New Zealand Transport Agency

Investigation of Soil Contamination at Three Auckland State Highway Corridor Sites

19 November 2012

Executive summary

For reliance on this executive summary, it must be read in conjunction with the full report.

In 2012, New Zealand Transport Agency engaged GHD Ltd (GHD) to undertake investigations of contaminants in soil potentially associated with aerial dispersion from three elevated sections of the State Highway Transport Corridor, within the Auckland Region. The sites included in the investigation included the Central Motorway Junction, Erin Point, and Oteha Valley.

The investigations comprised the sampling of near surface soils on a systematic 25 m grid pattern using an XRF for field screening for inorganics, and laboratory analysis for approximately 20% of the samples.

The data was analysed using geostatisitcs and linear regression analysis to establish relationships between XRF and laboratory results, and also between contaminants.

Based upon the findings of these investigations the following conclusions can be drawn:

- Elevated concentrations of lead, copper and zinc have been identified in near surface soils at both the Central Motorway Junction and Point Erin;
- The pattern of distribution tended to correlate with the prevailing westerly wind direction, with the highest concentrations east of the motorway section in the more exposed Point Erin and Central Motorway Junction locations.
- Concentrations of lead, copper and zinc measured in samples from these hotspots generally exceeded background concentrations, EPA SSL and Auckland Council permitted activity criteria;
- This may mean that concentrations of these contaminants pose a risk to terrestrial ecological receptors, and consent may also need to be sought from Auckland Council for the discharge of contaminants to ground;
- Based upon the current investigation results and comparisons with health risk based acceptance criteria, it appears that contaminants do not pose a risk to human health.
- PAH concentrations in soil samples were generally low, or below laboratory analytical detection limits.
- Regression analysis of lead, copper and zinc XRF results with laboratory data demonstrates that there is a strong relationship between the two, therefore correlate well;
- Regression analysis between lead and zinc, copper and zinc, and copper and lead, demonstrates that there is a strong relationship, indicating that their distribution may be interrelated; and
- The contaminant distribution at Central Motorway Junction and Point Erin appear to be isolated to relatively discrete contaminant “hotspots” located up to 50 metres from the motorway.

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1. Introduction

GHD Limited (GHD) was engaged by the New Zealand Transport Agency (NZTA) to undertake an investigation of contaminants in shallow soil potentially associated with aerial dispersion from elevated sections of the State Highway Transport Corridor (SH1), within the Auckland Region. The purpose of this assessment is to provide NZTA with an improved understanding of the potential effects of contaminants derived from the network upon human health and the environment at locations neighbouring elevated sections of motorway.

This investigation has included the following three locations, as shown in Figure 1, Appendix A:

- The Central Motorway Junction
- The Oteha Valley Bridge
- Point Erin Harbour Bridge Approach.

The contaminants of concern included heavy metals and polycyclic aromatic hydrocarbons (PAHs). Shallow soil samples were collected on a grid basis around each location and tested by both field screening and laboratory analysis. The results were plotted to assess the distribution of the contaminants, and the results were compared to human health and environmental guideline criteria.

1.1 Background

The NZTA is responsible for the ongoing maintenance, operation and improvement of the State Highway system.

The Auckland Harbour Bridge, and corresponding steel maintenance, is part of this responsibility. Since the bridge opened in 1959, additional lanes and periodic strengthening works have taken place. In addition, continuous road resurfacing and steel surface protection programmes have been on-going.

The Total Bridge Services (TBS) Corporation, a joint venture between TBS Farnsworth (50%), Opus International Consultants (25%) and Fulton Hogan (25%), was formed in 1998 to deliver the required maintenance, construction and management services on the Auckland Harbour Bridge for the NZTA. From July 2008, TBS has been involved with NZTA on a project to carry out significant strengthening of the box girders which carry the East (Southbound) and West (Northbound) outer lanes of the Auckland Harbour Bridge.

This strengthening project involved the abrasion of the box girders which were primed with a lead based paint. The lead paint removal process began in mid-2008 with abrasive blasting of the areas where new steel components were to be fitted. As the paint removal process continued it became evident that the fine lead dust generated by the abrasive blasting process was getting difficult to contain and the decision was made to change the paint removal process from abrasive blasting to chemical paint stripping.

At its peak, the project had approximately 200 people working over three shifts and up to seven days a week.

Environmental discharges from these programmes are controlled under the conditions contained in Auckland Council discharge permits 23954 and 23955. These conditions require soil contaminant monitoring at Stokes Point at the northern approaches to the Auckland Harbour Bridge and at the Point Erin reclamation at the southern approaches.

Monitoring results obtained in 2010 reveal that soil contaminant levels, in particular lead, had increased since 2001. Other metal and hydrocarbon (PAH) contamination was identified. It is recognised that these contaminants may pose a potential concern. High levels of lead contamination can have adverse effects on health through multiple pathways.

In response to these results, the NZTA developed an approach with its environmental consultants to assess the contamination hazard at multiple sites with elevated sections of motorway. Assessment of the spatial distribution and concentrations of these contaminants was intended to provide an improved understanding of the effects of the motorway.

1.2 Objective

The purpose of this investigation was to assess the extent and significance of near surface soil contamination at three NZTA sites located adjacent to the Auckland Motorway network.

1.3 Goals

The goals of this assessment were to:

- Assess concentrations of selected contaminants in soils beneath selected elevated sections of SH1 motorway through Auckland
- Assess significance of soil contaminants by comparison of contaminant concentrations against relevant guideline criteria
- Assess the spatial distribution of soil contaminants

1.4 Scope of Work

In order to meet the above objectives, the following work was completed:

- Development of an appropriate sampling plan
- Intrusive soil sampling including field screening of inorganic elements using an X-Ray Fluorescence (XRF) scanner
- Laboratory Analytical testing of selected samples
- Tier I risk assessment by comparison of soil analytical results with published risk based acceptance criteria

- Preparation of this report.

2. Site Identification

2.1 Site Description and Surrounding Land Use

Three NZTA Motorway sites from within the Auckland Region were investigated. The sites are described below and are included in Figures 1 – 3, Appendix A.

2.1.1 The Central Motorway Junction

The Central Motorway Junction is considered to be the motorways and motorway links between Newton Road, Upper Queen Street and Karangahape Road overbridges. These motorways include the Southern, Northern and North-Western motorways. The areas assessed are bounded by roads, have variable size and proximity to the roads. These areas have been significantly modified, engineered and landscaped. Some zones are grassed and others are landscaped with low cover plants of variable native species.

The Central Motorway Junction is surrounded on all sides by high density commercial and urban land use. Commercial entities include, but are not limited to, hospitality, electrical supplies, motor services, and panel beaters. The surrounding areas are elevated relative to motorway junction and are separated on most sides by a thin margin of low vegetation.

2.1.2 Oteha Valley Bridge

The Oteha Valley site includes the motorway bridges Oteha Valley Road and over an adjacent gully. The southern side of Oteha Valley Road consists of large open landscaped areas which are vegetated only with grass. Neighbouring these grassy areas are residential land use and the Albany Bus Station. North of the bridge are multiple man-made stormwater ponds and a natural gully. These areas are well vegetated with grass and mature trees.

The surrounding land uses are a mix of reserve, low productivity farmland, residential and open space undergoing development.

2.1.3 Point Erin Harbour Bridge Approach

Prior to the construction of the Auckland Harbour Bridge the southern foreshore was an open recreational area. Minor reclamation in the area started at Freemans Bay in the 1870s, with further reclamation continuing through to 1939. Point Erin comprises reclaimed land.

The eastern side of Point Erin is sealed parking and roadways with plant strips separating roads. On the western side is a large compacted soil / base coarse area with multiple small business establishments. South of the motorway is an open field which has undergone recent works but is moderately vegetated with grass and mature trees at the southern extent.

Land uses adjacent the Point Erin section of the motorway includes Westhaven Marina, Point Erin recreational park and partially developed open space.

2.2 Legal Descriptions

2.2.1 The Central Motorway Junction

All of the land assessed in this report is from within the boundaries of the Central Motorway Junction and is provided for under designation number 283 on the Auckland City District Plan (Central Area Section) 2004 and the requiring authority is NZTA (previously Transit).

2.2.2 Oteha Valley Bridge

The land directly adjacent the Oteha Valley overbridges is designation reference number 112 of the Auckland council District Plan (north shore section) 2009, and the requiring authority is NZTA (previously Transit). Only NZTA land is sampled at this site. The land outside this area is owned by a number of bodies and includes:

Legal ID	Legal Body
Lot 4 DP378416	Auckland Council
Lot 200 DP379416	Crown Land
Pt Allot 699 SO316695	Parish of Paremarema
Sec 1 SO316695	Village Green Minigolf Ltd
Lot 3 DP198079	Auckland Council
Sec 1 SO69304	North Shore Branch Vintage Car Club of NZ

2.2.3 Point Erin Harbour Bridge Approach

The land directly bounding the southern approach is provided for under designation reference number A07-01 in Auckland City District Plan (Isthmus Section) 1999, requiring authority NZTA (previously Transit). Both NZTA land and land owned by other bodies are included in the sampling regime for this site. The other land titles include:

Legal ID	Legal Body
Lot 17, 19, 20 and 21 DP133386	Auckland Waterfront Development Agency
Pt Allot 10 DP501	Auckland Council

2.3 Geology

The natural soil at all three locations is non – volcanic, which is relevant for comparison of the investigation results with published data for natural “background” trace element soil concentrations in the Auckland region (ref TO153)

2.3.1 Oteha Valley Bridge

The geology at the Oteha Valley site consists of the Puketoka Formation of the Tauranga Group which was deposited in the Pleistocene and is underlain by the East Coast Bays

Formation of the Waitemata Group deposited during the Miocene. The Puketoka Formation consists of undifferentiated, light grey to orange-brown, well sorted, bedded, mainly pumiceous deposits of mud sand and gravel comprising of angular to well-rounded rhyolite pumice and weathered hinterland rock. The Puketoka formation is soft and readily weathers to clays. The broader unit is of terrestrial to estuarine origins and correspondingly contains variable amounts of organic matter.

2.3.2 Point Erin Harbour Bridge Approach

The Point Erin harbour bridge approach and surrounding areas are constructed on reclaimed land place on the underlying East Coast Bays Formation of the Waitemata Group. The reclaimed land was achieved by pumping hydraulic fill using a suction dredge. Due to limited fill discharge points, segregation by grainsize occurred creating pockets of softer marine sediments and intertidal mud, sandwiched between the hydraulic fill and Waitemata Group Formation. The Motorway was established on a pavement of subgrade, compacted clay overlying the hydraulic fill[1].

Underlying the reclaimed soil is the East Coast Bays Formation which consists of well bedded, variably graded, grey to greenish grey muddy sandstone. These turbidite sandstones are very poorly to moderately sorted and consist of sub-rounded to well-rounded grains of siltstone, argillite and or andesite[2]. On average the East Coast Bays Formation is weak and has a moisture content of 15 to 30%[3]. Beneath this formation is a conformable contact with the Kawau Subgroup or, in places, a disconformity with the underlying Greywacke basement. The East Coast Bays sandstone is interbedded with Parnell Grit Member which consists of predominantly volcanogenic, dark grey to black, poorly sorted, angular diamictite. The Parnell Grit is a volcaniclastic basaltic andesite deposit and includes graded sand to boulder sized inclusions cemented in a fine grained matrix of similar origin (Kermode,1992). A more pronounced lense of Parnell Grit is known to be situated near the southern extend of the Point Erin harbour bridge approach.

2.3.3 The Central Motorway Junction

The entirety of the Central Motorway Junction is underlain by the East Coast Bays Formation with nearby deposits of pumiceous mud, sand and gravel to the north east and thin graded beds of lithic tuff comprising of native rock together with basaltic fragments to the south east.

The East Coast Bays Formation has likely been overlain with fill during the development, engineering and landscaping of the junction. This was supported by field observations and soil descriptions collected on site. All the soils tested had an engineered appearance with distinct layers and good drainage.

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[1] BECA, 2005. *Harbour Bridge to City Project – Preliminary Geotechnical Assessment - Northbound Tunnel to Transit New Zealand*.
[2] Kermode, L.O. 1992: Geology of the Auckland Urban Area, Scale 1:50 000. Institute of Geological & Nuclear Sciences GeoLogical Map 2. 1 sheet + 63p. Institute of Geological & Nuclear Sciences Ltd, Lower Hutt, New Zealand.
[3] Brown, I.R. 1974a. Engineering Geology of Tunnel Alignments, Auckland Rapid Transit Project. Unpublished New Zealand Survey Engineering Geology Report EG 202: 22p.

2.4 Contaminants of Concern

Based upon the information provided by NZTA, and previous monitoring data, the primary contaminants of concern are considered to include:

- Polycyclic Aromatic Hydrocarbons (PAHs) – in particular Benzo(a)pyrene.
- Heavy metals – particularly lead, copper and zinc.

PAHs are a common by product of combustion. In the context of the motorway, PAHs are associated with the combustion of petroleum hydrocarbon fuels.

Generally, PAHs are split into two main groups – carcinogenic compounds and non-carcinogenic compounds.

To allow comparison to relevant guidelines: for the carcinogenic PAH compounds, the individual PAH species concentrations are multiplied by a toxicity value (cancer end point) relative to benzo(a)pyrene. This is called the benzo(a)pyrene toxic equivalence. This allows for assessment of the combined toxicity of a number of PAH compounds.

Copper and zinc are common constituents of the paint used on the Auckland harbour bridge and other steel structures. Historically lead was also a common component in paint.

It should be noted that copper, lead and zinc are also common constituents found in urban stormwater of the Auckland region[4].

[4] Auckland Regional Council, 2005: Sources and loads of metals in urban stormwater. Auckland Regional Council, Technical Publication No. ARC04104, June 2005

3. Acceptance Criteria

3.1 Contaminated Land: Regulatory Controls

During this investigation guidelines were selected for the assessment of results in accordance with the MfE *Contaminated Land Management Guidelines No. 2: Hierarchy and Application in New Zealand of Environmental Guideline Values (Revised 2011).* This investigation is a Tier 1 risk assessment of the effects of the motorway on human health. Accordingly, priority was given to New Zealand derived guidelines. Where domestic guidelines were not available internationally derived values were selected. In addition, priority was given to risk based values as opposed to threshold values. As such, the following guidelines were selected:

3.2 The National Environmental Standard for Assessing and Managing Contaminants in Soil to Protect Human Health

3.2.1 General Overview

The NES provides a nationally consistent risk based criteria for the assessment of risks to human health.

The National Environmental Standard for Assessing and Managing Contaminants in Soil to Protect Human Health (Soil NES) sets national standards for contaminants in soil to protect human health. It contains a national set of soil contaminant standards for 12 priority contaminants for five standard land use scenarios. This includes land on which any activity in the Hazardous Activities and Industries List (HAIL) has occurred.

The Soil NES also regulates:

- Site investigation and reporting
- The sampling of soils for contamination assessment
- Contamination investigations and health risk assessments when disturbing soil, subdividing land and changing land use.

In the absence of Soil Contaminant Standard (health) for selected contaminants, the MfE Contaminated Land Management Guidelines No. 2[5] provides a hierarchy for the application of acceptance criteria.

3.2.2 Applicability

The intention of the Soil NES is to enable safe use of contaminated land to ensure that contaminated land is appropriately assessed prior to development, and if necessary, the land is made safe for human activity. The NES does not include criteria for environmental risk assessment.

[5] Hierarchy and Application in New Zealand of Environmental Guideline Values, 2001 (revised 2011).

However, by reference the NES incorporates relevant Ministry for the Environment guidelines for the site assessment.

For the purposes of this assessment, the land use at each site has been assessed separately. Although the land use at most of the sites sampled is motorway designation with restricted access, the land use has been selected based on the surrounding land uses and site attributes, to best represent likely exposure pathways.

- The Central Motorway Junction is predominantly surrounded by commercial land uses and the site itself has low accessibility and is significantly modified. As a result, acceptance criteria for **commercial/industrial** land use were selected.
- Point Erin is surrounded by a mixture of recreational and commercial land uses and much of the area is publicly accessible. In addition, the soil is moderately engineered and consists of reclaimed land and possible fill. As a result, acceptance criteria for **recreational** land use were selected.
- Oteha Valley is surrounded by a mixture of recreational, commercial and standard residential land uses and the area is partially accessible. Acceptance criteria for **residential land use with 10% produce consumption** were selected.

The NES includes SCS (health) criteria for for the primary contaminants of concern for this investigation.

The activities that occur within the motorway corridor are not covered in the Hazardous Activity and Industry List (HAIL), however the HAIL states that:

"Any other land that has been subject to the intentional or accidental release of hazardous substance in sufficient quality that could be a risk to human health or the environment"

Therefore, the maintenance activities within the motorway corridor, appear to be covered by this statement.

3.3 The Auckland Regional Plan

3.3.1 General Overview

Councils also regulate contaminated land, and may impose controls in addition to the NES for human health and environmental protection. The permitted activity criteria act as thresholds for determining whether resource consent(s) are required for discharges to ground and groundwater. The Auckland Council Regional Plan: Air Land and Water (ALW) 2012 applies to all of the area within the Auckland Region. The Plan provides for the management of air, land and water resources in the region. The plan was made operative in October 2010 and further parts became operative in April 2012. Appeals remain outstanding against some parts of the ALW plan. The ALW plan is now administered by Auckland Council. The ALW plan provides a schedule of permitted activity criteria that apply to contaminated sites, as noted below.

3.3.2 Applicability

The criteria specified in Auckland Regional Plan are found in Schedule 10: *Permitted Activity Soil Criteria*[6]. The human health values in Schedule 10. The NES users guide identifies that councils may impose additional controls under the Resource Management Act 1991 for the protection of the environment.

The Schedule 10 soil acceptance criteria are based upon published New Zealand and international risk based acceptance criteria for residential land use and are used for defining permitted activities. These criteria establish whether consent is required for the disturbance of the soil. "The contaminant levels specified apply to historical land uses only. They are not to be construed as levels to which land can be polluted up to as a result of ongoing discharges or as levels to which land must be remediated[6]". These values were selected as compliance with these criteria is significant for whether consent is required for the disturbance of the soil.

3.3.3 Background Concentrations of Inorganic elements

The Auckland Regional Plan: Air, Land and Water specifies in situ soil and material imported and/or deposited onto the land is a permitted activity if the contaminant concentrations do not exceed the greater of applicable specified acceptance criteria or the background concentration. Background concentrations have been derived from the Auckland Regional Council Background Concentrations of Inorganic Elements in Soils from the Auckland Region document (TP153).

These background concentrations have been used in lieu of collecting representative background samples and they provide a consistent set of reference samples.

For the purposes of this assessment, the non-volcanic range has been adopted for comparison purposes, as Oteha Valley and Central Motorway Junction have soils that are derived from sedimentary material.

The geology at Point Erin is identified as comprising reclaimed material. Anecdotal evidence suggests that of the majority of this material is comprised of sedimentary derived material from the Waitemata geology derived cliffs of Freemans Bay, and as such application of the non-volcanic range is also considered applicable for this site.

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[6] *Auckland Regional Plan: Air, Land and Water. Operative in Part. 16 February 2012. Schedule 10.*

3.4 The National Environment Protection Measure Guidelines

3.4.1 General Overview

In the absence of New Zealand risk based human health criteria for some parameters (such as nickel and zinc) the Australian National Environment Protection Measure 1999 (NEPM) guidelines[7] has been adopted for this investigation.

3.4.2 Applicability

The intention of the NEPM is to enable safe use of contaminated land to ensure that contaminated land is appropriately assessed prior to development. The NEPM covers a range of land uses

For the purposes of this assessment, the NEPM Health-based Investigation Levels A, E and F have been selected based on the surrounding land uses and site attributes, to best represent likely exposure pathways.

- The Central Motorway Junction is predominantly surrounded by industrial/commercial land uses and the site itself has low accessibility and is heavily engineered. As a result, health investigation levels for commercial land use were selected.
- Point Erin is surrounded by a mixture of industrial, recreational and commercial land uses and much of the area is publicly accessible. In addition, the soil is moderately engineered and consists of reclaimed land and possible fill. As a result, health investigation levels for recreational land use were selected.
- Oteha Valley is surrounded by a mixture of recreational, commercial and standard residential land uses and the area is partially accessible. The soils are slightly engineered but appear to be relatively in situ. As a result, health investigation levels for residential land use with 10% produce consumption were selected.

3.5 US EPA Ecological Soil Screening Level (Eco SSL)

3.5.1 General Overview

In the absence of New Zealand risk based acceptance criteria for terrestrial ecological receptors, the EPA Eco SSL have been applied to assess potential risk to terrestrial ecological receptors.

The Eco SSL have been developed to be protective of organisms found in North America, and includes protection levels for mammals, birds (avian), plants and invertebrates.

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[7] National Environment Protection (Assessment of Site Contamination) Measure. 1999. Schedule B(1) Guideline on the Investigation Levels for Soil and Groundwater.

3.5.2 Applicability

The most stringent of the applicable criteria for the organisms addressed by EPA SSL have been adopted for the purposes of assessment.

The mammalian criteria have not been considered for the purposes of this assessment as New Zealand only has two native mammals in the terrestrial environment (native short and long tailed bats), and therefore these criteria are considered to have limited relevance in the New Zealand environment.

The Eco SSL criteria for PAH assessment includes separate criteria for “high” and “low” molecular weight PAHs. The high molecular weight PAHs include the sum of concentrations of pyrene, fluoranthene, benzo(a)anthracene, chrysene, benzo(a)pyrene and dibenzo(a,h)anthrecene.

For the low molecular weight PAH, it includes the sum of concentrations of naphthalene, acenaphthalene, acenaphthene, fluorene, phenanthrene, anthracene and 2-methylnaphthalene. The compound 2-methylnaphthalene is not included in the Hill Laboratory PAH analytical suite and as such comparisons should be considered indicative. However, PAHs represent a broad range of compounds and the emission of only one compound from the laboratory test suite is not considered likely to compromise the investigation.

It should be noted that for a number of inorganic elements, the EPA SSL is stricter than naturally occurring concentrations of these elements in non-volcanic soils in the Auckland Region. Where the EPA SSL are stricter than naturally occurring background concentrations, comparisons against the soil analytical results have not been made.

3.6 The Health Risk Based Guideline Values for Thallium

Recently, Golder Associates derived a health risk based soil guideline value for thallium at the Moanataiari Subdivision, Thames. These values were calculated in a manner consistent with the existing Soil Contaminant Standards incorporated by reference in the soil NES. The guidelines were derived for risk to human health in multiple exposure scenarios. The have been selected for application for this project in accordance with the MfE *Contaminated Land Management Guidelines No. 2: Hierarchy and Application in New Zealand of Environmental Guideline Values (Revised 2011).*

The derived values for residential land use and “no produce consumption” were selected for the Central Motorway Junction, Oteha Valley Road Bridge and Point Erin sites.

3.7 The Auckland Harbour Bridge Resource Consent Conditions

3.7.1 General Overview

The discharges to the environment resulting from the maintenance activities of the Auckland Harbour Bridge are controlled by the by the following consents:

- Discharge permit for the discharge of contaminants to air (Application number 38519);
- Discharge permit for the discharge of contaminants to the coastal marine area (CMA) (application number 38836); and
- Discharge permit for the discharge of wash water, wastewater and dry matter to land where it will entre the water (application number 38835.

The consent was issued on the 30 August 2011 and it is valid for a period of 25 years.

There is no specific consent for the discharge of contaminants to land, or related monitoring requirements. The consents largely focus on minimising the impacts to the environment through improved methodology – essentially minimising the pollution in the first place.

4. Methodology

4.1 Sampling Strategy

The sites assessed are defined by areas of elevated motorway and the focus of the investigation was upon the aerial deposition of contaminants originating from this source. Because the particulates are likely to have a limited travel distance and gradational deposition from source, the working hypothesis for the investigation assumed that sampling would need to be proximal to the aerial segments of the motorway, whilst also stepping out to identify contaminant spatial distribution.

For the purposes of this assessment a 25 m square grid was adopted, with modifications to allow for site specific constraints such as structures and vegetation. It was not possible to sample entirely regular grids, however, due to physical constraints.

4.2 Soil Sampling and Analysis

4.2.1 Sampling method

The following procedures were applied for the required soil sampling:

- The Joint Traffic Operations Center was notified of the intent to carry out the intrusive site investigations
- For sampling of the Central Motorway Junction all transport, notification of Authorities, traffic management, traffic management plans and corresponding health and safety was organised by NZ Traffic Ltd
- Shallow (<100 mm depth) soil samples were collected at all sampling locations using hand tools
- Where buildings or impervious surfaces prevented sampling at the nominated grid location, samples were taken as close as practicable to the identified grid location
- Sampling points were navigated to by GPS co-ordinates using the Transverse Mercator 2000 grid.

4.2.2 X-Ray Fluorescence

Field analysis of trace elements at all sample sites was undertaken using a field portable Omega Innov X-ray Fluorescence (XRF) with a Silicone Drift Detector[8].

XRF analysis uses radiation to provide qualitative and quantitative data on the inorganic constituents of a material. The device functions by emitting radiation of a known and controlled energy into the material to be assessed. The radiation is absorbed by the receiving material and causes electrons to ‘jump’ into a higher energy state. As a result,

[8] FP-XRF is recommended by the USEPA guidance document (prepared to meet CERLA requirements) *Superfund Lead-Contaminated Residential Sites Handbook Final: OSWER 9285.7-50, United States Environmental Protection Agency August 2003EPA*

another electron ‘falls’ to fill the ‘hole’ created by the previous electron. When the electron ‘falls’ to the lower energy state the excess energy is emitted as radiation. This is known as fluorescence. The energy of the radiation emitted during fluorescence is characteristic of the parent element. The receiver in the XRF detects the amount (counts) and energy of the radiation emitted, allowing the determination of the amount of each element present in the source material.

4.2.3 XRF Sampling Methodology

The US EPA has developed a standard method for the use of XRF analysers in the field (US EPA Method 6200; US EPA, 2007). This method was the followed by GHD during this investigation and is outlined as follows:

- Turn on equipment and allow to warm up for at least 30 minutes
- Ensure soil is not saturated (no standing water)
- Remove any large, non-representative debris and homogenise sample
- Create a smooth, flat surface or exposed soil
- Select target analytes and appropriate excitation sources
- Select instrument parameters
- Perform energy calibration
- Analyse instrument blank at the start and end of each sampling day and following every 20 samples analysed
- Perform calibration verification at the start and end of each sampling day and at least once during analysis
- Analyse samples (clean analyser window between each sample)
- Analyse method blanks, calibration verification samples and energy calibration checks (standardisation) at the start and end of each sampling day
- Perform precision measurement at minimum of one sample per day, with the sample analysed at least seven consecutive times in an analytical run
- Report concentrations consistent with precision, and
- Submit at least 5% of samples for confirmatory analysis.

4.3 Analytical Testing

The following steps were undertaken for laboratory analysis for approximately 20% of the samples collected:

- One in five soil samples was analysed by the analytical laboratory for heavy metals and PAHs;
- Laboratory testing of soils was conducted by an International Accreditation New Zealand (IANZ) accredited laboratory – Hill Laboratories Ltd in Hamilton;

- The field and laboratory results was managed and presented using the "ESdat" database software[9].

