Geo & Hydro – K8 Ltd

Excellence in Environmental Engineering

DETAILED SITE INVESTIGATION

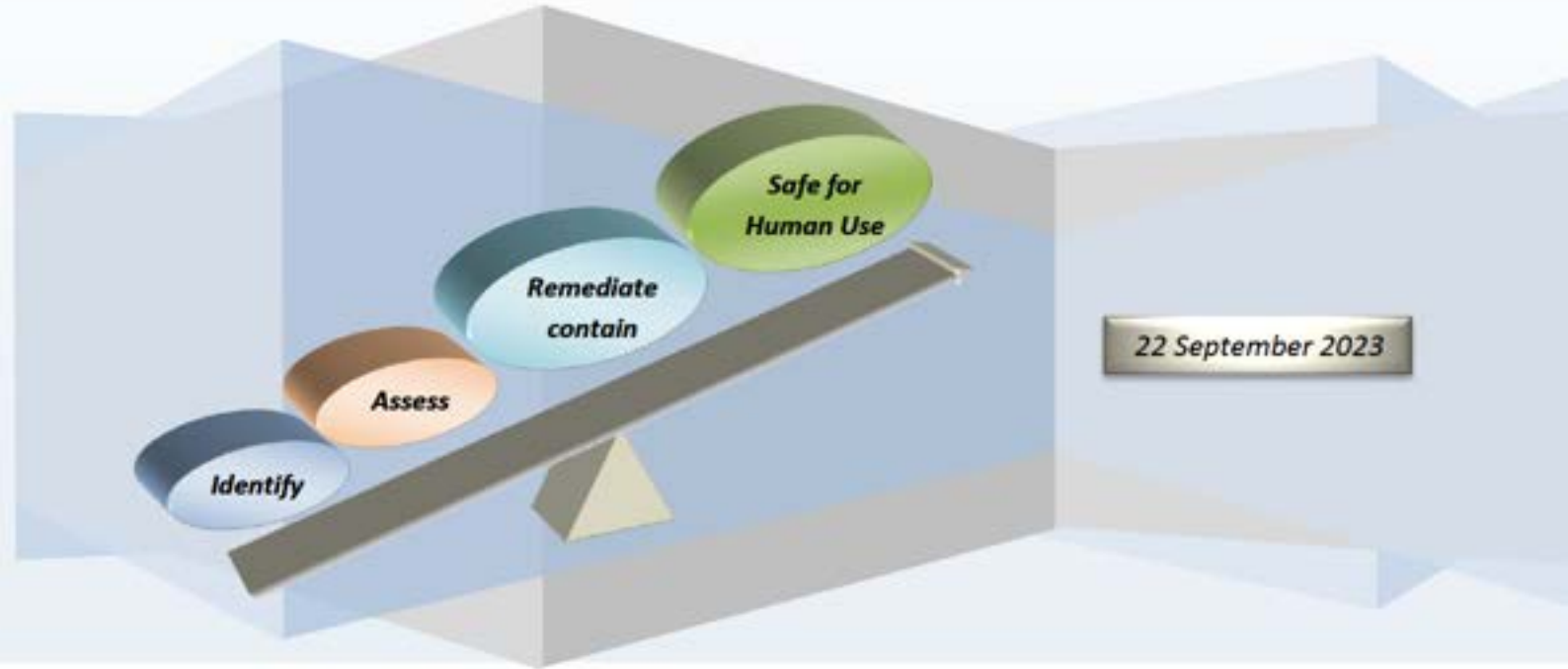
4 PIERCE STREET, GREYTOWN

IN ACCORDANCE WITH THE NATIONAL ENVIRONMENTAL STANDARD FOR ASSESSING AND MANAGING CONTAMINANTS IN SOIL TO PROTECT HUMAN HEALTH

PREPARED FOR SOUTH WAIRARAPA DISTRICT COUNCIL

PREPARED BY DRS. BEN KEET

PROJECT ID: GRPS-4 DSI REC



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Type of Investigation[1]

Detailed site investigation	Defined in regulation 3 of the NESCS as: An investigation that— (a) is done by a suitably qualified and experienced practitioner; and (b) is done in accordance with the current edition of Contaminated Land Management Guidelines No.5 – Site Investigation and Analysis of Soils, Wellington, Ministry for the Environment; and (c) is reported on in accordance with the current edition of Contaminated Land Management GuidelinesNo.1– Reporting on Contaminated Sites in New Zealand, Wellington, Ministry for the Environment; and (d) results in a report that is certified by the practitioner. A detailed site investigation involves intrusive techniques to collect field data and soil samples for analytical testing to determine the concentrations of contaminants of concern.

[1]Taken from the Users' guide: National Environmental Standard for Assessing and Managing Contaminants in Soil to Protect Human Health, publ. 04-2012; Ref. ME1092; web ref. http://www.mfe.govt.nz/publications/rma-land-hazards/users-guide-national-environmental-standard-assessing-and-managing

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Executive Summary

Geo & Hydro - K8 Ltd (GHK8) undertook a Detailed Site Investigation (DSI) on approximately 0.55 ha of land (the subject site/site) located at 4 Pierce Street, Greytown, with the legal description Sec 123 Maroa District / Pt Lot 4 DP 1187. The council intends to change the use of land from rural to recreational and develop Open Space and Wheels Park in Greytown.

The site is not listed on Greater Wellington Regional Council (GWRC) Selected Land Use Register (SLUR) but is close to the former gasworks site. Consequently, there have been concerns raised in the community about the site given its proximity to the sites listed on the SLUR.

This DSI was carried out in accordance with the current (2021) edition of the National Environmental Standard for Assessing and Managing Contaminants in Soil to Protect Human Health (NESCS) and the relevant Contaminated Land Management Guidelines.

Under the NESCS, land is considered to be actually or potentially contaminated if an activity or industry on the Ministry for the Environment's Hazardous Activities and Industries List (HAIL: MfE 2011) is more likely than not to have been undertaken on that land. Land-use history is therefore the trigger for determining whether the land is covered by the NESCS.

Following the above-referenced guidelines, part of the Resource Management Act, the subject site needs to be assessed as a 'piece of land' to be developed. In this particular case, the NESCS is triggered by the proposed development of the parcel of land via Regs 5(1)(a), 5(6) – changing the use of a piece of land which includes a probable 'piece of land' with a possible HAIL activity (Reg 5(7)).

The DSI has established that the subject site is more likely than not a HAIL site. The conclusion was made based on the review of the historic aerial photography. The proposed subdivision is subject to the NESCS due to the following HAIL activities:

- G5 - Waste disposal to land – *stockpiles of unknown materials possibly containing CCA-treated wood painted with lead-based paint.*
- H - Any land that has been subject to the migration of hazardous substances from adjacent land in sufficient quantity that it could be a risk to human health or the environment – *gasworks site on the neighbouring lot.*
- I - Any other land that has been subject to the intentional or accidental release of a hazardous substance in sufficient quantity that it could be a risk to human health or the environment – *proximity to the shed possibly made of asbestos-containing materials and fertilisers used to maintain pasture.*

Additional observations and assumptions can be made:

- The subject site was used as a pasture in the past. Potential contaminants could be DDT or Dieldrin if applied to combat grass grub, and cadmium as a residue from the superphosphate application.

- While the subject site is in proximity to a former gasworks site, there is no direct boundary between the two sites. The gasworks operation was short-lived and ceased to exist in the 1940s. Furthermore, the subject site has always been separated from the gasworks site by the shelter belt and a road both of which would have served as protective barriers/shields from the accidental migration of hazardous substances.

Given the history of land use, contaminants of potential concern (CoPC) could be:

- heavy metals such as arsenic (As)[2], cadmium (Cd) and lead (Pb)
- organo-chlorine pesticides (OCPs), mainly DDT and Dieldrin
- asbestos

Tests results of the samples collected during the intrusive site investigation established one contaminant of potential concern – lead (Pb) - to be at concentrations above the recreational SCS set by the NESCS.

Contamination with lead is limited to two targeted samples collected from one of the former waste piles. Lead contamination is generally associated with lead-based paint. Given the fact that only two samples showed lead concentration levels above the applicable (recreational) NES SCS, it is possible that paint flakes as residue from painted wood accumulated in one small area.

Therefore, it can be concluded that the use of the soil in the area of the former waste pile is likely to pose a risk to human health.

Since the soil contamination onsite exceeds the applicable standard reg. 10(2)(b), the activity is restricted discretionary under the NESCS.

[2] Arsenic is used as an indicator of residues of CCA treated timber and therefore analysis for arsenic is a surrogate for analyses for arsenic, copper, and chromium.

Introduction

Subject: Detailed site investigation, recreational land development
Purpose: To accompany an application for a resource consent, change of land use to establish/build a wheeler park

The purpose of the NESCS is to "protect human health" and the matters controlled in the NESCS relate only to the protection of human health.

The fact that an activity or industry appears on the HAIL list does not mean the site will have hazardous substances present in the land. Each case must be considered on its merits. In applying the list, the Ministry for the Environment (MfE) recommends to keep in mind that a particular activity is a small part of a particular industry, with the activity generally localised within larger sites. Therefore, the possibility of contamination can be limited to a certain area of the site.

The purpose of this Detailed Site Investigation (DSI) is to find out if the soil contamination present exceeds the applicable standard (Reg. 9(1)(b) or reg. 10(2)(b). If "yes", the activity is restricted discretionary under the NESCS; if "no", the activity is controlled under the NESCS – please refer to the decision diagram below).

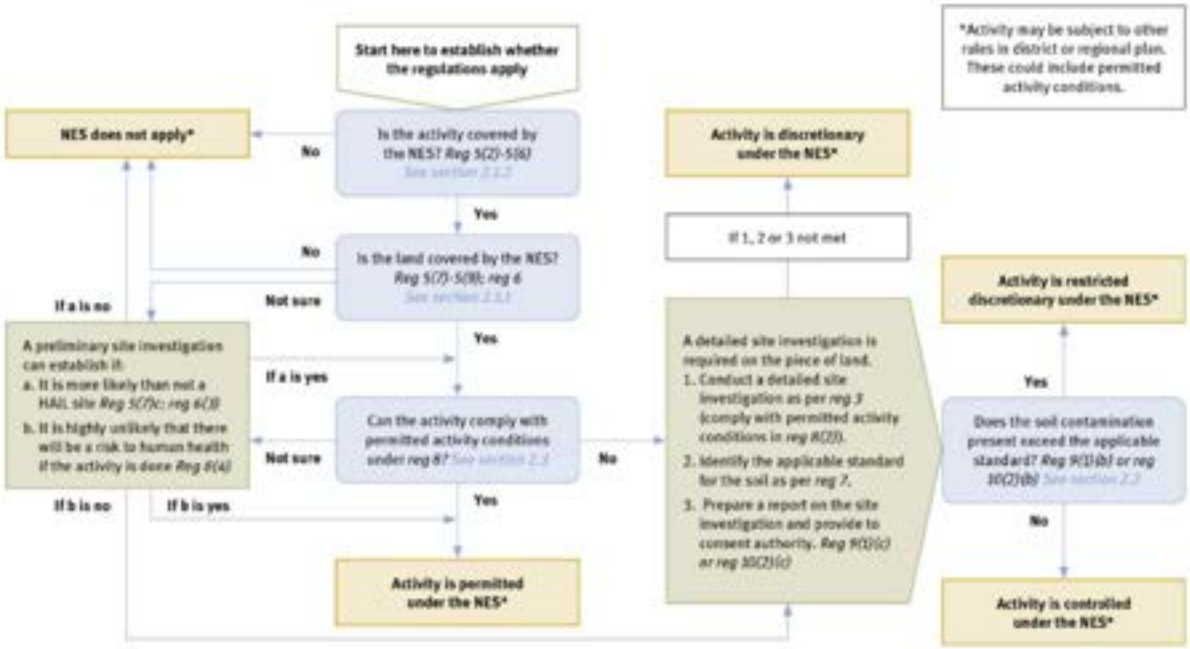

Figure 1 Determining resource consent requirements under the NESCS

Scope of Work

This DSI is concerned with a piece of land outlined in red on the maps and aerial photographs included in this report and referred to as the subject site/the site. The work involved preparing and completing this DSI consisted of the following:

- desk study
- review of the historical aerial photographs
- review of the property and SLUR records
- review of Greater Wellington Regional Council (GWRC) records
- interview of the people with knowledge of the site
- site visit/walkover on 26 August 2023
- taking soil samples
- analysis of all samples using an XRF analyser (heavy metals only)
- corroborative analysis of a few samples for heavy metals by Hill laboratories
- analysis of two composite samples for the OCPs by Hill laboratories
- analysis of four samples for asbestos presence/absence by Hill laboratories
- comparing test results with the applicable SCS set by the NESCS and other standards based on the hierarchy of guideline values
- developing a conceptual site model (CSM)
- risk assessment based on potential sources of contamination, pathways, and receptors under various future land use scenarios
- conclusions and recommendations

Site Identification

Site owner(s):	South Wairarapa District Council (SWDC)
c/o:	[redacted]
Site address:	4 Pierce Street, Greytown
Geographic coordinates:	41°05'20.67" S 175°26'52.79" E
Authority:	South Wairarapa District Council (SWDC)
Legal description:	Sec 123 Maroa District / Pt Lot 4 DP 1187
Subject site area:	Approximately 0.55 ha
Current land use	Rural
NESCS standard:	Recreational
Designations/Limitations:	None

Location

Property location is shown on the maps below.

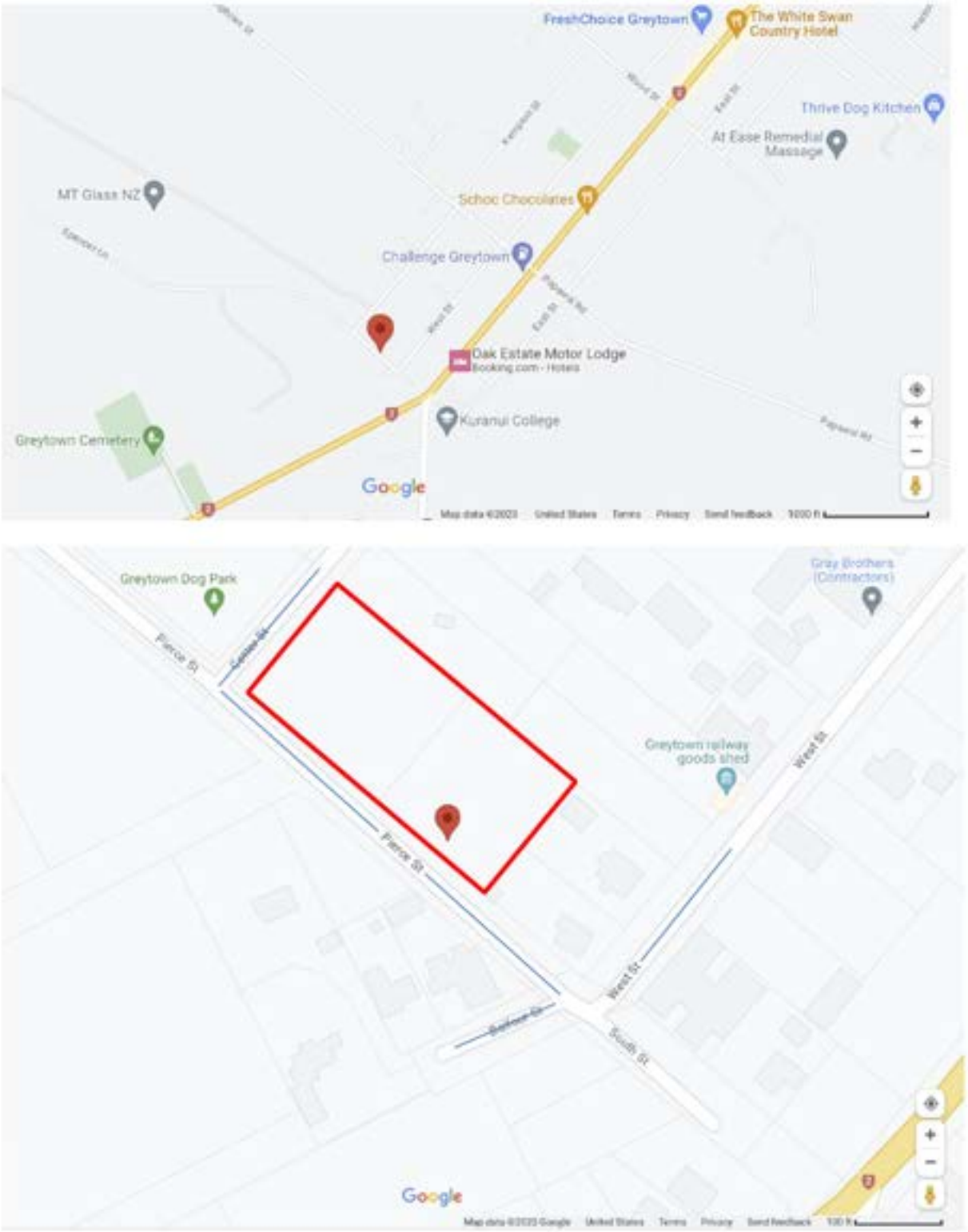

Figure 2 Property location: subject site in red

Figure 3 Scheme plan

Site History

Aerial Photography

The earliest available aerial photograph of the subject site goes back to 1941. Land use appears to be mostly pastoral overgrown with trees and bushes. The Greytown gasworks is located to the east of the site separated by the row of trees and the road.

