Sampling, Analytical and Quality Plan

One Rail

Berrimah Terminal

Table of Contents

1 INTRODUCTION

Greencap Pty Ltd (Greencap) has prepared this Sampling, Analytical and Quality Plan (SAQP) for additional assessment works to be undertaken at and relating to Berrimah Freight Terminal, Export Drive, Berrimah Northern Territory (NT) (the Site). The location of the site is presented in Figure 1.

Source: Google Earth

Figure 1. Site Location

The proposed environmental investigations presented in this document are intended to satisfy the requirements of the appointed Site Contamination Auditor, Mr Graeme Miller, with the aim of addressing data gaps to:

- Inform the understanding of the nature and extent of contamination; and
- Develop and implement and appropriate remedial / management strategy; and
- Allow completion of the audit program.

2 SITE DETAILS

2.1 Site Identification

A site summary is provided in Table 1.

Table 1: Site Summary

Details	Description
Street Address	Export Drive, Berrimah NT
Certificate of Title	Volume 757 Folio 262; and Volume 754 Folio 416
Parcel Reference	NT Portions 5411; and 5641, Hundred of Bagot
Plan	S2000/1912B; and S2003/163
Zoning	Zoned as Railway under the NT Planning Scheme
Local Government Authority	Darwin City

2.2 Current Land Use of the Site

The site is used as a freight rail terminal and consists of four railway lines (Main Line, 1 Road, Auxiliary Road and Ramp Road) all generally running east-west, an asphalt sealed container pad used for the loading and transfer of freight to and from heavy rail, locomotive/car maintenance sheds at the east end of the Site and an office building and gatehouse to the south on Export Drive.

2.3 Geology and Hydrogeology

The geological and hydrogeological setting is detailed in the Detailed Site Investigation[1].

2.4 Background

Spill Event

A diesel spill occurred on the 1 Road rail line, to the north of the office building and spread under the Auxiliary Road and Ramp Road rail lines to the south, and along an unlined vee-drain to the west where a temporary interception sump was excavated and used to recover some of the diesel. The vee-drain continues west past the recovery/interception sump and a second vee drain exists to the south of the spill site, approximately 20 metres to the south of the Ramp Road at its closest point. Directly to the north of the spill site is the asphalt lined container pad, further afield is the edge of the intertidal mangrove community located downgradient of the spill site, approximately 40 metres away. The rail lines are covered by ballast material (very coarse gravel and cobbles) which is also present on the surface between the rail lines. South of the Ramp Road is a cover of unsealed fine crushed rock/gravel material. A figure presenting the spill location is presented in Figure 2.

---

[1] Greencap. J168829 Detailed Site Investigation Report – One Rail Berrimah Freight Terminal, Export Drive, Berrimah NT. April 2021.

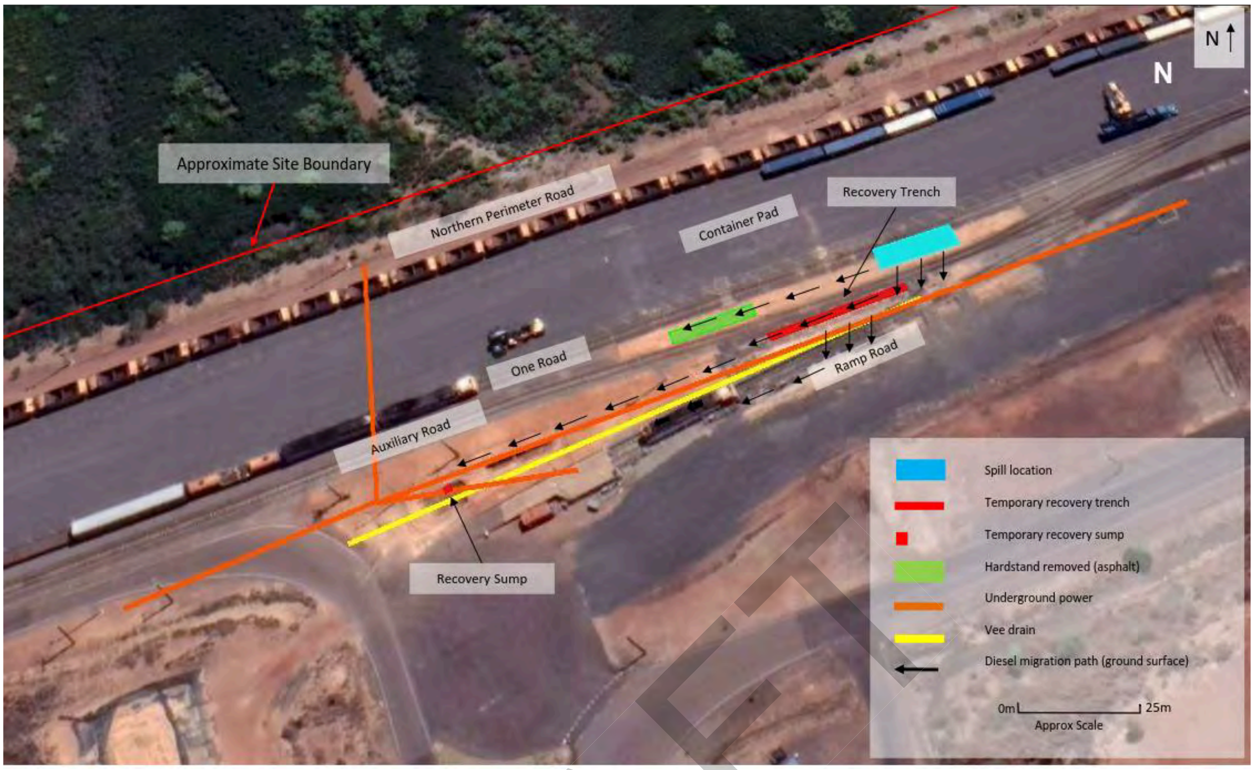


Figure 2. Spill Location

Summary of Works Completed

- Excavation of 38 test pits, drilling for soil bores at 17 locations, non-destructive test pitting at 10 locations, collection of 178 surface soil validation samples and subsequent soil sampling and laboratory analysis of soil samples;
- Installation and sampling of 11 groundwater monitoring wells; and
- Preparation of DSI report.

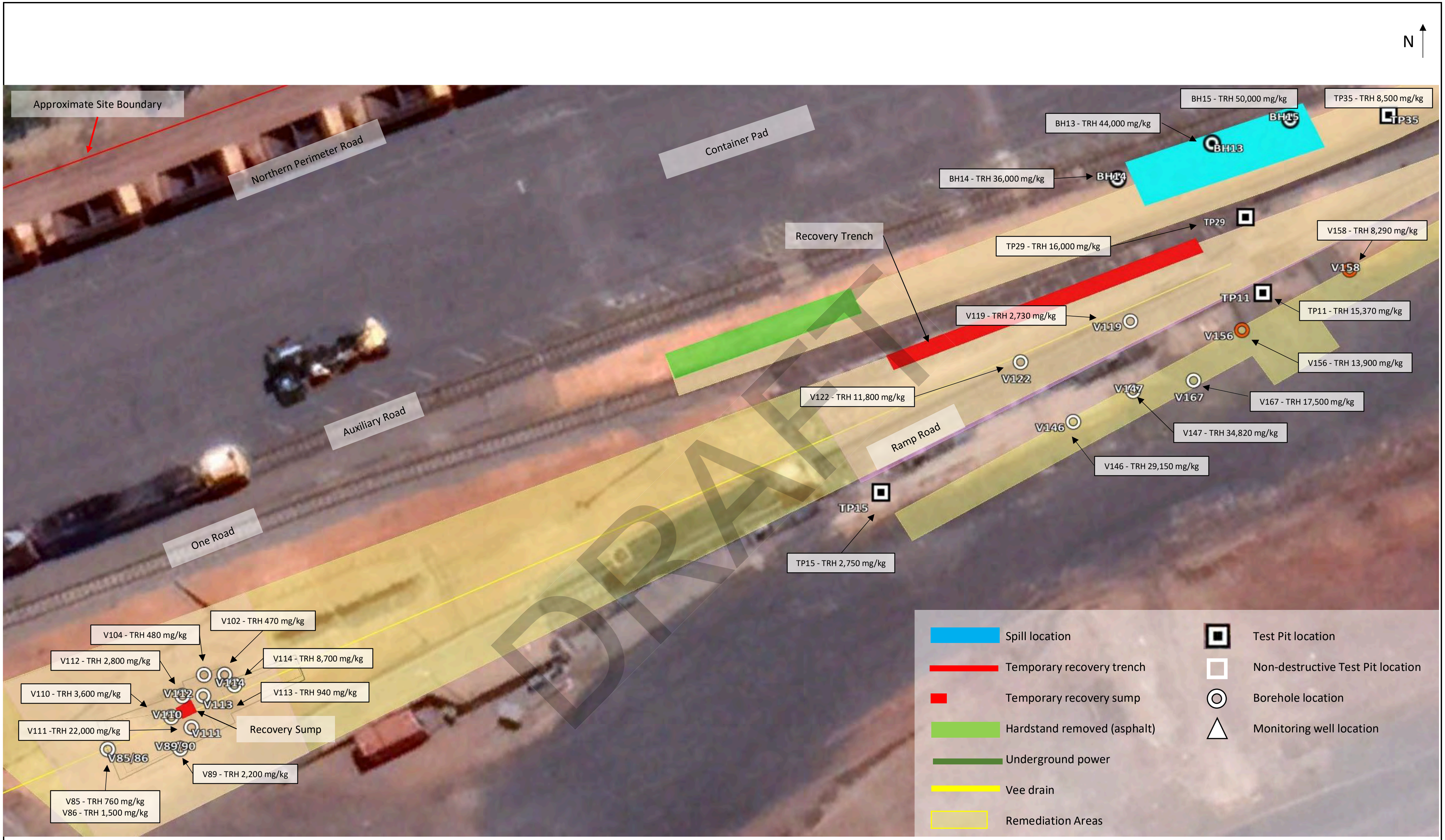
Soil Investigation Summary

Significant diesel impacts occurred to soils along the drainage line between and below the Auxiliary Road and Ramp Road rail lines. The spill migrated from the original location on the 1 Road rail line into sub-ballast materials and south into the unsealed ground between the 1 Road and Auxiliary Road rail lines. Diesel then migrated west between the rail lines and south over and under the Auxiliary Road rail lines where it collected in the Vee drain towards the road culvert approximately 100 m to the west at which point a temporary sump was excavated to halt flow and recover spilled diesel. To a lesser degree diesel also migrated beneath the Ramp Road rail line. Subsurface impacts, typically with the surface 0.5 m were observed throughout these areas.

Diesel-impacted soils were excavated to the extents practicable with the majority of validation results indicating successful removal of impacted materials. Final and validation analytical results confirmed residual hydrocarbon impacts in soil remain present:

- Beneath the 1 Road, Auxiliary Road and Ramp Road rail lines, presenting either a risk to human health (if encountered) and/or to down-gradient ecological receptors (if mobile). These impacts also present a potential light non-aqueous phase liquid (LNAPL)-related hazard.
- Within the deeper soils at the groundwater interface (typically at the western end of the Vee drain) that present a risk to down-gradient ecological receptors (if mobile).

The locations of the residual impacts are presented in Figure 3.



Project: SAQP

Location: Export Drive, Berrimah NT

Job Ref: J168829
Drawn: VB
Checked: DB
Date: 25/03/21
Scale: As shown
Source: Google Earth

FIGURE 3

Residual Impacts
(TRH C_{10}-C_{40})

GREENCAP
Going Further in Managing Risk
Unit 11/14 Winnellie Rd
Winnellie NT 0820
Telephone (08) 8879 1300

A mass balance calculation estimated approximately 18,000 L of diesel had been recovered either directly as free phase product or within spoil excavated during remedial activities. The calculation indicated approximately 2,000 L of diesel remains in situ within at the spill site.

Leachate analytical results indicated that in situ TRH is potentially partially mobile, thereby requiring ongoing monitoring of impact to groundwater and potential leaching in surface water and sediment run-off.

The impacted-soil stockpile is currently considered classified as Restricted Solid Waste as per NSW EPA (2014) and is subject to the development of a remediation management plan (in progress, under separate cover).

LNAPL

The presence of LNAPL was identified in one groundwater monitoring well (MW01). Based on the investigation results it was interpreted that LNAPL has limited mobility which is to be further monitored.

Groundwater Investigation

The presence of hydrocarbon impacts in groundwater was reported in two of eleven groundwater monitoring wells installed. The reported petroleum hydrocarbons were mainly represented by heavier fractions (>C_{10} to C_{40}) which are typical of diesel fuel. The groundwater sampling results and the presence of LNAPL in MW01 indicates that the diesel fuel from the spill area has generally moved subsurface in a north-westerly direction towards the intertidal mangrove community and is consistent with the soil investigation results.

The groundwater impacts are likely associated with the ongoing secondary source of hydrocarbon impacts in groundwater.

Potential Receptors and Exposure Pathways

Human and ecological receptors that could potentially be exposed to contamination at the diesel spill site may include:

- Onsite workers.
- Onsite intrusive maintenance workers
- Site visitors and contractors who may be spending some amount of time onsite.
- Potential offsite recreational users (within mangrove fringe).
- Potential groundwater users.
- Potential environmental receptor of the intertidal mangrove community and the Darwin Harbour.

2.5 Data Gaps to be Addressed

Following the completion of the Auditor's review of the DSI and supporting material, a number of data gaps have been identified. The gaps and proposed actions to address these are detailed in Table 2.

Table 2: Data Gaps and Actions

Item	Auditor Comment	Action
Nature of Contamination		
1	a. Testing of soil and groundwater samples appears have been limited to BTEXN and TPH. b. The BTEX component of diesel is only about 1% (CRC Care Tech report 10 – Table C3), with the virtually all of aromatic compounds being PAHs (21.8%). c. Phenols are also known to be present in diesel fuels.	Collect 5 x representative samples from ex-situ diesel-impacted stockpile to be analysed for: - TRH - BTEXN - PAH - Phenols See Section 4.2.

Item	Auditor Comment	Action
	d. Accordingly, the extent of contamination as it relates to PAHs and phenols has not been assessed.	
Extent of Contamination		
	a. Soil:	
2	i. A large number of the samples were collected soon after the spill during investigation and remediation work.	N/A.
	ii. The extent of soil contamination appears to have been delineated as it relates to TRH and BTEXN – noting that:	
3	- PAHs and phenols were not tested.	See Item 1.
4	- A significant mass of TRH remains in soil (concentrations are generally below the commercial and industrial land use guidelines but may form an ongoing source of groundwater contamination).	See Item 9.
	iii. There is the potential for contamination in soil to have migrated beyond the sampled area – particularly given:	
5	- The samples collected at and immediately down gradient of the spill were completed immediately after the spill.	Data to be rescreened to include additional criteria as per Sections 4.2.3 and 4.2.4. Also see Items 9 – 11 re: assessment of potential migration into groundwater and or via sediment loss.
6	- There is evidence of later stage migration of the fuel in the subsurface.	
7	iv. Sampling under the temporary location of the stockpile of excavated contaminated soils is yet to be completed – and therefore the presence and extent of contamination in this area is not known.	Captured in Remediation Management Plan (under separate cover).
8	v. Remediation of the excavated material has not been completed.	Ongoing – captured in Remediation Management Plan (under separate cover).
	b. Groundwater:	
9	i. A significant mass of hydrocarbons remains in soil (>20,000 mg/kg C_{10} – C_{34} TRH) at and surrounding the spill area and to a lesser extent near the collection sump – which may form an going source of groundwater contamination.	To be addressed via modelling, see Section 4.3.
10	ii. There are no monitoring wells located directly down hydraulic gradient of the spill area (i.e. northeast of MW06) and other areas where significant residual contamination remains (between MW05 and MW06).	To be addressed via installation and sampling of additional monitoring wells, see Sections 4.3 and 4.4.

Item	Auditor Comment	Action
11	iii. The potential for contaminated groundwater to migrate towards (and impact upon) the down gradient receptor in the future requires assessment.	To be addressed via installation and sampling of additional monitoring wells and modelling, see Item 10.

3 DATA QUALITY OBJECTIVES

The following sections provide an overview of the data quality objectives (DQO) used to define the type, quantity and quality of data needed to make decisions relating to the environmental conditions of a site. The process for developing the project specific DQOs is described in the following sections.

3.1 State the Problem

A diesel spill at the site resulted in contamination to both soil and groundwater underlying the site. Significant assessment and remediation works have been completed to date, a number of data gaps remain and are to be addressed to enable a Site Contamination Audit Report to be prepared. The data gaps are presented in Table 2 and addressed in Section 4.

3.2 Identify the Decision

In considering the nature of the spill event, are there any chemicals and / or substances present that pose an unacceptable risk to human health and / or the environment?

3.3 Identify Inputs to the Decision

Results from all previous assessment works are to be considered in conjunction with the re-screening of existing data against additional screening criteria (see Sections 4.2.3 and 4.3.3).

Additional sampling is based on discussions held between ORA and the Auditor following review of works completed to date. Additional sampling of soil and groundwater will be conducted to further assess the environmental condition of the site and surrounds. If soil or groundwater soil vapour screening levels are exceeded or indicators of unacceptable soil vapour contaminant concentrations are identified soil vapour sampling may be undertaken if required to determine whether an unacceptable risk exists.

The additional investigation program will use targeted soil sampling locations (stockpiled impacted material) and groundwater wells to characterise conditions across the site.

All environmental data will be compared to relevant screening criteria (as outlined in Section 4). If the additional sampling results and/or re-screening results present a risk posed by potential post-remediation expansion of diesel impact resulting from the spill, additional delineation sampling is to be considered.

3.4 Define the Study Boundaries

With reference to Appendix B of the ASC NEPM Schedule B (2), to define the boundaries of the study area, the spatial and temporal aspects of the environmental media need to be defined, as follows:

- The greater site has a total area of approximately 19 hectares. The subject site in which the spill occurred is restricted to an area as described in Section 2.4 and presented in Figure 3.
- The spatial extent of the soil investigation is spill extent as described in Section 2.4 and Figure 2.
- The spatial extent of the groundwater investigation is bound by:
    - North – mangrove fringe along Northern Perimeter Road
    - East – Ramp Road / Auxiliary Road junction
    - South – Ramp Road
    - West – Access Road and culvert
- Temporal boundaries of the investigation are limited by occurrence of the spill event.

Figure 3. Investigation Site Boundaries

3.5 Develop a Decision Rule

If soil, groundwater or modelling data indicate the presence of site contamination that is determined to pose an unacceptable risk to the environment or human health then further remediation and / or management of those areas may need to be established with respect to ongoing protection of the receiving environment.

3.6 Specify Limits on Decision Errors

Data quality indicators (DQIs) of completeness, comparability, representativeness, precision, and accuracy as presented in the NEPM are to be used to evaluate data acceptability. Decision error limits that the data will satisfy the DQIs and subsequent decisions of site suitability as acceptable when it is in fact not compliant would be 5% (i.e., tolerable limits of 95% confidence).

If statistical analysis is undertaken, it will be assessed with consideration to the limits outlined in Schedule B7 of the NEPM.

3.7 Optimise the Design for Obtaining Data

The soil investigation program is outlined in detail in Section 4.2 and includes: -

- Collection of diesel-impacted stockpiled soil to assess for the presence of PAH and phenolic compounds in the contaminated material.
- Re-screening of all soil data against additional screening criteria, see Section 4.2.3.

The groundwater sampling program is outlined in detail in Section 4.3 and includes: -

- Installing three new monitoring wells to further assess groundwater condition adjacent the spill location and leaving the site.
- Undertaking a gauging round of all onsite wells.
- Sampling of all onsite monitoring wells.

The groundwater modelling is to investigate the likelihood of the in situ residual contamination migrating offsite. Further detail is presented in Section 4.4.

4 PROPOSED SCOPE OF WORK

The works will be conducted with reference to industry standards and guidelines including, but not limited to: -

- National Environment Protection (Assessment of Site Contamination) Measure 1999 (as amended 2013) (National Environmental Protection Council, 2013).
- Australian Standard AS4482.1 – 2005 (Guide to the Investigation and Sampling of Potentially Contaminated Soil) (Standards Australia, 2005).
- Northern Territory Environment Protection Authority (2017). Contaminated Land Guideline.

4.1 Environment, Health and Safety

Site safety is of paramount concern, and the work described for the various stages of the investigation will be conducted in accordance with this SAQP. Accredited service locators will be engaged to check the proposed investigation locations for underground services prior to the commencement of environmental assessment works to ensure the safe placement of investigation locations. This will include obtaining “dial before you dig” service plans.

The fieldwork will be supervised by an experienced environmental consultant, who will be responsible for logging of the soils encountered, recording any signs of contamination, and collecting the required soil and groundwater and samples.

4.2 Soil Investigation

4.2.1 Soil Sampling Rationale and Methodology

The proposed soil investigation comprises the collection of diesel impacted soil to assess for the presence of polycyclic aromatic hydrocarbons (PAH) and phenols: -

- Five samples of impacted material will be collected from the stockpiled diesel-impacted material. Samples will be collected to ensure the most-impacted materials are selected to ensure they are indicative of the spill-impacted materials.
- All samples will be collected from stockpiles onsite. The representative samples will be collected from within the stockpile (i.e. surface material will be removed prior to sampling) and materials be logged by an experienced environmental consultant.
- The sampler will wear a clean pair of nitrile disposable gloves to collect samples. Hand equipment (when used, i.e. hand trowels, etc.) is to be decontaminated using phosphate free detergent, followed by rinsing in clean tap water and a final rinse in deionised water.
- Field screening will also be conducted for volatile compounds using a photo-ionisation detector (PID) with a 10.6 eV ultraviolet lamp.
- Soil samples will be stored in a chilled portable esky and transported to the analytical laboratory with chain of custody documentation. All laboratories used will be accredited with the National Association of Testing Authorities (NATA).
- Quality Assurance / Quality Control (QA/QC) sampling will comprise intra and inter-laboratory duplicates samples collected at a frequency of one each for every 20 primary samples collected, one rinsate blank per day of sampling and one trip blank per batch of samples.

Following the processing of results and re-screening of all data against additional data, further consideration is to be made in addressing any additional risk/migration that may require further assessment.

4.2.2 Soil Analysis

The soil testing will focus on the compounds identified Table 2, Item 1. Analysis will also include TRH to ensure the materials tested are diesel-impacted.

Quality Assurance / Quality Control (QA / QC) sampling and analysis will comprise an intra and inter-laboratory duplicate (TRH, BTEXN, PAH and Phenols), one rinsate blank (TRH) and one trip blank (BTEXN). The frequency of duplicate and triplicate sampling and analysis will be one for every 20 primary samples retrieved.

4.2.3 Soil and Soil Vapour Assessment Criteria

The selected soil assessment criteria are as follows:

- NEPM 2013 Table 1A(1) Health Investigation Levels (HILs) (D) for Soil Contaminants – Commercial/Industrial land use.
- NEPM 2013 Table 1A(3) Health Screening Levels (HSLs) (D) for Vapour Intrusion – Commercial/Industrial land use.
- NEPM 2013 Table 1B(6) Ecological Screening Levels (ESLs)/Ecological Investigation Levels (EILs) – Commercial/Industrial land use.
- NEPM 2013 Table 1B(7) Management Limits (MLs) – Commercial/Industrial land use.
- CRC Care (2011) Health Screening Levels for direct contact (commercial / industrial and maintenance intrusive worker scenarios).

Screening levels are applied based on the soil type encountered and the depth of sample, where relevant. The investigation exposure settings for coarse soils (sands) were adopted based on the excavations results.

4.2.4 Later Stage Subsurface Contamination Migration

Following the rescreening of data as per Section 4.2.3, a review will be undertaken to assess the significance of any in situ impacts exceeding one or more relevant guidelines. If data suggests a risk of later stage migration exists, the nature of any further assessment is to be considered and agreed. This may include:

- Ongoing groundwater monitoring to assess any potential increase in groundwater impacts that may be associated with the secondary source (i.e. in situ impacts).
- Sediment sampling to assess for any migration of in situ impacted material into the stormwater drainage network.
- Delineation/verification soil bores/pits if warranted.

4.3 Groundwater Investigation

4.3.1 Groundwater Investigation and Well Installation Rationale

The aim of the groundwater investigation is to determine whether any groundwater conditions are present which may pose a risk to the site occupants and/or receiving environment. The proposed groundwater investigation comprises the following works to provide further site-specific information: -

- The installation of three new wells onsite (MW09 to MW11). The proposed locations are shown on **Figure 4**.
- The sampling and analysis of groundwater from all onsite monitoring wells (MW01 to MW11).

The rationale for the locations of the proposed new groundwater monitoring wells is as follows:

- MW09 and MW10 – additional downgradient monitoring wells along the mangrove fringe to assess potential migration of contamination offsite.
- MW11 – immediately adjacent spill location.

The new groundwater monitoring wells will be drilled using solid flight auger drilling techniques and installed, developed, and surveyed as follows: -

- Drill to a depth of approximately two metres below water strike (target depth 5 mbgl) and install with a 3-3.5 metre length of slotted PVC screen at the base of the well, and solid PVC to the surface.
- Install sand pack around the screen extending 0.5 metres above the top of the screen.
- Install bentonite plug above the sand pack to prevent infiltration of rainfall.
- Grout to surface and install lockable gatic cover concreted in place level with the ground surface.
- Following installation, development of the groundwater wells will remove excess silt / entrained sediments to ensure representative groundwater is flowing into the well.
- A licensed surveyor will survey the groundwater wells to the Australian Height Datum to enable an assessment of the inferred groundwater flow direction across the site.

Legend

- 🟥 Site boundary
- ⊕ Existing Groundwater Monitoring Well
- ✕ Proposed Groundwater Monitoring Well

Date Data Collected: 30 Oct 2020
Source: Background Photomap courtesy of nearmap

Client:
One Rail Australia
Client No.
C105292
Project:
Diesel Spill Targeted Site Contamination Investigation
Job No.
J168829

Title:
Groundwater Monitoring Plan
Address:
Berrimah Freight Terminal - Export Drive, Berrimah NT
Groundwater Monitoring Well Locations

Approximate Scale
0 20 m

Drawn:	PM:	Date:	File Name:	Figure No.
AS	DB	09/12/2021	J168829 GW Plan	4

GREENCAP
Level 1
677 High Street
Kew East, VIC 3102
P: (03) 9896 8600
F: (03) 9896 8600
www.greencap.com.au

4.3.2 Groundwater Sampling Methodology

A round of sampling and analysis will be completed for the monitoring well network in December 2021. The proposed sampling methodology is as follows: -

- Undertake gauging of groundwater levels in all groundwater monitoring wells prior to sampling. Measure standing water levels and any separate phase (free) product present in the well from the top of the casing.
- Conduct groundwater sampling using low flow sampling techniques. Groundwater drawdown will be monitored continually during purging and sampling using a water level meter to ensure low-flow conditions are met. If drawdown cannot be maintained, either the well will be purged to the top of the screen and then sampled, or sampling will be undertaken using dedicated bailers.
- Monitor water quality parameters (pH, temperature, conductivity, oxidation-reduction potential and dissolved oxygen) during purging using a water quality meter. Sampling will occur when these parameters have shown to stabilise. Stabilisation will be considered after three successive readings of at least three parameters as follows: -
    - electrical conductivity to within 5%.
    - pH ± 0.1 unit.
    - temperature to within 0.2 degrees.
    - dissolved oxygen to within 10%; and
    - redox ± 10mV.
- The sampler will wear a clean pair of nitrile disposable gloves to collect each sample in containers provided by the analytical laboratory.
- Samples will be submitted to a NATA accredited laboratory for analyses for pH, TDS, TRH, BTEXN, PAH, phenols and MNA parameters.
- QA/QC sampling and analysis will comprise an intra-laboratory (blind) and an inter-laboratory (split) duplicate groundwater sample (for the compounds as listed above), one rinsate blank (TRH, BTEXN) and one trip blank (BTEXN).
    - The rinsate sample is to be collected from reusable sampling equipment following decontamination.
    - The trip blank(s) is to accompany samples from collected to receipt at the testing laboratory.

4.3.3 Groundwater Assessment Criteria

The selected groundwater assessment criteria as follows:

- NEPM 2013 Table 1A(4) Health Screening Levels (HSLs) (D) for Vapour Intrusion – Commercial/Industrial land use, 2m to <4m.
- NEPM 2013 Table 1C Groundwater Investigation Levels (GILs) – Marine Waters.
- NHMRC 2008 Guidelines for Managing Risks in Recreational Water.
- California Water Boards (2019) – San Francisco Bay Regional Water ESLs.
- WHO (2008) – Drinking Water Values.

