Ground Contamination Assessment: Detailed Site Investigation

59-93 Tosswill Road and 92 Hodgens Road, Prebbleton

Prepared for Suburban Estates Ltd

437433

Eliot Sinclair

surveyors | engineers | planners

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Quality Control Certificate

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Status:	Final		
Release Date:	30 July 2019		
Reference No:	437433		
Distributed to:	Suburban Estates Ltd Selwyn District Council Canterbury Regional Council Eliot Sinclair & Partners (file copy)		

Limitations
This report has been prepared for Suburban Estates Ltd according to their instructions and for the particular objectives described in this report. The information contained in this report should not be used by anyone else or for any other purposes.

Contents

Appendices

Executive Summary

Table 1: Tabulated summary of the Detailed Site Investigation of land at 59-93 Tosswill Road and 92 Hodgens Road, Prebbleton.

Site Address	59-93 Tosswill Road and 92 Hodgens Road, Prebbleton
Legal Description	Lot 2 (12.7470 ha), Lot 5 (4.4658 ha) (DP numbers are not available yet). Refer to Appendix A.
Resource consent	SDC RC195093 (Subdivision by way of boundary adjustment)
Owner	Sparr Developments Ltd (at the time of reporting)
Local authority	Selwyn District Council
Proposed activity	Residential subdivision (approx. 102 residential lots, roads, utility and recreational reserves), development-related earthworks
Adopted NESCS land-use scenarios	*Residential (10% produce consumption)* for residential allotments *Recreational* for recreational and utility reserve areas
Previous reporting	Eliot Sinclair & Partners 2019. Ground Contamination Assessment: Preliminary Site Investigation (PSI), prepared for Sparr Developments Ltd. February 2019. 35pp.
Areas of concern identified in PSI	**Area 1:** Historical stockyards with possible spray race operations and farm sheds with possible storage/mixing/rinsing of farm chemicals (HAIL A8, A10, I). **Area 2:** Possibly broad-acre elevated concentrations of trace elements (no HAIL).
Soil investigations	**Methodology:** Trace element concentrations from 33 XRF records across the site. 15 of the 33 records are from Area 1. 18 records are from Area 2. Trace element and pesticide screen concentrations from seven soil samples analysed by an accredited laboratory. Discounting an outlier, the relative percent difference between XRF and laboratory-analysed samples is 10.6%. **Results Area 1:** Most trace element concentrations are elevated above the natural background of *YGE: Regional* soil. However, all concentrations were below the applicable NESCS standards for residential and recreational land-use, respectively. Sampling sites 3.1 and 3.3 recorded As and/or Pb concentrations above NESCS standards for residential land-use but significantly below standards for recreational land-use. The pesticide screen recorded negligible traces (0.1mg/kg) DDT and its breakdown products that are well below the NESCS contaminant standard for residential land-use (70mg/kg). **Results Area 2:** Trace element concentrations are generally lower than in Area 1. However, all analysed samples recorded one or several analytes above the natural background concentrations of *YGE: Regional* soil. All analysed concentrations are significantly below the applicable NESCS contaminant standard for residential and recreational land-use, respectively.
Conclusions	Within the limits of the accidental discovery protocol (refer to Section 6), the investigated site history and analysed soil samples indicate that these areas are suitable for the residential and recreational land-use indicated on site plan in Figure 2 (Appendix A). The investigations indicate that any adverse effects or risks to people and/or the environment are considered to be so low as to be acceptable. The development is considered a controlled activity under Regulation 9(1)(b) of the NESCS.
Recommendations	1. If soil is removed from the site, it shall be confirmed that trace element concentrations in the removed material comply with the acceptance criteria of the facility authorised to accept the material. 2. Sampling sites 3.1 and 3.3 (as shown in Appendix B) shall be in a reserve area. If sites 3.1 and 3.3 are in a residential area, topsoil shall be remediated, and validation samples shall show that trace element concentrations are at or below NESCS standards for residential land-use. 3. Cross-contamination, e.g. by tracking soil from sampling sites 3.1-3.6 in Area 1 (as shown in Appendix A and Appendix B) across the balance of the site shall be avoided.

1 Introduction

Suburban Estates Ltd has engaged Eliot Sinclair to undertake a Detailed Site Investigation of land at 59-93 Tosswill Road and 92 Hodgens Road in Prebbleton, Canterbury.

The legal description of the site is Lot 2 (12.747 ha), and Lot 5 (4.4658 ha) as shown on the proposed subdivision plan and a residential development scheme plan attached in Appendix A[1].

It is proposed to develop approximately 102 residential allotments, roads, and a large stormwater management recreational reserve. The proposed development requires a contamination assessment under the regulations of the NESCS[2] because HAIL[3] activities were identified in the area.

2 Scope of Work

The scope of work was to undertake a Detailed Site Investigation in accordance with MfE's Contaminated Land Management Guidelines (CLMG)[4] and the NESCS. This includes:

- Summarising the results and recommendations of a Preliminary Site Investigation[5] (PSI).
- Conducting a stratified systematic soil-sampling programme in areas where potential HAIL activities have been identified, and to establish contaminant concentrations in topsoil across the site.
- Compare the analytical results with natural background concentrations, NESCS soil contaminant standards for residential and recreational land-use, and to Burwood Landfill acceptance criteria.
- Compile the results in accordance with the requirements of the CLMG, assess the results, provide recommendations and discuss further requirements.

[1] DP numbers are not available at the time of reporting and will be assigned in due course.

[2] Resource Management (National Environmental Standard for Assessing and Managing Contaminants in Soil to Protect Human Health) Regulations 2011 (NESCS)

[3] Ministry for the Environment 2011. Hazardous Activities and Industries List (HAIL). http://www.mfe.govt.nz/land/hazardous-activities-and-industries-list-hail

[4] Ministry for the Environment (MfE) 2011. Contaminated Land Management Guidelines (CLMG) Volumes 1 and 5.

[5] Eliot Sinclair & Partners 2019. Ground Contamination Assessment: Preliminary Site Investigation, 59-93 Tosswill Road and 92 Hodgens Road, Prebbleton. Issued 25 Feb. 2019. 35pp.

3 Site Investigations

3.1 Summary of previous investigations

The site is on land for which a Preliminary Site Investigation (PSI) has recently been undertaken. The investigation identified two areas of concern, which are shown on the site plan in Appendix A:

Area 1: Historical stockyards with possible spray race operations (HAIL A8) and farm sheds (HAIL I) (located in the central area near the northwestern boundary). The stockyard was identified on aerial images from the 1960s and 1970s. Several farm sheds were located to the southeast of the stockyard since pre 1940s until the early 2000s. All but one of the sheds were removed in the early 2000s.

Area 2: The balance of the site, which has been farmed (mainly cropped) for 80+ years. Recent investigations in Canterbury showed broad-acre elevated concentrations of trace elements above NESCS standards for residential land-use without identified HAIL activities (Malloch Environmental 2018)[6].

The PSI recommended investigating trace element concentrations across the balance of the site to confirm that contaminant concentrations are below the applicable NESCS standards, and to inform soil disposal options.

3.2 Sampling plan and methodology

The two areas of concern (Area 1 and Area 2) were investigated with a stratified systematic sampling regime[7] on 7 March 2019.

