

# SITE VALIDATION REPORT

34300 / OAKBRIDGE STAGE 2 / SOVEREIGN PALMS LTD

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Davis Ogilvie & Partners Ltd



### QUALITY ASSURANCE

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Reviewed By	Warren Sharp Technical Director CEnvP - SCS	Signature:



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### 1.0 INTRODUCTION

Davis Ogilvie & Partners Limited (Davis Ogilvie) was commissioned by Sovereign Palms Ltd to prepare this Site Validation Report (SVR) documenting contaminated soil remediation works undertaken over Oakbridge Stage 2, 10 Oakbridge Boulevard, Christchurch. The site extent is indicated on Site Plan E01 attached. Details of the site are provided in Table 1 below.

Table 1: Site details							
Owner:	Sovereign Palms Ltd						
Site Address (current):	10 Oakbridge Boulevard. Originally Stage 2 comprised a portion of 20 Mills Road and 31 Hawkins Road, Marshland.						
Legal Description (current):	Lot 4000 DP 569920 (part of)						
Total Area:	2.2 ha (approx.)						
Topography:	Flat lying						
Adjoining Site Uses:	Rural / Rural residential to north, east and south. Residential (Oakbridge Stage 1) to the west.						

### 2.0 BACKGROUND

Detailed background information on Oakbridge Stage 1 (the site) has been provided in the following reports:

- Davis Ogilvie report dated 26 May 2017: *Detailed Site Investigation Report, Oakbridge,* Reference 34300.
- Davis Ogilvie report dated 30 November 2020: *Remediation Action Plan Oakbridge Stage 2, Christchurch*. Reference 34300.

As described in the above reports, elevated concentrations of arsenic and cadmium were detected in relation to a historic sheep dip located just offsite to the south in 203 Prestons Road (Lot 2 DP 512479, refer Plan E01). Concentrations of arsenic and cadmium just north of the boundary with 203 Prestons Road exceeded Soil Contaminant Standards (SCS) for residential land use. Cadmium concentrations in excess of background were detected to the west. Arsenic at concentrations in excess of background were detected in four DSI investigation sampling locations over the western half of the site (a portion of the former full extent of 34 Hawkins Road). The source of this elevated arsenic was not able to be determined.



Resource Consent RMA/2022/330 was granted by Christchurch City Council (CCC) for subdivision of the site, including a requirement to remediate the site to meet SCS for residential land use. This SVR has been prepared in order to comply with consent conditions 10.6 and 10.7 of RMA/2022/330 and documents the remedial works and soil validation sampling undertaken.

### 3.0 SUMMARY OF WORKS

### 3.1 Excavation Works

The entire site extent was excavated to a depth between approximately 0.2 m and 0.4 m below the original ground level for geotechnical reasons (effectively stripping of topsoil), with the contamination remedial excavation works program being conducted as part of the wider site geotechnical excavation program. Excavation was deeper in road areas. The excavation works were conducted as a staged process driven by geotechnical requirements and were undertaken over the period April to November 2021. Photos of the completed excavation are provided in Figure 1. The excavation depth extent was verified via validation sampling (Section 3.4).

There was no significant deviation to the RAP during the remedial works program.

### 3.2 Soil Disposal

Management of excavated topsoil was as follows:

- Excavated topsoil from the northern half of the site was initially stockpiled within the site, and characterisation samples collected. Analytical results for these samples indicated residual arsenic concentrations in the topsoil in excess of adopted background, with a few samples also in excess of SCS for residential land use. As such, this topsoil was predominantly disposed of to the Oakbridge Stage 1 recreation reserve immediately west of Stage 2. Some topsoil was also used within roadway gardens in Stage 1, with this further described in the Oakbridge Stage 1 Site Validation Report.
- Excavated topsoil from the southwest portion of the site (former area impacted by offsite sheep dip to south) was placed directly into the Stage 1 reserve.
- Topsoil resulting from the southeast portion of the site was stockpiled and characterised (refer Section 3.4). The stockpile characterisation indicated residual concentrations less than SCS for residential land use, and also less than background for a portion of the stockpile. The portions of the stockpile which contained the majority of concentrations in excess of background was disposed of to the Stage 1 reserve, with the remainder mixed with Stage 1 derived topsoil and re-used over Stage 2 Lots.



Placement of topsoil (looking west over southern portion of site).

Partially topsoiled lots along southern boundary of site. Gravel filled roadbed. Looking west.

Figure 1: Selected remedial works photographs.

### 3.3 Fill Materials

As discussed above, the entire site was excavated to a depth of between 0.2m and 0.4m below original ground surface for geotechnical purposes, with some of these areas requiring engineered fill and all Lot areas requiring topsoil. Sources of fill materials utilised at the site were as follows:

- Quarry sourced gravels for roadways and service trenches.
- Silt (post validation sampling) derived from deeper roadway excavations for some Stage 2 Lot areas.

• Topsoil predominantly sourced from Oakbridge Stage 1 Lot foundation excavations, with a small portion of topsoil excavated over Stage 2 re-used (after mixing with Stage 1 derived soils). An evaluation of topsoil over Stage 1 is included in Appendix A.

### 3.4 Soil Validation Sampling

### 3.4.1 Methodology

As set out in the RAP the remediation criteria for the site was to meet SCS for residential land use, namely 20 mg/kg for arsenic and 3 mg/kg for cadmium. In addition, to avoid further contamination related encumbrance on finished lots, results were also compared to background / criteria for cleanfill disposal.

Validation sampling was carried out in stages as excavation works across the site progressed as follow:

- 9 April 2021 Excavation base samples VS60 to VS67. Northern area of site.
- 30 April 2021 Excavation base samples VS69 to VS72 and VS74 to VS78. Southwest area of site directly north and west of the former sheep dip. Note that samples VS68 and VS73 were also collected; however, soils represented by these samples were excavated and removed during works east of this area of the site.
- 21 September 2021 Excavation base samples VS100 VS111. Southeast portion of the site. Stockpile validation samples ST200 – ST219, stockpiled topsoil resulting from excavation in southeast corner of the site.
- 10 November 2021 Excavation base samples VS112 VS 122. Central portion of the site.

The excavation base soil validation samples were collected on a random grid basis with validation sample locations indicated on Plan E01 attached.