Screening levels are applied based on the soil type encountered and the depth of sample, where relevant. The investigation exposure settings for coarse soils (sands) were adopted based on the excavations results.

4.4 Groundwater Modelling

Predictive groundwater modelling will be undertaken using BIOSCREEN decision support system software developed by US EPA. The software is programmed in Microsoft Excel and is based on the Domenico analytical solute transport model. The program has the ability to simulate advection, dispersion, adsorption, and aerobic decay as well as anaerobic reactions that have been shown to be the dominant biodegradation processes at many petroleum release sites.

BIOSCREEN uses an analytical solute transport model with two options for simulating in-situ biodegradation: first-order decay and instantaneous reaction. The model will predict the maximum extent of plume migration, which may then be compared to the distance to potential points of exposure (e.g. drinking water wells, groundwater discharge areas, or property boundaries).

Initially, no decay or biodegradation of hydrocarbons in groundwater will be simulated to utilise the most conservative scenario. If the results show a potential for the identified receptors to be impacted the model will utilise conservative hydrocarbon degradation/retardation parameters to assess risk further.

4.5 Quality Assurance / Quality Control

QA/QC measures for all intrusive investigations include:

- Appropriate sample labelling, storage, and transport under chain of custody procedures.
- Collection and analysis of field QA/QC samples (duplicates and blanks).
- Conducting laboratory analyses within appropriate holding times.
- Use of laboratories that hold NATA accreditation for the analyses undertaken.
- Ensuring the sampling equipment (WQM and PID) are calibrated before use.
- Analysis of laboratory QA/QC samples including duplicates, blanks, matrix spikes, matrix spike duplicates, and surrogates.

Internal measures of laboratory quality assurance quality control are:

- Accuracy (measured by laboratory spike and surrogate recovery samples) within 70% - 130% recovery.
- Precision (measured by duplicate sample analysis) within 30% relative percentage difference (RPD).
- Minimum 95% completeness (measured by total number of analyses within acceptable limits).

4.6 Reporting

On completion of all investigation works, an Addendum report will be prepared detailing the additional works completed as presented above. The addendum report is to be appended to the Detailed Site Investigation (DSI).

The addendum report will include spatial and temporal trend assessments, a conceptual site model (CSM) and will reassessment of the significance of the results regarding continued future site use as a rail terminal and potential risk to the nearest sensitive receptor (i.e. the mangrove community to the north of the site). If necessary, the report will include recommendations for further works i.e., further assessment or remediation works.

The findings of the assessment will be summarised to both the client and the appointed Site Contamination Auditor prior to reporting to gain agreement on the potential requirement for any additional works if required.

4.7 Project Team

Table 3: Project Team

Team Role	Company	Team Member	Contact Details
Client	One Rail Australia	Adam Reed, Environment Manager	Adam.reed@1rail.com.au
Project Director / Technical Review	Greencap	Dylan Burford, Practice Manager – Environment SA/NT/WA	Dylan.burford@greencap.com.au
Technical Lead	Greencap	Alex Sereda, Senior Principal – Hydrogeology	Alex.sereda@greencap.com.au
Project Manager(s)	Greencap	Dylan Burford, Practice Manager – Environment SA/NT/WA Varun Bhagwat, Environmental Consultant – NT	Dylan.burford@greencap.com.au Varun.bhagwat@greencap.com.au
Field Engineer(s)	Greencap	Varun Bhagwat, Environmental Consultant – NT	Varun.bhagwat@greencap.com.au
Site Contamination Auditor	Senversa	Graeme Miller, Senior Principal / Contaminated Site Auditor	Graeme.miller@senversa.com.au

11/14 Winnellie Road
Winnellie NT 0820

DETAILED SITE INVESTIGATION REPORT - ADDENDUM

March 2023
J168829

AURIZON

Berrimah Freight Terminal
Export Drive, Berrimah NT

C105292 : **VB**

Document Control

<table>
<tr><th colspan="3">Document Quality Management Details</th></tr>
<tr><td>Report Name:</td><td colspan="2">Diesel Spill – Detailed Ste Investigation Addendum</td></tr>
<tr><td>Site Details:</td><td colspan="2">Berrimah Freight Terminal – Export Drive, Berrimah NT</td></tr>
<tr><td>Project Number:</td><td colspan="2">J168829-06</td></tr>
<tr><td>Client Name:</td><td colspan="2">Aurizon</td></tr>
<tr><td>Client Number:</td><td colspan="2">C105292</td></tr>
<tr><td rowspan="2">Signatures:</td><td>Prepared By:
Varun Bhagwat
Environmental Consultant</td><td>Reviewed By:
Dean Noske (CEnvP SC)
Principal Environmental Scientist</td></tr>
<tr><td>Prepared By:
Alex Sereda
Principal Hydrogeologist</td><td>Authorised By:
Dylan Burford
Practice Manager – Environment SA/NT/WA</td></tr>
</table>

Issue Status

Version No.	Status	Date	Creator	Reviewer
1.1	Draft	30/06/22	Varun Bhagwat / Alex Sereda	Dean Noske
1.2	Draft	16/12/22	Varun Bhagwat / Alex Sereda	Dean Noske
1	Final	23/02/23	Varun Bhagwat / Alex Sereda	Dean Noske
2	Final	21/03/23	Varun Bhagwat / Alex Sereda	Dean Noske

Document Circulation

No of Copies	Type	Position & Company
1	Electronic	Haydn Franklin – Principal Adviser Environment, Aurizon Graeme Miller – Senversa

Diesel Spill – Detailed Site Investigation Addendum

Aurizon

Berrimah Freight Terminal – Export Drive, Berrimah NT

Table of Contents

1 INTRODUCTION

Greencap Pty Ltd (Greencap) was commissioned by Aurizon (formerly One Rail Australia) to undertake additional works following the submission and Auditor review of the Detailed Site Investigation (DSI) and remediation and validation works following a diesel spill on the One Road rail line located at the Berrimah Freight Terminal, Export Drive, Berrimah Northern Territory (NT) (the Site).

The addendum report should be read in conjunction with the DSI[1] report dated April 2021.

1.1 Background

A diesel spill estimated at approximately 20,000 litres (L) occurred on the site during automatic refueling of a diesel locomotive on 30 May 2020. Upon discovery, temporary controls were immediately implemented by ORA, including:

- Excavation of a temporary sump downslope of the spill;
- Recovery of surface diesel with the use of a vacuum truck; and
- Placement of absorbent materials in the downstream drain to the southwest of the spill to contain any surface flow.

ORA notified the Northern Territory Environment Protection Authority (NT EPA) shortly thereafter who attended the Site on Saturday 30 May 2020 to inspect the spill. As a result, the NT EPA issued an Authorised Officer Direction (AOD) on 1 June 2020, directing ORA to:

> *"Immediately prevent pollution and environmental harm resulting from the spill. By the method of preventing all spilled liquids (including diesel/hydrocarbons) from contaminating soils, surface waters or ground waters."*

Subsequent to receiving this AOD, ORA undertook further spill clean-up works concurrently with investigation works documented in this DSI, including the following:

- Removal of soils impacted by diesel from stormwater spoon drain to the southwest of the spill site;
- Removal of soils impacted by diesel within and surrounding the vicinity of the rail line infrastructure; and
- Relocation of impacted spoil to a temporary lined (heavy duty plastic sheeting) bunded area on an elevated pad.

The NT EPA issued a second AOD on 4 June 2020, directing ORA to:

> 1) *To immediately manage waste on or in land by:*
>
>   a. *Undertaking sufficient surface water, groundwater and soil analysis to be able to determine the types, amount, distribution and mobility of contaminants in the environment as a result of the diesel spill that occurred at the premises on 30 May 2020; and*
>
>   b. *By 5 June 2020, determine and implement suitable actions to manage and start to recover waste in the land that have resulted from the diesel spill that occurred at the premises on 30 May 2020; and*
>
>   c. *Undertake daily inspections and sufficient monitoring to detect any pollution or impact to the surrounding environment as a result of the diesel spill, including but not limited to the identified Significant Biodiversity Area located adjacent to the spill location.*

---

[1] Detailed Site Investigation Report. One Rail Australia, Berrimah Freight Terminal, Export Drive, Berrimah NT. April 2021. Greencap Reference: J168829

The NT EPA issued a Notice to Carry Out Environmental Audit Program to One Rail Australia on 7 July 2021 *to evaluate:*

> i. *the types, amount, distribution and mobility of contaminants and wastes present in the environment resulting from "the incident" as defined in Reason 4 of Attachment "A"; and*
>
> ii. *the extents to which actions are required to be taken, or results required to be achieved, for waste management or the prevention, reduction, control, rectification or clean-up of pollution or environmental harm resulting from poluution have been taken or achieved as a result of the incident.*

The NT EPA issued a third AOD on 12 February 2021 in relation to management of stockpiled impacted material.

ORA engaged Greencap to assist with the diesel spill investigations and assessments to minimise risks to the human health and environment. The results of the site investigation and assessment undertaken by Greencap to date are presented in the aforementioned DSI report together with a summary of remediation work conducted to date and future remediation works to be undertaken.

ORA engaged an accredited Site Contamination Auditor, Mr Graeme Miller of Senversa to undertake the audit.

The DSI has been reviewed by the appointed Site Contamination Auditor, Mr Graeme Miller of Senversa. Following the Auditor review, a Sampling, Analytical and Quality Plan (SAQP)[2] was prepared and endorsed by the Auditor.

1.2 Objective

The objective of the DSI addendum report is to address data gaps in the DSI as per the Auditor comments detailed in the SAQP and comments provided via emails as follows:

- Email re: nature and extent of contamination – 13/04/22;
- Email re: nature and extent of contamination – 04/05/22; and
- Email re: groundwater modelling input parameters – 16/05/22.

---

[2] Sampling, Analytical and Quality Plan. One Rail Australia, Berrimah Terminal. February 2022. Greencap Reference: J168829

2 SCOPE OF WORK

The scope of additional works was addressed in the SAQP and is reproduced in Table 1. Further Auditor queries received via email are also included in Table 1.

Table 1: DSI Data Gaps and Actions

Item	Auditor Comment	Corrective Action / Comments	Addendum Report Section
DSI Review – Nature of Contamination			
1	a. Testing of soil and groundwater samples appears have been limited to BTEXN and TPH. b. The BTEX component of diesel is only about 1% (CRC Care Tech report 10 – Table C3), with the virtually all of aromatic compounds being PAHs (21.8%). c. Phenols are also known to be present in diesel fuels. d. Accordingly, the extent of contamination as it relates to PAHs and phenols has not been assessed.	Collect 5 x representative samples from ex-situ diesel-impacted stockpile to be analysed for: - TRH - BTEXN - PAH - Phenols Include PAH and Phenols in groundwater analytical suite in December 2021 GME.	Soil - Sections 3.1 and 3.3 Groundwater – Sections 3.2, 3.3.2 and Appendix C
DSI Review – Extent of Contamination			
	a. Soil:		
2	i. A large number of the samples were collected soon after the spill during investigation and remediation work.	N/A.	-
3	ii. The extent of soil contamination appears to have been delineated as it relates to TRH and BTEXN – noting that: - PAHs and phenols were not tested.	See Item 1.	Section 3.3.1
4	- A significant mass of TRH remains in soil (concentrations are generally below the commercial and industrial land use guidelines but may form an ongoing source of groundwater contamination).	See Item 9.	-
5	iii. There is the potential for contamination in soil to have migrated beyond the sampled area – particularly given: - The samples collected at and immediately down gradient of the spill were completed immediately after the spill.	Data rescreened to include additional criteria as per *Sections 4.2.3* and *4.3.3* of the SAQP. See Items 9 – 11 re: assessment of potential migration into groundwater and or via sediment loss.	Sections 4.1 and 4.2
6	- There is evidence of later stage migration of the fuel in the subsurface.		Section 5

Item	Auditor Comment	Corrective Action / Comments	Addendum Report Section
7	iv. Sampling under the temporary location of the stockpile of excavated contaminated soils is yet to be completed – and therefore the presence and extent of contamination in this area is not known.	Captured in Remediation Management Plan (under separate cover).	N/A
8	v. Remediation of the excavated material has not been completed.	Ongoing – captured in Remediation Management Plan (under separate cover).	N/A
	b. Groundwater:		
9	i. A significant mass of hydrocarbons remains in soil (>20,000 mg/kg C_{10} – C_{34} TRH) at and surrounding the spill area and to a lesser extent near the collection sump – which may form an ongoing source of groundwater contamination.	To be addressed via modelling.	Section 5
10	ii. There are no monitoring wells located directly down hydraulic gradient of the spill area (i.e. northeast of MW06) and other areas where significant residual contamination remains (between MW05 and MW06).	To be addressed via installation and sampling of additional monitoring wells.	Appendix C
11	iii. The potential for contaminated groundwater to migrate towards (and impact upon) the down gradient receptor in the future requires assessment.	To be addressed via installation and sampling of additional monitoring wells and modelling.	Section 5 and Appendix C

3 NATURE OF CONTAMINATION

3.1 Soil Investigation

The soil investigation comprised the collection of representative soil samples from the diesel-impacted material to assess for the presence of polycyclic aromatic hydrocarbons (PAHs) and phenols.

3.1.1 Methodology

The soil sampling methodology was as follows:

- Five representative soil samples (BP01 – BP05) were collected from the stockpiled diesel-contaminated soil. Samples were collected of the most obviously (visually and olfactorily) contaminated soil encountered within the stockpile to ensure sample results were inclusive of the likely higher hydrocarbon concentrations, and more adversely spill-impacted materials. Field records are attached in Appendix A.
- All samples were collected from stockpiles onsite, sourced from the remedial works conducted following the spill. The representative samples were collected from within the central portion of the stockpile (i.e. surface 300mm of material was removed prior to sampling) and materials were logged by an experienced Greencap environmental consultant.
- The sampler wore a clean pair of nitrile disposable gloves during the sampling process. Hand equipment (when used, i.e. hand trowel etc.) was decontaminated using phosphate free detergent, followed by rinsing in clean tap water and a final rinse in deionised water prior to the collection of each sample.
- Field screening was conducted for volatile compounds using a photo-ionisation detector (PID) with a 10.6 eV ultraviolet lamp. The PID was calibrated at the commencement of each day. The PID was calibrated by taking an ambient air only reading using a carbon filter for the zero reading and by using a gas bottle containing a mixture of air and standard gas of 100 ppm isobutylene. A copy of the calibration certificate is attached in Appendix A.
- Soil samples were placed within clean, laboratory supplied, pre labeled glass jars which were stored in a chilled portable cooler and transported to the analytical laboratory with chain of custody documentation. All laboratories used are accredited with the National Association of Testing Authorities (NATA).
- Quality Assurance / Quality Control (QA/QC) sampling complying with the requirements of Australian Standard (AS4482.1 – 2005)[3] comprised the collection of one intra and inter-laboratory duplicate sample, one rinsate blank (RB01) and one trip blank TB01) for the batch of samples.

3.1.2 Soil Analytical Program

The soil testing was focused on analysis for PAHs and phenols. Analysis also included TRH and BTEXN to ensure the materials tested were representative of the diesel spill-impacted material.

Quality Assurance / Quality Control (QA / QC) sampling and analysis comprised an intra (primary) and inter (secondary)-laboratory duplicate (TRH, BTEXN, PAH and Phenols), one rinsate blank (TRH) and one trip blank (BTEXN).

3.1.3 Soil Assessment Criteria

Refer to Section 4.1.1.

---

[3] AS 4482.1-2005 Guide to the investigation and sampling of sites with potentially contaminated soil Non-volatile and semi-volatile compounds, Part 1

3.2 Groundwater Investigation

The aim of the groundwater investigation was to determine whether any groundwater conditions were present which may pose a risk to the site occupants and/or the receiving environment. The proposed groundwater investigation comprised the following works to provide further site-specific information:

- The installation of three new monitoring wells onsite (MW09 to MW11). The locations of which are shown on Figure 7 in Section 5.1.

The sampling and analysis of groundwater from all existing onsite monitoring wells (MW01 to MW11) with the inclusion of PAH and phenols in the analytical suite.

The rationale for the locations of the new groundwater monitoring wells is as follows:

- MW09 and MW10 – additional downgradient monitoring wells along the mangrove fringe to assess potential migration of contamination offsite.
- MW11 – immediately adjacent (north of) spill location.

The new groundwater monitoring wells were drilled using solid flight auger drilling techniques and installed, developed, and surveyed as follows: -

- Drilled to a depth of approximately 2 m below water strike (target depth 5 mbgl) and installed with a 3-3.5 m length of slotted PVC screen at the base of the well and solid PVC to the surface.
- Installed sand pack around the screen extending 0.5 m above the top of the screen.
- Installed bentonite plug above the sand pack to prevent infiltration of rainfall/stormwater.
- Grouted to surface and installed lockable gatic cover concreted in place level with the ground surface.
- Following installation, development of the groundwater wells was undertaken to remove excess silt / entrained sediments to ensure representative groundwater was flowing into the well.

A licensed surveyor surveyed the groundwater wells to the Australian Height Datum (AHD) to enable an assessment of the inferred groundwater flow direction across the site. The aforementioned methodology for the installation and surveying of the new wells are consistent with those specified within the GME report (refer Appendix C).

3.2.1 Groundwater Sampling Methodology

A round of sampling and analysis was completed for the monitoring well network in December 2021. The sampling methodology implemented for the works was as follows: -

- Conducted gauging of groundwater levels in all groundwater monitoring wells prior to sampling. Measured standing water levels and any separate phase (free) product present in the well from the top of the casing. Measurements were recorded to the nearest 1mm using a calibrated interface probe.
- Conducted groundwater sampling using low flow sampling techniques. Groundwater drawdown was monitored continually during purging and sampling using a calibrated water level meter to ensure low-flow conditions were met. If drawdown was not maintained, the well was sampled using dedicated bailers. One well (MW01A) was sampled using a bailer and the other wells were sampled using low flow techniques.
- Monitored water quality parameters (pH, temperature, conductivity, oxidation-reduction potential and dissolved oxygen) were monitored during purging using a water quality meter. Sampling occurred when these parameters were deemed to have stabilised. Stabilisation was considered to have occurred after three successive readings of at least three parameters as follows: -
    - electrical conductivity to within 5%.
    - pH ± 0.1 unit.
    - temperature to within 0.2 degrees.

  - dissolved oxygen to within 10%; and
  - redox ± 10mV.
- The sampler wore a clean pair of nitrile disposable gloves during the sampling process.
- Samples were collected in clean, pre-labeled sample containers provided by the analytical laboratory.
- Groundwater samples were stored in a chilled portable cooler and transported to the analytical laboratory under industry standard chain of custody documentation. All laboratories used for analysis were accredited with the National Association of Testing Authorities (NATA).
- Quality Assurance / Quality Control (QA/QC) sampling comprised the collection of one intra and inter-laboratory duplicate samples collected, one rinsate blank and one trip blank for the batch of samples. Refer to GME report included as Appendix C for further details.

3.2.2 Groundwater Analytical Program

The groundwater analytical program comprised the analysis of all groundwater samples for pH, TDS, TRH, BTEXN, PAHs, phenols and MNA parameters.

3.2.3 Groundwater Assessment Criteria

Refer to Section 4.1.2.

3.3 Additional Investigation Results

3.3.1 Diesel-impacted Soil Stockpiles

The soils encountered in the stockpiles consisted predominantly of brown silty sand with gravel inclusions. A strong hydrocarbon odour was noted but no staining was observed. The PID results for the five samples collected are as follows:

- BP01 - 17.9 ppm
- BP02 - 37.3 ppm
- BP03 - 61.4 ppm
- BP04 - 12.8 ppm
- BP05 - 29.6 ppm

Field records and PID calibration records are attached in Appendix A.

The five soil samples collected were analysed for TRH, BTEXN, PAHs and phenols. The results are summarised below:

- **TRH/BTEX**
  - BP01 reported concentrations of 340 mg/kg for the TRH fraction C_{10}-C_{16} without naphthalene (F2) which is above the NEPM ESLs for commercial/industrial use (170 mg/kg).
  - BP02 reported concentrations for the TRH fractions F2 (3,600 mg/kg) and C_{16}-C_{34} (8,700 mg/kg) which is above the NEPM management limit for commercial/industrial use (3,500 mg/kg) and above ESLs for commercial/industrial use.
  - BP03 reported concentrations for the TRH fractions F2 (730 mg/kg) and C_{16}-C_{34} (2,200 mg/kg) which are above the NEPM ESLs for commercial/industrial use.
  - BP05 reported concentrations for the TRH fractions F2 (530 mg/kg) and C_{16-34} (1,800 mg/kg) which are above the NEPM ESLs for commercial/industrial use.
  - Though TRH impacts were reported for BP04, the reported concentrations were below the adopted criteria.

  - No elevated BTEXN results were reported.
  - The hydrocarbon impacts reported are considered indicative of the diesel-impacted material and therefore suitable for PAH/phenol analysis.
- **PAH/Phenols**
  - All five soil samples reported concentrations of 0.6 mg/kg for the PAH, benzo(a)pyrene (medium bound) and 1.2 mg/kg (upper bound). The HIL criterion for commercial/industrial land use (40 mg/kg limit for benzo(a)pyrene medium bound) was adopted as the site health based adopted criteria. All five samples reported concentrations below the adopted criteria.
  - BP02 reported concentrations of 0.9 mg/kg for pyrene and total PAHs respectively which is below the HILs for commercial/industrial use (4,000 mg /kg). At the time of reporting there was no guideline value for pyrene.
  - All other reported concentrations for PAHs and phenols were below the laboratory limits of reporting (LOR).

3.3.2 Groundwater

Hydrocarbon results exceed screening criteria at one or more locations. The reported concentrations of BTEXN, PAHs and phenols were below LOR.

See *Groundwater Monitoring Events – September and December 2021* report attached in Appendix C.

3.4 QA/QC

The results of the internal quality assurance programs of the analytical laboratories used for soil and groundwater analysis are presented with the certificates in Appendix A for soil and Appendix C for groundwater. Appropriate internal QA / QC were reported by both primary (Eurofins) and secondary (ALS) laboratories as follows:

- Accuracy (measured by laboratory spike and surrogate recovery samples) generally within 70% - 130% recovery.
- Precision (measured by duplicate sample analysis) within 30% relative percentage difference.
- Minimum 95% completeness (measured by total number of analyses within acceptable limits).

3.4.1 Soil

A field duplicate sample was collected and analysed at the primary and secondary laboratories as presented in Table 2.

Primary Sample	Field Duplicate – Primary Laboratory (Eurofins)	Field Duplicate – Primary Laboratory (ALS)
BP01	QC01 – TRH, BTEXN, PAH and Phenols	QC01A - TRH, BTEXN, PAH and Phenols

The frequency of field duplicate analyses for the primary contaminants of concern is deemed acceptable when compared to the 1 per 20 analyses recommended in the Australian Standard AS4482.1. A table summarising the field duplicate results for the investigation is attached at the end of this report.

The majority of intra and inter-laboratory duplicate relative percent differences (RPDs) calculated were considered acceptable i.e. < 50 %. This was with the exception of the following hydrocarbon fractions:

- BP01 / QC01 – TRH>C_{10}-C_{16} (74%)
- BP01 / QC01 – TRH>C_{10}-C_{16} without Naphthalene (74%)
- BP01 / QC01 – TRH>C_{10}-C_{14} (73%)
- BP01 / QC01 – TPH C_{15}-C_{28} (51%)

The elevated RPD%s above were deemed to be reflective of a non-uniform impact of spilled hydrocarbons, additionally reflective of the natural heterogeneity of the soils.

One rinsate blank (RB01) and one trip blank (TB01) sample were collected during the soil investigation and analysed at the primary laboratory for the primary contaminants of concern. The rinsate blank was analysed for TRH and the trip blanks for BTEXN. The rinsate blank was collected from decontaminated sampling equipment.

The rinsate and trip blanks samples collected were reported to have all TRH/BTEXN concentrations below the limits of reporting (LOR) indicating that no cross contamination occurred between locations during the transportation of samples.

A table summarizing the duplicate and blanks results is presented at the end of this addendum.

3.4.2 Groundwater

See Groundwater Monitoring Events – September and December 2021 report attached in Appendix C.

4 EXTENT OF CONTAMINATION

4.1 Additional Screening Criteria

4.1.1 Soil

The selected soil assessment criteria are as follows:

- NEPM 2013 Table 1A(1) Health Investigation Levels (HILs) (D) for Soil Contaminants – Commercial/ Industrial land use.
- NEPM 2013 Table 1A(3) Health Screening Levels (HSLs) (D) for Vapour Intrusion – Commercial/ Industrial land use.
- NEPM 2013 Table 1B(6) Ecological Screening Levels (ESLs)/Ecological Investigation Levels (EILs) – Commercial/ Industrial land use.
- NEPM 2013 Table 1B(7) Management Limits (MLs) – Commercial/Industrial land use.
- CRC Care (2011) Health Screening Levels for direct contact (commercial/industrial and intrusive maintenance worker scenarios).
- CRC Care (2011) Health Screening Levels for vapour intrusion (commercial/industrial land use and intrusive maintenance worker scenarios).

Screening levels are applied based on the soil type encountered and the depth of sample collection, where relevant. The investigation exposure settings for coarse soils (sands) were adopted based on the field observations during excavation works.

4.1.2 Groundwater

The selected groundwater assessment criteria as follows:

- NEPM 2013 Table 1A(4) Health Screening Levels (HSLs) (D) for Vapour Intrusion – Commercial/Industrial land use, 2m to <4m.
- NEPM 2013 Table 1C Groundwater Investigation Levels (GILs) – Marine Waters.
- NHMRC 2008 Guidelines for Managing Risks in Recreational Water.
- California Water Boards (2019) – San Francisco Bay Regional Water ESLs.

Screening levels are applied based on the soil type encountered and the depth of sample, where relevant. The investigation exposure settings for coarse soils (sands) were adopted based on the field observations during excavation works.

4.2 Screening Results – Soil

Results of the soil sample analyses were compared to the adopted assessment criteria as summarised in Section 4.1.1, refer summary tables presented as attachments to this report. The summary tables presented in the DSI have been reproduced below and updated where relevant based on the inclusion of additional screening criteria. The NATA laboratory certificates for soil samples are included in *Appendix D* of the DSI.

With the inclusion of the additional CRC Care screening criteria (see Section 4.1.1), the results presented in Table 2 were also equal to or above selected criteria. Note, Table 2 only presents additional exceedances (within the full data set) following the inclusion of the additional screening criteria, refer to the following tables for full summary.

There were no exceedances of:

- CRC Care (2011) Health Screening Levels for direct contact (intrusive maintenance worker).
- CRC Care (2011) Health Screening Levels for vapour intrusion (intrusive maintenance worker).

Table 2: Summary of Additional Screening Criteria Exceedances

	Depth (m bgl)	Concentration Range (mg/kg)		
		TRH (C_6-C_{10}) (F1)	TRH (>C_{10}-C_{16})	TRH (>C_{16}-C_{34})
CRC Care HSLs (HSL D) for Vapour Intrusion – Commercial/Industrial (Sand)	0 - <1m	260	-	-
	1 - <2m	370	-	-
CRC Care, HSL D (Commercial/Industrial) (Direct Contact)		26,000	20,000	27,000
BH13	0.25	270	24,000	20,000
BH14	0.25	430	20,000	16,000
BH15	0.25	440	27,000	23,000
NDTP07	<1	590	31,000	20,000
V12	0.025	<200	20,000	19,000
V18	0.03	<200	25,000	38,000
V72	0.75	290	5,700	6,000

4.2.1 Initial Assessment

Investigation locations and test results prior to undertaking any remedial activities are summarised in *Tables 2, 4, 5* and *6* of the DSI. Elevated results from initial sampling events presented in *Table 6* of the DSI have been reproduced in Table 3 to include the additional screening criteria.