4.4 Duplicate Sample QA/QC

The following measures were undertaken as part of the GHD quality assurance and quality control practices:

- A quality control/quality assurance (QA/QC) sample duplicate was collected for approximately 10% of samples at regular intervals. These samples were collected from the same location, depth and in the same manner as the corresponding primary sample, and analysed in the same laboratory batch.
- A minimum of one duplicate was selected for laboratory analysis at each site for the assessment of sample variation.

4.5 95% Upper Confidence Limit of the Mean Concentration

An accepted practice when comparing soil analytical results with acceptance criteria is to compare the 95% Upper Confidence Limit (UCL) of the mean concentration against the adopted criteria. Providing there is an appropriate sample size and a distribution that approximates normality or can be transformed to a normal distribution, the 95% UCL is a statistic that prescribes a 95% possibility that the true mean of the population is likely to fall below the 95% UCL value.

The UCL is a statistical term that can be calculated for data collected from a monitoring programme. The 95% confidence interval is the region about the *sample mean* that is likely to contain the underlying *population mean* (representing the whole site itself) with a probability of 95%. The UCL represents a limit above which the average concentration across the site is unlikely to occur. It provides a conservative estimation of long term exposure risk and can be used to compare results to a guideline value.

New Zealand guidelines promote the practice that involves comparison of the 95% UCL of the mean with the adopted acceptance criteria, provided no one concentration within the sample is more than twice the acceptance criteria[10].

4.6 Data Analysis

Data analysis and interpretation was undertaken using three methods, including:

- Linear regression analysis
- ESDat environmental software
- Geostatistics

[9] http://www.esdat.com.au/
[10] Appendix I, Contaminated Land Management Guidelines No. 5, Ministry for the Environment, 2004

4.6.1 Linear Regression Analysis (Relationship test)

Linear regression is a statistical analytical method that explores relationships between two data sets, by plotting one data set on the x axis of a graph and the other variable on the y axis, and then determining the slope of the trend line. This test was used to compare the XRF and lab test data

The analysis quantifies at the variability of the data from the mean / trend line (called coefficient determination ($R^{2)}$). Where there is significant variability in the data away from the trend line, R^2 will have a value closer to zero, where as if there is little variability of the data away from the mean, R^2 will have a value closer to one. A perfect 1:1 relationship yields $R^{2=}$1.0.

What this means, is that if graphs are demonstrating an R^2 close to one, then there is a positive, strong linear relationship between the two datasets. ESDat

GHD uses ESDat extensively to manage environmental data on projects. This software package enables quick and accurate conversion of data and comparison to adopted guideline data.

RJ Hill Laboratories issue the laboratory analytical reports in ESDat format to enable efficient conversion and interpretation of the data. The laboratory data is combined with spatial data collected on the site to allow efficient import of data in to spatial software programmes. This approach has the benefit of avoiding data transcription errors.

4.6.2 Geostatistics

Geostatistics is a form of statistical analysis applied to spatial datasets. Algorithms are used to interpolate between locations using variograms.

ARC GIS software was used to produce the sample location figures and the iso-concentration plots.

The iso-concentration plots were developed using a geo-referenced base aerial photo, and the coordinates of the sampling locations. The maximum concentrations from both XRF and laboratory results for copper, zinc and lead were assigned to the respective locations, and kriging was used to interpolate spatially between sample locations, in order to create the iso concentration contours.

The application of both XRF and laboratory data was deemed appropriate as the regression analysis demonstrated a strong relationship between the XRF and laboratory analytical results for these metals.

5. Results

5.1 Geology

The soils at Oteha Valley were light grey to brown clayey silts, with mottling in places that indicate a fluctuating environment for oxygen availability. This often indicates drainage limitations. There were minor fine sand and occasional gravel components. The soil was rich in organics including roots and leaves. The soil was moist to saturated and had low to moderate plasticity.

A variety of soils were present within the Point Erin sampling zone, although all were artificially emplaced. Soils included grass covered semi-natural soils and highly engineered soils. The soils were brown to black-brown clayey SILTs with minor fine sand and occasional gravels. The soil was mild to rich in organics including roots, leaves and bark. The soil was moist and had low to moderate plasticity.

The soils collected adjacent to the Central Motorway Junction were brown clayey silt with a minor fine sand component and occasional gravel. The soils were rich in organic matter including roots, leaves and bark. The soil was moist and had a low to moderate plasticity.

5.2 Soil Analytical Results

A tabulated summary of field Soil XRF and Laboratory Analytical Results as well as laboratory transcripts for the Central Motorway Junction, Oteha Valley Bridge and Point Erin Harbour Bridge Approach are presented in Tables 1 – 6, Appendix C.

Analysis of the XRF vs laboratory analytical data is included in Appendix E to show relationships (linear regression) between the XRF data and the laboratory data. Also in Appendix E are scatter plots (linear regression analysis) for selected contaminants that recorded elevated concentrations, including lead, copper and zinc.

5.2.1 Linear Regression Results

Analytical results from XRF readings in the XRF for arsenic, lead, copper and zinc concentrations were used to undertake linear regression plots for the assessment of potential relationships in contaminant distributions. The plots include results from variable localities from the sites and are presented in Appendix E.

In addition linear regression plots were also completed for comparison of laboratory analytical results with XRF to demonstrate reproducibility of the data. This essentially is a "test" to assess the reliability of the XRF data. These plots are also shown in Appendix E.

The Central Motorway Junction

Comparisons of the trace elements tested show a poor to moderate fit to a regression trend and are inferred to reflect a moderate relationship between the analyte distributions for some analytes.

The scatter plots for Copper / Zinc, Copper / Lead and Lead / Zinc showed best fit on the regression trend for trace elements. This demonstrates that concentrations copper, zinc and lead may be related, and lead and zinc are also likely to be associated with each other.

The remaining plots did not appear to reflect strong relationships between the analytes.

Point Erin Harbour Bridge Approach

The scatter plots for Copper / Lead showed best fit on the regression trend for trace elements, indicating that concentration distribution may be related.

The remaining plots did not appear to reflect strong relationships between the analytes.

Oteha Valley Bridge

The scatter plots for Copper / Zinc showed best fit on the regression trend for trace elements, however the relationship is relatively weak. The remaining plots reflected poor relationships between the analytes.

Laboratory versus XRF results

In general, comparisons the laboratory and XRF analytical results for copper, lead, and zinc appear to show a moderate fit on a regression trend and are inferred to reflect a moderate relationship between the results achieved between the XRF and laboratory.

This means that for most elements, there was a reasonable correlation between lab and XRF results.

The XRF readings for thallium and cadmium do not correlate with the laboratory results. The XRF results for thallium and cadmium are thought to represent “false positives”, potentially caused by “masking” from other metals. The nature of the light source and sensor receptivity can cause this type of “false positive” reading. The laboratory analytical result demonstrated thallium concentrations below laboratory analytical detection limits, and cadmium concentrations a few orders of magnitude lower. This indicates the XRF thallium and cadmium readings are not likely to be representative of concentrations in soil.

5.2.2 The Central Motorway Junction

Trace Elements

The results for the trace elements are summarized in Table 4, Appendix C.

Total **arsenic** concentrations measured in the soil samples ranged from below XRF analytical detection limits (<2mg/kg) to <16mg/kg whilst laboratory concentrations ranged between 3 and 7mg/kg. All of the measured concentrations complied with the Soil NES contaminant standards for health (Commercial / Industrial) acceptance criteria and the EPA Eco SSL. Arsenic concentrations complied with the Auckland Council Permitted Activity acceptance criterion.

Total **cadmium** concentrations measured in the soil samples ranged from below XRF analytical detection limits (<1mg/kg) to 59mg/kg whilst laboratory concentrations ranged between 0.16 to 0.36mg/kg. The XRF cadmium results are not considered to be representative of the soil concentrations at this location and are likely to represent “false positives” due to interference by other elements. This is discussed further in the Linear Regression section.

Total cadmium concentrations measured by the laboratory were elevated slightly above published background range for non-volcanic soils. This was likely a result of the natural soil mineralogy at the CMJ. Total **chromium** concentrations measured in soil samples ranged from below XRF analytical detection limits (<1mg/kg) to 87mg/kg whilst laboratory concentrations ranged between 11 to 20mg/kg. In general, the XRF results were higher and the data did not correlate welll with the laboratory data.

Laboratory total chromium results complied with all adopted acceptance criteria, and were also within the published background concentration range.

Total **copper** concentrations measured in soil samples ranged from <6 to 85mg/kg by XRF whilst laboratory concentrations ranged between 18 to 48mg/kg. The XRF and laboratory data correlated well.

All of the measured copper concentrations complied with Soil NES for health commercial / Industrial land use and the Auckland Council Schedule 10 acceptance criterion. However concentrations were generally above the background range, and concentrations were generally above the EPA Eco SSL for copper.

Total **lead** concentrations measured with the XRF in soil samples ranged between 4 and 328mg/kg whilst laboratory concentrations ranged between 16 and 80mg/kg.

All of the measured lead concentrations complied with Soil NES for health commercial / Industrial land use and the Auckland Council Schedule 10 acceptance criterion. However concentrations were generally above the selected background concentration, and concentrations were generally above the EPA Eco SSL.

Total **zinc** concentrations measured in soil samples ranged from 20 to 605mg/kg whilst laboratory concentrations ranged between 74 to 105mg/kg. Generally, the measured zinc concentrations were relatively consistent with the published background range . With the exception of one sample from location CMJ004 (605 mg/kg) all measured concentrations complied with the adopted human health acceptance criteria.

The USEPA Eco SSL criteria is below the background concentration range. Therefore no comparison to the Eco SSL was made.

The zinc concentration measured in the soil sample from CMJ004 using the XRF exceeded the Auckland Council Permitted Activity acceptance criterion.

Polycyclic Aromatic Hydrocarbons

Polycyclic Aromatic Hydrocarbons (PAH) were detected above the laboratory detection limits in all samples at the Central Motorway Junction with the exception of the sample taken at CMJ035. A summary of all PAH results are shown in Table 1, Appendix C.

The results for benzo(a)pyrene toxic equivalency (BaP TEQ)[11] complied with Commercial Industrial criteria in the Soil NES as well as the *Schedule 10 "Permitted Activity Criteria*".

Calculated concentrations of the sum of low and high molecular weight PAHs complied with the Eco SSLs.

5.2.3 Oteha Valley Bridge

Trace Elements

Concentrations of trace elements in soil samples collected from Oteha Valley were generally consistent with background concentrations.

Measurements undertaken using the XRF returned concentrations that were above background concentrations for cadmium, chromium and manganese, however when compared to the laboratory results, this appears to be due to interference (false positives) from other elements as the laboratory results were appreciably lower.

All concentrations complied with the adopted acceptance criteria for the protection of human health and environment.

Polycyclic Aromatic Hydrocarbons

Polycyclic Aromatic Hydrocarbons (PAH) were not detected above the laboratory detection limits in all samples collected in the vicinity of Oteha Valley Bridge.

5.2.4 Point Erin Harbour Bridge Approach

Trace Elements

The tabulated summary of the following results are shown in Table 6, Appendix C.

Total **arsenic** concentrations measured in the soil using the XRF ranged from below analytical detection limits (<1mg/kg) to 52mg/kg, whilst laboratory concentrations ranged

[11] The BaP is calculated as the sum of each of the detected concentrations of nine carcinogenic PAHs multiplied by their respective potency equivalency factors. The TEQ is the toxic equivalency, an indication of the toxicity of a mixture of compounds. Refer 85 of the Soil NES Uers Guide for details.

from 4 to 29mg/kg. All of the measured concentrations complied with the soil NES contaminant standards for to the protection of human health in the context of recreational land use.

Measured concentrations of arsenic generally complied with the EPA Eco SSLs, with the exception of two samples measured with the XRF. Some samples contained arsenic concentrations above background concentrations. All arsenic concentrations complied with the Auckland Council Permitted Activity acceptance criterion.

Total **cadmium** concentrations measured in soil samples ranged from below XRF analytical detection limits (<1mg/kg) to 55mg/kg whilst laboratory concentrations ranged from below laboratory analytical detection limits (<0.1 mg/kg) to 0.54 mg/kg. When the XRF and laboratory data are compared, they do not demonstrate a good correlation as the XRF are an order of two magnitudes higher, therefore the XRF measurements for cadmium at this location are not considered to be representative. The laboratory analytical data complied with the all the adopted acceptance criteria. Measured concentrations were within the non-volcanic background range, and complied with all the adopted acceptance criteria. Concentrations of cadmium were also below the background limit for non-volcanic soils.

Total **chromium** concentrations measured in soil samples using an XRF ranged from 19 to 144 mg/kg, whilst laboratory concentrations ranged from 12 to 68 mg/kg. Generally, the results demonstrated good correlation between XRF and laboratory results. All of the measured concentrations complied with the soil NES contaminant standards for health (Recreation) acceptance criteria, and the Auckland Council Permitted Activity acceptance criteria. Measured chromium concentrations were generally within the non-volcanic background range.

Total **copper** concentrations measured in soil samples using an XRF ranged from 11 to 163mg/kg whilst laboratory concentrations ranged from 16 to 132 mg/kg. Generally, the results demonstrated good correlation between XRF and laboratory results. All of the measured concentrations complied with the soil NES contaminant standards for health (Recreation) acceptance criteria and the Auckland Council Permitted Activity acceptance criteria. A number of copper concentrations were above back the back ground range.

Measured copper concentrations were generally above the background limit for non-volcanic soils.

Total **lead** concentrations measured in soil samples ranged between 6 and 275mg/kg whilst laboratory concentrations ranged between 25 and 507 mg/kg. Generally, the samples demonstrated good comparability between the XRF and laboratory results. All of the measured concentrations complied with the soil NES contaminant standards for health (Recreation) acceptance criteria, however a number of lead concentrations exceeded the Auckland council Permitted Activity criterion.

Total **zinc** concentrations measured in soil samples ranged from 30 to 824mg/kg whilst laboratory concentrations ranged from 54 to 882mg/kg. All of the measured concentrations complied with the soil NES contaminant standards for health (Recreation) acceptance criteria, however a number of zinc concentrations exceeded the Auckland council permitted activity criteria.

Polycyclic Aromatic Hydrocarbons

Polycyclic Aromatic Hydrocarbons (PAH) were detected above the laboratory detection limits in all samples at the Point Erin Harbour Bridge Approach. A summary of all PAH results are shown in Table 3, Appendix C.

The results for BaP TEQ complied with recreation acceptance criteria in the Soil NES as well as the Auckland Council Permitted Activity Acceptance Criteria.

The results for naphthalene and pyrene complied with the acceptance criteria referenced in the Oil Industry Guidelines.

Calculated concentrations of the sum of low and high molecular weight PAHs complied with the Eco SSLs.

5.2.5 QA/QC Discussion

The duplicate laboratory analyses of soil samples taken from the Central Motorway Junction, Oteha Valley Bridge and Point Erin Harbour Bridge Approach demonstrated that some variability was apparent between primary and duplicate soil sample analysis, as is typical and expected for environmental soil investigations..

The relative percentage difference in the duplicate analysis of trace element results from the Central Motorway Junction ranged between 0.9 and 19.1%, whilst PAH results ranged between 16.2 and 101.5%.

The variability in the duplicate analysis of trace element results from the Oteha Valley Bridge ranged between 4.2 and 17.8%, whilst PAH results were not detected above the laboratory detection limits in all samples therefore the RPD was not calculated.

The variability in the duplicate analysis of trace element results from Point Erin Harbour Bridge Approach ranged between 6.6 and 58%, whilst PAH results ranged between 19.7 and 147.5%.

Acceptable variability is generally considered to be RPD of <30%. This variability >30% in these samples is likely due to heterogeneity between the primary and duplicate soil samples.

Percentage Relative Difference calculations for the soil results are presented in Tables 7 – 9, Appendix C.

5.3 Contaminant Distribution

Iso-concentration plots have been developed for Point Erin and for the Central Motorway Junction for copper, lead and zinc. The figures are included in Appendix D. At each of the sampled locations, the concentration that was plotted was the highest of the measured XRF and laboratory results for the sample tested. A plot for PAHs was not prepared because concentrations were relatively low and compliant with all of the adopted acceptance criteria.

5.3.1 The Central Motorway Junction

Figure 8, Figure 9 and Figure 10 show maximum concentrations of XRF and laboratory measured copper, lead and Zinc at the Central Motorway Junction. The maximum concentrations of these contaminants are all located to the north west of the site with elevated concentrations stretching to the west and south of the site. This contaminant hotspot appears localised adjacent the end of Cobden Street, which may be a result of runoff from the street.

Two discrete hotspots also appear to be located in the southern portion of the site. The concentrations measured in these hot spots are lower than the hotspot in the north west corner of the site.

5.3.2 Point Erin

Copper

Figure 5 shows maximum concentrations of XRF and laboratory measured copper at Point Erin Harbour Bridge Approach. The maximum concentrations of copper deposition are generally located to the eastern side of the harbour bridge approach in the vicinity of Westhaven Drive and Shelly Beach Road off-ramp, possibly due to the prevailing westerly winds.

The most concentrated area of copper (up to 163 mg/kg) was located to the north east of the site. This hotspot appears to be concentrated along the bridge abutment at Curran Street and may be related to bridge maintenance work as well as traffic related deposition to the east. Copper is thought to be related to bridge maintenance. A separate hotspot is also located in Harbour Park, related to what appears to be a construction storage yard onsite.

Lead

Figure 6 shows maximum concentrations of XRF and laboratory measured lead at Point Erin Harbour Bridge Approach. The maximum concentrations of lead deposition are generally located to the eastern side of the harbour bridge approach in the vicinity of Westhaven Drive and Shelly Beach Road off-ramp which may again reflect the westerly prevailing winds. The most concentrated area (up to 507.3 mg/kg) is located to the north of the site. This hotspot appears to be concentrated along the bridge abutment at Curran Street and may be related to bridge maintenance work as well as traffic related deposition to the east. Compared to the copper concentrations, lead concentrations are higher across the site but conform to a similar distribution pattern. However there was a separate hotspot located in Harbour Park, related to what appears to be a construction storage yard onsite.

Zinc

Figure 7 shows maximum concentrations of XRF and laboratory measured zinc at Point Erin Harbour Bridge Approach. The maximum concentrations of zinc are located by the bridge abutment at Curran Street and to the eastern side of the harbour bridge approach in the vicinity of Westhaven Drive and Shelly Beach Road off-ramp in keeping with the westerly prevailing winds. The most concentrated area of zinc (up to 824 mg/kg) was located to the north of the site. This hotspot appears to be concentrated along the bridge abutment at Curran Street and may be related to bridge maintenance work steel (galvanising) as well as traffic related deposition..

Compared to the copper and lead concentrations, zinc appears to have a more concentrated distribution beside the bridge abutment however the general pattern of distribution was similar. A separate hotspot was also located in Erin Point Park, related to what appears to be a construction storage yard.

5.3.3 Oteha Valley

Iso-concentration plots were not completed for Oteha Valley given the low contaminant concentrations.

6. Conclusions

GHD has completed the site investigations which included sampling near surface soil in a grid pattern across three NZTA network locations with elevated motorways (the Central Motorway Junction, Point Erin Harbour Bridge Approach and the Oteha Valley Bridge).

Soil analytical results were obtained onsite by performing field XRF screening. Roughly one in five samples was also tested by laboratory for the inorganic elements and PAHs. From the results obtained from these events, it can be concluded that:

- Elevated concentrations of lead, copper and zinc have been identified in near surface soils at both the Central Motorway Junction and Point Erin;
- Concentrations of lead, copper and zinc measured in samples from these hotspots generally exceeded background concentrations, EPA SSL and Auckland Council permitted activity criteria;
- This may mean that concentrations of these contaminants pose a risk to terrestrial ecological receptors, and consent may also need to be sought from Auckland Council for the discharge of contaminants to ground;
- Based upon the current investigation results and comparisons with health risk based acceptance criteria, it appears that contaminants do not pose a risk to human health.
- PAH concentrations in soil samples were generally low, or below laboratory analytical detection limits.
- Regression analysis of lead, copper and zinc XRF results with laboratory data demonstrates that there is a strong relationship between the two, therefore correlate well;
- Regression analysis between lead and zinc, copper and zinc, and copper and lead, demonstrates that there is a strong relationship, indicating that their distribution may be interrelated;
- The contaminant distribution at Central Motorway Junction and Point Erin appear to be isolated to relatively discrete contaminant “hotspots” located up to 50 metres from the motorway ;
- The pattern of distribution tended to correlate with the prevailing westerly wind direction, with the highest concentrations east of the motorway section in the more exposed Point Erin and Central Motorway Junction locations.

7. Limitations

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GHD otherwise disclaims responsibility to any person other than NZTA arising in connection with this report. GHD also excludes implied warranties and conditions, to the extent legally permissible.

The services undertaken by GHD in connection with preparing this report were limited to those specifically detailed in the report and are subject to the scope limitations set out in the report.

The opinions, conclusions and any recommendations in this report are based on conditions encountered and information reviewed at the date of preparation of the report. GHD has no responsibility or obligation to update this report to account for events or changes occurring subsequent to the date that the report was prepared.

GHD has prepared this report on the basis of information provided by NZ Transport Agency, which GHD has not independently verified or checked beyond the agreed scope of work. GHD does not accept liability in connection with such unverified information, including errors and omissions in the report which were caused by errors or omissions in that information.

The opinions, conclusions and any recommendations in this report are based on information obtained from, and testing undertaken at or in connection with, specific sample points. Site conditions at other parts of the site may be different from the site conditions found at the specific sample points.

Investigations undertaken in respect of this report are constrained by the particular site conditions, such as the location of buildings, services and vegetation. As a result, not all relevant site features and conditions may have been identified in this report.

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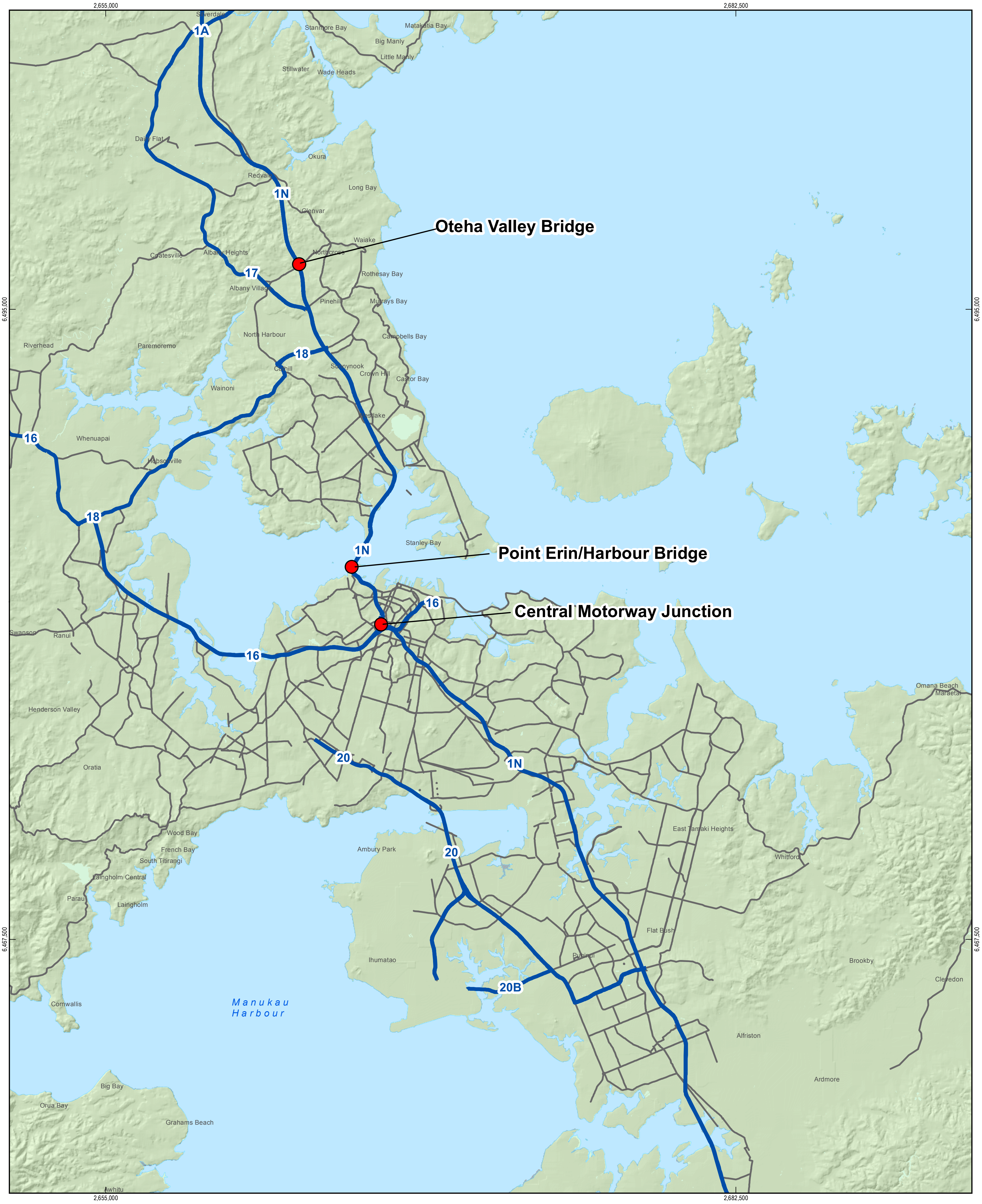
Appendix A
Sampling Sites and Soil Sampling Locations



Legend

- Sampling Sites
- State Highways
- Arterial Roads
- Auckland Region

Paper Size A3 Scale 1:150,000

0 0.5 1 2 3 4 5

Kilometres

Map Projection: New Zealand Map Grid
Horizontal Datum: New Zealand 1949
Grid: GD 1949 New Zealand Map Grid

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New Zealand Transport Agency
Auckland Harbour Bridge Risk Assessment

Overview
Proposed Sampling Sites

Job Number	51-29610
Revision	D
Date	12 Nov 2012

Figure 1

G:\51\29610\GIS\Maps\Mxd\51_29610_G005_RevD_Figure1_Overview.mxd

L3, GHD Centre, 27 Napier Street, Freemans Bay, Auckland 1011 New Zealand **T** 64 9 307 7373 **F** 64 9 307 7300 **E** aklmail@ghd.com **W** www.ghd.com

Data source: Auckland Council: Aerials, 31 January 2012, Roads & Ocean, 29 February 2012; GHD: Sampling Sites, July 2012 Created by:RdParsons

Legend

- Sample Site Locations
- 25m Grid

Paper Size A3 Scale 1:2000

0 10 20 40 60 80

Metres

Map Projection: New Zealand Map Grid
Horizontal Datum: New Zealand 1949
Grid: GD 1949 New Zealand Map Grid

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New Zealand Transport Agency
Auckland Harbour Bridge Risk Assessment