Area 1 (stockyard and farm sheds): Soil samples were taken along two transects in the stockyard area (three samples per transect) and along three transects in the area previously occupied by farm sheds (three samples per transect). This resulted in a total of 15 samples from the area near the central northwestern boundary of the site.

Area 2 (balance of the site): 18 soil samples were taken along three transects in the area with proposed residential lots (four samples from transect 1, five samples from transects 2 and 3). In addition, five samples were taken from the future stormwater management area.

The 33 samples were delivered to Davis Ogilvie & Partners, and trace element concentrations were recorded with an X-Ray analyser from each of the samples. In addition, every fifth sample (7 out of 33) was analysed by an accredited laboratory for trace elements and organochlorine pesticides.

The investigated areas, corresponding HAIL activities, sampling rationale and analytes are listed below in Table 2. The sampling locations are shown on a soil sample location plan in Appendix B.

[6] Malloch Environmental 2018. Arsenic bioavailability and Tier 2 Risk Assessment – A Case Study. Presentation at the WasteMINZ Conference + Expo 2018, 5-8 November 2018, Christchurch.

[7] MfE 2011. Contaminated Land Management Guidelines No. 5. Site Investigation and Analysis of Soils (Revised 2011): p. 15.

Table 2: Areas of concern, identified HAIL activities, sampling methodology and analytes.

Areas of Concern	Contaminants of Concern and Sampling Methodology	Sample IDs Analytes
Area 1 (HAIL A8/10) farm sheds (HAIL I) and stockyards	Contaminants of concern in stockyards with possible spray race and associated farm sheds where chemicals might have been mixed and stored are trace elements (arsenic and heavy metals) and organochlorine pesticides in near-surface soils. **Farm sheds**: Nine samples (3.1 to 3.9) from three transects (three samples per transect). **Stock yards**: Six samples (3.10-3.15) from two transects (three samples per transect). Two of the samples (3.14 and 3.15) are from a stockpile in the area. The future land-use in most of this area will be recreational. Refer to Figure 2 in Appendix A.	HMs, OCPs (pesticides screen) 15 XRF records (trace elements) 3 laboratory analyses (trace elements and OCPs
Area 2 (no HAIL) Balance of the site	Contaminants of concern are trace elements and organochlorine pesticides in near-surface soils. **Broad-acre:** 18 samples of near-surface soil from the balance of the site where the site history indicates 80+ years of mainly cropping. 13 samples are from proposed residential lots, 5 samples (16-20) from utility/recreational reserve.	HMs, OCPs (pesticides screen) 18 XRF records (trace elements) 4 laboratory analyses (trace elements and OCPs

3.3 Field Quality Assurance and Quality Control (QA/QC)

The fieldwork was conducted in accordance with MfE's Contaminated Land Management Guidelines (CLMG) No. 5[8], and followed a uniform and systematic approach comprising the following procedures:

- Decontamination: Wiping residual soil from the soil sampling equipment after each sample, and then rinsing with pressurised deionized water, before collecting any new soil samples.
- Sample ID procedures: Soil samples were immediately transferred to a sealed laboratory-supplied glass jar. Soil samples for XRF analysis were transferred to zip-lock low density polyethylene (LDPE) bags. Each sample was labelled with a permanent marker stating sample ID, date, time, sampling depth and ESP reference number. The soil samples for laboratory and XRF analysis were transferred to a chilly bin and couriered to the respective laboratories.
- Chain of Custody (CoC): A chain of custody form is completed for each batch of samples.

3.4 Laboratory Quality Assurance and Quality Control (QA/QC)

The samples collected by Eliot Sinclair & Partners (ESP) were analysed by Analytica Laboratories Ltd. Analytica are accredited by International Accreditation New Zealand (IANZ), which represents New Zealand in the International Laboratory Accreditation Cooperation (ILAC). Through the ILAC Mutual Recognition Arrangement (ILAC-MRA) this accreditation is internationally recognised. The tests reported herein have been performed in accordance with the terms of Analytica's accreditation.

Analytica performed a duplicate analysis of trace elements on sample 3.11. The duplicate results passed internal QC procedures.

[8] Ministry for the Environment (MfE) 2011. Contaminated Land Management Guidelines No. 5. Site Investigation and Analysis of Soils (Revised 2011).

3.5 ESP Quality Assurance/Quality Control Data Evaluation

The soil analytical results in this report have been examined for consistency, taking into account the site history, field observations and experience from other greenfield developments.

The soil test results are consistent with the range of expected low concentrations in greenfield developments without history of HAIL activities, and slightly higher concentrations of trace elements in areas of farm sheds and stockyards. No outliers were detected in the laboratory soil test results.

Relative percent differences of laboratory vs. XRF results were calculated for seven samples with the formula provided in CLMG no. 5 (p. 30). The results table is attached in Appendix C (Table 6). The overall calculated percent difference of soil samples analysed by an accredited laboratory vs. XRF records is 15.8%. This is significantly below the acceptable relative percent difference for split samples of 30-50%. The average is skewed by an outlier (41.8%) near the instrument's Limit of Detection (LOD) for chromium in sample 3.3; all other chromium concentrations were below the LOD. Without the outlier the relative percent difference is 10.6%. All samples taken for XRF records comprised fine-grained dry soil, which are expected to give more reliable XRF readings than coarse-grained wet samples.

Based on the above, the XRF records are considered to have a high level of accuracy, particularly the concentrations for arsenic, copper, lead and zinc.

3.6 Basis for guideline values

Based on the proposed residential land-use, the NESCS soil contaminant standards for residential land-use (10% produce consumption) were adopted for residential areas. NESCS standards for recreational land-use were adopted for the stormwater utility reserve and for recreational reserve areas.

To assess soil disposal options the contaminant concentrations were compared to Burwood Landfill acceptance criteria.

Natural background concentrations of *Yellow Grey Earth: Regional* soils are sourced from Environment Canterbury's GIS[9].

3.7 Results and discussion

The results are summarised and discussed in Table 3 below. Trace element concentrations from the soil laboratory analytical results and the XRF records are summarised in colour-coded tables in Table 4 in Appendix C.

Copies of the soil laboratory reports with trace elements and OCP (pesticide screen) analyses are also attached in Appendix C.

Photos from the site investigation are attached in Appendix D.

[9] https://mapviewer.canterburymaps.govt.nz/

Table 3: Areas of concern, sampling methodology and analytes.

Areas of Concern	Soil analytical results, discussion and conclusion	Conclusion
Area 1 (HAIL A8/10/I) farm sheds and stockyards	Most trace element concentrations in the area of the historical farm sheds and the stockyard area are elevated above the natural background of *Yellow Grey Earth (YGE): Regional*. However, all XRF records and soil laboratory results show trace element concentrations below the applicable NESCS soil contaminant standards for residential and recreational land-use, respectively. Samples 3.1 and 3.3 recorded As and/or Pb concentrations above NESCS standards for residential land-use, but below standards for recreational land-use. The pesticide screen recorded negligible traces (0.1mg/kg) DDT and its breakdown products that are well below the NESCS contaminant standard for residential land-use of 70mg/kg.	All analytes below the applicable standards: below recreational standards in reserve areas and below residential standards in residential areas
Area 2 (no HAIL) Balance of the site	Trace element concentrations on the balance of the site are generally lower than in the area of the historical stockyard and farm sheds. However, all analysed samples recorded one or several analytes above the natural background concentrations of *Yellow Grey Earth (YGE): Regional*. All analysed concentrations are significantly below the NESCS contaminant standard for all NESCS land-use scenarios.	All analytes below NESCS standards for all land-use scenarios

4 Conclusions

Based on our review of historical records and our site investigation, we have identified two areas of concern that warranted detailed investigation. Our stratified systematic soil investigations included XRF records of trace elements from 33 locations. In addition, every fifth sample was analysed by an accredited soil laboratory and a pesticide screen was performed on three samples from the historical stockyard area. This was conducted as a cross-check of the XRF results to accredited laboratory results. All samples recorded trace element concentrations below the applicable NESCS standards for residential land-use (10% produce consumption), and recreational land-use, respectively.

