

Baseline Environmental Monitoring, Program 2: Aquatic Organisms Sampling – Exploration Permit #51985 at Puhipuhi, Northland

Evolution Mining Pty Limited

Baseline Environmental Monitoring, Program 2: Aquatic Organisms Sampling - Exploration Permit #51985 at Puhipuhi, Northland

✦ Prepared for

Evolution Mining Pty Limited

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Executive Summary

Pattle Delamore Partners Ltd (PDP) was engaged by Evolution Mining New Zealand Pty Ltd (ENZ) in 2016 to undertake an environmental baseline assessment for the ENZ tenement area (Exploration Permit #51985) at Puhipuhi, Northland. Several reports have been produced to document the work.

This report discusses the levels of inorganic elements contaminants (arsenic, cadmium, and mercury) in aquatic organisms (fresh water crayfish, shortfin eels, and shellfish) within the permit area and in downstream catchments. A companion report on baseline water and sediment quality (PDP, 2016) should be read in conjunction with this report.

Tissue sampling (freshwater crayfish (Koura), shortfin eels and shellfish) for heavy metal contaminants was completed at 13 sites both within and outside the tenement boundary. A Sampling Analysis Plan was used to ensure the integrity of the sampling locations.

PDP found that concentrations of arsenic were at low or non-detect levels within freshwater crayfish within the tenement and within shortfin eels immediately downstream of the tenement. In contrast, localised elevated arsenic concentrations were found in shellfish in the Kaipara Harbour.

Cadmium concentrations were below the NZFSA guideline criteria (2.0 mg/kg for shellfish and 0.5 mg/kg for crustacean muscle tissue) in aquatic organisms sampled. This finding is consistent with the low or not detected cadmium concentrations found in surface water and sediments in accompanying investigations (PDP, 2016).

Mercury concentrations in tissue samples from crayfish within the tenement boundary were above the NZFSA guideline criteria (0.5 mg/kg) in the immediate area surrounding an historic mine site. Mercury concentrations at the same site also exceeded guideline values of ANZECC (2000) for 99% ecosystem protection in surface water and interim sediment quality guidelines (ISQG-high) in sediments. Mercury concentrations in other aquatic organisms sampled showed variable results that could not readily be correlated with sediment mercury levels at the sample sites.

Mercury concentrations in freshwater crayfish are highest at site PUX, the northernmost sampling location, closest to the historic mercury mine. Similarly, the highest concentrations of mercury in sediment and surface water were observed at PUX.

Beyond the immediate area of the historic mine site, there is no clear correlation between mercury concentrations in sediment and mercury concentrations in the tissue of aquatic organisms. However, shortfin eels from 2 sample sites near the tenement area showed greater concentration of mercury (0.6 to 0.8 mg/kg)

compared to shortfin eels from 2 sites further downstream, which contained between 0.1 – 0.25 mg/kg. The lower concentrations are similar to those described by NZFSA (MAF, 2011) for shortfin and longfinned eels.

Based on an assessment of human exposure to methyl mercury as a result of consuming eels, it is recommended that consumption of shortfin eels from the Puhipuhi area is limited to less than 3.5 servings of 150 grams per month for a 70 kg adult. It is recommended that freshwater crayfish collected from within the catchments sampled are not regularly consumed as part of an individual's regular diet.

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Note on Terms Used in this Report

Elements

The focus of this report is on concentrations of fifteen inorganic elements: antimony (Sb), arsenic (As), boron (B), cadmium (Cd), chromium (Cr), Cobalt (Co), copper (Cu), iron (Fe), manganese (Mn), mercury (Hg), nickel (Ni), lead (Pb), thallium (Th) and zinc (Zn). Sometimes antimony, arsenic, cadmium, chromium, cobalt, copper, nickel, manganese, mercury, lead, thallium and zinc are referred to as 'heavy metals.' However, this term is falling out of favour because it is an ambiguous one. A range of different definitions for 'heavy metal' exists in the scientific literature and the group of elements covered by that term changes depending on the definition used. Therefore the more general term "elements" is used in this report to describe both the metals and metalloids (arsenic, antimony, and boron) listed above.

Elevated Concentrations

Elements occur naturally. When their concentrations are higher than typical New Zealand background concentrations, they are usually referred to as being **elevated**. This can be caused by either natural chemical or physical processes or by the addition of substances into the environment by human activities.

Note on Guidelines Used in this Report for Arsenic, Cadmium Mercury Concentrations in Fish

The maximum allowable concentrations of inorganic elements such as arsenic, cadmium and mercury detected in aquatic organism samples are specified in the New Zealand Food Safety Authority (NZFSA) Animal Products (Contaminant Specifications) Notice 2016 Maximum Permissible Levels (MPLs) and the Australian New Zealand Food Standards Code – Schedule 19-7 (see Table below for the mean and maximum levels of mercury in fish).

Mean and Maximum Levels of Mercury in Fish, Crustacea and Molluscs (from Australian New Zealand Food Standards Code – Schedule 19-7)			
For:	If:	The mean level of mercury in sample units must be no greater than:	The maximum level of mercury in any sample unit must be no greater than:
gemfish, billfish (including marlin), southern bluefin tuna, barramundi, ling, orange roughy, rays and all species of shark	(a) both of the following are satisfied: (i) 10 or more sample units are available; (ii) the concentration of mercury in any sample unit is greater than 1.0 mg/kg.	1.0 mg/kg	1.5 mg/kg
	(b) 5 sample units are available	1.0 mg/kg	(no level set)
	(c) there are insufficient samples to analyse in accordance with subsection S19—7(2).		1.0 mg/kg
other fish, fish products, crustacea, and molluscs	(a) both of the following are satisfied: (i) 10 or more sample units are available; (ii) the concentration of mercury in any sample unit is greater than 1.0 mg/kg.	0.5 mg/kg	1.5 mg/kg
	(b) 5 sample units are available	0.5 mg/kg	(no level set)
	(c) there are insufficient samples to analyse in accordance with subsection S19—7(2).		1.0 mg/kg

The New Zealand Food Safety Authority (NZFSA) Animal Products (Contaminant Specifications) Notice 2016 and the Australian New Zealand Food Standards Code only applies to commercially caught fish species and is not legally enforceable for wild caught foods and foods collected as part of customary rights. In this report, an initial screening criterion of 0.5 mg/kg for other fish/fish products/crustacea and molluscs specified in the New Zealand Food Safety Authority (NZFSA) Animal Products (Contaminant Specifications) Notice 2016 Maximum Permissible Levels (MPLs). This value has been used because the amounts of fish and freshwater crayfish collected within this study are far less than the amounts of fish specified within the Australian New Zealand Food Standards Code and the study focus on wild caught eels and freshwater crayfish rather than commercially sold fish.

Recently, MPI has moved away from enforcing particular food standards for mercury in fish to providing guidance on how often people can safely consume certain types of fish species without the consumer exceeding the WHO reference health standard for methyl mercury in food (1.6 µg/kg bw/week) (see <https://www.mpi.govt.nz/food-safety/pregnant-and-at-risk-people/food-and-pregnancy/list-of-safe-food-in-pregnancy/>). MPI recommends that for:

- a) That for fish which contains mercury concentrations up to 0.2 mg/kg, that there are no restrictions on the amount of fish that can be consumed.
- b) Fish whose mercury concentrations are between 0.20 to 0.5 mg/kg that consumption of these types of fish is restricted to 3 to 4 serving per week.
- c) Fish which contains mercury concentrations of greater than 0.5 mg/kg that consumption of these fishes should be restricted to one serving every 1 to 2 weeks.

This approach would also be the most appropriate way of managing an individual's mercury exposure from the consumption of wild foods caught within the Puhipuhi area.

For these calculations, MPI assumes that a serving size of 150 grams is consumed per meal of fish. It should be noted the WHO health standard and the MPL are designed to protect consumers from chronic (long term) exposure to mercury compounds rather than from one-off (acute) or occasional exposure to mercury.

In this report, a risk assessment has been undertaken to determine the amount of eels and freshwater crayfish that could be consumed safely without exceeding the JECFA revised the Provisional Tolerable Weekly Intake (PTWI) for methyl mercury to 1.6 µg/kg bw/week (WHO, 2003). In this assessment a serving size of 150 grams has been assumed to keep the methodology consistent with the methodology used by MPI for its recommendations of safe levels of fish consumption.

Glossary¹

Baseline study – Data collected to document existing conditions.

IANZ – International Accreditation New Zealand. This organisation undertakes independent assessments of laboratories to verify that they have appropriate quality assurance/quality control method to assure that the analysis is undertaken in accordance with international best practice.

JECFA – Joint FAO/WHO Expert Committee on Food Additives. JECFA is an international expert scientific committee administered jointly by the Food and Agriculture and the World Health Organisation. For further information on the JECFA see http://www.who.int/foodsafety/areas_work/chemical-risks/FactSheet-whatIsJECFA.pdf?ua=1.

MPL – Maximum Permissible Level. The highest level of metal contaminants that is legally tolerated in, or on, a food which is intended for human consumption in NZ. MPL are designed to protect consumers from the risk of chronic dietary exposure to metals. MPLs are set by the Ministry of Primary Industries and are based on recommendations set by the WHO/FAO which are published in Codex Alimentarius.

NZTDS – New Zealand Total Diet Survey. The NZTDS assesses exposure to chemical residues, contaminants, and selected nutrients from foods representative of the average diet within the New Zealand population.