Table 3: Summary of Exceedances (Investigations)

	Depth	Concentration Range (mg/kg)				
		TRH (C_6-C_{10})	TRH (C_6-C_{10}) (F1)	TRH (>C_{10}-C_{16})	TRH (>C_{10}-C_{16}) (F2)	TRH (>C_{16}-C_{34})
NEPM/CRC Care HSLs for Vapour Intrusion, Commercial/Industrial (Sand)	0 - 1m		260		NL	
	1 - 2m		370		NL	
NEPM ESLs, Commercial/Industrial (Coarse Soil)			215		170	1,700
NEPM MLs Commercial/Industrial (Coarse Soil)				1,000		3,500
CRC Care, Commercial/Industrial (Direct Contact)				20,000		27,000
Perimeter of Spill Location	<1m	290 – 480	270 – 440	24,000 – 27,000	24,000 – 27,000	20,000 – 23,000
Under One Road and Auxiliary Road rail lines, west of spill	<1m	<20 – 45	43	1,200	1,200	990
Under One Road and Auxiliary Road rail lines, south of spill	<1m	<LOR	<20	8,000	8,000	8,000
Under Ramp Road, south of spill	<1m	<20 – 110	<20 – 100	610 – 17,000	610 – 17,000	1,900 – 15,000
Along length of electrical power line adjacent Vee drain	1.1m	270 – 700	210 – 590	14,000 – 31,000	14,000 – 31,000	10,000 – 20,000

	Depth	Concentration Range (mg/kg)				
		TRH (C_6-C_{10})	TRH (C_6-C_{10}) (F1)	TRH (>C_{10}-C_{16})	TRH (>C_{10}-C_{16}) (F2)	TRH (>C_{16}-C_{34})
NEPM/CRC Care HSLs for Vapour Intrusion, Commercial/Industrial (Sand)	0 - 1m		260		NL	
	1 - 2m		370		NL	
NEPM ESLs, Commercial/Industrial (Coarse Soil)			215		170	1,700
NEPM MLs Commercial/Industrial (Coarse Soil)				1,000		3,500
CRC Care, Commercial/Industrial (Direct Contact)				20,000		27,000
South of the Auxiliary Road at the western end of Vee drain	<1m	<20	<20	360 – 550	360 – 550	1,100 – 1,600
East of spill in the vicinity of One Road, Auxiliary Road and Ramp Road rail line junctions	<1m	<20 – 30	<20 – 30	600 – 3,700	600 – 3,700	540 – 4,800

Hydrocarbon impacts were identified in the vicinity of the spill and extending down the natural slope between the One Road and Auxiliary Road rail lines and between the Auxiliary Road and Ramp Road rail lines with the Vee drain and service trench acting as a conduit towards the temporary sump excavated to capture diesel. Impacts do not exceed beyond this point under the road via the adjacent culvert.

Impacts were typically significantly higher in surface and near surface soils with evidence of percolation further into the soil profile at various locations including the spill site, service trench and temporary sump.

The field observations and results were used to inform diesel-impacted soil excavation works which are detailed in *Section 7* of the DSI.

The validation samples are grouped by the areas remediated as detailed in the figures, summarised as:

- Area 1 – between One Road and Auxiliary Road rail lines, extending from asphalt hardstand in the west to rail junction.
- Area 2 – between Auxiliary Road and Ramp Road rail lines, extending from road and culvert in the west to rail junction in the east.
- Area 3 – south of Ramp Road rail line extending from south of the spill location in the east extending approximately 70m to the west.

Table 4 and Table 5 summarise the exceedances including the re-screened results of validation sampling after the initial excavation and further excavation works respectively.

Figure 1 (updated *Figure 8* from DSI) presents all investigation sampling locations. Figure 2 (updated *Figures 9a* and *9c* from DSI) and Figure 3 (updated *Figure 9b* from DSI) present all validation sampling locations.

TP	Test Pit
NDTP	Non-destructive Test Pit
BH	Soil Bore
	Stormwater Drainage
	Underground Power
	Spill Location
	Temp Recovery Sump/ Trench
	Spill migration along unlined drain
	Remediation Footprint
	Hardstand Removed

Project: Detailed Site Investigation - Addendum

Location: Berrimah Freight Terminal - Export Dr, Berrimah NT

Job Ref: J168829

Drawn: VB

Checked: DB

Date: 20/06/22

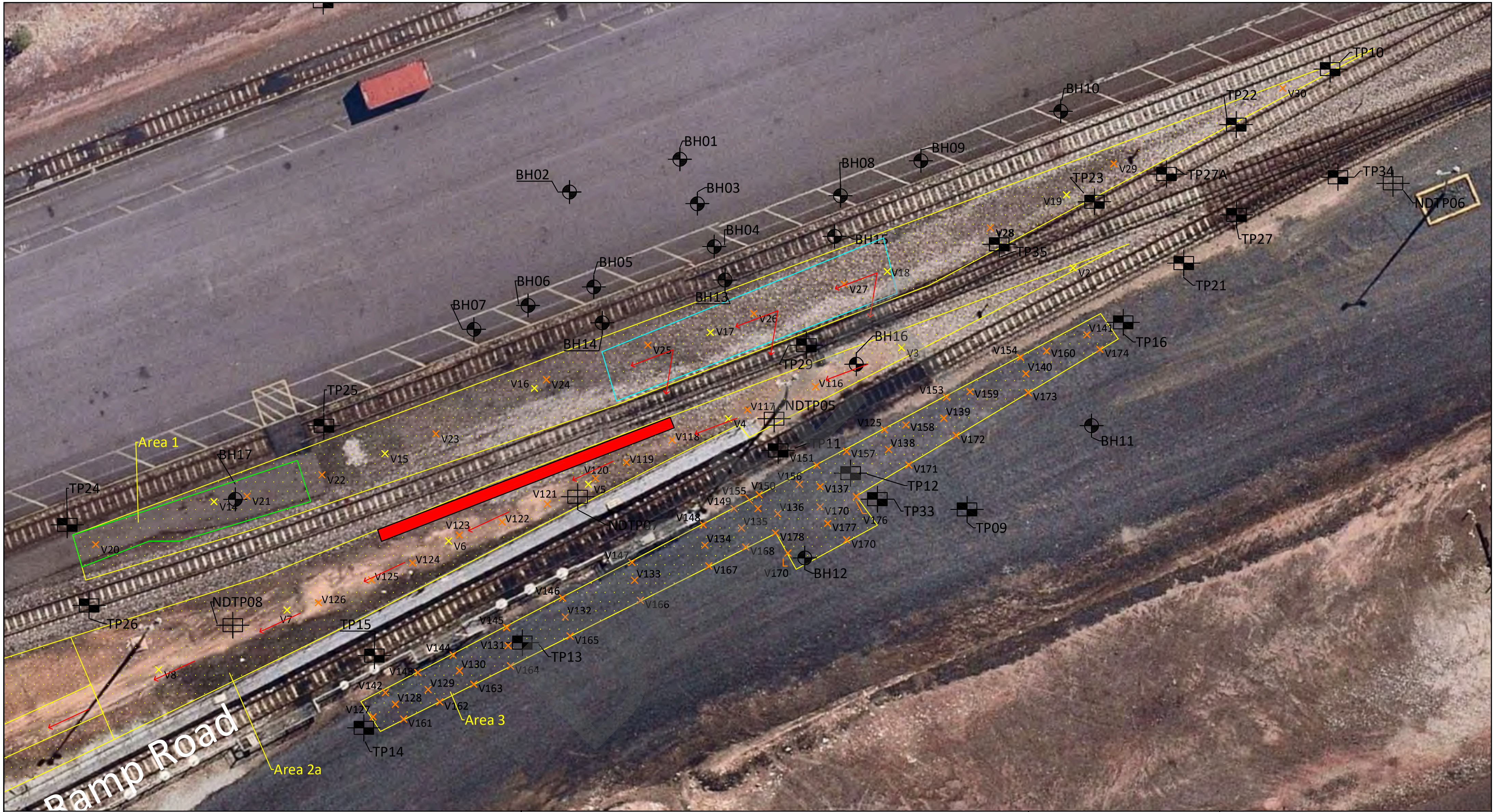
Scale: As shown

FIGURE 1
Sample Location
Plan

GREENCAP
Going Further in Managing Risk

11/14 Winnellie Road Winnellie NT 0820
www.greencap.com.au

Note: All data is approximate only and subject to survey



TP	Test Pit
NDTP	Non-destructive Test Pit
BH	Soil Bore
V	Validation Sample (initial)
V	Validation Sample (final)
	Spill Location
	Temp Recovery Sump/ Trench
	Spill migration along unlined drain
	Remediation Footprint
	Hardstand Removed

Project: Detailed Site Investigation - Addendum

Location: Berrimah Freight Terminal - Export Dr, Berrimah NT

Job Ref: J168829

Drawn: VB
Checked: DB
Date: 20/06/22
Scale: As shown

FIGURE 2
Validation Sample Location Plan (Areas 1, 2 and 3)

GREENCAP
Going Further in Managing Risk

11/14 Winnellie Road Winnellie NT 0820
www.greencap.com.au

Note: All data is approximate only and subject to survey

Project: Detailed Site Investigation - Addendum

Location: Berrimah Freight Terminal - Export Dr, Berrimah NT

Job Ref: J168829

Drawn: VB | Checked: DB | Date: 20/06/22

TP	Test Pit	☐	Spill Location
NDTP	Non-destructive Test Pit	🟥	Temp Recovery Sump/ Trench
BH	Soil Bore	←	Spill migration along unlined drain
V	Validation Sample (initial)	▨	Remediation Footprint
V	Validation Sample (final)	☐	Hardstand Removed

FIGURE 3
Validation Sample
Location Plan
(Areas 2b and 2c)

GREENCAP
Going Further in Managing Risk

11/14 Winnellie Road Winnellie NT 0820
www.greencap.com.au

Note: All data is approximate only and subject to survey

Table 4: Summary of Exceedances (Initial Validations)

	Depth (m bgl)	Concentration Range (mg/kg)				
		TRH (C_6-C_{10})	TRH (C_6-C_{10}) (F1)	TRH (>C_{10}-C_{16})	TRH (>C_{10}-C_{16}) (F2)	TRH (>C_{16}-C_{34})
NEPM/CRC Care HSLs for Vapour Intrusion, Commercial/ Industrial (Sand)	0-1m		260		NL	
	1-2m		370		NL	
NEPM ESLs, Commercial/Industrial (Coarse Soil)			215		170	1,700
NEPM MLs Commercial/Industrial (Coarse Soil)				1,000		3,500
CRC Care, Commercial/Industrial (Direct Contact)				20,000		27,000
Area 1	<1m	<20	<20 – 220	300 – 25,000	300 – 25,000	840 – 38,000
Area 2 (inc Areas 2b and 2c)	<1m	<20 - 240	<20 – 290	<50 – 20,000	<50 – 20,000	<100 – 19,000
Area 3	<1m	20 - 240	<20 – 220	<50 – 17,000	<50 – 17,000	<100 – 17,000

Validation sample results exceeding of the various screening criteria following the completion of the assessment (soil bores and test pits) and initial spill response remedial works (preliminary validations) are presented on Figure 4a (initial ESL exceedances), Figure 5a (initial VI HSL exceedances) and Figure 6a (initial ML exceedances). A summary of exceedances of the various screening criteria are presented for the remediation areas (Table 5) and by location (Section 4.3).

A summary of remediation works relating to the removal of soils considered impacted with diesel is detailed in *Table 10* of the DSI. This includes additional remediation works completed following the receipt of the results presented in Table 5.

Project: Detailed Site Investigation - Addendum

Location: Berrimah Freight Terminal - Export Dr, Berrimah NT

Job Ref: J168829

Drawn: VB
Checked: DB
Date: 20/06/22
Scale: As shown

TP Test Pit
NDTP Non-destructive Test Pit
BH Soil Bore
V Validation Sample
ESL exceedance

Spill Location
Temp Recovery Sump/ Trench
Spill migration along unlined drain
Remediation Footprint
Hardstand Removed

FIGURE 4a
Initial Investigation and Preliminary Validation Results > ESLs

GREENCAP
Going Further in Managing Risk

11/14 Winnellie Road Winnellie NT 0820
www.greencap.com.au

Note: All data is approximate only and subject to survey

TP	Test Pit
NDTP	Non-destructive Test Pit
BH	Soil Bore
╳ V	Validation Sample
✕	HSL exceedance
☐	Spill Location
🟥	Temp Recovery Sump/ Trench
	Spill migration along unlined drain
▨	Remediation Footprint
🟩	Hardstand Removed

Project: Detailed Site Investigation - Addendum

Location: Berrimah Freight Terminal - Export Dr, Berrimah NT

Job Ref: J168829

Drawn: VB

Checked: DB

Date: 20/06/22

Scale: As shown

FIGURE 5a
Initial Investigation and Preliminary Validation Results > VI HSLs

GREENCAP
Going Further in Managing Risk

11/14 Winnellie Road Winnellie NT 0820
www.greencap.com.au

Note: All data is approximate only and subject to survey

Project: Detailed Site Investigation - Addendum

Location: Berrimah Freight Terminal - Export Dr, Berrimah NT

Job Ref: J168829

Drawn: VB	Checked: DB	Date: 20/06/22	Scale: As shown

TP	Test Pit	☐	Spill Location
NDTP	Non-destructive Test Pit	🟥	Temp Recovery Sump/ Trench
BH	Soil Bore		Spill migration along unlined drain
× V	Validation Sample	▨	Remediation Footprint
● ● ● ×	ML exceedance	🟩	Hardstand Removed
● ● ● ×	ML + DC HSL exceedance		

FIGURE 6a
Initial Investigation and Preliminary Validation Results > Management Limits and Direct Contact HSLs

GREENCAP
Going Further in Managing Risk
11/14 Winnellie Road Winnellie NT 0820
www.greencap.com.au

Note: All data is approximate only and subject to survey

Table 5: Summary of Final Conditions (Final Validations)

	Depth (m bgl)	Concentration Range (mg/kg)				
		TRH (C_6-C_{10})	TRH (C_6-C_{10}) (F1)	TRH (>C_{10}-C_{16})	TRH (>C_{10}-C_{16}) (F2)	TRH (>C_{16}-C_{34})
NEPM/CRC Care HSLs for Vapour Intrusion, Commercial/ Industrial (Sand)	0-1m		260		NL	
	1-2m		370		NL	
NEPM ESLs, Commercial/Industrial (Coarse Soil)			215		170	1,700
NEPM Management Limits Commercial/Industrial (Coarse Soil)				1,000		3,500
CRC Care, Commercial/Industrial (Direct Contact)				20,000		27,000
Area 1 (inc Area 1a)	<1m	<20	<20	<50 – 160	<50 – 160	<100 – 1,500
Area 2 (exc Areas 2a, 2b and 2c)	<1m	<20	<20	<50	<50	<100
Area 2a	<1m	<20	<20	<50 – 4,100	<50 – 4,100	<100 – 6,600
Area 2b/c	<1m	<20	<20 – 270	<50 – 11,000	<50 – 11,000	<100 – 11,000
Area 3	<1m	<20 – 240	<20 – 220	<50 – 17,000	<50 – 17,000	<100 – 17,000

Results exceeding of the various screening criteria following the completion of all spill response remedial works (final validations) are presented on Figure 4b (final ESL exceedances), Figure 5b (final VI HSL exceedances) and Figure 6b (final ML exceedances).

Remediation works are summarised in *Section 7* of the DSI. Remediation Areas are also presented in Figures 1 to 6b.

TP	Test Pit	▭	Spill Location
NDTP	Non-destructive Test Pit	🟥	Temp Recovery Sump/ Trench
BH	Soil Bore		Spill migration along unlined drain
✕ V	Validation Sample	▨	Remediation Footprint
	ESL exceedance	▭	Hardstand Removed

Project: Detailed Site Investigation - Addendum

Location: Berrimah Freight Terminal - Export Dr, Berrimah NT

Job Ref: J168829

Drawn: VB
Checked: DB
Date: 20/06/22
Scale: As shown

FIGURE 4b
Final Investigation and Validation Results > ESLs

GREENCAP
Going Further in Managing Risk

11/14 Winnellie Road Winnellie NT 0820
www.greencap.com.au

Note: All data is approximate only and subject to survey

Project: Detailed Site Investigation - Addendum

Location: Berrimah Freight Terminal - Export Dr, Berrimah NT

Job Ref: J168829

Drawn: VB | Checked: DB | Date: 20/06/22 | Scale: As shown

TP	Test Pit	☐	Spill Location
NDTP	Non-destructive Test Pit	🟥	Temp Recovery Sump/ Trench
BH	Soil Bore	←	Spill migration along unlined drain
✕ V	Validation Sample	▨	Remediation Footprint
✕	HSL exceedance	🟩	Hardstand Removed

FIGURE 5b
Final Investigation and Validation Results > VI HSLs

GREENCAP
Going Further in Managing Risk

11/14 Winnellie Road Winnellie NT 0820
www.greencap.com.au

Note: All data is approximate only and subject to survey

Project: Detailed Site Investigation - Addendum

Location: Berrimah Freight Terminal - Export Dr, Berrimah NT

Job Ref: J168829

Drawn: VB

Checked: DB

Date: 20/06/22

Scale: As shown

TP Test Pit

NDTP Non-destructive Test Pit

BH Soil Bore

V Validation Sample

ML exceedance

ML + DC HSL exceedance

Spill Location

Temp Recovery Sump/ Trench

Spill migration along unlined drain

Remediation Footprint

Hardstand Removed

FIGURE 6b Final Investigation and Validation Results > Management Limits and Direct Contact HSLs

GREENCAP
Going Further in Managing Risk

11/14 Winnellie Road Winnellie NT 0820
www.greencap.com.au

Note: All data is approximate only and subject to survey

4.3 Review of Exceedances

Table 6 summarises the fate of exceedances presented in the attached results tables.

Table 6: Summary of Exceedances

Sample Location(s)	Description	Depth (m bgl)	Screening Criteria [1] Exceeded	Fate	Final/ Subsequent Sample Location
BH13 – BH15	Under One Road rail line	<0.5	HSLs, ESLs, MLs, Direct Contact	In situ (unfeasible to remove as sub rail line)	N/A
BH17	Under bitumen pad between One Road and Auxiliary Road rail lines	<0.5m	ESLs, MLs	Removed	V21
NDTP05, NDTP09	Along subsurface electrical power line	<0.5m	ESLs, MLs	In situ (unfeasible to remove given vicinity to services)	N/A
NDTP07			HSLs, ESLs, MLs, Direct Contact		
TP11	Under Ramp Road rail line	<0.5	ESLs, MLs	In situ (unfeasible to remove as sub rail line)	N/A
TP15			ESLs		
TP18	West of temporary sump	<0.5	ESLs	Removed	V85 – V86
TP27	Under Auxiliary Road and Ramp Road rail line junction	<0.5	ESLs	In situ (unfeasible to remove as sub rail line)	N/A
TP29	Under Auxiliary Road rail line	<0.5	ESLs, MLs	In situ (unfeasible to remove as sub rail line)	N/A
TP35	Under One Road and Auxiliary Road junction	<0.5			
TP37	Along subsurface electrical power line near temporary sump	1.6	ESLs, MLs	Potentially in situ **	N/A
V02*, V04 – V06	Along drainage line between Auxiliary Road and Ramp Road rail lines	0.15	ESLs, MLs	Removed	V116 – V124
V12	West of temporary sump, south of Auxiliary Road rail line	0.15	HSLs, ESLs, MLs, Direct Contact	Removed	V60, V63, V110 – V113
V14 – V17	Between One Road and Auxiliary Road rail lines near spill location	0.15	ESLs	Removed	V21 – V26
V18			HSLs, ESLs, MLs, Direct Contact	Removed	V27 – V29

Sample Location(s)	Description	Depth (m bgl)	Screening Criteria [1] Exceeded	Fate	Final/ Subsequent Sample Location
V19	Between One Road and Auxiliary Road rail lines east of spill location		ESLs, MLs		
V63	Base of excavation in area of temporary sump	1.65	ESLs	Removed	V110 – V113
V72	Walls of eastern excavation in area of temporary sump	0.75 – 1.75	HSLs, ESLs, MLs	Removed	V93 – V96, V99 – V106, V113 – V114
V73 – V74			ESLs		
V81			ESLs, MLs	Removed	V99 – V100, V115
V85 – V86, V89, V102, V104	Walls of western excavation in area of temporary sump	1.0 – 2.0	ESLs	In situ (excavation extent limited by underground power, rail lines and groundwater interface)	N/A
V110, V112, V114	Base of western excavation in area of temporary sump	2.0	ESLs, MLs		N/A
V111			HSLs, ESLs, MLs		
V113			ESLs		
V119	Trench between Auxiliary Road and Ramp Road rail lines	0.25	ESLs		N/A
V122			ESLs, MLs		
V145 – V146, V156, V158	South of Ramp Road – northern extent of excavation adjacent Ramp Road rail line	0.2 – 0.5	ESLs, MLs	In situ (further excavation unfeasible given proximity to Ramp Road rail line)	N/A
V160			ESLs		
V167	South of Ramp Road – southern boundary, central extent of excavation adjacent Ramp Road rail line	0.1	ESLs, MLs	In situ	N/A

[1] ESL - NEPM 2013 Table 1B(6) Ecological Screening Levels – Commercial/ Industrial land use.

HSL D - NEPM 2013 Table 1A(3) Health Screening Levels (D) for Vapour Intrusion – Commercial/ Industrial land use.

ML - NEPM 2013 Table 1B(7) Management Limits – Commercial/Industrial land use.

Direct Contact - CRC Care (2011) Health Screening Levels for direct contact (commercial/industrial and intrusive maintenance worker scenarios).

* further excavation works were undertaken through this area ('Area 2' and 'Area 2a' – see DSI *Figure 12*) and subsequent validation sampling undertaken (see DSI *Table 10*). It is acknowledged that the nearest post-additional remediation validation sample is V116, located to the west. It is considered that this has been removed.

** impact at 1.6m bgl – located adjacent subsurface power line. No evidence of impact above 1m, impact may be associated with service trench as conduit. Remediation works completed in area (i.e. Areas 2b and 2c excavated to 1.6m, however, TP37 is slightly to the east).

4.4 Delineation of Impacts

4.4.1 Contamination Exceeding Health-based Investigation/Screening Levels and/or Management Limits

In-situ impacts exceeding one or more of the adopted health-based screening criteria have been delineated as presented in Table 7. Delineation of impact has been assessed via a combination of quantitative laboratory sample analysis results, as well as qualitative field observations and PID readings for obviously contaminated materials.

Table 7: Delineation of impacts exceeding health-based screening criteria

Sample Location(s)	Description	Depth (m bgl)	Screening Criteria [1] Exceeded	Fate	Delineated By
BH13 – BH15	Under One Road rail line	<0.5	HSL, ML, DC	In situ (unfeasible to remove as sub rail line)	BH01 – BH09, V16, V17, V24 – V27, samples >0.5m
BH17	Under bitumen pad between One Road and Auxiliary Road rail lines	<0.5m	ML	Removed	V14, V21, samples >0.5m
NDTP05	Along subsurface electrical power line	<0.5m	ML	In situ (unfeasible to remove given vicinity to services)	V116 – V118
NDTP07			HSL, ML, DC		V120 – V121
NDTP09			ML		Area 2 excavation and validations
TP11	Under Ramp Road rail line	<0.5	ML	In situ (unfeasible to remove as sub rail line)	V116 – V118, samples >0.5m
TP29	Under Auxiliary Road rail line	<0.5	ML	In situ (unfeasible to remove as sub rail line)	Area 1 and Area 2 excavation and validations, samples >0.5m
TP35	Under One Road and Auxiliary Road junction	<0.5	ML		
TP37	Along subsurface electrical power line near temporary sump	1.6	ML	Potentially in situ **	Area 2 excavation and validations
V02, V04 – V06	Along drainage line between Auxiliary Road and Ramp Road rail lines	0.15	ML	Removed	
V12	West of temporary sump, south of Auxiliary Road rail line	0.15	ML, DC	Removed	
V18 – V19	Between One Road and Auxiliary Road rail lines near spill location	0.15	ML, DC	Removed	
V72	Walls of eastern excavation in area of temporary sump	0.75 – 1.75	HSL, ML	Removed	
V81			ML		

Sample Location(s)	Description	Depth (m bgl)	Screening Criteria [1] Exceeded	Fate	Delineated By
V110, V112, V114	Base of western excavation in area of temporary sump	2.0	ML	In situ (excavation extent limited by underground power, rail lines and/or groundwater interface)	Extent of excavation depth
V111			HSL, ML		
V122	Trench between Auxiliary Road and Ramp Road rail lines	0.25	ML		
V145 – V146, V156, V158, V160	South of Ramp Road – northern extent of excavation adjacent Ramp Road rail line	0.2 – 0.5	ML	In situ (further excavation unfeasible given proximity to Ramp Road rail line)	Area 3 excavation and validations
V167	South of Ramp Road – northern extent of excavation adjacent Ramp Road rail line	0.1	ML	In situ	

[1] ESL - NEPM 2013 Table 1B(6) Ecological Screening Levels – Commercial/ Industrial land use.

HSL D - NEPM 2013 Table 1A(3) Health Screening Levels (D) for Vapour Intrusion – Commercial/ Industrial land use.

ML - NEPM 2013 Table 1B(7) Management Limits – Commercial/Industrial land use.

Direct Contact - CRC Care (2011) Health Screening Levels for direct contact (commercial/industrial and intrusive maintenance worker scenarios).

4.4.2 Contamination Exceeding Ecological-based Investigation/Screening Levels

In-situ impacts exceeding one or more of the adopted ecological-based screening criteria have been delineated as presented in Table 7 (including HSL/ML exceedances) and Table 8.

Table 8: Delineation of impacts exceeding ecological-based screening criteria

Sample Location(s)	Description	Depth (m bgl)	Fate	Delineated By
TP15	Under Ramp Road rail line	<0.5	In situ (unfeasible to remove as sub rail line)	TP14, Areas 2 and 3 validations, samples >0.5m
TP18	West of temporary sump	<0.5	Removed	TP17, TP19, TP20, TP30, TP36, Area 2 excavation and validations
TP27	Under Auxiliary Road and Ramp Road rail line junction	<0.5	In situ (unfeasible to remove as sub rail line)	TP21, TP27A, TP34, samples >0.5m
V14 – V17	Between One Road and Auxiliary Road rail lines near spill location	0.15	Removed	Area 1 excavation and validations
V63	Base of excavation in area of temporary sump	1.65	Removed	Area 2 excavation and validations
V73 – V74	Walls of eastern excavation in area of temporary sump	0.0 – 1.5	Removed	
V85 – V86, V89, V102, V104	Walls of western excavation in area of temporary sump	1.0 – 2.0	In situ (excavation extent limited by underground power, rail lines and groundwater interface)	
V113	Base of western excavation in area of temporary sump	2.0		
V119	Trench between Auxiliary Road and Ramp Road rail lines	0.25		

4.4.3 Delineation of Impacts to the East

This subsection is in response to an Auditor query regarding the nature and delineation of impacts to the east of the spill. Impacts identified to the east of the spill (i.e. TP35, V19 etc) are unusual in that this area is upslope from the spill and unlikely to have been impacted as a result of the spill event. Further justification regarding the delineation of impacts to the east is as follows:

- BH09 and BH10 located in the container pad to the north of One Road presented no visual/PID evidence of impact.
- TP35 in the junction between One Road and Auxiliary Road reported impacts up to 1mbgl. The minor impact reported for V28 is consistent with some residual impact existing at the location of TP35.
- Further excavation in the area around TP35 is unviable given proximity to One Road/Auxiliary Road junction.
- TP10, TP22, TP23 located between One Road and Auxiliary Road, beyond TP35 presented no visual/PID evidence of impact and/or no reported impacts in analytical results (TP10, TP22).
- TP21 TP27, TP27A and V3 south of Auxiliary Road presented no visual/PID evidence of impact and/or no unacceptably elevated analytical results (TP21, TP27, TP27A).

- V2 impacts are likely indicative of in situ impacts in the tight Auxiliary Road/Ramp Road junction and further excavation being unfeasible in close proximity to the rail lines.

