Tier 2 evaluation was developed using published risk assessment methodology based on USEPA guidance (USEPA, 1989; 1992; 1993; 1997b,c,e; 1999a,b,c) and other recognized sources. For ecological exposures, a Tier 2 evaluation could be conducted for those chemicals that exceed Tier 1 screening values. However, a Tier 2 evaluation requires more information about local biota and their exposure to COPCs. It is important to know the ecological relevance (structure and function of the ecosystem), policy goals and societal values (endangered, threatened. or species of special concern), and susceptibility to the COPCs (i.e., chemical stressors) of potential receptors. In Tier 2, assessment endpoints, which are formal expressions of the environmental values that are to be protected, and measurement endpoints must be defined. All of these data, which were not explicitly developed for Tier 1, would be synthesized in the problem formulation phase of a Tier 2 evaluation. Regardless, based upon the requirement to raise the site grade by placement of on the order of 7m of fill at the site to support infrastructure development, complete pathways to ecological receptors would be preempted by the site development.

For exposures to soil, only those chemicals that exceeded the Tier 1 criteria were included in the Tier 2 evaluation. As discussed earlier, the 95 UCL of the arithmetic mean or the maximum observed concentration (whichever is lower) was used for the Tier 2 evaluation. Table 7-7 presents the chemicals that exceeded the Tier 1 criteria by area and their respective 95 UCL concentrations. Exposures to both theme park visitors and workers were evaluated using the exposure assumptions as presented in Appendix C.

For surface water exposures at the WRC, the predicted lake concentrations from the modeling discussed in Section 7.3.2 were used as direct input into the incidental ingestion and dermal contact exposure equations or as the input into the fish tissue concentration calculation. Table 7-3 presents the chemical concentrations used for the surface water evaluation.

The "Average Daily Dose" (ADD) and "Lifetime Average Daily Dose" (LADD) are the parameters used to quantify exposure doses in site risk assessments. The ADD is used as a standard measure for characterizing long-term non-carcinogenic effects. The LADD addresses exposures that may occur over varying durations from a single event to an average 70-year human lifetime and are used to estimate potential carcinogenic risks. These parameters are used to calculate an acceptable daily dose that then can be used to calculate an acceptable concentration in the relevant exposure medium such as surface water or fish tissue that can then be related back to an acceptable sediment concentration. The following subsections describe the equations that were used for each pathway.

In accordance with USEPA guidance, The Tier 2 evaluation is based on RME exposure assumptions. The RME is defined as the maximum exposure that is reasonably expected to occur at the site. USEPA (1997b) provides conservative default values for the RME scenario based on the type of individual exposed (i.e., park visitor, park worker). Where appropriate, site-specific values were used (i.e. average number of visits per year expected, number of fish meals per year).

7.5.1 Soil Exposures

Incidental Soil Ingestion

The rate of soil ingestion is based on the amount of soil a child or adult inadvertently swallows in a given day from all sources. Exposures to COPCs via incidental ingestion of soil are estimated using the following variables: 1) the rate of ingestion, 2) the fraction of ingested soil that is contaminated, and 3) the frequency and duration of exposure. Individuals may ingest soil through incidental contact of the mouth with hands and clothing. The following is the equation used to calculate the LADDs and ADDs of COPCs (units of mg/kg-day) via incidental ingestion of soil:

$$ADD/LADD = \frac{C_s \times IR_s \times ABS \times EF \times ED \times CF}{BW \times AT}$$

Where:

C_s	=	chemical concentration in soil (mg/kg)
IR_s	=	ingestion rate of soil (mg/day)
ABS	=	percent absorption (assumed to be 100 percent)
EF	=	exposure frequency (days/year)
ED	=	exposure duration (years)
CF	=	conversion factor for soil (10^{-6} kg/mg)
BW	=	body weight (kg)
AT	=	averaging time (days) cancer effects: 70 years x 365 days = 25,550 days noncancer effects: ED x 365 days

Details on the exposure parameters used to calculate intake of COPCs via incidental soil ingestion are provided in Appendix C.

Dermal Contact with Soil

COPCs in soil may come into contact with skin, and then become absorbed across the skin into the bloodstream. The amount of absorption into the body depends upon the amount of soil in contact with the skin, COPC concentrations in soil, the skin surface area exposed, and the potential for the chemical to be absorbed across the skin.

The following is the equation used to calculate the steady-state dose absorbed across the skin:

$$ADD/LADD = \frac{C_s \times SA \times SAF \times EF \times ED \times CF \times DAF}{BW \times AT}$$

Where:

C_s	=	chemical concentration in soil (mg/kg)
SA	=	skin surface area exposed to soil per day (cm^2/day)
SAF	=	soil-skin adherence factor (mg/cm^2)
EF	=	exposure frequency (days/year)
ED	=	exposure duration (years)
CF	=	conversion factor (10^{-6} kg/mg)
DAF	=	dermal absorption factor (unitless, chemical-specific)
BW	=	body weight (kg)
AT	=	averaging time (days) cancer effects: 70 years x 365 days = 25,550 days noncancer effects: ED x 365 days

Details on the exposure parameters used to calculate intake of COPCs via incidental soil ingestion are provided in Appendix C.

Inhalation of Fugitive Dust

Inhalation of fugitive dust-containing COPCs in outdoor air is a consideration for soil exposures. The potential dose for inhalation of fugitive dust is calculated using the following equation:

$$ADD/LADD = \frac{C_A \times IR_A \times ABS \times EF \times ED}{BW \times AT}$$

Where:

C_A	=	concentration in air (mg/m^3)
IR_A	=	inhalation rate (m^3/day)
ABS	=	percent absorption (assumed to be 100 percent)
EF	=	exposure frequency (days/year)
ED	=	exposure duration (years)
BW	=	body weight (kg)
AT	=	averaging time (days) cancer effects: 70 years x 365 days = 25,550 days noncancer effects: ED x 365 days

For the outdoor air pathway, the COPC concentratjons in soil were divided by a particulate emission factor (PEF) for non-VOCs to arrive at an outdoor air concentration (C_A) in mg/m^3. It was conservatively assumed that the dust concentration in air is equal to the US national ambient air quality standard of 50 $\mu g/m^3$.

7.5.2 Surface Water Exposures

Dermal Contact with Water Pathway

The LADDs and ADDs via dermal contact with water are calculated as follows:

$$ADD/LADD = \frac{C_w \times SA \times EF \times ED \times CF \times K_p^{eff}}{BW \times AT}$$

where:

C_w	=	chemical concentration in water (mg/L)
SA	=	skin surface area exposed (cm^2/event)
EF	=	exposure frequency (events/year)
ED	=	exposure duration (years)
CF	=	conversion factor (10 L/cm-m2)
K_p^{eff}	=	effective-dermal permeability constant (cm/hr)
BW	=	body weight (kg)
AT	=	averaging time (days) for carcinogenic effects: 70 years x 365 days for non-carcinogenic effects: ED x 365 days

Incidental Ingestion of Water

The LADDs and ADDs via incidental ingestion of water are calculated as follows:

$$ADD/LADD = \frac{C_w \times IR \times EF \times ED \times CF}{BW \times AT}$$

where:

C_w	=	concentration in water (mg/L)
IR	=	ingestion rate of water (L/day)
EF	=	exposure frequency (days/year)
ED	=	exposure duration (years)
CF	=	conversion factor for soil (10^{-6} kg/mg)
BW	=	body weight (kg)
AT	=	averaging time (days) for carcinogenic effects: 70 years x 365 days for non-carcinogenic effects: ED x 365 days

Ingestion of Fish

Uptake from the surface water into fish takes place through diffusion that is facilitated by the partitioning of organic chemicals from the hydrophilic environment (water) into a hydrophobic environment (body lipids). Therefore, organisms that contain larger amounts of lipid will contain larger amounts of organic contaminant. To calculate the concentrations in fish, the concentration of the surface water is typically multiplied by chemical-specific bioconcentration factors (BCFs) and food-chain multipliers (FCMs) to account for exposure to chemicals through both water and food sources. Because the lake is planned to be stocked with fish and most likely the fish will be fed an outside food source, the focus of the evaluation was on surface water and only the BCF was applied.

The fish tissue concentration was then used as an input into the following dose equations

$$ADD/LADD = \frac{C_F \times IR \times EF \times ED \times CF}{BW \times AT}$$

where:

C_F	=	concentration in fish (mg/kg)
IR	=	ingestion rate of fish (g/meal)
EF	=	exposure frequency (meals/year)
ED	=	exposure duration (years)
CF	=	conversion factor for soil (10^{-3} kg/mg)
BW	=	body weight (kg)
AT	=	averaging time (days) for carcinogenic effects: 70 years x 365 days for non-carcinogenic effects: ED x 365 days

For the fish ingestion pathway, chemicals were evaluated only if they met the criteria specified in the USEPA guidance document for evaluating exposure to fish (USEPA, 1997f). Target analytes for evaluation of fish ingestion were based on their occurrence in fish and shellfish in regional or national surveys, their persistence in the environment (half-life > 30 days), their potential for bioaccumulation

(BCF values > 300) and their oral toxicity to humans. The chemicals evaluated for fish ingestion are on the target list recommended by USEPA or met the above criteria.

7.6 HAZARD AND RISK SUMMATION

For chemical exposures to pathways discussed above, excess cancer risks were estimated by multiplying the LADD by the chemical carcinogenic toxicity criteria. The equation used to estimate the excess cancer risk is:

$$Excess\ Cancer\ Risk = LADD \times CSF$$

The excess cancer risks are then typically compared to the USEPA acceptable risk range of 10^{-6} to 10^{-4} and particularly the target risk of 1×10^{-5} identified for probable site receptors.

Hazard quotients were estimated by calculating the ratio of the ADD to the corresponding chronic reference dose for noncarcinogenic effects. The equation used to estimate the hazard quotient is:

$$Hazard\ Quotient = \frac{ADD}{RfD}$$

The hazard quotients were then compared to an acceptable hazard level. Hazard quotients less than the benchmark hazard level of one (1) indicate that no adverse health effects are predicted from exposure to the chemicals being evaluated.

Table 7-8 presents the results of the Tier 2 evaluation for potential human exposures. As shown in Table 7-8 all noncancer hazards are below the benchmark of 1, indicating that exposures via these pathways for noncarcinogens are below a level of concern. All estimated cancer risks were below the target risk level of 1×10^{-5} for theme park visitors. For theme park workers, estimated cancer risk estimates were above 1×10^{-5} with exposures to dioxin via the direct contact pathways contributing the majority to the risk estimates. Individual chemicals that contributed to risk levels above the target risk level of 1×10^{-5} are hexavalent chromium and dioxin in Area 1, Aroclor 1260 and dioxin in Area 2, and chromium and dioxin in Area 3.

7.7 UNCERTAINTY ANALYSIS

7.7.1 Human Health Evaluation

Like all modeling efforts, the risk assessment process relies on a set of assumptions and estimates with varying degrees of certainty. Major sources of uncertainty in risk assessment include: 1) natural variability (e.g., differences in body weight in a population); 2) lack of knowledge about basic physical, chemical, and biological properties and processes (e.g., the affinity of a chemical for soil and its solubility in water); 3) assumptions in the models used to estimate key inputs (e.g., dose-response models); and 4) measurement error. Perhaps the greatest single source of uncertainty in risk assessment are the chemical dose-response relationships, particularly carcinogenic slope factors. Additional uncertainty may also be associated with analytical data, which are subject to both systematic error (bias) and random error (imprecision). Other major sources of uncertainty include computation of exposure point concentrations using conservative fate and transport assumptions, and estimation of dose rate via default exposure assumptions.

The sources of uncertainty associated with the risk assessment and the potential biases in the results are presented in this section. With respect to the data evaluation and the exposure assessment, the major sources of uncertainty in the risk assessment are:

- Estimates of hypothetical future exposure point concentrations were based on current monitoring data, without allowing for decreasing concentrations over time due to degradation and other loss mechanisms.
- Use of the maximum detected value for the Tier 1 evaluation and the 95 UCL for the Tier 2 evaluation as the exposure point concentration will overestimate the chronic intake of a chemical, and is not realistic for long-term exposures. This is especially true if the maximum detected concentration is localized in nature or located at depths where soil may not be contacted.
- The reasonable maximum exposure (RME) scenario includes numerous assumptions on the type of exposures that may occur, the frequency and duration of those exposures, and the concentration of chemicals at the point of exposure. As such, it is intended to provide a conservative estimate of intake, more likely to overestimate than to underestimate the risk.

The major emphasis in analyzing the uncertainty of health risk estimates is usually on the values assumed for exposure parameters (e.g., how much air an individual inhales and for how long). These uncertainties associated with the exposure assessment typically range from one to two orders of magnitude. However, with respect to the toxicity assessment, the uncertainties associated with dose-response relationships and weight-of-evidence carcinogenicity classification may be much greater. The extrapolation of rodent carcinogen bioassay results to human risk at much lower levels of exposure involves a number of assumptions regarding effects thresholds, interspecies extrapolation, high- to low-dose extrapolation, and route-to-route extrapolation. The scientific validity of these assumptions is uncertain; because each of the individual extrapolations is designed to prevent underestimation of risk, in concert they result in unquantifiable but potentially very large overestimation of risk. Specifically, the extrapolation of cancer potency from laboratory animals to humans, which forms the basis for the cancer risk estimates may be associated with uncertainties ranging from as much as three to five orders of magnitude (1,000- to 100,000-fold) for selected chemicals.

In addition, the dioxin reassessment that was conducted in the U.S. indicates that the carcinogenic potency of dioxin may be approximately one order of magnitude higher than what is currently represented in the USEPA slope factor used in this risk assessment factor (USEPA Office of Research and Development, Washington D.C., Information Sheet 2, *Dioxin: Scientific Highlights from Draft Reassessment (2000)*, May 25, 2001 Update). As a result dioxin risks may be higher that what is reported.

In summary, because the majority of assumptions regarding exposure point concentrations, toxicity values, and contact rates made in this assessment are conservative, tending to overestimate exposure and risk, the incremental risks to the defined receptor populations from exposure to COPCs at the site are likely to be overestimated with the exception of the dioxin risk estimates.

7.7.2 Ecological Evaluation

In the process of identifying COPCs in surface soil and surface water, comparisons of maximum concentrations were made with available criteria, guidelines, or benchmarks. Inherent in those comparisons were a number of assumptions regarding limitations of the site data and toxicological benchmarks. The risk evaluation uses conservative, yet reasonable, assumptions where the available site-specific data or toxicological information is incomplete. Multiple conservative assumptions and uncertainty factors generally result in conservative or over-protective risk estimates for ecological receptors. The following uncertainties are associated with the Tier 1 ecological risk screening evaluation:

- Development of the CSM – Potential source of uncertainty due to limited information about site-specific exposure pathways, dietary composition, and spatial and temporal constraints on exposure – *May overestimate or underestimate risk.*
- Uncertain occurrence of receptors at sites – The actual presence/abundance onsite of the assumed functional groups that are included in the assessment is uncertain – *May overestimate risk.*
- Exposure point concentration – It is unlikely any receptor would be exposed to maximum concentrations of each contaminant in each area or in all media – *Likely overestimates exposure and risk.*
- Reporting limits are a common source of uncertainty in screening ERAs. Reporting limits for some chemicals are lower than the corresponding ecological screening benchmarks. The initial sampling program was not designed to meet specific ecological risk-based criteria nor to identify every possible area of contamination. – *Increases uncertainty and may underestimate risk.*
- Extrapolation of toxicological data from laboratory test species to wildlife receptor species – Species differ with respect to absorption, metabolism, distribution, and excretion of chemicals – *May overestimate or underestimate risk.*
- Ecological Risk Models – Exposure models for risk screening assume that all wildlife spend their entire lives within restricted habitats (that may be non-existent). The 100 percent area use factor results in unrealistic risk estimates for wildlife populations with home ranges substantially larger than the location or site.
- Uptake factor for prey items – An uptake factor typically derived using literature-derived equilibrium assumptions does not consider that only a finite mass of each chemical is available for the receptors – *May overestimate exposure and risk.*
- Bioavailability equal to one (1) – For most contaminants, it is unlikely that 100 percent of a measured concentration is available for uptake – *Likely overestimates exposure and risk.*
- Background contaminant levels – Ecological risk at each area is based on measured concentrations of chemicals. The portion of the total concentration that is attributable to background levels is included in the estimates of exposure and risk. – *May overestimate site-related risk.*
- Risk evaluated for individuals – Effects on individuals may occur with little population- or community-level effect; however, as the number of affected individuals increases, the likelihood of population-level effects increases – *Likely overestimates risk to populations.*
- Presence of contaminants without benchmarks – Contaminants without toxicity benchmarks may add an unknown amount of risk – *May underestimate overall risk.*

- Additive, synergistic, or antagonistic effects of multiple co-occurring contaminants. *May under estimate risk to wildlife at the site (or if antagonistic, may overestimated risk).*

7.8 BASELINE HEALTH RISK ASSESSMENT SUMMARY

The results of this baseline risk assessment indicate that chemical concentrations in soil may pose an unacceptable risk to park workers and ecological receptors via direct contact under existing site conditions. Chemicals that contributed to risk levels above the target risk level of 1×10^{-5} are hexavalent chromium and dioxin in Area 1, Aroclor 1260 (a PCB) and dioxin in Area 2, and chromium and dioxin in Area 3. In addition, as presented in Table 7-5, several chemicals exceeded Tier 1 ecological criteria.

The fate and transport modeling conducted for existing soil and groundwater concentrations indicate that migration of chemicals to the WRC will most likely be insignificant when accounting for migration pathway and chemical-specific properties of COPCs, and the combined liner and fill section underneath the WRC. Therefore, the combined fill section and liner constitute an effective barrier against exposure; thus making this pathway incomplete. Results of the risk assessment predict that there is no unacceptable human or ecological health risk associated with the lake if fitted with a 1.5-mm (0.060-inch) thick HDPE liner.

Based on the results of the baseline risk assessment it is recommended that further evaluation be considered in regards to direct exposures to chemicals in soil by human and ecological receptors at the site.

7.9 ASSUMPTIONS

The performance of this risk assessment was based upon several assumptions about the materials and methods that will be used in development of the site. If these assumptions are not met during site development, then the risk assessment would not be considered valid for changed conditions. Key among these assumptions are the following:

- That the lake will be fitted with an HDPE liner with a minimum thickness of 1.5 mm (0.060 inches) in accordance with the provisions of the EIA. Without the liner, the assumptions underpinning the risk assessment would be invalid.
- Clean imported fill material will be placed below the liner to raise site grade and as bedding for the liner. The risk assessment calculations do not allow for any contribution to risk from chemicals that may be present in the imported fill.

8.0 IEC RECOMMENDED CLEANUP LEVELS

The results of the baseline risk assessment indicate that, under baseline conditions, chemical concentrations in shallow soil within Areas 1, 2, and 3 of the CLS site do not meet risk-based criteria to protect theme park workers and ecological receptors from direct contact exposures. Additionally, chemical concentrations for a number of COPCs in soil exceed the Dutch 'B' Guidelines, as discussed in Section 6.

For chemicals detected in soil that may leach to groundwater, as well as concentrations of COPCs detected in groundwater samples, fate and transport modeling was conducted to evaluate potential impacts to the WRC. The results of this evaluation indicate that risks to human and ecological receptors at the WRC will be insignificant based on the current design for the artificial lake, which incorporates a minimum 1.5-mm (0.060-inch) thick HDPE liner.

Therefore, this section addresses cleanup levels for chemicals detected in site soils based upon both Hong Kong and U.S.-based standards and approaches. Consistent with Hong Kong practice and the general requirements of EPD, remediation is planned for soils with concentrations of COPCs exceeding Dutch 'B' values. As described in Section 9, these soils may be treated onsite or offsite and returned to the site and used as fill.

The IEC understands that the former shipyard property will be covered with up to 7m of clean fill to raise the site grade to +11mPD to allow for infrastructure development to support the theme park. Placement of the clean fill at the site is an important element of selecting appropriate cleanup levels for the site, because the fill will act as a physical barrier that will effectively prevent direct contact by human and ecological receptors to residual chemicals present in soil. Therefore recommendations are included in this section to address residual contamination that will be left in place as well as treatment levels for soils that may be brought back onsite.

8.1 ALLOWABLE SOIL CONCENTRATIONS

As discussed in Section 6, the RI has been conducted using an integrated approach that addresses both Hong Kong and U.S.-based standards and approaches to decision making regarding site remediation. Several types of criteria were considered in developing allowable chemical concentrations that can be left in soils at the site: 1) Dutch 'B' Guidelines, 2) risk-based criteria, and 3) background concentrations.

The Dutch 'B' Guidelines are recommended by EPD as general guidelines in Hong Kong to determine if soils are contaminated at levels that require remediation. As the EPD generally requires remediation of soil contamination above Dutch 'B' Guidelines, these values define the primary cleanup criteria to be used in making decisions regarding soil remediation.

For chemicals detected at the CLS site that are not included in the Dutch 'B' Guidelines, such as hexavalent chromium and tributyltin, risk-based criteria taking into account the planned future use of the site are appropriate for consideration as cleanup criteria. In addition, if risk-based concentrations are lower than corresponding Dutch 'B' values, the lower of the two criteria may be considered as a cleanup level.

For dioxins, which have been detected associated with burn pit residues at the CLS site, two values have been considered as screening and cleanup levels: 1.0 microgram per kilogram (μg/kg, equivalent to parts per billion, ppb) and 0.1 μg/kg (equivalent to 100 parts per trillion, ppt) of dioxin "toxicity equivalents" (TEQs). The reader is referred to Section 6.1 for a discussion and analysis of the current information regarding the comprehensive dioxin reassessment being undertaken by the USEPA in the context of dioxin screening levels. Based on the IEC's understanding of the current state of the dioxin reassessment, recommended cleanup levels for dioxins are as follows:

- 1 μg/kg (1 ppb) TEQ is considered protective for residual soils that will be left in place below a minimum of 3m of clean imported fill soil, and
- 0.1 μg/kg (100 ppt or 0.1 ppb) TEQ in areas of the site where a minimum of 3m of fill soils are not placed.

The 1 μg/kg value for deeper soils is consistent with the EPD's stated preference regarding dioxin cleanup levels in Hong Kong. This value is considered by the IEC to be risk protective for concentrations in residual soils that will be placed beneath 3m of fill. The more conservative recommended value of 0.1 μg/kg takes into consideration the higher cancer slope factor now being considered for dioxins by the USEPA and the greater opportunity for contact by potential receptors if dioxin-contaminated soils are left within shallow soils.

Another important consideration in establishing cleanup criteria is the background concentration of chemicals in soil. For inorganic chemicals, such as arsenic, oftentimes background concentrations exceed risk-based criteria. Therefore, cleanup levels should be set so that the remedial approach does not require cleanup to concentrations lower than background levels, even if background concentrations are higher than their respective risk-based standards. This is especially important for ecological receptors as many ecological criteria for metals are below background.

Both human health and ecological risk-based criteria are based on the assumption that there is a complete pathway of exposure between the receptor of concern and the exposure medium. Due to the thick section of imported fill (on the order of 7m) that is planned to be placed over the contaminated soil, no complete pathways of exposure will exist following site development for human or ecological receptors that may frequent the site. Therefore, an argument could be made that no risk-based cleanup levels are required, but rather a safe thickness of fill could be recommended to preclude direct contact of either human or ecological receptors to contaminated soils.

For human health exposures a common practice is to ensure that the top 8 to 10 feet of soil (approximately 3 m) does not contain chemical contamination at unacceptable levels. This thickness of soil is based on being protective of a person who may be exposed to soil during construction and maintenance activities, such as installing or maintaining utility lines and building foundations or during landscaping activities. For ecological receptors, a protective cover 2m is generally considered adequate to eliminate the pathway to terrestrial receptors from contaminated soils. A depth of 2m is greater than the root zone of plants expected to be at the site, and is greater than the burrowing depth of burrowing animals, if any are present at the site. Other mammals and birds would only be exposed to soil at the surface.

Therefore, based on the potential for future exposure to residual chemicals in soil, a minimum fill depth of 3m is recommended to eliminate the potential for direct contact by either human or ecological receptors.

Table 8-1 presents cleanup levels for the various chemicals detected at the site. Recommended cleanup levels for chemical concentrations that will remain in place are:

- Dutch 'B' values
- Risk-based concentrations for chemicals lacking Dutch 'B' values for protection of workers
- 1 µg/kg TEQ for dioxins in soils that will be covered with a minimum of 3m of fill, and
- 0.1 µg/kg TEQ for dioxins in surface soils or where less than 3m of fill will be placed.

The cover fill thickness of 3m of clean fill will provide an adequate level of protection of ecological receptors to residual contaminants at the site.

8.2 ALLOWABLE RESIDUAL CONCENTRATIONS FOR TREATED SOIL

It is the IEC's understanding that contaminated soil may be excavated, treated and placed back at the site as part of the fill section. If the fill is placed at depths below 3m, the cleanup levels presented in the previous section are applicable. However, if the treated soil will be placed in the top section of the fill where direct contact may occur, more stringent cleanup levels may be required.

As discussed in Section 6.1, the current state of the practice regarding dioxin cleanup in the U.S. is under review. It is anticipated that USEPA will adopt the proposed, more stringent, cancer slope factor, which will impact the use of the 1 µg/kg value recommended as a PRG in the current OSWER directive. In anticipation of a change in policy, the IEC recommends a more stringent allowable level of 0.1 µg/kg be used for shallow soil that may be available for contact for human exposures. Other criteria as identified in Section 8.1 are applicable for potential human exposures. Where Dutch 'B' or risk-based criteria are below background concentrations, the cleanup level should be set to background.

The Tier 1 risk assessment results for ecological receptors indicate that they are the more sensitive receptor for many of the chemicals detected at the site. Thus, if the site were to be developed without placement of clean fill soils to raise the site grade, impacts to ecological receptors would drive selection of cleanup levels. However, because site development plans require raising the site grade to +11mPD, placement of a minimum 2m buffer of clean fill would provide an adequate level of protection of ecological receptors.

Recommended residual concentrations of treated soils returned to the site as fill are as follows:

- TPH – Dutch 'B' Guideline values
- SVOCs – Risk-based concentrations
- Metals – Universal Treatment Standard soluble concentrations in a TCLP extract, as described in Section 10.11, and

- Dioxins – 1.0 µg/kg TEQ for treated soils that will be placed beneath a minimum of 3m of clean fill, and 0.1 TEQ µg/kg for treated soils that will be placed with less than 3m of clean fill cover.

Note that if soils containing 0.1 µg/kg of residual dioxins as TEQs are placed within the upper 2m of the fill section, this would not be risk-protective of ecological receptors.

8.3 ALLOWABLE GROUNDWATER CONCENTRATIONS

The results of the fate and transport modeling conducted for the risk assessment indicate that current concentrations of chemicals in groundwater will not impact the WRC which is considered the most important receptor point for groundwater migrating from the shipyard. Migration of contaminants via groundwater to the open sea is not considered to be a complete pathway. As a result no cleanup of dissolved phase chemicals in groundwater is recommended.

Separate-phase petroleum hydrocarbons were recorded on the groundwater in one well at the site (MW-D06). If free-phase hydrocarbons are encountered during excavation in this area of the site, the IEC recommends that they be skimmed, containerized, and properly managed.

9.0 REMEDIAL ALTERNATIVES EVALUATION

A Remedial Alternatives Evaluation (RAE) has been conducted in accordance with the RIWP. The evaluation of remedial alternatives takes into account technologies previously approved by EPD for application in Hong Kong, approaches used at other sites having similar contaminants and impacted media in the U.S. and elsewhere, available landfill space and landfill acceptance criteria in Hong Kong, and the general costs and timeframe needed to implement remediation within the context of the overall infrastructure development program. The remedial alternatives evaluation included the following:

- Establishing remedial action objectives and remedial goals
- Developing soil remediation volume estimates based on findings of the RI
- Reviewing applicable remedial approaches and process options
- Assembly and evaluation of remedial alternatives
- Comparison of remedial alternatives
- Summary of remedial alternatives evaluation, and
- Recommendation of preferred remedial alternative(s).

9.1 REMEDIAL ACTION OBJECTIVES AND REMEDIAL GOALS

Remedial Action Objectives (RAOs) were established consistent with guidance provided by the EPD of the HKSAR in ProPECC PN 3/94 (*Practice Note for Professional Persons, Contaminated Land Assessment and Remediation*) and the requirements of USEPA under CERCLA. RAOs consist of medium-specific goals for protecting human health and the environment. CERCLA requires that remedial actions:

- Attain a degree of cleanup of hazardous substances, pollutants, and contaminants released into the environment and control of further releases, which, at a minimum assure protection of human health and the environment, and
- Comply with or attain the level of any standard, requirement, criteria, or limitation under any Federal environmental law or any promulgated standard, requirement, criteria, or limitation under a state environmental or facility siting law that is more stringent than any Federal standard, requirement, criteria, or limitation that is found to be applicable or relevant and appropriate.

Consistent with the agreed-upon approach, and the integrated approach outlined in Section 1.4.4 above, standards and/or guidelines of the EPD of the HKSAR are included as applicable or relevant and appropriate requirements (ARARs) and under the second bullet above.

RAOs were established to be protective of humans and ecological receptors against exposures to both impacted soil and groundwater at the site. The RAOs for the CLS site are to:

- Minimize exposure of humans (site construction and maintenance workers, and occasional visitors) and ecological receptors to the COPCs identified in soils at the site (metals, petroleum hydrocarbons, polycyclic aromatic hydrocarbons, cyanide, and dioxins) through inhalation, dermal contact, and ingestion, and

- Reduce the potential for COPCs in soil at the site to migrate to and potentially impact the Water Recreation Centre artificial lake to be constructed upon reclaimed land within (former) Penny's Bay as part of the theme park development.

Remedial action goals have been established for the CLS site to achieve the RAOs identified above. Chemical-specific goals have been identified for the COPCs present at the site at concentrations above Tier 1 screening levels. These remedial action goals include both risk-based goals and compliance-based goals:

- Residual chemical concentrations in soil at the site do not result in an incremental cancer risk to potentially affected receptors greater than 1×10^{-5};
- Soils impacted by COPCs at concentrations exceeding environmental "bright line" standards recommended in Hong Kong by the EPD of the HKSAR (the Dutch 'B' Guidelines) are remediated to reduce contaminant concentrations to acceptable levels and/or reduce the mobility and availability of contaminants through stabilization or other processes; and
- Residual post-remediation concentrations of COPCs in soils that are intended to be returned to the CLS site and placed as fill are below risk-based and applicable compliance-based standards.

The selected remedial alternative(s) will be required to be reliable in the long-term, effective in the short-term, implementable within the HKSAR given its environment and land-use constraints, be compliant with applicable standards and/or guidelines, and result in an acceptable level of protection of human health and the environment.

9.2 SOIL REMEDIATION VOLUME ESTIMATES

The lateral and vertical extent of soils impacted by COPCs at concentrations that exceed Dutch 'B' Guidelines, USEPA PRGs (for hexavalent chromium and tributyltin), or 0.1 µg/kg dioxin TEQs in Areas 1, 2, and 3 of the CLS site is discussed in Section 6.6 and shown on Figures 6-7, 6-8, and 6-9. The depth of the interpreted lower limit of impacted soils is indicated by different patterns on the above-referenced figures.

Estimated volumes of impacted soil by area and by contaminant type are provided in Section 6.7. These estimated impacted soil volumes are summarized as follows:

Site Area	Estimated Volume (m^3)	Predominant COPCs
1	10,000	Metals, TPH, SVOCs, limited dioxins
2	16,000	Metals, TPH, SVOCs, dioxins
3	61,000	Metals, TPH, SVOCs, dioxins
Total	87,000	

Of greater importance than total volumes by area, are estimated volumes of soil impacted by different contaminants, because different remedial technologies are commonly appropriate for different types of contaminants. As discussed in Section 6.7, impacted soil volumes by contaminant types are estimated as follows:

Contaminant Type(s)	Estimated Volume (m^3)

Metals only	48,000
TPH and/or SVOCs	700
Metals and TPH and/or SVOCs	8,300
Dioxins, metals, and TPH and/or SVOCs	30,000
Total Estimated Volume	87,000

As discussed in Section 6.7 and in Sections 10.7 and 10.11, the final volume of soil requiring remediation will be determined at the time of remedial excavation, based on field observations and confirmation sampling. Following excavation to the indicated boundaries and depths shown on Figures 6-7, 6-8, and 6-9, confirmation sampling will be conducted and samples will be analyzed for appropriate chemical constituents to establish that cleanup objectives have been met. Detailed recommendations for confirmation sampling are included in Section 10.11, below.

9.3 APPLICABLE REMEDIAL TECHNOLOGIES AND PROCESS OPTIONS

A number of remedial technologies are potentially applicable to the different types of contaminants present at the CLS site. All available technologies fall into one of two general categories, *in situ* and *ex situ*. *In situ* technologies refer to those remedial technologies that are applied in-place without excavation of impacted soils, while *ex situ* technologies refer to technologies that are applied to impacted soil after excavation. Obviously, *in situ* technologies are applied onsite, while *ex situ* technologies may be applied either onsite or offsite. The IC, MCAL, was responsible for evaluation of *ex situ* remedial technologies for non-dioxin impacted and dioxin-impacted soils as part of the *Environmental Impact Assessment Report (Final) for Decommissioning of Cheoy Lee Shipyards at Penny's Bay* (Tables 4.45 and 4.47, respectively). With respect to *ex situ* treatment technologies, the IEC has reviewed the IC's analysis and, as discussed below, concurs with its findings.

Available selected remedial technologies and process options that potentially could be applied to the impacted soils at the CLS site were initially screened based upon relative ranking of effectiveness, implementability, and cost. A summary of these remedial technologies is provided in Table 9-1. Many of the technologies and process options screened have effectiveness limitations that make them not generally applicable to the nature of impacts at the CLS site, are not readily implementable in Hong Kong or within the constraints of the timeframe for site infrastructure development, or are cost prohibitive. Shaded boxes in Table 9-1 indicate those technologies that are deemed not applicable.

9.4 ASSEMBLY AND EVALUATION OF REMEDIAL ACTION ALTERNATIVES

Of the remedial technologies and process options identified and evaluated, the following remedial action alternatives were retained and assembled for further consideration and evaluation:

- Alternative 1 – No Action
- Alternative 2 – Onsite Cover of Impacted Soils
- Alternative 3 – Excavation and Entombment Within Lined Cell Beneath Engineered Cap
- Alternative 4 – Excavation and Offsite Landfill Disposal of Impacted Soils, and
- Alternative 5 – Excavation and Onsite or Offsite Treatment.

These alternatives are described and briefly evaluated in the following sections based upon a relative ranking of: 1) effectiveness; 2) implementability; 3) long-term reliability; 4) short-term risk; 5) reduction of toxicity, mobility, or volume through treatment; 6) overall protection of human health and the environment; 7) compliance with applicable or relevant and appropriate regulations; 8) regulatory and community acceptance; and 9) cost effectiveness.

9.4.1 Alternative 1 – No Action

The No Action alternative is a baseline alternative that assumes that no remedial action(s) will be conducted at the site. It is a required alternative under the CERCLA process and under the NCP. It was therefore retained to be consistent with the agreed-upon approach, which requires that the environmental assessment and remediation of the CLS site be done in accordance with both Hong Kong and U.S. environmental laws and standards.

Effectiveness

The short- and long-term effectiveness of this alternative is negligible, as it would not support development of the infrastructure elements necessary for the Hong Kong Disneyland project.

Implementability

There are no implementability issues associated with the No Action alternative, as there is nothing to implement.

Long-term Reliability

The long-term reliability of the No Action alternative is very low because it would leave contaminated soil in place where it could potentially be contacted by human or ecological receptors. It would not support use of the site for the planned purposes of infrastructure development.

Short-Term Risk

There is no short-term risk associated with the No Action Alternative, as this alternative would not involve any site work that would result in alteration of existing conditions. Thus, there would be no short-term risks associated with implementation of this alternative.

Reduction of Toxicity, Mobility, or Volume through Treatment

There would be no reduction of contaminant concentrations, toxicity, mobility, or volume associated with this alternative.

Overall Protection of Human Health and the Environment

Because there would be no reduction in contaminant concentrations, toxicity, mobility or volume, and human or ecological receptors could potentially be exposed to contaminated media, there is no increase in the protection of human health and the environment.

Compliance with Applicable or Relevant and Appropriate Requirements

The No Action alternative does not satisfy the general guidelines of the EPD that require remediation of soils impacted with contaminants at concentrations exceeding the Dutch 'B' Guidelines. Moreover, some of the impacted soils contain metals at concentrations well in excess of the Dutch 'C' criteria, indicating "serious pollution [is] present and cleanup [is] required". This alternative therefore does not meet ARARs.

Regulatory and Community Acceptance

Because of its failure to meet EPD guidelines regarding the need for remediation of impacted sites, this alternative is highly unlikely to receive EPD acceptance. Because it does not leave the site in a condition that provides for development of the planned infrastructure to support theme park development, it will not receive acceptance from the CED or HKITP. It also would likely not be acceptable to community groups.

Cost Effectiveness

There is no cost associated with the No Action alternative.

9.4.2 Alternative 2 – Onsite Cover of Impacted Soils

This *in situ* alternative would consist of leaving impacted soils in place where they currently exist and placing fill soils over the site to raise the site grade to +11mPD, consistent with site development plans. Since the current site grade ranges from approximately +3 to +4mPD, this would involve placing a minimum of 7m of engineered clean fill at the site. Alternative 2 could include placing an engineered cap composed of natural materials (e.g., clay) or manufactured materials (e.g., asphalt or a synthetic liner) over the impacted soils to reduce the potential for mobilization by infiltration of water. Alternatively, findings of the risk assessment would support leaving the impacted materials in place and placing of fill soils over them to raise the site grade per the site development plans without an engineered cap.

Alternative 2 may require long-term monitoring to assure that contaminants are not migrating from their buried location. If migration did occur at some time in the future following construction of the supporting infrastructure and theme park, corrective remedies would be difficult and costly.

Effectiveness

Placement of 7m of clean engineered fill soils onsite would provide an effective physical barrier that would greatly reduce the potential for receptors to come into direct contact with contaminated soils. Provision of a natural or synthetic cap would increase the effectiveness by providing a further physical barrier between the contaminated materials and potential receptors and by reducing the potential for infiltration of precipitation, which would decrease the potential for migration of contaminants.

Implementability

Implementability of this option is high. Planned site development requires placement of fill to raise the site grade to +11mPD. Little or no additional site work would be necessary to implement this alternative. If a cap is included, implementability remains high, as *in situ* capping technology is widely used and readily available. Some design interaction would be necessary to integrate the cap design with the geotechnical design for infrastructure development.

Long-term Reliability

Long-term reliability of this option is low, as it does not remedy the problem. Also, if migration of contaminants is later determined to be occurring through the monitoring program, implementation of a remedy after infrastructure development has been completed and the theme park constructed would be a significant issue.

Short-Term Risk

Short-term risk associated with the Alternative No. 2 would be minimal, as this alternative would not involve excavation or removal of impacted soils at the site that could result in potential releases of or exposure to contaminants. Minimal risks may be associated with earthmoving operations to place clean fill soil upon the contaminated soils; however, once covered with clean soil, short-term risks would be minimal.

Reduction of Toxicity, Mobility, or Volume through Treatment

There would be no reduction of contaminant concentrations, toxicity, or volume associated with this alternative. Some reduction in mobility would occur if an engineered cap is included.

Overall Protection of Human Health and the Environment

Findings of the human health and ecological risk assessment indicate that placing a minimum of 3m of clean fill over the contaminated soils at the site would be risk protective of both humans and ecological receptors.

Compliance with Applicable or Relevant and Appropriate Requirements

Alternative 2 does not satisfy the general guidelines of the EPD that require remediation of soils impacted with contaminants at concentrations exceeding the Dutch 'B' Guidelines. This alternative therefore also does not meet ARARs. Also, this alternative would be inconsistent with the approach adopted by USEPA at dioxin-impacted sites such as Times Beach, Missouri, where hot spot removal was required as part of the site remedy prior to placement of a cap.

Regulatory and Community Acceptance

Because of its failure to meet EPD guidelines regarding the need for remediation of impacted sites, Alternative 2 is unlikely to receive EPD acceptance. Because of the long-term liability associated with leaving contaminants in place, it is very unlikely to receive acceptance from the EPD, CED, or HKITP. It also likely would not be acceptable to community groups.

Cost Effectiveness

The cost effectiveness of leaving the contaminated soils in place and covering them with clean fill, with or without an engineered cap, is high. This is the lowest cost remedial option considered for the site that would leave the site in a condition that would support project development.

9.4.3 Alternative 3 – Excavation of Impacted Soils and Entombment within Lined Cell Beneath Engineered Cap

This *in situ* alternative would consist of excavating impacted soils and placing them within an engineered lined onsite cell. This alternative would include placing an engineered cap composed of natural materials (e.g., clay) or manufactured materials (e.g., asphalt or a synthetic liner), or a composite cap, over the cell. As summarized in Section 9.2, this alternative would entail excavation and handling of approximately 87,000 cubic meters of contaminated soil.

Effectiveness

Entombment of contaminated soil and waste materials and placement in an engineered cell with an integral liner and cap system would be an effective way to manage impacted materials onsite. Effectiveness of this of alternative would be further enhanced by placement of up to 7m of clean engineered fill soils onsite above the entombed materials. Entombment would provide an effective physical barrier that would reduce the potential for receptors to come into direct contact with contaminated soils. Entombment within a lined and capped cell would also reduce the potential for infiltration of precipitation, which would decrease the potential for migration of contaminants.

Implementability

From a technical perspective, Alternative 3 could readily be implemented. Excavation of impacted materials would require monitoring for and control of fugitive dust emissions, rainfall related site runoff, and appropriate worker protection measures. Existing technology exists for engineered cell and cap systems for waste disposal sites that could be applied to this alternative. Onsite entombment of wastes and impacted materials would, in essence, result in creation of an onsite waste disposal facility. This alternative would therefore require creating a regulated waste management unit that would need to be permitted by the EPD. Therefore, from a regulatory perspective, this alternative is judged to have a low implementability.

The timeframe for permitting a waste management unit onsite through EPD is uncertain. Permitting could potentially negatively impact the schedule for infrastructure development to support the theme park. It is likely that this alternative would take a long time to implement, which could further negatively impact the project infrastructure development schedule.

Alternative 3 would result in restrictions on future site use in the area where wastes and impacted materials are entombed. It would also affect the geotechnical properties of soils in the area, which could cause conflicts with intended site use.

Long-term Reliability

The long-term reliability of Alternative 3 could be high with sufficient engineered safeguards. These would include a multi-layer liner with a leak detection and leachate collection system to intercept any contaminants that may migrate through the upper layer of the liner, and a composite cap to provide a physical barrier to contact by receptors and prevent infiltration of rainwater. Long-term effectiveness would be monitored through an integrated monitoring system. An Operation and Maintenance (O&M) Program would be necessary to assure liner and cap integrity.

Short-Term Risk

There would be short-term risks associated with implementation of Alternative 3, as with all alternatives that would involve excavation and removal of impacted soils from the site. There would be short-term risks to construction workers engaged in the remediation work that would have to be addressed through a comprehensive worker health and safety program. There are also risks associated with spreading of contamination by fugitive dust emission during excavation, handling, and loading and unloading of impacted soils.

Reduction of Toxicity, Mobility, or Volume through Treatment

Placing the materials in a lined and capped onsite cell would reduce their mobility and potential for exposure to receptors, but it would not reduce the concentrations or toxicity of the COPCs.

Overall Protection of Human Health and the Environment

If properly designed, installed, and operated, this alternative would provide for a high degree of protection of human health and the environment.

Compliance with Applicable or Relevant and Appropriate Requirements

Alternative 3 does not satisfy the general guidelines of the EPD that require remediation of soils impacted with contaminants at concentrations exceeding the Dutch 'B' Guidelines. This alternative therefore also does not meet ARARs.

Regulatory and Community Acceptance

Because if its failure to meet EPD guidelines regarding the need for remediation of impacted soils, this alternative is unlikely to receive EPD acceptance. Because of this, it is very unlikely to receive acceptance from the CED or HKITP.

This alternative would result in creating an onsite waste management unit to contain wastes and impacted soils. Due to the stigma of having an onsite waste disposal facility associated with the theme park infrastructure development, as well as the long-term liability associated with leaving the contaminants onsite, it likely would not be acceptable to the parties involved. It also likely would not be acceptable to community groups.

Cost Effectiveness

Costs associated with permitting, designing, implementing and operating this alternative are judged to be medium to high. Long-term O&M costs are uncertain and could add to project costs.

9.4.4 Alternative 4 – Excavation and Offsite Landfill Disposal of Impacted Soils

This *ex situ* option would consist of excavation of impacted soils and transport to and disposal in a regulated landfill. The IC has analyzed this alternative in the EIA and has rejected it as a remedy for the site. The IEC concurs with the IC's conclusions for the following reasons:

Because of the high concentrations of COPCs detected in impacted soils at the site, especially metals and dioxins, much of the materials would require pre-treatment prior to disposal. Metals-impacted soils could be stabilized using cement, pozzolan, fly ash, or other cementing agents to reduce their solubility to allowable limits. Landfill disposal Toxicity Characteristic Leaching Procedure (TCLP) limit criteria for metals-impacted soils are provided in EPD's *Guidance Notes for Investigation and Remediation of Contaminated Sites of Petrol Filling Stations, Boatyards, and Car Repair/Dismantling Workshops* (1999). For other contaminants, approval for disposal would be assessed by EPD on a case-by-case basis. Treatment would likely be required to meet the Universal Treatment Standards concentration criteria contained in the U.S. Code of Federal Regulations (CFR) 40 CFR 268.48.

Effectiveness

Excavation and landfill disposal would have a high degree of effectiveness, as the contaminated materials would be removed permanently from the site and disposed in an appropriately managed waste disposal facility.

Implementability

Excavation of impacted materials can be easily implemented, but would require monitoring and control of fugitive dust emissions, rainfall related site runoff, and appropriate worker protection measures. Offsite transport of contaminated materials poses additional risks that would need to be managed by shipment in sealed containers. The need to pre-treat contaminated materials prior to disposal could pose a significant implementation problem if there is not adequate stockpile staging and treatment space available at the landfill site. Treatment of dioxin-impacted soils would require application of technologies not presently available in Hong Kong, which could have adverse schedule impacts. This alternative would consume valuable landfill space, which is at a premium in Hong Kong. Overall implementability of this alternative is therefore considered low.

Long-term Reliability

The long-term reliability of this alternative is considered very high with respect to remedy of site conditions, but low to moderate overall since it transfers the problem from one location to another. Long-term reliability is largely a function of the environmental security of the receiving landfill and the degree of environmental protection afforded by liner, cap, and monitoring systems at the landfill. Overall long-term reliability of Alternative 4 is therefore judged to be moderate.

Short-Term Risk

There would be short-term risks associated with implementation of Alternative 4, as with all alternatives that involve excavation and removal of impacted soils from the site. There would be short-term risks to construction workers engaged in the remediation work that would have to be addressed through a comprehensive worker health and safety program. There are also risks associated with spreading of contamination by fugitive dust emissions during excavation, handling, and loading and unloading of impacted soils. There would also be risks to workers, and potentially to the surrounding environment, at the receiving landfill associated with management of the soils and landfilling operations. Further, there would be short-term risks associated with overland transport of contaminated soils via truck, or marine transport of impacted soils via barges, from the site to the receiving landfill. These risks would include those associated with increased highway or marine traffic, and risk of upset and spillage of contaminated soil during transport. Contingency plans would need to be put in place to deal with any spillage of contaminated soils.

Reduction of Toxicity, Mobility, or Volume through Treatment

To the extent that wastes and impacted materials are pre-treated prior to disposal, there would be a reduction in toxicity and mobility of contaminants. Depending on the treatment system(s) used, there could be an increase in the volume of impacted materials (cement stabilization of metals for example) as opposed to a volume reduction.

Overall Protection of Human Health and the Environment

This alternative would provide moderate overall protection of human health and the environment, since wastes and impacted materials would be transferred from one location to another. Shipment of impacted materials poses a short-term risk to human health and the environment due to potential for upset and spillage.

Compliance with Applicable or Relevant and Appropriate Requirements

This alternative could be implemented in a manner that is in compliance with applicable regulations; however, this alternative would result in consumption of valuable landfill space. Landfill disposal is discouraged by EPD and should be considered as only a last resort per EPD guidance.

Regulatory and Community Acceptance

Guidance documents issued by EPD state that excavation and landfill disposal should be considered a last resort and employed only when there is only very localized contamination and the quantity of excavated material is small. Due to the large volume of impacted materials that must be managed (approximately 87,000 cubic meters), and the limited available landfill space in Hong Kong, this alternative is unlikely to gain regulatory acceptance from EPD. The likelihood of community acceptance is also judged to be low.

Cost Effectiveness

Costs associated with this alternative would be high due to treatment requirements and the possibility that a new secure landfill would need to be created to receive the materials.

9.4.5 Alternative 5 – Excavation and Onsite or Offsite Treatment

This *ex situ* alternative would consist of excavating impacted materials from the site and treating the contaminated soils to reduce contaminant toxicity, mobility or volume. Following excavation and treatment to acceptable residual contaminant levels, the treated soils could be placed in a reclamation area within the Hong Kong area, or they could be returned to the site and placed as fill, subject to meeting criteria for import of treated soils (Section 8.2).

The IC has analyzed this alternative in the EIA. The IC selected the following treatment technologies for the excavated soils from the CLS site:

- Stabilization/Solidification of metals-impacted soils
- Bioremediation (Biopiling) of petroleum hydrocarbon and SVOC-impacted soils, and
- Thermal Desorption of dioxin-impacted soils.

The IEC concurs with the IC's analysis and selection of treatment technologies for the following reasons:

Effectiveness

Excavation of impacted materials would have a high degree of effectiveness, as the contaminated materials would be removed permanently from their current location onsite for subsequent treatment. Post-excavation confirmatory sampling would provide further assurance and documentation that soils containing COPCs in excess of cleanup levels have been removed.

Stabilization/solidification of metals-impacted soils is an effective means of immobilizing the metals constituents in the soils. Although the total concentrations of metals are not significantly reduced (there is some incremental reduction in concentration due to the dilution effect of added reagents), their mobility, and therefore availability to the environment, is greatly reduced. This is the most widely used method to treat metals-impacted soils prior to landfilling in the U.S., and is commonly used in Hong Kong to treat metals-impacted soils. A variety of reagents can be used to stabilize and solidify the metals, including Portland cement, pozzolan, fly ash, soluble silicates, and other chemical stabilization agents. Treated soils are solidified and broken into cemented blocks of appropriate dimensions for placement in a landfill or in a reclamation or structural fill. Effectiveness of the stabilization process is established through post-treatment TCLP testing for soluble metals. Treatability studies would need to be conducted to evaluate the most effective mix of reagents to effectively immobilize the heavy metals present in site soils.

Bioremediation (biopiling) is an effective and commonly used approach to remediate petroleum hydrocarbons, including some SVOCs, particularly polycyclic aromatic hydrocarbons (PAHs). The bioremediation process relies on microorganisms to metabolize hydrocarbons to produce carbon dioxide and water. The process can occur under either anaerobic or aerobic conditions. The effectiveness of bioremediation can be enhanced by combining the bioremediation process with vapor extraction to promote volatilization while supplying air to the microorganisms, as in a biopile. Biopiling is an accepted remediation method that has been applied in Hong Kong. Because heavy metals can be toxic to microorganisms and inhibit the biodegradation process, treatability studies will be necessary to evaluate the impact of heavy metals present in the soils and to optimize design parameters for biopile treatment.

Thermal desorption has been successfully used to treat wide range of organic contaminants, including dioxin-contaminated soils at a number of locations, including in the U.S. and Australia. The effectiveness of thermal desorption is a function of a variety of factors, including the chemical makeup of the contaminants, their concentrations, soil gradation and moisture content, temperature of operation, and residence time. If impacted soils do not have excessive clay content (which site soils do not have), and sufficient residence time is allowed, thermal desorption can effectively achieve removal efficiencies of approximately 99% or greater. Considering average concentrations of detected dioxins, this level of efficiency should effectively remediate dioxin in impacted soils to acceptable levels. A treatability study would be required to establish design and operating conditions to meet established cleanup goals.

Implementability

Stabilization/solidification of metals-impacted soils can be readily implemented with available technology and equipment. This is an accepted presumptive remedy for soil contamination by heavy metals. This alternative could be carried out either offsite, or onsite, subject to schedule constraints and availability of suitable space. The actual mixing and stabilization process can be conducted either by mixing soils and reagents with earthmoving equipment or in a pug mill. Implementability could be affected by the presence of large fragments of debris and waste materials mixed with the contaminated soils. This can be addressed by screening the soils prior to stabilization treatment. If necessary, screening would need to be conducted in a contained and controlled manner to capture fugitive dust and other emissions, which could deposit on the ground and result in spreading of contamination. If screening is conducted onsite, it should be done in a fully contained, enclosed environment. Metals stabilization would have to be conducted in lined bermed cells in a manner that prevents migration of contaminants to the underlying soils and with a cover to prevent excess moisture from rainfall during curing of treated soils.

Biopiling of TPH and SVOC-impacted soils can also be readily implemented with available technology and equipment. This is an accepted presumptive remedy for this type of contamination. Due to the presence of heavy metals in some soils that are also contaminated by TPH and SVOCs, toxicity effects of the metals on microorganisms could impact implementability. This would have to be assessed during a treatability test. Biopiles would have to be constructed with lined bermed cells in a manner that prevents migration of contaminants to the underlying soils and with a cover to prevent excess moisture from rainfall during treatment.

Implementability and effectiveness of treatment of dioxin-contaminated soils by thermal desorption has been demonstrated by several past projects. Implementability of using thermal desorption to treat the dioxin-impacted soils at the CLS site should be good, but design parameters, operating temperatures, residence times, and number of treatment cycles necessary would have to be determined from a treatability test. This alternative would require transporting a thermal treatment unit to Hong Kong with associated setup, testing, shakedown, and permitting, as thermal desorption units are not presently available in Hong Kong. Implementability is therefore subject to availability of a treatment unit for use within the overall timeframe available to complete the project. Prior to treatment, large fragments of debris and waste materials mixed with the contaminated soils would have to be removed and soil clods broken to no larger than 5 cm. This can be addressed by screening the soils prior to treatment. Screening would need to be conducted in a contained and controlled manner to capture fugitive dust and other emissions, which could deposit on the ground and result in spreading of contamination. Onsite screening of dioxin-contaminated soils is not recommended.

Long-term Reliability

Long-term reliability of stabilized metals-impacted soils is a function to the degree the metals are permanently bound with the soils through the cementation/stabilization process. Long-term empirical data are not available for stabilized metals-impacted soils. However, sequential leaching tests designed to simulate long-term action by leachate in a landfill have shown good success with silicate-stabilized metals impacted soils. Adoption of conservative UTS values for soluble metals in a TCLP extract following stabilization would enhance long-term reliability of stabilized soils. Long-term reliability would also be enhanced by placing the treated soils in a land reclamation or structural fill above the water table and with sufficient cover to provide a physical barrier to contact.

Long-term reliability of both biopiling of TPH and SVOC-impacted soils and thermal treatment of dioxin-impacted soils is high, since the contaminants are permanently removed from the soils. This results in reduction in long-term liabilities associated with re-use of the treated soils.

Short-Term Risk

There are short-term risks associated with implementation of Alternative No. 5, as with all alternatives that would involve excavation and removal of impacted soils from the site that would have to be carefully addressed. There would be short-term risks to construction workers engaged in the remediation work that would have to be addressed through a comprehensive worker health and safety program. There are also risks associated with spreading of contamination by fugitive dust emission or site runoff during excavation, handling, and loading and unloading of impacted soils. There would also be risks to workers, and potentially to the surrounding environment, at the onsite and offsite treatment facility associated with management of the soils during treatment operations. Further, there would be short-term risks associated with overland transport of contaminated soils via truck, or marine transport of impacted soils via barges, from the site to the offsite treatment facility. These risks would include those associated with increased highway or marine traffic, and risk of upset and spillage of contaminated soil during transport. Contingency plans would need to be put in place to deal with any spillage of contaminated soils.

The greatest source of risk associated with fugitive dust emissions is associated with screening operations to segregate debris and waste materials from the impacted soils. As stated above, soil segregation and screening processes would need to be conducted in a controlled and monitored manner with redundant contingency dust suppressions systems. For the dioxin-impacted soils, screening should be conducted in a fully enclosed system with a dust collection and recovery system. Onsite screening of dioxin-contaminated soils is not recommended.

There are also short-term risks associated with vapor emissions from the biopile and thermal treatment operations that would have to be addressed and carefully monitored. Biopiles would need to be covered, and vapors withdrawn via the blower/vacuum system treated, typically by carbon absorption, prior to discharge to the atmosphere. Volatilized chemicals from the thermal desorption unit would need to be processed through a high-temperature afterburner to treat offgases. The thermal desorption process would also produce a concentrated oily residuum that would need to be properly managed. Both processes would require continuous emissions monitoring systems to verify that they systems are operated in accordance with discharge limits that would be contained in operating permits from the EPD.

Reduction of Toxicity, Mobility, or Volume through Treatment

There is no reduction in contaminant concentration (with the exception of incidental dilution due to addition of reagents) with the metals stabilization process. Therefore, in an absolute sense, toxicity would not be significantly reduced. Mobility of metals contaminants would be reduced by chemically and physically binding the metals up in the stabilized mass. Although the total metals concentrations would not be appreciably reduced, physically binding up the metals would have a resultant reduction in availability to receptors. Therefore, even though toxicity is not reduced *per se*, the stabilized metals would not be available and there would be no complete pathway by which receptors could come in contact with the metals species. There would be an incremental increase in volume of impacted materials associated with addition of treatment reagents.

Both biopiling of TPH and SVOC-impacted soils and thermal treatment of dioxin-impacted soils would result in removal of COPCs to designated cleanup levels. While the residual chemical constituents would have the same toxicity (cancer slope factors or reference doses) as the untreated soils, the reduction in concentration would have a net effect of lowering risk and hazard associated with exposure to treated soils. Reduction in volume would be minimal with these treatment methods.

Overall Protection of Human Health and the Environment

All three treatment methods associated with Alternative 5 (metals stabilization, biopiling, and thermal desorption) would result in an acceptable level of overall protection of human health and the environment. Metals contaminants would be bound up and immobilized in cemented blocks and no longer available for contact by human or ecological receptors. Removal of TPH/SVOCs and dioxins by biopiling and thermal treatment, respectively, results in a reduction in risk and hazard associated with these COPCs.

Compliance with Applicable or Relevant and Appropriate Requirements

All three treatment methods associated with Alternative 5 could be implemented in a manner that complies with applicable Hong Kong environmental regulations. Implementation of Alternative 5 would satisfy ARARs.

Specific systems operations permit requirements that would be imposed by the EPD are not known at this time. However, the fact that metals stabilization and biopiling have been used in Hong Kong in the past indicates that these treatment methods could be operated within operating constraints imposed by the EPD.

Although treatment by thermal desorption has, to the IEC's knowledge, not been applied in Hong Kong in the past, this method has been applied successfully elsewhere. It is therefore considered probable that thermal treatment of dioxin-impacted soils could be done in compliance with operating permit requirements imposed by the EPD.

Regulatory and Community Acceptance

Because they have been implemented effectively in Hong Kong in the past, stabilization/solidification of metals-impacted soils and *ex situ* bioremediation via biopiling of TPH and SVOC-impacted soils are likely to receive both regulatory and community acceptance.

With proper monitoring and control measures to safeguards against emissions release, it is believed that thermal treatment of dioxin-impacted soils can receive regulatory approval. It would also receive HKITP approval, providing RAOs are met for any thermally treated soils that are placed as fill on the site. Thermal treatment of dioxin-impacted soils may meet some community resistance due to the potential for atmospheric emissions associated with the treatment process. As previously stated, this option will require a continuous emissions monitoring system to verify that they systems are operated in accordance with discharge limits that would be contained in operating permits from the EPD.

Cost Effectiveness

The cost effectiveness of stabilization/solidification of metals-impacted soils and biopiling of TPH and SVOC-impacted soils is high. Both treatment technologies have been applied in Hong Kong in the past, and operational conditions and cost factors should be available.

Cost effectiveness of treatment by thermal desorption of dioxin-contaminated soils is good in comparison to other treatment methods available for dioxin-impacted soils, specifically incineration. Cost factors are less certain for thermal treatment for dioxins since desorption equipment is not available in Hong Kong, and it will be necessary to import the required equipment and expertise. None-the-less, costs associated with importing, permitting and operating a thermal desorption unit are judged to be lower than comparable costs for thermal treatment by incineration, which is equally not available for large volumes of impacted soils.

9.5 COMPARISON OF REMEDIAL ALTERNATIVES

The following section provides a comparison of the five remedial alternatives with respect to the evaluation criteria discussed in the previous section.

9.5.1 Effectiveness

The effectiveness of Alternatives 3, 4 and 5 are all judged to be good. Alternative 1, the No Action alternative, has negligible effectiveness, and although Alternative 2 would result in an effective barrier that would reduce the potential for receptors to come into contact with the contaminated soils, it is judged to be less effective than the other alternatives. Alternatives 4 and 5 are judged to have the highest effectiveness, since the contaminants are removed from their current location and either disposed offsite (Alternative 4) or treated to reduce contaminant toxicity, mobility, or mass (Alternative 5).

9.5.2 Implementability

Implementability of Alternative 1 is not factor, as there is nothing to implement with the No Action alternative. Implementability of Alternative 2 is judged to be high, as it does not rely on sophisticated technology. It may require long-term monitoring, however. Implementability of Alternatives 3 and 4 is considered to be low due to the need to permit an onsite regulated waste management unit (Alternative 3) and the need for pre-treatment of soils and consumption of available landfill space (Alternative 4). Implementability of Alternative 5 is judged to be good overall. Treatment of metals-impacted soils by stabilization/solidification and TPH and SVOC-impacted soils by biopiling are readily implementable. Implementability of treatment of dioxin-impacted soils by thermal desorption has been demonstrated by several past projects elsewhere, but necessary treatment equipment and expertise would need to be imported to Hong Kong for the project.

9.5.3 Long-Term Reliability

The long-term reliability of Alternative 1 is very low because it leaves contaminated soils in place without remedy. Long-term reliability of Alternative 2 is also considered to be low, as it does not remedy the problem and could result in future requirements for remedial action(s) if migration of contaminants is later found to occur. The long-term reliability of Alternative 3 could be high with sufficient engineered safeguards, but this alternative would require long-term monitoring and an O&M Program. Long-term reliability of Alternative 4 is considered to be high with respect to site conditions, but it transfers liability to another location (i.e., the receiving landfill). Overall long-term reliability of Alternative 4 is therefore judged to be moderate. The long-term reliability of Alternative 5 is judged to be the highest of the alternatives considered, since it would result in physical stabilization of metals and removal of COPCs in TPH, SVOC, and dioxin-impacted soils to acceptable levels.

9.5.4 Short-Term Risk

There are no significant short-term risks associated with Alternatives 1 and 2, as the contaminated soils would be left in place with both alternatives. There are short-term risks associated with Alternatives 3, 4, and 5, which would all involve excavation, handling, and transport of contaminated soils. These risks are lowest for Alternative 3, as soils would not be transported offsite and would not need to be screened to remove rubble and debris. Because Alternatives 4 and 5 would involve offsite transport of contaminated soils to either an offsite secure landfill (Alternative 4) or an offsite treatment facility (Alternative 5), there are risks associated with overland or marine transport, including risk associated with upset and spillage. These transport risks are slightly greater for Alternative 4 because all impacted soils would be transported offsite, whereas for Alternative 5 metals-only impacted soils may be treated onsite. This lower transport risk may be offset, however, by risks associated with transport of treated soils back to the site for placement as fill following offsite treatment.

The greatest short-term risk is likely associated with fugitive dust emissions from screening operations to segregate debris and waste materials from the impacted soils. Soil segregation and screening processes would need to be conducted in a controlled and monitored manner with redundant contingency dust suppressions systems. For the dioxin-impacted soils especially, screening should be conducted in a fully enclosed system with a dust collection and recovery system.

9.5.5 Reduction of Toxicity, Mobility, or Volume through Treatment

Only Alternative 5 results in a reduction of toxicity, mobility, or volume through treatment. Although 4 would require pre-treatment of some soils prior to disposal, only Alternative 5 would result in destructive removal of COPCs from TPH, SVOC, and dioxin-impacted soils and treatment of metals-impacted soils by stabilization/solidification. Alternatives 1 and 2 would not result in any reduction of toxicity, mobility or volume, and Alternative 3 would not result in a decrease in contaminant toxicity or volume.

9.5.6 Overall Protection of Human Health and the Environment

Alternative 1 would not result in acceptable protection of human health and the environment. Results of the human health and ecological risk assessment indicate that Alternative 2 would meet health-risk based RAOs for the project, even though it would not result in a reduction of toxicity, mobility or volume. Because Alternative 3 would entomb contaminated soils and wastes in a lined and capped cell, it could provide for a high degree of protection of human health and the environment. Because it would result in transfer of wastes and impacted materials from one location to another, Alternative 4 is judged to be only moderately protective. Of the alternatives considered, Alternative 5, Excavation and Onsite or Offsite Treatment, affords the greatest degree of protection of human health and the environment.

9.5.7 Compliance with Applicable or Relevant and Appropriate Requirements

Alternatives 1, 2, and 3 do not meet the general guidelines of the EPD that require remediation of soils impacted with contaminants at concentrations exceeding the Dutch 'B' Guidelines. These alternatives therefore do not meet ARARs. Alternative 4 could be implemented in a manner consistent with applicable regulations; however, this alternative would result in consumption of valuable landfill space. Landfill disposal is discouraged by EPD and should be considered as only a last resort per EPD guidance. Alternative 5 would satisfy the ARARs.

9.5.8 Regulatory and Community Acceptance

Regulatory and community acceptance of Alternatives 1, 2, and 3 is judged to be low because these alternatives do not satisfy the general guidelines of EPD. In addition, these alternatives are unlikely to meet with approval from CED or HKITP, nor from the general community. Regulatory acceptance of Alternative 4 is also judged to be low because it is inconsistent with general EPD guidance with respect to landfill disposal and consumption of valuable landfill space. Regulatory and community acceptance of Alternative 5 is judged to be highest of the alternatives considered; however, there may be some community opposition to thermal treatment of dioxin-contaminated soils.

9.5.9 Cost Effectiveness

There is no cost associated with Alternative 1; however, it would not leave the site in a condition that supports infrastructure development for the theme park. The cost effectiveness of Alternative 2 is considered to be high, as it would not involve a significant increase in work over current site development plans. The cost effectiveness of this alternative would be somewhat diminished if an engineered cap is included. The cost effectiveness of Alternatives 3 and 4 is judged to be medium to low. The cost effectiveness associated with excavation and treatment (Alternative 5) is considered to be medium overall. Cost effectiveness of this alternative could decrease to low depending on costs to import, setup, permit and operate a thermal desorption unit.

9.6 REMEDIAL ALTERNATIVE SELECTION

As noted in Section 9.3, the IC, MCAL, has conducted an evaluation of *ex situ* remedial technologies for non-dioxin impacted and dioxin-impacted soils as part of the *Environmental Impact Assessment Report (Final) for Decommissioning of Cheoy Lee Shipyards at Penny's Bay.* MCAL has recommended excavation and offsite treatment of impacted soils. Recommended treatment methods include cement solidification of metals-impacted soils, biopile treatment of TPH and SVOC-impacted soils, and thermal desorption treatment of dioxin-impacted soils. MCAL further recommends treating soils impacted by both metals and TPH/SVOCs first by biopiling followed by cement solidification. Soils impacted by dioxins and other contaminants would first be treated by thermal desorption to remove dioxins and other organic COPCs, followed by cement stabilization. Soils would be shipped by truck over Chok Ko Wan Pass to a treatment site at Tau Ka Wan on the northwest part of Lantau Island.

The IEC understands that consideration has also been given to conducting cement solidification treatment onsite, with biopile and thermal desorption treatment for organic constituents at Tau Ka Wan. The IEC further understands that MCAL and the CED have recommended placing the treated and stabilized soils within the fill section to be placed to raise the site grade by 7m.

Based upon the RAE summarized above, it is the IEC's opinion that the remediation approach recommended by MCAL can effectively meet the remedial action objectives and goals presented in Section 9.1, if implemented in accordance with the conditions outlined in the Remedial Action Work Plan (Section 10, below). The IEC therefore concurs with MCAL's selected remedy of excavation and treatment of metals-impacted soils by cement stabilization, TPH and SVOC-impacted soils by biopiling, and thermal treatment of dioxin-impacted soils by thermal desorption.

10.0 REMEDIAL ACTION WORK PLAN

This section presents a Remedial Action Work Plan (RAW) for the CLS site. The RAW presents a summary of site environmental conditions, recommended cleanup standards, remedial action objectives and goals, remedial alternatives evaluation, and the recommended remedy for soil contamination at the CLS site, along with justification for its selection. Also presented are discussions of engineering design and implementation considerations for the selected remedy, construction sequencing and implementation factors, soil confirmation sampling and post-remediation soil testing requirements, permitting considerations, monitoring and control measures and contingency plans, and site monitoring well closure/decommissioning requirements.

10.1 SUMMARY OF SITE ENVIRONMENTAL CONDITIONS

The site setting and physical characteristics of the CLS site are presented in Section 3, above. The scope of the RI conducted to assess land contamination at the CLS site is presented in Section 4, RI data evaluation is discussed in Section 5, and findings of the RI with respect to soil and groundwater contamination are discussed in Section 6. Findings of the RI are only briefly summarized here, and the reader is referred to relevant discussions in Section 6 for details of site environmental conditions.

For purposes of site definition and characterization, the CLS site has been divided into three areas, Areas 1, 2, and 3. These different areas generally correspond to different periods of development and land use by CLS.

Environmental impacts within Area 1 appear to be associated with operations that occurred within Buildings B, D, I, J, L, M, N, O, and P, as well as outside areas between buildings. Primary chemical contaminants found in Area 1 at concentrations exceeding Dutch 'B' Guidelines include metals (including hexavalent chromium), fuel hydrocarbons, and SVOCs. Prevalent metals and maximum detected concentrations in soils within Area 1 include arsenic (54 mg/kg), copper (7,680 mg/kg), lead (26,300 mg/kg), chromium (2,670 mg/kg), hexavalent chromium (392 mg/kg), nickel (1,780 mg/kg), and zinc (9,090 mg/kg). Significant contamination by TPH and SVOCs occurs locally, and dioxins (6 μg/kg TEQ) were discovered at the base of the slope across a concrete-lined drainage channel from Building L in an area formerly used to burn plastic insulation from wire.

Environmental impacts within Area 2 appear to be associated with operations in portions of Buildings R, S, T, W, X, Y, and Z; areas adjacent to several buildings; and in waste disposal mounds and pits located east of Buildings S and T. Prevalent metals and maximum detected concentrations in soils within Area 2 include copper (27,900 mg/kg), lead (4,630 mg/kg), chromium (672 mg/kg), and zinc (6,840 mg/kg). The largest area of impact is along the base of the slope where the former site tenant pushed debris and waste materials, including metals debris, drums, and other materials, into a series of mounds. Additionally, there is an area in the southeastern corner of Area 2 where burn pits were found in exploratory trenches and impacts by dioxins (up to 3 μg/kg TEQ) and metals were found to occur.

The majority of Area 3 was not formerly used for shipbuilding operations; rather, it apparently was used for disposal of wastes generated at the CLS facility. A large number of burn pits and buried waste pits were uncovered in exploratory trenches excavated in this portion of the site. These waste materials and burn pits were found to extend to depths up to 4.8m. Shallow soils to a depth of 1m are primarily impacted by metals and to a lesser extent by TPH. Deeper soils and waste materials and residues within waste and burn pits in Area 3 are impacted by dioxins and metals. Maximum concentrations of prevalent COPCs in Area 3 include: arsenic (114 mg/kg), barium (4,660 mg/kg), cadmium (118 mg/kg), chromium (5,390 mg/kg), cobalt (328 mg/kg), copper (28,100 mg/kg), lead (21,100 mg/kg), nickel (1,790 mg/kg), tin (3,650 mg/kg), zinc (35,700 mg/kg), and dioxins (109 μg/kg TEQ). SVOCs were also detected in a number of samples, as well as TPH.

10.2 VOLUMES OF AFFECTED MEDIA

As presented in Section 6.7 and summarized in Section 9.2, estimated in-place soil volumes in cubic meters, to two significant figures, and predominant soil contaminant type(s) are as follows:

Site Area	Estimated Volume (m^3)	Predominant COPCs
1	10,000	Metals, TPH, SVOCs, limited dioxins
2	16,000	Metals, TPH, SVOCs, dioxins
3	61,000	Metals, TPH, SVOCs, dioxins
Total	87,000	

Estimated volumes of soil impacted by different types of contaminants are as follows:

Contaminant Type(s)	Estimated Volume (m^3)
Metals only	48,000
TPH and/or SVOCs	700
Metals and TPH and/or SVOCs	8,300
Dioxins, metals, and TPH and/or SVOCs	30,000
Total Estimated Volume	87,000

10.3 SUMMARY OF REMEDIAL ACTION OBJECTIVES AND GOALS

Remedial Action Objectives (RAOs) and goals for the site were established consistent with guidance provided by EPD in ProPECC PN 3/94 (*Practice Note for Professional Persons, Contaminated Land Assessment and Remediation*) and the requirements of USEPA under CERCLA. The RAOs for the CLS site are to:

- Minimize exposure of humans (site construction and maintenance workers, and occasional visitors) and ecological receptors to the COPCs identified in soils at the site (metals, petroleum hydrocarbons, polycyclic aromatic hydrocarbons, cyanide, and dioxins) through inhalation, dermal contact, and ingestion, and
- Reduce the potential for COPCs in soil at the site to migrate to and potentially impact the Water Recreation Centre artificial lake to be constructed upon reclaimed land within (former) Penny's Bay as part of the theme park development.

Remedial action goals have been established for the CLS site to achieve these RAOs. Chemical-specific goals have been identified for the COPCs present at the site at concentrations above Tier 1 screening levels. These remedial action goals include both risk-based goals and compliance-based goals:

- Residual chemical concentrations in soil at the site do not result in an incremental cancer risk to potentially affected receptors greater than 1×10^{-5}
- Soils impacted by COPCs at concentrations exceeding environmental "bright line" standards recommended by the EPD (the Dutch 'B' Guidelines) are remediated to reduce contaminant concentrations to acceptable levels and/or reduce the mobility and availability of contaminants through stabilization or other processes, and
- Residual post-remediation concentrations of COPCs in soils that are intended to be returned to the CLS site and placed as fill are below risk-based and applicable compliance-based standards.

The selected remedial alternative(s) will be required to be reliable in the long-term, effective in the short-term, implementable within the HKSAR given its environment and land-use constraints, be compliant with applicable standards and/or guidelines, and result in an acceptable level of protection of human health and the environment.

10.4 RECOMMENDED CLEANUP LEVELS

IEC recommended cleanup levels for soil contamination at the CLS site are discussed in Section 8, above. Recommended cleanup levels for COPCs detected at the site are presented in Table 8-1 and are summarized as follows:

- TPH – Dutch 'B' Guideline values
  - $C_6 - C_{14}$ = 100 mg/kg
  - C_{15} and greater = 1,000 mg/kg
- SVOCs – Risk-based concentrations, as listed in Table 8-1
- Metals – Dutch 'B' Guideline values, as listed in Table 8-1
- Dioxins
  - 1 µg/kg TEQ for dioxins in soils that will be covered with a minimum of 3m of clean fill soils, and
  - 0.1 µg/kg TEQ for dioxins in surface soils or where less than 3m of clean fill soil will be placed.

10.5 SUMMARY OF REMEDIAL ALTERNATIVES EVALUATION

Available selected remedial approaches and process options that potentially could be applied to the impacted soils at the CLS site were initially screened based upon a relative ranking of effectiveness, implementability, and cost (Table 9-1). Based upon the results of this initial screening, the following remedial action alternatives were retained and further evaluated:

- Alternative 1 – No Action
- Alternative 2 – Onsite Cover of Impacted Soils
- Alternative 3 – Excavation and Entombment Within Lined Cell Beneath Engineered Cap
- Alternative 4 – Excavation and Offsite Landfill Disposal of Impacted Soils, and

- Alternative 5 – Excavation and Onsite or Offsite Treatment.

These alternatives were evaluated based upon the following nine criteria: 1) effectiveness; 2) implementability; 3) long-term reliability; 4) short-term risk; 5) reduction of toxicity, mobility, or volume through treatment; 6) overall protection of human health and the environment; 7) compliance with applicable or relevant and appropriate regulations; 8) regulatory and community acceptance; and 9) cost effectiveness.

This remedial alternatives evaluation is described in detail in Section 9, above.

10.6 DESCRIPTION AND JUSTIFICATION FOR THE RECOMMENDED REMEDIAL ALTERNATIVE(S);

As noted in Section 9, the recommended remedial action for impacted soil at the CLS site is excavation and treatment of metals-impacted soils by cement stabilization, TPH and SVOC-impacted soils by biopiling, and thermal treatment of dioxin-impacted soils by thermal desorption. This remedial action alternative will consist of excavating impacted materials from the site and treating the contaminated soils to reduce contaminant toxicity, mobility or volume. Following excavation and treatment to acceptable residual contaminant levels, the treated soils could be placed in a land reclamation within the Hong Kong area, or they could be returned to the site and placed as fill, subject to meeting criteria for import of treated soils (Section 8.2).

As discussed in Sections 9.4.5 and 9.5, cement stabilization/solidification of metals-impacted soils and bioremediation of TPH and SVOC-impacted soils in a biopile are presumptive remedies for these types of soil contamination. Both methods have been widely used in U.S., in Hong Kong, and elsewhere – they are effective, readily implemented, and capable of meeting the RAOs for the site. Moreover, following treatment, impacted soils could be re-used as part of a land reclamation or within the fill section to be placed at the CLS site to support infrastructure development. Both methods provide a high degree of protection of human health and the environment, result in either a reduction in mobility, and therefore environmental availability of contaminants, or toxicity, and are likely to achieve regulatory acceptance. Additionally, although not a deciding criterion, both methods have favorable evaluations with respect to cost effectiveness. The technologies associated with both cement stabilization/ solidification and biopile treatment are readily available and have been implemented in the past in Hong Kong.

Offsite treatment by thermal desorption is the recommended remedial alternative for dioxin-impacted soils. Of the remedial alternatives identified, screened, and evaluated, offsite thermal treatment technologies are considered more effective than non-thermal processes to reduce the concentration, and therefore the mobility and toxicity of dioxins in impacted site soils. The non-thermal remedial approaches evaluated would not satisfy the general requirements of the EPD and USEPA and therefore would not satisfy the agreed-upon approach. Both of the two thermal options considered (thermal desorption and incineration) have been previously applied for treatment of dioxins in soil, and both are capable of meeting cleanup objectives for dioxin-contaminated soil at the CLS site. The IC, in the EIA, recommends that a thermal desorption treatability study be conducted to demonstrate treatment efficiency and to verify design parameters such as operating temperature, residence time, feed rate, and related factors prior to implementation.

As noted by the IC in the EIA, the thermal desorption process will result in production of an oily residue that is enriched in dioxins. This concentrated residue will require further treatment by incineration to complete the destruction process for the dioxins. It is recommended that the oily residue be transported to the existing Chemical Waste Treatment Centre (CWTC) in Hong Kong for incineration. Following treatment to remove dioxins (and other organics that may be presented in some of the impacted soils) the treated soils will be tested to confirm that RAOs have been met. Because thermal desorption does not treat metals, if metals concentrations in thermally treated soils exceed relevant cleanup standards, the treated soils will then require further treatment by cement stabilization/solidification prior to placement in a reclamation or as part of the fill to support infrastructure development at the CLS site.

10.7 ENGINEERING DESIGN CONSIDERATIONS

The conservative excavation plans presented as Figures 6-7, 6-8, and 6-9 delineate areas recommended for excavation to meet the RAOs established for the site. The IEC recommends that the Site Remediation Contractor (SRC), under the technical direction of the IC, produce detailed design drawings for planned excavations in the indicated areas. Factors that should be considered include areas and depths of excavation and the engineering properties and stability of site materials to allow for safe working conditions. It is probable that excavations will require sloped or benched sides to provide stable and safe working conditions for men and equipment. The IEC recommends that the excavations be designed in accordance with geotechnical properties of site soils, and appropriate factors of safety for excavations as determined by the IC and approved by CED.

In addition to stability factors, the IEC recommends that excavations be designed in full consideration of the potential for encountering buried utility lines. Live electrical lines were discovered during test trenching at the site; general indications of the locations underground utilities are shown in the geophysical interpretation maps by Cosine. The IEC recommends that a proper utility survey be conducted in advance of site excavation work and that any live utility lines be properly de-energized prior to conducting excavation activities in the subject areas.

Excavation plans shall include contingencies to prevent erosion due to runoff from rainfall. Contingency plans shall be developed to control and contain runoff from contaminated soils and stockpiles so as to prevent spreading of contamination.

10.8 CONSTRUCTION SEQUENCING

The following general sequence of remediation construction activities is envisioned for the CLS site remediation. The actual sequencing of remediation construction operations proposed by the SRC shall be consistent with the recommendations provided in the bulleted list below.

- Existing buildings and infrastructure shall be decontaminated (including asbestos abatement as required) and demolished. Following demolition, construction and demolition (C&D) waste will be transported to an appropriate landfill or recycled, as appropriate.
- Areas of the site planned for excavation shall be set out by an appropriately qualified and licensed land surveyor based upon the Conservative Excavation Plan included as Figures 6-7, 6-8, and 6-9. The IEC recommends that actual surveyed boring and trench locations where

soils impacted by COPCs at concentrations exceeding cleanup levels be used in setting out areas to be excavated in combination with the areas identified on the Conservative Excavation Plan.

- Excavation may be conducted using excavation equipment and sequencing selected by the SRC.
- The IEC recommends that all construction activities be conducted by persons appropriately trained in health and safety and that persons engaged in remediation activities use appropriate personal protective equipment.
- Fugitive dust suppression measures shall be implemented during all excavation and soil handling activities to control fugitive dust emissions in accordance with applicable Hong Kong standards.
- Fugitive dust monitoring shall be conducted during all excavation and soil handling activities to provide assurance that contaminants are not released or otherwise spread by dust emissions.
- Appropriate run-off control measures shall be implemented onsite to minimize contact between precipitation induced run-off and the works areas.
- Run-off waters from work areas should be collected, stored, and tested for contaminants as detailed in the site discharge permit and, if necessary, treated prior to discharge.
- Consideration shall be given to the nature of chemical impact to soils, as established by the RI findings (summarized in Tables 6-2, 6-3, and 6-4 and on Figures 6-7, 6-8, and 6-9), so as not to mix soils with different types of contaminants and thereby increase the volume of soils that would require treatment by the different remedial treatment methods.
- Soils to be treated for metals contamination only may be excavated separately and stockpiled onsite upon appropriate protective sheeting to prevent spreading of contamination to subjacent layers. Stockpiled soils shall be covered to control fugitive dust emissions and minimize run-off. If metals treatment is to occur onsite, covered trucks may be used to transport affected soils to strategically located stockpile location(s) adjacent to the treatment area(s).
- Prior to stabilization, metals-impacted soils will likely require screening to segregate soil from debris, rock fragments, and other materials and to break soil clumps into sizes that promote effective mixing with stabilization reagents. Any onsite screening operations shall be conducted in a fully atmospherically controlled manner that provides for capture of fugitive dust emissions to prevent spreading of contamination.
- If metals-impacted soils are to be stabilized onsite, all stabilization processes shall be conducted in lined and bermed treatment cells so as to prevent spreading of contaminants to the underlying soils. Treatment and curing cells shall be covered to prevent rainwater from entering and diluting the treated soil mixture during curing, and to prevent runoff from leaving the treatment area and potentially spreading contamination.
- Following treatment, confirmation sampling shall be conducted on soils beneath the treatment area using the same sampling density and spacing as described in Section 10.11, below. If metals impact is found in soils beneath the treatment area(s) at concentrations exceeding cleanup levels, soils shall be excavated and further confirmation sampling conducted until residual concentrations metals concentrations are below designated cleanup levels.

- Soils to be treated for petroleum hydrocarbons and SVOCs only may be excavated and loaded into lined roll-off trucks with sealable tops for transport to the offsite treatment facility selected by the IC in accordance with all applicable Hong Kong laws and guidelines of the EPD. Similarly, soils contaminated by both THP/SVOCs and metals may be excavated and loaded into lined roll-off trucks with sealable tops for shipment to the offsite treatment facility. Care shall be exercised by the SRC to avoid mixing soils impacted by TPH/SVOCs only with soils also impacted by metals to reduce the total volume of soils that will require metals stabilization treatment subsequent to biopile treatment for TPH and SVOCs.
- Soils to be treated for petroleum hydrocarbons and SVOCs shall be shipped to the offsite treatment facility in accordance with all applicable Hong Kong laws and guidelines of the EPD.
- The potential exists that free hydrocarbon product may be encountered in the vicinity of Building D in Area 1 of the site. A thin layer of hydrocarbon product was encountered in one of the monitoring wells in this portion of the site. Any free product encountered shall be skimmed from the excavation area and properly drummed and managed in accordance with Hong Kong standards.
- For the area to be excavated within Area 3 of the site, the upper 1m of soil within the entire area shall be excavated first and managed as metals-impacted. Care shall be exercised so as not to mix apparent burn/waste pit materials with soils from this upper meter.
- Burn/waste pit materials shall be excavated separately and loaded into lined roll-off trucks with sealable tops for transport to the offsite treatment facility. Excavation of burn/waste pit areas shall continue until all visibly contaminated materials have been removed prior to confirmation sampling.
- Soil segregation and screening processes shall to be conducted in a highly controlled and monitored manner with redundant contingency dust suppressions systems. For the dioxin-impacted soils, screening and other feed preparation activities should be conducted in a fully enclosed system with a dust collection and recovery system. Onsite screening and feed preparation of dioxin-contaminated soils shall not be conducted; these activities shall occur at the offsite treatment facility location.
- Following removal of impacted soils, confirmation sampling shall be conducted as described in Section 10.11. Confirmatory samples shall be analyzed for the type of contaminants present in the original characterization samples and the results compared with applicable cleanup levels. If residual concentrations are below project cleanup levels, excavation of that part of the site will be deemed complete. If concentrations exceed cleanup levels, additional soil shall be excavated and confirmation sampling and testing conducted until cleanup levels have been met.
- Following treatment, samples from treated soils shall be analyzed as described in Section 10.11 to establish that contaminant-specific RAOs have been met. Soils represented by post-treatment sample analytical results which do not meet these RAOs shall be re-treated and re-tested until the RAOs are met.
- Treated soils that meet contaminant-specific RAOs may be backfilled onsite in accordance with the recommendations contained in Section 10.12.

10.9 PERMIT REQUIREMENTS

All site remediation work shall be done in accordance with and under appropriate permits issued by the EPD of the HKSAR, including permits that may be required under the following ordinances and regulations:

- EIA Ordinance
- Air Pollution Control Ordinance
- Construction Dust Regulation
- Waste Disposal Ordinance
- Water Pollution Control Ordinance
- Noise Control Ordinance, and
- Any other ordinance, regulation, or permit requirements that may be imposed by the EPD and or the CED. The SRC shall have primary responsibility for securing necessary permits under the technical direction of the IC.

Additionally, persons and businesses engaged in site remediation work shall have all appropriate registrations and licenses for the scope of activities they perform.

10.10 MONITORING, CONTROL MEASURES, AND CONTINGENCY PLANS

A variety of monitoring and control measures shall be included in the remedial design and implemented during onsite remedial activities. Monitoring and control measures for offsite remedial activities are beyond the purview of the IEC. The following is a list of minimum recommendations for these activities by the IEC. EPD, CED, the IC and the SRC may require or suggest additional measures:

- All excavated contaminated soils shall be placed on heavy duty and impermeable plastic sheeting or directly loaded into lined roll-off trucks with sealable tops.
- Any stockpiled soils left onsite shall be covered with plastic sheeting, and a berm shall be placed around the stockpile to prevent runoff from spreading of contamination.
- Best management practices shall be employed to control fugitive dust emissions from all excavation and soil handling operations onsite.
- Continuous fugitive dust monitoring shall be conducted to monitor dust emissions associated with soil excavation and handling operations to provide assurance and documentation that dust emissions and re-deposition do not result in spreading of contaminants.
- Contingency plans shall be developed by the SRC and approved by the IC and the IEC for capture and control of any runoff from stockpiles or excavated areas prior to backfill in the event of runoff-producing rainfall events.
- Control measures and contingency plans shall be developed to control and capture water and potentially other liquids that may drain from excavated soils from below the water table. Extreme care shall be exercised so that fluids that drain from excavated soils do not result in spreading of potential contaminants.

- Free product was encountered in Monitoring Well MW-D06 in the vicinity of Building D in Area 1, and could potentially occur at other areas of the site where fuel hydrocarbons were stored, used or dispensed. Contingency plans shall be developed and implemented to recover, containerize, and appropriately manage any free product that may be encountered floating upon the groundwater surface in excavated areas.
- Contingency plans shall be developed to recover, containerize, characterize, and properly manage any drums of waste that may be encountered, especially in burn/waste pits within Areas 2 and 3. This contingency plan shall be developed and available for implementation during excavation of all areas of the site. Due to the potential for encountering unknown toxic substances, the IEC suggests that the contingency plan include appropriate provisions for worker health and safety.
- The IEC recommends that all excavation activities be monitored for volatile vapors and gases with appropriate real-time monitoring equipment. A PID is recommended for non-methane gases, and a flame ionization detector (FID) or combustible gas indicator (CGI) would be appropriate for methane. These health and safety issues are the primary responsibility of the IC and the SRC.