1961 - pastural land use on the NW section, the SW section remains overgrown with bushes; the gasworks site appears to have been shut down by then.

1974 – the entire subject site is utilised for grazing.

1983 – continuous pastoral land use.

2004 – no change in land use; a possible waste pile is visible in the southern corner.

In 2010, land use remains consistently pastoral; a possible waste pile in the SE corner.

2018 - still mainly a pasture. Possible waste piles along the eastern boundary seem to be overgrown with weeds. A couple of smaller waste piles can be observed along the western boundary / northern corner.

Historic aerial photographs are presented in Appendix A.

Council Records

Council is aware of a HAIL activity on the neighbouring property adjacent to the subject site. The site has been a vacant paddock and based on Councils records, they are not aware of any hazardous activities onsite.

Possible HAIL Activities

- G5 - Waste disposal to land – *stockpiles of unknown materials possibly containing CCA-treated wood painted with lead-based paint.*
- H - Any land that has been subject to the migration of hazardous substances from adjacent land in sufficient quantity that it could be a risk to human health or the environment – *gasworks site on the neighbouring lot.*
- I - Any other land that has been subject to the intentional or accidental release of a hazardous substance in sufficient quantity that it could be a risk to human health or the environment – *proximity to the shed possibly made of asbestos-containing materials and fertilisers used to maintain pasture.*

SLUR Records

The site is not registered on Greater Wellington Regional Council's (GWRC) Selected Land Use Register (SLUR). The table below shows the nearby properties registered on the SLUR.

SLUR record	No.	HAIL	Location	Description
Greytown Transfer Station	SN/08/042/02	G5	N	Waste transfer from 1983, no burial of waste. LOT 1 DP 30169 Area 0.891 ha
Barret Engineering	SN/08/013/02	D	NE	Engineering workshops with metal fabrication. LOT 19 DEEDS PLAN 38 Area 0,245 Ha
Greytown Gasworks	SN/08/020/02	A7	E	Greytown Gasworks, PT LOT 14 DEEDS PLAN 38, Area 0,287 Ha
Greytown Gasworks	SN/08/020/02	A7	E	Greytown Gasworks, LOT 1 DP 52628 0,096 Ha
WRC Greytown	SN/08/082/02	A1, A17	SE	Railway Goods shed and WRC depot, LOT 2 DP 50634 Area 0,172 Ha

The HAIL sites near the subject site are highlighted in purple on Figure 4.

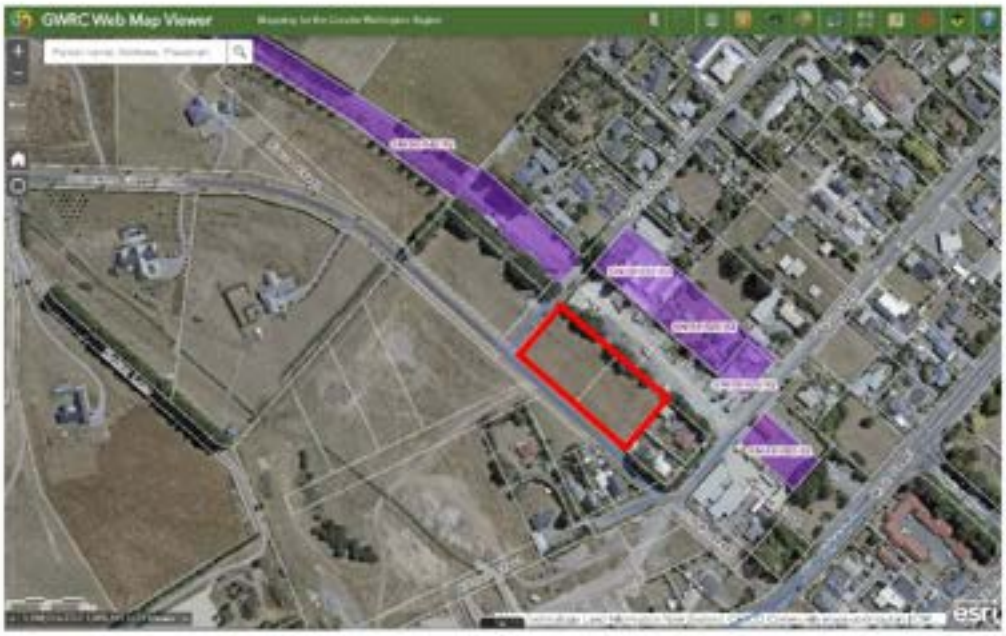

Figure 4 Subject site in relation to nearby HAIL sites[3]

Possibility of Accidental Migration of Hazardous Substances

While the subject site is in proximity to a former gasworks site, there has never been a direct boundary between the two sites. The gasworks operation was short-lived and ceased to exist over 7 decades ago in the 1940s. Furthermore, the subject site has always been separated from the gasworks site by the shelter belt and a road both of which would have served as protective barriers/shields from the accidental migration of hazardous substances.

The possibility of the accidental contamination with *VOCs, CN, NH_3 and BTEX via groundwater* is also highly unlikely as the groundwater flow bypasses the site by flowing parallel to the site as shown on Figure 6.

Considering the direction of the groundwater flow, any potential contaminants of concern from the gasworks operation, if present, will not flow towards the site.

It should be further noted that there will be natural biodegradation of the contaminants, if any, over time. The neighbouring gasworks site has not been in operation for over 70 years, therefore, any contaminants remaining on the former gasworks site are likely to be stable and immobile.

[3] Ref. https://mapping.gw.govt.nz/GW/GWpublicMap_Mobile/?webmap=72ece62d902e4c3fb6506136104abbf9

Site Conditions and Surrounding Environment

Topography

The subject site is mostly flat.

On-site evidence of contamination

A couple of waste piles were identified in the aerial photographs and confirmed during the site visit on 26 August 2023.

Surrounding areas

Adjacent properties are in use as follows:

North	Commercial/Industrial
East	Residential
South	Road/Residential
West	Recreational/Dog Park

Geology, Hydrology and Soil Profile

The "Wellington" map (Map 10; 1:250,000) of the Institute of Geological & Nuclear Sciences indicates that the site is likely to be underlain by "Alluvial fan, scree, and colluvial deposits consisting of poorly sorted gravels" of the Holocene age (Q1a)[4]. The soil is mapped as 60% Kaiopoif mottled-weathered fluvial recent soils. The Kaiopoif soils are described as deep (>100 cm), imperfectly drained, silty loam from the alluvial hard sandstone rock (S-map). The topography and soil type suggest that rainfall generally soaks into the ground.

The inspection of the soil on site provides the following soil profile:

	Top soil 0 – 300 mm – sand, gravel, and cobbles with occasional silt with humus, roots, medium brown in colour
	Sand with some gravel and cobbles from 300 mm, grey in colour

The site has no wells, however, according to the GWRC maps website, there are 2 wells in the neighbourhood located within a 100m radius from the site[5] – see the table below:

Well number / Resource consent	Direction from site	Distance (m)
BP34/0039 / WAR120159	North west	80m
S26/0536 / null	North east	95m

[4] GNS (2008) Geological Map of New Zealand, sheet 10, Wellington.

[5] Ref.: https://data-gwrc.opendata.arcgis.com/datasets/wells-and-bores/explore

Surface water is present in the form of two water races: one to the NE of the site and one to the SW. Both are part of the Moroa Water Race network[6] providing irrigation water to the Greytown area.

Figure 5 Subject site[7] (red square) in relation to Moroa Water Race network

The management zone map below shows existing groundwater bores (green squares) and simulated groundwater flow contours (brown dashed lines). Directions of the groundwater flow are indicated with the blue arrow. Judging by the arrows[8], the groundwater is flowing SW – SWW towards the Ruamahanga River, by-passing the subject site. The SLUR site to the north of the subject site, the old transfer station, operated from 1983 and is unlikely to have accepted liquid wastes. In addition, solid waste is only present at transfer stations for a short period of time. Therefore, likelihood of the nearby HAIL sites affecting the environmental quality of the subject site is very low.

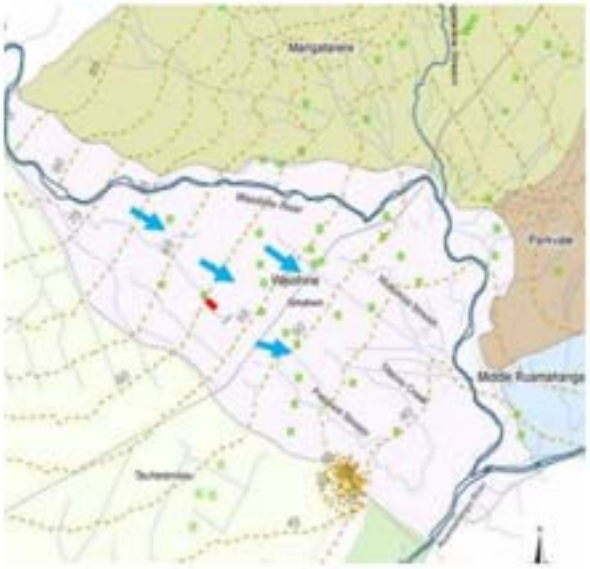

Figure 6 Subject site in relation to groundwater contours

[6] The Moroa Race is 240km long and services 8500ha of farmland, which intake water from the Waiohine river. Ref.: https://swdc.govt.nz/services/water-races/

[7] Ref.: https://www.topomap.co.nz/NZTopoMap?v=2&ll=-41.082149,175.446405&z=15

[8] Ref.: Page 166 of https://www.gw.govt.nz/assets/Documents/2011/05/Wairarapa-Valley-Groundwater-Resource-Investigation-Proposed-Framework-for-Conjunctive-Water-Management-Report-updated.pdf

Contaminants of Potential Concern

Based on the information at hand, the following remarks can be made concerning the contaminants of potential concern within the area of investigation (contaminants tested for are shown in red):

Priority Contaminant	Common use	Expected to exceed SCS?	Reason
Arsenic	Related to CCA-treated wood and sheep dipping, orchard sprays applied between 1900 and 1970	Possible	If CCA-treated wood was in the waste piles
Boron	Timber treatment	No	No such activity
Cadmium	Residue from super phosphate fertiliser	Highly unlikely to exceed SCS	Likely limited use of fertilisers due to non-intensive grazing
Chromium	Electroplating, pigments, treated timber	Highly unlikely to exceed SCS	CCA treated wood with arsenic being a more sensitive indicator
Copper	Foot-rot bath, organic spray, treated wood	No limit under NESCS	CCA treated wood with arsenic being a more sensitive indicator
Lead	Lead-based paint, Orchard sprays, Glasshouse paints	Possible	If wood in the waste piles was painted with lead-based paint
Zink	Related to anthropogenic influence, corrugated iron	No limit under NESCS	Tested as part of a standard heavy metal suite
Mercury	Old pesticides (sheep), industrial	No	No such activity
BaP (poly aromatic hydrocarbons)	Residue from Creosote, waste engine oil and burning of waste	No	No such activity onsite, soil highly unlikely to be impacted by the short-lived gasworks site shut down in the 1940s
DDT	Insecticide from the 1950s and 1960s	Highly unlikely to exceed SCS	Could have been used as insecticide when a pasture
Dieldrin	Often related to sheep dips and grass grubs.	Highly unlikely to exceed SCS	Could have been used to control grass grubs
PCPs	Fungicide, anti-sap-staining agent in timber industry	No	No such activity
Dioxins	Related to PCP, or formed during low temperature incineration of plastics	No	No such activity
Asbestos	Related to asbestos cement sheets (ACS), corrugated roofing and friable asbestos packing and heat insulation.	Highly unlikely	No pieces of asbestos of any kind observed during the walk-over survey; proximity to the neighbouring shed possibly made with asbestos containing materials

Initial Conceptual Site Model and Risk Assessment

Introduction

A conceptual site model ('CSM') is a working hypothesis that looks at potential sources of contamination within a piece of land, potential routes of exposure (pathways) and sensitive receptors that could be affected by the source(s) of contamination. The main objective of a CSM is to identify potential pathways between the known potential contaminant source(s) and the receptor(s). A CSM is a key decision-making tool to assess the risk to human and environmental health. All three - the pathways, receptors and sources of contamination - need to be linked for a risk to exist. Remove one of the links and no risk exists.

Risk assessment techniques are based on a causal stress-response model in which a contaminant is transported from a source through a known pathway to a receptor (people, plants, animals).

Source → Pathway → Receptor = Risk - Remove one of the links and no risk exists

S~~o~~e → Pathway → Receptor = No Risk

Source → Pa~~th~~ay → Receptor = No Risk

Source → Pathway → Re~~ce~~tor = No Risk

This concept forms the basis of risk assessment methods that have been developed internationally to help manage the impacts of contaminated sites.

In developing a CSM for this subject site, sources of potential contamination, potential pathways and potential receptors have been identified. The CSM will assist in assessing the current human health and environmental risk associated from past and current activities on the subject site.

Land Use, Soil Contamination, Likelihood of Risk

It has been established that the subject site is more likely than not a HAIL site; therefore, there could be a potential risk to human health.

Table 1 Activities, Industries and Hazardous Substances associated with a piece of land to be subdivided

Activity or Industry listed on the HAIL	Description	Hazardous Substances likely to be associated with the activity
G5	Waste disposal to land – *stockpiles of unknown materials possibly containing CCA-treated wood painted with lead-based paint.*	Heavy metals
H	Any land that has been subject to the migration of hazardous substances from adjacent land in sufficient quantity that it could be a risk to human health or the environment – *gasworks site on the neighbouring lot.*	Heavy metals and Volatile Organic Compounds (VOCs, *CN, NH_3 and BTEX) via groundwater*

I	Any other land that has been subject to the intentional or accidental release of a hazardous substance in sufficient quantity that it could be a risk to human health or the environment – *proximity to the shed possibly made of asbestos-containing materials and fertilisers used to maintain pasture.*	Asbestos and OCPs such as DDT and Dieldrin

Potential Sources of Contamination

Given the land use history, possible contamination of the subject site can be caused by:

- *Heavy metals*
- *OCPs mainly DDT and Dieldrin*
- *of VOCs, CN, NH_3 and BTEX via groundwater*
- *Asbestos*

If all sources of potential contamination are found at low concentrations (below the applicable SCS), then the applicable risk model will be as follows:

Source → Pathway → Receptor = NO Risk

In the above case scenario, no exposure to potential receptors exists and no risk-reducing strategies are required.

Contamination with *VOCs, CN, NH_3 and BTEX via groundwater* is highly unlikely as the gasworks site was short lived and shut down over 8 decades ago in the 1940s. Furthermore, the groundwater flow bypasses the site as shown on Figure 6. Since the groundwater flows parallel to the site, any potential contaminants of concern from the gasworks operation, if present, will not flow towards the site.

Potential Receptors

Given the location of the proposed development, potential receptors are limited to:

- Future residents/property owners
- Residents of the nearby properties
- Groundwater

Potential Pathways

Considering low likelihood of the CoPC to exceed the applicable NES SCS, potential exposure pathways (such as direct contact, incidental ingestion of contaminants, inhalation of contaminants, leachate to groundwater and migration by groundwater[9]) are highly unlikely to exist, the applicable risk model will be likely as follows:

Source → Pathway → Receptor = NO Risk

[9] See groundwater flow directions on Figure 6: the groundwater flows parallel with the site, therefore potential contaminants from the gasworks operation, if present, will not flow towards the site.

Soil Sampling and Analysis

The objectives of the soil sampling and analysis plan are to test for specific (most likely) potential contaminants of concern. In this process, the planned analyses should:

- prove homogeneity of the soil
- verify contamination levels
- check the hotspots

Soil Sampling Methodology

Since a few hotspots were identified, the sampling strategy for the site was a combination of two approaches: systematic and targeted.

The systematic approach was adopted by sampling on a grid. The positions of the gridlines are based on the observations of the historic aerial photographs.

The targeted approach was based on the observations of possible waste piles in historic aerial photographs.

All soil samples were collected at a depth of 0 – 150 mm. The sampling tool was cleaned between each sample point. Nitrile gloves were worn during sampling. The sampling containers (pots) were provided by an accredited laboratory.

The site investigation was designed in general accordance with the Ministry for the Environment "Contaminated Land Management Guidelines No.5: Site Investigation and Analysis of Soils".

Sample Selection for Analysis

Grid Samples

Grid-based samples were collected from the grids as shown on Figure 7. All samples were analysed for heavy metals using the XRF analyser (see Appendix B for use). Samples from the points with a blue circle were sent to an accredited laboratory for the corroborative heavy metal analysis. These samples are A3, B5, C2, E1, F2 and G4.

The Organochlorine Pesticides (OCPs), such as DDT and Dieldrin were expected to be present homogeneously and at low concentrations. One composite sample[10] was analysed to establish the contamination levels of the aforementioned chemicals. The composite consisted of four samples collected from the points with a green square. The selected samples are A5, B1, E3 and F1.

The two asbestos (ASB) samples were collected from the grid points G1 and G2 in proximity to the shed possibly clad with ACM. They are indicated with the red squares.