Samples 3.1-3.5, taken from a future reserve area, recorded lead and/or arsenic concentrations above the NESCS standard for residential land-use, but below contaminant standards for recreational land-use. The pesticide screen recorded negligible concentrations[10] of DDT and its breakdown products.

Within the limits of the accidental discovery protocol (refer to Section 6), the investigated site history and analysed soil samples indicate that these areas are suitable for the residential and recreational land-use indicated on site plan in Figure 2 (Appendix A). The investigations indicate that any adverse effects or risks to people and/or the environment are considered to be so low as to be acceptable.

All soil samples recorded trace element concentrations of one or several analytes above the reported natural background of *Yellow Grey Earth (YGE): Regional.* The concentrations in subgrade

[10] Environment Canterbury considers 0.431mg/kg ∑DDT to be the ambient concentration (R. Freeman, Contaminated Land Forum July 2019). The recorded ∑DDT concentration is 0.1mg/kg (approx. 4x lower than the ambient concentration. The NESCS standard for human health (the most conservative standard) is 45mg/kg.

are expected to be not elevated; i.e. at or below the natural background. If soil is removed from the site, it shall be confirmed that trace element concentrations comply with the acceptance criteria of the receiving cleanfill (Class 4) facility.

The proposed development is considered a controlled activity under Regulation 9(1)(b) of the NESCS.

5 Recommendations

It is recommended that:

1 If soil is removed from the site, it shall be confirmed that trace element concentrations in the removed material comply with the acceptance criteria of the facility authorised to accept the material[11].

2. Sampling sites 3.1 and 3.3 (as shown in Appendix B) shall be in a reserve area. If sites 3.1 and 3.3 are in a residential area, topsoil shall be remediated, and validation samples shall show that trace element concentrations are at or below NESCS standards for residential land-use.

3. Cross-contamination, e.g. by tracking soil from sampling sites 3.1-3.6 in Area 1 (as shown in Appendix A and Appendix B) across the balance of the site shall be avoided.

6 Accidental Discovery Protocol

This ground contamination assessment is based on our PSI, which comprised a review of Council records, and Eliot Sinclair's soil investigations on 7 March 2019. It is possible that unidentified contamination may be present on the site that is not currently known or was not encountered by the investigations outlined in this report. Therefore, if any of the following materials are encountered during future earthworks the actions provided below must be followed.

Potential contamination:

- Stained or odorous soil
- Slag, ash, charcoal
- Refuse comprising putrescible waste, metal or plastics
- Asbestos (bonded) in cement fibre sheets (ACM) or insulation material (friable)
- Obvious fill material or buried topsoil that is not natural

Actions:

- Works must stop immediately in the area of the discovery, and the site must be secured to stop people entering the area where potential contamination was encountered.
- Contact a contaminated land specialist. **Eliot Sinclair (03 379 4014)** can assist, assess the risk, and can determine a practicable course of action.

[11] NB: The contaminant concentrations in soils from residential areas are below the NESCS standards for rural/residential land-use (25% produce consumption). At the time of reporting, topsoil from Area 2 (residential land-use) complies with the acceptance criteria of the Wheatsheaf Quarry at 48 Selwyn Road, which is a Class 4/Controlled Fill facility. Gate fees at the time of reporting are $ 5.78/tonne. No organic material is accepted, and disposal is subject to an assessment of Winstone's environmental team.

7 Disclaimer

The comments made in this report are based on our previous reporting (PSI) and a site investigation on 7 March 2019. It is possible these may not provide a complete or accurate assessment of the entire site. As a result, Eliot Sinclair provides this information on the basis that it does not guarantee that the information is complete or without error and accepts no liability for any inaccuracy in, or omission from, this information.

All reasonable effort has been made to ensure that the conclusions drawn in this report are correct at the time of reporting. However, activities described on the HAIL may change in the future as knowledge about potentially hazardous activities develops.

It is possible there may be unidentified subsoil conditions that are not obvious from the information obtained by our desktop investigation, or were not encountered by our soil testing, and that differ from the conclusions of this report. Should unusual geotechnical conditions be encountered then Eliot Sinclair should be advised so that they can review any new information and to advise if the recommendations of this report are still valid.

This report has been prepared for the benefit of Suburban Estates Ltd and the Selwyn District Council. No liability is accepted by this company or any employee of this company with respect to the use of this report by any other party or for any other purpose other than what is stated in our scope of work.

This report is not intended to relieve contractors of their responsibilities under the Health and Safety at Work Act 2015. Site conditions relevant to construction works should be assessed by contractors who can make their own interpretation of the factual data provided. They should perform any additional tests as necessary for their own purposes, at their own expense.