10.11 CONFIRMATION SAMPLING AND TESTING REQUIREMENTS

10.11.1 Confirmation Sampling from Remedial Excavations

As discussed in Sections 6.6 and 6.7, the areas identified for excavation in Figures 6-7, 6-8, and 6-9 are based on interpretation of RI sample analytical data. Following excavation to the indicated initial excavation limits and depths, confirmation samples shall be collected and analyzed for the COPCs that exceeded screening and cleanup levels. Samples shall be analyzed, and if analytical results of confirmation samples are below relevant cleanup levels, excavation in that area shall be deemed complete. If analytical results exceed cleanup levels, additional soils shall be excavated, either laterally or vertically depending on whether the exceeding confirmation sample is from a sidewall or excavation base, and additional confirmation samples shall be taken and analyzed until all confirmation samples are below relevant cleanup levels.

For small excavation areas, such as the several areas that measure approximately 10 by 10m in size, one confirmation sample shall be taken from the base and one from each sidewall of the excavation. The depth of sampling shall be based on the depth of the original RI sample result that triggered excavation in that area. If RI samples from multiple depths exceeded screening/cleanup values and triggered the need for excavation, confirmation samples shall be taken for each depth where a sample exceeded these values. Additionally, if there are any visible indications of impact, samples shall be taken from the apparent impact zone(s).

For larger excavations, confirmation samples shall be taken from sidewalls of the excavation with a lateral spacing of not more than 15m. At least one confirmation sample shall be taken from each sidewall. Depth of sidewall samples shall be based on the depth of the original RI sample result that triggered excavation in that area. If RI samples from multiple depths exceeded screening/cleanup values and triggered the need for excavation, confirmation samples shall be taken for each depth where a sample exceeded these values. Additionally, if there are any visible indications of impact, samples shall be taken from the apparent impact zone(s).

Confirmation samples from the base of larger excavations shall be taken on a grid spacing not larger than 15 by 15m (one sample per approximately every 225m^2). Additionally, if there are any visible indications of impact, samples shall be taken from the apparent impact zone(s).

Confirmation samples shall be analyzed by a HOKLAS-accredited analytical laboratory using the same USEPA laboratory testing procedures, or equivalent, as used for the RI sample analyses. Five percent field duplicate QA/QC samples shall be collected by the SRC, given identifying sample numbers distinct from the original samples, and analyzed for QC purposes.

10.11.2 Post-Remediation Confirmation Sampling

Following treatment, all treated soils will require post-remediation confirmation sampling and analysis to confirm that RAOs have been met with regard to residual COPC concentrations.

Post-Treatment Confirmation Sampling for TPH/SVOC-Impacted Soils

For TPH and SVOC-impacted soils treated by biopiling, confirmation samples shall be collected with a frequency of not less than one sample per 100m^3 of soil treated. Samples shall be collected at representative locations distributed evenly throughout the biopiles and at various depths within the piles to assure representativeness of sample results. Sample locations within the biopiles shall be accurately documented so that analytical results can be correlated with locations within the biopile. Samples shall be analyzed by TPH as carbon-chain length, SVOCs, and total metals by a HOKLAS-accredited analytical laboratory using the same USEPA laboratory testing procedures, or equivalent, as used for the RI sample analyses. For TPH and SVOC confirmatory analyses, biopile operations shall continue until at least 95% of the analytical results are below respective cleanup concentrations.

Post-remediation samples from the biopiles shall also be analyzed for total metals to determine the need for subsequent treatment for metals by stabilization/solidification. If resulting metals concentrations exceed applicable cleanup levels (Dutch 'B' values), soils represented by those samples exceeding the Dutch 'B' values shall be handled separately and treated by metals stabilization. Soils passing the TPH/SVOC confirmation testing and with metals concentrations below respective cleanup levels may be returned to the site and placed as backfill, subject to the limitations in Section 10.12, below.

Post-Treatment Confirmation Sampling for Dioxin-Impacted Soils

Following treatment of dioxin-impacted soils by thermal desorption, treated soils discharged from the thermal treatment unit shall be sampled and analyzed for dioxins. Treated soils shall be managed and held until results of confirmatory sample testing are received and a determination can be made if treatment goals have been met. Initially upon treatment unit startup, the sampling frequency shall not be less than one sample per 50m^3 of treated soils. Following establishment of acceptable system performance, the sampling frequency can be decreased to one sample per 100m^3 of soils treated. As described in Sections 8.2 and 10.12, if treated dioxin-contaminated soils are to be placed as fill at the CLS site within the upper 3m of the fill section (as measured from planned final site grade), the allowable residual dioxin concentration as TEQ shall be 0.1 μg/kg (100 parts per trillion). If treated dioxin-contaminated soils are to be placed as fill at depths below 3m, with at least 3m clean fill soils overlying the treated soils, the allowable residual dioxin concentration as TEQ shall be 1.0 μg/kg (1 part per billion). If these concentrations are exceeded in post-treatment confirmation samples, the entire batch of treated soils discharged by the treatment unit since the last confirmation sample passing the applicable criteria shall be re-treated until the concentration criteria are met.

In addition to analysis for dioxins, confirmatory samples shall be analyzed for total metals to determine the need for subsequent metals stabilization treatment, as described in the preceding section.

Post-Treatment Confirmation Sampling for Metals-Impacted Stabilized Soils

Following treatment of metals-impacted soils by cement stabilization/solidification and curing of the stabilized soils, representative samples shall be collected and analyzed. Samples shall be collected and analyzed with a frequency of not less than one sample per $100m^3$ of treated material.

Stabilized soils shall be analyzed for soluble metals using the Toxicity Characteristic Leaching Procedure (TCLP) in accordance with USEPA Test Method 1311/1312/6010Bor 6020B. As noted by the IC in the EIA, applicable criteria for comparison of post-stabilization test results are contained in the Universal Treatment Standards (40 CFR 268.48), which have generally been adopted by EPD for use in Hong Kong for evaluation of post-treatment concentrations. Applicable concentrations for metals and cyanide are:

Metal	TCLP Limit (mg/L)
Antimony	1.15
Arsenic	5.0
Barium	21.0
Beryllium	1.22
Cadmium	0.11
Chromium (total)	0.60
Cobalt	NA
Copper	NA
Lead	0.75
Mercury	0.20
Molybdenum	NA
Nickel	11.0
Selenium	5.7
Silver	0.14
Thallium	0.20
Tin	NA
Vanadium	1.6
Zinc	4.3
Cyanide (total)	590

10.12 PLACEMENT OF TREATED SOILS AS FILL AT CLS SITE

Following treatment and post-treatment confirmation testing to demonstrate that soils have been treated to acceptable residual concentrations, as presented in Section 8.2, treated soils would be suitable for placement as fill within the fill section at the CLS site, or at other locations in Hong Kong as may be determined acceptable by the EPC and CED. As indicated in Section 8.2, two different criteria have been established for treated soils to be placed within the upper 3m of the fill section (effectively considered to be placed at the ground surface from a risk assessment perspective), and treated materials to be placed at depths below 3m. It is assumed that for the materials to be placed below a depth of 3m, clean imported fill soil that is free of contaminants will be placed over the treated soils.

Soils treated for metals contamination by stabilization/solidification will be in solid blocks following treatment. These materials shall be broken into pieces consistent with the largest size of solid materials commonly accepted for fill in Hong Kong, and consistent with the fill requirements established for the project.

Consistent with the approach recommended by MCAL in the *Environmental Impact Assessment Report (Final) for Decommissioning of Cheoy Lee Shipyards at Penny's Bay*, treated soils returned to the site for placement as fill shall be placed above the water table.

10.13 MONITORING WELL CLOSURE/DECOMMISSIONING REQUIREMENTS

Prior to placement of fill soils to raise the site grade to the final development grade of nominally +11mPD, all groundwater monitoring wells installed as part of the site RI shall be properly closed. Monitoring wells shall be decommissioned by pressure grouting the well bore with cement/bentonite grout containing at least 5% bentonite by dry weight. Following pressure grouting, the steel enclosure box should be removed and the well casing cut off below grade.

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TABLE 3-1
GROUNDWATER MONITORING DATA FOR AREAS 1, 2 AND 3

Monitoring Well	Date	Time (hrs)	Groundwater Elevation (mPD)	Max. Variation (m)	Range (m)	# Water Level Measure-ments	Monitoring Period	
							From	To
B24	8 Sep 01	1220	2.27	0.18	2.15 – 2.33	7	04 Sep 01	11 Sep 01
B34	16 Aug 01 18 Aug 01	0830 0830	2.00 1.98	0.08	1.92 – 2.00	7	13 Aug 01	20 Aug 01
C2	16 Aug 01	0956	2.21	0.03	2.18 – 2.21	7	06 Aug 01	16 Aug 01
D6	16 Aug 01	0959	2.25	0.03	2.24 – 2.27	7	10 Aug 01	17 Aug 01
I11	16 Aug 01	0953	2.43	0.04	2.43 – 2.47	7	10 Aug 01	17 Aug 01
J7	16 Aug 01 17 Aug 01 18 Aug 01	0855 0918 0846	2.58 2.58 2.58	0.05	2.57 – 2.62	9	10 Aug 01	20 Aug 01
L6	13 Aug 01 17 Aug 01 18 Aug 01	0958 1710 0842	2.42 2.32 2.31	0.01	2.31 – 2.32	3	17 Aug 01	20 Aug 01
L34	16 Aug 01 17 Aug 01 18 Aug 01	0852 0922 0844	2.36 2.37 2.36	0.08	2.36 – 2.42	8	13 Aug 01	22 Aug 01
L37	17 Aug 01 04 Sep 01	0956 0922	2.83 3.26	0.44	2.83 – 3.27	9	17 Aug 01	11 Sep 01
M2	04 Sep 01	0924	3.06	0.46	2.76 – 3.22	7	04 Sep 01	11 Sep 01
N3	30 Aug 01	0830	2.56	0.34	2.22 – 2.56	9	23 Aug 01	30 Aug 01
O8	04 Sep 01	0926	2.80	0.28	2.60 – 2.88	7	04 Sep 01	11 Sep 01
P8	16 Aug 01	0830	1.90	0.20	1.70 – 1.90	8	09 Aug 01	16 Aug 01
OB-2	16 Aug 01 17 Aug 01 18 Aug 01	0830 0830 0830	1.86 2.00 2.08	0.63	1.45 – 2.08	6	16 Aug 01	22 Aug 01
OB-4	20 Aug 01	0820	1.91	0.24	1.67 – 1.91	6	20 Aug 01	25 Aug 01
OB-5	16 Aug 01 17 Aug 01 18 Aug 01 04 Sep 01	0950 0945 0848 0920	3.82 3.83 3.85 4.02	0.21	3.81 – 4.02	7	14 Aug 01	04 Sep 01
OB-6	13 Aug 01	0840	2.19	0.09	2.19 – 2.28	13	04 Aug 01	13 Aug 01
R2	01 Sep 01 04 Sep 01	0900 0915	2.32 2.52	0.42	2.12 – 2.54	7	30 Aug 01	06 Sep 01
S4	01 Sep 01 03 Sep 01 04 Sep 01	0904 0845 0845	2.06 2.09 1.93	0.33	1.68 – 2.09	7	30 Aug 01	06 Sep 01
S8	03 Sep 01 04 Sep 01	0840 0847	1.82 1.85	0.20	1.65 – 1.85	10	03 Sep 01	14 Sep 01
T1	27 Aug 01	0850	1.80	0.14	1.76 – 1.90	11	20 Aug 01	27 Aug 01
T9	27 Aug 01 31 Aug 01	0850 1715	1.93 2.18	0.32	1.89 – 2.21	9	25 Aug 01	31 Aug 01
U2a	13 Sep 01	1312	1.75	0.49	1.31 – 1.86	8	05 Sep 01	14 Sep 01
V2	01 Sep 01 04 Sep 01	0900 0915	2.69 3.04	0.73	2.31 – 3.04	7	28 Aug 01	04 Sep 01
X2	01 Sep 01	0900	2.54	0.90	1.84 – 2.74	7	25 Aug 01	01 Sep 01
Z6	27 Aug 01 29 Aug 01	0840 0840	1.70 2.14	0.68	1.46 – 2.14	7	23 Aug 01	29 Aug 01
OB-11	01 Sep 01 03 Sep 01	0840 0845	2.15 2.10	0.43	1.72 – 2.15	8	25 Aug 01	03 Sep 01
OB-13	01 Sep 01 03 Sep 01	0845 0930	2.10 2.32	0.28	2.10 – 2.38	7	31 Aug 01	07 Sep 01
OB-15	01 Sep 01 03 Sep 01	0845 0930	2.18 1.09	1.11	1.09 – 2.20	7	28 Aug 01	04 Sep 01
OB-20	03 Sep 01	0900	2.16	0.29	1.87 – 2.16	10	03 Sep 01	14 Sep 01
OB-22	01 Sep 01	0900	2.30	0.38	1.99 – 2.37	11	25 Aug 01	01 Sep 01
AW-1c	19 Nov 01	1315	2.81	0.13	2.68 – 2.81	7	19 Nov 01	26 Nov 01
AW-2	18 Oct 01	0900	2.43	0.20	2.23 – 2.43	7	11 Oct 01	18 Oct 01
AW-3	18 Oct 01 23 Oct 01	0900 0845	2.74 3.34	0.7	2.74 – 3.44	6	18 Oct 01	24 Oct 01
AW-4	23 Oct 01 06 Nov 01	0845 1417	3.49 4.15	1.56	3.21 – 4.57	14	20 Oct 01	13 Nov 01

TABLE 3-1
GROUNDWATER MONITORING DATA FOR AREAS 1, 2 AND 3

Monitoring Well	Date	Time (hrs)	Groundwater Elevation (mPD)	Max. Variation (m)	Range (m)	# Water Level Measure-ments	Monitoring Period	
							From	To
AW-5	06 Nov 01 07 Nov 01 08 Nov 01	1415 1042 1122	4.40 4.41 4.38	0.51	3.96 – 4.47	7	06 Nov 01	13 Nov 01
AW-8	07 Nov 01 08 Nov 01	1335 1513	3.54 3.53	0.59	2.95 – 3.54	9	07 Nov 01	17 Nov 01
Q1	13 Sep 01	1250	1.55	0.40	1.33 – 1.73	6	07 Sep 01	14 Sep 01
Q5	13 Sep 01	1248	1.65	0.58	1.27 – 1.85	9	06 Sep 01	14 Sep 01
AW-6	07 Nov 01 08 Nov 01	1330 1516	3.40 3.39	0.55	2.85 – 3.40	9	07 Nov 01	17 Nov 01
AW-7	07 Nov 01 08 Nov 01	1346 1517	3.31 3.27	0.53	2.78 – 3.31	9	07 Nov 01	17 Nov 01
AW-9a	07 Nov 01 08 Nov 01	1047 1129	4.13 4.76	2.38	3.38 – 5.76	13	26 Oct 01	13 Nov 01
AW-10	07 Nov 01 08 Nov 01	1354 1521	2.32 2.26	0.44	1.88 – 2.32	9	07 Nov 01	17 Nov 01
AW-11	08 Nov 01 09 Nov 01	0840 0856	1.84 1.82	0.11	1.82 – 1.93	7	05 Nov 01	13 Nov 01
AW-12	08 Nov 01 09 Nov 01	1001 0837	1.86 1.87	0.10	1.83 – 1.93	7	05 Nov 01	13 Nov 01
AW-13	08 Nov 01 09 Nov 01	0835 0858	1.70 1.94	0.52	1.62 – 2.14	7	05 Nov 01	12 Nov 01
AW-14	03 Nov 01	1615	0.70	0.06	0.70 – 0.76	6	27 Oct 01	03 Nov 01
AW-15	07 Nov 01 08 Nov 01	0953 0832	1.70 1.76	0.37	1.67 – 2.04	7	05 Nov 01	12 Nov 01
AW-16a	07 Nov 01	1010	0.72	0.13	0.60 – 0.73	7	31 Oct 01	07 Nov 01
AW-17	07 Nov 01 08 Nov 01	0948 0830	1.48 1.50	0.43	1.40 – 1.83	7	07 Nov 01	14 Nov 01
AW-18	07 Nov 01 08 Nov 01	1015 0845	0.69 0.72	1.13	0.65 – 1.78	7	05 Nov 01	12 Nov 01
AW-19	07 Nov 01 08 Nov 01	1400 1527	1.87 1.86	0.26	1.75 – 2.01	9	07 Nov 01	17 Nov 01
AW-20	07 Nov 01 08 Nov 01 10 Nov 01	1405 1529 1554	1.53 1.51 1.51	0.10	1.43 – 1.53	9	07 Nov 01	17 Nov 01
AW-21	10 Nov 01	1551	1.65	0.07	1.58 – 1.65	6	10 Nov 01	17 Nov 01
AW-22	10 Nov 01 14 Nov 01	0840 1342	1.87 1.57	0.30	1.57 – 1.87	6	09 Nov 01	15 Nov 01
AW-23	12 Nov 01 14 Nov 01	0922 1340	1.77 1.46	0.45	1.46 – 1.99	6	12 Nov 01	17 Nov 01

TABLE 4-1
SUMMARY OF OBSERVATIONS
IEC TRENCHES IN WASTE / BURN PIT AREAS

Trench ID	Transect	Date Commenced	Date Completed	Supervisor	Length (m)	Mean Depth (m)	Water Table (m bgs)	Visual Observations of Impact
IEC-T9	11-12	05.10.2001	05.10.2001	VC	17	3.8	Dry	None Observed
IEC-T10	1-2	11.09.2001	11.09.2001	VC	14	3.7	4.2	None Observed
IEC-T11	1-2	10.09.2001	11.09.2001	HL	41	3.5	3.7	Burn Pit – maximum depth 3.5m; contains metal, fiberglass, metal cables etc.
IEC-T11	3-4	14.09.2001	14.09.2001	VC	15	2.8	2.8	Burn Pit – maximum depth 3.5m; contains metal, fiberglass, metal cables etc.
IEC-T12	1-2	03.10.2001	03.10.2001	BW	47.5	2.8	Dry	Waste / Burn Pits – maximum depths 2.7m; contain ash, fiberglass, metal and corroded drums, plastic, metal wire rags, and soil in various proportions
IEC-T12	3-4	10.09.2001	10.09.2001	VC	32	3.0	2.7	Waste / Burn Pit – contains asbestos roof sheeting, various metal (corroded scrap and shipyard products), cables, corroded 44 gal drums, fiberglass, etc.
IEC-T12	5-6	13.09.2001	13.09.2001	VC	13.5	3.2	3.8	Waste / Burn Pit – contains ash, fiberglass, metal and corroded drums, plastic, metal wire rags, and house bricks with some metal and other industrial waste
IEC-T12	7-8	12.09.2001	12.09.2001	KS	31.5	2.7	3.2	Waste Pit – maximum depth 3m; contains metal, fiberglass etc.
IEC-T12	9-10	04.10.2001	04.10.2001	BW	20	2.6	2.9	Burn Pit – maximum depth 2.9m; contains 20% ash, 10% metal, 5% wood and rags, 60% soil
IEC-T13	1-2	20.09.2001	20.09.2001	VC	22.5	3.0	2.9	Waste Pit – maximum depth 2.2m; contains steel cables with no visible evidence of contamination
IEC-T14	1-2	11.09.2001	11.09.2001	VC	35.3	3.0	3.8	None Observed
IEC-T14	3-4	14.09.2001	14.09.2001	VC	24	3.5	3.5	None Observed
IEC-T14	5-6	13.09.2001	13.09.2001	VC	24.5	3.5	3.8	None Observed
IEC-T15	1-2	10.09.2001	10.09.2001	JP	30	3.6	3.5	None Observed
IEC-T15	3-4	10.09.2001	10.09.2001	JP	12.2	3.0	3.5	None Observed

TABLE 4-1 (Cont.)
SUMMARY OF OBSERVATIONS
IEC TRENCHES IN WASTE / BURN PIT AREAS

Trench ID	Transect	Date Commenced	Date Completed	Supervisor	Length (m)	Mean Depth (m)	Water Table (m bgs)	Visual Observations of Impact
IEC-T16	1-2	10.09.2001	11.09.2001	JP	21	3.8	3.3	Visual evidence of impacted soil not observed - an apparent 'grease-trap' sump was present just below surface; subsurface cables encountered and trench terminated
IEC-T16	3-4	11.09.2001	11.09.2001	JP	9	4.2	3.30	Visual evidence of impacted soil not observed - an apparent 'grease-trap' sump was present just below surface; subsurface cables encountered and trench terminated
IEC-T18	1-2	15.09.2001	15.09.2001	VC	0 to 38	2.5	3.9	None observed
IEC-T18		17.09.2001	17.09.2001	VC	38 to 70	3.4	3.9	None observed
IEC-T18	3-4	18.09.2001	18.09.2001	VC	14	3.3	4.2	Burn Layer – maximum depth 1.2m; maximum extent not determined
IEC-T19	1-2	18.09.2001	18.09.2001	VC	29	3.1	3.2	Burn Pit – maximum depth 4m
IEC-T19	3-4	19.09.2001	19.09.2001	VC	14.5	3.4	3.5	Burn Pit – 'V'- shaped pit w/ maximum depth of 3.4m; contains metal, ash, fiberglass, textiles etc.
IEC-T19	5-6	21.09.2001	21.09.2001	VC	29	3.1	3.1	3 Burn Pits – 1st pit extends to 10m bgs and contains 10% metal, 35% ash, 5% fiber and plastic, 50% soil; 2nd pit diagonal shaped and extends to 3.1m bgs; 3rd pit to 0.5m bgs to base of trench; 2nd & 3rd pits contain 30% metal and wire, 20% ash, 5% wood, 5% fiberglass and plastic, and 40% soil
IEC-T19	7-8	06.10.2001	06.10.2001	BW	20	3.3	3.3	Burn Pit – extends to base of trench at 3.3m bgs; contains 20% ash, 5% wood, metal scrap & fiberglass, 75% soil
IEC-T20	1-2	28.09.2001	28.09.2001	HL	53.5	3.1	3.1	Three main burn pits – maximum depth 3.1 to 3.5m; dark brown to black, slight solvent odor; contain 15% metal, 5% fiberglass, 5% wood, some rubber pipes, 60% sand and gravel, 15% cobbles and boulders

TABLE 4-1 (Cont.)
SUMMARY OF OBSERVATIONS
IEC TRENCHES IN WASTE / BURN PIT AREAS

Trench ID	Transect	Date Commenced	Date Completed	Supervisor	Length (m)	Mean Depth (m)	Water Table (m bgs)	Visual Observations of Impact
IEC-T20	3-4	25.09.2001	25.09.2001	VC	74	3.3	3.8	Burn pits – extend to maximum depth of >4.6 m bgs; contain mostly ash, wood, metal and fibers; odorous sewage-like sludge @ 63m from end 3
IEC-T20	5-6	26.09.2001	27.09.2001	VC	63	3.1	3.6	Burn pits – maximum depth 3 to 4m; contain usual debris comprising metal drums and scrap, fiberglass, wood etc. w/ black color and strong hydrocarbon odor (PID: >80 ppm) plus wood and metal scrap; no source evident for hydrocarbon odors
IEC-T20	7-8	22.09.2001	22.09.2001	VC	33.0	3.0	3.1	Burn Pits – 1st pit extends to 4.8m bgs; contain 2 44gal drums of solidified chemical (possibly resin) w/ PID >90ppm; pits contain 10% metal, 20% ash, 10% fiber and 60% soil; pits on west face extend almost to full depth of trench and contain 30% metal, 30% ash, 10% fiber and 30% soil
IEC-T20	9-10	04.10.2001	04.10.2001	HL	21	2.7	2.7	Burn Pit – extends to 2.5m bgs and contains dark brown to black, 10% metal (predominantly steel cables), 5% wood, 5% fiberglass and trace burnt chemicals, 80% soil
IEC-T21	1-2	25.09.2001	25.09.2001	HL	27.5	3.0	2.8	Burn Pit –maximum depth 3.2m; contains 20% metal scrap and corroded 44 gal drums, 5% wood and fiber, 5% burnt chemicals
IEC-T21	3-4	29.09.2001	29.09.2001	HL	22	2.7	3.1	Burn Pits – extend from near surface to 3.1m bgs; contain dark brown to black 5% metal scrap and corroded 44 gal drums, 5% fiberglass, trace of textiles (rags), 90% soil
IEC-T21	5-6	27.09.2001	27.09.2001	HL	17.5	2.7	3.8	None Observed

TABLE 4-1 (Cont.)
SUMMARY OF OBSERVATIONS
IEC TRENCHES IN WASTE / BURN PIT AREAS

Trench ID	Transect	Date Commenced	Date Completed	Supervisor	Length (m)	Mean Depth (m)	Water Table (m bgs)	Visual Observations of Impact
(IEC-T21)	7-8							Trench wrongly labeled – There is no IEC-T21 (7-8) only IEC-T20 (7-8) – samples for T21 (9-10) submitted so re-numbering of trenches not possible
IEC-T21	9-10	06.10.2001	06.10.2001	BW	20	3.0	3.4	Burn Pit – extends to 3.6m bgs; contains 15% ash, 10% metal scrap and 44 gal drums, 5% wood and some fiberglass, 70% soil
IEC-T22	1-2	22.09.2001	22.09.2001	HL	24.5	3.2	3.4	Burn Pit – extends entire length of east face to 1m bgs; contains 20% corroded 44gal drums and other metal, 5% textiles and fiberglass, plus wood, burned chemicals (resins) etc.
IEC-T22	3-4	21.09.2001	21.09.2001	HL	18	3.8	3.2	Burn Pit – maximum depth 3.8m; contains several corroded 44gal drums, marine batteries, metal waste, fiberglass etc.
IEC-T22	5-6	26.09.2001	26.09.2001	HL	40	3.3	3.3	Burn pits – maximum depth 4m; contain 20% metal and burnt 44 gal drums, 5% fibers, 5% bluish colored ash from burnt chemicals, 60% cobbles, 10% other soils
IEC-T22	7-8	24.09.2001	24.09.2001	HL	16	3.4	3.0	Burn Pit – maximum depth 3.4m; contains blue-green and black residues, 5% ash, 15% metal and corroded 44 gal drums, burnt wood
IECI-T22	9-10	08.10.2001	08.10.2001	BW	16	3.9	4.0	None Observed
IEC-T23	1-2	17.09.2001	17.09.2001	BW	27	3.5	4.0	Waste Pit – extends to 3.2 m bgs; contains metal, cables, rags, crushed drums, scrap metal parts
IEC-T23	3-4	18.09.2001	18.09.2001	BW	24	3.0	3.5	None Observed
IEC-T23	5-6	19.09.2001	19.09.2001	BW	18	3.0	3.8	Waste Pit – extends to 2.8m bgs; contains metal, cables, rubber etc.
IEC-T24	1-2	12.09.2001	12.09.2001	JP	46.85	4.0	4.1	None Observed

TABLE 4-1 (Cont.)
SUMMARY OF OBSERVATIONS
IEC TRENCHES IN WASTE / BURN PIT AREAS

Trench ID	Transect	Date Commenced	Date Completed	Supervisor	Length (m)	Mean Depth (m)	Water Table (m bgs)	Visual Observations of Impact
IEC-T25	1-2	13.09.2001	13.09.2001	JP	33	3.2	4.1	Burn Pit – Small burn pit extends to 2m bgs; contains black ash and sandy silt material
IEC-T25	3-4	14.09.2001	14.09.2001	JP	10.8	3.1	dry	None Observed
IEC-T26	1-2	21.09.2001	21.09.2001	BW	26.0	3.0	4.6	None Observed
IEC-T26	3-4	19.09.2001	19.09.2001	BW	14.0	3.0	dry	None Observed
IEC-T27	1-2	20.09.2001	20.09.2001	BW	15.0	3.6	4.6	Waste Pit – maximum depth observed 0.8m; contains mixed debris; PID 67ppm
IEC-T28	1-2	15.09.2001	15.09.2001	BW	30.5	2.4	2.6	Burn Pit –extends to 3m bgs; contains metal, fiberglass, clothing etc.
IEC-T29	1-2	15.09.2001	15.09.2001	HL	32.7	3.0	3.5	Impacted Zone – extends to 2m bgs; contains thin layer (<30cm) black impacted soil; concrete block present in middle of trench; layer of what appears to possibly be casting sand similar to type found in Building I
IEC-T29	3-4	24.09.2001	24.09.2001	HL	13	3.5	4.1	Impacted Zone – impacted layers extending to 1.8 m bgs s/10 to 20cm thick with grey to black wood, fibers, rubber pipe etc.
IEC-T30	1-2	13.09.2001	14.09.2001	HL	45	2.7	3.3	Impacted Zone – to 1m bgs; impacted 30cm-thick layer of black casting sand type waste
IEC-T30	3-4	12.09.2001	12.09.2001	HL	25	3.5	3.5	None Observed
IEC-T31	1-2	22.09.2001	22.09.2001	BW	33	3.0	3.6	Burn Pit – 2 zones of impacted soil extend to 1.1m bgs; consist of corroded material and black silty sand and burned layer of black ash and fibrous material
IEC-T31	3-4	24.09.2001	24.09.2001	BW	14	3.4	4.0	None Observed

TABLE 4-1 (Cont.)
SUMMARY OF OBSERVATIONS
IEC TRENCHES IN WASTE / BURN PIT AREAS

Trench ID	Transect	Date Commenced	Date Completed	Supervisor	Length (m)	Mean Depth (m)	Water Table (m bgs)	Visual Observations of Impact
IEC-T31	5-6	24.09.2001	24.09.2001	BW	13.5	3.8	4.0	Waste Pit – extends to 1.1m bgs; consists of black sandy gravel, Aluminum plating fines and black asbestos sheeting
IEC-T32	1-2	14.09.2001	14.09.2001	JP	14.2	2.5	3.7	None Observed
IEC-T33	1-2	17.09.2001	17.09.2001	JP	32.5	3.65	3.5	None Observed
IEC-T33	3-4	15.09.2001	15.09.2001	JP	14.2	3.2	dry	Waste Pit – contains metal, rubber etc., no odors
IEC-T33	5-6	15.09.2001	15.09.2001	JP	17	3.0	dry	None Observed
IEC-T34	1-2	18.09.2001	18.09.2001	JP	13	3.7	dry	Waste Pit – extends to 4m bgs, consists of timber and plastic
IEC-T34	3-4	19.09.2001	19.09.2001	JP	7.0	4.0	dry	X-Trench to trace extent of dumped wood layer; None Observed
IEC-T35	1-2	20.09.2001	20.09.2001	HL	32.0	2.5	3.5	Burn Pits – maximum depth 3m; contains 2 burned layers w/ patches of impacted soil, metal, fiberglass, wood etc.
IEC-T35	3-4	19.09.2001	19.09.2001	JP	9.0	3.55	dry	None Observed
IEC-T35	5-6	19.09.2001	19.09.2001	JP	9.5	3.3	3.9	Burn Pits – 2 wedge-shaped layers extending to 3.5m bgs
IEC-T36	1-2	26.09.2001	26.09.2001	BW	24.5	3.2	3.8	Burn Pit – maximum depth 3m; contains mostly fibrous material, metal scraps, wood, iron pipes, and rags
IEC-T36	3-4	28.09.2001	28.09.2001	BW	20	3.3	3.8	None Observed
IEC-T36	5-6	27.09.2001	27.09.2001	BW	24.6	3.1	4.0	Waste Pit – extends to 1m bgs; contains black fibrous cloth sheeting with sandy gravel
IEC-T36	7-8	25.09.2001	25.09.2001	BW	23.5	3.9	3.9	None Observed
IEC-T36	9-10	28.09.2001	28.09.2001	BW	14.5	3.3	3.7	Burn pit – wedge shaped w/ maximum thickness of 2m; contains black ash, metal scrap, wood, and fiberglass

TABLE 4-1 (Cont.)
SUMMARY OF OBSERVATIONS
IEC TRENCHES IN WASTE / BURN PIT AREAS

Trench ID	Transect	Date Commenced	Date Completed	Supervisor	Length (m)	Mean Depth (m)	Water Table (m bgs)	Visual Observations of Impact
IEC-T36	11-12	08.10.2001	08.10.2001	BW	16	3.9	4.0	Burn Pit – extends from 0.9 to 3.9m bgs; wedge shaped, contains 15% ash, 20% fiberglass, trace metal and wood, 65% soil
IEC-T37	1-2	17.09.2001	17.09.2001	HL	47	3.5	3.0	Burn Pit – maximum depth 3.6m; contains 10% metal, fiberglass, wood, etc
IEC-T37	3-4	19.09.2001	19.09.2001	HL	20	2.8	3.2	Burn Pit – extends to 3.2 m bgs; thin layer 20 cm thick w/ same composition as above
IEC-T37	5-6	18.09.2001	18.09.2001	HL	20	2.9	3.6	Burn Pit – extends to 3.6 m bgs; same composition as above; slight solvent odor in some sections
IEC-T37	7-8	14.09.2001	14.09.2001	HL	12	2.5	2.6	Burn Pit – maximum depth 1.5m; similar composition as above w/ black ash, metal etc.
IEC-T37	9-10	19.09.2001	19.09.2001	HL	11	3.2	2.6	X-Trench to trace extent of burn pit
IEC-T37	11-12	20.09.2001	20.09.2001	HL	17.5	2.5	3.4	X-Trench to trace extent of burn pit; locations of minor impact
IEC-T38	1-2	12.11.2001	12.11.2001	Mr Tam	4.7	1.6	Dry	Burned 44 gal drum and impacted soil – extends to 1m bgs; intersected during drilling of AB-15, trench excavated to determine lateral extent

TABLE 6-1
INITIAL SOIL SCREENING LEVELS

Type of Chemical	Compound	USEPA Region IX PRG (mg/kg)	Dutch 'B' Value (mg/kg)
Volatile Organic Compounds	Dichlorodifluoromethane	94	
	Chloromethane	1.2	--
	Vinyl chloride	0.15	--
	Bromomethane	3.9	--
	Chloroethane	3.0	--
	Trichlorofluoromethane	390	--
	Acetone	1,600	--
	1,1-Dichloroethene	0.54	--
	Carbon Disulfide	360	--
	Methylene chloride	8.9	--
	trans-1,2-Dichloroethene	63	--
	1,1-Dichloroethane	590	--
	2-Butanone (MEK)	7,300	--
	cis-1,2-Dichloroethene	43	--
	Chloroform	0.24	--
	Bromochloromethane	--	--
	1,1,1-Trichloroethane	630	--
	Carbon Tetrachloride	0.24	--
	1,2-Dichloroethane	0.35	--
	Benzene	0.65	0.5
	Trichloroethene	2.8	--
	1,2-Dichloropropane	0.35	--
	Bromodichloromethane	1.0	--
	2-Hexanone	--	--
	cis-1,3-Dichloropropene[1]	0.70	--
	Toluene	520	3.0
	trans-1,3-Dichloropropene[1]	0.70	--
	4-Methyl-2-pentanone	--	--
	Tetrachloroethene	5.7	--
	Chlorobenzene	150	1
	Ethylbenzene	230	6
	Total Xylenes[2]	210	5
	Styrene	1,700	5
	Bromoform	62	--
	1,1,2,2-Tetrachloroethane	0.38	--
	1,3-Dichlorobenzene	13	1
	1,4-Dichlorobenzene	3.4	1
	1,2-Dichlorobenzene	370	1
	1,2-Dibromo-3-chloropropane	0.060	--
	Methyl-tert-butyl ether	17	--
	Naphthalene	560	5
	1,3-Dichloropropane	--	--
	Dibromomethane	--	--

TABLE 6-1
INITIAL SOIL SCREENING LEVELS
Page 2 of 6

Type of Chemical	Compound	USEPA Region IX PRG (mg/kg)	Dutch 'B' Value (mg/kg)
	1,2-Dibromoethane	0.0069	--
Volatile Organic Compounds	Dibromochloromethane	1.1	--
	4-Chlorotoluene	160	--
	Bromobenzene	28	--
	n-Butylbenzene	140	--
	Sec-Butylbenzene	110	--
	Tert-Butylbenzene	130	--
	2-Chlorotoluene	160	--
	2,2-Dichloropropane	--	5
	1,1-Dichloropropene	--	5
	Isopropylbenzene	160	--
	p-Isopropyltoluene	--	--
	n-Propylbenzene	140	--
	1,1,1,2-Tetrachloroethane	3.0	--
	1,2,3-Trichlorobenzene	--	1
	1,2,4-Trichlorobenzene	650	1
	1,1,2-Trichloroethane	0.84	--
	1,2,3-Trichloropropane	0.0014	5
	1,2,4-Trimethylbenzene	52	--
	1,3,5-Trimethylbenzene	21	--
	Vinyl Acetate	430	--
Semi-Volatile Organic Compounds	N-Nitrosodimethylamine	0.0095	--
	Phenol	37,000	1
	Bis(2-chloroethyl) ether	0.21	--
	2-Chlorophenol	63	0.5
	1,3-Dichlorobenzene	13	1
	1,4-Dichlorobenzene	3.4	1
	Benzyl alcohol	18,000	--
	1,2-Dichlorobenzene	370	1
	2-Methylphenol	3,100	--
	3/4-Methylphenol	3,100/310	--
	N-Nitroso-di-n-propylamine	0.69	--
	Nitrobenzene	20	--
	Isophorone	510	--
	2-Nitrophenol	490	1
	2,4-Dimethylphenol	1,200	1
	Benzoic acid	100,000	--
	Bis(2-choroethoxy)methane	--	--
	2,4-Dichlorophenol	180	0.5
	1,2,4-Trichlorobenzene	650	1
	Naphthalene	56	5
	4-Chloroaniline	240	--
	Hexachloro-1,3-butadiene[3]	6.2	--

TABLE 6-1
INITIAL SOIL SCREENING LEVELS
Page 3 of 6

Type of Chemical	Compound	USEPA Region IX PRG (mg/kg)	Dutch 'B' Value (mg/kg)
	2-Methylnaphthalene	--	20 Total PAHs
	Hexachlorocyclopentadiene	420	--
	4-Chloro-3-methylphenol	--	1
	2,4,6-Trichlorophenol	44	0.5
	2,4,5-Trichlorophenol	6,100	0.5
	2-Chloronaphthalene	3,900	20 Total PAHs
	2-Nitroaniline	3.5	--
	4-Bromophenyl-phenylether	--	--
	Hexachlorobenzene	0.3	1
	Pentachlorophenol	3.0	0.5
	Phenanthrene	--	10
	Anthracene	22,000	10
	Di-n-butylphthalate	6,100	--
	Fluoranthene	2,300	10
	Pyrene	2,300	10
	Butyl benzyl phthalate	12,000	--
	3,3-Dichlorobenzidine	1.1	--
	Benzo(a)anthracene	0.62	20 Total PAHs
	Chrysene	62	20 Total PAHs
	Bis(2-ethylhexyl)phthalate	35	--
	Di-n-Octyl phthalate	1,200	--
	Benzo(b)fluoranthene	0.62	20 Total PAHs
	Dimethylphthalate	100,000	--
	Acenaphthene	3,700	20 Total PAHs
	2,4-Dinitrotoluene	120	--
	2,6-Dinotrotoluene	61	--
	Diethyl phthalate	49,000	--
	4-Chlorophenyl-phenyl ether	--	--
	Fluorene	2,600	20 Total PAHs
	2-Nitroaniline	3.5	--
	4,6-Dinitro-2-Methylphenol	--	1
	N-Nitrosodiphenylamine	99	--
	Benzo(k)fluoranthene	6.2	20 Total PAHs
	Benzo(a)pyrene	0.062	1
	Indeno(1,2,3-cd)pyrene	0.62	20 Total PAHs
	Dibenz(a,h)anthracene	0.062	20 Total PAHs
	Benzo(g,h,i)perylene	--	20 Total PAHs
	Azobenzene	4.4	--
	Aniline	85	--
	Bis(2-chloroisopropyl)ether	2.9	--
	1-Methylnaphthalene	--	20 Total PAHs
	Acenaphthylene	--	20 Total PAHs
	2-Nitroaniline	3.5	--

TABLE 6-1
INITIAL SOIL SCREENING LEVELS

Type of Chemical	Compound	USEPA Region IX PRG (mg/kg)	Dutch 'B' Value (mg/kg)
	2,4-Dinitrophenol	120	1
	4-Nitrophenol	490	1
	Dibenzofuran	290	--
	Benzidine	0.0021	--
	Pyridine	61	2
Organochlorine Pesticides	alpha-BHC	0.090	0.5 Indiv. 1.0 Total
	beta-BHC	0.32	0.5 Indiv. 1.0 Total
	delta-BHC	N/A	0.5 Indiv. 1.0 Total
	gamma-BHC(Lindane)	0.44	0.5 Indiv. 1.0 Total
	Heptachlor	0.11	0.5 Indiv. 1.0 Total
	Aldrin	0.029	0.5 Indiv. 1.0 Total
	Heptachlor epoxide	0.053	0.5 Indiv. 1.0 Total
	Endosulfan I[1]	370	0.5 Indiv. 1.0 Total
	Dieldrin	0.030	0.5 Indiv. 1.0 Total
	4,4-DDE	1.7	0.5 Indiv. 1.0 Total
	4,4-DDD	2.4	0.5 Indiv. 1.0 Total
	Endrin	18	0.5 Indiv. 1.0 Total
	Endosulfan II[1]	370	0.5 Indiv. 1.0 Total
	Endosulfan sulfate	N/A	0.5 Indiv. 1.0 Total
	4,4-DDT	1.7	0.5 Indiv. 1.0 Total
	Methoxychlor	310	0.5 Indiv. 1.0 Total
	Endrin ketone	N/A	0.5 Indiv. 1.0 Total
	Endrin aldehyde	N/A	0.5 Indiv. 1.0 Total
	gamma-Chlordane[1]	1.6	0.5 Indiv. 1.0 Total

TABLE 6-1
INITIAL SOIL SCREENING LEVELS
Page 5 of 6

Type of Chemical	Compound	USEPA Region IX PRG (mg/kg)	Dutch 'B' Value (mg/kg)
	alpha-Chlordane[1]	1.6	0.5 Indiv. 1.0 Total
	Toxaphene	0.44	0.5 Indiv. 1.0 Total
PCBs	Aroclor-1016	3.9	1.0 Total
	Aroclor-1221	0.22	1.0 Total
	Aroclor-1232	0.22	1.0 Total
	Aroclor-1242	0.22	1.0 Total
	Aroclor-1248	0.22	1.0 Total
	Aroclor-1254	0.22	1.0 Total
	Aroclor-1260	0.22	1.0 Total
	Aroclor-1262	N/A	1.0 Total
Chlorinated Herbicides	Dalapon	1,800	0.50 Indiv. 1.0 Total
	Dicamba	N/A	0.50 Indiv. 1.0 Total
	MCPP	61	0.50 Indiv. 1.0 Total
	MCPA	31	0.50 Indiv. 1.0 Total
	1,2-Dichlorpropane	0.35	0.50 Indiv. 1.0 Total
	2,4-D	690	0.50 Indiv. 1.0 Total
	2,4,5-TP (Silvex)	490	0.50 Indiv. 1.0 Total
	2,4-DB	490	0.50 Indiv. 1.0 Total
	Dinoseb	61	0.50 Indiv. 1.0 Total
Total Petroleum Hydrocarbons (Carbon Chain C_6-C_{36})	$C_6 - C_{10}$	--	100
	$C_{11} - C_{14}$	--	1,000 Total
	$C_{15} - C_{18}$	--	
	$C_{19} - C_{22}$	--	
	$C_{23} - C_{26}$	--	
	$C_{27} - C_{30}$	--	
	$C_{31} - C_{36}$	--	
Chlorinated Dibenzo-dioxins and Chlorinated Dibenzofurans	Total 2,3,7,8 Tetrachlorodibenzo-p-dioxin (TCDD) Toxicity Equivalents (TEQs)	0.0000039 (3.9 ppt)	0.00001[4] (100 ppt)
Metals	Antimony[5]	31	--
	Arsenic	0.39	30

TABLE 6-1
INITIAL SOIL SCREENING LEVELS
Page 6 of 6

Type of Chemical	Compound	USEPA Region IX PRG (mg/kg)	Dutch 'B' Value (mg/kg)
	Barium[5]	5,400	400
	Beryllium[5]	150	--
	Cadmium[5]	37	5
	Chromium (Total)	210	250
	Chromium (Hexavalent)	30	--
	Cobalt	4,700	50
	Copper[5]	2,900	100
	Lead	400	150
	Mercury[5]	23	2
	Nickel[6]	150	100
	Molybdenum	390	40
	Selenium	390	--
	Silver[5]	390	--
	Tin	47,000	50
	Thallium[5]	5.2	--
	Vanadium	550	--
	Zinc	23,000	500
	Tributyltin[7]	18	--
Inorganics	Cyanide	11	10

Notes:

-- = Not available and/or applicable

1 PRG value shown for compound does not differentiate by isomer
2 PRG value shown reflects lowest value of the reported isomers.
3 Dutch B value for $C_6 - C_{10}$ are based on gasoline; values for $C_{11} - C_{36}$ are based on mineral oil.
4 PRG value shown is adopted by IEC based on initial reporting of USEPA Dioxin Reassessment (USEPA Office of Research and Development, Washington D.C., Information Sheet 2, *Scientific Highlights from Draft Reassessment (2000)*, May 25, 2001 Update.
5 PRG value shown is reported as metal and compounds
6 PRG value shown is for nickel soluble salts.
7 PRG value shown is for tributyltin oxide.

TABLE 6-2
AREA 1 SOIL CONCENTRATIONS EXCEEDING DUTCH 'B' OR RESIDENTAL PRG VALUES
All Units mg/kg

SITE ID	ANALYSIS	SAMPLE ID	DEPTH (m)	PARAMETER	CONCENTRATIO N	Dutch 'B'/PRG Value	EXCEED
AB-01	Carbon Chain	AB-01/0.08-0.23m/1	0.23	Carbon Chain => C15	5560	1000	>B
AB-01	Carbon Chain	AB-01/0.08-0.23m/1	0.23	Carbon Chain C6 - C14	384	100	>B
AB-03	Carbon Chain	AB-03/0.08-0.23m/1	0.23	Carbon Chain => C15	1180	1000	>B
AB-14	Metals	AB-14/0.05-0.30m/1	0.3	Chromium	682.00	250	>B
AB-14	Metals	AB-14/0.05-0.30m/1	0.3	Hexavalent Chromium	392.0	30	>PRG
AB-14	Metals	AB-14/0.68-0.83m/3	0.83	Chromium	788.00	250	>B
AB-14	Metals	AB-14/0.68-0.83m/3	0.83	Hexavalent Chromium	288.0	30	>PRG
AB-15	Metals	AB15/0.78-0.93m/3	0.93	Arsenic	54.4	30	>B
AB-15	Metals	AB15/0.78-0.93m/3	0.93	Barium	848.00	400	>B
AB-15	Metals	AB15/0.78-0.93m/3	0.93	Chromium	841.00	250	>B
AB-15	Metals	AB15/0.78-0.93m/3	0.93	Copper	4960.00	100	>B
AB-15	Metals	AB15/0.78-0.93m/3	0.93	Lead	1260.00	150	>B
AB-15	Metals	AB15/0.78-0.93m/3	0.93	Nickel	228.00	100	>B
AB-15	Metals	AB15/0.78-0.93m/3	0.93	Zinc	2380.0	500	>B
AB-21	Carbon Chain	AB-21/0.45-0.56m/1	0.56	Carbon Chain => C15	2480	1000	>B
AB-21	Carbon Chain	AB-21/0.45-0.56m/1	0.56	Carbon Chain C6 - C14	320	100	>B
AB-22	Metals	AB-22/0.70-0.85m/3	0.85	Lead	157.00	150	>B
AB-25	Metals	AB-25/0.08-0.23m/2	0.23	Copper	7680.00	100	>B
AB-25	Metals	AB-25/0.08-0.23m/2	0.23	Zinc	9090.0	500	>B
AB-34	Metals	AB-34/0.08-0.23m/1	0.23	Chromium	280.00	250	>B
AB-38	Carbon Chain	AB-38/1.35-1.60m/5	1.6	Carbon Chain => C15	10900	1000	>B
AB-38	Carbon Chain	AB-38/1.35-1.60m/5	1.6	Carbon Chain C6 - C14	3100	100	>B
AB-39	Carbon Chain	AB-39/1.35-1.60m/5	1.6	Carbon Chain => C15	22700	1000	>B
AB-39	Carbon Chain	AB-39/1.35-1.60m/5	1.6	Carbon Chain C6 - C14	4900	100	>B
B-02	Metals	B-02/0.78-1.03m/3	1.03	Lead	191.00	150	>B
B-B02	Metals	B-B2/0.15-0.30m/1	0.3	Copper	103.00	100	>B
B-B04	Metals	B-B4/0.12-0.27m/1	0.27	Nickel	275.00	100	>B
B-B04	Metals	B-B4/0.68-0.83m/3	0.83	Nickel	289.00	100	>B
B-B08	Metals	B-B8/0.15-0.30m/1	0.3	Chromium	508.00	250	>B
B-B08	Metals	B-B8/0.15-0.30m/1	0.3	Hexavalent Chromium	92.9	30	>PRG
B-B08	Metals	B-B8/0.15-0.30m/1	0.3	Nickel	152.00	100	>B
B-B14	Metals	B-B14/0.68-0.77	0.77	Nickel	161.00	100	>B
B-B18	Metals	B-B18/0.11-0.16	0.16	Chromium	906.00	250	>B
B-B20	Metals	B-B20/0.11-0.26	0.26	Copper	130.00	100	>B
B-B20	Metals	B-B20/0.11-0.26	0.26	Nickel	153.00	100	>B
B-B21	Metals	B-B21/0.12-0.29	0.29	Nickel	404.00	100	>B
B-B21	Metals	B-B21/0.65-0.81	0.81	Nickel	148.00	100	>B
B-B21	Metals	B-B21/1.45-1.61	1.61	Nickel	215.00	100	>B
B-B22	Metals	B-B22/0.14-0.29m/1	0.29	Copper	234.00	100	>B
B-B22	Metals	B-B22/0.14-0.29m/1	0.29	Nickel	444.00	100	>B
B-B22	Metals	B-B22/0.68-0.83m/3	0.83	Copper	541.00	100	>B
B-B22	Metals	B-B22/0.68-0.83m/3	0.83	Nickel	196.00	100	>B
B-B22	Metals	B-B22/1.38-1.68m/5	1.68	Copper	167.00	100	>B
B-B22	Metals	B-B22/1.38-1.68m/5	1.68	Nickel	148.00	100	>B
B-B23	Metals	B-B23/0.13-0.29m/1	0.29	Chromium	2670.00	250	>B
B-B23	Metals	B-B23/0.13-0.29m/1	0.29	Copper	331.00	100	>B

TABLE 6-2
AREA 1 SOIL CONCENTRATIONS EXCEEDING DUTCH 'B' OR RESIDENTAL PRG VALUES
All Units mg/kg

SITE ID	ANALYSIS	SAMPLE ID	DEPTH (m)	PARAMETER	CONCENTRATIO N	Dutch 'B'/PRG Value	EXCEED
B-B23	Metals	B-B23/0.13-0.29m/1	0.29	Hexavalent Chromium	32.2	30	>PRG
B-B23	Metals	B-B23/0.13-0.29m/1	0.29	Lead	153.00	150	>B
B-B23	Metals	B-B23/0.65-0.81m/3	0.81	Copper	775.00	100	>B
B-B23	Metals	B-B23/0.65-0.81m/3	0.81	Nickel	380.00	100	>B
B-B23	Metals	B-B23/1.40-1.56m/5	1.56	Copper	354.00	100	>B
B-B23	Metals	B-B23/1.40-1.56m/5	1.56	Nickel	397.00	100	>B
B-B23A	Metals	B-B23a/2.85-3.10m/1	3.1	Copper	109.00	100	>B
B-B23A	Metals	B-B23a/2.85-3.10m/1	3.1	Nickel	297.00	100	>B
B-B24	Metals	B-B24/0.14-0.29m/1	0.29	Copper	122.00	100	>B
B-B24	Metals	B-B24/0.14-0.29m/1	0.29	Nickel	195.00	100	>B
B-B24	Metals	B-B24/0.68-0.83m/3	0.83	Chromium	575.00	250	>B
B-B24	Metals	B-B24/0.68-0.83m/3	0.83	Copper	1790.00	100	>B
B-B24	Metals	B-B24/0.68-0.83m/3	0.83	Nickel	1780.00	100	>B
B-B24	Metals	B-B24/2.88-3.13m/6	3.13	Nickel	212.00	100	>B
B-B25	Metals	B-B25/0.15-3.0m/1	3	Chromium	291.00	250	>B
B-B25	Metals	B-B25/0.15-3.0m/1	3	Hexavalent Chromium	31.4	30	>PRG
B-B25	Metals	B-B25/0.15-3.0m/1	3	Nickel	298.00	100	>B
B-B25	Metals	B-B25/0.68-0.83m/3	0.83	Chromium	417.00	250	>B
B-B25	Metals	B-B25/0.68-0.83m/3	0.83	Hexavalent Chromium	85.4	30	>PRG
B-B25	Metals	B-B25/1.38-1.63m/5	1.63	Hexavalent Chromium	64.7	30	>PRG
B-B25	Metals	B-B25/1.38-1.63m/5	1.63	Nickel	119.00	100	>B
B-B25	Metals	B-B25/2.88-3.13m/6	3.13	Chromium	700.00	250	>B
B-B25	Metals	B-B25/2.88-3.13m/6	3.13	Nickel	174.00	100	>B
B-B26	Metals	B-B26/0.13-0.29m/1	0.29	Nickel	210.00	100	>B
B-B26	Metals	B-B26/0.65-0.81m/3	0.81	Nickel	206.00	100	>B
B-B27	Metals	B-B27/0.13-0.28m/1	0.28	Nickel	110.00	100	>B
B-B27	Metals	B-B27/0.45-0.69m/3	0.69	Nickel	195.00	100	>B
B-B33	Metals	B-B33/0.08-0.23m/1	0.23	Copper	274.00	100	>B
B-B33	Carbon Chain	B-B33/0.08-0.23m/1	0.23	Carbon Chain => C15	1340	1000	>B
B-B34	Carbon Chain	B-B34/0.07-0.22m/1	0.22	Carbon Chain => C15	1870	1000	>B
B-D01	Carbon Chain	B-D1/2.24-2.51m/5	2.51	Carbon Chain => C15	1220	1000	>B
B-D01	Carbon Chain	B-D1/2.24-2.51m/5	2.51	Carbon Chain C6 - C14	275	100	>B
B-D04	Carbon Chain	B-D4/0.63-0.79m/4	0.79	Carbon Chain => C15	1720	1000	>B
B-D04	Carbon Chain	B-D4/0.63-0.79m/4	0.79	Carbon Chain C6 - C14	229	100	>B
B-D04	Semi-volatiles	B-D4/1.45-1.61m/6	1.61	Naphthalene	20	5	>B
B-D04	Semi-volatiles	B-D4/1.45-1.61m/6	1.61	Phenanthrene	21.6	10	>B
B-D04	Carbon Chain	B-D4/1.45-1.61m/6	1.61	Carbon Chain => C15	18900	1000	>B
B-D04	Carbon Chain	B-D4/1.45-1.61m/6	1.61	Carbon Chain C6 - C14	7030	100	>B
B-D04	Volatiles	B-D4/1.45-1.61m/6	1.61	Naphthalene	18.9	5	>B
B-D05	Semi-volatiles	B-D5/1.47-1.63m/5	1.63	Naphthalene	10.9	5	>B
B-D05	Semi-volatiles	B-D5/1.47-1.63m/5	1.63	Phenanthrene	14.6	10	>B
B-D05	Carbon Chain	B-D5/1.47-1.63m/5	1.63	Carbon Chain => C15	13100	1000	>B
B-D05	Carbon Chain	B-D5/1.47-1.63m/5	1.63	Carbon Chain C6 - C14	3460	100	>B
B-D05	Carbon Chain	B-D5/2.48-2.71m/8	2.71	Carbon Chain C6 - C14	149	100	>B
B-D06	Semi-volatiles	B-D6/0.63-0.88m/3	0.88	Naphthalene	11.4	5	>B
B-D06	Semi-volatiles	B-D6/0.63-0.88m/3	0.88	Phenanthrene	14.3	10	>B

TABLE 6-2
AREA 1 SOIL CONCENTRATIONS EXCEEDING DUTCH 'B' OR RESIDENTAL PRG VALUES
All Units mg/kg

SITE ID	ANALYSIS	SAMPLE ID	DEPTH (m)	PARAMETER	CONCENTRATION	Dutch 'B'/PRG Value	EXCEED
B-D06	Carbon Chain	B-D6/0.63-0.88m/3	0.88	Carbon Chain => C15	12500	1000	>B
B-D06	Carbon Chain	B-D6/0.63-0.88m/3	0.88	Carbon Chain C6 - C14	3480	100	>B
B-D06	Carbon Chain	B-D6/1.37-1.62m/4	1.62	Carbon Chain => C15	6570	1000	>B
B-D06	Carbon Chain	B-D6/1.37-1.62m/4	1.62	Carbon Chain C6 - C14	1850	100	>B
B-D06	Volatiles	B-D6/1.37-1.62m/4	1.62	Naphthalene	14.1	5	>B
B-D07	Carbon Chain	B-D7/1.47-1.63m/7	1.63	Carbon Chain => C15	2890	1000	>B
B-D07	Carbon Chain	B-D7/1.47-1.63m/7	1.63	Carbon Chain C6 - C14	317	100	>B
B-D08	Carbon Chain	B-D8/0.15-0.31m/1	0.31	Carbon Chain => C15	10500	1000	>B
B-D08	Carbon Chain	B-D8/0.15-0.31m/1	0.31	Carbon Chain C6 - C14	1760	100	>B
B-D08	Metals	B-D8/0.64-0.80m/3	0.8	Zinc	550.0	500	>B
B-D08	Carbon Chain	B-D8/0.64-0.80m/3	0.8	Carbon Chain => C15	12200	1000	>B
B-D08	Carbon Chain	B-D8/0.64-0.80m/3	0.8	Carbon Chain C6 - C14	2800	100	>B
B-D08	Carbon Chain	B-D8/1.46-1.62m/5	1.62	Carbon Chain => C15	10000	1000	>B
B-D08	Carbon Chain	B-D8/1.46-1.62m/5	1.62	Carbon Chain C6 - C14	3020	100	>B
B-D15	Metals	B-D15/1.38-1.63	1.63	Copper	191.00	100	>B
B-D18	Metals	B-D18/0.05-0.20m/1	0.2	Copper	783.00	100	>B
B-D18	Metals	B-D18/0.05-0.20m/1	0.2	Lead	205.00	150	>B
B-D18	Metals	B-D18/0.05-0.20m/1	0.2	Zinc	574.0	500	>B
B-D19	Metals	B-D19/0.02-0.17m/1	0.17	Copper	1100.00	100	>B
B-D19	Metals	B-D19/0.02-0.17m/1	0.17	Zinc	968.0	500	>B
B-D21	Metals	B-D21/0.14-0.29m/1	0.29	Chromium	300.00	250	>B
B-D23	Metals	B-D23/0.07-0.22m/1	0.22	Copper	1400.00	100	>B
B-D23	Metals	B-D23/0.07-0.22m/1	0.22	Zinc	800.0	500	>B
B-D25	Semi-volatiles	B-D25/1.40-1.65m/5	1.65	Naphthalene	12.3	5	>B
B-D25	Semi-volatiles	B-D25/1.40-1.65m/5	1.65	Phenanthrene	18.6	10	>B
B-D25	Carbon Chain	B-D25/1.40-1.65m/5	1.65	Carbon Chain => C15	19600	1000	>B
B-D25	Carbon Chain	B-D25/1.40-1.65m/5	1.65	Carbon Chain C6 - C14	5660	100	>B
B-D25	Volatiles	B-D25/1.40-1.65m/5	1.65	Naphthalene	20.8	5	>B
B-D26	Semi-volatiles	B-D26/1.40-1.65m/5	1.65	Naphthalene	5.6	5	>B
B-D26	Carbon Chain	B-D26/1.40-1.65m/5	1.65	Carbon Chain => C15	7570	1000	>B
B-D26	Carbon Chain	B-D26/1.40-1.65m/5	1.65	Carbon Chain C6 - C14	1980	100	>B
B-D26	Volatiles	B-D26/1.40-1.65m/5	1.65	Naphthalene	8	5	>B
B-I01	Metals	B-I1/1.40-1.55m/7	1.55	Copper	507.00	100	>B
B-I02	Carbon Chain	B-I2/0.10-0.26m/1	0.26	Carbon Chain => C15	1200	1000	>B
B-I05	Metals	B-I5/0.12-0.28m/1	0.28	Copper	578.00	100	>B
B-I07	Metals	B-I7/0.1-0.25m/1	0.25	Lead	181.00	150	>B
B-J04	Metals	B-J4/1.02-1.27m/3	1.27	Lead	494.00	150	>B
B-J06	Metals	B-J6/0.0-0.16m/1	0.16	Copper	899.00	100	>B
B-J06	Metals	B-J6/0.0-0.16m/1	0.16	Lead	777.00	150	>B
B-J06	Metals	B-J6/0.0-0.16m/1	0.16	Nickel	140.00	100	>B
B-J06	Metals	B-J6/0.0-0.16m/1	0.16	Zinc	974.0	500	>B
B-L01	Metals	B-L1/0.68-0.83m/3	0.83	Lead	165.00	150	>B
B-L02	Metals	B-L2/0.20-0.35m/1	0.35	Copper	210.00	100	>B
B-L02	Carbon Chain	B-L2/0.20-0.35m/1	0.35	Carbon Chain => C15	5900	1000	>B
B-L02	Carbon Chain	B-L2/0.20-0.35m/1	0.35	Carbon Chain C6 - C14	426	100	>B
B-L02	Carbon Chain	B-L2/0.35-1.00m/3	1	Carbon Chain => C15	5590	1000	>B

TABLE 6-2
AREA 1 SOIL CONCENTRATIONS EXCEEDING DUTCH 'B' OR RESIDENTAL PRG VALUES
All Units mg/kg

SITE ID	ANALYSIS	SAMPLE ID	DEPTH (m)	PARAMETER	CONCENTRATION	Dutch 'B'/PRG Value	EXCEED
B-L02	Carbon Chain	B-L2/0.35-1.00m/3	1	Carbon Chain C6 - C14	227	100	>B
B-L02	Carbon Chain	B-L2/1.40-1.65m/5	1.65	Carbon Chain => C15	18900	1000	>B
B-L02	Carbon Chain	B-L2/1.40-1.65m/5	1.65	Carbon Chain C6 - C14	2870	100	>B
B-L03	Carbon Chain	B-L3/0.15-0.30m/1	0.3	Carbon Chain => C15	3010	1000	>B
B-L07	Carbon Chain	B-L7/0.08-0.23m/1	0.23	Carbon Chain => C15	10900	1000	>B
B-L07	Carbon Chain	B-L7/0.08-0.23m/1	0.23	Carbon Chain C6 - C14	1300	100	>B
B-L07	Carbon Chain	B-L7/0.83-0.98m/3	0.98	Carbon Chain => C15	1040	1000	>B
B-L13	Metals	B-L13/0.0-0.16m/1	0.16	Copper	1850.00	100	>B
B-L13	Metals	B-L13/0.0-0.16m/1	0.16	Nickel	110.00	100	>B
B-L13	Metals	B-L13/0.0-0.16m/1	0.16	Zinc	545.0	500	>B
B-L15	Metals	B-L15/0.0-0.16m/1	0.16	Copper	430.00	100	>B
B-L15	Metals	B-L15/0.0-0.16m/1	0.16	Zinc	636.0	500	>B
B-L16	Metals	B-L16/0.0-0.16m/1	0.16	Copper	283.00	100	>B
B-L16	Metals	B-L16/0.0-0.16m/1	0.16	Copper	102.00	100	>B
B-L16	Metals	B-L16/0.0-0.16m/1	0.16	Lead	170.00	150	>B
B-L17	Metals	B-L17/0.0-0.16m/1	0.16	Copper	485.00	100	>B
B-L17	Metals	B-L17/0.63-0.79m/3	0.79	Copper	111.00	100	>B
B-L19	Metals	B-L19/0.10-0.26m/1	0.26	Copper	350.00	100	>B
B-L20	Metals	B-L20/0.0-0.16m/1	0.16	Copper	845.00	100	>B
B-L20	Metals	B-L20/0.0-0.16m/1	0.16	Lead	535.00	150	>B
B-L20	Metals	B-L20/0.0-0.16m/1	0.16	Zinc	1590.0	500	>B
B-L22	Carbon Chain	B-L22/0.10-0.26m/1	0.26	Carbon Chain => C15	4190	1000	>B
B-L23	Metals	B-L23/0.0-0.16m/1	0.16	Copper	564.00	100	>B
B-L23	Metals	B-L23/0.0-0.16m/1	0.16	Lead	267.00	150	>B
B-L23	Metals	B-L23/0.0-0.16m/1	0.16	Nickel	138.00	100	>B
B-L23	Metals	B-L23/0.0-0.16m/1	0.16	Zinc	562.0	500	>B
B-L24	Metals	B-L24/0.0-.016m/1	0.16	Cadmium	18.10	5	>B
B-L24	Metals	B-L24/0.0-.016m/1	0.16	Cobalt	52.40	50	>B
B-L24	Metals	B-L24/0.0-.016m/1	0.16	Copper	2680.00	100	>B
B-L24	Metals	B-L24/0.0-.016m/1	0.16	Lead	1740.00	150	>B
B-L24	Metals	B-L24/0.0-.016m/1	0.16	Nickel	1140.00	100	>B
B-L24	Metals	B-L24/0.0-.016m/1	0.16	Zinc	4180.0	500	>B
B-L25	Metals	B-L25/0.0-0.13m/1	0.13	Cadmium	10.70	5	>B
B-L25	Metals	B-L25/0.0-0.13m/1	0.13	Cobalt	70.30	50	>B
B-L25	Metals	B-L25/0.0-0.13m/1	0.13	Copper	876.00	100	>B
B-L25	Metals	B-L25/0.0-0.13m/1	0.13	Lead	447.00	150	>B
B-L25	Metals	B-L25/0.0-0.13m/1	0.13	Nickel	1260.00	100	>B
B-L25	Metals	B-L25/0.0-0.13m/1	0.13	Zinc	2940.0	500	>B
B-L26	Metals	B-L26/0.0-0.16m/1	0.16	Antimony	66.60	31	>PRG
B-L26	Metals	B-L26/0.0-0.16m/1	0.16	Cadmium	6.92	5	>B
B-L26	Metals	B-L26/0.0-0.16m/1	0.16	Copper	235.00	100	>B
B-L26	Metals	B-L26/0.0-0.16m/1	0.16	Lead	26300.00	150	>B
B-L26	Metals	B-L26/0.68-0.84m/3	0.84	Copper	237.00	100	>B
B-L26	Metals	B-L26/0.68-0.84m/3	0.84	Lead	521.00	150	>B
B-L26A	Metals	B-L26a/1.40-1.65m/5	1.65	Lead	368.00	150	>B
B-L28	Metals	B-L28/0.10-0.26m/1	0.26	Arsenic	31.6	30	>B

TABLE 6-2
AREA 1 SOIL CONCENTRATIONS EXCEEDING DUTCH 'B' OR RESIDENTAL PRG VALUES
All Units mg/kg

SITE ID	ANALYSIS	SAMPLE ID	DEPTH (m)	PARAMETER	CONCENTRATIO N	Dutch 'B'/PRG Value	EXCEED
B-L28	Metals	B-L28/0.10-0.26m/1	0.26	Copper	377.00	100	>B
B-L28	Metals	B-L28/0.10-0.26m/1	0.26	Lead	420.00	150	>B
B-L28	Metals	B-L28/0.10-0.26m/1	0.26	Nickel	143.00	100	>B
B-L28	Semi-volatiles	B-L28/0.10-0.26m/1	0.26	Dibenz(a,h)anthracene	0.089	0.062	>PRG
B-L28	Metals	B-L28/0.64-0.80m/3	0.8	Chromium	624.00	250	>B
B-L29	Metals	B-L29/0.15-0.31m/1	0.31	Chromium	429.00	250	>B
B-L29	Carbon Chain	B-L29/0.15-0.31m/1	0.31	Carbon Chain => C15	1240	1000	>B
B-L30	Metals	B-L30/0.0-0.16m/1	0.16	Copper	281.00	100	>B
B-L30	Metals	B-L30/0.0-0.16m/1	0.16	Lead	880.00	150	>B
B-L30	Metals	B-L30/0.0-0.16m/1	0.16	Nickel	349.00	100	>B
B-L31	Metals	B-L31/0.0-0.16m/1	0.16	Barium	494.00	400	>B
B-L31	Metals	B-L31/0.0-0.16m/1	0.16	Copper	1380.00	100	>B
B-L31	Metals	B-L31/0.0-0.16m/1	0.16	Lead	1060.00	150	>B
B-L31	Metals	B-L31/0.0-0.16m/1	0.16	Nickel	125.00	100	>B
B-L31	Metals	B-L31/0.0-0.16m/1	0.16	Zinc	1510.0	500	>B
B-L31	Semi-volatiles	B-L31/0.0-0.16m/1	0.16	Dibenz(a,h)anthracene	0.076	0.062	>PRG
B-L32	Metals	B-L32/0.0-0.16m/1	0.16	Copper	499.00	100	>B
B-L33	Metals	B-L33/0.0-0.16m/1	0.16	Copper	1180.00	100	>B
B-L33	Metals	B-L33/0.0-0.16m/1	0.16	Lead	488.00	150	>B
B-L33	Metals	B-L33/0.0-0.16m/1	0.16	Zinc	812.0	500	>B
B-L33	Carbon Chain	B-L33/0.0-0.16m/1	0.16	Carbon Chain => C15	2260	1000	>B
B-L33	Carbon Chain	B-L33/0.0-0.16m/1	0.16	Carbon Chain C6 - C14	114	100	>B
B-M01	Metals	B-M1/0.10-0.25m/1	0.25	Arsenic	30.5	30	>B
B-M01	Metals	B-M1/0.10-0.25m/1	0.25	Chromium	303.00	250	>B
B-M01	Metals	B-M1/0.10-0.25m/1	0.25	Copper	127.00	100	>B
B-M01	Metals	B-M1/0.10-0.25m/1	0.25	Nickel	867.00	100	>B
B-M01	Metals	B-M1/0.68-0.87m/3	0.87	Chromium	331.00	250	>B
B-M01	Metals	B-M1/0.68-0.87m/3	0.87	Nickel	322.00	100	>B
B-M05	Metals	B-M5/0.07-0.22m/1	0.22	Nickel	302.00	100	>B
B-M06	ioxins & Furan	B-M6 / 0.00-0.16 / 1&2	0.16	Total I-TEQ with 1/2 RL	6070	1000	>B
B-M06	Metals	B-M6/0.0-0.16m/1	0.16	Copper	4490.00	100	>B
B-M06	Metals	B-M6/0.0-0.16m/1	0.16	Lead	1390.00	150	>B
B-M06	Metals	B-M6/0.65-0.81m/3	0.81	Copper	579.00	100	>B
B-M06	Metals	B-M6/0.65-0.81m/3	0.81	Lead	448.00	150	>B
B-M06	Metals	B-M6/0.65-0.81m/3	0.81	Nickel	327.00	100	>B
B-N01	Carbon Chain	B-N1/0.02-0.18m/1	0.18	Carbon Chain => C15	2680	1000	>B
B-N01	Carbon Chain	B-N1/1.43-1.59m/5	1.59	Carbon Chain => C15	1640	1000	>B
B-N01	Carbon Chain	B-N1/1.43-1.59m/5	1.59	Carbon Chain C6 - C14	273	100	>B
B-N02	Metals	B-N2/0.07-0.22m/1	0.22	Cadmium	5.28	5	>B
B-N02	Metals	B-N2/0.07-0.22m/1	0.22	Copper	504.00	100	>B
B-N02	Metals	B-N2/0.07-0.22m/1	0.22	Lead	245.00	150	>B
B-N02	Metals	B-N2/0.07-0.22m/1	0.22	Nickel	178.00	100	>B
B-N02	Metals	B-N2/0.07-0.22m/1	0.22	Tin	139.00	50	>B
B-N02	Carbon Chain	B-N2/0.07-0.22m/1	0.22	Carbon Chain => C15	6580	1000	>B
B-N02	Carbon Chain	B-N2/0.07-0.22m/1	0.22	Carbon Chain C6 - C14	2030	100	>B
B-N05	Metals	B-N5/0.68-0.83m/3	0.83	Copper	255.00	100	>B

TABLE 6-2
AREA 1 SOIL CONCENTRATIONS EXCEEDING DUTCH 'B' OR RESIDENTAL PRG VALUES
All Units mg/kg

SITE ID	ANALYSIS	SAMPLE ID	DEPTH (m)	PARAMETER	CONCENTRATION	Dutch 'B'/PRG Value	EXCEED
B-N06	Metals	B-N6/0.05-0.20m/1	0.2	Lead	249.00	150	>B
B-N06	Carbon Chain	B-N6/1.40-1.65m/5	1.65	Carbon Chain => C15	1210	1000	>B
B-N06	Carbon Chain	B-N6/1.40-1.65m/5	1.65	Carbon Chain C6 - C14	433	100	>B
B-O06	Metals	B-O6/1.63-1.73m/5	1.73	Copper	290.00	100	>B
B-O07	Metals	B-O7/0.15-0.30m/1	0.3	Copper	1260.00	100	>B
B-P01	Metals	B-P1/0.10-0.26m/1	0.26	Lead	475.00	150	>B
B-P06	Carbon Chain	B-P6/0.40-0.56m/1	0.56	Carbon Chain => C15	13600	1000	>B
B-P08	Carbon Chain	B-P8/0.15-0.30m/1	0.3	Carbon Chain C6 - C14	200	100	>B
B-P10	Carbon Chain	B-P10/0.08-0.23m/1	0.23	Carbon Chain => C15	19000	1000	>B
B-P10	Carbon Chain	B-P10/0.08-0.23m/1	0.23	Carbon Chain C6 - C14	219	100	>B
B-P10	Carbon Chain	B-P10/0.68-0.83m/3	0.83	Carbon Chain => C15	5830	1000	>B
OB-05	Metals	OB-5/0.15-0.25m/1	0.25	Barium	1100.00	400	>B
OB-05	Metals	OB-5/0.15-0.25m/1	0.25	Chromium	274.00	250	>B
OB-05	Metals	OB-5/0.15-0.25m/1	0.25	Copper	2780.00	100	>B
OB-05	Metals	OB-5/0.15-0.25m/1	0.25	Lead	2730.00	150	>B
OB-05	Metals	OB-5/0.15-0.25m/1	0.25	Nickel	221.00	100	>B
OB-05	Metals	OB-5/0.15-0.25m/1	0.25	Zinc	1740.0	500	>B
OB-05	Metals	OB-5/1.40-1.65m/6	1.65	Copper	713.00	100	>B
OB-05	Metals	OB-5/1.40-1.65m/6	1.65	Lead	1830.00	150	>B
OB-05	Metals	OB-5/2.87-3.12m/9	3.12	Copper	150.00	100	>B
OB-05	Metals	OB-5/2.87-3.12m/9	3.12	Lead	502.00	150	>B
SD-01	Carbon Chain	SD-1/0.08-0.23m/1	0.23	Carbon Chain => C15	1190	1000	>B
SD-03	Metals	SD-3/0.15-0.30m/1	0.3	Copper	380.00	100	>B
SD-04	Metals	SD-4/0.08-0.23m/1	0.23	Copper	291.00	100	>B
SD-06	Metals	SD-6/0.07-0.22m/1	0.22	Copper	117.00	100	>B
SD-07	Metals	SD-7/0.08-0.23m/1	0.23	Copper	1280.00	100	>B
SD-08	Metals	SD-8/0.0-0.18m/1	0.18	Copper	130.00	100	>B
SD-09	Metals	SD-9/0.0-0.18m/1	0.18	Lead	230.00	150	>B
T-01	Metals	T1/0.74m/2	0.74	Copper	105.00	100	>B
T-01	Metals	T1/0.74m/2	0.74	Lead	311.00	150	>B

TABLE 6-3
AREA 2 SOIL CONCENTRATIONS EXCEEDING DUTCH 'B' OR RESIDENTAL PRG VALUES
All Units mg/kg

SITE ID	ANALYSIS	SAMPLE ID	DEPTH (m)	PARAMETER	CONCENTRATION	Dutch 'B'/PRG Value	EXCEED
AB-43	Metals	AB-43/0.80-0.95m/3	0.95	Copper	191.00	100	>B
AB-44	Metals	AB-44/0.72-0.87m/3	0.87	Copper	258.00	100	>B
AB-46	Metals	AB-46/0.07-0.22m/1	0.22	Copper	225.00	100	>B
AB-48	Metals	AB-48/0.65-0.80m/3	0.8	Copper	107.00	100	>B
AB-50	Metals	AB-50/0.08-0.23m/1	0.23	Copper	7780.00	100	>B
AB-50	Metals	AB-50/0.08-0.23m/1	0.23	Lead	2690.00	150	>B
AB-50	Metals	AB-50/0.08-0.23m/1	0.23	Tin	167.00	50	>B
AB-50	Metals	AB-50/0.08-0.23m/1	0.23	Zinc	1950.0	500	>B
AB-50	Metals	AB-50/0.80-0.95m/6	0.95	Copper	3050.00	100	>B
AB-50	Metals	AB-50/0.80-0.95m/6	0.95	Lead	3020.00	150	>B
AB-50	Metals	AB-50/0.80-0.95m/6	0.95	Tin	156.00	50	>B
AB-50	Metals	AB-50/0.80-0.95m/6	0.95	Zinc	790.0	500	>B
AB-65	Metals	AB-65/0.08-0.23m/1	0.23	Copper	315.00	100	>B
AB-65	Metals	AB-65/0.65-0.80m/3	0.8	Copper	223.00	100	>B
AB-68	Metals	AB-68/0.68-0.83m/3	0.83	Zinc	564.0	500	>B
AB-70	Metals	AB-70/0.65-0.80m/3	0.8	Zinc	1270.0	500	>B
AB-71	Metals	AB-71/0.08-0.23m/1	0.23	Lead	151.00	150	>B
AB-71	Metals	AB-71/0.08-0.23m/1	0.23	Zinc	2070.0	500	>B
AB-73	Metals	AB73/0.08-0.23m/1	0.23	Copper	199.00	100	>B
AB-80	Metals	AB-80/0.65-0.80m/3	0.8	Lead	162.00	150	>B
AB-81	Metals	AB-81/0.08-0.23m/1	0.23	Copper	147.00	100	>B
AB-82	Metals	AB-82/0.08-0.23m/1	0.23	Copper	124.00	100	
AB-T03	Semi-volatiles	AB-T3/0.08-0.23m/1	0.23	Benzo(a)anthracene	1.6	0.62	[illegible]
AB-T03	Semi-volatiles	AB-T3/0.08-0.23m/1	0.23	Benzo(a)pyrene	1.43	1	>B
AB-T03	Semi-volatiles	AB-T3/0.08-0.23m/1	0.23	Benzo(b)fluoranthene	1.4	0.62	>PRG
AB-T03	Semi-volatiles	AB-T3/0.08-0.23m/1	0.23	Benzo(k)fluoranthene	1.19	0.61	>PRG
AB-T03	Semi-volatiles	AB-T3/0.08-0.23m/1	0.23	Dibenz(a,h)anthracene	0.212	0.062	>PRG
AB-T03	Semi-volatiles	AB-T3/0.08-0.23m/1	0.23	Indeno(1,2,3-cd)pyrene	1.09	0.62	>PRG
AB-T06	Metals	AB-T6/0.1-0.25m/1	0.25	Copper	245.00	100	>B
AB-T06	Metals	AB-T6/0.65-0.80m/3	0.8	Copper	208.00	100	>B
AB-T07	Semi-volatiles	AB-T7/0.30-0.45m/1	0.45	Bis(2-ethylhexyl)phthalate	46	35	>PRG
AB-T08	Metals	AB-T8/0.25-0.40m/1	0.4	Copper	179.00	100	>B
AB-T12	Carbon Chain	AB-T12/0.40-0.56m/1	0.56	Carbon Chain => C15	2540	1000	>B
AB-T15	Metals	AB-T15/0.65-0.80m/3	0.8	Lead	155.00	150	>B
AB-T18	Metals	AB-T18/0.35-0.50m/1	0.5	Copper	362.00	100	>B
AB-T21A	Metals	AB-T21A/0.08-0.23m/1	0.23	Copper	398.00	100	>B
AB-T22	Metals	AB-T22/0.20-0.35m/1	0.35	Copper	110.00	100	>B
AW-03	Metals	AW-3/0.08-0.23m/1	0.23	Barium	545.00	400	>B
AW-03	Metals	AW-3/0.08-0.23m/1	0.23	Cadmium	5.15	5	>B
AW-03	Metals	AW-3/0.08-0.23m/1	0.23	Copper	2180.00	100	>B
AW-03	Metals	AW-3/0.08-0.23m/1	0.23	Lead	760.00	150	>B
AW-03	Metals	AW-3/0.08-0.23m/1	0.23	Nickel	157.00	100	>B
AW-03	Metals	AW-3/0.08-0.23m/1	0.23	Zinc	1090.0	500	>B
AW-04	Metals	AW-4/0.08-0.23m/1	0.23	Copper	176.00	100	>B
B-R03	Metals	B-R3/0.71-0.86m/30.71-0.8	0.86	Lead	155.00	150	>B
B-S06	Metals	B-S6/0.18-0.34m/1	0.34	Copper	159.00	100	>B
B-S08	Carbon Chain	B-S8/0.08-0.23m/1	0.23	Carbon Chain => C15	8940	1000	>B
B-S08	Carbon Chain	B-S8/0.08-0.23m/1	0.23	Carbon Chain C6 - C14	2280	100	[illegible]

TABLE 6-3
AREA 2 SOIL CONCENTRATIONS EXCEEDING DUTCH 'B' OR RESIDENTAL PRG VALUES
All Units mg/kg

SITE ID	ANALYSIS	SAMPLE ID	DEPTH (m)	PARAMETER	CONCENTRATION	Dutch 'B'/PRG Value	EXCEE
B-S09	Semi-volatiles	B-S9/0.30-0.45m/1	0.45	Benzo(a)anthracene	1.18	0.62	>PRG
B-S09	Semi-volatiles	B-S9/0.30-0.45m/1	0.45	Benzo(b)fluoranthene	1.26	0.62	>PRG
B-S09	Semi-volatiles	B-S9/0.30-0.45m/1	0.45	Benzo(k)fluoranthene	0.67	0.61	>PRG
B-S09	Semi-volatiles	B-S9/0.30-0.45m/1	0.45	Dibenz(a,h)anthracene	0.16	0.062	>PRG
B-S09	Semi-volatiles	B-S9/0.30-0.45m/1	0.45	Indeno(1,2,3-cd)pyrene	0.716	0.62	>PRG
B-S09	Carbon Chain	B-S9/0.30-0.45m/1	0.45	Carbon Chain => C15	1350	1000	>B
B-S10	Metals	B-S10/0.17-0.32m/1	0.32	Lead	431.00	150	>B
B-S11	Metals	B-S11/0.68-0.82m/3	0.82	Copper	126.00	100	>B
B-T03	Metals	B-T3/0.12-0.30m/1	0.3	Barium	789.00	400	>B
B-T05	Metals	B-T5/0.35-0.53m/1	0.53	Barium	437.00	400	>B
B-T05	Metals	B-T5/0.35-0.53m/1	0.53	Copper	2950.00	100	>B
B-T05	Metals	B-T5/0.35-0.53m/1	0.53	Lead	1760.00	150	>B
B-T05	Metals	B-T5/0.35-0.53m/1	0.53	Zinc	1300.0	500	>B
B-T05	Semi-volatiles	B-T5/0.35-0.53m/1	0.53	Benzo(a)anthracene	1.22	0.62	>PRG
B-T05	Semi-volatiles	B-T5/0.35-0.53m/1	0.53	Benzo(b)fluoranthene	1.15	0.62	>PRG
B-T05	Semi-volatiles	B-T5/0.35-0.53m/1	0.53	Benzo(k)fluoranthene	0.88	0.61	>PRG
B-T05	Semi-volatiles	B-T5/0.35-0.53m/1	0.53	Dibenz(a,h)anthracene	0.159	0.062	>PRG
B-T05	Semi-volatiles	B-T5/0.35-0.53m/1	0.53	Indeno(1,2,3-cd)pyrene	0.794	0.62	>PRG
B-T05	Metals	B-T5/1.28-1.72m/5	1.72	Copper	156.00	100	>B
B-T06	Carbon Chain	B-T6/0.25-0.40m/1	0.4	Carbon Chain => C15	6370	1000	>B
B-T06	Carbon Chain	B-T6/0.25-0.40m/1	0.4	Carbon Chain C6 - C14	1270	100	>B
B-T06	Carbon Chain	B-T6/0.68-0.83m/3	0.83	Carbon Chain => C15	1180	1000	>B
B-T06	Carbon Chain	B-T6/0.68-0.83m/3	0.83	Carbon Chain C6 - C14	108	100	>B
B-V02	Metals	B-V2/0.68-0.83m/3	0.83	Copper	166.00	100	>B
B-V02	Carbon Chain	B-V2/0.68-0.83m/3	0.83	Carbon Chain => C15	3060	1000	>B
B-W02	Metals	B-W2/0.20-0.35m/20.20-0.3	0.35	Lead	414.00	150	>B
B-W02	Carbon Chain	B-W2/0.20-0.35m/20.20-0.3	0.35	Carbon Chain => C15	6870	1000	>B
B-W02	Carbon Chain	B-W2/0.20-0.35m/20.20-0.3	0.35	Carbon Chain C6 - C14	782	100	>B
B-X04	Semi-volatiles	B-X4/0.11-0.26m/1	0.26	Dibenz(a,h)anthracene	0.093	0.062	>PRG
B-Y04	Semi-volatiles	B-Y4/0.08-0.23m/1	0.23	Benzo(a)anthracene	1.67	0.62	>PRG
B-Y04	Semi-volatiles	B-Y4/0.08-0.23m/1	0.23	Benzo(a)pyrene	1.6	1	>B
B-Y04	Semi-volatiles	B-Y4/0.08-0.23m/1	0.23	Benzo(b)fluoranthene	1.5	0.62	>PRG
B-Y04	Semi-volatiles	B-Y4/0.08-0.23m/1	0.23	Benzo(k)fluoranthene	1.33	0.61	>PRG
B-Y04	Semi-volatiles	B-Y4/0.08-0.23m/1	0.23	Dibenz(a,h)anthracene	0.18	0.062	>PRG
B-Y04	Semi-volatiles	B-Y4/0.08-0.23m/1	0.23	Indeno(1,2,3-cd)pyrene	0.92	0.62	>PRG
B-Z02	Carbon Chain	B-Z2/0.25-0.40m/1	0.4	Carbon Chain => C15	6760	1000	>B
B-Z02	Carbon Chain	B-Z2/0.25-0.40m/1	0.4	Carbon Chain C6 - C14	268	100	>B
IEC-T01(1-10)	Metals	IEC-T1(1-10)/1.3m/5	1.3	Copper	3850.00	100	>B
IEC-T01(1-10)	Metals	IEC-T1(1-10)/1.3m/5	1.3	Lead	509.00	150	>B
IEC-T01(1-10)	Metals	IEC-T1(1-10)/1.3m/5	1.3	Zinc	2150.0	500	>B
IEC-T01(1-10)	Biphenyls (PC	IEC-T1(1-10)/1.3m/5	1.3	Aroclor-1260	33.4	1	>B
IEC-T01(1-10)	ioxins & Furan	IEC-T1(1-10)/1.9/7	1.9	Total I-TEQ with 1/2 RL	1400	1000	>B
IEC-T01(1-10)	Metals	IEC-T1(1-10)/2.46m/1	2.46	Copper	408.00	100	>B
IEC-T01(1-10)	Metals	IEC-T1(1-10)/2.46m/1	2.46	Lead	1580.00	150	>B
IEC-T01(1-8)	ioxins & Furan	IEC-T1(1-8) /2.4 /1&2	2.4	Total I-TEQ with 1/2 RL	1020	1000	>B
IEC-T01(2-3)	Metals	IEC-T1(2-3)/0.9m/21	0.9	Copper	10300.00	100	>B
IEC-T01(2-3)	Metals	IEC-T1(2-3)/0.9m/21	0.9	Lead	359.00	150	>B
IEC-T01(2-3)	Metals	IEC-T1(2-3)/0.9m/21	0.9	Tin	64.09	50	>B