Heavy Metals (HM)	A3, B5, C2, E1, F2 and G4
OCPs	A5, B1, E3 and F1
ASB	G1 and G2

[10]Compositing was carried out by the Hill Laboratories Ltd.

Figure 7 Grid-based sampling plan

Targeted Samples

Targeted samples were taken from the areas with a raised surface likely caused by waste deposited on the surface. The location of the targeted samples is shown on Figure 8. All samples were tested for heavy metals using the XRF analyser. The following targeted samples were sent to an accredited laboratory for the corroborative analysis:

Heavy Metals (HM)	T3 and T5
OCPs	T2, T6, T9 and T12
ASB	T4 and T7

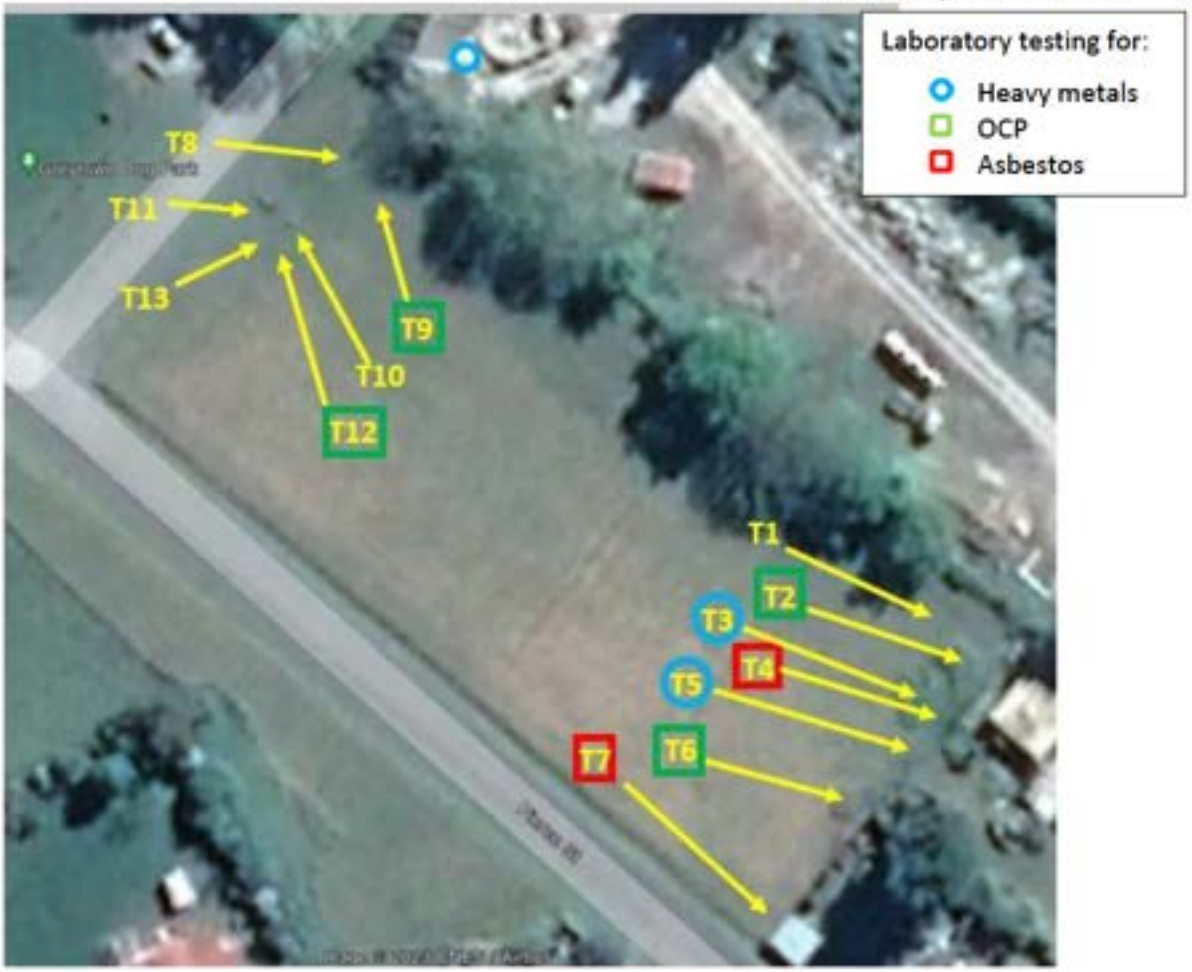

Figure 8 Targeted sampling plan

XRF QA/QC

To assure the quality of field testing, the XRF analyser was calibrated by using a soil standard reference material prepared by the National Institute of Standards and Technology (NIST). A blank sample was also tested three times. The results presented below compare well with the standardised test results.

	As	Pb	
NIST2711A (standard)	**111**	**1378**	**mg/kg**
NIST2711A (tested 31-8-2023)	113	1423	mg/kg
NIST2711A (tested 31-8-2023)	116	1412	mg/kg
NIST2711A (tested 31-8-2023)	104	1372	mg/kg
BLANK (standard)	**0**	**0**	**mg/kg**
BLANK (tested 31-8-2023)	0	1	mg/kg
BLANK (tested 31-8-2023)	2	2	mg/kg
BLANK (tested 31-8-2023)	1	0	mg/kg

QA/QC of Soil Screening and Laboratory Analysis

To check the contaminant concentration in the topsoil on site and the validity of the hypothesis that the contaminants of potential concern are homogeneously distributed in the soil, the following samples of the topsoil (0 – 150 mm) were collected:

	Grid based	Targeted	Total
Samples	35	13	48
XRF analyses	105	39	144

All samples were analysed for heavy metals using the X-Ray Fluorescence (XRF) analyser for screening purposes. Comparative studies have shown test results conducted by the XRF to be within 5 – 10% of those conducted by the laboratory analysis[11]. Each sample was analysed three times to check the homogeneity of the collected samples. A total of 144 analyses were completed using the XRF analyser. The XRF test results of each sample are presented in Appendix C.

The use of XRF analyser is incorporated in the NESCS by reference. According to the NESCS, approximately one in 10-20 samples should be sent to a certified laboratory for the corroborative analysis. In our case, approximately every sixth sample was sent to the Hill Laboratory to corroborate the XRF test results. The XRF results have been adjusted using the correlation between the laboratory results and the average XRF for As, Pb and Zn. The correlation graphs are provided in Appendix C.

External laboratory QA/QC reports were obtained from the Hill Laboratories Ltd. and reviewed to assess the quality of the reported data. The reports are provided as part of Appendix G. A review of the quality assurance report showed the following key findings:

- All method blank analyses returned concentrations below the laboratory detection limits
- All laboratory QC samples resulted in concentrations within the known limits of uncertainty

Based on this review, the analytical data was considered representative of the site conditions and suitable for interpretation.

[11]US EPA (2006) 'Field Portable X-Ray Fluorescence Spectroscopy - http://www.epa.gov/osw/hazard/testmethods/sw846/pdfs/6200.pdf (downloaded 22-2-13)

Interpretation of Results

Arsenic and Lead

Test results for arsenic are below the recreational NES SCS of 80 mg/kg d.w.

Test results for lead are above the recreational NES SCS of 880 mg/kg d.w. in two targeted samples, T3 and T5.

Zinc, Copper, Chromium and Nickel

Under the NESCS, there is no limit for Zinc, Copper, Nickel, and Chromium III. Recreational NES SCS for Chromium VI is 2700 mg/kg. All eight individual test results are well below the latter concentration.

The Australian NEPM standard for Zinc is 30000 mg/kg. All individual test results are well below this concentration.

The Australian NEPM standard for Nickel is 1200 mg/kg. All individual test results are well below this concentration.

Cadmium

The XRF analyser is not sensitive to cadmium because the NESCS soil contaminant standards are low. The laboratory results are all below the applicable NES SCS of 400mg/kg.

Test statistics on cadmium:

Median	0.41
Average	0.85
Standard Deviation	0.83
Samples Size	8
Confidence Coefficient	1.96
Margin of Error	0.57
UCL 95 %	1.42
LCL 95 %	0.27
Max	2.70
Min	0.24
Range	2.46

Organochlorine Pesticides (OCPs)

Two composite samples were analysed for the Organochlorine Pesticides (OCPs). DDT and Dieldrin have the highest likelihood of being present in the soil, therefore, they are discussed individually below. The composite samples represent the top soil (0 – 150 mm) and is made from sub-sampling samples by the Hill Laboratories:

- Grid Composite: A5, B1, E3 and F1
- Targeted Composite: T2, T6, T9 and T12

∑DDT

DDT is the generic name for a group of DDT-like pesticides such as DDT, DDD and DDE, all of which are produced together and often found in soils consequently. Usually their break-down cycle is as follows: DDT → DDD → DDE. These types of chemicals have a half-life ranging from 5 to 30 years[12].

The maximum level for all DDT-like chemicals combined is set by the NESCS at 400 mg/kg for recreational land uses. Four samples were used for each composite and compared against the applicable NESCS for DDT divided by 4. The ∑DDT concentration found by the laboratory is < 0.11 and < 0.09mg/kg, respectively, which is well below the composite guideline of 100 mg/kg. None of the subsamples exceeds the applicable NESCS soil quality standard.

Dieldrin

In the composite samples taken at 4 positions each, Dieldrin is found below the detection limit of < 0.018 and < 0.014 mg/kg, respectively, - well below the recreational NES SCS for a composite sample made from 4 samples, which is 70 mg/kg divided by 4 = 17.5mg/kg.

Asbestos

Four samples were collected and sent to the accredited laboratory for the presence/absence test. Two grid samples were taken close to potentially asbestos containing sheds located just across the property boundary (G1 and G2), and two targeted samples in waste piles with the most non-soil particles (T4 and T7). NO asbestos was found in any of the samples.

Full laboratory test results are included with the report in Appendix G.

Sample Analysis Conclusion

Concentrations of all but one site-specific potential contaminants of concern analysed for the purpose of this DSI report are below the SCS provided in the NESCS guidelines for the recreational land use.

Lead concentrations are above the applicable standard in two targeted samples collected from the one of the waste piles.

[12] http://www.atsdr.cdc.gov/toxprofiles/tp35.pdf

Updated Conceptual Site Model and Risk Assessment

The Conceptual Site Model (CSM) is an iterative process, 'living representation' of a site that summarizes and helps visualise and understand available information. The CSM is updated when new information comes available such as test results of the collected samples.

Since concentrations of one site-specific contaminant of potential concern (Pb) analysed for the purpose of this DSI are above the SCS provided in the NESCS guidelines for the recreational land use, it can be concluded that there is a "source" of contamination limited to one specific area that can pose a risk to human health.

Therefore, in our professional opinions, test results confirmed the following risk assessment model:

Source → Pathway → Receptor = Risk

As to the possible run-off of contaminated sediment, the subject site is mainly flat thus making run-off of contaminated sediment from the small area, unlikely.

Groundwater is not expected to be affected as the heavy metal contamination is most likely the result of paint flakes. Lead (Pb) in paint flakes hardly dissolve, remain in the soil, and generally do not leach to the groundwater.

However, given the fact that the small area is contaminated with lead, exposure to potential receptors exists and risk-reducing strategies will be required.

The risk-reducing strategies can be, but not limited to:

- Soil disposal and replacement
- Soil blending
- Capping
- A combination of strategies

DSI CONCLUSION

Of all site-specific CoPC, test results for lead (Pb) are above the applicable SCS set by the NESCS for recreational soils in two targeted samples. This allows us to conclude that **the soil onsite limited to one area is likely to pose a risk to human health.** Since the soil contamination exceeds the applicable standard reg. 10(2)(b), the activity is restricted discretionary under the NESCS.

RECOMMENDATIONS

Waste piles are generally highly heterogeneous. With only two targeted samples exceeding the applicable standard, it may be excessively expensive to produce a Remedial Action Plan (RAP) for an extremely limited area of contamination. A more pragmatic approach would be to remove the waste while testing the surface soil during the removal process to ensure all contaminated material has been removed and issue a final DSI report certifying the site meets recreational NES SCS.

Report Limitations

This report describes the site investigation processes and data collection provided by a third party and interpretation of all data combined. Conclusions of this report are specific to this property only, and are valid for the purpose it was requested. The report is also valid only in its original form and must be reproduced in its entirety. Geo & Hydro – K8 Ltd has not independently verified the provided information and has relied upon it being accurate and sufficient for use by Geo & Hydro – K8 Ltd. While this report has been compiled very carefully, to the extent that its conclusions are based on data analysis made available by a third party, no responsibility or liability is accepted for the consequences arising from 1) erroneous and/or omitted data, 2) property areas not analysed, 3) factors and/or data intentionally or unintentionally made unavailable to Geo & Hydro – K8 Ltd., 4) factors and/or data Geo & Hydro – K8 Ltd could not ascertain by reasonable inquiry in the ordinary course of investigation. Anyone who relies on this report other than SWDC does so at his/her own risk.

SQEP Sign-off Statement

This DSI has been prepared by a Suitably Qualified and Experienced Practitioner (SQEP) as required by the NESCS. Drs. Ben Keet has over 35 years of experience in contaminated land assessment, remediation and validation and is a Certified Environmental Practitioner in Contaminated Sites through the CEnvP accreditation scheme. A CV/Bio is appended to this report.

SQEP Certification of Report

DETAILED SITE INVESTIGATION CERTIFYING STATEMENT

I, *Drs. Ben Keet of Geo & Hydro – K8 Limited,* certify that:

1. this detailed site investigation meets the requirements of the Resource Management (National Environmental Standard for Assessing and Managing Contaminants in Soil to Protect Human Health) Regulations 2011 (the NESCS) because it has been:

a. done by a suitably qualified and experienced practitioner, and

b. done in accordance with the current edition of *Contaminated land management guidelines No 5 – Site investigation and analysis of soils*, and

c. reported on in accordance with the current edition of *Contaminated land management guidelines No 1 – Reporting on contaminated sites in New Zealand*, and

d. the report is certified by a suitably qualified and experienced practitioner.

2. This detailed site investigation concludes that contamination does exceed the applicable standard in Regulation 7 of the Resource Management (National Environmental Standard for Assessing and Managing Contaminants in Soil to Protect Human Health) Regulations

Evidence of the qualifications and experience of the suitably qualified and experienced practitioner(s) who have done this investigation and certified this report is appended to this detailed site investigation report.

Signed and dated:

Drs. Ben Keet

Date: 22 September 2023

References

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Appendix A: Historic Aerial Photographs

The earliest available aerial photograph of the subject site goes back to 1941. Land use appears to be pastoral overgrown with bushes. The Greytown gasworks is located to the east of the site separated by the row of trees and the road.

Figure 9 Aerial photograph 1941

1961 - pastural land use on the NW section, the SW section remains overgrown with bushes; the gasworks site appears to have been shut down by then.

Figure 10 Aerial photograph 1961

1974 – the entire subject site is utilised for grazing

Figure 11 Aerial photograph 1974

1983 – continuous pastoral land use

Figure 12 Aerial photograph 1983

2004 – no change in land use; a possible waste pile is visible in the southern corner

Figure 13 Aerial photograph 2004

In 2010, land use remains consistently pastoral; a possible waste pile in the SE corner

Figure 14 Aerial photograph 2010

2018 - still mainly a pasture. Possible waste piles along the eastern boundary seem to be overgrown with weeds. A couple of smaller waste piles can be observed along the western boundary / northern corner.

Figure 15 Aerial photograph 2018

Appendix B: Use of an X-Ray Fluorescence (XRF) Analyser

Comparison with Laboratory Results

Field XRF analysis yields a 'wet weight' (w.w.) result, i.e., a sample 'diluted' with water. Laboratory results and guideline standards are given as dry weight (d.w.), also called dry matter (d.m.) concentrations. Therefore, results from the XRF analysis must be corrected by the percentage of soil moisture in order to be compared with the guideline values and laboratory results. The soil moisture content of the samples nearest to those analysed in the lab is used. All results in the report are corrected for soil moisture (as the laboratory does) and are given in mg/kg d.w.

The difference between laboratory results and those obtained from the XRF analysis is that the XRF analyses a small *near surface area* of the sample, whereas a *small volume* of the sample will be extracted for laboratory analysis (2 gram). Sample heterogeneity is accounted for by analysing the sample at least three times at various positions (different places in the sample bags) and if needed determining an average concentration. In the laboratory, the sample is mechanically mixed and sieved (2 mm) before the sub-sample is taken. For example, larger paint flakes are omitted in laboratory analysis, but the XRF results would be higher if the flakes are close to the surface in the sample. On the other hand, the XRF results are moderated by the air gaps often associated with flat grains such as paint flakes effectively diluting the sample, which in turn reduces the concentration read on the instrument.

Consequently, consistent compaction of each sample is important as the more soil grains are present in the near surface area in front of the XRF analyser's X-ray window; the more fluorescence generated and emitted back to the detector and the higher the concentration read. When using the XRF on-site in an in-situ mode, care should be taken while analysing soil which was either not yet excavated or when measuring a loose sample like on a mixed pile of soil, selecting a well compacted area, like a spot inside the wheel tracks of earthmoving machinery, to gain consistent readings. When analysing soil in bags or in the field care has been taken to compress each bag or sample before analysis to obtain similar compaction for each bag / sample analysed. As there is most likely not 95% compaction everywhere in the bag, some variability can be expected.