Job Number	51-29610
Revision	1
Date	15 Nov 2012

Central Motorway Junction

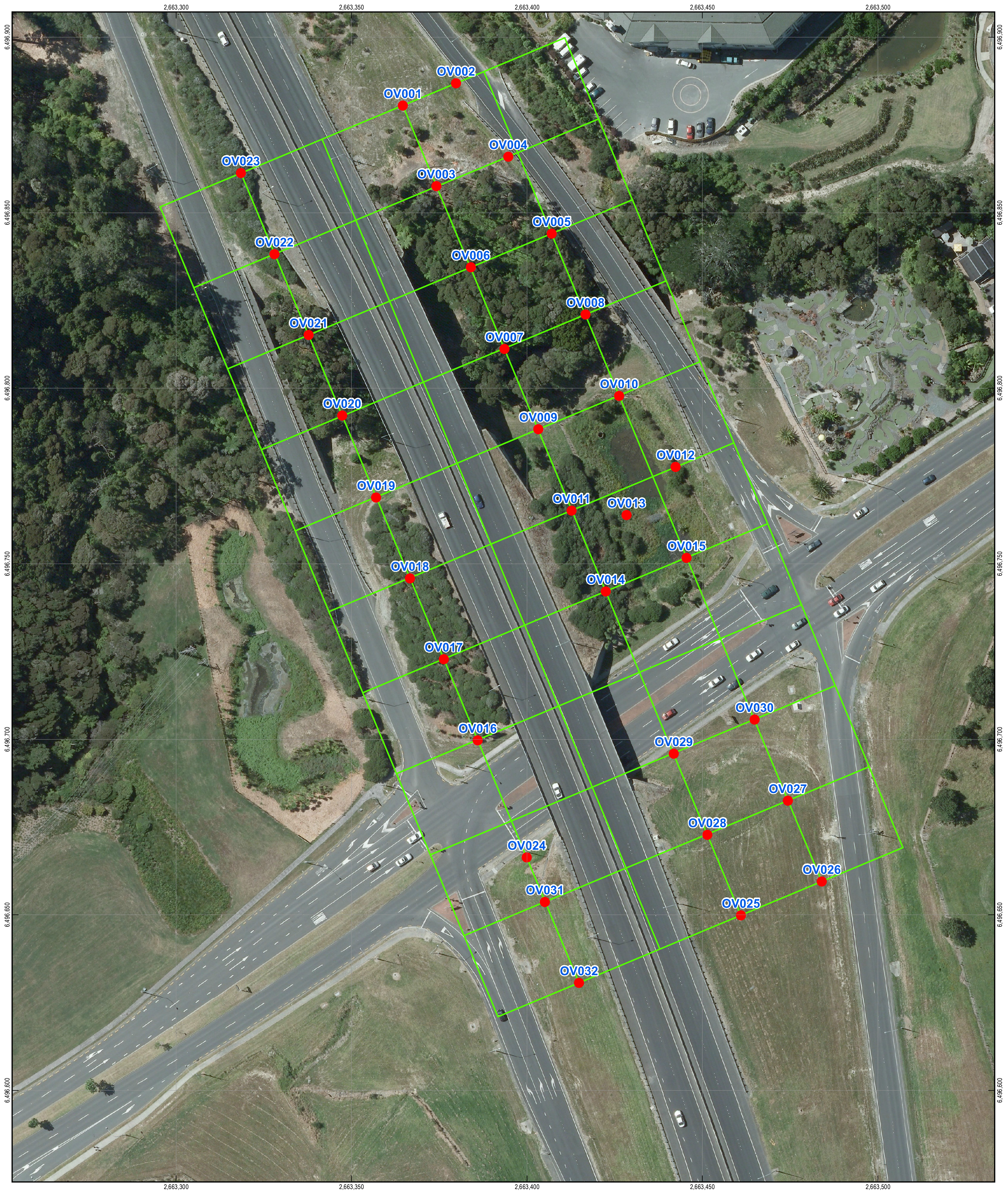
Soil Sampling Locations and Approximate Grid

Figure 3

G:\51\29610\GIS\Maps\Mxd\51_29610_G004_Rev1_Figure3_Central Motorway Junction.mxd

L3, GHD Centre, 27 Napier Street, Freemans Bay, Auckland 1011 New Zealand T 64 9 307 7373 F 64 9 307 7300 E aklmail@ghd.com W www.ghd.com

Data source: Auckland Council: Aerials, 31 January 2012; GHD: Sampling Sites, July 2012 Created by:rdparsons



Legend

- Sample Site Locations
- 25m Grid

Paper Size A3 Scale 1:1000

0 5 10 20 30 40

Metres

Map Projection: New Zealand Map Grid
Horizontal Datum: New Zealand 1949
Grid: GD 1949 New Zealand Map Grid

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New Zealand Transport Agency
Auckland Harbour Bridge Risk Assessment

Job Number	51-29610
Revision	2
Date	15 Nov 2012

Oteha Valley Bridge

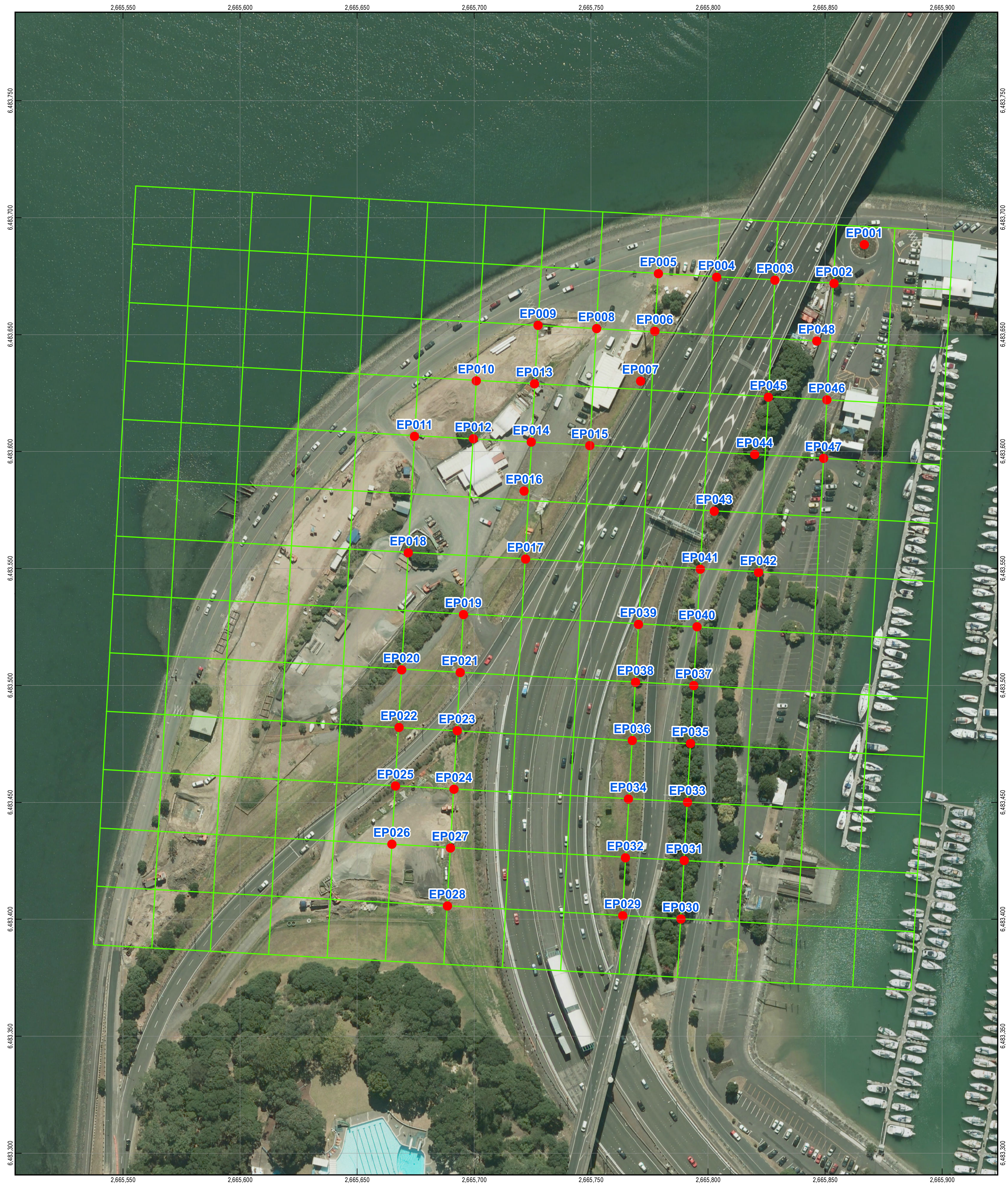
Soil Sampling Locations and Approximate Grid

Figure 4

G:\51\29610\GIS\Maps\Mxd\51_29610_G003_Rev2_Figure4_Oteha_Valley_Bridge.mxd

L3, GHD Centre, 27 Napier Street, Freemans Bay, Auckland 1011 New Zealand **T** 64 9 307 7373 **F** 64 9 307 7300 **E** aklmail@ghd.com **W** www.ghd.com

Data source: Auckland Council: Aerials, 31 January 2012; GHD: Sampling Sites, July 2012 Created by:rdparsons



Legend

- Sample Site Locations
- 25m Grid

Paper Size A3 Scale 1:1500

0 5 10 20 30 40 50

Metres

Map Projection: New Zealand Map Grid
Horizontal Datum: New Zealand 1949
Grid: GD 1949 New Zealand Map Grid

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Auckland Harbour Bridge Risk Assessment

Job Number 51-29610
Revision 1
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Point Erin

Soil Sampling Locations and Approximate Grid

Figure 2

G:\51\29610\GIS\Maps\Mxd\51_29610_G002_Rev1_Figure2_Point_Erin.mxd

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Data source: Auckland Council: Aerials, 31 January 2012; GHD: Sampling Sites and Grid, July 2012 Created by:rdparsons

Appendix B
Sample Analytical Results

Table 1: Soil Laboratory Analytical Results - The Central Motorway Junction

Trace Elements

Field_ID	LocCode	Sampled_Date	x_coord	y_coord	Dry Matter	Arsenic	Cadmium	Chromium (III+VI)	Copper	Lead	Nickel	Thallium	Zinc	Sum LMW PAH	Sum HMW PAH
					g/100g	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg
ARC Sched10 - Discharge						100	7.5	400	325	250	105		400		
Moanataiari Subdivision SGV												35			
NEPM 1999 HIL F											3000		3500		
USEPA Eco-SSLs Ecological Receptors						18	0.77		28	11	38		46	29	18
OIG Agri Sandy Silt <1m - All Pathways															
NES 2011 Commercial Industrial						70	1300	6300	10,000	3300					
TP153 - Upper Limit for Background Concentrations for Non Volcanic Soils						12	0.65	55	45	65	180		180		
CMJ005	CMJ005	30/08/2012	2666946	6481022	39.68	4.003	0.3622	13.49	31.22	68.42	11.58	<0.2	98.19	0.61	0.95
CMJ011	CMJ011	30/08/2012	2666981	6480928	67.92	7.256	0.3196	20.85	45.12	80.88	18.43	<0.2	105.7	0.4	1.04
CMJ011 DUP	CMJ011	30/08/2012	2666981	6480928	65.04	6.939	0.312	18.29	44.69	66.72	16.3	<0.2	103.7	0.66	1.63
CMJ022	CMJ022	30/08/2012	2667046	6480899	45.68	4.069	0.301	11.8	36.59	55.32	8.849	<0.2	97.65	0.54	0.76
CMJ035	CMJ035	30/08/2012	2667195	6480928	39.23	3.286	0.249	12.35	18.8	16.48	12.26	<0.2	74.43	1.12	0.66
CMJ040	CMJ040	30/08/2012	2667054	6480876	63.76	5.387	0.3372	15.55	48.26	55.48	11.05	<0.2	82.46	0.36	0.59
CMJ048	CMJ048	30/08/2012	2667133	6480879	67.32	3.669	0.1622	14.56	24.27	23.76	13.56	<0.2	82.31	0.32	0.24

Statistical Summary

Statistic	Dry Matter	Arsenic	Cadmium	Chromium (III+VI)	Copper	Lead	Nickel	Thallium	Zinc	Sum LMW PAH	Sum HMW PAH
Number of Results	7	7	7	7	7	7	7	7	7	7	7
Number of Detects	7	7	7	7	7	7	7	0	7	7	7
Minimum Concentration	39.23	3.286	0.1622	11.8	18.8	16.48	8.849	<0.2	74.43	0.32	0.24
Minimum Detect	39.23	3.286	0.1622	11.8	18.8	16.48	8.849	ND	74.43	0.32	0.24
Maximum Concentration	67.92	7.256	0.3622	20.85	48.26	80.88	18.43	<0.2	105.7	1.12	1.63
Maximum Detect	67.92	7.256	0.3622	20.85	48.26	80.88	18.43	ND	105.7	1.12	1.63
Average Concentration	56	4.9	0.29	15	36	52	13	0.1	92	0.57	0.83
Median Concentration	63.76	4.069	0.312	14.56	36.59	55.48	12.26	0.1	97.65	N/A	N/A
Standard Deviation	13	1.6	0.067	3.3	11	24	3.3	0	12	N/A	N/A
Number of Guideline Exceedances	0	0	0	0	5	7	0	0	7	N/A	N/A
Number of Guideline Exceedances(Detects Only)	0	0	0	0	5	7	0	0	7	N/A	N/A
95% UCL of the mean	N/A	6.126	0.341	17.68	43.85	69.92	15.55	N/A	101	N/A	N/A

PAH

Field_ID	Acenaphthene	Acenaphthylene	Anthracene	Benz(a)anthracene	Benzo(a) pyrene	Benzo(a) Pyrene TEQ	Benzo(g,h,i)perylene	Benzo(k)fluoranthene	Benzo[b+j]fluoranthene	Chrysene	Dibenz(a,h)anthracene	Fluoranthene	Fluorene	Indeno(1,2,3-c,d)pyrene	Naphthalene	Phenanthrene	Pyrene
	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
ARC Sched10 - Discharge						2.15											
Moanataiari Subdivision SGV																	
NEPM 1999 HIL F																	
USEPA Eco-SSLs Ecological Receptors																	
OIG Agri Sandy Silt <1m - All Pathways															7.2		160
NES 2011 Commercial Industrial						35											
TP153 - Upper Limit for Background Concentrations for Non Volcanic Soils																	
CMJ005	<0.05382	<0.05382	<0.05382	0.1007	0.1395	0.2435	0.1793	0.07355	0.1691	0.1126	<0.05382	0.2302	<0.05382	0.1472	<0.2691	0.1336	0.3169
CMJ011	<0.03277	<0.03277	<0.03277	0.1331	0.169	0.2623	0.1907	0.08845	0.2027	0.1303	<0.03277	0.2646	<0.03277	0.168	<0.1638	0.1066	0.3636
CMJ011 DUP	<0.03422	<0.03422	0.06031	0.2	0.2548	0.3827	0.2705	0.1301	0.298	0.2006	0.03855	0.4529	<0.03422	0.2449	<0.1711	0.3265	0.6103
CMJ022	<0.05174	<0.05174	<0.05174	0.08951	0.109	0.2005	0.1252	0.05885	0.1355	0.08858	<0.05174	0.1793	<0.05174	0.1054	<0.2587	0.08092	0.2546
CMJ035	<0.1129	<0.1129	<0.1129	<0.1129	<0.1129	<0.272	<0.1129	<0.1129	<0.1129	<0.1129	<0.1129	<0.1129	<0.1129	<0.1129	<0.5643	<0.1129	<0.1129
CMJ040	<0.03343	<0.03343	<0.03343	0.07066	0.0916	0.1582	0.109	0.04914	0.1137	0.07385	<0.03343	0.1399	<0.03343	0.091	<0.1672	0.06464	0.2021
CMJ048	<0.03226	<0.03226	<0.03226	<0.03226	0.03772	0.08619	0.05559	<0.03226	0.05053	<0.03226	<0.03226	0.05201	<0.03226	0.04382	<0.1613	<0.03226	0.07884

Statistical Summary

Statistic	Acenaphthene	Acenaphthylene	Anthracene	Benz(a)anthracene	Benzo(a) pyrene	Benzo(a) Pyrene TEQ	Benzo(g,h,i)perylene	Benzo(k)fluoranthene	Benzo[b+j]fluoranthene	Chrysene	Dibenz(a,h)anthracene	Fluoranthene	Fluorene	Indeno(1,2,3-c,d)pyrene	Naphthalene	Phenanthrene	Pyrene
Number of Results	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7
Number of Detects	0	0	1	5	6	6	6	5	6	5	1	6	0	6	0	5	6
Minimum Concentration	<0.03226	<0.03226	<0.03226	<0.03226	0.03772	0.08619	0.05559	<0.03226	0.05053	<0.03226	<0.03226	0.05201	<0.03226	0.04382	<0.1613	<0.03226	0.07884
Minimum Detect	ND	ND	0.06031	0.07066	0.03772	0.08619	0.05559	0.04914	0.05053	0.07385	0.03855	0.05201	ND	0.04382	ND	0.06464	0.07884
Maximum Concentration	<0.1129	<0.1129	<0.1129	0.2	0.2548	0.3827	0.2705	0.1301	0.298	0.2006	<0.1129	0.4529	<0.1129	0.2449	<0.5643	0.3265	0.6103
Maximum Detect	ND	ND	0.06031	0.2	0.2548	0.3827	0.2705	0.1301	0.298	0.2006	0.03855	0.4529	ND	0.2449	ND	0.3265	0.6103
Average Concentration	0.025	0.025	0.031	0.095	0.12	0.21	0.14	0.068	0.15	0.097	0.028	0.2	0.025	0.12	0.13	0.11	0.27
Median Concentration	0.01711	0.01711	0.02587	0.08951	0.109	0.2005	0.1252	0.05885	0.1355	0.08858	0.02587	0.1793	0.01711	0.1054	0.08555	0.08092	0.2546
Standard Deviation	0.015	0.015	0.019	0.059	0.074	0.098	0.078	0.036	0.087	0.059	0.015	0.14	0.015	0.07	0.073	0.1	0.19
Number of Guideline Exceedances	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Number of Guideline Exceedances(Detects Only)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
95% UCL of the mean	N/A	N/A	N/A	0.167	0.195	0.305	0.217	0.11	0.231	0.168	N/A	0.332	N/A	0.191	N/A	0.244	0.452

The High Molecular Weight PAH calculations are the sum of concentrations of pyrene, fluoranthene, benzo(a)anthracene, chrysene, benzo(a)pyrene and dibenzo(a,h)anthrecene

The Low Molecular Weight PAH calculation are the sum of concentrations of naphthalene, acenaphthalene, acenaphthene, fluorene, phenanthrene and anthracene. However, 2-methylnaphthalene results were not available for inclusion thus this calculation should only be used as a guide.

USEPA Eco-SSLs Ecological Receptor criteria were utilised as follows;

Cadmium, Copper, Lead, Zinc - Avian

Arsenic, Nickel - Plants

PAH - Soil Invertebrates

Table 2: Soil XRF Analytical Results - Central Motorway Junction

Field_ID	LocCode	Sampled	x_coord	y_coord	Sulphur	Inorganics: Chlorine	Inorganics: Thorium	Inorganics: Tungsten	Major Ions: Calcium	Major Ions: Potassium	Trace Elements: Antimony	Arsenic	Bismuth	Cadmium	Chromium (III+VI)	Cobalt	Copper	Iron	Lead	Manganese	Mercury	Molybdenum	Nickel	Phosphorus	Rubidium	Selenium	Silver	Strontium	Thallium	Tin	Titanium	Uranium	Vanadium	Zinc	Zirconium
					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	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg
ARC Sched10 - Discharge												100		7.5	400		325		250		0.75		105											400	
Moanataiari Subdivision SGV																													35						
NEPM 1999 HIL F																500				7500			3000												
NES 2011 Commercial Industrial												70		1300	6300		10,000		3300		4200														
TP153 - Upper Limit for Background Concentrations for Non Volcanic Soils												12		0.65	55	35	45		65	2500			35							<0.7			41.3	180	
CMJ001 30/08/2012	CMJ001	30/08/2012	2666952	6481078	283	<1	12	<1	10,980	967	<1	<5	<1	<1	<1	7	<14	7474	22	164	<1	3	<1	<1	5	<1	<1	97	<1	<1	957	8	9	76	34
CMJ004 30/08/2012	CMJ004	30/08/2012	2666960	6481054	766	234	<1	<1	16,550	3187	<1	15	<1	31	52	20	85	27,540	328	485	<1	<1	<1	<1	16	<1	<1	170	9	<1	3344	5	37	605	93
CMJ005 30/08/2012	CMJ005	30/08/2012	2666946	6481022	203	<1	12	<1	7946	669	<1	2	<1	<1	<1	1	9	2298	9	90	<1	4	<1	<1	5	<1	<1	49	<1	<1	430	4	3	68	46
CMJ006 30/08/2012	CMJ006	30/08/2012	2666955	6480999	455	<1	8	<1	12,130	3413	<1	<10	<1	27	51	17	26	28,510	36	547	<1	<1	<1	<1	20	<1	<1	123	<1	<1	4088	<1	51	93	98
CMJ008 29/08/2012	CMJ008	29/08/2012	2666987	6480984	<1	<1	15	<1	4867	1652	<1	6	<1	<1	13	6	19	10,660	22	191	<1	3	<1	<1	14	<1	<1	71	<1	<1	2127	6	26	78	173
CMJ009 29/08/2012	CMJ009	29/08/2012	2666996	6480961	233	<1	15	<1	6534	629	<1	<4	<1	<1	<1	1	<6	2608	14	73	<1	4	<1	<1	5	<1	<1	36	<1	<1	488	6	4	48	57
CMJ010 29/08/2012	CMJ010	29/08/2012	2667004	6480937	119	<1	10	<1	2897	813	<1	<4	<1	29	6	3	<9	5701	21	107	<1	2	<1	<1	6	<1	<1	28	4	<1	1051	4	10	42	88
CMJ011 29/08/2012	CMJ011	29/08/2012	2666981	6480928	404	<1	7	<1	6359	2570	<1	5	<1	<1	23	7	32	14,950	52	251	<1	<1	<1	<1	17	<1	<1	48	6	<1	3125	<1	32	72	190
CMJ012 29/08/2012	CMJ012	29/08/2012	2666990	6480905	367	<1	8	<1	7507	5548	<1	10	<1	39	29	14	23	22,310	13	255	<1	<1	<1	<1	24	<1	<1	54	<1	<1	3281	<1	53	52	189
CMJ013 29/08/2012	CMJ013	29/08/2012	2667013	6480914	345	<1	<1	<1	5692	1812	<1	<7	<1	59	13	4	29	10,680	35	243	<1	<1	<1	<1	12	<1	<1	39	<1	<1	2757	<1	27	72	210
CMJ014 29/08/2012	CMJ014	29/08/2012	2666998	6480881	<1	<1	<1	<1	3341	2685	<1	<5	<1	<1	30	7	12	17,450	10	457	<1	<1	<1	<1	21	<1	<1	46	<1	<1	2367	<1	27	57	76
CMJ015 29/08/2012	CMJ015	29/08/2012	2666961	6480841	<1	<1	<1	<1	3315	2165	<1	3	<1	41	24	7	<14	15,480	<6	390	<1	<1	<1	<1	17	<1	<1	40	<1	<1	2172	<1	23	50	69
CMJ016 29/08/2012	CMJ016	29/08/2012	2666984	6480849	<1	<1	14	<1	2193	962	<1	<5	<1	<1	<1	2	<6	3587	21	73	<1	4	<1	<1	4	<1	<1	28	<1	<1	388	4	3	35	21
CMJ018 29/08/2012	CMJ018	29/08/2012	2667010	6480993	291	<1	<1	<1	7607	2052	<1	<7	<1	<1	<1	5	<18	6282	<11	155	<1	<1	<1	<1	14	<1	<1	56	<1	<1	896	<1	12	39	101
CMJ019 29/08/2012	CMJ019	29/08/2012	2667024	6480971	270	<1	11	<1	9220	2390	25	5	<1	<1	<1	5	13	9645	11	216	<1	<1	<1	<1	11	<1	<1	81	<1	<1	1058	6	20	80	36
CMJ020 29/08/2012	CMJ020	29/08/2012	2667038	6480950	379	<1	22	<1	9229	1817	<1	<16	<1	<1	10	9	<20	10,860	23	257	<1	8	<1	<1	18	<1	<1	89	<1	<1	1423	<1	19	20	70
CMJ021 29/08/2012	CMJ021	29/08/2012	2667036	6480922	726	<1	24	<1	17,260	1840	<1	<6	<1	<1	<1	5	9	4281	13	184	<1	7	<1	<1	11	<1	<1	97	<1	<1	468	13	7	55	51
CMJ022 30/08/2012	CMJ022	30/08/2012	2667046	6480899	208	<1	8	<1	4111	1418	<1	<5	<1	40	<1	<1	9	6417	17	112	<1	<1	<1	<1	9	<1	<1	28	<1	<1	1443	<1	12	46	80
CMJ023 29/08/2012	CMJ023	29/08/2012	2667060	6480931	253	<1	9	<1	7638	634	<1	<5	<1	21	<1	3	<10	4704	9	126	<1	2	<1	<1	7	<1	<1	54	<1	<1	558	4	3	64	35
CMJ024 30/08/2012	CMJ024	30/08/2012	2667069	6480908	800	267	12	<1	18,380	2409	<1	6	<1	<1	23	9	36	13,020	51	215	<1	4	<1	<1	19	<1	<1	67	9	<1	2697	<1	30	82	242
CMJ025 29/08/2012	CMJ025	29/08/2012	2667047	6481007	<1	<1	<1	<1	2684	885	<1	<4	<1	<1	<1	2	<7	3389	5	67	<1	<1	<1	<1	8	<1	<1	29	<1	<1	581	<1	6	110	63
CMJ026 29/08/2012	CMJ026	29/08/2012	2667066	6480987	<1	<1	6	<1	2446	3006	<1	3	<1	26	22	5	<9	12,630	4	153	<1	<1	<1	<1	15	<1	<1	34	<1	<1	2540	<1	26	40	164
CMJ027 29/08/2012	CMJ027	29/08/2012	2667075	6480963	278	<1	<1	<1	6163	2403	<1	<5	<1	<1	14	4	9	10,430	6	125	<1	<1	<1	<1	16	<1	<1	45	<1	<1	1926	<1	23	36	139
CMJ028 29/08/2012	CMJ028	29/08/2012	2667098	6480972	<1	<1	<1	<1	4580	1545	<1	<3	<1	<1	<1	3	<11	6626	<6	87	<1	<1	<1	<1	10	<1	<1	33	<1	<1	1192	<1	14	51	88
CMJ029 29/08/2012	CMJ029	29/08/2012	2667107	6480949	<1	<1	<1	<1	2511	2753	<1	5	<1	43	25	6	<14	15,100	<7	188	<1	<1	<1	<1	23	<1	<1	37	6	<1	2460	<1	32	52	173
CMJ030 29/08/2012	CMJ030	29/08/2012	2667130	6480958	277	180	<1	<1	15,110	7332	<1	<4	<1	31	<1	4	<9	5563	6	101	<1	<1	<1	<1	16	<1	<1	44	<1	<1	884	4	11	36	133
CMJ031 30/08/2012	CMJ031	30/08/2012	2667092	6480917	218	<1	13	<1	7539	6053	<1	8	<1	<1	87	11	15	21,010	14	475	<1	<1	<1	<1	35	<1	<1	145	<1	<1	2753	5	47	64	132
CMJ032 30/08/2012	CMJ032	30/08/2012	2667120	6480927	<1	<1	<1	<1	10,980	5495	<1	6	<1	<1	54	14	21	23,430	19	338	<1	<1	<1	<1	35	<1	<1	126	<1	<1	3497	<1	48	60	184
CMJ033 30/08/2012	CMJ033	30/08/2012	2667148	6480910	431	114	21	<1	10,570	1481	<1	<4	<1	<1	<1	2	<14	8288	<6	216	<1	7	<1	<1	14	<1	<1	52	15	<1	1177	4	14	41	94
CMJ034 30/08/2012	CMJ034	30/08/2012	2667171	6480920	<1	131	<1	<1	4355	4688	<1	7	<1	<1	43	12	<18	18,860	15	221	<1	<1	<1	<1	27	<1	<1	75	<1	<1	2813	<1	41	40	157
CMJ035 30/08/2012	CMJ035	30/08/2012	2667195	6480928	138	<1	7	<1	2703	1066	<1	3	<1	<1	<1	2	<6	4262	5	59	<1	3	<1	<1	6	<1	<1	34	<1	<1	566	<1	5	36	37
CMJ036 30/08/2012	CMJ036	30/08/2012	2667203	6480905	220	<1	7	<1	10,360	3638	<1	3	<1	<1	23	6	14	13,340	9	267	<1	<1	<1	<1	23	<1	<1	82	<1	<1	1616	<1	31	60	65
CMJ037 30/08/2012	CMJ037	30/08/2012	2667227	6480914	189	<1	<1	<1	5241	2643	<1	<5	<1	<1	14	5	<13	11,870	7	357	<1	<1	<1	<1	17	<1	<1	45	<1	<1	1475	<1	23	60	49
CMJ038 30/08/2012	CMJ038	30/08/2012	2667250	6480923	152	<1	<1	<1	2326	1505	<1	<4	<1	<1	8	4	<7	8326	4	116	<1	<1	<1	<1	10	<1	<1	26	<1	<1	1410	<1	15	30	88
CMJ039 30/08/2012	CMJ039	30/08/2012	2667031	6480867	<1	<1	<1	<1	7685	1626	<1	<5	<1	<1	10	6	10	8121	23	157	<1	<1	<1	<1	11	<1	<1	46	<1	<1	1598	<1	15	52	130
CMJ040 30/08/2012	CMJ040	30/08/2012	2667054	6480876	167	<1	11	<1	2837	1186	<1	<5	<1	<1	<1	2	8	5193	13	110	<1	3	<1	<1	8	<1	<1	28	<1	<1	1276	<1	11	47	86
CMJ041 30/08/2012	CMJ041	30/08/2012	2667078	6480885	250	<1	9	<1	8397	670	<1	<5	<1	<1	<1	2	9	4141	17	127	<1	3	<1	<1	8	<1	<1	57	<1	<1	769	<1	6	70	88
CMJ042 30/08/2012	CMJ042	30/08/2012	2667103	6480889	206	<1	15	<1	4381	1269	<1	4	<1	<1	<1	2	8	4603	6	99	<1	4	<1	<1	9	<1	<1	49	<1	<1	721	4	8	61	53
CMJ043 30/08/2012	CMJ043	30/08/2012	2667016	6480835	<1	<1	<1	<1	3830	2241	<1	<5	<1	26	22	5	15	11,820	24	233	<1	<1	<1	<1	14	<1	<1	40	<1	<1	2105	<1	25	47	120
CMJ044 30/08/2012	CMJ044	30/08/2012	2667040	6480844	205	<1	5	<1	3623	1480	<1	<4	<1	23	<1	3	9	6018	16	145	<1	<1	<1	<1	7	<1	<1	24	<1	<1	1212	4	11	46	105
CMJ045 30/08/2012	CMJ045	30/08/2012	2667063	6480853	357	<1	<1	<1	9668	1511	<1	4	<1	27	<1	5	30	8297	30	193	<1	<1	<1	<1	13	<1	<1	50	6	<1	2033	<1	18	76	178
CMJ046 30/08/2012	CMJ046	30/08/2012	2667087	6480861	<1	<1	10	<1	2285	681	<1	<2	<1	<1	<1	2	<8	2629	10	37	<1	3	<1	<1	5	<1	<1	26	<1	<1	390	<1	<1	36	46
CMJ047 30/08/2012	CMJ047	30/08/2012	2667110	6480870	178	<1	<1	<1	3550	2439	<1	7	<1	<1	36	8	16	15,200	48	244	<1	<1	<1	<1	19	<1	<1	51	6	<1	3736	<1	32	71	209
CMJ048 30/08/2012	CMJ048	30/08/2012	2667133	6480879	606	<1	23	<1	8839	3079	<1	9	<1	<1	32	7	23	10,350	9	250	<1	8	<1	<1	24	<1	<1	100	<1	<1	1413	6	20	75	68

