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Dear Dominique

XRF SURVEY OF A FUN PLACE TO BE

1.0 Introduction

Waikato Regional Council (WRC) has engaged Pattle Delamore Partners Limited (PDP) to undertake an x-ray fluorescence (XRF) survey of A Fun Place To Be to identify the concentration of trace elements in surface soils at this site. WRC, on request from the Ministry of Education, has commissioned this work because elevated concentrations of arsenic (and in some other cases antimony, lead and thallium) were found in surface soils on the roadside verges near the Thames Early Childhood Education Centre and Moanataiari School.

The aim of this investigation was to use a screening method (XRF) to identify areas of low, medium and high trace element concentrations (particularly arsenic) to assist with the prioritisation of sites for further investigation.

2.0 Methodology

To determine the concentration of trace elements, an XRF instrument was used to test the surface soils. All XRF measurements were undertaken by a licensed XRF operator.

The XRF measurements were not undertaken in accordance with US EPA protocol 6200. Rationale for this is because the purpose of this investigation was only to identity areas of high trace element concentrations from areas of low trace element concentrations. Specifically, measurements were taken in-situ rather than being collected and sieved through a minus 2 mm sieve and dried before XRF measurements were undertaken. The consequence of the methodology undertaken is that the in-situ soils will likely have higher moisture content than laboratory analysed samples and may have included material greater than 2 mm (i.e. gravels). Furthermore, higher moisture content of the in-situ soils and the presence of gravels in the sample may result in the XRF measurements being slightly reduced. Thus the results provided should be regarded as only indicative of the concentration of target elements in the soils.

A total of eight XRF measurements were carried out by PDP, the measurement locations and dates are provided below;

- Five XRF readings were taken from the grassed area of the childcare centre (1 December 2011); and
- Three XRF readings were taken from the garden at the childcare centre (1 December 2011).

Figure L1 shows all XRF measurement locations with arsenic readings.

As discussed above, the XRF is only a field screening tool and due to the methodology used (compared with the standard methodology), there is a higher level of measurement uncertainty (greater than 30%). Results obtained should therefore not been compared to any New Zealand (or where applicable International) soil guidelines or standards for human health assessments to assess compliance or non-compliance with the soil guideline or standard. To assess both potential health risks; and compliance with any applicable soil guideline value or standard for human health protection, soil sampling will need to be undertaken and sent to an IANZ accredited laboratory for analysis.

The XRF measurement locations were recorded using a GPS (x-y positional RMS, error less than 10 m). GPS locations were obtained so that any sampling site could be revisited should further sampling be required (for example, an area with elevated arsenic concentrations (known as a hotspot[1]).

A small hole 0.1m in diameter was dug to a depth of approximately 0.1m to expose the soil below the root zone of the grass. The portable XRF instrument was placed on the exposed soil to ensure that the X-ray window was in full contact with the soil. XRF readings were taken for a minimum 90 seconds. The X-ray window was cleaned between sampling locations in accordance with the XRF manufacturer's Manual.

3.0 Results

For the trace elements which were reliably detected by the XRF (arsenic, copper, chromium, iron, lead, manganese and zinc) only arsenic and lead were found to exceed New Zealand (or where applicable International) soil guidelines or standards for human health assessments. The concentrations of arsenic and lead have therefore only been compiled and discussed in this report (see Table L1). An electronic copy of the full multi-element analysis has been provided to Waikato Regional Council (WRC file reference DM2093695) and is not included in this report.

The XRF data collected during this survey has been grouped into two areas of distinct use, based on soil type, likely exposure scenario, and if there was a hotspot detected. The two areas of distinct use were:

1. The grassed area (fun01 to fun05), and
2. The garden (fun06 to fun08).

3.1 Traffic Light Assessment

The aim of this work is to assess the site as either a low, medium or high priority area for further investigation. For child care centres, the term 'further investigation' may include the possibility of developing a site specific soil contaminant standard. To present these results, a 'traffic light" assessment tool has been developed to rank the sample locations. The traffic light system is based upon the likelihood that the average concentration, obtained from XRF measurements for a given assessment area, is likely to exceed Soil Contaminant Standard (SCS) values based on the 'Methodology for Deriving Standards for Contaminants in Soil to Protect Human Health (MfE, 2011).

MfE, 2011 does not provide a specific standard for schools or childcare centres. Thus, for the purposes of carrying out a first "screening" comparison it has been assumed that one of the standard guideline scenarios is valid for this investigation. For example, a residential value has been used for a childcare centre or primary school. A residential value is anticipated to provide a conservative analysis because it assumes more frequent exposure to soil than the

[1] For the purpose of this report a hotspot is any value which; is either more than three times the SCS or when the average of the site exceeds the SCS; or any value which is more than 3.5 times the average concentration of that exposure area.

exposure that is likely to occur at a school or childcare centre (seven days per week for most weeks in a year rather than the maximum five days per week at a school or childcare centre). This assumption also includes a greater allowance for exposure to home-grown produce than is likely to occur even if a school has a vegetable garden. Similarly, the recreational guideline value has been used for a secondary school playing field (MfE, 2011) on the basis that human contact with the soil of the playing field is more appropriate to recreational use than residential use.