Appendix A: Site Plans

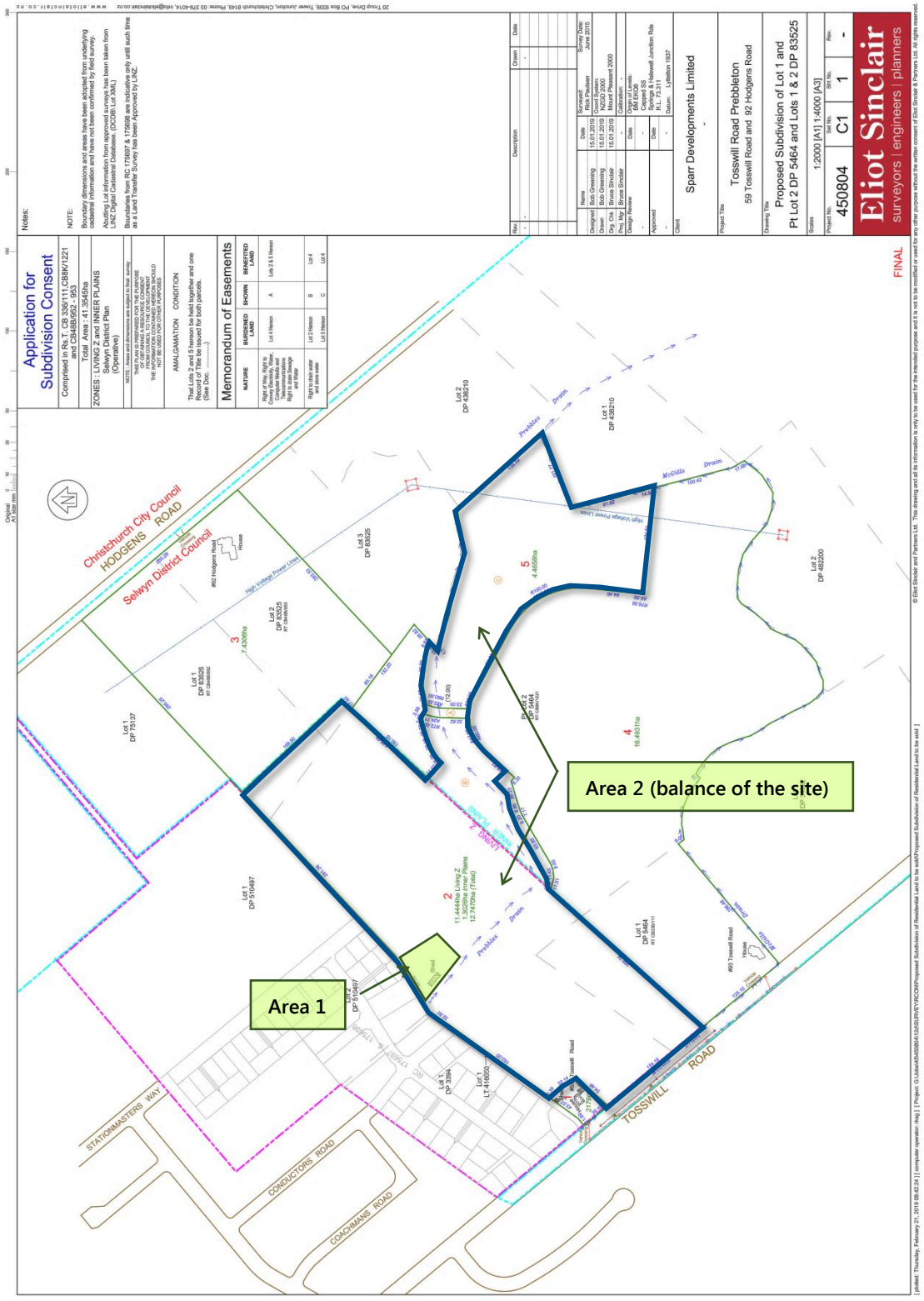


Figure 1: Site Plan.

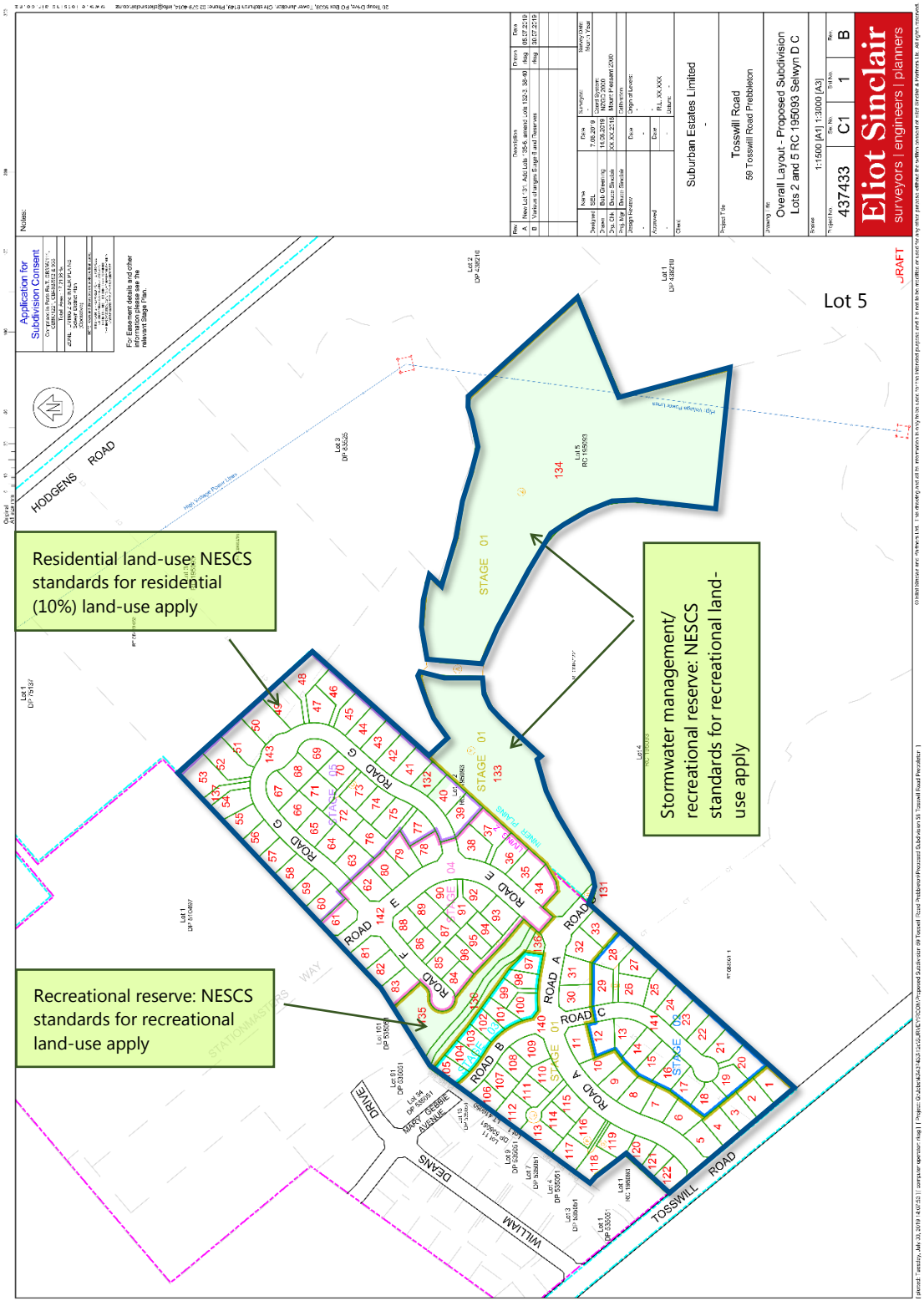
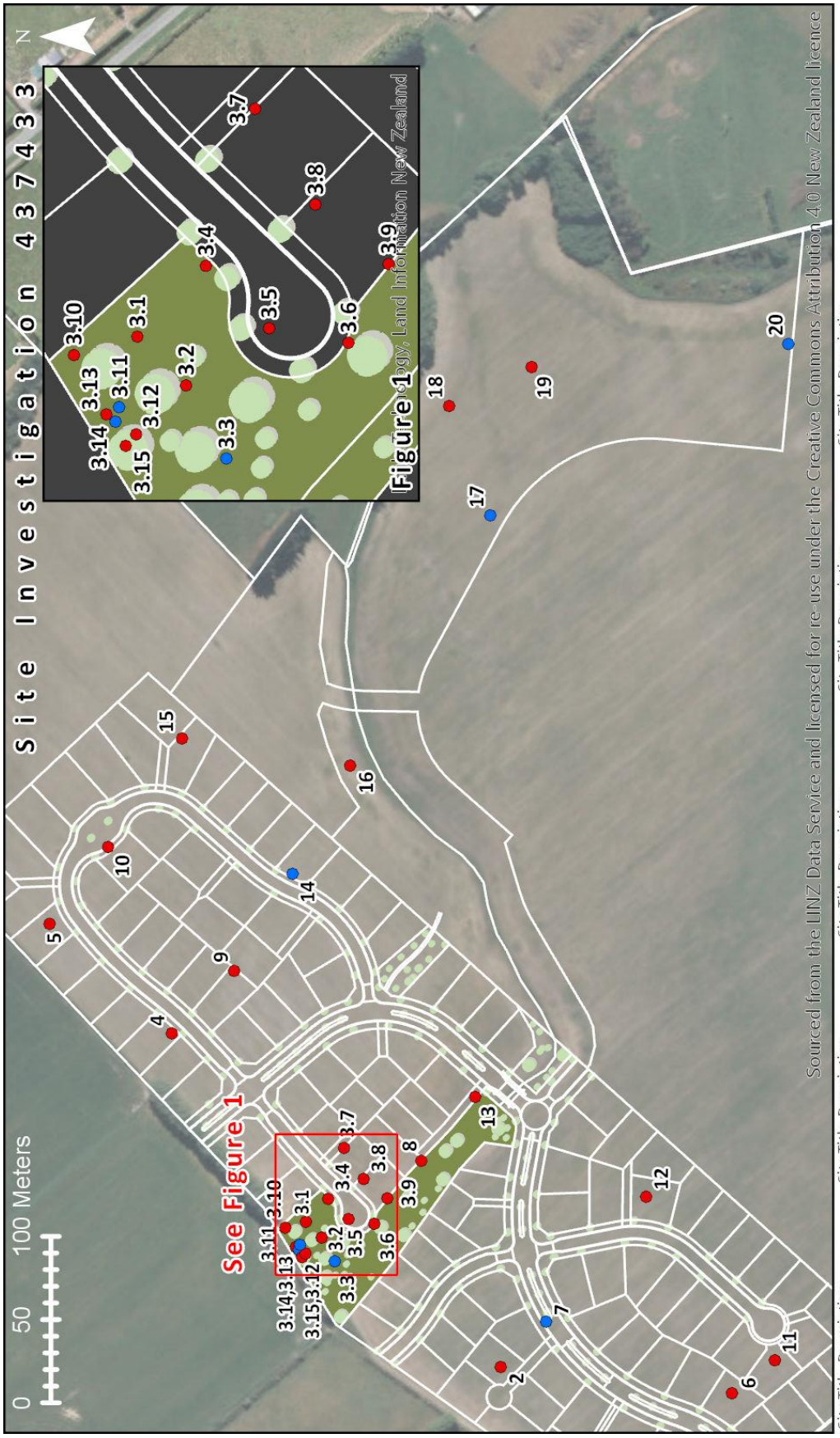