The stockpile resulting from excavation of topsoil in the southeast portion of the site was conservatively estimated to be 2,000 m<sup>3</sup> in size. The stockpile was considered well mixed as a result of excavation and stockpile forming works. Stockpile characterisation samples were collected on a systematic basis along each side of the stockpile, with samples ST200 to ST209 along one side and samples ST210 – ST219 at the same location on the opposite stockpile face (e.g. Sample ST219 opposite ST200, ST210 opposite ST209).



The soil validation samples were collected by Davis Ogilvie staff in general accordance with Ministry for the Environment Contaminated Land Management Guidelines. All soil validation samples were field screened using an X-Ray Fluorescence Analyser (XRF), with the majority of samples then submitted to Analytica Laboratories Ltd and analysed for heavy metals.

### 3.4.2 Results

Soil validation sample analytical results are summarised in Tables 2 (excavation base) and 3 (stockpile characterisation samples). Laboratory reports are included as Appendix B. Soil validation sample results were compared to SCS for residential land use and to adopted background / cleanfill disposal criteria, conservatively being the acceptance criteria for most cleanfill sites in the wider Canterbury area: background values for the Regional Recent soil type. Relevant SCS and background / cleanfill criteria are included in Tables 2 and 3. Results can be summarised as follows:

### Remedial excavation base

No analysed heavy metals were detected at concentrations above SCS for residential land use in the excavation base soil validation samples.

With the exception of arsenic in one sample, no analysed heavy metals were detected at a concentration in excess of adopted background. Statistical analysis using USEPA's ProUCL software of arsenic across the excavation base over the site area indicates a 95% UCL for arsenic in these soils of 7.4 mg/kg, less than adopted background.

### Southeast Area Topsoil Stockpile

No analysed heavy metals were detected at concentrations in excess of SCS for residential land use. Arsenic was detected at concentrations in excess of adopted background in a number of stockpile characterisation samples. Based on the validation results portions of the stockpile with the highest residual concentrations were separated and disposed of to the Reserve (indicated in table 3). The remaining soils were mixed with imported topsoil from Stage 1 foundation excavations are re-used on the site. While concentrations in excess of adopted background still remained within the re-used soils, when added to the Stage 1 topsoil dataset (considered appropriate as stockpiled soils were mixed with Stage 1 soils), statistical analysis indicates a 95% UCL of 11.4 mg/kg, less than adopted background. As such, it is considered that residual concentrations within topsoil across Stage 2 are within adopted background, and suitable for disposal as cleanfill.

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### 3.5 QA/QC

All fieldwork has been managed by a Suitably Qualified and Experienced Practitioner (SQEP) and this report was reviewed by a SQEP, as required by the National Environmental Standard for Soil Contamination (NESCS).

The XRF used was an Olympus Vanta C-Series VCW Model. The manufacturer's instructions were followed in the use of the device. Manufacturer supplied calibration samples were tested frequently in the field. USEPA Method 6200, *Field Portable X-ray Fluorescence Spectrometry for the Determination of Elemental Concentrations in Soil and Sediment* (2007), was used as guidance for the use of the XRF and quality assurance measures. A linear regression analysis of XRF readings and laboratory results was performed on the analytical results for arsenic. Concentrations of other heavy metals of concern (copper, lead, zinc) are all well below evaluation criteria and accordingly regression analysis for these elements was not considered necessary. The calculated regression value for arsenic was 0.80, in excess of the acceptable value of 0.70 set out in Method 6200. The analysis also indicated the XRF typically read between 5% and 10% lower than the laboratory for arsenic; however, results have not been altered in the results table as a review of XRF readings indicates adjusting XRF results would not significantly change report conclusions.

With regards to laboratory analysis, soil samples were submitted to Analytica Laboratories Ltd, a recognised laboratory endorsed by International Accreditation New Zealand (IANZ). The laboratory analysis was performed in accordance with the terms of accreditation. No issues were noted.

On the basis of the QA/QC work undertaken the XRF and laboratory results were considered suitable for interpretation.

### 4.0 SUMMARY

Soil remedial and general excavation works have been completed at the site. All contaminated soils have been successfully removed, with residual contaminant concentrations on the Stage 2 Lots below SCS for residential land use and adopted background. Excavated contaminated topsoils were predominantly disposed of the Reserve within Oakbridge Stage 1.

On the basis of the remedial works and associated soil validation sampling conducted, it is considered that the site is suitable for residential land use. Surplus soils that will be generated during further development of residential lots within the site are considered to be suitable for disposal as cleanfill (subject to facility acceptance).