Statistical Summary

Statistic	Sulphur	Chlorine	Thorium	Tungsten	Calcium	Potassium	Antimony	Arsenic	Bismuth	Cadmium	Chromium (III+VI)	Cobalt	Copper	Iron	Lead	Manganese	Mercury	Molybdenum	Nickel	Phosphorus	Rubidium	Selenium	Silver	Strontium	Thallium	Tin	Titanium	Uranium	Vanadium	Zinc	Zirconium
Number of Results	44	44	44	44	44	44	44	44	44	44	44	44	44	44	44	44	44	44	44	44	44	44	44	44	44	44	44	44	44	44	44
Number of Detects	31	5	26	0	44	44	1	19	0	14	24	43	25	44	39	44	0	17	0	0	44	0	0	44	8	0	44	16	43	44	44
Minimum Concentration	<1	<1	<1	<1	2193	629	<1	<2	<1	<1	<1	<1	<6	2298	4	37	<1	<1	<1	<1	4	<1	<1	24	<1	<1	388	<1	<1	20	21
Minimum Detect	119	114	5	ND	2193	629	25	2	ND	21	6	1	8	2298	4	37	ND	2	ND	ND	4	ND	ND	24	4	ND	388	4	3	20	21
Maximum Concentration	800	267	24	<1	18,380	7332	25	<16	<1	59	87	20	85	28,510	328	547	<1	8	<1	<1	35	<1	<1	170	15	<1	4088	13	53	605	242
Maximum Detect	800	267	24	ND	18,380	7332	25	15	ND	59	87	20	85	28,510	328	547	ND	8	ND	ND	35	ND	ND	170	15	ND	4088	13	53	605	242
Average Concentration	227	21	7.3	0.5	6964	2280	1.1	4	0.5	11	15	5.8	14	10,544	23	204	0.5	1.9	0.5	0.5	14	0.5	0.5	59	1.8	0.5	1710	2.3	20	69	105
Median Concentration	207	0.5	7	0.5	6261	1828.5	0.5	3	0.5	0.5	9	5	9	8985.5	13	186	0.5	0.5	0.5	0.5	14	0.5	0.5	48.5	0.5	0.5	1433	0.5	18.5	53.5	88
Standard Deviation	212	63	7.1	0	4251	1541	3.7	2.8	0	16	19	4.3	14	6668	49	122	0	2.2	0	0	7.6	0	0	34	3.1	0	1022	2.8	14	85	57
Number of Guideline Exceedances	0	0	0	0	0	0	0	2	0	44	1	0	1	0	1	0	44	0	0	0	0	0	0	0	8	0	0	0	4	1	0
Number of Guideline Exceedances(Detects Only)	0	0	0	0	0	0	0	1	0	14	1	0	1	0	1	0	0	0	0	0	0	0	0	0	8	0	0	0	4	1	0
95% UCL of the mean	376.9	247.5	13.99	N/A	8135	2686	N/A	7.202	N/A	37.92	35.04	7.086	24.59	12420	61.34	237.2	N/A	5.096	N/A	N/A	16.4	N/A	N/A	67.32	10.31	N/A	2018	6.462	25.04	90.35	121.2

The High Molecular Weight PAH calculations are the sum of concentrations of pyrene, fluoranthene, benzo(a)anthracene, chrysene, benzo(a)pyrene and dibenzo(a,h)anthrecene
The Low Molecular Weight PAH calculation are the sum of concentrations of naphthalene, acenaphthalene, acenaphthene, fluorene, phenanthrene and anthracene. However, 2-methylnaphthalene results were not available for inclusion thus this calculation should only be used as a guide.
USEPA Eco-SSLs Ecological Receptor criteria were utilised as follows;
Cadmium, Copper, Lead, Zinc - Avian
Arsenic, Nickel - Plants
PAH - Soil Invertebrates

Table 3: Soil Laboratory Analytical Results - Point Erin Harbour Bridge Approach

Guideline criteria – Trace Elements

	Dry Matter (g/100g)	Arsenic (mg/kg)	Cadmium (mg/kg)	Chromium (III+VI) (mg/kg)	Copper (mg/kg)	Lead (mg/kg)	Nickel (mg/kg)	Thallium (mg/kg)	Zinc (mg/kg)	Sum LMW PAH (mg/kg)	Sum HMW PAH (mg/kg)
ARC Sched10 - Discharge		100	7.5	400	325	250	105		400		
Moanataiari Subdivision SGV								35			
NEPM 1999 HIL F							3000		3500		
USEPA Eco-SSLs Ecological Receptors		18	0.77		28	11	38		46	29	18
OIG Agri Sandy Silt <1m - All Pathways											
NES 2011 Recreation		80	400	2700	10,000	880					
TP153 - Upper Limit for Background Concentrations for Non Volcanic Soils		12	0.65	55	45	65	180		180		

Guideline criteria – PAH

	Acenaphthene (mg/kg)	Acenaphthylene (mg/kg)	Anthracene (mg/kg)	Benz(a)anthracene (mg/kg)	Benzo(a) pyrene (mg/kg)	Benzo(a) Pyrene TEQ (mg/kg)	Benzo(g,h,i)perylene (mg/kg)	Benzo(k)fluoranthene (mg/kg)	Benzo[b+j]fluoranthene (mg/kg)	Chrysene (mg/kg)	Dibenz(a,h)anthracene (mg/kg)	Fluoranthene (mg/kg)	Fluorene (mg/kg)	Indeno(1,2,3-c,d)pyrene (mg/kg)	Naphthalene (mg/kg)	Phenanthrene (mg/kg)	Pyrene (mg/kg)
ARC Sched10 - Discharge						2.15											
Moanataiari Subdivision SGV																	
NEPM 1999 HIL F																	
USEPA Eco-SSLs Ecological Receptors																	
OIG Agri Sandy Silt <1m - All Pathways															7.2		160
NES 2011 Recreation						40											
TP153 - Upper Limit for Background Concentrations for Non Volcanic Soils																	

Results – Trace Elements

Field_ID	LocCode	Sampled_Date	x_coord	y_coord	Dry Matter	Arsenic	Cadmium	Chromium (III+VI)	Copper	Lead	Nickel	Thallium	Zinc	Sum LMW PAH	Sum HMW PAH
EP001	EP001	28/09/2012	2665867	6483689	58.59	5.554	0.2848	68.41	59.52	200.8	59.31	<0.2	555.9	0.85	2.52
EP004	EP004	28/09/2012	2665804	6483675	77.02	4.269	0.2268	52.62	30.92	224.4	26.99	<0.2	654.9	0.29	0.25
EP006	EP006	28/09/2012	2665777	6483651	70.92	4.81	0.2864	32.54	74.44	416.5	36.15	<0.2	670.9	1.05	5.45
EP006 DUP	EP006	28/09/2012	2665777	6483651	61.38	4.033	0.3666	29.49	69.68	457.9	19.89	<0.2	858.1	0.39	1.09
EP011	EP011	28/09/2012	2665675	6483607	79.41	7.78	<0.1	12	16.22	25.07	22.5	<0.2	55.18	0.51	2.05
EP018	EP018	28/09/2012	2665672	6483557	73.65	29.2	0.4206	47.82	91.63	195.4	85.82	<0.2	817.5	0.78	5.34
EP026	EP026	29/08/2012	2665665	6483432	49.76	24.21	0.4936	26.36	30.78	27.52	6.479	<0.2	54.92	0.41	0.26
EP030	EP030	29/08/2012	2665788	6483400	73.18	5.515	0.186	22.92	36.21	46.25	27.95	<0.2	69.53	0.31	0.42
EP033	EP033	29/08/2012	2665791	6483450	62.37	8.896	0.3486	39.01	87.85	195.2	66.45	<0.2	166	0.47	1.11
EP038	EP038	29/08/2012	2665769	6483501	67.8	22.58	0.5482	50.26	129.4	401.1	63.51	<0.2	337.1	0.62	3.38
EP045	EP045	28/09/2012	2665826	6483623	64.47	4.853	0.4586	66.57	132.7	507.3	97.6	<0.2	882.7	0.35	0.85

Results – PAH

Field_ID	Acenaphthene	Acenaphthylene	Anthracene	Benz(a)anthracene	Benzo(a) pyrene	Benzo(a) Pyrene TEQ	Benzo(g,h,i)perylene	Benzo(k)fluoranthene	Benzo[b+j]fluoranthene	Chrysene	Dibenz(a,h)anthracene	Fluoranthene	Fluorene	Indeno(1,2,3-c,d)pyrene	Naphthalene	Phenanthrene	Pyrene
EP001	<0.04023	<0.04023	0.06003	0.2705	0.3138	0.4722	0.3209	0.1548	0.3639	0.3168	0.04741	0.7098	<0.04023	0.2898	<0.2012	0.4788	0.8644
EP004	<0.02792	<0.02792	<0.02792	<0.02792	<0.02792	0.06756	0.02999	<0.02792	0.03062	<0.02792	<0.02792	0.05577	<0.02792	<0.02792	<0.1396	0.03271	0.06717
EP006	0.04253	0.04522	0.1689	0.9158	0.9163	1.368	0.7395	0.4834	1.145	0.7524	0.1134	1.693	0.04066	0.761	<0.1699	0.5769	2.06
EP006 DUP	<0.0349	<0.0349	<0.0349	0.151	0.1621	0.2578	0.1463	0.09026	0.2181	0.1418	<0.0349	0.2553	<0.0349	0.1345	<0.1745	0.09223	0.3528
EP011	<0.02912	<0.02912	0.05127	0.2701	0.2776	0.4148	0.2161	0.1478	0.3545	0.2496	0.03519	0.5393	<0.02912	0.2225	<0.1456	0.2175	0.6654
EP018	<0.0317	0.06908	0.0995	0.7015	1.005	1.545	1.12	0.5555	1.317	0.6051	0.1639	1.248	<0.0317	1.123	<0.1585	0.3924	1.606
EP026	<0.04219	<0.04219	<0.04219	<0.04219	<0.04219	0.1033	0.04918	<0.04219	0.05323	<0.04219	<0.04219	<0.04219	<0.04219	0.04755	<0.211	<0.04219	0.05789
EP030	<0.02991	<0.02991	<0.02991	0.05266	0.0647	0.1202	0.07186	0.03903	0.09175	0.05272	<0.02991	0.1006	<0.02991	0.06713	<0.1496	0.03718	0.1343
EP033	<0.03609	<0.03609	<0.03609	0.1379	0.1612	0.2552	0.1495	0.08805	0.2003	0.1224	<0.03609	0.2803	<0.03609	0.1411	<0.1805	0.1288	0.3712
EP038	<0.03139	0.03833	0.07495	0.4322	0.5363	0.8253	0.5518	0.3022	0.6829	0.3889	0.08853	0.8436	<0.03139	0.5485	<0.157	0.2931	1.093
EP045	<0.03413	<0.03413	<0.03413	0.1098	0.1491	0.2387	0.17	0.08696	0.2036	0.1088	<0.03413	0.1853	<0.03413	0.1431	<0.1706	0.06256	0.2618

Statistical Summary

Statistic	Dry Matter	Arsenic	Cadmium	Chromium (III+VI)	Copper	Lead	Nickel	Thallium	Zinc	Sum LMW PAH	Sum HMW PAH
Number of Results	11	11	11	11	11	11	11	11	11	11	11
Number of Detects	11	11	10	11	11	11	11	0	11	11	11
Minimum Concentration	49.76	4.033	<0.1	12	16.22	25.07	6.479	<0.2	54.92	0.29	0.25
Minimum Detect	49.76	4.033	0.186	12	16.22	25.07	6.479	ND	54.92	0.29	0.25
Maximum Concentration	79.41	29.2	0.5482	68.41	132.7	507.3	97.6	<0.2	882.7	1.05	5.45
Maximum Detect	79.41	29.2	0.5482	68.41	132.7	507.3	97.6	ND	882.7	1.05	5.45
Average Concentration	67	11	0.33	41	69	245	47	0.1	466	0.548	2.065
Median Concentration	67.8	5.554	0.3486	39.01	69.68	200.8	36.15	0.1	555.9	N/A	N/A
Standard Deviation	8.8	9.4	0.15	18	39	176	30	0	337	N/A	N/A
Number of Guideline Exceedances	0	3	0	2	10	11	5	0	11	N/A	N/A
Number of Guideline Exceedances(Detects Only)	0	3	0	2	10	11	5	0	11	N/A	N/A
95% UCL of the mean	N/A	23.42	0.431	50.6	90.52	341.5	62.75	N/A	650.1	N/A	N/A

Statistic	Acenaphthene	Acenaphthylene	Anthracene	Benz(a)anthracene	Benzo(a) pyrene	Benzo(a) Pyrene TEQ	Benzo(g,h,i)perylene	Benzo(k)fluoranthene	Benzo[b+j]fluoranthene	Chrysene	Dibenz(a,h)anthracene	Fluoranthene	Fluorene	Indeno(1,2,3-c,d)pyrene	Naphthalene	Phenanthrene	Pyrene
Number of Results	11	11	11	11	11	11	11	11	11	11	11	11	11	11	11	11	11
Number of Detects	1	3	5	9	9	11	11	9	11	9	5	10	1	10	0	10	11
Minimum Concentration	<0.02792	<0.02792	<0.02792	<0.02792	<0.02792	0.06756	0.02999	<0.02792	0.03062	<0.02792	<0.02792	<0.04219	<0.02792	<0.02792	<0.1396	0.03271	0.05789
Minimum Detect	0.04253	0.03833	0.05127	0.05266	0.0647	0.06756	0.02999	0.03903	0.03062	0.05272	0.03519	0.05577	0.04066	0.04755	ND	0.03271	0.05789
Maximum Concentration	0.04253	0.06908	0.1689	0.9158	1.005	1.545	1.12	0.5555	1.317	0.7524	0.1639	1.693	<0.04219	1.123	<0.211	0.5769	2.06
Maximum Detect	0.04253	0.06908	0.1689	0.9158	1.005	1.545	1.12	0.5555	1.317	0.7524	0.1639	1.693	0.04066	1.123	ND	0.5769	2.06
Average Concentration	0.019	0.026	0.051	0.28	0.33	0.52	0.32	0.18	0.42	0.25	0.05	0.54	0.019	0.32	0.084	0.21	0.68
Median Concentration	0.017065	0.018045	0.021095	0.151	0.1621	0.2578	0.17	0.09026	0.2181	0.1418	0.021095	0.2803	0.017065	0.1431	0.08495	0.1288	0.3712
Standard Deviation	0.0081	0.017	0.049	0.29	0.35	0.51	0.34	0.19	0.44	0.24	0.05	0.54	0.0075	0.35	0.011	0.2	0.66
Number of Guideline Exceedances	0	0	0	0	2	0	0	0	0	0	0	0	0	0	0	0	0
Number of Guideline Exceedances(Detects Only)	0	0	0	0	2	0	0	0	0	0	0	0	0	0	0	0	0
95% UCL of the mean	N/A	N/A	0.136	0.52	0.731	0.932	0.613	0.393	0.814	0.453	0.139	0.914	N/A	0.659	N/A	0.345	1.048

The High Molecular Weight PAH calculations are the sum of concentrations of pyrene, fluoranthene, benzo(a)anthracene, chrysene, benzo(a)pyrene and dibenzo(a,h)anthrecene
The Low Molecular Weight PAH calculation are the sum of concentrations of naphthalene, acenaphthalene, acenaphthene, fluorene, phenanthrene and anthracene. However, 2-methylnaphthalene results were not available for inclusion thus this calculation should only be used as a guide.
USEPA Eco-SSLs Ecological Receptor criteria were utilised as follows;
Cadmium, Copper, Lead, Zinc - Avian
Arsenic, Nickel - Plants
PAH - Soil Invertebrates

Table 4: Soil XRF Analytical Results - Point Erin Harbour Bridge Approach

Field_ID	LocCode	Sampled_Date	x_coord	y_coord		Inorganics			Major Ions		Trace Elements																								
					Sulphur	Chlorine	Thorium	Tungsten	Calcium	Potassium	Antimony	Arsenic	Bismuth	Cadmium	Chromium (III+VI)	Cobalt	Copper	Iron	Lead	Manganese	Mercury	Molybdenum	Nickel	Phosphorus	Rubidium	Selenium	Silver	Strontium	Thallium	Tin	Titanium	Uranium	Vanadium	Zinc	Zirconium
					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	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg
ARC Sched10 - Discharge												100		7.5	400		325		250		0.75		105											400	
Moanataiari Subdivision SGV																													35						
NEPM 1999 HIL F																500							3000											3500	
USEPA Eco-SSLs Ecological Receptors												18		0.77			28		11				38											46	
NES 2011 Recreation												80		400	2700		10,000		880		1800														
TP153 - Upper Limit for Background Concentrations for Non Volcanic Soils												12		0.65	55	35	45		65	2500	0.45		180							4			160	180	
EP001_28/08/2012	EP001	28/08/2012	2665867	6483689	309	<1	11	<1	7864	1581	<1	9	<1	<1	36	8	22	10,910	110	316	<1	<1	<1	<1	14	<1	<1	93	8	<1	1092	7	19	371	64
EP002_28/08/2012	EP002	28/08/2012	2665854	6483672	<1	<1	<1	<1	7390	3570	<1	<2	<1	<1	55	11	31	20,630	65	480	<1	<1	<1	<1	25	<1	<1	78	8	<1	2974	<1	34	503	129
EP004_28/08/2012	EP004	28/08/2012	2665804	6483675	<1	<1	13	<1	4853	3896	<1	10	<1	<1	62	14	21	22,090	65	488	<1	3	<1	<1	24	<1	<1	71	7	<1	2630	<1	33	824	115
EP005_28/08/2012	EP005	28/08/2012	2665779	6483676	<1	<1	<1	<1	7945	5138	<1	13	<1	<1	52	9	26	16,660	88	268	<1	<1	<1	<1	27	<1	<1	141	<1	<1	3198	<1	32	221	218
EP006_28/08/2012	EP006	28/08/2012	2665777	6483651	313	<1	<1	<1	4598	2377	<1	<1	<1	<1	33	7	50	12,720	275	175	<1	<1	<1	<1	16	<1	<1	54	22	<1	2165	<1	27	441	144
EP007_28/08/2012	EP007	28/08/2012	2665771	6483630	287	<1	<1	<1	2695	1190	<1	<1	<1	39	21	4	24	9387	138	160	<1	<1	<1	<1	10	<1	<1	34	21	<1	2507	<1	20	176	239
EP008_28/08/2012	EP008	28/08/2012	2665752	6483653	314	<1	<1	<1	18,140	4461	<1	8	<1	<1	39	6	26	12,730	80	182	<1	<1	<1	<1	21	<1	<1	137	<1	<1	2221	<1	27	126	180
EP009_28/08/2012	EP009	28/08/2012	2665727	6483654	560	<1	<1	<1	15,490	5543	<1	8	<1	<1	39	7	35	15,120	88	207	<1	<1	<1	<1	25	<1	<1	162	<1	<1	2793	7	34	129	223
EP010_28/08/2012	EP010	28/08/2012	2665701	6483630	<1	<1	8	<1	9544	6241	<1	12	<1	<1	70	10	21	15,850	39	202	<1	4	<1	<1	25	<1	<1	180	<1	40	2630	<1	33	65	220
EP011_28/08/2012	EP011	28/08/2012	2665675	6483607	<1	<1	<1	<1	21,490	5262	<1	6	<1	38	45	5	14	13,020	29	167	<1	<1	<1	<1	23	<1	<1	182	<1	<1	2159	<1	29	62	155
EP013_28/08/2012	EP013	28/08/2012	2665726	6483629	342	<1	11	<1	16,010	6004	<1	9	<1	43	42	9	36	17,730	81	313	<1	<1	<1	<1	42	<1	<1	269	<1	<1	2576	7	32	154	187
EP015_28/08/2012	EP015	28/08/2012	2665750	6483603	<1	<1	<1	<1	1437	1104	<1	7	<1	<1	24	6	<12	10,590	19	134	<1	<1	<1	<1	10	<1	<1	15	6	<1	3000	<1	22	38	246
EP016_28/08/2012	EP016	28/08/2012	2665721	6483583	297	<1	<1	<1	10,420	6117	<1	<2	<1	40	76	11	28	23,280	83	340	<1	<1	<1	<1	26	<1	<1	122	<1	<1	4100	<1	43	118	230
EP017_28/08/2012	EP017	28/08/2012	2665722	6483554	307	<1	<1	<1	3412	1697	<1	<2	<1	41	29	8	29	13,820	169	195	<1	<1	<1	<1	13	<1	<1	60	16	<1	2815	<1	27	176	181
EP018_28/08/2012	EP018	28/08/2012	2665672	6483557	<1	<1	<1	<1	16,090	6939	<1	16	<1	38	68	19	53	33,640	103	569	<1	<1	<1	<1	29	<1	<1	217	12	37	4417	<1	110	451	110
EP019_28/08/2012	EP019	28/08/2012	2665695	6483530	<1	<1	<1	<1	4279	5512	<1	7	<1	34	125	13	25	30,020	13	1280	<1	<1	<1	<1	51	<1	<1	79	<1	<1	4908	6	61	60	240
EP020_28/08/2012	EP020	28/08/2012	2665669	6483507	<1	<1	8	<1	1172	2434	<1	6	<1	41	48	11	11	20,640	6	365	<1	<1	<1	<1	24	<1	<1	25	8	<1	3362	<1	35	30	276
EP021_28/08/2012	EP021	28/08/2012	2665694	6483506	330	<1	<1	<1	6212	4548	<1	<2	<1	31	47	10	17	19,940	119	354	<1	<1	<1	<1	22	<1	<1	95	7	<1	3107	5	40	123	159
EP022_28/08/2012	EP022	28/08/2012	2665668	6483482	<1	<1	8	<1	7307	4335	<1	17	<1	34	54	12	36	19,890	191	254	<1	<1	<1	<1	32	<1	<1	127	11	<1	2955	<1	39	220	126
EP023_29/08/2012	EP023	29/08/2012	2665693	6483481	<1	<1	<1	<1	2688	5371	<1	5	<1	<1	104	16	17	33,830	16	1102	<1	<1	<1	<1	43	<1	<1	50	<1	<1	4983	<1	57	57	193
EP024_29/08/2012	EP024	29/08/2012	2665691	6483456	<1	<1	<1	<1	3824	5574	<1	8	<1	<1	106	17	22	36,080	9	1221	<1	<1	<1	<1	44	<1	<1	89	<1	<1	5264	<1	68	66	221
EP025_29/08/2012	EP025	29/08/2012	2665666	6483457	189	<1	11	<1	2987	3557	<1	16	<1	<1	85	19	31	23,080	25	845	<1	<1	<1	<1	42	<1	<1	72	<1	<1	3088	9	39	71	203
EP026_29/08/2012	EP026	29/08/2012	2665665	6483432	250	<1	<1	<1	1922	1969	<1	9	<1	25	20	5	13	11,170	15	207	<1	<1	<1	<1	20	<1	<1	30	28	<1	2536	<1	31	34	135
EP027_29/08/2012	EP027	29/08/2012	2665690	6483431	<1	353	<1	<1	4051	6295	<1	7	<1	<1	107	19	23	34,600	12	1411	<1	<1	<1	<1	48	<1	<1	61	<1	<1	4671	6	56	66	247
EP028_29/08/2012	EP028	29/08/2012	2665689	6483406	<1	265	8	<1	3354	6060	<1	5	<1	<1	99	15	12	31,010	11	1242	<1	<1	<1	<1	43	<1	<1	57	<1	<1	4465	5	57	50	223
EP029_29/08/2012	EP029	29/08/2012	2665764	6483402	<1	<1	22	16	3187	1052	<1	15	<1	39	33	4	52	9984	53	233	<1	3	35	<1	16	<1	<1	62	28	37	1550	8	17	320	85
EP030_29/08/2012	EP030	29/08/2012	2665788	6483400	352	<1	<1	<1	6091	4200	<1	8	<1	<1	51	11	27	23,240	31	320	<1	<1	<1	<1	24	<1	<1	79	9	<1	4337	<1	46	59	170
EP031_29/08/2012	EP031	29/08/2012	2665790	6483425	202	<1	<1	<1	7068	3907	<1	<16	<1	<1	61	12	125	26,040	199	356	<1	<1	<1	<1	26	<1	<1	80	11	<1	3850	<1	47	163	120
EP032_29/08/2012	EP032	29/08/2012	2665765	6483426	236	<1	<1	<1	2912	1755	<1	14	<1	49	52	9	42	14,640	114	250	<1	<1	<1	<1	20	<1	<1	55	12	<1	1818	<1	22	74	109
EP033_29/08/2012	EP033	29/08/2012	2665791	6483450	274	<1	<1	<1	6782	4739	<1	<13	<1	55	56	15	63	29,030	132	469	<1	<1	<1	<1	34	<1	<1	87	14	<1	4359	<1	54	99	140
EP034_29/08/2012	EP034	29/08/2012	2665766	6483452	<1	<1	<1	<1	3081	1929	<1	<9	<1	50	22	5	27	13,340	90	178	<1	<1	<1	<1	13	<1	<1	38	9	<1	1903	<1	19	84	70
EP035_29/08/2012	EP035	29/08/2012	2665793	6483475	266	<1	9	<1	11,050	4418	<1	8	<1	<1	60	18	60	38,140	133	757	<1	<1	<1	<1	29	<1	<1	94	24	<1	5742	<1	61	149	142
EP036_29/08/2012	EP036	29/08/2012	2665768	6483476	<1	<1	7	<1	3346	2464	<1	52	<1	29	46	8	49	13,720	135	191	<1	<1	<1	<1	19	<1	<1	59	7	<1	2079	<1	21	119	97
EP037_28/08/2012	EP037	28/08/2012	2665794	6483500	<1	<1	<1	<1	7189	3354	<1	<11	<1	<1	56	22	77	38,290	164	663	<1	<1	<1	<1	24	<1	<1	75	18	<1	5862	<1	61	129	182
EP038_29/08/2012	EP038	29/08/2012	2665769	6483501	374	<1	7	<1	9071	3643	<1	25	<1	46	52	12	76	23,680	226	423	<1	<1	<1	<1	26	<1	<1	109	15	<1	3511	<1	42	264	124
EP039_29/08/2012	EP039	29/08/2012	2665770	6483526	219	<1	7	<1	10,190	4611	<1	16	<1	42	144	14	73	26,730	245	450	<1	<1	<1	<1	24	<1	<1	122	10	<1	4147	5	45	152	115
EP040_28/08/2012	EP040	28/08/2012	2665795	6483525	476	<1	10	15	10,520	3515	<1	15	<1	48	48	9	137	25,130	261	460	<1	<1	<1	<1	22	<1	<1	93	34	<1	3889	<1	46	230	135
EP041_28/08/2012	EP041	28/08/2012	2665797	6483550	438	<1	<1	<1	9840	4045	<1	15	<1	<1	71	15	148	26,560	356	607	<1	<1	<1	<1	24	<1	<1	129	12	<1	3851	6	43	389	141
EP042_28/08/2012	EP042	28/08/2012	2665822	6483548	178	<1	<1	<1	3997	3076	<1	<9	<1	<1	19	6	16	13,390	49	212	<1	<1	<1	<1	24	<1	<1	44	10	<1	2920	5	28	153	206
EP043_28/08/2012	EP043	28/08/2012	2665803	6483575	567	<1	<1	<1	12,230	2582	<1	<19	<1	32	72	26	93	40,230	257	693	<1	<1	<1	<1	17	<1	<1	122	29	<1	6366	6	65	200	122
EP044_28/08/2012	EP044	28/08/2012	2665820	6483599	<1	<1	<1	<1	13,830	3427	<1	19	<1	33	97	30	106	45,550	436	719	<1	<1	<1	<1	22	<1	<1	139	26	<1	7143	<1	85	263	170
EP045_28/08/2012	EP045	28/08/2012	2665826	6483623	571	<1	<1	<1	13,280	2291	<1	<12	<1	<1	50	13	72	21,640	303	553	<1	<1	<1	<1	15	<1	<1	105	22	<1	2993	<1	40	613	90
EP047_28/08/2012	EP047	28/08/2012	2665849	6483597	328	<1	7	<1	4587	2503	<1	6	<1	28	45	8	18	19,380	13	600	<1	<1	<1	<1	20	<1	<1	51	<1	<1	2969	<1	28	84	117
EP048_28/08/2012	EP048	28/08/2012	2665846	6483647	1161	<1	10	<1	14,410	3300	<1	<24	<1	32	124	20	163	29,390	422	463	<1	4	<1	<1	19	<1	<1	151	17	<1	3777	5	66	737	87