TABLE 6-3
AREA 2 SOIL CONCENTRATIONS EXCEEDING DUTCH 'B' OR RESIDENTAL PRG VALUES
All Units mg/kg

SITE ID	ANALYSIS	SAMPLE ID	DEPTH (m)	PARAMETER	CONCENTRATION	Dutch 'B'/PRG Value	EXCEED
IEC-T01(2-3)	Metals	IEC-T1(2-3)/0.9m/21	0.9	Zinc	3650.0	500	>B
IEC-T01(2-3)	Biphenyls (PC	IEC-T1(2-3)/0.9m/21	0.9	Aroclor-1260	5.7	1	>B
IEC-T01(2-3)	Carbon Chain	IEC-T1(2-3)/0.9m/21	0.9	Carbon Chain => C15	1410	1000	>B
IEC-T01(2-3)	Metals	IEC-T1(2-3)/1.35m/23	1.35	Copper	140.00	100	>B
IEC-T02(1-8)	ioxins & Furan	IEC-T2(1-8) /2.5 /7 & 8	2.5	Total I-TEQ with 1/2 RL	3990	1000	>B
IEC-T02(1-8)	Metals	IEC-T2(1-8)/2.4m/1	2.4	Barium	1360.00	400	>B
IEC-T02(1-8)	Metals	IEC-T2(1-8)/2.4m/1	2.4	Copper	2400.00	100	>B
IEC-T02(1-8)	Metals	IEC-T2(1-8)/2.4m/1	2.4	Lead	1770.00	150	>B
IEC-T02(1-8)	Metals	IEC-T2(1-8)/2.4m/1	2.4	Nickel	159.00	100	>B
IEC-T02(1-8)	Metals	IEC-T2(1-8)/2.4m/1	2.4	Zinc	1190.0	500	>B
IEC-T02(1-8)	Metals	IEC-T2(1-8)/2.5m/7	2.5	Barium	524.00	400	>B
IEC-T02(1-8)	Metals	IEC-T2(1-8)/2.5m/7	2.5	Cadmium	12.90	5	>B
IEC-T02(1-8)	Metals	IEC-T2(1-8)/2.5m/7	2.5	Copper	27900.00	100	>B
IEC-T02(1-8)	Metals	IEC-T2(1-8)/2.5m/7	2.5	Lead	675.00	150	>B
IEC-T02(1-8)	Metals	IEC-T2(1-8)/2.5m/7	2.5	Nickel	239.00	100	>B
IEC-T02(1-8)	Metals	IEC-T2(1-8)/2.5m/7	2.5	Tin	232.00	50	>B
IEC-T02(1-8)	Metals	IEC-T2(1-8)/2.5m/7	2.5	Zinc	6840.0	500	>B
IEC-T02(2-3)	ioxins & Furan	IEC-T2(2-3) /0.1/13	0.1	Total I-TEQ with 1/2 RL	1580	1000	>B
IEC-T02(2-3)	Metals	IEC-T2(2-3)/0.1m/13	0.1	Barium	2190.00	400	>B
IEC-T02(2-3)	Metals	IEC-T2(2-3)/0.1m/13	0.1	Cadmium	5.24	5	>B
IEC-T02(2-3)	Metals	IEC-T2(2-3)/0.1m/13	0.1	Chromium	350.00	250	>B
IEC-T02(2-3)	Metals	IEC-T2(2-3)/0.1m/13	0.1	Copper	5010.00	100	
IEC-T02(2-3)	Metals	IEC-T2(2-3)/0.1m/13	0.1	Lead	2010.00	150	
IEC-T02(2-3)	Metals	IEC-T2(2-3)/0.1m/13	0.1	Nickel	327.00	100	>B
IEC-T02(2-3)	Metals	IEC-T2(2-3)/0.1m/13	0.1	Zinc	3240.0	500	>B
IEC-T02(4-5)	ioxins & Furan	IEC-T2(4-5)/1.0/21 & 22	1	Total I-TEQ with 1/2 RL	2160	1000	>B
IEC-T02(4-5)	Metals	IEC-T2(4-5)/1.0m/21	1	Barium	1880.00	400	>B
IEC-T02(4-5)	Metals	IEC-T2(4-5)/1.0m/21	1	Cadmium	6.11	5	>B
IEC-T02(4-5)	Metals	IEC-T2(4-5)/1.0m/21	1	Cobalt	50.80	50	>B
IEC-T02(4-5)	Metals	IEC-T2(4-5)/1.0m/21	1	Copper	5690.00	100	>B
IEC-T02(4-5)	Metals	IEC-T2(4-5)/1.0m/21	1	Lead	4630.00	150	>B
IEC-T02(4-5)	Metals	IEC-T2(4-5)/1.0m/21	1	Nickel	393.00	100	>B
IEC-T02(4-5)	Metals	IEC-T2(4-5)/1.0m/21	1	Tin	73.20	50	>B
IEC-T02(4-5)	Metals	IEC-T2(4-5)/1.0m/21	1	Zinc	5710.0	500	>B
IEC-T02(4-5)	ioxins & Furan	IEC-T2(4-5)/1.5/19 & 20	1.5	Total I-TEQ with 1/2 RL	2440	1000	>B
IEC-T02(4-5)	Metals	IEC-T2(4-5)/1.5m/19	1.5	Barium	885.00	400	>B
IEC-T02(4-5)	Metals	IEC-T2(4-5)/1.5m/19	1.5	Copper	1470.00	100	>B
IEC-T02(4-5)	Metals	IEC-T2(4-5)/1.5m/19	1.5	Lead	1180.00	150	>B
IEC-T02(4-5)	Metals	IEC-T2(4-5)/1.5m/19	1.5	Zinc	1190.0	500	>B
IEC-T02(6-7)	ioxins & Furan	IEC-T2(6-7) /0.3 /31&32	0.3	Total I-TEQ with 1/2 RL	3000	1000	>B
IEC-T02(6-7)	ioxins & Furan	IEC-T2(6-7) /0.8 /27&28	0.8	Total I-TEQ with 1/2 RL	2710	1000	>B
IEC-T02(6-7)	Metals	IEC-T2(6-7)/0.3m/31	0.3	Barium	1050.00	400	>B
IEC-T02(6-7)	Metals	IEC-T2(6-7)/0.3m/31	0.3	Cadmium	7.87	5	>B
IEC-T02(6-7)	Metals	IEC-T2(6-7)/0.3m/31	0.3	Chromium	655.00	250	>B
IEC-T02(6-7)	Metals	IEC-T2(6-7)/0.3m/31	0.3	Cobalt	56.50	50	>B
IEC-T02(6-7)	Metals	IEC-T2(6-7)/0.3m/31	0.3	Copper	9360.00	100	>B
IEC-T02(6-7)	Metals	IEC-T2(6-7)/0.3m/31	0.3	Lead	2000.00	150	>B
IEC-T02(6-7)	Metals	IEC-T2(6-7)/0.3m/31	0.3	Nickel	728.00	100	>B

TABLE 6-3
AREA 2 SOIL CONCENTRATIONS EXCEEDING DUTCH 'B' OR RESIDENTAL PRG VALUES
All Units mg/kg

SITE ID	ANALYSIS	SAMPLE ID	DEPTH (m)	PARAMETER	CONCENTRATION	Dutch 'B'/PRG Value	EXCEED
IEC-T02(6-7)	Metals	IEC-T2(6-7)/0.3m/31	0.3	Tin	61.00	50	>B
IEC-T02(6-7)	Metals	IEC-T2(6-7)/0.3m/31	0.3	Zinc	5860.0	500	>B
IEC-T02(6-7)	Metals	IEC-T2(6-7)/0.8m/27	0.8	Barium	1340.00	400	>B
IEC-T02(6-7)	Metals	IEC-T2(6-7)/0.8m/27	0.8	Cadmium	5.36	5	>B
IEC-T02(6-7)	Metals	IEC-T2(6-7)/0.8m/27	0.8	Chromium	313.00	250	>B
IEC-T02(6-7)	Metals	IEC-T2(6-7)/0.8m/27	0.8	Copper	3840.00	100	>B
IEC-T02(6-7)	Metals	IEC-T2(6-7)/0.8m/27	0.8	Lead	1390.00	150	>B
IEC-T02(6-7)	Metals	IEC-T2(6-7)/0.8m/27	0.8	Nickel	234.00	100	>B
IEC-T02(6-7)	Metals	IEC-T2(6-7)/0.8m/27	0.8	Zinc	2340.0	500	>B
IEC-T03(1-8)	Metals	IEC-T3(1-8)/0.3-0.45m/3	0.3	Barium	1470.00	400	>B
IEC-T03(1-8)	Metals	IEC-T3(1-8)/0.3-0.45m/3	0.3	Chromium	524.00	250	>B
IEC-T03(1-8)	Metals	IEC-T3(1-8)/0.3-0.45m/3	0.3	Copper	5570.00	100	>B
IEC-T03(1-8)	Metals	IEC-T3(1-8)/0.3-0.45m/3	0.3	Lead	1980.00	150	>B
IEC-T03(1-8)	Metals	IEC-T3(1-8)/0.3-0.45m/3	0.3	Nickel	357.00	100	>B
IEC-T03(1-8)	Metals	IEC-T3(1-8)/0.3-0.45m/3	0.3	Zinc	5570.0	500	>B
IEC-T03(1-8)	Metals	IEC-T3(1-8)/0.45m/9	0.45	Barium	771.00	400	>B
IEC-T03(1-8)	Metals	IEC-T3(1-8)/0.45m/9	0.45	Chromium	388.00	250	>B
IEC-T03(1-8)	Metals	IEC-T3(1-8)/0.45m/9	0.45	Copper	3590.00	100	>B
IEC-T03(1-8)	Metals	IEC-T3(1-8)/0.45m/9	0.45	Lead	1600.00	150	>B
IEC-T03(1-8)	Metals	IEC-T3(1-8)/0.45m/9	0.45	Nickel	343.00	100	>B
IEC-T03(1-8)	Metals	IEC-T3(1-8)/0.45m/9	0.45	Zinc	1960.0	500	>B
IEC-T03(1-8)	Metals	IEC-T3(1-8)/0.6m/13	0.6	Copper	134.00	100	>B
IEC-T03(1-8)	Metals	IEC-T3(1-8)0.65-0.8m/5	0.8	Barium	1060.00	400	>B
IEC-T03(1-8)	Metals	IEC-T3(1-8)0.65-0.8m/5	0.8	Copper	8070.00	100	>B
IEC-T03(1-8)	Metals	IEC-T3(1-8)0.65-0.8m/5	0.8	Lead	1140.00	150	>B
IEC-T03(1-8)	Metals	IEC-T3(1-8)0.65-0.8m/5	0.8	Nickel	411.00	100	>B
IEC-T03(1-8)	Metals	IEC-T3(1-8)0.65-0.8m/5	0.8	Tin	56.60	50	>B
IEC-T03(1-8)	Metals	IEC-T3(1-8)0.65-0.8m/5	0.8	Zinc	4830.0	500	>B
OB-16	Metals	OB-16/0.18-0.38m/1	0.38	Copper	637.00	100	>B
OB-16	Metals	OB-16/0.18-0.38m/1	0.38	Nickel	469.00	100	>B
OB-18	Metals	OB-18/1.41-1.66m/5	1.66	Copper	171.00	100	>B
OB-18	Metals	OB-18/1.41-1.66m/5	1.66	Lead	300.00	150	>B
OB-19	Metals	OB-19/0.72-0.87m/3	0.87	Copper	244.00	100	>B
OB-20	Metals	OB-20/0.07-0.22m/1	0.22	Copper	276.00	100	>B
OB-26	Metals	OB-26/0.14-0.29m/1	0.29	Copper	206.00	100	>B
OB-26	Semi-volatiles	OB-26/0.14-0.29m/1	0.29	Benzo(a)anthracene	0.699	0.62	>PRG
OB-26	Semi-volatiles	OB-26/0.14-0.29m/1	0.29	Benzo(a)pyrene	1.01	1	>B
OB-26	Semi-volatiles	OB-26/0.14-0.29m/1	0.29	Benzo(b)fluoranthene	0.98	0.62	>PRG
OB-26	Semi-volatiles	OB-26/0.14-0.29m/1	0.29	Benzo(k)fluoranthene	0.98	0.61	>PRG
OB-26	Semi-volatiles	OB-26/0.14-0.29m/1	0.29	Dibenz(a,h)anthracene	0.177	0.062	>PRG
OB-26	Semi-volatiles	OB-26/0.14-0.29m/1	0.29	Indeno(1,2,3-cd)pyrene	0.812	0.62	>PRG
OB-27	Metals	OB-27/0.08-0.23m/1	0.23	Zinc	1340.0	500	>B
OB-31	Metals	OB-31/0.06-0.21m/1	0.21	Copper	181.00	100	>B
S-D22	Metals	S-D22/0.30-0.45m/1	0.45	Barium	858.00	400	>B
SD-16	Metals	SD-16/1.23-1.48m/5	1.48	Zinc	545.0	500	>B
SD-19A	Metals	SD-19A/2.0-2.25m/6	2.25	Copper	111.00	100	>B
SD-21	Metals	SD-21/0.80-0.94m/3	0.94	Copper	115.00	100	>B
SD-21	Semi-volatiles	SD-21/0.80-0.94m/3	0.94	Benzo(a)anthracene	1.34	0.62	>PRG

TABLE 6-3
AREA 2 SOIL CONCENTRATIONS EXCEEDING DUTCH 'B' OR RESIDENTAL PRG VALUES
All Units mg/kg

SITE ID	ANALYSIS	SAMPLE ID	DEPTH (m)	PARAMETER	CONCENTRATION	Dutch 'B'/PRG Value	EXCEED
SD-21	Semi-volatiles	SD-21/0.80-0.94m/3	0.94	Benzo(a)pyrene	1.9	1	>B
SD-21	Semi-volatiles	SD-21/0.80-0.94m/3	0.94	Benzo(b)fluoranthene	2.38	0.62	>PRG
SD-21	Semi-volatiles	SD-21/0.80-0.94m/3	0.94	Benzo(k)fluoranthene	1.45	0.61	>PRG
SD-21	Semi-volatiles	SD-21/0.80-0.94m/3	0.94	Dibenz(a,h)anthracene	0.657	0.062	>PRG
SD-21	Semi-volatiles	SD-21/0.80-0.94m/3	0.94	Indeno(1,2,3-cd)pyrene	1.51	0.62	>PRG
SD-21	Metals	SD-21/1.46-1.71m/5	1.71	Lead	169.00	150	>B
SD-21	Semi-volatiles	SD-21/1.46-1.71m/5	1.71	Benzo(b)fluoranthene	0.76	0.62	>PRG
SD-21	Semi-volatiles	SD-21/1.46-1.71m/5	1.71	Dibenz(a,h)anthracene	0.088	0.062	>PRG
T-05	Carbon Chain	T5/0.96m/3	0.96	Carbon Chain => C15	14200	1000	>B
T-06	Metals	T6/0.96m/5	0.96	Copper	393.00	100	>B
T-07	Metals	T7/1.08m/1	1.08	Copper	111.00	100	>B
T-07	Metals	T7/1.47m/3	1.47	Copper	162.00	100	>B
T-08	Metals	T8/0.25m/1	0.25	Chromium	672.00	250	>B
T-08	Metals	T8/0.25m/1	0.25	Cobalt	67.80	50	>B
T-08	Metals	T8/0.25m/1	0.25	Copper	7080.00	100	>B
T-08	Metals	T8/0.25m/1	0.25	Lead	1310.00	150	>B
T-08	Metals	T8/0.25m/1	0.25	Nickel	726.00	100	>B
T-08	Metals	T8/0.25m/1	0.25	Tin	66.40	50	>B
T-08	Metals	T8/0.25m/1	0.25	Zinc	4350.0	500	>B
T-09	Metals	T9/0.92m/5	0.92	Barium	1800.00	400	>B
T-09	Metals	T9/0.92m/5	0.92	Chromium	432.00	250	>B
T-09	Metals	T9/0.92m/5	0.92	Copper	4270.00	100	
T-09	Metals	T9/0.92m/5	0.92	Lead	881.00	150	
T-09	Metals	T9/0.92m/5	0.92	Nickel	487.00	100	>B
T-09	Metals	T9/1.17m/1	1.17	Barium	3290.00	400	>B
T-09	Metals	T9/1.17m/1	1.17	Chromium	477.00	250	>B
T-09	Metals	T9/1.17m/1	1.17	Copper	11400.00	100	>B
T-09	Metals	T9/1.17m/1	1.17	Lead	1300.00	150	>B
T-09	Metals	T9/1.17m/1	1.17	Nickel	497.00	100	>B
T-09	Metals	T9/1.17m/1	1.17	Tin	64.09	50	>B
T-10	Carbon Chain	T10/0.26m/7	0.26	Carbon Chain => C15	1270	1000	>B
T-10	Metals	T10/0.79m/5	0.79	Copper	222.00	100	>B
T-10	Metals	T10/1.11m/3	1.11	Copper	103.00	100	>B
T-11	Volatiles	T11/0.31m/1	0.31	Styrene	6.3	5	>B

TABLE 6-4
AREA 3 SOIL CONCENTRATIONS EXCEEDING DUTCH 'B' OR RESIDENTAL PRG VALUES
All Units mg/kg

SITE ID	ANALYSIS	SAMPLE ID	DEPTH (m)	PARAMETER	CONCENTRATION	Dutch 'B'/PRG Value	EXCEED
AW-06	Metals	AW-6/0.1-0.25m/1	0.25	Copper	175.00	100	>B
AW-06	Metals	AW-6/0.1-0.25m/1	0.25	Zinc	2500.0	500	>B
AW-07	Metals	AW7/2.90-3.15m/5	3.15	Lead	201.00	150	>B
AW-09	Metals	AW-9/1.60-1.85m/5	1.85	Lead	200.00	150	>B
AW-10	Metals	AW-10/2.88-3.13m/6	3.13	Lead	185.00	150	>B
AW-10	Dioxins & Furans	AW10/0.68-0.83/3	0.83	Total I-TEQ with 1/2 RL	59400	1000	>B
AW-10	Metals	AW10/0.68-0.83m/3	0.83	Antimony	59.50	31	>PRG
AW-10	Metals	AW10/0.68-0.83m/3	0.83	Barium	1420.00	400	>B
AW-10	Metals	AW10/0.68-0.83m/3	0.83	Copper	5890.00	100	>B
AW-10	Metals	AW10/0.68-0.83m/3	0.83	Lead	582.00	150	>B
AW-10	Metals	AW10/0.68-0.83m/3	0.83	Nickel	189.00	100	>B
AW-10	Metals	AW10/0.68-0.83m/3	0.83	Zinc	3390.0	500	>B
AW-10	Metals	AW10/1.41-1.66m/5	1.66	Copper	778.00	100	>B
AW-10	Metals	AW10/1.41-1.66m/5	1.66	Zinc	2170.0	500	>B
AW-11	Metals	AW-11/0.08-0.23m/1	0.23	Lead	212.00	150	>B
AW-11	Metals	AW-11/0.65-0.80m/11	0.8	Copper	1970.00	100	>B
AW-11	Metals	AW-11/0.65-0.80m/11	0.8	Lead	357.00	150	>B
AW-11	Metals	AW-11/0.65-0.80m/11	0.8	Nickel	124.00	100	>B
AW-11	Metals	AW-11/0.65-0.80m/11	0.8	Zinc	868.0	500	>B
AW-11	Metals	AW-11/1.40-1.65m/5	1.65	Copper	764.00	100	>B
AW-11	Metals	AW-11/1.40-1.65m/5	1.65	Nickel	156.00	100	>B
AW-11	Metals	AW-11/1.40-1.65m/5	1.65	Zinc	763.0	500	>B
AW-11	Metals	AW-11/3.10-3.35m/6	3.35	Copper	133.00	100	>B
AW-14	Metals	AW-14/2.85-3.10m/3	3.1	Copper	455.00	100	>B
AW-14	Semi-volatiles	AW-14/2.85-3.10m/3	3.1	Phenol	1.3	1	>B
AW-15	Metals	AW-15/1.40-1.65m/3	1.65	Lead	305.00	150	>B
AW-16	Metals	AW16/0.05-0.23m/1	0.23	Copper	322.00	100	>B
AW-16	Metals	AW16/0.05-0.23m/1	0.23	Lead	179.00	150	>B
AW-18	Carbon Chain	AW18/0.20-0.35m/1	0.35	Carbon Chain => C15	9490	1000	>B
AW-18	Carbon Chain	AW18/0.20-0.35m/1	0.35	Carbon Chain C6 - C14	1190	100	>B
AW-21	Metals	AW21/1.38-1.63m/5	1.63	Lead	189.00	150	>B
B-Q02	Metals	B-Q2/0.20-0.35m/1	0.35	Copper	275.00	100	>B
B-Q04	Carbon Chain	B-Q4/0.10-0.25m/1	0.25	Carbon Chain => C15	7410	1000	>B
B-Q04	Carbon Chain	B-Q4/0.10-0.25m/1	0.25	Carbon Chain C6 - C14	1710	100	>B
B-Q07	Metals	B-Q7/0.08-0.23m/1	0.23	Copper	142.00	100	>B
B-Q07	Metals	B-Q7/0.68-0.83m/3	0.83	Copper	438.00	100	>B
B-Q07	Metals	B-Q7/1.38-1.63m/5	1.63	Copper	566.00	100	>B
B-Q07	Metals	B-Q7/1.38-1.63m/5	1.63	Lead	278.00	150	>B
B-Q14	Carbon Chain	B-Q14/0.22-0.38m/1	0.38	Carbon Chain => C15	2580	1000	>B
B-Q15	Carbon Chain	B-Q15/0.24-0.39m/1	0.39	Carbon Chain => C15	2800	1000	>B
B-Q15	Carbon Chain	B-Q15/0.24-0.39m/1	0.39	Carbon Chain C6 - C14	230	100	>B
IEC-T04(1-8)	Metals	IEC-T4(1-8)/3.0m/1	3	Lead	189.00	150	>B
IEC-T06(1-6)	Metals	IEC-T6(1-6)0.4m/5	5	Copper	1410.00	100	>B
IEC-T06(1-6)	Metals	IEC-T6(1-6)0.4m/5	5	Nickel	172.00	100	>B
IEC-T06(1-6)	Metals	IEC-T6(1-6)0.4m/5	5	Zinc	1210.0	500	>B
IEC-T07(2-3)	Metals	IEC-T7(2-3)/1.2m/9	1.2	Lead	183.00	150	>B
IEC-T07(2-3)	Metals	IEC-T7(2-3)0.6m/13	0.6	Lead	184.00	150	>B
IEC-T09(1-10)	Dioxins & Furans	IEC-T9(1-10)/0.84/9	0.84	Total I-TEQ with 1/2 RL	1550	1000	>B
IEC-T09(1-10)	Metals	IEC-T9(1-10)/0.84m/9	0.84	Barium	538.00	400	>B

TABLE 6-4
AREA 3 SOIL CONCENTRATIONS EXCEEDING DUTCH 'B' OR RESIDENTAL PRG VALUES
All Units mg/kg

SITE ID	ANALYSIS	SAMPLE ID	DEPTH (m)	PARAMETER	CONCENTRATION	Dutch 'B'/PRG Value	EXCEED
IEC-T09(1-10)	Metals	IEC-T9(1-10)/0.84m/9	0.84	Cadmium	6.42	5	>B
IEC-T09(1-10)	Metals	IEC-T9(1-10)/0.84m/9	0.84	Copper	819.00	100	>B
IEC-T09(1-10)	Metals	IEC-T9(1-10)/0.84m/9	0.84	Lead	412.00	150	>B
IEC-T09(1-10)	Metals	IEC-T9(1-10)/0.84m/9	0.84	Nickel	103.00	100	>B
IEC-T09(1-10)	Metals	IEC-T9(1-10)/0.84m/9	0.84	Zinc	5860.0	500	>B
IEC-T09(1-10)	Dioxins & Furans	IEC-T9(1-10)/1.27/5	1.27	Total I-TEQ with 1/2 RL	14900	1000	>B
IEC-T09(1-10)	Metals	IEC-T9(1-10)/1.27m/5	1.27	Barium	643.00	400	>B
IEC-T09(1-10)	Metals	IEC-T9(1-10)/1.27m/5	1.27	Cadmium	10.20	5	>B
IEC-T09(1-10)	Metals	IEC-T9(1-10)/1.27m/5	1.27	Copper	1510.00	100	>B
IEC-T09(1-10)	Metals	IEC-T9(1-10)/1.27m/5	1.27	Lead	296.00	150	>B
IEC-T09(1-10)	Metals	IEC-T9(1-10)/1.27m/5	1.27	Zinc	2000.0	500	>B
IEC-T09(8-9)	Dioxins & Furans	IEC-T9(8-9) / 1.91/17	1.91	Total I-TEQ with 1/2 RL	1500	1000	>B
IEC-T09(8-9)	Metals	IEC-T9(8-9)/0.4m/13	0.4	Copper	837.00	100	>B
IEC-T09(8-9)	Metals	IEC-T9(8-9)/0.4m/13	0.4	Lead	179.00	150	>B
IEC-T09(8-9)	Metals	IEC-T9(8-9)/0.4m/13	0.4	Nickel	214.00	100	>B
IEC-T09(8-9)	Metals	IEC-T9(8-9)/0.4m/13	0.4	Zinc	1110.0	500	>B
IEC-T09(8-9)	Metals	IEC-T9(8-9)/1.91m/17	1.91	Cadmium	7.38	5	>B
IEC-T09(8-9)	Metals	IEC-T9(8-9)/1.91m/17	1.91	Chromium	984.00	250	>B
IEC-T09(8-9)	Metals	IEC-T9(8-9)/1.91m/17	1.91	Cobalt	328.00	50	>B
IEC-T09(8-9)	Metals	IEC-T9(8-9)/1.91m/17	1.91	Copper	28100.00	100	>B
IEC-T09(8-9)	Metals	IEC-T9(8-9)/1.91m/17	1.91	Lead	2000.00	150	>B
IEC-T09(8-9)	Metals	IEC-T9(8-9)/1.91m/17	1.91	Molybdenum	599.00	40	[illegible]
IEC-T09(8-9)	Metals	IEC-T9(8-9)/1.91m/17	1.91	Nickel	1790.00	100	[illegible]
IEC-T09(8-9)	Metals	IEC-T9(8-9)/1.91m/17	1.91	Tin	107.00	50	>B
IEC-T09(8-9)	Metals	IEC-T9(8-9)/1.91m/17	1.91	Zinc	23400.0	500	>B
IEC-T11(1-2)	Metals	IEC-T11(1-2)/0.9m/11	0.9	Copper	294.00	100	>B
IEC-T11(1-2)	Metals	IEC-T11(1-2)/0.9m/11	0.9	Lead	1060.00	150	>B
IEC-T11(1-2)	Metals	IEC-T11(1-2)/0.9m/11	0.9	Nickel	108.00	100	>B
IEC-T11(1-2)	Metals	IEC-T11(1-2)/0.9m/11	0.9	Zinc	682.0	500	>B
IEC-T11(1-2)	Metals	IEC-T11(1-2)/1.0m/15	1	Copper	408.00	100	>B
IEC-T11(1-2)	Metals	IEC-T11(1-2)/1.1m/7	1.1	Copper	534.00	100	>B
IEC-T11(1-2)	Metals	IEC-T11(1-2)/1.1m/7	1.1	Lead	401.00	150	>B
IEC-T11(1-2)	Metals	IEC-T11(1-2)/1.1m/7	1.1	Zinc	885.0	500	>B
IEC-T11(1-2)	Metals	IEC-T11(1-2)/3.3m/13	3.3	Lead	254.00	150	>B
IEC-T11(3-4)	Metals	IEC-T11(3-4)/1.8m/3	1.8	Arsenic	42.0	30	>B
IEC-T11(3-4)	Metals	IEC-T11(3-4)/1.8m/3	1.8	Cadmium	6.21	5	>B
IEC-T11(3-4)	Metals	IEC-T11(3-4)/1.8m/3	1.8	Chromium	890.00	250	>B
IEC-T11(3-4)	Metals	IEC-T11(3-4)/1.8m/3	1.8	Copper	5300.00	100	>B
IEC-T11(3-4)	Metals	IEC-T11(3-4)/1.8m/3	1.8	Lead	590.00	150	>B
IEC-T11(3-4)	Metals	IEC-T11(3-4)/1.8m/3	1.8	Nickel	280.00	100	>B
IEC-T11(3-4)	Metals	IEC-T11(3-4)/1.8m/3	1.8	Zinc	2870.0	500	>B
IEC-T11(3-4)	Carbon Chain	IEC-T11(3-4)/1.8m/3	1.8	Carbon Chain => C15	1520	1000	>B
IEC-T11(3-4)	Carbon Chain	IEC-T11(3-4)/1.8m/3	1.8	Carbon Chain C6 - C14	102	100	>B
IEC-T12 (1-2)	Dioxins & Furans	IEC-T12 (1-2)/1.6/1	1.6	Total I-TEQ with 1/2 RL	4550	1000	>B
IEC-T12 (1-2)	Dioxins & Furans	IEC-T12 (1-2)/1.8/7	1.8	Total I-TEQ with 1/2 RL	1220	1000	>B
IEC-T12 (9-10)	Dioxins & Furans	IEC-T12 (9-10)/1.80/5	1.8	Total I-TEQ with 1/2 RL	3550	1000	>B
IEC-T12(1-2)	Metals	IEC-T12(1-2)/1.4m/3	1.4	Copper	485.00	100	>B
IEC-T12(1-2)	Metals	IEC-T12(1-2)/1.4m/3	1.4	Lead	168.00	150	>B
IEC-T12(1-2)	Metals	IEC-T12(1-2)/1.6m/1	1.6	Barium	442.00	400	[illegible]

TABLE 6-4
AREA 3 SOIL CONCENTRATIONS EXCEEDING DUTCH 'B' OR RESIDENTAL PRG VALUES
All Units mg/kg

SITE ID	ANALYSIS	SAMPLE ID	DEPTH (m)	PARAMETER	CONCENTRATION	Dutch 'B'/PRG Value	EXCEED
IEC-T12(1-2)	Metals	IEC-T12(1-2)/1.6m/1	1.6	Copper	3220.00	100	>B
IEC-T12(1-2)	Metals	IEC-T12(1-2)/1.6m/1	1.6	Lead	181.00	150	>B
IEC-T12(1-2)	Metals	IEC-T12(1-2)/1.6m/1	1.6	Nickel	123.00	100	>B
IEC-T12(1-2)	Metals	IEC-T12(1-2)/1.8m/7	1.8	Copper	5770.00	100	>B
IEC-T12(1-2)	Metals	IEC-T12(1-2)/1.8m/7	1.8	Lead	307.00	150	>B
IEC-T12(1-2)	Metals	IEC-T12(1-2)/1.8m/7	1.8	Nickel	222.00	100	>B
IEC-T12(1-2)	Metals	IEC-T12(1-2)/1.8m/7	1.8	Zinc	997.0	500	>B
IEC-T12(1-2)	Semi-volatiles	IEC-T12(1-2)/1.8m/7	1.8	Benzo(b)fluoranthene	0.66	0.62	>PRG
IEC-T12(1-2)	Semi-volatiles	IEC-T12(1-2)/1.8m/7	1.8	Benzo(k)fluoranthene	0.66	0.61	>PRG
IEC-T12(1-2)	Semi-volatiles	IEC-T12(1-2)/1.8m/7	1.8	Dibenz(a,h)anthracene	0.169	0.062	>PRG
IEC-T12(1-2)	Semi-volatiles	IEC-T12(1-2)/1.8m/7	1.8	Indeno(1,2,3-cd)pyrene	0.669	0.62	>PRG
IEC-T12(3-4)	Dioxins & Furans	IEC-T12(3-4) /1.8 /5&6	1.8	Total I-TEQ with 1/2 RL	1570	1000	>B
IEC-T12(3-4)	Dioxins & Furans	IEC-T12(3-4) /4.1 /1&2	4.1	Total I-TEQ with 1/2 RL	5060	1000	>B
IEC-T12(3-4)	Metals	IEC-T12(3-4)/2.0m/4	2	Lead	188.00	150	>B
IEC-T12(3-4)	Metals	IEC-T12(3-4)/4.1m/1	4.1	Cadmium	6.47	5	>B
IEC-T12(3-4)	Metals	IEC-T12(3-4)/4.1m/1	4.1	Copper	3240.00	100	>B
IEC-T12(3-4)	Metals	IEC-T12(3-4)/4.1m/1	4.1	Lead	252.00	150	>B
IEC-T12(3-4)	Metals	IEC-T12(3-4)/4.1m/1	4.1	Nickel	105.00	100	>B
IEC-T12(3-4)	Metals	IEC-T12(3-4)/4.1m/1	4.1	Zinc	1330.0	500	>B
IEC-T12(5-6)	Metals	IEC-T12(5-6)/2.5m/1	2.5	Copper	158.00	100	>B
IEC-T12(9-10)	Metals	IEC-T12(9-10)/1.80m/5	1.8	Copper	1900.00	100	>B
IEC-T12(9-10)	Metals	IEC-T12(9-10)/1.80m/5	1.8	Nickel	159.00	100	>B
IEC-T12(9-10)	Metals	IEC-T12(9-10)/1.80m/5	1.8	Zinc	954.0	500	>B
IEC-T13(1-2)	Metals	IEC-T13(1-2)/0.6m/7	0.6	Lead	335.00	150	>B
IEC-T13(1-2)	Metals	IEC-T13(1-2)/1.5m/1	1.5	Zinc	543.0	500	>B
IEC-T13(7-8)	Metals	IEC-T13(7-8)/2.1m/9	2.1	Antimony	101.00	31	>PRG
IEC-T13(7-8)	Metals	IEC-T13(7-8)/2.1m/9	2.1	Zinc	28900.0	500	>B
IEC-T13(7-8)	Metals	IEC-T13(7-8)/2.4m/5	2.4	Arsenic	114.0	30	>B
IEC-T13(7-8)	Metals	IEC-T13(7-8)/2.4m/5	2.4	Barium	619.00	400	>B
IEC-T13(7-8)	Metals	IEC-T13(7-8)/2.4m/5	2.4	Chromium	524.00	250	>B
IEC-T13(7-8)	Metals	IEC-T13(7-8)/2.4m/5	2.4	Copper	619.00	100	>B
IEC-T13(7-8)	Metals	IEC-T13(7-8)/2.4m/5	2.4	Lead	2410.00	150	>B
IEC-T13(7-8)	Metals	IEC-T13(7-8)/2.4m/5	2.4	Nickel	907.00	100	>B
IEC-T13(7-8)	Metals	IEC-T13(7-8)/2.4m/5	2.4	Tin	50.10	50	>B
IEC-T13(7-8)	Metals	IEC-T13(7-8)/2.4m/5	2.4	Zinc	2940.0	500	>B
IEC-T18(3-4)	Metals	IEC-T18(3-4)/1.4m/5	1.4	Copper	2100.00	100	>B
IEC-T18(3-4)	Metals	IEC-T18(3-4)/1.4m/5	1.4	Lead	278.00	150	>B
IEC-T19(1-2)	Metals	IEC-T19(1-2)/1.03m/1	1.03	Copper	7490.00	100	>B
IEC-T19(1-2)	Metals	IEC-T19(1-2)/1.03m/1	1.03	Lead	624.00	150	>B
IEC-T19(1-2)	Metals	IEC-T19(1-2)/1.03m/1	1.03	Nickel	114.00	100	>B
IEC-T19(1-2)	Metals	IEC-T19(1-2)/1.03m/1	1.03	Zinc	2150.0	500	>B
IEC-T19(1-2)	Metals	IEC-T19(1-2)/3.5m/5	3.5	Chromium	1110.00	250	>B
IEC-T19(1-2)	Metals	IEC-T19(1-2)/3.5m/5	3.5	Copper	643.00	100	>B
IEC-T19(1-2)	Metals	IEC-T19(1-2)/3.5m/5	3.5	Lead	215.00	150	>B
IEC-T19(1-2)	Metals	IEC-T19(1-2)/3.5m/5	3.5	Zinc	602.0	500	>B
IEC-T19(3-4)	Metals	IEC-T19(3-4)/1.0m/1	1	Barium	1780.00	400	>B
IEC-T19(3-4)	Metals	IEC-T19(3-4)/1.0m/1	1	Copper	202.00	100	>B
IEC-T19(3-4)	Metals	IEC-T19(3-4)/1.0m/1	1	Lead	825.00	150	>B
IEC-T19(5-6)	Metals	IEC-T19(5-6)/1.1m/1	1.1	Copper	1150.00	100	>B

TABLE 6-4
AREA 3 SOIL CONCENTRATIONS EXCEEDING DUTCH 'B' OR RESIDENTAL PRG VALUES
All Units mg/kg

SITE ID	ANALYSIS	SAMPLE ID	DEPTH (m)	PARAMETER	CONCENTRATION	Dutch 'B'/PRG Value	EXCEED
IEC-T19(5-6)	Metals	IEC-T19(5-6)/1.1m/1	1.1	Lead	685.00	150	>B
IEC-T19(5-6)	Metals	IEC-T19(5-6)/1.1m/1	1.1	Zinc	706.0	500	>B
IEC-T19(5-6)	Metals	IEC-T19(5-6)/1.3m/9	1.3	Copper	388.00	100	>B
IEC-T19(5-6)	Metals	IEC-T19(5-6)/1.9m/5	1.9	Arsenic	36.0	30	>B
IEC-T19(5-6)	Metals	IEC-T19(5-6)/1.9m/5	1.9	Cadmium	8.17	5	>B
IEC-T19(5-6)	Metals	IEC-T19(5-6)/1.9m/5	1.9	Chromium	266.00	250	>B
IEC-T19(5-6)	Metals	IEC-T19(5-6)/1.9m/5	1.9	Copper	4050.00	100	>B
IEC-T19(5-6)	Metals	IEC-T19(5-6)/1.9m/5	1.9	Lead	3110.00	150	>B
IEC-T19(5-6)	Metals	IEC-T19(5-6)/1.9m/5	1.9	Nickel	331.00	100	>B
IEC-T19(5-6)	Metals	IEC-T19(5-6)/1.9m/5	1.9	Tin	67.50	50	>B
IEC-T19(5-6)	Metals	IEC-T19(5-6)/1.9m/5	1.9	Zinc	3910.0	500	>B
IEC-T19(7-8)	Metals	IEC-T19(7-8)/2.4m/7	2.4	Chromium	516.00	250	>B
IEC-T19(7-8)	Metals	IEC-T19(7-8)/2.4m/7	2.4	Copper	6300.00	100	>B
IEC-T19(7-8)	Metals	IEC-T19(7-8)/2.4m/7	2.4	Lead	424.00	150	>B
IEC-T19(7-8)	Metals	IEC-T19(7-8)/2.4m/7	2.4	Nickel	285.00	100	>B
IEC-T19(7-8)	Metals	IEC-T19(7-8)/2.4m/7	2.4	Zinc	2230.0	500	>B
IEC-T20 (7-8)	Dioxins & Furans	IEC-T20 (7-8)/1.0/5	1	Total I-TEQ with 1/2 RL	7570	1000	>B
IEC-T20(1-2)	Dioxins & Furans	IEC-T20(1-2)/1.1/13	1.1	Total I-TEQ with 1/2 RL	5390	1000	>B
IEC-T20(1-2)	Dioxins & Furans	IEC-T20(1-2)/1.3/9	1.3	Total I-TEQ with 1/2 RL	1070	1000	>B
IEC-T20(1-2)	Metals	IEC-T20(1-2)/1.3m/7	1.3	Copper	142.00	100	>B
IEC-T20(1-2)	Metals	IEC-T20(1-2)/1.3m/9	1.3	Barium	3100.00	400	>B
IEC-T20(1-2)	Metals	IEC-T20(1-2)/1.3m/9	1.3	Cobalt	51.40	50	>
IEC-T20(1-2)	Metals	IEC-T20(1-2)/1.3m/9	1.3	Copper	3310.00	100	[illegible]
IEC-T20(1-2)	Metals	IEC-T20(1-2)/1.3m/9	1.3	Lead	860.00	150	>B
IEC-T20(1-2)	Metals	IEC-T20(1-2)/1.3m/9	1.3	Nickel	234.00	100	>B
IEC-T20(1-2)	Metals	IEC-T20(1-2)/1.3m/9	1.3	Zinc	3610.0	500	>B
IEC-T20(1-2)	Dioxins & Furans	IEC-T20(1-2)/1.6/2	1.6	Total I-TEQ with 1/2 RL	1150	1000	>B
IEC-T20(1-2)	Metals	IEC-T20(1-2)/1.6m/5	1.6	Copper	137.00	100	>B
IEC-T20(1-2)	Dioxins & Furans	IEC-T20(1-2)/2.2/11	2.2	Total I-TEQ with 1/2 RL	1470	1000	>B
IEC-T20(1-2)	Metals	IEC-T20(1-2)/2.2m/11	2.2	Barium	1820.00	400	>B
IEC-T20(1-2)	Metals	IEC-T20(1-2)/2.2m/11	2.2	Copper	3450.00	100	>B
IEC-T20(1-2)	Metals	IEC-T20(1-2)/2.2m/11	2.2	Lead	1380.00	150	>B
IEC-T20(1-2)	Metals	IEC-T20(1-2)/2.2m/11	2.2	Nickel	170.00	100	>B
IEC-T20(1-2)	Metals	IEC-T20(1-2)/2.2m/11	2.2	Zinc	1810.0	500	>B
IEC-T20(1-2)	Metals	IEC-T20(1-2)/2.8m/3	2.8	Copper	117.00	100	>B
IEC-T20(3-4)	Metals	IEC-T20(3-4)/2.0m/19	2	Copper	790.00	100	>B
IEC-T20(3-4)	Metals	IEC-T20(3-4)/2.0m/19	2	Lead	689.00	150	>B
IEC-T20(3-4)	Metals	IEC-T20(3-4)/2.0m/19	2	Zinc	559.0	500	>B
IEC-T20(3-4)	Dioxins & Furans	IEC-T20(3-4)/3.8/10	3.8	Total I-TEQ with 1/2 RL	1780	1000	>B
IEC-T20(3-4)	Metals	IEC-T20(3-4)/3.8m/9	3.8	Barium	3520.00	400	>B
IEC-T20(3-4)	Metals	IEC-T20(3-4)/3.8m/9	3.8	Copper	4590.00	100	>B
IEC-T20(3-4)	Metals	IEC-T20(3-4)/3.8m/9	3.8	Lead	1670.00	150	>B
IEC-T20(3-4)	Metals	IEC-T20(3-4)/3.8m/9	3.8	Nickel	262.00	100	>B
IEC-T20(3-4)	Metals	IEC-T20(3-4)/3.8m/9	3.8	Tin	81.10	50	>B
IEC-T20(3-4)	Metals	IEC-T20(3-4)/3.8m/9	3.8	Zinc	2910.0	500	>B
IEC-T20(3-4)	Dioxins & Furans	IEC-T20(3-4)/3.9/6	3.9	Total I-TEQ with 1/2 RL	1880	1000	>B
IEC-T20(3-4)	Metals	IEC-T20(3-4)/3.9m/5	3.9	Barium	4660.00	400	>B
IEC-T20(3-4)	Metals	IEC-T20(3-4)/3.9m/5	3.9	Copper	5470.00	100	>B
IEC-T20(3-4)	Metals	IEC-T20(3-4)/3.9m/5	3.9	Lead	1500.00	150	>

TABLE 6-4
AREA 3 SOIL CONCENTRATIONS EXCEEDING DUTCH 'B' OR RESIDENTAL PRG VALUES
All Units mg/kg

SITE ID	ANALYSIS	SAMPLE ID	DEPTH (m)	PARAMETER	CONCENTRATION	Dutch 'B'/PRG Value	EXCEED
IEC-T20(3-4)	Metals	IEC-T20(3-4)/3.9m/5	3.9	Nickel	352.00	100	>B
IEC-T20(3-4)	Metals	IEC-T20(3-4)/3.9m/5	3.9	Tin	64.60	50	>B
IEC-T20(3-4)	Metals	IEC-T20(3-4)/3.9m/5	3.9	Zinc	3020.0	500	>B
IEC-T20(5-6)	Dioxins & Furans	IEC-T20(5-6)/1.4/10	1.4	Total I-TEQ with 1/2 RL	3460	1000	>B
IEC-T20(5-6)	Metals	IEC-T20(5-6)/1.4m/9	1.4	Barium	2050.00	400	>B
IEC-T20(5-6)	Metals	IEC-T20(5-6)/1.4m/9	1.4	Copper	4470.00	100	>B
IEC-T20(5-6)	Metals	IEC-T20(5-6)/1.4m/9	1.4	Lead	1300.00	150	>B
IEC-T20(5-6)	Metals	IEC-T20(5-6)/1.4m/9	1.4	Nickel	471.00	100	>B
IEC-T20(5-6)	Metals	IEC-T20(5-6)/1.4m/9	1.4	Zinc	2370.0	500	>B
IEC-T20(5-6)	Metals	IEC-T20(5-6)/2.0m/11	2	Lead	227.00	150	>B
IEC-T20(5-6)	Metals	IEC-T20(5-6)/2.0m/13	2	Antimony	340.00	31	>PRG
IEC-T20(5-6)	Metals	IEC-T20(5-6)/2.0m/13	2	Cadmium	118.00	5	>B
IEC-T20(5-6)	Metals	IEC-T20(5-6)/2.0m/13	2	Chromium	412.00	250	>B
IEC-T20(5-6)	Metals	IEC-T20(5-6)/2.0m/13	2	Cobalt	69.00	50	>B
IEC-T20(5-6)	Metals	IEC-T20(5-6)/2.0m/13	2	Copper	14100.00	100	>B
IEC-T20(5-6)	Metals	IEC-T20(5-6)/2.0m/13	2	Lead	21100.00	150	>B
IEC-T20(5-6)	Metals	IEC-T20(5-6)/2.0m/13	2	Nickel	664.00	100	>B
IEC-T20(5-6)	Metals	IEC-T20(5-6)/2.0m/13	2	Tin	3650.00	50	>B
IEC-T20(5-6)	Metals	IEC-T20(5-6)/2.0m/13	2	Zinc	35700.0	500	>B
IEC-T20(5-6)	Semi-volatiles	IEC-T20(5-6)/2.0m/13	2	Bis(2-ethylhexyl)phthalate	563	35	>PRG
IEC-T20(5-6)	Carbon Chain	IEC-T20(5-6)/2.0m/13	2	Carbon Chain => C15	82900	1000	>B
IEC-T20(5-6)	Carbon Chain	IEC-T20(5-6)/2.0m/13	2	Carbon Chain C6 - C14	5580	100	>B
IEC-T20(5-6)	Dioxins & Furans	IEC-T20(5-6)/3.5/1	3.5	Total I-TEQ with 1/2 RL	1460	1000	>B
IEC-T20(5-6)	Metals	IEC-T20(5-6)/3.5m/1	3.5	Copper	233.00	100	>B
IEC-T20(5-6)	Metals	IEC-T20(5-6)/3.5m/1	3.5	Lead	237.00	150	>B
IEC-T20(5-6)	Carbon Chain	IEC-T20(5-6)/3.5m/1	3.5	Carbon Chain => C15	12400	1000	>B
IEC-T20(5-6)	Carbon Chain	IEC-T20(5-6)/3.5m/1	3.5	Carbon Chain C6 - C14	2710	100	>B
IEC-T20(7-8)	Metals	IEC-T20(7-8)/2.0m/5	2	Chromium	798.00	250	>B
IEC-T20(7-8)	Metals	IEC-T20(7-8)/2.0m/5	2	Copper	780.00	100	>B
IEC-T20(7-8)	Metals	IEC-T20(7-8)/2.0m/5	2	Lead	418.00	150	>B
IEC-T20(7-8)	Metals	IEC-T20(7-8)/2.0m/5	2	Nickel	706.00	100	>B
IEC-T20(7-8)	Metals	IEC-T20(7-8)/2.0m/5	2	Zinc	509.0	500	>B
IEC-T20(7-8)	Metals	IEC-T20(7-8)/4.5m/1	4.5	Chromium	5390.00	250	>B
IEC-T20(7-8)	Metals	IEC-T20(7-8)/4.5m/1	4.5	Copper	4080.00	100	>B
IEC-T20(7-8)	Metals	IEC-T20(7-8)/4.5m/1	4.5	Hexavalent Chromium	30.4	30	>PRG
IEC-T20(7-8)	Metals	IEC-T20(7-8)/4.5m/1	4.5	Lead	867.00	150	>B
IEC-T20(7-8)	Metals	IEC-T20(7-8)/4.5m/1	4.5	Nickel	108.00	100	>B
IEC-T20(7-8)	Metals	IEC-T20(7-8)/4.5m/1	4.5	Zinc	1690.0	500	>B
IEC-T20(9-10)	Metals	IEC-T20(9-10)/1.0m/5	1	Antimony	35.50	31	>PRG
IEC-T20(9-10)	Metals	IEC-T20(9-10)/1.0m/5	1	Barium	1180.00	400	>B
IEC-T20(9-10)	Metals	IEC-T20(9-10)/1.0m/5	1	Chromium	703.00	250	>B
IEC-T20(9-10)	Metals	IEC-T20(9-10)/1.0m/5	1	Cobalt	59.00	50	>B
IEC-T20(9-10)	Metals	IEC-T20(9-10)/1.0m/5	1	Copper	3960.00	100	>B
IEC-T20(9-10)	Metals	IEC-T20(9-10)/1.0m/5	1	Lead	1140.00	150	>B
IEC-T20(9-10)	Metals	IEC-T20(9-10)/1.0m/5	1	Molybdenum	56.60	40	>B
IEC-T20(9-10)	Metals	IEC-T20(9-10)/1.0m/5	1	Nickel	906.00	100	>B
IEC-T20(9-10)	Metals	IEC-T20(9-10)/1.0m/5	1	Tin	50.60	50	>B
IEC-T20(9-10)	Metals	IEC-T20(9-10)/1.0m/5	1	Zinc	3590.0	500	>B
IEC-T20(9-10)	Metals	IEC-T20(9-10)/1.5m/3	1.5	Lead	170.00	150	>B

TABLE 6-4
AREA 3 SOIL CONCENTRATIONS EXCEEDING DUTCH 'B' OR RESIDENTAL PRG VALUES
All Units mg/kg

SITE ID	ANALYSIS	SAMPLE ID	DEPTH (m)	PARAMETER	CONCENTRATION	Dutch 'B'/PRG Value	EXCEED
IEC-T20(9-10)	Metals	IEC-T20(9-10)/2.6m/7	2.6	Copper	259.00	100	>B
IEC-T21(1-2)	Metals	IEC-T21(1-2)/1.0m/5	1	Copper	110.00	100	>B
IEC-T21(1-2)	Dioxins & Furans	IEC-T21(1-2)/1.4/14	1.4	Total I-TEQ with 1/2 RL	14100	1000	>B
IEC-T21(1-2)	Metals	IEC-T21(1-2)/1.4m/1	1.4	Copper	789.00	100	>B
IEC-T21(1-2)	Metals	IEC-T21(1-2)/1.4m/1	1.4	Lead	160.00	150	>B
IEC-T21(1-2)	Metals	IEC-T21(1-2)/1.4m/13	1.4	Copper	10300.00	100	>B
IEC-T21(1-2)	Metals	IEC-T21(1-2)/1.4m/13	1.4	Lead	182.00	150	>B
IEC-T21(1-2)	Metals	IEC-T21(1-2)/1.4m/13	1.4	Nickel	767.00	100	>B
IEC-T21(1-2)	Metals	IEC-T21(1-2)/1.4m/13	1.4	Zinc	2190.0	500	>B
IEC-T21(1-2)	Dioxins & Furans	IEC-T21(1-2)/2.6/16	2.6	Total I-TEQ with 1/2 RL	1210	1000	>B
IEC-T21(1-2)	Metals	IEC-T21(1-2)/2.6m/15	2.6	Barium	1690.00	400	>B
IEC-T21(1-2)	Metals	IEC-T21(1-2)/2.6m/15	2.6	Chromium	266.00	250	>B
IEC-T21(1-2)	Metals	IEC-T21(1-2)/2.6m/15	2.6	Cobalt	65.10	50	>B
IEC-T21(1-2)	Metals	IEC-T21(1-2)/2.6m/15	2.6	Copper	3420.00	100	>B
IEC-T21(1-2)	Metals	IEC-T21(1-2)/2.6m/15	2.6	Lead	256.00	150	>B
IEC-T21(1-2)	Metals	IEC-T21(1-2)/2.6m/15	2.6	Nickel	337.00	100	>B
IEC-T21(1-2)	Metals	IEC-T21(1-2)/2.6m/15	2.6	Tin	55.00	50	>B
IEC-T21(1-2)	Metals	IEC-T21(1-2)/2.6m/15	2.6	Zinc	1700.0	500	>B
IEC-T21(1-2)	Metals	IEC-T21(1-2)/2.9m/3	2.9	Barium	617.00	400	>B
IEC-T21(1-2)	Metals	IEC-T21(1-2)/2.9m/3	2.9	Copper	490.00	100	>B
IEC-T21(1-2)	Metals	IEC-T21(1-2)/2.9m/3	2.9	Lead	193.00	150	>B
IEC-T21(1-2)	Metals	IEC-T21(1-2)/2.9m/3	2.9	Nickel	215.00	100	>[illegible]
IEC-T21(1-2)	Metals	IEC-T21(1-2)/2.9m/3	2.9	Tin	169.00	50	[illegible]
IEC-T21(3-4)	Dioxins & Furans	IEC-T21(3-4)/1.4/7	1.4	Total I-TEQ with 1/2 RL	23600	1000	>B
IEC-T21(3-4)	Metals	IEC-T21(3-4)/1.4m/7	1.4	Copper	3430.00	100	>B
IEC-T21(3-4)	Metals	IEC-T21(3-4)/1.4m/7	1.4	Lead	583.00	150	>B
IEC-T21(3-4)	Metals	IEC-T21(3-4)/1.4m/7	1.4	Nickel	286.00	100	>B
IEC-T21(3-4)	Metals	IEC-T21(3-4)/1.4m/7	1.4	Zinc	2140.0	500	>B
IEC-T21(3-4)	Dioxins & Furans	IEC-T21(3-4)/1.5/1	1.5	Total I-TEQ with 1/2 RL	1470	1000	>B
IEC-T21(3-4)	Metals	IEC-T21(3-4)/1.5m/1	1.5	Arsenic	36.0	30	>B
IEC-T21(3-4)	Metals	IEC-T21(3-4)/1.5m/1	1.5	Barium	431.00	400	>B
IEC-T21(3-4)	Metals	IEC-T21(3-4)/1.5m/1	1.5	Chromium	252.00	250	>B
IEC-T21(3-4)	Metals	IEC-T21(3-4)/1.5m/1	1.5	Copper	3590.00	100	>B
IEC-T21(3-4)	Metals	IEC-T21(3-4)/1.5m/1	1.5	Lead	751.00	150	>B
IEC-T21(3-4)	Metals	IEC-T21(3-4)/1.5m/1	1.5	Nickel	411.00	100	>B
IEC-T21(3-4)	Metals	IEC-T21(3-4)/1.5m/1	1.5	Zinc	919.0	500	>B
IEC-T21(3-4)	Metals	IEC-T21(3-4)/1.6m/5	1.6	Lead	183.00	150	>B
IEC-T21(3-4)	Dioxins & Furans	IEC-T21(3-4)/2.6/3	2.6	Total I-TEQ with 1/2 RL	2950	1000	>B
IEC-T21(3-4)	Metals	IEC-T21(3-4)/2.6m/3	2.6	Copper	5230.00	100	>B
IEC-T21(3-4)	Metals	IEC-T21(3-4)/2.6m/3	2.6	Lead	241.00	150	>B
IEC-T21(3-4)	Metals	IEC-T21(3-4)/2.6m/3	2.6	Nickel	269.00	100	>B
IEC-T21(3-4)	Metals	IEC-T21(3-4)/2.6m/3	2.6	Zinc	782.0	500	>B
IEC-T21(9-10)	Metals	IEC-T21(9-10)/3.0m/5	3	Copper	315.00	100	>B
IEC-T21(9-10)	Metals	IEC-T21(9-10)/3.0m/5	3	Nickel	155.00	100	>B
IEC-T21(9-10)	Metals	IEC-T21(9-10)/3.0m/5	3	Zinc	3180.0	500	>B
IEC-T21(9-10)	Semi-volatiles	IEC-T21(9-10)/3.0m/5	3	Dibenz(a,h)anthracene	0.092	0.062	>PRG
IEC-T22(1-2)	Metals	IEC-T22(1-2)/1.1m/13	1.1	Barium	4330.00	400	>B
IEC-T22(1-2)	Metals	IEC-T22(1-2)/1.1m/13	1.1	Cobalt	63.30	50	>B
IEC-T22(1-2)	Metals	IEC-T22(1-2)/1.1m/13	1.1	Copper	4830.00	100	>B

TABLE 6-4
AREA 3 SOIL CONCENTRATIONS EXCEEDING DUTCH 'B' OR RESIDENTAL PRG VALUES
All Units mg/kg

SITE ID	ANALYSIS	SAMPLE ID	DEPTH (m)	PARAMETER	CONCENTRATION	Dutch 'B'/PRG Value	EXCEED
IEC-T22(1-2)	Metals	IEC-T22(1-2)/1.1m/13	1.1	Lead	6580.00	150	>B
IEC-T22(1-2)	Metals	IEC-T22(1-2)/1.1m/13	1.1	Nickel	295.00	100	>B
IEC-T22(1-2)	Metals	IEC-T22(1-2)/1.1m/13	1.1	Tin	51.70	50	>B
IEC-T22(1-2)	Metals	IEC-T22(1-2)/1.1m/13	1.1	Zinc	3350.0	500	>B
IEC-T22(1-2)	Metals	IEC-T22(1-2)/1.4m/5	1.4	Copper	863.00	100	>B
IEC-T22(1-2)	Metals	IEC-T22(1-2)/1.4m/5	1.4	Lead	162.00	150	>B
IEC-T22(1-2)	Metals	IEC-T22(1-2)/1.4m/5	1.4	Zinc	730.0	500	>B
IEC-T22(1-2)	Metals	IEC-T22(1-2)/1.5m/15	1.5	Copper	137.00	100	>B
IEC-T22(1-2)	Metals	IEC-T22(1-2)/1.5m/15	1.5	Tin	51.00	50	>B
IEC-T22(1-2)	Metals	IEC-T22(1-2)/2.3m/1	2.3	Copper	274.00	100	>B
IEC-T22(1-2)	Metals	IEC-T22(1-2)/2.3m/1	2.3	Lead	3340.00	150	>B
IEC-T22(1-2)	Metals	IEC-T22(1-2)/2.9m/7	2.9	Copper	361.00	100	>B
IEC-T22(4-3)	Metals	IEC-T22(4-3)/1.1m/5	1.1	Copper	1210.00	100	>B
IEC-T22(4-3)	Metals	IEC-T22(4-3)/1.1m/5	1.1	Lead	174.00	150	>B
IEC-T22(4-3)	Metals	IEC-T22(4-3)/1.1m/5	1.1	Zinc	803.0	500	>B
IEC-T22(4-3)	Metals	IEC-T22(4-3)/1.5m/1	1.5	Arsenic	37.9	30	>B
IEC-T22(4-3)	Metals	IEC-T22(4-3)/1.5m/1	1.5	Barium	401.00	400	>B
IEC-T22(4-3)	Metals	IEC-T22(4-3)/1.5m/1	1.5	Cadmium	6.70	5	>B
IEC-T22(4-3)	Metals	IEC-T22(4-3)/1.5m/1	1.5	Chromium	299.00	250	>B
IEC-T22(4-3)	Metals	IEC-T22(4-3)/1.5m/1	1.5	Copper	4950.00	100	>B
IEC-T22(4-3)	Metals	IEC-T22(4-3)/1.5m/1	1.5	Lead	5060.00	150	>B
IEC-T22(4-3)	Metals	IEC-T22(4-3)/1.5m/1	1.5	Nickel	299.00	100	>B
IEC-T22(4-3)	Metals	IEC-T22(4-3)/1.5m/1	1.5	Tin	90.20	50	>B
IEC-T22(4-3)	Metals	IEC-T22(4-3)/1.5m/1	1.5	Zinc	4230.0	500	>B
IEC-T22(4-3)	Carbon Chain	IEC-T22(4-3)/3.8m/3	3.8	Carbon Chain => C15	1620	1000	>B
IEC-T22(6-5)	Metals	IEC-T22(6-5)/1.2m/11	1.2	Copper	908.00	100	>B
IEC-T22(6-5)	Metals	IEC-T22(6-5)/1.2m/11	1.2	Lead	170.00	150	>B
IEC-T22(6-5)	Metals	IEC-T22(6-5)/1.2m/11	1.2	Zinc	640.0	500	>B
IEC-T22(6-5)	Carbon Chain	IEC-T22(6-5)/1.2m/11	1.2	Carbon Chain => C15	1340	1000	>B
IEC-T22(6-5)	Metals	IEC-T22(6-5)/1.4m/5	1.4	Antimony	35.20	31	>PRG
IEC-T22(6-5)	Metals	IEC-T22(6-5)/1.4m/5	1.4	Chromium	284.00	250	>B
IEC-T22(6-5)	Metals	IEC-T22(6-5)/1.4m/5	1.4	Copper	876.00	100	>B
IEC-T22(6-5)	Metals	IEC-T22(6-5)/1.4m/5	1.4	Lead	168.00	150	>B
IEC-T22(6-5)	Metals	IEC-T22(6-5)/1.4m/5	1.4	Molybdenum	353.00	40	>B
IEC-T22(6-5)	Metals	IEC-T22(6-5)/1.4m/5	1.4	Nickel	726.00	100	>B
IEC-T22(6-5)	Metals	IEC-T22(6-5)/1.4m/5	1.4	Zinc	2900.0	500	>B
IEC-T22(6-5)	Metals	IEC-T22(6-5)/2.9m/7	2.9	Barium	554.00	400	>B
IEC-T22(6-5)	Metals	IEC-T22(6-5)/2.9m/7	2.9	Chromium	1520.00	250	>B
IEC-T22(6-5)	Metals	IEC-T22(6-5)/2.9m/7	2.9	Cobalt	62.10	50	>B
IEC-T22(6-5)	Metals	IEC-T22(6-5)/2.9m/7	2.9	Copper	5670.00	100	>B
IEC-T22(6-5)	Metals	IEC-T22(6-5)/2.9m/7	2.9	Lead	8460.00	150	>B
IEC-T22(6-5)	Metals	IEC-T22(6-5)/2.9m/7	2.9	Molybdenum	84.20	40	>B
IEC-T22(6-5)	Metals	IEC-T22(6-5)/2.9m/7	2.9	Nickel	1450.00	100	>B
IEC-T22(6-5)	Metals	IEC-T22(6-5)/2.9m/7	2.9	Zinc	4470.0	500	>B
IEC-T22(7-8)	Dioxins & Furans	IEC-T22(7-8)/1.4/1	1.4	Total I-TEQ with 1/2 RL	6270	1000	>B
IEC-T22(7-8)	Metals	IEC-T22(7-8)/1.4m/1	1.4	Barium	862.00	400	>B
IEC-T22(7-8)	Metals	IEC-T22(7-8)/1.4m/1	1.4	Copper	14900.00	100	>B
IEC-T22(7-8)	Metals	IEC-T22(7-8)/1.4m/1	1.4	Lead	1450.00	150	>B
IEC-T22(7-8)	Metals	IEC-T22(7-8)/1.4m/1	1.4	Nickel	162.00	100	>B

TABLE 6-4
AREA 3 SOIL CONCENTRATIONS EXCEEDING DUTCH 'B' OR RESIDENTAL PRG VALUES
All Units mg/kg

SITE ID	ANALYSIS	SAMPLE ID	DEPTH (m)	PARAMETER	CONCENTRATION	Dutch 'B'/PRG Value	EXCEED
IEC-T22(7-8)	Metals	IEC-T22(7-8)/1.4m/1	1.4	Zinc	3170.0	500	>B
IEC-T22(7-8)	Metals	IEC-T22(7-8)/1.4m/5	1.4	Cobalt	108.00	50	>B
IEC-T22(7-8)	Metals	IEC-T22(7-8)/1.4m/5	1.4	Copper	4230.00	100	>B
IEC-T22(7-8)	Metals	IEC-T22(7-8)/1.4m/5	1.4	Lead	856.00	150	>B
IEC-T22(7-8)	Metals	IEC-T22(7-8)/1.4m/5	1.4	Nickel	197.00	100	>B
IEC-T22(7-8)	Metals	IEC-T22(7-8)/1.4m/5	1.4	Tin	55.50	50	>B
IEC-T22(7-8)	Metals	IEC-T22(7-8)/1.4m/5	1.4	Zinc	4930.0	500	>B
IEC-T22(7-8)	Metals	IEC-T22(7-8)/2.8m/3	2.8	Barium	452.00	400	>B
IEC-T22(7-8)	Metals	IEC-T22(7-8)/2.8m/3	2.8	Copper	3670.00	100	>B
IEC-T22(7-8)	Metals	IEC-T22(7-8)/2.8m/3	2.8	Lead	402.00	150	>B
IEC-T22(7-8)	Metals	IEC-T22(7-8)/2.8m/3	2.8	Tin	56.50	50	>B
IEC-T25(1-2)	Metals	IEC-T25(1-2)/1.4m/3	1.4	Barium	486.00	400	>B
IEC-T25(1-2)	Metals	IEC-T25(1-2)/1.4m/3	1.4	Lead	155.00	150	>B
IEC-T26(1-2)	Metals	IEC-T26(1-2)/0.7m/9	0.7	Lead	182.00	150	>B
IEC-T26(3-4)	Metals	IEC-T26(3-4)/0.55m/7	0.55	Copper	207.00	100	>B
IEC-T26(3-4)	Metals	IEC-T26(3-4)/0.9m/3	0.9	Copper	173.00	100	>B
IEC-T26(3-4)	Metals	IEC-T26(3-4)/0.9m/3	0.9	Lead	178.00	150	>B
IEC-T29(3-4)	Metals	IEC-T29(3-4)/1.4m/1	1.4	Chromium	2740.00	250	>B
IEC-T29(3-4)	Metals	IEC-T29(3-4)/1.4m/1	1.4	Cobalt	57.60	50	>B
IEC-T29(3-4)	Metals	IEC-T29(3-4)/1.4m/1	1.4	Copper	3310.00	100	>B
IEC-T29(3-4)	Metals	IEC-T29(3-4)/1.4m/1	1.4	Lead	174.00	150	>B
IEC-T29(3-4)	Metals	IEC-T29(3-4)/1.4m/1	1.4	Nickel	1210.00	100	>r
IEC-T29(3-4)	Metals	IEC-T29(3-4)/1.4m/1	1.4	Zinc	1050.0	500	(
IEC-T3(2-3)	Metals	IEC-T3(2-3)/0.65m/1	0.65	Barium	2220.00	400	>B
IEC-T3(2-3)	Metals	IEC-T3(2-3)/0.65m/1	0.65	Cadmium	5.50	5	>B
IEC-T3(2-3)	Metals	IEC-T3(2-3)/0.65m/1	0.65	Chromium	1670.00	250	>B
IEC-T3(2-3)	Metals	IEC-T3(2-3)/0.65m/1	0.65	Cobalt	134.00	50	>B
IEC-T3(2-3)	Metals	IEC-T3(2-3)/0.65m/1	0.65	Copper	10100.00	100	>B
IEC-T3(2-3)	Metals	IEC-T3(2-3)/0.65m/1	0.65	Lead	2420.00	150	>B
IEC-T3(2-3)	Metals	IEC-T3(2-3)/0.65m/1	0.65	Molybdenum	46.00	40	>B
IEC-T3(2-3)	Metals	IEC-T3(2-3)/0.65m/1	0.65	Nickel	1380.00	100	>B
IEC-T3(2-3)	Metals	IEC-T3(2-3)/0.65m/1	0.65	Tin	92.70	50	>B
IEC-T3(2-3)	Metals	IEC-T3(2-3)/0.65m/1	0.65	Zinc	8800.0	500	>B
IEC-T30(2-1)	Metals	IEC-T30(2-1)/1.2m/9	1.2	Chromium	343.00	250	>B
IEC-T30(2-1)	Metals	IEC-T30(2-1)/1.2m/9	1.2	Copper	3190.00	100	>B
IEC-T30(2-1)	Metals	IEC-T30(2-1)/1.2m/9	1.2	Lead	2760.00	150	>B
IEC-T30(2-1)	Metals	IEC-T30(2-1)/1.2m/9	1.2	Nickel	368.00	100	>B
IEC-T30(2-1)	Metals	IEC-T30(2-1)/1.2m/9	1.2	Zinc	3390.0	500	>B
IEC-T30(2-1)	Semi-volatiles	IEC-T30(2-1)/1.2m/9	1.2	Dibenz(a,h)anthracene	0.085	0.062	>PRG
IEC-T30(2-1)	Metals	IEC-T30(2-1)/2.3m/11	2.3	Copper	2300.00	100	>B
IEC-T30(3-4)	Carbon Chain	IEC-T30(3-4)/0.6m/7	0.6	Carbon Chain => C15	3500	1000	>B
IEC-T30(3-4)	Carbon Chain	IEC-T30(3-4)/0.6m/7	0.6	Carbon Chain C6 - C14	320	100	>B
IEC-T31(1-2)	Carbon Chain	IEC-T31(1-2)/0.2m/1	0.2	Carbon Chain => C15	2010	1000	>B
IEC-T33(3-4)	Metals	IEC-T33(3-4)/1.8m/5	1.8	Copper	2300.00	100	>B
IEC-T33(3-4)	Metals	IEC-T33(3-4)/1.8m/5	1.8	Zinc	1210.0	500	>B
IEC-T33(3-4)	Carbon Chain	IEC-T33(3-4)/4.6m/1	4.6	Carbon Chain => C15	3800	1000	>B
IEC-T33(3-4)	Carbon Chain	IEC-T33(3-4)/4.6m/1	4.6	Carbon Chain C6 - C14	670	100	>B
IEC-T35(2-1)	Dioxins & Furans	IEC-T35(2-1)/1.2/6	1.2	Total I-TEQ with 1/2 RL	7950	1000	>B
IEC-T35(2-1)	Metals	IEC-T35(2-1)/1.2m/5	1.2	Cadmium	12.00	5	>P

TABLE 6-4
AREA 3 SOIL CONCENTRATIONS EXCEEDING DUTCH 'B' OR RESIDENTAL PRG VALUES
All Units mg/kg

SITE ID	ANALYSIS	SAMPLE ID	DEPTH (m)	PARAMETER	CONCENTRATION	Dutch 'B'/PRG Value	EXCEED
IEC-T35(2-1)	Metals	IEC-T35(2-1)/1.2m/5	1.2	Cobalt	132.00	50	>B
IEC-T35(2-1)	Metals	IEC-T35(2-1)/1.2m/5	1.2	Copper	3020.00	100	>B
IEC-T35(2-1)	Metals	IEC-T35(2-1)/1.2m/5	1.2	Lead	834.00	150	>B
IEC-T35(2-1)	Metals	IEC-T35(2-1)/1.2m/5	1.2	Nickel	107.00	100	>B
IEC-T35(2-1)	Metals	IEC-T35(2-1)/1.2m/5	1.2	Zinc	3170.0	500	>B
IEC-T35(2-1)	Metals	IEC-T35(2-1)/2.5m/9	2.5	Chromium	269.00	250	>B
IEC-T35(2-1)	Metals	IEC-T35(2-1)/2.5m/9	2.5	Copper	4700.00	100	>B
IEC-T35(2-1)	Metals	IEC-T35(2-1)/2.5m/9	2.5	Lead	491.00	150	>B
IEC-T35(2-1)	Metals	IEC-T35(2-1)/2.5m/9	2.5	Nickel	245.00	100	>B
IEC-T35(2-1)	Metals	IEC-T35(2-1)/2.5m/9	2.5	Zinc	4300.0	500	>B
IEC-T35(5-6)	Metals	IEC-T35(5-6)/1.1m/1	1.1	Copper	903.00	100	>B
IEC-T35(5-6)	Metals	IEC-T35(5-6)/1.1m/1	1.1	Lead	269.00	150	>B
IEC-T35(5-6)	Metals	IEC-T35(5-6)/1.1m/1	1.1	Nickel	177.00	100	>B
IEC-T35(5-6)	Metals	IEC-T35(5-6)/1.1m/1	1.1	Zinc	1560.0	500	>B
IEC-T36(1-2)	Metals	IEC-T36(1-2)/0.6m/5	0.6	Lead	151.00	150	>B
IEC-T36(1-2)	Metals	IEC-T36(1-2)/2.0m/11	2	Cadmium	5.89	5	>B
IEC-T36(1-2)	Metals	IEC-T36(1-2)/2.0m/11	2	Chromium	793.00	250	>B
IEC-T36(1-2)	Metals	IEC-T36(1-2)/2.0m/11	2	Copper	2660.00	100	>B
IEC-T36(1-2)	Metals	IEC-T36(1-2)/2.0m/11	2	Lead	6090.00	150	>B
IEC-T36(1-2)	Metals	IEC-T36(1-2)/2.0m/11	2	Nickel	1590.00	100	>B
IEC-T36(1-2)	Metals	IEC-T36(1-2)/2.0m/11	2	Tin	175.00	50	>B
IEC-T36(1-2)	Metals	IEC-T36(1-2)/2.0m/11	2	Zinc	6290.0	500	>B
IEC-T36(11-12)	Metals	IEC-T36(11-12)/3.1m/1	3.1	Chromium	615.00	250	>B
IEC-T36(11-12)	Metals	IEC-T36(11-12)/3.1m/1	3.1	Cobalt	103.00	50	>B
IEC-T36(11-12)	Metals	IEC-T36(11-12)/3.1m/1	3.1	Copper	5410.00	100	>B
IEC-T36(11-12)	Metals	IEC-T36(11-12)/3.1m/1	3.1	Lead	898.00	150	>B
IEC-T36(11-12)	Metals	IEC-T36(11-12)/3.1m/1	3.1	Nickel	803.00	100	>B
IEC-T36(11-12)	Metals	IEC-T36(11-12)/3.1m/1	3.1	Tin	113.00	50	>B
IEC-T36(11-12)	Metals	IEC-T36(11-12)/3.1m/1	3.1	Zinc	3440.0	500	>B
IEC-T36(11-12)	Metals	IEC-T36(11-12)/4.0m/3	4	Copper	257.00	100	>B
IEC-T36(11-12)	Metals	IEC-T36(11-12)/4.0m/3	4	Lead	255.00	150	>B
IEC-T36(7-8)	Metals	IEC-T36(7-8)/0.9m/1	0.9	Copper	2970.00	100	>B
IEC-T36(7-8)	Metals	IEC-T36(7-8)/0.9m/1	0.9	Lead	274.00	150	>B
IEC-T36(7-8)	Metals	IEC-T36(7-8)/0.9m/1	0.9	Zinc	3070.0	500	>B
IEC-T36(9-10)	Metals	IEC-T36(9-10)/1.8m/5	1.8	Cobalt	88.80	50	>B
IEC-T36(9-10)	Metals	IEC-T36(9-10)/1.8m/5	1.8	Copper	3250.00	100	>B
IEC-T36(9-10)	Metals	IEC-T36(9-10)/1.8m/5	1.8	Lead	1320.00	150	>B
IEC-T36(9-10)	Metals	IEC-T36(9-10)/1.8m/5	1.8	Nickel	405.00	100	>B
IEC-T36(9-10)	Metals	IEC-T36(9-10)/1.8m/5	1.8	Zinc	1790.0	500	>B
IEC-T37(1-2)	Metals	IEC-T37(1-2)/0.6m/13	0.6	Copper	887.00	100	>B
IEC-T37(1-2)	Metals	IEC-T37(1-2)/1.0m/9	1	Copper	116.00	100	>B
IEC-T37(1-2)	Metals	IEC-T37(1-2)/1.5m/7	1.5	Barium	1480.00	400	>B
IEC-T37(1-2)	Metals	IEC-T37(1-2)/1.5m/7	1.5	Copper	2650.00	100	>B
IEC-T37(1-2)	Metals	IEC-T37(1-2)/1.5m/7	1.5	Lead	4080.00	150	>B
IEC-T37(1-2)	Metals	IEC-T37(1-2)/1.5m/7	1.5	Nickel	188.00	100	>B
IEC-T37(1-2)	Metals	IEC-T37(1-2)/1.5m/7	1.5	Zinc	7840.0	500	>B
IEC-T37(1-2)	Metals	IEC-T37(1-2)/2.9m/11	2.9	Barium	986.00	400	>B
IEC-T37(1-2)	Metals	IEC-T37(1-2)/2.9m/11	2.9	Copper	2970.00	100	>B
IEC-T37(1-2)	Metals	IEC-T37(1-2)/2.9m/11	2.9	Lead	921.00	150	>B

TABLE 6-4
AREA 3 SOIL CONCENTRATIONS EXCEEDING DUTCH 'B' OR RESIDENTAL PRG VALUES
All Units mg/kg

SITE ID	ANALYSIS	SAMPLE ID	DEPTH (m)	PARAMETER	CONCENTRATION	Dutch 'B'/PRG Value	EXCEED
IEC-T37(1-2)	Metals	IEC-T37(1-2)/2.9m/11	2.9	Nickel	171.00	100	>B
IEC-T37(1-2)	Metals	IEC-T37(1-2)/2.9m/11	2.9	Tin	71.30	50	>B
IEC-T37(1-2)	Metals	IEC-T37(1-2)/2.9m/11	2.9	Zinc	2060.0	500	>B
IEC-T37(1-2)	Metals	IEC-T37(1-2)/3.3m/15	3.3	Copper	117.00	100	>B
IEC-T37(12-11)	Metals	IEC-T37(12-11)/3.4m/3	3.4	Lead	158.00	150	>B
IEC-T37(3-4)	Metals	IEC-T37(3-4)/0.6m/1	0.6	Lead	213.00	150	>B
IEC-T37(3-4)	Metals	IEC-T37(3-4)/2.4m/3	2.4	Copper	337.00	100	>B
IEC-T37(6-5)	Dioxins & Furans	IEC-T37(6-5)/0.8/6	0.8	Total I-TEQ with 1/2 RL	109000	1000	>B
IEC-T37(6-5)	Metals	IEC-T37(6-5)/0.8m/5	0.8	Barium	2220.00	400	>B
IEC-T37(6-5)	Metals	IEC-T37(6-5)/0.8m/5	0.8	Copper	6050.00	100	>B
IEC-T37(6-5)	Metals	IEC-T37(6-5)/0.8m/5	0.8	Lead	599.00	150	>B
IEC-T37(6-5)	Metals	IEC-T37(6-5)/0.8m/5	0.8	Nickel	191.00	100	>B
IEC-T37(6-5)	Metals	IEC-T37(6-5)/0.8m/5	0.8	Zinc	1330.0	500	>B
IEC-T37(6-5)	Carbon Chain	IEC-T37(6-5)/0.8m/5	0.8	Carbon Chain => C15	6970	1000	>B
IEC-T37(6-5)	Carbon Chain	IEC-T37(6-5)/0.8m/5	0.8	Carbon Chain C6 - C14	1690	100	>B
IEC-T37(8-7)	Dioxins & Furans	IEC-T37(8-7)/0.7/2	0.7	Total I-TEQ with 1/2 RL	3130	1000	>B
IEC-T37(8-7)	Metals	IEC-T37(8-7)/1.3m/5	1.3	Chromium	305.00	250	>B
IEC-T37(8-7)	Metals	IEC-T37(8-7)/1.3m/5	1.3	Copper	5360.00	100	>B
IEC-T37(8-7)	Metals	IEC-T37(8-7)/1.3m/5	1.3	Lead	658.00	150	>B
IEC-T37(8-7)	Metals	IEC-T37(8-7)/1.3m/5	1.3	Nickel	519.00	100	>B
IEC-T37(8-7)	Metals	IEC-T37(8-7)/1.3m/5	1.3	Zinc	1750.0	500	>B
IEC-T37(8-7)	Metals	IEC-T37(8-7)/2.8m/7	2.8	Copper	245.00	100	>
IEC-T4(4-5)	Metals	IEC-T4(4-5)/3.4m/1	3.4	Lead	158.00	150	[illegible]

TABLE 6-5
GROUNDWATER CONCENTRATIONS EXCEEDING DUTCH VALUES
All Units ug/L

ANALYSIS	Site ID	SAMPLE ID	PARAMETER	CONCENTRATION	Dutch 'B' Value	Dutch 'C' Value	EXCEED
Dioxins & Furans	AW-23	AW23 AFTERPURGE	Total Hexa CDD	0.000046	Detected		>B
Dioxins & Furans	AW-11	AW11 AFTER PURGE	Total Penta CDD	0.000035	Detected		>B
Dioxins & Furans	AW-23	AW23 AFTERPURGE	Total Penta CDD	0.00003	Detected		>B
Dioxins & Furans	AW-11	AW11 AFTER PURGE	Total Penta CDF	0.000042	Detected		>B
Dioxins & Furans	AW-23	AW23 AFTERPURGE	Total Penta CDF	0.000027	Detected		>B
Dioxins & Furans	AW-11	AW11 AFTER PURGE	Total Tetra CDD	0.000039	Detected		>B
Dioxins & Furans	AW-23	AW23 AFTERPURGE	Total Tetra CDD	0.000011	Detected		>B
Dioxins & Furans	AW-11	AW11 AFTER PURGE	Total Tetra CDF	0.000042	Detected		>B
General Minerals	AW-11	AW11 afterpurge	Ammonia	1550	1000	3000	>B
General Minerals	MW-OB02	MW OB2 After Purge	Ammonia	9100	1000	3000	>C
General Minerals	MW-OB02	MW/OB2 After purge	Ammonia	6760	1000	3000	>C
General Minerals	MW-OB13	MW OB13 After Purge	Ammonia	1280	1000	3000	>B
General Minerals	MW-S08	MW S8 After purge	Ammonia	1460	1000	3000	>B
General Minerals	MW-U2A	MW U2A After Purge	Ammonia	1460	1000	3000	>B
Metals	AW-02	AW2 afterpurge	Barium	146	100	500	>B
Metals	AW-12	AW12 afterpurge	Barium	233	100	500	>B
Metals	AW-16A	AW16A Afterpurge	Barium	101	100	500	>B
Metals	MW-B34	MW B34 After Purge	Barium	219	100	500	>B
Metals	MW-B34	MW-B34 After purge	Barium	261	100	500	>B
Metals	MW-C02	MW-C2 After purge	Barium	108	100	500	>B
Metals	MW-D06	MW-D6 After purge	Barium	130	100	500	>B
Metals	MW-J07	MW-J7 After purge	Barium	106	100	500	>B
Metals	MW-OB05	MW OB5 After Purge	Barium	252	100	500	>B
Metals	MW-OB05	MW-OB5 After purge	Barium	240	100	500	>B
Metals	MW-L34	MW-L34 After purge	Cadmium	4.3	2.5	10	>B
Metals	MW-L37	MW-L37 After purge	Cadmium	5.5	2.5	10	>B
Metals	MW-P08	MW-P8 aft purge	Cadmium	7.7	2.5	10	>B
Metals	MW-B24	MW-B24 After purge	Copper	52	50	200	>B
Metals	AW-13	AW13 afterpurge	Molybdenum	28	20	100	>B
Metals	MW-S08	MW S8 After purge	Molybdenum	29	20	100	>B
Metals	MW-B24	MW-B24 After purge	Nickel	7200	50	200	>C
Metals	AW-02	AW2 afterpurge	Zinc	237	200	800	>B
Metals	AW-05	AW5 afterpurge	Zinc	206	200	800	>B
Metals	MW-B24	MW-B24 After purge	Zinc	220	200	800	>B
Metals	MW-Q01	MW Q1 After purge	Zinc	742	200	800	>B
Metals	MW-Q05	MW Q5 After purge	Zinc	620	200	800	>B
Metals	MW-S04	MW S4 After purge	Zinc	788	200	800	>B
Carbon Chain	MW-B34	MW B34 After Purge	Carbon Chain C6 - C14	44.0	40	150	>B
Carbon Chain	MW-D06	MW-D6 After purge	Carbon Chain C6 - C14	94.0	40	150	>B
Carbon Chain	MW-J07	MW-J7 After purge	Carbon Chain C6 - C14	56.0	40	150	>B
Carbon Chain	MW-OB11	MW OB11 After purge	Carbon Chain C6 - C14	59.0	40	150	>B
Carbon Chain	MW-B24	MW-B24 After purge	Total Carbon Chain	231	200	600	>B
Carbon Chain	MW-B34	MW B34 After Purge	Total Carbon Chain	1030	200	600	>C
Carbon Chain	MW-D06	MW-D6 After purge	Total Carbon Chain	433	200	600	>B
Carbon Chain	MW-L34	MW L34 After purge	Total Carbon Chain	304	200	600	>B
Carbon Chain	MW-OB11	MW OB11 After purge	Total Carbon Chain	334	200	600	>B
Carbon Chain	MW-P08	MW-P8 aft purge	Total Carbon Chain	459	200	600	>B
Volatiles	MW-B34	MW-B34 After purge	Naphthalene	25	7	30	>B

TABLE 7-1
CHEMICALS DETECTED IN SOIL
BASELINE RISK ASSESSMENT

Area	Chemical	Number of Samples	Number of Detects	Frequency of Detection (%)	Minimum Detected Concentration (mg/kg)	Maximum Detected Concentration (mg/kg)	T-based UCL95 (mg/kg)	Sample with Maximum Concentration
Area 1	*Metals*							
	Antimony	702	130	19	0.050	66.6	0.412	B-L26/0.0-0.16m/1
	Arsenic	702	523	75	0.500	54.4	1.63	AB15/0.78-0.93m/3
	Barium	702	702	100	1.83	1100	37.2	OB-5/0.15-0.25m/1
	Beryllium	700	698	100	0.050	3.92	0.69	B-I04/2.87-3.12m/5
	Cadmium	702	483	69	0.020	18.1	0.22	B-L24/0.0-.016m/1
	Chromium	702	700	100	0.150	2670	34.1	B-B23/0.13-0.29m/1
	Cobalt	702	702	100	0.250	70.3	3	B-L25/0.0-0.13m/1
	Copper	702	702	100	0.210	7680	108	AB-25/0.08-0.23m/2
	Hexavalent Chromium	208	40	19	0.600	392	9.44	AB-14/0.05-0.30m/1
	Lead	702	702	100	3.21	26300	154	B-L26/0.0-0.16m/1
	Mercury	700	232	33	0.020	1.06	0.029	AB15/0.78-0.93m/3
	Molybdenum	702	693	99	0.050	26.8	1.06	B-L28/0.10-0.26m/1
	Nickel	702	696	99	0.080	1780	30.7	B-B24/0.68-0.83m/3
	Selenium	702	503	72	0.500	7.4	1.03	B-A1/0.15-0.3m/1
	Silver	702	113	16	0.050	1.64	0.058	AB15/0.78-0.93m/3
	Thallium	702	30	4	0.500	1.6	0.273	B-J4/1.02-1.27m/3
	Tin	702	505	72	0.050	139	1.06	B-N2/0.07-0.22m/1
	Vanadium	702	700	100	0.500	22.7	4.42	B-L31/0.0-0.16m/1
	Zinc	702	702	100	3.5	9090	112	AB-25/0.08-0.23m/2
	Cyanide							
	Cyanide	380	7	2	1	123	1.42	B-B24/0.68-0.83m/3
	PCBs							
	Aroclor-1260	31	1	3	0.200	0.200	0.063	B-I9/0.10-0.26m/1
	Dioxins & Furans							
	1,2,3,4,5,6,7,8-Octa CDD	11	11	100	2.2E-06	6.1E-03	1.8E-03	B-M6 / 0.00-0.16 / 1&2
	1,2,3,4,5,6,7,8-Octa CDF	11	6	55	1.9E-06	1.7E-02	4.4E-03	B-M6 / 0.00-0.16 / 1&2
	1,2,3,4,6,7,8-Hepta CDD	11	10	91	3.4E-07	4.8E-03	1.3E-03	B-M6 / 0.00-0.16 / 1&2
	1,2,3,4,6,7,8-Hepta CDF	9	7	78	3.7E-07	2.3E-02	7.4E-03	B-M6 / 0.00-0.16 / 1&2
	1,2,3,4,7,8,9-Hepta CDF	11	4	36	8.4E-07	4.6E-03	1.2E-03	B-M6 / 0.00-0.16 / 1&2
	1,2,3,4,7,8-Hexa CDD	8	3	38	1.6E-06	4.3E-04	1.6E-04	B-M6 / 0.00-0.16 / 1&2
	1,2,3,4,7,8-Hexa CDF	10	6	60	3.5E-06	1.7E-02	4.9E-03	B-M6 / 0.00-0.16 / 1&2
	1,2,3,6,7,8-Hexa CDD	11	3	27	2.2E-06	1.1E-03	2.9E-04	B-M6 / 0.00-0.16 / 1&2
	1,2,3,6,7,8-Hexa CDF	11	5	45	1.5E-06	5.4E-03	1.4E-03	B-M6 / 0.00-0.16 / 1&2
	1,2,3,7,8,9-Hexa CDD	11	4	36	7.2E-06	4.7E-03	1.2E-03	B-M6 / 0.00-0.16 / 1&2
	1,2,3,7,8,9-Hexa CDF	11	2	18	1.3E-05	5.5E-04	1.4E-04	B-M6 / 0.00-0.16 / 1&2
	1,2,3,7,8-Penta CDD	11	4	36	4.9E-07	6.1E-04	1.6E-04	B-M6 / 0.00-0.16 / 1&2
	1,2,3,7,8-Penta CDF	11	4	36	3.0E-06	5.1E-03	1.3E-03	B-M6 / 0.00-0.16 / 1&2
	2,3,4,6,7,8-Hexa CDF	11	5	45	1.7E-06	3.9E-03	1.0E-03	B-M6 / 0.00-0.16 / 1&2
	2,3,4,7,8-Penta CDF	11	5	45	2.2E-06	2.9E-03	7.6E-04	B-M6 / 0.00-0.16 / 1&2
	2,3,7,8-Tetra CDD	11	3	27	6.1E-07	1.8E-04	4.7E-05	B-M6 / 0.00-0.16 / 1&2
	2,3,7,8-Tetra CDF	11	5	45	2.5E-07	2.2E-03	5.7E-04	B-M6 / 0.00-0.16 / 1&2
	Total Hepta CDD	11	10	91	6.1E-07	7.9E-03	2.1E-03	B-M6 / 0.00-0.16 / 1&2