Figure 2: Development plan (as per July 2019) and applicable NESCS soil contaminant standards.

Appendix B: Soil Sample Location Plans



Site	Title	Description
10	Xrf10	
11	Xrf 11	
12	Xrf12	
13	Xrf13	
14	Xrf and lab 14	
15	Xrf 15	
16	Xrf 16	
17	Lab and Xrf17	
18	Xrf18	
19	Xrf19	
2	Xrf 2	
20	Lab and Xrf20	
3.1	Xrf 3.1	
3.10	Xrf 3.10	
3.11	Lab and xrf 3.11	
3.12	Xrf3.12 stockyard	
3.13	Xrf 3.13	
3.14	Lab and xrf 3.14 stockpile	
3.15	Xrf 3.15 stockpile	
3.2	Xrf 3.2	
3.3	Lab and Xrf 3.3	
3.4	Xrf 3.4	
3.5	Xrf 3.5	
3.6	Xrf 3.6	
3.7	Xrf 3.7	
3.8	Xrf 3.8	
3.9	Xrf 3.9	
4	Xrf 4	
5	Xrf5	
6	Xrf 6	
7	Lab and Xrf7	
8	Xrf 8	
9	Xrf 9	

Appendix C: Soil Analytical Results

Table 4: Trace element concentrations (soil laboratory analytical results). Red shading denotes exceedance of the respective criterion. Yellow shading denotes concentrations between 80 and 100% of the respective criterion.

Eliot Sinclair surveyors | engineers | planners	Sample ID	3.3	3.11	3.11 duplicate	3.14	7	14	17	20
	Depth:	0-75	0-75	0-75	0-75	0-75	0-75	0-75	0-75
	Sample Date:	7/03/2019	7/03/2019	7/03/2019	7/03/2019	7/03/2019	7/03/2019	7/03/2019	7/03/2019
Job Number: 437433	Lab Number:	19-07217-5	19-07217-6	19-07217-6	19-07217-7	19-07217-8	19-07217-9	19-07217-10	19-07217-11
	Land-use	recreational	recreational	recreational	recreational	residential	residential	recreational	recreational
		Farm Shed	hist. stockyard	hist. stockyard	stockpile	cropped	cropped	cropped	cropped
Background Level 2 Yellow Grey Earth: Regional	Criteria [mg/kg]								
Arsenic	4.9 (As)	51.7	6.77	7.32	6.67	3.09	4.62	4.06	2.99
Chromium	16.9 (Cr)	56	17.2	17.9	17.2	13.9	15.7	15.3	14.3
Copper	12.4 (Cu)	84.4	8.52	8.9	8.62	4.85	6.77	5.9	5.22
Lead	21.3 (Pb)	145	21.9	23.8	20.8	16.9	20.8	17.4	16.8
Nickel	13.1 (Ni)	13	13.1	14.1	13.5	9.37	12.2	11.3	9.87
Zinc	69.6 (Zn)	265	71.6	75.1	71	62.7	76.5	63.5	65.8
NES SCS Rural Residential 25%	Criteria [mg/kg]								
Arsenic	17 (As)	51.7	6.77	7.32	6.67	3.09	4.62	4.06	2.99
Cadmium	0.8 (Cd)	0.51	0.085	0.083	0.092	0.18	0.14	0.13	0.13
Chromium	290 (Cr)	56	17.2	17.9	17.2	13.9	15.7	15.3	14.3
Copper	NL (Cu)	84.4	8.52	8.9	8.62	4.85	6.77	5.9	5.22
Lead	160 (Pb)	145	21.9	23.8	20.8	16.9	20.8	17.4	16.8
Nickel	1200 (Ni)	13	13.1	14.1	13.5	9.37	12.2	11.3	9.87
Zinc	60000 (Zn)	265	71.6	75.1	71	62.7	76.5	63.5	65.8
NES SCS Residential 10%	Criteria [mg/kg]								
Arsenic	20 (As)	51.7	6.77	7.32	6.67	3.09	4.62	4.06	2.99
Cadmium	3 (Cd)	0.51	0.085	0.083	0.092	0.18	0.14	0.13	0.13
Chromium	460 (Cr)	56	17.2	17.9	17.2	13.9	15.7	15.3	14.3
Copper	NL (Cu)	84.4	8.52	8.9	8.62	4.85	6.77	5.9	5.22
Lead	210 (Pb)	145	21.9	23.8	20.8	16.9	20.8	17.4	16.8
Nickel	400 (Ni)	13	13.1	14.1	13.5	9.37	12.2	11.3	9.87
Zinc	7400 (Zn)	265	71.6	75.1	71	62.7	76.5	63.5	65.8
NES SCS Recreational	Criteria [mg/kg]								
Arsenic	80 (As)	51.7	6.77	7.32	6.67	3.09	4.62	4.06	2.99
Cadmium	400 (Cd)	0.51	0.085	0.083	0.092	0.18	0.14	0.13	0.13
Chromium	2700 (Cr)	56	17.2	17.9	17.2	13.9	15.7	15.3	14.3
Copper	NL (Cu)	84.4	8.52	8.9	8.62	4.85	6.77	5.9	5.22
Lead	880 (Pb)	145	21.9	23.8	20.8	16.9	20.8	17.4	16.8
Nickel	1200 (Ni)	13	13.1	14.1	13.5	9.37	12.2	11.3	9.87
Zinc	30000 (Zn)	265	71.6	75.1	71	62.7	76.5	63.5	65.8
Burwood Landfill acceptance	Criteria [mg/kg]								
Arsenic	80 (As)	51.7	6.77	7.32	6.67	3.09	4.62	4.06	2.99
Cadmium	400 (Cd)	0.51	0.085	0.083	0.092	0.18	0.14	0.13	0.13
Chromium	2700 (Cr)	56	17.2	17.9	17.2	13.9	15.7	15.3	14.3
Copper	>10,000 (Cu)	84.4	8.52	8.9	8.62	4.85	6.77	5.9	5.22
Lead	880 (Pb)	145	21.9	23.8	20.8	16.9	20.8	17.4	16.8
Nickel	600 (Ni)	13	13.1	14.1	13.5	9.37	12.2	11.3	9.87
Zinc	14000 (Zn)	265	71.6	75.1	71	62.7	76.5	63.5	65.8