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Table 2: Soil Validation Sample Analytical Results - Topsoil										
				Arsenic	Cadmium	Chromium	Copper	Lead	Nickel	Zinc
	SCS Resident	ial Land Use <sup>1</sup>		20	3	460 <sup>2</sup>	>10,000	210	400 <sup>3</sup>	7,400 <sup>3</sup>
	Backg	round <sup>4</sup>		12.58	0.19	22.7	20.3	40.96	20.7	93.94
Sample ID	Depth (m)	Date	Method							
V\$60	0.0-0.15	9/04/2021	XRF	2	-	-	5	11	24	37
\$300	0.0-0.15	5/04/2021	21-19831-28	1.2	0.033	11	8.78	8.95	10.6	41
VS61	0.0-0.15	9/04/2021	XRF	3	-	-	5	11	24	36
VS62	0.0-0.15	9/04/2021	XRF	13	-	-	7	19	19	52
			21-19831-29	12	0.046	14.4	6.5	15.4	9.55	50.9
V\$63	0.0-0.15	9/04/2021	XRF	6	-	-	5	21	31	54
VS64	0.0-0.15	9/04/2021	XKF	5 8.6	-	- 10.2	11 8 4	24	32	55
V\$65	0.0-0.15	9/04/2021	21-19851-50 VRE	8.0 /	0.052	19.2	0.4 7	1/	20	39.0 12
V305	0.0-0.15	5/04/2021	XRF	5	-	_	6	17	25	42
VS66	0.0-0.15	9/04/2021	21-19831-31	4.8	0.027	15.3	7.5	15.5	12	49.4
VS67	0.0-0.15	9/04/2021	XRF	9	-	-	11	20	20	78
VS69	0.3 - 0.4	30/04/2021	21-19831-2	7.8	0.069	16.9	9.12	18.2	12.5	73.9
VS70	0.3 - 0.4	30/04/2021	21-19831-3	4.3	0.049	13.2	5.4	13.3	8.55	46.7
VS71	0.3 - 0.4	30/04/2021	21-19831-4	3.4	0.045	13.3	6	10.9	9.78	45.2
VS72	0.3 - 0.4	30/04/2021	21-19831-5	2.2	0.031	10	4.8	9.79	8.34	37.9
VS74	0.2	30/04/2021	21-19831-7	12	0.13	17.8	9.74	22.6	12.6	64.9
VS75	0.2	30/04/2021	21-19831-8	5.8	0.065	14.7	7.7	17	8.35	45.1
VS76	0.3 - 0.4	30/04/2021	21-19831-9	7.8	0.062	17.9	6.7	20	11.7	62.9
VS77	0.3 - 0.4	30/04/2021	21-19831-10	3.7	0.038	16.2	4.8	16.3	11.6	65.2
VS78	0.3 - 0.4	30/04/2021	21-19831-11	2.8	0.033	17.2	5.8	20.2	12.5	60.5
VS100	0.4	21/09/2021	XRF	6	-	-	5	20	19	48
V6101	0.4	21/00/2021	21-41/44-1	1	0.03	18.2	5.6	20	12	53.8
V3101	0.4	21/09/2021		0	-	-	5	20	20	65
VS102	0.4	21/09/2021	21-41744-3	63	- 0.048	17.6	56	18.6	10.8	65.7
V\$103	0.4	21/09/2021	XRF	8	-	-	8	19	22	62
	0.1	21,00,2021	XRF	8	-	-	10	20	19	69
VS104	0.4	21/09/2021	21-41744-5	11	0.084	20.5	11.1	23.2	16.4	78.8
N/610F	0.4	21/00/2021	XRF	10	-	-	5	19	26	58
V3105	0.4	21/09/2021	21-41744-6	13.9	0.087	20.4	9.49	24.6	15.1	77
V\$106	0.4	21/09/2021	XRF	9	-	-	7	19	18	49
V3100	0.4	21/03/2021	21-41744-7	8.4	0.033	18.5	5.3	19.8	13.1	55.3
VS107	0.4	21/09/2021	XRF	3	-	-	7	15	24	39
VS108	0.4	21/09/2021	XRF	7	-	-	10	19	21	48
			21-41744-9	7.3	0.042	18.2	8.57	18.3	15.1	57.7
VS109	0.4	21/09/2021	XRF	10	-	-	/	18	15	47
			21-41744-10	8.8 C	0.044	17.3	0.7	17.9	14.1	54
VS110	0.4	21/09/2021	ARF	87	-	-	 0_21	19	1/ 0	40 52 7
VS111	0.4	21/09/2021	21-41744-11 XRF	7	-	-	5	16	19	47
VS111 VS112	0.3 - 0.4	10/11/2021	21-47343-1	1.9	0.057	11	3.9	8.35	10	44.3
VS112	0.3 - 0.4	10/11/2021	21-47343-2	3.6	0.033	16.7	9.49	14.4	13.5	49.7
VS114	0.3 - 0.4	10/11/2021	21-47343-3	3.7	0.026	19.4	8.48	14.8	15	49.9
VS115	0.3 - 0.4	10/11/2021	21-47343-4	7.4	0.023	19.5	5.2	15.2	14.5	52.4
VS116	0.3 - 0.4	10/11/2021	21-47343-5	5.6	0.021	20.7	6.9	16.1	15.9	51.2
VS117	0.3 - 0.4	10/11/2021	21-47343-6	9.2	0.044	19.4	6.1	20.7	15	67.5
VS118	0.3 - 0.4	10/11/2021	21-47343-7	5.3	0.048	17.7	10.4	18.9	15.2	64.7
VS119	0.3 - 0.4	10/11/2021	21-47343-8	4.2	0.053	20.8	13.5	23.4	18.7	75.4
VS120	0.3 - 0.4	10/11/2021	21-47343-9	10	0.036	22.2	11.7	24	18.6	66.9
VS121	0.3 - 0.4	10/11/2021	21-47343-10	10	0.03	17.9	6	18.9	13.6	61.4
VS122	0.3 - 0.4	10/11/2021	21-47343-11	9.4	0.038	17.3	6.6	17.1	14.7	61

### Notes:

All results in mg/kg

Bold - indicates exceeds adopted background criteria

1. Resource Management (National Environmental Standard for Assessing and Managing Contaminants in Soil to Protect Human Health) Regulations

2011 (NESCS). 2. NES SCS criteria presented are for Chromium (VI)

3. National Environment Protection Council (NEPC) (2013). National Environmental Protection (Assessment of Site Contamination) Measure 2013 Schedule C.

4. Environment Canterbury (Ecan 2007). Background Concentrations of selected trace elements in Canterbury Soils. Regional Recent

		Table 3: Stockpile (	Characterisa	ation Samp	le Analytic	al Results			
			Arsenic	Cadmium	Chromium	Copper	Lead	Nickel	Zinc
	SCS Resident	ial Land Use <sup>1</sup>	20	3	460 <sup>2</sup>	>10,000	210	400 <sup>3</sup>	7,400 <sup>3</sup>
	Backg	round <sup>4</sup>	12.58	0.19	22.7	20.3	40.96	20.7	93.94
Sample ID	Lab. ID	Comment							
ST200	21-41744-13	Disposed to Reserve	16.4	0.1	18.2	9.31	22.5	13.5	71.5
ST201	21-41744-14	Disposed to Reserve	17.2	0.1	19	9.45	23.1	13.9	71.6
ST202	21-41744-15	Disposed to Reserve	18.4	0.11	19.5	10.2	23.9	14.8	78.9
ST203	21-41744-16	Re-used	12	0.11	17.5	8.79	19.6	13.9	66.6
ST204	21-41744-17	Re-used	13.8	0.11	17.7	9.74	21.8	13.9	70.1
ST205	21-41744-18	Re-used	12	0.06	17.5	7.93	20.1	13.5	63.9
ST206	21-41744-19	Disposed to Reserve	16.8	0.15	18.9	9.92	22.7	15	74.2
ST207	21-41744-20	Disposed to Reserve	17.5	0.13	19.2	10.4	22.7	15.5	78.7
ST208	21-41744-21	Re-used	12	0.1	17.8	9.45	22.2	14.3	71.6
ST209	21-41744-22	Re-used	11	0.13	17.7	11.2	21.9	14.4	85.2
ST210	21-41744-23	Re-used	12	0.11	17	9.91	22.2	13.4	79.2
ST211	21-41744-24	Re-used	12.9	0.12	18.1	10.3	21.5	14.1	80.2
ST212	21-41744-25	Disposed to Reserve	16.4	0.11	17	9.03	20.9	12.9	69.1
ST213	21-41744-26	Disposed to Reserve	13.6	0.1	17	9.49	19.6	12.5	69.4
ST214	21-41744-27	Re-used	14.1	0.086	17.7	8.17	20.8	13.1	67.2
ST215	21-41744-28	Re-used	15	0.099	17.4	8.45	21.6	12.8	69.7
ST216	21-41744-29	Re-used	15.7	0.097	18.1	9.1	22.1	13.5	71.5
ST217	21-41744-30	Disposed to Reserve	17.1	0.11	18	9.56	22.4	13.3	71.2
ST218	21-41744-31	Disposed to Reserve	16.5	0.11	18	9.07	23	12.4	70.2
ST219	21-41744-32	Disposed to Reserve	16.5	0.13	17.6	10.9	22.4	13.4	75.1