Parameter – Any variable that can be measured, e.g. nitrate.

PTWI – Provisional Tolerable Weekly Intake. The maximum acceptable level of contaminants and naturally occurring toxicants that can be consumed (via ingestion) on a weekly basis. These values are set by the Joint FAO/WHO Expert Committee on Food Additives (JECFA).

Quality Assurance (QA) – Evaluation of data collection and analysis techniques to ensure correct procedures was followed.

Sediment – Particles of sand, clay, silt, and plant or animal matter carried in water.

Serving – the amount of food that is enough for one person. The NZTDS defines a serving as being 150 grams for an adult.

Tributary – A stream or river that flows into a larger stream or river.

¹ Primary sources:

Government of British Columbia, Ministry of Environment, Glossary of Water Quality Terms <http://www.env.gov.bc.ca/wat/wq/reference/glossary.html#index> accessed 05/02/16, and;

Wai Care Manual Book 6 - Fact Sheets, Wai Care, 2003.

1.0 Introduction

Pattle Delamore Partners Ltd (PDP) has been engaged by Evolution Mining NZ Pty Limited (ENZ) to undertake an assessment of metal contaminants in the tissues of aquatic organisms within their Puhipuhi gold exploration tenement and at a number of selected sites in the upper and middle reaches of the Wairua River. The primary aim of this programme is to provide defensible and high quality baseline data prior to any exploration-related environmental disturbance at Puhipuhi, Northland.

This report presents the results of the sampling of aquatic organisms undertaken at 13 sites in March and April 2016.

2.0 Project Background

The aquatic organism sampling programme is one of several baseline environmental investigations being undertaken by PDP on behalf of ENZ. Other environmental investigations being undertaken include surface water, sediment, groundwater, ecological and air monitoring, hydrogeological assessments and physical environmental surveys. The scope of the project has incorporated the concerns expressed by local iwi and local residents about existing water quality and ecosystem health, including food sources such as eels, and the potential effects of exploration-related activities such as exploration drilling.

A number of studies of water and sediment quality have been undertaken previously at Puhipuhi, both by regulators such as Northland Regional Council and by academic researchers. One study has assessed mercury concentrations in shellfish in the Kaipara Harbour (Hoggins and Brooks, 1973). Studies have focused on the levels of mercury and other metals in water and sediment in response to legacy issues associated with an abandoned small-scale mercury mine and processing plant, which is located in the headwaters of Waikiore Stream and was active between 1907 and 1945 (DoC, 2010). Previous geological and geochemical surveys have shown that elevated mercury values, consistent with geothermal influence such as at Ngawha (NZEL, 2003), are widespread in Puhipuhi rocks and soils and are not confined to the Waikiore Stream. The current study utilises previous sample locations as a basis for comparison and also extends sample coverage to include catchments not previously assessed.

The main streams draining the Puhipuhi area are the Pukekaikiore, Waikiore and Whenuaroa Streams which are the major tributaries of the Waiariki River. The western side of the tenement area is drained by tributaries of the Waiotu River and a small area on the eastern side is drained by tributaries of Kaimamaku Stream (see Figure 1). The streams and river in the tenement area are part of the Wairua/ Wairoa River catchment that drains a substantial part of central Northland. Further, downstream the Wairua River becomes the Wairoa River

and flows past Dargaville into the Kaipara Harbour on the west coast. The key receiving river environments downstream of the study area are the Waiariki River, Waiotu River, Kaimamaku Stream, Whakapara River, Wairua River, Wairoa River and the Kaipara Harbour (See Figure 2).

3.0 Scope and Objectives

Evolution Mining has requested aquatic fauna tissue sampling and analysis for heavy metals of aquatic organisms collected within and beyond the tenement boundary for comparison against the previous sampling in the area and to provide a baseline for future monitoring.

Evolution Mining has requested:

- I. Tissue sampling from aquatic organisms collected within and outside the exploration tenement boundaries replicating the locations of the previous sampling, to determine if there have been any changes to the system over time and to provide background data for the future.
- II. All tissue samples to be analysed at an accredited laboratory (accredited laboratories require an independent assessment of quality control and accuracy standards e.g. by IANZ).

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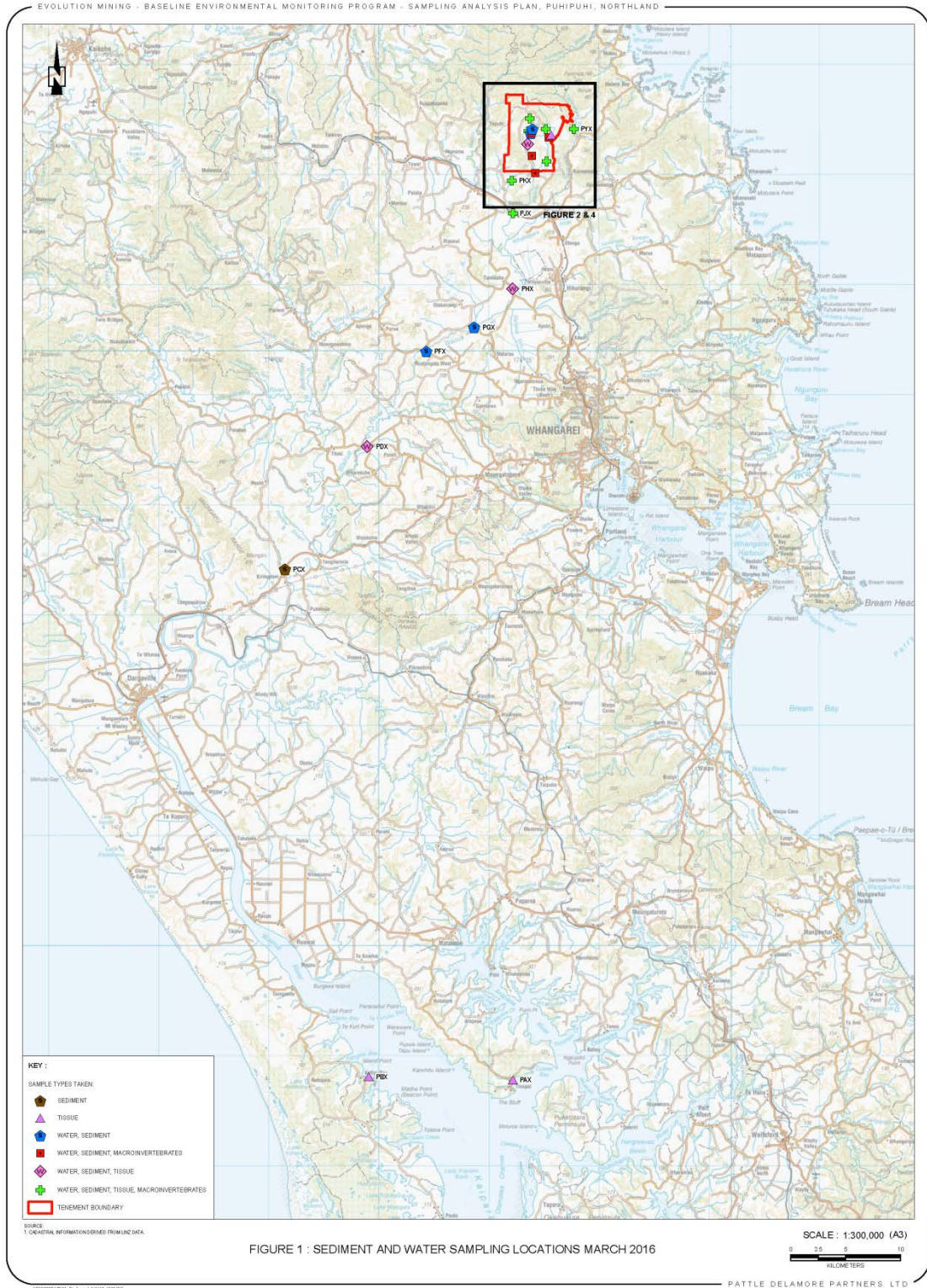



Figure 1: Sampling locations

4.0 Methodology

4.1 Sampling Locations

PDP collected aquatic organisms from 13 sampling locations within and downstream of the tenement boundary (refer to Table 1 and Figures 1 and 2). The sampling locations were chosen to replicate the sites in the 1973 study by F.E. Hoggins and R.R. Brooks and to replicate the sampling locations in Program 2 (e.g., sediment, water quality and macroinvertebrates) where practicable.

Of these two sites (PAX and PBX) were estuaries and the remainder were freshwater streams.

Table 1: Aquatic Organism Sampling Sites					
Location	Environment	Site ID	Site Name	Northing	Easting
<div>Upstream</div> <div></div>	Freshwater	PUX	Waikiore Stream DoC reserve	6075093	1713678
		PYX	Kaimamaku Stream at Peach Orchard Road	6074154	1717673
		PVX	Tributary of Pukekaikiore Stream upstream of Puhipuhi Road	6074132	1715150
		PTX	Upper Western Tributary of Waikiore Stream	6073955	1713590
		PZX	Pukekaikiore Stream	6073609	1715613
		PNX	Whenuaroa Stream via Mine Road	6072774	1713526
		POX	Waiariki River	6071209	1715202
		PKX	Papanui Creek at Umuwhawha Road	6069466	1712057
		PJX	Waiariki River upstream of SH1 bridge downstream of the waterfall.	6066496	1712151
		PHX / PIX	Wairua River at Heaton Road Bridge (Jordan Valley Road)	6059650	1712129
		PDX	Wairua River at Mangakahia Road (Wairua River Bridge)	6045315	1698925
Downstream	Estuarine	PAX	Komiti Bay, Tinopai	5987786	1712139
		PBX	Kellys Bay, Rototuna	5988077	1699050

Notes:

New Zealand Transverse Mercator Projection Coordinates are used in this table.