Table 5: Trace element concentrations (XRF records). Red shading denotes exceedance of the respective criterion. Yellow shading denotes concentrations between 80 and 100% of the respective criterion.

Eliot Sinclair surveyors | engineers | planners		historical farm sheds -> reserve/residential lots									historical stockyards -> reserve						cropped -> residential lots													cropped -> stormwater mgt. reserve					AVG
	Sample ID:	3.1	3.2	3.3	3.4	3.5	3.6	3.7	3.8	3.9	3.10	3.11	3.12	3.13	3.14	3.15	2	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	
	Depth:	surface	surface	surface	surface	surface	surface	surface	surface	surface	surface	surface	surface	surface	surface	surface	surface	surface	surface	surface	surface	surface	surface	surface	surface	surface	surface	surface	surface	surface	surface	surface	surface	surface	
	Sample Date:	7.03.19	7.03.19	7.03.19	7.03.19	7.03.19	7.03.19	7.03.19	7.03.19	7.03.19	7.03.19	7.03.19	7.03.19	7.03.19	7.03.19	7.03.19	7.03.19	7.03.19	7.03.19	7.03.19	7.03.19	7.03.19	7.03.19	7.03.19	7.03.19	7.03.19	7.03.19	7.03.19	7.03.19	7.03.19	7.03.19	7.03.19	7.03.19	7.03.19	
Job Number: 437433	future land-use	rec.	rec.	rec.	rec.	rec.	rec.	res 10%	res 10%	res 10%	rec.	rec.	rec.	rec.	rec.	rec.	res 10%	res 10%	res 10%	res 10%	res 10%	res 10%	res 10%	res 10%	res 10%	res 10%	res 10%	res 10%	res 10%	rec.	rec.	rec.	rec.	rec.	
Background Level 2 Yellow Grey Earth: Regional	Criteria [mg/kg]																																		
Arsenic	4.9 (As)	16	5	48.5	19	7	7	5	5	8	5	9	6	8	6	4	0	5	5	4	0	4	4	5	4	3	6	3	5	2	3	3	4	3	11.7
Chromium	16.9 (Cd)	11	<LOD	11.5	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	13	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	84.0
Copper	12.4 (Cr)	46	16	122	32	29	29	21	14	15	13	9	17	20	10	0	7	9	10	5	7	7	9	5	5	0	10	6	8	5	6	6	5	9	56.8
Lead	21.3 (Cu)	215	77	142	153	165	159	71	52	54	59	19	47	80	24	15	19	21	23	19	19	30	23	17	26	23	25	21	16	17	16	19	21	18	19.3
Nickel	13.1 (Pb)	23	15	18.5	20	22	21	24	18	16	11	19	24	16	27	19	20	18	18	18	16	25	19	20	23	20	10	18	17	19	26	23	18	16	113.7
Zinc	69.6 (Ni)	223	116	314	263	201	166	178	121	116	104	70	82	114	69	47	59	70	78	67	60	83	70	67	62	64	69	76	58	46	56	57	66	60	113.7
NES SCS Residential 10%	Criteria [mg/kg]																																		
Arsenic	20 (As)	16	5	48.5	19	7	7	5	5	8	5	9	6	8	6	4	0	5	5	4	0	4	4	5	4	3	6	3	5	2	3	3	4	3	
Chromium	460 (Cd)	11	0	11.5	0	0	0	0	0	0	0	0	0	0	0	0	13	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
Copper	NL (Cr)	46	16	122	32	29	29	21	14	15	13	9	17	20	10	0	7	9	10	5	7	7	9	5	5	0	10	6	8	5	6	6	5	9	
Lead	210 (Cu)	215	77	142	153	165	159	71	52	54	59	19	47	80	24	15	19	21	23	19	19	30	23	17	26	23	25	21	16	17	16	19	21	18	
Nickel	400 (Pb)	23	15	18.5	20	22	21	24	18	16	11	19	24	16	27	19	20	18	18	18	16	25	19	20	23	20	10	18	17	19	26	23	18	16	
Zinc	7400 (Ni)	223	116	314	263	201	166	178	121	116	104	70	82	114	69	47	59	70	78	67	60	83	70	67	62	64	69	76	58	46	56	57	66	60	
NES SCS Rural Residential 25%	Criteria [mg/kg]																																		
Arsenic	17 (As)	16	5	48.5	19	7	7	5	5	8	5	9	6	8	6	4	0	5	5	4	0	4	4	5	4	3	6	3	5	2	3	3	4	3	
Chromium	290 (Cd)	11	0	11.5	0	0	0	0	0	0	0	0	0	0	0	0	13	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
Copper	NL (Cr)	46	16	122	32	29	29	21	14	15	13	9	17	20	10	0	7	9	10	5	7	7	9	5	5	0	10	6	8	5	6	6	5	9	
Lead	160 (Cu)	215	77	142	153	165	159	71	52	54	59	19	47	80	24	15	19	21	23	19	19	30	23	17	26	23	25	21	16	17	16	19	21	18	
Nickel	1200 (Pb)	23	15	18.5	20	22	21	24	18	16	11	19	24	16	27	19	20	18	18	18	16	25	19	20	23	20	10	18	17	19	26	23	18	16	
Zinc	60000 (Ni)	223	116	314	263	201	166	178	121	116	104	70	82	114	69	47	59	70	78	67	60	83	70	67	62	64	69	76	58	46	56	57	66	60	
NES SCS Recreational	Criteria [mg/kg]																																		
Arsenic	80 (As)	16	5	48.5	19	7	7	5	5	8	5	9	6	8	6	4	0	5	5	4	0	4	4	5	4	3	6	3	5	2	3	3	4	3	
Chromium	2700 (Cd)	11	0	11.5	0	0	0	0	0	0	0	0	0	0	0	0	13	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
Copper	NL (Cr)	46	16	122	32	29	29	21	14	15	13	9	17	20	10	0	7	9	10	5	7	7	9	5	5	0	10	6	8	5	6	6	5	9	
Lead	880 (Cu)	215	77	142	153	165	159	71	52	54	59	19	47	80	24	15	19	21	23	19	19	30	23	17	26	23	25	21	16	17	16	19	21	18	
Nickel	1200 (Pb)	23	15	18.5	20	22	21	24	18	16	11	19	24	16	27	19	20	18	18	18	16	25	19	20	23	20	10	18	17	19	26	23	18	16	
Zinc	30000 (Ni)	223	116	314	263	201	166	178	121	116	104	70	82	114	69	47	59	70	78	67	60	83	70	67	62	64	69	76	58	46	56	57	66	60	
Burwood Landfill acceptance	Criteria [mg/kg]																																		
Arsenic	80 (As)	16	5	48.5	19	7	7	5	5	8	5	9	6	8	6	4	0	5	5	4	0	4	4	5	4	3	6	3	5	2	3	3	4	3	
Chromium	2700 (Cd)	11	0	11.5	0	0	0	0	0	0	0	0	0	0	0	0	13	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
Copper	>10,000 (Cr)	46	16	122	32	29	29	21	14	15	13	9	17	20	10	0	7	9	10	5	7	7	9	5	5	0	10	6	8	5	6	6	5	9	
Lead	880 (Cu)	215	77	142	153	165	159	71	52	54	59	19	47	80	24	15	19	21	23	19	19	30	23	17	26	23	25	21	16	17	16	19	21	18	
Nickel	600 (Pb)	23	15	18.5	20	22	21	24	18	16	11	19	24	16	27	19	20	18	18	18	16	25	19	20	23	20	10	18	17	19	26	23	18	16	
Zinc	14000 (Ni)	223	116	314	263	201	166	178	121	116	104	70	82	114	69	47	59	70	78	67	60	83	70	67	62	64	69	76	58	46	56	57	66	60	