TABLE 7-1
CHEMICALS DETECTED IN SOIL
BASELINE RISK ASSESSMENT

Area	Chemical	Number of Samples	Number of Detects	Frequency of Detection (%)	Minimum Detected Concentration (mg/kg)	Maximum Detected Concentration (mg/kg)	T-based UCL95 (mg/kg)	Sample with Maximum Concentration
	Total Hepta CDF	11	6	55	1.5E-06	3.9E-02	1.0E-02	B-M6 / 0.00-0.16 / 1&2
	Total Hexa CDD	11	6	55	5.4E-06	2.0E-02	5.3E-03	B-M6 / 0.00-0.16 / 1&2
	Total Hexa CDF	11	8	73	7.8E-07	7.1E-02	1.9E-02	B-M6 / 0.00-0.16 / 1&2
	Total Penta CDD	11	4	36	2.4E-06	3.4E-03	8.9E-04	B-M6 / 0.00-0.16 / 1&2
	Total Penta CDF	11	6	55	6.1E-06	1.7E-02	4.4E-03	B-M6 / 0.00-0.16 / 1&2
	Total Tetra CDD	11	4	36	8.4E-06	1.3E-03	3.4E-04	B-M6 / 0.00-0.16 / 1&2
	Total Tetra CDF	11	5	45	1.9E-06	1.4E-02	3.6E-03	B-M6 / 0.00-0.16 / 1&2
	TCDD TEQ	11	11	100	3.9E-07	6.1E-03	1.6E-03	B-M6 / 0.00-0.16 / 1&2
	SVOCs							
	1-Methylnaphthalene	312	8	3	0.900	41.6	2.29	B-D4/1.45-1.61m/6
	2-Methylnaphthalene	312	8	3	0.900	60.7	2.59	B-D4/1.45-1.61m/6
	Benzo(a)anthracene	312	58	19	0.005	0.573	0.032	B-L31/0.0-0.16m/1
	Benzo(a)pyrene	312	51	16	0.006	0.552	0.032	B-L31/0.0-0.16m/1
	Benzo(b)fluoranthene	312	41	13	0.010	0.520	0.054	B-L28/0.10-0.26m/1
	Benzo(k)fluoranthene	312	37	12	0.010	0.520	0.052	B-L31/0.0-0.16m/1
	Bis(2-ethylhexyl)phthalate	312	2	1	8	16	22.1	B-D25/1.40-1.65m/5
	Chrysene	312	1	0	0.600	0.600	2.21	B-D25/1.40-1.65m/5
	Dibenz(a,h)anthracene	312	14	4	0.006	0.089	0.023	B-D25/1.40-1.65m/5
	Dimethylphthalate	312	9	3	0.600	42.1	2.46	B-N2/0.07-0.22m/1
	Di-n-butylphthalate	312	1	0	0.800	0.800	2.21	B-D25/1.40-1.65m/5
	Fluoranthene	312	1	0	0.900	0.900	2.21	B-D25/1.40-1.65m/5
	Fluorene	312	2	1	6.3	6.9	2.07	B-D26/1.40-1.65m/5
	Indeno(1,2,3-cd)pyrene	312	46	15	0.006	0.483	0.030	B-L31/0.0-0.16m/1
	Phenanthrene	312	7	2	0.600	21.6	2.04	B-D6/1.37-1.62m/4
	Pyrene	312	2	1	0.700	0.900	2.21	B-D25/1.40-1.65m/5
	Tributyltin	20	2	10	0.0007	0.001	0.0004	T1/0.31m/3
	Petroleum Hydrocarbons							
	Carbon Chain C11-C14	787	73	9	10	6670	90.7	B-D4/1.45-1.61m/6
	Carbon Chain C15-C18	787	100	13	11	10200	190	B-D4/1.45-1.61m/6
	Carbon Chain C19-C22	787	121	15	11	6760	142	B-P10/0.08-0.23m/1
	Carbon Chain C23-C26	787	134	17	10	5720	78.4	B-P10/0.08-0.23m/1
	Carbon Chain C27-C30	787	147	19	12	4990	61.4	B-P6/0.40-0.56m/1
	Carbon Chain C31-C36	787	154	20	10	5760	59.7	B-P6/0.40-0.56m/1
	Carbon Chain C6-C10	787	22	3	2	1380	8.17	B-N2/0.07-0.22m/1
	VOCs							
	Acetone	382	1	0	11	11	5.04	B-I12/1.13-1.38m/7
	Benzene	382	1	0	0.020	0.020	0.010	B-D6/1.37-1.62m/4
	n-Butylbenzene	382	3	1	1	2.6	0.276	B-D25/1.40-1.65m/5
	Sec-Butylbenzene	382	4	1	0.500	1.9	0.270	B-D4/1.45-1.61m/6
	Tert-Butylbenzene	382	1	0	3.3	3.3	0.271	B-D4/1.45-1.61m/6
	Ethylbenzene	382	4	1	0.200	0.900	0.108	B-D6/1.37-1.62m/4
	Isopropylbenzene	382	3	1	0.500	1.1	0.259	B-D4/1.45-1.61m/6
	MEK (2-Butanone)	382	50	13	5	7	3.07	B-J3/0.66-0.74m/3

TABLE 7-1
CHEMICALS DETECTED IN SOIL
BASELINE RISK ASSESSMENT

Area	Chemical	Number of Samples	Number of Detects	Frequency of Detection (%)	Minimum Detected Concentration (mg/kg)	Maximum Detected Concentration (mg/kg)	T-based UCL95 (mg/kg)	Sample with Maximum Concentration
	Methylene chloride	382	25	7	1	2	0.594	B-05/2.88-3.13m/6
	Naphthalene	694	15	2	0.800	20.8	1.13	B-D6/1.37-1.62m/4
	n-Propylbenzene	382	4	1	0.500	2.6	0.278	B-D4/1.45-1.61m/6
	Styrene	382	2	1	0.600	0.7	0.255	B-K04/0.75-1.00m/3
Area 2	*Metals*							
	Antimony	540	99	18	0.050	17.3	0.386	IEC-T1(1-10)/2.46m/1
	Arsenic	540	251	46	0.500	24.8	1.06	T8/0.25m/1
	Barium	540	540	100	4.59	3290	89.7	T9/1.17m/1
	Beryllium	540	540	100	0.080	1.67	0.578	B-T2/1.27-1.72m/5
	Cadmium	540	363	67	0.020	12.9	0.255	IEC-T2(1-8)/2.5m/7
	Chromium	540	535	99	0.160	672	18.5	T8/0.25m/1
	Cobalt	540	540	100	0.140	67.8	5.25	T8/0.25m/1
	Copper	540	540	100	0.100	27900	374	IEC-T2(1-8)/2.5m/7
	Hexavalent Chromium	97	14	14	0.500	4.2	0.512	T10/1.11m/3
	Lead	540	540	100	3.5	4630	143	IEC-T2(4-5)/1.0m/21
	Mercury	539	72	13	0.020	0.800	0.021	B-T5/0.35-0.53m/1
	Molybdenum	540	539	100	0.060	24.9	1.31	IEC-T2(6-7)/0.3m/31
	Nickel	540	540	100	0.050	728	18.3	IEC-T2(6-7)/0.3m/31
	Selenium	540	495	92	0.500	7.2	1.55	B-S8/0.08-0.23m/1
	Silver	540	76	14	0.050	7.17	0.125	IEC-T2(1-8)/2.5m/7
	Thallium	540	86	16	0.500	1.1	0.318	OB-31/0.68-0.83m/3
	Tin	540	357	66	0.050	232	3.51	IEC-T2(1-8)/2.5m/7
	Vanadium	540	526	97	0.500	31.4	3.50	B-T11/1.47-1.72m/5
	Zinc	540	538	100	1.8	6840	200	IEC-T2(1-8)/2.5m/7
	Cyanide							
	Cyanide	97	2	2	2	5	0.643	T6/0.71m/7
	PCBs							
	Aroclor-1260	10	2	20	5.7	33.4	10.0	IEC-T1(1-10)/1.3m/5
	Herbicides							
	2,4-D	26	1	4	0.200	0.200	0.066	T11/0.38m/4
	MCPA	13	1	8	0.200	0.200	0.082	T11/0.38m/4
	MCPP	13	1	8	0.200	0.200	0.082	T11/0.38m/4
	Dioxins & Furans							
	1,2,3,4,5,6,7,8-Octa CDD	22	22	100	3.0E-04	3.1E-02	8.4E-03	IEC-T2(4-5)/1.0/23 & 24
	1,2,3,4,5,6,7,8-Octa CDF	22	19	86	1.0E-06	2.3E-03	8.6E-04	IEC-T2(1-8) /2.5 /7 & 8
	1,2,3,4,6,7,8-Hepta CDD	22	22	100	3.5E-06	9.4E-03	2.4E-03	IEC-T2(1-8) /2.5 /7 & 8
	1,2,3,4,6,7,8-Hepta CDF	22	20	91	6.6E-07	1.3E-02	4.1E-03	IEC-T2(1-8) /2.5 /7 & 8
	1,2,3,4,7,8,9-Hepta CDF	22	11	50	2.4E-06	4.5E-04	1.7E-04	IEC-T2(1-8) /2.5 /7 & 8
	1,2,3,4,7,8-Hexa CDD	22	13	59	4.7E-07	8.9E-04	2.3E-04	IEC-T2(1-8) /2.5 /7 & 8
	1,2,3,4,7,8-Hexa CDF	22	17	77	3.0E-07	2.6E-03	8.1E-04	IEC-T2(6-7) /0.3 /31&32
	1,2,3,6,7,8-Hexa CDD	22	14	64	6.4E-07	2.1E-03	4.8E-04	IEC-T2(1-8) /2.5 /7 & 8
	1,2,3,6,7,8-Hexa CDF	22	17	77	4.4E-07	2.7E-03	8.8E-04	IEC-T2(1-8) /2.5 /7 & 8
	1,2,3,7,8,9-Hexa CDD	22	14	64	7.7E-07	1.5E-03	3.8E-04	IEC-T2(1-8) /2.5 /7 & 8

TABLE 7-1
CHEMICALS DETECTED IN SOIL
BASELINE RISK ASSESSMENT

Area	Chemical	Number of Samples	Number of Detects	Frequency of Detection (%)	Minimum Detected Concentration (mg/kg)	Maximum Detected Concentration (mg/kg)	T-based UCL95 (mg/kg)	Sample with Maximum Concentration
	1,2,3,7,8,9-Hexa CDF	22	10	45	4.2E-07	1.0E-04	3.1E-05	IEC-T2(1-8) /2.5 /7 & 8
	1,2,3,7,8-Penta CDD	22	13	59	4.7E-07	1.1E-03	2.7E-04	IEC-T2(1-8) /2.5 /7 & 8
	1,2,3,7,8-Penta CDF	22	16	73	2.9E-07	2.2E-03	5.7E-04	IEC-T2(1-8) /2.5 /7 & 8
	2,3,4,6,7,8-Hexa CDF	22	17	77	4.4E-07	4.0E-03	1.3E-03	IEC-T2(1-8) /2.5 /7 & 8
	2,3,4,7,8-Penta CDF	22	17	77	4.9E-07	3.0E-03	1.1E-03	IEC-T2(1-8) /2.5 /7 & 8
	2,3,7,8-Tetra CDD	22	12	55	2.2E-07	2.6E-04	7.4E-05	IEC-T2(4-5)/1.5/19 & 20
	2,3,7,8-Tetra CDF	22	14	64	6.5E-07	1.8E-03	5.2E-04	IEC-T2(4-5)/1.5/19 & 20
	Total Hepta CDD	22	22	100	8.9E-06	2.1E-02	5.2E-03	IEC-T2(1-8) /2.5 /7 & 8
	Total Hepta CDF	22	20	91	9.3E-07	1.5E-02	4.8E-03	IEC-T2(1-8) /2.5 /7 & 8
	Total Hexa CDD	22	18	82	4.1E-06	4.1E-02	9.5E-03	IEC-T2(1-8) /2.5 /7 & 8
	Total Hexa CDF	22	18	82	2.7E-06	2.2E-02	7.7E-03	IEC-T2(1-8) /2.5 /7 & 8
	Total Penta CDD	22	16	73	1.2E-06	2.1E-02	4.8E-03	IEC-T2(1-8) /2.5 /7 & 8
	Total Penta CDF	22	18	82	3.1E-06	2.8E-02	8.7E-03	IEC-T2(1-8) /2.5 /7 & 8
	Total Tetra CDD	22	14	64	7.2E-07	1.3E-02	3.0E-03	IEC-T2(1-8) /2.5 /7 & 8
	Total Tetra CDF	22	17	77	4.0E-06	2.7E-02	9.6E-03	IEC-T2(1-8) /2.5 /7 & 8
	TCDD TEQ	22	22	100	1.4E-06	4.0E-03	1.3E-03	IEC-T2(1-8) /2.5 /7 & 8
	SVOCs							
	1-Methylnaphthalene	286	1	0	2.6	2.6	1.03	B-S8/0.08-0.23m/1
	2-Methylnaphthalene	286	1	0	5.2	5.2	1.04	B-S8/0.08-0.23m/1
	Acenaphthene	286	2	1	1.8	2.3	1.03	B-S8/0.08-0.23m/1
	Acenaphthylene	286	2	1	0.700	0.800	1.02	B-S8/0.08-0.23m/1
	Anthracene	286	3	1	0.600	0.600	1.03	B-S8/0.08-0.23m/1
	Benzo(a)anthracene	286	56	20	0.006	1.67	0.062	B-Y4/0.08-0.23m/1
	Benzo(a)pyrene	286	52	18	0.006	1.9	0.063	SD-21/0.80-0.94m/3
	Benzo(b)fluoranthene	286	45	16	0.010	2.38	0.079	SD-21/0.80-0.94m/3
	Benzo(g,h,i)perylene	286	7	2	0.600	1.9	1.04	B-S8/0.08-0.23m/1
	Benzo(k)fluoranthene	286	40	14	0.010	1.45	0.063	SD-21/0.80-0.94m/3
	Bis(2-ethylhexyl)phthalate	286	4	1	5	46	10.5	B-S8/0.08-0.23m/1
	Chrysene	286	7	2	0.700	2.3	1.06	B-S8/0.08-0.23m/1
	Dibenz(a,h)anthracene	286	24	8	0.006	0.657	0.019	SD-21/0.80-0.94m/3
	Dibenzofuran	286	1	0	0.900	0.900	1.02	B-S8/0.08-0.23m/1
	Dimethylphthalate	286	24	8	0.500	9.5	1.23	B-S8/0.08-0.23m/1
	Di-n-butylphthalate	286	3	1	0.800	1.2	1.03	B-S8/0.08-0.23m/1
	Fluoranthene	286	7	2	0.800	4.2	1.08	B-S8/0.08-0.23m/1
	Fluorene	286	2	1	0.800	1.4	1.02	B-S8/0.08-0.23m/1
	Indeno(1,2,3-cd)pyrene	286	46	16	0.006	1.51	0.052	SD-21/0.80-0.94m/3
	Phenanthrene	286	4	1	1.7	4.3	1.06	B-S8/0.08-0.23m/1
	Pyrene	286	8	3	0.700	4.8	1.08	B-S8/0.08-0.23m/1
	Tributyltin	321	44	14	0.0005	0.023	0.001	B-T3/0.12-0.30m/1
	Petroleum Hydrocarbons							
	Carbon Chain C11-C14	579	32	6	11	2280	21.8	B-S8/0.08-0.23m/1
	Carbon Chain C15-C18	579	47	8	11	5120	51.5	B-S8/0.08-0.23m/1
	Carbon Chain C19-C22	579	64	11	12	3020	45.7	B-S8/0.08-0.23m/1

TABLE 7-1
CHEMICALS DETECTED IN SOIL
BASELINE RISK ASSESSMENT

Area	Chemical	Number of Samples	Number of Detects	Frequency of Detection (%)	Minimum Detected Concentration (mg/kg)	Maximum Detected Concentration (mg/kg)	T-based UCL95 (mg/kg)	Sample with Maximum Concentration
	Carbon Chain C23-C26	579	85	15	11	3740	36.4	T5/0.96m/3
	Carbon Chain C27-C30	579	104	18	11	4870	38.6	T5/0.96m/3
	Carbon Chain C31-C36	579	111	19	11	3330	38.4	T5/0.96m/3
	Carbon Chain C6-C10	579	8	1	2	16	1.18	AB-81/0.08-0.23m/1
	VOCs							
	MEK (2-Butanone)	269	7	3	5	7	2.66	T4/1.55m/3
	Methylene chloride	269	4	1	1	2	0.529	T2/0.35m/1
	Styrene	269	1	0	6.3	6.3	0.310	T11/0.31m/1
Area 3	*Metals*							
	Antimony	545	142	26	0.050	340	3.10	IEC-T20(5-6)/2.0m/13
	Arsenic	545	286	52	0.500	114	2.24	IEC-T13(7-8)/2.4m/5
	Barium	545	545	100	2.93	4660	142	IEC-T20(3-4)/3.9m/5
	Beryllium	545	544	100	0.110	2.18	0.598	AW19/0.1-0.25m/1
	Cadmium	545	370	68	0.020	118	0.966	IEC-T20(5-6)/2.0m/13
	Chromium	545	524	96	0.140	5390	72.6	IEC-T20(7-8)/4.5m/1
	Cobalt	545	545	100	0.430	328	8.74	IEC-T9(8-9)/1.91m/17
	Copper	545	545	100	0.180	28100	637	IEC-T9(8-9)/1.91m/17
	Hexavalent Chromium	253	42	17	0.500	30.4	0.906	IEC-T20(7-8)/4.5m/1
	Lead	545	545	100	7.93	21100	321	IEC-T20(5-6)/2.0m/13
	Mercury	545	95	17	0.020	0.570	0.019	IEC-T18(3-4)/1.4m/5
	Molybdenum	545	545	100	0.170	599	6.06	IEC-T9(8-9)/1.91m/17
	Nickel	545	545	100	0.060	1790	56.8	IEC-T9(8-9)/1.91m/17
	Selenium	545	516	95	0.500	8.1	1.64	IEC-T36(11-12)/4.0m/3
	Silver	545	151	28	0.050	29.9	0.326	IEC-T20(5-6)/2.0m/13
	Thallium	545	164	30	0.500	1.6	0.398	IEC-T7(2-3)/1.2m/9
	Tin	545	364	67	0.050	3650	22.2	IEC-T20(5-6)/2.0m/13
	Vanadium	545	523	96	0.500	331	5.03	IEC-T9(8-9)/1.91m/17
	Zinc	545	531	97	0.800	35700	637	IEC-T20(5-6)/2.0m/13
	Cyanide							
	Cyanide	249	1	0	1	1	0.505	IEC-T30(2-1)/1.2m/9
	PCBs							
	Aroclor-1242	43	1	2	0.200	0.200	0.575	IEC-T20(5-6)/2.0m/13
	Aroclor-1260	43	7	16	0.100	0.700	0.607	IEC-T20(5-6)/2.0m/13
	Dioxins & Furans							
	1,2,3,4,5,6,7,8-Octa CDD	145	144	99	1.6E-05	3.0E-01	1.0E-02	IEC-T37(6-5)/0.8/6
	1,2,3,4,5,6,7,8-Octa CDF	144	99	69	1.7E-06	9.9E-02	3.4E-03	IEC-T37(6-5)/0.8/6
	1,2,3,4,6,7,8-Hepta CDD	145	134	92	1.9E-06	2.2E-01	6.1E-03	IEC-T37(6-5)/0.8/6
	1,2,3,4,6,7,8-Hepta CDF	145	117	81	1.0E-06	3.6E-01	1.1E-02	IEC-T37(6-5)/0.8/6
	1,2,3,4,7,8,9-Hepta CDF	145	76	52	3.8E-07	2.7E-02	7.2E-04	IEC-T37(6-5)/0.8/6
	1,2,3,4,7,8-Hexa CDD	145	82	57	6.2E-07	1.9E-02	5.8E-04	IEC-T37(6-5)/0.8/6
	1,2,3,4,7,8-Hexa CDF	145	106	73	5.7E-07	2.0E-01	6.7E-03	IEC-T37(6-5)/0.8/6
	1,2,3,6,7,8-Hexa CDD	145	93	64	4.9E-07	3.4E-02	1.0E-03	IEC-T37(6-5)/0.8/6
	1,2,3,6,7,8-Hexa CDF	145	95	66	6.3E-07	8.6E-02	2.6E-03	IEC-T37(6-5)/0.8/6

TABLE 7-1
CHEMICALS DETECTED IN SOIL
BASELINE RISK ASSESSMENT

Area	Chemical	Number of Samples	Number of Detects	Frequency of Detection (%)	Minimum Detected Concentration (mg/kg)	Maximum Detected Concentration (mg/kg)	T-based UCL95 (mg/kg)	Sample with Maximum Concentration
	1,2,3,7,8,9-Hexa CDD	145	95	66	7.2E-07	5.4E-02	1.5E-03	IEC-T37(6-5)/0.8/6
	1,2,3,7,8,9-Hexa CDF	145	59	41	2.2E-07	7.6E-03	2.0E-04	IEC-T37(6-5)/0.8/6
	1,2,3,7,8-Penta CDD	145	89	61	3.6E-07	2.3E-02	6.1E-04	IEC-T37(6-5)/0.8/6
	1,2,3,7,8-Penta CDF	145	99	68	4.7E-07	5.4E-02	1.5E-03	IEC-T37(6-5)/0.8/6
	2,3,4,6,7,8-Hexa CDF	145	96	66	8.5E-07	8.5E-02	3.3E-03	IEC-T37(6-5)/0.8/6
	2,3,4,7,8-Penta CDF	145	105	72	4.5E-07	6.5E-02	2.3E-03	IEC-T37(6-5)/0.8/6
	2,3,7,8-Tetra CDD	145	68	47	5.3E-07	6.6E-03	1.5E-04	IEC-T37(6-5)/0.8/6
	2,3,7,8-Tetra CDF	145	92	63	1.5E-07	2.0E-02	8.2E-04	AW10/0.68-0.83/3
	Total Hepta CDD	145	137	94	3.1E-06	4.2E-01	1.3E-02	IEC-T37(6-5)/0.8/6
	Total Hepta CDF	145	119	82	1.0E-06	4.9E-01	1.5E-02	IEC-T37(6-5)/0.8/6
	Total Hexa CDD	145	124	86	2.5E-06	4.6E-01	1.9E-02	IEC-T37(6-5)/0.8/6
	Total Hexa CDF	145	118	81	1.4E-06	6.4E-01	2.3E-02	IEC-T37(6-5)/0.8/6
	Total Penta CDD	145	106	73	2.0E-06	2.2E-01	9.2E-03	IEC-T37(6-5)/0.8/6
	Total Penta CDF	145	119	82	4.5E-07	7.8E-01	2.9E-02	IEC-T37(6-5)/0.8/6
	Total Tetra CDD	145	110	76	5.7E-07	1.8E-01	6.5E-03	AW10/0.68-0.83/3
	Total Tetra CDF	145	122	84	1.0E-06	4.6E-01	1.6E-02	AW10/0.68-0.83/3
	TCDD TEQ	145	145	100	9.3E-07	1.1E-01	3.5E-03	IEC-T37(6-5)/0.8/6
	SVOCs							
	3/4-Methylphenol	276	1	0	6	6	2.37	B-Q15/0.24-0.39m/1
	Benzo(a)anthracene	276	51	18	0.006	0.439	0.022	IEC-T30(2-1)/1.2m/9
	Benzo(a)pyrene	276	43	16	0.005	0.547	0.024	IEC-T12(1-2)/1.8m/7
	Benzo(b)fluoranthene	276	44	16	0.010	0.660	0.036	IEC-T12(1-2)/1.8m/7
	Benzo(k)fluoranthene	276	39	14	0.010	0.660	0.034	IEC-T12(1-2)/1.8m/7
	Bis(2-ethylhexyl)phthalate	276	2	1	11	563	14.0	IEC-T20(5-6)/2.0m/13
	Chrysene	276	1	0	0.600	0.600	1.17	B-Q15/0.24-0.39m/1
	Dibenz(a,h)anthracene	276	12	4	0.006	0.169	0.014	B-Q15/0.24-0.39m/1
	Dimethylphthalate	276	14	5	0.500	42	1.71	IEC-T21(9-10)/3.0m/5
	Di-n-butylphthalate	276	3	1	0.600	16.1	1.25	B-Q15/0.24-0.39m/1
	Fluoranthene	276	2	1	0.600	0.700	1.18	B-Q15/0.24-0.39m/1
	Hexachlorobenzene	276	1	0	1	1	2.35	B-Q15/0.24-0.39m/1
	Indeno(1,2,3-cd)pyrene	276	36	13	0.005	0.669	0.022	IEC-T12(1-2)/1.8m/7
	Phenanthrene	276	3	1	0.500	1.1	1.18	B-Q15/0.24-0.39m/1
	Phenol	276	2	1	0.800	1.3	1.18	B-Q15/0.24-0.39m/1
	Pyrene	276	2	1	0.600	0.7	1.18	B-Q15/0.24-0.39m/1
	Tributyltin	204	51	25	0.0005	1.78	0.024	IEC-T20(5-6)/3.5m/1
	Petroleum Hydrocarbons							
	Carbon Chain C11-C14	546	41	8	11	5560	51.7	IEC-T20(5-6)/2.0m/13
	Carbon Chain C15-C18	546	71	13	11	15100	130	IEC-T20(5-6)/2.0m/13
	Carbon Chain C19-C22	546	85	16	12	10600	98.0	IEC-T20(5-6)/2.0m/13
	Carbon Chain C23-C26	546	98	18	11	13500	91.7	IEC-T20(5-6)/2.0m/13
	Carbon Chain C27-C30	546	104	19	11	16100	98.14	IEC-T20(5-6)/2.0m/13
	Carbon Chain C31-C36	546	105	19	11	27600	158	IEC-T20(5-6)/2.0m/13
	Carbon Chain C6-C10	546	10	2	3	106	2.17	IEC-T20(5-6)/3.5m/1

TABLE 7-1
CHEMICALS DETECTED IN SOIL
BASELINE RISK ASSESSMENT

Area	Chemical	Number of Samples	Number of Detects	Frequency of Detection (%)	Minimum Detected Concentration (mg/kg)	Maximum Detected Concentration (mg/kg)	T-based UCL95 (mg/kg)	Sample with Maximum Concentration
	VOCs							
	1,2,4-Trimethylbenzene	183	2	1	1.2	1.6	0.277	AW18/0.20-0.35m/1
	1,3,5-Trimethylbenzene	183	1	1	0.600	0.600	0.255	AW18/0.20-0.35m/1
	Benzene	183	3	2	0.020	0.050	0.011	IEC-T22(1-2)/1.1m/13
	n-Butylbenzene	183	1	1	0.600	0.600	0.255	B-Q4/0.10-0.25m/1
	Naphthalene	459	3	1	0.500	0.700	0.809	B-Q15/0.24-0.39m/1
	Styrene	183	1	1	1.6	1.6	0.270	IEC-T9(8-9)/0.4m/13

TABLE 7-2
CHEMICALS DETECTED IN GROUNDWATER
BASELINE RISK ASSESSMENT

Area	Chemical	Number of Samples	Number of Detects	Frequency of Detection (%)	Minimum Detected Concentration (ug/l)	Maximum Detected Concentration (ug/l)	Sample with Maximum Concentration
Area 1	***Metals***						
	Barium	25	23	92.00	8	261	MW-B34
	Cadmium	25	7	28.00	0.3	7.7	MW-P8
	Chromium	25	10	40.00	1	41	MW-B24
	Cobalt	25	11	44.00	1	22	MW-B24
	Copper	25	8	32.00	1	52	MW-B24
	Iron (Total)	33	11	33.33	70	330	MW-B24
	Lead	25	8	32.00	1	5	MW-L37
	Magnesium	11	11	100.00	1840	447000	MW-OB2
	Manganese	11	11	100.00	49	2730	MW-B24
	Molybdenum	25	14	56.00	1	18	MW-P8
	Nickel	25	16	64.00	1	7200	MW-B24
	Potassium	11	11	100.00	2070	159000	MW-OB2
	Selenium	25	3	12.00	10	33	MW-OB2
	Sodium	11	11	100.00	8770	3450000	MW-OB2
	Vanadium	25	8	32.00	1	22	MW-OB2
	Zinc	25	14	56.00	10	220	MW-B24
	SVOCs						
	Di-n-butylphthalate	18	3	16.67	2	2	MW-08
	Naphthalene	25	1	4.00	25	25	MW-B34
	Tributyltin	23	1	4.35	0.008	0.008	MW-L34
	Petroleum Hydrocarbons						
	Carbon Chain C11-C14	16	7	43.75	26	94	MW-D6
	Carbon Chain C15-C18	16	8	50.00	26	163	MW-D6
	Carbon Chain C19-C22	16	9	56.25	28	281	MW-B34
	Carbon Chain C23-C26	16	6	37.50	26	325	MW-B34
	Carbon Chain C27-C30	16	4	25.00	40	181	MW-B34
	Carbon Chain C31-C36	16	4	25.00	33	85	MW-B34
	VOCs						
	Methyl-tert-butyl ether	25	1	4.00	11	11	MW-B34
Area 2	***Metals***						
	Arsenic	20	2	10.00	20	24	MW-Z6
	Barium	20	19	95.00	1	146	AW2
	Cadmium	20	3	15.00	0.2	1.4	AW2
	Chromium	20	5	25.00	1	4	MW-S4
	Cobalt	20	10	50.00	1	10	AW-2
	Copper	20	8	40.00	1	11	MW-S4
	Iron (Total)	23	11	47.83	50	460	MW-V2
	Lead	20	3	15.00	1	3	MW-V2
	Magnesium	11	11	100.00	1730	914000	MW-Z6
	Manganese	11	11	100.00	23	3610	MW-U2A
	Molybdenum	20	12	60.00	1	29	MW-S8
	Nickel	20	6	30.00	1	13	MW-S4
	Potassium	11	11	100.00	3190	209000	MW-Z6
	Selenium	20	5	25.00	14	153	MW-Z6
	Sodium	11	11	100.00	8670	5690000	MW-Z6
	Vanadium	20	11	55.00	1	22	MW-Z6
	Zinc	20	16	80.00	13	788	MW-S4
	SVOCs						
	Bis(2-ethylhexyl)phthalate	19	1	5.26	27	27	MW-OB11
	Di-n-butylphthalate	19	6	31.58	2	4	MW-Z6
	Petroleum Hydrocarbons						
	Carbon Chain C11-C14	18	2	11.11	29	59	MW-OB11
	Carbon Chain C15-C18	18	1	5.56	154	154	MW-OB11
	Carbon Chain C23-C26	18	1	5.56	78	78	MW-OB11
	Carbon Chain C27-C30	18	1	5.56	43	43	MW-OB11

TABLE 7-2
CHEMICALS DETECTED IN GROUNDWATER
BASELINE RISK ASSESSMENT

Area	Chemical	Number of Samples	Number of Detects	Frequency of Detection (%)	Minimum Detected Concentration (ug/l)	Maximum Detected Concentration (ug/l)	Sample with Maximum Concentration
	VOCs						
	Chloroform	19	1	5.26	0.7	0.7	AW-1C

TABLE 7-2
CHEMICALS DETECTED IN GROUNDWATER
BASELINE RISK ASSESSMENT

Area	Chemical	Number of Samples	Number of Detects	Frequency of Detection (%)	Minimum Detected Concentration (ug/l)	Maximum Detected Concentration (ug/l)	Sample with Maximum Concentration
Area 3	***Metals***						
	Antimony	17	1	5.88	2	2	AW-22
	Arsenic	17	2	11.76	11	12	AW-20
	Barium	17	17	100.00	21	233	AW-12
	Cadmium	17	6	35.29	0.2	0.6	AW-6
	Chromium	17	10	58.82	1	6	AW-23
	Cobalt	17	16	94.12	1	12	MW-Q1
	Copper	17	10	58.82	1	13	MW-Q1
	Iron (Total)	14	4	28.57	60	440	AW-22
	Lead	17	5	29.41	2	5	AW-20
	Magnesium	7	7	100.00	280	888000	AW-11
	Manganese	7	7	100.00	158	3220	AW-20
	Molybdenum	17	13	76.47	1	28	AW-13
	Nickel	17	14	82.35	1	17	AW-22
	Potassium	7	7	100.00	2530	292000	AW-11
	Selenium	17	10	58.82	17	39	MW-Q1
	Sodium	7	7	100.00	6780	7440000	AW-11
	Vanadium	17	9	52.94	1	57	AW-10
	Zinc	17	17	100.00	11	742	MW-Q1
	Cyanide						
	Cyanide	17	2	11.76	10	20	AW-23
	Dioxins & Furans						
	Total Hexa CDD	8	1	12.50	0.000046	0.000046	AW-23
	Total Penta CDD	8	2	25.00	0.00003	0.000035	AW-11
	Total Penta CDF	8	2	25.00	0.000027	0.000042	AW-11
	Total Tetra CDD	8	2	25.00	0.000011	0.000039	AW-11
	Total Tetra CDF	8	1	12.50	0.000042	0.000042	AW-11
	SVOCs						
	Di-n-butylphthalate	17	2	11.76	3	4	AW-12
	Tributyltin	17	2	11.76	0.006	0.084	AW-10
	Petroleum Hydrocarbons						
	Carbon Chain C15-C18	17	1	5.88	31	31	AW-10
	Carbon Chain C19-C22	17	3	17.65	28	40	AW-10

TABLE 7-3
PREDICTED SURFACE WATER CONCENTRATIONS
BASELINE RISK ASSESSMENT

Chemical	Predicted Surface Water Concentration from Soil (ug/L)	Predicted Surface Water Concentration from Groundwater (ug/L)
Metals		
Antimony	2.5E-03	1.8E-04
Arsenic	2.8E-05	2.2E-03
Barium	8.4E-04	2.4E-02
Beryllium	2.8E-05	--
Cadmium	1.3E-05	7.0E-04
Chromium	2.1E-03	3.7E-03
Cobalt	2.4E-03	2.0E-03
Copper	4.3E-04	4.7E-03
Hexavalent Chromium	1.5E-04	--
Lead	4.9E-04	4.6E-04
Manganese	--	3.3E-01
Mercury	1.9E-07	--
Molybdenum	4.1E-06	2.6E-03
Nickel	2.2E-04	6.6E-01
Selenium	1.1E-05	1.4E-02
Silver	3.3E-05	--
Thallium	1.6E-07	--
Tin	2.6E-02	--
Vanadium	2.4E-03	5.2E-03
Zinc	4.2E-03	7.2E-02
Cyanide		
Cyanide	8.9E-04	1.8E-03
SVOCs		
Bis(2-ethylhexyl)phthalate	3.1E-10	2.5E-03
Dimethylphthalate	1.9E-05	--
Di-n-butylphthalate	1.9E-08	3.6E-04
Naphthalene	2.1E-05	2.3E-03
Tributyltin	1.7E-09	7.6E-03
VOCs		
Chloroform	--	6.4E-05
MEK (2-Butanone)	1.9E-03	--
MTBE (methyl-tert-butyl ether)	--	1.0E-03
Methylene Chloride	2.4E-04	--

Note:
" -- " Not Detected in Media

TABLE 7-4
TIER 1 EVALUATION
CHEMICALS DETECTED IN SOIL <3m
BASELINE RISK ASSESSMENT - HUMAN HEALTH

Area	Chemical	Number of Samples	Number of Detects	Frequency of Detection (%)	Maximum Detected Concentration (mg/kg)	USEPA Residential Soil PRG (mg/kg)	Exceed PRG?
Area 1	*Metals*						
	Antimony	642	122	19	66.6	31	Yes
	Arsenic	642	475	74	54.4	0.390	Yes
	Barium	642	642	100	1100	5400	No
	Beryllium	642	641	100	2.98	150	No
	Cadmium	642	440	69	18.1	37	No
	Chromium	642	640	100	2670	210	Yes
	Cobalt	642	642	100	70.3	4700	No
	Copper	642	642	100	7680	2900	Yes
	Hexavalent Chromium	169	37	22	392	30	Yes
	Lead	642	642	100	26300	400	Yes
	Mercury	642	219	34	1.06	23	No
	Molybdenum	642	633	99	26.8	390	No
	Nickel	642	636	99	1780	1600	Yes
	Selenium	642	468	73	7.40	390	No
	Silver	642	107	17	1.64	390	No
	Thallium	642	29	5	1.60	5.2	No
	Tin	642	463	72	139	47000	No
	Vanadium	642	641	100	22.7	550	No
	Zinc	642	642	100	9090	23000	No
	Cyanide						
	Cyanide	324	7	2	123	11	Yes
	PCBs						
	Aroclor-1260	31	1	3	0.200	0.220	No
	Dioxins & Furans						
	TCDD TEQ	10	10	100	6.1E-03	3.9E-06	Yes
	SVOCs						
	1-Methylnaphthalene	303	8	3	41.6	56	No
	2-Methylnaphthalene	303	8	3	60.7	56	Yes
	Benzo(a)anthracene	303	58	19	0.573	0.620	No
	Benzo(a)pyrene	303	51	17	0.552	0.062	Yes
	Benzo(b)fluoranthene	303	41	14	0.520	0.620	No
	Benzo(k)fluoranthene	303	37	12	0.520	6.2	No
	Bis(2-ethylhexyl)phthalate	303	2	1	16.0	35	No
	Chrysene	303	1	0	0.600	62	No
	Dibenz(a,h)anthracene	303	14	5	0.089	0.062	Yes
	Dimethylphthalate	303	9	3	42.1	100000	No
	Di-n-butylphthalate	303	1	0	0.800	6100	No
	Fluoranthene	303	1	0	0.900	2300	No
	Fluorene	303	2	1	6.90	2600	No
	Indeno(1,2,3-cd)pyrene	303	46	15	0.483	0.620	No
	Naphthalene	303	6	2	20.0	56	No
	Phenanthrene	303	7	2	21.6	3700	No
	Pyrene	303	2	1	0.900	2300	No
	Tributyltin	16	2	13	0.001	18	No
	VOCs						
	Acetone	277	1	0	11.0	1600	No
	Benzene	277	1	0	0.020	0.65	No
	n-Butylbenzene	277	3	1	2.60	140	No
	Sec-Butylbenzene	277	4	1	1.90	110	No
	Tert-Butylbenzene	277	1	0	3.30	130	No
	Ethylbenzene	277	4	1	0.900	230	No
	Isopropylbenzene	277	3	1	1.10	160	No
	MEK (2-Butanone)	277	40	14	7.00	7300	No
	Methylene chloride	277	20	7	2.00	8.9	No
	Naphthalene	277	9	3	20.8	56	No
	n-Propylbenzene	277	4	1	2.60	140	No
	Styrene	277	2	1	0.700	1700	No

TABLE 7-4
TIER 1 EVALUATION
CHEMICALS DETECTED IN SOIL <3m
BASELINE RISK ASSESSMENT - HUMAN HEALTH

Area	Chemical	Number of Samples	Number of Detects	Frequency of Detection (%)	Maximum Detected Concentration (mg/kg)	USEPA Residential Soil PRG (mg/kg)	Exceed PRG?
Area 2	***Metals***						
	Antimony	492	95	19	17.3	31	No
	Arsenic	492	233	47	24.8	0.390	Yes
	Barium	492	492	100	3290	5400	No
	Beryllium	492	492	100	1.67	150	No
	Cadmium	492	341	69	12.9	37	No
	Chromium	492	487	99	672	210	Yes
	Cobalt	492	492	100	67.8	4700	No
	Copper	492	492	100	27900	2900	Yes
	Hexavalent Chromium	92	14	15	4.20	30	No
	Lead	492	492	100	4630	400	Yes
	Mercury	491	69	14	0.800	23	No
	Molybdenum	492	491	100	24.9	390	No
	Nickel	492	492	100	728	1600	No
	Selenium	492	458	93	7.20	390	No
	Silver	492	74	15	7.17	390	No
	Thallium	492	78	16	1.10	5.2	No
	Tin	492	326	66	232	47000	No
	Vanadium	492	483	98	31.4	550	No
	Zinc	492	490	100	6840	23000	No
	Cyanide						
	Cyanide	93	2	2	5.00	11	No
	PCBs						
	Aroclor-1260	10	2	20	33.4	0.220	Yes
	Herbicides						
	2,4-D	26	1	4	0.200	490	No
	MCPA	13	1	8	0.200	31	No
	MCPP	13	1	8	0.200	61	No
	Dioxins & Furans						
	TCDD TEQ	22	22	100	4.0E-03	3.9E-06	Yes
	SVOCs						
	1-Methylnaphthalene	279	1	0	2.60	56	No
	2-Methylnaphthalene	279	1	0	5.20	56	No
	Acenaphthene	279	2	1	2.30	3700	No
	Acenaphthylene	279	2	1	0.800	3700	No
	Anthracene	279	3	1	0.600	22000	No
	Benzo(a)anthracene	279	56	20	1.67	0.620	Yes
	Benzo(a)pyrene	279	52	19	1.90	0.062	Yes
	Benzo(b)fluoranthene	279	45	16	2.38	0.620	Yes
	Benzo(g,h,i)perylene	279	7	3	1.90	2300	No
	Benzo(k)fluoranthene	279	40	14	1.45	6.2	No
	Bis(2-ethylhexyl)phthalate	279	4	1	46.0	35	Yes
	Chrysene	279	7	3	2.30	62	No
	Dibenz(a,h)anthracene	279	24	9	0.657	0.062	Yes
	Dibenzofuran	279	1	0	0.900	290	No
	Dimethylphthalate	279	24	9	9.50	100000	No
	Di-n-butylphthalate	279	3	1	1.20	6100	No
	Fluoranthene	279	7	3	4.20	2300	No
	Fluorene	279	2	1	1.40	2600	No
	Indeno(1,2,3-cd)pyrene	279	46	16	1.51	0.620	Yes
	Phenanthrene	279	4	1	4.30	3700	No
	Pyrene	279	8	3	4.80	2300	No
	Tributyltin	267	39	15	0.023	18	No
	VOCs						
	MEK (2-Butanone)	199	7	4	7.0	7300	No
	Methylene chloride	199	4	2	2.0	8.9	No
	Styrene	199	1	1	6.3	1700	No

TABLE 7-4
TIER 1 EVALUATION
CHEMICALS DETECTED IN SOIL <3m
BASELINE RISK ASSESSMENT - HUMAN HEALTH

Area	Chemical	Number of Samples	Number of Detects	Frequency of Detection (%)	Maximum Detected Concentration (mg/kg)	USEPA Residential Soil PRG (mg/kg)	Exceed PRG?
Area 3	*Metals*						
	Antimony	378	121	32	340	31	Yes
	Arsenic	378	211	56	114	0.390	Yes
	Barium	378	378	100	4330	5400	No
	Beryllium	378	377	100	2.18	150	No
	Cadmium	378	278	74	118	37	Yes
	Chromium	378	364	96	2740	210	Yes
	Cobalt	378	378	100	328	4700	No
	Copper	378	378	100	28100	2900	Yes
	Hexavalent Chromium	196	36	18	16.9	30	No
	Lead	378	378	100	21100	400	Yes
	Mercury	378	63	17	0.570	23	No
	Molybdenum	378	378	100	599	390	Yes
	Nickel	378	378	100	1790	1600	Yes
	Selenium	378	358	95	4.70	390	No
	Silver	378	127	34	29.9	390	No
	Thallium	378	105	28	1.6	5.2	No
	Tin	378	263	70	3650	47000	No
	Vanadium	378	366	97	331	550	No
	Zinc	378	370	98	35700	23000	Yes
	Cyanide						
	Cyanide	192	1	1	1.00	11	No
	PCBs						
	Aroclor-1242	35	1	3	0.200	0.220	No
	Aroclor-1260	35	7	20	0.700	0.220	Yes
	Dioxins & Furans						
	TCDD TEQ	114	114	100	1.1E-01	3.9E-06	Yes
	SVOCs						
	Benzo(a)anthracene	219	43	20	0.439	0.620	No
	Benzo(a)pyrene	219	37	17	0.547	0.062	Yes
	Benzo(b)fluoranthene	219	38	17	0.660	0.620	Yes
	Benzo(k)fluoranthene	219	34	16	0.660	6.2	No
	Bis(2-ethylhexyl)phthalate	219	2	1	563	35	Yes
	Chrysene	219	1	0	0.600	62	No
	Dibenz(a,h)anthracene	219	11	5	0.169	0.062	Yes
	Dimethylphthalate	219	12	5	42.0	100000	No
	Di-n-butylphthalate	219	3	1	16.1	6100	No
	Fluoranthene	219	2	1	0.700	2300	No
	Hexachlorobenzene	219	1	0	1.00	0.300	Yes
	Indeno(1,2,3-cd)pyrene	219	32	15	0.669	0.620	Yes
	Naphthalene	219	1	0	0.500	56	No
	Phenanthrene	219	3	1	1.10	3700	No
	Phenol	219	1	0	0.800	37000	No
	Pyrene	219	2	1	0.700	2300	No
	Tributyltin	154	39	25	0.012	18	No
	VOCs						
	1,2,4-Trimethylbenzene	156	2	1	1.60	52	No
	1,3,5-Trimethylbenzene	156	1	1	0.600	21	No
	Benzene	156	3	2	0.050	0.650	No
	n-Butylbenzene	156	1	1	0.600	140	No
	Naphthalene	156	2	1	0.700	56	No
	Styrene	156	1	1	1.60	1700	No

TABLE 7-5
TIER 1 EVALUATION
CHEMICALS DETECTED IN SOIL <2m
BASELINE RISK ASSESSMENT - ECOLOGICAL

Area	Chemical	Number of Samples	Number of Detects	Frequency of Detection (%)	Maximum Detected Concentration (mg/kg)	Ecological Soil Screening Values (mg/kg)	Exceed Soil Screening Values?
Area 1	*Metals*						
	Antimony	632	121	19	66.6	5	Yes
	Arsenic	632	469	74	54.4	9.9	Yes
	Barium	632	632	100	1100	283	Yes
	Beryllium	632	631	100	2.98	10	No
	Cadmium	632	434	69	18.1	4	Yes
	Chromium	632	630	100	2670	0.4	Yes
	Cobalt	632	632	100	70.3	20	Yes
	Copper	632	632	100	7680	60	Yes
	Hexavalent Chromium	165	36	22	392	--	--
	Lead	632	632	100	26300	40.5	Yes
	Mercury	632	217	34	1.06	0.0005	Yes
	Molybdenum	632	623	99	26.8	2	Yes
	Nickel	632	626	99	1780	30	Yes
	Selenium	632	463	73	7.4	0.21	Yes
	Silver	632	107	17	1.64	2	No
	Thallium	632	28	4	1.6	1	Yes
	Tin	632	456	72	139	50	Yes
	Vanadium	632	631	100	22.7	2	Yes
	Zinc	632	632	100	9090	8.5	Yes
	Cyanide						
	Cyanide	316	7	2	123	0.013	Yes
	PCBs						
	Aroclor-1260	31	1	3	0.2	0.001	Yes
	Dioxins & Furans						
	TCDD TEQ	10	10	100	6.1E-03	3.0E-07	Yes
	SVOCs						
	1-Methylnaphthalene	300	7	2	41.6	--	--
	2-Methylnaphthalene	300	7	2	60.7	--	--
	Benzo(a)anthracene	300	56	19	0.573	0.005	Yes
	Benzo(a)pyrene	300	49	16	0.552	5.7	No
	Benzo(b)fluoranthene	300	39	13	0.52	0.0009	Yes
	Benzo(k)fluoranthene	300	35	12	0.52	0.0009	Yes
	Bis(2-ethylhexyl)phthalate	300	2	1	16	0.63	Yes
	Chrysene	300	1	0	0.6	0.006	Yes
	Dibenz(a,h)anthracene	300	14	5	0.089	0.002	Yes
	Dimethylphthalate	300	9	3	42.1	200	No
	Di-n-butylphthalate	300	1	0	0.8	200	No
	Fluoranthene	300	1	0	0.9	3500	No
	Fluorene	300	2	1	6.9	40	No
	Indeno(1,2,3-cd)pyrene	300	44	15	0.483	0.006	Yes
	Naphthalene	300	6	2	20	390	No
	Phenanthrene	300	6	2	21.6	44	No
	Pyrene	300	2	1	0.9	740	No
	Tributyltin	16	2	13	0.0011	--	No
	VOCs						
	Acetone	262	38	15	7	7.9	Yes
	Benzene	262	1	0	11	170	No
	n-Butylbenzene	262	1	0	0.02	--	--
	Sec-Butylbenzene	262	4	2	0.9	--	--
	Tert-Butylbenzene	262	3	1	1.1	--	--
	Ethylbenzene	262	18	7	2	6200	No
	Isopropylbenzene	262	9	3	20.8	--	--
	MEK (2-Butanone)	262	3	1	2.6	--	--
	Methylene chloride	262	4	2	2.6	12	No
	Naphthalene	262	4	2	1.9	--	--
	n-Propylbenzene	262	2	1	0.7	--	--
	Styrene	262	1	0	3.3	300	No

TABLE 7-5
TIER 1 EVALUATION
CHEMICALS DETECTED IN SOIL <2m
BASELINE RISK ASSESSMENT - ECOLOGICAL

Area	Chemical	Number of Samples	Number of Detects	Frequency of Detection (%)	Maximum Detected Concentration (mg/kg)	Ecological Soil Screening Values (mg/kg)	Exceed Soil Screening Values?
Area 2	***Metals***						
	Antimony	475	90	19	16.9	5	Yes
	Arsenic	475	226	48	24.8	9.9	Yes
	Barium	475	475	100	3290	283	Yes
	Beryllium	475	475	100	1.67	10	No
	Cadmium	475	332	70	7.87	4	Yes
	Chromium	475	470	99	672	0.4	Yes
	Cobalt	475	475	100	67.8	20	Yes
	Copper	475	475	100	11400	60	Yes
	Hexavalent Chromium	86	14	16	4.2	--	--
	Lead	475	475	100	4630	40.5	Yes
	Mercury	475	66	14	0.8	0.0005	Yes
	Molybdenum	475	474	100	24.9	2	Yes
	Nickel	475	475	100	728	30	Yes
	Selenium	475	443	93	7.2	0.21	Yes
	Silver	475	70	15	3.51	2	Yes
	Thallium	475	76	16	1.1	1	Yes
	Tin	475	314	66	167	50	Yes
	Vanadium	475	467	98	31.4	2	Yes
	Zinc	475	473	100	5860	8.5	Yes
	Cyanide						
	Cyanide	87	2	2	5	0.013	Yes
	PCBs						
	Aroclor-1260	9	2	22	33.4	0.0014	Yes
	Herbicides						
	2,4-D	26	1	4	0.2	--	--
	MCPA	13	1	8	0.2	--	--
	MCPP	13	1	8	0.2	--	--
	Dioxins & Furans						
	TCDD TEQ	17	17	100	0.003	3.0E-07	Yes
	SVOCs						
	1-Methylnaphthalene	272	1	0	2.6	--	--
	2-Methylnaphthalene	272	1	0	5.2	--	--
	Acenaphthene	272	2	1	2.3	20	No
	Acenaphthylene	272	2	1	0.8	2400	No
	Anthracene	272	3	1	0.6	8700	No
	Benzo(a)anthracene	272	54	20	1.67	0.005	Yes
	Benzo(a)pyrene	272	50	18	1.9	5.7	No
	Benzo(b)fluoranthene	272	43	16	2.38	0.0009	Yes
	Benzo(g,h,i)perylene	272	7	3	1.9	--	--
	Benzo(k)fluoranthene	272	38	14	1.45	0.0009	Yes
	Bis(2-ethylhexyl)phthalate	272	4	1	46	0.63	Yes
	Chrysene	272	7	3	2.3	0.006	Yes
	Dibenz(a,h)anthracene	272	24	9	0.657	0.002	Yes
	Dibenzofuran	272	1	0	0.9	5000	No
	Dimethylphthalate	272	24	9	9.5	200	No
	Di-n-butylphthalate	272	3	1	1.2	200	No
	Fluoranthene	272	7	3	4.2	3500	No
	Fluorene	272	2	1	1.4	40	No
	Indeno(1,2,3-cd)pyrene	272	44	16	1.51	0.006	Yes
	Phenanthrene	272	4	1	4.3	44	No
	Pyrene	272	8	3	4.8	740	No
	Tributyltin	253	38	15	0.023	--	--
	VOCs						
	MEK (2-Butanone)	188	7	4	7	--	--
	Methylene chloride	188	4	2	2	12	No
	Styrene	188	1	1	6.3	300	No

TABLE 7-5
TIER 1 EVALUATION
CHEMICALS DETECTED IN SOIL <2m
BASELINE RISK ASSESSMENT - ECOLOGICAL

Area	Chemical	Number of Samples	Number of Detects	Frequency of Detection (%)	Maximum Detected Concentration (mg/kg)	Ecological Soil Screening Values (mg/kg)	Exceed Soil Screening Values?
Area 3	***Metals***						
	Antimony	307	90	29	59.5	5	Yes
	Arsenic	307	169	55	42	9.9	Yes
	Barium	307	307	100	4330	283	Yes
	Beryllium	307	307	100	2.18	10	No
	Cadmium	307	223	73	12	4	Yes
	Chromium	307	299	97	2740	0.4	Yes
	Cobalt	307	307	100	328	20	Yes
	Copper	307	307	100	28100	60	Yes
	Hexavalent Chromium	145	23	16	9.7	--	--
	Lead	307	307	100	6580	40.5	Yes
	Mercury	307	49	16	0.57	0.0005	Yes
	Molybdenum	307	307	100	599	2	Yes
	Nickel	307	307	100	1790	30	Yes
	Selenium	307	293	95	4.7	0.21	Yes
	Silver	307	96	31	4.11	2	Yes
	Thallium	307	79	26	1.6	1	Yes
	Tin	307	206	67	107	50	Yes
	Vanadium	307	297	97	331	2	Yes
	Zinc	307	303	99	23400	8.5	Yes
	Cyanide						
	Cyanide	141	1	1	1	0.013	Yes
	PCBs						
	Aroclor-1242	26	1	4	0.2	0.010	Yes
	Aroclor-1260	26	6	23	0.7	0.001	Yes
	Dioxins & Furans						
	TCDD TEQ	80	80	100	0.109	3.0E-07	Yes
	SVOCs						
	Benzo(a)anthracene	168	33	20	0.439	0.005	Yes
	Benzo(a)pyrene	168	28	17	0.547	5.7	No
	Benzo(b)fluoranthene	168	29	17	0.66	0.0009	Yes
	Benzo(k)fluoranthene	168	26	15	0.66	0.0009	Yes
	Bis(2-ethylhexyl)phthalate	168	1	1	11	0.63	Yes
	Chrysene	168	1	1	0.6	0.006	Yes
	Dibenz(a,h)anthracene	168	9	5	0.169	0.002	Yes
	Dimethylphthalate	168	10	6	38.2	200	No
	Di-n-butylphthalate	168	2	1	16.1	200	No
	Fluoranthene	168	1	1	0.6	3500	No
	Hexachlorobenzene	168	1	1	1	1000	No
	Indeno(1,2,3-cd)pyrene	168	24	14	0.669	0.006	Yes
	Phenanthrene	168	2	1	1.1	44	No
	Pyrene	168	1	1	0.7	740	No
	Tributyltin	125	38	30	0.012	--	--
	VOCs						
	1,2,4-Trimethylbenzene	150	2	1	1.6	--	--
	1,3,5-Trimethylbenzene	150	1	1	0.6	--	--
	Benzene	150	2	1	0.05	170	No
	n-Butylbenzene	150	2	1	0.7	--	--
	Naphthalene	150	1	1	0.6	--	--
	Styrene	150	1	1	1.6	300	No

Note:
NA: Not available

TABLE 7-6
TIER 1 EVALUATION
SURFACE WATER PATHWAY
BASELINE RISK ASSESSMENT - ECOLOGICAL

Chemical	Predicted Surface Water Concentration from Soil (mg/L)	Predicted Surface Water Concentration from Groundwater (ug/L)	Surface Water Chronic PRG[a] (ug/L)	Note	Chronic AWQC[b] (ug/L)	Note	Selected Screening Value[c] (ug/L)
Metals							
Antimony	2.5E-03	1.8E-04	3.0E+01	2	--		3.0E+01
Arsenic	2.8E-05	2.2E-03	1.9E+02	1	1.5E+02		1.5E+02
Barium	8.4E-04	2.4E-02	4.0E+00	2	--		4.0E+00
Beryllium	2.8E-05	--	6.6E-01	2	--		6.6E-01
Cadmium	1.3E-05	7.0E-04	1.1E+00	1;e	2.2E+00	e	1.1E+00
Chromium	2.1E-03	3.7E-03	1.1E+01	3	1.1E+01	3	1.1E+01
Cobalt	2.4E-03	2.0E-03	2.3E+01	2	--		2.3E+01
Copper	4.3E-04	4.7E-03	1.2E+01	1;e	9.0E+00	e	9.0E+00
Hexavalent Chromium	1.5E-04	--	1.1E+01	1	1.1E+01		1.1E+01
Lead	4.9E-04	4.6E-04	3.2E+00	1;e	2.5E+00	e	2.5E+00
Manganese	--	3.3E-01	1.2E+02	2	--		1.2E+02
Mercury	1.9E-07	--	1.3E+00	2	7.7E-01		7.7E-01
Molybdenum	4.1E-06	2.6E-03	3.7E+02	2	--		3.7E+02
Nickel	2.2E-04	6.6E-01	1.6E+02	1;e	5.2E+01	e	5.2E+01
Selenium	1.1E-05	1.4E-02	3.9E-01	4	5.0E+00		3.9E-01
Silver	3.3E-05	--	3.6E-01	2	--		3.6E-01
Thallium	1.6E-07	--	9.0E+00	4	--		9.0E+00
Tin	2.6E-02	--	7.3E+01	2	--		7.3E+01
Vanadium	2.4E-03	5.2E-03	2.0E+01	2	--		2.0E+01
Zinc	4.2E-03	7.2E-02	1.1E+02	1;e	1.2E+02	e	1.1E+02
Cyanide							
Cyanide	8.9E-04	1.8E-03	5.2E+00	1	5.2E+00		5.2E+00
SVOCs							
Bis(2-ethylhexyl)phthalate	3.1E-10	2.5E-03	1.2E-01	4	--		1.2E-01
Dimethylphthalate	1.9E-05	--	--				--
Di-n-butylphthalate	1.9E-08	3.6E-04	1.0E+00	5	--		1.0E+00
Naphthalene	2.1E-05	2.3E-03	1.2E+01	2	--		1.2E+01
Tributyltin	1.7E-09	7.6E-03	--		6.3E-02		6.3E-02
VOCs							
Chloroform	--	6.4E-05	2.8E+01	2	--		2.8E+01
MEK (2-Butanone)	1.9E-03	--	1.4E+04	2	--		1.4E+04
MTBE (methyl-tert-butyl ether)	--	1.0E-03	--		--		--
Methylene chloride	2.4E-04	--	2.2E+03	2	--		2.2E+03

Notes:

a - Efroymson, RA, GW Suter, II, BE Sample and DS Jones. 1997a. Preliminary Remediation Goals for Ecological Endpoints. Table 1. Oak Ridge National Laboratory, TN. Prepared for US Dept of Energy. August.

b - U.S. Environmental Protection Agency (USEPA). 1999. National Recommended Water Quality Criteria - Correction. Office of Water. EPA 822-Z-99-001. April.; dissolved metals (except iron).

c - Lower of the surface water chronic PRG and the Chronic AWQC.

d - Eisler, R. 1986. Dioxin Hazards to Fish, Wildlife, and Invertebrates: A Synoptic Review. US Fish and Wildlife Biological Report 85 (1.8). Contaminant Hazard Reviews Report No.8. May. 37pp.

e - Hardness-dependent values; 100 mg/L as $CaCO_3$ assumed.

1 - Chronic National Ambient Water Quality Criteria (NAWQC)

2 - Tier II, Secondary Chronic Value

3 - Based on criteria for Cr VI

4 - River otter LOAEL

5 - Belted kingfisher LOAEL

" -- " water quality criterion not available.

TABLE 7-7
TIER 2 EVALUATION
SOIL EPC SELECTION
BASELINE RISK ASSESSMENT

Area	Chemical	Data Set				Alternate EPCs				Selected EPC	
		Number of Samples	Number of Detects	Frequency of Detection (%)	Minimum Detected Concentration	T-based UCL95	Land Based UCL95	Chebychev UCL95	Maximum Detected Concentration	Selected Method	EPC (mg/kg)
Area 1	*Metals*										
	Antimony	642	122	19	0.050	0.445	0.070	0.754	66.6	C	0.754
	Arsenic	642	475	74	0.500	1.62	1.34	1.96	54.4	C	1.96
	Chromium	642	640	100	0.150	35.2	15.4	50.2	2670	C	50.2
	Copper	642	642	100	0.210	117	42.8	168	7680	C	168
	Hexavalent Chromium	169	37	22	0.600	11.4	1.43	19.8	392	C	19.8
	Lead	642	642	100	3.88	166	45.7	283	26300	C	283
	Nickel	642	636	99	0.080	32.1	15.0	44.9	1780	C	44.9
	Cyanide										
	Cyanide	324	7	2	1.0	1.58	0.005	2.65	123	C	2.65
	Dioxins & Furans										
	TCDD TEQ	10	10	100	4E-07	1.8E-03	2.1E+00	3.3E-03	6.1E-03	C	3.3E-03
	SVOCs										
	2-Methylnaphthalene	303	8	3	0.900	2.66	0.147	3.81	60.7	C	3.81
	Benzo(a)pyrene	303	51	17	0.006	0.033	0.016	0.044	0.552	C	0.044
	Dibenz(a,h)anthracene	303	14	5	0.006	0.024	0.009	0.033	0.089	C	0.033

TABLE 7-7
TIER 2 EVALUATION
SOIL EPC SELECTION
BASELINE RISK ASSESSMENT

Area	Chemical	Data Set				Alternate EPCs				Selected EPC	
		Number of Samples	Number of Detects	Frequency of Detection (%)	Minimum Detected Concentration	T-based UCL95	Land Based UCL95	Chebychev UCL95	Maximum Detected Concentration	Selected Method	EPC (mg/kg)
Area 2	*Metals*										
	Arsenic	492	233	47	0.500	1.11	0.109	1.39	24.8	C	1.39
	Chromium	492	487	99	0.160	20.1	8.49	28.4	672	C	28.4
	Copper	492	492	100	0.100	410	109	625	27900	C	625
	Lead	492	492	100	3.50	152	93.8	199	4630	C	199
	PCBs										
	Aroclor-1260	10	2	20	5.70	10.0	467	18.8	33.4	C	18.8
	Dioxin & Furans										
	TCDD TEQ	22	22	100	1.4E-06	1.3E-03	3.2E-01	2.1E-03	4.0E-03	C	2.1E-03
	SVOCs										
	Benzo(a)anthracene	279	56	20	0.006	0.063	0.016	0.097	1.67	C	0.097
	Benzo(a)pyrene	279	52	19	0.006	0.065	0.016	0.099	1.90	C	0.099
	Benzo(b)fluoranthene	279	45	16	0.010	0.081	0.024	0.120	2.38	C	0.120
	Bis(2-ethylhexyl)phthalate	279	4	1	5.0	10.7	3.87	16.2	46.0	C	16.2
	Dibenz(a,h)anthracene	279	24	9	0.006	0.020	0.007	0.029	0.657	C	0.029
	Indeno(1,2,3-cd)pyrene	279	46	16	0.006	0.053	0.015	0.079	1.51	C	0.079

TABLE 7-7
TIER 2 EVALUATION
SOIL EPC SELECTION
BASELINE RISK ASSESSMENT

Area	Chemical	Data Set				Alternate EPCs				Selected EPC	
		Number of Samples	Number of Detects	Frequency of Detection (%)	Minimum Detected Concentration	T-based UCL95	Land Based UCL95	Cheby chev UCL95	Maximum Detected Concentration	Selected Method	EPC (mg/kg)
Area 3	*Metals*										
	Antimony	378	121	32	0.050	4.39	1.08	7.14	340	C	7.14
	Arsenic	378	211	56	0.500	2.90	1.75	3.99	114	C	3.99
	Cadmium	378	278	74	0.020	1.32	0.0004	2.22	118	C	2.22
	Chromium	378	364	96	0.190	71.0	40.5	102	2740	C	102
	Copper	378	378	100	0.280	841	1480	1170	28100	C	1170
	Lead	378	378	100	7.93	418	191	611	21100	C	611
	Molybdenum	378	378	100	0.170	8.27	2.37	13.5	599	C	13.5
	Nickel	378	378	100	0.060	75.8	54.8	106	1790	C	106
	Zinc	378	370	98	0.800	869	396	1280	35700	C	1280
	PCBs										
	Aroclor-1260	35	7	20	0.100	0.488	0.215	0.882	0.700	C	0.700
	Dioxins & Furans										
	TCDD TEQ	114	114	100	9.3E-07	4.4E-03	8.7E-03	7.5E-03	1.1E-01	C	7.5E-03
	SVOCs										
	Benzo(a)pyrene	219	37	17	0.005	0.027	0.010	0.040	0.547	C	0.040
	Benzo(b)fluoranthene	219	38	17	0.010	0.041	0.017	0.059	0.660	C	0.059
	Bis(2-ethylhexyl)phthalate	219	2	1	11.0	15.5	4.29	25.1	563	C	25.1
	Dibenz(a,h)anthracene	219	11	5	0.006	0.015	0.005	0.022	0.169	C	0.022
	Hexachlorobenzene	219	1	0.46	1.0	2.53	0.156	3.94	1.0	C	1.0
	Indeno(1,2,3-cd)pyrene	219	32	15	0.005	0.025	0.009	0.038	0.669	C	0.038

TABLE 7-8
TIER 2 EVALUATION
SUMMARY OF NONCANCER HAZARD AND CANCER RISK
THEME PARK WORKERS AND VISITORS
BASELINE RISK ASSESSMENT - HUMAN HEALTH

Receptors and Areas of Concern	Cancer Risk	Noncancer Hazard
Park Worker		
Area 1 Soil	2E-04	1E-02
Area 2 Soil	1E-04	1E-02
Area 3 Soil	3E-04	4E-02
Surface Water	2E-09	9E-04
Fish Ingestion	3E-08	4E-02
Park Visitor		
Area 1 Soil	3E-06	8E-04
Area 2 Soil	2E-06	8E-04
Area 3 Soil	6E-06	3E-03
Surface Water	3E-11	4E-05
Fish Ingestion	3E-09	3E-03

Note:
Noncancer Hazard for the Park Visitor is based on exposure factors for a child.
Exposures to sitewide surface water include incidental ingestion and dermal contact

TABLE 8-1
RECOMMENDED CRITERIA FOR SOIL

Area	Chemical [1]	Dutch 'B' Criteria (mg/kg)	Site-specific Theme Park Worker Criteria (mg/kg)[2]	Background Metals Concentration (mg/kg)	Recommended Criteria [3]
Sitewide	Cyanide	50	35		35
	1,2,3,7,8,9-Hexa CDD		4.0E-04		1.5
	Total TCDD-TEQ		2.7E-05		0.001/0.0001
	Antimony		820	1	820
	Arsenic	30	27	4	30
	Barium	400	1.0E+05	309	400
	Cadmium	5	810	0.22	5
	Chromium	250	4500	10	250
	Cobalt	50	1.0E+05	5	50
	Copper	100	7.6E+04	11	100
	Hexavalent Chromium		640		64
	Lead	150	750	35	150
	Mercury	2	610	0.2	2
	Molybdenum	40	1.0E+04	5.7	40
	Nickel	100	4.1E+04	6	100
	Selenium		1.0E+04		1.0E+04
	Silver		1.0E+04	0.3	1.0E+04
	Thallium		130		130
	Tin	50	1.0E+05	30	50
	Vanadium		1.4E+05		1.4E+05
	Zinc	500	1.0E+05	52	500
	Aroclor-1242	1	10		1
	Aroclor-1260	1	10		1
	2-Methylnaphthalene		190		190
	Benzo(a)anthracene		2.9		0.29
	Benzo(a)pyrene	1	2.9		1
	Benzo(b)fluoranthene		29		2.9
	Benzo(k)fluoranthene		290		29
	Bis(2-ethylhexyl)phthalate		1800		180
	Chrysene		2900		290
	Dibenz(a,h)anthracene		2.9		0.29
	Indeno(1,2,3-cd)pyrene		29		2.9
	Naphthalene	5	190		5
	Phenanthrene	10	3.8E+04		10
	Carbon Chain C6 - C14	100			100
	Carbon Chain => C15	1000			1.0E+03
	Acetone		6.2E+03		6.2E+03
	Hexachlorobenzene	1	15		1
	Styrene	5	1.7E+03		5.0E+00

(1) Chemicals present at concentrations above any Tier 1 criteria
(2) Human health risk-based criteria based on cancer risk of 10^{-5} and Hazard Index of 1
(3) Assumes minimum of 3m of cover soil for human and 2m cover for ecological receptors
Blank spaces - No criteria available

Table 9-1
INITIAL SCREENING OF REMEDIAL TECHNOLOGIES AND PROCESS OPTIONS

General Response Action	Remedial Technology	Process Option	Description	Effectiveness	Implementability	Cost
NO ACTION	NONE	NOT APPLICABLE	No remedial action taken at site.	No reduction in concentrations, mobility, or potential for exposure to COPCs. Does not meet ARARs and does not support project development.	Not applicable	Not applicable
CONTAINMENT	PHYSICAL BARRIER	SOIL COVER	Area of impacted soil is contained by placement of soil fill cover as part of planned infrastructure development.	Does not reduce concentration, toxicity or mobility of COPCs. Reduces potential for exposure to COPCs. Does not meet ARARs.	Could be implemented at site using standard earthmoving equipment planned for site infrastructure development. Will restrict future site use.	Low
		ENTOMBMENT WITHIN LINED CELL BENEATH ENGINEERED CAP	Impacted soil is contained within an onsite cell with an engineered liner and cap.	Does not reduce concentration or toxicity of COPCs. Reduces mobility and potential for exposure to COPCs. Does not meet ARARs.	Operation & Maintenance Program required to assure liner and cap integrity. May restrict future site use. Would affect geotechnical properties of soils.	Medium to High
IN SITU TREATMENT	ACTIVE IN SITU TREATMENT	IN SITU STABILIZATION / SOLIDIFICATION	Contaminants are immobilized in soil by mixing with inorganic or organic chemical agents.	Effective for reducing solubility and environmental availability of metals. Effectiveness on organic constituents uncertain. Does not reduce toxicity of COPCs and only minimal reduction in concentration. Does not meet ARARs.	Presence of buried debris and depth of waste and burn pits would make mixing problematic. Confirmatory sampling difficult. Would affect geotechnical properties of soils.	High

General Response Action	Remedial Technology	Process Option	Description	Effectiveness	Implementability	Cost
		IN SITU VITRIFICATION	Electrodes are placed in the ground and used to heat the soil to extremely high temperatures converting it to a glass-like material.	Contaminants are permanently immobilized in a glass-like material; some destruction of COPCs by pyrolysis. Does not reduce concentration or toxicity of metals.	Shallow water table would make this technology very difficult to implement. Limited technology vendors are available. Would permanently alter geotechnical properties of soil. Would restrict future site use	Very high
		SVE / BIOVENTING	An induced vacuum is used to volatilize and remove VOCs from unsaturated soil. Volatilized chemicals are then treated to meet air discharge requirements.	Applicable to TPH and VOCs. Limited applicability to SVOCs. In situ ozonation can increase effectiveness on aromatic SVOCs. Not effective for metals and will not meet ARARs.	Could be implemented at the site. Long-term timeframe for implementation would likely affect site development schedule.	Medium
		SOIL FLUSHING	Contaminants are mobilized and flushed from soil by introduction of surfactant-containing flushing fluids. Flushing fluids are recovered via extraction wells and treated.	Effective for removing volatile chemicals and some SVOCs. Not effective for non-soluble metals species. Likely will not meet ARARs.	Recovery of flushing fluids difficult. Increased hydraulic head could drive contaminants laterally beyond capture zone and impact WRC. May alter geotechnical properties of soils.	High
	PASSIVE IN SITU TREATMENT	IN SITU BIOREMEDIATION	Moisture, oxygen, and nutrients are added to the soil to enhance biological degradation by naturally occurring or introduced microorganisms.	Most effective for nonhalogenated volatiles and fuel hydrocarbons. Not effective for SVOCs and dioxins. Does not address metals. Does not meet ARARs.	The timeframe to complete this option would adversely impact the projected site construction program.	Low to Medium

General Response Action	Remedial Technology	Process Option	Description	Effectiveness	Implementability	Cost
REMOVAL	REMOVAL	EXCAVATION	Impacted soil is removed using backhoes, large diameter augers, or other appropriate construction equipment. Removed soil would be subsequently treated or disposed.	Effective means for removing impacted soil. Would meet ARARs.	Vapor and fugitive dust control would be required. Dewatering may be required to address impacted soil below the water table.	Low to Medium
		OFFSITE LANDFILL DISPOSAL	Impacted soil removed from the site is transported to an appropriate approved facility for disposal. Some impacted soils would require pre-treatment prior to disposal.	Effective for removing impacted soil from the site. Mobility of the chemicals in the impacted soil is reduced by placing the material in a designed landfill facility.	Large volume of impacted soils would consume limited available landfill space in HK. Best applied when impacted soil volumes are low. May require design and permitting of a new secure landfill. Could meet public opposition.	Medium to high (for developing new landfill)
EX SITU TREATMENT	PHYSICAL TREATMENT	SOIL WASHING	An aqueous based wash solution is used to remove the VOCs from excavated soil. Operation is conducted in treatment cells or bins.	Could be effective for removing some organics and metals from soil. Significant quantities of residual wash solutions would be produced that require further treatment or disposal. Limited data available for treatment of dioxins.	Residual fines and wash solutions would require additional treatment or disposal. Amount of space required would be substantial. Limited experienced contractor availability.	Medium to High
		EX SITU SVE	Applying an induced vacuum to VOC impacted soil contained in a treatment cell. Extracted vapors would undergo further treatment.	Effective for removing volatile chemicals from soil with high permeability. Not as effective in low permeability soil and for seim-volatile chemicals.	Could be implemented at the site. However, the remediation timeframe would interfere with projected site construction program.	Medium

General Response Action	Remedial Technology	Process Option	Description	Effectiveness	Implementability	Cost
		EX SITU STABILIZATION / SOLIDIFICATION	Stabilizing agents such as cement, pozzolon and/or fly ash are mixed with soils forming a stable monolithic block. Stabilized soils subsequently can be incorporated in structural fill or land reclamation.	Primary effective in stabilizing inorganics such as metals. Not effective for treatment of organics due to interference with curing process. Some decrease in COPC concentration from dilution. Effectively reduces mobility of metals.	Readily implementable onsite or offsite. Requires establishment of treatment cells or batch treatment reactor. Well proven technology that can be implemented in relatively short timeframe.	Low to medium
	BIOLOGICAL TREATMENT	EX SITU BIOREMEDIATION (BIOPILE)	Moisture, oxygen, and nutrients are added to soil within a treatment cell to enhance chemical degradation by naturally occurring or introduced microorganisms.	Effective for biodegradable hydrocarbons and SVOCs. Not effective for treatment of dioxins. Presence of heavy metals may be toxic to microorganisms and inhibit degradation process.	Could be readily implemented for treatment of TPH, VOCs, and SVOCs. Would require treatability tests to evaluate potential negative impacts on degradation process and rates from heavy metals.	Low to medium
	THERMAL TREATMENT	THERMAL DESORPTION	Excavated soil is heated to volatilize organics. The volatilized chemicals are then treated to meet air discharge requirements.	Effective for treating soil containing VOCs, SVOCs, PCBs, pesticides and dioxins. Treatment can be conducted on- or offsite. Treated soil would be used as backfill material. Treatment residuals would require further treatment to destroy contaminants. Would not address metals contamination.	Thermal desporption is a well-established technology. Availability in HK is questionable. Would require treatability study to establish design parameters to meet treatment efficiency requirements for backfill of soils onsite.	Medium to high

General Response Action	Remedial Technology	Process Option	Description	Effectiveness	Implementability	Cost
		INCINERATION	Excavated soil is heated to high temperature to thermally oxidize and combust organic contaminants. Offgases are further treated in a secondary afterburner.	Highly effective for treating soil containing organics, including dioxins. Treatment would be conducted offsite. Would not address metals contamination.	Would require import of an incineration unit and trial burn to establish design parameters. Would be difficult to permit and may be met with public opposition.	High to very high

NOTE: Shading indicates the process option was not retained due to issues associated with effectiveness and/or implementability.

APPENDIX C

EVALUATION OF INTERMEDIA TRANSFERS AND ASSOCIATED EXPOSURE POINT CONCENTRATIONS

Intermedia Transfer Factors

When chemicals move from one environmental medium to another (e.g., groundwater to outdoor air) the chemical movement is referred to as an intermedia transfer. Intermedia transfers can be mathematically modeled, provided the transfer rates between compartments representing the relevant media can be reasonably estimated. The chemical flux rates into receiving environmental media can be evaluated using mixing models and the resulting concentration estimates used to evaluate potential human exposures. For this risk assessment study, exposure point concentrations (EPCs) were calculated individually for each chemical of potential concern (COPC) using intermedia transfer factors (ITFs) developed from mass-balance principles. The operational definition of and ITF is as follows.

$$ITF = \left(\frac{C_{exposure}}{C_{source}} \right)$$

where,

$C_{exposure}$ = Exposure point concentration (also called EPC; units vary depending on which exposure medium is considered),

C_{source} = Source medium concentration (units vary depending on which source medium is considered).

For the specific source media and exposure media evaluated in this risk assessment study, ITFs are defined as follows.

$$ITF_{soil \rightarrow lake} = \left(\frac{C_{lake\text{-}soil}}{C_{soil}} \right)$$

$$ITF_{groundwater \rightarrow lake} = \left(\frac{C_{lake\text{-}GW}}{C_{groundwater}} \right)$$

Soil Leachate and Groundwater Mixing Model

The "box model" is based on the principle of conservation of mass. In applications of this model various environmental media are simulated as distinct compartments (or "boxes"). All of the chemical mass that enters an environmental compartment is considered to mix uniformly and eventually reach a steady-state (i.e., constant) concentration. The rate of mixing, and the resulting chemical concentrations, are governed by the compartment volume(s), surface area(s) available for chemical exchanges, and chemical and bulk fluid exchange rates between compartments.

For this study, groundwater chemical concentrations resulting from soil leaching were calculated using the Summers model (USEPA, 1989; Summers et al., 1980):

$$C_{gws} = \frac{Q_{pw} \cdot C_{pw} + Q_{mz} \cdot C_{mz}}{Q_{pw} + Q_{mz}}$$

where

C_{gws}	=	concentration in groundwater mixing zone resulting from soil leaching (g/m^3)
Q_{pw}	=	volumetric flow rate of soil pore water infiltrating through soil (m^3/day)
C_{pw}	=	chemical concentration in soil pore water leachate (g/m^3)
Q_{mz}	=	volumetric flow rate of ambient groundwater through the mixing zone (m^3/day)
C_{mz}	=	background chemical concentration in ambient groundwater (g/m^3)

Q_{pw} was calculated from the net infiltration equation:

Net infiltration = rainfall − evapotranspiration − runoff

C_{pw} was calculated from the equilibrium soil chemical partitioning eqution:

$$C_{pw} = C_{soil}/K_d$$

where

C_{soil}	=	chemical concentration in soil (mg/Kg)
K_d	=	soil-water partition coefficient (mL/g)

Q_{mz} was calculated from Darcy's law:

$$Q_{mz} = K \cdot A \cdot \frac{dh}{dL}$$

where

$\frac{dh}{dL}$	=	groundwater hydraulic gradient across mixing zone (unitless)
K	=	groundwater aquifer hydraulic conductivity (m/day)
A	=	cross-sectional area of mixing zone perpendicular to direction of groundwater flow (m^2); this is calculated from the product of the *Site Width* perpendicular to direction of groundwater flow (m) and the leachate penetration depth into the aquifer (P_d) (m):

$$A = (Site\ Width)(P_d)$$

P_d was calculated from the following equation (USEPA, 1988):

$$P_d = (2 \cdot \alpha \cdot L)^{0.5} + d\left(1 - \exp\left[-\frac{L \cdot I}{d \cdot V_x \cdot p}\right]\right)$$

P_d	=	penetration depth (m)
α_v	=	vertical dispersivity coefficient (m)
L	=	length of source (e.g., landfill) parallel to primary groundwater flow direction (m)
D	=	thickness of aquifer (m)
V_x	=	longitudinal seepage velocity (m)
I	=	infiltration velocity (m/yr)
p	=	effective porosity (unitless)

Upward Diffusion and Chemical Mixing in Lake

Soil-to-lake ITFs were developed using $C_{lake\text{-}soil}$ values calculated from Fick's second law combined with the mixing box model. A conservative assumption was made that no attenuation of groundwater chemical concentrations occurred during lateral transport from the mixing zone beneath the source area to the area beneath the lake. The following chemical fate and transport equations were used to calculate $C_{lake\text{-}soil}$.

$$C_{lake\text{-}soil}\left[\frac{mg}{L}\right] = \left(\frac{J}{k}\right)$$

where,

$$J\left[\frac{mg}{m^3 - s}\right] = D_{cm}\frac{\left(C_{gws} - C_{Li}\right)}{L_{cm}} \cdot \frac{A_L}{V_L}$$

$$k\left[\frac{1}{s}\right] = \left(\frac{Q_L}{V_L}\right)$$

where

A_L	=	Area of the artificial lake bottom subject to chemical diffusion [m^2]
C_{Li}	=	Initial chemical concentration in lake water [mg/m^3]
D_{cm}	=	Diffusion coefficient for chemical flux through HDPE liner [m^2/sec]
L_{cm}	=	Thickness of HDPE liner placed at the bottom of the lake [m]
Q_L	=	Volumetric flowrate of water exchanged in lake [m^3/sec]
V_L	=	Volume of the artificial lake [m^3]

Groundwater-to-lake ITFs were developed using $C_{lake\text{-}GW}$ values calculated Fick's from second law combined with the mixing box model. A conservative assumption was made that no attenuation of groundwater chemical concentrations occurred during lateral transport from source area groundwater to the area beneath the lake. The following chemical fate and transport equations were used to calculate $C_{lake\text{-}GW}$.

$$C_{lake\text{-}GW}\left[\frac{mg}{L}\right] = \left(\frac{J}{k}\right)$$

where,

$$J\left[\frac{mg}{m^3 - s}\right] = D_{cm}\frac{\left(C_{gww} - C_{Li}\right)}{L_{cm}} \cdot \frac{A_L}{V_L}$$

$$k\left[\frac{1}{s}\right] = \left(\frac{Q_L}{V_L}\right)$$

$$C_{gw}\left[\frac{mg}{L}\right] = C_{groundwater}$$

where

C_{gw} = Chemical concentration measured in groundwater wells [mg/m^3]

Model Input Parameters

Parameters for Modeling Soil Infiltration and Chemical Leaching

Parameter	Units	Value Used	Source/Rationale
rainfall	m/year	2.22	Annual average rainfall in Hong Kong (2,220 mm/yr)
evapotranspiration	m/year	1.02	Average evapotranspiration in Hong Kong (2.8 mm/day)
runoff	m/year	1.11	Assume runoff coefficient of 0.5 (conservative estimate)
C_{soil}	mg/kg	various	Based on maximum detected soil chemical concentrations
K_d	mL/g	various	USEPA (2001), EPRI (1988), USEPA (2002), Syrres.com (2002), Schwartzenbach et al. (1993)

Parameters for Modeling Groundwater Mixing

Parameter	Units	Value Used	Source/Rationale
dh/dL	unitless	0.0024	Estimated water levels 4m Pd at CLS site and 3m Pd below artificial lake. Average distance between CLS site and artificial lake 125 m.
A	m^2	24,000	Assume typical soil chemical leaching source area.
K	m/sec	1 x 10^{-4}	Hydraulic conductivity for deep compacted sand fill
Site Width	m	155	Square root of typical soil chemical leaching source area
α_v	m	1.2	[1/10][(1/10)(travel distance)] = (0.01)(125 m)
L	m	155	Square root of typical soil chemical leaching source area
D	m	15	Approximate depth of alluvial sediments and fill above grade III rock
I	m/yr	2.5 x 10^{-4}	Rainfall - Evapotranspiration - Runoff (see infiltration summary table)
p	unitless	0.25	Porosity of deep compacted sand fill

Parameters for Modeling Upward Diffusion and Chemical Mixing in Lake

Parameter	Units	Value Used	Source/Rationale
A_L	m^2	120,000	Obtained from civil engineering design report for lake
$C_{L,i}$	mg/L	0	Conservative assumption for maximum concentration gradient
D_{cm}	m^2/sec	2×10^{-13}	Diffusion of aqueous toluene through HDPE liner (Rowe, 1998)
L_{cm}	m	1.52×10^{-3}	60 mil liner thickness (equivalent m)
Q_L	m^3/sec	0.178	Average water usage for irrigation (15,408 m^3/day)
V_L	m^3	120,000	Obtained from civil engineering design report for lake
$C_{groundwater}$	mg/L	various	Based on maximum detected groundwater chemical concentrations

CALCULATION OF LARGE ORGANIC MOLECULES' RETARDATION FACTORS AND TRAVEL TIMES

Calculate retardation factors

*log Koc (L/kg) = 0.00028 + (0.983 x log Kow) **

*Kd = foc * Koc*

Chem	*log Kow*	*Koc*	*foc*	*Kd*
Dioxin	6.64	3.37E+06	6.00E-03	2.02E+04
PAH	3.34	1.93E+03	6.00E-03	1.16E+01
PCB	3.36	2.02E+03	6.00E-03	1.21E+01

*R = 1 + ((Kd * Pb)/n)*

Pb	*n*	*R*
1.8	0.25	145,508
1.8	0.25	84
1.8	0.25	88

Calculate groundwater flow rate

K	1.00E-04	m/s
dh/dL	0.0024	unitless
n	0.25	unitless

*Vx = (K/n) * dh/dL*

Vx =	9.60E-07	m/s
	30.3	m/yr

Calculate travel times

Travel distance	125	m

Travel time = (Travel distance)/Vx

Travel times (to cross Travel distance)		
tracer	4.1	years
Dioxin	600,374	years
PAH	348	years
PCB	364	years

* USEPA (1996)

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TABLE 1
PREDICTED LAKE CONCENTRATIONS FROM SOIL LEACHING

Area	Chemical	Kd (mL/g)	Pore Water Conc (mg/L)	Lake Concentration (mg/L)
Area 1	2-Butanone (MEK)	0.027	259.2593	0.001871
Area 1	2-Methylnaphthalene	1000.792	0.060652	4.38E-07
Area 1	Acetone	0.00345	3188.406	0.023004
Area 1	Antimony	1	66.6	0.000481
Area 1	Aroclor-1260	10145653	1.97E-08	1.42E-13
Area 1	Arsenic	29	1.875862	1.35E-05
Area 1	Barium	40	27.5	0.000198
Area 1	Benzene	0.372	0.053763	3.88E-07
Area 1	Beryllium	1	3.92	2.83E-05
Area 1	Bis(2-ethylhexyl)phthalate	13025188	1.23E-06	8.86E-12
Area 1	Cadmium	64	0.282813	2.04E-06
Area 1	Chromium	19	140.5263	0.001014
Area 1	Chrysene	2388	0.000251	1.81E-09
Area 1	Cobalt	1	70.3	0.000507
Area 1	Copper	472.5	16.25397	0.000117
Area 1	Cyanide	1	123	0.000887
Area 1	Di-n-butylphthalate	6120.685	0.000131	9.43E-10
Area 1	Dibenz(a,h)anthracene	420107.1	2.12E-07	1.53E-12
Area 1	Dimethylphthalate	15.62399	2.694574	1.94E-05
Area 1	Ethylbenzene	1.224	0.735294	5.31E-06
Area 1	Hexavalent Chromium	19	20.63158	0.000149
Area 1	Isopropylbenzene	1.32	0.833333	6.01E-06
Area 1	Lead	388.5714	67.68382	0.000488
Area 1	Mercury	40	0.0265	1.91E-07
Area 1	Methylene chloride	0.06	33.33333	0.000241
Area 1	Molybdenum	1056.054	0.025377	1.83E-07
Area 1	Naphthalene	7.146	2.910719	2.1E-05
Area 1	Nickel	58	30.68966	0.000221
Area 1	Sec-Butylbenzene	12.9	0.147287	1.06E-06
Area 1	Selenium	5.3	1.396226	1.01E-05
Area 1	Silver	6.6	0.248485	1.79E-06
Area 1	Styrene	5.472	0.127924	9.23E-07
Area 1	Tert-Butylbenzene	12.9	0.255814	1.85E-06
Area 1	Thallium	71	0.022535	1.63E-07
Area 1	Tin	1	139	0.001003
Area 1	Tributyltin	7360.037	1.49E-07	1.08E-12
Area 1	Vanadium	1	22.7	0.000164
Area 1	Zinc	62	146.6129	0.001058
Area 1	n-Butylbenzene	16.98	0.153121	1.1E-06
Area 1	n-Propylbenzene	16.98	0.153121	1.1E-06
Area 2	2,4-DB (2,4-Dichlorophenoxybut	789.7179	0.000253	1.83E-09
Area 2	2-Butanone (MEK)	0.027	259.2593	0.001871
Area 2	2-Methylnaphthalene	1000.792	0.005196	3.75E-08
Area 2	Anthracene	141	0.004255	3.07E-08
Area 2	Antimony	1	17.3	0.000125

TABLE 1
PREDICTED LAKE CONCENTRATIONS FROM SOIL LEACHING

Area	Chemical	Kd (mL/g)	Pore Water Conc (mg/L)	Lake Concentration (mg/L)
Area 2	Arsenic	29	0.855172	6.17E-06
Area 2	Barium	40	82.25	0.000593
Area 2	Beryllium	1	1.67	1.2E-05
Area 2	Bis(2-ethylhexyl)phthalate	13025188	3.53E-06	2.55E-11
Area 2	Cadmium	64	0.201563	1.45E-06
Area 2	Chromium	19	35.36842	0.000255
Area 2	Chrysene	2388	0.000963	6.95E-09
Area 2	Cobalt	1	67.8	0.000489
Area 2	Copper	472.5	59.04762	0.000426
Area 2	Cyanide	1	5	3.61E-05
Area 2	Di-n-butylphthalate	6120.685	0.000196	1.41E-09
Area 2	Hexavalent Chromium	19	0.221053	1.59E-06
Area 2	Lead	388.5714	11.91544	8.6E-05
Area 2	MCPA (Acetic acid, (4-chloro-2-	88.63393	0.002256	1.63E-08
Area 2	MCPP	206.5799	0.000968	6.99E-09
Area 2	Mercury	40	0.02	1.44E-07
Area 2	Methylene chloride	0.06	33.33333	0.000241
Area 2	Molybdenum	1056.054	0.023578	1.7E-07
Area 2	Nickel	58	12.55172	9.06E-05
Area 2	Selenium	5.3	1.358491	9.8E-06
Area 2	Silver	6.6	1.086364	7.84E-06
Area 2	Styrene	5.472	1.151316	8.31E-06
Area 2	Thallium	71	0.015493	1.12E-07
Area 2	Tin	1	232	0.001674
Area 2	Tributyltin	7360.037	3.12E-06	2.25E-11
Area 2	Vanadium	1	31.4	0.000227
Area 2	Zinc	62	110.3226	0.000796
Area 3	1,2,4-Trimethylbenzene	22.32	0.071685	5.17E-07
Area 3	1,3,5-Trimethylbenzene	4.914	0.1221	8.81E-07
Area 3	3/4-Methylphenol	34.90503	0.171895	1.24E-06
Area 3	Antimony	1	340	0.002453
Area 3	Arsenic	29	3.931034	2.84E-05
Area 3	Barium	40	116.5	0.000841
Area 3	Benzene	0.372	0.134409	9.7E-07
Area 3	Beryllium	1	2.18	1.57E-05
Area 3	Bis(2-ethylhexyl)phthalate	13025188	4.32E-05	3.12E-10
Area 3	Cadmium	64	1.84375	1.33E-05
Area 3	Chromium	19	283.6842	0.002047
Area 3	Chrysene	2388	0.000251	1.81E-09
Area 3	Cobalt	1	328	0.002367
Area 3	Copper	472.5	59.4709	0.000429
Area 3	Cyanide	1	1	7.22E-06
Area 3	Di-n-butylphthalate	6120.685	0.00263	1.9E-08
Area 3	Dimethylphthalate	15.62399	2.688173	1.94E-05
Area 3	Hexachlorobenzene	77054.85	1.3E-05	9.36E-11

TABLE 1

PREDICTED LAKE CONCENTRATIONS FROM SOIL LEACHING

Area	Chemical	Kd (mL/g)	Pore Water Conc (mg/L)	Lake Concentration (mg/L)
Area 3	Hexavalent Chromium	19	1.6	1.15E-05
Area 3	Indeno(1,2,3-cd)pyrene	420107.1	1.59E-06	1.15E-11
Area 3	Lead	388.5714	54.30147	0.000392
Area 3	Mercury	40	0.01425	1.03E-07
Area 3	Molybdenum	1056.054	0.567206	4.09E-06
Area 3	Naphthalene	7.146	0.097957	7.07E-07
Area 3	Nickel	58	30.86207	0.000223
Area 3	Phenanthrene	3577.668	0.000307	2.22E-09
Area 3	Phenol	11.515	0.112896	8.15E-07
Area 3	Pyrene	407.952	0.001716	1.24E-08
Area 3	Selenium	5.3	1.528302	1.1E-05
Area 3	Silver	6.6	4.530303	3.27E-05
Area 3	Styrene	5.472	0.292398	2.11E-06
Area 3	Thallium	71	0.022535	1.63E-07
Area 3	Tin	1	3650	0.026335
Area 3	Tributyltin	7360.037	0.000242	1.74E-09
Area 3	Vanadium	1	331	0.002388
Area 3	Zinc	62	575.8065	0.004154
Area 3	n-Butylbenzene	16.98	0.035336	2.55E-07

TABLE 2
PREDICTED LAKE CONCENTRATIONS FROM GROUNDWATER

Chemical	Maximum Concentration	units	units (ug/L)	Dilution Factor	Lake conc (ug/L)
Cyanide	20	ug/l	20	11000	1.82E-03
Antimony	2	ug/l	2	11000	1.82E-04
Arsenic	24	ug/l	24	11000	2.18E-03
Barium	261	ug/l	261	11000	2.37E-02
Cadmium	7.7	ug/l	7.7	11000	7.00E-04
Chromium	41	ug/l	41	11000	3.73E-03
Cobalt	22	ug/l	22	11000	2.00E-03
Copper	52	ug/l	52	11000	4.73E-03
Lead	5	ug/l	5	11000	4.55E-04
Magnesium	914	mg/l	914000	11000	8.31E+01
Manganese	3.61	mg/l	3610	11000	3.28E-01
Molybdenum	29	ug/l	29	11000	2.64E-03
Nickel	7200	ug/l	7200	11000	6.55E-01
Selenium	153	ug/l	153	11000	1.39E-02
Vanadium	57	ug/l	57	11000	5.18E-03
Zinc	788	ug/l	788	11000	7.16E-02
Bis(2-ethylhexyl)phthalate	27	ug/l	27	11000	2.45E-03
Di-n-butylphthalate	4	ug/l	4	11000	3.64E-04
Naphthalene	25	ug/l	25	11000	2.27E-03
Tributyltin	84	ng/l	84	11000	7.64E-03
Chloroform	0.7	ug/l	0.7	11000	6.36E-05
Methyl-tert-butyl ether	11	ug/l	11	11000	1.00E-03

TABLE 1

Tier 2 Analysis

Calculation of Chemical Concentrations in Surface Water and Fish - SMOZ-West[a] Sediment

60 mil Liner

Hong Kong Disneyland

Phase 1 Remedial Investigation

	95 UCL Sediment Concentration (Cs)	Soil/Water Partition Coefficient (Kd) (l/kg)	Organic Carbon Partition Coefficient (Koc)(L/kg)	Fraction of Organic Carbon in Soil (Foc)	Log Kow	Pore Water Concentration (mg/L)	Surface Water Concentration (mg/L) (a)	Fish Concentration (mg/kg)
METAL (mg/kg)								
Arsenic	5.00	2.90E+01	NA	NA	2.544	0.17	1.6E-05	3.84E-03
Cadmium	0.12	7.50E+01	NA	NA	2.513	0.002	1.5E-07	3.32E-05
Chromium (b)	41.20	1.90E+01	NA	NA	NA	2.17	2.0E-04	NA
Mercury	0.19	5.20E+01	NA	NA	2.000	0.00	3.3E-07	2.33E-05
Lead	25.60	4.50E+00	NA	NA	NA	5.69	5.2E-04	NA
SVOC (ug/mg)								
Hexachlorobenzene	74.12	3.26E+02	5.50E+04	0.006	5.470	2.3E-04	2.1E-08	4.27E-03
2-Methylnaphthalene	50.00	NA	NA	0.006	NA	NA	NA	NA
Naphthalene	75.40	7.06E+00	1.19E+03	0.006	3.870	1.1E-02	9.7E-07	5.04E-03
Acenapthylene	50.00	2.90E+01	4.90E+03	0.006	4.070	1.7E-03	1.6E-07	1.29E-03
Chrysene	70.70	2.36E+03	3.98E+05	0.006	5.860	3.0E-05	2.7E-09	1.38E-03
Benzo(a)anthracene	63.20	2.12E+03	3.58E+05	0.006	5.910	3.0E-05	2.7E-09	1.54E-03
Dibenzo(a,h) anthracene	21.80	1.01E+04	1.70E+06	0.006	6.750	2.2E-06	1.4E-12	5.48E-06
Fluoranthene	73.80	2.91E+02	4.91E+04	0.006	5.220	2.5E-04	2.3E-08	2.68E-03
Indeno[1,2,3-cd]pyrene	53.50	2.06E+04	3.47E+06	0.006	7.000	2.6E-06	2.4E-10	1.65E-03
Pyrene	66.80	4.03E+02	6.80E+04	0.006	5.180	1.7E-04	1.5E-08	1.60E-03
Dimethyl phthalate	26.80	6.23E+02	1.05E+05	0.006	1.610	4.3E-05	3.9E-09	1.12E-07
Diethyl phthalate	166.10	4.87E-01	8.22E+01	0.006	1.400	3.4E-01	3.1E-05	5.45E-04
Di-n-butyl phthalate	461.10	9.31E+00	1.57E+03	0.006	4.130	5.0E-02	4.5E-06	4.25E-02
Butyl benzyl phthalate	1478.30	8.12E+01	1.37E+04	0.006	4.050	1.8E-02	1.7E-06	1.30E-02
Bis[2-ethylhexyl]phthalate	1481.20	6.58E+02	1.11E+05	0.006	4.200	2.3E-03	2.0E-07	2.27E-03
Di-n-octyl phthalate	33.60	4.92E+05	8.30E+07	0.006	8.060	6.8E-08	6.2E-12	4.99E-04
Phenol	24.30	1.71E-01	2.88E+01	0.006	1.460	1.4E-01	1.3E-05	2.61E-04
VOC (ug/kg)								
Methylene chloride	23.30	8.30E-01	1.40E+02	0.006	NA	2.8E-02	2.6E-06	NA
TBT (ug/L)								
Tributyl Tin ion	0.05	NA	NA	NA	3.740	0.08	7.0E-06	2.69E-02

NA - Not Applicable

(a) Includes chemicals relevant for fish pathway (US EPA, 1997) and chemicals exceeding Tier I critieria (chromium, lead and methylene chloride)

(b) Kd for Cr (VI) used, more mobile than Cr III

Maximum Contaminant Levels: Methylene Chloride - 0.005 mg/L; Chromium - 0.100 mg/L; Lead - 0.015 mg/L

Transport is described by one-dimensional diffusion (Fick's second law).