The sampling location for PIX was combined with PHX as these locations are generally relative.

4.2 Sample Collection

4.2.1 Freshwater Aquatic Organisms

There were two separate sampling rounds. During initial sampling, freshwater aquatic organisms were collected on the 8th - 10th March 2016 and the 12th and 13th of April 2016 in accordance with the Sampling and Analysis Plan prepared by PDP (PDP, 2016b). A summary of the Sampling and Analysis Plan is attached in Appendix A. Two nets and two traps were deployed overnight at each site, the nets and traps were retrieved individually the following morning at each site with the catch, processed and recorded (i.e. species, length, weight, and health).

In the initial sampling round up to two eels from each of two sites (between 400 mm and 500 mm long and roughly of the same weight) were selected for sampling. All other eels were released. Eels taken for analysis were euthanized and frozen immediately on ice.

Up to two freshwater crayfish (Koura) from each site (between 50 mm to 70 mm long) were selected for sampling. Freshwater crayfish taken for analysis were frozen immediately on ice.

At several sample sites the initial sampling did not recover eels within the size range specified by the Sampling and Analysis Plan. For example at sites PKX, PIX and PJX the eels that were caught were either less than 400 mm long or longer than 500 mm. Therefore, a second round of sampling was undertaken on the 30th March under a customary fishing permit, under the supervision of iwi representatives from Te Urioroi and from Ngati Hau ki Whakapara. The same sampling protocols were followed as previously, other than several eels from each site were retained as kai by the customary permit holders.

4.2.2 Estuarine Aquatic Organisms

The estuarine aquatic organism samples were collected on the 7th and 8th March 2016 from sites PAX (oysters) and PBX (oysters, cockles, and pipis). The samples were collected by hand at low tide, their species identified and length measured. The shellfish were frozen immediately on ice.

4.3 Laboratory Analysis

Frozen aquatic organism samples were sent on ice under standard PDP chain of custody documentation to the laboratory as soon as practicable. The laboratory then the edible portion of the sample was analysed after the sample had been deskinning and filleted.

Samples were prepared and analysed for the following inorganic elements:

- ✧ Methyl mercury;
- ✧ Total mercury;

- ✧ Total arsenic;
- ✧ Total cadmium.

Mercury and arsenic were chosen for analysis due to these two elements naturally occurring in the mineralised rocks of the Puhipuhi area (Craw *et al.*, 2000). Cadmium was analysed for because it has been identified as a potential contaminant in shellfish, particularly oysters (MAF, 2011). Total arsenic, rather than inorganic arsenic was measured as part of this study as no commercial laboratory was identified that were able to accurately measure inorganic arsenic in fish and/or shellfish tissues.

5.0 Results


Table 2 below shows the sampling sites along with the types of organisms sampled at each site. Tissue samples were sent to Eurofins Frontiers Global Science in Seattle for laboratory analysis to determine the concentration of methyl mercury, total mercury, arsenic, and cadmium.

Nine shortfin eel tissue samples collected from 4 locations (See Table B1 in Appendix B), eleven freshwater crayfish (Koura) collected from 8 locations (See Table B2 in Appendix B) and 4 shellfish collected from 2 locations (See Table B3 in Appendix B). Laboratory reports are attached in Appendix C.

Eight freshwater crayfish (Koura) samples and five shortfin eel tissue samples exceeded the guideline values for total mercury.

Arsenic was below the guideline value in all crayfish samples and was not detected in any eel tissue samples. Conversely, all of the shellfish contained concentrations of arsenic which exceeded the guideline value.

Cadmium was detected in every sample. Although there is no guideline value for cadmium in eels, shellfish and freshwater crayfish samples were below the respective guidelines.

Table 2: Locations where Target Aquatic Organisms were Collected					
Location	Site ID	Location	Abbreviated Site Location	Eels Sampled	Crayfish Sampled
Upstream 			Freshwater Locations		
	PUX	On-tenement	Waikiore Stream		✓
	PYX	Off-tenement	Kaimamaku Stream	✓	
	PVX	On-tenement	Tributary of Pukekaikiore Stream		✓
	PTX	On-tenement	Tributary of Waikiore Stream		✓
	PZX	On-tenement	Pukekaikiore Stream		✓
	PNX	On-tenement	Whenuaroa Stream		✓
	POX	On-tenement	Waiariki River		✓
	PKX	Off-tenement	Papanui Creek		✓
	PJX	Off-tenement	Waiariki River	✓	✓
	PHX / PIX	Off-tenement	Wairua River	✓	
	PDX	Off-tenement	Wairua River	✓	
			Estuarine Locations	Shellfish Sampled	
Downstream	PAX	Off-tenement	Komiti Bay, Tinopai	✓	
	PBX	Off-tenement	Kellys Bay, Rototuna	✓	

No eels were caught within the tenement. The waterfall located below site PLX (refer to Figure 1) downstream of the tenement on the Waiariki Stream may present a barrier to eel migration upstream.

5.1 Comparison of Tissues Results with New Zealand Food Safety MPLs

Metals detected in aquatic organism samples were compared to the New Zealand Food Safety Authority (NZFSA) Animal Products (Contaminant Specifications) Notice 2016 Maximum Permissible Levels (as shown in Tables B1 to B3 in Appendix B and Figures 3 and 4).

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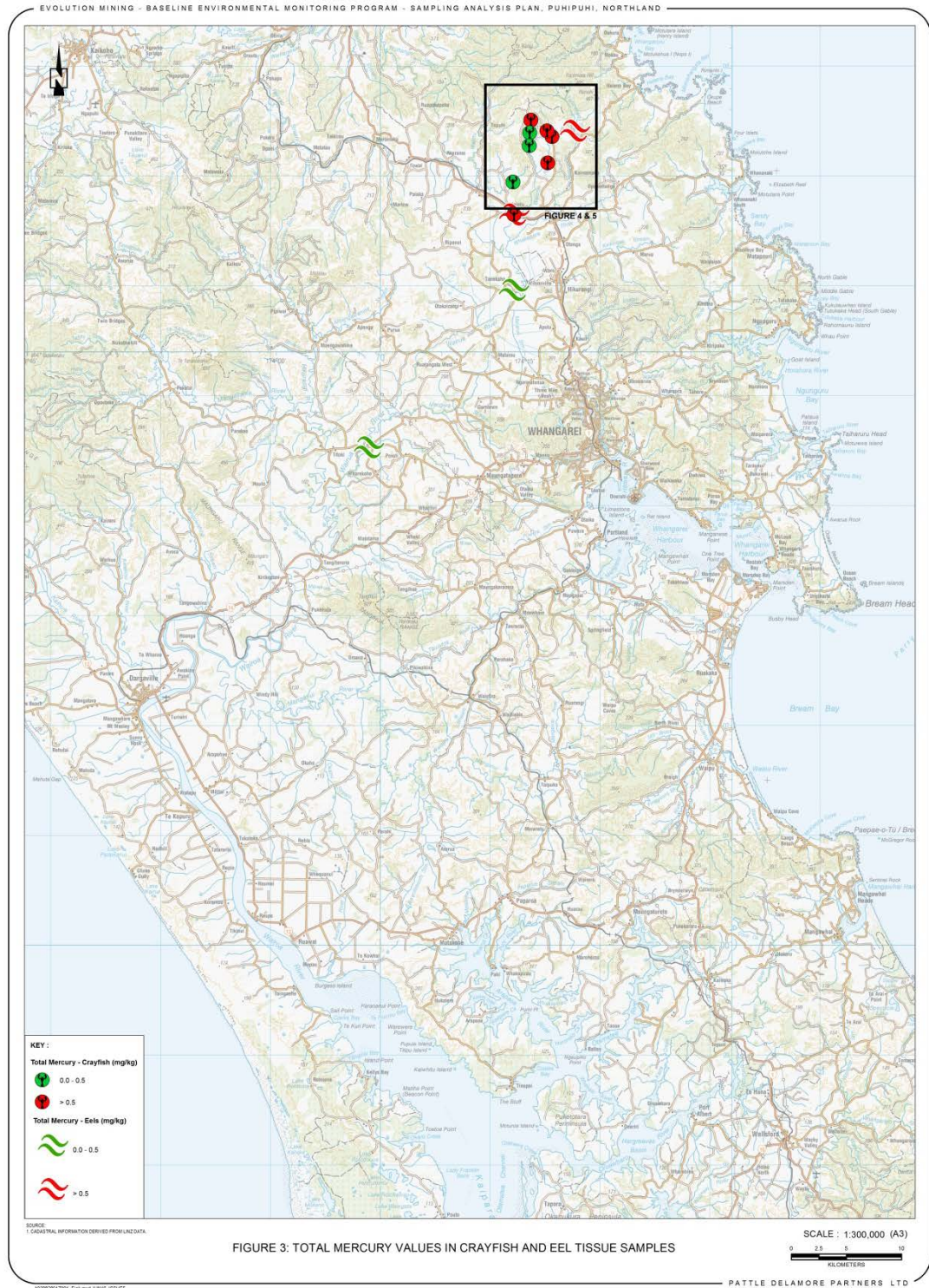