Statistical Summary

Statistic	Sulphur	Chlorine	Thorium	Tungsten	Calcium	Potassium	Antimony	Arsenic	Bismuth	Cadmium	Chromium (III+VI)	Cobalt	Copper	Iron	Lead	Manganese	Mercury	Molybdenum	Nickel	Phosphorus	Rubidium	Selenium	Silver	Strontium	Thallium	Tin	Titanium	Uranium	Vanadium	Zinc	Zirconium
Number of Results	44	44	44	44	44	44	44	44	44	44	44	44	44	44	44	44	44	44	44	44	44	44	44	44	44	44	44	44	44	44	44
Number of Detects	25	2	16	2	44	44	0	30	0	23	44	44	43	44	44	44	0	4	1	0	44	0	0	44	30	3	44	14	44	44	44
Minimum Concentration	<1	<1	<1	<1	1172	1052	<1	<1	<1	<1	19	4	11	9387	6	134	<1	<1	<1	<1	10	<1	<1	15	<1	<1	1092	<1	17	30	64
Minimum Detect	178	265	7	15	1172	1052	ND	5	ND	25	19	4	11	9387	6	134	ND	3	35	ND	10	ND	ND	15	6	37	1092	5	17	30	64
Maximum Concentration	1161	353	22	16	21,490	6939	<1	52	<1	55	144	30	163	45,550	436	1411	<1	4	35	<1	51	<1	<1	269	34	40	7143	9	110	824	276
Maximum Detect	1161	353	22	16	21,490	6939	ND	52	ND	55	144	30	163	45,550	436	1411	ND	4	35	ND	51	ND	ND	269	34	40	7143	9	110	824	276
Average Concentration	208	15	3.9	1.2	7678	3809	0.5	9.8	0.5	20	60	12	47	22,421	124	479	0.5	0.77	1.3	0.5	25	0.5	0.5	95	11	3.1	3493	2.3	42	203	161
Median Concentration	210.5	0.5	0.5	0.5	6925	3769.5	0.5	8	0.5	26.5	52	11	30	21,140	89	360.5	0.5	0.5	0.5	0.5	24	0.5	0.5	83.5	9	0.5	3097.5	0.5	39	139	149.5
Standard Deviation	236	66	5	3.2	4994	1605	0	8.5	0	20	30	5.9	39	9376	113	335	0	0.89	5.2	0	10	0	0	53	9.6	9.6	1319	2.8	19	187	55
Number of Guideline Exceedances	0	0	0	0	0	0	0	17	0	44	20	0	24	0	42	0	44	0	0	0	0	0	0	0	30	3	0	0	0	41	0
Number of Guideline Exceedances(Detects Only)	0	0	0	0	0	0	0	13	0	23	20	0	24	0	42	0	0	0	0	0	0	0	0	0	30	3	0	0	0	41	0
95% UCL of the mean	434	N/A	11.37	N/A	9136	4216	N/A	19.47	N/A	41.32	68.34	13.61	59.5	25002	161.2	566.6	N/A	N/A	N/A	N/A	27.93	N/A	N/A	110.1	18.08	N/A	3827	6.836	46.78	251.4	174.9

The High Molecular Weight PAH calculations are the sum of concentrations of pyrene, fluoranthene, benzo(a)anthracene, chrysene, benzo(a)pyrene and dibenzo(a,h)anthrecene

The Low Molecular Weight PAH calculation are the sum of concentrations of naphthalene, acenaphthalene, acenaphthene, fluorene, phenanthrene and anthracene. However, 2-methylnaphthalene results were not available for inclusion thus this calculation should only be used as a guide.

USEPA Eco-SSLs Ecological Receptor criteria were utilised as follows;

Cadmium, Copper, Lead, Zinc - Avian

Arsenic, Nickel - Plants

PAH - Soil Invertebrates

Table 5: Soil XRF Analytical Results - Oteha Valley Bridge

Field_ID	LocCode	Sampled_Date	x_coord	y_coord	Sulphur	Chlorine	Thorium	Tungsten	Calcium	Potassium	Antimony	Arsenic	Bismuth	Cadmium	Chromium (III+VI)	Cobalt
						Inorganics			Major Ions		Trace Elements					
					mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg
ARC Sched10 - Discharge												100		7.5	400	
Moanataiari Subdivision SGV																
NEPM 1999 HIL F																
USEPA Eco-SSLs Ecological Receptors												18		0.77		
NES 2011 Residential 10%												20		3	460	
TP153 - Upper Limit for Background Concentrations for Non Volcanic Soils												12		0.65	55	35
OV001__29/08/2012	OV001	29/08/2012	2663365	6496881	206	<1	<1	<1	3767	3424	<1	<4	<1	39	19	4
OV002__29/08/2012	OV002	29/08/2012	2663380	6496887	<1	<1	7	<1	2704	3361	<1	4	<1	<1	28	3
OV003__29/08/2012	OV003	29/08/2012	2663374	6496858	283	1275	<1	<1	1706	7775	<1	<5	<1	26	30	5
OV004__29/08/2012	OV004	29/08/2012	2663395	6496866	<1	<1	<1	<1	2256	734	<1	<5	<1	<1	<1	2
OV005__29/08/2012	OV005	29/08/2012	2663407	6496844	<1	<1	<1	<1	2556	2229	<1	<4	<1	28	32	4
OV006__29/08/2012	OV006	29/08/2012	2663384	6496834	<1	<1	<1	<1	951	1895	<1	<5	<1	29	21	5
OV008__29/08/2012	OV008	29/08/2012	2663417	6496821	197	<1	<1	<1	2406	2405	<1	<5	<1	<1	26	4
OV009__29/08/2012	OV009	29/08/2012	2663403	6496788	<1	<1	<1	<1	1491	1192	<1	<5	<1	33	9	3
OV010__29/08/2012	OV010	29/08/2012	2663426	6496798	<1	<1	<1	<1	1900	1255	<1	<5	<1	25	19	3
OV011__29/08/2012	OV011	29/08/2012	2663413	6496765	<1	<1	<1	<1	1162	1512	<1	<1	<1	32	21	3
OV012__29/08/2012	OV012	29/08/2012	2663442	6496778	<1	<1	<1	<1	2784	2445	<1	<7	<1	<1	14	5
OV013__29/08/2012	OV013	29/08/2012	2663428	6496764	233	<1	<1	<1	2274	2934	<1	4	<1	<1	24	5
OV014__29/08/2012	OV014	29/08/2012	2663422	6496742	<1	<1	<1	<1	2620	3685	<1	<5	<1	35	28	4
OV015__29/08/2012	OV015	29/08/2012	2663446	6496752	<1	<1	<1	<1	1981	1367	<1	<5	<1	29	15	3
OV016__29/08/2012	OV016	29/08/2012	2663386	6496700	<1	<1	<1	<1	2264	1943	<1	<5	<1	<1	19	4
OV017__29/08/2012	OV017	29/08/2012	2663376	6496723	325	<1	<1	<1	3947	1869	<1	<5	<1	<1	24	5
OV018__29/08/2012	OV018	29/08/2012	2663367	6496746	<1	<1	<1	<1	3580	1985	<1	<5	<1	<1	<1	4
OV019__29/08/2012	OV019	29/08/2012	2663357	6496769	<1	<1	<1	<1	3372	3835	<1	<1	<1	33	22	6
OV020__29/08/2012	OV020	29/08/2012	2663347	6496792	<1	<1	<1	<1	899	1899	<1	<4	<1	<1	17	3
OV021__29/08/2012	OV021	29/08/2012	2663338	6496815	<1	203	<1	<1	1185	1538	<1	<5	<1	<1	18	3
OV022__29/08/2012	OV022	29/08/2012	2663328	6496838	<1	<1	<1	<1	2289	2650	<1	4	<1	<1	21	6
OV023__29/08/2012	OV023	29/08/2012	2663318	6496861	<1	<1	<1	<1	2419	2396	<1	3	<1	<1	11	3
OV024__29/08/2012	OV024	29/08/2012	2663400	6496666	<1	131	11	<1	1300	2566	<1	3	<1	<1	9	2
OV025__29/08/2012	OV025	29/08/2012	2663461	6496650	<1	<1	<1	<1	1774	1931	<1	<4	<1	39	15	3
OV026__29/08/2012	OV026	29/08/2012	2663484	6496659	192	<1	<1	<1	1506	1849	<1	<4	<1	29	12	3
OV027__29/08/2012	OV027	29/08/2012	2663474	6496683	<1	<1	<1	<1	2237	2601	<1	4	<1	<1	<1	4
OV028__29/08/2012	OV028	29/08/2012	2663451	6496673	235	<1	<1	<1	2074	2259	<1	<4	<1	<1	20	4
OV029__29/08/2012	OV029	29/08/2012	2663442	6496696	<1	<1	<1	<1	1196	1882	<1	<3	<1	23	10	3
OV030__29/08/2012	OV030	29/08/2012	2663465	6496706	<1	<1	<1	<1	1135	1725	<1	<4	<1	<1	9	2
OV031__29/08/2012	OV031	29/08/2012	2663405	6496654	<1	<1	<1	<1	1299	2598	<1	<1	<1	<1	20	4
OV032__29/08/2012	OV032	29/08/2012	2663415	6496631	166	<1	<1	<1	1211	2607	<1	<4	<1	32	17	3

Field_ID	Copper	Iron	Lead	Manganese	Mercury	Molybdenum	Nickel	Phosphorus	Rubidium	Selenium	Silver	Strontium	Thallium	Tin	Titanium	Uranium	Vanadium	Zinc	Zirconium
	Trace Elements																		
	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
ARC Sched10 - Discharge	325		250		0.75		105											400	
Moanataiari Subdivision SGV													35						
NEPM 1999 HIL F							3000											3500	
USEPA Eco-SSLs Ecological Receptors	28		11				38											46	
NES 2011 Residential 10%			210		310														
TP153 - Upper Limit for Background Concentrations for Non Volcanic Soils	45		65	2500			35											180	
OV001__29/08/2012	<14	9133	<6	113	<1	<1	<1	<1	26	<1	<1	47	<1	<1	2049	<1	32	40	131
OV002__29/08/2012	<13	7158	<6	85	<1	<1	<1	<1	28	<1	<1	55	<1	<1	1924	<1	30	32	189
OV003__29/08/2012	<9	9394	<4	109	<1	<1	<1	<1	25	<1	<1	13	<1	<1	2086	<1	25	13	197
OV004__29/08/2012	<8	5134	5	63	<1	<1	<1	<1	7	<1	<1	18	7	<1	2649	4	18	38	407
OV005__29/08/2012	<11	9986	7	148	<1	<1	<1	<1	23	<1	<1	25	11	<1	2739	<1	32	17	250
OV006__29/08/2012	<14	9312	<6	99	<1	<1	<1	<1	18	<1	<1	9	6	<1	2998	<1	23	17	297
OV008__29/08/2012	<1	10,510	5	96	<1	<1	<1	<1	33	<1	<1	30	7	<1	2105	<1	25	14	235
OV009__29/08/2012	<14	5957	5	97	<1	<1	<1	<1	12	<1	<1	24	<1	<1	1807	<1	20	37	185
OV010__29/08/2012	<16	6053	8	66	<1	<1	<1	<1	11	<1	<1	21	<1	<1	2469	<1	24	40	211
OV011__29/08/2012	16	7319	6	85	<1	<1	<1	<1	14	<1	<1	21	<1	<1	2201	<1	23	43	197
OV012__29/08/2012	<10	8819	<5	63	<1	<1	<1	<1	15	<1	<1	30	<1	<1	1930	<1	22	<7	145
OV013__29/08/2012	<13	10,860	6	141	<1	<1	<1	<1	21	<1	<1	42	5	<1	2469	4	31	37	152
OV014__29/08/2012	<17	13,410	9	129	<1	<1	<1	<1	26	<1	<1	35	<1	<1	2553	<1	28	35	175
OV015__29/08/2012	<13	6854	7	107	<1	<1	<1	<1	11	<1	<1	20	<1	<1	2298	<1	22	37	173
OV016__29/08/2012	<10	8193	6	95	<1	<1	<1	<1	14	<1	<1	22	<1	<1	1981	<1	21	13	148
OV017__29/08/2012	<16	8931	5	207	<1	<1	<1	<1	18	<1	<1	31	5	<1	1639	<1	23	45	174
OV018__29/08/2012	<8	8663	4	206	<1	<1	<1	<1	16	<1	<1	32	6	<1	1791	<1	21	28	189
OV019__29/08/2012	10	12,560	<1	119	<1	<1	<1	<1	26	<1	<1	54	<1	<1	2139	<1	29	34	137
OV020__29/08/2012	<11	7968	<5	57	<1	<1	<1	<1	18	<1	<1	25	7	<1	1793	<1	20	14	186
OV021__29/08/2012	<8	6734	<5	56	<1	<1	<1	<1	10	<1	<1	11	6	<1	2407	<1	20	10	254
OV022__29/08/2012	<10	11,280	11	144	<1	<1	<1	<1	19	<1	<1	40	<1	<1	1745	<1	22	28	117
OV023__29/08/2012	<9	9167	<5	154	<1	<1	<1	<1	16	<1	<1	26	5	<1	1875	<1	24	17	174
OV024__29/08/2012	<7	6040	<4	77	<1	5	<1	<1	11	<1	<1	22	<1	<1	1036	4	14	30	81
OV025__29/08/2012	<9	9617	<5	96	<1	<1	<1	<1	15	<1	<1	19	<1	<1	2286	<1	27	18	167
OV026__29/08/2012	<7	8072	<4	84	<1	<1	<1	<1	13	<1	<1	17	5	<1	2151	<1	19	17	211
OV027__29/08/2012	<13	5531	<5	48	<1	<1	<1	<1	32	<1	<1	24	<1	<1	1379	<1	17	24	137
OV028__29/08/2012	<11	9364	4	128	<1	<1	<1	<1	18	<1	<1	23	<1	<1	2329	<1	24	22	208
OV029__29/08/2012	<11	6878	<6	105	<1	<1	<1	<1	14	<1	<1	18	5	<1	1818	<1	20	31	178
OV030__29/08/2012	<9	7073	<5	114	<1	<1	<1	<1	14	<1	<1	22	<1	<1	1894	<1	23	29	205
OV031__29/08/2012	<1	10,250	<7	95	<1	<1	<1	<1	19	<1	<1	25	<1	<1	2471	<1	28	20	228
OV032__29/08/2012	9	9879	6	147	<1	<1	<1	<1	21	<1	<1	23	<1	<1	2133	<1	24	24	175

Statistical Summary

Statistic	Sulphur	Chlorine	Thorium	Tungsten	Calcium	Potassium	Antimony	Arsenic	Bismuth	Cadmium	Chromium (III+VI)	Cobalt
Number of Results	31	31	31	31	31	31	31	31	31	31	31	31
Number of Detects	8	3	2	0	31	31	0	6	0	14	28	31
Minimum Concentration	<1	<1	<1	<1	899	734	<1	<1	<1	<1	<1	2
Minimum Detect	166	131	7	ND	899	734	ND	3	ND	23	9	2
Maximum Concentration	325	1275	11	<1	3947	7775	<1	<7	<1	39	32	6
Maximum Detect	325	1275	11	ND	3947	7775	ND	4	ND	39	32	6
Average Concentration	60	52	1	0.5	2072	2398	0.5	2.4	0.5	14	17	3.7
Median Concentration	0.5	0.5	0.5	0.5	2074	2229	0.5	2.5	0.5	0.5	19	4
Standard Deviation	105	231	2.2	0	836	1234	0	0.92	0	16	8.3	1.1
Number of Guideline Exceedances	0	0	0	0	0	0	0	0	0	31	0	0
Number of Guideline Exceedances(Detects Only)	0	0	0	0	0	0	0	0	0	14	0	0
95% UCL of the mean	264.6	N/A	N/A	N/A	2327	2751	N/A	4.091	N/A	33.13	21.01	4.036

Statistic	Copper	Iron	Lead	Manganese	Mercury	Molybdenum	Nickel	Phosphorus	Rubidium	Selenium	Silver	Strontium	Thallium	Tin	Titanium	Uranium	Vanadium	Zinc	Zirconium
Number of Results	31	31	31	31	31	31	31	31	31	31	31	31	31	31	31	31	31	31	31
Number of Detects	3	31	15	31	0	1	0	0	31	0	0	31	12	0	31	3	31	30	31
Minimum Concentration	<1	5134	<1	48	<1	<1	<1	<1	7	<1	<1	9	<1	<1	1036	<1	14	<7	81
Minimum Detect	9	5134	4	48	ND	5	ND	ND	7	ND	ND	9	5	ND	1036	4	14	10	81
Maximum Concentration	<17	13,410	11	207	<1	5	<1	<1	33	<1	<1	55	11	<1	2998	4	32	45	407
Maximum Detect	16	13,410	11	207	ND	5	ND	ND	33	ND	ND	55	11	ND	2998	4	32	45	407
Average Concentration	5.9	8584	4.3	108	0.5	0.65	0.5	0.5	18	0.5	0.5	27	2.7	0.5	2101	0.84	24	26	191
Median Concentration	5.5	8819	3.5	99	0.5	0.5	0.5	0.5	18	0.5	0.5	24	0.5	0.5	2105	0.5	23	28	185
Standard Deviation	2.8	2020	2.4	39	0	0.81	0	0	6.6	0	0	11	3	0	403	1.1	4.4	11	59
Number of Guideline Exceedances	0	0	1	0	31	0	0	0	0	0	0	0	12	0	0	0	0	0	0
Number of Guideline Exceedances(Detects Only)	0	0	1	0	0	0	0	0	0	0	0	0	12	0	0	0	0	0	0
95% UCL of the mean	N/A	9200	7.134	119.5	N/A	N/A	N/A	N/A	20.19	N/A	N/A	30.23	7.141	N/A	2224	N/A	24.93	30.01	209

The High Molecular Weight PAH calculations are the sum of concentrations of pyrene, fluoranthene, benzo(a)anthracene, chrysene, benzo(a)pyrene and dibenzo(a,h)anthrecene
The Low Molecular Weight PAH calculation are the sum of concentrations of naphthalene, acenaphthalene, acenaphthene, fluorene, phenanthrene and anthracene. However, 2-methylnaphthalene results were not available for inclusion thus this calculation should only be used as a guide.
USEPA Eco-SSLs Ecological Receptor criteria were utilised as follows;
Cadmium, Copper, Lead, Zinc - Avian
Arsenic, Nickel - Plants
PAH - Soil Invertebrates

Table 6: Soil Laboratory Analytical Results - Oteha Valley Bridge

Guideline criteria (Trace Elements and PAH)

	Dry Matter	Arsenic	Cadmium	Chromium (III+VI)	Copper	Lead	Nickel	Thallium	Zinc	Sum LMW PAH	Sum HMW PAH	Acenaphthene	Acenaphthylene	Anthracene	Benz(a)anthracene	Benzo(a) pyrene	Benzo(a) Pyrene TEQ	Benzo(g,h,i)perylene	Benzo(k)fluoranthene	Benzo[b+j]fluoranthene	Chrysene	Dibenz(a,h)anthracene	Fluoranthene	Fluorene	Indeno(1,2,3-c,d)pyrene	Naphthalene	Phenanthrene	Pyrene
	g/100g	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	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg
ARC Sched10 - Discharge		100	7.5	400	325	250	105		400								2.15											
Moanataiari Subdivision SGV								35																				
USEPA Eco-SSLs Ecological Receptors		18	0.77		28	11	38		46	29	18																	
NEPM 1999 HIL A							600		7000																			
OIG Agri Sandy Silt <1m - All Pathways																										7.2		160
NES 2011 Residential 10%		20	3	460	>10,000	210											10											
TP153 - Upper Limit for Background Concentrations for Non Volcanic Soils		12	0.65	55	45	65	35		180																			

Field_ID	LocCode	Sampled_Date	x_coord	*y_coord*	Dry Matter	Arsenic	Cadmium	Chromium (III+VI)	Copper	Lead	Nickel	Thallium	Zinc	Sum LMW PAH	Sum HMW PAH
OV002	OV002	29/08/2012	2663380	*6496887*	79.51	<2	<0.1	5.151	5.881	5.465	4.455	<0.2	24.54	0.23	0.18
OV006	OV006	29/08/2012	2663384	*6496834*	73.94	<2	<0.1	5.377	2.806	8.59	<2	<0.2	8.397	0.24	0.18
OV012	OV012	29/08/2012	2663442	*6496778*	65.87	<2	<0.1	7.217	6.537	5.336	2.731	<0.2	16.13	0.32	0.18
OV018	OV018	29/08/2012	2663367	*6496746*	73.19	2.338	0.123	7.071	6.103	5.845	2.887	<0.2	21.31	0.31	0.18
OV025	OV025	29/08/2012	2663461	*6496650*	62.29	<2	<0.1	9.007	8.857	6.441	5.684	<0.2	22.94	0.32	0.18
OV028	OV028	29/08/2012	2663451	*6496673*	65.24	<2	<0.1	5.883	6.662	5.85	2.564	<0.2	20.98	0.32	0.18
OV028 DUP	OV028	29/08/2012	2663451	*6496673*	62.7	<2	<0.1	6.136	7.423	6.448	3.065	<0.2	22.34	0.33	0.24