#### Notes:

All results in mg/kg Bold - indicates exceeds adopted background criteria

Resource Management (National Environmental Standard for Assessing and Managing Contaminants in Soil to Protect Human Health) Regulations 2011 (NESCS).
 NES SCS criteria presented are for Chromium (VI)
 National Environment Protection Council (NEPC) (2013). National Environmental Protection (Assessment of Site Contamination) Measure 2013 Schedule C.
 Environment Canterbury (Ecan 2007). Background Concentrations of selected trace elements in Canterbury Soils. Regional Recent

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# MEMORANDUM

То:	Sovereign Palms Ltd
From:	Warren Sharp
Date:	29 April 2022
Subject:	Oakbridge Stage 1 - Topsoil

### Introduction

Sovereign Palms Ltd engaged Davis Ogilvie (DO) to prepare this memorandum setting out residual contaminant concentrations in topsoil present over Stage 1 of the Oakbridge Residential development.

The methodology and results of topsoil characterisation / validation over Stage 1 are detailed in the Stage 1 Site Validation Report (SVR); Davis Ogilive Report dated 6 October 2021, *Site Validation Report – Oakbridge Stage 1.* However, Davis Ogilive understand that further analysis of topsoil results was required to facilitate disposal of surplus soils resulting from individual Lot foundation excavations to cleanfill facilities.

### Background

As described in the SVR report, arsenic contamination in excess of Soil Contaminant Standards (SCS) for residential land use and related to a former sheep dip was present in shallow soils over the central northern portion of the Oakbridge Stage 1 development. Arsenic concentrations in excess of background were detected in shallow soils around and particularly to the west of the primary area of arsenic contamination. Cadmium concentrations in excess of background, also related to a former sheep dip, were present in shallow soils over the eastern portion of the development. Resource Consent RMA/2017/2059/A was granted by Christchurch City Council (CCC) for subdivision of the site, including a requirement to remediate the site to meet SCS for residential land use. As set out in the SVR the remedial works successfully removed arsenic impacted soils with residual concentrations exceeding SCS.

The development works in general required stripping of all topsoil along with a significant thickness of underlying silts in most areas of the site, with this process resulting in significant mixing of stripped topsoil both vertically and laterally. It was considered likely that such mixing would reduce the concentrations of any areas of residual contamination above background to less than background levels. With regards to topsoil this was verified via a combination of stockpile field screening and in particular by validation sampling of topsoil replaced on Lots over Stage 1. This memorandum presents a more in depth analysis of topsoil validation sampling results.

### **Topsoil Validation Sampling and Results**

Full details of the topsoil validation sampling methodology are set out in the SVR. In summary a total of 48 surface (0.0 - 0.15 m depth) soil samples were collected from placed topsoil on a random grid basis over the Stage 1 Lots. All collected samples were analysed for heavy metals using a X-Ray Fluorescence analyser (XRF), with 26 of these samples laboratory analysed as QA/QC on XRF results.

Topsoil validation results are summarised in Table 1 attached. To evaluate the data results have been compared to cleanfill acceptance criteria for most cleanfill sites in the Christchurch Region; typically 'regional recent' background values for those cleanfills in the groundwater recharge zone, and up to 'urban recent' background for cleanfill facilities in less sensitive areas. Relevant criteria are presented in Table 1.

The XRF typically reads less than laboratory results for most metals and as such XRF only results in Table 1 for arsenic, copper, and zinc have been adjusted on the basis of regression analysis (detailed in the SVR). Lead has not been adjusted as all results are well below relevant background values and adjustment was considered unlikely to change report conclusions. Nickel XRF results have not been adjusted as the XRF typically reads well above the laboratory for nickel and as such, primarily on the basis of the laboratory results, nickel was considered unlikely to exceed background. Cadmium and chromium are not well read by the XRF with laboratory only results relied upon. Statistical analysis of the topsoil validation results was undertaken using USEPA's Pro-UCL software.

Topsoil validation results can be summarised as follows:

- Arsenic Some individual results exceed adopted background values; however statistical analysis
  results in a 95% upper confidence limit (UCL) of 11.01 mg/kg, less than regional recent
  background.
- Cadmium All results less than regional recent background.
- Chromium Results for two samples exceed background. 95% UCL of 20.9 mg/kg is less than regional recent background.
- Copper Some individual results exceed background. 95% UCL of 16.14 mg/kg is less than regional recent background.
- Lead All results less than regional recent background.
- Nickel All results less than regional recent background.
- Zinc Some individual results exceed background. 95% UCL of 79.72 mg/kg is less than regional recent background.

### Conclusion

While residual concentrations of selected metals exceed adopted background in some individual samples, statistical analysis indicates topsoil over Stage 1 as a whole contains residual contamination less than 'regional recent' background values.

As such it is considered that surplus topsoil from Oakbridge Stage 1 foundation excavations would be suitable for disposal to any Christchurch cleanfill facility, subject to facility acceptance.