International Use of XRF

The United Stated Environmental Protection Agency has produced a number of guidelines and method statements for the use of XRF devices. In the USA, portable XRF devices are used in the field for initial site characterisation and the identification of contamination patterns, as well as to make informed decisions on sample selection for further analysis. Method Statement 6200 has been published by the EPA under the Resource Conservation and Recovery Act (RCRA) to provide guidance and regulation for field-portable XRF analysis (www.epa.gov).

The EPA methods are referenced in the NESCS.

Appendix C: XRF Test Results

SAMPLE ID	As Adj	Cr Adj	Cu Adj	Pb Adj	Ni Adj	Zn Adj
	in mg/kg d.w. As, Pb & Zn adjusted using correlation with lab - others using s.m.%					
A1	5	53	32	26	24	96
A1	6	90	24	26	11	101
A1	10	48	24	28	11	77
A2	2	44	19	22	31	90
A2	3	50	19	19	16	83
A2	5	29	15	16	29	79
A3	3	18	8	17	15	57
A3	4	31	8	20	8	46
A3	4	16	11	7	10	63
A4	3	24	19	4	18	46
A4	3	32	24	5	19	65
A4	4	10	29	9	19	55
A5	5	42	8	3	31	52
A5	2	32	19	8	31	67
A5	2	31	11	8	10	50
B1	2	56	27	21	13	65
B1	2	21	32	16	13	50
B1	3	18	18	19	13	52
B2	3	29	24	12	13	50
B2	2	8	23	8	19	44
B2	5	15	15	6	6	44
B3	7	34	13	8	10	52
B3	3	11	21	6	24	56
B3	2	50	18	12	16	48
B4	2	27	24	3	8	49
B4	3	34	50	5	16	46
B4	2	42	27	3	18	57
B5	4	23	13	20	18	62
B5	6	16	8	17	13	61
B5	3	13	11	21	16	57
C1	5	26	50	25	24	75
C1	3	13	23	22	31	66
C1	3	10	19	22	35	68
C2	4	11	15	30	3	89
C2	2	40	10	25	3	96
C2	4	23	11	28	6	92
C3	4	34	18	6	21	50
C3	4	40	24	8	10	50
C3	2	18	27	13	24	55
C4	3	50	35	16	35	91
C4	3	23	23	9	15	61
C4	2	47	50	12	21	73
C5	3	35	21	3	16	58
C5	5	27	21	9	11	68
C5	4	55	24	25	5	92
NES SCS Recreational	80	2700 Cr(VI)	no limit	880	n/a	n/a
NEPM Recreational C	300	300	17000	600	1200	30000
PCB Medium	2.38	11.76	11.23	7.11	6.24	23.61
PCB UCL95	9.97	56.88	48.14	25.83	35.15	97.97

Table (Cont.)

SAMPLE ID	As Adj	Cr Adj	Cu Adj	Pb Adj	Ni Adj	Zn Adj
	in mg/kg d.w. As, Pb & Zn adjusted using correlation with lab - others using s.m.%					
D1	3	29	19	37	24	63
D1	2	31	27	39	29	68
D1	5	53	29	29	24	57
D2	4	48	18	11	23	66
D2	4	18	35	7	24	58
D2	5	29	19	7	24	52
D3	2	19	13	6	21	51
D3	3	13	18	6	10	55
D3	2	13	32	11	6	57
D4	5	34	23	7	15	52
D4	3	32	23	13	18	57
D4	2	15	23	12	8	52
D5	2	35	24	20	10	97
D5	4	15	19	12	6	114
D5	2	31	24	6	15	66
E1	7	24	24	75	13	84
E1	5	29	23	85	15	85
E1	4	18	19	77	13	84
E2	3	13	18	60	16	73
E2	2	40	11	62	18	79
E2	2	23	6	63	23	91
E3	2	18	8	62	15	91
E3	2	34	35	49	16	86
E3	2	37	29	58	31	92
E4	2	58	18	21	16	91
E4	5	31	10	19	29	72
E4	2	18	23	13	6	77
E5	6	27	13	16	8	71
E5	2	45	13	21	10	63
E5	2	24	32	26	15	72
F1	5	40	21	46	24	86
F1	2	39	23	35	3	66
F1	5	16	24	30	19	62
F2	6	21	45	497	21	156
F2	6	24	55	516	8	207
F2	7	23	47	572	23	194
F3	2	11	23	43	6	156
F3	2	15	24	56	24	193
F3	2	39	15	43	11	152
F4	2	47	8	221	5	311
F4	2	44	15	227	19	317
F4	2	13	23	205	21	353
F5	7	50	15	30	3	110
F5	2	45	32	33	5	96
F5	3	37	23	34	35	117
NES SCS Recreational	80	2700 Cr(VI)	no limit	880	n/a	n/a
NEPM Recreational C	300	300	17000	600	1200	30000
PCB Medium	2.38	11.76	11.23	7.11	6.24	23.61
PCB UCL95	9.97	56.88	48.14	25.83	35.15	97.97

Table (Cont.)

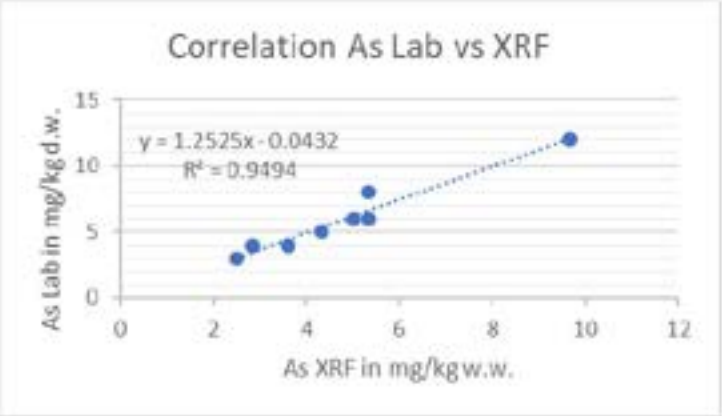
SAMPLE ID	As Adj	Cr Adj	Cu Adj	Pb Adj	Ni Adj	Zn Adj
	in mg/kg d.w. As, Pb & Zn adjusted using correlation with lab - others using s.m.%					
G1	4	58	11	54	35	79
G1	6	60	19	43	15	84
G1	4	47	10	51	11	80
G2	9	18	24	213	23	291
G2	2	55	24	231	15	285
G2	6	19	18	101	19	170
G3	6	45	23	137	19	131
G3	5	15	29	103	5	106
G3	2	52	34	236	15	154
G4	5	19	37	172	11	282
G4	6	35	21	194	21	341
G4	7	24	8	187	31	288
G5	2	47	10	24	35	95
G5	5	23	27	29	13	118
G5	9	60	35	29	13	126
T1	9	47	24	8	35	61
T1	2	48	8	13	24	54
T1	4	27	5	12	10	71
T2	7	48	8	13	31	83
T2	5	21	10	17	8	78
T2	5	47	8	16	11	78
T3	10	39	248	1161	21	1206
T3	14	34	503	812	26	1499
T3	12	26	263	1224	18	1465
T4	10	48	131	291	13	315
T4	9	32	111	240	29	274
T4	6	15	27	226	11	242
T5	7	37	76	914	15	609
T5	6	31	63	1075	16	545
T5	6	35	87	931	19	572
T6	2	27	19	170	24	124
T6	7	55	18	197	6	177
T6	14	34	16	202	23	170
T7	10	29	24	97	13	468
T7	7	50	29	84	11	447
T7	10	27	11	89	18	437
T8	4	34	23	17	21	72
T8	5	27	5	13	11	80
T8	5	55	23	19	19	90
T9	5	92	13	17	29	81
T9	4	61	24	21	18	80
T9	11	23	6	17	24	89
T10	5	42	5	24	21	91
T10	8	44	6	20	16	86
T10	2	56	13	20	23	78
NES SCS Recreational	80	2700 Cr(VI)	no limit	880	n/a	n/a
NEPM Recreational C	300	300	17000	600	1200	30000
PCB Medium	2.38	11.76	11.23	7.11	6.24	23.61
PCB UCL95	9.97	56.88	48.14	25.83	35.15	97.97

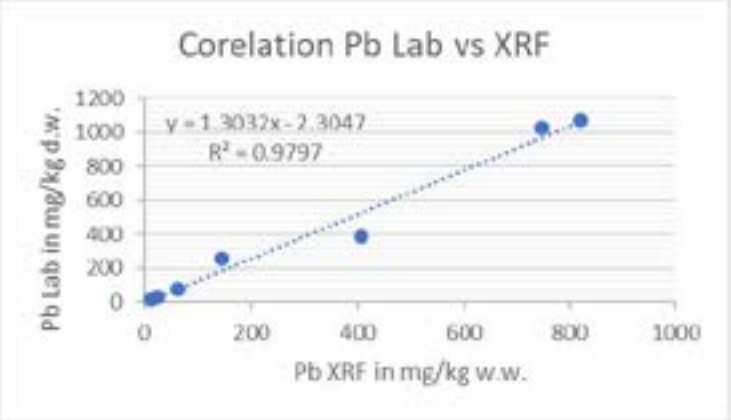
Table (Cont.)

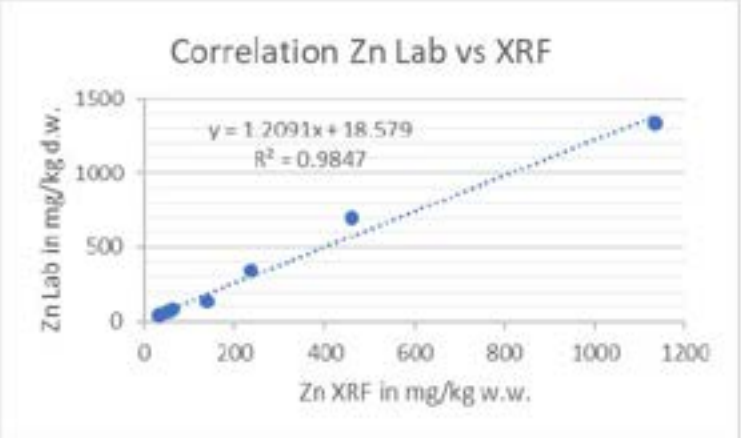
SAMPLE ID	As Adj	Cr Adj	Cu Adj	Pb Adj	Ni Adj	Zn Adj
	in mg/kg d.w. As, Pb & Zn adjusted using correlation with lab - others using s.m.%					
T11	7	24	13	16	31	80
T11	14	53	50	11	16	90
T11	4	48	13	19	35	81
T12	3	23	10	9	24	55
T12	4	44	35	3	11	58
T12	4	19	24	3	23	48
T13	3	24	18	1	24	54
T13	2	26	18	9	10	66
T13	2	50	10	9	24	51
NES SCS Recreational	80	2700 Cr(VI)	no limit	880	n/a	n/a
NEPM Recreational C	300	300	17000	600	1200	30000
PCB Medium	2.38	11.76	11.23	7.11	6.24	23.61
PCB UCL95	9.97	56.88	48.14	25.83	35.15	97.97

Note: Test results highlighted in red are above the applicable NES SCS. Under the NESCS, chromium (III) has 'no limit', therefore, chromium (VI) is used as the most stringent standard.

Correlation graphs presented below are based on the XRF analyser vs laboratory test results of the three of the heavy metals (As, Pb and Zn) with the highest concentrations. Concentrations of chromium, copper and nickel are too low and too homogeneous to provide a good correlation line. Concentrations detected by the XRF analyses were adjusted using the soil moisture percentage to be comparable with the laboratory results







Appendix D: Current Soil Standards

The NESCS was set forth in January 2012. CLMG No. 1 and No. 5 were revised on 1 July 2021. MfE CLMG No. 1[13] requires to establish a site specific/appropriate standard. Recreational SCS indicated with the red arrows in the tables below was chosen for this site based on the future property zoning.

Table 2: Summary of soil contaminant values for inorganic substances (mg/kg)

	Arsenic	Boron[1]	Cadmium (pH 5)[2]	Chromium[1]		Copper[1]	Inorganic lead	Inorganic mercury compounds[3]
				III	VI			
Rural residential / lifestyle block 25% produce	17[4]	NL	0.8	NL	290	NL	160	200
Residential 10% produce	20	NL	3	NL	460	NL	210	310
High-density residential	45	NL	230	NL	1,500	NL	500	1,000
Recreational	80	NL	400	NL	2,700	NL	880	1,800
Commercial / industrial outdoor worker / maintenance	70	NL	1,300	NL	6,300	NL	3,300	4,200

1 SCVs for boron, chromium III and copper are much greater than the soil concentration at which plant health will be affected. Plant and other environmental effects may need to be considered separately.

2 Default value is for pH 5. See Appendix 1 of the *Methodology Report*[22] for SCVs at other soil pH values.

3 The inorganic mercury SCV does not apply to elemental (pure) mercury.

4 Derived value replaced with 99th percentile of national dataset of background concentrations as described in the *Methodology Report*.

Note: NL = No Limit. Derived value exceeds 10,000 mg/kg.

Table 3: Summary of soil contaminant values for organic compounds (mg/kg unless shown otherwise)

Scenario	BaP[1] (mg/kg)	DDT (mg/kg)	Dieldrin[2] (mg/kg)	PCP[3] (mg/kg)	Dioxin (µg/kg TEQ)[4]	
					TCDD	Dioxin-like PCBs[5]
Rural residential / lifestyle block 25% produce	6	45	1.1	55	0.12	0.09
Residential 10% produce	10	70	2.6	55	0.15	0.12
High-density residential	24	240	45	110	0.35	0.33
Recreational	40	400	70	150	0.60	0.52
Commercial / industrial outdoor worker / maintenance	35	1,000	160	360	1.4	1.2

[13] http://www.mfe.govt.nz/publications/land-hazards/contaminated-land-management-guidelines-no-1-reporting-contaminated-sites

Australian NEPM guidelines are used for contaminants not listed in the NZ NES.

Table 1A(1) Health investigation levels for soil contaminants

Chemical	Health-based investigation levels (mg/kg)			
	Residential[1] A	Residential[1] B	Recreational[1] C	Commercial/ industrial[1] D
Metals and Inorganics				
Arsenic[2]	100	500	300	3 000
Beryllium	60	90	90	500
Boron	4500	40 000	20 000	300 000
Cadmium	20	150	90	900
Chromium (VI)	100	500	300	3600
Cobalt	100	600	300	4000
Copper	6000	30 000	17 000	240 000
Lead[3]	300	1200	600	1 500
Manganese	3800	14 000	19 000	60 000
Mercury (inorganic)[5]	40	120	80	730
Methyl mercury[4]	10	30	13	180
Nickel	400	1200	1200	6 000
Selenium	200	1400	700	10 000
Zinc	7400	60 000	30 000	400 000
Cyanide (free)	250	300	240	1 500
Polycyclic Aromatic Hydrocarbons (PAHs)				
Carcinogenic PAHs (as BaP TEQ)[6]	3	4	3	40
Total PAHs[7]	300	400	300	4000
Phenols				
Phenol	3000	45 000	40 000	240 000
Pentachlorophenol	100	130	120	660
Cresols	400	4 700	4 000	25 000
Organochlorine Pesticides				
DDT+DDE+DDD	240	600	400	3600
Aldrin and dieldrin	6	10	10	45
Chlordane	50	90	70	530
Endosulfan	270	400	340	2000
Endrin	10	20	20	100
Heptachlor	6	10	10	50
HCB	10	15	10	80
Methoxychlor	300	500	400	2500
Mirex	10	20	20	100
Toxaphene	20	30	30	160
Herbicides				
2,4,5-T	600	900	800	5000
2,4-D	900	1600	1300	9000
MCPA	600	900	800	5000

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Chemical	Health-based investigation levels (mg/kg)			
	Residential[1] A	Residential[1] B	Recreational[1] C	Commercial/ industrial[1] D
MCPB	600	900	800	5000
Mecoprop	600	900	800	5000
Picloram	4500	6600	5700	35000
Other Pesticides				
Atrazine	320	470	400	2500
Chlorpyrifos	160	340	250	2000
Bifenthrin	600	840	730	4500
Other Organics				
PCBs[8]	1	1	1	7
PBDE Flame Retardants (Br1–Br9)	1	2	2	10

Notes:

(1) Generic land uses are described in detail in Schedule B7 Section 3

HIL A – Residential with garden/accessible soil (home grown produce <10% fruit and vegetable intake (no poultry), also includes childcare centres, preschools and primary schools.

HIL B – Residential with minimal opportunities for soil access; includes dwellings with fully and permanently paved yard space such as high-rise buildings and apartments.

HIL C – Public open space such as parks, playgrounds, playing fields (e.g. ovals), secondary schools and footpaths. This does not include undeveloped public open space where the potential for exposure is lower and where a site-specific assessment may be more appropriate.

HIL D – Commercial/industrial, includes premises such as shops, offices, factories and industrial sites.

(2) Arsenic: HIL assumes 70% oral bioavailability. Site-specific bioavailability may be important and should be considered where appropriate (refer Schedule B7).

(3) Lead: HIL is based on blood lead models (IEUBK for HILs A, B and C and adult lead model for HIL D where 50% oral bioavailability has been considered. Site-specific bioavailability may be important and should be considered where appropriate.