4.4.4 Delineation of Impacts to the South

This subsection is in response to an Auditor query regarding the nature and delineation of impacts to the south of the spill, specifically over the Ramp Road rail line. Further discussion and justification regarding the delineation of impacts to the south is as follows:

- This has primarily been addressed by the interception of the spill migration to the south via the excavation of a trench to divert the spill to the temporary sump and the suite of validations conducted along Remediation Area 2.
- Impacts in Remediation Area 3 are considered likely to be indicative of historic impacts resulting from the use of the site as a rail terminal and the near proximity to Ramp Road rather than a product of the spill event. Further evidence/notes as follows:
    - Chromatograms (attached in Appendix B) were reviewed for known spill areas and Remediation Area 3 to the south of Ramp Rd:
        - BH13, BH14, BH15 (sub-rail line/ballast impacts resulting from the spill)
        - V4 and V18 (Remediation Area 2, pre-additional remediation)
        - V119 and V122 (in situ impacts resulting from migration of spill along drainage line)
        - Remediation Area 3 impacts – TP11, V156, V158 and V167 (in alignment with BH13-15, V119 and V167) and V167 (remaining ML exceedance in southern extent of investigation/remediation).
    - The chromatograms show a distinct diesel impact in the spill area and Remediation Area 2 where the spill was known to migrate (i.e. locations north of Ramp Road). During early investigations and remedial activities there was an element of ambiguity as to spill migration beyond Ramp Road as not only does the elevated rail line present a migration barrier, the spill was intercepted by the unlined drain between Auxiliary Road and Ramp Road as well as the temporary trench excavated to retard the spill migration.
    - The chromatograms for the Remediation Area 3 (i.e. TP11, V156, V158 and V167) patterns differ, presenting as a diesel/oil mix pattern.
    - Historic staining is also evident in aerial photography along Ramp Road.
    - Remediation works in this area were governed by field observations and elevated impacts (e.g. the line of test pits along Ramp Rd, TP11-TP16), all of which present a surface impact lessening with depth. At the time splitting this impact from the spill event was not considered as contractors were mobilized to site it was considered beneficial to address at the time.

Greencap is of the opinion that impacts identified south of Ramp Road are a result of historic rail use and do not influence the nature and extent of impacts caused by this spill event. The remedial works in this area are in effect an ‘advantageous by-product’ of the remediation works completed for the spill event. In situ impacts are limited to the northern extent of the area, i.e. limited extent of excavation along Ramp Road, and an isolated impact at V167. Adjacent validation results (e.g. V133-135, V147-149, V155, V166 and V168) support this being an isolated exceedance.

4.5 Remedial Works and Final Condition Summary

Refer to *Section 7* of the DSI for a summary of remaining diesel impacts.

4.6 Soil Investigation Result Summary

The diesel spill occurred adjacent the One Road Rail line, resulting in surface diesel contamination under this line and on to the land between the One Road Rail line and Auxiliary Road rail line. Diesel migrated across and under the Auxiliary Road rail line into the drainage line where it progressed downgradient towards the road culvert approximately 100 metres from the spill. The spill was intercepted here via the installation of a temporary sump. To a lesser extent, diesel migrated also below the Ramp Road rail siding.

The soil investigation confirmed that diesel impacts were present at the site area at concentrations exceeding the adopted environmental and human health criteria as follows:

- Within the One Road rail line.
- Within and between the One Road, Auxiliary Road and Ramp Road rail lines at concentrations that present a risk to down-gradient ecological receptors and that present a potential light non-aqueous phase liquid (LNAPL)-related hazard.
- In underground services backfill between the Auxiliary Road and Ramp Road, directly south of the spill point lines that presents a risk to down-gradient ecological receptors and that present a potential LNAPL-related hazard.
- Within the western end of the Vee-drain, between/around the underground services crossover and the road underpass drain that presents a risk to down-gradient ecological receptors.

Remediation activities were undertaken concurrently with the assessment works and are considered to have addressed the majority of the issues noted above. These works and results are detailed in *Sections 6.6* and *7* of the DSI.

The remaining impacts present an on-going, albeit manageable risk on site given the industrial nature of the site use. Risk to human health is to be managed via the implementation of an Environmental Management Plan, whilst ecological risk is to be managed via the implementation of ongoing groundwater, sediment and stormwater monitoring (refer to Section 6.2).

4.7 Later Stage Subsurface Migration

Assessment for potential post-spill subsurface diesel migration was addressed via:

- The installation and sampling of additional groundwater monitoring wells;
- Groundwater impact modelling; and
- Surface water and sediment monitoring.

Groundwater sampling and modelling is summarised in Sections 4.8 and 5 respectively.

Surface water and sediment sampling was undertaken to assess for any subsurface contaminant migration that may discharge into the adjacent drainage network via sub-rail ballast and base course material as well as any potential release of impacted sediment or water from the impacted stockpiled material. A summary report was prepared detailing the results of the sampling program[4].

Hydrocarbon impacts in stormwater were detected in six of the 22 monitoring events. Two results were considered to be potentially associated with site activity, however, it is noted that the results were not repeated in subsequent monitoring events, nor were impacts detected in the receiving sensitive environment.

---

[4] Berrimah Freight Terminal Diesel Spill – Surface Water and Sediment Sampling (February to September 2021. October 2021.

The majority of sediment results analysed were reported below the laboratory limits of reporting. Isolated impacts were reported adjacent the stockpile with upgradient and downgradient sediment sample results supporting the conclusion that the impacts were localised. An approximate 0.1m layer of sediment was removed from the drain adjacent to the stockpile where SED 2 is located with subsequent sampling results below limits of reporting.

4.8 Groundwater Analytical Results

4.8.1 PAH/Phenols

The September and December 2021 GME report is attached in Appendix C. The reported concentrations of PAHs and phenols were below laboratory limits of reporting (LORs).

4.8.2 Groundwater Results Summary

Hydrocarbons impacts consistent with the diesel spill remain present. Groundwater condition is summarised in Appendix C, Section 8 of the DSI and in the modelling completed as part of this addendum report in Section 5.

Hydrocarbon impacts have been reported in monitoring wells adjacent the temporary sump location (MW01, MW01A and MW07), along the drainage line impacted during the spill event (MW04) and adjacent the spill location (MW08 and MW11). This includes the presence of LNAPL in MW01 (between October 2020 and May 2021) which is located immediately adjacent the former temporary sump. The monitoring wells immediately down gradient (MW01A and MW07) have reported minor impacts below the adopted screening criteria. Impacts reported in the monitoring wells located in the immediate vicinity of the original spill marginally exceed limits of detection and are below the adopted screening criteria. No impacts have been identified along the northern boundary of the site adjacent the mangrove fringe.

Limited data sets for total recoverable hydrocarbons (i.e. results exceeding limits of detection of four or more occasions) limit the accuracy of temporal trend analysis. Of the results for which impacts have been reported on multiple occasions (MW01 and MW04), no statistically significant trends are evident.

A Conceptual Site Model has been developed and is presented in Section 5.1.

5 GROUNDWATER MODELLING

5.1 Conceptual Site Model

5.1.1 Contamination Source

As discussed above and in further detail within the DSI, the spilled diesel fuel moved across a large area of the site but has been essentially removed at and near the surface within accessible areas. Spilled diesel remains in situ beneath the rail lines (One Road and Auxiliary Road) and has possibly infiltrated subsurface in some areas (e.g. Remediation Area 2). This infiltrated diesel forms a potential secondary source of groundwater contamination. Groundwater monitoring wells constructed at the spill area are to assess for potential impacts. The well locations are shown on Figure 7.

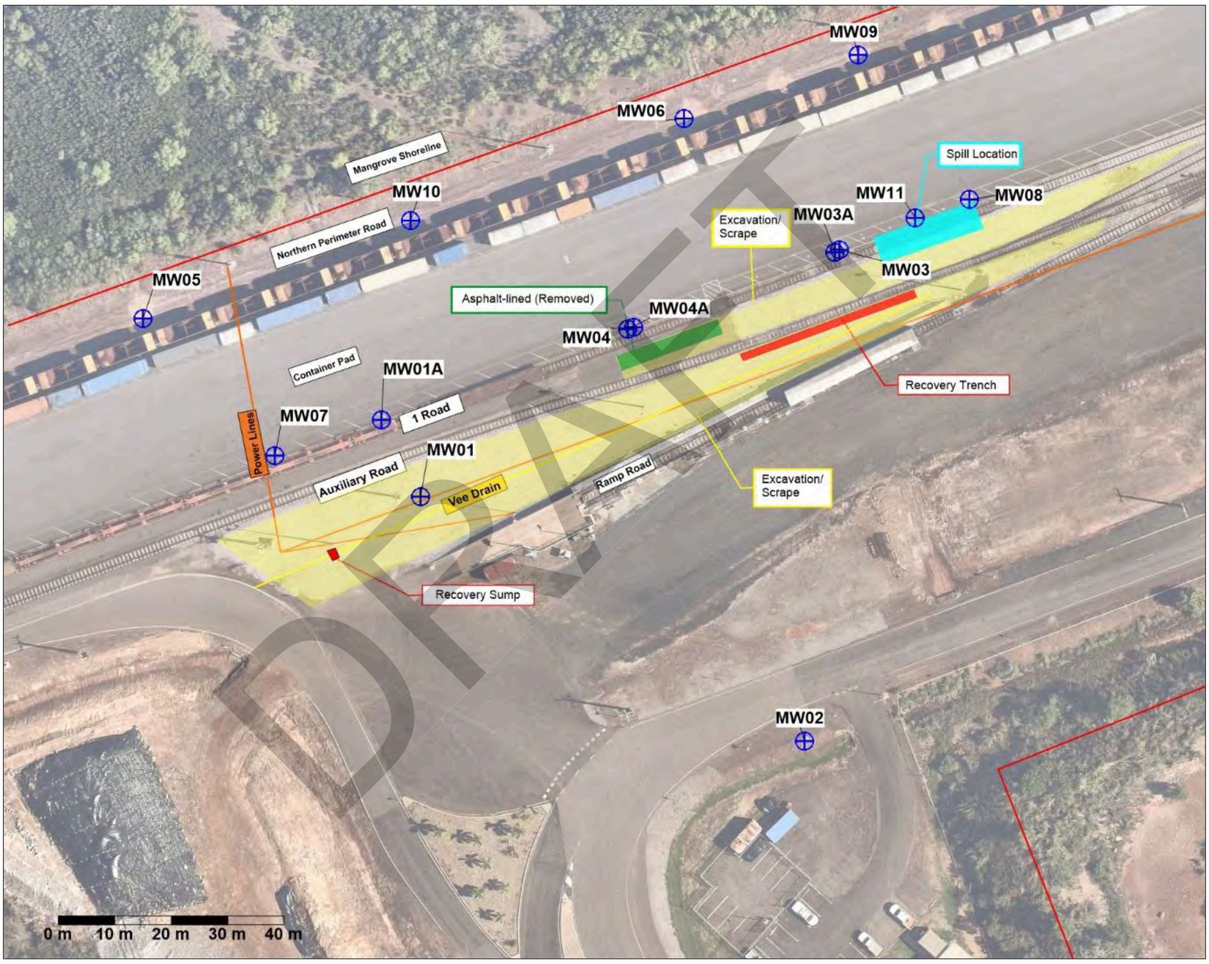


Figure 7: Monitoring Well Locations

Groundwater sampling results from the monitoring events conducted since the spill occurred are attached to this addendum report and show diesel type hydrocarbon impacts ($>C_{10}$ to C_{34}) at monitoring wells located along the spilled diesel migration path, indicating that some portion of spilled diesel might have infiltrated and reached groundwater. The highest concentrations of the dissolved phase hydrocarbons were reported at MW04 located near railway lines under which spilled diesel could not be recovered.

No significant concentrations of hydrocarbons or increasing trends in groundwater were noted at the location of the actual spill potentially indicating limited infiltration of diesel subsurface at this area.

The presence of floating diesel in the form of LNAPL was only observed at MW01 located near the Vee-drain and temporary capture sump which has likely acted as an unlined conduit which transferred diesel from the spill area. It is noted that this feature did however prevent direct diesel loss to the stormwater system that discharges to the adjacent mangroves. LNAPL was measured in MW01 between July 2020 and September 2021 and then the concentrations of dissolved hydrocarbon appeared to have gradually increased from September to December 2021.

Diesel within groundwater, resultant from surface infiltration may have resulted in the creation of a smear zone caused by seasonal fluctuation of groundwater levels. Groundwater level hydrographs shown on Figure 8 indicate that the smear zone thickness may be in order of 0.5-0.7m.

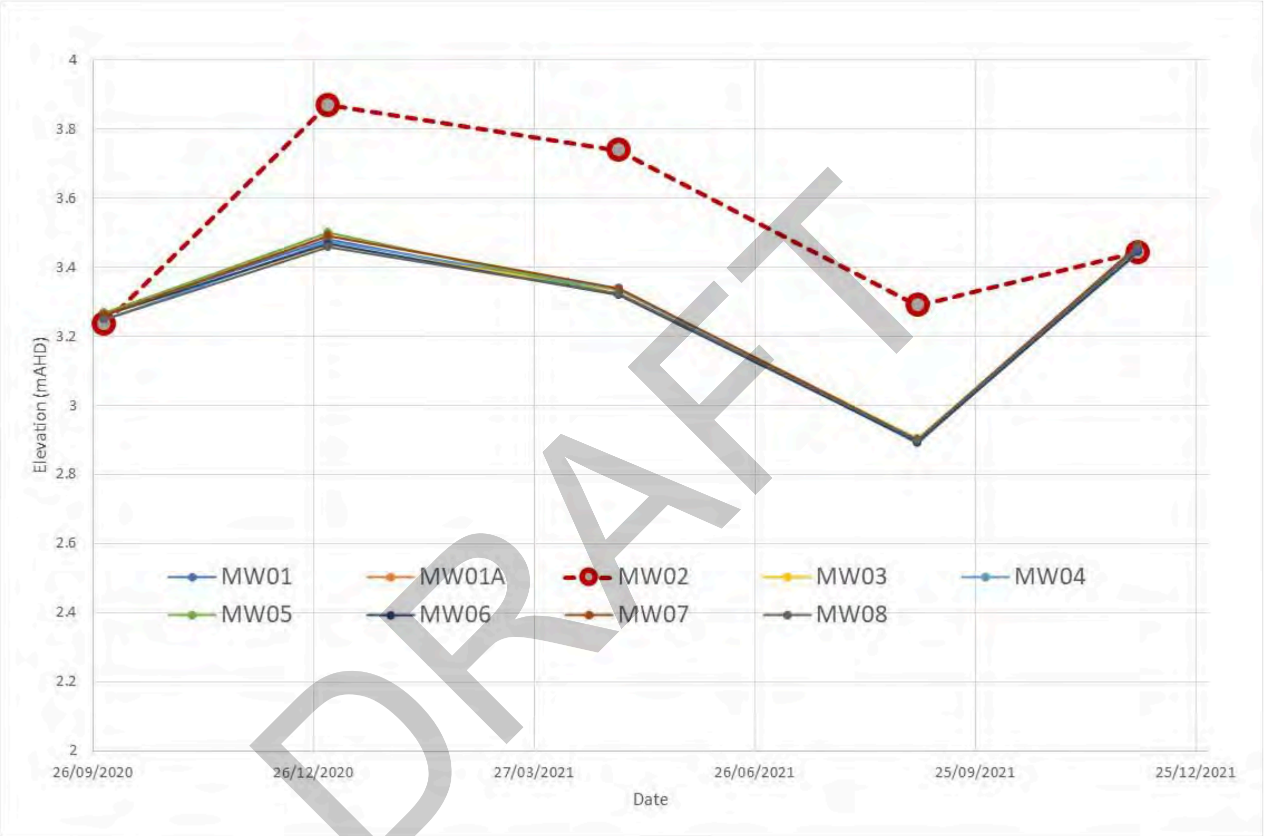


Figure 8: Hydrographs

5.1.2 Contamination Transport

Groundwater flow was assessed during GMEs to occur to the north towards the mangrove area, indicating that migration of dissolved hydrocarbons would likely occur in the same direction. From Figure 8 it also appears that the elevations of groundwater levels in the monitoring wells located within the spill area and along the northern site boundary bordering mangrove fringe are very similar. This is further illustrated on Figure 9 showing similarity in water levels measured in September 2021 (dry season) and December 2021 (wet season).

A review of historical arial photographs from Google Earth showed that the site area was developed after 2004 involving likely filling a portion of mangrove forest as illustrated on Figure 10. A schematic cross section illustrating conceptual site settings is shown as Figure 11.

Figure 11 shows that groundwater underlying the spill area and the area to the north occurs within coarse grained fill material (refer monitoring well installation logs attached to the DSI report) and that the groundwater surface within the backfilled area is relatively flat, presenting a near “0” gradient during the dry season and an approximate 0.0007 gradient during the wet season. The wet season gradient was estimated using an averaged December standing water level of 3.46 mAHD in the vicinity of the spill area (MW03, MW08 and MW11 – refer Figure 9) and an averaged standing water level of 3.44 mAHD along the downgradient site boundary (MW06 and MW09 – refer Figure 9) over a linear distance of 30m between these monitoring wells. The groundwater level pattern is likely to be further complicated by tidal influence on groundwater levels which would slow the transport of contamination toward the mangrove fringe.

Figure 9: Groundwater Seasonal Variations (September and December 2021)

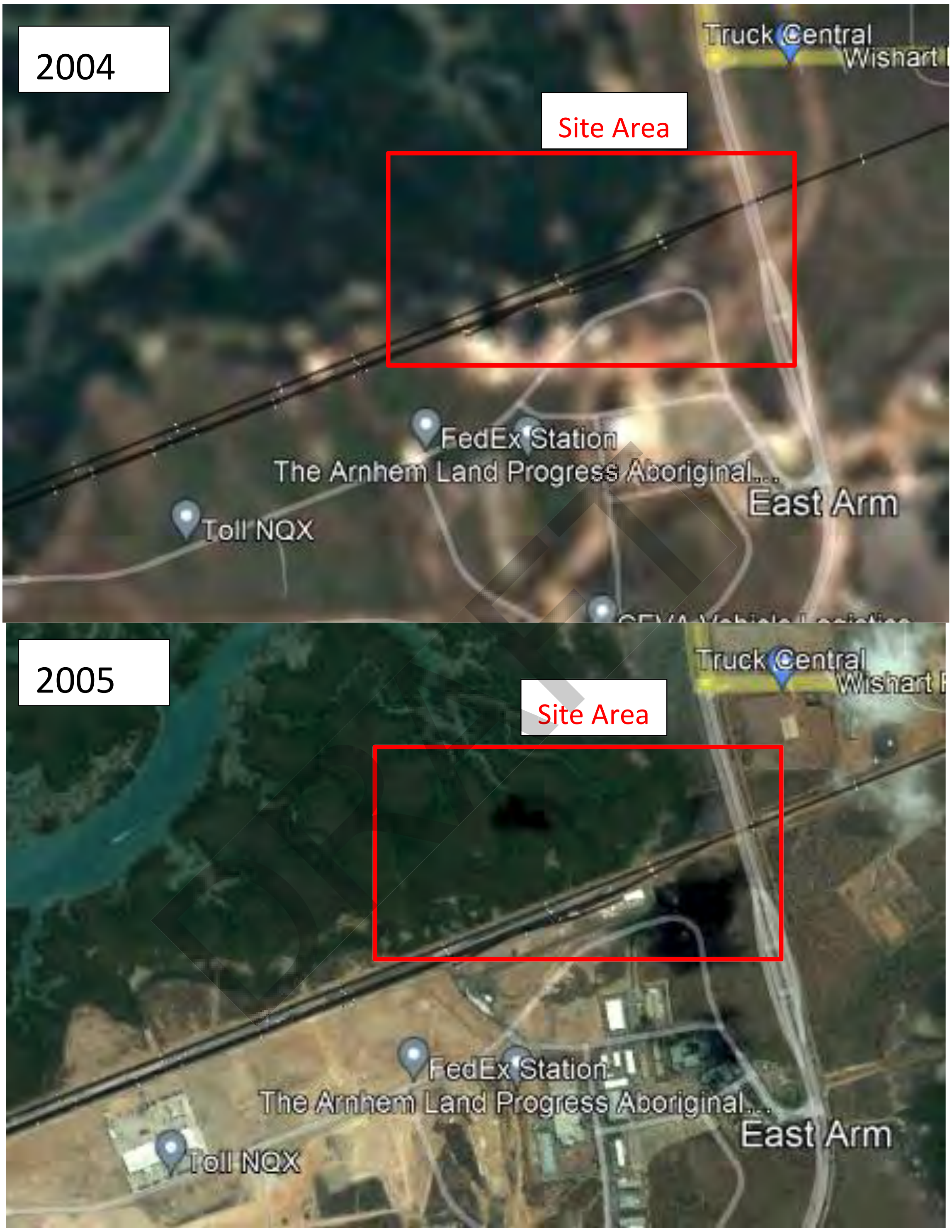
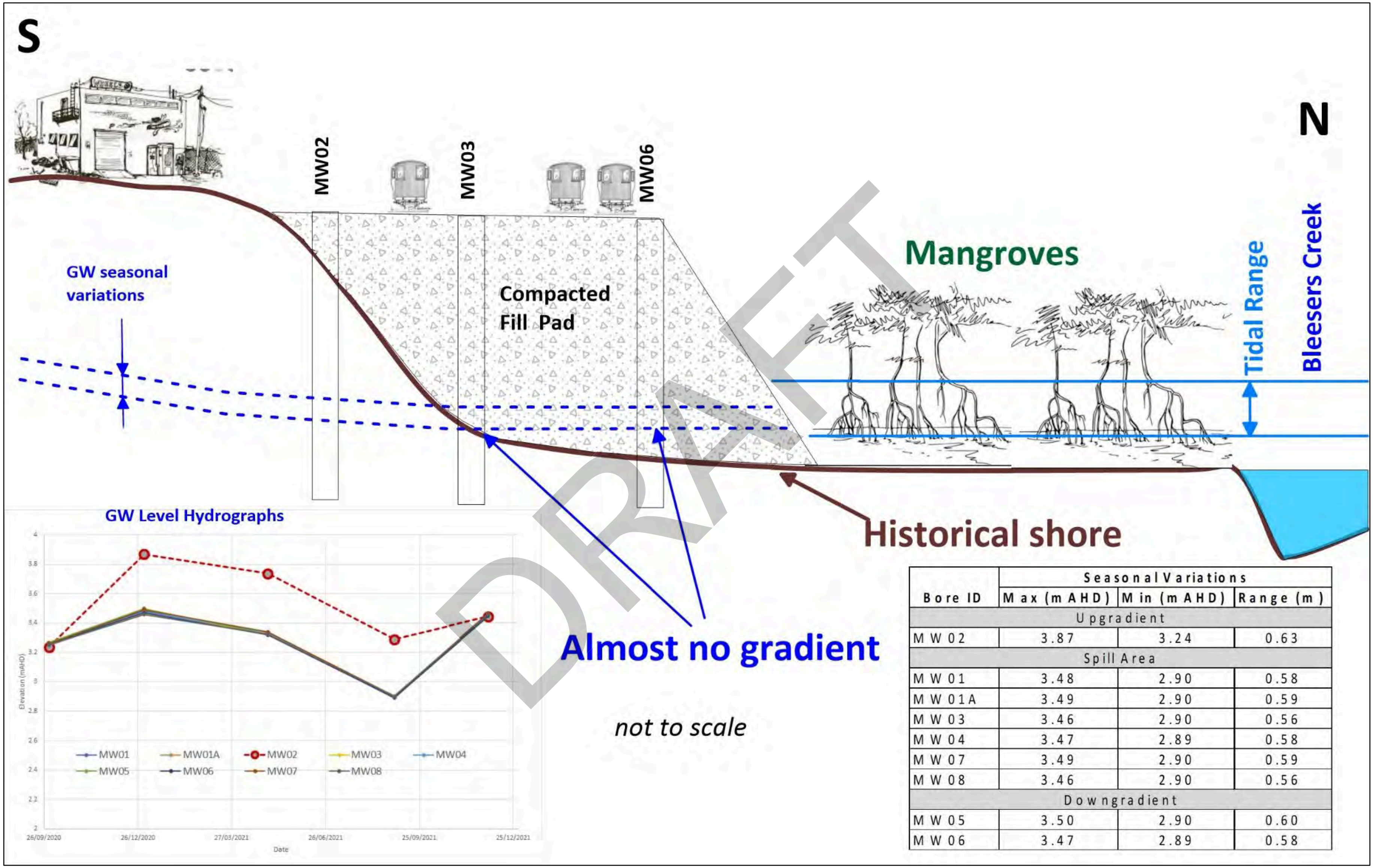


Figure 10: 2004 and 2005 Site Images (source: Google Earth)



Bore ID	Seasonal Variations		
	Max (mAHD)	Min (mAHD)	Range (m)
	Upgradient		
MW02	3.87	3.24	0.63
	Spill Area		
MW01	3.48	2.90	0.58
MW01A	3.49	2.90	0.59
MW03	3.46	2.90	0.56
MW04	3.47	2.89	0.58
MW07	3.49	2.90	0.59
MW08	3.46	2.90	0.56
	Downgradient		
MW05	3.50	2.90	0.60
MW06	3.47	2.89	0.58

Figure 11: Conceptual Schematic CSM

5.1.3 Sensitive Receptors

The direction of the groundwater flow is inferred to be generally to the north, northwest towards Bleesers Creek which discharges into Frances Bay of the Darwin Harbour (Figure 12). Therefore, the marine aquatic ecosystem of Bleesers Creek is considered a sensitive environmental receptor. Considering the presence of multiple tributaries of the creek extending towards the site, the nearest to the site tributary is approximately 45 metres down inferred hydraulic gradient of the spill area (refer Figure 13).

Figure 12: Bleesers Creek Location

Figure 13: Sensitive Receptor

The Primary Contact Recreation environmental value has also been considered for any potential recreational users in the mangrove community, however given the location of the site and nature of the mangrove community this is considered highly unlikely. This use has also adopted criteria for both aquatic ecosystems and recreational use as outlined in Section 5.2.2.5.

5.2 Modelling

Given the proximity of the site to the adjacent offsite receptors and the identified groundwater contamination resultant from the fuel release, qualitative screening modelling was undertaken to determine biodegradation and transport mechanisms.

5.2.1 Model Software

BIOSCREEN, Natural Attenuation Decision Support System from https://www.epa.gov/water-research/bioscreen-natural-attenuation-decision-support-system has been used. BIOSCREEN uses an analytical solute transport model with an option that simulates conservative transport with no contaminant decay and plume retardation; and two options for simulating in-situ biodegradation: first-order decay and instantaneous reaction.

5.2.2 Model Input Parameters

The input parameters required in the BIOSCREEN model are discussed in the subsections below.

5.2.2.1 *Hydrogeological Parameters*

Hydrogeological parameters required by the model include hydraulic conductivity of the aquifer material, hydraulic gradient and effective porosity of the aquifer material. These parameters are used to calculate groundwater flow velocity using Darcy's formula:

$V = kI/n$, *where:*

V – *velocity*

k – *hydraulic conductivity*

I – *gradient*

n – *porosity*

The K value was estimated in the Annual GME report dated July 2021 using the results of groundwater sampling. Table 9 presents the estimated K values for the monitoring wells installed along the spill area (refer Figure 13). The highest K values from Table 9 were estimated for MW01 located in the area where LNAPL was observed. This highest value of 4.7 m/day was adopted for conservative prediction.

Table 9: Hydraulic Conductivity Estimates (refer Annual Review GME)

Well ID	Sample Date	Pump rate (L/min)	*Draw-down (m)	Radius of influence (m)	Aquifer thickness ** (m)	K (m/day)	K (m/sec)	K (cm/sec)	K, m/day-average / well
MW01	Jul-20	0.38	0.01	0.5	5	5.14	5.95E-05	5.95E-03	5.14
MW03	Jan-21	0.42	0.70	7	5	0.16	1.80E-06	1.80E-04	0.16
MW04	Jan-21	0.58	0.16	2	5	0.73	8.47E-06	8.47E-04	0.64
	Apr-21	0.44	0.16			0.55	6.42E-06	6.42E-04	
MW07	Jan-21	0.28	0.01	0.5	5	3.78	4.38E-05	4.38E-03	4.28
	Apr-21	0.35	0.01			4.77	5.52E-05	5.52E-03	
MW08	Jan-21	0.46	0.05	1	5	1.56	1.80E-05	1.80E-03	1.15
	Apr-21	0.35	0.08			0.75	8.67E-06	8.67E-03	

* denotes difference between standing water level and water level during purging (pumping)

** assumed to be 5 metres based on well logs included in the DSI

With the reference to Section 5.1.2 there is very flat hydraulic gradient observed across the area between the spill and the receptor, with the highest gradient estimated for the wet season period of 0.0007. This value was conservatively adopted for the model. Adopted effective porosity of 0.1 is based on commonly published data for gravelly sandy aquifers. The estimated flow velocity was 12 m/year or 39 feet/year.