### Closure

I trust this satisfies your requirements at this time. This memorandum has been prepared on the specific instructions of Sovereign Palms Ltd regarding review of Oakbridge Stage 1 topsoil characterisation results. Davis Ogilvie Ltd accepts no liability to anyone other than Sovereign Palms Ltd in any way in relation to this memorandum and the content of it and any direct or indirect effect this report may have.

### Warren Sharp

Technical Director, CEnvP - SCS



Table 1: Oakbridge Stage 1 Topsoil										
				Arsenic	Cadmium	Chromium	Copper	Lead	Nickel	Zinc
Ac	ceptance Criteria	- Regional Recei	nt <sup>1</sup>	12.58	0.19	22.7	20.3	40.96	20.7	93.94
A	cceptance Criter	ia - Urban Recent	t <sup>1</sup>	16.3	0.2	22.7	20.3	128.8	20.7	166.8
Sample ID	95%	UCL	Method	11.01	-	20.9	16.14	-	-	79.72
Sample ID			XRF	8	-		12	21	25	53
VS79	0.0-0.15	30/04/2021	21-19831-12	8.4	0.17	20.7	12.8	23.5	14.2	66.2
VS80	0.0-0.15	30/04/2021	XRF	8	-	17.0	11	19	20	52
			XRF	<u> </u>	-	17.0	8	21.7	21	50
VS81	0.0-0.15	30/04/2021	21-19831-14	7.9	0.17	17.7	10.9	22	11.9	58.7
VS82	0.0-0.15	30/04/2021	XRF	11	-	20.1	13	23	18	53
	0.0.0.15	20/04/2024	XRF	11	-	20.1	13.2	24.6	14.6	50
VS83	0.0-0.15	30/04/2021	21-19831-16	11	0.16	18.5	13.3	24.5	13.5	58.6
VS84	0.0-0.15	30/04/2021	XRF	8	- 0.11	16	9	20	19	52
	0.0.0.15	20/04/2024	XRF	11	-	10	14	26	23	66
V585	0.0-0.15	30/04/2021	21-19831-18	9.9	0.11	20.2	13.8	25.7	15.5	70.2
VS86	0.0-0.15	30/04/2021	XRF	6	- 0.11	18.7	9.42	19	24	47
	0.0.0.15	20/04/2024	XRF	10	-	10.7	18	23.7	31	63
V587	0.0-0.15	30/04/2021	21-19831-20	15.7	0.13	20.7	21.4	27.5	17.1	85
VS88	0.0-0.15	30/04/2021	XRF	9	- 0.14	20.7	12	22	19	65
	0.0.0.15	20/04/2024	XRF	8	-	20.7	14	20	25	51
VS89	0.0-0.15	30/04/2021	21-19831-22	8.4	0.11	18.7	10.5	23.3	13.6	65.4
VS90	0.0-0.15	30/04/2021	XRF	10	- 0.12	20	13	21	22	60
	0.0.0.15	20/04/2024	XRF	3	-	20	4	15	21	45
VS91	0.0-0.15	30/04/2021	21-19831-24	4.1	0.028	14.8	4.3	15.5	10.3	50
VS92	0.0-0.15	30/04/2021	XRF	3	-	12.0	5	16	20	43
	0.0.0.15	20/04/2024	XRF	5	-	15.9	5.7	13.5	22	47
VS93	0.0-0.15	30/04/2021	21-19831-26	4.9	0.037	16.7	5.5	18.3	11.3	57.2
VS120	0.0-0.15	28/07/2021	XRF	9	- 0.1	21.1	14	26	24	63
VS121	0.0-0.15	28/07/2021	21-34409-1 XRF	7	-	21.1	7	23.8	10.0	112
VS122	0.0-0.15	28/07/2021	XRF	8	-		22	29	15	92
VS123	0.0-0.15	28/07/2021	XRF	13	-	22.4	16	28	16	77
	0.0.0.15	20/07/2024	XRF	10.5	-	23.4	13	26	16	76
VS124	0.0-0.15	28/0//2021	21-34409-3	13.4	0.12	22.7	18.4	33.1	20	94.2
VS125	0.0-0.15	28/07/2021	XRF	9.5	-		18	21	20	78
V3120	0.0-0.15	20/07/2021	XRF	11	-		24	24	16	73
VS127	0.0-0.15	28/07/2021	21-34409-4	15.3	0.13	22	35.1	29.8	19.1	96.8
VS128	0.0-0.15	28/07/2021	XRF	7	-		11	23	12	68
VS125 VS130	0.0-0.15	28/07/2021	XRF	9.5	-		13	24	20	84
VS131	0.0-0.15	28/07/2021	XRF	8	-		11	23	20	64
V(\$132	0.0-0.15	28/07/2021	21-34409-5 XRF	12 8	0.13	22.6	17.2	31.4	20.1 9	88.8 68
V6132	0.0.0.15	28/07/2021	XRF	11	-		16	26	21	73
V3133	0.0-0.13	28/07/2021	21-34409-6	13.7	0.13	23	18.1	33.2	20	89.6
VS134	0.0-0.15	28/07/2021	XRF	9.5	-		14	23	25 19	78 84
V\$135	0.0-0.15	28/07/2021	XRF	12	-	24	15	27	15	84
VS137	0.0-0.15	28/07/2021	XRF	9	-		13	23	16	61
V\$138	0.0-0.15	28/07/2021	21-34409-7 XRF	13.1 x	0.15	22.5	16.5 15	30.4 19	17.6 <9	82.7 70
V\$138	0.0-0.15	28/07/2021	XRF	11	-		14	21	22	78
VS140	0.0-0.15	28/07/2021	XRF	11	-		26	20	15	69
V\$141 V\$142	0.0-0.15	28/07/2021	XRF	13 11	-		26 16	23 17	22 <9	88 62.6
1/51/2	0.0.0.15	28/07/2021	XRF	10	-		12	23	15	67
V3143	0.0-0.15	20/07/2021	21-34409-8	12	0.12	20.4	15.8	28.3	18	85.6
VS144 VS145	0.0-0.15	28/07/2021	XRF	13 12			12	24	13 21	73 75
VS145	0.0-0.15	28/07/2021	XRF	8	-		9	17	<8	64
VS147	0.0-0.15	28/07/2021	XRF	7	-		9	24	21	79.5
VS148	0.0-0.15	28/07/2021	XRF 21-34409-9	6 7 2	- 0.14	21.1	10 11 4	19 26 2	18 14	48 67 9
VS149	0.0-0.15	28/07/2021	XRF	12	-		12	20	23	77
V\$150	0.0-0.15	28/07/2021	XRF	11	-		14	16	21	78
VS151	0.0-0.15	28/07/2021	XRF	12 12			20	9 20	22 21	81 59
VS152	0.0-0.15	28/07/2021	21-34409-10	15.7	0.13	22.2	23.2	30.3	19.1	89.1
Notes: All results in mo	r/ka									
Arsenic, copper	ль , zinc XRF only va	lues adjusted per	r regression							
1. Cleanfill acce	ptance criteria - f	rom Environment	Canterbury (Ec	an 2007). Bac	kground Cond	centrations of	selected trace	e elements in	Canterbury	
Solis. Urban Re	lent / кеgional Re	cent								