3.1.1 Green: Low Priority for Further Investigation

A sample that represents a "green status" indicates that the results obtained by XRF suggest that arsenic concentrations are likely to be low, and if soil samples were analysed by the conventional method, they would be likely to fall below the SCS for recreational areas (parks) (for secondary schools) or the standard for residential soils (primary schools).

3.1.2 Orange: Medium Priority for Further Investigation

An "orange status" is assigned to a sample location when results by XRF suggest that arsenic concentrations are moderately elevated for that land use, and may equal or marginally exceed the SCS for recreational areas (for secondary schools) or the SCS for residential areas (primary schools). Due to the measurement uncertainty of the XRF method used in this investigation, 'moderately elevated' is defined by the average of readings that appear to exceed the nominated standard by up to 20 mg/kg – i.e. up to 40 mg/kg for a primary school and up to 100 mg/kg for a secondary school.

3.1.3 Red: High Priority for Further Investigation

A "red status" is given when indicative results by XRF suggest that either:

- Average arsenic concentrations across all samples from a school are likely to be a multiple of the SCS; and
- One or more 'hot spot' sites are located on the school where samples are likely to be a multiple of the SCS.

4.0 Discussion

The results obtained from this investigation have been compiled together into the two different areas of distinct use (see Section 3.0). The average arsenic and lead concentrations for each area of distinct use have then been calculated. When concentrations of arsenic or lead were below the instrumental detection limit then the value of the published detection limit (9 mg/kg for arsenic and 13 mg/kg for lead) has been used to calculate the average concentration of that element in soils. The interpretation of the areas of distinct use is discussed below.

4.1 The Grassed Area

The concentrations of arsenic in two of the samples collected from the grassed area were lower than the XRF instrument's detection limit (approximately 9 mg/kg). The average arsenic and lead concentrations measured over the five XRF samples was 11 mg/kg (ranging from below the limit of detection (9 mg/kg) to 15 mg/kg) and 27 mg/kg (ranging from 19 mg/kg to 33 mg/kg) respectively. Based on the sample test results, the average concentration of arsenic in the surface soils is lower than the SCS for arsenic in residential soils of 20 mg/kg and the average concentration of lead is lower than the SCS for lead in residential soils of 210 mg/kg. For these reasons, this area is not a high priority for further investigations **(Green light)**.

4.2 The Garden

The concentrations of arsenic in the three samples collected from the garden were below or at the XRF instrument's detection limit (approximately 9 mg/kg). The concentration of one of the samples of lead (fun07) was also lower than

the XRF instrument's detection limit (approximately 13 mg/kg). The other two samples had a lead concentration of 16 mg/kg and 13 mg/kg respectively. For these reasons, this area is a low priority for further investigations (**Green light**).

5.0 Conclusion

An XRF survey of the grassed and garden areas of the A Fun Place To Be was undertaken in December 2011. The survey found the following:

1. The back grassed area is a low priority for further investigations (green light); and
2. The garden area is a low priority for further investigations (green light).

6.0 References

MfE, 2011. *Methodology for Deriving Standards for Contaminants in Soil to Protect Human Health* Office of the Minister for the Environment.

Yours faithfully

PATTLE DELAMORE PARTNERS LIMITED

Georgina Chase

Environmental Geologist

Keith Delamore

Director

Table L1: X-Ray Fluoresence (XRF) Raw Data A Fun Place to be Childcare				
Location	**Sample**	**Units**	**Arsenic (As)**	**Lead (Pb)**
Grassed area	fun01	ppm	9	32
	fun02	ppm	13	26
	fun03	ppm	15	33
	fun04	ppm	11	19
	fun05	ppm	9	26
Garden	fun06	ppm	9	16
	fun07	ppm	9	13
	fun08	ppm	8	13
Statisitical Analysis of Raw XRF Data from A Fun Place to be Childcare				
Location	**Statistic**	**Units**	**Arsenic (As)**	**Lead (Pb)**
Grassed area	COUNT		5	5
	AVERAGE	ppm	11	27
	MIN	ppm	<LOD	19
	MAX	ppm	15	33
Garden	COUNT		3	3
	AVERAGE	ppm	<LOD	14
	MIN	ppm	<LOD	<LOD
	MAX	ppm	8	16

Notes:

Measurement below the level of measurement of the XRF. The value is set as equal to the estimated detection limit.

Count = number of samples

<LOD = below limit of detection

SOURCE: AERIAL IMAGERY SUPPLIED BY THAMES-COROMANDEL DISTRICT COUNCIL.
CADASTRAL INFORMATION DERIVED FROM LINZ DATA.

FIGURE L1 : A FUN PLACE TO BE CHILDCARE XRF SAMPLING LOCATIONS WITH ARSENIC RESULTS

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