	3.3 lab	3.3 XRF	rel % diff*	3.11 lab	3.11 XRF	rel % diff	3.14 lab	3.14 XRF	rel % diff	7 lab	7 XRF	rel % diff	14 lab	14 XRF	rel % diff	17 lab	17 XRF	rel % diff	20 lab	20 XRF	rel % diff	total
Arsenic	51.7	52	**0.3**	7.05	9	**12.1**	6.67	6	**5.3**	3.09	<LOD	**n/a**	4.62	3	**21.3**	4.06	3	**15.0**	2.99	3	**0.2**	9.0
Chromium	56	23	**41.8**	17.55	<LOD	**n/a**	17.2	<LOD	**n/a**	13.9	<LOD	**n/a**	15.7	<LOD	**n/a**	15.3	<LOD	**n/a**	14.3	<LOD	**n/a**	41.8
Copper	84.4	144	**26.1**	8.71	9	**1.6**	8.62	10	**7.4**	4.85	7	**18.1**	6.77	6	**6.0**	5.9	6	**0.8**	5.22	9	**26.6**	11.4
Lead	145	155	**3.3**	22.85	19	**9.2**	20.8	24	**7.1**	16.9	19	**5.8**	20.8	21	**0.5**	17.4	16	**4.2**	16.8	18	**3.4**	4.6
Nickel	13	16	**10.3**	13.60	19	**16.6**	13.5	27	**33.3**	9.37	16	**26.1**	12.2	18	**19.2**	11.3	26	**39.4**	9.87	16	**23.7**	23.8
Zinc	265	331	**11.1**	73.35	70	**2.3**	71	69	**1.4**	62.7	60	**2.2**	76.5	76	**0.3**	63.5	56	**6.3**	65.8	60	**4.6**	4.3
																					overall:	**15.8**

*The relative percent difference is calculated as per CLMG 5, p. 30

30-50% difference are acceptable

Table 6: Relative percent difference between laboratory and XRF results.

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Certificate of Analysis

Eliot Sinclair & Partners
20 Troup Drive
Christchurch 8149
Attention: Jens Zollhofer
Phone: 021 0477981
Email: jmz@eliotsinclair.co.nz

Lab Reference: 19-07217
Submitted by: JMZ
Date Received: 8/03/2019
Date Completed: 12/03/2019
Order Number:
Reference: 437433

Sampling Site: 59 Tossvill

Report Comments

Samples were collected by yourselves (or your agent) and analysed as received at Analytica Laboratories. Samples were in acceptable condition unless otherwise noted on this report.

Heavy Metals in Soil

Client Sample ID			not part of the site				3.3 0-75
Date Sampled							7/03/2019
Analyte	Unit	Reporting Limit					19-07217-5
Arsenic	mg/kg dry wt	0.125	8.65	17.1	8.83	8.55	51.7
Cadmium	mg/kg dry wt	0.005	not part of the site				0.51
Chromium	mg/kg dry wt	0.125					56.0
Copper	mg/kg dry wt	0.075	9.92	71.4	17.4	13.1	84.4
Lead	mg/kg dry wt	0.05	290	3,590	219	176	145
Mercury	mg/kg dry wt	0.025	0.060	0.29	0.090	0.10	0.19
Nickel	mg/kg dry wt	0.05	8.91	21.5	10.9	10.2	13.0
Zinc	mg/kg dry wt	0.05	370	1,550	170	126	265

Heavy Metals in Soil

Client Sample ID			3.11 0-75	3.17 0-75	7 0-75	14 0-75	17 0-75
Date Sampled			7/03/2019	7/03/2019	7/03/2019	7/03/2019	7/03/2019
Analyte	Unit	Reporting Limit	19-07217-6	19-07217-7	19-07217-8	19-07217-9	19-07217-10
Arsenic	mg/kg dry wt	0.125	6.77	6.67	3.09	4.62	4.06
Cadmium	mg/kg dry wt	0.005	0.085	0.092	0.18	0.14	0.13
Chromium	mg/kg dry wt	0.125	17.2	17.2	13.9	15.7	15.3
Copper	mg/kg dry wt	0.075	8.52	8.62	4.85	6.77	5.90
Lead	mg/kg dry wt	0.05	21.9	20.8	16.9	20.8	17.4
Mercury	mg/kg dry wt	0.025	0.058	0.062	0.039	0.048	0.046
Nickel	mg/kg dry wt	0.05	13.1	13.5	9.37	12.2	11.3
Zinc	mg/kg dry wt	0.05	71.6	71.0	62.7	76.5	63.5

IANZ ACCREDITED LABORATORY

All tests reported herein have been performed in accordance with the laboratory's scope of accreditation, with the exception of tests marked *, which are not accredited.

NB: Sample 3.17 was mis-read by the laboratory and should read 3.14; refer to the Chain of Custody form.