### **APPENDIX B**

Laboratory Reports



Analytica Laboratories Limited Ruakura Research Centre 10 Bisley Road Hamilton 3214, New Zealand Ph +64 (07) 974 4740 sales@analytica.co.nz www.analytica.co.nz

# Certificate of Analysis

Davis Ogilv	vie & Partners Ltd	Lab Reference:	21-19831		
Level 1 The	e Ricoh Building, 24 Moorhouse Ave	Submitted by: W Sharp			
Christchurg	ch 8011	Date Received:	03/05/2021		
		Testing Initiated:	3/05/2021		
Attention:	Warren Sharp	Date Completed:	6/05/2021		
Phone:	027 7007603	Order Number:			
Email:	warren@do.nz	Reference:	34300		
Sampling S	Site: Oakbridge				

### **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.

Specific testing dates are available on request.

### **Heavy Metals in Soil**

Client Sample ID			US69	US70	US71	US72	US73
	Da	te Sampled	30/04/2021	30/04/2021	30/04/2021	30/04/2021	30/04/2021
Analyte	Unit	Reporting Limit	21-19831-2	21-19831-3	21-19831-4	21-19831-5	21-19831-6
Arsenic	mg/kg dry wt	0.125	7.8	4.3	3.4	2.2	6.3
Cadmium	mg/kg dry wt	0.005	0.069	0.049	0.045	0.031	0.056
Chromium	mg/kg dry wt	0.125	16.9	13.2	13.3	10	12.9
Copper	mg/kg dry wt	0.075	9.12	5.4	6.0	4.8	5.2
Lead	mg/kg dry wt	0.25	18.2	13.3	10.9	9.79	13.8
Nickel	mg/kg dry wt	0.05	12.5	8.55	9.78	8.34	7.65
Zinc	mg/kg dry wt	0.05	73.9	46.7	45.2	37.9	43.6

### **Heavy Metals in Soil**

Client Sample ID			US74	US75	US76	US77	US78
	Da	te Sampled	30/04/2021	30/04/2021	30/04/2021	30/04/2021	30/04/2021
Analyte	Unit	Reporting Limit	21-19831-7	21-19831-8	21-19831-9	21-19831-10	21-19831-11
Arsenic	mg/kg dry wt	0.125	12	5.8	7.8	3.7	2.8
Cadmium	mg/kg dry wt	0.005	0.13	0.065	0.062	0.038	0.033
Chromium	mg/kg dry wt	0.125	17.8	14.7	17.9	16.2	17.2
Copper	mg/kg dry wt	0.075	9.74	7.70	6.7	4.8	5.8
Lead	mg/kg dry wt	0.25	22.6	17.0	20.0	16.3	20.2
Nickel	mg/kg dry wt	0.05	12.6	8.35	11.7	11.6	12.5
Zinc	mg/kg dry wt	0.05	64.9	45.1	62.9	65.2	60.5

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.

This test report shall not be reproduced except in full, without the written permission of Analytica Laboratories.



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### Heavy Metals in Soil

	Clien	t Sample ID	US79	US80	US81	US82	US83
	Da	te Sampled	30/04/2021	30/04/2021	30/04/2021	30/04/2021	30/04/2021
Analyte	Unit	Reporting Limit	21-19831-12	21-19831-13	21-19831-14	21-19831-15	21-19831-16
Arsenic	mg/kg dry wt	0.125	8.4	8.3	7.9	11	11
Cadmium	mg/kg dry wt	0.005	0.17	0.13	0.17	0.18	0.16
Chromium	mg/kg dry wt	0.125	20.7	17.8	17.7	20.1	18.5
Copper	mg/kg dry wt	0.075	12.8	10.8	10.9	13.2	13.3
Lead	mg/kg dry wt	0.25	23.5	21.7	22.0	24.6	24.5
Nickel	mg/kg dry wt	0.05	14.2	12.2	11.9	14.6	13.5
Zinc	mg/kg dry wt	0.05	66.2	62.2	58.7	61.9	58.6

### Heavy Metals in Soil

Client Sample ID		US84	US85	US86	US87	US88	
Date Sampled		30/04/2021	30/04/2021	30/04/2021	30/04/2021	30/04/2021	
Analyte	Unit	Reporting Limit	21-19831-17	21-19831-18	21-19831-19	21-19831-20	21-19831-21
Arsenic	mg/kg dry wt	0.125	9.1	9.9	8.2	15.7	10
Cadmium	mg/kg dry wt	0.005	0.11	0.11	0.11	0.13	0.14
Chromium	mg/kg dry wt	0.125	16.0	20.2	18.7	20.7	20.7
Copper	mg/kg dry wt	0.075	7.59	13.8	9.42	21.4	14.0
Lead	mg/kg dry wt	0.25	18.4	25.7	23.7	27.5	25.0
Nickel	mg/kg dry wt	0.05	11.2	15.5	13.1	17.1	16.2
Zinc	mg/kg dry wt	0.05	51.0	70.2	62.6	85.0	73.5