Figure 3: Total mercury values in crayfish and eel tissue samples

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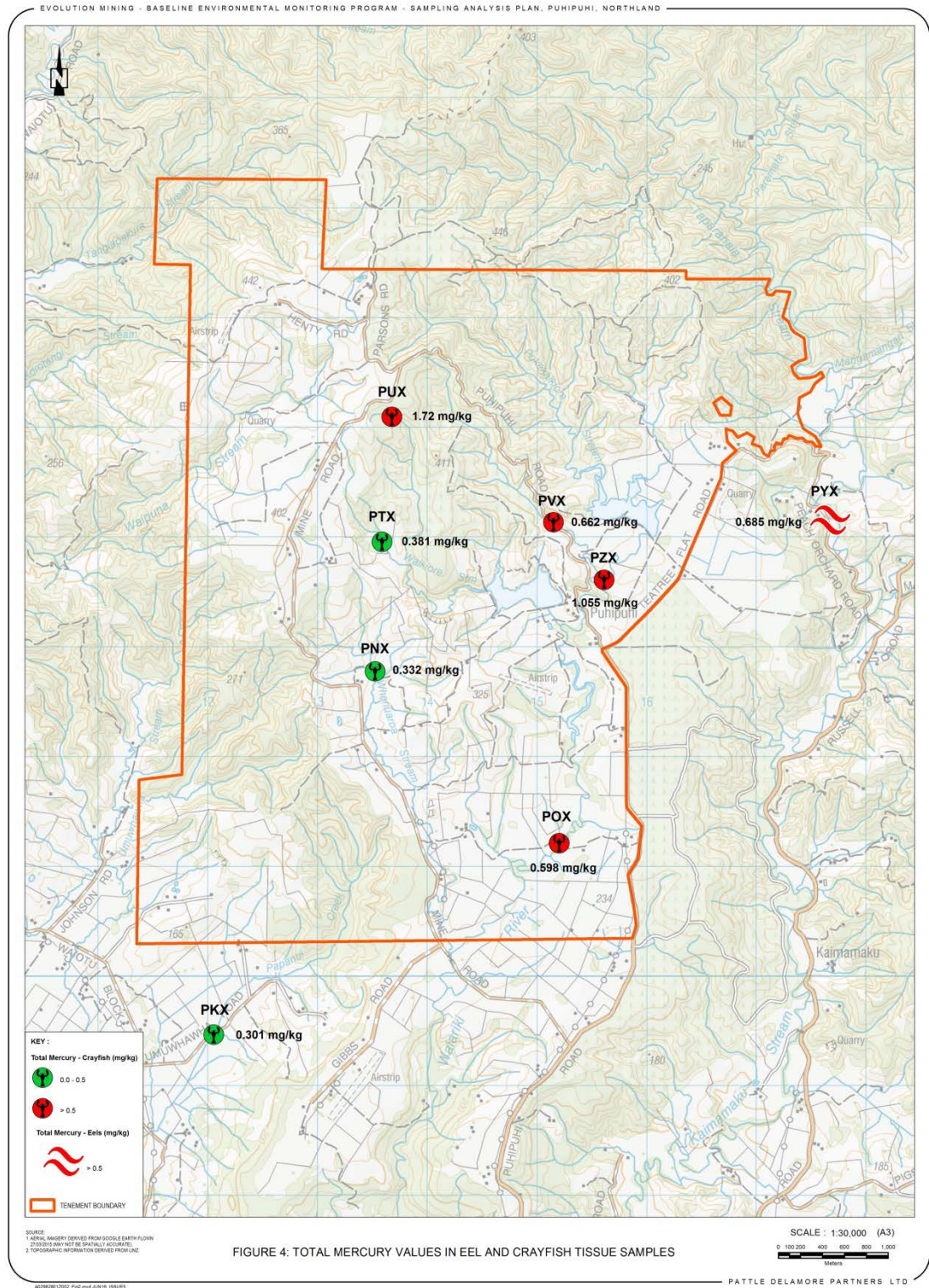


Figure 4: Total mercury values in eel and crayfish tissue samples

5.1.1 Total Mercury

Seven of eleven samples of freshwater crayfish samples exceeded the NZFSA Maximum Permissible Level of 0.5 mg/kg for total mercury in shellfish. The highest concentration of total mercury, 1.72 mg/kg, was recorded at site PUX, the most up gradient site.

Five out of nine shortfin eel samples exceeded the NZFSA Maximum Permissible Level of 0.5 mg/kg for total mercury in most fish species (which includes eels). The highest values of mercury measured in eel tissue samples (0.612 – 0.803 mg/kg) were collected from sampling location PJX. It should be noted that none of the tissues sampled from any of the eels collected as part of this study had concentrations of mercury which exceeded the maximum level of mercury in fish of 1.0 mg/kg specified in Australian New Zealand Food Standards Code – Schedule 19-7².

All shellfish samples (0.008 – 0.032 mg/kg) were below the NZFSA Maximum Permissible Level of 0.5 mg/kg for total mercury in shellfish.

5.1.2 Total Arsenic

Total arsenic was not detected in any of the shortfin eel or freshwater crayfish samples.

All shellfish (oyster, cockle, and pipi) samples (total arsenic 1.52 – 3.56 mg/kg) collected contained total arsenic concentration higher than the NZFSA Maximum Permissible Level of 1 mg/kg for inorganic arsenic in shellfish. However, it should be noted that inorganic arsenic content in shellfish tissue is normally less than 10% of the total arsenic concentration; therefore the inorganic arsenic concentration in all the shellfish samples may not exceed the NZFSA Maximum Permissible Level of 1 mg/kg for inorganic arsenic in shellfish.

5.1.3 Total Cadmium

All freshwater crayfish samples (ND – 0.425 mg/kg) and shellfish (oyster, cockle, and pipi) samples (0.031 – 0.369 mg/kg) were below the NZFSA Maximum Permissible Level of 2 mg/kg for total cadmium. No guideline value for cadmium in shortfin eels is available for comparison.

5.2 Comparison of Contaminants between the Targeted Aquatic Organisms

Total cadmium concentrations in freshwater crayfish (koura) sampled at sites within the tenement boundary were higher than those presented in eels sampled

² There were too few samples collected at each sampling site to compare to the mean level of mercury specified in the Australian New Zealand Food Standards Code – Schedule 19-7.

outside of the tenement boundary but were below the NZFSA guidelines for all samples.

Mercury concentrations were highest in freshwater crayfish (koura) followed by shortfin eels, whereas shellfish (oysters, cockles, and pipi) samples contained the lowest mercury concentrations.

Overall, arsenic and cadmium concentrations (specifically in oysters) were higher in shellfish than in freshwater crayfish and shortfin eels.

6.0 Discussion

6.1 Aquatic Contaminant Trends

6.1.1 Mercury in Tissue Samples

Figure 5 shows the mercury content of all freshwater crayfish (koura) tissue samples from locations ordered approximately from upstream to downstream. The different catchments are also highlighted. For reference, the NZFSA maximum permissible level for total mercury in shellfish and most fish species of 0.5 mg/kg is shown as a blue line. The location of the tenement boundary relative to the sample sites is also shown. In general, concentrations of mercury in crayfish tissue samples show a decreasing trend with a distance of sample location downstream from the historic Puhipuhi mine site (Figure 3). However, it should be noted that one location elevated mercury concentrations in sediment appear to correlate with elevated mercury concentrations in freshwater crayfish (koura)(PUX), however, at other sampling locations mercury is elevated in sediment but not in freshwater crayfish (e.g. PTX and PNX). The highest concentrations of total mercury in sediments were found in PUX which corresponds with the highest concentrations of total mercury detected in freshwater crayfish (koura).

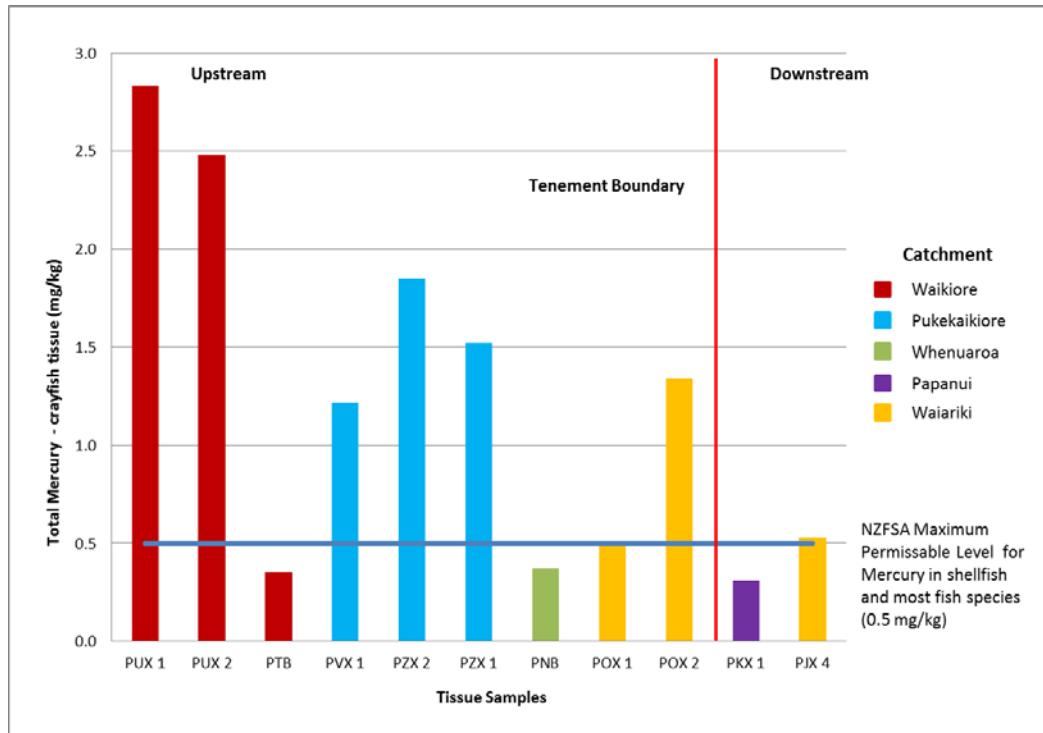


Figure 5: Mercury concentrations in freshwater crayfish tissue samples

A similar trend of decreasing mercury concentration with distance downstream is found in shortfin eel tissue samples (Figure 6).