The source concentration is represented by the calculated pore water concentration.

The source concentration is assumed to remain constant with time.

The concentration of chemical in the lake is assumed to be negligible compared with the source concentration.

The model assumes soil voids are filled completely with water.

TABLE 2
Tier 2 Analysis
Hazard Index and Cancer Risk Estimates - SMOZ-West Sediment
60 mil Liner
Hong Kong Disneyland
Phase 1 Remedial Investigation

COPC	Predicted Fish Conc (mg/kg)	Reference Dose (mg/kg/day)	Cancer Slope Factor (mg/kg-day)-1	ADD (mg/kg/day)	LADD (mg/kg/day)	HI unitless	RISK unitless
Metals							
Arsenic	3.84E-03	0.0003	1.5	4.09E-07	1.46E-07	1.36E-03	2.19E-07
Cadmium	3.32E-05	0.0005		3.54E-09	1.26E-09	7.07E-06	
Mercury	2.33E-05	0.0001		2.48E-09	8.85E-10	2.48E-05	
SVOCs							
Hexachlorobenzene	4.27E-03	0.0008	1.60	4.55E-07	1.63E-07	5.69E-04	2.60E-07
2-Methylnaphthalene	NA	NA		NA	NA		
Naphthalene	5.04E-03	0.020		5.37E-07	1.92E-07	2.69E-05	
Acenapthylene	1.29E-03	0.0600		1.37E-07	4.90E-08	2.29E-06	
Chrysene	1.38E-03		0.007	1.47E-07	5.26E-08		3.68E-10
Benzo(a)anthracene	1.54E-03		0.730	1.64E-07	5.86E-08		4.28E-08
Dibenzo(a,h) anthracene	5.48E-06		7.3	5.85E-10	2.09E-10		1.52E-09
Fluoranthene	2.68E-03	0.04		2.85E-07	1.02E-07	7.14E-06	
Indeno[1,2,3-cd]pyrene	1.65E-03		0.73	1.76E-07	6.30E-08		4.60E-08
Pyrene	1.60E-03	0.03		1.70E-07	6.08E-08	5.67E-06	
Dimethyl phthalate	1.12E-07	10		1.19E-11	4.25E-12	1.19E-12	
Diethyl phthalate	5.45E-04	0.8		5.81E-08	2.07E-08	7.26E-08	
Di-n-butyl phthalate	4.25E-02	0.1		4.53E-06	1.62E-06	4.53E-05	
Butyl benzyl phthalate	1.30E-02	0.2		1.39E-06	4.95E-07	6.93E-06	
Bis[2-ethylhexyl]phthalate	2.27E-03	0.02	0.014	2.42E-07	8.64E-08	1.21E-05	1.21E-09
Di-n-octyl phthalate	4.99E-04	0.02		5.32E-08	1.90E-08	2.66E-06	
TBT							
Tributyl Tin ion	2.69E-02	0.0003		2.87E-06	1.02E-06	9.56E-03	
TOTAL						**1E-02**	**6E-07**

Notes: "NA" not applicable/not available

Equations:

where: LADD = Cf * IR * EF * ED * 1/CF * 1/ BW * 1/Atc

Cancer Risk = (LADD * CSF) ADD = Cf * IR * EF * ED * 1/CF * 1/ BW * 1/Atnc

Hazard Index = (ADD/RfD)

Exposure Parameter	Units	RME Value
Chemical Concentration in Fish (Cf)	mg/kg	--
Ingestion Rate of Fish (IR)	g/meal	227
Exposure Frequency (EF)	meals/year	12
Exposure Duration (ED)	years	25
Conversion Factor (CF)	g/kg	1.0E+03
Body Weight (BW)	kg	70
Averaging Time (cancer) (ATc)	days	25,550
Averaging Time (noncancer) (ATnc)	unitless	9,125

TABLE C-1
EXPOSURE PARAMETERS FOR PARK WORKERS
VALUES USED FOR SOIL INTAKE CALCULATIONS

Exposure Route	Parameter Code	Parameter Definition	Units	RME Value	RME Rationale/ Reference	Intake Equation/ Model Name
Incidental Ingestion	CS	Chemical Concentration in Soil	mg/kg	--	--	Chronic Daily Intake (CDI) (mg/kg/day) =
	IR-S	Ingestion Rate of Soil	mg/day	50	USEPA 1991	
	EF	Exposure Frequency	days/year	250	USEPA 1991	For evaluating noncarcinogens:
	ED	Exposure Duration	years	25	USEPA 1991	= CS x IR-S x EF x ED x CF x 1/BW x 1/AT-N
	CF	Conversion Factor	kg/mg	1.0E-06	--	
	BW	Body Weight	kilograms	70	USEPA 1989	For evaluating carcinogens:
	AT-C	Averaging Time (Cancer)	days	25,550	USEPA 1989	= CS x IR-S x EF x ED x CF x 1/BW x 1/AT-C
	AT-N	Averaging Time (Non-cancer)	days	ED x 365	USEPA 1989	
Dermal Contact	CS	Chemical Concentration in Soil	mg/kg	--	--	Chronic Daily Intake (CDI) (mg/kg/day) =
	SA	Surface Area Available for Contact	cm^2/day	3,300	USEPA 2000	
	EF	Exposure Frequency	days/year	250	USEPA 1991	For evaluating noncarcinogens:
	ED	Exposure Duration	years	25	USEPA 1991	= CS x SA x EF x ED x AF x AbsD x CF x 1/BW x 1/AT-N
	AF	Adherence Factor	mg/cm^2	0.2	USEPA 2000	
	AbsD	Dermal Absorption	unitless	chemical-specific	USEPA 2000	For evaluating carcinogens:
	CF	Conversion Factor	kg/mg	1.0E-06	--	= CS x SA x EF x ED x AF x AbsD x CF x 1/BW x 1/AT-C
	BW	Body Weight	kilograms	70	USEPA 1989	
	AT-C	Averaging Time (Cancer)	days	25,550	USEPA 1989	
	AT-N	Averaging Time (Non-cancer)	days	ED x 365	USEPA 1989	
Inhalation	CS	Chemical Concentration in Soil	mg/kg	--	--	Chronic Daily Intake (CDI) (mg/kg/day) =
	CA	Chemical Concentration in Outdoor Air	mg/m^3	CS x NAAQS	CalEPA 1994	
	NAAQS	National Ambient Air Quality Standard	kg/m^3	5.0E-08	CalEPA 1994	CA = CS x 5.0E-08 kg/m^3
	IR-A	Inhalation Rate	m^3/day	20	USEPA 1991	For evaluating noncarcinogens:
	EF	Exposure Frequency	days/year	250	USEPA 1991	= CA x IR-A x EF x ED x 1/BW x 1/AT-N
	ED	Exposure Duration	years	25	USEPA 1991	
	BW	Body Weight	kilograms	70	USEPA 1989	For evaluating carcinogens:
	AT-C	Averaging Time (Cancer)	days	25,550	USEPA 1989	= CA x IR-A x EF x ED x 1/BW x 1/AT-C
	AT-N	Averaging Time (Non-cancer)	days	ED x 365	USEPA 1989	

NOTES: na: not applicable; -- not available

Sources: CalEPA 1994. Preliminary Endangerment Assessment Guidance Manual. January. (Second Printing, June 1999).

USEPA 1989. Risk Assessment Guidance for Superfund. Volume I: Human Health Evaluation Manual, Part A. OERR. EPA/540/1-89/002.

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USEPA 1996. Soil Screening Guidance: User's Guide. Second Edition. Office of Emergency and Remedial Response. Washington, D.C. EPA 540/R-96/018.

USEPA 2000. RAGS Vol I: Human Health Evaluation Manual, Part E, Supplemental Guidance for Dermal Risk Assessment, Interim Guidance. EPA/540/R-99/005.

TABLE C-2
EXPOSURE PARAMETERS FOR PARK WORKERS
VALUES USED FOR SURFACE WATER INTAKE CALCULATIONS

Exposure Route	Parameter Code	Parameter Definition	Units	RME Value	RME Rationale/ Reference	Intake Equation/ Model Name
Incidental Ingestion	CW	Chemical Concentration in Water	ug/l	--	--	Chronic Daily Intake (CDI) (mg/kg/day) =
	IR-W	Incidental Ingestion Rate of Water	ml/hour	10	USEPA 2002	
	EF	Exposure Frequency	days/year	250	USEPA 1991	For evaluating noncarcinogens:
	ET	Exposure Time	hour/day	1	professional judgment	= CW x IR-W x EF x ET x ED x CF1 x CF2 x 1/BW x 1/AT-N
	ED	Exposure Duration	years	25	USEPA 1991	
	CF1	Conversion Factor 1	ug/mg	1.0E-03	--	For evaluating carcinogens:
	CF2	Conversion Factor 2	l/ml	1.0E-03	--	= CW x IR-W x EF x ET x ED x CF1 x CF2 x 1/BW x 1/AT-C
	BW	Body Weight	kilograms	70	USEPA 1989	
	AT-C	Averaging Time (Cancer)	days	25,550	USEPA 1989	
	AT-N	Averaging Time (Non-cancer)	days	ED x 365	USEPA 1989	
Dermal Contact	CW	Chemical Concentration in Water	ug/l	--	--	CDI (mg/kg-day) =
	SA	Surface Area Available for Contact	cm^2	3,300	USEPA 2000	
	EF	Exposure Frequency	days/year	250	USEPA 1991	For evaluating noncarcinogens:
	ET	Exposure Time	hour/day	1	professional judgment	= CW x SA x EF x ET x ED x PC x CF1 x CF2 x 1/BW x 1/AT-N
	ED	Exposure Duration	years	25	USEPA 1991	
	PC	Permeability Constant	cm/hour	chem-specific	USEPA 2000	For evaluating carcinogens:
	CF1	Conversion Factor 1	mg/ug	1.0E-03	--	= CW x SA x EF x ET x ED x PC x CF1 x CF2 x 1/BW x 1/AT-C
	CF2	Conversion Factor 2	l/cm^3	1.0E-03	--	
	BW	Body Weight	kilograms	70	USEPA 1989	
	AT-C	Averaging Time (Cancer)	days	25,550	USEPA 1989	
	AT-N	Averaging Time (Non-cancer)	days	ED x 365	USEPA 1989	
Fish Ingestion	CW	Chemical Concentration in Water	ug/l	--	--	Chronic Daily Intake (CDI) (mg/kg/day) =
	BCF	Bioconcentration Factor	L/kg	chem-specific	Sample et al 1996	
	CF	Chemical Concentration in Fish	mg/kg	--	--	CF = CW x BCF x 0.001 mg/ug
	IR-F	Ingestion Rate of Fish	grams/meal	227	USEPA 1998	
	EF	Exposure Frequency	meals/year	12	prof judgment	For evaluating noncarcinogens:
	ED	Exposure Duration	years	25	USEPA 1991	= CF x IR-F x EF x ED x CF1 x 1/BW x 1/AT-N
	CF1	Conversion Factor 1	kg/g	1.0E-03	--	
	BW	Body Weight	kilograms	70	USEPA 1989	For evaluating carcinogens:
	AT-C	Averaging Time (Cancer)	days	25,550	USEPA 1989	= CF x IR-F x EF x ED x CF1 x 1/BW x 1/AT-C
	AT-N	Averaging Time (Non-cancer)	days	ED x 365	USEPA 1989	

NOTES: na: not applicable; -- not available

Sources: Sample, BE, DM Opresko, and GW Suter II. 1996. Toxicological Benchmarks for Wildlife: 1996 Revision. Prepared for US Dept of Energy by the Risk Assessment Program, Oak Ridge National Laboratory.
USEPA 1989. Risk Assessment Guidance for Superfund. Volume I: Human Health Evaluation Manual, Part A. OERR. EPA/540/1-89/002.
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USEPA 2002. Region IV Human Health Risk Assessment Bulletins - Supplement to RAGS, Interim. Website address http://www.epa.gov/region4/waste/ots/healtbul.htm accessed January.

TABLE C-3
EXPOSURE PARAMETERS FOR PARK VISITORS
VALUES USED FOR SOIL INTAKE CALCULATIONS

Exposure Route	Parameter Code	Parameter Definition	Units	RME Value	RME Rationale/ Reference	Intake Equation/ Model Name
Incidental Ingestion	CS	Chemical Concentration in Soil	mg/kg	--	--	Chronic Daily Intake (CDI) (mg/kg/day) =
	IR-Sa	Ingestion Rate of Soil (adult)	mg/day	100	USEPA 1991	
	IR-Sc	Ingestion Rate of Soil (child)	mg/day	200	USEPA 1991	For evaluating noncarcinogens (child only):
	EF	Exposure Frequency	day/year	1	site-specific assumption	= CS x IR-Sc x EF x EDc x CF x 1/BWc x 1/AT-N
	EDa	Exposure Duration (adult)	years	24	USEPA 1991	
	EDc	Exposure Duration (child)	years	6	USEPA 1991	For evaluating carcinogens (combined adult and child):
	CF	Conversion Factor	kg/mg	1.0E-06	--	IngFadj =
	BWa	Body Weight (adult)	kilograms	70	USEPA 1989	= (EDc x IR-Sc / BWc) + (EDa x IR-Sa / BWa)
	BWc	Body Weight (child)	kilograms	15	USEPA 1991	Therefore,
	AT-C	Averaging Time (Cancer)	days	25,550	USEPA 1989	CDIadj = CS x EF x CF x IngFadj x 1/AT-C
	AT-N	Averaging Time (Non-cancer)	days	ED x 365	USEPA 1989	
Dermal Contact	CS	Chemical Concentration in Soil	mg/kg	--	--	CDI (mg/kg-day) =
	SAa	Surface Area Available for Contact (adult)	cm^2	5,700	USEPA 2000	
	SAc	Surface Area Available for Contact (child)	cm^2	2,800	USEPA 2000	For evaluating noncarcinogens (child only):
	EF	Exposure Frequency	day/year	1	site-specific assumption	= CS x SAc x EF x EDc x AFc x AbsD x CF x 1/BWc x 1/AT-N
	EDa	Exposure Duration (adult)	years	24	USEPA 1991	
	EDc	Exposure Duration (child)	years	6	USEPA 1991	For evaluating carcinogens (combined adult and child):
	AFa	Adherence Factor (adult)	mg/cm^2	0.07	USEPA 2000	SFSadj =
	AFc	Adherence Factor (child)	mg/cm^2	0.2	USEPA 2000	= [(EDc x SAc x AFc) / BWc] + [(EDa x SAa x AFa) / BWa]
	AbsD	Dermal Absorption	unitless	chem-specific	USEPA 2000	Therefore,
	CF	Conversion Factor	kg/mg	1.0E-06	--	CDIadj = CS x EF x CF x AbsD x SFSadj x 1/AT-C
	BWa	Body Weight (adult)	kilograms	70	USEPA 1989	
	BWc	Body Weight (child)	kilograms	15	USEPA 1991	
	AT-C	Averaging Time (Cancer)	days	25,550	USEPA 1989	
	AT-N	Averaging Time (Non-cancer)	days	ED x 365	USEPA 1989	

TABLE C-3
EXPOSURE PARAMETERS FOR PARK VISITORS
VALUES USED FOR SOIL INTAKE CALCULATIONS

Exposure Route	Parameter Code	Parameter Definition	Units	RME Value	RME Rationale/ Reference	Intake Equation/ Model Name
Inhalation	CS	Chemical Concentration in Soil	mg/kg	--	--	Chronic Daily Intake (CDI) (mg/kg/day) =
	CA	Chemical Concentration in Outdoor Air	mg/m^3	CS x NAAQS	CalEPA 1994	
	NAAQS	National Ambient Air Quality Standard	kg/m^3	5.0E-08	CalEPA 1994	CA = CS x 5.0E-08 kg/m^3
	IR-Aa	Inhalation Rate (adult)	m^3/day	20	USEPA 1991	For evaluating noncarcinogens (child only):
	IR-Ac	Inhalation Rate (child)	m^3/day	10	USEPA 1997	= CS x IR-Ac x EF x EDc x 1/PEF x 1/BWc x 1/AT-N
	EF	Exposure Frequency	day/year	1	site-specific assumption	
	EDa	Exposure Duration (adult)	years	24	USEPA 1991	For evaluating carcinogens (combined adult and child):
	EDc	Exposure Duration (child)	years	6	USEPA 1991	InhFadj =
	BWa	Body Weight (adult)	kilograms	70	USEPA 1989	= (EDc x IR-Ac / BWc) + (EDa x IR-Aa / BWa)
	BWc	Body Weight (child)	kilograms	15	USEPA 1991	Therefore,
	AT-C	Averaging Time (Cancer)	days	25,550	USEPA 1989	CDIadj = CS x EF x InhFadj x 1/PEF x 1/AT-C
	AT-N	Averaging Time (Non-cancer)	days	ED x 365	USEPA 1989	

NOTES: na: not applicable; -- not available

Sources: CalEPA 1994. Preliminary Endangerment Assessment Guidance Manual. January. (Second Printing, June 1999).

USEPA 1989. Risk Assessment Guidance for Superfund. Volume I: Human Health Evaluation Manual, Part A. OERR. EPA/540/1-89/002.

USEPA 1991. Risk Assessment Guidance for Superfund. Volume I: Human Health Evaluation Manual - Supplemental Guidance, Standard Default Exposure Factors. Interim Final. OSWER Directive 9285.6-03.

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USEPA 2000. RAGS Vol I: Human Health Evaluation Manual, Part E, Supplemental Guidance for Dermal Risk Assessment, Interim Guidance. EPA/540/R-99/005.

TABLE C-4
EXPOSURE PARAMETERS FOR PARK VISITORS
VALUES USED FOR SURFACE WATER INTAKE CALCULATIONS

Exposure Route	Parameter Code	Parameter Definition	Units	RME Value	RME Rationale/ Reference	Intake Equation/ Model Name
Incidental	CW	Chemical Concentration in Water	ug/l	--	--	Chronic Daily Intake (CDI) (mg/kg/day) =
Ingestion	IR-Wa	Incidental Ingestion Rate of Water (adult)	ml/hour	10	USEPA 2002	
	IR-Wc	Incidental Ingestion Rate of Water (child)	ml/hour	30	USEPA 1998	For evaluating noncarcinogens (child only):
	EF	Exposure Frequency	day/year	1	site-specific assumption	= CW x IR-Wc x EF x ET x EDc x CF1 x CF2 x 1/BWc x 1/AT-N
	ET	Exposure Time	hour/day	1	USEPA 1997	
	EDa	Exposure Duration (adult)	years	24	USEPA 1991	For evaluating carcinogens (combined adult and child):
	EDc	Exposure Duration (child)	years	6	USEPA 1991	IngFadj =
	CF1	Conversion Factor 1	mg/ug	1.0E-03	--	= (IR-Wc x EDc / BWc) + (IR-Wa x EDa / BWa)
	CF2	Conversion Factor 2	l/ml	1.0E-03	--	Therefore,
	BWa	Body Weight (adult)	kilograms	70	USEPA 1989	CDIadj = CW x EF x ET x CF1 x CF2 x IngFadj x 1/AT-C
	BWc	Body Weight (child)	kilograms	15	USEPA 1991	
	AT-C	Averaging Time (Cancer)	days	25,550	USEPA 1989	
	AT-N	Averaging Time (Non-cancer)	days	ED x 365	USEPA 1989	
Dermal	CW	Chemical Concentration in Water	ug/l	--	--	CDI (mg/kg-day) =
Contact	SAa	Surface Area Available for Contact (adult)	cm^2	5,700	USEPA 2000	
	SAc	Surface Area Available for Contact (child)	cm^2	2,800	USEPA 2000	For evaluating noncarcinogens (child only):
	EF	Exposure Frequency	day/year	1	site-specific assumption	= CW x SAc x EF x ET x EDc x PC x CF1 x CF2 x 1/BWc x 1/AT-N
	ET	Exposure Time	hour/day	1	USEPA 1997	
	EDa	Exposure Duration (adult)	years	24	USEPA 1991	For evaluating carcinogens (combined adult and child):
	EDc	Exposure Duration (child)	years	6	USEPA 1991	SFSadj =
	PC	Permeability Constant	cm/hour	chem-specific	USEPA 2000	= [(EDc x SAc) / BWc] + [(EDa x SAa) / BWa]
	CF1	Conversion Factor 1	mg/ug	1.0E-03	--	Therefore,
	CF2	Conversion Factor 2	l/cm^3	1.0E-03	--	CDIadj = CW x EF x ET x PC x CF1 x CF2 x SFSadj x 1/AT-C
	BWa	Body Weight (adult)	kilograms	70	USEPA 1989	
	BWc	Body Weight (child)	kilograms	15	USEPA 1991	
	AT-C	Averaging Time (Cancer)	days	25,550	USEPA 1989	
	AT-N	Averaging Time (Non-cancer)	days	ED x 365	USEPA 1989	

TABLE C-4
EXPOSURE PARAMETERS FOR PARK VISITORS
VALUES USED FOR SURFACE WATER INTAKE CALCULATIONS

Exposure Route	Parameter Code	Parameter Definition	Units	RME Value	RME Rationale/ Reference	Intake Equation/ Model Name
Fish Ingestion	CW	Chemical Concentration in Water	ug/l	--	--	Chronic Daily Intake (CDI) (mg/kg/day) =
	BCF	Bioconcentration Factor	L/kg	chem-specific	Sample et al 1996	
	CF	Chemical Concentration in Fish	mg/kg	--	--	CF = CW x BCF x 0.001 mg/ug
	IR-Fa	Ingestion Rate of Fish (adult)	grams/meal	227	USEPA 1998	
	EF	Exposure Frequency	meals/year	1	prof judgment	For evaluating noncarcinogens (adult only):
	ED	Exposure Duration	years	30	USEPA 1991	= CF x IR-F x EF x ED x CF1 x 1/BW x 1/AT-N
	CF1	Conversion Factor 1	kg/g	1.0E-03	--	
	BWa	Body Weight (adult)	kilograms	70	USEPA 1989	For evaluating carcinogens:
	AT-C	Averaging Time (Cancer)	days	25,550	USEPA 1989	= CF x IR-F x EF x ED x CF1 x 1/BW x 1/AT-C
	AT-N	Averaging Time (Non-cancer)	days	ED x 365	USEPA 1989	

NOTES: na: not applicable; -- not available

Sources: Sample, BE, DM Opresko, and GW Suter II. 1996. Toxicological Benchmarks for Wildlife: 1996 Revision. Prepared for US Dept of Energy by the Risk Assessment Program, Oak Ridge National Laboratory.

USEPA 1989. Risk Assessment Guidance for Superfund. Volume I: Human Health Evaluation Manual, Part A. OERR. EPA/540/1-89/002.

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USEPA 2002. Region IV Human Health Risk Assessment Bulletins - Supplement to RAGS, Interim. Website address http://www.epa.gov/region4/waste/ots/healtbul.htm accessed January.

TABLE C-5
CHRONIC TOXICITY CRITERIA
HUMAN HEALTH RISK ASSESSMENT

Chemical	Chronic Oral Reference Dose (RfDo) [mg/kg-day]		Chronic Inhalation Reference Dose (RfDi) [mg/kg-day]		Oral Cancer Slope Factor (CSFo) [mg/kg-day]$^{-1}$		Inhalation Cancer Slope Factor (CSFi) [mg/kg-day]$^{-1}$	
Metals								
Antimony	4.0E-04	I	--		--		--	
Arsenic	3.0E-04	I	--		1.5E+00	I	1.5E+01	I
Barium	7.0E-02	I	1.4E-04	E/H	--		--	
Beryllium	2.0E-03	I	5.7E-06	I	--		8.4E+00	I
Cadmium	5.0E-04	I	--		--		6.3E+00	I
Chromium[a]	1.5E+00	I	--		--		4.2E+01	I
Chromium VI	3.0E-03	I	--		--		2.9E+02	I
Cobalt	6.0E-02	E/N	--		--		--	
Copper	3.7E-02	E/H	--		--		--	
Lead	--		--		--		--	
Manganese	2.4E-02	I	1.4E-05	I	--		--	
Mercury	3.0E-04	I	--		--		--	
Molybdenum	5.0E-03	E/H	--		--		--	
Nickel	2.0E-02	I	--		--		8.4E-01	I
Selenium	5.0E-03	I	--		--		--	
Silver	5.0E-03	I	--		--		--	
Thallium	6.6E-05	I	--		--		--	
Tin	6.0E-01	H/E	--		--		--	
Vanadium	7.0E-03	E/H	--		--		--	
Zinc	3.0E-01	I	--		--		--	
Cyanide								
Cyanide	2.0E-02	I	8.6E-04	I	--		--	
Pesticides								
Aroclor 1260	--		--		2.0E+00	I	2.0E+00	I
Dioxins								
TCDD TEQ	--		--		1.5E+05	E/H	1.5E+05	E/H
SVOCs								
Benzo(a)anthracene	--		--		7.3E-01	E/N	3.1E-01	E/N
Benzo(a)pyrene	--		--		7.3E+00	I	3.1E+00	E/N
Benzo(b)fluoranthene	--		--		7.3E-01	E/N	3.1E-01	E/N
Bis(2-Ethylhexyl)phthalate	2.0E-02	I	2.0E-02	R	1.4E-02	I	1.4E-02	R
Dibenz(a,h)anthracene	--		--		7.3E+00	E/N	3.1E+00	E/N
Dimethylphthalate	1.0E+01	X	1.0E+01	R	--		--	
Di-n-butylphthalate	1.0E-01	I	1.0E-01	R	--		--	
Hexachlorobenzene	8.0E-04	I	8.0E-04	R	1.6E+00	I	1.6E+00	I
Indeno(1,2,3-c,d)pyrene	--		--		7.3E-01	E/N	3.1E-01	E/N
2-Methylnaphthalene (naphthalene)	2.0E-02	I	8.6E-04	I	--		--	
Naphthalene	2.0E-02	I	8.6E-04	I	--		--	
Tributyltin (as oxide)	3.0E-04	I	--		--		--	
VOCs								
Chloroform	1.0E-02	I	8.6E-05	E/N	6.1E-03	I	8.1E-02	I
MEK (methyl-ethyl-ketone)	6.0E-01	I	2.9E-01	I	--		--	
MTBE (methyl-tert-butyl ether)	--		8.6E-01	I	--		--	
Methylene Chloride	6.0E-02	I	8.6E-01	E/H	7.5E-03	I	1.6E-03	I

Notes:
Surrogate oral and/or inhalation RfDs were used for 2-methylnaphthalene and tributyltin
" -- " = Not available or not applicable.
[a] oral RfD based on chromium III, while inhalation CSF based on total chromium
I = Integrated Risk Information System (USEPA, 2002)
E = HEAST (H) or NCEA (N) toxicity value as listed in Region IX PRG Table (USEPA, 2000)
R = Oral to Inhalation Route Extrapolation
X = Withdrawn

TABLE 1 - AREA 1
INCIDENTAL SOIL INGESTION
NONCANCER HAZARD FOR PARK WORKERS
HUMAN HEALTH RISK ASSESSMENT

COPC	Combined Soil EPC (mg/kg)	Oral Reference Dose (mg/kg-d)	Park Worker Exposure Scenario	
			Average Daily Intake (mg/kg-d) Adult	Hazard Quotient (Unitless) Adult
Metals				
Antimony	0.754	4.0E-04	3.7E-07	9.2E-04
Arsenic	1.96	3.0E-04	9.6E-07	3.2E-03
Cadmium	*	5.0E-04	*	*
Chromium	50.2	1.5E+00	2.5E-05	1.6E-05
Chromium VI	19.8	3.0E-03	9.7E-06	3.2E-03
Copper	168	3.7E-02	8.2E-05	2.2E-03
Lead	283	--	1.4E-04	--
Molybdenum	*	5.0E-03	*	*
Nickel	44.9	2.0E-02	2.2E-05	1.1E-03
Zinc	*	3.0E-01	*	*
Cyanide				
Cyanide	2.65	2.0E-02	1.3E-06	6.5E-05
Pesticides				
Aroclor 1260	*	--	*	*
Dioxins				
TCDD TEQ	0.003	--	1.6E-09	--
SVOCs				
Benzo(a)anthracene	*	--	*	*
Benzo(a)pyrene	0.044	--	2.2E-08	--
Benzo(b)fluoranthene	*	--	*	*
Bis(2-Ethylhexyl)phthalate	*	2.0E-02	*	*
Dibenz(a,h)anthracene	0.033	--	1.6E-08	--
Hexachlorobenzene	*	8.0E-04	*	*
Indeno(1,2,3-c,d)pyrene	*	--	*	*
2-Methylnaphthalene	3.81	2.0E-02	1.9E-06	9.3E-05
Total Hazard Index				1E-02

Notes:
"EPC" Exposure Point Concentration
"--" not applicable or not available; " * " not selected as a COPC in this media
Equations:
Worker INTAKE-N (mg/kg-day) = ((CS * IR-S * EF * ED * CF) / (BW * AT-N))
Noncancer Hazard = (INTAKE-N / RfD)

TABLE 2 - AREA 1
DERMAL CONTACT WITH SOIL
NONCANCER HAZARD FOR PARK WORKERS
HUMAN HEALTH RISK ASSESSMENT

COPC	Combined Soil EPC (mg/kg)	Soil-to-Skin Absorption Factor (unitless)	Oral/Dermal Reference Dose (mg/kg-d)	Park Worker Exposure Scenario	
				Average Daily Intake (mg/kg-d) Adult	Hazard Quotient (Unitless) Adult
Metals					
Antimony	0.754	0	4.0E-04	0.0E+00	0.0E+00
Arsenic	1.96	0.03	3.0E-04	3.8E-07	1.3E-03
Cadmium	*	0.001	5.0E-04	*	*
Chromium	50.2	0	1.5E+00	0.0E+00	0.0E+00
Chromium VI	19.8	0	3.0E-03	0.0E+00	0.0E+00
Copper	168	0	3.7E-02	0.0E+00	0.0E+00
Lead	283	0	--	0.0E+00	--
Molybdenum	*	0	5.0E-03	*	*
Nickel	44.9	0	2.0E-02	0.0E+00	0.0E+00
Zinc	*	0	3.0E-01	*	*
Cyanide					
Cyanide	2.65	0	2.0E-02	0.0E+00	0.0E+00
Pesticides					
Aroclor 1260	*	0.14	--	*	*
Dioxins					
TCDD TEQ	0.003	0.03	--	6.4E-10	--
SVOCs					
Benzo(a)anthracene	*	0.13	--	*	*
Benzo(a)pyrene	0.044	0.13	--	3.7E-08	--
Benzo(b)fluoranthene	*	0.13	--	*	*
Bis(2-Ethylhexyl)phthalate	*	0.10	2.0E-02	*	*
Dibenz(a,h)anthracene	0.033	0.13	--	2.8E-08	--
Hexachlorobenzene	*	0.10	8.0E-04	*	*
Indeno(1,2,3-c,d)pyrene	*	0.13	--	*	*
2-Methylnaphthalene	3.81	0.13	2.0E-02	3.2E-06	1.6E-04
Total Hazard Index					1E-03

Notes:
"EPC" Exposure Point Concentration
"--" not applicable or not available; " * " not selected as a COPC in this media
Equations:
Worker INTAKE-N (mg/kg-day) = ((CS * SA * AF * ABS * EF * ED * CF) / (BW * AT-N))
Noncancer Hazard = (INTAKE-N / RfD)

TABLE 3 - AREA 1
INHALATION OF SOIL
NONCANCER HAZARD FOR PARK WORKERS
HUMAN HEALTH RISK ASSESSMENT

COPC	Combined Soil EPC (mg/kg)	Modeled Air EPC (mg/m^3)	Inhalation Reference Dose[a] (mg/kg-d)	Park Worker Exposure Scenario: Average Daily Intake (mg/kg-d) Adult	Park Worker Exposure Scenario: Hazard Quotient (Unitless) Adult
Metals					
Antimony	0.754	3.8E-08	--	7.4E-09	--
Arsenic	1.96	9.8E-08	--	1.9E-08	--
Cadmium	*	*	--	*	*
Chromium	50.2	2.5E-06	--	4.9E-07	--
Chromium VI	19.8	9.9E-07	--	1.9E-07	--
Copper	168	8.4E-06	--	1.6E-06	--
Lead	283	1.4E-05	--	2.8E-06	--
Molybdenum	*	*	--	*	*
Nickel	44.9	2.2E-06	--	4.4E-07	--
Zinc	*	*	--	*	*
Cyanide					
Cyanide	2.65	1.3E-07	8.6E-04	2.6E-08	3.0E-05
Pesticides					
Aroclor 1260	*	*	--	*	*
Dioxins					
TCDD TEQ	0.003	1.7E-10	--	3.2E-11	--
SVOCs					
Benzo(a)anthracene	*	*	--	*	*
Benzo(a)pyrene	0.044	2.2E-09	--	4.3E-10	--
Benzo(b)fluoranthene	*	*	--	*	*
Bis(2-Ethylhexyl)phthalate	*	*	2.0E-02	*	*
Dibenz(a,h)anthracene	0.033	1.7E-09	--	3.2E-10	--
Hexachlorobenzene	*	*	8.0E-04	*	*
Indeno(1,2,3-c,d)pyrene	*	*	--	*	*
2-Methylnaphthalene	3.81	1.9E-07	8.6E-04	3.7E-08	4.3E-05
Total Hazard Index					7E-05

Notes:
"EPC" Exposure Point Concentration
"--" not applicable or not available; " * " not selected as a COPC in this media
Equations:
Modeled Air EPC (CA) = CS * 5.0E-08 kg/m^3
Worker INTAKE-N (mg/kg-day) = ((CA * IR-A * EF * ED) / (BW * AT-N))
Noncancer Hazard = (INTAKE-N / RfD)

TABLE 4 - AREA 1
SUMMARY OF NONCANCER HAZARD
THEME PARK WORKERS
HUMAN HEALTH RISK ASSESSMENT

COPC	Combined Soil EPC (mg/kg)	Noncancer Hazard Adult Worker Ingestion	Dermal	Inhalation	Total HI
Metals					
Antimony	0.754	9.2E-04	0.0E+00	--	9.2E-04
Arsenic	1.96	3.2E-03	1.3E-03	--	4.5E-03
Cadmium	*	*	*	*	--
Chromium	50.2	1.6E-05	0.0E+00	--	1.6E-05
Chromium VI	19.8	3.2E-03	0.0E+00	--	3.2E-03
Copper	168	2.2E-03	0.0E+00	--	2.2E-03
Lead	283	--	--	--	--
Molybdenum	*	*	*	*	--
Nickel	44.9	1.1E-03	0.0E+00	--	1.1E-03
Zinc	*	*	*	*	--
Cyanide					
Cyanide	2.65	6.5E-05	0.0E+00	3.0E-05	9.5E-05
Pesticides					
Aroclor 1260	*	*	*	*	--
Dioxins					
TCDD TEQ	0.003	--	--	--	--
SVOCs					
Benzo(a)anthracene	*	*	*	*	--
Benzo(a)pyrene	0.044	--	--	--	--
Benzo(b)fluoranthene	*	*	*	*	--
Bis(2-Ethylhexyl)phthalate	*	*	*	*	--
Dibenz(a,h)anthracene	0.033	--	--	--	--
Hexachlorobenzene	*	*	*	*	--
Indeno(1,2,3-c,d)pyrene	*	*	*	*	--
2-Methylnaphthalene	3.81	9.3E-05	1.6E-04	4.3E-05	3.0E-04
Total Hazard Index					1E-02

Notes:
"EPC" Exposure Point Concentration
"--" not applicable or not available; " * " not selected as a COPC in this media

TABLE 5 - AREA 1
INCIDENTAL SOIL INGESTION
CANCER RISK FOR PARK WORKERS
HUMAN HEALTH RISK ASSESSMENT

COPC	Combined Soil EPC (mg/kg)	Oral Slope Factor $(mg/kg\text{-}d)^{-1}$	Park Worker Exposure Scenario	
			Average Daily Intake (mg/kg-d) Adult	Cancer Risk (Unitless) Adult
Metals				
Antimony	0.754	--	1.3E-07	--
Arsenic	1.96	1.5E+00	3.4E-07	5.1E-07
Cadmium	*	--	*	*
Chromium	50.2	--	8.8E-06	--
Chromium VI	19.8	--	3.5E-06	--
Copper	168	--	2.9E-05	--
Lead	283	--	4.9E-05	--
Molybdenum	*	--	*	*
Nickel	44.9	--	7.8E-06	--
Zinc	*	--	*	*
Cyanide				
Cyanide	2.65	--	4.6E-07	--
Pesticides				
Aroclor 1260	*	2.0E+00	*	*
Dioxins				
TCDD TEQ	0.003	1.5E+05	5.8E-10	8.6E-05
SVOCs				
Benzo(a)anthracene	*	7.3E-01	*	*
Benzo(a)pyrene	0.044	7.3E+00	7.7E-09	5.6E-08
Benzo(b)fluoranthene	*	7.3E-01	*	*
Bis(2-Ethylhexyl)phthalate	*	1.4E-02	*	*
Dibenz(a,h)anthracene	0.033	7.3E+00	5.8E-09	4.2E-08
Hexachlorobenzene	*	1.6E+00	*	*
Indeno(1,2,3-c,d)pyrene	*	7.3E-01	*	*
2-Methylnaphthalene	3.81	--	6.7E-07	--
Total Cancer Risk				9E-05

Notes:
"EPC" Exposure Point Concentration
"--" not applicable or not available; " * " not selected as a COPC in this media
Equations:
Worker INTAKE-C (mg/kg-day) = ((CS * IR-S * EF * ED * CF) / (BW * AT-C))
Cancer Risk = (INTAKE-C * CSF)

TABLE 6 - AREA 1
DERMAL CONTACT WITH SOIL
CANCER RISK FOR PARK WORKERS
HUMAN HEALTH RISK ASSESSMENT

COPC	Combined Soil EPC (mg/kg)	Soil-to-Skin Absorption Factor (unitless)	Oral/Dermal Slope Factor (mg/kg-d)$^{-1}$	Park Worker Exposure Scenario	
				Average Daily Intake (mg/kg-d) Adult	Cancer Risk (Unitless) Adult
Metals					
Antimony	0.754	0	--	0.0E+00	--
Arsenic	1.96	0.03	1.5E+00	1.4E-07	2.0E-07
Cadmium	*	0.001	--	*	*
Chromium	50.2	0	--	0.0E+00	--
Chromium VI	19.8	0	--	0.0E+00	--
Copper	168	0	--	0.0E+00	--
Lead	283	0	--	0.0E+00	--
Molybdenum	*	0	--	*	*
Nickel	44.9	0	--	0.0E+00	--
Zinc	*	0	--	*	*
Cyanide					
Cyanide	2.65	0	--	0.0E+00	--
Pesticides					
Aroclor 1260	*	0.14	2.0E+00	*	*
Dioxins					
TCDD TEQ	0.003	0.03	1.5E+05	2.3E-10	3.4E-05
SVOCs					
Benzo(a)anthracene	*	0.13	7.3E-01	*	*
Benzo(a)pyrene	0.044	0.13	7.3E+00	1.3E-08	9.6E-08
Benzo(b)fluoranthene	*	0.13	7.3E-01	*	*
Bis(2-Ethylhexyl)phthalate	*	0.10	1.4E-02	*	*
Dibenz(a,h)anthracene	0.033	0.13	7.3E+00	9.9E-09	7.2E-08
Hexachlorobenzene	*	0.10	1.6E+00	*	*
Indeno(1,2,3-c,d)pyrene	*	0.13	7.3E-01	*	*
2-Methylnaphthalene	3.81	0.13	--	1.1E-06	--
Total Cancer Risk					3E-05

Notes:
"EPC" Exposure Point Concentration
"--" not applicable or not available; " * " not selected as a COPC in this media
Equations:
Worker INTAKE-C (mg/kg-day) = ((CS * SA * EF * ED * AF * ABS * CF) / (BW * AT-C))
Cancer Risk = (INTAKE-C * CSF)

TABLE 7 - AREA 1
INHALATION OF SOIL
CANCER RISK FOR PARK WORKERS
HUMAN HEALTH RISK ASSESSMENT

COPC	Combined Soil EPC (mg/kg)	Modeled Air EPC (mg/m^3)	Inhalation Slope Factor (mg/kg-d)$^{-1}$	Park Worker Exposure Scenario	
				Average Daily Intake (mg/kg-d) Adult	Cancer Risk (Unitless) Adult
Metals					
Antimony	0.754	3.8E-08	--	2.6E-09	--
Arsenic	1.96	9.8E-08	1.5E+01	6.8E-09	1.0E-07
Cadmium	*	*	6.3E+00	*	*
Chromium	50.2	2.5E-06	4.2E+01	1.8E-07	7.4E-06
Chromium VI	19.8	9.9E-07	2.9E+02	6.9E-08	2.0E-05
Copper	168	8.4E-06	--	5.9E-07	--
Lead	283	1.4E-05	--	9.9E-07	--
Molybdenum	*	*	--	*	*
Nickel	44.9	2.2E-06	--	1.6E-07	--
Zinc	*	*	--	*	*
Cyanide					
Cyanide	2.65	1.3E-07	--	9.3E-09	--
Pesticides					
Aroclor 1260	*	*	2.0E+00	*	*
Dioxins					
TCDD TEQ	0.003	1.7E-10	1.5E+05	1.2E-11	1.7E-06
SVOCs					
Benzo(a)anthracene	*	*	3.1E-01	*	*
Benzo(a)pyrene	0.044	2.2E-09	3.1E+00	1.5E-10	4.8E-10
Benzo(b)fluoranthene	*	*	3.1E-01	*	*
Bis(2-Ethylhexyl)phthalate	*	*	1.4E-02	*	*
Dibenz(a,h)anthracene	0.033	1.7E-09	3.1E+00	1.2E-10	3.6E-10
Hexachlorobenzene	*	*	1.6E+00	*	*
Indeno(1,2,3-c,d)pyrene	*	*	3.1E-01	*	*
2-Methylnaphthalene	3.81	1.9E-07	--	1.3E-08	--
Total Cancer Risk					3E-05

Notes:
"EPC" Exposure Point Concentration
"--" not applicable or not available; " * " not selected as a COPC in this media
Equations:
Modeled Air EPC (CA) = CS * 5.0E-08 kg/m^3
Worker INTAKE-C (mg/kg-day) = ((CA * IR-A * EF * ED) / (BW * AT-C))
Cancer Risk = (INTAKE-C * CSF)

TABLE 8 - AREA 1
SUMMARY OF CANCER RISK
THEME PARK WORKERS
HUMAN HEALTH RISK ASSESSMENT

COPC	Combined Soil EPC (mg/kg)	Cancer Risk			
		Adult Worker			
		Ingestion	Dermal	Inhalation	Total Risk
Metals					
Antimony	0.754	--	--	--	--
Arsenic	1.96	5.1E-07	2.0E-07	1.0E-07	8.2E-07
Cadmium	*	*	*	*	--
Chromium	50.2	--	--	7.4E-06	7.4E-06
Chromium VI	19.8	--	--	2.0E-05	2.0E-05
Copper	168	--	--	--	--
Lead	283	--	--	--	--
Molybdenum	*	*	*	*	--
Nickel	44.9	--	--	--	--
Zinc	*	*	*	*	--
Cyanide					
Cyanide	2.65	--	--	--	--
Pesticides					
Aroclor 1260	*	*	*	*	--
Dioxins					
TCDD TEQ	0.003	8.6E-05	3.4E-05	1.7E-06	1.2E-04
SVOCs					
Benzo(a)anthracene	*	*	*	*	--
Benzo(a)pyrene	0.044	5.6E-08	9.6E-08	4.8E-10	1.5E-07
Benzo(b)fluoranthene	*	*	*	*	--
Bis(2-Ethylhexyl)phthalate	*	*	*	*	--
Dibenz(a,h)anthracene	0.033	4.2E-08	7.2E-08	3.6E-10	1.1E-07
Hexachlorobenzene	*	*	*	*	--
Indeno(1,2,3-c,d)pyrene	*	*	*	*	--
2-Methylnaphthalene	3.31	--	--	--	--
Total Cancer Risk					2E-04

Notes:
"EPC" Exposure Point Concentration
"--" not applicable or not available; " * " not selected as a COPC in this media

TABLE 9 - AREA 1
INCIDENTAL SOIL INGESTION
NONCANCER HAZARD FOR PARK VISITORS
HUMAN HEALTH RISK ASSESSMENT

COPC	Combined Soil EPC (mg/kg)	Oral Reference Dose (mg/kg-d)	Recreational Exposure Scenario	
			Average Daily Intake (mg/kg-d) Child	Hazard Quotient (Unitless) Child
Metals				
Antimony	0.754	4.0E-04	2.8E-08	6.9E-05
Arsenic	1.96	3.0E-04	7.2E-08	2.4E-04
Cadmium	*	5.0E-04	*	*
Chromium	50.2	1.5E+00	1.8E-06	1.2E-06
Chromium VI	19.8	3.0E-03	7.2E-07	2.4E-04
Copper	168	3.7E-02	6.1E-06	1.7E-04
Lead	283	--	1.0E-05	--
Molybdenum	*	5.0E-03	*	*
Nickel	44.9	2.0E-02	1.6E-06	8.2E-05
Zinc	*	3.0E-01	*	*
Cyanide				
Cyanide	2.65	2.0E-02	9.7E-08	4.8E-06
Pesticides				
Aroclor 1260	*	--	*	*
Dioxins				
TCDD TEQ	0.003	--	1.2E-10	--
SVOCs				
Benzo(a)anthracene	*	--	*	*
Benzo(a)pyrene	0.044	--	1.6E-09	--
Benzo(b)fluoranthene	*	--	*	*
Bis(2-Ethylhexyl)phthalate	*	2.0E-02	*	*
Dibenz(a,h)anthracene	0.033	--	1.2E-09	--
Hexachlorobenzene	*	8.0E-04	*	*
Indeno(1,2,3-c,d)pyrene	*	--	*	*
2-Methylnaphthalene	3.81	2.0E-02	1.4E-07	7.0E-06
Total Hazard Index				8E-04

Notes:
"EPC" Exposure Point Concentration
"--" not applicable or not available; " * " not selected as a COPC in this media
Equations:
Child Visitor INTAKE-N (mg/kg-day) = ((CS * IR-Sc * EFc * EDc * CF) / (BWc * AT-N))
Noncancer Hazard = (INTAKE-N / RfD)

TABLE 10 - AREA 1
DERMAL CONTACT WITH SOIL
NONCANCER HAZARD FOR PARK VISITORS
HUMAN HEALTH RISK ASSESSMENT

COPC	Combined Soil EPC (mg/kg)	Soil-to-Skin Absorption Factor (unitless)	Oral/Dermal Reference Dose (mg/kg-d)	Recreational Exposure Scenario	
				Average Daily Intake (mg/kg-d) Child	Hazard Quotient (Unitless) Child
Metals					
Antimony	0.754	0	4.0E-04	0.0E+00	0.0E+00
Arsenic	1.96	0.03	3.0E-04	6.0E-09	2.0E-05
Cadmium	*	0.001	5.0E-04	*	*
Chromium	50.2	0	1.5E+00	0.0E+00	0.0E+00
Chromium VI	19.8	0	3.0E-03	0.0E+00	0.0E+00
Copper	168	0	3.7E-02	0.0E+00	0.0E+00
Lead	283	0	--	0.0E+00	--
Molybdenum	*	0	5.0E-03	*	*
Nickel	44.9	0	2.0E-02	0.0E+00	0.0E+00
Zinc	*	0	3.0E-01	*	*
Cyanide					
Cyanide	2.65	0	2.0E-02	0.0E+00	0.0E+00
Pesticides					
Aroclor 1260	*	0.14	--	*	*
Dioxins					
TCDD TEQ	0.003	0.03	--	1.0E-11	--
SVOCs					
Benzo(a)anthracene	*	0.13	--	*	*
Benzo(a)pyrene	0.044	0.13	--	5.9E-10	--
Benzo(b)fluoranthene	*	0.13	--	*	*
Bis(2-Ethylhexyl)phthalate	*	0.10	2.0E-02	*	*
Dibenz(a,h)anthracene	0.033	0.13	--	4.4E-10	--
Hexachlorobenzene	*	0.10	8.0E-04	*	*
Indeno(1,2,3-c,d)pyrene	*	0.13	--	*	*
2-Methylnaphthalene	3.81	0.13	2.0E-02	5.1E-08	2.5E-06
Total Hazard Index					2E-05

Notes:
"EPC" Exposure Point Concentration
"--" not applicable or not available; " * " not selected as a COPC in this media
Equations:
Child Visitor INTAKE-N (mg/kg-day) = ((CS * SAc * AFc * ABS * EFc * EDc * CF) / (BWc * AT-N))
Noncancer Hazard = (INTAKE-N / RfD)

TABLE 11 - AREA 1
INHALATION OF SOIL
NONCANCER HAZARD FOR PARK VISITORS
HUMAN HEALTH RISK ASSESSMENT

COPC	Combined Soil EPC (mg/kg)	Modeled Air EPC (mg/m^3)	Inhalation Reference Dose[a] (mg/kg-d)	Recreational Exposure Scenario	
				Average Daily Intake (mg/kg-d) Child	Hazard Quotient (Unitless) Child
Metals					
Antimony	0.754	3.8E-08	--	6.9E-11	--
Arsenic	1.96	9.8E-08	--	1.8E-10	--
Cadmium	*	*	--	*	*
Chromium	50.2	2.5E-06	--	4.6E-09	--
Chromium VI	19.8	9.9E-07	--	1.8E-09	--
Copper	168	8.4E-06	--	1.5E-08	--
Lead	283	1.4E-05	--	2.6E-08	--
Molybdenum	*	*	--	*	*
Nickel	44.9	2.2E-06	--	4.1E-09	--
Zinc	*	*	--	*	*
Cyanide					
Cyanide	2.65	1.3E-07	8.6E-04	2.4E-10	2.8E-07
Pesticides					
Aroclor 1260	*	*	--	*	*
Dioxins					
TCDD TEQ	0.003	1.7E-10	--	3.0E-13	--
SVOCs					
Benzo(a)anthracene	*	*	--	*	*
Benzo(a)pyrene	0.044	2.2E-09	--	4.0E-12	--
Benzo(b)fluoranthene	*	*	--	*	*
Bis(2-Ethylhexyl)phthalate	*	*	2.0E-02	*	*
Dibenz(a,h)anthracene	0.033	1.7E-09	--	3.0E-12	--
Hexachlorobenzene	*	*	8.0E-04	*	*
Indeno(1,2,3-c,d)pyrene	*	*	--	*	*
2-Methylnaphthalene	3.81	1.9E-07	8.6E-04	3.5E-10	4.0E-07
Total Hazard Index					7E-07

Notes:
"EPC" Exposure Point Concentration
"--" not applicable or not available; " * " not selected as a COPC in this media
Equations:
Modeled Air EPC (CA) = CS * 5.0E-08 kg/m^3
Child Visitor INTAKE-N (mg/kg-day) = (CA * IR-Ac * EFc * EDc) / (BWc * AT-N))
Noncancer Hazard = (INTAKE-N / RfD)

TABLE 12 - AREA 1
SUMMARY OF NONCANCER HAZARD
THEME PARK VISITORS
HUMAN HEALTH RISK ASSESSMENT

COPC	Combined Soil EPC (mg/kg)	Noncancer Hazard Recreational Visitor - Child Ingestion	Dermal	Inhalation	Total HI
Metals					
Antimony	0.754	6.9E-05	0.0E+00	--	6.9E-05
Arsenic	1.96	2.4E-04	2.0E-05	--	2.6E-04
Cadmium	*	*	*	*	--
Chromium	50.2	1.2E-06	0.0E+00	--	1.2E-06
Chromium VI	19.8	2.4E-04	0.0E+00	--	2.4E-04
Copper	168	1.7E-04	0.0E+00	--	1.7E-04
Lead	283	--	--	--	--
Molybdenum	*	*	*	*	--
Nickel	44.9	8.2E-05	0.0E+00	--	8.2E-05
Zinc	*	*	*	*	--
Cyanide					
Cyanide	2.65	4.8E-06	0.0E+00	2.8E-07	5.1E-06
Pesticides					
Aroclor 1260	*	*	*	*	--
Dioxins					
TCDD TEQ	0.003	--	--	--	--
SVOCs					
Benzo(a)anthracene	*	*	*	*	--
Benzo(a)pyrene	0.044	--	--	--	--
Benzo(b)fluoranthene	*	*	*	*	--
Bis(2-Ethylhexyl)phthalate	*	*	*	*	--
Dibenz(a,h)anthracene	0.033	--	--	--	--
Hexachlorobenzene	*	*	*	*	--
Indeno(1,2,3-c,d)pyrene	*	*	*	*	--
2-Methylnaphthalene	3.81	7.0E-06	2.5E-06	4.0E-07	9.9E-06
Total Hazard Index					8E-04

Notes:
"EPC" Exposure Point Concentration
"--" not applicable or not available; " * " not selected as a COPC in this media

TABLE 13 - AREA 1
INCIDENTAL SOIL INGESTION
CANCER RISK FOR PARK VISITORS
HUMAN HEALTH RISK ASSESSMENT

COPC	Combined Soil EPC (mg/kg)	Oral Slope Factor $(mg/kg\text{-}d)^{-1}$	Recreational Exposure Scenario	
			Average Daily Intake (mg/kg-d) Adult/Child	Cancer Risk (Unitless) Adult/Child
Metals				
Antimony	0.754	--	3.4E-09	--
Arsenic	1.96	1.5E+00	8.8E-09	1.3E-08
Cadmium	*	--	*	*
Chromium	50.2	--	2.2E-07	--
Chromium VI	19.8	--	8.9E-08	--
Copper	168	--	7.5E-07	--
Lead	283	--	1.3E-06	--
Molybdenum	*	--	*	*
Nickel	44.9	--	2.0E-07	--
Zinc	*	--	*	*
Cyanide				
Cyanide	2.65	--	1.2E-08	--
Pesticides				
Aroclor 1260	*	2.0E+00	*	*
Dioxins				
TCDD TEQ	0.003	1.5E+05	1.5E-11	2.2E-06
SVOCs				
Benzo(a)anthracene	*	7.3E-01	*	*
Benzo(a)pyrene	0.044	7.3E+00	2.0E-10	1.4E-09
Benzo(b)fluoranthene	*	7.3E-01	*	*
Bis(2-Ethylhexyl)phthalate	*	1.4E-02	*	*
Dibenz(a,h)anthracene	0.033	7.3E+00	1.5E-10	1.1E-09
Hexachlorobenzene	*	1.6E+00	*	*
Indeno(1,2,3-c,d)pyrene	*	7.3E-01	*	*
2-Methylnaphthalene	3.81	--	1.7E-08	--
Total Cancer Risk				2E-06

Notes:
"EPC" Exposure Point Concentration
"--" not applicable or not available; " * " not selected as a COPC in this media
Equations:
Adult/Child Visitor INTAKE-C (mg/kg-day) = (CS * EF * $ING_{adjusted}$ * CF) / (AT-C))
Where $ING_{adjusted}$ = [(IR-Sc * EDc / BWc) + (IR-Sa * EDa / BWa)]
Cancer Risk = (INTAKE-C * CSF)

TABLE 14 - AREA 1
DERMAL CONTACT WITH SOIL
CANCER RISK FOR PARK VISITORS
HUMAN HEALTH RISK ASSESSMENT

COPC	Combined Soil EPC (mg/kg)	Soil-to-Skin Absorption Factor (unitless)	Oral/Dermal Slope Factor $(mg/kg\text{-}d)^{-1}$	Recreational Exposure Scenario	
				Average Daily Intake (mg/kg-d) Adult/Child	Cancer Risk (Unitless) Adult/Child
Metals					
Antimony	0.754	0	--	0.0E+00	--
Arsenic	1.96	0.03	1.5E+00	8.3E-10	1.2E-09
Cadmium	*	0.001	--	*	*
Chromium	50.2	0	--	0.0E+00	--
Chromium VI	19.8	0	--	0.0E+00	--
Copper	168	0	--	0.0E+00	--
Lead	283	0	--	0.0E+00	--
Molybdenum	*	0	--	*	*
Nickel	44.9	0	--	0.0E+00	--
Zinc	*	0	--	*	*
Cyanide					
Cyanide	2.65	0	--	0.0E+00	--
Pesticides					
Aroclor 1260	*	0.14	2.0E+00	*	*
Dioxins					
TCDD TEQ	0.003	0.03	1.5E+05	1.4E-12	2.1E-07
SVOCs					
Benzo(a)anthracene	*	0.13	7.3E-01	*	*
Benzo(a)pyrene	0.044	0.13	7.3E+00	8.1E-11	5.9E-10
Benzo(b)fluoranthene	*	0.13	7.3E-01	*	*
Bis(2-Ethylhexyl)phthalate	*	0.10	1.4E-02	*	*
Dibenz(a,h)anthracene	0.033	0.13	7.3E+00	6.1E-11	4.4E-10
Hexachlorobenzene	*	0.10	1.6E+00	*	*
Indeno(1,2,3-c,d)pyrene	*	0.13	7.3E-01	*	*
2-Methylnaphthalene	3.81	0.13	--	7.0E-09	--
Total Cancer Risk					2E-07

Notes:
"EPC" Exposure Point Concentration
"--" not applicable or not available; " * " not selected as a COPC in this media

Equations:
Adult/Child Visitor INTAKE-C (mg/kg-day) = $((CS * SAF_{adjusted} * ABS * CF) / (AT\text{-}C))$
Where $SAF_{adjusted} = [(SAc * AFc * EFc * EDc / BWc) + (SAa * AFa * EFa * EDa / BWa)]$

Cancer Risk = (INTAKE-C * CSF)

TABLE 15 - AREA 1
INHALATION OF SOIL
CANCER RISK FOR PARK VISITORS
HUMAN HEALTH RISK ASSESSMENT

COPC	Combined Soil EPC (mg/kg)	Modeled Air EPC (mg/m^3)	Inhalation Slope Factor (mg/kg-d)$^{-1}$	Recreational Exposure Scenario	
				Average Daily Intake (mg/kg-d) Adult/Child	Cancer Risk (Unitless) Adult/Child
Metals					
Antimony	0.754	3.8E-08	--	1.6E-11	--
Arsenic	1.96	9.8E-08	1.5E+01	4.2E-11	6.2E-10
Cadmium	*	*	6.3E+00	*	*
Chromium	50.2	2.5E-06	4.2E+01	1.1E-09	4.5E-08
Chromium VI	19.8	9.9E-07	2.9E+02	4.2E-10	1.2E-07
Copper	168	8.4E-06	--	3.6E-09	--
Lead	283	1.4E-05	--	6.0E-09	--
Molybdenum	*	*	--	*	*
Nickel	44.9	2.2E-06	--	9.5E-10	--
Zinc	*	*	--	*	*
Cyanide					
Cyanide	2.65	1.3E-07	--	5.6E-11	--
Pesticides					
Aroclor 1260	*	*	2.0E+00	*	*
Dioxins					
TCDD TEQ	0.003	1.7E-10	1.5E+05	7.0E-14	1.1E-08
SVOCs					
Benzo(a)anthracene	*	*	3.1E-01	*	*
Benzo(a)pyrene	0.044	2.2E-09	3.1E+00	9.3E-13	2.9E-12
Benzo(b)fluoranthene	*	*	3.1E-01	*	*
Bis(2-Ethylhexyl)phthalate	*	*	1.4E-02	*	*
Dibenz(a,h)anthracene	0.033	1.7E-09	3.1E+00	7.0E-13	2.2E-12
Hexachlorobenzene	*	*	1.6E+00	*	*
Indeno(1,2,3-c,d)pyrene	*	*	3.1E-01	*	*
2-Methylnaphthalene	3.81	1.9E-07	--	8.1E-11	--
Total Cancer Risk					2E-07

Notes:
"EPC" Exposure Point Concentration
"--" not applicable or not available; " * " not selected as a COPC in this media
Equations:
Modeled Air EPC (CA) = CS * 5.0E-08 kg/m^3
Adult/Child Visitor INTAKE-C (mg/kg-day) = ((CA * EF * $INH_{adjusted}$) / (AT-C))
Where: $INH_{adjusted}$ = [(IR-Ac * EDc / BWc) + (IR-Aa * EDa / BWa)]
Cancer Risk = (INTAKE-C * CSF)

TABLE 16 - AREA 1
SUMMARY OF CANCER RISK
THEME PARK VISITORS
HUMAN HEALTH RISK ASSESSMENT

COPC	Combined Soil EPC (mg/kg)	Cancer Risk			
		Recreational Visitor - Adult/Child			
		Ingestion	Dermal	Inhalation	Total Risk
Metals					
Antimony	0.754	--	--	--	--
Arsenic	1.96	1.3E-08	1.2E-09	6.2E-10	1.5E-08
Cadmium	*	*	*	*	--
Chromium	50.2	--	--	4.5E-08	4.5E-08
Chromium VI	19.8	--	--	1.2E-07	1.2E-07
Copper	168	--	--	--	--
Lead	283	--	--	--	--
Molybdenum	*	*	*	*	--
Nickel	44.9	--	--	--	--
Zinc	*	*	*	*	--
Cyanide					
Cyanide	2.65	--	--	--	--
Pesticides					
Aroclor 1260	*	*	*	*	--
Dioxins					
TCDD TEQ	0.003	2.2E-06	2.1E-07	1.1E-08	2.4E-06
SVOCs					
Benzo(a)anthracene	*	*	*	*	--
Benzo(a)pyrene	0.044	1.4E-09	5.9E-10	2.9E-12	2.0E-09
Benzo(b)fluoranthene	*	*	*	*	--
Bis(2-Ethylhexyl)phthalate	*	*	*	*	--
Dibenz(a,h)anthracene	0.033	1.1E-09	4.4E-10	2.2E-12	1.5E-09
Hexachlorobenzene	*	*	*	*	--
Indeno(1,2,3-c,d)pyrene	*	*	*	*	--
2-Methylnaphthalene	3.81	--	--	--	--
Total Cancer Risk					3E-06

Notes:
"EPC" Exposure Point Concentration
"--" not applicable or not available; " * " not selected as a COPC in this media

TABLE 17 - AREA 1
SUMMARY OF NONCANCER HAZARD AND CANCER RISK
THEME PARK WORKERS AND VISITORS
HUMAN HEALTH RISK ASSESSMENT

Receptor and Exposure Routes of Concern	Area 1	
	Cancer Risk	Noncancer Hazard
Park Worker		
Incidental Soil Ingestion	9E-05	1E-02
Dermal Contact with Soil	3E-05	1E-03
Fugitive Dust Inhalation	3E-05	7E-05
Total	2E-04	1E-02
Park Visitor		
Incidental Soil Ingestion	2E-06	8E-04
Dermal Contact with Soil	2E-07	2E-05
Fugitive Dust Inhalation	2E-07	7E-07
Total	3E-06	8E-04

Note:
Noncancer Hazard for the Park Visitor is based on exposure factors for a child.

TABLE 18 - AREA 1
LEAD RISK ASSESSMENT SPREADSHEET
CALIFORNIA DEPARTMENT OF TOXIC SUBSTANCES CONTROL
PREDICTED BLOOD LEAD RESULTS

USER'S GUIDE to version 7

INPUT

MEDIUM	LEVEL
Lead in Air (ug/m^3)	0.028
Lead in Soil/Dust (ug/g)	283
Lead in Water (ug/l)	15
% Home-grown Produce	0%
Respirable Dust (ug/m^3)	1.5

OUTPUT

	Percentile Estimate of Blood Pb (ug/dl)					PRG-99	PRG-95
	50th	90th	95th	98th	99th	(ug/g)	(ug/g)
BLOOD Pb, ADULT	1.1	2.0	2.3	2.8	3.2	894292	1398749
BLOOD Pb, CHILD	1.5	2.8	3.3	4.1	4.6	92664	158331
BLOOD Pb, PICA CHILD	1.5	2.8	3.3	4.1	4.6	46538	79517
BLOOD Pb, OCCUPATIONAL	1.3	2.4	2.8	3.4	3.9	3468	5452

EXPOSURE PARAMETERS

	units	adults	children
Days per week	days/wk	0.02	
Days per week, occupational		5	
Geometric Standard Deviation		1.6	
Blood lead level of concern (ug/dl)		10	
Skin area, residential	cm^2	5700	2900
Skin area occupational	cm^2	2900	
Soil adherence	ug/cm^2	70	200
Dermal uptake constant	(ug/dl)/(ug/day)	0.00011	
Soil ingestion	kg/day	50	100
Soil ingestion, pica	kg/day		200
Ingestion constant	(ug/dl)/(ug/day)	0.04	0.16
Bioavailability	unitless	0.44	
Breathing rate	m^3/day	20	6.8
Inhalation constant	(ug/dl)/(ug/day)	0.08	0.192
Water ingestion	l/day	1.4	0.4
Food ingestion	kg/day	1.9	1.1
Lead in market basket	ug/kg	3.1	
Lead in produce	ug/kg	127.4	

PATHWAYS

ADULTS	Residential			Occupational		
	Pathway contribution			Pathway contribution		
Pathway	PEF	ug/dl	percent	PEF	ug/dl	percent
Soil Contact	1.2E-7	0.00	0%	1.5E-5	0.00	0%
Soil Ingestion	2.4E-6	0.00	0%	6.3E-4	0.18	14%
Inhalation1		0.00	0%		0.03	3%
Inhalation	6.8E-9	0.00	0%	1.8E-6	0.00	0%
Water Ingestion		0.84	78%		0.84	65%
Food Ingestion1		0.23	22%		0.23	18%
Food Ingestion	0.0E+0	0.00	0%			0%

CHILDREN	typical			with pica		
	Pathway contribution			Pathway contribution		
Pathway	PEF	ug/dl	percent	PEF	ug/dl	percent
Soil Contact	1.7E-7	0.00	0%		0.00	0%
Soil Ingestion	1.9E-5	0.01	0%	3.9E-5	0.01	1%
Inhalation1	4.1E-9	0.00	0%		0.00	0%
Inhalation		0.04	2%		0.04	2%
Water Ingestion		0.96	62%		0.96	62%
Food Ingestion, child		0.54	35%		0.54	35%
Food Ingestion	0.0E+0	0.00	0%		0.00	0%

TABLE 1 - AREA 2
INCIDENTAL SOIL INGESTION
NONCANCER HAZARD FOR PARK WORKERS
HUMAN HEALTH RISK ASSESSMENT

COPC	Combined Soil EPC (mg/kg)	Oral Reference Dose (mg/kg-d)	Park Worker Exposure Scenario	
			Average Daily Intake (mg/kg-d) Adult	Hazard Quotient (Unitless) Adult
Metals				
Antimony	*	4.0E-04	*	*
Arsenic	1.39	3.0E-04	6.8E-07	2.3E-03
Cadmium	*	5.0E-04	*	*
Chromium	28.4	1.5E+00	1.4E-05	9.3E-06
Chromium VI	*	3.0E-03	*	*
Copper	625	3.7E-02	3.1E-04	8.3E-03
Lead	199	--	9.7E-05	--
Molybdenum	*	5.0E-03	*	*
Nickel	*	2.0E-02	*	*
Zinc	*	3.0E-01	*	*
Cyanide				
Cyanide	*	2.0E-02	*	*
Pesticides				
Aroclor 1260	18.8	--	9.2E-06	--
Dioxins				
TCDD TEQ	0.002	--	1.0E-09	--
SVOCs				
Benzo(a)anthracene	0.097	--	4.7E-08	--
Benzo(a)pyrene	0.099	--	4.8E-08	--
Benzo(b)fluoranthene	0.120	--	5.9E-08	--
Bis(2-Ethylhexyl)phthalate	16.2	2.0E-02	7.9E-06	4.0E-04
Dibenz(a,h)anthracene	0.029	--	1.4E-08	--
Hexachlorobenzene	*	8.0E-04	*	*
Indeno(1,2,3-c,d)pyrene	0.079	--	3.9E-08	--
2-Methylnaphthalene	*	2.0E-02	*	*
Total Hazard Index				1E-02

Notes:
"EPC" Exposure Point Concentration
"--" not applicable or not available; " * " not selected as a COPC in this media
Equations:
Worker INTAKE-N (mg/kg-day) = ((CS * IR-S * EF * ED * CF) / (BW * AT-N))
Noncancer Hazard = (INTAKE-N / RfD)

TABLE 2 - AREA 2
DERMAL CONTACT WITH SOIL
NONCANCER HAZARD FOR PARK WORKERS
HUMAN HEALTH RISK ASSESSMENT

COPC	Combined Soil EPC (mg/kg)	Soil-to-Skin Absorption Factor (unitless)	Oral/Dermal Reference Dose (mg/kg-d)	Park Worker Exposure Scenario	
				Average Daily Intake (mg/kg-d) Adult	Hazard Quotient (Unitless) Adult
Metals					
Antimony	*	0	4.0E-04	*	*
Arsenic	1.39	0.03	3.0E-04	2.7E-07	9.0E-04
Cadmium	*	0.001	5.0E-04	*	*
Chromium	28.4	0	1.5E+00	0.0E+00	0.0E+00
Chromium VI	*	0	3.0E-03	*	*
Copper	625	0	3.7E-02	0.0E+00	0.0E+00
Lead	199	0	--	0.0E+00	--
Molybdenum	*	0	5.0E-03	*	*
Nickel	*	0	2.0E-02	*	*
Zinc	*	0	3.0E-01	*	*
Cyanide					
Cyanide	*	0	2.0E-02	*	*
Pesticides					
Aroclor 1260	18.8	0.14	--	1.7E-05	--
Dioxins					
TCDD TEQ	0.002	0.03	--	4.1E-10	--
SVOCs					
Benzo(a)anthracene	0.097	0.13	--	8.1E-08	--
Benzo(a)pyrene	0.099	0.13	--	8.3E-08	--
Benzo(b)fluoranthene	0.120	0.13	--	1.0E-07	--
Bis(2-Ethylhexyl)phthalate	16.2	0.10	2.0E-02	1.0E-05	5.2E-04
Dibenz(a,h)anthracene	0.029	0.13	--	2.4E-08	--
Hexachlorobenzene	*	0.10	8.0E-04	*	*
Indeno(1,2,3-c,d)pyrene	0.079	0.13	--	6.6E-08	--
2-Methylnaphthalene	*	0.13	2.0E-02	*	*
Total Hazard Index					1E-03

Notes:
"EPC" Exposure Point Concentration
"--" not applicable or not available; " * " not selected as a COPC in this media
Equations:
Worker INTAKE-N (mg/kg-day) = ((CS * SA * AF * ABS * EF * ED * CF) / (BW * AT-N))
Noncancer Hazard = (INTAKE-N / RfD)

TABLE 3 - AREA 2
INHALATION OF SOIL
NONCANCER HAZARD FOR PARK WORKERS
HUMAN HEALTH RISK ASSESSMENT

COPC	Combined Soil EPC (mg/kg)	Modeled Air EPC (mg/m^3)	Inhalation Reference Dose[a] (mg/kg-d)	Park Worker Exposure Scenario	
				Average Daily Intake (mg/kg-d) Adult	Hazard Quotient (Unitless) Adult
Metals					
Antimony	*	*	--	*	*
Arsenic	1.39	7.0E-08	--	1.4E-08	--
Cadmium	*	*	--	*	*
Chromium	28.4	1.4E-06	--	2.8E-07	--
Chromium VI	*	*	--	*	*
Copper	625	3.1E-05	--	6.1E-06	--
Lead	199	1.0E-05	--	1.9E-06	--
Molybdenum	*	*	--	*	*
Nickel	*	*	--	*	*
Zinc	*	*	--	*	*
Cyanide					
Cyanide	*	*	8.6E-04	*	*
Pesticides					
Aroclor 1260	18.8	9.4E-07	--	1.8E-07	--
Dioxins					
TCDD TEQ	0.002	1.1E-10	--	2.1E-11	--
SVOCs					
Benzo(a)anthracene	0.097	4.9E-09	--	9.5E-10	--
Benzo(a)pyrene	0.099	5.0E-09	--	9.7E-10	--
Benzo(b)fluoranthene	0.120	6.0E-09	--	1.2E-09	--
Bis(2-Ethylhexyl)phthalate	16.2	8.1E-07	2.0E-02	1.6E-07	7.9E-06
Dibenz(a,h)anthracene	0.029	1.5E-09	--	2.8E-10	--
Hexachlorobenzene	*	*	8.0E-04	*	*
Indeno(1,2,3-c,d)pyrene	0.079	4.0E-09	--	7.7E-10	--
2-Methylnaphthalene	*	*	8.6E-04	*	*
Total Hazard Index					8E-06

Notes:
"EPC" Exposure Point Concentration
"--" not applicable or not available; " * " not selected as a COPC in this media
Equations:
Modeled Air EPC (CA) = CS * 5.0E-08 kg/m^3
Worker INTAKE-N (mg/kg-day) = ((CA * IR-A * EF * ED) / (BW * AT-N))
Noncancer Hazard = (INTAKE-N / RfD)

TABLE 4 - AREA 2
SUMMARY OF NONCANCER HAZARD
THEME PARK WORKERS
HUMAN HEALTH RISK ASSESSMENT

COPC	Combined Soil EPC (mg/kg)	Noncancer Hazard Adult Worker Ingestion	Dermal	Inhalation	Total HI
Metals					
Antimony	*	*	*	*	--
Arsenic	1.39	2.3E-03	9.0E-04	--	3.2E-03
Cadmium	*	*	*	*	--
Chromium	28.4	9.3E-06	0.0E+00	--	9.3E-06
Chromium VI	*	*	*	*	--
Copper	625	8.3E-03	0.0E+00	--	8.3E-03
Lead	199	--	--	--	--
Molybdenum	*	*	*	*	--
Nickel	*	*	*	*	--
Zinc	*	*	*	*	--
Cyanide					
Cyanide	*	*	*	*	--
Pesticides					
Aroclor 1260	18.3	--	--	--	--
Dioxins					
TCDD TEQ	0.002	--	--	--	--
SVOCs					
Benzo(a)anthracene	0.097	--	--	--	--
Benzo(a)pyrene	0.099	--	--	--	--
Benzo(b)fluoranthene	0.120	--	--	--	--
Bis(2-Ethylhexyl)phthalate	16.2	4.0E-04	5.2E-04	7.9E-06	9.3E-04
Dibenz(a,h)anthracene	0.029	--	--	--	--
Hexachlorobenzene	*	*	*	*	--
Indeno(1,2,3-c,d)pyrene	0.079	--	--	--	--
2-Methylnaphthalene	*	*	*	*	--
Total Hazard Index					1E-02

Notes:
"EPC" Exposure Point Concentration
"--" not applicable or not available; " * " not selected as a COPC in this media

TABLE 5 - AREA 2
INCIDENTAL SOIL INGESTION
CANCER RISK FOR PARK WORKERS
HUMAN HEALTH RISK ASSESSMENT

COPC	Combined Soil EPC (mg/kg)	Oral Slope Factor $(mg/kg\text{-}d)^{-1}$	Park Worker Exposure Scenario	
			Average Daily Intake (mg/kg-d) Adult	Cancer Risk (Unitless) Adult
Metals				
Antimony	*	--	*	*
Arsenic	1.39	1.5E+00	2.4E-07	3.6E-07
Cadmium	*	--	*	*
Chromium	28.4	--	5.0E-06	--
Chromium VI	*	--	*	*
Copper	625	--	1.1E-04	--
Lead	199	--	3.5E-05	--
Molybdenum	*	--	*	*
Nickel	*	--	*	*
Zinc	*	--	*	*
Cyanide				
Cyanide	*	--	*	*
Pesticides				
Aroclor 1260	18.8	2.0E+00	3.3E-06	6.6E-06
Dioxins				
TCDD TEQ	0.002	1.5E+05	3.7E-10	5.5E-05
SVOCs				
Benzo(a)anthracene	0.097	7.3E-01	1.7E-08	1.2E-08
Benzo(a)pyrene	0.099	7.3E+00	1.7E-08	1.3E-07
Benzo(b)fluoranthene	0.120	7.3E-01	2.1E-08	1.5E-08
Bis(2-Ethylhexyl)phthalate	16.2	1.4E-02	2.8E-06	4.0E-08
Dibenz(a,h)anthracene	0.029	7.3E+00	5.1E-09	3.7E-08
Hexachlorobenzene	*	1.6E+00	*	*
Indeno(1,2,3-c,d)pyrene	0.079	7.3E-01	1.4E-08	1.0E-08
2-Methylnaphthalene	*	--	*	*
Total Cancer Risk				6E-05

Notes:
"EPC" Exposure Point Concentration
"--" not applicable or not available; " * " not selected as a COPC in this media
Equations:
Worker INTAKE-C (mg/kg-day) = ((CS * IR-S * EF * ED * CF) / (BW * AT-C))
Cancer Risk = (INTAKE-C * CSF)

TABLE 6 - AREA 2
DERMAL CONTACT WITH SOIL
CANCER RISK FOR PARK WORKERS
HUMAN HEALTH RISK ASSESSMENT

COPC	Combined Soil EPC (mg/kg)	Soil-to-Skin Absorption Factor (unitless)	Oral/Dermal Slope Factor $(mg/kg\text{-}d)^{-1}$	Park Worker Exposure Scenario	
				Average Daily Intake (mg/kg-d) Adult	Cancer Risk (Unitless) Adult
Metals					
Antimony	*	0	--	*	*
Arsenic	1.39	0.03	1.5E+00	9.6E-08	1.4E-07
Cadmium	*	0.001	--	*	*
Chromium	28.4	0	--	0.0E+00	--
Chromium VI	*	0	--	*	*
Copper	625	0	--	0.0E+00	--
Lead	199	0	--	0.0E+00	--
Molybdenum	*	0	--	*	*
Nickel	*	0	--	*	*
Zinc	*	0	--	*	*
Cyanide					
Cyanide	*	0	--	*	*
Pesticides					
Aroclor 1260	18.8	0.14	2.0E+00	6.1E-06	1.2E-05
Dioxins					
TCDD TEQ	0.002	0.03	1.5E+05	1.5E-10	2.2E-05
SVOCs					
Benzo(a)anthracene	0.097	0.13	7.3E-01	2.9E-08	2.1E-08
Benzo(a)pyrene	0.099	0.13	7.3E+00	3.0E-08	2.2E-07
Benzo(b)fluoranthene	0.120	0.13	7.3E-01	3.6E-08	2.6E-08
Bis(2-Ethylhexyl)phthalate	16.2	0.10	1.4E-02	3.7E-06	5.2E-08
Dibenz(a,h)anthracene	0.029	0.13	7.3E+00	8.7E-09	6.3E-08
Hexachlorobenzene	*	0.10	1.6E+00	*	*
Indeno(1,2,3-c,d)pyrene	0.079	0.13	7.3E-01	2.4E-08	1.7E-08
2-Methylnaphthalene	*	0.13	--	*	*
Total Cancer Risk					3E-05

Notes:
"EPC" Exposure Point Concentration
"--" not applicable or not available; " * " not selected as a COPC in this media
Equations:
Worker INTAKE-C (mg/kg-day) = ((CS * SA * EF * ED * AF * ABS * CF) / (BW * AT-C))
Cancer Risk = (INTAKE-C * CSF)

TABLE 7 - AREA 2
INHALATION OF SOIL
CANCER RISK FOR PARK WORKERS
HUMAN HEALTH RISK ASSESSMENT

COPC	Combined Soil EPC (mg/kg)	Modeled Air EPC (mg/m^3)	Inhalation Slope Factor (mg/kg-d)$^{-1}$	Park Worker Exposure Scenario	
				Average Daily Intake (mg/kg-d) Adult	Cancer Risk (Unitless) Adult
Metals					
Antimony	*	*	--	*	*
Arsenic	1.39	7.0E-08	1.5E+01	4.9E-09	7.3E-08
Cadmium	*	*	6.3E+00	*	*
Chromium	28.4	1.4E-06	4.2E+01	9.9E-08	4.2E-06
Chromium VI	*	*	2.9E+02	*	*
Copper	625	3.1E-05	--	2.2E-06	--
Lead	199	1.0E-05	--	7.0E-07	--
Molybdenum	*	*	--	*	*
Nickel	*	*	--	*	*
Zinc	*	*	--	*	*
Cyanide					
Cyanide	*	*	--	*	*
Pesticides					
Aroclor 1260	18.8	9.4E-07	2.0E+00	6.6E-08	1.3E-07
Dioxins					
TCDD TEQ	0.002	1.1E-10	1.5E+05	7.3E-12	1.1E-06
SVOCs					
Benzo(a)anthracene	0.097	4.9E-09	3.1E-01	3.4E-10	1.1E-10
Benzo(a)pyrene	0.099	5.0E-09	3.1E+00	3.5E-10	1.1E-09
Benzo(b)fluoranthene	0.120	6.0E-09	3.1E-01	4.2E-10	1.3E-10
Bis(2-Ethylhexyl)phthalate	16.2	8.1E-07	1.4E-02	5.7E-08	7.9E-10
Dibenz(a,h)anthracene	0.029	1.5E-09	3.1E+00	1.0E-10	3.1E-10
Hexachlorobenzene	*	*	1.6E+00	*	*
Indeno(1,2,3-c,d)pyrene	0.079	4.0E-09	3.1E-01	2.8E-10	8.6E-11
2-Methylnaphthalene	*	*	--	*	*
Total Cancer Risk					5E-06

Notes:
"EPC" Exposure Point Concentration
"--" not applicable or not available; " * " not selected as a COPC in this media
Equations:
Modeled Air EPC (CA) = CS * 5.0E-08 kg/m^3
Worker INTAKE-C (mg/kg-day) = ((CA * IR-A * EF * ED) / (BW * AT-C))
Cancer Risk = (INTAKE-C * CSF)