(4) Methyl mercury: assessment of methyl mercury should only occur where there is evidence of its potential source. It may be associated with inorganic mercury and anaerobic microorganism activity in aquatic environments. In addition the reliability and quality of sampling/analysis should be considered.

(5) Elemental mercury: HIL does not address elemental mercury. A site-specific assessment should be considered if elemental mercury is present, or suspected to be present.

(6) Carcinogenic PAHs: HIL is based on the 8 carcinogenic PAHs and their TEFs (potency relative to B(a)P) adopted by CCME 2008 (refer Schedule B7). The B(a)P TEQ is calculated by multiplying the concentration of each carcinogenic PAH in the sample by its B(a)P TEF, given below, and summing these products.

PAH species	TEF	PAH species	TEF
Benzo(a)anthracene	0.1	Benzo(g,h,i)perylene	0.01
Benzo(a)pyrene	1	Chrysene	0.01
Benzo(b+j)fluoranthene	0.1	Dibenz(a,h)anthracene	1
Benzo(k)fluoranthene	0.1	Indeno(1,2,3-c,d)pyrene	0.1

Where the B(a)P occurs in bitumen fragments it is relatively immobile and does not represent a significant health risk.

Schedule B 1 - Guideline on Investigation Levels for Soil and Groundwater 49
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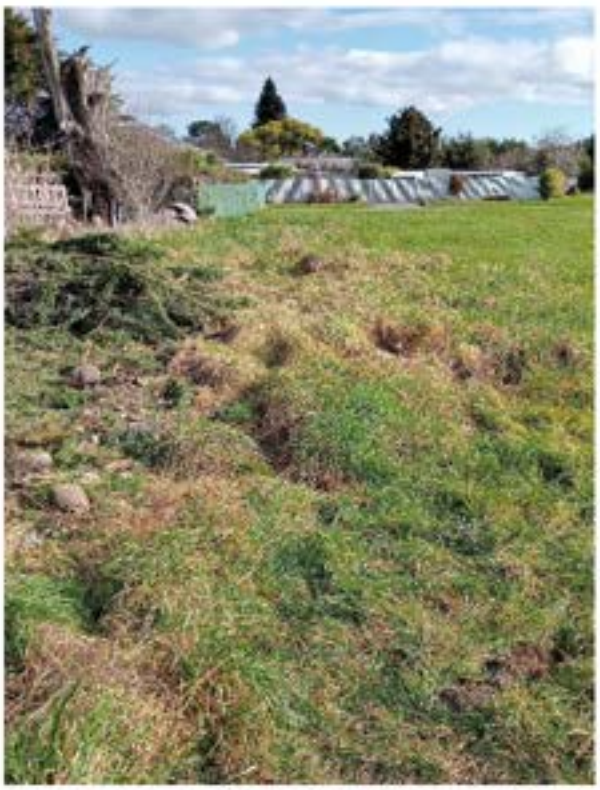
Appendix E: Site Photographs

Site overview at grid point A1

Waste containing area of samples T3 – T5



At grid point G1 an attempt was made to try to obtain a groundwater sample. However, groundwater appeared to be too deep for the small excavator and the soil too stony.

Appendix F: Brief Biography - Ben Keet

Drs. Ben Keet MBA, SQEP(NESCL), FRSC, MRSNZ
Senior Environmental Auditor
Certified General CEnvP and Site Contamination Specialist (CEnvP SC)

Ben studied Physics and Hydrogeology in Amsterdam. He holds 1st class Honours Doctoral Degree in Hydrogeology specialising in Isotope Hydrochemistry. He is a Fellow of the Royal Society of Chemistry (which requires 15 years of significant contributions to the field of chemistry), a Member of the Royal Society of NZ and a full member of the Institute of Directors NZ. In February 2016, Ben completed an Executive MBA at Massey University with his final thesis on the National Economic Impact of Lead Contamination in the Home Environment. Ben holds **the General Certified Environmental Practitioner (CEnvP) certificate number 1098 and the Site Contamination Specialist (CEnvP SC) certificate number SC40078.**

Experience:

5 years of teaching groundwater modelling and medical physics at the Free University, Amsterdam.

5 years of petroleum reservoir management with Shell International.

35+ years of experience in contaminated land management; directly overseeing 5000+ projects in 10 different countries, including NZ; investigating 70% of oil terminals in the ports of NZ, numerous Carter Holt Timber treatment sites and the first investigation of the Mapua FFC site.

Between '88 - '91, Ben oversaw remediation projects of six major and numerous small petroleum contaminated sites. He was in charge of four start-up offices in Australia with over 800 service station assessment and remedial projects throughout Australia including the remediation of the Sydney Airport's largest underground kerosene spill (>1 million litres).

Between '94 - '04 Ben was one of the four Accredited Environmental Auditors in the Grand Duche of Luxembourg. He managed the Luxembourg International Airport environmental audit that encompassed the investigation and remediation of a deep groundwater aquifer.

During Ben's carrier, some of his responsibilities included investigating, pilot testing, designing and implementing novel remediation techniques on multiple defence properties, mainly air force bases, in Europe and US, and a variety of chemical plants of AKZO Nobel, DOW, Sika, Philips, etc.

Since 1995 Ben has conducted over 1000 site assessments and participated in over 400 complex in-situ biological remedial programs. Ben holds several patents in the field of environmental engineering and sustainability.

Since 2005 Ben carries out peer reviewing and audit reports for district councils in New Zealand, such as Horowhenua, Gisborne and South Wairarapa DC. He also carried out peer reviews and validation studies for several regional councils, including the Waikato and Greater Wellington Regional Councils.

Ben was one of the first to introduce emerging contaminants like PFAS/PFOS to New Zealand in his 2003 Keynote Presentation at the WasteMINZ conference. He has worked on several PFAS/PFOS projects including NZ first on-site PFAS in soil stabilisation project using Rembind®.

Ben has completed over 750 NES reports since the introduction of the NESCL on 1-1-2012.

Ben is the author of several major reports for Ministry for the Environment (MfE) on brominated flame retardants and chemicals in E-waste (available on the MfE website); he has edited the MfE guidelines for local councils on Sheep-dips and the MfE Handbook on Natural Attenuation of Petroleum Hydrocarbons.

Ben has taught hundreds of courses and workshops to the environmental professionals and government agencies in New Zealand, Australia, Europe and the Middle East. More info on www.benkeet.com.

Fellow or Member of:

Appendix G: Laboratory Reports

Report	Pages
Certificate of Analysis	2
Chain of Custody Record	4
Quality Assurance Report	8
Certificate of Analysis with the 95% confidence limits	2
Certificate of Analysis - ASB	2
Chain of Custody Record - ASB	2
Total	20

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Ham lton 3240 New Zealand

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www.hill-labs.co.nz

Certificate of Analysis

Client:	K8 Limited	**Lab No:**	3357326	SPv1
Contact:	Dr B Keet	**Date Received:**	05-Sep-2023	
	C/- Geo & Hydro Limited	**Date Reported:**	08-Sep-2023	
	621 Marine Parade	**Quote No:**	72158	
	Napier South	**Order No:**		
	Napier 4110	**Client Reference:**	GRPS-4	
		Submitted By:	Dr B Keet	

Sample Type: Soil

	Sample Name:	GRPS-4-A3	GRPS-4-B5	GRPS-4-C2	GRPS-4-E1	GRPS-4-F2
	Lab Number:	3357326.1	3357326.2	3357326.3	3357326.4	3357326.5
Heavy Metals, Screen Level						
Total Recoverable Arsenic	mg/kg dry wt	4	4	< 4	5	6
Total Recoverable Cadmium	mg/kg dry wt	0.35	0.43	0.39	0.24	0.39
Total Recoverable Chromium	mg/kg dry wt	14	13	8	15	15
Total Recoverable Copper	mg/kg dry wt	6	6	9	14	39
Total Recoverable Lead	mg/kg dry wt	16.9	22	30	74	390
Total Recoverable Nickel	mg/kg dry wt	7	6	4	7	13
Total Recoverable Zinc	mg/kg dry wt	40	44	81	66	138

	Sample Name:	GRPS-4-G4	GRPS-4-T3	GRPS-4-T5	Composite of GRPS-4-A5, GRPS-4-B1, GRPS-4-E3 & GRPS-4-F1	Composite of GRPS-4-T2, GRPS-4-T6, GRPS-4-T9 & GRPS-4-T12
	Lab Number:	3357326.6	3357326.7	3357326.8	3357326.17	3357326.18
Individual Tests						
Dry Matter	g/100g as rcvd	-	-	-	55	70
Heavy Metals, Screen Level						
Total Recoverable Arsenic	mg/kg dry wt	6	12	8	-	-
Total Recoverable Cadmium	mg/kg dry wt	1.09	1.19	2.7	-	-
Total Recoverable Chromium	mg/kg dry wt	16	27	16	-	-
Total Recoverable Copper	mg/kg dry wt	27	280	77	-	-
Total Recoverable Lead	mg/kg dry wt	260	1,070	1,030	-	-
Total Recoverable Nickel	mg/kg dry wt	11	19	14	-	-
Total Recoverable Zinc	mg/kg dry wt	340	1,340	700	-	-
Organochlorine Pesticides Screening in Soil						
Aldrin	mg/kg dry wt	-	-	-	< 0.018	< 0.014
alpha-BHC	mg/kg dry wt	-	-	-	< 0.018	< 0.014
beta-BHC	mg/kg dry wt	-	-	-	< 0.018	< 0.014
delta-BHC	mg/kg dry wt	-	-	-	< 0.018	< 0.014
gamma-BHC (Lindane)	mg/kg dry wt	-	-	-	< 0.018	< 0.014
cis-Chlordane	mg/kg dry wt	-	-	-	< 0.018	< 0.014
trans-Chlordane	mg/kg dry wt	-	-	-	< 0.018	< 0.014
2,4'-DDD	mg/kg dry wt	-	-	-	< 0.018	< 0.014
4,4'-DDD	mg/kg dry wt	-	-	-	< 0.018	< 0.014
2,4'-DDE	mg/kg dry wt	-	-	-	< 0.018	< 0.014
4,4'-DDE	mg/kg dry wt	-	-	-	0.037	< 0.014
2,4'-DDT	mg/kg dry wt	-	-	-	< 0.018	< 0.014
4,4'-DDT	mg/kg dry wt	-	-	-	< 0.018	< 0.014
Total DDT Isomers	mg/kg dry wt	-	-	-	< 0.11	< 0.09
Dieldrin	mg/kg dry wt	-	-	-	< 0.018	< 0.014

Sample Type: Soil						
Sample Name:		GRPS-4-G4	GRPS-4-T3	GRPS-4-T5	Composite of GRPS-4-A5, GRPS-4-B1, GRPS-4-E3 & GRPS-4-F1	Composite of GRPS-4-T2, GRPS-4-T6, GRPS-4-T9 & GRPS-4-T12
Lab Number:		3357326.6	3357326.7	3357326.8	3357326.17	3357326.18
Organochlorine Pesticides Screening in Soil						
Endosulfan I	mg/kg dry wt	-	-	-	< 0.018	< 0.014
Endosulfan II	mg/kg dry wt	-	-	-	< 0.018	< 0.014
Endosulfan sulphate	mg/kg dry wt	-	-	-	< 0.018	< 0.014
Endrin	mg/kg dry wt	-	-	-	< 0.018	< 0.014
Endrin aldehyde	mg/kg dry wt	-	-	-	< 0.018	< 0.014
Endrin ketone	mg/kg dry wt	-	-	-	< 0.018	< 0.014
Heptachlor	mg/kg dry wt	-	-	-	< 0.018	< 0.014
Heptachlor epoxide	mg/kg dry wt	-	-	-	< 0.018	< 0.014
Hexachlorobenzene	mg/kg dry wt	-	-	-	< 0.018	< 0.014
Methoxychlor	mg/kg dry wt	-	-	-	< 0.018	< 0.014

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 simple 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. A detection limit range indicates the lowest and highest detection limits in the associated suite of analytes. A full listing of compounds and detection limits are available from the laboratory upon request.
Unless otherwise indicated, analyses were performed at Hill Labs, 28 Duke Street, Frankton, Hamilton 3204.

Sample Type: Soil			
Test	**Method Description**	**Default Detection Limit**	**Sample No**
Environmental Solids Sample Drying*	Air dried at 35°C Used for sample preparation. May contain a residual moisture content of 2-5%.	-	1-8
Heavy Metals, Screen Level	Dried sample, < 2mm fraction. Nitric/Hydrochloric acid digestion US EPA 200.2. Complies with NES Regulations. ICP-MS screen level, interference removal by Kinetic Energy Discrimination if required.	0.10 - 4 mg/kg dry wt	1-8
Organochlorine Pesticides Screening in Soil	Sonication extraction, GC-ECD analysis. Tested on as received sample. In-house based on US EPA 8081.	0.010 - 0.06 mg/kg dry wt	17-18
Dry Matter	Dried at 103°C for 4-22hr (removes 3-5% more water than air dry) , gravimetry. (Free water removed before analysis, non-soil objects such as sticks, leaves, grass and stones also removed). US EPA 3550.	0.10 g/100g as rcvd	17-18
Composite Environmental Solid Samples*	Individual sample fractions mixed together to form a composite fraction.	-	9-16

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

Testing was completed between 05-Sep-2023 and 08-Sep-2023. For completion dates of individual analyses please contact the laboratory.

Samples are held at the laboratory after reporting for a length of time based on the stability of the samples and analytes being tested (considering any preservation used), and the storage space available. Once the storage period is completed, the samples are discarded unless otherwise agreed with the customer. Extended storage times may incur additional charges.

Ara Heron BSc (Tech)
Client Services Manager - Environmental

Hill Laboratories
TRIED, TESTED AND TRUSTED

ANALYSIS REQUEST

R J Hill Laboratories Limited
28 Duke Street, Hamilton 3204
Private Bag 3205
Hamilton 3240, New Zealand

T 0508 HILL LAB (44 555 22)
T +64 7 858 2000
E mail@hill-labs.co.nz
W www.hill-laboratories.com

Job No: **335 7326**

Date Recv: 05-Sep-23 07:20

Received by: Nathaniel Sue

3133573265

Quote No

Primary Contact Drs. Ben Keet

Submitted By Drs Ben Keet

Client Name Geo & Hydro - K8 Ltd

Address 621 Marine Parade

Napier *Postcode* 4110

Phone 021 117 1148 *Mobile* 021 117 1148

Email ben@benkeet.com

Charge To K8 Ltd

Client Reference GRPS-4

Order No

Results To *Reports will be emailed to Primary Contact by default. Additional Reports will be sent as specified below.*

☑ *Email Primary Contact* ☐ *Email Submitter* ☐ *Email Client*

☐ *Email Other*

☐ *Other*

ADDITIONAL INFORMATION

CHAIN OF CUSTODY RECORD

Sent to Hill Laboratories

Date & Time: 1-9-23 - 13.55

Name: B Keet

☑ *Tick if you require COC to be emailed back*

Signature:

Received at Hill Laboratories

Date & Time:

Name:

Signature:

Condition Temp: 13-8

☐ *Room Temp* ☐ *Chilled* ☐ *Frozen*

☐ *Sample and Analysis details checked*

Signature:

Priority ☐ **Low** ☐ **Normal** ☑ **High**

☐ **Urgent** (ASAP, extra charge applies, please contact lab first)

Requested Reporting Date:

No.	Sample Name	Sample Date	Sample Time	Sample Type	Tests Required (if not as per Quote)
1	GRPS-4-A3			ES	MSHM
2	GRPS-4-B5			ES	MSHM
3	GRPS-4-C2			ES	MSHM
4	GRPS-4-E1			ES	MSHM
5	GRPS-4-F2			ES	MSHM
6	GRPS-4-G4			ES	MSHM
7	GRPS-4-T3			ES	MSHM
8	GRPS-4-T5			ES	MSHM
9	GRPS-4-A5			ES	Composite 1
10	GRPS-4-B1			ES	Composite 1
11	GRPS-4-E3			ES	Composite 1
12	GRPS-4-F1			ES	Composite 1

over →

Continued on next page

No.	Sample Name	Sample Date	Sample Time	Sample Type	Tests Required (if not as per Quote)
13	GRPS-4-T2			ES	Composite 2
14	GRPS-4-T6			ES	Composite 2
15	GRPS-4-T9			ES	Composite 2
16	GRPS-4-T12			ES	Composite 2
17	Composite 1				OCPsc
18	Composite 2				OCPsc
19					
20					
21					
22					
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36					
37					
38					
39					
40					

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www.hill-labs.co.nz

Job Information Summary

Client:	K8 Limited	**Lab No:**	3357326
Contact	Dr B Keet	**Date Registered:**	05-Sep-2023 8:55 am
	C/- Geo & Hydro Limited	**Priority:**	High
	621 Marine Parade	**Quote No:**	72158
	Napier South	**Order No:**	
	Napier 4110	**Client Reference:**	GRPS-4
		Add. Client Ref:	
		Submitted By:	Dr B Keet
		Charge To:	K8 Limited
		Target Date:	08-Sep-2023 4:30 pm

Samples

No	Sample Name	Sample Type	Containers	Tests Requested
1	GRPS 4-A3	Soil	PSoil250	Heavy Metals, Screen Level
2	GRPS-4-B5	Soil	PSoil250	Heavy Metals, Screen Level
3	GRPS 4 C2	Soil	PSoil250	Heavy Metals, Screen Level
4	GRPS-4-E1	Soil	PSoil250	Heavy Metals, Screen Level
5	GRPS 4 F2	Soil	PSoil250	Heavy Metals, Screen Level
6	GRPS-4-G4	Soil	PSoil250	Heavy Metals, Screen Level
7	GRPS 4 T3	Soil	PSoil250	Heavy Metals, Screen Level
8	GRPS-4-T5	Soil	PSoil250	Heavy Metals, Screen Level
9	GRPS-4-A5	Soil	GSoil300	Composite Environmental Solid Samples
10	GRPS-4-B1	Soil	GSoil300	Composite Environmental Solid Samples
11	GRPS-4-E3	Soil	GSoil300	Composite Environmental Solid Samples
12	GRPS-4-F1	Soil	GSoil300	Composite Environmental Solid Samples
13	GRPS-4-T2	Soil	GSoil300	Composite Environmental Solid Samples
14	GRPS-4-T6	Soil	GSoil300	Composite Environmental Solid Samples
15	GRPS-4-T9	Soil	GSoil300	Composite Environmental Solid Samples
16	GRPS 4 T12	Soil	GSoil300	Composite Environmental Solid Samples
17	Composite of GRPS-4-A5, GRPS-4-B1, GRPS-4-E3 & GRPS-4-F1	Soil	OrgComp	Organochlorine Pesticides Screening in Soil
18	Composite of GRPS 4 T2, GRPS 4 T6, GRPS 4 T9 & GRPS-4-T12	Soil	OrgComp	Organochlorine Pesticides Screening in Soil

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 simple 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. A detection limit range indicates the lowest and highest detection limits in the associated suite of analytes. A full listing of compounds and detection limits are available from the laboratory upon request. Unless otherwise indicated, analyses were performed at Hill Labs, 28 Duke Street, Frankton, Hamilton 3204.