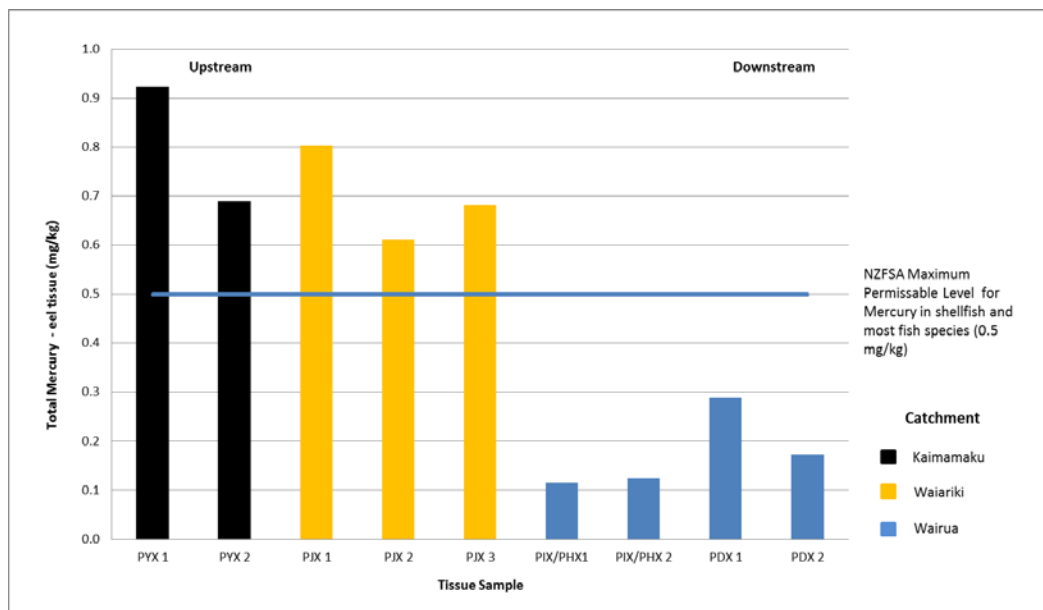


Figure 6: Mercury concentrations in shortfin eel tissue samples

Mercury concentrations in eels are elevated at PYX on the Kaimamaku Stream east of the tenement, and PJX located just south of the tenement on the Waiariki River. Mercury concentrations in eels are considerably lower at PDX and PIX (PHX) further downstream on the Wairua River. The mercury concentrations in eels do not appear to correlate with mercury concentrations in water and sediment samples from the same sites, for example PYX had significantly lower concentrations of mercury in water and similar sediment mercury levels compared to water and sediment samples from sites PDX and PHX.

In addition there is some variability in mercury concentrations between fish caught at the same sampling location.

The age of fish caught could explain the different levels of mercury in different fish, as mercury accumulates over an animal's lifetime as well as up the food chain (e.g. predators accumulate the mercury from the prey they eat), however all sampled eels were of a similar size, between 400 – 550 mm in length.

The results from the freshwater crayfish (koura) and short finned eel tissue sampling also show a significant variation between catchments as well as a degree of variation between samples collected from the same location (Figure 5 and Figure 6).

6.1.2 Arsenic and Cadmium in Tissues Samples

Pipi and cockles are relatively stationary animals that live in sediment and filter particles out of the water column. It has been found that cockles accumulate more arsenic than fish (FSA, 2005). This may be partly due to their feeding or habitat preferences. This appears to be the case in shellfish sampled at sites PAX and PBX where concentrations of elevated arsenic and cadmium were detected and were presented at much higher than concentrations in freshwater crayfish (koura) and eel. Arsenic and cadmium concentrations were low or not detected in freshwater crayfish (koura) and eels at sample locations within and outside of the tenement boundary.

6.2 Correlation of Mercury in Tissue, Water and Sediment Samples

Samples collected from location PUX, which had the greatest mercury concentrations in water and sediment samples also had the greatest concentration of mercury in crayfish tissue (see Figure 7). However, when comparing samples of freshwater crayfish (koura) and short finned eel tissue with water and sediment samples collected from other locations, there appears to be little correlation between mercury content of tissue samples and mercury concentrations of water or sediment. This is the case for both total mercury and methyl mercury concentrations in sediment.

The lack of correlation may be an indication that much of the mercury present is in a more insoluble form and therefore less bio-available. In some instances, this is supported by the AVS/SEM and TCLP/SPLP test results, particularly at site PRX where AVS/SEM ratios indicate the majority of the mercury is in a non-bioavailable sulfide mineral form (PDP, 2016).

Conversely, the lack of correlation may be due to other factors such as differences in life history and dispersal of individuals. Although eels are known to travel large distances over the course of a lifetime, studies of adult eels have generally shown they have a limited “home range” occupied over lengthy periods (e.g. Chisnall and Kalish, 1993). Nevertheless, the mercury tissue content may not necessarily represent the mercury content of the location where they were caught. Studies of long-finned eels in New Zealand South Island Rivers have shown that high mercury levels in eel tissue do not necessarily imply high concentrations of mercury within a catchment (Redmayne *et al.*, 2000).

Certainly, the age of fish caught will effect different levels of mercury in different fish, as mercury accumulates over an animal’s lifetime as well as up the food chain (e.g. predators accumulate the mercury from the prey they eat). Further work could be undertaken looking at the age of aquatic organisms as well as their mercury content with the view of determining mean annual rates of mercury accumulation.

Shellfish sampled at sites PAX and PBX contained relatively low concentrations of total mercury. The highest concentration of total mercury was 0.032 mg/kg in an oyster tissue sample collected from PAX. This is well below the NZSFA maximum permissible level of 0.5 mg/kg.

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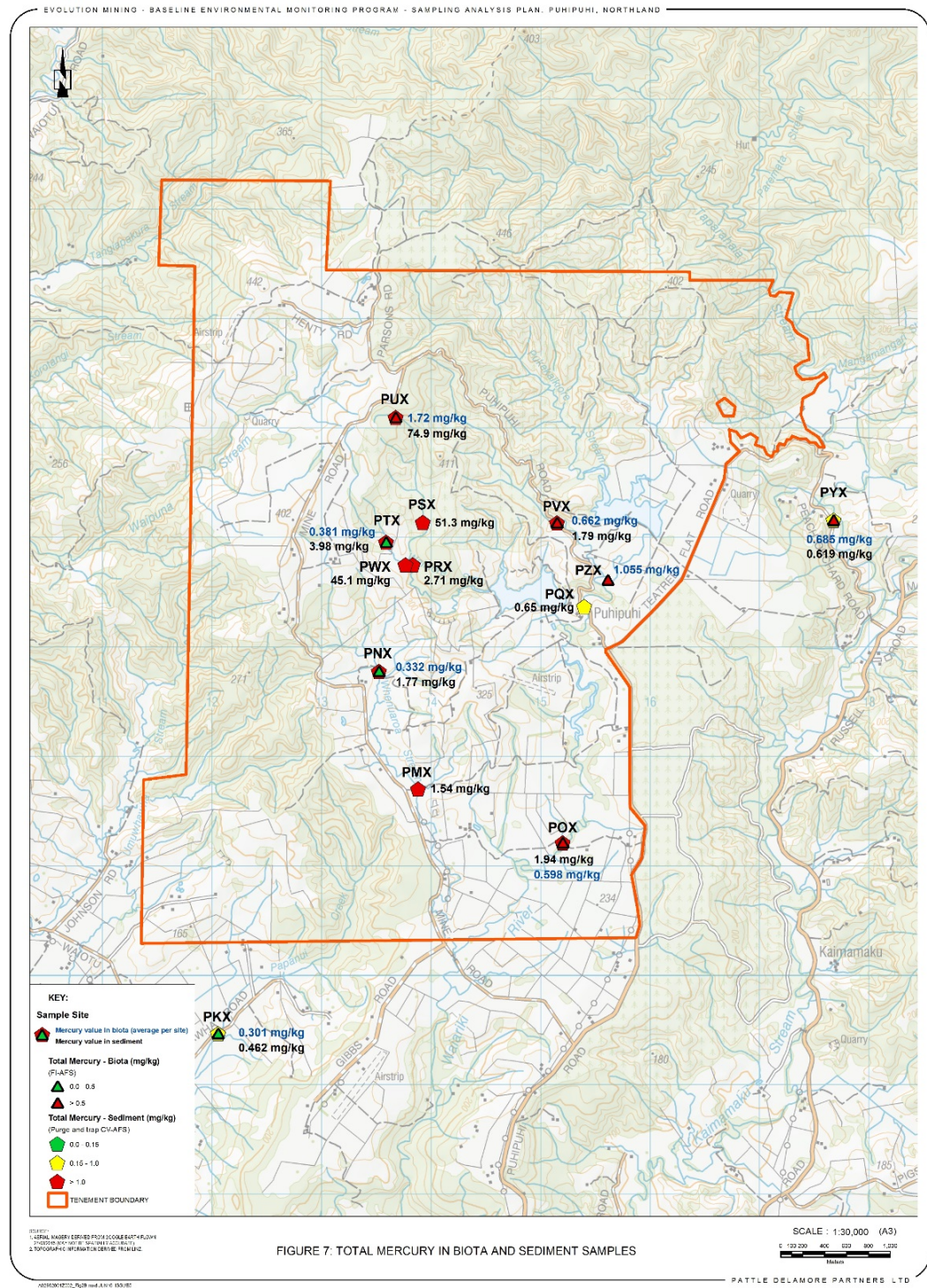