TABLE 8 - AREA 2
SUMMARY OF CANCER RISK
THEME PARK WORKERS
HUMAN HEALTH RISK ASSESSMENT

COPC	Combined Soil EPC (mg/kg)	Cancer Risk – Adult Worker – Ingestion	Dermal	Inhalation	Total Risk
Metals					
Antimony	*	*	*	*	--
Arsenic	1.39	3.6E-07	1.4E-07	7.3E-08	5.8E-07
Cadmium	*	*	*	*	--
Chromium	28.4	--	--	4.2E-06	4.2E-06
Chromium VI	*	*	*	*	--
Copper	625	--	--	--	--
Lead	199	--	--	--	--
Molybdenum	*	*	*	*	--
Nickel	*	*	*	*	--
Zinc	*	*	*	*	--
Cyanide					
Cyanide	*	*	*	*	--
Pesticides					
Aroclor 1260	18.8	6.6E-06	1.2E-05	1.3E-07	1.9E-05
Dioxins					
TCDD TEQ	0.002	5.5E-05	2.2E-05	1.1E-06	7.8E-05
SVOCs					
Benzo(a)anthracene	0.097	1.2E-08	2.1E-08	1.1E-10	3.4E-08
Benzo(a)pyrene	0.099	1.3E-07	2.2E-07	1.1E-09	3.4E-07
Benzo(b)fluoranthene	0.120	1.5E-08	2.6E-08	1.3E-10	4.2E-08
Bis(2-Ethylhexyl)phthalate	16.2	4.0E-08	5.2E-08	7.9E-10	9.3E-08
Dibenz(a,h)anthracene	0.029	3.7E-08	6.3E-08	3.1E-10	1.0E-07
Hexachlorobenzene	*	*	*	*	--
Indeno(1,2,3-c,d)pyrene	0.079	1.0E-08	1.7E-08	8.6E-11	2.7E-08
2-Methylnaphthalene	*	*	*	*	--
Total Cancer Risk					1E-04

Notes:
"EPC" Exposure Point Concentration
"--" not applicable or not available; " * " not selected as a COPC in this media

TABLE 9 - AREA 2
INCIDENTAL SOIL INGESTION
NONCANCER HAZARD FOR PARK VISITORS
HUMAN HEALTH RISK ASSESSMENT

COPC	Combined Soil EPC (mg/kg)	Oral Reference Dose (mg/kg-d)	Recreational Exposure Scenario	
			Average Daily Intake (mg/kg-d) Child	Hazard Quotient (Unitless) Child
Metals				
Antimony	*	4.0E-04	*	*
Arsenic	1.39	3.0E-04	5.1E-08	1.7E-04
Cadmium	*	5.0E-04	*	*
Chromium	28.4	1.5E+00	1.0E-06	6.9E-07
Chromium VI	*	3.0E-03	*	*
Copper	625	3.7E-02	2.3E-05	6.2E-04
Lead	199	--	7.3E-06	--
Molybdenum	*	5.0E-03	*	*
Nickel	*	2.0E-02	*	*
Zinc	*	3.0E-01	*	*
Cyanide				
Cyanide	*	2.0E-02	*	*
Pesticides				
Aroclor 1260	18.8	--	6.9E-07	--
Dioxins				
TCDD TEQ	0.002	--	7.7E-11	--
SVOCs				
Benzo(a)anthracene	0.097	--	3.5E-09	--
Benzo(a)pyrene	0.099	--	3.6E-09	--
Benzo(b)fluoranthene	0.120	--	4.4E-09	--
Bis(2-Ethylhexyl)phthalate	16.2	2.0E-02	5.9E-07	3.0E-05
Dibenz(a,h)anthracene	0.029	--	1.1E-09	--
Hexachlorobenzene	*	8.0E-04	*	*
Indeno(1,2,3-c,d)pyrene	0.079	--	2.9E-09	--
2-Methylnaphthalene	*	2.0E-02	*	*
Total Hazard Index				8E-04

Notes:
"EPC" Exposure Point Concentration
"--" not applicable or not available; " * " not selected as a COPC in this media
Equations:
Child Visitor INTAKE-N (mg/kg-day) = ((CS * IR-Sc * EFc * EDc * CF) / (BWc * AT-N))
Noncancer Hazard = (INTAKE-N / RfD)

TABLE 10 - AREA 2
DERMAL CONTACT WITH SOIL
NONCANCER HAZARD FOR PARK VISITORS
HUMAN HEALTH RISK ASSESSMENT

COPC	Combined Soil EPC (mg/kg)	Soil-to-Skin Absorption Factor (unitless)	Oral/Dermal Reference Dose (mg/kg-d)	Recreational Exposure Scenario	
				Average Daily Intake (mg/kg-d) Child	Hazard Quotient (Unitless) Child
Metals					
Antimony	*	0	4.0E-04	*	*
Arsenic	1.39	0.03	3.0E-04	4.3E-09	1.4E-05
Cadmium	*	0.001	5.0E-04	*	*
Chromium	28.4	0	1.5E+00	0.0E+00	0.0E+00
Chromium VI	*	0	3.0E-03	*	*
Copper	625	0	3.7E-02	0.0E+00	0.0E+00
Lead	199	0	--	0.0E+00	--
Molybdenum	*	0	5.0E-03	*	*
Nickel	*	0	2.0E-02	*	*
Zinc	*	0	3.0E-01	*	*
Cyanide					
Cyanide	*	0	2.0E-02	*	*
Pesticides					
Aroclor 1260	18.8	0.14	--	2.7E-07	--
Dioxins					
TCDD TEQ	0.002	0.03	--	6.4E-12	--
SVOCs					
Benzo(a)anthracene	0.097	0.13	--	1.3E-09	--
Benzo(a)pyrene	0.099	0.13	--	1.3E-09	--
Benzo(b)fluoranthene	0.120	0.13	--	1.6E-09	--
Bis(2-Ethylhexyl)phthalate	16.2	0.10	2.0E-02	1.7E-07	8.3E-06
Dibenz(a,h)anthracene	0.029	0.13	--	3.9E-10	--
Hexachlorobenzene	*	0.10	8.0E-04	*	*
Indeno(1,2,3-c,d)pyrene	0.079	0.13	--	1.1E-09	--
2-Methylnaphthalene	*	0.13	2.0E-02	*	*
Total Hazard Index					2E-05

Notes:
"EPC" Exposure Point Concentration
"--" not applicable or not available; " * " not selected as a COPC in this media
Equations:
Child Visitor INTAKE-N (mg/kg-day) = ((CS * SAc * AFc * ABS * EFc * EDc * CF) / (BWc * AT-N))
Noncancer Hazard = (INTAKE-N / RfD)

TABLE 11 - AREA 2
INHALATION OF SOIL
NONCANCER HAZARD FOR PARK VISITORS
HUMAN HEALTH RISK ASSESSMENT

COPC	Combined Soil EPC (mg/kg)	Modeled Air EPC (mg/m^3)	Inhalation Reference Dose[a] (mg/kg-d)	Recreational Exposure Scenario	
				Average Daily Intake (mg/kg-d) Child	Hazard Quotient (Unitless) Child
Metals					
Antimony	*	*	--	*	*
Arsenic	1.39	7.0E-08	--	1.3E-10	--
Cadmium	*	*	--	*	*
Chromium	28.4	1.4E-06	--	2.6E-09	--
Chromium VI	*	*	--	*	*
Copper	625	3.1E-05	--	5.7E-08	--
Lead	199	1.0E-05	--	1.8E-08	--
Molybdenum	*	*	--	*	*
Nickel	*	*	--	*	*
Zinc	*	*	--	*	*
Cyanide					
Cyanide	*	*	8.6E-04	*	*
Pesticides					
Aroclor 1260	18.8	9.4E-07	--	1.7E-09	--
Dioxins					
TCDD TEQ	0.002	1.1E-10	--	1.9E-13	--
SVOCs					
Benzo(a)anthracene	0.097	4.9E-09	--	8.9E-12	--
Benzo(a)pyrene	0.099	5.0E-09	--	9.0E-12	--
Benzo(b)fluoranthene	0.120	6.0E-09	--	1.1E-11	--
Bis(2-Ethylhexyl)phthalate	16.2	8.1E-07	2.0E-02	1.5E-09	7.4E-08
Dibenz(a,h)anthracene	0.029	1.5E-09	--	2.6E-12	--
Hexachlorobenzene	*	*	8.0E-04	*	*
Indeno(1,2,3-c,d)pyrene	0.079	4.0E-09	--	7.2E-12	--
2-Methylnaphthalene	*	*	8.6E-04	*	*
Total Hazard Index					7E-08

Notes:
"EPC" Exposure Point Concentration
"--" not applicable or not available; " * " not selected as a COPC in this media
Equations:
Modeled Air EPC (CA) = CS * 5.0E-08 kg/m^3
Child Visitor INTAKE-N (mg/kg-day) = (CA * IR-Ac * EFc * EDc) / (BWc * AT-N))
Noncancer Hazard = (INTAKE-N / RfD)

TABLE 12 - AREA 2
SUMMARY OF NONCANCER HAZARD
THEME PARK VISITORS
HUMAN HEALTH RISK ASSESSMENT

COPC	Combined Soil EPC (mg/kg)	Noncancer Hazard			
		Recreational Visitor - Child			
		Ingestion	Dermal	Inhalation	Total HI
Metals					
Antimony	*	*	*	*	--
Arsenic	1.39	1.7E-04	1.4E-05	--	1.8E-04
Cadmium	*	*	*	*	--
Chromium	28.4	6.9E-07	0.0E+00	--	6.9E-07
Chromium VI	*	*	*	*	--
Copper	625	6.2E-04	0.0E+00	--	6.2E-04
Lead	199	--	--	--	--
Molybdenum	*	*	*	*	--
Nickel	*	*	*	*	--
Zinc	*	*	*	*	--
Cyanide					
Cyanide	*	*	*	*	--
Pesticides					
Aroclor 1260	18.8	--	--	--	--
Dioxins					
TCDD TEQ	0.002	--	--	--	--
SVOCs					
Benzo(a)anthracene	0.097	--	--	--	--
Benzo(a)pyrene	0.099	--	--	--	--
Benzo(b)fluoranthene	0.120	--	--	--	--
Bis(2-Ethylhexyl)phthalate	16.2	3.0E-05	8.3E-06	7.4E-08	3.8E-05
Dibenz(a,h)anthracene	0.029	--	--	--	--
Hexachlorobenzene	*	*	*	*	--
Indeno(1,2,3-c,d)pyrene	0.079	--	--	--	--
2-Methylnaphthalene	*	*	*	*	--
Total Hazard Index					8E-04

Notes:
"EPC" Exposure Point Concentration
"--" not applicable or not available; " * " not selected as a COPC in this media

TABLE 13 - AREA 2
INCIDENTAL SOIL INGESTION
CANCER RISK FOR PARK VISITORS
HUMAN HEALTH RISK ASSESSMENT

COPC	Combined Soil EPC (mg/kg)	Oral Slope Factor $(mg/kg\text{-}d)^{-1}$	Recreational Exposure Scenario	
			Average Daily Intake (mg/kg-d) Adult/Child	Cancer Risk (Unitless) Adult/Child
Metals				
Antimony	*	--	*	*
Arsenic	1.39	1.5E+00	6.2E-09	9.3E-09
Cadmium	*	--	*	*
Chromium	28.4	--	1.3E-07	--
Chromium VI	*	--	*	*
Copper	625	--	2.8E-06	--
Lead	199	--	8.9E-07	--
Molybdenum	*	--	*	*
Nickel	*	--	*	*
Zinc	*	--	*	*
Cyanide				
Cyanide	*	--	*	*
Pesticides				
Aroclor 1260	18.8	2.0E+00	8.4E-08	1.7E-07
Dioxins				
TCDD TEQ	0.002	1.5E+05	9.4E-12	1.4E-06
SVOCs				
Benzo(a)anthracene	0.097	7.3E-01	4.3E-10	3.2E-10
Benzo(a)pyrene	0.099	7.3E+00	4.4E-10	3.2E-09
Benzo(b)fluoranthene	0.120	7.3E-01	5.4E-10	3.9E-10
Bis(2-Ethylhexyl)phthalate	16.2	1.4E-02	7.2E-08	1.0E-09
Dibenz(a,h)anthracene	0.029	7.3E+00	1.3E-10	9.5E-10
Hexachlorobenzene	*	1.6E+00	*	*
Indeno(1,2,3-c,d)pyrene	0.079	7.3E-01	3.5E-10	2.6E-10
2-Methylnaphthalene	*	--	*	*
Total Cancer Risk				2E-06

Notes:
"EPC" Exposure Point Concentration
"--" not applicable or not available; " * " not selected as a COPC in this media

Equations:
Adult/Child Visitor INTAKE-C (mg/kg-day) = ((CS * EF * $ING_{adjusted}$ * CF) / (AT-C))

Where $ING_{adjusted}$ = [(IR-Sc * EDc / BWc) + (IR-Sa * EDa / BWa)]

Cancer Risk = (INTAKE-C * CSF)

TABLE 14 - AREA 2
DERMAL CONTACT WITH SOIL
CANCER RISK FOR PARK VISITORS
HUMAN HEALTH RISK ASSESSMENT

COPC	Combined Soil EPC (mg/kg)	Soil-to-Skin Absorption Factor (unitless)	Oral/Dermal Slope Factor $(mg/kg\text{-}d)^{-1}$	Recreational Exposure Scenario: Average Daily Intake (mg/kg-d) Adult/Child	Recreational Exposure Scenario: Cancer Risk (Unitless) Adult/Child
Metals					
Antimony	*	0	--	*	*
Arsenic	1.39	0.03	1.5E+00	5.9E-10	8.8E-10
Cadmium	*	0.001	--	*	*
Chromium	28.4	0	--	0.0E+00	--
Chromium VI	*	0	--	*	*
Copper	625	0	--	0.0E+00	--
Lead	199	0	--	0.0E+00	--
Molybdenum	*	0	--	*	*
Nickel	*	0	--	*	*
Zinc	*	0	--	*	*
Cyanide					
Cyanide	*	0	--	*	*
Pesticides					
Aroclor 1260	18.8	0.14	2.0E+00	3.7E-08	7.4E-08
Dioxins					
TCDD TEQ	0.002	0.03	1.5E+05	8.9E-13	1.3E-07
SVOCs					
Benzo(a)anthracene	0.097	0.13	7.3E-01	1.8E-10	1.3E-10
Benzo(a)pyrene	0.099	0.13	7.3E+00	1.8E-10	1.3E-09
Benzo(b)fluoranthene	0.120	0.13	7.3E-01	2.2E-10	1.6E-10
Bis(2-Ethylhexyl)phthalate	16.2	0.10	1.4E-02	2.3E-08	3.2E-10
Dibenz(a,h)anthracene	0.029	0.13	7.3E+00	5.3E-11	3.9E-10
Hexachlorobenzene	*	0.10	1.6E+00	*	*
Indeno(1,2,3-c,d)pyrene	0.079	0.13	7.3E-01	1.5E-10	1.1E-10
2-Methylnaphthalene	*	0.13	--	*	*
Total Cancer Risk					2E-07

Notes:
"EPC" Exposure Point Concentration
"--" not applicable or not available; " * " not selected as a COPC in this media

Equations:
Adult/Child Visitor INTAKE-C (mg/kg-day) = $((CS * SAF_{adjusted} * ABS * CF) / (AT\text{-}C))$
Where $SAF_{adjusted} = [(SAc * AFc * EFc * EDc / BWc) + (SAa * AFa * EFa * EDa / BWa)]$

Cancer Risk = (INTAKE-C * CSF)

TABLE 15 - AREA 2
INHALATION OF SOIL
CANCER RISK FOR PARK VISITORS
HUMAN HEALTH RISK ASSESSMENT

COPC	Combined Soil EPC (mg/kg)	Modeled Air EPC (mg/m^3)	Inhalation Slope Factor $(mg/kg\text{-}d)^{-1}$	Recreational Exposure Scenario	
				Average Daily Intake (mg/kg-d) Adult/Child	Cancer Risk (Unitless) Adult/Child
Metals					
Antimony	*	*	--	*	*
Arsenic	1.39	7.0E-08	1.5E+01	3.0E-11	4.4E-10
Cadmium	*	*	6.3E+00	*	*
Chromium	28.4	1.4E-06	4.2E+01	6.0E-10	2.5E-08
Chromium VI	*	*	2.9E+02	*	*
Copper	625	3.1E-05	--	1.3E-08	--
Lead	199	1.0E-05	--	4.2E-09	--
Molybdenum	*	*	--	*	*
Nickel	*	*	--	*	*
Zinc	*	*	--	*	*
Cyanide					
Cyanide	*	*	--	*	*
Pesticides					
Aroclor 1260	18.8	9.4E-07	2.0E+00	4.0E-10	8.0E-10
Dioxins					
TCDD TEQ	0.002	1.1E-10	1.5E+05	4.5E-14	6.7E-09
SVOCs					
Benzo(a)anthracene	0.097	4.9E-09	3.1E-01	2.1E-12	6.4E-13
Benzo(a)pyrene	0.099	5.0E-09	3.1E+00	2.1E-12	6.5E-12
Benzo(b)fluoranthene	0.120	6.0E-09	3.1E-01	2.5E-12	7.9E-13
Bis(2-Ethylhexyl)phthalate	16.2	8.1E-07	1.4E-02	3.4E-10	4.8E-12
Dibenz(a,h)anthracene	0.029	1.5E-09	3.1E+00	6.2E-13	1.9E-12
Hexachlorobenzene	*	*	1.6E+00	*	*
Indeno(1,2,3-c,d)pyrene	0.079	4.0E-09	3.1E-01	1.7E-12	5.2E-13
2-Methylnaphthalene	*	*	--	*	*
Total Cancer Risk					3E-08

Notes:

"EPC" Exposure Point Concentration

"--" not applicable or not available; " * " not selected as a COPC in this media

Equations:

Modeled Air EPC (CA) = CS * 5.0E-08 kg/m^3

Adult/Child Visitor INTAKE-C (mg/kg-day) = ((CA * EF * $INH_{adjusted}$) / (AT-C))

Where: $INH_{adjusted}$ = [(IR-Ac * EDc / BWc) + (IR-Aa * EDa / BWa)]

Cancer Risk = (INTAKE-C * CSF)

TABLE 16 - AREA 2
SUMMARY OF CANCER RISK
THEME PARK VISITORS
HUMAN HEALTH RISK ASSESSMENT

COPC	Combined Soil EPC (mg/kg)	Cancer Risk			
		Recreational Visitor - Adult/Child			
		Ingestion	Dermal	Inhalation	Total Risk
Metals					
Antimony	*	*	*	*	--
Arsenic	1.39	9.3E-09	8.8E-10	4.4E-10	1.1E-08
Cadmium	*	*	*	*	--
Chromium	28.4	--	--	2.5E-08	2.5E-08
Chromium VI	*	*	*	*	--
Copper	625	--	--	--	--
Lead	199	--	--	--	--
Molybdenum	*	*	*	*	--
Nickel	*	*	*	*	--
Zinc	*	*	*	*	--
Cyanide					
Cyanide	*	*	*	*	--
Pesticides					
Aroclor 1260	18.8	1.7E-07	7.4E-08	8.0E-10	2.4E-07
Dioxins					
TCDD TEQ	0.002	1.4E-06	1.3E-07	6.7E-09	1.5E-06
SVOCs					
Benzo(a)anthracene	0.097	3.2E-10	1.3E-10	6.4E-13	4.5E-10
Benzo(a)pyrene	0.099	3.2E-09	1.3E-09	6.5E-12	4.6E-09
Benzo(b)fluoranthene	0.120	3.9E-10	1.6E-10	7.9E-13	5.5E-10
Bis(2-Ethylhexyl)phthalate	16.2	1.0E-09	3.2E-10	4.8E-12	1.3E-09
Dibenz(a,h)anthracene	0.029	9.5E-10	3.9E-10	1.9E-12	1.3E-09
Hexachlorobenzene	*	*	*	*	--
Indeno(1,2,3-c,d)pyrene	0.079	2.6E-10	1.1E-10	5.2E-13	3.6E-10
2-Methylnaphthalene	*	*	*	*	--
Total Cancer Risk					2E-06

Notes:
"EPC" Exposure Point Concentration
"--" not applicable or not available; " * " not selected as a COPC in this media

TABLE 17 - AREA 2
SUMMARY OF NONCANCER HAZARD AND CANCER RISK
THEME PARK WORKERS AND VISITORS
HUMAN HEALTH RISK ASSESSMENT

Receptor and Exposure Routes of Concern	Area 2	
	Cancer Risk	Noncancer Hazard
Park Worker		
Incidental Soil Ingestion	6E-05	1E-02
Dermal Contact with Soil	3E-05	1E-03
Fugitive Dust Inhalation	5E-06	8E-06
Total	1E-04	1E-02
Park Visitor		
Incidental Soil Ingestion	2E-06	8E-04
Dermal Contact with Soil	2E-07	2E-05
Fugitive Dust Inhalation	3E-08	7E-08
Total	2E-06	8E-04

Note:
Noncancer Hazard for the Park Visitor is based on exposure factors for a child.

TABLE 18 - AREA 2
LEAD RISK ASSESSMENT SPREADSHEET
CALIFORNIA DEPARTMENT OF TOXIC SUBSTANCES CONTROL
PREDICTED BLOOD LEAD RESULTS

USER'S GUIDE to version 7

INPUT	
MEDIUM	LEVEL
Lead in Air (ug/m^3)	0.028
Lead in Soil/Dust (ug/g)	199
Lead in Water (ug/l)	15
% Home-grown Produce	0%
Respirable Dust (ug/m^3)	1.5

OUTPUT	Percentile Estimate of Blood Pb (ug/dl)					PRG-99	PRG-95
	50th	90th	95th	98th	99th	(ug/g)	(ug/g)
BLOOD Pb, ADULT	1.1	2.0	2.3	2.8	3.2	894292	1398749
BLOOD Pb, CHILD	1.5	2.8	3.3	4.0	4.6	92664	158331
BLOOD Pb, PICA CHILD	1.5	2.8	3.3	4.1	4.6	46538	79517
BLOOD Pb, OCCUPATIONAL	1.2	2.3	2.7	3.2	3.7	3468	5452

EXPOSURE PARAMETERS	units	adults	children
Days per week	days/wk	0.02	
Days per week, occupational		5	
Geometric Standard Deviation		1.6	
Blood lead level of concern (ug/dl)		10	
Skin area, residential	cm^2	5700	2900
Skin area occupational	cm^2	2900	
Soil adherence	ug/cm^2	70	200
Dermal uptake constant	(ug/dl)/(ug/day)	0.00011	
Soil ingestion	kg/day	50	100
Soil ingestion, pica	kg/day		200
Ingestion constant	(ug/dl)/(ug/day)	0.04	0.16
Bioavailability	unitless	0.44	
Breathing rate	m^3/day	20	6.8
Inhalation constant	(ug/dl)/(ug/day)	0.08	0.192
Water ingestion	l/day	1.4	0.4
Food ingestion	kg/day	1.9	1.1
Lead in market basket	ug/kg	3.1	
Lead in produce	ug/kg	89.6	

PATHWAYS

ADULTS	Residential			Occupational		
	Pathway contribution			Pathway contribution		
Pathway	PEF	ug/dl	percent	PEF	ug/dl	percent
Soil Contact	1.2E-7	0.00	0%	1.5E-5	0.00	0%
Soil Ingestion	2.4E-6	0.00	0%	6.3E-4	0.13	10%
Inhalation1		0.00	0%		0.03	3%
Inhalation	6.8E-9	0.00	0%	1.8E-6	0.00	0%
Water Ingestion		0.84	78%		0.84	68%
Food Ingestion1		0.23	22%		0.23	19%
Food Ingestion	0.0E+0	0.00	0%			0%

CHILDREN	typical			with pica		
	Pathway contribution			Pathway contribution		
Pathway	PEF	ug/dl	percent	PEF	ug/dl	percent
Soil Contact	1.7E-7	0.00	0%		0.00	0%
Soil Ingestion	1.9E-5	0.00	0%	3.9E-5	0.01	0%
Inhalation1	4.1E-9	0.00	0%		0.00	0%
Inhalation		0.04	2%		0.04	2%
Water Ingestion		0.96	62%		0.96	62%
Food Ingestion, child		0.54	35%		0.54	35%
Food Ingestion	0.0E+0	0.00	0%		0.00	0%

TABLE 1 - AREA 3
INCIDENTAL SOIL INGESTION
NONCANCER HAZARD FOR PARK WORKERS
HUMAN HEALTH RISK ASSESSMENT

COPC	Combined Soil EPC (mg/kg)	Oral Reference Dose (mg/kg-d)	Park Worker Exposure Scenario	
			Average Daily Intake (mg/kg-d) Adult	Hazard Quotient (Unitless) Adult
Metals				
Antimony	7.14	4.0E-04	3.5E-06	8.7E-03
Arsenic	3.99	3.0E-04	2.0E-06	6.5E-03
Cadmium	2.22	5.0E-04	1.1E-06	2.2E-03
Chromium	102	1.5E+00	5.0E-05	3.3E-05
Chromium VI	*	3.0E-03	*	*
Copper	1170	3.7E-02	5.7E-04	1.5E-02
Lead	611	--	3.0E-04	--
Molybdenum	13.5	5.0E-03	6.6E-06	1.3E-03
Nickel	106	2.0E-02	5.2E-05	2.6E-03
Zinc	1280	3.0E-01	6.3E-04	2.1E-03
Cyanide				
Cyanide	*	2.0E-02	*	*
Pesticides				
Aroclor 1260	0.700	--	3.4E-07	--
Dioxins				
TCDD TEQ	0.008	--	3.7E-09	--
SVOCs				
Benzo(a)anthracene	*	--	*	*
Benzo(a)pyrene	0.040	--	2.0E-08	--
Benzo(b)fluoranthene	0.059	--	2.9E-08	--
Bis(2-Ethylhexyl)phthalate	25.1	2.0E-02	1.2E-05	6.1E-04
Dibenz(a,h)anthracene	0.022	--	1.1E-08	--
Hexachlorobenzene	1.0	8.0E-04	4.9E-07	6.1E-04
Indeno(1,2,3-c,d)pyrene	0.038	--	1.9E-08	--
2-Methylnaphthalene	*	2.0E-02	*	*
Total Hazard Index				4E-02

Notes:
"EPC" Exposure Point Concentration
"--" not applicable or not available; " * " not selected as a COPC in this media
Equations:
Worker INTAKE-N (mg/kg-day) = ((CS * IR-S * EF * ED * CF) / (BW * AT-N))
Noncancer Hazard = (INTAKE-N / RfD)

TABLE 2 - AREA 3
DERMAL CONTACT WITH SOIL
NONCANCER HAZARD FOR PARK WORKERS
HUMAN HEALTH RISK ASSESSMENT

COPC	Combined Soil EPC (mg/kg)	Soil-to-Skin Absorption Factor (unitless)	Oral/Dermal Reference Dose (mg/kg-d)	Park Worker Exposure Scenario	
				Average Daily Intake (mg/kg-d) Adult	Hazard Quotient (Unitless) Adult
Metals					
Antimony	7.14	0	4.0E-04	0.0E+00	0.0E+00
Arsenic	3.99	0.03	3.0E-04	7.7E-07	2.6E-03
Cadmium	2.22	0.001	5.0E-04	1.4E-08	2.9E-05
Chromium	102	0	1.5E+00	0.0E+00	0.0E+00
Chromium VI	*	0	3.0E-03	*	*
Copper	1170	0	3.7E-02	0.0E+00	0.0E+00
Lead	611	0	--	0.0E+00	--
Molybdenum	13.5	0	5.0E-03	0.0E+00	0.0E+00
Nickel	106	0	2.0E-02	0.0E+00	0.0E+00
Zinc	1280	0	3.0E-01	0.0E+00	0.0E+00
Cyanide					
Cyanide	*	0	2.0E-02	*	*
Pesticides					
Aroclor 1260	0.700	0.14	--	6.3E-07	--
Dioxins					
TCDD TEQ	0.008	0.03	--	1.5E-09	--
SVOCs					
Benzo(a)anthracene	*	0.13	--	*	*
Benzo(a)pyrene	0.040	0.13	--	3.4E-08	--
Benzo(b)fluoranthene	0.059	0.13	--	5.0E-08	--
Bis(2-Ethylhexyl)phthalate	25.1	0.10	2.0E-02	1.6E-05	8.1E-04
Dibenz(a,h)anthracene	0.022	0.13	--	1.8E-08	--
Hexachlorobenzene	1.0	0.10	8.0E-04	6.5E-07	8.1E-04
Indeno(1,2,3-c,d)pyrene	0.038	0.13	--	3.2E-08	--
2-Methylnaphthalene	*	0.13	2.0E-02	*	*
Total Hazard Index					4E-03

Notes:
"EPC" Exposure Point Concentration
"--" not applicable or not available; " * " not selected as a COPC in this media
Equations:
Worker INTAKE-N (mg/kg-day) = ((CS * SA * AF * ABS * EF * ED * CF) / (BW * AT-N))
Noncancer Hazard = (INTAKE-N / RfD)

TABLE 3 - AREA 3
INHALATION OF SOIL
NONCANCER HAZARD FOR PARK WORKERS
HUMAN HEALTH RISK ASSESSMENT

COPC	Combined Soil EPC (mg/kg)	Modeled Air EPC (mg/m^3)	Inhalation Reference Dose[a] (mg/kg-d)	Park Worker Exposure Scenario: Average Daily Intake (mg/kg-d) Adult	Park Worker Exposure Scenario: Hazard Quotient (Unitless) Adult
Metals					
Antimony	7.14	3.6E-07	--	7.0E-08	--
Arsenic	3.99	2.0E-07	--	3.9E-08	--
Cadmium	2.22	1.1E-07	--	2.2E-08	--
Chromium	102	5.1E-06	--	1.0E-06	--
Chromium VI	*	*	--	*	*
Copper	1170	5.9E-05	--	1.1E-05	--
Lead	611	3.1E-05	--	6.0E-06	--
Molybdenum	13.5	6.8E-07	--	1.3E-07	--
Nickel	106	5.3E-06	--	1.0E-06	--
Zinc	1280	6.4E-05	--	1.3E-05	--
Cyanide					
Cyanide	*	*	8.6E-04	*	*
Pesticides					
Aroclor 1260	0.700	3.5E-08	--	6.8E-09	--
Dioxins					
TCDD TEQ	0.008	3.8E-10	--	7.3E-11	--
SVOCs					
Benzo(a)anthracene	*	*	--	*	*
Benzo(a)pyrene	0.040	2.0E-09	--	3.9E-10	--
Benzo(b)fluoranthene	0.059	3.0E-09	--	5.8E-10	--
Bis(2-Ethylhexyl)phthalate	25.1	1.3E-06	2.0E-02	2.5E-07	1.2E-05
Dibenz(a,h)anthracene	0.022	1.1E-09	--	2.2E-10	--
Hexachlorobenzene	1.0	5.0E-08	8.0E-04	9.8E-09	1.2E-05
Indeno(1,2,3-c,d)pyrene	0.038	1.9E-09	--	3.7E-10	--
2-Methylnaphthalene	*	*	8.6E-04	*	*
Total Hazard Index					2E-05

Notes:
"EPC" Exposure Point Concentration
"--" not applicable or not available; " * " not selected as a COPC in this media
Equations:
Modeled Air EPC (CA) = CS * 5.0E-08 kg/m^3
Worker INTAKE-N (mg/kg-day) = ((CA * IR-A * EF * ED) / (BW * AT-N))
Noncancer Hazard = (INTAKE-N / RfD)

TABLE 4 - AREA 3
SUMMARY OF NONCANCER HAZARD
THEME PARK WORKERS
HUMAN HEALTH RISK ASSESSMENT

COPC	Combined Soil EPC (mg/kg)	Noncancer Hazard			
		Adult Worker			
		Ingestion	Dermal	Inhalation	Total HI
Metals					
Antimony	7.14	8.7E-03	0.0E+00	--	8.7E-03
Arsenic	3.99	6.5E-03	2.6E-03	--	9.1E-03
Cadmium	2.22	2.2E-03	2.9E-05	--	2.2E-03
Chromium	102	3.3E-05	0.0E+00	--	3.3E-05
Chromium VI	*	*	*	*	--
Copper	1170	1.5E-02	0.0E+00	--	1.5E-02
Lead	611	--	--	--	--
Molybdenum	13.5	1.3E-03	0.0E+00	--	1.3E-03
Nickel	106	2.6E-03	0.0E+00	--	2.6E-03
Zinc	1280	2.1E-03	0.0E+00	--	2.1E-03
Cyanide					
Cyanide	*	*	*	*	--
Pesticides					
Aroclor 1260	0.700	--	--	--	--
Dioxins					
TCDD TEQ	0.008	--	--	--	--
SVOCs					
Benzo(a)anthracene	*	*	*	*	--
Benzo(a)pyrene	0.040	--	--	--	--
Benzo(b)fluoranthene	0.059	--	--	--	--
Bis(2-Ethylhexyl)phthalate	25.1	6.1E-04	8.1E-04	1.2E-05	1.4E-03
Dibenz(a,h)anthracene	0.022	--	--	--	--
Hexachlorobenzene	1.0	6.1E-04	8.1E-04	1.2E-05	1.4E-03
Indeno(1,2,3-c,d)pyrene	0.038	--	--	--	--
2-Methylnaphthalene	*	*	*	*	--
Total Hazard Index					4E-02

Notes:
"EPC" Exposure Point Concentration
"--" not applicable or not available; " * " not selected as a COPC in this media

TABLE 5 - AREA 3
INCIDENTAL SOIL INGESTION
CANCER RISK FOR PARK WORKERS
HUMAN HEALTH RISK ASSESSMENT

COPC	Combined Soil EPC (mg/kg)	Oral Slope Factor (mg/kg-d)$^{-1}$	Park Worker Exposure Scenario	
			Average Daily Intake (mg/kg-d) Adult	Cancer Risk (Unitless) Adult
Metals				
Antimony	7.14	--	1.2E-06	--
Arsenic	3.99	1.5E+00	7.0E-07	1.0E-06
Cadmium	2.22	--	3.9E-07	--
Chromium	102	--	1.8E-05	--
Chromium VI	*	--	*	*
Copper	1170	--	2.0E-04	--
Lead	611	--	1.1E-04	--
Molybdenum	13.5	--	2.4E-06	--
Nickel	106	--	1.9E-05	--
Zinc	1280	--	2.2E-04	--
Cyanide				
Cyanide	*	--	*	*
Pesticides				
Aroclor 1260	0.700	2.0E+00	1.2E-07	2.4E-07
Dioxins				
TCDD TEQ	0.008	1.5E+05	1.3E-09	2.0E-04
SVOCs				
Benzo(a)anthracene	*	7.3E-01	*	*
Benzo(a)pyrene	0.040	7.3E+00	7.0E-09	5.1E-08
Benzo(b)fluoranthene	0.059	7.3E-01	1.0E-08	7.5E-09
Bis(2-Ethylhexyl)phthalate	25.1	1.4E-02	4.4E-06	6.1E-08
Dibenz(a,h)anthracene	0.022	7.3E+00	3.8E-09	2.8E-08
Hexachlorobenzene	1.0	1.6E+00	1.7E-07	2.8E-07
Indeno(1,2,3-c,d)pyrene	0.038	7.3E-01	6.6E-09	4.8E-09
2-Methylnaphthalene	*	--	*	*
Total Cancer Risk				2E-04

Notes:
"EPC" Exposure Point Concentration
"--" not applicable or not available; " * " not selected as a COPC in this media
Equations:
Worker INTAKE-C (mg/kg-day) = ((CS * IR-S * EF * ED * CF) / (BW * AT-C))
Cancer Risk = (INTAKE-C * CSF)

TABLE 6 - AREA 3
DERMAL CONTACT WITH SOIL
CANCER RISK FOR PARK WORKERS
HUMAN HEALTH RISK ASSESSMENT

COPC	Combined Soil EPC (mg/kg)	Soil-to-Skin Absorption Factor (unitless)	Oral/Dermal Slope Factor $(mg/kg\text{-}d)^{-1}$	Park Worker Exposure Scenario	
				Average Daily Intake (mg/kg-d) Adult	Cancer Risk (Unitless) Adult
Metals					
Antimony	7.14	0	--	0.0E+00	--
Arsenic	3.99	0.03	1.5E+00	2.8E-07	4.1E-07
Cadmium	2.22	0.001	--	5.1E-09	--
Chromium	102	0	--	0.0E+00	--
Chromium VI	*	0	--	*	*
Copper	1170	0	--	0.0E+00	--
Lead	611	0	--	0.0E+00	--
Molybdenum	13.5	0	--	0.0E+00	--
Nickel	106	0	--	0.0E+00	--
Zinc	1280	0	--	0.0E+00	--
Cyanide					
Cyanide	*	0	--	*	*
Pesticides					
Aroclor 1260	0.700	0.14	2.0E+00	2.3E-07	4.5E-07
Dioxins					
TCDD TEQ	0.008	0.03	1.5E+05	5.2E-10	7.8E-05
SVOCs					
Benzo(a)anthracene	*	0.13	7.3E-01	*	*
Benzo(a)pyrene	0.040	0.13	7.3E+00	1.2E-08	8.8E-08
Benzo(b)fluoranthene	0.059	0.13	7.3E-01	1.8E-08	1.3E-08
Bis(2-Ethylhexyl)phthalate	25.1	0.10	1.4E-02	5.8E-06	8.1E-08
Dibenz(a,h)anthracene	0.022	0.13	7.3E+00	6.6E-09	4.8E-08
Hexachlorobenzene	1.0	0.10	1.6E+00	2.3E-07	3.7E-07
Indeno(1,2,3-c,d)pyrene	0.038	0.13	7.3E-01	1.1E-08	8.3E-09
2-Methylnaphthalene	*	0.13	--	*	*
Total Cancer Risk					8E-05

Notes:
"EPC" Exposure Point Concentration
"--" not applicable or not available; " * " not selected as a COPC in this media
Equations:
Worker INTAKE-C (mg/kg-day) = ((CS * SA * EF * ED * AF * ABS * CF) / (BW * AT-C))
Cancer Risk = (INTAKE-C * CSF)

TABLE 7 - AREA 3
INHALATION OF SOIL
CANCER RISK FOR PARK WORKERS
HUMAN HEALTH RISK ASSESSMENT

COPC	Combined Soil EPC (mg/kg)	Modeled Air EPC (mg/m^3)	Inhalation Slope Factor $(mg/kg\text{-}d)^{-1}$	Park Worker Exposure Scenario	
				Average Daily Intake (mg/kg-d) Adult	Cancer Risk (Unitless) Adult
Metals					
Antimony	7.14	3.6E-07	--	2.5E-08	--
Arsenic	3.99	2.0E-07	1.5E+01	1.4E-08	2.1E-07
Cadmium	2.22	1.1E-07	6.3E+00	7.8E-09	4.9E-08
Chromium	102	5.1E-06	4.2E+01	3.6E-07	1.5E-05
Chromium VI	*	*	2.9E+02	*	*
Copper	1170	5.9E-05	--	4.1E-06	--
Lead	611	3.1E-05	--	2.1E-06	--
Molybdenum	13.5	6.8E-07	--	4.7E-08	--
Nickel	106	5.3E-06	--	3.7E-07	--
Zinc	1280	6.4E-05	--	4.5E-06	--
Cyanide					
Cyanide	*	*	--	*	*
Pesticides					
Aroclor 1260	0.700	3.5E-08	2.0E+00	2.4E-09	4.9E-09
Dioxins					
TCDD TEQ	0.008	3.8E-10	1.5E+05	2.6E-11	3.9E-06
SVOCs					
Benzo(a)anthracene	*	*	3.1E-01	*	*
Benzo(a)pyrene	0.040	2.0E-09	3.1E+00	1.4E-10	4.3E-10
Benzo(b)fluoranthene	0.059	3.0E-09	3.1E-01	2.1E-10	6.4E-11
Bis(2-Ethylhexyl)phthalate	25.1	1.3E-06	1.4E-02	8.8E-08	1.2E-09
Dibenz(a,h)anthracene	0.022	1.1E-09	3.1E+00	7.7E-11	2.4E-10
Hexachlorobenzene	1.0	5.0E-08	1.6E+00	3.5E-09	5.6E-09
Indeno(1,2,3-c,d)pyrene	0.038	1.9E-09	3.1E-01	1.3E-10	4.1E-11
2-Methylnaphthalene	*	*	--	*	*
Total Cancer Risk					2E-05

Notes:
"EPC" Exposure Point Concentration
"--" not applicable or not available; " * " not selected as a COPC in this media
Equations:
Modeled Air EPC (CA) = CS * 5.0E-08 kg/m^3
Worker INTAKE-C (mg/kg-day) = ((CA * IR-A * EF * ED) / (BW * AT-C))
Cancer Risk = (INTAKE-C * CSF)

TABLE 8 - AREA 3
SUMMARY OF CANCER RISK
THEME PARK WORKERS
HUMAN HEALTH RISK ASSESSMENT

COPC	Combined Soil EPC (mg/kg)	Cancer Risk			
		Adult Worker			
		Ingestion	Dermal	Inhalation	Total Risk
Metals					
Antimony	7.14	--	--	--	--
Arsenic	3.99	1.0E-06	4.1E-07	2.1E-07	1.7E-06
Cadmium	2.22	--	--	4.9E-08	4.9E-08
Chromium	102	--	--	1.5E-05	1.5E-05
Chromium VI	*	*	*	*	--
Copper	1170	--	--	--	--
Lead	611	--	--	--	--
Molybdenum	13.5	--	--	--	--
Nickel	106	--	--	--	--
Zinc	1280	--	--	--	--
Cyanide					
Cyanide	*	*	*	*	--
Pesticides					
Aroclor 1260	0.700	2.4E-07	4.5E-07	4.9E-09	7.0E-07
Dioxins					
TCDD TEQ	0.008	2.0E-04	7.8E-05	3.9E-06	2.8E-04
SVOCs					
Benzo(a)anthracene	*	*	*	*	--
Benzo(a)pyrene	0.040	5.1E-08	8.8E-08	4.3E-10	1.4E-07
Benzo(b)fluoranthene	0.059	7.5E-09	1.3E-08	6.4E-11	2.1E-08
Bis(2-Ethylhexyl)phthalate	25.1	6.1E-08	8.1E-08	1.2E-09	1.4E-07
Dibenz(a,h)anthracene	0.022	2.8E-08	4.8E-08	2.4E-10	7.6E-08
Hexachlorobenzene	1.0	2.8E-07	3.7E-07	5.6E-09	6.5E-07
Indeno(1,2,3-c,d)pyrene	0.038	4.8E-09	8.3E-09	4.1E-11	1.3E-08
2-Methylnaphthalene	*	*	*	*	--
Total Cancer Risk					3E-04

Notes:
"EPC" Exposure Point Concentration
"--" not applicable or not available; " * " not selected as a COPC in this media

TABLE 9 - AREA 3
INCIDENTAL SOIL INGESTION
NONCANCER HAZARD FOR PARK VISITORS
HUMAN HEALTH RISK ASSESSMENT

COPC	Combined Soil EPC (mg/kg)	Oral Reference Dose (mg/kg-d)	Recreational Exposure Scenario	
			Average Daily Intake (mg/kg-d) Child	Hazard Quotient (Unitless) Child
Metals				
Antimony	7.14	4.0E-04	2.6E-07	6.5E-04
Arsenic	3.99	3.0E-04	1.5E-07	4.9E-04
Cadmium	2.22	5.0E-04	8.1E-08	1.6E-04
Chromium	102	1.5E+00	3.7E-06	2.5E-06
Chromium VI	*	3.0E-03	*	*
Copper	1170	3.7E-02	4.3E-05	1.2E-03
Lead	611	--	2.2E-05	--
Molybdenum	13.5	5.0E-03	4.9E-07	9.9E-05
Nickel	106	2.0E-02	3.9E-06	1.9E-04
Zinc	1280	3.0E-01	4.7E-05	1.6E-04
Cyanide				
Cyanide	*	2.0E-02	*	*
Pesticides				
Aroclor 1260	0.700	--	2.6E-08	--
Dioxins				
TCDD TEQ	0.008	--	2.7E-10	--
SVOCs				
Benzo(a)anthracene	*	--	*	*
Benzo(a)pyrene	0.040	--	1.5E-09	--
Benzo(b)fluoranthene	0.059	--	2.2E-09	--
Bis(2-Ethylhexyl)phthalate	25.1	2.0E-02	9.2E-07	4.6E-05
Dibenz(a,h)anthracene	0.022	--	8.0E-10	--
Hexachlorobenzene	1.0	8.0E-04	3.7E-08	4.6E-05
Indeno(1,2,3-c,d)pyrene	0.038	--	1.4E-09	--
2-Methylnaphthalene	*	2.0E-02	*	*
Total Hazard Index				3E-03

Notes:
"EPC" Exposure Point Concentration
"--" not applicable or not available; " * " not selected as a COPC in this media
Equations:
Child Visitor INTAKE-N (mg/kg-day) = ((CS * IR-Sc * EFc * EDc * CF) / (BWc * AT-N))
Noncancer Hazard = (INTAKE-N / RfD)

TABLE 10 - AREA 3
DERMAL CONTACT WITH SOIL
NONCANCER HAZARD FOR PARK VISITORS
HUMAN HEALTH RISK ASSESSMENT

COPC	Combined Soil EPC (mg/kg)	Soil-to-Skin Absorption Factor (unitless)	Oral/Dermal Reference Dose (mg/kg-d)	Recreational Exposure Scenario	
				Average Daily Intake (mg/kg-d) Child	Hazard Quotient (Unitless) Child
Metals					
Antimony	7.14	0	4.0E-04	0.0E+00	0.0E+00
Arsenic	3.99	0.03	3.0E-04	1.2E-08	4.1E-05
Cadmium	2.22	0.001	5.0E-04	2.3E-10	4.5E-07
Chromium	102	0	1.5E+00	0.0E+00	0.0E+00
Chromium VI	*	0	3.0E-03	*	*
Copper	1170	0	3.7E-02	0.0E+00	0.0E+00
Lead	611	0	--	0.0E+00	--
Molybdenum	13.5	0	5.0E-03	0.0E+00	0.0E+00
Nickel	106	0	2.0E-02	0.0E+00	0.0E+00
Zinc	1280	0	3.0E-01	0.0E+00	0.0E+00
Cyanide					
Cyanide	*	0	2.0E-02	*	*
Pesticides					
Aroclor 1260	0.700	0.14	--	1.0E-08	--
Dioxins					
TCDD TEQ	0.008	0.03	--	2.3E-11	--
SVOCs					
Benzo(a)anthracene	*	0.13	--	*	*
Benzo(a)pyrene	0.040	0.13	--	5.3E-10	--
Benzo(b)fluoranthene	0.059	0.13	--	7.8E-10	--
Bis(2-Ethylhexyl)phthalate	25.1	0.10	2.0E-02	2.6E-07	1.3E-05
Dibenz(a,h)anthracene	0.022	0.13	--	2.9E-10	--
Hexachlorobenzene	1.0	0.10	8.0E-04	1.0E-08	1.3E-05
Indeno(1,2,3-c,d)pyrene	0.038	0.13	--	5.1E-10	--
2-Methylnaphthalene	*	0.13	2.0E-02	*	*
Total Hazard Index					7E-05

Notes:
"EPC" Exposure Point Concentration
"--" not applicable or not available; " * " not selected as a COPC in this media
Equations:
Child Visitor INTAKE-N (mg/kg-day) = ((CS * SAc * AFc * ABS * EFc * EDc * CF) / (BWc * AT-N))
Noncancer Hazard = (INTAKE-N / RfD)

TABLE 11 - AREA 3
INHALATION OF SOIL
NONCANCER HAZARD FOR PARK VISITORS
HUMAN HEALTH RISK ASSESSMENT

COPC	Combined Soil EPC (mg/kg)	Modeled Air EPC (mg/m³)	Inhalation Reference Dose[a] (mg/kg-d)	Recreational Exposure Scenario: Average Daily Intake (mg/kg-d) Child	Recreational Exposure Scenario: Hazard Quotient (Unitless) Child
Metals					
Antimony	7.14	3.6E-07	--	6.5E-10	--
Arsenic	3.99	2.0E-07	--	3.6E-10	--
Cadmium	2.22	1.1E-07	--	2.0E-10	--
Chromium	102	5.1E-06	--	9.3E-09	--
Chromium VI	*	*	--	*	*
Copper	1170	5.9E-05	--	1.1E-07	--
Lead	611	3.1E-05	--	5.6E-08	--
Molybdenum	13.5	6.8E-07	--	1.2E-09	--
Nickel	106	5.3E-06	--	9.7E-09	--
Zinc	1280	6.4E-05	--	1.2E-07	--
Cyanide					
Cyanide	*	*	8.6E-04	*	*
Pesticides					
Aroclor 1260	0.700	3.5E-08	--	6.4E-11	--
Dioxins					
TCDD TEQ	0.008	3.8E-10	--	6.8E-13	--
SVOCs					
Benzo(a)anthracene	*	*	--	*	*
Benzo(a)pyrene	0.040	2.0E-09	--	3.7E-12	--
Benzo(b)fluoranthene	0.059	3.0E-09	--	5.4E-12	--
Bis(2-Ethylhexyl)phthalate	25.1	1.3E-06	2.0E-02	2.3E-09	1.1E-07
Dibenz(a,h)anthracene	0.022	1.1E-09	--	2.0E-12	--
Hexachlorobenzene	1.0	5.0E-08	8.0E-04	9.1E-11	1.1E-07
Indeno(1,2,3-c,d)pyrene	0.038	1.9E-09	--	3.5E-12	--
2-Methylnaphthalene	*	*	8.6E-04	*	*
Total Hazard Index					2E-07

Notes:
"EPC" Exposure Point Concentration
"--" not applicable or not available; " * " not selected as a COPC in this media
Equations:
Modeled Air EPC (CA) = CS * 5.0E-08 kg/m³
Child Visitor INTAKE-N (mg/kg-day) = (CA * IR-Ac * EFc * EDc) / (BWc * AT-N))
Noncancer Hazard = (INTAKE-N / RfD)

TABLE 12 - AREA 3
SUMMARY OF NONCANCER HAZARD
THEME PARK VISITORS
HUMAN HEALTH RISK ASSESSMENT

COPC	Combined Soil EPC (mg/kg)	Noncancer Hazard			
		Recreational Visitor - Child			
		Ingestion	Dermal	Inhalation	Total HI
Metals					
Antimony	7.14	6.5E-04	0.0E+00	--	6.5E-04
Arsenic	3.99	4.9E-04	4.1E-05	--	5.3E-04
Cadmium	2.22	1.6E-04	4.5E-07	--	1.6E-04
Chromium	102	2.5E-06	0.0E+00	--	2.5E-06
Chromium VI	*	*	*	*	--
Copper	1170	1.2E-03	0.0E+00	--	1.2E-03
Lead	611	--	--	--	--
Molybdenum	13.5	9.9E-05	0.0E+00	--	9.9E-05
Nickel	106	1.9E-04	0.0E+00	--	1.9E-04
Zinc	1280	1.6E-04	0.0E+00	--	1.6E-04
Cyanide					
Cyanide	*	*	*	*	--
Pesticides					
Aroclor 1260	0.700	--	--	--	--
Dioxins					
TCDD TEQ	0.008	--	--	--	--
SVOCs					
Benzo(a)anthracene	*	*	*	*	--
Benzo(a)pyrene	0.040	--	--	--	--
Benzo(b)fluoranthene	0.059	--	--	--	--
Bis(2-Ethylhexyl)phthalate	25.1	4.6E-05	1.3E-05	1.1E-07	5.9E-05
Dibenz(a,h)anthracene	0.022	--	--	--	--
Hexachlorobenzene	1.0	4.6E-05	1.3E-05	1.1E-07	5.9E-05
Indeno(1,2,3-c,d)pyrene	0.038	--	--	--	--
2-Methylnaphthalene	*	*	*	*	--
Total Hazard Index					3E-03

Notes:
"EPC" Exposure Point Concentration
"--" not applicable or not available; " * " not selected as a COPC in this media

TABLE 13 - AREA 3
INCIDENTAL SOIL INGESTION
CANCER RISK FOR PARK VISITORS
HUMAN HEALTH RISK ASSESSMENT

COPC	Combined Soil EPC (mg/kg)	Oral Slope Factor $(mg/kg\text{-}d)^{-1}$	Recreational Exposure Scenario	
			Average Daily Intake (mg/kg-d) Adult/Child	Cancer Risk (Unitless) Adult/Child
Metals				
Antimony	7.14	--	3.2E-08	--
Arsenic	3.99	1.5E+00	1.8E-08	2.7E-08
Cadmium	2.22	--	9.9E-09	--
Chromium	102	--	4.6E-07	--
Chromium VI	*	--	*	*
Copper	1170	--	5.2E-06	--
Lead	611	--	2.7E-06	--
Molybdenum	13.5	--	6.0E-08	--
Nickel	106	--	4.7E-07	--
Zinc	1280	--	5.7E-06	--
Cyanide				
Cyanide	*	--	*	*
Pesticides				
Aroclor 1260	0.700	2.0E+00	3.1E-09	6.3E-09
Dioxins				
TCDD TEQ	0.008	1.5E+05	3.4E-11	5.0E-06
SVOCs				
Benzo(a)anthracene	*	7.3E-01	*	*
Benzo(a)pyrene	0.040	7.3E+00	1.8E-10	1.3E-09
Benzo(b)fluoranthene	0.059	7.3E-01	2.6E-10	1.9E-10
Bis(2-Ethylhexyl)phthalate	25.1	1.4E-02	1.1E-07	1.6E-09
Dibenz(a,h)anthracene	0.022	7.3E+00	9.8E-11	7.2E-10
Hexachlorobenzene	1.0	1.6E+00	4.5E-09	7.2E-09
Indeno(1,2,3-c,d)pyrene	0.038	7.3E-01	1.7E-10	1.2E-10
2-Methylnaphthalene	*	--	*	*
Total Cancer Risk				5E-06

Notes:
"EPC" Exposure Point Concentration
"--" not applicable or not available; " * " not selected as a COPC in this media
Equations:
Adult/Child Visitor INTAKE-C (mg/kg-day) = ((CS * EF * $ING_{adjusted}$ * CF) / (AT-C))
Where $ING_{adjusted}$ = [(IR-Sc * EDc / BWc) + (IR-Sa * EDa / BWa)]
Cancer Risk = (INTAKE-C * CSF)

TABLE 14 - AREA 3
DERMAL CONTACT WITH SOIL
CANCER RISK FOR PARK VISITORS
HUMAN HEALTH RISK ASSESSMENT

COPC	Combined Soil EPC (mg/kg)	Soil-to-Skin Absorption Factor (unitless)	Oral/Dermal Slope Factor $(mg/kg\text{-}d)^{-1}$	Recreational Exposure Scenario: Average Daily Intake (mg/kg-d) Adult/Child	Recreational Exposure Scenario: Cancer Risk (Unitless) Adult/Child
Metals					
Antimony	7.14	0	--	0.0E+00	--
Arsenic	3.99	0.03	1.5E+00	1.7E-09	2.5E-09
Cadmium	2.22	0.001	--	3.1E-11	--
Chromium	102	0	--	0.0E+00	--
Chromium VI	*	0	--	*	*
Copper	1170	0	--	0.0E+00	--
Lead	611	0	--	0.0E+00	--
Molybdenum	13.5	0	--	0.0E+00	--
Nickel	106	0	--	0.0E+00	--
Zinc	1280	0	--	0.0E+00	--
Cyanide					
Cyanide	*	0	--	*	*
Pesticides					
Aroclor 1260	0.700	0.14	2.0E+00	1.4E-09	2.8E-09
Dioxins					
TCDD TEQ	0.008	0.03	1.5E+05	3.2E-12	4.8E-07
SVOCs					
Benzo(a)anthracene	*	0.13	7.3E-01	*	*
Benzo(a)pyrene	0.040	0.13	7.3E+00	7.3E-11	5.4E-10
Benzo(b)fluoranthene	0.059	0.13	7.3E-01	1.1E-10	7.9E-11
Bis(2-Ethylhexyl)phthalate	25.1	0.10	1.4E-02	3.5E-08	5.0E-10
Dibenz(a,h)anthracene	0.022	0.13	7.3E+00	4.0E-11	2.9E-10
Hexachlorobenzene	1.0	0.10	1.6E+00	1.4E-09	2.3E-09
Indeno(1,2,3-c,d)pyrene	0.038	0.13	7.3E-01	7.0E-11	5.1E-11
2-Methylnaphthalene	*	0.13	--	*	*
Total Cancer Risk					5E-07

Notes:
"EPC" Exposure Point Concentration
"--" not applicable or not available; " * " not selected as a COPC in this media
Equations:
Adult/Child Visitor INTAKE-C (mg/kg-day) = $((CS * SAF_{adjusted} * ABS * CF) / (AT\text{-}C))$
Where $SAF_{adjusted} = [(SAc * AFc * EFc * EDc / BWc) + (SAa * AFa * EFa * EDa / BWa)]$
Cancer Risk = (INTAKE-C * CSF)

TABLE 15 - AREA 3
INHALATION OF SOIL
CANCER RISK FOR PARK VISITORS
HUMAN HEALTH RISK ASSESSMENT

COPC	Combined Soil EPC (mg/kg)	Modeled Air EPC (mg/m^3)	Inhalation Slope Factor (mg/kg-d)$^{-1}$	Recreational Exposure Scenario	
				Average Daily Intake (mg/kg-d) Adult/Child	Cancer Risk (Unitless) Adult/Child
Metals					
Antimony	7.14	3.6E-07	--	1.5E-10	--
Arsenic	3.99	2.0E-07	1.5E+01	8.5E-11	1.3E-09
Cadmium	2.22	1.1E-07	6.3E+00	4.7E-11	3.0E-10
Chromium	102	5.1E-06	4.2E+01	2.2E-09	9.1E-08
Chromium VI	*	*	2.9E+02	*	*
Copper	1170	5.9E-05	--	2.5E-08	--
Lead	611	3.1E-05	--	1.3E-08	--
Molybdenum	13.5	6.8E-07	--	2.9E-10	--
Nickel	106	5.3E-06	--	2.3E-09	--
Zinc	1280	6.4E-05	--	2.7E-08	--
Cyanide					
Cyanide	*	*	--	*	*
Pesticides					
Aroclor 1260	0.700	3.5E-08	2.0E+00	1.5E-11	3.0E-11
Dioxins					
TCDD TEQ	0.008	3.8E-10	1.5E+05	1.6E-13	2.4E-08
SVOCs					
Benzo(a)anthracene	*	*	3.1E-01	*	*
Benzo(a)pyrene	0.040	2.0E-09	3.1E+00	8.5E-13	2.6E-12
Benzo(b)fluoranthene	0.059	3.0E-09	3.1E-01	1.3E-12	3.9E-13
Bis(2-Ethylhexyl)phthalate	25.1	1.3E-06	1.4E-02	5.3E-10	7.5E-12
Dibenz(a,h)anthracene	0.022	1.1E-09	3.1E+00	4.7E-13	1.4E-12
Hexachlorobenzene	1.0	5.0E-08	1.6E+00	2.1E-11	3.4E-11
Indeno(1,2,3-c,d)pyrene	0.038	1.9E-09	3.1E-01	8.1E-13	2.5E-13
2-Methylnaphthalene	*	*	--	*	*
Total Cancer Risk					1E-07

Notes:
"EPC" Exposure Point Concentration
"--" not applicable or not available; " * " not selected as a COPC in this media
Equations:
Modeled Air EPC (CA) = CS * 5.0E-08 kg/m^3
Adult/Child Visitor INTAKE-C (mg/kg-day) = ((CA * EF * $INH_{adjusted}$) / (AT-C))
Where: $INH_{adjusted}$ = [(IR-Ac * EDc / BWc) + (IR-Aa * EDa / BWa)]
Cancer Risk = (INTAKE-C * CSF)

TABLE 16 - AREA 3
SUMMARY OF CANCER RISK
THEME PARK VISITORS
HUMAN HEALTH RISK ASSESSMENT

COPC	Combined Soil EPC (mg/kg)	Cancer Risk			
		Recreational Visitor - Adult/Child			
		Ingestion	Dermal	Inhalation	Total Risk
Metals					
Antimony	7.14	--	--	--	--
Arsenic	3.99	2.7E-08	2.5E-09	1.3E-09	3.1E-08
Cadmium	2.22	--	--	3.0E-10	3.0E-10
Chromium	102	--	--	9.1E-08	9.1E-08
Chromium VI	*	*	*	*	--
Copper	1,170	--	--	--	--
Lead	611	--	--	--	--
Molybdenum	13.5	--	--	--	--
Nickel	106	--	--	--	--
Zinc	1280	--	--	--	--
Cyanide					
Cyanide	*	*	*	*	--
Pesticides					
Aroclor 1260	0.700	6.3E-09	2.8E-09	3.0E-11	9.1E-09
Dioxins					
TCDD TEQ	0.008	5.0E-06	4.8E-07	2.4E-08	5.5E-06
SVOCs					
Benzo(a)anthracene	*	*	*	*	--
Benzo(a)pyrene	0.040	1.3E-09	5.4E-10	2.6E-12	1.8E-09
Benzo(b)fluoranthene	0.059	1.9E-10	7.9E-11	3.9E-13	2.7E-10
Bis(2-Ethylhexyl)phthalate	25.1	1.6E-09	5.0E-10	7.5E-12	2.1E-09
Dibenz(a,h)anthracene	0.022	7.2E-10	2.9E-10	1.4E-12	1.0E-09
Hexachlorobenzene	1.0	7.2E-09	2.3E-09	3.4E-11	9.5E-09
Indeno(1,2,3-c,d)pyrene	0.038	1.2E-10	5.1E-11	2.5E-13	1.8E-10
2-Methylnaphthalene	*	*	*	*	--
Total Cancer Risk					6E-06

Notes:
"EPC" Exposure Point Concentration
"--" not applicable or not available; " * " not selected as a COPC in this media

TABLE 17 - AREA 3
SUMMARY OF NONCANCER HAZARD AND CANCER RISK
THEME PARK WORKERS AND VISITORS
HUMAN HEALTH RISK ASSESSMENT

Receptor and Exposure Routes of Concern	Area 3	
	Cancer Risk	Noncancer Hazard
Park Worker		
Incidental Soil Ingestion	2E-04	4E-02
Dermal Contact with Soil	8E-05	4E-03
Fugitive Dust Inhalation	2E-05	2E-05
Total	3E-04	4E-02
Park Visitor		
Incidental Soil Ingestion	5E-06	3E-03
Dermal Contact with Soil	5E-07	7E-05
Fugitive Dust Inhalation	1E-07	2E-07
Total	6E-06	3E-03

Note:
Noncancer Hazard for the Park Visitor is based on exposure factors for a child.

TABLE 18 - AREA 3
LEAD RISK ASSESSMENT SPREADSHEET
CALIFORNIA DEPARTMENT OF TOXIC SUBSTANCES CONTROL
PREDICTED BLOOD LEAD RESULTS

USER'S GUIDE to version 7

INPUT

MEDIUM	LEVEL
Lead in Air (ug/m^3)	0.028
Lead in Soil/Dust (ug/g)	611
Lead in Water (ug/l)	15
% Home-grown Produce	0%
Respirable Dust (ug/m^3)	1.5

OUTPUT

	Percentile Estimate of Blood Pb (ug/dl)					PRG-99	PRG-95
	50th	90th	95th	98th	99th	(ug/g)	(ug/g)
BLOOD Pb, ADULT	1.1	2.0	2.3	2.8	3.2	894292	1398749
BLOOD Pb, CHILD	1.5	2.8	3.3	4.1	4.6	92664	158331
BLOOD Pb, PICA CHILD	1.6	2.9	3.4	4.1	4.7	46538	79517
BLOOD Pb, OCCUPATIONAL	1.5	2.7	3.2	3.9	4.5	3468	5452

EXPOSURE PARAMETERS

	units	adults	children
Days per week	days/wk	0.02	
Days per week, occupational		5	
Geometric Standard Deviation		1.6	
Blood lead level of concern (ug/dl)		10	
Skin area, residential	cm^2	5700	2900
Skin area occupational	cm^2	2900	
Soil adherence	ug/cm^2	70	200
Dermal uptake constant	(ug/dl)/(ug/day)	0.00011	
Soil ingestion	kg/day	50	100
Soil ingestion, pica	kg/day		200
Ingestion constant	(ug/dl)/(ug/day)	0.04	0.16
Bioavailability	unitless	0.44	
Breathing rate	m^3/day	20	6.8
Inhalation constant	(ug/dl)/(ug/day)	0.08	0.192
Water ingestion	l/day	1.4	0.4
Food ingestion	kg/day	1.9	1.1
Lead in market basket	ug/kg	3.1	
Lead in produce	ug/kg	275.0	

PATHWAYS

ADULTS	Residential			Occupational		
	Pathway contribution			Pathway contribution		
Pathway	PEF	ug/dl	percent	PEF	ug/dl	percent
Soil Contact	1.2E-7	0.00	0%	1.5E-5	0.01	1%
Soil Ingestion	2.4E-6	0.00	0%	6.3E-4	0.38	26%
Inhalation1		0.00	0%		0.03	2%
Inhalation	6.8E-9	0.00	0%	1.8E-6	0.00	0%
Water Ingestion		0.84	78%		0.84	56%
Food Ingestion1		0.23	22%		0.23	16%
Food Ingestion	0.0E+0	0.00	0%			0%

CHILDREN	typical			with pica		
	Pathway contribution			Pathway contribution		
Pathway	PEF	ug/dl	percent	PEF	ug/dl	percent
Soil Contact	1.7E-7	0.00	0%		0.00	0%
Soil Ingestion	1.9E-5	0.01	1%	3.9E-5	0.02	2%
Inhalation1	4.1E-9	0.00	0%		0.00	0%
Inhalation		0.04	2%		0.04	2%
Water Ingestion		0.96	62%		0.96	62%
Food Ingestion, child		0.54	35%		0.54	35%
Food Ingestion	0.0E+0	0.00	0%		0.00	0%

TABLE 1
INCIDENTAL INGESTION OF SURFACE WATER
NONCANCER HAZARD FOR PARK WORKERS
HUMAN HEALTH RISK ASSESSMENT

COPC	Predicted SW EPC (ug/L)	Oral Reference Dose (mg/kg-d)	Park Worker Exposure Scenario: Average Daily Intake (mg/kg-d) Adult	Park Worker Exposure Scenario: Hazard Quotient (Unitless) Adult
Metals				
Antimony	2.5E+00	4.0E-04	2.4E-07	6.1E-04
Arsenic	2.8E-02	3.0E-04	2.7E-09	9.1E-06
Barium	8.4E-01	7.0E-02	8.2E-08	1.2E-06
Beryllium	2.8E-02	2.0E-03	2.7E-09	1.4E-06
Cadmium	1.3E-02	5.0E-04	1.3E-09	2.5E-06
Chromium	2.1E+00	1.5E+00	2.1E-07	1.4E-07
Chromium VI	1.5E-01	3.0E-03	1.5E-08	4.9E-06
Cobalt	2.4E+00	6.0E-02	2.3E-07	3.9E-06
Copper	4.3E-01	3.7E-02	4.2E-08	1.1E-06
Lead	4.9E-01	--	4.8E-08	--
Manganese	3.3E-01	2.4E-02	3.2E-08	1.3E-06
Mercury	1.9E-04	3.0E-04	1.9E-11	6.2E-08
Molybdenum	4.1E-03	5.0E-03	4.0E-10	8.0E-08
Nickel	6.6E-01	2.0E-02	6.5E-08	3.2E-06
Selenium	1.4E-02	5.0E-03	1.4E-09	2.7E-07
Silver	3.3E-02	5.0E-03	3.2E-09	6.5E-07
Thallium	1.6E-04	6.6E-05	1.6E-11	2.4E-07
Tin	2.6E+01	6.0E-01	2.5E-06	4.2E-06
Vanadium	2.4E+00	7.0E-03	2.3E-07	3.4E-05
Zinc	4.2E+00	3.0E-01	4.1E-07	1.4E-06
Cyanide				
Cyanide	8.9E-01	2.0E-02	8.7E-08	4.4E-06
SVOCs				
Bis(2-Ethylhexyl)phthalate	2.5E-03	2.0E-02	2.4E-10	1.2E-08
Dimethylphthalate	1.9E-02	1.0E+01	1.9E-09	1.9E-10
Di-n-butylphthalate	3.6E-04	1.0E-01	3.6E-11	3.6E-10
Naphthalene	2.1E-02	2.0E-02	2.1E-09	1.0E-07
Tributyltin (oxide)	7.6E-03	3.0E-04	7.5E-10	2.5E-06
VOCs				
Chloroform	6.4E-05	1.0E-02	6.2E-12	6.2E-10
MEK (2-Butanone)	1.9E+00	6.0E-01	1.9E-07	3.1E-07
MTBE (methyl-tert-butyl ether)	1.0E-03	--	9.8E-11	--
Methylene Chloride	2.4E-01	6.0E-02	2.3E-08	3.9E-07
Total Hazard Index				7E-04

Notes:
"EPC" Exposure Point Concentration; "--" not applicable or not available; " * " not selected as a COPC in this media
Equations:
Worker INTAKE-N (mg/kg-day) = ((CW * IR-W * EF * ET * ED * CF1 * CF2) / (BW * AT-N))
Noncancer Hazard = (INTAKE-N / RfD)

TABLE 2
DERMAL CONTACT WITH SURFACE WATER
NONCANCER HAZARD FOR PARK WORKERS
HUMAN HEALTH RISK ASSESSMENT

COPC	Predicted SW EPC (ug/L)	Permeability Constant PC (cm/hour)	Oral/Dermal Reference Dose (mg/kg-d)	Park Worker Exposure Scenario: Average Daily Intake (mg/kg-d) Adult	Park Worker Exposure Scenario: Hazard Quotient (Unitless) Adult
Metals					
Antimony	2.5E-03	1.0E-03	4.0E-04	7.9E-11	2.0E-07
Arsenic	2.2E-03	1.0E-03	3.0E-04	7.0E-11	2.3E-07
Barium	2.4E-02	1.0E-03	7.0E-02	7.7E-10	1.1E-08
Beryllium	2.8E-05	1.0E-03	2.0E-03	9.1E-13	4.6E-10
Cadmium	7.0E-04	1.0E-03	5.0E-04	2.3E-11	4.5E-08
Chromium	3.7E-03	1.0E-03	1.5E+00	1.2E-10	8.0E-11
Chromium VI	1.5E-04	2.0E-03	3.0E-03	9.6E-12	3.2E-09
Cobalt	2.4E-03	1.0E-03	6.0E-02	7.7E-11	1.3E-09
Copper	4.7E-03	1.0E-03	3.7E-02	1.5E-10	4.1E-09
Lead	4.9E-04	1.0E-03	--	1.6E-11	--
Manganese	3.3E-01	1.0E-03	2.4E-02	1.1E-08	4.4E-07
Mercury	1.9E-07	1.0E-03	3.0E-04	6.2E-15	2.1E-11
Molybdenum	2.6E-03	1.0E-03	5.0E-03	8.5E-11	1.7E-08
Nickel	6.6E-01	2.0E-04	2.0E-02	4.2E-09	2.1E-07
Selenium	1.4E-02	1.0E-03	5.0E-03	4.5E-10	9.0E-08
Silver	3.3E-05	6.0E-04	5.0E-03	6.3E-13	1.3E-10
Thallium	1.6E-07	1.0E-03	6.6E-05	5.3E-15	8.0E-11
Tin	2.6E-02	1.0E-03	6.0E-01	8.5E-10	1.4E-09
Vanadium	5.2E-03	1.0E-03	7.0E-03	1.7E-10	2.4E-08
Zinc	7.2E-02	6.0E-04	3.0E-01	1.4E-09	4.6E-09
Cyanide					
Cyanide	1.8E-03	7.5E-03	2.0E-02	4.4E-10	2.2E-08
SVOCs					
Bis(2-Ethylhexyl)phthalate	2.5E-03	2.5E-02	2.0E-02	2.0E-09	9.9E-08
Dimethylphthalate	1.9E-05	1.4E-03	1.0E+01	8.8E-13	8.8E-14
Di-n-butylphthalate	3.6E-04	2.4E-02	1.0E-01	2.8E-10	2.8E-09
Naphthalene	2.3E-03	4.7E-02	2.0E-02	3.4E-09	1.7E-07
Tributyltin (oxide)	7.6E-03	3.4E-04	3.0E-04	8.4E-11	2.8E-07
VOCs					
Chloroform	6.4E-05	6.8E-03	1.0E-02	1.4E-11	1.4E-09
MEK (2-Butanone)	1.9E-03	9.6E-04	6.0E-01	5.8E-11	9.7E-11
MTBE (methyl-tert-butyl ether)	1.0E-03	2.6E-03	--	8.4E-11	--
Methylene Chloride	2.4E-04	3.5E-03	6.0E-02	2.7E-11	4.5E-10
Total Hazard Index					2E-06

Notes:
"EPC" Exposure Point Concentration; "--" not applicable or not available; " * " not selected as a COPC in this media
Equations:
Worker INTAKE-N (mg/kg-day) = ((CW * SA * EF * ET * ED * PC * CF1 * CF2) / (BW * AT-N))
Noncancer Hazard = (INTAKE-N / RfD)

TABLE 3
INGESTION OF FISH
NONCANCER HAZARD FOR PARK WORKERS
HUMAN HEALTH RISK ASSESSMENT

COPC	Predicted SW EPC (ug/L)	BCF (L/kg)	Predicted Fish EPC CF (mg/kg)	Oral Reference Dose (mg/kg-d)	Park Worker Exposure Scenario	
					Average Daily Intake (mg/kg-d) Adult	Hazard Quotient (Unitless) Adult
Metals						
Antimony	2.5E-03	1.0E+00	*	4.0E-04	*	*
Arsenic	2.2E-03	1.7E+01	3.7E-05	3.0E-04	4.0E-09	1.3E-05
Barium	2.4E-02	8.8E-01	*	7.0E-02	*	*
Beryllium	2.8E-05	1.9E+01	*	2.0E-03	*	*
Cadmium	7.0E-04	1.2E+04	8.7E-03	5.0E-04	9.3E-07	1.9E-03
Chromium	3.7E-03	3.0E+00	*	1.5E+00	*	*
Chromium VI	1.5E-04	3.0E+00	*	3.0E-03	*	*
Cobalt	2.4E-03	8.8E-01	*	6.0E-02	*	*
Copper	4.7E-03	2.9E+02	*	3.7E-02	*	*
Lead	4.9E-04	4.5E+01	*	--	*	*
Manganese	3.3E-01	8.8E-01	*	2.4E-02	*	*
Mercury	1.9E-07	1.7E+00	3.3E-10	3.0E-04	3.5E-14	1.2E-10
Molybdenum	2.6E-03	8.8E-01	*	5.0E-03	*	*
Nickel	6.6E-01	1.1E+02	*	2.0E-02	*	*
Selenium	1.4E-02	9.0E-01	1.2E-05	5.0E-03	1.3E-09	2.7E-07
Silver	3.3E-05	8.8E-01	*	5.0E-03	*	*
Thallium	1.6E-07	3.4E+01	*	6.6E-05	*	*
Tin	2.6E-02	5.6E+00	*	6.0E-01	*	*
Vanadium	5.2E-03	8.8E-01	*	7.0E-03	*	*
Zinc	7.2E-02	9.7E+02	*	3.0E-01	*	*
Cyanide						
Cyanide	1.8E-03	4.0E+00	*	2.0E-02	*	*
SVOCs						
Bis(2-Ethylhexyl)phthalate	2.5E-03	2.1E+05	*	2.0E-02	*	*
Dimethylphthalate	1.9E-05	1.6E+01	*	1.0E+01	*	*
Di-n-butylphthalate	3.6E-04	1.9E+03	*	1.0E-01	*	*
Naphthalene	2.3E-03	2.1E+02	*	2.0E-02	*	*
Tributyltin (oxide)	7.6E-03	4.9E+02	3.7E-03	3.0E-04	4.0E-07	1.3E-03
VOCs						
Chloroform	6.4E-05	1.7E+01	*	1.0E-02	*	*
MEK (2-Butanone)	1.9E-03	9.6E-01	*	6.0E-01	*	*
MTBE (methyl-tert-butyl ether)	1.0E-03	1.6E+01	*	--	*	*
Methylene Chloride	2.4E-04	5.2E+00	*	6.0E-02	*	*
Total Hazard Index						3E-03

Notes:
"EPC" Exposure Point Concentration; "BCF" Bioconcentration Factor
"--" not applicable or not available; " * " not selected as a COPC in this media
Equations:
Estimated Fish Tissue Concentration CF (mg/kg) = (CW * BCF * 0.001 mg/ug)
INTAKE-N (mg/kg-day) = ((CF * IR-F * EF * ED * CF1) / (BW * AT-N))
Noncancer Hazard = (INTAKE-N / RfD)

TABLE 4
SUMMARY OF NONCANCER HAZARD
THEME PARK WORKERS
HUMAN HEALTH RISK ASSESSMENT

COPC	Predicted SW EPC (ug/L)	Predicted Fish EPC (mg/kg)	Noncancer Hazard			
			Adult Worker			
			Ingestion	Dermal	Total HI	Fish Ingestion
Metals						
Antimony	2.5E-03	*	6.0E-07	2.0E-07	8.0E-07	*
Arsenic	2.2E-03	3.7E-05	7.1E-07	2.3E-07	9.5E-07	1.3E-05
Barium	2.4E-02	*	3.3E-08	1.1E-08	4.4E-08	*
Beryllium	2.8E-05	*	1.4E-09	4.6E-10	1.8E-09	*
Cadmium	7.0E-04	8.7E-03	1.4E-07	4.5E-08	1.8E-07	1.9E-03
Chromium	3.7E-03	*	2.4E-10	8.0E-11	3.2E-10	*
Chromium VI	1.5E-04	*	4.9E-09	3.2E-09	8.1E-09	*
Cobalt	2.4E-03	*	3.9E-09	1.3E-09	5.1E-09	*
Copper	4.7E-03	*	1.3E-08	4.1E-09	1.7E-08	*
Lead	4.9E-04	*	–	–	–	*
Manganese	3.3E-01	*	1.3E-06	4.4E-07	1.8E-06	*
Mercury	1.9E-07	3.3E-10	6.2E-11	2.1E-11	8.3E-11	1.2E-10
Molybdenum	2.6E-03	*	5.2E-08	1.7E-08	6.9E-08	*
Nickel	6.6E-01	*	3.2E-06	2.1E-07	3.4E-06	*
Selenium	1.4E-02	1.2E-05	2.7E-07	9.0E-08	3.6E-07	2.7E-07
Silver	3.3E-05	*	6.4E-10	1.3E-10	7.7E-10	*
Thallium	1.6E-07	*	2.4E-10	8.0E-11	3.2E-10	*
Tin	2.6E-02	*	4.3E-09	1.4E-09	5.7E-09	*
Vanadium	5.2E-03	*	7.2E-08	2.4E-08	9.6E-08	*
Zinc	7.2E-02	*	2.3E-08	4.6E-09	2.8E-08	*
Cyanide						
Cyanide	1.8E-03	*	8.9E-09	2.2E-08	3.1E-08	*
SVOCs						
Bis(2-Ethylhexyl)phthalate	2.5E-03	*	1.2E-08	9.9E-08	1.1E-07	*
Dimethylphthalate	1.9E-05	*	1.9E-13	8.8E-14	2.8E-13	*
Di-n-butylphthalate	3.6E-04	*	3.6E-10	2.8E-09	3.2E-09	*
Naphthalene	2.3E-03	*	1.1E-08	1.7E-07	1.8E-07	*
Tributyltin (oxide)	7.6E-03	3.7E-03	2.5E-06	2.8E-07	2.8E-06	1.3E-03
VOCs						
Chloroform	6.4E-05	*	6.2E-10	1.4E-09	2.0E-09	*
MEK (2-Butanone)	1.9E-03	*	3.0E-10	9.7E-11	4.0E-10	*
MTBE (methyl-tert-butyl ether)	1.0E-03	*	–	–	–	*
Methylene Chloride	2.4E-04	*	3.9E-10	4.5E-10	8.5E-10	*
Total Hazard Index					1E-05	3E-03

Notes:
"EPC" Exposure Point Concentration; "–" not applicable or not available; " * " not selected as a COPC in this media

TABLE 5
INCIDENTAL INGESTION OF SURFACE WATER
CANCER RISK FOR PARK WORKERS
HUMAN HEALTH RISK ASSESSMENT

COPC	Predicted SW EPC (ug/L)	Oral Slope Factor $(mg/kg\text{-}d)^{-1}$	Park Worker Exposure Scenario: Average Daily Intake (mg/kg-d) Adult	Park Worker Exposure Scenario: Cancer Risk (Unitless) Adult
Metals				
Antimony	2.5E-03	--	8.6E-11	--
Arsenic	2.2E-03	1.5E+00	7.6E-11	1.1E-10
Barium	2.4E-02	--	8.3E-10	--
Beryllium	2.8E-05	--	9.9E-13	--
Cadmium	7.0E-04	--	2.4E-11	--
Chromium	3.7E-03	--	1.3E-10	--
Chromium VI	1.5E-04	--	5.2E-12	--
Cobalt	2.4E-03	--	8.3E-11	--
Copper	4.7E-03	--	1.7E-10	--
Lead	4.9E-04	--	1.7E-11	--
Manganese	3.3E-01	--	1.1E-08	--
Mercury	1.9E-07	--	6.7E-15	--
Molybdenum	2.6E-03	--	9.2E-11	--
Nickel	6.6E-01	--	2.3E-08	--
Selenium	1.4E-02	--	4.9E-10	--
Silver	3.3E-05	--	1.1E-12	--
Thallium	1.6E-07	--	5.7E-15	--
Tin	2.6E-02	--	9.2E-10	--
Vanadium	5.2E-03	--	1.8E-10	--
Zinc	7.2E-02	--	2.5E-09	--
Cyanide				
Cyanide	1.8E-03	--	6.4E-11	--
SVOCs				
Bis(2-Ethylhexyl)phthalate	2.5E-03	1.4E-02	8.6E-11	1.2E-12
Dimethylphthalate	1.9E-05	--	6.8E-13	--
Di-n-butylphthalate	3.6E-04	--	1.3E-11	--
Naphthalene	2.3E-03	--	7.9E-11	--
Tributyltin (oxide)	7.6E-03	--	2.7E-10	--
VOCs				
Chloroform	6.4E-05	6.1E-03	2.2E-12	1.4E-14
MEK (2-Butanone)	1.9E-03	--	6.5E-11	--
MTBE (methyl-tert-butyl ether)	1.0E-03	--	3.5E-11	--
Methylene Chloride	2.4E-04	7.5E-03	8.4E-12	6.3E-14
Total Cancer Risk				1E-10

Notes:
"EPC" Exposure Point Concentration; "--" not applicable or not available; " * " not selected as a COPC in this media
Equations:
Worker INTAKE-C (mg/kg-day) = ((CW * IR-W * EF * ET * ED * CF1 * CF2) / (BW * AT-C))
Cancer Risk = (INTAKE-C * CSF)

TABLE 6
DERMAL CONTACT WITH SURFACE WATER
CANCER RISK FOR PARK WORKERS
HUMAN HEALTH RISK ASSESSMENT

COPC	Predicted SW EPC (ug/L)	Permeability Constant PC (cm/hour)	Oral/Dermal Slope Factor (mg/kg-d)$^{-1}$	Park Worker Exposure Scenario	
				Average Daily Intake (mg/kg-d) Adult	Cancer Risk (Unitless) Adult
Metals					
Antimony	2.5E-03	1.0E-03	--	2.8E-11	--
Arsenic	2.2E-03	1.0E-03	1.5E+00	2.5E-11	3.8E-11
Barium	2.4E-02	1.0E-03	--	2.7E-10	--
Beryllium	2.8E-05	1.0E-03	--	3.3E-13	--
Cadmium	7.0E-04	1.0E-03	--	8.1E-12	--
Chromium	3.7E-03	1.0E-03	--	4.3E-11	--
Chromium VI	1.5E-04	2.0E-03	--	3.4E-12	--
Cobalt	2.4E-03	1.0E-03	--	2.7E-11	--
Copper	4.7E-03	1.0E-03	--	5.5E-11	--
Lead	4.9E-04	1.0E-03	--	5.6E-12	--
Manganese	3.3E-01	1.0E-03	--	3.8E-09	--
Mercury	1.9E-07	1.0E-03	--	2.2E-15	--
Molybdenum	2.6E-03	1.0E-03	--	3.0E-11	--
Nickel	6.6E-01	2.0E-04	--	1.5E-09	--
Selenium	1.4E-02	1.0E-03	--	1.6E-10	--
Silver	3.3E-05	6.0E-04	--	2.3E-13	--
Thallium	1.6E-07	1.0E-03	--	1.9E-15	--
Tin	2.6E-02	1.0E-03	--	3.0E-10	--
Vanadium	5.2E-03	1.0E-03	--	6.0E-11	--
Zinc	7.2E-02	6.0E-04	--	5.0E-10	--
Cyanide					
Cyanide	1.8E-03	7.5E-03	--	1.6E-10	--
SVOCs					
Bis(2-Ethylhexyl)phthalate	2.5E-03	2.5E-02	1.4E-02	7.1E-10	9.9E-12
Dimethylphthalate	1.9E-05	1.4E-03	--	3.1E-13	--
Di-n-butylphthalate	3.6E-04	2.4E-02	--	1.0E-10	--
Naphthalene	2.3E-03	4.7E-02	--	1.2E-09	--
Tributyltin (oxide)	7.6E-03	3.4E-04	--	3.0E-11	--
VOCs					
Chloroform	6.4E-05	6.8E-03	6.1E-03	5.0E-12	3.0E-14
MEK (2-Butanone)	1.9E-03	9.6E-04	--	2.1E-11	--
MTBE (methyl-tert-butyl ether)	1.0E-03	2.6E-03	--	3.0E-11	--
Methylene Chloride	2.4E-04	3.5E-03	7.5E-03	9.7E-12	7.3E-14
Total Cancer Risk					5E-11

Notes:
"EPC" Exposure Point Concentration; "--" not applicable or not available; " * " not selected as a COPC in this media
Equations:
Worker INTAKE-C (mg/kg-day) = ((CW * SA * EF * ET * ED * PC * CF1 *CF2) / (BW * AT-C))
Cancer Risk = (INTAKE-C * CSF)

TABLE 7
INGESTION OF FISH
CANCER RISK FOR PARK WORKERS
HUMAN HEALTH RISK ASSESSMENT

COPC	Predicted SW EPC (ug/L)	BCF (L/kg)	Predicted Fish EPC CF (mg/kg)	Oral Slope Factor $(mg/kg\text{-}d)^{-1}$	Park Worker Exposure Scenario: Average Daily Intake (mg/kg-d) Adult	Park Worker Exposure Scenario: Cancer Risk (Unitless) Adult
Metals						
Antimony	2.5E-03	1.0E+00	*	–	*	*
Arsenic	2.2E-03	1.7E+01	3.7E-05	1.5E+00	1.4E-09	2.1E-09
Barium	2.4E-02	8.8E-01	*	–	*	*
Beryllium	2.8E-05	1.9E+01	*	–	*	*
Cadmium	7.0E-04	1.2E+04	8.7E-03	–	3.3E-07	–
Chromium	3.7E-03	3.0E+00	*	–	*	*
Chromium VI	1.5E-04	3.0E+00	*	–	*	*
Cobalt	2.4E-03	8.8E-01	*	–	*	*
Copper	4.7E-03	2.9E+02	*	–	*	*
Lead	4.9E-04	4.5E+01	*	–	*	*
Manganese	3.3E-01	8.8E-01	*	–	*	*
Mercury	1.9E-07	1.7E+00	3.3E-10	–	1.3E-14	–
Molybdenum	2.6E-03	8.8E-01	*	–	*	*
Nickel	6.6E-01	1.1E+02	*	–	*	*
Selenium	1.4E-02	9.0E-01	1.2E-05	–	4.7E-10	–
Silver	3.3E-05	8.8E-01	*	–	*	*
Thallium	1.6E-07	3.4E+01	*	–	*	*
Tin	2.6E-02	5.6E+00	*	–	*	*
Vanadium	5.2E-03	8.8E-01	*	–	*	*
Zinc	7.2E-02	9.7E+02	*	–	*	*
Cyanide						
Cyanide	1.8E-03	4.0E+00	*	–	*	*
SVOCs						
Bis(2-Ethylhexyl)phthalate	2.5E-03	2.1E+05	*	1.4E-02	*	*
Dimethylphthalate	1.9E-05	1.6E+01	*	–	*	*
Di-n-butylphthalate	3.6E-04	1.9E+03	*	–	*	*
Naphthalene	2.3E-03	2.1E+02	*	–	*	*
Tributyltin (oxide)	7.6E-03	4.9E+02	3.7E-03	–	1.4E-07	–
VOCs						
Chloroform	6.4E-05	1.7E+01	*	6.1E-03	*	*
MEK (2-Butanone)	1.9E-03	9.6E-01	*	–	*	*
MTBE (methyl-tert-butyl ether)	1.0E-03	1.6E+01	*	–	*	*
Methylene Chloride	2.4E-04	5.2E+00	*	7.5E-03	*	*
Total Cancer Risk						2E-09

Notes:
"EPC" Exposure Point Concentration; "BCF" Bioconcentration Factor
"–" not applicable or not available; " * " not selected as a COPC in this media
Equations:
Estimated Fish Tissue Concentration CF (mg/kg) = (CW * BCF * 0.001 mg/ug)
INTAKE-C (mg/kg-day) = ((CF * IR-F * EF * ED * CF1) / (BW * AT-C))
Cancer Risk = (INTAKE-C * CSF)