Sample Type: Soil

Test	Method Description	Default Detection Limit	Sample No
Environmental Solids Sample Drying	Air dried at 35°C Used for sample preparation. May contain a residual moisture content of 2-5%.	-	1-8
Heavy Metals, Screen Level	Dried sample, < 2mm fraction. Nitric/Hydrochloric acid digestion US EPA 200.2. Complies with NES Regulations. ICP-MS screen level, interference removal by Kinetic Energy Discrimination if required.	0.10 - 4 mg/kg dry wt	1-8
Organochlorine Pesticides Screening in Soil	Sonication extraction, GC-ECD analysis. Tested on as received sample. In-house based on US EPA 8081.	0.010 - 0.06 mg/kg dry wt	17 18
Dry Matter	Dried at 103°C for 4-22hr (removes 3-5% more water than air dry) , gravimetry. (Free water removed before analysis, non-soil objects such as sticks, leaves, grass and stones also removed). US EPA 3550.	0.10 g/100g as rcvd	17-18

Sample Type: Soil			
Test	**Method Description**	**Default Detection Limit**	**Sample No**
Composite Environmental Solid Samples	Individual sample fractions mixed together to form a composite fraction.	-	9-16

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Quality Assurance Report

Client:	K8 Limited	**Lab No:**	3357326	QCPv1
Contact:	Dr B Keet	**Date Received:**	05-Sep-2023	
	C/- Geo & Hydro Limited	**Date Reported:**	21-Sep-2023	
	621 Marine Parade	**Quote No:**	72158	
	Napier South	**Order No:**		
	Napier 4110	**Client Reference:**	GRPS-4	
		Submitted By:	Dr B Keet	

Sample Specific QCs

Organochlorine Pesticides Screening in Soil

		3357326.17	Control Limits	Outside Limit (Yes/No)
2,4,5,6-tetrachloro-m-xylene	%	114	40 – 120	No

Organochlorine Pesticides Screening in Soil

		3357326.18	Control Limits	Outside Limit (Yes/No)
2,4,5,6-tetrachloro-m-xylene	%	104	40 – 120	No

Blank QCs

Digest Blank 1 PrepWS esDig - WS: High Volume Environmental Soils by ICP-MS (HVesTR): 9205.16

		Results	Control Limits	Outside Limit (Yes/No)
Total Recoverable Arsenic	mg/kg dry wt	< 2 ± 1.3	-2.0 – 2.0	No
Total Recoverable Cadmium	mg/kg dry wt	< 0.10 ± 0.066	-0.100 – 0.100	No
Total Recoverable Chromium	mg/kg dry wt	< 2 ± 1.3	-2.0 – 2.0	No
Total Recoverable Copper	mg/kg dry wt	< 2 ± 1.4	-2.0 – 2.0	No
Total Recoverable Lead	mg/kg dry wt	< 0.4 ± 0.26	-0.40 – 0.40	No
Total Recoverable Nickel	mg/kg dry wt	< 2 ± 1.4	-2.0 – 2.0	No
Total Recoverable Zinc	mg/kg dry wt	< 4 ± 2.7	-4.0 – 4.0	No

Digest Blank 2 PrepWS esDig - WS: High Volume Environmental Soils by ICP-MS (HVesTR): 9205.63

		Results	Control Limits	Outside Limit (Yes/No)
Total Recoverable Arsenic	mg/kg dry wt	< 2 ± 1.3	-2.0 – 2.0	No
Total Recoverable Cadmium	mg/kg dry wt	< 0.10 ± 0.066	-0.100 – 0.100	No
Total Recoverable Chromium	mg/kg dry wt	< 2 ± 1.3	-2.0 – 2.0	No
Total Recoverable Copper	mg/kg dry wt	< 2 ± 1.4	-2.0 – 2.0	No
Total Recoverable Lead	mg/kg dry wt	< 0.4 ± 0.26	-0.40 – 0.40	No
Total Recoverable Nickel	mg/kg dry wt	< 2 ± 1.4	-2.0 – 2.0	No
Total Recoverable Zinc	mg/kg dry wt	< 4 ± 2.7	-4.0 – 4.0	No

Digest Blank 1 PrepWS esDig - WS: High Volume Environmental Soils by ICP-MS (HVesTR): 9206.16

		Results	Control Limits	Outside Limit (Yes/No)
Total Recoverable Arsenic	mg/kg dry wt	< 2 ± 1.3	-2.0 – 2.0	No
Total Recoverable Cadmium	mg/kg dry wt	< 0.10 ± 0.066	-0.100 – 0.100	No
Total Recoverable Chromium	mg/kg dry wt	< 2 ± 1.3	-2.0 – 2.0	No
Total Recoverable Copper	mg/kg dry wt	< 2 ± 1.4	-2.0 – 2.0	No
Total Recoverable Lead	mg/kg dry wt	< 0.4 ± 0.26	-0.40 – 0.40	No
Total Recoverable Nickel	mg/kg dry wt	< 2 ± 1.4	-2.0 – 2.0	No
Total Recoverable Zinc	mg/kg dry wt	< 4 ± 2.7	-4.0 – 4.0	No

Digest Blank 2 PrepWS esDig - WS: High Volume Environmental Soils by ICP-MS (HVesTR): 9206.42				
		Results	Control Limits	Outside Limit (Yes/No)
Total Recoverable Arsenic	mg/kg dry wt	< 2 ± 1.3	-2.0 – 2.0	No
Total Recoverable Cadmium	mg/kg dry wt	< 0.10 ± 0.066	-0.100 – 0.100	No
Total Recoverable Chromium	mg/kg dry wt	< 2 ± 1.3	-2.0 – 2.0	No
Total Recoverable Copper	mg/kg dry wt	< 2 ± 1.4	-2.0 – 2.0	No
Total Recoverable Lead	mg/kg dry wt	< 0.4 ± 0.26	-0.40 – 0.40	No
Total Recoverable Nickel	mg/kg dry wt	< 2 ± 1.4	-2.0 – 2.0	No
Total Recoverable Zinc	mg/kg dry wt	< 4 ± 2.7	-4.0 – 4.0	No

Digest Blank 1 PrepWS esDig - WS: High Volume Environmental Soils by ICP-MS (HVesTR): 9207.16				
		Results	Control Limits	Outside Limit (Yes/No)
Total Recoverable Arsenic	mg/kg dry wt	< 2 ± 1.3	-2.0 – 2.0	No
Total Recoverable Cadmium	mg/kg dry wt	< 0.10 ± 0.066	-0.100 – 0.100	No
Total Recoverable Chromium	mg/kg dry wt	< 2 ± 1.3	-2.0 – 2.0	No
Total Recoverable Copper	mg/kg dry wt	< 2 ± 1.4	-2.0 – 2.0	No
Total Recoverable Lead	mg/kg dry wt	< 0.4 ± 0.26	-0.40 – 0.40	No
Total Recoverable Nickel	mg/kg dry wt	< 2 ± 1.4	-2.0 – 2.0	No
Total Recoverable Zinc	mg/kg dry wt	< 4 ± 2.7	-4.0 – 4.0	No

Digest Blank 2 PrepWS esDig - WS: High Volume Environmental Soils by ICP-MS (HVesTR): 9207.27				
		Results	Control Limits	Outside Limit (Yes/No)
Total Recoverable Arsenic	mg/kg dry wt	< 2 ± 1.3	-2.0 – 2.0	No
Total Recoverable Cadmium	mg/kg dry wt	< 0.10 ± 0.066	-0.100 – 0.100	No
Total Recoverable Chromium	mg/kg dry wt	< 2 ± 1.3	-2.0 – 2.0	No
Total Recoverable Copper	mg/kg dry wt	< 2 ± 1.4	-2.0 – 2.0	No
Total Recoverable Lead	mg/kg dry wt	< 0.4 ± 0.26	-0.40 – 0.40	No
Total Recoverable Nickel	mg/kg dry wt	< 2 ± 1.4	-2.0 – 2.0	No
Total Recoverable Zinc	mg/kg dry wt	< 4 ± 2.7	-4.0 – 4.0	No

50x Manual Dilution Digest Blank PrepWS esDig - WS: High Volume Environmental Soils by ICP-MS (HVesTR): 9207.69				
		Results	Control Limits	Outside Limit (Yes/No)
Total Recoverable Arsenic	mg/kg dry wt	< 2 ± 1.3	-2.0 – 2.0	No
Total Recoverable Cadmium	mg/kg dry wt	< 0.10 ± 0.066	-0.100 – 0.100	No
Total Recoverable Chromium	mg/kg dry wt	< 2 ± 1.3	-2.0 – 2.0	No
Total Recoverable Copper	mg/kg dry wt	< 2 ± 1.4	-2.0 – 2.0	No
Total Recoverable Lead	mg/kg dry wt	< 0.4 ± 0.26	-0.40 – 0.40	No
Total Recoverable Nickel	mg/kg dry wt	< 2 ± 1.4	-2.0 – 2.0	No
Total Recoverable Zinc	mg/kg dry wt	< 4 ± 2.7	-4.0 – 4.0	No

Blank 1 PrepWS xsSHOC - Organochlorine Pesticides Soil Analysis: 7568.1				
		Results	Control Limits	Outside Limit (Yes/No)
Aldrin	mg/kg dry wt	< 0.010 ± 0.0030	0.0 – 0.0100	No
alpha-BHC	mg/kg dry wt	< 0.010 ± 0.0030	0.0 – 0.0100	No
beta-BHC	mg/kg dry wt	< 0.010 ± 0.0028	0.0 – 0.0100	No
delta-BHC	mg/kg dry wt	< 0.010 ± 0.0029	0.0 – 0.0100	No
gamma-BHC (Lindane)	mg/kg dry wt	< 0.010 ± 0.0031	0.0 – 0.0100	No
cis-Chlordane	mg/kg dry wt	< 0.010 ± 0.0030	0.0 – 0.0100	No
trans-Chlordane	mg/kg dry wt	< 0.010 ± 0.0030	0.0 – 0.0100	No
2,4'-DDD	mg/kg dry wt	< 0.010 ± 0.0029	0.0 – 0.0100	No
4,4'-DDD	mg/kg dry wt	< 0.010 ± 0.0024	0.0 – 0.0100	No

Blank 1 PrepWS xsSHOC - Organochlorine Pesticides Soil Analysis: 7568.1				
		Results	Control Limits	Outside Limit (Yes/No)
2,4'-DDE	mg/kg dry wt	< 0.010 ± 0.0030	0.0 – 0.0100	No
4,4'-DDE	mg/kg dry wt	< 0.010 ± 0.0023	0.0 – 0.0100	No
2,4'-DDT	mg/kg dry wt	< 0.010 ± 0.0021	0.0 – 0.0100	No
4,4'-DDT	mg/kg dry wt	< 0.010 ± 0.0017	0.0 – 0.0100	No
Dieldrin	mg/kg dry wt	< 0.010 ± 0.0026	0.0 – 0.0100	No
Endosulfan I	mg/kg dry wt	< 0.010 ± 0.0029	0.0 – 0.0100	No
Endosulfan II	mg/kg dry wt	< 0.010 ± 0.0026	0.0 – 0.0100	No
Endosulfan sulphate	mg/kg dry wt	< 0.010 ± 0.0013	0.0 – 0.0100	No
Endrin	mg/kg dry wt	< 0.010 ± 0.00048	0.0 – 0.0100	No
Endrin aldehyde	mg/kg dry wt	< 0.010 ± 0.0025	0.0 – 0.0100	No
Endrin ketone	mg/kg dry wt	< 0.010 ± 0.0024	0.0 – 0.0100	No
Heptachlor	mg/kg dry wt	< 0.010 ± 0.0029	0.0 – 0.0100	No
Heptachlor epoxide	mg/kg dry wt	< 0.010 ± 0.0031	0.0 – 0.0100	No
Hexachlorobenzene	mg/kg dry wt	< 0.010 ± 0.0029	0.0 – 0.0100	No
Methoxychlor	mg/kg dry wt	< 0.010 ± 0.00048	0.0 – 0.0100	No

Digest Blank 1 PrepWS esDig - WS: High Volume Environmental Soils by ICP-MS (HVesTR): 9216.16				
		Results	Control Limits	Outside Limit (Yes/No)
Total Recoverable Arsenic	mg/kg dry wt	< 2 ± 1.3	-2.0 – 2.0	No
Total Recoverable Cadmium	mg/kg dry wt	< 0.10 ± 0.066	-0.100 – 0.100	No
Total Recoverable Chromium	mg/kg dry wt	< 2 ± 1.3	-2.0 – 2.0	No
Total Recoverable Copper	mg/kg dry wt	< 2 ± 1.4	-2.0 – 2.0	No
Total Recoverable Lead	mg/kg dry wt	< 0.4 ± 0.26	-0.40 – 0.40	No
Total Recoverable Nickel	mg/kg dry wt	< 2 ± 1.4	-2.0 – 2.0	No
Total Recoverable Zinc	mg/kg dry wt	< 4 ± 2.7	-4.0 – 4.0	No

Digest Blank 2 PrepWS esDig - WS: High Volume Environmental Soils by ICP-MS (HVesTR): 9216.39				
		Results	Control Limits	Outside Limit (Yes/No)
Total Recoverable Arsenic	mg/kg dry wt	< 2 ± 1.3	-2.0 – 2.0	No
Total Recoverable Cadmium	mg/kg dry wt	< 0.10 ± 0.066	-0.100 – 0.100	No
Total Recoverable Chromium	mg/kg dry wt	< 2 ± 1.3	-2.0 – 2.0	No
Total Recoverable Copper	mg/kg dry wt	< 2 ± 1.4	-2.0 – 2.0	No
Total Recoverable Lead	mg/kg dry wt	< 0.4 ± 0.26	-0.40 – 0.40	No
Total Recoverable Nickel	mg/kg dry wt	< 2 ± 1.4	-2.0 – 2.0	No
Total Recoverable Zinc	mg/kg dry wt	< 4 ± 2.7	-4.0 – 4.0	No

QC Spike QCs

LCS OC/PAH PrepWS xsSHOC - Organochlorine Pesticides Soil Analysis: 7568.2				
		Results	Control Limits	Outside Limit (Yes/No)
Aldrin	%	101 ± 31	86 – 115	No
alpha-BHC	%	92 ± 28	82 – 111	No
beta-BHC	%	90 ± 35	72 – 109	No
delta-BHC	%	94 ± 32	81 – 108	No
gamma-BHC (Lindane)	%	93 ± 27	81 – 110	No
cis-Chlordane	%	98 ± 32	84 – 114	No
trans-Chlordane	%	96 ± 29	80 – 115	No
2,4'-DDD	%	89 ± 33	85 – 116	No
4,4'-DDD	%	94 ± 46	88 – 122	No

LCS OC/PAH PrepWS xsSHOC - Organochlorine Pesticides Soil Analysis: 7568.2				
		Results	**Control Limits**	**Outside Limit (Yes/No)**
2,4'-DDE	%	87 ± 28	86 – 118	No
4,4'-DDE	%	92 ± 47	62 – 120	No
2,4'-DDT	%	87 ± 46	87 – 125	No
4,4'-DDT	%	88 ± 52	71 – 124	No
Dieldrin	%	104 ± 46	83 – 114	No
Endosulfan I	%	102 ± 37	85 – 116	No
Endosulfan II	%	93 ± 41	83 – 126	No
Endosulfan sulphate	%	95 ± 59	83 – 120	No
Endrin	%	99 ± 66	81 – 118	No
Endrin aldehyde	%	102 ± 58	81 – 115	No
Endrin ketone	%	90 ± 44	79 – 117	No
Heptachlor	%	95 ± 33	82 – 114	No
Heptachlor epoxide	%	99 ± 28	86 – 115	No
Hexachlorobenzene	%	102 ± 35	86 – 118	No
Methoxychlor	%	94 ± 63	76 – 128	No