Field_ID	Acenaphthene	Acenaphthylene	Anthracene	Benz(a)anthracene	Benzo(a) pyrene	Benzo(a) Pyrene TEQ	Benzo(g,h,i)perylene	Benzo(k)fluoranthene	Benzo[b+j]fluoranthene	Chrysene	Dibenz(a,h)anthracene	Fluoranthene	Fluorene	Indeno(1,2,3-c,d)pyrene	Naphthalene	Phenanthrene	Pyrene
OV002	<0.02703	<0.02703	<0.02703	<0.02703	<0.02703	<0.06515	<0.02703	<0.02703	<0.02703	<0.02703	<0.02703	<0.02703	<0.02703	<0.02703	<0.1352	<0.02703	<0.02703
OV006	<0.02849	<0.02849	<0.02849	<0.02849	<0.02849	<0.06866	<0.02849	<0.02849	<0.02849	<0.02849	<0.02849	<0.02849	<0.02849	<0.02849	<0.1425	<0.02849	<0.02849
OV012	<0.03481	<0.03481	<0.03481	<0.03481	<0.03481	<0.08389	<0.03481	<0.03481	<0.03481	<0.03481	<0.03481	<0.03481	<0.03481	<0.03481	<0.174	<0.03481	<0.03481
OV018	<0.03306	<0.03306	<0.03306	<0.03306	<0.03306	<0.07969	<0.03306	<0.03306	<0.03306	<0.03306	<0.03306	<0.03306	<0.03306	<0.03306	<0.1653	<0.03306	<0.03306
OV025	<0.0344	<0.0344	<0.0344	<0.0344	<0.0344	<0.0829	<0.0344	<0.0344	<0.0344	<0.0344	<0.0344	<0.0344	<0.0344	<0.0344	<0.172	<0.0344	<0.0344
OV028	<0.03473	<0.03473	<0.03473	<0.03473	<0.03473	<0.0837	<0.03473	<0.03473	<0.03473	<0.03473	<0.03473	<0.03473	<0.03473	<0.03473	<0.1737	<0.03473	<0.03473
OV028 DUP	<0.03592	<0.03592	<0.03592	<0.03592	<0.03592	<0.08656	<0.03592	<0.03592	<0.03592	<0.03592	<0.03592	<0.03592	<0.03592	<0.03592	<0.1796	<0.03592	<0.03592

Statistical Summary

Statistic	Dry Matter	Arsenic	Cadmium	Chromium (III+VI)	Copper	Lead	Nickel	Thallium	Zinc	Sum LMW PAH	Sum HMW PAH
Number of Results	7	7	7	7	7	7	7	7	7	7	7
Number of Detects	7	1	1	7	7	7	6	0	7	7	7
Minimum Concentration	62.29	<2	<0.1	5.151	2.806	5.336	<2	<0.2	8.397	0.23	0.18
Minimum Detect	62.29	2.338	0.123	5.151	2.806	5.336	2.564	ND	8.397	0.23	0.18
Maximum Concentration	79.51	2.338	0.123	9.007	8.857	8.59	5.684	<0.2	24.54	0.33	0.24
Maximum Detect	79.51	2.338	0.123	9.007	8.857	8.59	5.684	ND	24.54	0.33	0.24
Average Concentration	69	1.2	0.06	6.5	6.3	6.3	3.2	0.1	20	N/A	N/A
Median Concentration	65.87	1	0.05	6.136	6.537	5.85	2.887	0.1	21.31	N/A	N/A
Standard Deviation	6.6	0.51	0.028	1.3	1.8	1.1	1.5	0	5.6	N/A	N/A
Number of Guideline Exceedances	0	0	0	0	0	0	0	0	0	N/A	N/A
Number of Guideline Exceedances(Detects Only)	0	0	0	0	0	0	0	0	0	N/A	N/A
95% UCL of the mean	N/A	N/A	N/A	7.53	7.679	7.155	4.585	N/A	23.6	N/A	N/A

Statistic	Acenaphthene	Acenaphthylene	Anthracene	Benz(a)anthracene	Benzo(a) pyrene	Benzo(a) Pyrene TEQ	Benzo(g,h,i)perylene	Benzo(k)fluoranthene	Benzo[b+j]fluoranthene	Chrysene	Dibenz(a,h)anthracene	Fluoranthene	Fluorene	Indeno(1,2,3-c,d)pyrene	Naphthalene	Phenanthrene	Pyrene
Number of Results	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7
Number of Detects	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Minimum Concentration	<0.02703	<0.02703	<0.02703	<0.02703	<0.02703	<0.06515	<0.02703	<0.02703	<0.02703	<0.02703	<0.02703	<0.02703	<0.02703	<0.02703	<0.1352	<0.02703	<0.02703
Minimum Detect	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Maximum Concentration	<0.03592	<0.03592	<0.03592	<0.03592	<0.03592	<0.08656	<0.03592	<0.03592	<0.03592	<0.03592	<0.03592	<0.03592	<0.03592	<0.03592	<0.1796	<0.03592	<0.03592
Maximum Detect	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Average Concentration	0.016	0.016	0.016	0.016	0.016	0.039	0.016	0.016	0.016	0.016	0.016	0.016	0.016	0.016	0.082	0.016	0.016
Median Concentration	0.0172	0.0172	0.0172	0.0172	0.0172	0.04145	0.0172	0.0172	0.0172	0.0172	0.0172	0.0172	0.0172	0.0172	0.086	0.0172	0.0172
Standard Deviation	0.0017	0.0017	0.0017	0.0017	0.0017	0.0042	0.0017	0.0017	0.0017	0.0017	0.0017	0.0017	0.0017	0.0017	0.0086	0.0017	0.0017
Number of Guideline Exceedances	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Number of Guideline Exceedances(Detects Only)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
95% UCL of the mean	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A

The High Molecular Weight PAH calculations are the sum of concentrations of pyrene, fluoranthene, benzo(a)anthracene, chrysene, benzo(a)pyrene and dibenzo(a,h)anthrecene

The Low Molecular Weight PAH calculation are the sum of concentrations of naphthalene, acenaphthalene, acenaphthene, fluorene, phenanthrene and anthracene. However, 2-methylnaphthalene results were not available for inclusion thus this calculation should only be used as a guide.

USEPA Eco-SSLs Ecological Receptor criteria were utilised as follows;

Cadmium, Copper, Lead, Zinc - Avian

Arsenic, Nickel - Plants

PAH - Soil Invertebrates

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ANALYSIS REPORT

Client:	GHD Limited	**Lab No:**	1042680 SPv2
Contact:	W Udema	**Date Registered:**	04-Sep-2012
	C/- GHD Limited	**Date Reported:**	12-Sep-2012
	PO Box 6543	**Quote No:**	
	Wellesley Street	**Order No:**	
	AUCKLAND 1141	**Client Reference:**	5129610
		Submitted By:	James Ferrier-Kerr

Amended Report

This report replaces an earlier report issued on the 11 Sep 2012 at 4:29 pm
Results for Thallium have been included for all samples at the request of the client.

Sample Type: Soil

Sample Name:		OV002 29-Aug-2012	OV006 29-Aug-2012	OV012 29-Aug-2012	OV018 29-Aug-2012	OV025 29-Aug-2012
Lab Number:		1042680.1	1042680.2	1042680.3	1042680.4	1042680.5
Individual Tests						
Dry Matter	g/100g as rcvd	80	74	66	73	62
Total Recoverable Thallium	mg/kg dry wt	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2
Heavy metal screen level As,Cd,Cr,Cu,Ni,Pb,Zn						
Total Recoverable Arsenic	mg/kg dry wt	< 2	< 2	< 2	2	< 2
Total Recoverable Cadmium	mg/kg dry wt	< 0.10	< 0.10	< 0.10	0.12	< 0.10
Total Recoverable Chromium	mg/kg dry wt	5	5	7	7	9
Total Recoverable Copper	mg/kg dry wt	6	3	7	6	9
Total Recoverable Lead	mg/kg dry wt	5.5	8.6	5.3	5.8	6.4
Total Recoverable Nickel	mg/kg dry wt	4	< 2	3	3	6
Total Recoverable Zinc	mg/kg dry wt	25	8	16	21	23
Polycyclic Aromatic Hydrocarbons Screening in Soil						
Acenaphthene	mg/kg dry wt	< 0.03	< 0.03	< 0.04	< 0.04	< 0.04
Acenaphthylene	mg/kg dry wt	< 0.03	< 0.03	< 0.04	< 0.04	< 0.04
Anthracene	mg/kg dry wt	< 0.03	< 0.03	< 0.04	< 0.04	< 0.04
Benzo[a]anthracene	mg/kg dry wt	< 0.03	< 0.03	< 0.04	< 0.04	< 0.04
Benzo[a]pyrene (BAP)	mg/kg dry wt	< 0.03	< 0.03	< 0.04	< 0.04	< 0.04
Benzo[b]fluoranthene + Benzo[j] fluoranthene	mg/kg dry wt	< 0.03	< 0.03	< 0.04	< 0.04	< 0.04
Benzo[g,h,i]perylene	mg/kg dry wt	< 0.03	< 0.03	< 0.04	< 0.04	< 0.04
Benzo[k]fluoranthene	mg/kg dry wt	< 0.03	< 0.03	< 0.04	< 0.04	< 0.04
Chrysene	mg/kg dry wt	< 0.03	< 0.03	< 0.04	< 0.04	< 0.04
Dibenzo[a,h]anthracene	mg/kg dry wt	< 0.03	< 0.03	< 0.04	< 0.04	< 0.04
Fluoranthene	mg/kg dry wt	< 0.03	< 0.03	< 0.04	< 0.04	< 0.04
Fluorene	mg/kg dry wt	< 0.03	< 0.03	< 0.04	< 0.04	< 0.04
Indeno(1,2,3-c,d)pyrene	mg/kg dry wt	< 0.03	< 0.03	< 0.04	< 0.04	< 0.04
Naphthalene	mg/kg dry wt	< 0.14	< 0.15	< 0.18	< 0.17	< 0.18
Phenanthrene	mg/kg dry wt	< 0.03	< 0.03	< 0.04	< 0.04	< 0.04
Pyrene	mg/kg dry wt	< 0.03	< 0.03	< 0.04	< 0.04	< 0.04

Sample Name:		OV028 29-Aug-2012	OV028 DUP 29-Aug-2012	EP001 28-Sep-2012	EP004 28-Sep-2012	EP006 28-Sep-2012
Lab Number:		1042680.6	1042680.7	1042680.8	1042680.9	1042680.10
Individual Tests						
Dry Matter	g/100g as rcvd	65	63	59	77	71
Total Recoverable Thallium	mg/kg dry wt	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2
Heavy metal screen level As,Cd,Cr,Cu,Ni,Pb,Zn						

Sample Type: Soil						
Sample Name:		OV028 29-Aug-2012	OV028 DUP 29-Aug-2012	EP001 28-Sep-2012	EP004 28-Sep-2012	EP006 28-Sep-2012
Lab Number:		1042680.6	1042680.7	1042680.8	1042680.9	1042680.10
Heavy metal screen level As,Cd,Cr,Cu,Ni,Pb,Zn						
Total Recoverable Arsenic	mg/kg dry wt	< 2	< 2	6	4	5
Total Recoverable Cadmium	mg/kg dry wt	< 0.10	< 0.10	0.28	0.23	0.29
Total Recoverable Chromium	mg/kg dry wt	6	6	68	53	33
Total Recoverable Copper	mg/kg dry wt	7	7	60	31	74
Total Recoverable Lead	mg/kg dry wt	5.9	6.4	200	220	420
Total Recoverable Nickel	mg/kg dry wt	3	3	59	27	36
Total Recoverable Zinc	mg/kg dry wt	21	22	560	650	670
Polycyclic Aromatic Hydrocarbons Screening in Soil						
Acenaphthene	mg/kg dry wt	< 0.04	< 0.04	< 0.05	< 0.03	0.04
Acenaphthylene	mg/kg dry wt	< 0.04	< 0.04	< 0.05	< 0.03	0.05
Anthracene	mg/kg dry wt	< 0.04	< 0.04	0.06	< 0.03	0.17
Benzo[a]anthracene	mg/kg dry wt	< 0.04	< 0.04	0.27	< 0.03	0.92
Benzo[a]pyrene (BAP)	mg/kg dry wt	< 0.04	< 0.04	0.31	< 0.03	0.92
Benzo[b]fluoranthene + Benzo[j] fluoranthene	mg/kg dry wt	< 0.04	< 0.04	0.36	0.03	1.14
Benzo[g,h,i]perylene	mg/kg dry wt	< 0.04	< 0.04	0.32	0.03	0.74
Benzo[k]fluoranthene	mg/kg dry wt	< 0.04	< 0.04	0.15	< 0.03	0.48
Chrysene	mg/kg dry wt	< 0.04	< 0.04	0.32	< 0.03	0.75
Dibenzo[a,h]anthracene	mg/kg dry wt	< 0.04	< 0.04	0.05	< 0.03	0.11
Fluoranthene	mg/kg dry wt	< 0.04	< 0.04	0.71	0.06	1.69
Fluorene	mg/kg dry wt	< 0.04	< 0.04	< 0.05	< 0.03	0.04
Indeno(1,2,3-c,d)pyrene	mg/kg dry wt	< 0.04	< 0.04	0.29	< 0.03	0.76
Naphthalene	mg/kg dry wt	< 0.18	< 0.18	< 0.3	< 0.14	< 0.17
Phenanthrene	mg/kg dry wt	< 0.04	< 0.04	0.48	0.03	0.58
Pyrene	mg/kg dry wt	< 0.04	< 0.04	0.86	0.07	2.1

Sample Name:		EP006 DUP 28-Sep-2012	EP011 28-Sep-2012	EP018 28-Sep-2012	EP026 29-Aug-2012	EP030 29-Aug-2012
Lab Number:		1042680.11	1042680.12	1042680.13	1042680.14	1042680.15
Individual Tests						
Dry Matter	g/100g as rcvd	61	79	74	50	73
Total Recoverable Thallium	mg/kg dry wt	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2
Heavy metal screen level As,Cd,Cr,Cu,Ni,Pb,Zn						
Total Recoverable Arsenic	mg/kg dry wt	4	8	29	24	6
Total Recoverable Cadmium	mg/kg dry wt	0.37	< 0.10	0.42	0.49	0.19
Total Recoverable Chromium	mg/kg dry wt	29	12	48	26	23
Total Recoverable Copper	mg/kg dry wt	70	16	92	31	36
Total Recoverable Lead	mg/kg dry wt	460	25	195	28	46
Total Recoverable Nickel	mg/kg dry wt	20	22	86	6	28
Total Recoverable Zinc	mg/kg dry wt	860	55	820	55	70
Polycyclic Aromatic Hydrocarbons Screening in Soil						
Acenaphthene	mg/kg dry wt	< 0.04	< 0.03	< 0.04	< 0.05	< 0.03
Acenaphthylene	mg/kg dry wt	< 0.04	< 0.03	0.07	< 0.05	< 0.03
Anthracene	mg/kg dry wt	< 0.04	0.05	0.10	< 0.05	< 0.03
Benzo[a]anthracene	mg/kg dry wt	0.15	0.27	0.70	< 0.05	0.05
Benzo[a]pyrene (BAP)	mg/kg dry wt	0.16	0.28	1.01	< 0.05	0.06
Benzo[b]fluoranthene + Benzo[j] fluoranthene	mg/kg dry wt	0.22	0.35	1.32	0.05	0.09
Benzo[g,h,i]perylene	mg/kg dry wt	0.15	0.22	1.12	0.05	0.07
Benzo[k]fluoranthene	mg/kg dry wt	0.09	0.15	0.56	< 0.05	0.04
Chrysene	mg/kg dry wt	0.14	0.25	0.61	< 0.05	0.05
Dibenzo[a,h]anthracene	mg/kg dry wt	< 0.04	0.04	0.16	< 0.05	< 0.03
Fluoranthene	mg/kg dry wt	0.26	0.54	1.25	< 0.05	0.10
Fluorene	mg/kg dry wt	< 0.04	< 0.03	< 0.04	< 0.05	< 0.03
Indeno(1,2,3-c,d)pyrene	mg/kg dry wt	0.13	0.22	1.12	0.05	0.07
Naphthalene	mg/kg dry wt	< 0.18	< 0.15	< 0.16	< 0.3	< 0.15

Sample Type: Soil						
Sample Name:		EP006 DUP 28-Sep-2012	EP011 28-Sep-2012	EP018 28-Sep-2012	EP026 29-Aug-2012	EP030 29-Aug-2012
Lab Number:		1042680.11	1042680.12	1042680.13	1042680.14	1042680.15
Polycyclic Aromatic Hydrocarbons Screening in Soil						
Phenanthrene	mg/kg dry wt	0.09	0.22	0.39	< 0.05	0.04
Pyrene	mg/kg dry wt	0.35	0.67	1.61	0.06	0.13

Sample Name:		EP033 29-Aug-2012	EP038 29-Aug-2012	EP045 28-Sep-2012	CMJ005 30-Aug-2012	CMJ011 30-Aug-2012
Lab Number:		1042680.16	1042680.17	1042680.18	1042680.19	1042680.20
Individual Tests						
Dry Matter	g/100g as rcvd	62	68	64	40	68
Total Recoverable Thallium	mg/kg dry wt	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2
Heavy metal screen level As,Cd,Cr,Cu,Ni,Pb,Zn						
Total Recoverable Arsenic	mg/kg dry wt	9	23	5	4	7
Total Recoverable Cadmium	mg/kg dry wt	0.35	0.55	0.46	0.36	0.32
Total Recoverable Chromium	mg/kg dry wt	39	50	67	13	21
Total Recoverable Copper	mg/kg dry wt	88	129	133	31	45
Total Recoverable Lead	mg/kg dry wt	195	400	510	68	81
Total Recoverable Nickel	mg/kg dry wt	66	64	98	12	18
Total Recoverable Zinc	mg/kg dry wt	166	340	880	98	106
Polycyclic Aromatic Hydrocarbons Screening in Soil						
Acenaphthene	mg/kg dry wt	< 0.04	< 0.04	< 0.04	< 0.06	< 0.04
Acenaphthylene	mg/kg dry wt	< 0.04	0.04	< 0.04	< 0.06	< 0.04
Anthracene	mg/kg dry wt	< 0.04	0.07	< 0.04	< 0.06	< 0.04
Benzo[a]anthracene	mg/kg dry wt	0.14	0.43	0.11	0.10	0.13
Benzo[a]pyrene (BAP)	mg/kg dry wt	0.16	0.54	0.15	0.14	0.17
Benzo[b]fluoranthene + Benzo[j] fluoranthene	mg/kg dry wt	0.20	0.68	0.20	0.17	0.20
Benzo[g,h,i]perylene	mg/kg dry wt	0.15	0.55	0.17	0.18	0.19
Benzo[k]fluoranthene	mg/kg dry wt	0.09	0.30	0.09	0.07	0.09
Chrysene	mg/kg dry wt	0.12	0.39	0.11	0.11	0.13
Dibenzo[a,h]anthracene	mg/kg dry wt	< 0.04	0.09	< 0.04	< 0.06	< 0.04
Fluoranthene	mg/kg dry wt	0.28	0.84	0.19	0.23	0.26
Fluorene	mg/kg dry wt	< 0.04	< 0.04	< 0.04	< 0.06	< 0.04
Indeno(1,2,3-c,d)pyrene	mg/kg dry wt	0.14	0.55	0.14	0.15	0.17
Naphthalene	mg/kg dry wt	< 0.19	< 0.16	< 0.18	< 0.3	< 0.17
Phenanthrene	mg/kg dry wt	0.13	0.29	0.06	0.13	0.11
Pyrene	mg/kg dry wt	0.37	1.09	0.26	0.32	0.36

Sample Name:		CMJ011 DUP 30-Aug-2012	CMJ022 30-Aug-2012	CMJ035 30-Aug-2012	CMJ040 30-Aug-2012	CMJ048 30-Aug-2012
Lab Number:		1042680.21	1042680.22	1042680.23	1042680.24	1042680.25
Individual Tests						
Dry Matter	g/100g as rcvd	65	46	39	64	67
Total Recoverable Thallium	mg/kg dry wt	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2
Heavy metal screen level As,Cd,Cr,Cu,Ni,Pb,Zn						
Total Recoverable Arsenic	mg/kg dry wt	7	4	3	5	4
Total Recoverable Cadmium	mg/kg dry wt	0.31	0.30	0.25	0.34	0.16
Total Recoverable Chromium	mg/kg dry wt	18	12	12	16	15
Total Recoverable Copper	mg/kg dry wt	45	37	19	48	24
Total Recoverable Lead	mg/kg dry wt	67	55	16.5	55	24
Total Recoverable Nickel	mg/kg dry wt	16	9	12	11	14
Total Recoverable Zinc	mg/kg dry wt	104	98	74	82	82
Polycyclic Aromatic Hydrocarbons Screening in Soil						
Acenaphthene	mg/kg dry wt	< 0.04	< 0.06	< 0.12	< 0.04	< 0.04
Acenaphthylene	mg/kg dry wt	< 0.04	< 0.06	< 0.12	< 0.04	< 0.04
Anthracene	mg/kg dry wt	0.06	< 0.06	< 0.12	< 0.04	< 0.04
Benzo[a]anthracene	mg/kg dry wt	0.20	0.09	< 0.12	0.07	< 0.04
Benzo[a]pyrene (BAP)	mg/kg dry wt	0.25	0.11	< 0.12	0.09	0.04

Sample Type: Soil						
Sample Name:		CMJ011 DUP 30-Aug-2012	CMJ022 30-Aug-2012	CMJ035 30-Aug-2012	CMJ040 30-Aug-2012	CMJ048 30-Aug-2012
Lab Number:		1042680.21	1042680.22	1042680.23	1042680.24	1042680.25
Polycyclic Aromatic Hydrocarbons Screening in Soil						
Benzo[b]fluoranthene + Benzo[j] fluoranthene	mg/kg dry wt	0.30	0.14	< 0.12	0.11	0.05
Benzo[g,h,i]perylene	mg/kg dry wt	0.27	0.13	< 0.12	0.11	0.06
Benzo[k]fluoranthene	mg/kg dry wt	0.13	0.06	< 0.12	0.05	< 0.04
Chrysene	mg/kg dry wt	0.20	0.09	< 0.12	0.07	< 0.04
Dibenzo[a,h]anthracene	mg/kg dry wt	0.04	< 0.06	< 0.12	< 0.04	< 0.04
Fluoranthene	mg/kg dry wt	0.45	0.18	< 0.12	0.14	0.05
Fluorene	mg/kg dry wt	< 0.04	< 0.06	< 0.12	< 0.04	< 0.04
Indeno(1,2,3-c,d)pyrene	mg/kg dry wt	0.24	0.11	< 0.12	0.09	0.04
Naphthalene	mg/kg dry wt	< 0.18	< 0.3	< 0.6	< 0.17	< 0.17
Phenanthrene	mg/kg dry wt	0.33	0.08	< 0.12	0.06	< 0.04
Pyrene	mg/kg dry wt	0.61	0.25	< 0.12	0.20	0.08

Analyst's Comments

It has been noted that as samples 1042680.10 & .11 for PAH analysis showed greater variation than would normally be expected for a client duplicate, the samples were re-extracted. The reported results still reflect a greater variation and this may reflect the heterogeneity of the sample(s).

SUMMARY OF METHODS

The following table(s) gives a brief description of the methods used to conduct the analyses for this job. The detection limits given below are those attainable in a relatively clean matrix. Detection limits may be higher for individual samples should insufficient sample be available, or if the matrix requires that dilutions be performed during analysis.

Sample Type: Soil			
Test	**Method Description**	**Default Detection Limit**	**Samples**
Environmental Solids Sample Preparation	Air dried at 35°C and sieved, <2mm fraction. Used for sample preparation. May contain a residual moisture content of 2-5%.	-	1-25
Heavy metal screen level As,Cd,Cr,Cu,Ni,Pb,Zn	Dried sample, <2mm fraction. Nitric/Hydrochloric acid digestion, ICP-MS, screen level.	-	1-25
Polycyclic Aromatic Hydrocarbons Screening in Soil	Sonication extraction, Dilution or SPE cleanup (if required), GC-MS SIM analysis (modified US EPA 8270). Tested on as received sample.	-	1-25
Dry Matter (Env)	Dried at 103°C for 4-22hr (removes 3-5% more water than air dry) , gravimetry. US EPA 3550. (Free water removed before analysis).	0.10 g/100g as rcvd	1-25
Total Recoverable digestion	Nitric / hydrochloric acid digestion. US EPA 200.2.	-	1-25
Total Recoverable Thallium	Dried sample, sieved as specified (if required). Nitric/Hydrochloric acid digestion, ICP-MS, screen level. US EPA 200.2.	0.2 mg/kg dry wt	1-25

These samples were collected by yourselves (or your agent) and analysed as received at the laboratory.

Samples are held at the laboratory after reporting for a length of time depending on the preservation used and the stability of the analytes being tested. Once the storage period is completed the samples are discarded unless otherwise advised by the client.

Graham Corban MSc Tech (Hons)
Client Services Manager - Environmental Division

Appendix C
QA/QC Relative Percent Difference

Table 7: Laboratory Results QA/QC – Central Motorway Junction

Parameter	CMJ011	Duplicate	RPD (%)
Arsenic	7.256	6.939	4.4
Cadmium	0.3196	0.312	2.4
Chromium (III+VI)	20.85	18.29	13
Copper	45.12	44.69	0.9
Lead	80.88	66.72	19.1
Nickel	18.43	16.3	12.2
Zinc	105.7	103.7	1.9
Anthracene	<0.03277 [1]	0.06031	59.1
Benz(a)anthracene	0.1331	0.2	40.1
Benzo(a)pyrene	0.169	0.2548	40.4
Benzo(g,h,i)perylene	0.1907	0.2705	34.6
Benzo(k)fluoranthene	0.08845	0.1301	38.1
Benzo[b+j]fluoranthene	0.2027	0.298	38.0
Chrysene	0.1303	0.2006	42.4
Dibenz(a,h)anthracene	<0.03277	0.03855	16.2
Fluoranthene	0.2646	0.4529	52.4
Indeno(1,2,3-c,d)pyrene	0.168	0.2449	37.2
Phenanthrene	0.1066	0.3265	101.5
Pyrene	0.3636	0.6103	50.6

Table 8: Laboratory Results QA/QC – Oteha Valley Bridge

Parameter	OV028	Duplicate	RPD (%)
Chromium (III+VI)	5.883	6.136	4.2
Copper	6.662	7.423	10.8
Lead	5.85	6.448	9.7
Nickel	2.564	3.065	17.8
Zinc	20.98	22.34	6.2

[1] Where sample result was below laboratory detection limit the detection limit was used in RPD calculation. Where sample and duplicate results were both below laboratory detection limits the RPD was not calculated.