Heavy Metals in Soil

			Client Sample ID	20 0-75
			Date Sampled	7/03/2019
Analyte		Unit	*Reporting Limit*	19-07217-11
Arsenic		mg/kg dry wt	*0.125*	2.99
Cadmium		mg/kg dry wt	*0.005*	0.13
Chromium		mg/kg dry wt	*0.125*	14.3
Copper		mg/kg dry wt	*0.075*	5.22
Lead		mg/kg dry wt	*0.05*	16.8
Mercury		mg/kg dry wt	*0.025*	0.052
Nickel		mg/kg dry wt	*0.05*	9.87
Zinc		mg/kg dry wt	*0.05*	65.8

Organochlorine Pesticides - Soil

		Client Sample ID	3.3 0-75	3.11 0-75	3.17 0-75
		Date Sampled	7/03/2019	7/03/2019	7/03/2019
Analyte	Unit	*Reporting Limit*	19-07217-5	19-07217-6	19-07217-7
2,4'-DDD	mg/kg dry wt	*0.005*	<0.005	<0.005	<0.005
2,4'-DDE	mg/kg dry wt	*0.005*	<0.005	<0.005	<0.005
2,4'-DDT	mg/kg dry wt	*0.005*	0.010	<0.005	<0.005
4,4'-DDD	mg/kg dry wt	*0.003*	<0.003	<0.003	<0.003
4,4'-DDE	mg/kg dry wt	*0.005*	0.036	0.007	0.006
4,4'-DDT	mg/kg dry wt	*0.005*	0.052	<0.005	<0.005
Total DDT	mg/kg dry wt	*0.02*	0.10	<0.02	<0.02
alpha-BHC	mg/kg dry wt	*0.005*	<0.005	<0.005	<0.005
Aldrin	mg/kg dry wt	*0.005*	<0.005	<0.005	<0.005
beta-BHC	mg/kg dry wt	*0.005*	<0.005	<0.005	<0.005
cis-Chlordane	mg/kg dry wt	*0.005*	<0.005	<0.005	<0.005
cis-Nonachlor	mg/kg dry wt	*0.01*	<0.01	<0.01	<0.01
delta-BHC	mg/kg dry wt	*0.005*	<0.005	<0.005	<0.005
Dieldrin	mg/kg dry wt	*0.05*	<0.05	<0.05	<0.05
Endosulfan I	mg/kg dry wt	*0.005*	<0.005	<0.005	<0.005
Endosulfan II	mg/kg dry wt	*0.01*	<0.01	<0.01	<0.01
Endosulfan sulphate	mg/kg dry wt	*0.005*	<0.005	<0.005	<0.005
Endrin	mg/kg dry wt	*0.05*	<0.05	<0.05	<0.05
Endrin aldehyde	mg/kg dry wt	*0.01*	<0.01	<0.01	<0.01
Endrin ketone	mg/kg dry wt	*0.005*	<0.005	<0.005	<0.005
gamma-BHC	mg/kg dry wt	*0.005*	<0.005	<0.005	<0.005
Heptachlor	mg/kg dry wt	*0.005*	<0.005	<0.005	<0.005
Heptachlor epoxide	mg/kg dry wt	*0.005*	<0.005	<0.005	<0.005
Hexachlorobenzene	mg/kg dry wt	*0.005*	<0.005	<0.005	<0.005
Methoxychlor	mg/kg dry wt	*0.01*	<0.01	<0.01	<0.01
trans-nonachlor	mg/kg dry wt	*0.01*	<0.01	<0.01	<0.01
trans-Chlordane	mg/kg dry wt	*0.01*	<0.01	<0.01	<0.01
Chlordane (sum)	mg/kg dry wt	*0.02*	<0.020	<0.020	<0.020
TCMX (Surrogate)	%	*1*	69.4	93.4	91.5

NB: Sample 3.17 was mis-read by the laboratory and should read 3.14; refer to the Chain of Custody form.

Asbestos in Soil (Qualitative)

		Client Sample ID	1.1 0-75	1.2 0-75	1.3 0-75	1.4 0-75
		Date Sampled	7/03/2019	7/03/2019	7/03/2019	7/03/2019
Analyte	Unit	*Reporting Limit*	19-07217-1	19-07217-2	19-07217-3	19-07217-4
Asbestos in Soil (Qualitative)			Complete	Complete	Complete	Complete

Method Summary

Elements in Soil	Acid digestion followed by ICP-MS analysis. (US EPA method 200.8). Results are based on a dried sample passed through a 2 mm sieve.
OCP in Soil	Samples are extracted with hexane, pre-concetrated then analysed by GC-MSMS.(In-house procedure). (Chlordane (sum) is calculated from the main actives in technical Chlordane: Chlordane, Nonachlor and Heptachlor)
Total DDT	Sum of DDT, DDD and DDE (4,4' and 2,4 isomers)

Elizabeth Fitzgerald, B.Sc.
Inorganics Team Leader

Nathan Howse, B.Sc.
Senior Technician

Karam Wadi, B.E. (Hons)
Technologist

ENVIRONMENTAL TESTING

CHAIN OF CUSTODY

19-07217 LYTICA LABORATORIES

CLIENT INFORMATION		Lab ID (Lab use only)	19-07217	Registered By	KC	Date Registered	8/3/19
Client	Eliot Sinclair & Partners	Customer Comments/Instructions					
Address	PO Box 9339						
Project Leader	JMZ						
Project ID	437433						
Site	59 Tosswill						
Sampler	JMZ						
Phone	0210 477 981						
Email	jmz@eliotsinclair.co.nz						
Invoice Email	dlw@eliotsinclair.co.nz; jmz@eliotsinclair.co.nz						

CLIENT REQUESTS (Please Tick)									
Routine	✓	Priority		Urgent		ESDAT		QC Report		Drinking Water	

TESTS REQUESTED					Analysis Requests/Suites [Enter Test Code Below]			
Sample ID	Depth	Sampling Date	Time	Matrix	HMs8	OCP	Asbestos p/a	Sample Comments (ie: extra test requests,high odour, bulk material)
1	1.1	7.3.19		soil	✓		✓	semi-quantitative if positive
2					✓		✓	4
3					✓		✓	4
4	1.4				✓		✓	4
5	3.3				✓	✓		
6	3.11				✓	✓		
7	3.17				✓	✓		
8	5				✓			
9	7				✓			
10	14				✓			
11	17				✓			
12	20				✓			
13								
14								
15								
16								
17								
18								
19								

Not part of the site

Matrix Key	S (Solids)	CW (Clean Water)	SW (Saline Water)	WW (Waste Water)
	All soils, sediment, sludge	Potable, Ground, Bore, Surface, Fresh	Sea Water, Geothermal	Effluent, Trade Waste, Leachate

Sender Name		Received by (Lab Staff)	EC	Courier company	NZC	Courier #	
Date Sent		Time sent	am : pm	7/3/19	Time Received	6.30 pm	Seal Status		Sample Chilled	

Page ____ of ____

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Appendix D: Site Investigation Photos (7 March 2019)

Figure 3: Soil sampling Site 2.

Figure 4: Soil sampling site 3.1 under Macrocarpa tree.

Figure 5: Soil sampling Site 3.2.

Figure 6: Soil sampling Site 3.3.

Figure 7: Soil sampling Site 3.4.

Figure 8: Soil sampling Site 3.6.

Figure 9: Soil sampling Site 3.9.

Figure 10: Soil sampling Site 3.10 (historical stockyard).

Figure 11: Soil sampling Site 3.11 (historical stockyard).

Figure 12: Soil sampling Site 3.13 (historical stockyard).

Figure 13: Soil sampling Site 3.14 (stockpile in historical stockyard area).

Figure 14: Soil sampling Site 3.15 (stockpile in historical stockyard area).

Figure 15: Soil sampling Site 8.

Figure 16: Soil sampling Site 13.

Figure 17: Soil sampling Site 16.

Figure 18: Soil sampling Site 20.