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Dear Dominique

XRF SURVEY OF SAINT FRANCIS SCHOOL, THAMES

1.0 Introduction

Waikato Regional Council (WRC) has engaged Pattle Delamore Partners Limited (PDP) to undertake an x-ray fluorescence (XRF) survey of St Francis School to identify the concentration of trace elements in surface soils at these sites. 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) have been found in surface soils on the roadside verges near the schools in the Moanataiari area and some soil testing undertaken by WRC in 2007 found elevated concentrations of arsenic in some schools playing field.

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 18 XRF measurements were carried out by PDP on 29 November 2011, the measurement locations are provided below;

- Three readings of a small vegetable garden on the northern side of the school,

- Three readings in the grassed lawn area outside the old parish house and the grass lawn area of the northern side of the school,
- Three readings of the triangular grass area near the playground on the eastern side of the school, and
- Nine readings from the main playfields on the southern side of the school.

Figure B1 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 the samples 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 B1). 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 three areas of distinct use, based on soil type, likely exposure scenario, and if there was a hotspot detected. These four areas of distinct use (with samples in brackets) were:

1. The small vegetable garden on the northern side of the school (stf01-stf03),
2. The grassed area northern side of the school include the old parish house (Stf04-stf06),
3. The grassed area near the playground (stf07, stf17 & stf18), and
4. The main playing field (stf08 –stf16).

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 primary schools, the term 'further investigation' may include the possibility of developing a site specific soil

[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.

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 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 together with the results have been compiled together into the three different areas of distinct use (see Section 3.0). The average arsenic and lead concentrations for each area of distinct has 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 Vegetable Gardens on the Northern Side of the School

Results of the XRF survey undertaken by PDP on 29 November 2011 indicate that the average arsenic concentration in the soil of the gardens is likely to be lower than SCS for arsenic in residential soils of 20 mg/kg.

Since, low concentrations of arsenic and lead were detected in all of the samples collected from the gardens, the garden area has been assessed as being a low priority for further investigations **(Green light).**

4.2 Northern Grassed Areas of the School Grounds (including the grassed area near the old Parish House)

The concentration of arsenic in all three XRF samples taken in this area was less than the instrumental detection limit (9 mg/kg). However, at one sampling location (stf05) the concentration of lead (400 mg/kg) was higher than the SCS for lead in residential soils of 210 mg/kg. It is possible that this elevated lead in the soil near the old parish house might come from lead based paint that could have been used historically on the outside of the house. Therefore, further soil sampling may be needed in this area

As a result of these measurements, part of the site near the old parish house has been assessed as being a medium priority for further investigations **(Orange light)** on the basis of high lead results in one sample**.** Further investigations could include undertaking soil sampling and then analysis at an IANZ accredited laboratory. With respect to the concentration of arsenic found in the soils of the northern grassed areas the site would be classified low priority for further investigations **(Green light**).

4.3 Grassed Areas on the Eastern Side of the School near the playground

The average concentration of arsenic and lead measured over three samples was 106 mg/kg (ranged from 29 mg/kg to 247 mg/kg) and 161 mg/kg (ranged from 127 to 183 mg/kg) respectively. A single soil sample (srt07) had an arsenic concentration of 247 mg/kg, which is more than 10 times the SCS for residential soils (20 mg/kg for arsenic). It should be noted that the other two samples collected from this area had much lower arsenic concentrations (29 and 40 mg/kg) but the concentration of arsenic in those samples are higher than the SCS for arsenic in residential soils. As a result of these findings, the grassed areas on the eastern side of the school near the playground have been assessed as being a high priority for further investigations (**Red light**).

4.4 Main Playing Field

The average concentrations of arsenic in the nine samples measured in the main playing fields was 21 mg/kg (ranged from less than 9 mg/kg to 39 mg/kg). Five of the nine sampling locations measured using the XRF had arsenic concentrations greater than the SCS for arsenic in residential soils of 20 mg/kg. The average concentration of lead in the nine samples was 57 mg/kg and no samples exceeded the SCS for lead in residential soil of 210 mg/kg (samples ranged from 25 to 137 mg/kg).

On the basis of the concentration of arsenic found in these soils the main playing field has been assessed as being a medium priority for further investigations **(Orange light).**

5.0 Conclusion

An XRF survey of the grassed areas of the St Francis School grounds was undertaken in 29 November 2011. The survey found the following:

1. Vegetable gardens to the north side of the school building are a low priority for further investigations (green light).
2. The grassed area near the old parish house is a medium priority for further investigations (orange light).
3. Grassed areas on the eastern side of the school buildings near the playgrounds are a high priority for further investigation (red light)

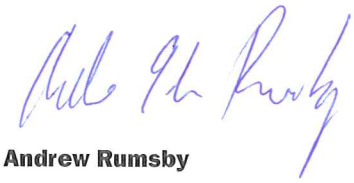
4. The main playing fields to the south of the school buildings are a medium priority for further investigations (orange light).

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



Andrew Rumsby

Environmental Chemist

Keith Delamore

Director

Table B1: X-Ray Fluoresence (XRF) Raw Data St Francis School				
Location	**Sample**	**Units**	**Arsenic (As)**	**Lead (Pb)**
Vegetable garden on northern side of the school	stf01	ppm	9	24
	stf02	ppm	10	10
	stf03	ppm	9	10
Grassed area and parish house on northern side of the school	stf04	ppm	9	61
	stf05	ppm	9	400
	stf06	ppm	9	22
Grassed area near the playground	stf07	ppm	247	183
	stf17	ppm	40	172
	stf18	ppm	29	127
Main playing field	stf08	ppm	21	66
	stf09	ppm	19	69
	stf10	ppm	9	29
	stf11	ppm	9	61
	stf12	ppm	23	44
	stf13	ppm	15	25
	stf14	ppm	23	52
	stf15	ppm	36	137
	stf16	ppm	39	32
Statistical Analysis of XRF Data from St Francis Catholic School				
Location	**Statistic**	**Units**	**Arsenic (As)**	**Lead (Pb)**
Vegetable garden on northern side of the school	COUNT		3	3
	AVERAGE	ppm	9	15
	MIN	ppm	<LOD	10
	MAX	ppm	10	24
Grassed area and parish house on northern side of the school	COUNT		3	3
	AVERAGE	ppm	<LOD	161
	MIN	ppm	<LOD	22
	MAX	ppm	<LOD	400
Grassed area near the playground	COUNT		3	3
	AVERAGE	ppm	106	161
	MIN	ppm	29	127
	MAX	ppm	247	183
Main playing field	COUNT		9	9
	AVERAGE	ppm	21	57
	MIN	ppm	<LOD	25
	MAX	ppm	39	137

Notes:

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

<LOD = below limit of detection

Count = number of samples

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

FIGURE B1 : ST FRANCIS CATHOLIC SCHOOL XRF SAMPLING LOCATIONS WITH ARSENIC RESULTS