TABLE 8
SUMMARY OF CANCER RISK
THEME PARK WORKERS
HUMAN HEALTH RISK ASSESSMENT

COPC	Predicted SW EPC (ug/L)	Predicted Fish EPC (mg/kg)	Cancer Risk			
			Adult Worker			
			Ingestion	Dermal	Total Risk	Fish Ingestion
Metals						
Antimony	2.5E-03	*	--	--	--	*
Arsenic	2.2E-03	3.7E-05	1.1E-10	3.8E-11	1.5E-10	2.1E-09
Barium	2.4E-02	*	--	--	--	*
Beryllium	2.8E-05	*	--	--	--	*
Cadmium	7.0E-04	8.7E-03	--	--	--	--
Chromium	3.7E-03	*	--	--	--	*
Chromium VI	1.5E-04	*	--	--	--	*
Cobalt	2.4E-03	*	--	--	--	*
Copper	4.7E-03	*	--	--	--	*
Lead	4.9E-04	*	--	--	--	*
Manganese	3.3E-01	*	--	--	--	--
Mercury	1.9E-07	3.3E-10	--	--	--	*
Molybdenum	2.6E-03	*	--	--	--	*
Nickel	6.6E-01	*	--	--	--	--
Selenium	1.4E-02	1.2E-05	--	--	--	*
Silver	3.3E-05	*	--	--	--	*
Thallium	1.6E-07	*	--	--	--	*
Tin	2.6E-02	*	--	--	--	*
Vanadium	5.2E-03	*	--	--	--	*
Zinc	7.2E-02	*	--	--	--	
Cyanide						
Cyanide	1.8E-03	*	--	--	--	*
SVOCs						
Bis(2-Ethylhexyl)phthalate	2.5E-03	*	1.2E-12	9.9E-12	1.1E-11	*
Dimethylphthalate	1.9E-05	*	--	--	--	*
Di-n-butylphthalate	3.6E-04	*	--	--	--	*
Naphthalene	2.3E-03	*	--	--	--	--
Tributyltin (oxide)	7.6E-03	3.7E-03	--	--	--	
VOCs						
Chloroform	6.4E-05	*	1.4E-14	3.0E-14	4.4E-14	*
MEK (2-Butanone)	1.9E-03	*	--	--	--	*
MTBE (methyl-tert-butyl ether)	1.0E-03	*	--	--	--	*
Methylene Chloride	2.4E-04	*	6.3E-14	7.3E-14	1.4E-13	*
Total Cancer Risk					2E-10	2E-09

Notes:
"EPC" Exposure Point Concentration; "--" not applicable or not available; " * " not selected as a COPC in this media

TABLE 9
INCIDENTAL INGESTION OF SURFACE WATER
NONCANCER HAZARD FOR PARK VISITORS
HUMAN HEALTH RISK ASSESSMENT

COPC	Predicted SW EPC (ug/L)	Oral Reference Dose (mg/kg-d)	Recreational Exposure Scenario	
			Average Daily Intake (mg/kg-d) Child	Hazard Quotient (Unitless) Child
Metals				
Antimony	2.5E-03	4.0E-04	1.3E-11	3.4E-08
Arsenic	2.2E-03	3.0E-04	1.2E-11	4.0E-08
Barium	2.4E-02	7.0E-02	1.3E-10	1.9E-09
Beryllium	2.8E-05	2.0E-03	1.6E-13	7.8E-11
Cadmium	7.0E-04	5.0E-04	3.8E-12	7.7E-09
Chromium	3.7E-03	1.5E+00	2.0E-11	1.4E-11
Chromium VI	1.5E-04	3.0E-03	8.2E-13	2.7E-10
Cobalt	2.4E-03	6.0E-02	1.3E-11	2.2E-10
Copper	4.7E-03	3.7E-02	2.6E-11	7.0E-10
Lead	4.9E-04	--	2.7E-12	--
Manganese	3.3E-01	2.4E-02	1.8E-09	7.5E-08
Mercury	1.9E-07	3.0E-04	1.0E-15	3.5E-12
Molybdenum	2.6E-03	5.0E-03	1.4E-11	2.9E-09
Nickel	6.6E-01	2.0E-02	3.6E-09	1.8E-07
Selenium	1.4E-02	5.0E-03	7.6E-11	1.5E-08
Silver	3.3E-05	5.0E-03	1.8E-13	3.6E-11
Thallium	1.6E-07	6.6E-05	8.9E-16	1.4E-11
Tin	2.6E-02	6.0E-01	1.4E-10	2.4E-10
Vanadium	5.2E-03	7.0E-03	2.8E-11	4.1E-09
Zinc	7.2E-02	3.0E-01	3.9E-10	1.3E-09
Cyanide				
Cyanide	1.8E-03	2.0E-02	1.0E-11	5.0E-10
SVOCs				
Bis(2-Ethylhexyl)phthalate	2.5E-03	2.0E-02	1.3E-11	6.7E-10
Dimethylphthalate	1.9E-05	1.0E+01	1.1E-13	1.1E-14
Di-n-butylphthalate	3.6E-04	1.0E-01	2.0E-12	2.0E-11
Naphthalene	2.3E-03	2.0E-02	1.2E-11	6.2E-10
Tributyltin (oxide)	7.6E-03	3.0E-04	4.2E-11	1.4E-07
VOCs				
Chloroform	6.4E-05	1.0E-02	3.5E-13	3.5E-11
MEK (2-Butanone)	1.9E-03	6.0E-01	1.0E-11	1.7E-11
MTBE (methyl-tert-butyl ether)	1.0E-03	--	5.5E-12	--
Methylene Chloride	2.4E-04	6.0E-02	1.3E-12	2.2E-11
Total Hazard Index				5E-07

Notes:
"EPC" Exposure Point Concentration; "--" not applicable or not available; " * " not selected as a COPC in this media
Equations:
Child Visitor INTAKE-N (mg/kg-day) = ((CW * IR-Wc * EFc * ET * EDc * CF1 *CF2) / (BWc * AT-N))
Noncancer Hazard = (INTAKE-N / RfD)

TABLE 10
DERMAL CONTACT WITH SURFACE WATER
NONCANCER HAZARD FOR PARK VISITORS
HUMAN HEALTH RISK ASSESSMENT

COPC	Predicted SW EPC (ug/L)	Permeability Constant PC (cm/hour)	Oral/Dermal Reference Dose (mg/kg-d)	Recreational Exposure Scenario: Average Daily Intake (mg/kg-d) Child	Recreational Exposure Scenario: Hazard Quotient (Unitless) Child
Metals					
Antimony	2.5E-03	1.0E-03	4.0E-04	1.3E-12	3.1E-09
Arsenic	2.2E-03	1.0E-03	3.0E-04	1.1E-12	3.7E-09
Barium	2.4E-02	1.0E-03	7.0E-02	1.2E-11	1.7E-10
Beryllium	2.8E-05	1.0E-03	2.0E-03	1.4E-14	7.2E-12
Cadmium	7.0E-04	1.0E-03	5.0E-04	3.6E-13	7.2E-10
Chromium	3.7E-03	1.0E-03	1.5E+00	1.9E-12	1.3E-12
Chromium VI	1.5E-04	2.0E-03	3.0E-03	1.5E-13	5.1E-11
Cobalt	2.4E-03	1.0E-03	6.0E-02	1.2E-12	2.0E-11
Copper	4.7E-03	1.0E-03	3.7E-02	2.4E-12	6.5E-11
Lead	4.9E-04	1.0E-03	--	2.5E-13	--
Manganese	3.3E-01	1.0E-03	2.4E-02	1.7E-10	7.0E-09
Mercury	1.9E-07	1.0E-03	3.0E-04	9.8E-17	3.3E-13
Molybdenum	2.6E-03	1.0E-03	5.0E-03	1.4E-12	2.7E-10
Nickel	6.6E-01	2.0E-04	2.0E-02	6.7E-11	3.3E-09
Selenium	1.4E-02	1.0E-03	5.0E-03	7.1E-12	1.4E-09
Silver	3.3E-05	6.0E-04	5.0E-03	1.0E-14	2.0E-12
Thallium	1.6E-07	1.0E-03	6.6E-05	8.3E-17	1.3E-12
Tin	2.6E-02	1.0E-03	6.0E-01	1.3E-11	2.2E-11
Vanadium	5.2E-03	1.0E-03	7.0E-03	2.6E-12	3.8E-10
Zinc	7.2E-02	6.0E-04	3.0E-01	2.2E-11	7.3E-11
Cyanide					
Cyanide	1.8E-03	7.5E-03	2.0E-02	7.0E-12	3.5E-10
SVOCs					
Bis(2-Ethylhexyl)phthalate	2.5E-03	2.5E-02	2.0E-02	3.1E-11	1.6E-09
Dimethylphthalate	1.9E-05	1.4E-03	1.0E+01	1.4E-14	1.4E-15
Di-n-butylphthalate	3.6E-04	2.4E-02	1.0E-01	4.5E-12	4.5E-11
Naphthalene	2.3E-03	4.7E-02	2.0E-02	5.5E-11	2.7E-09
Tributyltin (oxide)	7.6E-03	3.4E-04	3.0E-04	1.3E-12	4.4E-09
VOCs					
Chloroform	6.4E-05	6.8E-03	1.0E-02	2.2E-13	2.2E-11
MEK (2-Butanone)	1.9E-03	9.6E-04	6.0E-01	9.2E-13	1.5E-12
MTBE (methyl-tert-butyl ether)	1.0E-03	2.6E-03	--	1.3E-12	--
Methylene Chloride	2.4E-04	3.5E-03	6.0E-02	4.3E-13	7.2E-12
Total Hazard Index					3E-08

Notes:
"EPC" Exposure Point Concentration; "--" not applicable or not available; " * " not selected as a COPC in this media
Equations:
Child Visitor INTAKE-N (mg/kg-day) = ((CW * SAc * EF * ET * EDc * PC * CF1 * CF2) / (BWc * AT-N))
Noncancer Hazard = (INTAKE-N / RfD)

TABLE 11
INGESTION OF FISH
NONCANCER HAZARD FOR PARK VISITORS
HUMAN HEALTH RISK ASSESSMENT

COPC	Predicted SW EPC (ug/L)	BCF (L/kg)	Predicted Fish EPC CF (mg/kg)	Oral Reference Dose (mg/kg-d)	Recreational Exposure Scenario	
					Average Daily Intake (mg/kg-d) Adult	Hazard Quotient (Unitless) Adult
Metals						
Antimony	2.5E-03	1.0E+00	*	4.0E-04	*	*
Arsenic	2.2E-03	1.7E+01	3.7E-05	3.0E-04	3.3E-10	1.1E-06
Barium	2.4E-02	8.8E-01	*	7.0E-02	*	*
Beryllium	2.8E-05	1.9E+01	*	2.0E-03	*	*
Cadmium	7.0E-04	1.2E+04	8.7E-03	5.0E-04	7.7E-08	1.5E-04
Chromium	3.7E-03	3.0E+00	*	1.5E+00	*	*
Chromium VI	1.5E-04	3.0E+00	*	3.0E-03	*	*
Cobalt	2.4E-03	8.8E-01	*	6.0E-02	*	*
Copper	4.7E-03	2.9E+02	*	3.7E-02	*	*
Lead	4.9E-04	4.5E+01	*	--	*	*
Manganese	3.3E-01	8.8E-01	*	2.4E-02	*	*
Mercury	1.9E-07	1.7E+00	3.3E-10	3.0E-04	3.0E-15	9.9E-12
Molybdenum	2.6E-03	8.8E-01	*	5.0E-03	*	*
Nickel	6.6E-01	1.1E+02	*	2.0E-02	*	*
Selenium	1.4E-02	9.0E-01	1.2E-05	5.0E-03	1.1E-10	2.2E-08
Silver	3.3E-05	8.8E-01	*	5.0E-03	*	*
Thallium	1.6E-07	3.4E+01	*	6.6E-05	*	*
Tin	2.6E-02	5.6E+00	*	6.0E-01	*	*
Vanadium	5.2E-03	8.8E-01	*	7.0E-03	*	*
Zinc	7.2E-02	9.7E+02	*	3.0E-01	*	*
Cyanide						
Cyanide	1.8E-03	4.0E+00	*	2.0E-02	*	*
SVOCs						
Bis(2-Ethylhexyl)phthalate	2.5E-03	2.1E+05	*	2.0E-02	*	*
Dimethylphthalate	1.9E-05	1.6E+01	*	1.0E+01	*	*
Di-n-butylphthalate	3.6E-04	1.9E+03	*	1.0E-01	*	*
Naphthalene	2.3E-03	2.1E+02	*	2.0E-02	*	*
Tributyltin (oxide)	7.6E-03	4.9E+02	3.7E-03	3.0E-04	3.3E-08	1.1E-04
VOCs						
Chloroform	6.4E-05	1.7E+01	*	1.0E-02	*	*
MEK (2-Butanone)	1.9E-03	9.6E-01	*	6.0E-01	*	*
MTBE (methyl-tert-butyl ether)	1.0E-03	1.6E+01	*	--	*	*
Methylene Chloride	2.4E-04	5.2E+00	*	6.0E-02	*	*
Total Hazard Index						3E-04

Notes:
"EPC" Exposure Point Concentration; "BCF" Bioconcentration Factor
"--" not applicable or not available; " * " not selected as a COPC in this media
Equations:
Estimated Fish Tissue Concentration CF (mg/kg) = (CW * BCF * 0.001 mg/ug)
INTAKE-N (mg/kg-day) = ((CF * IR-F * EF * ED * CF1) / (BW * AT-N))
Noncancer Hazard = (INTAKE-N / RfD)

TABLE 12
SUMMARY OF NONCANCER HAZARD
THEME PARK VISITORS
HUMAN HEALTH RISK ASSESSMENT

COPC	Predicted SW EPC (ug/L)	Predicted Fish EPC (mg/kg)	Noncancer Hazard			
			Recreational Visitor - Child			
			Ingestion	Dermal	Total HI	Fish Ingestion
Metals						
Antimony	2.5E-03	*	3.4E-08	3.1E-09	3.7E-08	*
Arsenic	2.2E-03	3.7E-05	4.0E-08	3.7E-09	4.4E-08	1.1E-06
Barium	2.4E-02	*	1.9E-09	1.7E-10	2.0E-09	*
Beryllium	2.8E-05	*	7.8E-11	7.2E-12	8.5E-11	*
Cadmium	7.0E-04	8.7E-03	7.7E-09	7.2E-10	8.4E-09	1.5E-04
Chromium	3.7E-03	*	1.4E-11	1.3E-12	1.5E-11	*
Chromium VI	1.5E-04	*	2.7E-10	5.1E-11	3.2E-10	*
Cobalt	2.4E-03	*	2.2E-10	2.0E-11	2.4E-10	*
Copper	4.7E-03	*	7.0E-10	6.5E-11	7.7E-10	*
Lead	4.9E-04	*	--	--	--	*
Manganese	3.3E-01	*	7.5E-08	7.0E-09	8.2E-08	*
Mercury	1.9E-07	3.3E-10	3.5E-12	3.3E-13	3.8E-12	9.9E-12
Molybdenum	2.6E-03	*	2.9E-09	2.7E-10	3.2E-09	*
Nickel	6.6E-01	*	1.8E-07	3.3E-09	1.8E-07	*
Selenium	1.4E-02	1.2E-05	1.5E-08	1.4E-09	1.7E-08	2.2E-08
Silver	3.3E-05	*	3.6E-11	2.0E-12	3.8E-11	*
Thallium	1.6E-07	*	1.4E-11	1.3E-12	1.5E-11	*
Tin	2.6E-02	*	2.4E-10	2.2E-11	2.6E-10	*
Vanadium	5.2E-03	*	4.1E-09	3.8E-10	4.4E-09	*
Zinc	7.2E-02	*	1.3E-09	7.3E-11	1.4E-09	*
Cyanide						
Cyanide	1.8E-03	*	5.0E-10	3.5E-10	8.5E-10	*
SVOCs						
Bis(2-Ethylhexyl)phthalate	2.5E-03	*	6.7E-10	1.6E-09	2.2E-09	*
Dimethylphthalate	1.9E-05	*	1.1E-14	1.4E-15	1.2E-14	*
Di-n-butylphthalate	3.6E-04	*	2.0E-11	4.5E-11	6.5E-11	*
Naphthalene	2.3E-03	*	6.2E-10	2.7E-09	3.4E-09	*
Tributyltin (oxide)	7.6E-03	3.7E-03	1.4E-07	4.4E-09	1.4E-07	1.1E-04
VOCs						
Chloroform	6.4E-05	*	3.5E-11	2.2E-11	5.7E-11	*
MEK (2-Butanone)	1.9E-03	*	1.7E-11	1.5E-12	1.9E-11	*
MTBE (methyl-tert-butyl ether)	1.0E-03	*	--	--	--	*
Methylene Chloride	2.4E-04	*	2.2E-11	7.2E-12	2.9E-11	*
Total Hazard Index					5E-07	3E-04

Notes:
"EPC" Exposure Point Concentration; "--" not applicable or not available; " * " not selected as a COPC in this media

TABLE 13
INCIDENTAL INGESTION OF SURFACE WATER
CANCER RISK FOR PARK VISITORS
HUMAN HEALTH RISK ASSESSMENT

COPC	Predicted SW EPC (ug/L)	Oral Slope Factor $(mg/kg\text{-}d)^{-1}$	Recreational Exposure Scenario	
			Average Daily Intake (mg/kg-d) Adult/Child	Cancer Risk (Unitless) Adult/Child
Metals				
Antimony	2.5E-03	--	1.5E-12	--
Arsenic	2.2E-03	1.5E+00	1.3E-12	2.0E-12
Barium	2.4E-02	--	1.4E-11	--
Beryllium	2.8E-05	--	1.7E-14	--
Cadmium	7.0E-04	--	4.2E-13	--
Chromium	3.7E-03	--	2.3E-12	--
Chromium VI	1.5E-04	--	9.0E-14	--
Cobalt	2.4E-03	--	1.4E-12	--
Copper	4.7E-03	--	2.9E-12	--
Lead	4.9E-04	--	2.9E-13	--
Manganese	3.3E-01	--	2.0E-10	--
Mercury	1.9E-07	--	1.2E-16	--
Molybdenum	2.6E-03	--	1.6E-12	--
Nickel	6.6E-01	--	4.0E-10	--
Selenium	1.4E-02	--	8.4E-12	--
Silver	3.3E-05	--	2.0E-14	--
Thallium	1.6E-07	--	9.8E-17	--
Tin	2.6E-02	--	1.6E-11	--
Vanadium	5.2E-03	--	3.1E-12	--
Zinc	7.2E-02	--	4.3E-11	--
Cyanide				
Cyanide	1.8E-03	--	1.1E-12	--
SVOCs				
Bis(2-Ethylhexyl)phthalate	2.5E-03	1.4E-02	1.5E-12	2.1E-14
Dimethylphthalate	1.9E-05	--	1.2E-14	--
Di-n-butylphthalate	3.6E-04	--	2.2E-13	--
Naphthalene	2.3E-03	--	1.4E-12	--
Tributyltin (oxide)	7.6E-03	--	4.6E-12	--
VOCs				
Chloroform	6.4E-05	6.1E-03	3.8E-14	2.3E-16
MEK (2-Butanone)	1.9E-03	--	1.1E-12	--
MTBE (methyl-tert-butyl ether)	1.0E-03	--	6.0E-13	--
Methylene Chloride	2.4E-04	7.5E-03	1.5E-13	1.1E-15
Total Cancer Risk				2E-12

Notes:
"EPC" Exposure Point Concentration; "--" not applicable or not available; " * " not selected as a COPC in this media

Equations:
Adult/Child Visitor INTAKE-C (mg/kg-day) = $((CW * EF * ET * ING_{adjusted} * CF1 * CF2) / (AT\text{-}C))$

Where $ING_{adjusted} = [(IR\text{-}Wc * EDc / BWc) + (IR\text{-}Wa * EDa / BWa)]$

Cancer Risk = (INTAKE-C * CSF)

TABLE 14
DERMAL CONTACT WITH SURFACE WATER
CANCER RISK FOR PARK VISITORS
HUMAN HEALTH RISK ASSESSMENT

COPC	Predicted SW EPC (ug/L)	Permeability Constant PC (cm/hour)	Oral/Dermal Slope Factor $(mg/kg\text{-}d)^{-1}$	Recreational Exposure Scenario: Average Daily Intake (mg/kg-d) Adult/Child	Recreational Exposure Scenario: Cancer Risk (Unitless) Adult/Child
Metals					
Antimony	2.5E-03	1.0E-03	--	2.9E-13	--
Arsenic	2.2E-03	1.0E-03	1.5E+00	2.6E-13	3.9E-13
Barium	2.4E-02	1.0E-03	--	2.9E-12	--
Beryllium	2.8E-05	1.0E-03	--	3.4E-15	--
Cadmium	7.0E-04	1.0E-03	--	8.4E-14	--
Chromium	3.7E-03	1.0E-03	--	4.5E-13	--
Chromium VI	1.5E-04	2.0E-03	--	3.6E-14	--
Cobalt	2.4E-03	1.0E-03	--	2.9E-13	--
Copper	4.7E-03	1.0E-03	--	5.7E-13	--
Lead	4.9E-04	1.0E-03	--	5.9E-14	--
Manganese	3.3E-01	1.0E-03	--	3.9E-11	--
Mercury	1.9E-07	1.0E-03	--	2.3E-17	--
Molybdenum	2.6E-03	1.0E-03	--	3.2E-13	--
Nickel	6.6E-01	2.0E-04	--	1.6E-11	--
Selenium	1.4E-02	1.0E-03	--	1.7E-12	--
Silver	3.3E-05	6.0E-04	--	2.4E-15	--
Thallium	1.6E-07	1.0E-03	--	2.0E-17	--
Tin	2.6E-02	1.0E-03	--	3.2E-12	--
Vanadium	5.2E-03	1.0E-03	--	6.2E-13	--
Zinc	7.2E-02	6.0E-04	--	5.2E-12	--
Cyanide					
Cyanide	1.8E-03	7.5E-03	--	1.6E-12	--
SVOCs					
Bis(2-Ethylhexyl)phthalate	2.5E-03	2.5E-02	1.4E-02	7.4E-12	1.0E-13
Dimethylphthalate	1.9E-05	1.4E-03	--	3.3E-15	--
Di-n-butylphthalate	3.6E-04	2.4E-02	--	1.1E-12	--
Naphthalene	2.3E-03	4.7E-02	--	1.3E-11	--
Tributyltin (oxide)	7.6E-03	3.4E-04	--	3.1E-13	--
VOCs					
Chloroform	6.4E-05	6.8E-03	6.1E-03	5.2E-14	3.2E-16
MEK (2-Butanone)	1.9E-03	9.6E-04	--	2.2E-13	--
MTBE (methyl-tert-butyl ether)	1.0E-03	2.6E-03	--	3.1E-13	--
Methylene Chloride	2.4E-04	3.5E-03	7.5E-03	1.0E-13	7.6E-16
Total Cancer Risk					5E-13

Notes:
"EPC" Exposure Point Concentration; "--" not applicable or not available; " * " not selected as a COPC in this media

Equations:
Adult/Child Visitor INTAKE-C (mg/kg-day) = $((CW * EF * ET * PC * SAF_{adjusted} * CF1 * CF2) / (AT\text{-}C))$

Where $SAF_{adjusted} = [(SAc * EDc / BWc) + (SAa * EDa / BWa)]$

Cancer Risk = (INTAKE-C * CSF)

TABLE 15
INGESTION OF FISH
CANCER RISK FOR PARK VISITORS
HUMAN HEALTH RISK ASSESSMENT

COPC	Predicted SW EPC (ug/L)	BCF (L/kg)	Predicted Fish EPC CF (mg/kg)	Oral Slope Factor $(mg/kg\text{-}d)^{-1}$	Recreational Exposure Scenario: Average Daily Intake (mg/kg-d) Adult	Recreational Exposure Scenario: Cancer Risk (Unitless) Adult
Metals						
Antimony	2.5E-03	1.0E+00	*	--	*	*
Arsenic	2.2E-03	1.7E+01	3.7E-05	1.5E+00	1.1E-10	1.7E-10
Barium	2.4E-02	8.8E-01	*	--	*	*
Beryllium	2.8E-05	1.9E+01	*	--	*	*
Cadmium	7.0E-04	1.2E+04	8.7E-03	--	2.6E-08	--
Chromium	3.7E-03	3.0E+00	*	--	*	*
Chromium VI	1.5E-04	3.0E+00	*	--	*	*
Cobalt	2.4E-03	8.8E-01	*	--	*	*
Copper	4.7E-03	2.9E+02	*	--	*	*
Lead	4.9E-04	4.5E+01	*	--	*	*
Manganese	3.3E-01	8.8E-01	*	--	*	*
Mercury	1.9E-07	1.7E+00	3.3E-10	--	1.0E-15	--
Molybdenum	2.6E-03	8.8E-01	*	--	*	*
Nickel	6.6E-01	1.1E+02	*	--	*	*
Selenium	1.4E-02	9.0E-01	1.2E-05	--	3.8E-11	--
Silver	3.3E-05	8.8E-01	*	--	*	*
Thallium	1.6E-07	3.4E+01	*	--	*	*
Tin	2.6E-02	5.6E+00	*	--	*	*
Vanadium	5.2E-03	8.8E-01	*	--	*	*
Zinc	7.2E-02	9.7E+02	*	--	*	*
Cyanide						
Cyanide	1.8E-03	4.0E+00	*	--	*	*
SVOCs						
Bis(2-Ethylhexyl)phthalate	2.5E-03	2.1E+05	*	1.4E-02	*	*
Dimethylphthalate	1.9E-05	1.6E+01	*	--	*	*
Di-n-butylphthalate	3.6E-04	1.9E+03	*	--	*	*
Naphthalene	2.3E-03	2.1E+02	*	--	*	*
Tributyltin (oxide)	7.6E-03	4.9E+02	3.7E-03	--	1.1E-08	--
VOCs						
Chloroform	6.4E-05	1.7E+01	*	6.1E-03	*	*
MEK (2-Butanone)	1.9E-03	9.6E-01	*	--	*	*
MTBE (methyl-tert-butyl ether)	1.0E-03	1.6E+01	*	--	*	*
Methylene Chloride	2.4E-04	5.2E+00	*	7.5E-03	*	*
Total Cancer Risk						2E-10

Notes:
"EPC" Exposure Point Concentration; "BCF" Bioconcentration Factor
"--" not applicable or not available; " * " not selected as a COPC in this media
Equations:
Estimated Fish Tissue Concentration CF (mg/kg) = (CW * BCF * 0.001 mg/ug)
INTAKE-C (mg/kg-day) = ((CF * IR-F * EF * ED * CF1) / (BW * AT-C))
Cancer Risk = (INTAKE-C * CSF)

TABLE 16
SUMMARY OF CANCER RISK
THEME PARK VISITORS
HUMAN HEALTH RISK ASSESSMENT

COPC	Predicted SW EPC (ug/L)	Predicted Fish EPC (mg/kg)	Cancer Risk			
			Recreational Visitor - Adult/Child			
			Ingestion	Dermal	Total Risk	Fish Ingestion
Metals						
Antimony	2.5E-03	*	–	–	–	*
Arsenic	2.2E-03	3.7E-05	2.0E-12	3.9E-13	2.4E-12	1.7E-10
Barium	2.4E-02	*	–	–	–	*
Beryllium	2.8E-05	*	–	–	–	*
Cadmium	7.0E-04	8.7E-03	–	–	–	–
Chromium	3.7E-03	*	–	–	–	*
Chromium VI	1.5E-04	*	–	–	–	*
Cobalt	2.4E-03	*	–	–	–	*
Copper	4.7E-03	*	–	–	–	*
Lead	4.9E-04	*	–	–	–	*
Manganese	3.3E-01	*	–	–	–	*
Mercury	1.9E-07	3.3E-10	–	–	–	–
Molybdenum	2.6E-03	*	–	–	–	*
Nickel	6.6E-01	*	–	–	–	*
Selenium	1.4E-02	1.2E-05	–	–	–	–
Silver	3.3E-05	*	–	–	–	*
Thallium	1.6E-07	*	–	–	–	*
Tin	2.6E-02	*	–	–	–	*
Vanadium	5.2E-03	*	–	–	–	*
Zinc	7.2E-02	*	–	–	–	*
Cyanide						
Cyanide	1.8E-03	*	–	–	–	*
SVOCs						
Bis(2-Ethylhexyl)phthalate	2.5E-03	*	2.1E-14	1.0E-13	1.2E-13	*
Dimethylphthalate	1.9E-05	*	–	–	–	*
Di-n-butylphthalate	3.6E-04	*	–	–	–	*
Naphthalene	2.3E-03	*	–	–	–	*
Tributyltin (oxide)	7.6E-03	3.7E-03	–	–	–	–
VOCs						
Chloroform	6.4E-05	*	2.3E-16	3.2E-16	5.5E-16	*
MEK (2-Butanone)	1.9E-03	*	–	–	–	*
MTBE (methyl-tert-butyl ether)	1.0E-03	*	–	–	–	*
Methylene Chloride	2.4E-04	*	1.1E-15	7.6E-16	1.9E-15	*
Total Cancer Risk					2E-12	2E-10

Notes:
"EPC" Exposure Point Concentration; "–" not applicable or not available; " * " not selected as a COPC in this media

TABLE 17
SUMMARY OF NONCANCER HAZARD AND CANCER RISK
THEME PARK WORKERS AND VISITORS
HUMAN HEALTH RISK ASSESSMENT

Receptor and Exposure Routes of Concern	Surface Water Exposures	
	Cancer Risk	Noncancer Hazard
Park Worker		
Incidental Ingestion of Surface Water	1E-10	9E-06
Dermal Contact with Surface Water	5E-11	2E-06
Total	**2E-10**	**1E-05**
Fish Ingestion	**2E-09**	**3E-03**
Park Visitor		
Incidental Ingestion of Surface Water	2E-12	5E-07
Dermal Contact with Surface Water	5E-13	3E-08
Total	**2E-12**	**5E-07**
Fish Ingestion	**2E-10**	**3E-04**

APPENDIX C

TIER 1 ECOLOGICAL ASSESSMENT
CALCULATION OF ALTERNATIVE SOIL SCREENING VALUES

Analysis

The relationship between exposure or dose of a chemical and the ecological effects of that chemical is evaluated through calculation of a hazard quotient (HQ). The risk-based concentration (RBC) or toxicity benchmark is considered to represent a "safe" concentration or dose that will not result in an ecologically significant adverse effect.

$$HQ = \frac{\text{Exposure or Dose}}{\text{RBC or Toxicity Benchmark}}$$

Generally speaking, if the exposure or dose exceeds the RBC or toxicity benchmark (and the calculated HQ exceeds one) for a wildlife functional group, the potential exists for unacceptable risk to that group from the chemical being evaluated. If the HQ is equal to or less than 1, the potential for unacceptable risk is negligible; if the HQ equals 1, the exposure dose equals the toxicity benchmark.

The basic question answered by calculating RBCs is "What soil contaminant concentration will result in a dose that does not represent an unacceptable risk to the receptor?" By setting the HQ at 1.0, the dose is equivalent to the toxicity benchmark. The equation is then solved for the contaminant concentration in soil or sediment. RBCs are more readily comparable to site concentrations than forward-calculated HQs because RBCs, expressed as concentrations (mg/kg contaminant in soil), are calculated only one time for each receptor and contaminant. Comparisons of RBCs with soil concentrations (mg/kg) are more intuitively obvious than comparisons of exposure doses to toxicity benchmarks, which are expressed as mg of chemical per kg of body weight per day (mg/kg-bw/day).

Ecological Effects of Chemicals

The purpose of this section of the analysis component is to develop terrestrial RBCs for abiotic exposure media (i.e., soil) based on toxicological data for birds and mammals available in literature.

Six ecological terrestrial receptor categories and representative surrogate receptors were identified for the purpose of developing RBCs. In the Phase 1 ecological risk screen, the most sensitive of these receptors will be used to evaluate potential risk. Receptor groups (and surrogate wildlife receptors) include:

- a large herbivorous bird (Canada goose)
- a small omnivorous bird (American robin)
- a large carnivorous bird (red-tailed hawk
- an omnivorous mammal (white-footed mouse)
- a small-sized herbivorous mammal (prairie dog)
- a medium-sized carnivorous mammal (red fox)

RBCs were developed based on literature toxicity benchmarks and receptor-based exposure media concentrations. RBCs for avian and mammalian receptors are calculated by setting the HQ at 1 and back-calculating RBCs for each receptor from literature-based no observed adverse effects levels (NOAELs).

Hazard Quotient

For birds and mammals, the numerator of the HQ algorithm (HQ = Exposure Dose/Toxicity Benchmark) is based on an estimate of chemical doses as follows:

Exposure Dose (mg/kg-bw/day) = (EDI x BA x F)/(BW)

where:

EDI (estimated daily intake of the chemical of potential concern (COPC) [expressed as mg/day]) = (C_f x I_f) + (C_s x I_s)

C_f = COPC exposure concentration in food (i.e., plants, invertebrates or mammals) (expressed as mg/kg)

and C_f = BAF x C_s

where:

BAF = chemical-specific bioaccumulation factor for each food item (unitless)

C_s = COPC concentration in soil or sediment (expressed as mg/kg)

I_f = ingestion rate of each food item (expressed as kg/day)

I_s = incidental soil or sediment ingestion rate (expressed as kg/day)

For the risk screening, intake of analytes through water ingestion (C_w x I_w) is not included.

BA = bioavailability of the contaminant (expressed as a percentage)

Bioavailability is assumed to be 100 percent (equal to 1) in the risk screen.

F = receptor- and site-specific area use factor

In the risk screening, F is set at 1. This factor accounts for the proportion of the receptor's time spent potentially exposed to chemicals at a particular site and considers home range, foraging behavior, migratory patterns, and the size of potentially contaminated habitat available; for each receptor and site combination, F can have a value equal to or less than 1.0.

BW = body weight of the receptor; expressed as kg.

Risk Based Concentration

By setting the HQ at 1.0 (Exposure Dose = Toxicity Benchmark), the dose is equivalent to the toxicity benchmark. The equation for the Exposure Dose (i.e., Toxicity Benchmark) is then solved, using the values describe above, for the analyte concentration in soil or sediment (C_s) that would not result in an unacceptable risk to the receptor:

$$C_s = \frac{\text{Toxicity Benchmark x BW}}{(\text{BAF x } I_f) + I_s}$$

Values for BAF and I_f vary with the food items consumed and receptor. The calculated concentration in soil or sediment (C_s) is termed the RBC for the analyte and receptor of interest.

Exposure Constants

Wildlife exposure factors for body weight, food ingestion rate, incidental soil ingestion rate, water intake rate, and dietary composition for each representative wildlife receptor are shown in Table 1. Chemical parameters and uptake factors (bioaccumulation and bioconcentration factors [BAFs and BCFs])for the analytes to be evaluated are shown in Table 2. Sources for uptake factors from soil to vegetation and prey also are referenced in this table.

Wildlife Toxicity Reference Values and Benchmarks for Birds and Mammals

USEPA has not yet developed standard toxicity benchmark concentrations or toxicity reference values (TRVs) for terrestrial receptors. Therefore, TRVs from the literature were used to derive NOAEL toxicity benchmarks for calculating risk to terrestrial wildlife. The TRVs, the literature sources for each TRV, and the calculated NOAEL benchmarks are shown in Tables 3 and 4 for birds and mammals, respectively.

Literature-based TRVs for test organisms were adjusted to wildlife toxicity benchmarks by applying one uncertainty factor from each of three categories: study duration (f_d), toxicity test endpoint (f_t), and intertaxon extrapolation (f_i), in accordance with USEPA Region 8 guidance in *Uncertainty Factor Protocol for Ecological Risk Assessment* (1997). These three categories of uncertainty factors are multiplicative:

$$\text{Total Uncertainty Factor} = f_d \times f_t \times f_i$$

The total uncertainty factor was used in the denominator to adjust the literature-based TRV to a wildlife toxicity benchmark:

$$\text{Wildlife Toxicity Benchmark} = \frac{\text{TRV}}{\text{Total Uncertainty Factor}}$$

Uncertainty factors recommended by USEPA Region 8 (1997) for study duration (f_d) and toxicity test endpoint (f_t) were used to adjust the literature-based TRVs to the avian and mammalian chronic NOAEL benchmarks provided in Tables 3 and 4. These values are:

Study Duration Extrapolation Factors (f_d):

Chronic	1
Subchronic to Chronic Exposure	3
Subacute to Chronic Exposure	5
Acute to Chronic Exposure	10

Test Endpoint Extrapolation Factor (f_t):

Nonlethal no observed effect	1
Lethal NOAEL to non-lethal NOAEL	3
Lethal LOAEL to non-lethal LOAEL	3
Non-lethal LOAEL to non-lethal NOAEL	3
Lethal LOAEL to non-lethal NOAEL	10
Frank effect (death) to non-lethal NOAEL	15

Intertaxon uncertainty factors (f_i) were used to calculate RBCs for mammalian receptors but were not used to calculate RBCs for avian receptors, as science does not currently support their use. Also, in the absence of avian TRVs for some COPCs, mammalian TRVs were not used for birds because extrapolation across classes of organisms is not recommended (USEPA Region 8, 1997). Table 5 contains the f_i values applied to the combinations of test and receptor species used in the risk evaluation.

Intertaxon Uncertainty Factors (f_i):

Same species	1
Same genus, different species	2
Same family, different genus	3
Same order, different family	4
Same class, different order	5
Same phylum, different class	generally too far to extrapolate

RBC calculations for the listed avian and mammalian receptors using NOAEL-based benchmarks are presented in Tables 6 through 11. A summary of NOAEL-based benchmarks is presented in Table 12.

TABLE

EXPOSURE FACTORS FOR TERRESTRIAL WILDLIFE

Representative Species			Body Weight			Food Ingestion Rate			Composition of Diet (%)					Soil Ingestion Rate			Water Intake			Home Range		
Food-web classification	Common Name	Scientific Name	kg	Comment	Reference	kg/day	Comment	Reference	Plants	Inverte-brates	Small Mammals	Comment	Reference	kg/day	Comment	Reference	L/d	Comment	Reference	Acres	Comment	Reference
Birds small omnivore	American robin	*Turdus migratorius*	0.077	avg. all seasons	Sample et al. 1996	0.093		Sample et al. 1996	50%	50%	0%	based on adults in western states for all seasons	EPA 1993	0.0097	10.4% soil in diet based on American woodcock	EPA 1993	0.0106		Sample et al. 1996	0.3	avg. in Wisconsin	DeGraff & Rudis 1987
large herbivore	Canada goose	*Branta candadensis*	2.6	avg. Colorado winter weight	EPA 1993	0.086	0.033 kg/kg-d x BW	EPA 1993	100%	0%	0%		EPA 1993	0.007	8.2% soil in diet	EPA 1993	0.112	WI (L/day)= 0.059*BW0.67 (BW in wet wt. kg) all birds	EPA 1993	2429	adult female and brood mean	EPA 1993
large carnivore	Red-tailed hawk	*Buteo jamaicensis*	1.126		Sample et al. 1996	0.109		Sample et al. 1996	0%	0%	100%		Efroymson et al. 1997	0		Efroymson et al. 1997	0.064		Sample et al. 1996	4372	mean adult male and female for fall	EPA 1993
Mammals small herbivore	Prairie dog	*Cynomys ludovicianus*	1.5	midpoint of range presented	TTU 1997	0.12	0.577(BW0.727 (g/day)) / 1000 - mammal herbivore	EPA 1993	99%	1%	0%		TTU 1997	0.0029	2.4% soil in diet based on Meadow vole	EPA 1993	0.14	0.099(BW0.90) for all mammals	EPA 1993	3.5	average of adult males and females	VTFWIE 2002
medium omnivore	Red fox	*Vulpes vulpes*	4.5		Sample et al. 1996	0.45		Sample et al. 1996	10%	9%	81%		Efroymson et al. 1997	0.0126		Efroymson et al. 1997	0.38		Sample et al. 1996	3835	avg. of adult male mean and adult female mean in summer	EPA 1993
small omnivore	White-footed mouse	*Peromyscus leucopus*	0.022		Sample et al. 1996	0.0034		Sample et al. 1996	50%	50%	0%		Efroymson et al. 1997	7E-05		Efroymson et al. 1997	0.0066		Sample et al. 1996	0.15	mean, Virginia mixe deciduous forest	Sample and Suter 1994

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TABLE 2

BIOACCUMULATION/BIOCONCENTRATION FACTORS FOR CONTAMINANTS IN SOIL

			BAFs and BCFs for Terrestrial Food Items					
Analytes	Log Kow	Kow Reference	Plants	Reference	Soil Inverte-brates	Reference	Small Birds/ Mammals	Reference
VOCs								
Acetone	-0.24	EPA 1996	1.1E+01	Travis and Arms 1988	6.0E-02	Total PAH used as surrogate	1.7E-07	Travis and Arms 1988
Benzene	2.13	EPA 1996	4.5E-01	Travis and Arms 1988	6.0E-02	Total PAH used as surrogate	4.1E-05	Travis and Arms 1988
Ethylbenzene	3.14	EPA 1996	1.2E-01	Travis and Arms 1988	6.0E-02	Total PAH used as surrogate	4.2E-04	Travis and Arms 1988
Methylene chloride	1.25	EPA 1996	1.5E+00	Travis and Arms 1988	6.0E-02	Total PAH used as surrogate	5.4E-06	Travis and Arms 1988
SVOCs								
4-Methylphenol	2.14	Montgomery and Welkom 1991	4.5E-01	Travis and Arms 1988	6.0E-02	Total PAH used as surrogate	4.2E-05	Travis and Arms 1988
Acenaphthylene	4.07	USACE 1998	3.4E-02	Travis and Arms 1988	4.4E-02	Beyer and Stafford (1993)	3.5E-03	Travis and Arms 1988
Anthracene	4.55	EPA 1996	1.8E-02	Travis and Arms 1988	6.4E-02	Beyer and Stafford (1993)	1.1E-02	Travis and Arms 1988
Benzo(a)anthracene	5.7	EPA 1996	3.9E-03	Travis and Arms 1988	5.4E-02	Beyer and Stafford (1993)	1.5E-01	Travis and Arms 1988
Benzo(a)pyrene	6.11	EPA 1996	2.3E-03	Travis and Arms 1988	6.8E-02	Beyer and Stafford (1993)	3.9E-01	Travis and Arms 1988
Benzo(b)fluoranthene	6.2	EPA 1996	2.0E-03	Travis and Arms 1988	4.2E-02	Beyer and Stafford (1993)	4.8E-01	Travis and Arms 1988
Benzo(k)fluoranthene	6.2	EPA 1996	2.0E-03	Travis and Arms 1988	4.2E-02	Beyer and Stafford (1993)	4.8E-01	Travis and Arms 1988
bis(2-ethylhexyl)phthalate	7.3	EPA 1996	4.7E-04	Travis and Arms 1988	2.7E+00	EPA 1995	6.0E+00	Travis and Arms 1988
Chrysene	5.7	EPA 1996	3.9E-03	Travis and Arms 1988	8.8E-02	Total PAH used as surrogate	1.5E-01	Travis and Arms 1988
Dibenzo(a,h)anthracene	6.69	EPA 1996	1.1E-03	Travis and Arms 1988	9.8E-02	Total PAH used as surrogate	1.5E+00	Travis and Arms 1988
Dibenzofuran	4.17	USACE 1998	3.0E-02	Travis and Arms 1988	6.0E-02	Total PAH used as surrogate	4.5E-03	Travis and Arms 1988
Fluoranthene	5.12	EPA 1996	8.5E-03	Travis and Arms 1988	7.4E-02	Beyer and Stafford 1993	4.0E-02	Travis and Arms 1988
Fluorene	4.21	EPA 1996	2.9E-02	Travis and Arms 1988	4.0E-02	Beyer and Stafford 1993	4.9E-03	Travis and Arms 1988
Indeno(1,2,3-cd)pyrene	6.65	EPA 1996	1.1E-03	Travis and Arms 1988	8.2E-02	Beyer and Stafford 1993	1.3E+00	Travis and Arms 1988
Naphthalene	3.36	EPA 1996	8.9E-02	Travis and Arms 1988	4.2E-02	Beyer and Stafford 1993	6.9E-04	Travis and Arms 1988
Phenanthrene	4.57	USACE 1998	1.8E-02	Travis and Arms 1988	5.6E-02	Beyer and Stafford 1993	1.1E-02	Travis and Arms 1988
Pyrene	5.11	EPA 1996	8.6E-03	Travis and Arms 1988	7.8E-02	Beyer and Stafford 1993	3.9E-02	Travis and Arms 1988
Pesticides and PCBs								
Aroclor 1242	4.11	Montgomery and Welkom 1991	3.3E-02	Travis and Arms 1988	1.8E+01	EPA 1995	3.9E-03	Travis and Arms 1988
Aroclor 1260	6.97	USACE 1998	7.3E-04	Travis and Arms 1988	1.8E+01	EPA 1995	2.8E+00	Travis and Arms 1988
Dioxins/Furans								
2,3,7,8-TCDD	6.15	USACE 1998	2.2E-03	Travis and Arms 1988	9.1E+00	EPA 1995	7.2E+00	EPA 1995

Notes:

-Dry weight BCF values provided for plants and invertebrates were adjusted to wet weight BCF values by using a factor of 0.02 (assumes 80 percent water).

-USACE (1998) cites Roberts and Hartley (1992, p. 183) as basis for BCFs and BAF of zero for nitrocellulose.

-For organics, except as noted, the following equations were used to calculate BCFs and BAFs for vegetation and small mammals:

TABLE 2

BIOACCUMULATION/BIOCONCENTRATION FACTORS FOR CONTAMINANTS IN SOIL

-USACE (1998) cites Roberts and Hartley (1992, p. 183) as basis for BCFs and BAF of zero for nitrocellulose.

-For organics, except as noted, the following equations were used to calculate BCFs and BAFs for vegetation and small mammals:

Vegetation -- Log BCF = 1.588 - 0.578 x Log K_{ow}. BCF * 0.2 (the 0.2 adjusts for dry to wet weight -- taken from USACE 1998)

Small mammals -- Log biotransfer factor (BTF) = -7.6 + log K_{ow} and BAF = BTF * 12 kg/d

-For soil invertebrates:

Organochlorine BCFs from several studies provided in Beyer (1990) were combined and an average organochlorine BCF was calculated by USACE (1998). Except as noted this value is used as a surrogate for all organochlorine compounds.

BCF for total PAHs (0.3 x 0.2 = 0.06), adjusted to wet weight, was used as a surrogate for explosives, VOCs, and SVOCs (except PAHs).

BCF for zinc was used as surrogate for metals in invertebrates.

-For metals some BCFs for soil invertebrates and BAFs for small mammals were calculated using data from Baes et al. (1984) and a procedure from USACE (1998).

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TABLE 3
TRVs AND BENCHMARKS FOR BIRDS

Analyte	Form	Test Species	Exposure Duration	Exposure Route	Endpoint	Lethal/Non-lethal Endpoint	Acute LD50 (mg/kg-bw/d)	Acute LD50 to Chronic UF	Acute LOAEL	Acute NOAEL	Acute to Chronic UF	Subchronic LOAEL (mg/kg-bw/d)	Subchronic NOAEL (mg/kg-bw/d)	Subchronic to Chronic UF	Chronic LOAEL (mg/kg-bw/d)	Chronic NOAEL (mg/kg-bw/d)	LOAEL to NOAEL UF	Final Chronic LOAEL (mg/kg-bw/d)	Final Chronic NOAEL (mg/kg-bw/d)	Source
VOCs																				
Acetone	n/a	Japanese quail	5 days	food	clinical signs of toxicity	lethal	--	--	--	--	--	--	--	--	--	52	10	520	52	EPA 1999
Benzene	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	No TRV	No TRV	--
Ethylbenzene	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	No TRV	No TRV	--
Methylene chloride	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	No TRV	No TRV	--
SVOCs																				
4-Methylphenol	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	No TRV	No TRV	--
Acenaphthylene	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	No TRV	No TRV	--
Anthracene	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	No TRV	No TRV	--
Benzo(a)anthracene	--	chicken embryo	--	--	--	--	--	--	--	--	--	--	--	--	--	0.00079	10	0.0079	0.00079	EPA 1999
Benzo(a)pyrene	n/a	duck	single dose	gavage	mortality	lethal	50	15	--	--	--	--	--	--	--	--	10	33.33333	3.333333	Sample et al. 1996
Benzo(b)fluoranthene	benzo(k)fluoranthene used as a surrogate	chicken embryo	--	--	--	--	--	--	--	--	--	--	--	--	--	0.00014	10	0.0014	0.00014	EPA 1999
Benzo(k)fluoranthene	--	chicken embryo	--	--	--	--	--	--	--	--	--	--	--	--	--	0.00014	10	0.0014	0.00014	EPA 1999
bis(2-Ethylhexyl)phthalate	n/a	ringed dove	4 wks, critical lifestage	food	reproduction	non-lethal	--	--	--	--	--	--	--	--	--	1.1	10	11	1.1	Sample et al 1996
Chrysene	--	chicken embryo	--	--	--	--	--	--	--	--	--	--	--	--	--	0.001	10	0.01	0.001	EPA 1999
Dibenzo(a,h)anthracene	--	chicken embryo	--	--	--	--	--	--	--	--	--	--	--	--	--	0.00039	10	0.0039	0.00039	EPA 1999
Dibenzofuran	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	No TRV	No TRV	--
Fluoranthene	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	No TRV	No TRV	--
Fluorene	n/a	red-winged blackbird	single dose	gavage	lethality	lethal	>101	15	--	--	--	--	--	--	--	--	10	67.33333	6.733333	Schafer et al 1983
Naphthalene	mix of PAHs but primarily naphthalene	mallard	7 mo	oral	increased liver weight	non-lethal	--	--	--	--	--	--	--	--	800	--	10	800	80	Patton and Dieter 1980
Phenanthrene	n/a	red-winged blackbird	single dose	gavage	mortality	lethal	>113	15	--	--	--	--	--	--	--	--	10	75.33333	7.533333	Schafer et al 1983
Pyrene	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	No TRV	No TRV	--
Pesticides and PCBs																				
Aroclor 1242	n/a	screech owl	2 gen	food	reproduction	non-lethal	--	--	--	--	--	--	--	--	--	0.41	10	4.1	0.41	Sample et al. 1996
Aroclor 1260	Aroclor 1254	ring-necked pheasant	17 wks, critical lifestage	oral, capsule	reproduction	non-lethal	--	--	--	--	--	--	--	--	1.8	--	10	1.8	0.18	Sample et al. 1996
Dioxins as 2,3,7,8-TCDD																				
2,3,7,8-TCDD	n/a	ring-necked pheasant	10 wk, critical lifestage	intraperitonal injection	reproduction	non-lethal	--	--	--	--	--	--	--	--	0.00014	0.000014	--	0.00014	0.000014	Sample et al. 1996

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TABLE 4

TRVs AND BENCHMARKS FOR MAMMALS

Analyte	Form	Test Species	Exposure Duration	Exposure Route	Endpoint(s)	Lethal/Non-lethal Endpoint Designation	Acute LD50 (mg/kg-bw/d)	Acute LD50 to Chronic UF	Acute LOAEL	Acute NOAEL	Acute to Chronic UF	Subchronic LOAEL (mg/kg-bw/d)	Subchronic NOAEL (mg/kg-bw/d)	Subchronic to Chronic UF	Chronic LOAEL (mg/kg-bw/d)	Chronic NOAEL (mg/kg-bw/d)	LOAEL to NOAEL UF	Final Chronic LOAEL (mg/kg-bw/d)	Final Chronic NOAEL (mg/kg-bw/d)	Source of Toxicity Data
VOCs																				
Acetone	n/a	rat	90 d	intubation	liver and kidney damage	non-lethal	--	--	--	--	--	500	100	3	--	--	--	166 6667	33.333333	Sample et al 1996
Benzene	n/a	mouse	day 6-12 gestation, critical lifestage	gavage	reproduction (maternal mortality, embryonic resorption, fetal weight)	non-lethal	--	--	--	--	--	--	--	--	263 6	--	10	263.6	26 36	Sample et al 1996
Ethylbenzene	n/a	rat	1 day	gavage	lethality	lethal	4728	15	--	--	--	--	--	--	--	--	10	3152	315 2	Smyth et al 1962
Methyl ethyl ketone	n/a	rat	2 gen, critical lifestage	water	reproduction	non-lethal	--	--	--	--	--	--	--	--	4571	1771	--	4571	1771	Sample et al. 1996
SVOCs																				
4-Methylphenol	n/a	rat	acute	oral	mortality	lethal	207	15	--	--	--	--	--	--	--	--	10	138	13 8	Lewis 1992
Acenaphthylene	--	rat	32 days	food	hepatic, renal	non-lethal	--	--	--	--	--	2000	--	3	--	--	10	666 6667	66 666667	--
Anthracene	--	rodents	NS	oral	carcinogenicity	non-lethal	--	--	--	--	--	--	--	--	3300	--	10	3300	330	--
Benzo(a)anthracene	--	mouse	single dose	--	gastrointestinal effects	--	--	--	--	--	--	--	--	--	--	0.167	10	1 67	0.167	EPA 1999
Benzo(a)pyrene	n/a	mouse	days 7-16 gestation, critical lifestage	intubation	reproduction	non-lethal	--	--	--	--	--	--	--	--	10	--	10	10	1	Sample et al 1996
Benzo(b)fluoranthene	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	No TRV	No TRV	--
Benzo(k)fluoranthene	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	No TRV	No TRV	--
bis(2-Ethylhexyl)phthalate	n/a	mouse	105 d, critical lifestage	food	reproduction	non-lethal	--	--	--	--	--	--	--	--	183	18 3	--	183	18 3	Sample et al. 1996
Chrysene	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	No TRV	No TRV	--
Dibenzo(a,h)anthracene	--	rat	15 days	--	growth	--	--	--	--	--	--	--	--	--	--	0 002	10	0 02	0 002	EPA 1999
Dibenzofuran	n/a	mouse	gestation	food	development, teratogenisis	non-lethal	--	--	--	--	--	--	--	--	--	100	10	1000	100	Shepard 1986
Fluoranthene	n/a	rodents	single dose	oral	mortality	lethal	2000	15	--	--	--	--	--	--	--	--	10	1333.333	133 33333	USACE 1998
Fluorene	n/a	mouse	13-weeks	gavage	hematological effects, decreased erythrocytes	non-lethal	--	--	--	--	--	250	125	3	--	--	--	83 33333	41.666667	--
Indeno(1,2,3-cd)pyrene	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	No TRV	No TRV	--
Naphthalene	n/a	mouse	13 weeks	food	hematological, increased lymphocytes	non-lethal	--	--	--	--	--	200	100	3	--	--	--	66.66667	33 333333	--
Phenanthrene	n/a	mouse	acute	oral	mortality	lethal	700	15	--	--	--	--	--	--	--	--	10	466 6667	46 666667	Sample et al. 1996
Pyrene	n/a	mouse	13 weeks	gavage	renal, renal tubular pathology	non-lethal	--	--	--	--	--	125	75	3	--	--	--	41.66667	25	--
Pesticides and PCBs																				
Aroclor 1242	n/a	mink	7 mo, critical lifestage	food	reproduction	non-lethal	--	--	--	--	--	--	--	--	0 69	--	10	0.69	0.069	Sample et al. 1996
Aroclor 1260	Aroclor 1248	Rhesus monkey	14 mo, critical lifestage	food	reproduction	non-lethal	--	--	--	--	--	--	--	--	0 1	--	10	0 1	0 01	Sample et al. 1996
Dioxins as 2,3,7,8-TCDD																				
2,3,7,8-TCDD	n/a	rat	3 gen	food	reproduction	non-lethal	--	--	--	--	--	--	--	--	0.00001	0 000001	--	0 00001	0 000001	Sample et al 1996

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TABLE 5
MAMMALIAN INTERTAXON UNCERTAINTY FACTORS

Classification of TRV Test Animals and Mammalian Receptors

Organism	Receptor or Test Species	Class	Order	Family	Genus	Species
Dog	Test Species	Mammalia	Carnivora	Canidae	*Canis*	*familiaris*
Mink	Test Species	Mammalia	Carnivora	Mustelidae	*Mustela*	*vison*
Mouse	Test Species	Mammalia	Rodentia	Muridae	*Peromyscus*	sp.
Oldfield mouse	Test Species	Mammalia	Rodentia	Muridae	*Peromyscus*	*polionotus*
Prairie dog	Receptor	Mammalia	Rodentia	Sciuridae	*Cynomys*	*ludovicianus*
Rat	Test Species	Mammalia	Rodentia	Muridae	*Rattus*	sp.
Red fox	Receptor	Mammalia	Carnivora	Canidae	*Vulpes*	*vulpes*
Rhesus monkey	Test Species	Mammalia	Primates	Ceropithecidae	*Macaca*	*rhesus*
Rodents	Test Species	Mammalia	Rodentia	--	--	--
White-footed mouse	Receptor/ Test Species	Mammalia	Rodentia	Muridae	*Peromyscus*	*leucopus*

Taxon Uncertainty Factors For Mammalian Receptors Based On TRV Test Species

Receptor	TRV Test Species															
	white-footed mouse		mouse		oldfield mouse		rat		rodents		mink		Rhesus monkey		dog	
	UF	Basis	UF	Basis	UF	Basis	UF	Basis	UF	Basis	UF	Basis	UF	Basis	UF	Basis
Prairie dog	4	Family	4	Family	4	Family	4	Family	4	Family	5	Order	5	Order	5	Order
Red fox	5	Order	5	Order	5	Order	5	Order	5	Order	4	Family	5	Order	3	Genus
White-footed mouse	1	NA	2	Species	2	Species	3	Genus	4	Family	5	Order	5	Order	5	Order

TRV - Toxicity Reference Value
UF - Uncertainty Factor; Source: USEPA Region 8 1997
U.S. Environmental Protection Agency Region 8 1997. Uncertainty Factor Protocol for Ecological Risk Assessment – Toxicological Extrapolations to Wildlife Receptors. February.

TABLE 6
RBCs FOR CANADA GOOSE USING NOAELs

Analyte	Soil RBC (mg/kg)	Plant BCF	Invertebrate BCF	Mammal BAF	Estimated Plant Conc. (mg/kg)	Estimated Invertebrate Conc. (mg/kg)	Estimated Mammal Conc. (mg/kg)	Body Wt (kg)	Plant Ingestion Rate (kg/d)	Invertebrate Ingestion Rate (kg/d)	Mammal Ingestion Rate (kg/d)	Soil Ingestion Rate (kg/d)	Plant Exposure (mg/kg-bw/d)	Invertebrate Exposure (mg/kg-bw/d)	Mammal Exposure (mg/kg-bw/d)	Soil Exposure (mg/kg-bw/d)	Total Exposure (mg/kg-bw/d)	Area Use	Bioavail-ability	Chronic NOAEL Dose (mg/kg-bw/d)
VOCs																				
Acetone	1.5E+02	1.1E+01	6.0E-02	1.7E-07	1.6E+03	8.8E+00	2.5E-05	2.60E+00	8.60E-02	0.00E+00	0.00E+00	7.00E-03	5.16E+01	0.00E+00	0.00E+00	3.94E-01	5.20E+01	1	1	5.20E+01
Benzene	nc	4.5E-01	6.0E-02	4.1E-05	nc	nc	nc	2.60E+00	8.60E-02	0.00E+00	0.00E+00	7.00E-03	nc	nc	nc	nc	nc	1	1	No TRV
Ethylbenzene	nc	1.2E-01	6.0E-02	4.2E-04	nc	nc	nc	2.60E+00	8.60E-02	0.00E+00	0.00E+00	7.00E-03	nc	nc	nc	nc	nc	1	1	No TRV
Methylene chloride	nc	1.5E+00	6.0E-02	5.4E-06	nc	nc	nc	2.60E+00	8.60E-02	0.00E+00	0.00E+00	7.00E-03	nc	nc	nc	nc	nc	1	1	No TRV
SVOCs																				
4-Methylphenol	nc	4.5E-01	6.0E-02	4.2E-05	nc	nc	nc	2.60E+00	8.60E-02	0.00E+00	0.00E+00	7.00E-03	nc	nc	nc	nc	nc	1	1	No TRV
Acenaphthylene	nc	3.4E-02	4.4E-02	3.5E-03	nc	nc	nc	2.60E+00	8.60E-02	0.00E+00	0.00E+00	7.00E-03	nc	nc	nc	nc	nc	1	1	No TRV
Anthracene	nc	1.8E-02	6.4E-02	1.1E-02	nc	nc	nc	2.60E+00	8.60E-02	0.00E+00	0.00E+00	7.00E-03	nc	nc	nc	nc	nc	1	1	No TRV
Benzo(a)anthracene	2.8E-01	3.9E-03	5.4E-02	1.5E-01	1.1E-03	1.5E-02	4.2E-02	2.60E+00	8.60E-02	0.00E+00	0.00E+00	7.00E-03	3.64E-05	0.00E+00	0.00E+00	7.54E-04	7.90E-04	1	1	7.90E-04
Benzo(a)pyrene	1.2E+03	2.3E-03	6.8E-02	3.9E-01	2.7E+00	8.2E+01	4.7E+02	2.60E+00	8.60E-02	0.00E+00	0.00E+00	7.00E-03	9.07E-02	0.00E+00	0.00E+00	3.24E+00	3.33E+00	1	1	3.33E+00
Benzo(b)fluoranthene	5.1E-02	2.0E-03	4.2E-02	4.8E-01	1.0E-04	2.1E-03	2.4E-02	2.60E+00	8.60E-02	0.00E+00	0.00E+00	7.00E-03	3.39E-06	0.00E+00	0.00E+00	1.37E-04	1.40E-04	1	1	1.40E-04
Benzo(k)fluoranthene	5.1E-02	2.0E-03	4.2E-02	4.8E-01	1.0E-04	2.1E-03	2.4E-02	2.60E+00	8.60E-02	0.00E+00	0.00E+00	7.00E-03	3.39E-06	0.00E+00	0.00E+00	1.37E-04	1.40E-04	1	1	1.40E-04
bis(2-Ethylhexyl)phthalate	4.1E+02	4.7E-04	2.7E+00	6.0E+00	1.9E-01	1.1E+03	2.4E+03	2.60E+00	8.60E-02	0.00E+00	0.00E+00	7.00E-03	6.28E-03	0.00E+00	0.00E+00	1.09E+00	1.10E+00	1	1	1.10E+00
Chrysene	3.5E-01	3.9E-03	8.8E-02	1.5E-01	1.4E-03	3.1E-02	5.4E-02	2.60E+00	8.60E-02	0.00E+00	0.00E+00	7.00E-03	4.61E-05	0.00E+00	0.00E+00	9.54E-04	1.00E-03	1	1	1.00E-03
Dibenzo(a,h)anthracene	1.4E-01	1.1E-03	9.8E-02	1.5E+00	1.5E-04	1.4E-02	2.1E-01	2.60E+00	8.60E-02	0.00E+00	0.00E+00	7.00E-03	4.98E-06	0.00E+00	0.00E+00	3.85E-04	3.90E-04	1	1	3.90E-04
Dibenzofuran	nc	3.0E-02	6.0E-02	4.5E-03	nc	nc	nc	2.60E+00	8.60E-02	0.00E+00	0.00E+00	7.00E-03	nc	nc	nc	nc	nc	1	1	No TRV
Fluoranthene	nc	8.5E-03	7.4E-02	4.0E-02	nc	nc	nc	2.60E+00	8.60E-02	0.00E+00	0.00E+00	7.00E-03	nc	nc	nc	nc	nc	1	1	No TRV
Fluorene	1.9E+03	2.9E-02	4.0E-02	4.9E-03	5.3E+01	7.4E+01	9.1E+00	2.60E+00	8.60E-02	0.00E+00	0.00E+00	7.00E-03	1.75E+00	0.00E+00	0.00E+00	4.98E+00	6.73E+00	1	1	6.73E+00
Indeno(1,2,3-cd)pyrene	3.7E-01	1.1E-03	8.2E-02	1.3E+00	4.1E-04	3.0E-02	4.9E-01	2.60E+00	8.60E-02	0.00E+00	0.00E+00	7.00E-03	1.35E-05	0.00E+00	0.00E+00	9.87E-04	1.00E-03	1	1	1.00E-03
Naphthalene	1.4E+04	8.9E-02	4.2E-02	6.9E-04	1.3E+03	6.0E+02	9.8E+00	2.60E+00	8.60E-02	0.00E+00	0.00E+00	7.00E-03	4.17E+01	0.00E+00	0.00E+00	3.83E+01	8.00E+01	1	1	8.00E+01
Phenanthrene	2.3E+03	1.8E-02	5.6E-02	1.1E-02	4.1E+01	1.3E+02	2.6E+01	2.60E+00	8.60E-02	0.00E+00	0.00E+00	7.00E-03	1.34E+00	0.00E+00	0.00E+00	6.19E+00	7.53E+00	1	1	7.53E+00
Pyrene	nc	8.6E-03	7.8E-02	3.9E-02	nc	nc	nc	2.60E+00	8.60E-02	0.00E+00	0.00E+00	7.00E-03	nc	nc	nc	nc	nc	1	1	No TRV
Pesticides and PCBs																				
Aroclor 1242	1.1E+02	3.3E-02	1.8E+01	3.9E-03	3.5E+00	2.0E+03	4.2E-01	2.60E+00	8.60E-02	0.00E+00	0.00E+00	7.00E-03	1.17E-01	0.00E+00	0.00E+00	2.93E-01	4.10E-01	1	1	4.10E-01
Aroclor 1260	6.6E+01	7.3E-04	1.8E+01	2.8E+00	4.8E-02	1.2E+03	1.9E+02	2.60E+00	8.60E-02	0.00E+00	0.00E+00	7.00E-03	1.59E-03	0.00E+00	0.00E+00	1.78E-01	1.80E-01	1	1	1.80E-01
Dioxins/Furans																				
2,3,7,8-TCDD	5.1E-03	2.2E-03	9.1E+00	7.2E+00	1.1E-05	4.6E-02	3.6E-02	2.60E+00	8.60E-02	0.00E+00	0.00E+00	7.00E-03	3.62E-07	0.00E+00	0.00E+00	1.36E-05	1.40E-05	1	1	1.40E-05

Soil RBC (Cs) = (HQ x Safe Dose x Bw) / [BA x AU x (IRs + (BCFp x IRp) + (BCFi x IRi) + (BCFm x IRm)]
where: HQ (Hazard Quotient) = 1
Bw = Body weight; BA = Bioavailability; AU = Area use; IR = Ingestion rate; S = Soil; BCF = Bioconcentration factor; P = Plant; I = Invertebrate; M = Mammal
No TRV = no toxicity reference value

TABLE 7

RBCs FOR AMERICAN ROBIN USING NOAELs

Analyte	Soil RBC (mg/kg)	Plant BCF	Invertebrate BCF	Mammal BAF	Estimated Plant Conc. (mg/kg)	Estimated Invertebrate Conc. (mg/kg)	Estimated Mammal Conc. (mg/kg)	Body Wt (kg)	Plant Ingestion Rate (kg/d)	Invertebrate Ingestion Rate (kg/d)	Mammal Ingestion Rate (kg/d)	Soil Ingestion Rate (kg/d)	Plant Exposure (mg/kg-bw/d)	Invertebrate Exposure (mg/kg-bw/d)	Mammal Exposure (mg/kg-bw/d)	Soil Exposure (mg/kg-bw/d)	Total Exposure (mg/kg-bw/d)	Area Use	Bioavail-ability	Chronic NOAEL Dose (mg/kg-bw/d)
VOCs																				
Acetone	7.9E+00	1.1E+01	6.0E-02	1.7E-07	8.4E+01	4.7E-01	1.4E-06	7.70E-02	4.65E-02	4.65E-02	0.00E+00	9.70E-03	5.07E+01	2.85E-01	0.00E+00	9.93E-01	5.20E+01	1	1	5.20E+01
Benzene	nc	4.5E-01	6.0E-02	4.1E-05	nc	nc	nc	7.70E-02	4.65E-02	4.65E-02	0.00E+00	9.70E-03	nc	nc	nc	nc	nc	1	1	No TRV
Ethylbenzene	nc	1.2E-01	6.0E-02	4.2E-04	nc	nc	nc	7.70E-02	4.65E-02	4.65E-02	0.00E+00	9.70E-03	nc	nc	nc	nc	nc	1	1	No TRV
Methylene chloride	nc	1.5E+00	6.0E-02	5.4E-06	nc	nc	nc	7.70E-02	4.65E-02	4.65E-02	0.00E+00	9.70E-03	nc	nc	nc	nc	nc	1	1	No TRV
SVOCs																				
4-Methylphenol	nc	4.5E-01	6.0E-02	4.2E-05	nc	nc	nc	7.70E-02	4.65E-02	4.65E-02	0.00E+00	9.70E-03	nc	nc	nc	nc	nc	1	1	No TRV
Acenaphthylene	nc	3.4E-02	4.4E-02	3.5E-03	nc	nc	nc	7.70E-02	4.65E-02	4.65E-02	0.00E+00	9.70E-03	nc	nc	nc	nc	nc	1	1	No TRV
Anthracene	nc	1.8E-02	6.4E-02	1.1E-02	nc	nc	nc	7.70E-02	4.65E-02	4.65E-02	0.00E+00	9.70E-03	nc	nc	nc	nc	nc	1	1	No TRV
Benzo(a)anthracene	4.9E-03	3.9E-03	5.4E-02	1.5E-01	1.9E-05	2.7E-04	7.4E-04	7.70E-02	4.65E-02	4.65E-02	0.00E+00	9.70E-03	1.16E-05	1.60E-04	0.00E+00	6.18E-04	7.90E-04	1	1	7.90E-04
Benzo(a)pyrene	2.0E+01	2.3E-03	6.8E-02	3.9E-01	4.5E-02	1.3E+00	7.7E+00	7.70E-02	4.65E-02	4.65E-02	0.00E+00	9.70E-03	2.72E-02	8.13E-01	0.00E+00	2.49E+00	3.33E+00	1	1	3.33E+00
Benzo(b)fluoranthene	9.2E-04	2.0E-03	4.2E-02	4.8E-01	1.9E-06	3.9E-05	4.4E-04	7.70E-02	4.65E-02	4.65E-02	0.00E+00	9.70E-03	1.12E-06	2.33E-05	0.00E+00	1.16E-04	1.40E-04	1	1	1.40E-04
Benzo(k)fluoranthene	9.2E-04	2.0E-03	4.2E-02	4.8E-01	1.9E-06	3.9E-05	4.4E-04	7.70E-02	4.65E-02	4.65E-02	0.00E+00	9.70E-03	1.12E-06	2.33E-05	0.00E+00	1.16E-04	1.40E-04	1	1	1.40E-04
bis(2-Ethylhexyl)phthalate	6.3E-01	4.7E-04	2.7E+00	6.0E+00	2.9E-04	1.7E+00	3.8E+00	7.70E-02	4.65E-02	4.65E-02	0.00E+00	9.70E-03	1.77E-04	1.02E+00	0.00E+00	7.89E-02	1.10E+00	1	1	1.10E+00
Chrysene	5.5E-03	3.9E-03	8.8E-02	1.5E-01	2.2E-05	4.8E-04	8.3E-04	7.70E-02	4.65E-02	4.65E-02	0.00E+00	9.70E-03	1.31E-05	2.93E-04	0.00E+00	6.94E-04	1.00E-03	1	1	1.00E-03
Dibenzo(a,h)anthracene	2.1E-03	1.1E-03	9.8E-02	1.5E+00	2.2E-06	2.1E-04	3.1E-03	7.70E-02	4.65E-02	4.65E-02	0.00E+00	9.70E-03	1.33E-06	1.24E-04	0.00E+00	2.64E-04	3.90E-04	1	1	3.90E-04
Dibenzofuran	nc	3.0E-02	6.0E-02	4.5E-03	nc	nc	nc	7.70E-02	4.65E-02	4.65E-02	0.00E+00	9.70E-03	nc	nc	nc	nc	nc	1	1	No TRV
Fluoranthene	nc	8.5E-03	7.4E-02	4.0E-02	nc	nc	nc	7.70E-02	4.65E-02	4.65E-02	0.00E+00	9.70E-03	nc	nc	nc	nc	nc	1	1	No TRV
Fluorene	4.0E+01	2.9E-02	4.0E-02	4.9E-03	1.1E+00	1.6E+00	2.0E-01	7.70E-02	4.65E-02	4.65E-02	0.00E+00	9.70E-03	6.94E-01	9.72E-01	0.00E+00	5.07E+00	6.73E+00	1	1	6.73E+00
Indeno(1,2,3-cd)pyrene	5.7E-03	1.1E-03	8.2E-02	1.3E+00	6.3E-06	4.7E-04	7.6E-03	7.70E-02	4.65E-02	4.65E-02	0.00E+00	9.70E-03	3.81E-06	2.81E-04	0.00E+00	7.15E-04	1.00E-03	1	1	1.00E-03
Naphthalene	3.9E+02	8.9E-02	4.2E-02	6.9E-04	3.5E+01	1.6E+01	2.7E-01	7.70E-02	4.65E-02	4.65E-02	0.00E+00	9.70E-03	2.09E+01	9.91E+00	0.00E+00	4.92E+01	8.00E+01	1	1	8.00E+01
Phenanthrene	4.4E+01	1.8E-02	5.6E-02	1.1E-02	7.8E-01	2.5E+00	4.9E-01	7.70E-02	4.65E-02	4.65E-02	0.00E+00	9.70E-03	4.72E-01	1.49E+00	0.00E+00	5.57E+00	7.53E+00	1	1	7.53E+00
Pyrene	nc	8.6E-03	7.8E-02	3.9E-02	nc	nc	nc	7.70E-02	4.65E-02	4.65E-02	0.00E+00	9.70E-03	nc	nc	nc	nc	nc	1	1	No TRV
Pesticides and PCBs																				
Aroclor 1242	3.7E-02	3.3E-02	1.8E+01	3.9E-03	1.2E-03	6.7E-01	1.4E-04	7.70E-02	4.65E-02	4.65E-02	0.00E+00	9.70E-03	7.33E-04	4.05E-01	0.00E+00	4.69E-03	4.10E-01	1	1	4.10E-01
Aroclor 1260	1.6E-02	7.3E-04	1.8E+01	2.8E+00	1.2E-05	2.9E-01	4.6E-02	7.70E-02	4.65E-02	4.65E-02	0.00E+00	9.70E-03	7.17E-06	1.78E-01	0.00E+00	2.06E-03	1.80E-01	1	1	1.80E-01
Dioxins/Furans																				
2,3,7,8-TCDD	2.5E-06	2.2E-03	9.1E+00	7.2E+00	5.4E-09	2.3E-05	1.8E-05	7.70E-02	4.65E-02	4.65E-02	0.00E+00	9.70E-03	3.25E-09	1.37E-05	0.00E+00	3.14E-07	1.40E-05	1	1	1.40E-05

Soil RBC (Cs) = (HQ x Safe Dose x Bw) / [BA x AU x (IRs + (BCFp x IRp) + (BCFi x IRi) + (BCFm x IRm)]

where: HQ (Hazard Quotient) = 1

Bw = Body weight; BA = Bioavailability; AU = Area use; IR = Ingestion rate; S = Soil; BCF = Bioconcentration factor; P = Plant; I = Invertebrate; M = Mammal

No TRV = no toxicity reference value

TABLE 8
RBCs FOR RED-TAILED HAWK USING NOAELs

Analyte	Soil RBC (mg/kg)	Plant BCF	Invertebrate BCF	Mammal BAF	Estimated Plant Conc. (mg/kg)	Estimated Invertebrate Conc. (mg/kg)	Estimated Mammal Conc. (mg/kg)	Body Wt (kg)	Plant Ingestion Rate (kg/d)	Invertebrate Ingestion Rate (kg/d)	Mammal Ingestion Rate (kg/d)	Soil Ingestion Rate (kg/d)	Plant Exposure (mg/kg-bw/d)	Invertebrate Exposure (mg/kg-bw/d)	Mammal Exposure (mg/kg-bw/d)	Soil Exposure (mg/kg-bw/d)	Total Exposure (mg/kg-bw/d)	Area Use	Bioavailability	Chronic NOAEL Dose (mg/kg-bw/d)
VOCs																				
Acetone	3.1E+09	1.1E+01	6.0E-02	1.7E-07	3.3E+10	1.9E+08	5.4E+02	1.13E+00	0.00E+00	0.00E+00	1.09E-01	0.00E+00	0.00E+00	0.00E+00	5.20E+01	0.00E+00	5.20E+01	1	1	5 20E+01
Benzene	nc	4.5E-01	6.0E-02	4.1E-05	nc	nc	nc	1.13E+00	0.00E+00	0.00E+00	1.09E-01	0.00E+00	nc	nc	nc	nc	nc	1	1	No TRV
Ethylbenzene	nc	1.2E-01	6.0E-02	4.2E-04	nc	nc	nc	1.13E+00	0.00E+00	0.00E+00	1.09E-01	0.00E+00	nc	nc	nc	nc	nc	1	1	No TRV
Methylene chloride	nc	1.5E+00	6.0E-02	5.4E-06	nc	nc	nc	1.13E+00	0.00E+00	0.00E+00	1.09E-01	0.00E+00	nc	nc	nc	nc	nc	1	1	No TRV
SVOCs																				
4-Methylphenol	nc	4.5E-01	6.0E-02	4.2E-05	nc	nc	nc	1.13E+00	0.00E+00	0.00E+00	1.09E-01	0.00E+00	nc	nc	nc	nc	nc	1	1	No TRV
Acenaphthylene	nc	3.4E-02	4.4E-02	3.5E-03	nc	nc	nc	1.13E+00	0.00E+00	0.00E+00	1.09E-01	0.00E+00	nc	nc	nc	nc	nc	1	1	No TRV
Anthracene	nc	1.8E-02	6.4E-02	1.1E-02	nc	nc	nc	1.13E+00	0.00E+00	0.00E+00	1.09E-01	0.00E+00	nc	nc	nc	nc	nc	1	1	No TRV
Benzo(a)anthracene	5.4E-02	3.9E-03	5.4E-02	1.5E-01	2.1E-04	2.9E-03	8.2E-03	1.13E+00	0.00E+00	0.00E+00	1.09E-01	0.00E+00	0.00E+00	0.00E+00	7.90E-04	0.00E+00	7.90E-04	1	1	7 90E-04
Benzo(a)pyrene	8.9E+01	2.3E-03	6.8E-02	3.9E-01	2.0E-01	6.0E+00	3.4E+01	1.13E+00	0.00E+00	0.00E+00	1.09E-01	0.00E+00	0.00E+00	0 00E+00	3 33E+00	0.00E+00	3.33E+00	1	1	3 33E+00
Benzo(b)fluoranthene	3.0E-03	2.0E-03	4.2E-02	4.8E-01	6.1E-06	1.3E-04	1.4E-03	1.13E+00	0.00E+00	0.00E+00	1.09E-01	0.00E+00	0.00E+00	0.00E+00	1 40E-04	0 00E+00	1.40E-04	1	1	1 40E-04
Benzo(k)fluoranthene	3 0E 03	2 0E-03	4.2E-02	4.8E-01	6 1E-06	1 3E-04	1 4E-03	1.13E+00	0.00E+00	0.00E+00	1.09E-01	0.00E+00	0.00E+00	0 00E+00	1 40E-04	0.00E+00	1.40E-04	1	1	1 40E 04
bis(2-Ethylhexyl)phthalate	1.9E+00	4.7E-04	2.7E+00	6 0E+00	8.8E-04	5.1E+00	1.1E+01	1.13E+00	0.00E+00	0.00E+00	1.09E-01	0.00E+00	0.00E+00	0 00E+00	1.10E+00	0 00E+00	1 10E+00	1	1	1 10E+00
Chrysene	6 8E-02	3.9E-03	8.8E-02	1.5E-01	2.7E-04	6.0E-03	1.0E-02	1.13E+00	0.00E+00	0.00E+00	1.09E-01	0.00E+00	0.00E+00	0.00E+00	1.00E-03	0.00E+00	1.00E-03	1	1	1 00E-03
Dibenzo(a,h)anthracene	2.7E-03	1.1E-03	9.8E-02	1.5E+00	2.9E-06	2.7E-04	4.0E-03	1.13E+00	0.00E+00	0.00E+00	1.09E-01	0.00E+00	0.00E+00	0.00E+00	3.90E-04	0.00E+00	3.90E-04	1	1	3 90E-04
Dibenzofuran	nc	3.0E-02	6.0E-02	4.5E-03	nc	nc	nc	1.13E+00	0.00E+00	0.00E+00	1.09E-01	0.00E+00	nc	nc	nc	nc	nc	1	1	No TRV
Fluoranthene	nc	8.5E-03	7.4E-02	4.0E-02	nc	nc	nc	1.13E+00	0.00E+00	0.00E+00	1.09E-01	0.00E+00	nc	nc	nc	nc	nc	1	1	No TRV
Fluorene	1.4E+04	2.9E-02	4.0E-02	4.9E-03	4.1E+02	5.7E+02	7.0E+01	1.13E+00	0.00E+00	0.00E+00	1.09E-01	0.00E+00	0.00E+00	0.00E+00	6.73E+00	0.00E+00	6.73E+00	1	1	6 73E+00
Indeno(1,2,3-cd)pyrene	7.7E-03	1.1E-03	8.2E-02	1.3E+00	8.5E-06	6.3E-04	1.0E-02	1.13E+00	0.00E+00	0.00E+00	1.09E-01	0.00E+00	0.00E+00	0.00E+00	1.00E-03	0.00E+00	1.00E-03	1	1	1.00E-03
Naphthalene	1.2E+06	8.9E-02	4.2E-02	6.9E-04	1.1E+05	5.0E+04	8.3E+02	1.13E+00	0.00E+00	0.00E+00	1.09E-01	0.00E+00	0.00E+00	0.00E+00	8.00E+01	0.00E+00	8.00E+01	1	1	8 00E+01
Phenanthrene	6.9E+03	1.8E-02	5.6E-02	1.1E-02	1.2E+02	3.9E+02	7.8E+01	1.13E+00	0.00E+00	0.00E+00	1.09E-01	0.00E+00	0.00E+00	0.00E+00	7.53E+00	0.00E+00	7.53E+00	1	1	7.53E+00
Pyrene	nc	8.6E-03	7.8E-02	3.9E-02	nc	nc	nc	1.13E+00	0.00E+00	0.00E+00	1.09E-01	0.00E+00	nc	nc	nc	nc	nc	1	1	No TRV
Pesticides and PCBs																				
Aroclor 1242	1.1E+03	3.3E-02	1.8E+01	3.9E-03	3.6E+01	2.0E+04	4.2E+00	1.13E+00	0.00E+00	0.00E+00	1.09E-01	0.00E+00	0.00E+00	0.00E+00	4.10E-01	0.00E+00	4.10E-01	1	1	4 10E-01
Aroclor 1260	6.6E-01	7.3E-04	1.8E+01	2.8E+00	4.8E-04	1.2E+01	1.9E+00	1.13E+00	0.00E+00	0.00E+00	1.09E-01	0.00E+00	0.00E+00	0 00E+00	1.80E-01	0.00E+00	1.80E-01	1	1	1 80E-01
Dioxins/Furans																				
2,3,7,8-TCDD	2.0E-05	2.2E-03	9.1E+00	7.2E+00	0.0E+00	0.0E+00	0.0E+00	1.13E+00	0.00E+00	0.00E+00	1.09E-01	0.00E+00	0.00E+00	0.00E+00	0 00E+00	0.00E+00	0 00E+00	1	1	1 40E-05

Soil RBC (Cs) = (HQ x Safe Dose x Bw) / [BA x AU x (IRs + (BCFp x IRp) + (BCFi x IRi) + (BCFm x IRm)]
where: HQ (Hazard Quotient) = 1
Bw = Body weight; BA = Bioavailability; AU = Area use; IR = Ingestion rate; S = Soil; BCF = Bioconcentration factor; P = Plant; I = Invertebrate; M = Mammal
No TRV = no toxicity reference value

TABLE 9

RBCs FOR WHITE-FOOTED MOUSE USING NOAELs

Analyte	Soil RBC (mg/kg)	Plant BCF	Invertebrate BCF	Mammal BAF	Estimated Plant Conc. (mg/kg)	Estimated Invertebrate Conc. (mg/kg)	Estimated Mammal Conc. (mg/kg)	Body Wt (kg)	Plant Ingestion Rate (kg/d)	Invertebrate Ingestion Rate (kg/d)	Mammal Ingestion Rate (kg/d)	Soil Ingestion Rate (kg/d)	Plant Exposure (mg/kg-bw/d)	Invertebrate Exposure (mg/kg-bw/d)	Mammal Exposure (mg/kg-bw/d)	Soil Exposure (mg/kg-bw/d)	Total Exposure (mg/kg-bw/d)	Area Use	Bioavail-ability	Chronic NOAEL Dose (mg/kg-bw/d)
VOCs																				
Acetone	1.3E+01	1.1E+01	6.0E-02	1.7E-07	1.4E+02	8.0E-01	2.3E-06	2.20E-02	1.70E-03	1.70E-03	0.00E+00	6.80E-05	1.10E+01	6.20E-02	0.00E+00	4.13E-02	1.11E+01	1	1	1.1E+01
Benzene	3.1E+02	4.5E-01	6.0E-02	4.1E-05	1.4E+02	1.8E+01	1.2E-02	2.20E-02	1.70E-03	1.70E-03	0.00E+00	6.80E-05	1.08E+01	1.43E+00	0.00E+00	9.50E-01	1.32E+01	1	1	1.3E+01
Ethylbenzene	6.2E+03	1.2E-01	6.0E-02	4.2E-04	7.4E+02	3.7E+02	2.6E+00	2.20E-02	1.70E-03	1.70E-03	0.00E+00	6.80E-05	5.70E+01	2.88E+01	0.00E+00	1.92E+01	1.05E+02	1	1	1.1E+02
Methylene chloride	1.6E+01	1.5E+00	6.0E-02	5.4E-06	2.4E+01	9.7E-01	8.6E-05	2.20E-02	1.70E-03	1.70E-03	0.00E+00	6.80E-05	1.83E+00	7.46E-02	0.00E+00	4.98E-02	1.95E+00	1	1	2.0E+00
SVOCs																				
4-Methylphenol	1.1E+02	4.5E-01	6.0E-02	4.2E-05	4.9E+01	6.5E+00	4.5E-03	2.20E-02	1.70E-03	1.70E-03	0.00E+00	6.80E-05	3.76E+00	5.03E-01	0.00E+00	3.35E-01	4.60E+00	1	1	4.6E+00
Acenaphthylene	2.4E+03	3.4E-02	4.4E-02	3.5E-03	8.4E+01	1.1E+02	8.6E+00	2.20E-02	1.70E-03	1.70E-03	0.00E+00	6.80E-05	6.46E+00	8.26E+00	0.00E+00	7.51E+00	2.22E+01	1	1	2.2E+01
Anthracene	8.7E+03	1.8E-02	6.4E-02	1.1E-02	1.6E+02	5.6E+02	9.3E+01	2.20E-02	1.70E-03	1.70E-03	0.00E+00	6.80E-05	1.23E+01	4.32E+01	0.00E+00	2.70E+01	8.25E+01	1	1	8.3E+01
Benzo(a)anthracene	1.1E+01	3.9E-03	5.4E-02	1.5E-01	4.3E-02	6.0E-01	1.7E+00	2.20E-02	1.70E-03	1.70E-03	0.00E+00	6.80E-05	3.35E-03	4.60E-02	0.00E+00	3.41E-02	8.35E-02	1	1	8.4E-02
Benzo(a)pyrene	5.9E+01	2.3E-03	6.8E-02	3.9E-01	1.3E-01	4.0E+00	2.3E+01	2.20E-02	1.70E-03	1.70E-03	0.00E+00	6.80E-05	1.03E-02	3.08E-01	0.00E+00	1.81E-01	5.00E-01	1	1	5.0E-01
Benzo(b)fluoranthene	nc	2.0E-03	4.2E-02	4.8E-01	nc	nc	nc	2.20E-02	1.70E-03	1.70E-03	0.00E+00	6.80E-05	nc	nc	nc	nc	nc	1	1	No TRV
Benzo(k)fluoranthene	nc	2.0E-03	4.2E-02	4.8E-01	nc	nc	nc	2.20E-02	1.70E-03	1.70E-03	0.00E+00	6.80E-05	nc	nc	nc	nc	nc	1	1	No TRV
bis(2-Ethylhexyl)phthalate	4.3E+01	4.7E-04	2.7E+00	6.0E+00	2.0E-02	1.2E+02	2.6E+02	2.20E-02	1.70E-03	1.70E-03	0.00E+00	6.80E-05	1.56E-03	9.01E+00	0.00E+00	1.34E-01	9.15E+00	1	1	9.2E+00
Chrysene	nc	3.9E-03	8.8E-02	1.5E-01	nc	nc	nc	2.20E-02	1.70E-03	1.70E-03	0.00E+00	6.80E-05	nc	nc	nc	nc	nc	1	1	No TRV
Dibenzo(a,h)anthracene	6.2E-02	1.1E-03	9.8E-02	1.5E+00	6.5E-05	6.1E-03	9.2E-02	2.20E-02	1.70E-03	1.70E-03	0.00E+00	6.80E-05	5.05E-06	4.70E-04	0.00E+00	1.92E-04	6.67E-04	1	1	6.7E-04
Dibenzofuran	5.0E+03	3.0E-02	6.0E-02	4.5E-03	1.5E+02	3.0E+02	2.2E+01	2.20E-02	1.70E-03	1.70E-03	0.00E+00	6.80E-05	1.16E+01	2.31E+01	0.00E+00	1.54E+01	5.00E+01	1	1	5.0E+01
Fluoranthene	3.5E+03	8.5E-03	7.4E-02	4.0E-02	3.0E+01	2.6E+02	1.4E+02	2.20E-02	1.70E-03	1.70E-03	0.00E+00	6.80E-05	2.31E+00	2.01E+01	0.00E+00	1.09E+01	3.33E+01	1	1	3.3E+01
Fluorene	2.5E+03	2.9E-02	4.0E-02	4.9E-03	7.1E+01	9.9E+01	1.2E+01	2.20E-02	1.70E-03	1.70E-03	0.00E+00	6.80E-05	5.48E+00	7.68E+00	0.00E+00	7.68E+00	2.08E+01	1	1	2.1E+01
Indeno(1,2,3-cd)pyrene	nc	1.1E-03	8.2E-02	1.3E+00	nc	nc	nc	2.20E-02	1.70E-03	1.70E-03	0.00E+00	6.80E-05	nc	nc	nc	nc	nc	1	1	No TRV
Naphthalene	1.3E+03	8.9E-02	4.2E-02	6.9E-04	1.1E+02	5.3E+01	8.7E-01	2.20E-02	1.70E-03	1.70E-03	0.00E+00	6.80E-05	8.65E+00	4.11E+00	0.00E+00	3.91E+00	1.67E+01	1	1	1.7E+01
Phenanthrene	2.7E+03	1.8E-02	5.6E-02	1.1E-02	4.7E+01	1.5E+02	3.0E+01	2.20E-02	1.70E-03	1.70E-03	0.00E+00	6.80E-05	3.63E+00	1.15E+01	0.00E+00	8.21E+00	2.33E+01	1	1	2.3E+01
Pyrene	1.3E+03	8.6E-03	7.8E-02	3.9E-02	1.1E+01	1.0E+02	5.0E+01	2.20E-02	1.70E-03	1.70E-03	0.00E+00	6.80E-05	8.51E-01	7.70E+00	0.00E+00	3.95E+00	1.25E+01	1	1	1.3E+01
Pesticides and PCBs																				
Aroclor 1242	9.9E-03	3.3E-02	1.8E+01	3.9E-03	3.2E-04	1.8E-01	3.8E-05	2.20E-02	1.70E-03	1.70E-03	0.00E+00	6.80E-05	2.49E-05	1.37E-02	0.00E+00	3.05E-05	1.38E-02	1	1	1.4E-02
Aroclor 1260	1.4E-03	7.3E-04	1.8E+01	2.8E+00	1.0E-06	2.6E-02	4.0E-03	2.20E-02	1.70E-03	1.70E-03	0.00E+00	6.80E-05	8.04E-08	2.00E-03	0.00E+00	4.43E-06	2.00E-03	1	1	2.0E-03
Dioxins/Furans																				
2,3,7,8-TCDD	4.7E-07	2.2E-03	9.1E+00	7.2E+00	1.0E-09	4.3E-06	3.4E-06	2.20E-02	1.70E-03	1.70E-03	0.00E+00	6.80E-05	7.87E-11	3.32E-07	0.00E+00	1.46E-09	3.33E-07	1	1	3.3E-07