Figure 7: Total mercury in Biota and sediment samples

6.2.1 Arsenic and Cadmium in Tissue, Water and Sediment Samples

There appears to be little correlation between total arsenic concentrations in tissue samples and total arsenic concentrations in water and sediment samples from the same location. Arsenic and cadmium concentrations were low or not detected in freshwater crayfish (koura) and short fin eels at sample locations within and outside of the tenement boundary. This suggests the arsenic identified in sediment samples within the tenement is not in a readily available form and therefore is not being taken up by freshwater crayfish or shortfin eels in significant amounts.

Shellfish sampled at sites PAX and PBX contained elevated concentrations of arsenic and cadmium at much higher levels than found in crayfish or eel collected from locations further upstream. Pipi, cockles and to a lesser extent oysters are relatively stationary animals that live in sediment and filter particles out of the water column. It has been found that cockles accumulate more arsenic than fish do (FSA, 2005). No water or sediment samples were collected from PAX or PBX so no correlations between arsenic content in tissue, water and sediment can be inferred. A discussion of the possible sources of arsenic in shellfish tissue samples is outside of the scope of this report.

6.3 Comparison with the Results of Previous Studies

The two estuarine sampling locations in the Kaipara Harbour, PAX and PBX were chosen to replicate shellfish tissue sampling conducted in the early 1970's by Hoggins and Brooks (1973). The results of both studies are shown in Table B4 in Appendix B. The results show that total mercury concentrations in shellfish are higher in the 1973 study, albeit in some cases marginally so.

7.0 Risk Assessment of Consuming Wild Foods

7.1 Mercury in Freshwater Crayfish and Shortfin Eels

In order to assess the risk to people from exposure to heavy metals through consumption of seafood, it is necessary to establish what exposure is acceptable. This is typically expressed as a mass (in micrograms or milligrams) per kilogram body weight (kg bw) per day, or in some cases per week or month. Average exposure above the standard indicates a potential for effects whereas exposure below the standard suggests no effects.

7.1.1 Fish Consumption

To determine the estimated potential exposure to inorganic elements (mercury, arsenic, and cadmium) in fish and crustaceans, an assumption needs to be made on how much fish is consumed.

The New Zealand 'average' fish consumption rate is approximately 32 g/day (Kim & Smith, 2006). The Kim and Smith (2006) study indicates that by assuming the average fish consumption is entirely sourced from eels and crayfish that are caught locally is a conservative approach and considered to be an overestimate of the exposure risks to individuals. In 2010-2011 NIWA undertook a risk assessment of contaminants in kai from with the Te Arawa rohe (Phillips *et al*, 2011). This study found that wild caught fish represented a relatively small proportion of the fish for a local community.

It is unknown what proportion of local residents (if any) might consume the fish sourced from the Puhipuhi area. A detailed study on wild kai consumption would need to be undertaken on the gathering and eating of wild foods within the Puhipuhi area to determine how much and how often that wild caught foods are consumed. However, based upon the evidence present above it is considered highly unlikely that an individual's intake of fish would consist of a regular (i.e. weekly) consumption of wild caught eels and/or freshwater crayfish (koura) sourced from the Puhipuhi area. Therefore, it may be more appropriate to assess the risk associated with consuming freshwater crayfish (koura) eels from occasional consumption of wild caught foods (i.e. several times per month) instead of a regular daily intake. To undertake this risk assessment an average serving size of 150 grams of eels or freshwater crayfish (koura) has been assumed.

7.1.2 Assessment of Contaminant Intake

In a number of samples, the total mercury concentrations in the aquatic organisms exceed the NZFSA MPLs within the tenement boundary and some samples collected outside of the tenement boundary. Therefore, a risk assessment has been undertaken to determine a safe level of consumption of freshwater crayfish (koura) and eels from the general Puhipuhi area. As the analysis of tissue samples has confirmed that methyl mercury is the predominant form of mercury in aquatic organisms and methyl mercury is the most toxic form of mercury, only exposure to methyl mercury has been considered in this risk assessment.

The Joint FAO/WHO Expert Committee on Food Additives has set a Provisional tolerable Weekly Intake of methyl mercury of 1.6 ug/kg bw/week (WHO, 2007). This methylmercury PTWI is considered to be sufficient to protect developing foetuses in pregnant women, which are the most sensitive group to methyl mercury toxicity (MAF, 2011).

Based on the consumption average of an average serving of 150 grams per meal and the maximum concentration of mercury detected in freshwater crayfish

(koura) and eel samples, an assessment of the maximum 'safe'³ level of methyl mercury consumption through eel and freshwater crayfish (koura) is presented in Table 3.

Table 3: Assessment of Acceptable Number of Servings per Month of Wild Caught Freshwater Crayfish and Eels from Puhipuhi Area					
Sample	Contaminant	Maximum concentration (µg)	Maximum Methyl Mercury per animal (µg) ²	PTMI (µg/kg 70 kg adult) ³	Number of serving per month ⁴
Freshwater Crayfish (koura)	Methyl mercury	2830	141.5	480	1.1
Eel	Methyl mercury	923	276.9	480	3.5
Notes: <ol style="list-style-type: none"> 1. µg – micrograms. 2. Based on the average weight of the catch. Crayfish ~ 0.05 kg and eel ~0.3 kg. 3. Based on PTWI value for methyl mercury JECFA of 1.6 ug/kg-b/week (WHO, 2007) recalculated for a 70 kg adult for a 30 day period. 4. Based on a 30 day month and serving size of 150 g. 					

Table 3 shows that the recommended maximum serving of eel from within the Puhipuhi area is less than 3.5 serving per month. This is a similar consumption level that MPI suggests for predatory fish species such as dogfish, school sharks, trout species caught from geothermal areas, southern Bluefin tuna and swordfish. Table 3 indicates that regular consumption of freshwater crayfish (koura) should be restricted to less than 150 grams per month for an adult. As small children have significantly less body mass than an adult it is recommended that they do not consume freshwater crayfish (koura) caught from the Puhipuhi area.

7.2 Health Risk Associated with Arsenic in Shellfish

Although arsenic concentrations in shellfish exceeded the NZFSA guideline values for inorganic arsenic, according to the New Zealand Total Diet Study 2009 and international studies have demonstrated that most (>90%) of the arsenic present in fish is in the relatively non-toxic organic form (MAF, 2011). Inorganic arsenic compounds are more toxic to humans than the organic forms. Using the United States Food and Drug Administration (US FDA) assumption, which it notes as conservative, 10% of total arsenic in fish/seafood is inorganic. Therefore the amount of inorganic arsenic present within the samples collected in this study

³ A safe level of methylmercury is considered a chronic exposure which would not result in the exceedance of the PTWI of methyl mercury set by JECFA.

will only be a small fraction of the total arsenic measured, with most of the arsenic present being present in the relatively non-toxic organic arsenic species.

8.0 Summary

Elevated mercury concentrations have been reported in sediments, surface water and tissue samples of aquatic organisms within the tenement boundary, and present a localised impact to the immediate area surrounding the former mine site where mercury concentrations exceeded guideline values of ANZECC (2000) for 99% ecosystem protection (surface water), ISQG-high (sediments) and NZFSA (tissue samples from crustacean muscle tissue). The findings of this report are summarised below:

- ✧ Mercury concentrations in freshwater crayfish are highest at PUX, the northernmost sampling location, closest to the closed mercury mine. Similarly, the highest concentrations of mercury in sediment and surface water were observed at PUX.
- ✧ Other than in the immediate vicinity of the historic former mercury mine and processing area, where mercury concentrations are locally elevated, there is no consistent correlation between mercury concentrations in sediment, water and tissue samples of aquatic organisms at the individual sample sites. However, shortfin eels collected from sites significantly downstream of the tenement do have lower mercury concentration than shortfin eels closer to the tenement.
- ✧ Arsenic and cadmium concentrations were higher in shellfish than in freshwater crayfish (koura) or shortfin eels, in which arsenic and cadmium concentrations were low or below detection. Conversely mercury concentrations were highest in eels, followed by freshwater crayfish (koura), and lowest in shellfish.
- ✧ Although arsenic concentrations in sediments and surface water were above the ISQG-high and ANZECC (99% Protection of Freshwater Species) guideline value, this did not appear to translate to show elevated concentrations in shortfin eels and freshwater crayfish (koura).
- ✧ The total arsenic concentrations in shellfish were higher than the NZFSA guideline criteria for inorganic arsenic (1.0 mg/kg). However, local and international studies indicate that most (>90%) of the arsenic present in fish is in the relatively non-toxic organic form (MAF, 2009). According to the United States Food and Drug Administration (US FDA), which it notes as conservative, only 10% of total arsenic in fish/seafood is inorganic. Therefore, the inorganic arsenic within shellfish samples are unlikely to exceed NZFSA guideline criteria for inorganic arsenic.