5.2.2.2 *Dispersivity Values*

The plume dispersion occurs longitudinally, i.e. along groundwater flow, laterally and vertically. For the model the BIOSCREEN default Xu and Eckstein (1995) equation was adopted for the longitudinal dispersivity which is dependent on the plume length adopted to be 46m or 150 feet, refer Section 5.1.3). For lateral, or transverse, and vertical dispersivity, the BIOSCREEN default equation was adopted, i.e. the lateral is 10% of longitudinal and vertical is 1% of longitudinal dispersivity.

5.2.2.3 *Source Data*

As discussed in Section 5.1.1 the source of the groundwater impact is likely to be diesel fuel sorbed onto soil matrix having formed a smear zone as a result of seasonal groundwater level fluctuation. LNAPL has not been reported in any of the monitoring wells located within the spill area with the exception of MW01 where LNAPL was measured in July 2021. It was not measured in September (end of dry season) and December 2021 (beginning of wet season) when LNAPL would typically be reported during seasonal low groundwater levels. It is highly possible that most of mobile LNAPL is now ‘trapped’ within the smear zone.

Based on a review of available publications including NEPM 2013 and CRC CARE Technical report #10 diesel fuel typically comprises >C_{10} to C_{34} hydrocarbon chains and includes both aromatic and aliphatic hydrocarbons. Table C6 from CRC CARE report #10 presents solubility limits for various hydrocarbon fractions in diesel fuels ranging from 1.08 mg/L >C_{10}-C_{12} aromatic species to as low as a fraction of micrograms per litre for heavy aliphatic hydrocarbons >C_{21} to C_{35}. The NEPM lists the solubility limit of 3 mg/L for F2 (>C_{10}-C_{16}) fractions. Concentration of hydrocarbons reported in groundwater samples to date are included in the summary tables attached. The highest concentration of the diesel range hydrocarbons (sum of >C_{10} to C_{34}) of 1.82 mg/L was reported at MW04 in October 2020. Since then, the concentrations of hydrocarbons in this well have decreased significantly. However, considering that this concentration may be a worst-case concentration at the source, and it is within the published ranges it has been adopted for the model.

Infinite source mass was also adopted in the model as a conservative approach.

5.2.2.4 *Contamination Transport Parameters*

As mentioned in Section 5.2.1 BIOSCREEN runs three parallel scenarios with and without natural degradation of hydrocarbons in the plume. The main parameters included in the model are discussed below.

Retardation

A contaminated plume typically moves with groundwater down hydraulic gradient towards a groundwater discharge area. However, plume migration velocity is typically lower compared to groundwater flow velocity (estimated in Section 5.2.2.1) generally a result of adsorption of hydrocarbons by soil. No site-specific data to estimate the plume retardation is available as no presence of diesel-related hydrocarbons was reported above laboratory limits of detection in the monitoring wells located along the downgradient site boundary approximately 30 metres from the spill area. This is generally consistent with the estimated groundwater flow velocity of 12 m/year indicating any plume emerging from the spill area is unlikely to migrate over the 30m distance within 1.5 years (between May 2020 and December 2021).

A retardation factor can be estimated using the equation included in the BIOSCREEN manual for which values of soil bulk density, organic carbon fraction, organic carbon/water partitioning coefficient and material porosity are required. However, the model is generally very sensitive to these parameters and due to the absence of site-specific testing results for the above parameters, a retardation factor of 1 was conservatively adopted for initial model runs.

Solute Half-Life

As diesel fuels include a wide range of hydrocarbon fractions the natural decay rate varies, i.e. lighter aromatic fractions may have higher decay rates when compared to heavier fractions which are more persistent.

The maximum first order decay recommended in BIOSCREEN and in ASTM E-1739 is for light fraction hydrocarbons including BTEX[5]. The value is 2 years (730 days) or 0.00095 day^{-1}. The maximum first order decay value referenced in publication[6] is up to 1,000 days for naphthalene (soluble hydrocarbon included in diesel fuel) which equates to 2.8 years. This conservative value was adopted in the model.

Instantaneous Reaction Model

The instantaneous reaction model addresses biodegradation of hydrocarbons in groundwater based on change in concentrations of primary indicators for aerobic and anaerobic degradation such as dissolved oxygen, nitrate, ferrous iron, sulphate and methane. The concentrations of the indicators measured or reported to date for the monitoring wells located within the spill area are presented in Table 10.

Table 10: Natural Attenuation Indicators (mg/L)

Well ID	Sample Date	Fe^{2+}	NO_3	SO_4	DO	Methane	TDS[#]
MW01	9-Sep-21	29	0.02	640	4.8*	<0.05	9,239
	10-Dec-21	33	<0.02	320	7.5**	<0.05	9,600
MW01A	21-Jan-21	20	0.63	2,900	3.6*	<0.05	35,200
	5-May-21	7.6	0.11	2,800	4.2*	<0.05	34,755
	9-Sep-21	12	<0.02	3,100	6.1*	<0.05	39,380
	8-Dec-21	10	0.38	2,900	8.3**	<0.05	36,170
MW03	21-Jan-21	<0.05	1	180	0.6*	<0.05	2,290
	5-May-21	0.4	1.7	190	0.3*	<0.05	1,962
	9-Sep-21	2.5	0.06	700	6.1*	<0.05	14,719
	8-Dec-21	0.1	0.68	110	3.4*	<0.05	1,153
MW04	21-Jan-21	0.18	1.2	290	0.7*	<0.05	3,800
	5-May-21	0.36	0.78	410	0.2*	<0.05	5,344
	9-Sep-21	4.8	<0.02	800	6.1*	<0.05	12,171
	8-Dec-21	2.5	<0.02	660	3.8*	<0.05	9,750

---

[5] Standard Guide for Risk-Based Corrective Action Applied at Petroleum Release Sites (ASTM E1739-95(2015)).

[6] CL:AIRE, 2017. Petroleum Hydrocarbons in Groundwater: Guidance on assessing petroleum hydrocarbons using existing hydrogeological risk assessment methodologies. CL:AIRE, London. ISBN 978-1-905046-31-7. Download at www.claire.co.uk/phg.

Table 10: Natural Attenuation Indicators (mg/L)

Well ID	Sample Date	Fe^{2+}	NO_3	SO_4	DO	Methane	TDS[#]
MW07	21-Jan-21	3.8	0.69	850	0.8*	<0.05	10,070
	5-May-21	6.2	0.7	530	0.85*	<0.05	8,088
	9-Sep-21	18	0.13	1,600	5.1*	<0.05	18,845
	8-Dec-21	0.75	0.35	580	0.45*	<0.05	7,862
MW08	21-Jan-21	1	1.2	290	0.5*	<0.05	3,600
	5-May-21	2.3	1.3	430	0.08*	<0.05	5,897
	9-Sep-21	5.3	<0.02	1,600	7.2**	<0.05	19,380
	8-Dec-21	1.4	1.1	500	7.5**	<0.05	7,395
MW11	8-Dec-21	1.9	<0.02	870	4.1*	<0.05	12,900

* DO was converted from % saturation to mg/L at ground elevation of 6 mAHD and water temperature of 30 deg

** Parameters are likely to be influenced by the presence of air bubbles in purging tubing

[#] TDS calculated from the field measured EC (refer DSI and monitoring reports)

To assess whether the concentrations of bioremediation indicators demonstrate appropriate conditions for the active degradation of hydrocarbons a series of graphs were plotted and discussed below.

Following the review of the data in Table 10, '0' values have been adopted as input parameters for delta DO and methane as no discernible changes in these parameters relevant to ongoing biodegradation have been identified. This also presents a more conservative modelling approach.

The concentrations of sulphate were assessed against TDS as shown on Figure 14. Figure 14 demonstrates a direct relationship between the sulphate and TDS concentrations indicating that variations in sulphate concentrations are likely attributable to seasonal variations in the groundwater salinity rather than a result of biodegradation of hydrocarbons causing a depletion in sulphate concentrations by bacteria. Based on this, a '0' value for delta SO_4 was adopted in the model.

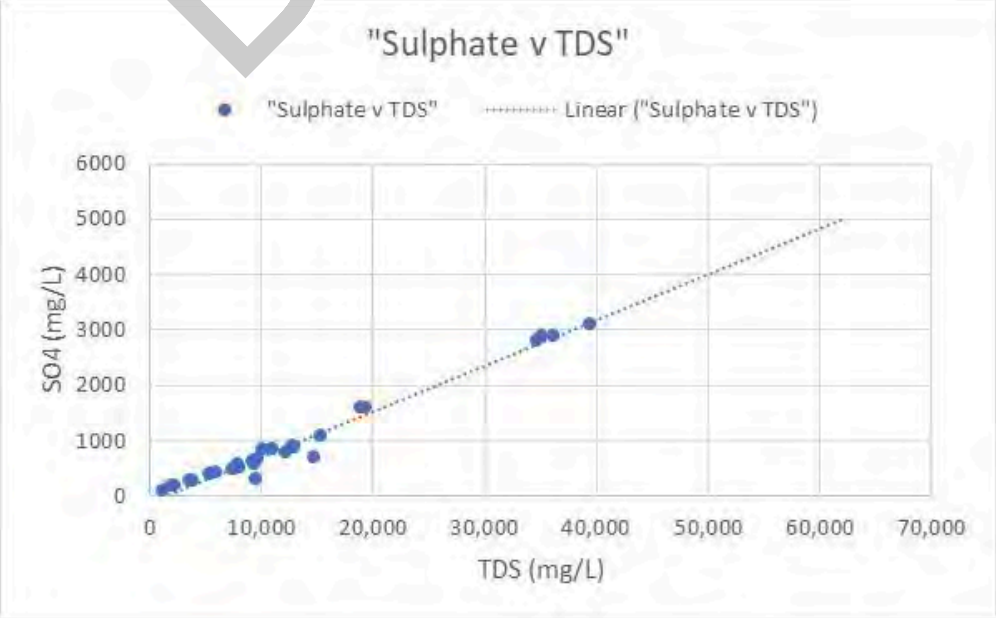


Figure 14: Sulphate versus TDS Concentrations

The concentrations of ferrous iron were compared to groundwater salinity as presented in Figure 15. There is general correlation between ferrous iron and TDS concentrations. The concentrations of Fe^{2+} reported at MW01 and MW07 located along the spill impacted area show increased concentrations, potentially indicative of reducing conditions created by biodegradation bacteria. Due to limited sampling rounds conducted for MW01 to verify whether natural levels of Fe^{2+} are high at this location, only data from MW07 was used and an average conservative value of 8 mg/L was adopted in the model.

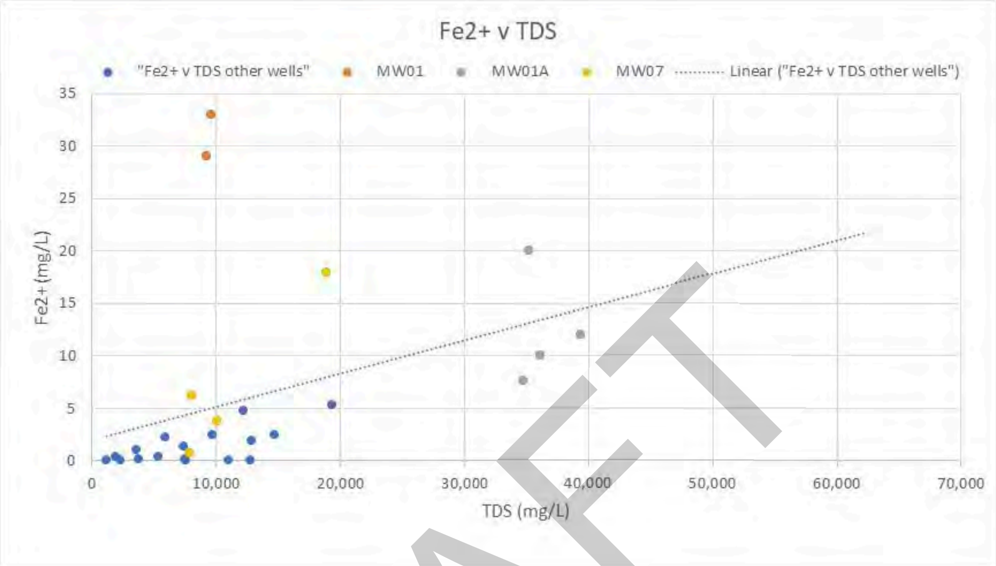


Figure 15: Ferrous Iron versus TDS Concentrations

Delta NO_3 was assessed by plotting NO_3 concentrations against C_{10}-C_{34} hydrocarbons. A decreasing trend is noted at MW03 as shown on Figure 16. Other locations do not show clear trends possibly due to seasonal variation in hydrocarbon concentrations. Despite this the overall concentrations of NO_3 were noted to decrease in the monitoring wells where the presence of hydrocarbons was reported. Based on the above, delta NO_3 of 1 mg/L has been adopted as a conservative input parameter for the model.

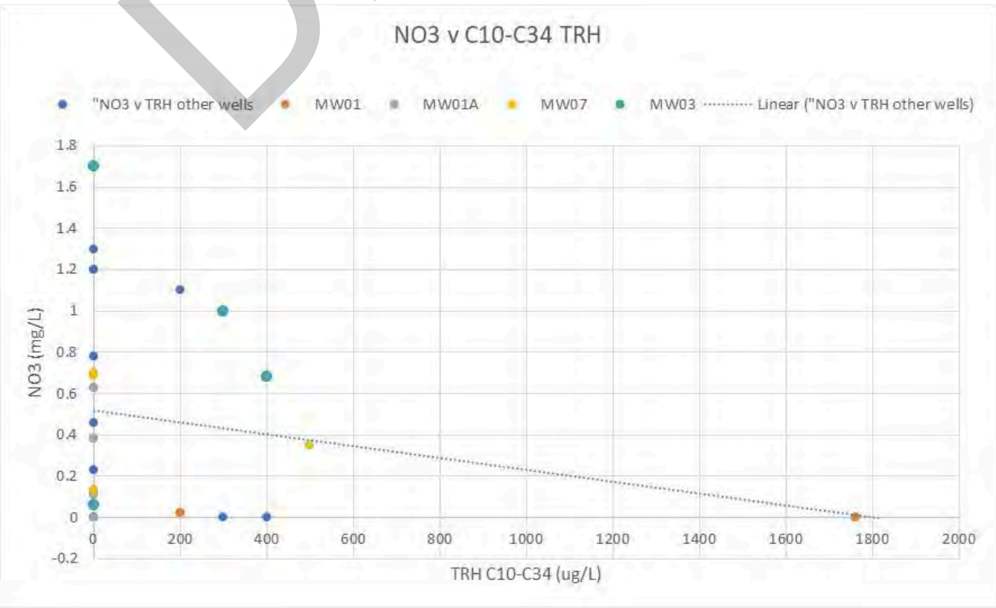


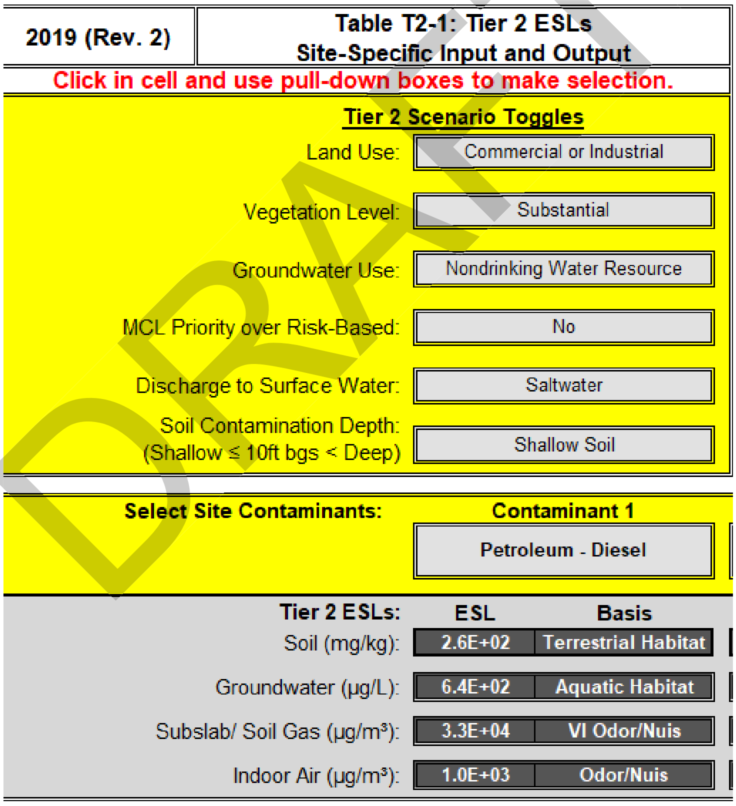
Figure 16: NO_3 versus TRH C_{10}-C_{34} Concentrations

5.2.2.5 *Assessment Criteria*

Total recoverable hydrocarbon fractions $>C_{10}$-C_{34} were adopted to represent groundwater contamination associated with the diesel spill in the predictive modelling. Due to the absence of Australian guideline values, the adopted environmental criteria for the modelling was sourced from Californian Environmental Screening Levels (ESLs) developed by San Francisco Bay Regional Water Quality Control Board, refer https://www.waterboards.ca.gov/sanfranciscobay/water_issues/programs/esl.html.

Figure 17 presents the adopted ESL of 640 µg/L for a petroleum mixture such as diesel and adopted site settings for marine aquatic ecosystem receptors. For the consideration of recreational use, guidance from the *Guidelines for Managing Risks in Recreational Water* published by the Natural Resource Management Ministerial Council (NRMMC) has been adopted. This guideline advocates a screening approach where *'a substance occurring in recreational water at a concentration of 10 times that stipulated in the drinking water guidelines may merit further consideration'*.

A value of 0.9mg/L was adopted based on the drinking water criteria of 0.09 mg/L presented in the document '*Petroleum Products in Drinking-water. Background document for development of WHO Guidelines for Drinking-water Quality*', 2008.



2019 (Rev. 2)

Table T2-1: Tier 2 ESLs
Site-Specific Input and Output

Click in cell and use pull-down boxes to make selection.

Tier 2 Scenario Toggles

Land Use: Commercial or Industrial
Vegetation Level: Substantial
Groundwater Use: Nondrinking Water Resource
MCL Priority over Risk-Based: No
Discharge to Surface Water: Saltwater
Soil Contamination Depth: (Shallow ≤ 10ft bgs < Deep): Shallow Soil

Select Site Contaminants: **Contaminant 1** **Petroleum - Diesel**

Tier 2 ESLs:	**ESL**	**Basis**
Soil (mg/kg):	2.6E+02	Terrestrial Habitat
Groundwater (µg/L):	6.4E+02	Aquatic Habitat
Subslab/ Soil Gas (µg/m³):	3.3E+04	VI Odor/Nuis
Indoor Air (µg/m³):	1.0E+03	Odor/Nuis

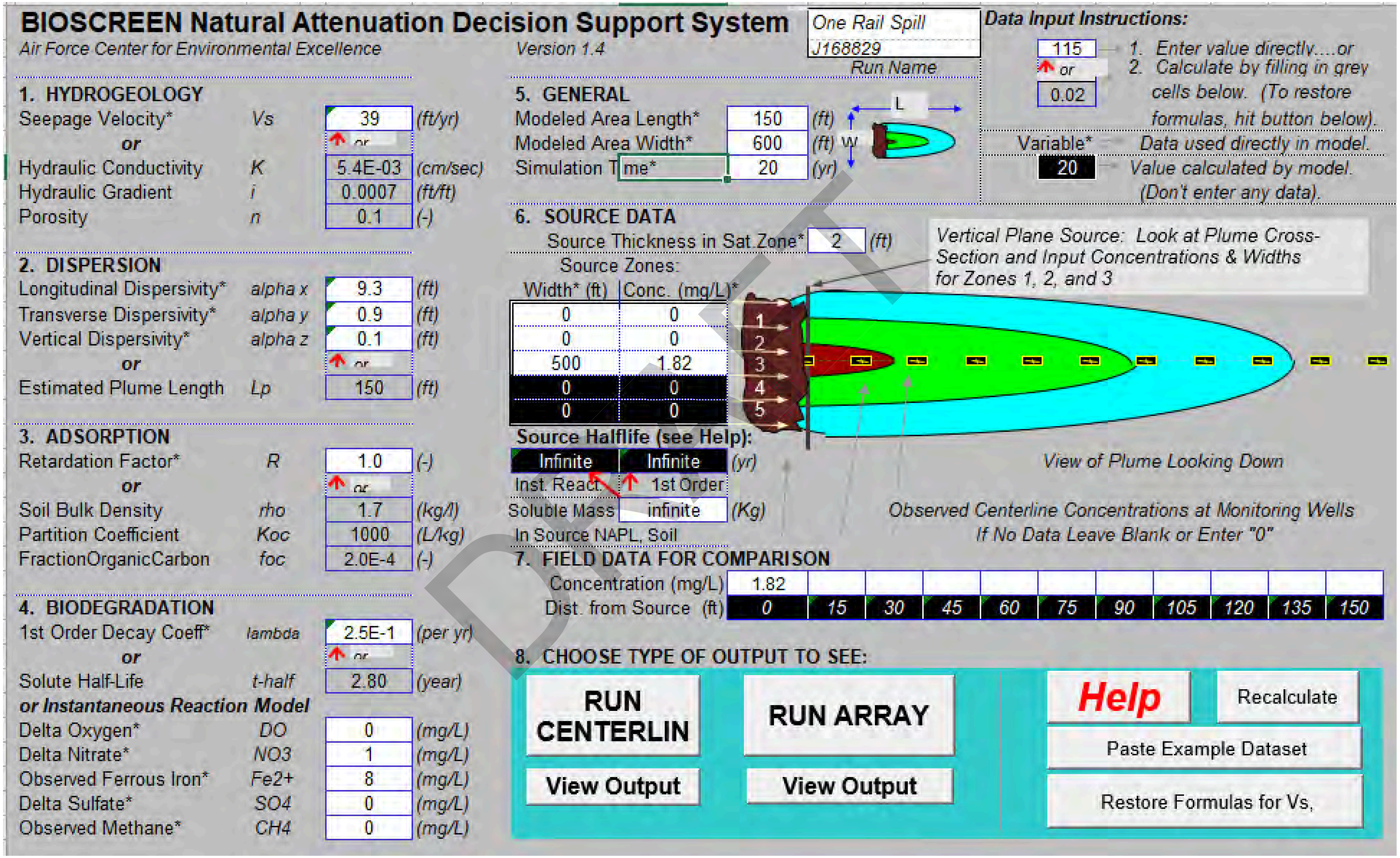
Figure 17: Diesel Fuel Aquatic Ecosystem Criteria (source California ESL)

5.2.2.6 *Input Summary*

Table 11 summarises the adopted input parameters and Figure 18 presents a BIOSCREEN input page.

Table 11: Input Parameters

Parameter	Value	Justification
Groundwater Hydraulics		
Hydraulic Conductivity	4.7 m/day or $5.4*10^{-3}$ cm/sec	Section 5.2.2.1
Hydraulic Gradient	0.0007 (dimensionless)	
Porosity	0.1 or 10% (dimensionless)	
Seepage Velocity	12 m/year or 39 ft/year	
Source Data		
Source Width	150 m or 500 feet	Figure 13
Source Thickness	0.6 m or 2 feet	The thickness of the source below groundwater level is based on seasonal groundwater level fluctuation
Concentration at source	1.82 mg/L - >C_{10}- C_{34}	Section 5.2.2.3
Modelling domain		
Modelled Area Length	46m or 150 feet	Figure 13
Modelled area width	600 feet	Assumed based on the source width
Dispersivity values		
Longitudinal	9.3 feet	Section 5.2.2.2
Transverse	0.9 feet	
Vertical	0.1 feet	
Contaminant Transport		
Retardation factor	1	It is assumed that there is no adsorption (most conservative approach) – Section 5.2.2.4
Half-life	2.8 years	Section 5.2.2.4
Delta Oxygen	0 mg/L	Section 5.2.2.4
Delta Nitrate	1 mg/L	
Observed Fe2+	8 mg/L	
Delta Sulphate	0 mg/L	
Observed Methane	0 mg/L	



BIOSCREEN Natural Attenuation Decision Support System
Air Force Center for Environmental Excellence
Version 1.4

Run Name: One Rail Spill
J168829

Data Input Instructions:
115 1. Enter value directly....or
or 2. Calculate by filling in grey cells below. (To restore formulas, hit button below).
0.02
Variable* Data used directly in model.
20 Value calculated by model. (Don't enter any data).

1. HYDROGEOLOGY
Seepage Velocity* Vs 39 (ft/yr)
or
Hydraulic Conductivity K 5.4E-03 (cm/sec)
Hydraulic Gradient i 0.0007 (ft/ft)
Porosity n 0.1 (-)

2. DISPERSION
Longitudinal Dispersivity* alpha x 9.3 (ft)
Transverse Dispersivity* alpha y 0.9 (ft)
Vertical Dispersivity* alpha z 0.1 (ft)
or
Estimated Plume Length Lp 150 (ft)

3. ADSORPTION
Retardation Factor* R 1.0 (-)
or
Soil Bulk Density rho 1.7 (kg/l)
Partition Coefficient Koc 1000 (L/kg)
FractionOrganicCarbon foc 2.0E-4 (-)

4. BIODEGRADATION
1st Order Decay Coeff* lambda 2.5E-1 (per yr)
or
Solute Half-Life t-half 2.80 (year)
or Instantaneous Reaction Model
Delta Oxygen* DO 0 (mg/L)
Delta Nitrate* NO3 1 (mg/L)
Observed Ferrous Iron* Fe2+ 8 (mg/L)
Delta Sulfate* SO4 0 (mg/L)
Observed Methane* CH4 0 (mg/L)

5. GENERAL
Modeled Area Length* 150 (ft)
Modeled Area Width* 600 (ft)
Simulation Time* 20 (yr)

6. SOURCE DATA
Source Thickness in Sat.Zone* 2 (ft)
Source Zones:

Width* (ft)	Conc. (mg/L)*
0	0
0	0
500	1.82
0	0
0	0

Source Halflife (see Help):

Infinite	Infinite	(yr)
Inst. React.	1st Order	
Soluble Mass	infinite	(Kg)

In Source NAPL, Soil

Vertical Plane Source: Look at Plume Cross-Section and Input Concentrations & Widths for Zones 1, 2, and 3

View of Plume Looking Down

Observed Centerline Concentrations at Monitoring Wells
If No Data Leave Blank or Enter "0"

7. FIELD DATA FOR COMPARISON

Concentration (mg/L)	1.82										
Dist. from Source (ft)	0	15	30	45	60	75	90	105	120	135	150

8. CHOOSE TYPE OF OUTPUT TO SEE:

Figure 18: BIOSCREEN input page

5.2.3 Modelling Results

The BIOSCREEN screenshot of the results is presented in Figure 19.

The model predicts that the plume will reach a steady state condition in 12 years. The modelling results on Figure 19 demonstrate that for the 'No Degradation' and 'Infinite Contaminant Mass' scenarios the concentrations of petroleum hydrocarbons representative of the diesel fuel range (sum of $>C_{10}$ to C_{34}) are unlikely to exceed the adopted environmental criteria of 640 µg/L (aquatic system protection) and 1,000 µg/L (recreational water use) and therefore, no unacceptable risks to the nearest aquatic ecosystem of Bleesers Creek and human health have been predicted.

It is important to note that some of the input parameters used for the most conservative 'No Degradation' scenario were based on a literature review rather than on site-specific testing and therefore require a sensitivity analysis. This is presented in Section 5.2.4.