Sample Spike QCs

Spike OC/PAH PrepWS xsSHOC - Organochlorine Pesticides Soil Analysis: 7568.10				
		Results	**Control Limits**	**Outside Limit (Yes/No)**
Aldrin	%	100 ± 31	85 – 118	No
alpha-BHC	%	113 ± 34	83 – 115	No
beta-BHC	%	94 ± 36	73 – 113	No
delta-BHC	%	116 ± 40	75 – 116	No
gamma-BHC (Lindane)	%	103 ± 29	80 – 113	No
cis-Chlordane	%	97 ± 32	82 – 117	No
trans-Chlordane	%	94 ± 29	80 – 120	No
2,4'-DDD	%	90 ± 33	84 – 119	No
4,4'-DDD	%	96 ± 47	87 – 125	No
2,4'-DDE	%	86 ± 28	84 – 118	No
4,4'-DDE	%	93 ± 47	68 – 123	No
2,4'-DDT	%	83 ± 44	85 – 126	**Yes**
4,4'-DDT	%	82 ± 48	72 – 123	No
Dieldrin	%	103 ± 46	82 – 116	No
Endosulfan I	%	100 ± 37	84 – 118	No
Endosulfan II	%	88 ± 39	77 – 118	No
Endosulfan sulphate	%	92 ± 58	79 – 125	No
Endrin	%	96 ± 64	80 – 121	No
Endrin aldehyde	%	102 ± 58	79 – 117	No
Endrin ketone	%	88 ± 43	76 – 119	No
Heptachlor	%	103 ± 36	82 – 119	No
Heptachlor epoxide	%	97 ± 28	83 – 116	No
Hexachlorobenzene	%	99 ± 34	84 – 121	No
Methoxychlor	%	94 ± 63	77 – 130	No

Reference Material QCs

QC A7 PrepWS esDig - WS: High Volume Environmental Soils by ICP-MS (HVesTR): 9205.17

		Results	Control Limits	Outside Limit (Yes/No)
Total Recoverable Arsenic	mg/kg dry wt	11.9 ± 2.2	9.4 – 13.9	No
Total Recoverable Lead	mg/kg dry wt	12.6 ± 2.0	10.0 – 14.8	No

QC A6 PrepWS esDig - WS: High Volume Environmental Soils by ICP-MS (HVesTR): 9205.19

		Results	Control Limits	Outside Limit (Yes/No)
Total Recoverable Arsenic	mg/kg dry wt	5.3 ± 1.6	4.2 – 6.1	No
Total Recoverable Cadmium	mg/kg dry wt	0.328 ± 0.080	0.25 – 0.37	No
Total Recoverable Chromium	mg/kg dry wt	9.5 ± 2.0	7.0 – 10.8	No
Total Recoverable Copper	mg/kg dry wt	12.9 ± 2.2	10.5 – 14.5	No
Total Recoverable Lead	mg/kg dry wt	22.6 ± 3.4	13.2 – 30	No
Total Recoverable Nickel	mg/kg dry wt	4.2 ± 1.5	2.8 – 5.1	No
Total Recoverable Zinc	mg/kg dry wt	63.6 ± 5.2	48 – 72	No

QC A6 PrepWS esDig - WS: High Volume Environmental Soils by ICP-MS (HVesTR): 9205.37

		Results	Control Limits	Outside Limit (Yes/No)
Total Recoverable Arsenic	mg/kg dry wt	5.4 ± 1.6	4.2 – 6.1	No
Total Recoverable Cadmium	mg/kg dry wt	0.313 ± 0.079	0.25 – 0.37	No
Total Recoverable Chromium	mg/kg dry wt	9.4 ± 2.0	7.0 – 10.8	No
Total Recoverable Copper	mg/kg dry wt	12.9 ± 2.2	10.5 – 14.5	No
Total Recoverable Lead	mg/kg dry wt	21.1 ± 3.2	13.2 – 30	No
Total Recoverable Nickel	mg/kg dry wt	4.1 ± 1.5	2.8 – 5.1	No
Total Recoverable Zinc	mg/kg dry wt	62.8 ± 5.2	48 – 72	No

QC A6 PrepWS esDig - WS: High Volume Environmental Soils by ICP-MS (HVesTR): 9205.68

		Results	Control Limits	Outside Limit (Yes/No)
Total Recoverable Arsenic	mg/kg dry wt	6.5 ± 1.7	4.2 – 6.1	**Yes** #1
Total Recoverable Cadmium	mg/kg dry wt	0.303 ± 0.078	0.25 – 0.37	No
Total Recoverable Chromium	mg/kg dry wt	10.3 ± 2.1	7.0 – 10.8	No
Total Recoverable Copper	mg/kg dry wt	13.9 ± 2.4	10.5 – 14.5	No
Total Recoverable Lead	mg/kg dry wt	21.3 ± 3.2	13.2 – 30	No
Total Recoverable Nickel	mg/kg dry wt	4.1 ± 1.5	2.8 – 5.1	No
Total Recoverable Zinc	mg/kg dry wt	64.9 ± 5.3	48 – 72	No

QC A7 PrepWS esDig - WS: High Volume Environmental Soils by ICP-MS (HVesTR): 9206.17

		Results	Control Limits	Outside Limit (Yes/No)
Total Recoverable Arsenic	mg/kg dry wt	11.5 ± 2.2	9.4 – 13.9	No
Total Recoverable Lead	mg/kg dry wt	12.2 ± 1.9	10.0 – 14.8	No

QC A6 PrepWS esDig - WS: High Volume Environmental Soils by ICP-MS (HVesTR): 9206.19

		Results	Control Limits	Outside Limit (Yes/No)
Total Recoverable Arsenic	mg/kg dry wt	5.6 ± 1.6	4.2 – 6.1	No
Total Recoverable Cadmium	mg/kg dry wt	0.297 ± 0.077	0.25 – 0.37	No
Total Recoverable Chromium	mg/kg dry wt	8.6 ± 1.9	7.0 – 10.8	No
Total Recoverable Copper	mg/kg dry wt	13.2 ± 2.3	10.5 – 14.5	No
Total Recoverable Lead	mg/kg dry wt	20.9 ± 3.2	13.2 – 30	No
Total Recoverable Nickel	mg/kg dry wt	4.1 ± 1.5	2.8 – 5.1	No
Total Recoverable Zinc	mg/kg dry wt	63.2 ± 5.2	48 – 72	No

QC A6 PrepWS esDig - WS: High Volume Environmental Soils by ICP-MS (HVesTR): 9206.46				
		Results	**Control Limits**	**Outside Limit (Yes/No)**
Total Recoverable Arsenic	mg/kg dry wt	5.4 ± 1.6	4.2 – 6.1	No
Total Recoverable Cadmium	mg/kg dry wt	0.317 ± 0.079	0.25 – 0.37	No
Total Recoverable Chromium	mg/kg dry wt	9.5 ± 2.0	7.0 – 10.8	No
Total Recoverable Copper	mg/kg dry wt	13.0 ± 2.2	10.5 – 14.5	No
Total Recoverable Lead	mg/kg dry wt	20.7 ± 3.2	13.2 – 30	No
Total Recoverable Nickel	mg/kg dry wt	4.2 ± 1.5	2.8 – 5.1	No
Total Recoverable Zinc	mg/kg dry wt	62.7 ± 5.2	48 – 72	No

QC A6 PrepWS esDig - WS: High Volume Environmental Soils by ICP-MS (HVesTR): 9206.66				
		Results	**Control Limits**	**Outside Limit (Yes/No)**
Total Recoverable Arsenic	mg/kg dry wt	5.0 ± 1.5	4.2 – 6.1	No
Total Recoverable Cadmium	mg/kg dry wt	0.327 ± 0.080	0.25 – 0.37	No
Total Recoverable Chromium	mg/kg dry wt	8.8 ± 1.9	7.0 – 10.8	No
Total Recoverable Copper	mg/kg dry wt	12.3 ± 2.2	10.5 – 14.5	No
Total Recoverable Lead	mg/kg dry wt	20.4 ± 3.1	13.2 – 30	No
Total Recoverable Nickel	mg/kg dry wt	6.0 ± 1.6	2.8 – 5.1	**Yes** [#1]
Total Recoverable Zinc	mg/kg dry wt	59.8 ± 5.0	48 – 72	No

QC A7 PrepWS esDig - WS: High Volume Environmental Soils by ICP-MS (HVesTR): 9207.17				
		Results	**Control Limits**	**Outside Limit (Yes/No)**
Total Recoverable Arsenic	mg/kg dry wt	11.1 ± 2.2	9.4 – 13.9	No
Total Recoverable Lead	mg/kg dry wt	11.4 ± 1.8	10.0 – 14.8	No

QC A6 PrepWS esDig - WS: High Volume Environmental Soils by ICP-MS (HVesTR): 9207.19				
		Results	**Control Limits**	**Outside Limit (Yes/No)**
Total Recoverable Arsenic	mg/kg dry wt	5.2 ± 1.6	4.2 – 6.1	No
Total Recoverable Cadmium	mg/kg dry wt	0.313 ± 0.079	0.25 – 0.37	No
Total Recoverable Chromium	mg/kg dry wt	8.4 ± 1.9	7.0 – 10.8	No
Total Recoverable Copper	mg/kg dry wt	12.3 ± 2.2	10.5 – 14.5	No
Total Recoverable Lead	mg/kg dry wt	19.9 ± 3.0	13.2 – 30	No
Total Recoverable Nickel	mg/kg dry wt	3.7 ± 1.4	2.8 – 5.1	No
Total Recoverable Zinc	mg/kg dry wt	59.7 ± 5.0	48 – 72	No

QC A6 PrepWS esDig - WS: High Volume Environmental Soils by ICP-MS (HVesTR): 9207.35				
		Results	**Control Limits**	**Outside Limit (Yes/No)**
Total Recoverable Arsenic	mg/kg dry wt	5.3 ± 1.6	4.2 – 6.1	No
Total Recoverable Cadmium	mg/kg dry wt	0.300 ± 0.078	0.25 – 0.37	No
Total Recoverable Chromium	mg/kg dry wt	8.4 ± 1.9	7.0 – 10.8	No
Total Recoverable Copper	mg/kg dry wt	12.9 ± 2.2	10.5 – 14.5	No
Total Recoverable Lead	mg/kg dry wt	19.8 ± 3.0	13.2 – 30	No
Total Recoverable Nickel	mg/kg dry wt	3.8 ± 1.4	2.8 – 5.1	No
Total Recoverable Zinc	mg/kg dry wt	57.5 ± 4.9	48 – 72	No

QC A6 PrepWS esDig - WS: High Volume Environmental Soils by ICP-MS (HVesTR): 9207.60				
		Results	**Control Limits**	**Outside Limit (Yes/No)**
Total Recoverable Arsenic	mg/kg dry wt	5.2 ± 1.6	4.2 – 6.1	No
Total Recoverable Cadmium	mg/kg dry wt	0.296 ± 0.077	0.25 – 0.37	No
Total Recoverable Chromium	mg/kg dry wt	8.9 ± 1.9	7.0 – 10.8	No
Total Recoverable Copper	mg/kg dry wt	12.7 ± 2.2	10.5 – 14.5	No
Total Recoverable Lead	mg/kg dry wt	22.7 ± 3.4	13.2 – 30	No

QC A6 PrepWS esDig - WS: High Volume Environmental Soils by ICP-MS (HVesTR): 9207.60				
		Results	**Control Limits**	**Outside Limit (Yes/No)**
Total Recoverable Nickel	mg/kg dry wt	3.6 ± 1.4	2.8 – 5.1	No
Total Recoverable Zinc	mg/kg dry wt	58.9 ± 5.0	48 – 72	No

QC A7 PrepWS esDig - WS: High Volume Environmental Soils by ICP-MS (HVesTR): 9207.70				
		Results	**Control Limits**	**Outside Limit (Yes/No)**
Total Recoverable Arsenic	mg/kg dry wt	10.7 ± 2.1	9.4 – 13.9	No
Total Recoverable Lead	mg/kg dry wt	11.0 ± 1.7	10.0 – 14.8	No

QC A6 PrepWS esDig - WS: High Volume Environmental Soils by ICP-MS (HVesTR): 9207.72				
		Results	**Control Limits**	**Outside Limit (Yes/No)**
Total Recoverable Arsenic	mg/kg dry wt	4.9 ± 1.5	4.2 – 6.1	No
Total Recoverable Cadmium	mg/kg dry wt	0.301 ± 0.078	0.25 – 0.37	No
Total Recoverable Chromium	mg/kg dry wt	8.1 ± 1.9	7.0 – 10.8	No
Total Recoverable Copper	mg/kg dry wt	12.1 ± 2.2	10.5 – 14.5	No
Total Recoverable Lead	mg/kg dry wt	19.4 ± 3.0	13.2 – 30	No
Total Recoverable Nickel	mg/kg dry wt	3.5 ± 1.4	2.8 – 5.1	No
Total Recoverable Zinc	mg/kg dry wt	57.0 ± 4.9	48 – 72	No

QC A7 PrepWS esDig - WS: High Volume Environmental Soils by ICP-MS (HVesTR): 9216.17				
		Results	**Control Limits**	**Outside Limit (Yes/No)**
Total Recoverable Arsenic	mg/kg dry wt	12.0 ± 2.3	9.4 – 13.9	No
Total Recoverable Lead	mg/kg dry wt	12.4 ± 1.9	10.0 – 14.8	No

QC A6 PrepWS esDig - WS: High Volume Environmental Soils by ICP-MS (HVesTR): 9216.19				
		Results	**Control Limits**	**Outside Limit (Yes/No)**
Total Recoverable Arsenic	mg/kg dry wt	6.9 ± 1.7	4.2 – 6.1	**Yes** [#1]
Total Recoverable Cadmium	mg/kg dry wt	0.296 ± 0.077	0.25 – 0.37	No
Total Recoverable Chromium	mg/kg dry wt	9.0 ± 2.0	7.0 – 10.8	No
Total Recoverable Copper	mg/kg dry wt	12.3 ± 2.2	10.5 – 14.5	No
Total Recoverable Lead	mg/kg dry wt	20.0 ± 3.0	13.2 – 30	No
Total Recoverable Nickel	mg/kg dry wt	3.9 ± 1.5	2.8 – 5.1	No
Total Recoverable Zinc	mg/kg dry wt	60.8 ± 5.1	48 – 72	No

QC A6 PrepWS esDig - WS: High Volume Environmental Soils by ICP-MS (HVesTR): 9216.46				
		Results	**Control Limits**	**Outside Limit (Yes/No)**
Total Recoverable Arsenic	mg/kg dry wt	5.1 ± 1.6	4.2 – 6.1	No
Total Recoverable Cadmium	mg/kg dry wt	0.331 ± 0.080	0.25 – 0.37	No
Total Recoverable Chromium	mg/kg dry wt	8.9 ± 1.9	7.0 – 10.8	No
Total Recoverable Copper	mg/kg dry wt	12.4 ± 2.2	10.5 – 14.5	No
Total Recoverable Lead	mg/kg dry wt	21.9 ± 3.3	13.2 – 30	No
Total Recoverable Nickel	mg/kg dry wt	3.5 ± 1.4	2.8 – 5.1	No
Total Recoverable Zinc	mg/kg dry wt	57.2 ± 4.9	48 – 72	No

QC A6 PrepWS esDig - WS: High Volume Environmental Soils by ICP-MS (HVesTR): 9216.50				
		Results	**Control Limits**	**Outside Limit (Yes/No)**
Total Recoverable Arsenic	mg/kg dry wt	5.3 ± 1.6	4.2 – 6.1	No
Total Recoverable Cadmium	mg/kg dry wt	0.330 ± 0.080	0.25 – 0.37	No
Total Recoverable Chromium	mg/kg dry wt	8.9 ± 1.9	7.0 – 10.8	No
Total Recoverable Copper	mg/kg dry wt	12.7 ± 2.2	10.5 – 14.5	No
Total Recoverable Lead	mg/kg dry wt	21.4 ± 3.3	13.2 – 30	No
Total Recoverable Nickel	mg/kg dry wt	3.9 ± 1.5	2.8 – 5.1	No

QC A6 PrepWS esDig - WS: High Volume Environmental Soils by ICP-MS (HVesTR): 9216.50				
		Results	**Control Limits**	**Outside Limit (Yes/No)**
Total Recoverable Zinc	mg/kg dry wt	59.9 ± 5.0	48 – 72	No

Analyst's Comments

[#1] The recovery for this analyte was outside the acceptable recovery range of the method. The corresponding sample result was accepted because the related recovery in the other QC material analysed was within the expected range.