- ✧ No exceedances to cadmium concentrations were reported in shellfish or crustaceans (no MPL is specified for cadmium in fish) sampled which is consistent with cadmium concentrations in surface water and sediments.
- ✧ Based on an assessment of the level of methyl mercury consumption through eel and freshwater crayfish (koura) that would exceed the provisional tolerable daily intake guidelines, it is recommended that the maximum consumption of short finned eel is less than 3.5 serving per month.

9.0 References

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Appendix A

Variation from the Sampling and Analysis Plan

Appendix A: Variation from the Sampling and Analysis Plan

Samples were collected in accordance with the PDP Sampling and Analysis Plan, 2016. This document set out the proposed sample methodology, addressed contaminants of concern, and detailed QA/QC field procedures.

Variations from the Plan and further detail on methodology are provided below.

1.0 Sample Locations

Eleven sites were selected for the investigation and sampling of aquatic organisms were comprised of six sites within and five sites “downstream” of the exploration tenement boundary. Of these two sites (PAX and PBX) were estuaries and the remainder were freshwater streams.

Aquatic organisms were unable to be obtained from a number of proposed locations due to the following reasons:

- ✧ Aquatic organisms were not obtained from sampling locations PRX, PLX and PMX due to either no catch or unsuitably sized aquatic organisms caught;
- ✧ Sampling location PCX was not sampled for aquatic organisms due to health and safety reasons (thick mud on the banks which potentially could have entrapped staff); and
- ✧ Sampling location PYX was added to the sampling plan as a control site at the request of ENZ.

Sampling was also conducted at the following additional sites:

- ✧ Aquatic organisms were hand-caught at PNX and PTX while undertaking water quality sampling; and
- ✧ Aquatic organisms were collected from PIX and PKX (at ENZ’s request) in a second-round of sampling undertaken by ENZ under the supervised by iwi representatives, with bycatch sampled under customary permit (i.e. main purpose was customary fishing; 4 eels sacrificed for sampling purpose).

2.0 Sample Collection

2.1 Freshwater Aquatic Organisms

Freshwater aquatic organisms were collected in accordance with the Sampling and Analysis Plan prepared by PDP. Two fyke nets and two gee minnow traps were deployed overnight at each site. Nets and traps were retrieved individually the following morning at each site with the catch processed and recorded (i.e. length, weight, and health).

2.1.1 Eels

Individual eels were processed using a similar methodology to that developed by Redmayne et al. (2000). Eels were counted, measured (snout to end of the caudal fin) and weighed. Up to two eels from each site (between 400 mm and 500 mm long and roughly of the same weight) were selected for sampling. All other eels were released. Eels taken for analysis were dispatched via the iki jime method and frozen immediately on ice.

2.1.2 Freshwater Crayfish (koura)

Up to two freshwater crayfish (koura) from each site (between 50 mm to 70 mm long) were selected for sampling. Freshwater crayfish taken for analysis were frozen immediately on ice.

2.1.3 Other Freshwater Species

Other freshwater species caught (i.e. tadpoles, trout, bullies) were identified, counted, weighed and measured, and then released.

2.2 Estuarine Aquatic Organisms

The estuarine aquatic organism samples were collected on the 7th and 8th March 2016 from sites PAX (oysters) and PBX (oysters, cockles, and pipis). The samples were collected by hand at low tide, their species identified and length measured. The shellfish were immediately put into chilly bins containing dry ice and then delivered to Hill Laboratories for testing of arsenic, cadmium, and mercury.

3.0 Laboratory Analysis

Frozen aquatic organism samples were sent on ice under standard PDP chain of custody documentation to the laboratory as soon as practicable. The laboratory then analysed the edible portion of the sample after the sample had been deskinning/deshelled and filleted.

Samples were prepared and analysed for heavy metals using the following methods:

- ✧ Methyl mercury: determined by cold vapour gas chromatography atomic fluorescence spectrometry (CV-GC-AFS) in accordance with EPA 1630. (EFGS-010 KOH/Methanol Hg Digestion).
- ✧ Total mercury: determined by flow injection atomic fluorescence spectrometry (FI-AFS) in accordance with EPA 1631E. (EFGS-011 Nitric/Sulfuric Hg Digestion).
- ✧ Total arsenic: determined by inductively coupled plasma mass spectrometry (ICP-MS) in accordance with EPA 1638. (EFGS-058 Teflon Conc. Nitric Tissue Digestion).

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- ∴ Total cadmium: determined by inductively coupled plasma mass spectrometry (ICP-MS) in accordance with EPA 1638. (EFGS-058 Teflon Conc. Nitric Tissue Digestion).

Appendix B

Results Tables

Table B1: Shortfin Eel Sampling Results											
Sample ID	Units	PYX Sample 1	PYX Sample 2	PDX Sample 1	PDX Sample 2	PIX Sample 1	PIX Sample 2	PJX Sample 1	PJX Sample 2	PJX Sample 3	NZFSA ⁵ Animal Products (Contaminant Specifications) Notice 2008 Maximum Permissible Levels
Species		Shortfin eel	Shortfin eel	Shortfin eel	Shortfin eel	Shortfin eel	Shortfin eel	Shortfin eel	Shortfin eel	Shortfin eel	
Length ¹	mm	560	480	445	420	480	480	540	460	550	
Weight	kg	0.5	0.28	0.24	0.21	0.2	0.24	0.31	0.22	0.37	
Sample Site Location		PYX	PYX	PDX	PDX	PIX	PIX	PJX	PJX	PJX	
Eurofins Sample ID		M16-Ma20696	M16-Ma20697	M16-Ma20701	M16-Ma20702	M16-Ap23670	M16-Ap23671	M16-Ap23673	M16-Ap23674	M16-Ap23675	
Eurofins Laboratory ID		1604390-03	1604390-04	1604390-08	1604390-09	1605156-01	1605156-02	1605156-04	1605156-05	1605156-06	
Sampling Date		11-Mar-16	11-Mar-16	10-Mar-16	10-Mar-16	30-Mar-16	30-Mar-16	30-Mar-16	30-Mar-16	30-Mar-16	
Heavy Metals											
Methyl Mercury ²	mg/kg	0.923	0.682	0.289	0.172	0.100	0.102	0.684	0.536	0.557	See note 6
Total Mercury ³	mg/kg	0.679	0.69	0.235	0.127	0.115	0.125	0.803	0.612	0.682	0.5 ⁷
Total Arsenic ⁴	mg/kg	ND	ND	ND	ND	ND	ND	ND	ND	ND	2 ⁸
Total Cadmium ⁴	mg/kg	0.018	0.019	0.015	0.025	0.014	0.013	0.021	0.016	0.029	NGV

Notes:

- Length of eel measured from snout to caudal fin.
- Methyl Mercury determined by cold vapor gas chromatography atomic fluorescence spectrometry (CV-GC-AFS) in accordance with EPA 1630.
- Total Mercury determined by flow injection atomic fluorescence spectrometry (FI-AFS) in accordance with EPA 1631E.
- Total Arsenic and total Cadmium determined by inductively coupled plasma mass spectrometry (ICP-MS) in accordance with EPA 1638.
- New Zealand Food Safety Authority.
- WHO/FAO Joint Expert Committee on Food Additives (JECFA) has set a provisional tolerable weekly intake (PTWI) for methyl mercury of 1.6 µg/kg bw/week. For a 70 kg adult this works out to be 112 µg/kg per week.
- Sum of inorganic and organic mercury in fish (includes all species of finfish and shellfish at any stage of their life history).
- Inorganic Arsenic in muscle meat of fish (except shellfish).

NGV	No Guideline Value available due to insufficient data.
ND	Non Detection of Contaminant.
0.612	Value equals or exceeds NZFSA Animal Products (Contaminant Specifications) Notice 2008 Maximum Permissible Levels.