Soil RBC (Cs) = (HQ x Safe Dose x Bw) / [BA x AU x (IRs + (BCFp x IRp) + (BCFi x IRi) + (BCFm x IRm)]

where: HQ (Hazard Quotient) = 1

Bw = Body weight; BA = Bioavailability; AU = Area use; IR = Ingestion rate; S = Soil; BCF = Bioconcentration factor; P = Plant; I = Invertebrate; M = Mammal

No TRV = no toxicity reference value

TABLE 10

RBCs FOR PRAIRIE DOG USING NOAELs

Analyte	Soil RBC (mg/kg)	Plant BCF	Invertebrate BCF	Mammal BAF	Estimated Plant Conc. (mg/kg)	Estimated Invertebrate Conc. (mg/kg)	Estimated Mammal Conc. (mg/kg)	Body Wt (kg)	Plant Ingestion Rate (kg/d)	Invertebrate Ingestion Rate (kg/d)	Mammal Ingestion Rate (kg/d)	Soil Ingestion Rate (kg/d)	Plant Exposure (mg/kg-bw/d)	Invertebrate Exposure (mg/kg-bw/d)	Mammal Exposure (mg/kg-bw/d)	Soil Exposure (mg/kg-bw/d)	Total Exposure (mg/kg-bw/d)	Area Use	Bioavail-ability	Chronic NOAEL Dose (mg/kg-bw/d)
VOCs																				
Acetone	9.8E+00	1.1E+01	6.0E-02	1.7E-07	1.0E+02	5.9E-01	1.7E-06	1.50E+00	1.19E-01	1.20E-03	0.00E+00	2.88E-03	8.31E+00	4.73E-04	0.00E+00	1.89E-02	8.33E+00	1	1	8.3E+00
Benzene	1.7E+02	4.5E-01	6.0E-02	4.1E-05	7.9E+01	1.0E+01	7.1E-03	1.50E+00	1.19E-01	1.20E-03	0.00E+00	2.88E-03	6.25E+00	8.33E-03	0.00E+00	3.33E-01	6.59E+00	1	1	6.6E+00
Ethylbenzene	6.9E+03	1.2E-01	6.0E-02	4.2E-04	8.2E+02	4.2E+02	2.9E+00	1.50E+00	1.19E-01	1.20E-03	0.00E+00	2.88E-03	6.52E+01	3.33E-01	0.00E+00	1.33E+01	7.88E+01	1	1	7.9E+01
Methylene chloride	1.2E+01	1.5E+00	6.0E-02	5.4E-06	1.8E+01	7.4E-01	6.6E-05	1.50E+00	1.19E-01	1.20E-03	0.00E+00	2.88E-03	1.44E+00	5.94E-04	0.00E+00	2.38E-02	1.46E+00	1	1	1.5E+00
SVOCs																				
4-Methylphenol	9.2E+01	4.5E-01	6.0E-02	4.2E-05	4.1E+01	5.5E+00	3.8E-03	1.50E+00	1.19E-01	1.20E-03	0.00E+00	2.88E-03	3.27E+00	4.41E-03	0.00E+00	1.77E-01	3.45E+00	1	1	3.5E+00
Acenaphthylene	3.6E+03	3.4E-02	4.4E-02	3.5E-03	1.2E+02	1.6E+02	1.3E+01	1.50E+00	1.19E-01	1.20E-03	0.00E+00	2.88E-03	9.70E+00	1.25E-01	0.00E+00	6.84E+00	1.67E+01	1	1	1.7E+01
Anthracene	2.4E+04	1.8E-02	6.4E-02	1.1E-02	4.4E+02	1.5E+03	2.6E+02	1.50E+00	1.19E-01	1.20E-03	0.00E+00	2.88E-03	3.48E+01	1.24E+00	0.00E+00	4.65E+01	8.25E+01	1	1	8.3E+01
Benzo(a)anthracene	1.8E+01	3.9E-03	5.4E-02	1.5E-01	7.2E-02	9.9E-01	2.8E+00	1.50E+00	1.19E-01	1.20E-03	0.00E+00	2.88E-03	5.71E-03	7.93E-04	0.00E+00	3.52E-02	4.18E-02	1	1	4.2E-02
Benzo(a)pyrene	1.2E+02	2.3E-03	6.8E-02	3.9E-01	2.6E-01	7.9E+00	4.5E+01	1.50E+00	1.19E-01	1.20E-03	0.00E+00	2.88E-03	2.09E-02	6.31E-03	0.00E+00	2.23E-01	2.50E-01	1	1	2.5E-01
Benzo(b)fluoranthene	nc	2.0E-03	4.2E-02	4.8E-01	nc	nc	nc	1.50E+00	1.19E-01	1.20E-03	0.00E+00	2.88E-03	nc	nc	nc	nc	nc	1	1	No TRV
Benzo(k)fluoranthene	nc	2.0E-03	4.2E-02	4.8E-01	nc	nc	nc	1.50E+00	1.19E-01	1.20E-03	0.00E+00	2.88E-03	nc	nc	nc	nc	nc	1	1	No TRV
bis(2-Ethylhexyl)phthalate	1.1E+03	4.7E-04	2.7E+00	6.0E+00	5.2E-01	3.0E+03	6.7E+03	1.50E+00	1.19E-01	1.20E-03	0.00E+00	2.88E-03	4.11E-02	2.40E+00	0.00E+00	2.13E+00	4.58E+00	1	1	4.6E+00
Chrysene	nc	3.9E-03	8.8E-02	1.5E-01	nc	nc	nc	1.50E+00	1.19E-01	1.20E-03	0.00E+00	2.88E-03	nc	nc	nc	nc	nc	1	1	No TRV
Dibenzo(a,h)anthracene	2.4E-01	1.1E-03	9.8E-02	1.5E+00	2.5E-04	2.4E-02	3.5E-01	1.50E+00	1.19E-01	1.20E-03	0.00E+00	2.88E-03	2.00E-05	1.88E-05	0.00E+00	4.61E-04	5.00E-04	1	1	5.0E-04
Dibenzofuran	5.7E+03	3.0E-02	6.0E-02	4.5E-03	1.7E+02	3.4E+02	2.6E+01	1.50E+00	1.19E-01	1.20E-03	0.00E+00	2.88E-03	1.37E+01	2.76E-01	0.00E+00	1.10E+01	2.50E+01	1	1	2.5E+01
Fluoranthene	1.3E+04	8.5E-03	7.4E-02	4.0E-02	1.1E+02	9.3E+02	5.0E+02	1.50E+00	1.19E-01	1.20E-03	0.00E+00	2.88E-03	8.46E+00	7.44E-01	0.00E+00	2.41E+01	3.33E+01	1	1	3.3E+01
Fluorene	2.5E+03	2.9E-02	4.0E-02	4.9E-03	7.1E+01	9.9E+01	1.2E+01	1.50E+00	1.19E-01	1.20E-03	0.00E+00	2.88E-03	5.59E+00	7.91E-02	0.00E+00	4.75E+00	1.04E+01	1	1	1.0E+01
Indeno(1,2,3-cd)pyrene	nc	1.1E-03	8.2E-02	1.3E+00	nc	nc	nc	1.50E+00	1.19E-01	1.20E-03	0.00E+00	2.88E-03	nc	nc	nc	nc	nc	1	1	No TRV
Naphthalene	9.3E+02	8.9E-02	4.2E-02	6.9E-04	8.2E+01	3.9E+01	6.4E-01	1.50E+00	1.19E-01	1.20E-03	0.00E+00	2.88E-03	6.52E+00	3.12E-02	0.00E+00	1.79E+00	8.33E+00	1	1	8.3E+00
Phenanthrene	3.5E+03	1.8E-02	5.6E-02	1.1E-02	6.1E+01	1.9E+02	3.9E+01	1.50E+00	1.19E-01	1.20E-03	0.00E+00	2.88E-03	4.86E+00	1.55E-01	0.00E+00	6.66E+00	1.17E+01	1	1	1.2E+01
Pyrene	2.3E+03	8.6E-03	7.8E-02	3.9E-02	2.0E+01	1.8E+02	9.1E+01	1.50E+00	1.19E-01	1.20E-03	0.00E+00	2.88E-03	1.60E+00	1.46E-01	0.00E+00	4.50E+00	6.25E+00	1	1	6.3E+00
Pesticides and PCBs																				
Aroclor 1242	7.3E-01	3.3E-02	1.8E+01	3.9E-03	2.4E-02	1.3E+01	2.8E-03	1.50E+00	1.19E-01	1.20E-03	0.00E+00	2.88E-03	1.89E-03	1.05E-02	0.00E+00	1.40E-03	1.38E-02	1	1	1.4E-02
Aroclor 1260	1.2E-01	7.3E-04	1.8E+01	2.8E+00	8.9E-05	2.2E+00	3.4E-01	1.50E+00	1.19E-01	1.20E-03	0.00E+00	2.88E-03	7.01E-06	1.76E-03	0.00E+00	2.34E-04	2.00E-03	1	1	2.0E-03
Dioxins/Furans																				
2,3,7,8-TCDD	2.7E-05	2.2E-03	9.1E+00	7.2E+00	5.8E-08	2.4E-04	1.9E-04	1.50E+00	1.19E-01	1.20E-03	0.00E+00	2.88E-03	4.56E-09	1.94E-07	0.00E+00	5.12E-08	2.50E-07	1	1	2.5E-07

Soil RBC (Cs) = (HQ x Safe Dose x Bw) / [BA x AU x (IRs + (BCFp x IRp) + (BCFi x IRi) + (BCFm x IRm)]

where: HQ (Hazard Quotient) = 1

Bw = Body weight; BA = Bioavailability; AU = Area use; IR = Ingestion rate; S = Soil; BCF = Bioconcentration factor; P = Plant; I = Invertebrate; M = Mammal

No TRV = no toxicity reference value

TABLE 11
RBCs FOR RED FOX USING NOAELs

Analyte	Soil RBC (mg/kg)	Plant BCF	Invertivore BCF	Mammal BAF	Estimated Plant Conc. (mg/kg)	Estimated Invertebrate Conc. (mg/kg)	Estimated Mammal Conc. (mg/kg)	Body Wt (kg)	Plant Ingestion Rate (kg/d)	Invertebrate Ingestion Rate (kg/d)	Mammal Ingestion Rate (kg/d)	Soil Ingestion Rate (kg/d)	Plant Exposure (mg/kg-bw/d)	Invertebrate Exposure (mg/kg-bw/d)	Mammal Exposure (mg/kg-bw/d)	Soil Exposure (mg/kg-bw/d)	Total Exposure (mg/kg-bw/d)	Area Use	Bioavail-ability	Chronic NOAEL Dose (mg/kg-bw/d)
VOCs																				
Acetone	6.1E+01	1.1E+01	6.0E-02	1.7E-07	6.5E+02	3.6E+00	1.1E-05	4.50E+00	4.50E-02	4.05E-02	3.65E-01	1.26E-02	6.46E+00	3.27E-02	8.52E-07	1.70E-01	6.67E+00	1	1	6.7E+00
Benzene	6.7E+02	4.5E-01	6.0E-02	4.1E-05	3.0E+02	4.0E+01	2.7E-02	4.50E+00	4.50E-02	4.05E-02	3.65E-01	1.26E-02	3.04E+00	3.61E-01	2.20E-03	1.87E+00	5.27E+00	1	1	5.3E+00
Ethylbenzene	1.4E+04	1.2E-01	6.0E-02	4.2E-04	1.6E+03	8.3E+02	5.8E+00	4.50E+00	4.50E-02	4.05E-02	3.65E-01	1.26E-02	1.64E+01	7.47E+00	4.66E-01	3.87E+01	6.30E+01	1	1	6.3E+01
Methylene chloride	6.5E+01	1.5E+00	6.0E-02	5.4E-06	9.5E+01	3.9E+00	3.5E-04	4.50E+00	4.50E-02	4.05E-02	3.65E-01	1.26E-02	9.53E-01	3.51E-02	2.82E-05	1.82E-01	1.17E+00	1	1	1.2E+00
SVOCs																				
4-Methylphenol	3.5E+02	4.5E-01	6.0E-02	4.2E-05	1.6E+02	2.1E+01	1.5E-02	4.50E+00	4.50E-02	4.05E-02	3.65E-01	1.26E-02	1.58E+00	1.90E-01	1.19E-03	9.87E-01	2.76E+00	1	1	2.8E+00
Acenaphthylene	3.5E+03	3.4E-02	4.4E-02	3.5E-03	1.2E+02	1.5E+02	1.2E+01	4.50E+00	4.50E-02	4.05E-02	3.65E-01	1.26E-02	1.20E+00	1.38E+00	9.99E-01	9.76E+00	1.33E+01	1	1	1.3E+01
Anthracene	1.5E+04	1.8E-02	6.4E-02	1.1E-02	2.7E+02	9.5E+02	1.6E+02	4.50E+00	4.50E-02	4.05E-02	3.65E-01	1.26E-02	2.71E+00	8.59E+00	1.29E+01	4.18E+01	6.60E+01	1	1	6.6E+01
Benzo(a)anthracene	2.1E+00	3.9E-03	5.4E-02	1.5E-01	8.4E-03	1.2E-01	3.2E-01	4.50E+00	4.50E-02	4.05E-02	3.65E-01	1.26E-02	8.44E-05	1.04E-03	2.63E-02	6.01E-03	3.34E-02	1	1	3.3E-02
Benzo(a)pyrene	5.7E+00	2.3E-03	6.8E-02	3.9E-01	1.3E-02	3.9E-01	2.2E+00	4.50E+00	4.50E-02	4.05E-02	3.65E-01	1.26E-02	1.31E-04	3.51E-03	1.80E-01	1.61E-02	2.00E-01	1	1	2.0E-01
Benzo(b)fluoranthene	nc	2.0E-03	4.2E-02	4.8E-01	nc	nc	nc	4.50E+00	4.50E-02	4.05E-02	3.65E-01	1.26E-02	nc	nc	nc	nc	nc	1	1	No TRV
Benzo(k)fluoranthene	nc	2.0E-03	4.2E-02	4.8E-01	nc	nc	nc	4.50E+00	4.50E-02	4.05E-02	3.65E-01	1.26E-02	nc	nc	nc	nc	nc	1	1	No TRV
bis(2-Ethylhexyl)phthalate	7.1E+00	4.7E-04	2.7E+00	6.0E+00	3.3E-03	1.9E+01	4.3E+01	4.50E+00	4.50E-02	4.05E-02	3.65E-01	1.26E-02	3.33E-05	1.73E-01	3.47E+00	1.99E-02	3.66E+00	1	1	3.7E+00
Chrysene	nc	3.9E-03	8.8E-02	1.5E-01	nc	nc	nc	4.50E+00	4.50E-02	4.05E-02	3.65E-01	1.26E-02	nc	nc	nc	nc	nc	1	1	No TRV
Dibenzo(a,h)anthracene	3.2E-03	1.1E-03	9.8E-02	1.5E+00	3.4E-06	3.2E-04	4.8E-03	4.50E+00	4.50E-02	4.05E-02	3.65E-01	1.26E-02	3.42E-08	2.86E-06	3.88E-04	9.09E-06	4.00E-04	1	1	4.0E-04
Dibenzofuran	5.0E+03	3.0E-02	6.0E-02	4.5E-03	1.5E+02	3.0E+02	2.2E+01	4.50E+00	4.50E-02	4.05E-02	3.65E-01	1.26E-02	1.50E+00	2.70E+00	1.80E+00	1.40E+01	2.00E+01	1	1	2.0E+01
Fluoranthene	3.9E+03	8.5E-03	7.4E-02	4.0E-02	3.4E+01	2.9E+02	1.6E+02	4.50E+00	4.50E-02	4.05E-02	3.65E-01	1.26E-02	3.35E-01	2.62E+00	1.27E+01	1.10E+01	2.67E+01	1	1	2.7E+01
Fluorene	2.2E+03	2.9E-02	4.0E-02	4.9E-03	6.2E+01	8.7E+01	1.1E+01	4.50E+00	4.50E-02	4.05E-02	3.65E-01	1.26E-02	6.19E-01	7.81E-01	8.59E-01	6.07E+00	8.33E+00	1	1	8.3E+00
Indeno(1,2,3-cd)pyrene	nc	1.1E-03	8.2E-02	1.3E+00	nc	nc	nc	4.50E+00	4.50E-02	4.05E-02	3.65E-01	1.26E-02	nc	nc	nc	nc	nc	1	1	No TRV
Naphthalene	1.6E+03	8.9E-02	4.2E-02	6.9E-04	1.4E+02	6.8E+01	1.1E+00	4.50E+00	4.50E-02	4.05E-02	3.65E-01	1.26E-02	1.43E+00	6.12E-01	9.05E-02	4.53E+00	6.67E+00	1	1	6.7E+00
Phenanthrene	2.1E+03	1.8E-02	5.6E-02	1.1E-02	3.8E+01	1.2E+02	2.4E+01	4.50E+00	4.50E-02	4.05E-02	3.65E-01	1.26E-02	3.76E-01	1.07E+00	1.93E+00	5.96E+00	9.33E+00	1	1	9.3E+00
Pyrene	7.4E+02	8.6E-03	7.8E-02	3.9E-02	6.4E+00	5.8E+01	2.9E+01	4.50E+00	4.50E-02	4.05E-02	3.65E-01	1.26E-02	6.40E-02	5.21E-01	2.34E+00	2.08E+00	5.00E+00	1	1	5.0E+00
Pesticides and PCBs																				
Aroclor 1242	1.0E-01	3.3E-02	1.8E+01	3.9E-03	3.4E-03	1.9E+00	4.0E-04	4.50E+00	4.50E-02	4.05E-02	3.65E-01	1.26E-02	3.40E-05	1.69E-02	3.28E-05	2.92E-04	1.73E-02	1	1	1.7E-02
Aroclor 1260	5.1E-03	7.3E-04	1.8E+01	2.8E+00	3.7E-06	9.2E-02	1.4E-02	4.50E+00	4.50E-02	4.05E-02	3.65E-01	1.26E-02	3.69E-08	8.25E-04	1.16E-03	1.43E-05	2.00E-03	1	1	2.0E-03
Dioxins/Furans																				
2,3,7,8-TCDD	3.0E-07	2.2E-03	9.1E+00	7.2E+00	6.5E-10	2.7E-06	2.2E-06	4.50E+00	4.50E-02	4.05E-02	3.65E-01	1.26E-02	6.47E-12	2.45E-08	1.75E-07	8.38E-10	2.00E-07	1	1	2.0E-07

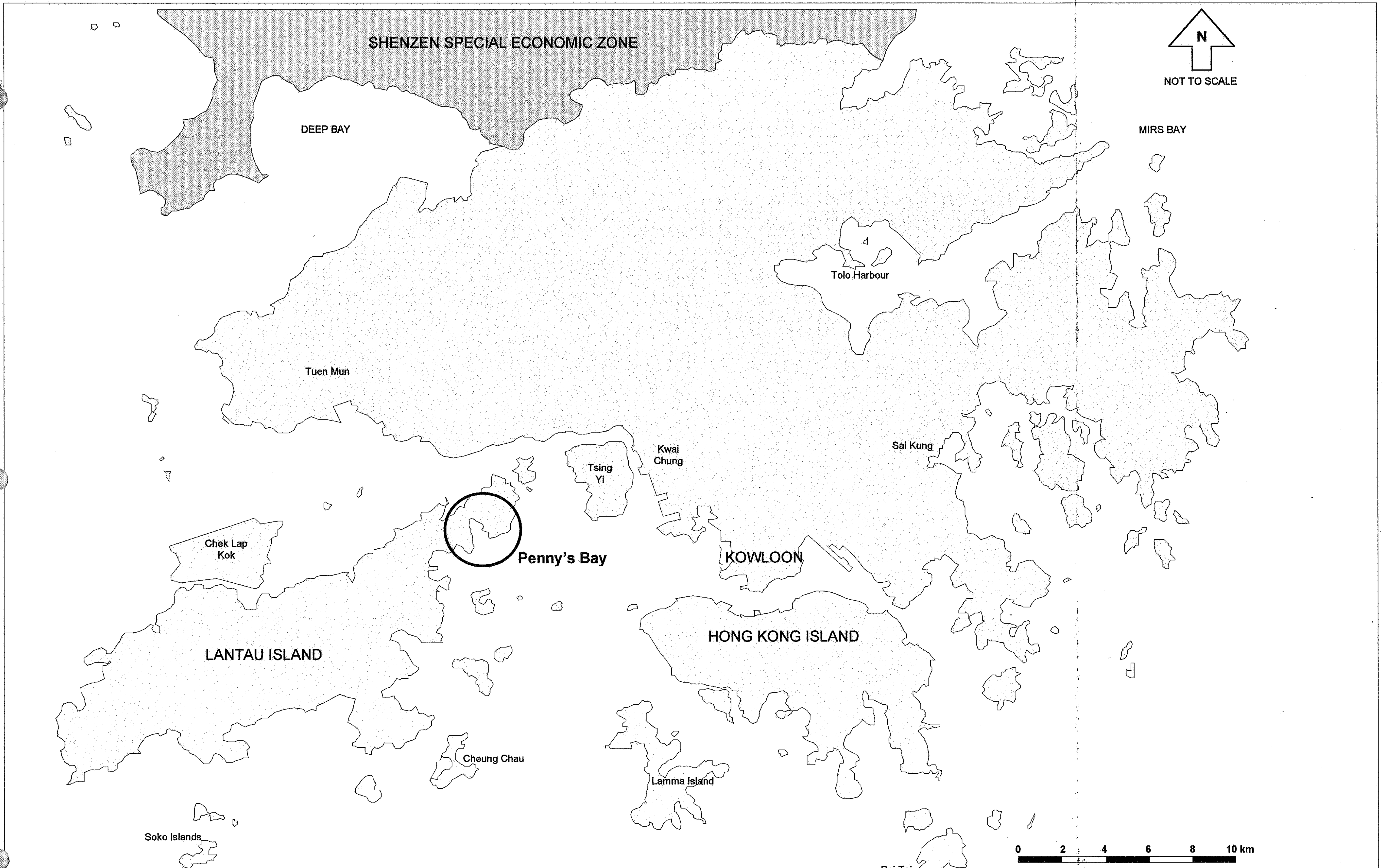
Soil RBC (Cs) = (HQ x Safe Dose x Bw) / [BA x AU x (IRs + (BCFp x IRp) + (BCFi x IRi) + (BCFm x IRm)]
where: HQ (Hazard Quotient) = 1
Bw = Body weight; BA = Bioavailability; AU = Area use; IR = Ingestion rate; S = Soil; BCF = Bioconcentration factor; P = Plant; I = Invertebrate; M = Mammal
No TRV = no toxicity reference value

TABLE 12

RBCs SUMMARY TABLE FOR NOAELs

Analytes	Migratory, Herbivorous Avian Canada Goose	Migratory, Omnivorous Avian American Robin	Carnivorous Avian Red-tailed Hawk	Omnivorous Small Mammal White-footed Mouse	Herbivorous Small Mammal Prairie Dog	Omnivorous Large Mammal Red Fox	Lowest RBC
VOCs							
Acetone	1.5E+02	7.9E+00	3.1E+09	1.3E+01	9.8E+00	6.1E+01	7.9E+00
Benzene	nc	nc	nc	3.1E+02	1.7E+02	6.7E+02	1.7E+02
Ethylbenzene	nc	nc	nc	6.2E+03	6.9E+03	1.4E+04	6.2E+03
Methylene chloride	nc	nc	nc	1.6E+01	1.2E+01	6.5E+01	1.2E+01
SVOCs							
4-Methylphenol	nc	nc	nc	1.1E+02	9.2E+01	3.5E+02	9.2E+01
Acenaphthylene	nc	nc	nc	2.4E+03	3.6E+03	3.5E+03	2.4E+03
Anthracene	nc	nc	nc	8.7E+03	2.4E+04	1.5E+04	8.7E+03
Benzo(a)anthracene	2.8E-01	4.9E-03	5.4E-02	1.1E+01	1.8E+01	2.1E+00	4.9E-03
Benzo(a)pyrene	1.2E+03	2.0E+01	8.9E+01	5.9E+01	1.2E+02	5.7E+00	5.7E+00
Benzo(b)fluoranthene	5.1E-02	9.2E-04	3.0E-03	nc	nc	nc	9.2E-04
Benzo(k)fluoranthene	5.1E-02	9.2E-04	3.0E-03	nc	nc	nc	9.2E-04
bis(2-Ethylhexyl)phthalate	4.1E+02	6.3E-01	1.9E+00	4.3E+01	1.1E+03	7.1E+00	6.3E-01
Chrysene	3.5E-01	5.5E-03	6.8E-02	nc	nc	nc	5.5E-03
Dibenzo(a,h)anthracene	1.4E-01	2.1E-03	2.7E-03	6.2E-02	2.4E-01	3.2E-03	2.1E-03
Dibenzofuran	nc	nc	nc	5.0E+03	5.7E+03	5.0E+03	5.0E+03
Fluoranthene	nc	nc	nc	3.5E+03	1.3E+04	3.9E+03	3.5E+03
Fluorene	1.9E+03	4.0E+01	1.4E+04	2.5E+03	2.5E+03	2.2E+03	4.0E+01
Indeno(1,2,3-cd)pyrene	3.7E-01	5.7E-03	7.7E-03	nc	nc	nc	5.7E-03
Naphthalene	1.4E+04	3.9E+02	1.2E+06	1.3E+03	9.3E+02	1.6E+03	3.9E+02
Phenanthrene	2.3E+03	4.4E+01	6.9E+03	2.7E+03	3.5E+03	2.1E+03	4.4E+01
Pyrene	nc	nc	nc	1.3E+03	2.3E+03	7.4E+02	7.4E+02
Pesticides and PCBs							
Aroclor 1242	1.1E+02	3.7E-02	1.1E+03	9.9E-03	7.3E-01	1.0E-01	9.9E-03
Aroclor 1260	6.6E+01	1.6E-02	6.6E-01	1.4E-03	1.2E-01	5.1E-03	1.4E-03
Dioxins/Furans							
2,3,7,8-TCDD	5.1E-03	2.5E-06	2.0E-05	4.7E-07	2.7E-05	3.0E-07	3.0E-07

nc: no RBC calculated

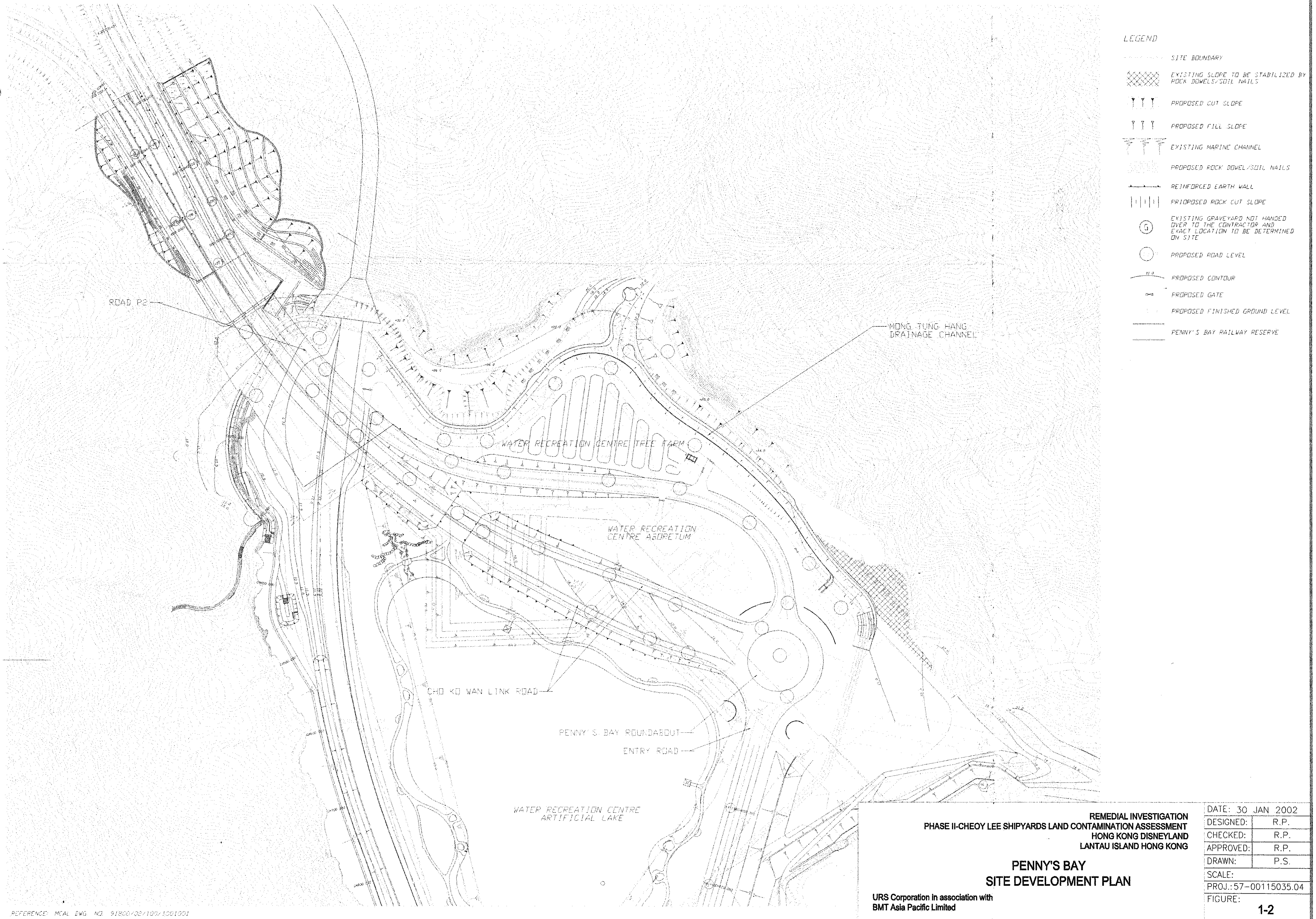


REMEDIAL INVESTIGATION WORK PLAN
PHASE II-CHEOY LEE SHIPYARDS LAND CONTAMINATION ASSESSMENT
HONG KONG DISNEYLAND
LANTAU ISLAND HONG KONG

REMEDIAL INVESTIGATION/ REMEDIAL ALTERNATIVES AND REMEDIAL ACTION WORK PLAN

URS Corporation in association with
BMT Asia Pacific Limited

DATE:	
DESIGNED:	E.C.
CHECKED:	E.C.
APPROVED:	S.V.P.
DRAWN:	E.C.
SCALE:	
PROJ.:	57-00115035.01
FIGURE:	1



REMEDIAL INVESTIGATION
PHASE II-CHEOY LEE SHIPYARDS LAND CONTAMINATION ASSESSMENT
HONG KONG DISNEYLAND
LANTAU ISLAND HONG KONG

PENNY'S BAY
SITE DEVELOPMENT PLAN

URS Corporation in association with
BMT Asia Pacific Limited

DATE: 30 JAN 2002	
DESIGNED:	R.P.
CHECKED:	R.P.
APPROVED:	R.P.
DRAWN:	P.S.
SCALE:	
PROJ.: 57-00115035.04	
FIGURE:	1-2

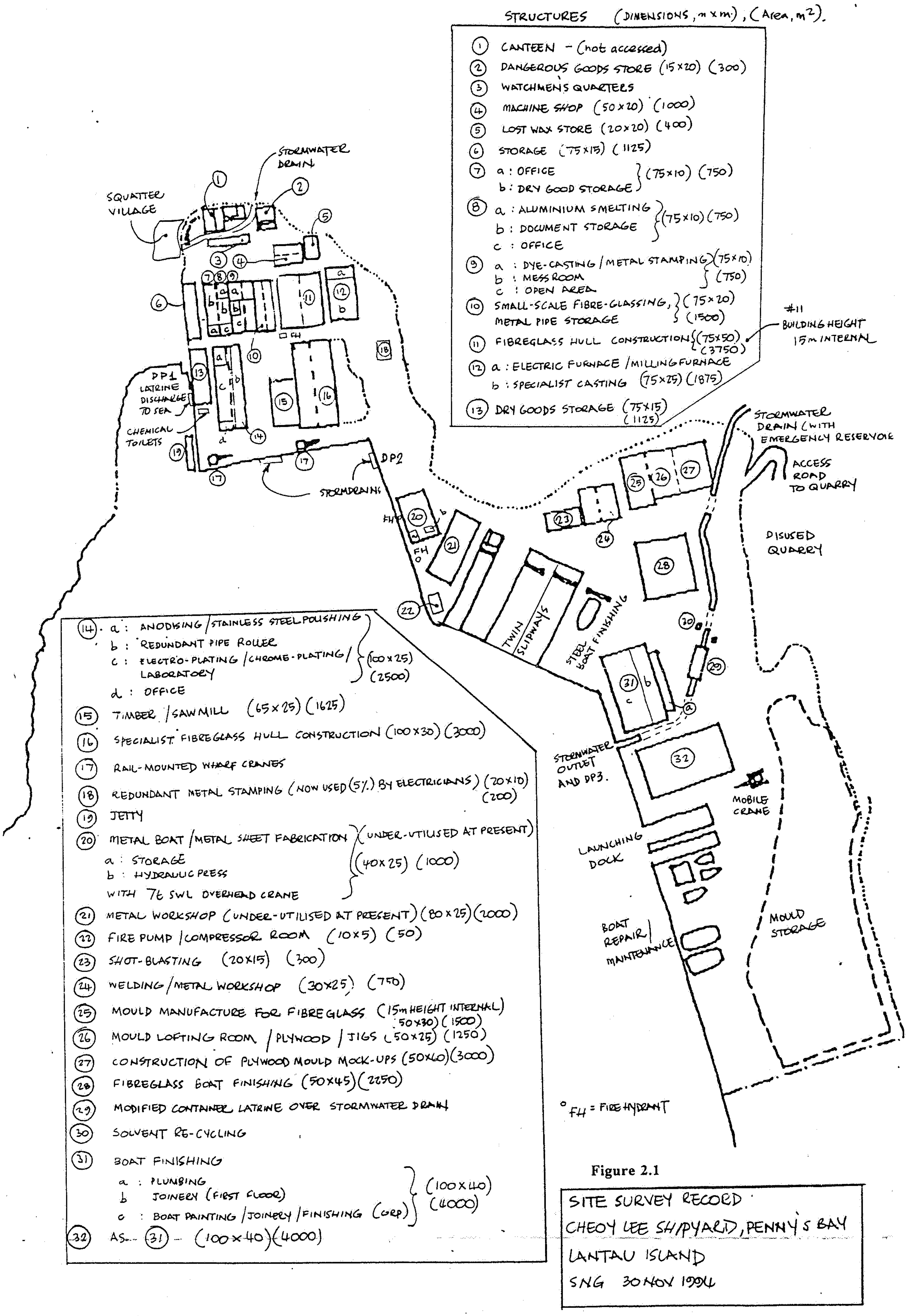


Figure 2.1

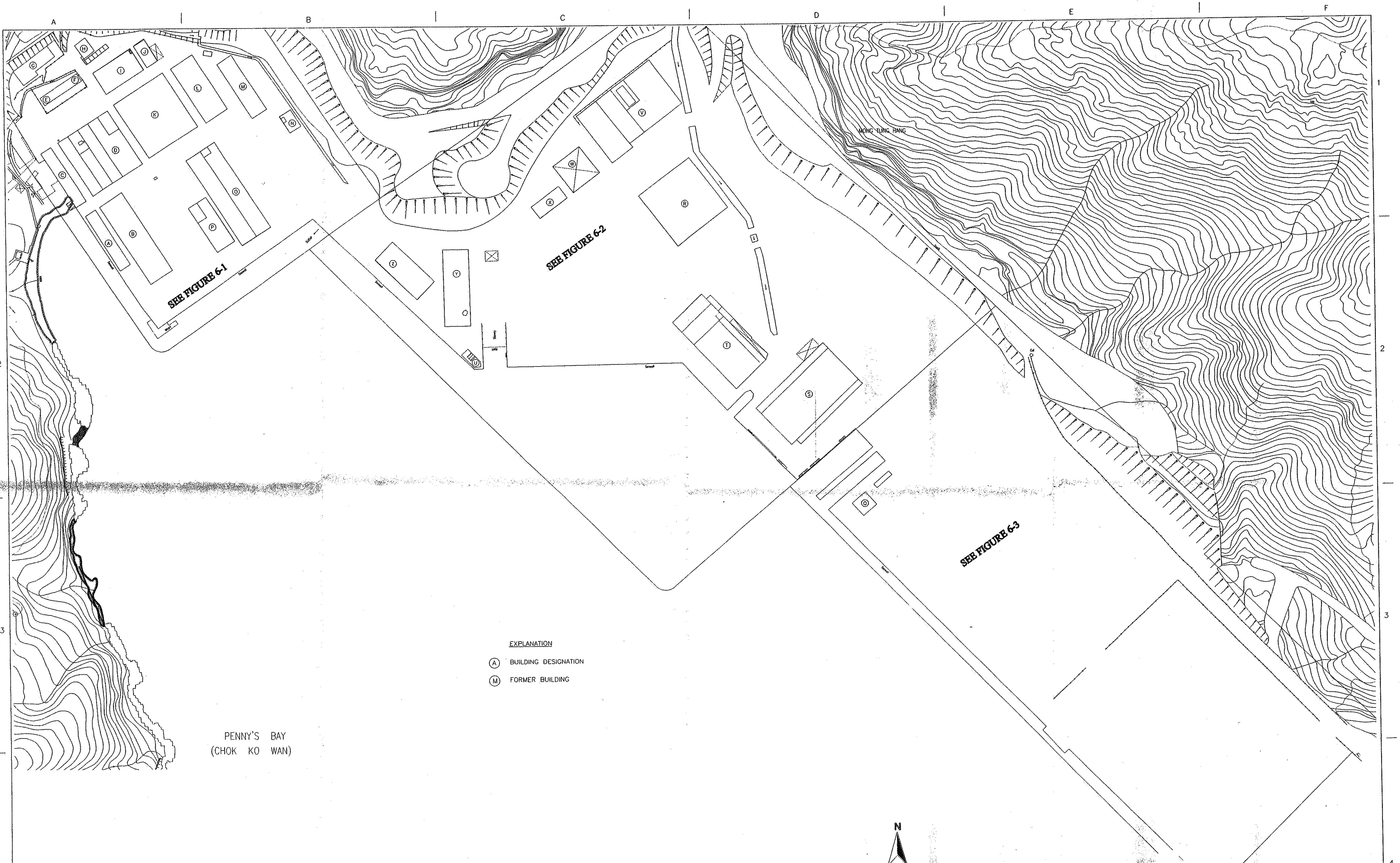
SITE SURVEY RECORD
CHEOY LEE SHIPYARD, PENNY'S BAY
LANTAU ISLAND
SNG 30 NOV 1994

REMEDIAL INVESTIGATION
PHASE II–CHEOY LEE SHIPYARDS LAND CONTAMINATION ASSESSMENT
HONG KONG DISNEYLAND
LANTAU ISLAND HONG KONG

BCL SITE SURVEY RECORD,
NOV. 1994

URS Corporation in association with
BMT Asia Pacific Limited

DATE:	30 JAN 2002
DESIGNED:	C.O.
CHECKED:	C.O.
APPROVED:	R.P.
DRAWN:	M.H.
SCALE:	
PROJ.: 57-00115035.01	
FIGURE:	2–1

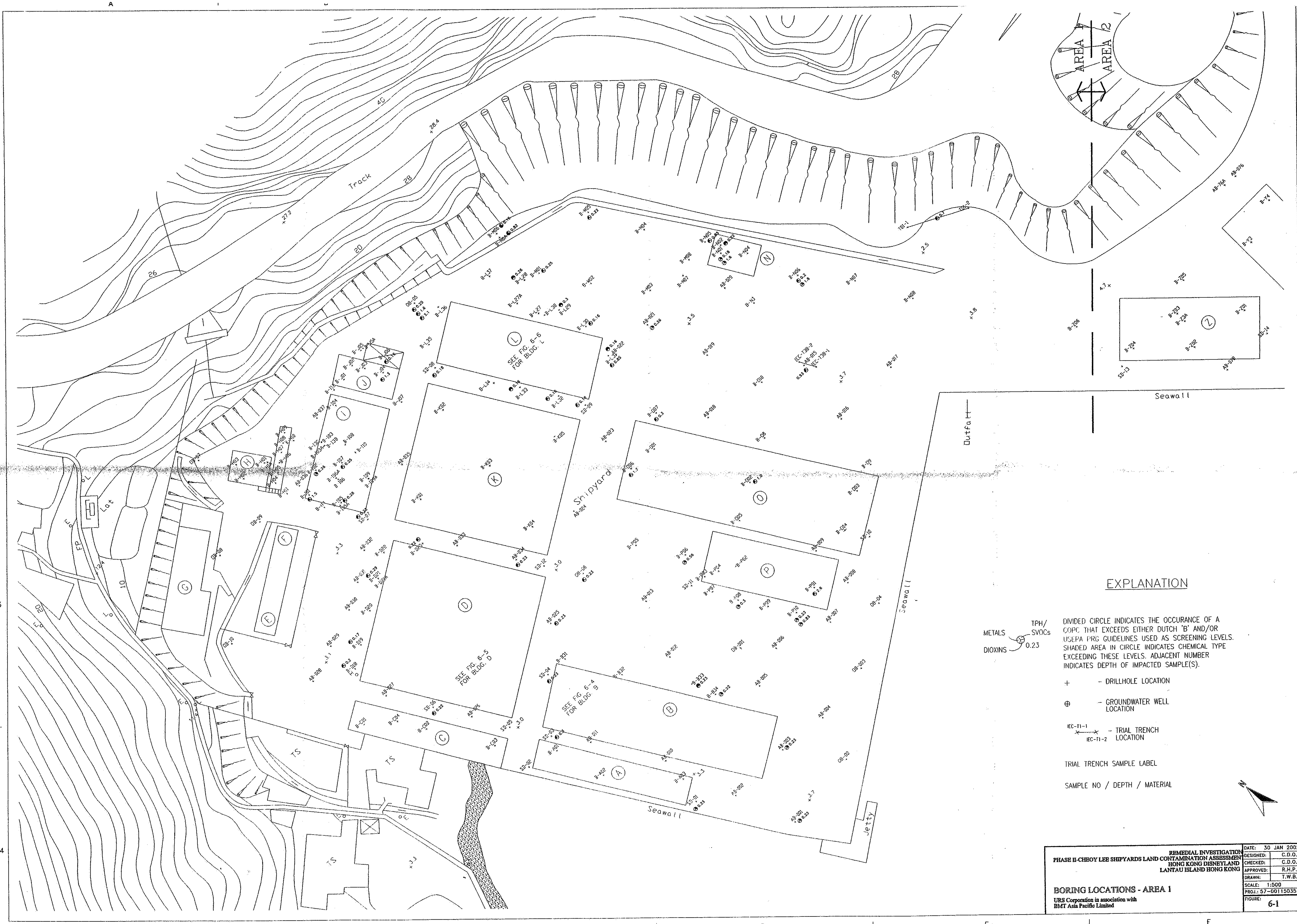


REMEDIAL INVESTIGATION
PHASE II-CHEOY LEE SHIPYARDS LAND CONTAMINATION ASSESSMENT
HONG KONG DISNEYLAND
LANTAU ISLAND HONG KONG

SITE PLAN

URS Corporation in association with
BMT Asia Pacific Limited

DATE:	30 JAN 2002
DESIGNED:	C.O.
CHECKED:	C.O.
APPROVED:	R.P.
DRAWN:	M.H.
SCALE:	1:1200
PROJ.:	57-00115035.01
FIGURE:	2-2



EXPLANATION

METALS, TPH/SVOCs, DIOXINS, 0.23

DIVIDED CIRCLE INDICATES THE OCCURANCE OF A COPC THAT EXCEEDS EITHER DUTCH 'B' AND/OR USEPA PRG GUIDELINES USED AS SCREENING LEVELS. SHADED AREA IN CIRCLE INDICATES CHEMICAL TYPE EXCEEDING THESE LEVELS. ADJACENT NUMBER INDICATES DEPTH OF IMPACTED SAMPLE(S).

+ - DRILLHOLE LOCATION

⊕ - GROUNDWATER WELL LOCATION

IEC-T1-1 / IEC-T1-2 - TRIAL TRENCH LOCATION

TRIAL TRENCH SAMPLE LABEL

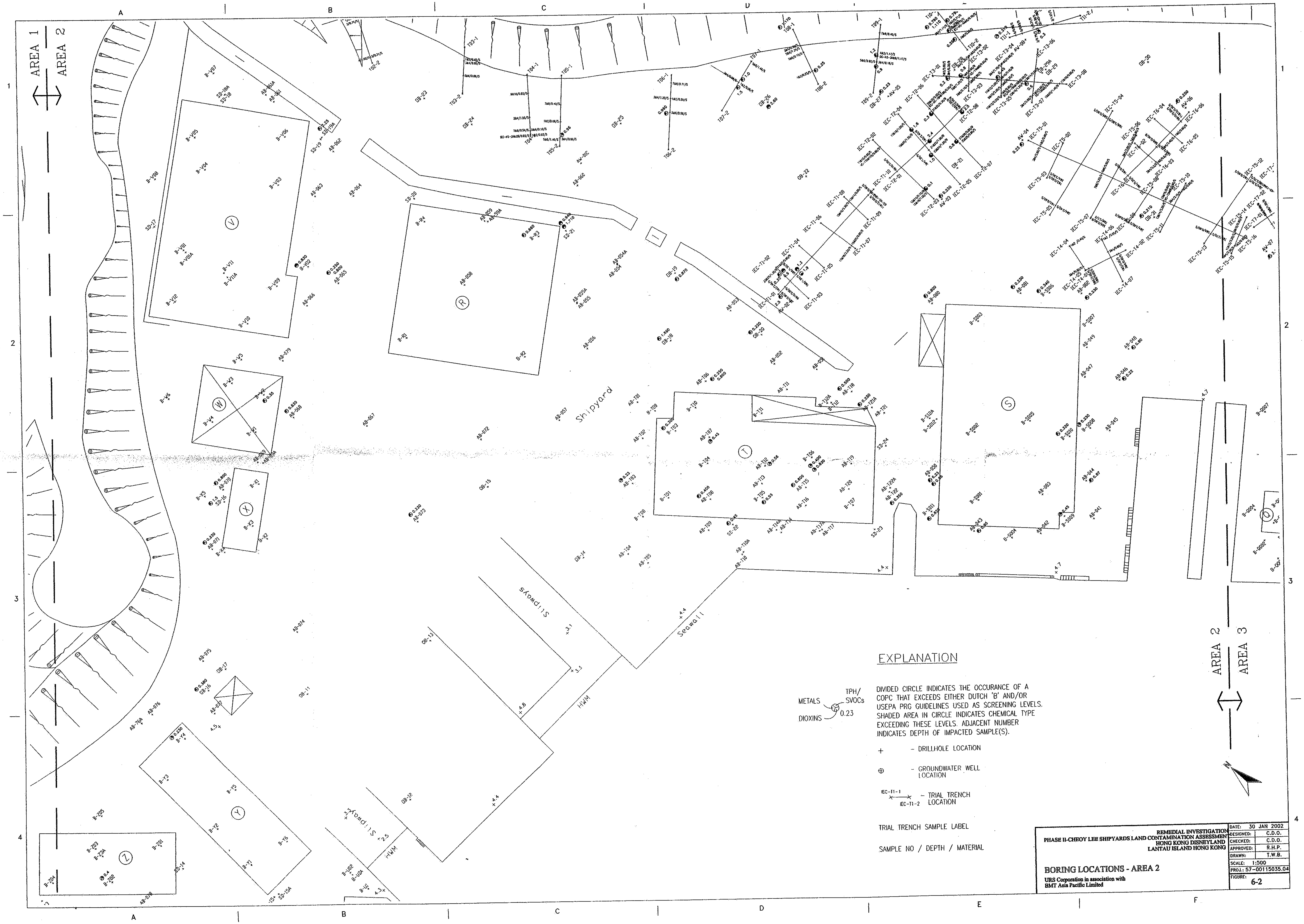
SAMPLE NO / DEPTH / MATERIAL

PHASE II-CHEOY LEE SHIPYARDS LAND CONTAMINATION ASSESSMENT REMEDIAL INVESTIGATION
HONG KONG DISNEYLAND
LANTAU ISLAND HONG KONG

BORING LOCATIONS - AREA 1

URS Corporation in association with BMT Asia Pacific Limited

DATE:	30 JAN 2002
DESIGNED:	C.D.O.
CHECKED:	C.D.O.
APPROVED:	R.H.P.
DRAWN:	T.W.B.
SCALE:	1:500
PROJ.:	57-00115035.04
FIGURE:	6-1



REMEDIAL INVESTIGATION
PHASE II-CHEOY LEE SHIPYARDS LAND CONTAMINATION ASSESSMENT
HONG KONG DISNEYLAND
LANTAU ISLAND HONG KONG

BORING LOCATIONS - AREA 2

URS Corporation in association with
BMT Asia Pacific Limited

DATE:	30 JAN 2002
DESIGNED:	C.D.O.
CHECKED:	C.D.O.
APPROVED:	R.H.P.
DRAWN:	T.W.B.
SCALE:	1:500
PROJ.:	57-00115035.04
FIGURE:	6-2

EXPLANATION

METALS — TPH/SVOCs — DIOXINS — 0.23

DIVIDED CIRCLE INDICATES THE OCCURANCE OF A COPC THAT EXCEEDS EITHER DUTCH 'B' AND/OR USEPA PRG GUIDELINES USED AS SCREENING LEVELS. SHADED AREA IN CIRCLE INDICATES CHEMICAL TYPE EXCEEDING THESE LEVELS. ADJACENT NUMBER INDICATES DEPTH OF IMPACTED SAMPLE(S).

\+ – DRILLHOLE LOCATION

⊕ – GROUNDWATER WELL LOCATION

IEC-T1-1 / IEC-T1-2 – TRIAL TRENCH LOCATION

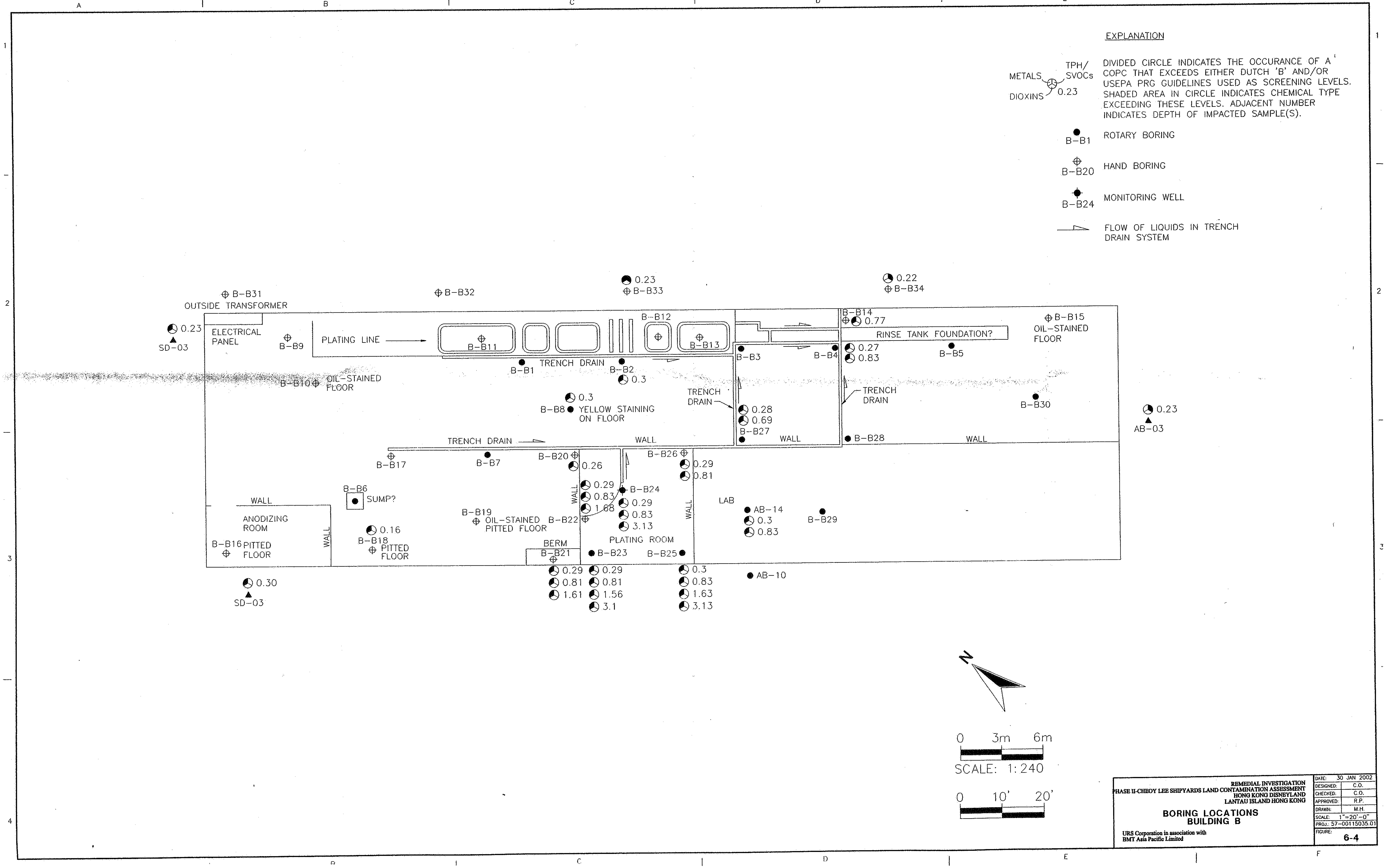
TRIAL TRENCH SAMPLE LABEL
SAMPLE NO / DEPTH / MATERIAL

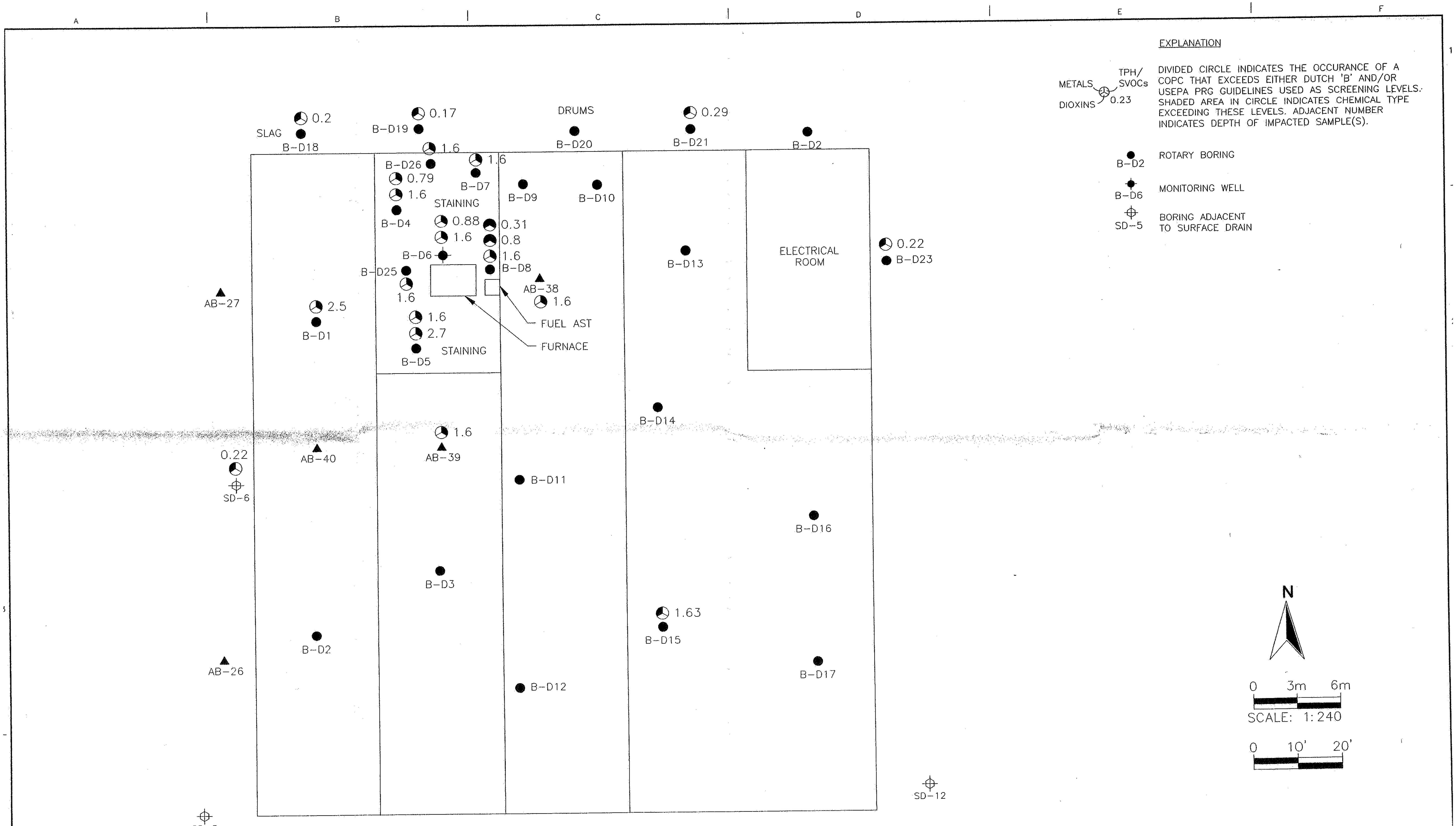
DATE:	30 JAN 2002
DESIGNED:	C.D.O.
CHECKED:	C.D.O.
APPROVED:	R.H.P.
DRAWN:	T.W.B.
SCALE:	1:500
PROJ.:	57-00115035.04
FIGURE:	6-3

REMEDIAL INVESTIGATION
PHASE II-CHEOY LEE SHIPYARDS LAND CONTAMINATION ASSESSMENT
HONG KONG DISNEYLAND
LANTAU ISLAND HONG KONG

BORING LOCATIONS - AREA 3

URS Corporation in association with
BMT Asia Pacific Limited


EXPLANATION
METALS
TPH/ SVOCs
DIOXINS
0.23
DIVIDED CIRCLE INDICATES THE OCCURANCE OF A COPC THAT EXCEEDS EITHER DUTCH 'B' AND/OR USEPA PRG GUIDELINES USED AS SCREENING LEVELS. SHADED AREA IN CIRCLE INDICATES CHEMICAL TYPE EXCEEDING THESE LEVELS. ADJACENT NUMBER INDICATES DEPTH OF IMPACTED SAMPLE(S).
B-B1 ROTARY BORING
B-B20 HAND BORING
B-B24 MONITORING WELL
FLOW OF LIQUIDS IN TRENCH DRAIN SYSTEM
B-B31
OUTSIDE TRANSFORMER
B-B32
0.23
B-B33
0.22
B-B34
0.23
SD-03
ELECTRICAL PANEL
B-B9
PLATING LINE
B-B11
B-B12
B-B13
B-B14
0.77
RINSE TANK FOUNDATION?
B-B15
OIL-STAINED FLOOR
TRENCH DRAIN
B-B1
B-B2
0.3
B-B3
B-B4
0.27
0.83
B-B5
B-B10
OIL-STAINED FLOOR
0.3
B-B8
YELLOW STAINING ON FLOOR
TRENCH DRAIN
0.28
0.69
B-B27
WALL
TRENCH DRAIN
B-B30
0.23
AB-03
B-B28
WALL
TRENCH DRAIN
WALL
B-B17
B-B7
B-B20
0.26
B-B26
0.29
0.81
B-B6
SUMP?
0.29
0.83
1.68
B-B24
0.29
0.83
3.13
WALL
ANODIZING ROOM
WALL
WALL
WALL
LAB
AB-14
0.3
0.83
B-B29
B-B19
OIL-STAINED PITTED FLOOR
B-B22
0.16
B-B18
PITTED FLOOR
B-B16
PITTED FLOOR
BERM
B-B21
PLATING ROOM
B-B23
B-B25
0.29
0.81
1.61
0.29
0.81
1.56
3.1
0.3
0.83
1.63
3.13
AB-10
0.30
SD-03
N
0 3m 6m
SCALE: 1:240
0 10' 20'
REMEDIAL INVESTIGATION
PHASE II-CHEOY LEE SHIPYARDS LAND CONTAMINATION ASSESSMENT
HONG KONG DISNEYLAND
LANTAU ISLAND HONG KONG
BORING LOCATIONS
BUILDING B
URS Corporation in association with
BMT Asia Pacific Limited
DATE: 30 JAN 2002
DESIGNED: C.O.
CHECKED: C.O.
APPROVED: R.P.
DRAWN: M.H.
SCALE: 1"=20'-0"
PROJ.: 57-00115035.01
FIGURE: 6-4

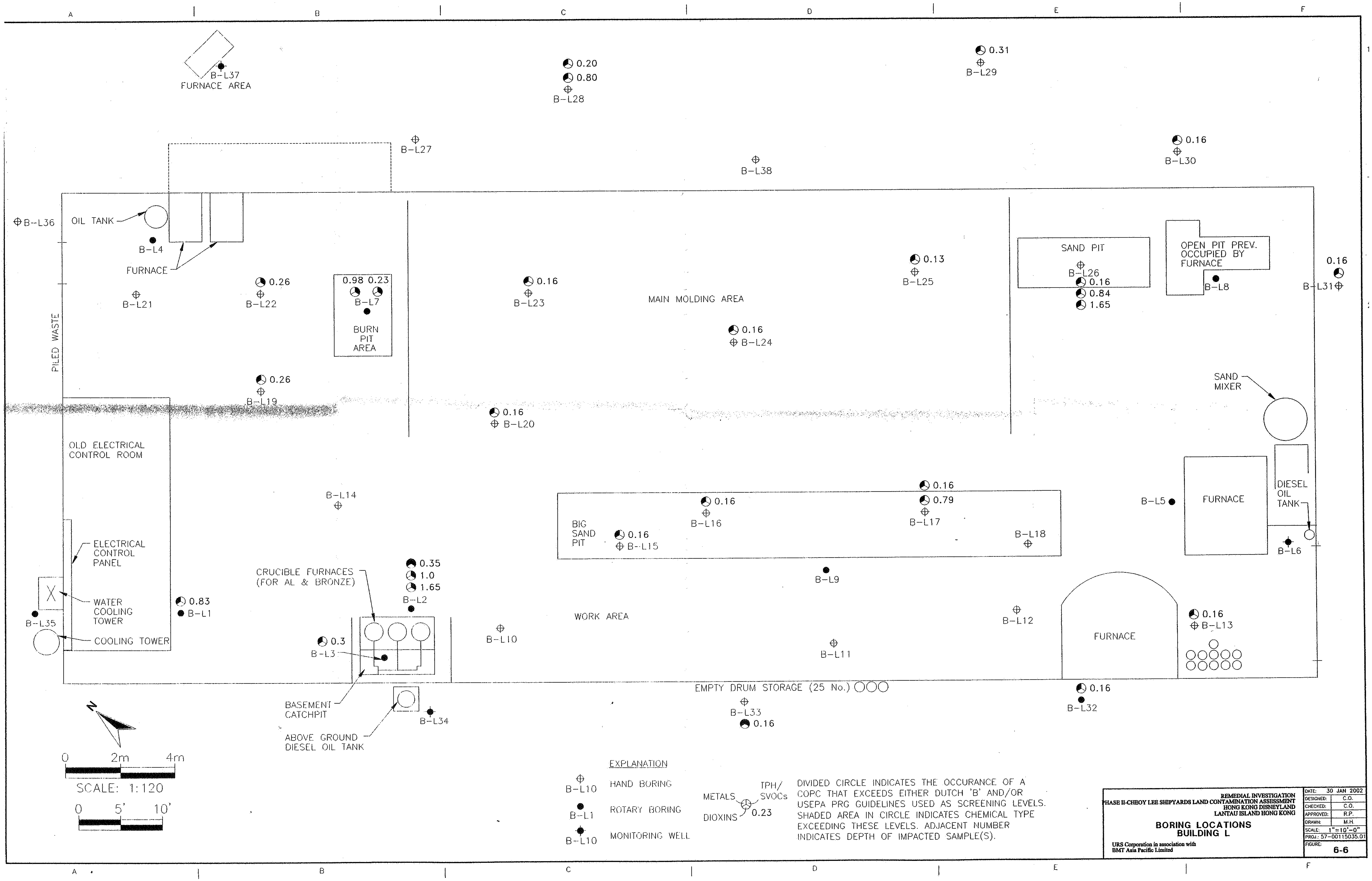


REMEDIAL INVESTIGATION
PHASE II-CHEOY LEE SHIPYARDS LAND CONTAMINATION ASSESSMENT
HONG KONG DISNEYLAND
LANTAU ISLAND HONG KONG

BORING LOCATIONS
BUILDING D

URS Corporation in association with
BMT Asia Pacific Limited

DATE:	30 JAN 2002
DESIGNED:	C.O.
CHECKED:	C.O.
APPROVED:	R.P.
DRAWN:	M.H.
SCALE:	1"=20'-0"
PROJ.:	57-00115035.01
FIGURE:	6-5


A
B
C
D
E
F
B-L37
FURNACE AREA
0.20
0.80
B-L28
0.31
B-L29
B-L27
B-L38
0.16
B-L30
B-L36
OIL TANK
B-L4
FURNACE
0.26
B-L22
B-L21
0.98 0.23
B-L7
BURN PIT AREA
0.16
B-L23
MAIN MOLDING AREA
0.13
B-L25
SAND PIT
B-L26
0.16
0.84
1.65
OPEN PIT PREV. OCCUPIED BY FURNACE
B-L8
0.16
B-L31
PILED WASTE
0.16
B-L24
0.26
B-L19
0.16
B-L20
SAND MIXER
OLD ELECTRICAL CONTROL ROOM
B-L14
0.16
B-L16
0.16
0.79
B-L17
BIG SAND PIT
0.16
B-L15
B-L18
B-L5
FURNACE
DIESEL OIL TANK
B-L6
ELECTRICAL CONTROL PANEL
WATER COOLING TOWER
B-L35
COOLING TOWER
0.83
B-L1
CRUCIBLE FURNACES (FOR AL & BRONZE)
0.35
1.0
1.65
B-L2
0.3
B-L3
B-L10
WORK AREA
B-L9
B-L11
B-L12
FURNACE
0.16
B-L13
EMPTY DRUM STORAGE (25 No.)
B-L33
0.16
0.16
B-L32
BASEMENT CATCHPIT
B-L34
ABOVE GROUND DIESEL OIL TANK
N
0 2m 4m
SCALE: 1:120
0 5' 10'
EXPLANATION
B-L10 HAND BORING
B-L1 ROTARY BORING
B-L10 MONITORING WELL
METALS
TPH/ SVOCs
DIOXINS
0.23
DIVIDED CIRCLE INDICATES THE OCCURANCE OF A COPC THAT EXCEEDS EITHER DUTCH 'B' AND/OR USEPA PRG GUIDELINES USED AS SCREENING LEVELS. SHADED AREA IN CIRCLE INDICATES CHEMICAL TYPE EXCEEDING THESE LEVELS. ADJACENT NUMBER INDICATES DEPTH OF IMPACTED SAMPLE(S).
REMEDIAL INVESTIGATION
PHASE II-CHEOY LEE SHIPYARDS LAND CONTAMINATION ASSESSMENT
HONG KONG DISNEYLAND
LANTAU ISLAND HONG KONG
BORING LOCATIONS
BUILDING L
URS Corporation in association with
BMT Asia Pacific Limited
DATE: 30 JAN 2002
DESIGNED: C.O.
CHECKED: C.O.
APPROVED: R.P.
DRAWN: M.H.
SCALE: 1"=10'-0"
PROJ.: 57-00115035.01
FIGURE: 6-6

EXPLANATION

ESTIMATED DEPTHS FOR EXCAVATION OF IMPACTED SOILS IN METERS

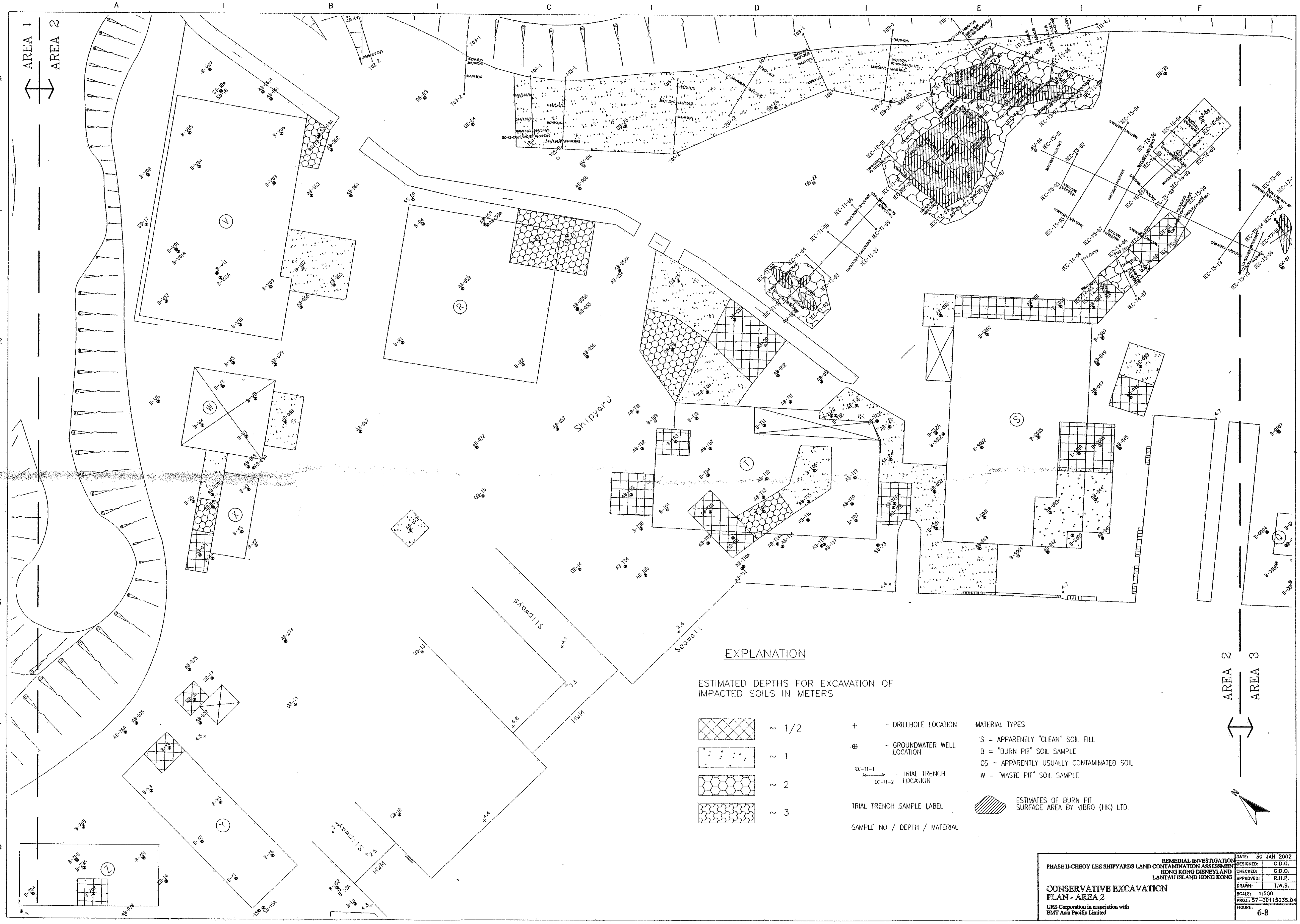
- ~ 1/2
- ~ 1
- ~ 2
- ~ 3

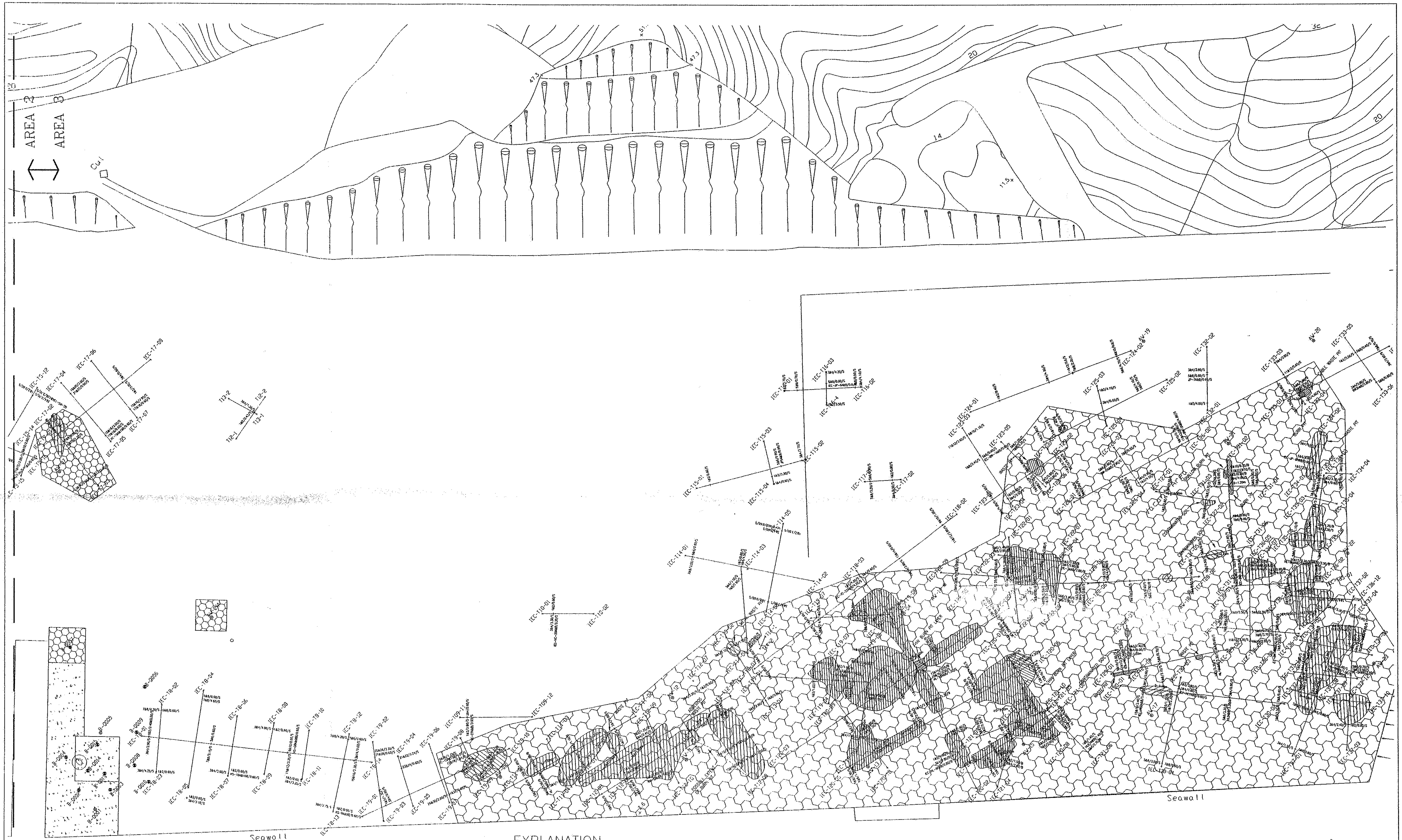
REMEDIAL INVESTIGATION
PHASE II-CHEOY LEE SHIPYARDS LAND CONTAMINATION ASSESSMENT
HONG KONG DISNEYLAND
LANTAU ISLAND HONG KONG

CONSERVATIVE EXCAVATION PLAN - AREA 1

URS Corporation in association with
BMT Asia Pacific Limited

DATE:	30 JAN 2002
DESIGNED:	C.D.O.
CHECKED:	C.D.O.
APPROVED:	R.H.P.
DRAWN:	T.W.B.
SCALE:	1:500
PROJ.:	57-00115035.04
FIGURE:	6-7


AREA 1
AREA 2
AREA 3
Shipyard
Slipways
Seawall
HWM
EXPLANATION
ESTIMATED DEPTHS FOR EXCAVATION OF IMPACTED SOILS IN METERS
~ 1/2
~ 1
~ 2
~ 3
+ - DRILLHOLE LOCATION
- GROUNDWATER WELL LOCATION
IEC-T1-1 IEC-T1-2 - TRIAL TRENCH LOCATION
TRIAL TRENCH SAMPLE LABEL
SAMPLE NO / DEPTH / MATERIAL
MATERIAL TYPES
S = APPARENTLY "CLEAN" SOIL FILL
B = "BURN PIT" SOIL SAMPLE
CS = APPARENTLY USUALLY CONTAMINATED SOIL
W = "WASTE PIT" SOIL SAMPLE
ESTIMATES OF BURN PIT SURFACE AREA BY VIBRO (HK) LTD.
REMEDIAL INVESTIGATION
PHASE II-CHEOY LEE SHIPYARDS LAND CONTAMINATION ASSESSMENT
HONG KONG DISNEYLAND
LANTAU ISLAND HONG KONG
CONSERVATIVE EXCAVATION PLAN - AREA 2
URS Corporation in association with BMT Asia Pacific Limited
DATE: 30 JAN 2002
DESIGNED: C.D.O.
CHECKED: C.D.O.
APPROVED: R.H.P.
DRAWN: T.W.B.
SCALE: 1:500
PROJ.: 57-00115035.04
FIGURE: 6-8



EXPLANATION

ESTIMATED DEPTHS FOR EXCAVATION OF IMPACTED SOILS IN METERS

~ 1/2
~ 1
~ 2
~ 3

+ - DRILLHOLE LOCATION

⊕ - GROUNDWATER WELL LOCATION

IEC-11-1 / IEC-11-2 - TRIAL TRENCH LOCATION

TRIAL TRENCH SAMPLE LABEL

SAMPLE NO / DEPTH / MATERIAL

MATERIAL TYPES OBSERVED IN TRENCHES

S = APPARENTLY "CLEAN" SOIL FILL

B = "BURN PIT" SOIL SAMPLE

CS = APPARENTLY USUALLY CONTAMINATED SOIL

W = "WASTE PIT" SOIL SAMPLE

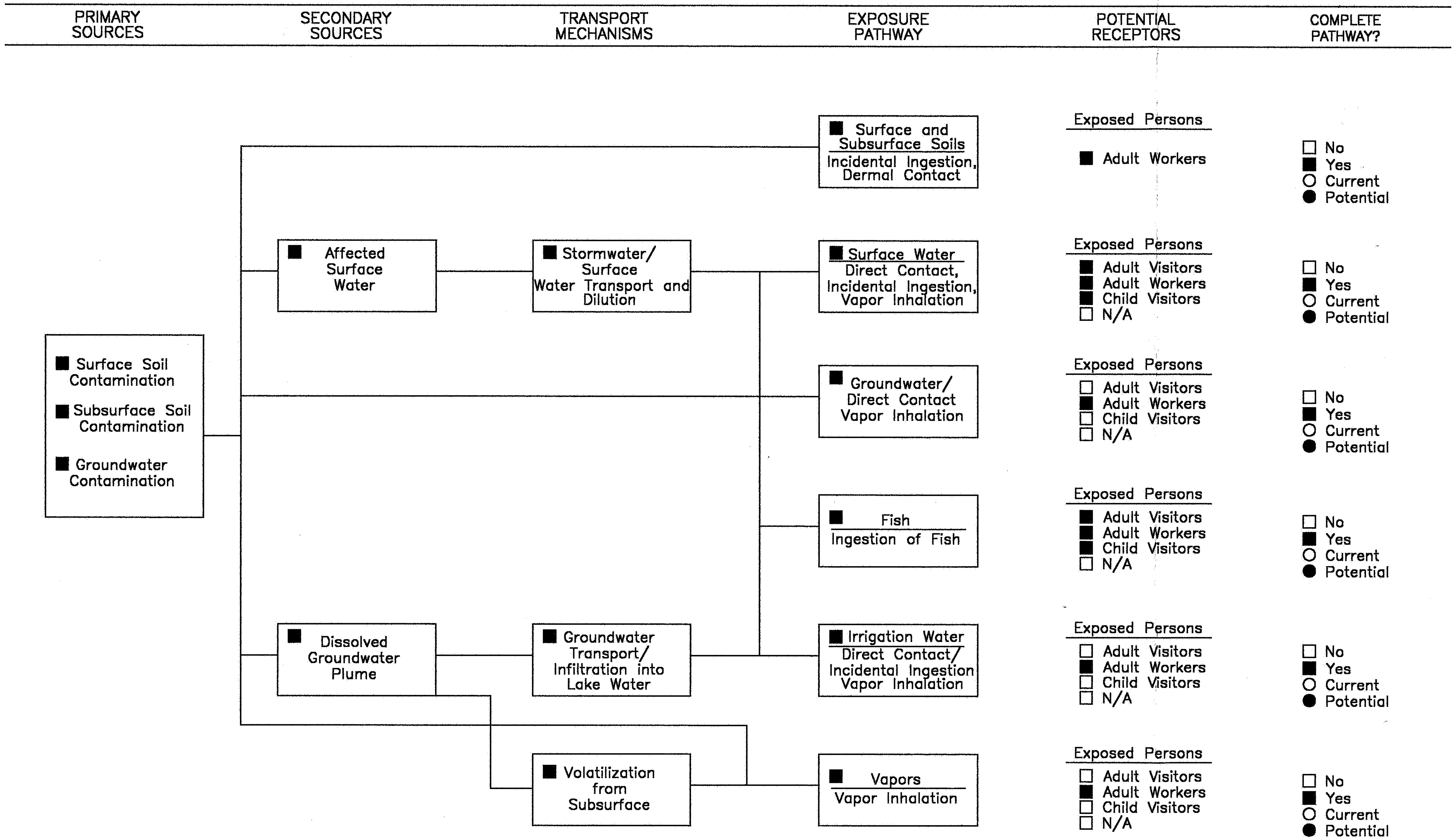
ESTIMATES OF BURN PIT SURFACE AREA VIBRO (KH) LTD.

REMEDIAL INVESTIGATION
PHASE II-CHEOY LEE SHIPYARDS LAND CONTAMINATION ASSESSMENT
HONG KONG DISNEYLAND
LANTAU ISLAND HONG KONG

CONSERVATIVE EXCAVATION PLAN - AREA 3

URS Corporation in association with BMT Asia Pacific Limited

DATE:	30 JAN 2002
DESIGNED:	C.D.O.
CHECKED:	C.D.O.
APPROVED:	R.H.P.
DRAWN:	T.W.B.
SCALE:	1:500
PROJ.:	57-00115035.04
FIGURE:	6-9



REMEDIAL INVESTIGATION
PHASE II CHEOY LEE SHIPYARDS LAND CONTAMINATION ASSESSMENT
HONG KONG DISNEYLAND
LANTAU ISLAND HONG KONG

HUMAN HEALTH CONCEPTUAL SITE MODEL

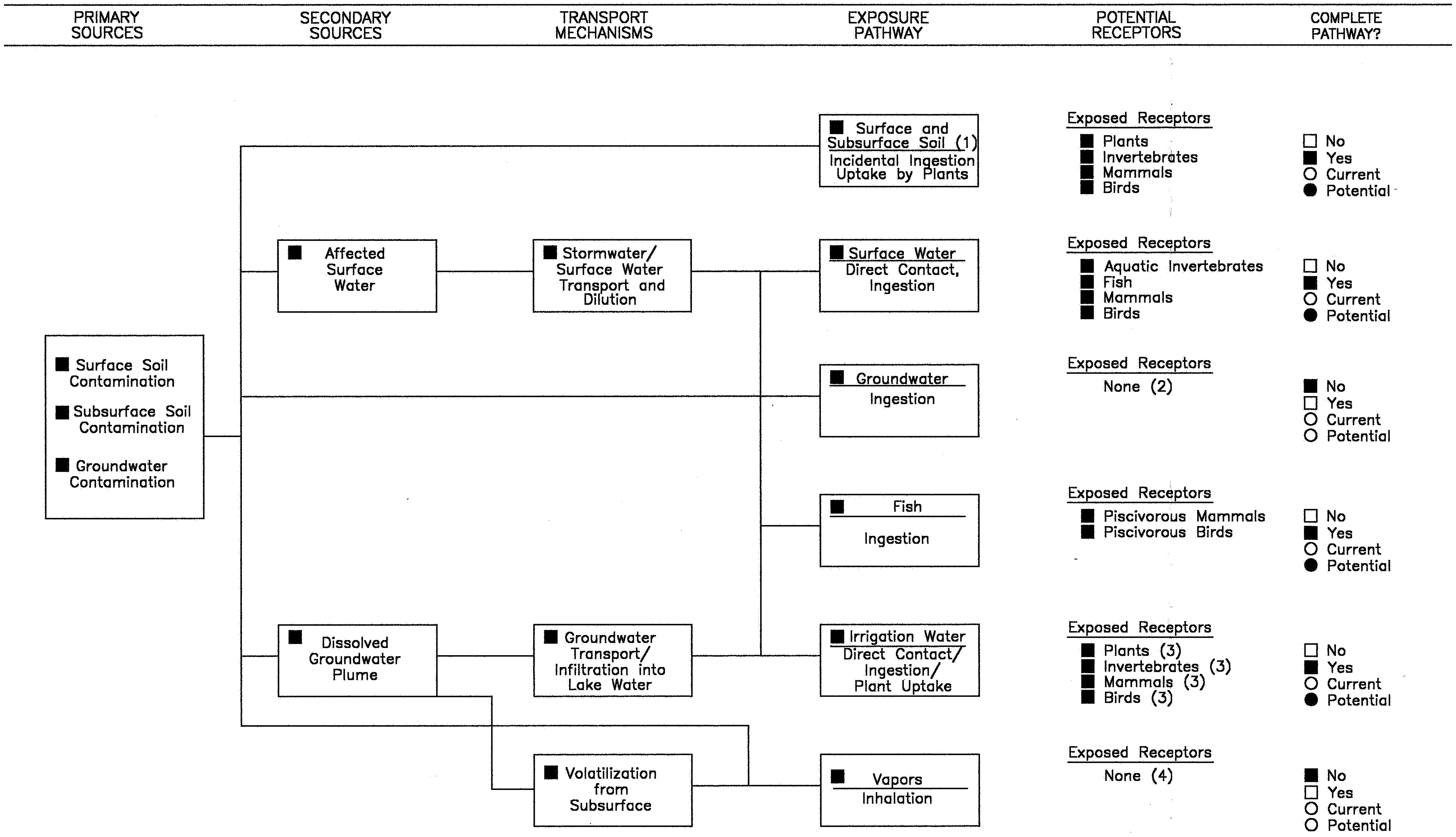
URS Corporation in association with
BMT Asia Pacific Limited

DATE JANUARY 2002

SCALE NONE

FIGURE 7.1

T:\DISNEY\012502-01.dwg 1/25/02 (derived from: S:\Blanc\Disney\Figure9.dwg &
G:\128\DISNEY HONG KONG\PHASE II\WORKPLAN\CAD DWGS\FIGURE 9.DWG APRIL 2001)



(1) Exposure to surface (<2 meters) soil only.
(2) No exposure of ecological receptors to groundwater.
(3) Exposure primarily through plant uptake and plant tissue ingestion.
(4) Exposure of ecological receptors to subsurface vapors not expected to be significant.

REMEDIAL INVESTIGATION
PHASE II CHEOY LEE SHIPYARDS LAND CONTAMINATION ASSESSMENT
HONG KONG DISNEYLAND
LANTAU ISLAND HONG KONG

ECOLOGICAL CONCEPTUAL SITE MODEL

URS Corporation in association with
BMT Asia Pacific Limited

DATE JANUARY 2002
SCALE NONE
FIGURE 7.2

T:\DISNEY\012502-01.dwg 1/29/02 (derived from: S:\Blanc\Disney\Figure9.dwg &
G:\128\DISNEY HONG KONG\PHASE II\WORKPLAN\CAD DWGS\FIGURE 9.DWG APRIL 2001)