Table 9: Laboratory Results QA/QC – Erin Point Harbour Bridge Approach

Parameter	EP006	Duplicate	RPD (%)
Arsenic	4.81	4.033	17.5
Cadmium	0.2864	0.3666	24.5
Chromium (III+VI)	32.54	29.49	9.8
Copper	74.44	69.68	6.6
Lead	416.5	457.9	9.4
Nickel	36.15	19.89	58
Zinc	670.9	858.1	24.4
Acenaphthene	0.04253	<0.0349	19.7
Acenaphthylene	0.04522	<0.0349	25.7
Anthracene	0.1689	<0.0349	131.5
Benz(a)anthracene	0.9158	0.151	143.3
Benzo(a)pyrene	0.9163	0.1621	139.8
Benzo(g,h,i)perylene	0.7395	0.1463	133.9
Benzo(k)fluoranthene	0.4834	0.09026	137
Benzo[b+j]fluoranthene	1.145	0.2181	135.9
Chrysene	0.7524	0.1418	136.5
Dibenz(a,h)anthracene	0.1134	<0.0349	105.8
Fluoranthene	1.693	0.2553	147.5
Fluorene	0.04066	<0.0349	15.2
Indeno(1,2,3-c,d)pyrene	0.761	0.1345	139.9
Phenanthrene	0.5769	0.09223	144.8
Pyrene	2.06	0.3528	141.5

Appendix D
Iso-Concentration Plots

LEGEND

Copper Distribution (mg/kg)) - Combined XRF & Laboratory Results

- Sample Location
- Maximum Copper - 20mg/kg Contour

11.2 - 20	40.1 - 60	80.1 - 100	121 - 140	161 - 170
20.1 - 40	60.1 - 80	101 - 120	141 - 160	

Paper Size A4

0 7.5 15 22.5 30 37.5

Metres

Map Projection: New Zealand Map Grid
Horizontal Datum: New Zealand 1949
Grid: GD 1949 New Zealand Map Grid

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Contaminant Risk: Elevated Highways

Job Number 51 - 29610
Revision 1
Date 12 Nov 2012

Point Erin Harbour Bridge Approach - Contours for Maximum Copper Concentrations

Figure 5

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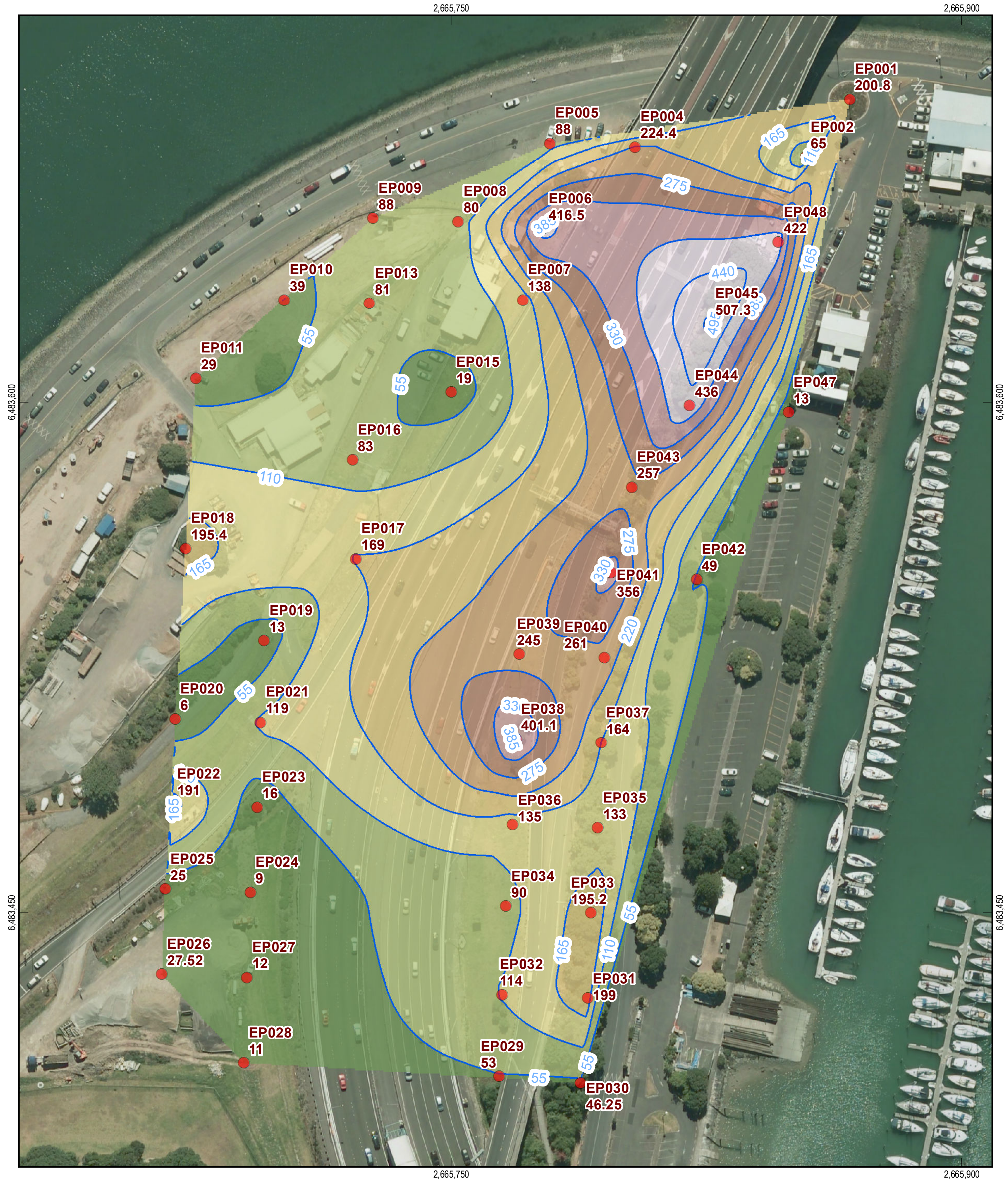
G:\51\29610\GIS\Maps\Mxd\51_29610_G006_Rev1_Figure5_Point Erin Harbour Bridge Approach – Contours for Maximum Copper Concentration - Combined.mxd

Data source: Auckland Council: Aerials - 31 Jan. 2012; GHD: Site Locations, Copper values, grid, contours for copper - 8 Nov. 2012. Created by:RdParsons



LEGEND

Lead Distribution (mg/kg) - Combined XRF & Laboratory Results

Sample Location	7.59 - 55	111 - 165	221 - 275	331 - 385
Maximum Lead - 55mg/kg Contour	55.1 - 110	166 - 220	276 - 330	386 - 440

Paper Size A4

0 7.5 15 22.5 30 37.5

Metres

Map Projection: New Zealand Map Grid
Horizontal Datum: New Zealand 1949
Grid: GD 1949 New Zealand Map Grid

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Point Erin Harbour Bridge Approach -
Contours for Maximum Lead Concentrations

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Date 09 Nov 2012

Figure 6

Data source: Auckland Council: Aerials - 31 Jan. 2012; GHD: Site Locations, Contaminant values, grid, contours for contaminant - 8 Nov. 2012. Created by:jhchen

LEGEND

Zinc Distribution (mg/kg) - Combined XRF & Laboratory Results

Sample Location	32.2 - 100	201 - 300	401 - 500	601 - 700	801 - 900
Maximum Zinc - 100mg/kg Contour	101 - 200	301 - 400	501 - 600	701 - 800	

Paper Size A4

0 7.5 15 22.5 30 37.5

Metres

Map Projection: New Zealand Map Grid
Horizontal Datum: New Zealand 1949
Grid: GD 1949 New Zealand Map Grid

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Point Erin Harbour Bridge Approach - Contours for Maximum Zinc Concentration

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Date 12 Nov 2012

Figure 7

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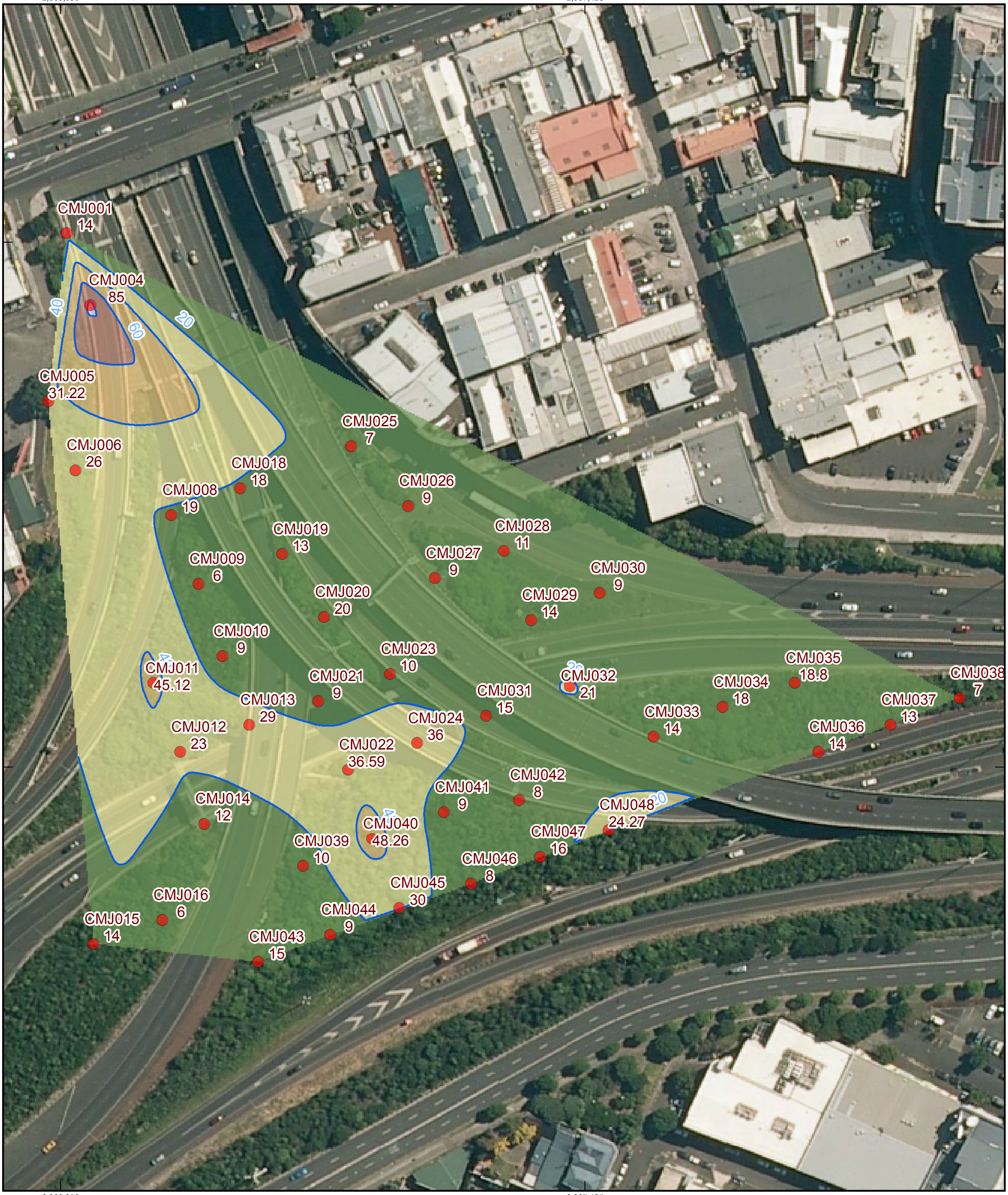
G:\51\29610\GIS\Maps\Mxd\51_29610_G008_Rev1_Figure7_Point Erin Harbour Bridge Approach – Contours for Maximum Zinc Concentration - Combined.mxd

Data source: Auckland Council: Aerials - 31 Jan. 2012; GHD: Site Locations, Contaminant values, grid, contours for contaminant - 8 Nov. 2012. Created by:RdParsons



LEGEND

Sample Location

Maximum Copper - 20mg/kg Contour

Copper Distribution (mg/kg) Combined XRF & Laboratory Results

6 - 20 | 21 - 40 | 41 - 60 | 61 - 80 | 81 - 90

Paper Size A4

0 10 20 30 40 50

Metres

Map Projection: New Zealand Map Grid
Horizontal Datum: New Zealand 1949
Grid: GD 1949 New Zealand Map Grid

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Central Motorway Junction -
Contours for Maximum Copper Concentrations

Figure 8

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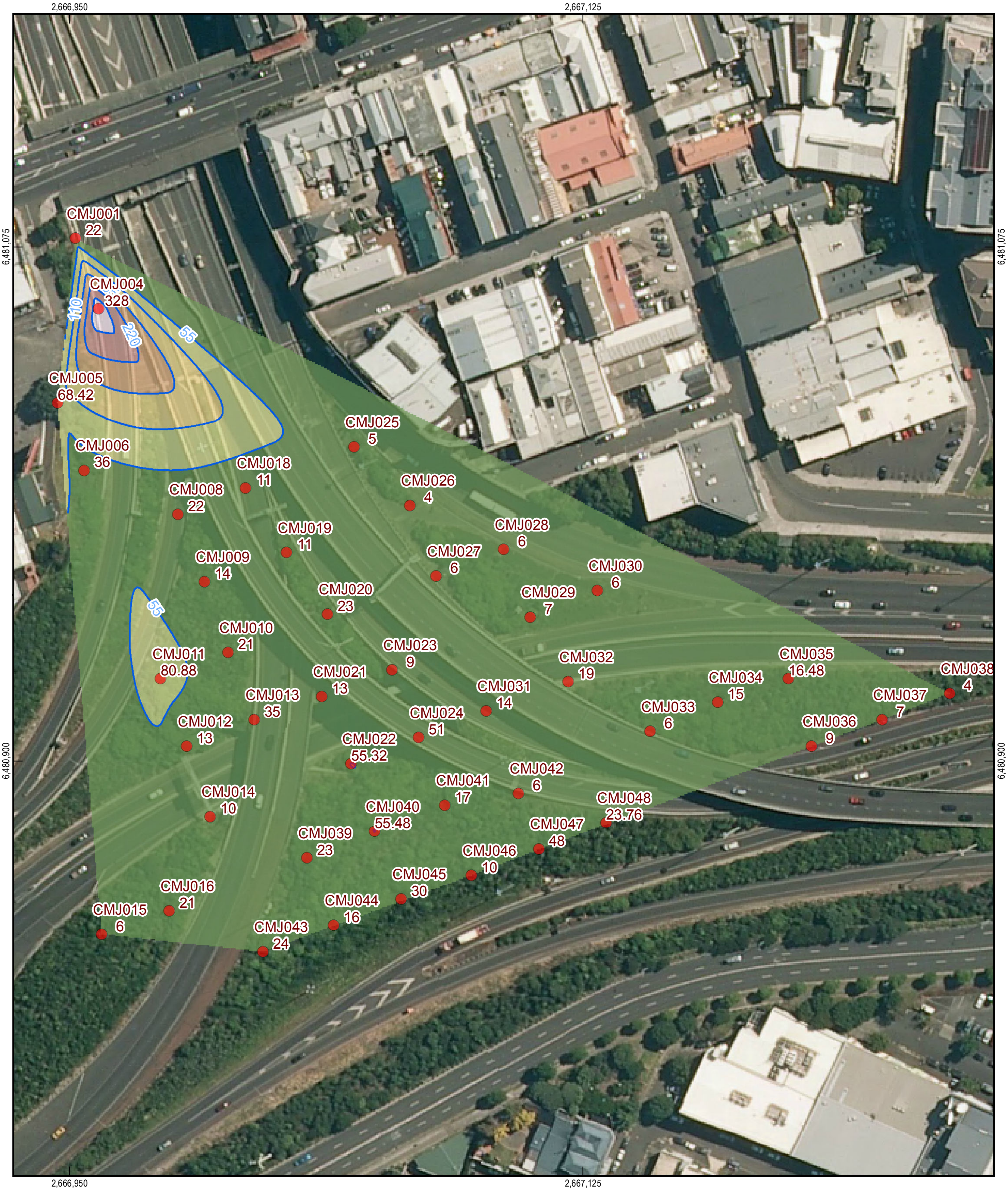
G:\51\29610\GIS\Maps\Mxd\51_29610_G009_Rev1_Figure8_Central Motorway Junction – Contours for Maximum Copper Concentration - Combined.mxd

Data source: Auckland Council: Aerials - 31 Jan. 2012; GHD: Site Locations, Contaminant values, grid, contours for contaminant - 8 Nov. 2012. Created by:RdParsons



LEGEND

Sample Location

Maximum Lead - 55mg/kg Contour

Lead Distribution (mg/kg) Combined XRF & Laboratory Results

4 - 55
56 - 110
111 - 165
166 - 220
221 - 275
276 - 330

Paper Size A4

0 10 20 30 40 50

Metres

Map Projection: New Zealand Map Grid
Horizontal Datum: New Zealand 1949
Grid: GD 1949 New Zealand Map Grid

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Central Motorway Junction -
Contours for Maximum Lead Concentrations

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Date 12 Nov 2012

Figure 9

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G:\51\29610\GIS\Maps\Mxd\51_29610_G010_Rev1_Figure9_Central Motorway Junction – Contours for Maximum Lead Concentration - Combined.mxd

Data source: Auckland Council: Aerials - 31 Jan. 2012; GHD: Site Locations, Contaminant values, grid, contours for contaminant - 8 Nov. 2012. Created by:RdParsons

LEGEND

- Sample Location
- Maximum Zinc - 100mg/kg Contour

Zinc Distribution (mg/kg) - Combined XRF & Laboratory Results

20 - 100	201 - 300	401 - 500	601 - 700
101 - 200	301 - 400	501 - 600	

Paper Size A4

0 10 20 30 40 50

Metres

Map Projection: New Zealand Map Grid
Horizontal Datum: New Zealand 1949
Grid: GD 1949 New Zealand Map Grid

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Central Motorway Junction - Contours for Maximum Zinc Concentrations

Job Number	51 - 29610
Revision	0
Date	09 Nov 2012

Figure 10

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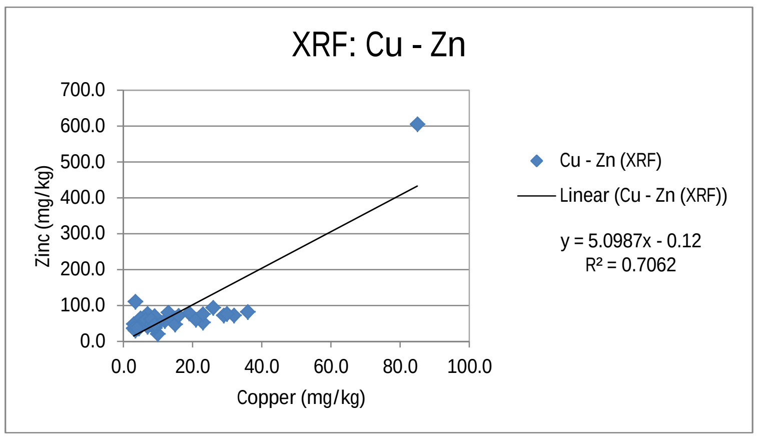
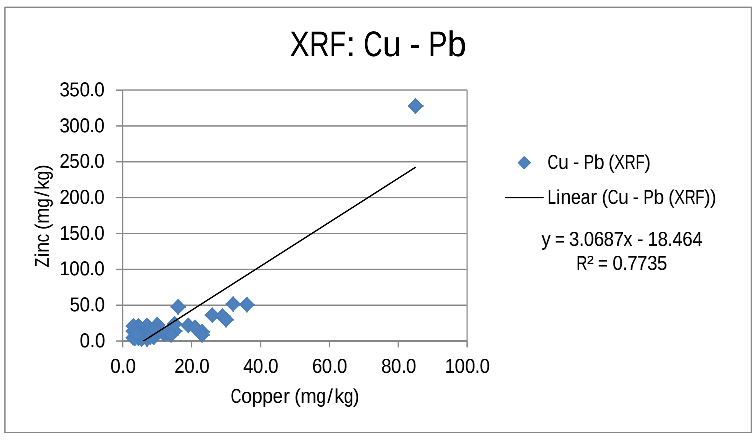
G:\51\29610\GIS\Maps\Mxd\51_29610_G011_Rev0_Figure10_Central Motorway Junction –Contours for Maximum Zinc Concentration - Combined.mxd

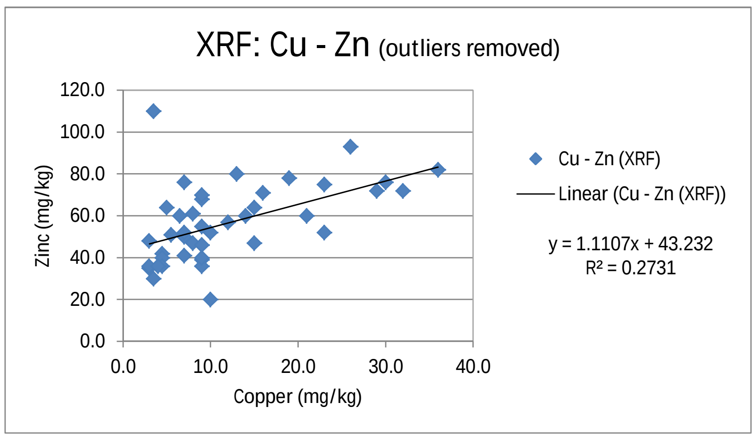
Data source: Auckland Council: Aerials - 31 Jan. 2012; GHD: Site Locations, Contaminant values, grid, contours for contaminant - 8 Nov. 2012. Created by:RdParsons

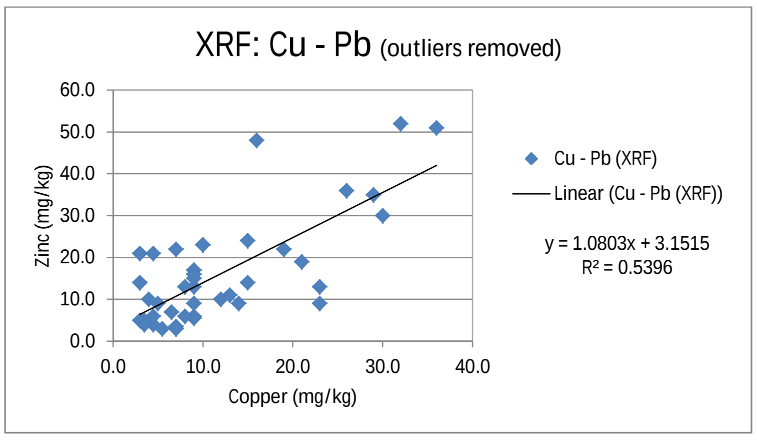
Appendix E
Linear Regression Analysis

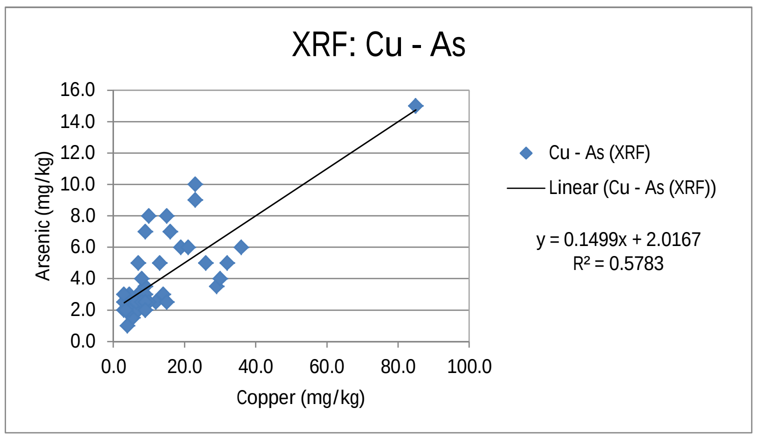
Scatter Plots 1: Depicting Relationships Between Analytes - The Central Motorway Junction