5.2.4 Sensitivity Analysis

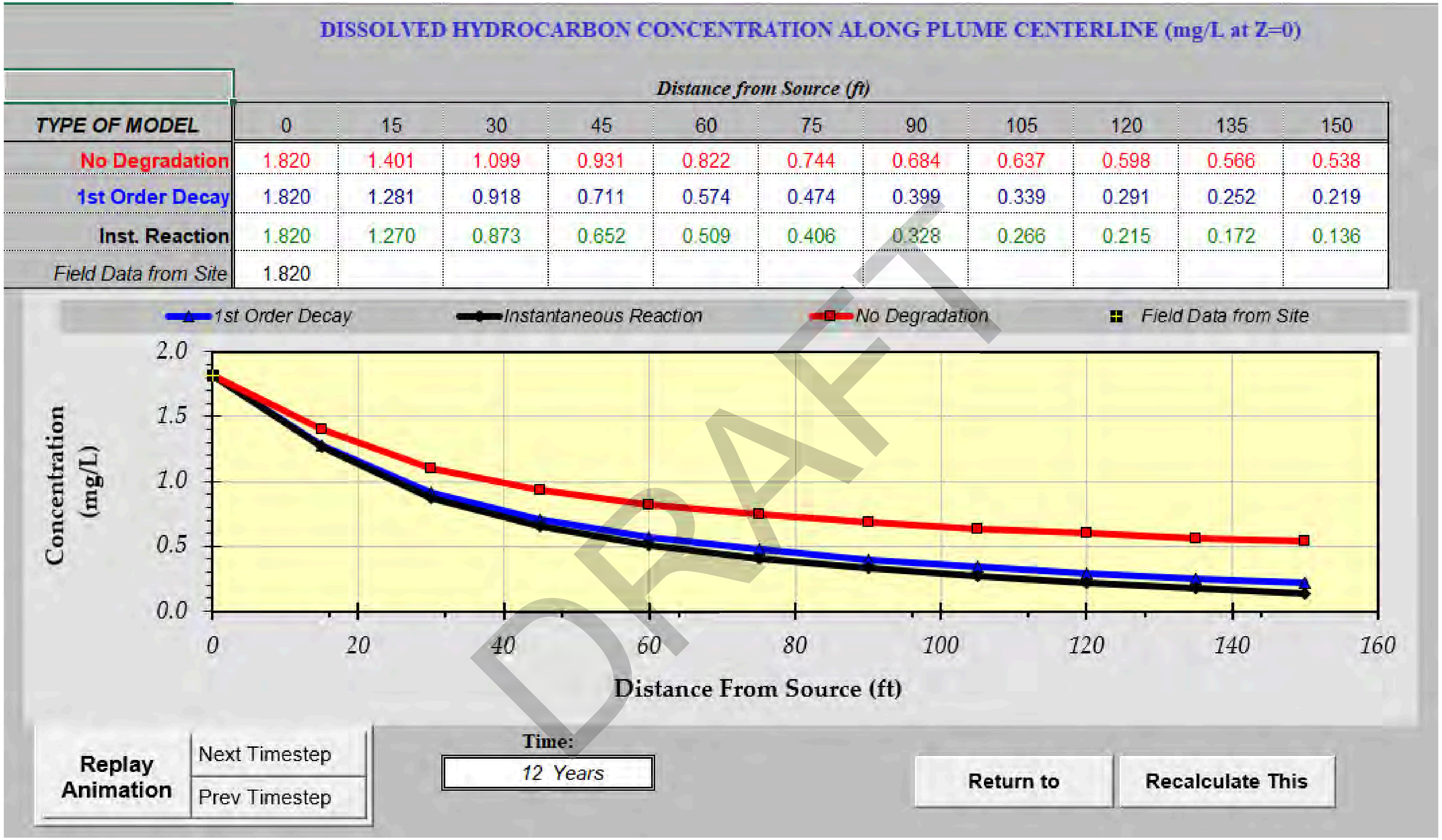
Sensitivity analyses have been undertaken for the two model parameters which would have the greatest influence on the modelling outcomes for the worst case 'No Degradation' scenario. These are:

- Plume dispersivity – although a default value recommended in the BIOSCREEN modelling manual was used, local soil properties may result in a narrower plume with a higher concentration migrating towards the receptor.
- Concentration at the source – the source concentration was increased to a maximum solubility of diesel range hydrocarbons of 3 mg/L as recommended in NEPM.

For the sensitivity analysis the plume dispersivity was reduced from 9.3 feet to 4.7 feet, the results are illustrated on Figure 20. This figure shows that assuming a lower plume dispersion the hydrocarbon concentrations were predicted to exceed the adopted aquatic ecosystem criteria only (at the worst-case 'No Degradation' scenario) with the plume to reach steady state conditions over a shorter period of eight years. However, the modelling results for the more realistic (albeit still conservative) first order decay scenario and the instantaneous reaction scenario still showed no adverse impacts on the sensitive receptor as well as on the human health.

For the source concentration sensitivity analysis, the source concentration was assumed to match the solubility limit of diesel range hydrocarbons of 3 mg/L. The results are illustrated on Figure 21. This figure shows that at the higher source concentration the hydrocarbons concentrations were predicted to exceed the adopted aquatic ecosystem criteria only at the worst-case 'No Degradation' scenario. However, as above, the modelling results for the first order decay and instantaneous reaction scenarios still showed no adverse impacts on the sensitive receptor.

Based on the sensitivity analyses conducted it can be demonstrated that, whilst changes to the most critical parameters drive the model to predict exceedances of the adopted aquatic ecosystem criteria only at the worst-case (unrealistic) modelling scenario, the more realistic scenarios which take into account natural hydrocarbon decays and/or natural biodegradation (whilst adopting highly conservative input parameters) predict no adverse impacts on the sensitive receptor, the nearest aquatic ecosystem of Bleesers Creek and to the human health if groundwater is theoretically used for recreational purposes.

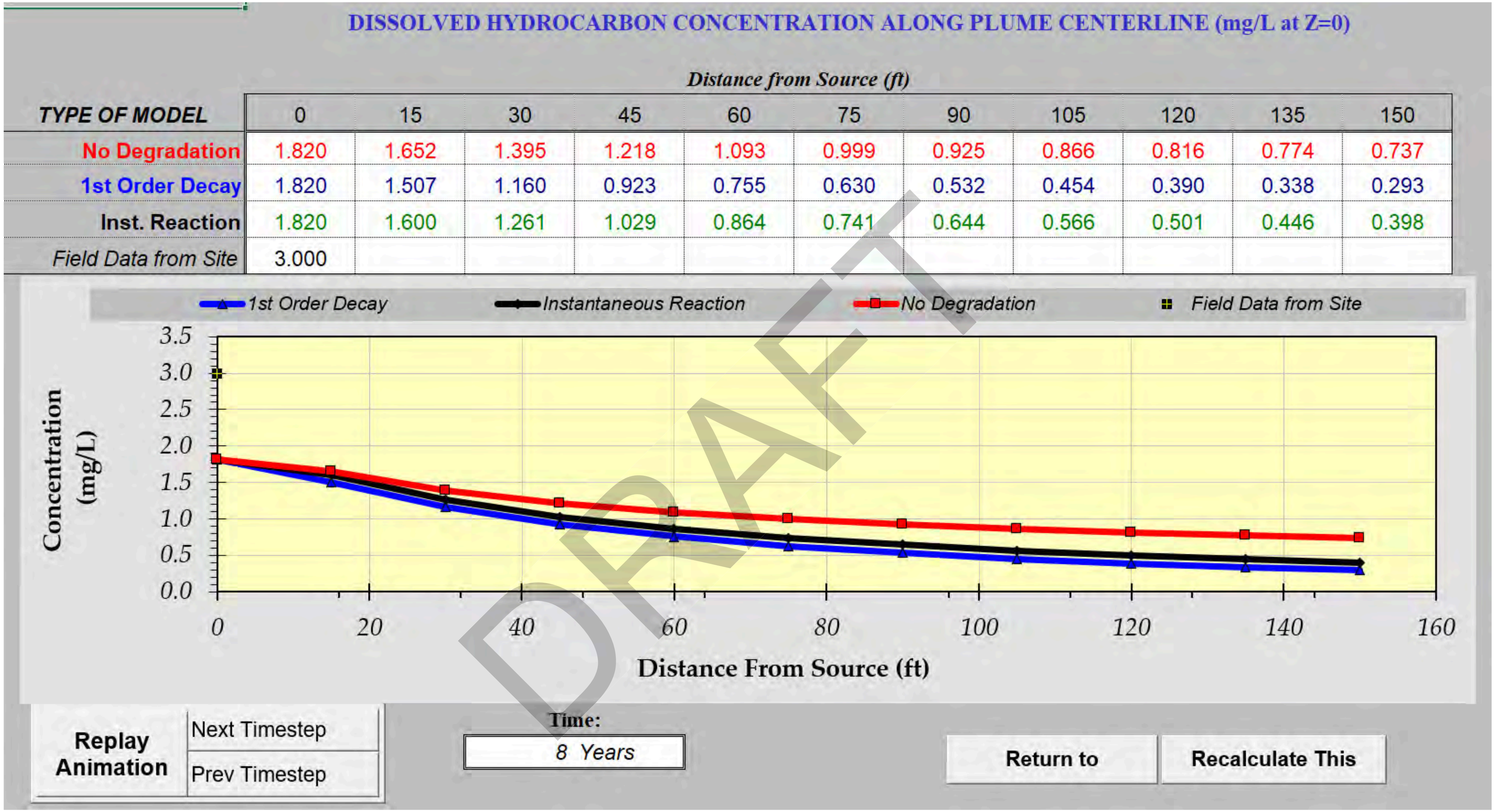


DISSOLVED HYDROCARBON CONCENTRATION ALONG PLUME CENTERLINE (mg/L at Z=0)

	Distance from Source (ft)										
TYPE OF MODEL	0	15	30	45	60	75	90	105	120	135	150
No Degradation	1.820	1.401	1.099	0.931	0.822	0.744	0.684	0.637	0.598	0.566	0.538
1st Order Decay	1.820	1.281	0.918	0.711	0.574	0.474	0.399	0.339	0.291	0.252	0.219
Inst. Reaction	1.820	1.270	0.873	0.652	0.509	0.406	0.328	0.266	0.215	0.172	0.136
Field Data from Site	1.820										

Time: 12 Years

Figure 19: BIOSCREEN Output

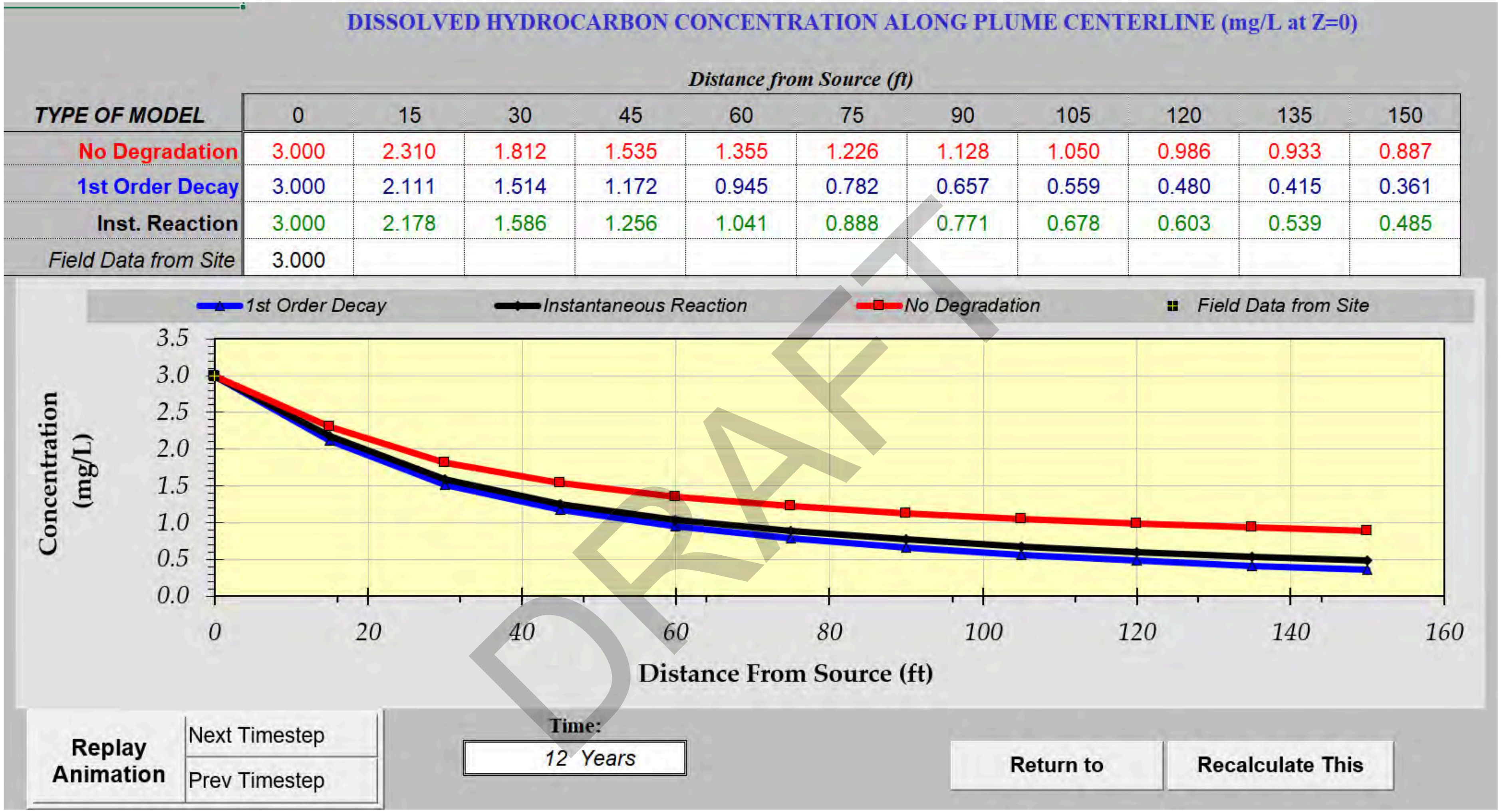


DISSOLVED HYDROCARBON CONCENTRATION ALONG PLUME CENTERLINE (mg/L at Z=0)

	Distance from Source (ft)										
TYPE OF MODEL	0	15	30	45	60	75	90	105	120	135	150
No Degradation	1.820	1.652	1.395	1.218	1.093	0.999	0.925	0.866	0.816	0.774	0.737
1st Order Decay	1.820	1.507	1.160	0.923	0.755	0.630	0.532	0.454	0.390	0.338	0.293
Inst. Reaction	1.820	1.600	1.261	1.029	0.864	0.741	0.644	0.566	0.501	0.446	0.398
Field Data from Site	3.000										

Time: 8 Years

Figure 20: BIOSCREEN Sensitivity - Dispersion



DISSOLVED HYDROCARBON CONCENTRATION ALONG PLUME CENTERLINE (mg/L at Z=0)

	Distance from Source (ft)										
TYPE OF MODEL	0	15	30	45	60	75	90	105	120	135	150
No Degradation	3.000	2.310	1.812	1.535	1.355	1.226	1.128	1.050	0.986	0.933	0.887
1st Order Decay	3.000	2.111	1.514	1.172	0.945	0.782	0.657	0.559	0.480	0.415	0.361
Inst. Reaction	3.000	2.178	1.586	1.256	1.041	0.888	0.771	0.678	0.603	0.539	0.485
Field Data from Site	3.000										

Time: 12 Years

Figure 21: BIOSCREEN Sensitivity – Source Concentration

5.3 Modelling Conclusions

BIOSCREEN modelling software was selected as it simulates conservative transport with no contaminant decay and plume retardation as well as in-situ decay and biodegradation.

The BIOSCREEN model predicted that a plume emerging from the diesel spill area would reach a steady state condition in 12 years at concentrations below the adopted criterion for the protection of the marine aquatic ecosystem of Bleesers Creek and adopted recreational use (human health criterion), even under the most conservative (worst-case) scenarios including infinite contaminant mass at the source and no natural decay or biodegradation of hydrocarbons in the plume.

Based on the sensitivity analyses conducted it was demonstrated that, whilst changes to the most critical parameters predict exceedances of the adopted aquatic ecosystem criteria (note human health) under the worst-case modelling scenario, the more realistic scenarios which take into account natural hydrocarbon decays and/or natural biodegradation (adopting highly conservative input parameters) predict no adverse impacts on the sensitive receptors.

It is concluded that based on the results and outcomes of spill remediation works, groundwater sampling and predictive modelling the reported concentrations of hydrocarbons within groundwater reported to date are unlikely to pose unacceptable risks to the sensitive receptors.

Additional groundwater sampling is required to verify the predictive modelling results and will be captured as part of the implementation of a Groundwater Monitoring and Management Plan (GMMP) developed for the site.

6 CONCLUSIONS AND RECOMMENDATIONS

6.1 Conclusions

Greencap was commissioned by Aurizon to prepare a DSI addendum following review of the DSI by the Auditor.

The objective was to address data gaps identified by the Auditor as part of the review. As per the additional works presented in this addendum report, Greencap considers that the nature and extent of contamination relating to the spill of diesel-fuel and subsequent remedial activities have been adequately assessed.

In situ impacts in soil and groundwater are not considered to pose and unacceptable risk to human health or the environment.

6.2 Recommendations

To ensure the current risk profile is maintained, the following works are recommended:

- Update and re-implementation of a Groundwater Monitoring and Management Plan, inclusive of:
    - Ongoing groundwater monitoring;
    - Annual review of data, including comparison to modelling outputs;
    - Review of appropriateness of monitoring program; and
    - Consideration of cessation of monitoring pending suitable data.
- Preparation of an Environmental Management Plan to address management of in-situ impacts for maintenance and any other future works.

March 2023

Diesel Spill – Detailed Site Investigation

Aurizon

Berrimah Freight Terminal, Export Drive, Berrimah NT

RESULTS SUMMARY TABLES (INCLUDING QAQC)

One Rail Diesel Spil - Soil Bores, Test Pits Validation Samples Results

						Inorganic	TRH						TPH					BTEXN						
						Moisture Content (dried @ 103°C)	C6-C10	C6-C10 - BTEX (F1)	TRH >C10-C16	C10-C16 - Napth (F2)	TRH >C16-C34	TRH >C34-C40	C6 - C9	C10 - C14	C15 - C28	C29-C36	+C10 - C36 (Sum of)	Benzene	Ethylbenzene	Toluene	Xylene (m & p)	Xylene (o)	Xylene Total	Naphthalene
						%	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg
					LOR	1	20	20	50	50	100	100	20	20	50	50	50	0.1	0.1	0.1	0.2	0.1	0.3	0.5
NEPM 2013 Table 1A(1) Comm/Ind D Soil HIL for Soil Contaminants, Sand																								
NEPM 2013 Table 1A(3) Comm/Ind D Soil HSL for Vapour Intrusion, Sand																								
0-1m								260		NL								3	NL	NL			230	NL
1-2m								370		NL								3	NL	NL			NL	NL
2-4m								630		NL								3	NL	NL			NL	NL
>4m								NL		NL								3	NL	NL			NL	NL
NEPM 2013 Table 1B(6) ESLs for Comm/Ind, Coarse Soil								215		170	1700	3300						75	165	135			180	370
NEPM 2013 Table 1B(7) Management Limits Comm / Ind, Coarse Soil							700		1000		3500	10000												
CRC Care (2011) HSL D (Comm/Ind) (Direct Contact)							26000		20000		27000	38000						430	27000	99000			81000	11000
CRC Care (2011) HSL Intrusive Maintenance Worker (Direct Contact)							82000		62000		85000	120000						1100	85000	120000			130000	29000
Location	Area	Depth (m)	Field_ID	Sample_Date	Lab_Report_#																			
SOIL BORE SAMPLES																								
BH03		0	BH03-0.00	4/06/2020	724546	5.4	<20	<20	<50	<50	110	110	<20	<20	90	70	160	<0.1	<0.1	<0.1	<0.2	<0.1	<0.3	<0.5
BH03		0.6	BH03-0.60	4/06/2020	724546	11	<20	<20	<50	<50	<100	<100	<20	<20	<50	<50	<50	<0.1	<0.1	<0.1	<0.2	<0.1	<0.3	<0.5
BH03		2	BH03-2.00	4/06/2020	724546	6.8	<20	<20	<50	<50	<100	<100	<20	<20	<50	<50	<50	<0.1	<0.1	<0.1	<0.2	<0.1	<0.3	<0.5
BH04		0	BH04-0.00	4/06/2020	724546	5	<20	<20	<50	<50	160	180	<20	<20	120	120	240	<0.1	<0.1	<0.1	<0.2	<0.1	<0.3	<0.5
BH06		0.7	BH06-0.70	4/06/2020	724546	8.6	<20	<20	<50	<50	<100	<100	<20	<20	<50	<50	<50	<0.1	<0.1	<0.1	<0.2	<0.1	<0.3	<0.5
BH07		0.5	BH07-0.50	4/06/2020	724546	10	<20	<20	<50	<50	<100	<100	<20	<20	<50	<50	<50	<0.1	<0.1	<0.1	<0.2	<0.1	<0.3	<0.5
BH07		1.35	BH07-1.35	4/06/2020	724546	8.3	<20	<20	<50	<50	<100	<100	<20	<20	<50	<50	<50	<0.1	<0.1	<0.1	<0.2	<0.1	<0.3	<0.5
BH08		2.5	BH08A-2.50	4/06/2020	724546	7.1	<20	<20	<50	<50	<100	<100	<20	<20	<50	<50	<50	<0.1	<0.1	<0.1	<0.2	<0.1	<0.3	<0.5
BH08		3.5	BH08A-3.50	4/06/2020	724546	18	<20	<20	<50	<50	<100	<100	<20	<20	<50	<50	<50	<0.1	<0.1	<0.1	<0.2	<0.1	<0.3	<0.5
BH12		0.03	BH12-0.03	4/06/2020	724546	4.7	<20	<20	<50	<50	180	230	<20	<20	96	170	266	<0.1	<0.1	<0.1	<0.2	<0.1	<0.3	<0.5
BH13		0.25	BH13-0.25	5/06/2020	724546	9	290	270	24000	24000	20000	10,000	<200	15000	32000	<5000	47000	<1	2.7	1.1	8.9	6.4	15	<5
BH13		0.55	BH13-0.55	5/06/2020	724546	15	<20	<20	<50	<50	<100	<100	<20	<20	<50	<50	<50	<0.1	<0.1	<0.1	<0.2	<0.1	<0.3	<0.5
BH14		0.25	BH14-0.25	5/06/2020	724546	3.8	470	430	20000	20000	16000	10,000	<200	13000	26000	<5000	39000	<1	6.1	4	20	12	32	<5
BH14		0.6	BH14-0.60	5/06/2020	724546	11	<20	<20	<50	<50	<100	<100	<20	<20	82	<50	82	<0.1	<0.1	<0.1	<0.2	<0.1	<0.3	<0.5
BH14		0.9	BH14-0.90	5/06/2020	724546	7.9	<20	<20	140	140	150	<100	<20	79	220	<50	299	<0.1	<0.1	<0.1	<0.2	<0.1	<0.3	<0.5
BH14		3.1	BH14-3.10	5/06/2020	724546	17	<20	<20	<50	<50	<100	<100	<20	<20	<50	<50	<50	<0.1	<0.1	<0.1	<0.2	<0.1	<0.3	<0.5
BH15		0.25	BH15-0.25	5/06/2020	724546	8.1	480	440	27000	27000	23000	10,000	<200	18000	36000	<5000	54000	<1	5.2	2.6	17	11	28	<5
BH15		0.3	BH15-0.30	5/06/2020	724546	7.8	<20	<20	550	550	730	<100	<20	270	1000	<50	1270	<0.1	<0.1	<0.1	<0.2	<0.1	<0.3	<0.5
BH15		0.8	BH15-0.80	5/06/2020	724546	6.9	<20	<20	<50	<50	<100	<100	<20	<20	<50	<50	<50	<0.1	<0.1	<0.1	<0.2	<0.1	<0.3	<0.5
BH15		3.05	BH15-3.05	5/06/2020	724546	15	<20	<20	<50	<50	<100	<100	<20	<20	<50	<50	<50	<0.1	<0.1	<0.1	<0.2	<0.1	<0.3	<0.5
BH16		0	BH16-0.00	5/06/2020	724546	7	<20	<20	<50	<50	<100	<100	<20	<20	<50	<50	<50	<0.1	<0.1	<0.1	<0.2	<0.1	<0.3	<0.5
BH16		0.3	BH16-0.30	5/06/2020	724546	9.3	<20	<20	<50	<50	<100	<100	<20	<20	<50	<50	<50	<0.1	<0.1	<0.1	<0.2	<0.1	<0.3	<0.5
BH17		0	BH17-0.00	5/06/2020	724546	6.5	<20	<20	<50	<50	<100	<100	<20	<20	<50	<50	<50	<0.1	<0.1	<0.1	<0.2	<0.1	<0.3	<0.5
BH17		0.45	BH17-0.45	5/06/2020	724546	9.1	45	43	1200	1200	990	<100	<20	740	1500	<50	2240	<0.1	0.3	0.1	1.1	0.7	1.8	<0.5
BH17		0.65	BH17-0.65	5/06/2020	726580	10	<20	<20	95	95	120	<100	<20	55	150	<50	215	<0.1	<0.1	<0.1	<0.2	<0.1	<0.3	<0.5
BH17		2.4	BH17-2.4	5/06/2020	726580	9.2	<20	<20	140	140	160	<100	<20	77	220	<50	297	<0.1	<0.1	<0.1	<0.2	<0.1	<0.3	<0.5
BH17		3.4	BH17-3.4	5/06/2020	726580	13	<20	<20	<50	<50	<100	<100	<20	<20	100	<50	100	<0.1	<0.1	<0.1	<0.2	<0.1	<0.3	<0.5
NON DESTRUCTIVE TEST PIT SAMPLES																								
NDTP01		0.5	NDTP01_0.5	10/06/2020	725276	10	<20	<20	<50	<50	<100	<100	<20	<20	<50	<50	<50	<0.1	<0.1	<0.1	<0.2	<0.1	<0.3	<0.5
NDTP02		0.5	NDTP02_0.5	10/06/2020	725276	7.9	<20	<20	<50	<50	<100	<100	<20	<20	<50	<50	<50	<0.1	<0.1	<0.1	<0.2	<0.1	<0.3	<0.5
NDTP03		0.5	NDTP03_0.5	10/06/2020	725276	7.4	<20	<20	<50	<50	<100	<100	<20	<20	<50	<50	<50	<0.1	<0.1	<0.1	<0.2	<0.1	<0.3	<0.5
NDTP04		0.6	NDTP04_0.6	10/06/2020	725276	2.4	<20	<20	<50	<50	<100	<100	<20	<20	<50	<50	<50	<0.1	<0.1	<0.1	<0.2	<0.1	<0.3	<0.5
NDTP05		0.2	NDTP05_0.2	10/06/2020	725276	4.9	<200	<200	17000	17000	15000	<500	<200	11000	23000	<250	34000	<1	2.3	<1	11	7.4	18	<10
NDTP06		0.35	NDTP06_0.35	10/06/2020	725276	7.1	<20	<20	<50	<50	<100	<100	<20	<20	<50	64	64	<0.1	<0.1	<0.1	<0.2	<0.1	<0.3	<0.5
NDTP07		1.1	NDTP07	16/07/2020	732705	7.3	700	590	31000	30997.5	20000	<100	270	19000	33000	96	52096	<0.4	18	11	53	33	86	2.5
NDTP08		1.1	NDTP08	16/07/2020	732705	11	<20	<20	<50	<50	<100	<100	<20	<20	<50	<50	<50	<0.1	<0.1	<0.1	<0.2	<0.1	<0.3	<0.5
NDTP09		0.3	NDTP09	16/07/2020	732705	6.0	270	250	14000	14000	10000	510	97	8400	16000	200	24600	<0.5	3	2	11	6.5	17	<2.5
NDTP10		1.5	NDTP10	16/07/2020	732705	3.2	<20	<20	<50	<50	<100	<100	<20	<20	<50	<50	<50	<0.1	<0.1	<0.1	<0.2	<0.1	<0.3	<0.5