### Heavy Metals in Soil

	Clien	t Sample ID	US89	US90	US91	US92	US93
Date Sampled		30/04/2021	30/04/2021	30/04/2021	30/04/2021	30/04/2021	
Analyte	Unit	Reporting Limit	21-19831-22	21-19831-23	21-19831-24	21-19831-25	21-19831-26
Arsenic	mg/kg dry wt	0.125	8.4	10	4.1	3.3	4.9
Cadmium	mg/kg dry wt	0.005	0.11	0.12	0.028	0.033	0.037
Chromium	mg/kg dry wt	0.125	18.7	20.0	14.8	13.9	16.7
Copper	mg/kg dry wt	0.075	10.5	15.2	4.3	3.7	5.5
Lead	mg/kg dry wt	0.25	23.3	24.7	15.5	15.3	18.3
Nickel	mg/kg dry wt	0.05	13.6	15.6	10.3	10.1	11.3
Zinc	mg/kg dry wt	0.05	65.4	72.6	50.0	52.1	57.2

### Heavy Metals in Soil

Client Sample ID			US94	US60	US62	US64	US66
Date Sampled		30/04/2021	09/04/2021	09/04/2021	09/04/2021	09/04/2021	
Analyte	Unit	Reporting Limit	21-19831-27	21-19831-28	21-19831-29	21-19831-30	21-19831-31
Arsenic	mg/kg dry wt	0.125	2.4	1.2	12	8.6	4.8
Cadmium	mg/kg dry wt	0.005	0.019	0.033	0.046	0.032	0.027
Chromium	mg/kg dry wt	0.125	13.9	11	14.4	19.2	15.3
Copper	mg/kg dry wt	0.075	4.1	8.78	6.5	8.40	7.5
Lead	mg/kg dry wt	0.25	11.7	8.95	15.4	21.8	15.5
Nickel	mg/kg dry wt	0.05	10.6	10.6	9.55	14.9	12.0
Zinc	mg/kg dry wt	0.05	39.1	41.0	50.9	59.8	49.4

## **Method Summary**

**Elements in Soil** 

Samples dried and passed through a 2 mm sieve followed by acid digestion and analysis by ICP-MS. In accordance with in-house procedure based on US EPA method 200.8.

Emily Hanna, B.Sc. Trace Elements Team Leader



Analytica Laboratories Limited Ruakura Research Centre 10 Bisley Road Hamilton 3214, New Zealand Ph +64 (07) 974 4740 sales@analytica.co.nz www.analytica.co.nz

# Certificate of Analysis

Davis Ogilv	vie & Partners Ltd	Lab Reference: 21-41744				
Level 1 The	e Ricoh Building, 24 Moorhouse Ave	Submitted by: W. Sharp				
Christchurc	ch 8011	Date Received: 04/10/2021				
		Testing Initiated:	4/10/2021			
Attention:	Warren Sharp	Date Completed:	7/10/2021			
Phone:	027 7007603	Order Number:				
Email:	warren@do.nz	Reference:	34300			
Sampling S	Site: Oakbridge					

### **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.

Specific testing dates are available on request.

### **Heavy Metals in Soil**

	Client Sample ID		VS100	VS102	VS104	VS105	VS106
	Da	te Sampled	21/09/2021	21/09/2021	21/09/2021	21/09/2021	21/09/2021
Analyte	Unit	Reporting Limit	21-41744-1	21-41744-3	21-41744-5	21-41744-6	21-41744-7
Arsenic	mg/kg dry wt	0.125	7.0	6.3	11	13.9	8.4
Cadmium	mg/kg dry wt	0.005	0.030	0.048	0.084	0.087	0.033
Chromium	mg/kg dry wt	0.125	18.2	17.6	20.5	20.4	18.5
Copper	mg/kg dry wt	0.075	5.6	5.6	11.1	9.49	5.3
Lead	mg/kg dry wt	0.25	20.0	18.6	23.2	24.6	19.8
Nickel	mg/kg dry wt	0.05	12.0	10.8	16.4	15.1	13.1
Zinc	mg/kg dry wt	0.05	53.8	65.7	78.8	77.0	55.3

### Heavy Metals in Soil

	Client Sample ID		VS108	VS109	VS110	ST200	ST201
	Date Sampled		21/09/2021	21/09/2021	21/09/2021	21/09/2021	21/09/2021
Analyte	Unit	Reporting Limit	21-41744-9	21-41744-10	21-41744-11	21-41744-13	21-41744-14
Arsenic	mg/kg dry wt	0.125	7.3	8.8	8.7	16.4	17.2
Cadmium	mg/kg dry wt	0.005	0.042	0.044	0.027	0.10	0.10
Chromium	mg/kg dry wt	0.125	18.2	17.3	16.8	18.2	19.0
Copper	mg/kg dry wt	0.075	8.57	6.7	9.21	9.31	9.45
Lead	mg/kg dry wt	0.25	18.3	17.9	17.0	22.5	23.1
Nickel	mg/kg dry wt	0.05	15.1	14.1	14.9	13.5	13.9
Zinc	mg/kg dry wt	0.05	57.7	54.0	52.7	71.5	71.6

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.

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### Heavy Metals in Soil

	Client Sample ID			ST203	ST204	ST205	ST206
Date Sampled		te Sampled	21/09/2021	21/09/2021	21/09/2021	21/09/2021	21/09/2021
Analyte	Unit	Reporting Limit	21-41744-15	21-41744-16	21-41744-17	21-41744-18	21-41744-19
Arsenic	mg/kg dry wt	0.125	18.4	12	13.8	12	16.8
Cadmium	mg/kg dry wt	0.005	0.11	0.11	0.11	0.060	0.15
Chromium	mg/kg dry wt	0.125	19.5	17.5	17.7	17.5	18.9
Copper	mg/kg dry wt	0.075	10.2	8.79	9.74	7.93	9.92
Lead	mg/kg dry wt	0.25	23.9	19.6	21.8	20.1	22.7
Nickel	mg/kg dry wt	0.05	14.8	13.9	13.9	13.5	15.0
Zinc	mg/kg dry wt	0.05	78.9	66.6	70.1	63.9	74.2