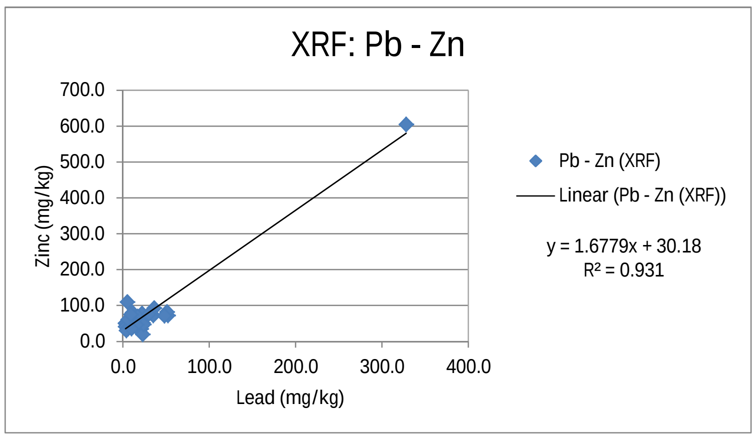


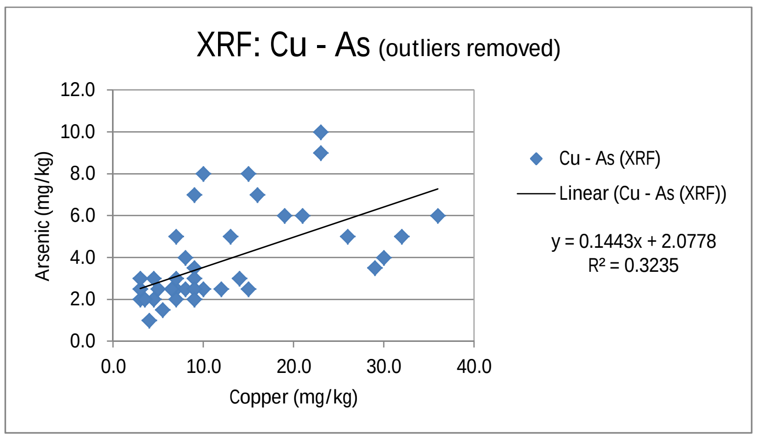


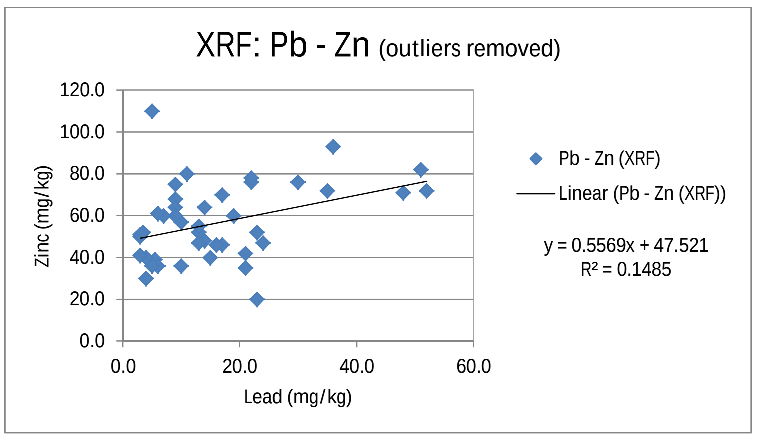


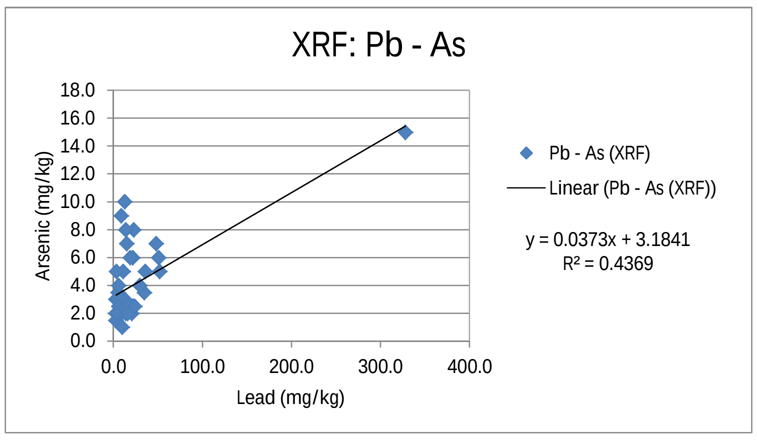


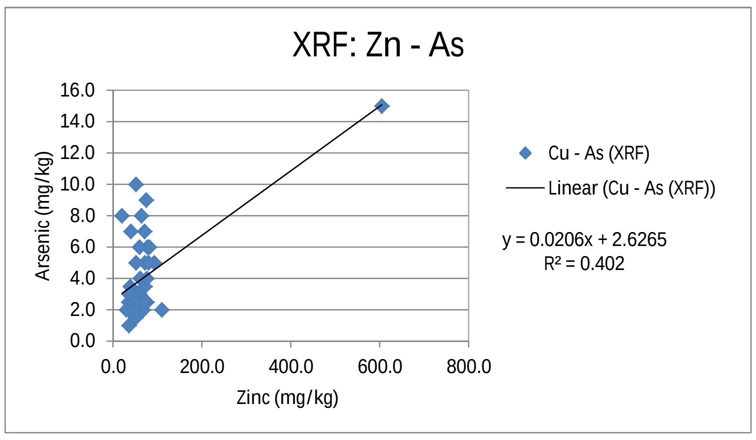


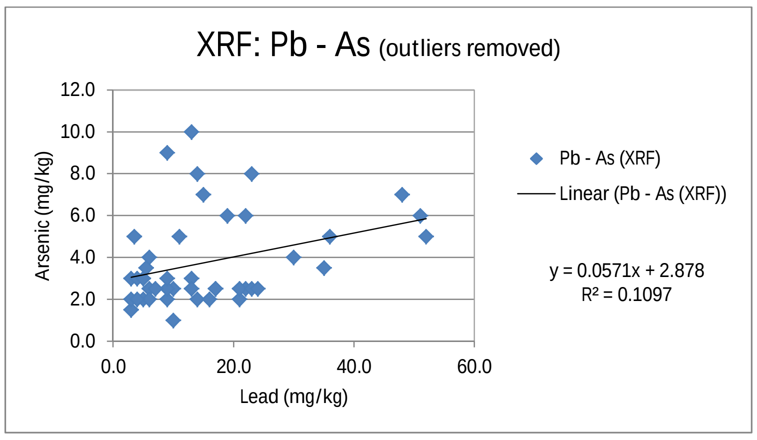


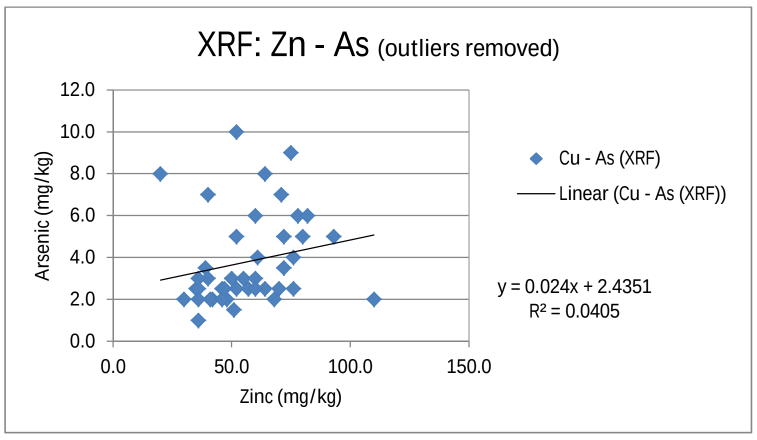




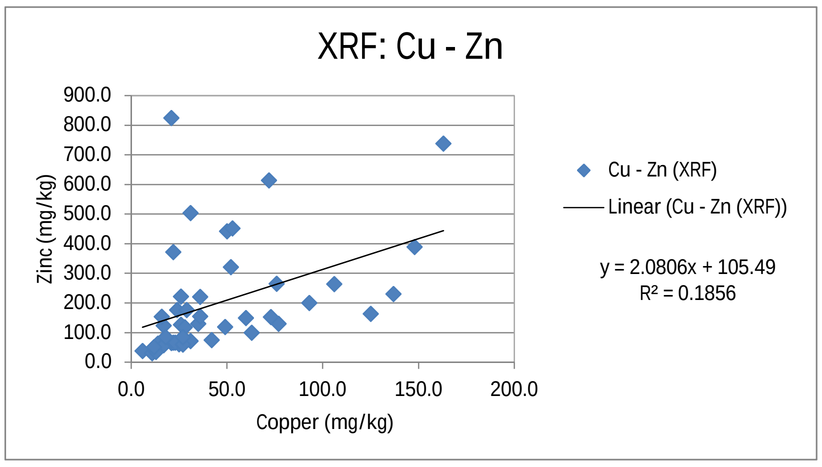


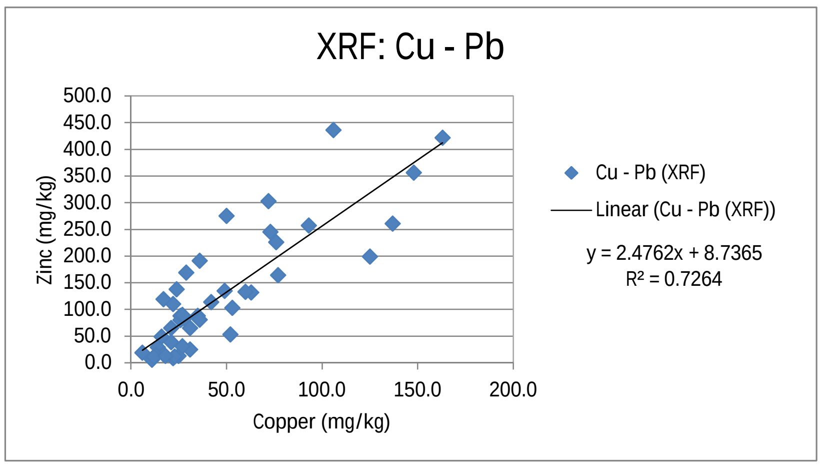


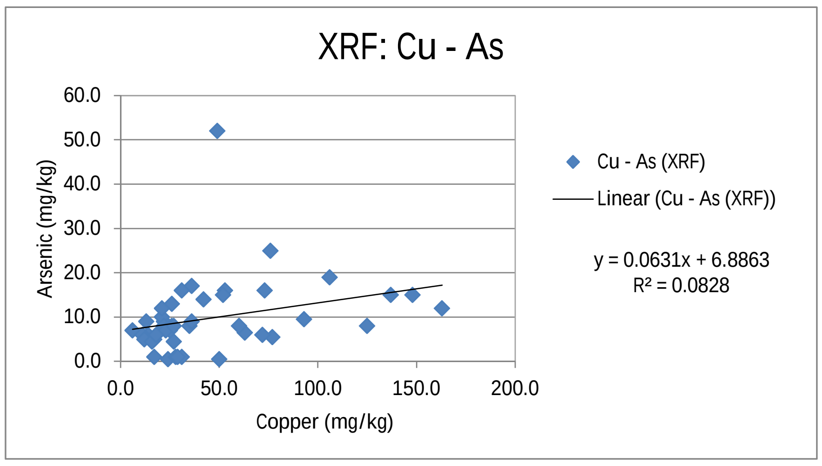


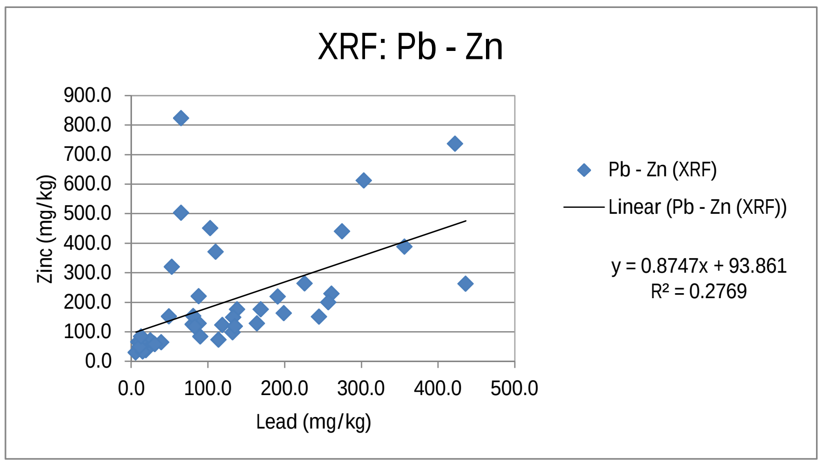


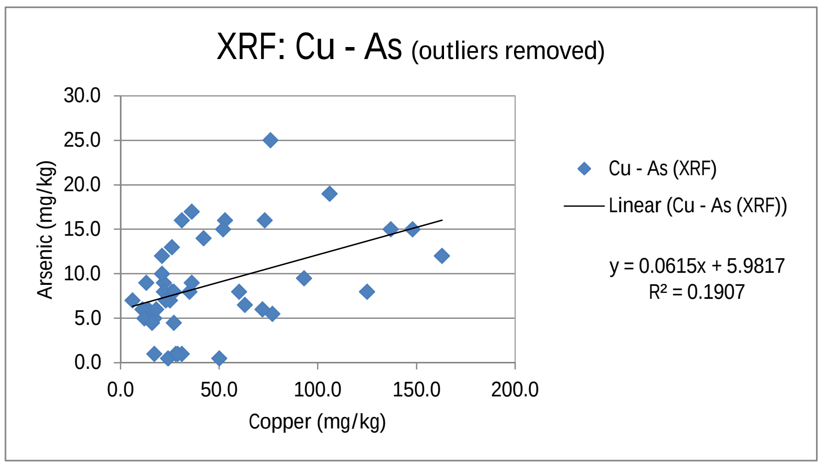
Scatter Plots 2: Depicting Relationships Between Analytes - Point Erin Harbour Bridge Approach

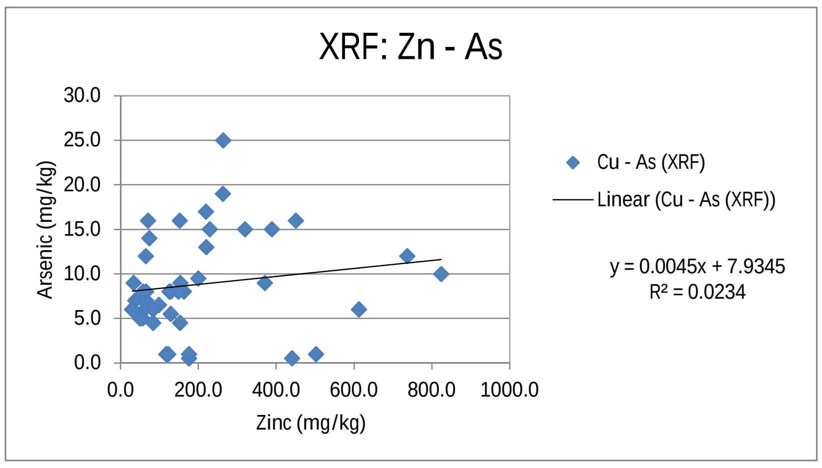


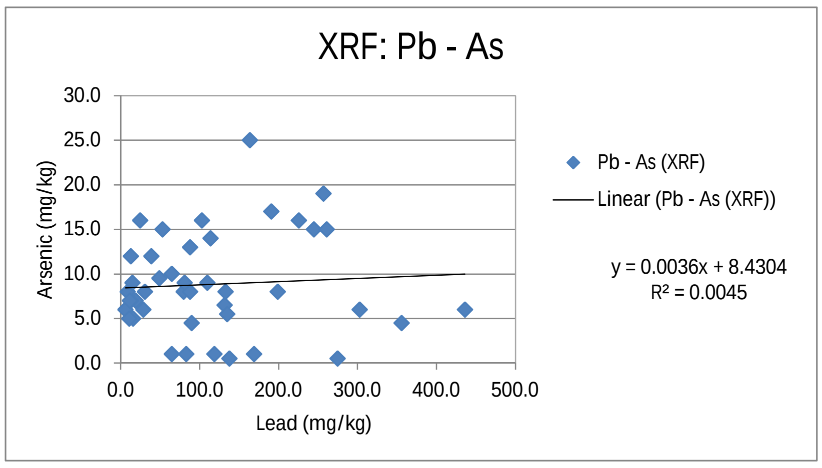




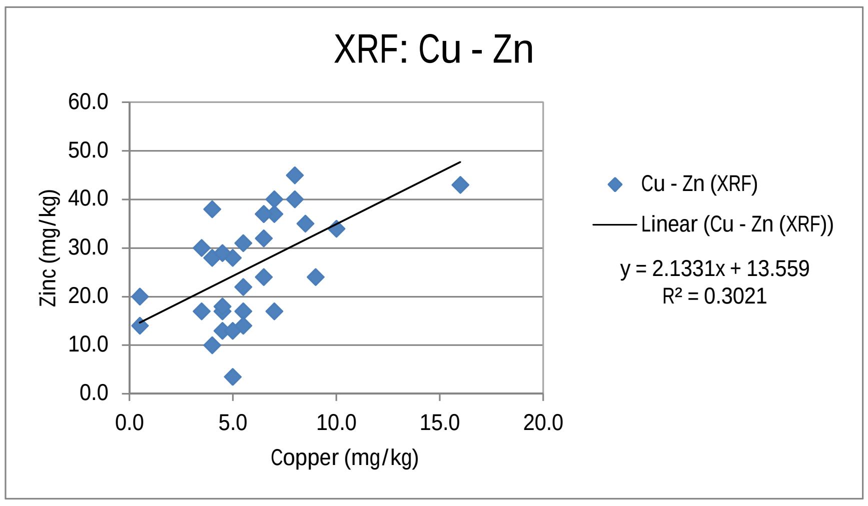


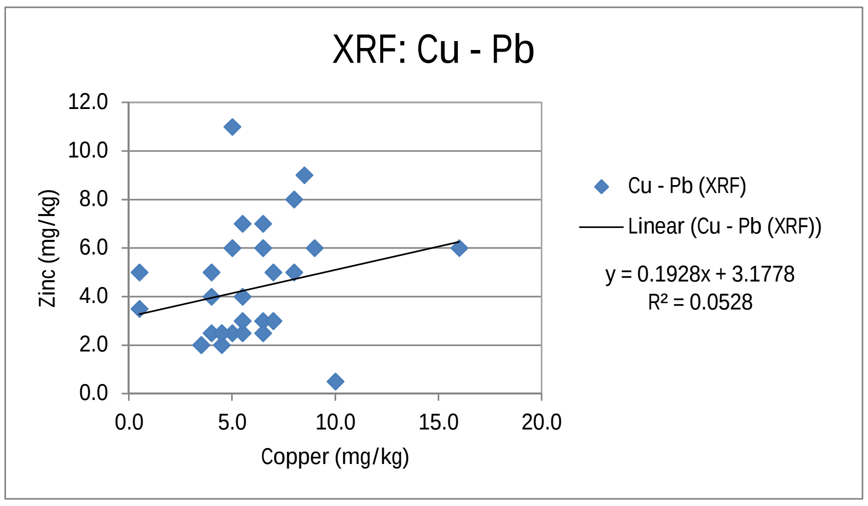


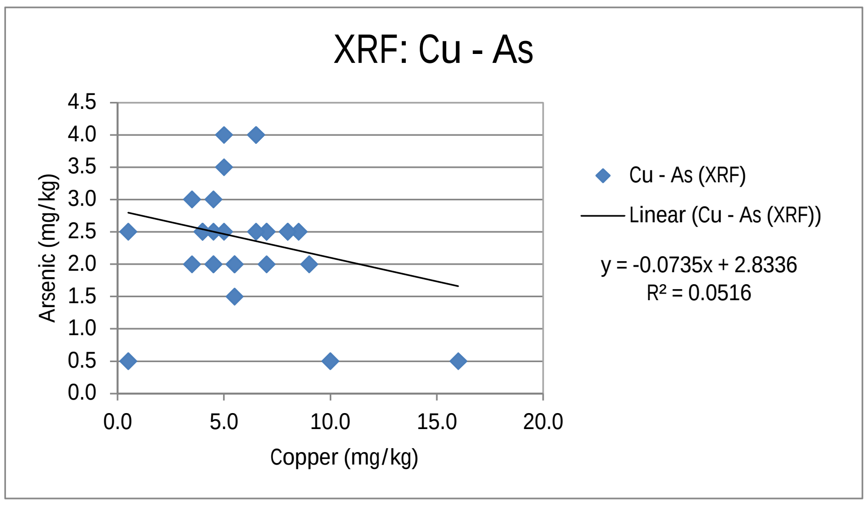


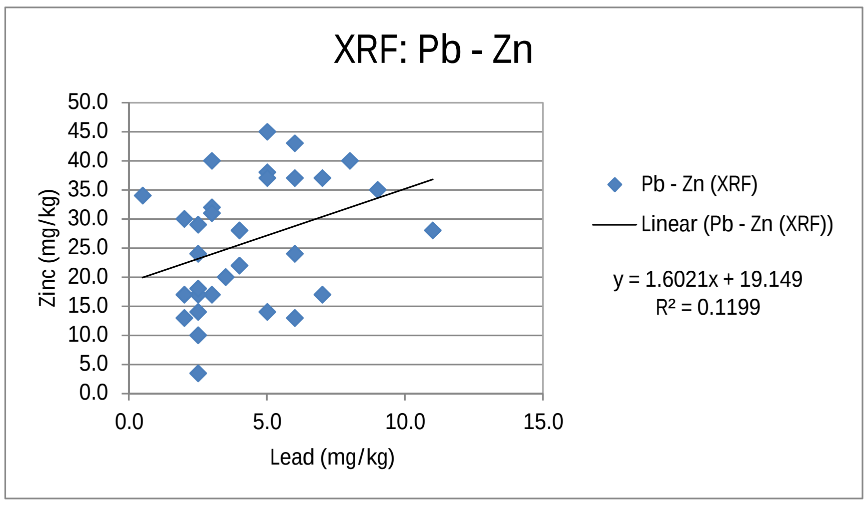


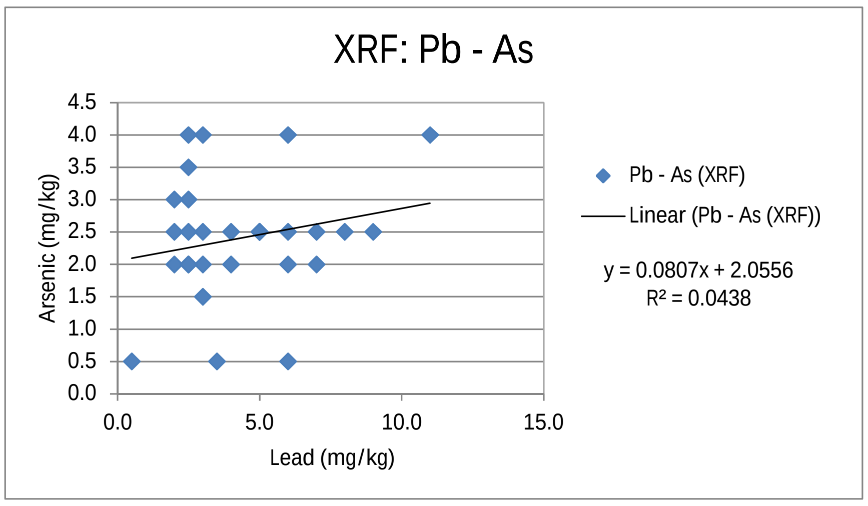
Scatter Plots 3: Depicting Relationships Between Analytes - Oteha Valley Bridge

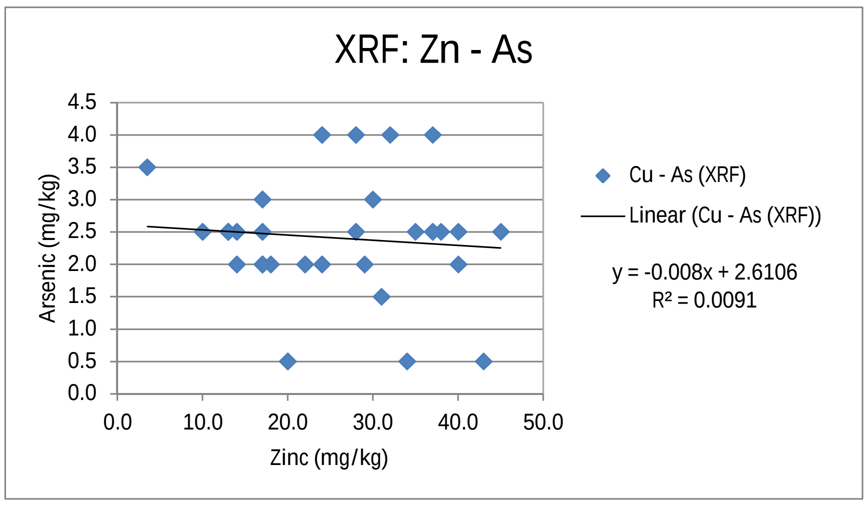


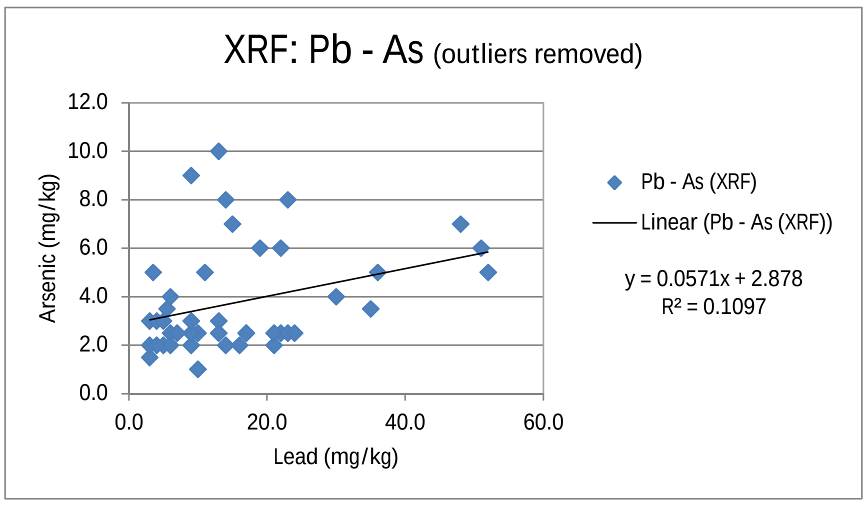


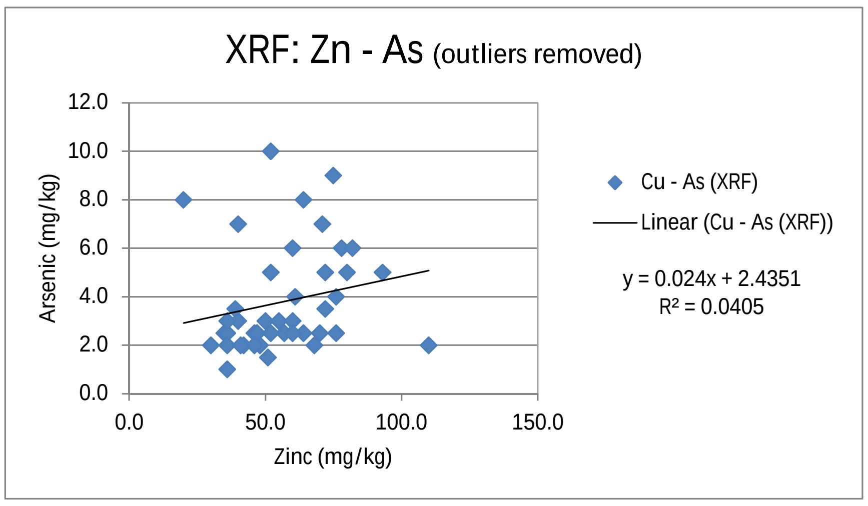




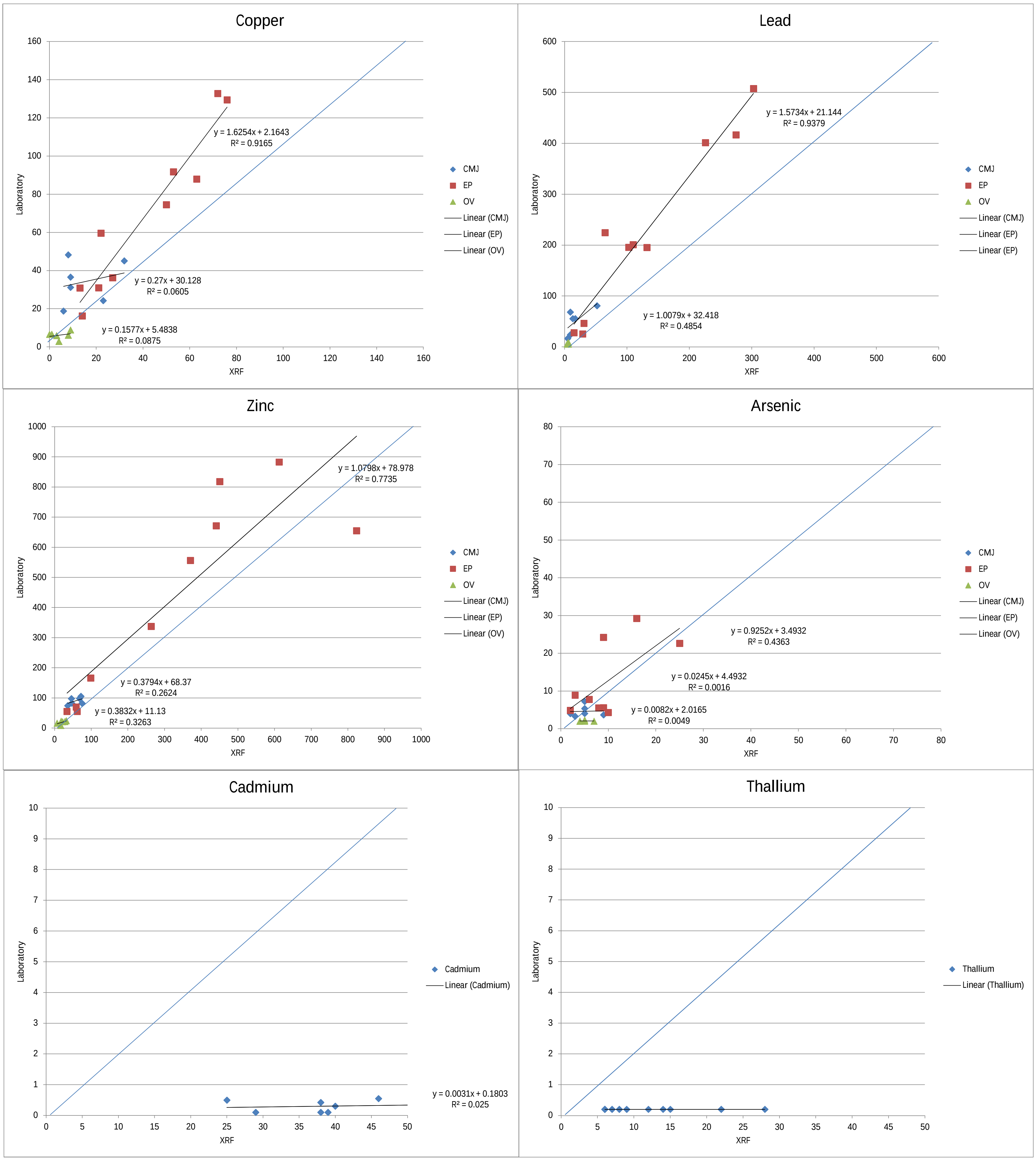








Scatter Plots 4: Depicting Relationships Between Laboratory and XRF Results



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Document Status

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