One Rail Diesel Spil - Soil Bores, Test Pits Validation Samples Results

						Inorganic	TRH						TPH					BTEXN						
						Moisture Content (dried @ 103°C)	C6-C10	C6-C10 - BTEX (F1)	TRH >C10-C16	C10-C16 - Napth (F2)	TRH >C16-C34	TRH >C34-C40	C6 - C9	C10 - C14	C15 - C28	C29-C36	+C10 - C36 (Sum of)	Benzene	Ethylbenzene	Toluene	Xylene (m & p)	Xylene (o)	Xylene Total	Naphthalene
						%	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg
					LOR	1	20	20	50	50	100	100	20	20	50	50	50	0.1	0.1	0.1	0.2	0.1	0.3	0.5
NEPM 2013 Table 1A(1) Comm/Ind D Soil HIL for Soil Contaminants, Sand																								
NEPM 2013 Table 1A(3) Comm/Ind D Soil HSL for Vapour Intrusion, Sand																								
0-1m								260		NL								3	NL	NL			230	NL
1-2m								370		NL								3	NL	NL			NL	NL
2-4m								630		NL								3	NL	NL			NL	NL
>4m								NL		NL								3	NL	NL			NL	NL
NEPM 2013 Table 1B(6) ESLs for Comm/Ind, Coarse Soil								215		170	1700	3300						75	165	135			180	370
NEPM 2013 Table 1B(7) Management Limits Comm / Ind, Coarse Soil							700		1000		3500	10000												
CRC Care (2011) HSL D (Comm/Ind) (Direct Contact)							26000		20000		27000	38000						430	27000	99000			81000	11000
CRC Care (2011) HSL Intrusive Maintenance Worker (Direct Contact)							82000		62000		85000	120000						1100	85000	120000			130000	29000
Location	Area	Depth (m)	Field_ID	Sample_Date	Lab_Report_#																			
TEST PIT SAMPLES																								
TP05		1	TP05-1.00	3/06/2020	724546	30	<20	<20	<50	<50	<100	<100	<20	<20	<50	<50	<50	<0.1	<0.1	<0.1	<0.2	<0.1	<0.3	<0.5
TP07		1.2	TP07-1.20	3/06/2020	724546	46	<20	<20	<50	<50	<100	<100	<20	<20	<50	<50	<50	<0.1	<0.1	<0.1	<0.2	<0.1	<0.3	<0.5
TP08		1.7	TP08-1.70	3/06/2020	724546	19	<20	<20	<50	<50	<100	<100	<20	<20	<50	<50	<50	<0.1	<0.1	<0.1	<0.2	<0.1	<0.3	<0.5
TP09		0	TP09-0.00	3/06/2020	724546	9	<20	<20	<50	<50	<100	<100	<20	<20	<50	<50	<50	<0.1	<0.1	<0.1	<0.2	<0.1	<0.3	<0.5
TP10		0.25	TP10-0.25	5/06/2020	724546	2.7	<20	<20	<50	<50	<100	<100	<20	<20	<50	<50	<50	<0.1	<0.1	<0.1	<0.2	<0.1	<0.3	<0.5
TP11		0.35	TP11_0.35	10/06/2020	725276	9	110	100	7200	7199	7800	730	<40	4600	10000	1000	15600	<0.2	<0.2	<0.2	3.2	2.2	5.4	1.5
TP11		0.8	TP11_0.80	10/06/2020	725276	11	<20	<20	90	90	120	<100	<20	47	150	<50	197	<0.1	<0.1	<0.1	<0.2	<0.1	<0.3	<0.5
TP12		0	TP12_0.0	10/06/2020	725276	<1	<20	<20	<50	<50	170	250	<20	<20	86	170	256	<0.1	<0.1	<0.1	<0.2	<0.1	<0.3	<0.5
TP12		0.6	TP12_0.6	10/06/2020	725276	11	<20	<20	<50	<50	<100	<100	<20	<20	<50	<50	<50	<0.1	<0.1	<0.1	<0.2	<0.1	<0.3	<0.5
TP14		0	TP14_0.0	10/06/2020	726613	1.5	<20	<20	<50	<50	<100	<100	<20	<20	<50	<50	<50	<0.1	<0.1	<0.1	<0.2	<0.1	<0.3	<0.5
TP14		0.4	TP14_0.4	10/06/2020	726613	10	<20	<20	<50	<50	<100	<100	<20	<20	<50	<50	<50	<0.1	<0.1	<0.1	<0.2	<0.1	<0.3	<0.5
TP15		0.3	TP15_0.3	10/06/2020	725276	8.2	<20	<20	610	610	1900	240	<20	210	2000	440	2650	<0.1	<0.1	<0.1	<0.2	<0.1	<0.3	<0.5
TP17		0.15	TP17_0.15	10/06/2020	726613	8.8	<20	<20	12	120	370	<100	<20	<20	480	<50	480	<0.1	<0.1	<0.1	<0.2	<0.1	<0.3	<0.5
TP18		0	TP18_0.0	10/06/2020	725276	2.3	<20	<20	550	550	1600	<100	<20	170	2000	<50	2170	<0.1	<0.1	<0.1	<0.2	<0.1	<0.3	<0.5
TP18		0.1	TP18_0.1	10/06/2020	725276	5.5	<20	<20	360	360	1100	<100	<20	110	1400	<50	1510	<0.1	<0.1	<0.1	<0.2	<0.1	<0.3	<0.5
TP19		0.35	TP19_0.35	10/06/2020	725276	15	<20	<20	<50	<50	<100	<100	<20	<20	<50	<50	<50	<0.1	<0.1	<0.1	<0.2	<0.1	<0.3	<0.5
TP20		0.9	TP20_0.9	10/06/2020	725276	8.7	<20	<20	<50	<50	<100	<100	<20	<20	<50	<50	<50	<0.1	<0.1	<0.1	<0.2	<0.1	<0.3	<0.5
TP21		0.35	TP21_0.35	10/06/2020	725276	6	<20	<20	<50	<50	<100	<100	<20	<20	<50	<50	<50	<0.1	<0.1	<0.1	<0.2	<0.1	<0.3	<0.5
TP22		0.35	TP22_0.35	10/06/2020	725276	8.2	<20	<20	<50	<50	<100	<100	<20	<20	<50	<50	<50	<0.1	<0.1	<0.1	<0.2	<0.1	<0.3	<0.5
TP24		0.3	TP24_0.3	10/06/2020	725276	6.9	<20	<20	<50	<50	1000	490	<20	<20	440	870	1310	<0.1	<0.1	<0.1	<0.2	<0.1	<0.3	<0.5
TP26		0.35	TP26_0.35	10/06/2020	725276	5.4	<20	<20	<50	<50	<100	<100	<20	<20	<50	<50	<50	<0.1	<0.1	<0.1	<0.2	<0.1	<0.3	<0.5
TP27		0.35	TP27_0.35	10/06/2020	725276	2.7	<20	<20	600	600	570	<100	<20	340	860	<50	1200	<0.1	<0.1	<0.1	0.2	0.2	0.4	<0.5
TP27A		0.35	TP27A_0.35	11/06/2020	725527	6.7	<20	<20	<50	<50	<100	<100	<20	<20	<50	<50	<50	<0.1	<0.1	<0.1	<0.2	<0.1	<0.3	<0.5
TP27A		0.45	TP27A_0.45	11/06/2020	725527	8.8	<20	<20	<50	<50	<100	<100	<20	<20	<50	<50	<50	<0.1	<0.1	<0.1	<0.2	<0.1	<0.3	<0.5
TP28		0.45	TP28_0.45	10/06/2020	725276	10	<20	<20	<50	<50	<100	<100	<20	<20	<50	<50	<50	<0.1	<0.1	<0.1	<0.2	<0.1	<0.3	<0.5
TP29		0.35	TP29_0.35	10/06/2020	725276	7.8	<200	<200	8000	8000	8000	<500	<200	4900	12000	<250	16900	<1	<1	<1	<2	<1	<3	<5
TP29		1	TP29_1.0	10/06/2020	725276	10	<20	<20	<50	<50	<100	<100	<20	25	75	<50	100	<0.1	<0.1	<0.1	<0.2	<0.1	<0.3	<0.5
TP30		0.6	TP30_0.6	19/06/2020	727254	12	<20	<20	<50	<50	<100	<100	<20	<20	<50	<50	<50	<0.1	<0.1	<0.1	<0.2	<0.1	<0.3	<0.5
TP31		0	TP31_0.0	19/06/2020	727254	<1	<20	<20	<50	<50	720	<100	<20	<20	840	<50	840	<0.1	<0.1	<0.1	<0.2	<0.1	<0.3	<0.5
TP34		0.35	TP34_0.35	16/07/2020	732705	4.5	<20	<20	<50	<50	<100	<100	<20	<20	67	<50	67	<0.1	<0.1	<0.1	<0.2	<0.1	<0.3	<0.5
TP35		1.05	TP35_1.05	24/08/2020	740295	11	30	30	3700	3700	4800	<100	<20	2000	6000	<50	8000	<0.1	<0.1	<0.1	0.2	0.3	0.5	<0.5
TP36		1	TP36_1.0	26/08/2020	740295	11	<20	<20	<50	<50	<100	<100	<20	<20	<50	<50	<50	<0.1	<0.1	<0.1	<0.2	<0.1	<0.3	<0.5
TP36		1.5	TP36_1.5	26/08/2020	740295	11	<20	<20	<50	<50	<100	<100	<20	<20	<50	<50	<50	<0.1	<0.1	<0.1	<0.2	<0.1	<0.3	<0.5
TP37		1.6	TP37_1.6	26/08/2020	740295	11	91	86	3400	3400	3400	<100	23	2200	4200	<50	6400	<0.1	0.7	0.2	2	1.8	4.4	<0.5
MONITORING WELL INSTALLATION SOIL SAMPLES																								
MW01		3	MW01_3.0	16/07/2020	732705	13	<20	<20	<50	<50	<100	<100	<20	<20	<50	<50	<50	<0.1	<0.1	<0.1	<0.2	<0.1	<0.3	<0.5
MW02		2.2	MW02_2.2	16/07/2020	732705	12	<20	<20	<50	<50	<100	<100	<20	<20	<50	<50	<50	<0.1	<0.1	<0.1	<0.2	<0.1	<0.3	<0.5
MW03		3.4	MW03_3.4	16/07/2020	732705	10	<20	<20	<50	<50	<100	<100	<20	<20	<50	<50	<50	<0.1	<0.1	<0.1	<0.2	<0.1	<0.3	<0.5
MW04		3.5	MW04_3.5	16/07/2020	732705	19	<20	<20	<50	<50	<100	<100	<20	<20	<50	<50	<50	<0.1	<0.1	<0.1	<0.2	<0.1	<0.3	<0.5

One Rail Diesel Spil - Soil Bores, Test Pits Validation Samples Results

						Inorganic	TRH						TPH					BTEXN						
						Moisture Content (dried @ 103°C)	C6-C10	C6-C10 - BTEX (F1)	TRH >C10-C16	C10-C16 - Napth (F2)	TRH >C16-C34	TRH >C34-C40	C6 - C9	C10 - C14	C15 - C28	C29-C36	+C10 - C36 (Sum of)	Benzene	Ethylbenzene	Toluene	Xylene (m & p)	Xylene (o)	Xylene Total	Naphthalene
						%	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg
					LOR	1	20	20	50	50	100	100	20	20	50	50	50	0.1	0.1	0.1	0.2	0.1	0.3	0.5
NEPM 2013 Table 1A(1) Comm/Ind D Soil HIL for Soil Contaminants, Sand																								
NEPM 2013 Table 1A(3) Comm/Ind D Soil HSL for Vapour Intrusion, Sand																								
0-1m								260		NL								3	NL	NL			230	NL
1-2m								370		NL								3	NL	NL			NL	NL
2-4m								630		NL								3	NL	NL			NL	NL
>4m								NL		NL								3	NL	NL			NL	NL
NEPM 2013 Table 1B(6) ESLs for Comm/Ind, Coarse Soil								215		170	1700	3300						75	165	135			180	370
NEPM 2013 Table 1B(7) Management Limits Comm / Ind, Coarse Soil							700		1000		3500	10000												
CRC Care (2011) HSL D (Comm/Ind) (Direct Contact)							26000		20000		27000	38000						430	27000	99000			81000	11000
CRC Care (2011) HSL Intrusive Maintenance Worker (Direct Contact)							82000		62000		85000	120000						1100	85000	120000			130000	29000
Location	Area	Depth (m)	Field_ID	Sample_Date	Lab_Report_#																			
VALIDATION SAMPLES																								
V02	Trench b/w Aux & Ramp	0.03	V02_0.03	16/06/2020	726076	6.5	240	220	14000	14000	15000	<100	<200	8100	22000	190	30290	<1	2.4	1.3	8.5	5.6	14	<5
V03	Trench b/w Aux & Ramp	0.03	V03_0.03	16/06/2020	726076	5	<20	<20	<50	<50	<100	<100	<20	<20	<50	<50	<50	<0.1	<0.1	<0.1	<0.2	<0.1	<0.3	<0.5
V04	Trench b/w Aux & Ramp	0.03	V04_0.03	16/06/2020	726076	6.4	<200	<200	5500	5500	5200	<100	<200	3600	7800	<50	11400	<1	1.2	<1	4.1	2.6	6.7	<5
V05	Trench b/w Aux & Ramp	0.03	V05_0.03	16/06/2020	726076	7.5	<200	<200	4500	4500	5100	<100	<200	2600	7400	<50	10000	<1	<1	<1	<2	0.7	<3	<5
V06	Trench b/w Aux & Ramp	0.05	V06_0.05	16/06/2020	726076	6.6	<200	<200	5600	5600	7700	<100	<200	2900	11000	<50	13900	<1	<1	<1	<2	<0.4	<3	<5
V07	Trench b/w Aux & Ramp	0.06	V07_0.06	16/06/2020	726076	6.3	<20	<20	<50	<50	<100	<100	<20	<20	<50	<50	<50	<0.1	<0.1	<0.1	<0.2	<0.1	<0.3	<0.5
V08	Trench b/w Aux & Ramp	0.04	V08_0.04	16/06/2020	726076	5.1	<20	<20	<50	<50	<100	<100	<20	<20	97	<50	97	<0.1	<0.1	<0.1	<0.2	<0.1	<0.3	<0.5
V09	Trench b/w Aux & Ramp	0.04	V09_0.04	16/06/2020	726076	4.5	<20	<20	<50	<50	<100	<100	<20	<20	90	<50	90	<0.1	<0.1	<0.1	<0.2	<0.1	<0.3	<0.5
V10	Trench b/w Aux & Ramp	0.04	V10_0.04	16/06/2020	726076	4	<20	<20	<50	<50	<100	<100	<20	<20	<50	<50	<50	<0.1	<0.1	<0.1	<0.2	<0.1	<0.3	<0.5
V11	Trench b/w Aux & Ramp	0.03	V11_0.03	16/06/2020	726076	4.3	<20	<20	<50	<50	<100	<100	<20	<20	<50	<50	<50	<0.1	<0.1	<0.1	<0.2	<0.1	<0.3	<0.5
V12	Trench b/w Aux & Ramp	0.025	V12_0.025	16/06/2020	726076	3.5	<200	<200	20000	20000	19000	<100	<200	12000	29000	69	41069	<1	1.3	<1	4.4	3.2	7.6	<5
V13	Trench b/w Aux & Ramp	0.05	V13_0.05	16/06/2020	726076	9.1	<20	<20	<50	<50	<100	<100	<20	<20	<50	<50	<50	<0.1	<0.1	<0.1	<0.2	<0.1	<0.3	<0.5
V14	1/Aux Road	0.03	V14_0.03	16/06/2020	726076	2.3	<20	<20	480	480	1700	<100	<20	160	2100	<50	2260	<0.1	<0.1	<0.1	<0.2	<0.1	<0.3	<0.5
V15	1/Aux Road	0.03	V15_0.03	16/06/2020	726076	1.7	<20	<20	330	330	1400	<100	<20	98	1700	<50	1798	<0.1	<0.1	<0.1	<0.2	<0.1	<0.3	<0.5
V16	1/Aux Road	0.03	V16_0.03	16/06/2020	726076	1.6	<20	<20	320	320	1800	<100	<20	61	2100	<50	2161	<0.1	<0.1	<0.1	<0.2	<0.1	<0.3	<0.5
V17	1/Aux Road	0.03	V17_0.03	16/06/2020	726076	<1	<20	<20	300	300	840	<100	<20	99	1100	<50	1199	<0.1	<0.1	<0.1	<0.2	<0.1	<0.3	<0.5
V18	1/Aux Road	0.03	V18_0.03	16/06/2020	726076	2.8	<200	<200	25000	25000	38000	170	<200	12000	53000	420	65420	<1	<1	<1	2.3	1.9	4.2	<5
V19	1/Aux Road	0.03	V19_0.03	16/06/2020	726076	1.7	<200	<200	3500	3500	7700	<100	<200	1300	10000	150	11450	<1	<1	<1	<2	<1	<3	<5
V20	1/Aux Road	0	V20	24/08/2020	740295	1.6	< 20	< 20	54	54	1500	< 100	< 20	< 20	1500	< 50	1500	< 0.1	< 0.1	< 0.1	< 0.2	< 0.1	< 0.3	< 0.5
V21	1/Aux Road	0	V21	24/08/2020	740295	6.8	< 20	< 20	< 50	< 50	< 100	< 100	< 20	< 20	< 50	< 50	< 50	< 0.1	< 0.1	< 0.1	< 0.2	< 0.1	< 0.3	< 0.5
V22	1/Aux Road	0	V22	24/08/2020	740295	6.9	< 20	< 20	< 50	< 50	< 100	< 100	< 20	< 20	< 50	< 50	< 50	< 0.1	< 0.1	< 0.1	< 0.2	< 0.1	< 0.3	< 0.5
V23	1/Aux Road	0	V23	24/08/2020	740295	5.8	< 20	< 20	< 50	< 50	< 100	< 100	< 20	< 20	< 50	< 50	< 50	< 0.1	< 0.1	< 0.1	< 0.2	< 0.1	< 0.3	< 0.5
V24	1/Aux Road	0	V24	24/08/2020	740295	6.6	< 20	< 20	< 50	< 50	< 100	< 100	< 20	< 20	< 50	< 50	< 50	< 0.1	< 0.1	< 0.1	< 0.2	< 0.1	< 0.3	< 0.5
V25	1/Aux Road	0	V25	24/08/2020	740295	8.3	< 20	< 20	< 50	< 50	< 100	< 100	< 20	< 20	< 50	< 50	< 50	< 0.1	< 0.1	< 0.1	< 0.2	< 0.1	< 0.3	< 0.5
V26	1/Aux Road	0	V26	24/08/2020	740295	7.2	< 20	< 20	< 50	< 50	< 100	< 100	< 20	< 20	< 50	< 50	< 50	< 0.1	< 0.1	< 0.1	< 0.2	< 0.1	< 0.3	< 0.5
V27	1/Aux Road	0	V27	24/08/2020	740295	7.1	< 20	< 20	< 50	< 50	< 100	< 100	< 20	< 20	< 50	< 50	< 50	< 0.1	< 0.1	< 0.1	< 0.2	< 0.1	< 0.3	< 0.5
V28	1/Aux Road	0	V28	24/08/2020	740295	7.7	< 20	< 20	160	160	< 100	< 100	< 20	23	110	< 50	133	< 0.1	< 0.1	< 0.1	< 0.2	< 0.1	< 0.3	< 0.5
V29	1/Aux Road	0	V29	24/08/2020	740295	4.4	< 20	< 20	< 50	< 50	220	< 100	< 20	< 20	210	< 50	210	< 0.1	< 0.1	< 0.1	< 0.2	< 0.1	< 0.3	< 0.5
V30	1/Aux Road	0	V30	24/08/2020	740295	1.2	< 20	< 20	< 50	< 50	< 100	< 100	< 20	< 20	54	< 50	54	< 0.1	< 0.1	< 0.1	< 0.2	< 0.1	< 0.3	< 0.5
V57	West Exc - N	1.5	V57	26/08/2020	740295	9.2	< 20	< 20	< 50	< 50	< 100	< 100	< 20	< 20	< 50	< 50	< 50	< 0.1	< 0.1	< 0.1	< 0.2	< 0.1	< 0.3	< 0.5
V60	West Exc - E	1.5	V60	26/08/2020	740295	13	< 20	< 20	< 50	< 50	< 100	< 100	< 20	< 20	73	< 50	73	< 0.1	< 0.1	< 0.1	< 0.2	< 0.1	< 0.3	< 0.5
V63	West Exc - B	1.75	V63	26/08/2020	740295	11	< 20	< 20	180	180	< 100	< 100	< 20	31	100	< 50	131	< 0.1	< 0.1	< 0.1	< 0.2	< 0.1	< 0.3	< 0.5
V64	West Exc - S	1.5	V64	26/08/2020	740295	11	< 20	< 20	< 50	< 50	< 100	< 100	< 20	< 20	< 50	< 50	< 50	< 0.1	< 0.1	< 0.1	< 0.2	< 0.1	< 0.3	< 0.5
V65	West Exc - S	0.75	V65	26/08/2020	740295	10	< 20	< 20	< 50	< 50	< 100	< 100	< 20	< 20	< 50	< 50	< 50	< 0.1	< 0.1	< 0.1	< 0.2	< 0.1	< 0.3	< 0.5
V66	West Exc - S	0	V66	26/08/2020	740295	4.4	< 20	< 20	150	150	280	< 100	< 20	67	360	< 50	427	< 0.1	< 0.1	< 0.1	< 0.2	< 0.1	< 0.3	< 0.5
V67	West Exc - W	1.5	V67	26/08/2020	740295	10	< 20	< 20	< 50	< 50	< 100	< 100	< 20	< 20	< 50	< 50	< 50	< 0.1	< 0.1	< 0.1	< 0.2	< 0.1	< 0.3	< 0.5
V68	West Exc - W	0.75	V68	26/08/2020	740295	9.6	< 20	< 20	< 50	< 50	< 100	< 100	< 20	< 20	< 50	< 50	< 50	< 0.1	< 0.1	< 0.1	< 0.2	< 0.1	< 0.3	< 0.5
V69	West Exc - W	0	V69	26/08/2020	740295	8.4	< 20	< 20	< 50	< 50	140	< 100	< 20	< 20	130	< 50	130	< 0.1	< 0.1	< 0.1	< 0.2	< 0.1	< 0.3	< 0.5
V70	West Exc - B	2	V70	26/08/2020	740295	13	< 20	< 20	< 50	< 50	< 100	< 100	< 20	< 20	< 50	< 50	< 50	< 0.1	< 0.1	< 0.1	< 0.2	< 0.1	< 0.3	< 0.5
V71	East Exc - W	1.5	V71	26/08/2020	740295	13	< 20	< 20	160	160	< 100	< 100	< 20	50	88	< 50	138	< 0.1	< 0.1	< 0.1	< 0.2	< 0.1	< 0.3	< 0.5
V72	East Exc - W	0.75	V72	26/08/2020	740295	13	300	290	5700	5700	6000	< 100	64	3800	7100	< 50	10900	< 0.1	0.9	0.2	4	2	6	< 0.5
V73	East Exc - W	0	V73	26/08/2020	740295	9.5	< 20	< 20	270	270	330	< 100	< 20	150	420	< 50	570	< 0.1	< 0.1	< 0.1	< 0.2	< 0.1	< 0.3	< 0.5
V74	East Exc - S	1.5	V74	26/08/2020	740295	11	< 20	< 20	410	410	470	< 100	< 20	240	590	< 50	830	< 0.1	< 0.1	< 0.1	< 0.2	< 0.1	< 0.3	< 0.5
V77	East Exc - B	2	V77	26/08/2020	740295	12	< 20	< 20	< 50	< 50	< 100	< 100	< 20	< 20	63	< 50	63	< 0.1	< 0.1	< 0.1	< 0.2	< 0.1	< 0.3	< 0.5
V78	East Exc - E	1.5	V78	26/08/2020	740295	10	< 20	< 20	< 50	< 50	< 100	< 100	< 20	< 20	< 50	< 50	< 50	< 0.1	< 0.1	< 0.1	< 0.2	< 0.1	< 0.3	< 0.5
V79	East Exc - E	0.75	V79	26/08/2020	740295	8.5	< 20	< 20	< 50	< 50	< 100	< 100	< 20	< 20	< 50	< 50	< 50	< 0.1	< 0.1	< 0.1	< 0.2	< 0.1	< 0.3	< 0.5
V80	East Exc - E	0	V80	26/08/2020	740295	8.1	< 20	< 20	< 50	< 50	< 100	< 100	< 20	< 20	< 50	< 50	< 50	< 0.1	< 0.1	< 0.1	< 0.2	< 0.1	< 0.3	< 0.5
V81	East Exc - N	1.75	V81	26/08/2020	740295	11	37	36	1200	1200	1000	< 100	< 20	830	1300	< 50	2130	< 0.1	< 0.1	< 0.1	0.5	0.4	0.8	< 0.5
V84	East Exc - B	2.0	V84	26/08/2020	740295	12	< 20	< 20	< 50	< 50	< 100	< 100	< 20	< 20	< 50	< 50	< 50	< 0.1	< 0.1	< 0.1	< 0.2	< 0.1	< 0.3	< 0.5
V85	West Exc - W	1.0	V85	22/09/2020	745838	11	< 20	< 20	340	340	420	< 100	< 20	130	580	<50	710	< 0.1	< 0.1	< 0.1	< 0.2	< 0.1	< 0.3	< 0.5
V86	West Exc - W	2.0	V86	22/09/2020	745838	12	< 20	< 20	820	820	680	< 100	< 20	400	1000	<50	1400	< 0.1	< 0.1	< 0.1	< 0.2	< 0.1	< 0.3	< 0.5
V87	West Exc - S	1.0	V87	22/09/2020	745838	11	< 20	< 20	<50	<50	< 100	< 100	< 20	< 20	<50	<50	<50	< 0.1	< 0.1	< 0.1	< 0.2	< 0.1	< 0.3	< 0.5