### Heavy Metals in Soil

	Client Sample ID		ST207	ST208	ST209	ST210	ST211
	Da	te Sampled	21/09/2021	21/09/2021	21/09/2021	21/09/2021	21/09/2021
Analyte	Unit	Reporting Limit	21-41744-20	21-41744-21	21-41744-22	21-41744-23	21-41744-24
Arsenic	mg/kg dry wt	0.125	17.5	12	11	12	12.9
Cadmium	mg/kg dry wt	0.005	0.13	0.10	0.13	0.11	0.12
Chromium	mg/kg dry wt	0.125	19.2	17.8	17.7	17.0	18.1
Copper	mg/kg dry wt	0.075	10.4	9.45	11.2	9.91	10.3
Lead	mg/kg dry wt	0.25	22.7	22.2	21.9	22.2	21.5
Nickel	mg/kg dry wt	0.05	15.5	14.3	14.4	13.4	14.1
Zinc	mg/kg dry wt	0.05	78.7	71.6	85.2	79.2	80.2

### Heavy Metals in Soil

	Clien	t Sample ID	ST212	ST213	ST214	ST215	ST216
	Date Sampled		21/09/2021	21/09/2021	21/09/2021	21/09/2021	21/09/2021
Analyte	Unit	Reporting Limit	21-41744-25	21-41744-26	21-41744-27	21-41744-28	21-41744-29
Arsenic	mg/kg dry wt	0.125	16.4	13.6	14.1	15.0	15.7
Cadmium	mg/kg dry wt	0.005	0.11	0.10	0.086	0.099	0.097
Chromium	mg/kg dry wt	0.125	17.0	17.0	17.7	17.4	18.1
Copper	mg/kg dry wt	0.075	9.03	9.49	8.17	8.45	9.10
Lead	mg/kg dry wt	0.25	20.9	19.6	20.8	21.6	22.1
Nickel	mg/kg dry wt	0.05	12.9	12.5	13.1	12.8	13.5
Zinc	mg/kg dry wt	0.05	69.1	69.4	67.2	69.7	71.5

### Heavy Metals in Soil

	Clien	t Sample ID	ST217	ST218	ST219
	Date Sampled			21/09/2021	21/09/2021
Analyte	Unit	Reporting Limit	21-41744-30	21-41744-31	21-41744-32
Arsenic	mg/kg dry wt	0.125	17.1	16.5	16.5
Cadmium	mg/kg dry wt	0.005	0.11	0.11	0.13
Chromium	mg/kg dry wt	0.125	18.0	18.0	17.6
Copper	mg/kg dry wt	0.075	9.56	9.07	10.9
Lead	mg/kg dry wt	0.25	22.4	23.0	22.4
Nickel	mg/kg dry wt	0.05	13.3	12.4	13.4
Zinc	mg/kg dry wt	0.05	71.2	70.2	75.1

## **Method Summary**

Elements in Soil

Samples dried and passed through a 2 mm sieve followed by acid digestion and analysis by ICP-MS. In accordance with in-house procedure based on US EPA method 200.8.

Sharelle Frank, B.Sc. (Tech) Technologist



Analytica Laboratories Limited Ruakura Research Centre 10 Bisley Road Hamilton 3214, New Zealand Ph +64 (07) 974 4740 sales@analytica.co.nz www.analytica.co.nz

# Certificate of Analysis

Davis Ogilv	vie & Partners Ltd	Lab Reference: 21-47343		
Level 1 The	e Ricoh Building, 24 Moorhouse Ave	Submitted by: W.Sharp		
Christchurc	ch 8011	Date Received: 12/11/2021		
		Testing Initiated:	12/11/2021	
Attention:	Warren Sharp	Date Completed:	16/11/2021	
Phone:	027 7007603	Order Number:		
Email:	warren@do.nz	Reference:	34300	
Sampling S	Site: Oakbridge Stg2			

### **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.

Specific testing dates are available on request.

### Heavy Metals in Soil

	Client Sample ID		VS112	VS113	VS114	VS115	VS116
	Date Sampled		10/11/2021	10/11/2021	10/11/2021	10/11/2021	10/11/2021
Analyte	Unit	Reporting Limit	21-47343-1	21-47343-2	21-47343-3	21-47343-4	21-47343-5
Arsenic	mg/kg dry wt	0.125	1.9	3.6	3.7	7.4	5.6
Cadmium	mg/kg dry wt	0.005	0.057	0.033	0.026	0.023	0.021
Chromium	mg/kg dry wt	0.125	11	16.7	19.4	19.5	20.7
Copper	mg/kg dry wt	0.075	3.9	9.49	8.48	5.2	6.9
Lead	mg/kg dry wt	0.25	8.35	14.4	14.8	15.2	16.1
Nickel	mg/kg dry wt	0.05	10.0	13.5	15.0	14.5	15.9
Zinc	mg/kg dry wt	0.05	44.3	49.7	49.9	52.4	51.2

### Heavy Metals in Soil

Client Sample ID		VS117	VS118	VS119	VS120	VS121	
Date Sampled		10/11/2021	10/11/2021	10/11/2021	10/11/2021	10/11/2021	
Analyte	Unit	Reporting Limit	21-47343-6	21-47343-7	21-47343-8	21-47343-9	21-47343-10
Arsenic	mg/kg dry wt	0.125	9.2	5.3	4.2	10	10
Cadmium	mg/kg dry wt	0.005	0.044	0.048	0.053	0.036	0.030
Chromium	mg/kg dry wt	0.125	19.4	17.7	20.8	22.2	17.9
Copper	mg/kg dry wt	0.075	6.1	10.4	13.5	11.7	6.0
Lead	mg/kg dry wt	0.25	20.7	18.9	23.4	24.0	18.9
Nickel	mg/kg dry wt	0.05	15.0	15.2	18.7	18.6	13.6
Zinc	mg/kg dry wt	0.05	67.5	64.7	75.4	66.9	61.4

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.

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### Heavy Metals in Soil

	VS122		
	Da	10/11/2021	
Analyte	Unit	Reporting Limit	21-47343-11
Arsenic	mg/kg dry wt	0.125	9.4
Cadmium	mg/kg dry wt	0.005	0.038
Chromium	mg/kg dry wt	0.125	17.3
Copper	mg/kg dry wt	0.075	6.6
Lead	mg/kg dry wt	0.25	17.1
Nickel	mg/kg dry wt	0.05	14.7
Zinc	mg/kg dry wt	0.05	61.0

### **Method Summary**

**Elements in Soil** 

Samples dried and passed through a 2 mm sieve followed by acid digestion and analysis by ICP-MS. In accordance with in-house procedure based on US EPA method 200.8.

Sharelle Frank, B.Sc. (Tech) Technologist