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Certificate of Analysis

Client:	K8 Limited	**Lab No:**	3357326	SUPv1
Contact:	Dr B Keet	**Date Received:**	05-Sep-2023	
	C/- Geo & Hydro Limited	**Date Reported:**	08-Sep-2023	
	621 Marine Parade	**Quote No:**	72158	
	Napier South	**Order No:**		
	Napier 4110	**Client Reference:**	GRPS-4	
		Submitted By:	Dr B Keet	

Sample Type: Soil

		Sample Name:	GRPS-4-A3	GRPS-4-B5	GRPS-4-C2	GRPS-4-E1
		Lab Number:	3357326.1	3357326.2	3357326.3	3357326.4
Heavy Metals, Screen Level						
Total Recoverable Arsenic	mg/kg dry wt		4.1 ± 1.5	3.8 ± 1.5	< 4 ± 1.5	5.2 ± 1.6
Total Recoverable Cadmium	mg/kg dry wt		0.354 ± 0.082	0.427 ± 0.088	0.386 ± 0.085	0.236 ± 0.073
Total Recoverable Chromium	mg/kg dry wt		13.5 ± 2.5	13.1 ± 2.5	8.2 ± 1.9	14.9 ± 2.7
Total Recoverable Copper	mg/kg dry wt		6.2 ± 1.6	5.5 ± 1.6	8.5 ± 1.8	13.6 ± 2.3
Total Recoverable Lead	mg/kg dry wt		16.9 ± 2.6	22.0 ± 3.4	30.4 ± 4.6	74 ± 12
Total Recoverable Nickel	mg/kg dry wt		6.9 ± 1.6	5.7 ± 1.5	3.9 ± 1.4	6.9 ± 1.6
Total Recoverable Zinc	mg/kg dry wt		40.0 ± 3.9	44.2 ± 4.1	81.1 ± 6.3	66.2 ± 5.4

		Sample Name:	GRPS-4-F2	GRPS-4-G4	GRPS-4-T3	GRPS-4-T5
		Lab Number:	3357326.5	3357326.6	3357326.7	3357326.8
Heavy Metals, Screen Level						
Total Recoverable Arsenic	mg/kg dry wt		5.9 ± 1.6	6.2 ± 1.6	11.8 ± 2.2	8.4 ± 1.9
Total Recoverable Cadmium	mg/kg dry wt		0.393 ± 0.085	1.09 ± 0.17	1.19 ± 0.18	2.66 ± 0.38
Total Recoverable Chromium	mg/kg dry wt		15.2 ± 2.7	15.7 ± 2.8	27.2 ± 4.5	16.4 ± 2.9
Total Recoverable Copper	mg/kg dry wt		39.1 ± 5.5	27.3 ± 4.0	281 ± 39	77 ± 11
Total Recoverable Lead	mg/kg dry wt		391 ± 59	255 ± 39	1,070 ± 160	1,030 ± 160
Total Recoverable Nickel	mg/kg dry wt		13.1 ± 2.2	10.7 ± 1.9	19.5 ± 2.9	14.2 ± 2.3
Total Recoverable Zinc	mg/kg dry wt		138 ± 11	343 ± 25	1,342 ± 95	704 ± 50

		Sample Name:	Composite of GRPS-4-A5, GRPS-4-B1, GRPS-4-E3 & GRPS-4-F1	Composite of GRPS-4-T2, GRPS-4-T6, GRPS-4-T9 & GRPS-4-T12
		Lab Number:	3357326.17	3357326.18
Individual Tests				
Dry Matter	g/100g as rcvd		54.5 ± 5.0	70.0 ± 5.0
Organochlorine Pesticides Screening in Soil				
Aldrin	mg/kg dry wt		< 0.018 ± 0.0061	< 0.014 ± 0.0052
alpha-BHC	mg/kg dry wt		< 0.018 ± 0.0061	< 0.014 ± 0.0052
beta-BHC	mg/kg dry wt		< 0.018 ± 0.0072	< 0.014 ± 0.0060
delta-BHC	mg/kg dry wt		< 0.018 ± 0.0067	< 0.014 ± 0.0056
gamma-BHC (Lindane)	mg/kg dry wt		< 0.018 ± 0.0058	< 0.014 ± 0.0050
cis-Chlordane	mg/kg dry wt		< 0.018 ± 0.0064	< 0.014 ± 0.0054
trans-Chlordane	mg/kg dry wt		< 0.018 ± 0.0061	< 0.014 ± 0.0052
2,4'-DDD	mg/kg dry wt		< 0.018 ± 0.0069	< 0.014 ± 0.0058
4,4'-DDD	mg/kg dry wt		< 0.018 ± 0.0068	< 0.014 ± 0.0071
2,4'-DDE	mg/kg dry wt		< 0.018 ± 0.0064	< 0.014 ± 0.0054
4,4'-DDE	mg/kg dry wt		0.037 ± 0.019	< 0.014 ± 0.0073
2,4'-DDT	mg/kg dry wt		< 0.018 ± 0.0094	< 0.014 ± 0.0076
4,4'-DDT	mg/kg dry wt		< 0.018 ± 0.011	< 0.014 ± 0.0083
Total DDT Isomers	mg/kg dry wt		< 0.11 ± 0.027	< 0.09 ± 0.017
Dieldrin	mg/kg dry wt		< 0.018 ± 0.0081	< 0.014 ± 0.0067

Sample Type: Soil			
	Sample Name:	Composite of GRPS-4-A5, GRPS-4-B1, GRPS-4-E3 & GRPS-4-F1	Composite of GRPS-4-T2, GRPS-4-T6, GRPS-4-T9 & GRPS-4-T12
	Lab Number:	3357326.17	3357326.18
Organochlorine Pesticides Screening in Soil			
Endosulfan I	mg/kg dry wt	< 0.018 ± 0.0069	< 0.014 ± 0.0058
Endosulfan II	mg/kg dry wt	< 0.018 ± 0.0081	< 0.014 ± 0.0067
Endosulfan sulphate	mg/kg dry wt	< 0.018 ± 0.011	< 0.014 ± 0.0087
Endrin	mg/kg dry wt	< 0.018 ± 0.012	< 0.014 ± 0.0092
Endrin aldehyde	mg/kg dry wt	< 0.018 ± 0.010	< 0.014 ± 0.0080
Endrin ketone	mg/kg dry wt	< 0.018 ± 0.0088	< 0.014 ± 0.0071
Heptachlor	mg/kg dry wt	< 0.018 ± 0.0067	< 0.014 ± 0.0056
Heptachlor epoxide	mg/kg dry wt	< 0.018 ± 0.0058	< 0.014 ± 0.0050
Hexachlorobenzene	mg/kg dry wt	< 0.018 ± 0.0067	< 0.014 ± 0.0056
Methoxychlor	mg/kg dry wt	< 0.018 ± 0.012	< 0.014 ± 0.0092

The reported uncertainty is an expanded uncertainty with a level of confidence of approximately 95 percent (i.e. two standard deviations, calculated using a coverage factor of 2). Reported uncertainties are calculated from the performance of typical matrices, and do not include variation due to sampling.

For further information on uncertainty of measurement at Hill Laboratories, refer to the technical note on our website: www.hill-laboratories.com/files/Intro_To_UOM.pdf, or contact the laboratory.

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 simple 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. A detection limit range indicates the lowest and highest detection limits in the associated suite of analytes. A full listing of compounds and detection limits are available from the laboratory upon request. Unless otherwise indicated, analyses were performed at Hill Labs, 28 Duke Street, Frankton, Hamilton 3204.

Sample Type: Soil			
Test	**Method Description**	**Default Detection Limit**	**Sample No**
Environmental Solids Sample Drying*	Air dried at 35°C Used for sample preparation. May contain a residual moisture content of 2-5%.	-	1-8
Heavy Metals, Screen Level	Dried sample, < 2mm fraction. Nitric/Hydrochloric acid digestion US EPA 200.2. Complies with NES Regulations. ICP-MS screen level, interference removal by Kinetic Energy Discrimination if required.	0.10 - 4 mg/kg dry wt	1-8
Organochlorine Pesticides Screening in Soil	Sonication extraction, GC-ECD analysis. Tested on as received sample. In-house based on US EPA 8081.	0.010 - 0.06 mg/kg dry wt	17-18
Dry Matter	Dried at 103°C for 4-22hr (removes 3-5% more water than air dry) , gravimetry. (Free water removed before analysis, non-soil objects such as sticks, leaves, grass and stones also removed). US EPA 3550.	0.10 g/100g as rcvd	17-18
Composite Environmental Solid Samples*	Individual sample fractions mixed together to form a composite fraction.	-	9-16

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

Testing was completed between 05-Sep-2023 and 08-Sep-2023. For completion dates of individual analyses please contact the laboratory.

Samples are held at the laboratory after reporting for a length of time based on the stability of the samples and analytes being tested (considering any preservation used), and the storage space available. Once the storage period is completed, the samples are discarded unless otherwise agreed with the customer. Extended storage times may incur additional charges.

Ara Heron BSc (Tech)
Client Services Manager - Environmental

R J H ll Laborator es L m ted
Ground Fl 28 Heather Street
Parnell
Auckland 1052 New Zealand

0508 HILL LAB (44 555 22)
+64 7 858 2000
ma l@h ll-labs.co.nz
www.hill-labs.co.nz

Certificate of Analysis

Client:	Geo & Hydro Limited	**Lab No:**	3358054	A2Pv1
Contact:	Dr B Keet	**Date Received:**	05-Sep-2023	
	C/- Geo & Hydro Limited	**Date Reported:**	07-Sep-2023	
	621 Marine Parade	**Quote No:**	72158	
	Napier South	**Order No:**		
	Napier 4110	**Client Reference:**	GRPS-4-ASB	
		Submitted By:	Dr B Keet	

Sample Type: Soil

Sample Name	Lab Number	As Received Weight Presence / Absence Testing (g)	Dry Weight Presence / Absence Testing (g)	<2mm Subsample Weight Presence / Absence Testing (g dry wt)	Asbestos Presence / Absence from Presence / Absence Testing	Description of Asbestos Form Presence / Absence Testing
GRPS-4-ASB-G1	3358054.1	163.5	106.0	57.9	Asbestos NOT detected.	-
GRPS-4-ASB-G2	3358054.2	110.7	56.4	26.2	Asbestos NOT detected.	-
GRPS-4-ASB-T4	3358054.3	80.8	56.6	19.0	Asbestos NOT detected.	-
GRPS-4-ASB-T7	3358054.4	113.2	69.9	27.1	Asbestos NOT detected.	-

Glossary of Terms

- Loose fibres (Minor) - One or two f bres/fibre bundles identified during analysis by stereo microscope/PLM.
- Loose f bres (Major) - Three or more fibres/fibre bundles identified during analysis by stereo microscope/PLM.
- ACM Debris (Minor) - One or two small (<2mm) pieces of material attached to f bres identified during analysis by stereo microscope/PLM.
- ACM Debris (Major) - Large (>2mm) piece, or more than three small (<2mm) pieces of material attached to f bres identified during analysis by stereo microscope/PLM.
- Unknown Mineral Fibres - Mineral fibres of unknown type detected by polarised light microscopy including dispersion staining. The fibres detected may or may not be asbestos fibres. To confirm the identities, another independent analytical technique may be required.
- Trace - Trace levels of asbestos, as defined by AS4964-2004.

For further details, please contact the Asbestos Team.

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 simple 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. A detection limit range indicates the lowest and highest detection limits in the associated suite of analytes. A full listing of compounds and detection limits are available from the laboratory upon request. Unless otherwise indicated, analyses were performed at Hill Labs, 28 Duke Street, Frankton, Hamilton 3204.

Sample Type: Soil

Test	Method Description	Default Detection Limit	Sample No
Asbestos in Soil			
As Received Weight Presence / Absence Testing	Measurement on analytical balance. Analysed at Hill Laboratories - Asbestos; 28 Heather Street, Auckland.	0.1 g	1-4
Dry Weight Presence / Absence Testing	Sample dried at 100 to 105°C, measurement on balance. Analysed at Hill Laboratories - Asbestos; 28 Heather Street, Auckland.	0.1 g	1-4
<2mm Subsample Weight Presence / Absence Testing	Sample ashed at 400°C, weight of <2mm sample fraction taken for asbestos identification if less than entire fraction. Analysed at Hill Laboratories - Asbestos; 28 Heather Street, Auckland.	-	1-4
Asbestos Presence / Absence from Presence / Absence Testing	Examination using Low Powered Stereomicroscopy followed by 'Polarised Light Microscopy' including 'Dispersion Staining Techniques'. Analysed at Hill Laboratories - Asbestos; 28 Heather Street, Auckland. AS 4964 (2004) - Method for the Qualitative Identification of Asbestos in Bulk Samples.	0.01%	1-4
Description of Asbestos Form Presence / Absence Testing	Description of asbestos form and/or shape if present. Analysed at Hill Laboratories - Asbestos; 28 Heather Street, Auckland.	-	1-4

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

Testing was completed on 07-Sep-2023. For completion dates of individual analyses please contact the laboratory.

Samples are held at the laboratory after reporting for a length of time based on the stability of the samples and analytes being tested (considering any preservation used), and the storage space available. Once the storage period is completed, the samples are discarded unless otherwise agreed with the customer. Extended storage times may incur additional charges.

This certificate of analysis must not be reproduced, except in full, without the written consent of the signatory.

Alexa Badenhorst BSc (Hons)
Team Leader - Asbestos

Hill Laboratories
TRIED, TESTED AND TRUSTED

ANALYSIS REQUEST

R J Hill Laboratories Limited
28 Duke Street, Hamilton 3204
Private Bag 3205
Hamilton 3240, New Zealand

T 0508 HILL LAB (44 555 22)
T +64 7 858 2000
E mail@hill-labs.co.nz
W www.hill-laboratories.com

Job No: **335 8054**

Date Recv: 05-Sep-23 16:07

Received by: Lya Avila

3133580548

Quote No

Primary Contact Drs. Ben Keet

Submitted By Drs Ben Keet

Client Name Geo & Hydro - K8 Ltd

Address 621 Marine Parade

Napier *Postcode* 4110

Phone 021 117 1148 *Mobile* 021 117 1148

Email ben@benkeet.com

Charge To K8 Ltd

Client Reference GRPS-4-ASB

Order No

Results To *Reports will be emailed to Primary Contact by default. Additional Reports will be sent as specified below.*

☑ *Email Primary Contact* ☐ *Email Submitter* ☐ *Email Client*

☐ *Email Other*

☐ *Other*

ADDITIONAL INFORMATION

CHAIN OF CUSTODY RECORD

Sent to Hill Laboratories

Date & Time: 1-9-2023 - 13.05

Name: B Keet

☑ *Tick if you require COC to be emailed back*

Signature:

Received at Hill Laboratories

Date & Time:

Name:

Signature:

Condition Temp:

☐ *Room Temp* ☐ *Chilled* ☐ *Frozen*

☐ *Sample and Analysis details checked*

Signature:

Priority ☐ **Low** ☐ **Normal** ☑ **High**

☐ **Urgent** (ASAP, extra charge applies, please contact lab first)

Requested Reporting Date:

No.	Sample Name	Sample Date	Sample Time	Sample Type	Tests Required (if not as per Quote)
1	GRPS-4-ASB-G1			ES	ASB presence - absence
2	GRPS-4-ASB-G2			ES	ASB presence - absence
3	GRPS-4-ASB-T4			ES	ASB presence - absence
4	GRPS-4-ASB-T7			ES	ASB presence - absence
5					
6					
7					
8					
9					
10					
11					
12					

Continued on next page

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mail@hill-labs.co.nz
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Job Information Summary

Client:	Geo & Hydro Limited	**Lab No:**	3358054
Contact	Dr B Keet	**Date Registered:**	06-Sep-2023 12:06 pm
	C/- Geo & Hydro Limited	**Priority:**	Normal
	621 Marine Parade	**Quote No:**	72158
	Napier South	**Order No:**	
	Napier 4110	**Client Reference:**	GRPS-4-ASB
		Add. Client Ref:	
		Submitted By:	Dr B Keet
		Charge To:	K8 Limited
		Target Date:	07-Sep-2023 4:30 pm

Samples

No	Sample Name	Sample Type	Containers	Tests Requested
1	GRPS 4 ASB G1	Soil	PSoil125Asb	Asbestos in Soil
2	GRPS-4-ASB-G2	Soil	PSoil125Asb	Asbestos in Soil
3	GRPS 4 ASB T4	Soil	PSoil125Asb	Asbestos in Soil
4	GRPS-4-ASB-T7	Soil	PSoil125Asb	Asbestos in Soil

Summary of Methods

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<2mm Subsample Weight Presence / Absence Testing	Sample ashed at 400°C, weight of <2mm sample fraction taken for asbestos identification if less than entire fraction. Analysed at Hill Laboratories - Asbestos; 28 Heather Street, Auckland.	-	1-4
Asbestos Presence / Absence from Presence / Absence Testing	Examination using Low Powered Stereomicroscopy followed by 'Polarised Light Microscopy' including 'Dispersion Staining Techniques'. Analysed at Hill Laboratories - Asbestos; 28 Heather Street, Auckland. AS 4964 (2004) - Method for the Qualitative Identification of Asbestos in Bulk Samples.	0.01%	1-4
Description of Asbestos Form Presence / Absence Testing	Description of asbestos form and/or shape if present. Analysed at Hill Laboratories - Asbestos; 28 Heather Street, Auckland.	-	1-4