One Rail Diesel Spil - Soil Bores, Test Pits Validation Samples Results

						Inorganic	TRH						TPH					BTEXN						
						Moisture Content (dried @ 103°C)	C6-C10	C6-C10 - BTEX (F1)	TRH >C10-C16	C10-C16 - Napth (F2)	TRH >C16-C34	TRH >C34-C40	C6 - C9	C10 - C14	C15 - C28	C29-C36	+C10 - C36 (Sum of)	Benzene	Ethylbenzene	Toluene	Xylene (m & p)	Xylene (o)	Xylene Total	Naphthalene
						%	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg
					LOR	1	20	20	50	50	100	100	20	20	50	50	50	0.1	0.1	0.1	0.2	0.1	0.3	0.5
NEPM 2013 Table 1A(1) Comm/Ind D Soil HIL for Soil Contaminants, Sand																								
NEPM 2013 Table 1A(3) Comm/Ind D Soil HSL for Vapour Intrusion, Sand																								
0-1m								260		NL								3	NL	NL			230	NL
1-2m								370		NL								3	NL	NL			NL	NL
2-4m								630		NL								3	NL	NL			NL	NL
>4m								NL		NL								3	NL	NL			NL	NL
NEPM 2013 Table 1B(6) ESLs for Comm/Ind, Coarse Soil								215		170	1700	3300						75	165	135			180	370
NEPM 2013 Table 1B(7) Management Limits Comm / Ind, Coarse Soil							700		1000		3500	10000												
CRC Care (2011) HSL D (Comm/Ind) (Direct Contact)							26000		20000		27000	38000						430	27000	99000			81000	11000
CRC Care (2011) HSL Intrusive Maintenance Worker (Direct Contact)							82000		62000		85000	120000						1100	85000	120000			130000	29000
Location	Area	Depth (m)	Field_ID	Sample_Date	Lab_Report_#																			
V88	West Exc - S	2.0	V88	22/09/2020	745838	12	< 20	< 20	<50	<50	< 100	< 100	< 20	< 20	<50	<50	<50	< 0.1	< 0.1	< 0.1	< 0.2	< 0.1	< 0.3	< 0.5
V89	West Exc - S	1.0	V89	22/09/2020	745838	13	< 20	< 20	1000	1000	1200	< 100	< 20	400	1700	< 50	2100	< 0.1	< 0.1	< 0.1	< 0.2	< 0.1	< 0.3	< 0.5
V90	West Exc - S	2.0	V90	22/09/2020	745838	15	< 20	< 20	270	270	300	< 100	< 20	110	430	< 50	540	< 0.1	< 0.1	< 0.1	< 0.2	< 0.1	< 0.3	< 0.5
V91	West Exc - S	1.0	V91	22/09/2020	745838	6.1	< 20	< 20	< 50	< 50	< 100	< 100	< 20	< 20	< 50	< 50	< 50	< 0.1	< 0.1	< 0.1	< 0.2	< 0.1	< 0.3	< 0.5
V92	West Exc - S	2.0	V92	22/09/2020	745838	10	< 20	< 20	< 50	< 50	< 100	< 100	< 20	< 20	73	< 50	73	< 0.1	< 0.1	< 0.1	< 0.2	< 0.1	< 0.3	< 0.5
V93	West Exc - S	1.0	V93	22/09/2020	745838	13	< 20	< 20	< 50	< 50	< 100	< 100	< 20	< 20	< 50	< 50	< 50	< 0.1	< 0.1	< 0.1	< 0.2	< 0.1	< 0.3	< 0.5
V94	West Exc - S	2.0	V94	22/09/2020	745838	13	< 20	< 20	< 50	< 50	< 100	< 100	< 20	< 20	< 50	< 50	< 50	< 0.1	< 0.1	< 0.1	< 0.2	< 0.1	< 0.3	< 0.5
V95	West Exc - S	1.0	V95	22/09/2020	745838	13	< 20	< 20	< 50	< 50	< 100	< 100	< 20	< 20	< 50	< 50	< 50	< 0.1	< 0.1	< 0.1	< 0.2	< 0.1	< 0.3	< 0.5
V96	West Exc - S	2.0	V96	22/09/2020	745838	14	< 20	< 20	< 50	< 50	< 100	< 100	< 20	< 20	< 50	< 50	< 50	< 0.1	< 0.1	< 0.1	< 0.2	< 0.1	< 0.3	< 0.5
V97	West Exc - E	1.0	V97	22/09/2020	745838	11	< 20	< 20	< 50	< 50	< 100	< 100	< 20	< 20	< 50	< 50	< 50	< 0.1	< 0.1	< 0.1	< 0.2	< 0.1	< 0.3	< 0.5
V98	West Exc - E	2.0	V98	22/09/2020	745838	19	< 20	< 20	< 50	< 50	< 100	< 100	< 20	< 20	< 50	< 50	< 50	< 0.1	< 0.1	< 0.1	< 0.2	< 0.1	< 0.3	< 0.5
V99	West Exc - N	1.0	V99	22/09/2020	745838	13	< 20	< 20	< 50	< 50	< 100	< 100	< 20	< 20	< 50	< 50	< 50	< 0.1	< 0.1	< 0.1	< 0.2	< 0.1	< 0.3	< 0.5
V100	West Exc - N	2.0	V100	22/09/2020	745838	13	< 20	< 20	< 50	< 50	< 100	< 100	< 20	< 20	< 50	< 50	< 50	< 0.1	< 0.1	< 0.1	< 0.2	< 0.1	< 0.3	< 0.5
V101	West Exc - N	1.0	V101	22/09/2020	745838	12	< 20	< 20	< 50	< 50	< 100	< 100	< 20	< 20	< 50	< 50	< 50	< 0.1	< 0.1	< 0.1	< 0.2	< 0.1	< 0.3	< 0.5
V102	West Exc - N	2.0	V102	22/09/2020	745838	13	< 20	< 20	240	240	230	< 100	< 20	140	330	< 50	470	< 0.1	< 0.1	< 0.1	< 0.2	< 0.1	< 0.3	< 0.5
V103	West Exc - N	1.0	V103	22/09/2020	745838	1.5	< 20	< 20	< 50	< 50	< 100	< 100	< 20	< 20	< 50	< 50	< 50	< 0.1	< 0.1	< 0.1	< 0.2	< 0.1	< 0.3	< 0.5
V104	West Exc - N	2.0	V104	22/09/2020	745838	12	< 20	< 20	200	200	280	< 100	< 20	89	370	< 50	459	< 0.1	< 0.1	< 0.1	< 0.2	< 0.1	< 0.3	< 0.5
V105	West Exc - N	1.0	V105	22/09/2020	745838	6.5	< 20	< 20	< 50	< 50	< 100	< 100	< 20	< 20	< 50	< 50	< 50	< 0.1	< 0.1	< 0.1	< 0.2	< 0.1	< 0.3	< 0.5
V106	West Exc - N	2.0	V106	22/09/2020	745838	12	< 20	< 20	< 50	< 50	< 100	< 100	< 20	< 20	80	< 50	80	< 0.1	< 0.1	< 0.1	< 0.2	< 0.1	< 0.3	< 0.5
V107	West Exc - N	1.0	V107	22/09/2020	745838	12	< 20	< 20	< 50	< 50	< 100	< 100	< 20	< 20	< 50	< 50	< 50	< 0.1	< 0.1	< 0.1	< 0.2	< 0.1	< 0.3	< 0.5
V108	West Exc - N	2.0	V108	22/09/2020	745838	14	< 20	< 20	< 50	< 50	< 100	< 100	< 20	< 20	< 50	< 50	< 50	< 0.1	< 0.1	< 0.1	< 0.2	< 0.1	< 0.3	< 0.5
V109	West Exc - B	2.0	V109	22/09/2020	745838	13	< 20	< 20	< 50	< 50	< 100	< 100	< 20	< 20	87	< 50	87	< 0.1	< 0.1	< 0.1	< 0.2	< 0.1	< 0.3	< 0.5
V110	West Exc - B	2.0	V110	22/09/2020	745838	18	28	28	1800	1800	1800	< 100	< 20	1100	2500	< 50	3600	< 0.1	< 0.1	< 0.1	< 0.2	0.2	< 0.3	< 0.5
V111	West Exc - B	2.0	V111	22/09/2020	745838	8.4	280	270	11000	10997.6	11000	< 100	56	6700	15000	< 50	21700	< 0.1	< 0.1	< 0.1	7.6	5.1	13	2.4
V112	West Exc - B	2.0	V112	22/09/2020	745838	15	25	25	1200	1200	1600	< 100	< 20	630	2200	< 50	2830	< 0.1	< 0.1	< 0.1	< 0.2	< 0.1	< 0.3	< 0.5
V113	West Exc - B	2.0	V113	22/09/2020	745838	15	< 20	< 20	440	440	500	< 100	< 20	240	700	< 50	940	< 0.1	< 0.1	< 0.1	< 0.2	< 0.1	< 0.3	< 0.5
V114	West Exc - B	2.0	V114	22/09/2020	745838	17	< 20	< 20	1800	1800	6900	< 100	< 20	390	8000	< 50	8390	< 0.1	< 0.1	< 0.1	< 0.2	< 0.1	< 0.3	< 0.5
V115	West Exc - B	2.0	V115	22/09/2020	745838	13	< 20	< 20	< 50	< 50	< 100	< 100	< 20	< 20	< 50	< 50	< 50	< 0.1	< 0.1	< 0.1	< 0.2	< 0.1	< 0.3	< 0.5
V116	Trench b/w Aux & Ramp	0	V116	1/10/2020	747984	14	< 20	< 20	170	170	690	100	< 20	75	740	67	< 50	< 0.1	< 0.1	< 0.1	< 0.2	< 0.1	< 0.3	< 0.5
V117	Trench b/w Aux & Ramp	0	V117	1/10/2020	747984	12	< 20	< 20	< 50	< 50	200	110	< 20	22	170	69	< 50	< 0.1	< 0.1	< 0.1	< 0.2	< 0.1	< 0.3	< 0.5
V118	Trench b/w Aux & Ramp	0	V118	1/10/2020	747984	18	< 20	< 20	< 50	< 50	330	350	< 20	<20	220	210	< 50	< 0.1	< 0.1	< 0.1	< 0.2	< 0.1	< 0.3	< 0.5
V119	Trench b/w Aux & Ramp	0	V119	1/10/2020	747984	13	< 20	< 20	590	590	2000	140	< 20	200	2300	90	< 50	< 0.1	< 0.1	< 0.1	< 0.2	< 0.1	< 0.3	< 0.5
V120	Trench b/w Aux & Ramp	0	V120	1/10/2020	747984	11	< 20	< 20	< 50	< 50	< 100	< 100	< 20	< 20	< 50	< 50	< 50	< 0.1	< 0.1	< 0.1	< 0.2	< 0.1	< 0.3	< 0.5
V121	Trench b/w Aux & Ramp	0	V121	1/10/2020	747984	6.9	< 20	< 20	< 50	< 50	390	510	< 20	< 20	230	310	540	< 0.1	< 0.1	< 0.1	< 0.2	< 0.1	< 0.3	< 0.5
V122	Trench b/w Aux & Ramp	0	V122	1/10/2020	747984	11	<20	<20	4100	4100	6600	1100	<20	1800	8600	430	10830	< 0.1	< 0.1	< 0.1	< 0.2	< 0.1	< 0.3	< 0.5
V123	Trench b/w Aux & Ramp	0	V123	1/10/2020	747984	7	< 20	< 20	< 50	< 50	210	440	<20	<20	79	230	309	< 0.1	< 0.1	< 0.1	< 0.2	< 0.1	< 0.3	< 0.5
V124	Trench b/w Aux & Ramp	0	V124	1/10/2020	747984	15	< 20	< 20	< 50	< 50	230	520	<20	<20	79	270	349	< 0.1	< 0.1	< 0.1	< 0.2	< 0.1	< 0.3	< 0.5
V125	Trench b/w Aux & Ramp	0	V125	1/10/2020	747984	15	< 20	< 20	< 50	< 50	630	270	<20	<20	560	150	710	< 0.1	< 0.1	< 0.1	< 0.2	< 0.1	< 0.3	< 0.5
V126	Trench b/w Aux & Ramp	0	V126	1/10/2020	747984	11	< 20	< 20	< 50	< 50	< 100	< 100	<20	<20	< 50	< 50	< 50	< 0.1	< 0.1	< 0.1	< 0.2	< 0.1	< 0.3	< 0.5
V127	S of Ramp Rd	0.1	V127	1/10/2020	747984	6.8	< 20	< 20	< 50	< 50	< 100	< 100	<20	<20	< 50	< 50	< 50	< 0.1	< 0.1	< 0.1	< 0.2	< 0.1	< 0.3	< 0.5
V128	S of Ramp Rd	0	V128	1/10/2020	747984	<1	<20	<20	< 50	< 50	< 100	< 100	<20	<20	54	60	114	< 0.1	< 0.1	< 0.1	< 0.2	< 0.1	< 0.3	< 0.5
V129	S of Ramp Rd	0	V129	1/10/2020	747984	<1	<20	<20	< 50	< 50	<100	120	<20	<20	<50	72	72	< 0.1	< 0.1	< 0.1	< 0.2	< 0.1	< 0.3	< 0.5
V130	S of Ramp Rd	0	V130	1/10/2020	747984	1.3	<20	<20	< 50	< 50	<100	160	<20	<20	<50	95	95	< 0.1	< 0.1	< 0.1	< 0.2	< 0.1	< 0.3	< 0.5
V131	S of Ramp Rd	0	V131	1/10/2020	747984	1.9	<20	<20	< 50	< 50	<100	170	<20	<20	52	94	146	< 0.1	< 0.1	< 0.1	< 0.2	< 0.1	< 0.3	< 0.5
V132	S of Ramp Rd	0	V132	1/10/2020	747984	<1	<20	<20	< 50	< 50	130	180	<20	<20	85	110	195	< 0.1	< 0.1	< 0.1	< 0.2	< 0.1	< 0.3	< 0.5
V133	S of Ramp Rd	0	V133	1/10/2020	747984	6.9	<20	<20	< 50	< 50	<100	100	<20	<20	<50	71	71	< 0.1	< 0.1	< 0.1	< 0.2	< 0.1	< 0.3	< 0.5
V134	S of Ramp Rd	0.5	V134	1/10/2020	747984	2.7	<20	<20	< 50	< 50	100	190	<20	<20	<50	120	120	< 0.1	< 0.1	< 0.1	< 0.2	< 0.1	< 0.3	< 0.5
V135	S of Ramp Rd	0.5	V135	1/10/2020	747984	3.3	<20	<20	< 50	< 50	<100	200	<20	<20	<50	110	110	< 0.1	< 0.1	< 0.1	< 0.2	< 0.1	< 0.3	< 0.5
V136	S of Ramp Rd	0.5	V136	1/10/2020	747984	10	<20	<20	< 50	< 50	130	120	<20	<20	<50	54	54	< 0.1	< 0.1	< 0.1	< 0.2	< 0.1	< 0.3	< 0.5
V137	S of Ramp Rd	0.5	V137	1/10/2020	747984	7.2	<20	<20	< 50	< 50	<100	160	<20	<20	<50	80	80	< 0.1	< 0.1	< 0.1	< 0.2	< 0.1	< 0.3	< 0.5
V138	S of Ramp Rd	0.5	V138	1/10/2020	747984	6.4	<20	<20	< 50	< 50	100	160	<20	<20	<50	79	79	< 0.1	< 0.1	< 0.1	< 0.2	< 0.1	< 0.3	< 0.5
V139	S of Ramp Rd	0.5	V139	1/10/2020	747984	6.1	<20	<20	< 50	< 50	<100	160	<20	<20	<50	84	84	< 0.1	< 0.1	< 0.1	< 0.2	< 0.1	< 0.3	< 0.5
V140	S of Ramp Rd	0.5	V140	1/10/2020	747984	4.8	< 20	< 20	< 50	< 50	< 100	130	<20	<20	< 50	65	65	< 0.1	< 0.1	< 0.1	< 0.2	< 0.1	< 0.3	< 0.5
V141	S of Ramp Rd	0.5	V141	1/10/2020	747984	9.3	< 20	< 20	< 50	< 50	< 100	< 100	<20	<20	< 50	< 50	< 50	< 0.1	< 0.1	< 0.1	< 0.2	< 0.1	< 0.3	< 0.5
V142	S of Ramp Rd	0.2	V142	1/10/2020	747984	8	< 20	< 20	< 50	< 50	< 100	< 100	<20	<20	< 50	< 50	< 50	< 0.1	< 0.1	< 0.1	< 0.2	< 0.1	< 0.3	< 0.5
V143	S of Ramp Rd	0.2	V143	1/10/2020	747984	11	< 20	< 20	< 50	< 50	< 100	< 100	<20	<20	< 50	< 50	< 50	< 0.1	< 0.1	< 0.1	< 0.2	< 0.1	< 0.3	< 0.5
V144	S of Ramp Rd	0.2	V144	1/10/2020	747984	9.4	< 20	< 20	< 50	< 50	< 100	< 100	<20	<20	< 50	< 50	< 50	< 0.1	< 0.1	< 0.1	< 0.2	< 0.1	< 0.3	< 0.5
V145	S of Ramp Rd	0.2	V145	1/10/2020	747984	5.6	180	170	16000	15999.1	13000	510	45	8400	19000	480	27880	< 0.1	0.3	< 0.1	5.5	4.5	10	0.9
V146	S of Ramp Rd	0.2	V146	1/10/2020	747984	6.9	240	220	17000	16999	17000	820	72	11000	23000	770	34770	< 0.1	0.2	< 0.1	9	7.6	17	1
V147	S of Ramp Rd	0.2	V147	1/10/2020	747984	9.2	< 20	< 20	< 50	< 50	< 100	< 100	<20	<20	< 50	< 50	< 50	< 0.1	< 0.1	< 0.1	< 0.2	< 0.1	< 0.3	< 0.5
V148	S of Ramp Rd	0.5	V148	1/10/2020	747984	14	< 20	< 20	< 50	< 50	110	< 100	< 20	< 20	120	< 50	120	< 0.1	< 0.1	< 0.1	< 0.2	< 0.1	< 0.3	< 0.5
V149	S of Ramp Rd	0	V149	1/10/2020	747984	11	< 20	< 20	< 50	< 50	< 100	< 100	< 20	< 20	< 50	< 50	< 50	< 0.1	< 0.1	< 0.1	< 0.2	< 0.1	< 0.3	< 0.5

One Rail Diesel Spil - Soil Bores, Test Pits Validation Samples Results

						Inorganic	TRH						TPH					BTEXN						
						Moisture Content (dried @ 103°C)	C6-C10	C6-C10 - BTEX (F1)	TRH >C10-C16	C10-C16 - Napth (F2)	TRH >C16-C34	TRH >C34-C40	C6 - C9	C10 - C14	C15 - C28	C29-C36	+C10 - C36 (Sum of)	Benzene	Ethylbenzene	Toluene	Xylene (m & p)	Xylene (o)	Xylene Total	Naphthalene
						%	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg
					LOR	1	20	20	50	50	100	100	20	20	50	50	50	0.1	0.1	0.1	0.2	0.1	0.3	0.5
NEPM 2013 Table 1A(1) Comm/Ind D Soil HIL for Soil Contaminants, Sand																								
NEPM 2013 Table 1A(3) Comm/Ind D Soil HSL for Vapour Intrusion, Sand																								
0-1m								260		NL								3	NL	NL			230	NL
1-2m								370		NL								3	NL	NL			NL	NL
2-4m								630		NL								3	NL	NL			NL	NL
>4m								NL		NL								3	NL	NL			NL	NL
NEPM 2013 Table 1B(6) ESLs for Comm/Ind, Coarse Soil								215		170	1700	3300						75	165	135			180	370
NEPM 2013 Table 1B(7) Management Limits Comm / Ind, Coarse Soil							700		1000		3500	10000												
CRC Care (2011) HSL D (Comm/Ind) (Direct Contact)							26000		20000		27000	38000						430	27000	99000			81000	11000
CRC Care (2011) HSL Intrusive Maintenance Worker (Direct Contact)							82000		62000		85000	120000						1100	85000	120000			130000	29000
Location	Area	Depth (m)	Field_ID	Sample_Date	Lab_Report_#																			
V150	S of Ramp Rd	0	V150	1/10/2020	747984	8.7	< 20	< 20	< 50	< 50	< 100	< 100	< 20	< 20	< 50	< 50	< 50	< 0.1	< 0.1	< 0.1	< 0.2	< 0.1	< 0.3	< 0.5
V151	S of Ramp Rd	0	V151	1/10/2020	747984	11	< 20	< 20	< 50	< 50	< 100	< 100	< 20	< 20	< 50	< 50	< 50	< 0.1	< 0.1	< 0.1	< 0.2	< 0.1	< 0.3	< 0.5
V152	S of Ramp Rd	0	V152	1/10/2020	747984	11	< 20	< 20	< 50	< 50	< 100	< 100	< 20	< 20	< 50	< 50	< 50	< 0.1	< 0.1	< 0.1	< 0.2	< 0.1	< 0.3	< 0.5
V153	S of Ramp Rd	0	V153	1/10/2020	747984	8.4	< 20	< 20	< 50	< 50	< 100	< 100	< 20	< 20	< 50	< 50	< 50	< 0.1	< 0.1	< 0.1	< 0.2	< 0.1	< 0.3	< 0.5
V154	S of Ramp Rd	0	V154	1/10/2020	747984	9.3	< 20	< 20	< 50	< 50	< 100	< 100	< 20	< 20	< 50	< 50	< 50	< 0.1	< 0.1	< 0.1	< 0.2	< 0.1	< 0.3	< 0.5
V155	S of Ramp Rd	0.5	V155	1/10/2020	747984	13	< 20	< 20	< 50	< 50	140	< 100	< 20	< 20	150	< 50	150	< 0.1	< 0.1	< 0.1	< 0.2	< 0.1	< 0.3	< 0.5
V156	S of Ramp Rd	0.5	V156	1/10/2020	747984	9.7	< 20	< 20	1400	1400	7600	4900	< 20	620	5000	5100	10720	< 0.1	< 0.1	< 0.1	< 0.2	< 0.1	< 0.3	< 0.5
V157	S of Ramp Rd	0.5	V157	1/10/2020	747984	4.6	< 20	< 20	< 50	< 50	< 100	< 100	< 20	< 20	< 50	< 50	< 50	< 0.1	< 0.1	< 0.1	< 0.2	< 0.1	< 0.3	< 0.5
V158	S of Ramp Rd	0.5	V158	1/10/2020	747984	11	< 20	< 20	2900	2900	4400	990	< 20	1500	5200	900	7600	< 0.1	< 0.1	< 0.1	< 0.2	< 0.1	< 0.3	< 0.5
V159	S of Ramp Rd	0.5	V159	1/10/2020	747984	9.5	< 20	< 20	< 50	< 50	< 100	< 100	< 20	21	90	< 50	111	< 0.1	< 0.1	< 0.1	< 0.2	< 0.1	< 0.3	< 0.5
V160	S of Ramp Rd	0.5	V160	1/10/2020	747984	9.8	< 20	< 20	240	240	640	< 100	< 20	100	770	< 50	870	< 0.1	< 0.1	< 0.1	< 0.2	< 0.1	< 0.3	< 0.5
V161	S of Ramp Rd	0.1	V161	1/10/2020	747984	6.2	< 20	< 20	< 50	< 50	< 100	< 100	< 20	< 20	< 50	< 50	< 50	< 0.1	< 0.1	< 0.1	< 0.2	< 0.1	< 0.3	< 0.5
V162	S of Ramp Rd	0.1	V162	1/10/2020	747984	3.5	< 20	< 20	< 50	< 50	< 100	< 100	< 20	< 20	< 50	< 50	< 50	< 0.1	< 0.1	< 0.1	< 0.2	< 0.1	< 0.3	< 0.5
V163	S of Ramp Rd	0.1	V163	1/10/2020	747984	6	< 20	< 20	< 50	< 50	< 100	100	< 20	< 20	< 50	60	60	< 0.1	< 0.1	< 0.1	< 0.2	< 0.1	< 0.3	< 0.5
V164	S of Ramp Rd	0.1	V164	1/10/2020	747984	5.1	< 20	< 20	< 50	< 50	< 100	120	< 20	< 20	< 50	70	70	< 0.1	< 0.1	< 0.1	< 0.2	< 0.1	< 0.3	< 0.5
V165	S of Ramp Rd	0.1	V165	1/10/2020	747984	5.5	< 20	< 20	< 50	< 50	< 100	< 100	< 20	< 20	< 50	< 50	< 50	< 0.1	< 0.1	< 0.1	< 0.2	< 0.1	< 0.3	< 0.5
V166	S of Ramp Rd	0.1	V166	1/10/2020	747984	4.5	< 20	< 20	< 50	< 50	120	130	< 20	< 20	81	75	156	< 0.1	< 0.1	< 0.1	< 0.2	< 0.1	< 0.3	< 0.5
V167	S of Ramp Rd	0.1	V167	1/10/2020	747984	11	20	< 20	5300	5300	7500	4700	< 20	3200	7600	3800	14600	< 0.1	< 0.1	< 0.1	< 0.2	0.2	< 0.3	< 0.5
V168	S of Ramp Rd	0.1	V168	1/10/2020	747984	5	< 20	< 20	< 50	< 50	< 100	220	< 20	< 20	< 50	120	120	< 0.1	< 0.1	< 0.1	< 0.2	< 0.1	< 0.3	< 0.5
V169	S of Ramp Rd	0.1	V169	1/10/2020	747984	5.5	< 20	< 20	< 50	< 50	< 100	170	< 20	< 20	< 50	93	93	< 0.1	< 0.1	< 0.1	< 0.2	< 0.1	< 0.3	< 0.5
V170	S of Ramp Rd	0.1	V170	1/10/2020	747984	5.2	< 20	< 20	< 50	< 50	< 100	< 100	< 20	< 20	< 50	58	58	< 0.1	< 0.1	< 0.1	< 0.2	< 0.1	< 0.3	< 0.5
V171	S of Ramp Rd	0.1	V171	1/10/2020	747984	4.9	< 20	< 20	< 50	< 50	< 100	< 100	< 20	< 20	< 50	< 50	< 50	< 0.1	< 0.1	< 0.1	< 0.2	< 0.1	< 0.3	< 0.5
V172	S of Ramp Rd	0.1	V172	1/10/2020	747984	6	< 20	< 20	< 50	< 50	< 100	130	< 20	< 20	< 50	76	76	< 0.1	< 0.1	< 0.1	< 0.2	< 0.1	< 0.3	< 0.5
V173	S of Ramp Rd	0.1	V173	1/10/2020	747984	5.8	< 20	< 20	< 50	< 50	< 100	< 100	< 20	< 20	< 50	< 50	< 50	< 0.1	< 0.1	< 0.1	< 0.2	< 0.1	< 0.3	< 0.5
V174	S of Ramp Rd	0.1	V174	1/10/2020	747984	6	< 20	< 20	< 50	< 50	< 100	< 100	< 20	< 20	< 50	< 50	< 50	< 0.1	< 0.1	< 0.1	< 0.2	< 0.1	< 0.3	< 0.5
BIOPILE SAMPLES (PAH/Phenol Assessment)																								
BP01	Biopile 1			10/12/2021	850365	<1	<20	<20	340	340	1400	370	2110	<20	130	1300	420	<0.1	<0.1	<0.1	<0.2	<0.1	<0.3	<0.5
BP02	Biopile 2			10/12/2021	850365	1.2	<20	<20	3600	3600	8700	210	12510	<20	1200	10000	190	<0.1	<0.1	<0.1	<0.2	<0.1	<0.3	<0.5
BP03	Biopile 3			10/12/2021	850365	2.6	<20	<20	730	730	2200	120	3050	<20	230	2500	99	<0.1	<0.1	<0.1	<0.2	<0.1	<0.3	<0.5
BP04	Biopile 4			10/12/2021	850365	2.5	<20	<20	57	57	450	<100	507	<20	<20	430	55	<0.1	<0.1	<0.1	<0.2	<0.1	<0.3	<0.5
BP05	Biopile 5			10/12/2021	850365	1.8	<20	<20	530	530	1800	190	2520	<20	160	2000	180	<0.1	<0.1	<0.1	<0.2	<0.1	<0.3	<0.5

One Rail Diesel Spil - Soil Bores, Test Pits Validation Samples Results

						PAH																			
						Acenaphthene	Acenaphthylene	Anthracene	Benz(a)anthracene	Benzo(a)pyrene	Benzo(a)pyrene TEQ (lower bound) *	Benzo(a)pyrene TEQ (medium bound) *	Benzo(a)pyrene TEQ (upper bound) *	Benzo(b&j)fluoranthene	Benzo(g.h.i)perylene	Benzo(k)fluoranthene	Chrysene	Dibenz(a.h)anthracene	Fluoranthene	Fluorene	Indeno(1.2.3-cd)pyrene	Naphthalene	Phenanthrene	Pyrene	Total PAH*
						mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg
					LOR	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5
NEPM 2013 Table 1A(1) Comm/Ind D Soil HIL for Soil Contaminants, Sand												40													4000
NEPM 2013 Table 1A(3) Comm/Ind D Soil HSL for Vapour Intrusion, Sand																									
0-1m																									
1-2m																									
2-4m																									
>4m																									
NEPM 2013 Table 1B(6) ESLs for Comm/Ind, Coarse Soil																									
NEPM 2013 Table 1B(7) Management Limits Comm / Ind, Coarse Soil																									
CRC Care (2011) HSL D (Comm/Ind) (Direct Contact)																									
CRC Care (2011) HSL Intrusive Maintenance Worker (Direct Contact)																									
Location	Area	Depth (m)	Field_ID	Sample_Date	Lab_Report_#																				
V150	S of Ramp Rd	0	V150	1/10/2020	747984																				
V151	S of Ramp Rd	0	V151	1/10/2020	747984																				
V152	S of Ramp Rd	0	V152	1/10/2020	747984																				
V153	S of Ramp Rd	0	V153	1/10/2020	747984																				
V154	S of Ramp Rd	0	V154	1/10/2020	747984																				
V155	S of Ramp Rd	0.5	V155	1/10/2020	747984																				
V156	S of Ramp Rd	0.5	V156	1/10/2020	747984																				
V157	S of Ramp Rd	0.5	V157	1/10/2020	747984																				
V158	S of Ramp Rd	0.5	V158	1/10/2020	747984																				
V159	S of Ramp Rd	0.5	V159	1/10/2020	747984																				
V160	S of Ramp Rd	0.5	V160	1/10/2020	747984																				
V161	S of Ramp Rd	0.1	V161	1/10/2020	747984																				
V162	S of Ramp Rd	0.1	V162	1/10/2020	747984																				
V163	S of Ramp Rd	0.1	V163	1/10/2020	747984																				
V164	S of Ramp Rd	0.1	V164	1/10/2020	747984																				
V165	S of Ramp Rd	0.1	V165	1/10/2020	747984																				
V166	S of Ramp Rd	0.1	V166	1/10/2020	747984																				
V167	S of Ramp Rd	0.1	V167	1/10/2020	747984																				
V168	S of Ramp Rd	0.1	V168	1/10/2020	747984																				
V169	S of Ramp Rd	0.1	V169	1/10/2020	747984																				
V170	S of Ramp Rd	0.1	V170	1/10/2020	747984																				
V171	S of Ramp Rd	0.1	V171	1/10/2020	747984																				
V172	S of Ramp Rd	0.1	V172	1/10/2020	747984																				
V173	S of Ramp Rd	0.1	V173	1/10/2020	747984																				
V174	S of Ramp Rd	0.1	V174	1/10/2020	747984																				
BIOPILE SAMPLES (PAH/Phenol Assessment)																									
BP01	Biopile 1			10/12/2021	850365	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	0.6	1.2	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5
BP02	Biopile 2			10/12/2021	850365	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	0.6	1.2	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	0.9	0.9
BP03	Biopile 3			10/12/2021	850365	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	0.6	1.2	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5
BP04	Biopile 4			10/12/2021	850365	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	0.6	1.2	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5
BP05	Biopile 5			10/12/2021	850365	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	0.6	1.2	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5