Table B2: Crayfish Sampling Results													
Sample ID	Units	POX Sample 1	POX Sample 2	PZX Sample 1	PZX Sample 2	PVX Sample 1	PUX Sample 1	PUX Sample 2	PTB	PNB	PKX Sample 1	PJX Sample 4	NZFSA ⁵ Animal Products (Contaminant Specifications) Notice 2008 Maximum Permissible Levels
Species		Crayfish	Crayfish	Crayfish	Crayfish	Crayfish	Crayfish	Crayfish	Crayfish	Crayfish	Crayfish	Crayfish	
Tail Length ¹	mm	59	52	53	60	57	50	50	-	-	-	-	
Tail Width ¹	mm	26	21	20	25	20	20	20	-	-	-	-	
Weight ¹	kg	0.07	0.04	0.04	0.05	0.05	0.04	0.07	-	-	-	-	
Sample Site Location		POX	POX	PZX	PZX	PVX	PUX	PUX	PTX	PNX	PKX	PJX	
Eurofins Sample ID		M16-Ma20694	M16-Ma20695	M16-Ma20698	M16-Ma20699	M16-Ma20703	M16-Ma20704	M16-Ma20705	M16-Ma20708	M16-Ma20709	M16-Ap23672	M16-Ap23676	
Eurofins Laboratory ID		1604390-01	1604390-02	1604390-05	1604390-06	1604390-10	1604390-11	1604390-12	1604390-15	1604390-16	1605156-03	1605156-07	
Sampling Date		11-Mar-16	11-Mar-16	10-Mar-16	10-Mar-16	10-Mar-16	9-Mar-16	9-Mar-16	12-Mar-16	13-Mar-16	30-Mar-16	30-Mar-16	
Heavy Metals													
Methyl Mercury ²	mg/kg	0.51	1.34	1.52	1.85	1.22	2.83	2.48	0.351	0.372	0.311	0.514	See note 6
Total Mercury ³	mg/kg	0.468	0.728	0.789	1.32	0.662	1.72	1.71	0.381	0.332	0.301	0.527	0.5 ⁷
Total Arsenic ⁴	mg/kg	0.23	0.22	0.20	0.19	0.17	ND	ND	ND	0.43	0.61	0.32	1 ⁸
Total Cadmium ⁴	mg/kg	0.12	0.172	0.077	0.064	0.045	0.132	0.023	ND	0.046	0.425	0.058	2 ⁹

- Notes:
- 1. Crayfish length, width and weight measured in field (approximate only).
 - 2. Methyl Mercury determined by cold vapor gas chromatography atomic fluorescence spectrometry (CV-GC-AFS) in accordance with EPA 1630.
 - 3. Total Mercury determined by flow injection atomic fluorescence spectrometry (FI-AFS) in accordance with EPA 1631E.
 - 4. Total Arsenic and total Cadmium determined by inductively coupled plasma mass spectrometry (ICP-MS) in accordance with EPA 1638.
 - 5. New Zealand Food Safety Authority.
 - 6. WHO/FAO Joint Expert Committee on Food Additives (JECFA) has set a provisional tolerable weekly intake (PTWI) for methyl mercury of 1.6 µg/kg bw/week. For a 70 kg adult this works out to be 112 µg/kg per week.
 - 7. Sum of inorganic and organic mercury in fish (includes all species of finfish and shellfish at any stage of their life history).
 - 8. Inorganic arsenic in shellfish (all species of the Phylum Echinodermata and the Phylum Mollusca and all species of the class Crustacea).
 - 9. Inorganic and organic cadmium in shellfish (all species of the Phylum Echinodermata and the Phylum Mollusca and all species of the class Crustacea) except dredge/Bluff oysters and Queen Scallops.

ND	Non Detection of Contaminant.
0.527	Value equals or exceeds NZFSA Animal Products (Contaminant Specifications) Notice 2008 Maximum Permissible Levels.

Table B3: Shellfish Sampling Results					
Sample ID	PAX	PBX - Cockle	PBX - Oyster	PBX Pipi	NZFSA ⁵ Animal Products (Contaminant Specifications) Notice 2008 Maximum Permissible Levels
Species	Oyster	Cockle	Oyster	Pipi	
Sample Site Location	PAX	PBX	PBX	PBX	
Eurofins Sample ID	M16-Ma20706	M16-Ma20707	M16-Ma20710	M16-Ma20711	
Eurofins Laboratory ID	1604390-13	1604390-14	1604390-17	1604390-18	
Sampling Date	7-Mar-16	8-Mar-16	8-Mar-16	8-Mar-16	
Heavy Metals					
Methyl Mercury ²	0.006	0.002	0.006	0.002	See note 6
Total Mercury ³	0.032	0.008	0.014	0.008	0.5 ⁷
Total Arsenic ⁴	1.81	3.56	2.02	1.52	1 ⁸
Total Cadmium ⁴	0.369	0.031	0.368	0.033	2 ⁹

Notes:

1. All values in mg/kg unless otherwise specified.
2. Methyl Mercury determined by cold vapor gas chromatography atomic fluorescence spectrometry (CV-GC-AFS) in accordance with EPA 1630.
3. Total Mercury determined by flow injection atomic fluorescence spectrometry (FI-AFS) in accordance with EPA 1631E.
4. Total Arsenic and Total Cadmium determined by inductively coupled plasma mass spectrometry (ICP-MS) in accordance with EPA 1638.
5. New Zealand Food Safety Authority.
6. WHO/FAO Joint Expert Committee on Food Additives (JECFA) has set a provisional tolerable weekly intake (PTWI) for methyl mercury of 1.6 µg/kg bw/week. For a 70 kg adult this works out to be 112 µg/kg per week.
7. Sum of inorganic and organic mercury in fish (includes all species of finfish and shellfish at any stage of their life history).
8. Inorganic arsenic in shellfish (all species of the Phylum Echinodermata and the Phylum Mollusca and all species of the class Crustacea).
9. Inorganic and organic cadmium in shellfish (all species of the Phylum Echinodermata and the Phylum Mollusca and all species of the class Crustacea) except dredge/Bluff oysters and Queen Scallops.

1.52

Value equals or exceeds NZFSA Animal Products (Contaminant Specifications) Notice 2008 Maximum Permissible Levels.

Table B4: Combined Shellfish Sampling Results for 1973 and 2016								
Study	PDP, 2016				Hoggins & Brooks, 1973 ⁵			NZFSA ⁹ Animal Products (Contaminant Specifications) Notice 2008 Maximum Permissible Levels
Sample ID	PAX	PBX - Cockle	PBX - Oyster	PBX Pipi	-	-	-	
Species	Oyster	Cockle	Oyster	Pipi	Cockle	Pipi	Oyster	
Sample Site Location	PAX	PBX	PBX	PBX	PBX ⁶	PBX ⁶	PAX ⁷	
Eurofins Sample ID	M16-Ma20706	M16-Ma20707	M16-Ma20710	M16-Ma20711	NA	NA	NA	
Eurofins Laboratory ID	1604390-13	1604390-14	1604390-17	1604390-18	NA	NA	NA	
Sampling Date	7-Mar-16	8-Mar-16			1/01/1972 ⁸			
Heavy Metals								
Methyl Mercury ²	0.006	0.002	0.006	0.002	-	-	-	See note 10
Total Mercury ³	0.032	0.008	0.014	0.008	0.037	0.009	0.080	0.5 ¹¹
Total Arsenic ⁴	1.81	3.56	2.02	1.52	-	-	-	1 ¹²
Total Cadmium ⁴	0.369	0.031	0.368	0.033	-	-	-	2 ¹³

Notes:

- All values in mg/kg unless otherwise specified.
- Methyl Mercury determined by cold vapor gas chromatography atomic fluorescence spectrometry (CV-GC-AFS) in accordance with EPA 1630.
- Total Mercury determined by flow injection atomic fluorescence spectrometry (FI-AFS) in accordance with EPA 1631E.
- Total Arsenic and Total Cadmium determined by inductively coupled plasma mass spectrometry (ICP-MS) in accordance with EPA 1638.
- Hoggins FE, Brooks RR (1973). Natural Dispersion of mercury from Puhipuhi, Northland, New Zealand. New Zealand Journal of Marine and Freshwater Research, 7:1-2.
- Location synonymous with PBX (Kellys Bay, Dargaville)
- Location synonymous with PAX (Otaiwhata Bay, Dargaville)
- No exact sampling date specified (Samples collected sometime in January 1972).
- New Zealand Food Safety Authority.
- WHO/FAO Joint Expert Committee on Food Additives (JECFA) has set a provisional tolerable weekly intake (PTWI) for methyl mercury of 1.6 µg/kg bw/week. For a 70 kg adult this works out to be 112 µg/kg per week.
- Sum of inorganic and organic mercury in fish (includes all species of finfish and shellfish at any stage of their life history).
- Inorganic arsenic in shellfish (all species of the Phylum Echinodermata and the Phylum Mollusca and all species of the class Crustacea).
- Inorganic and organic cadmium in shellfish (all species of the Phylum Echinodermata and the Phylum Mollusca and all species of the class Crustacea) except dredge/Bluff oysters and Queen Scallops.

1.52

Value equals or exceeds NZFSA Animal Products (Contaminant Specifications) Notice 2008 Maximum Permissible Levels.

Appendix C

Laboratory Reports

27 May 2016

Onur Mehmet
Eurofins MGT (Melbourne)
2-5 Kingston Town Close
Oakleigh, VIC 3164
RE: Freshwater Sediments And Tissues

Enclosed are the analytical results for samples received by Eurofins Frontier Global Sciences. All quality control measurements are within established control limits and there were no analytical difficulties encountered with the exception of those listed in the case narrative section of this report.

If you have any questions concerning this report, please feel free to contact me.

Sincerely,



Amy Goodall
Project Manager

Eurofins MGT (Melbourne)
2-5 Kingston Town Close
Oakleigh VIC, 3164

Project: Freshwater Sediments And Tissues
Project Number: 16/0238 493888
Project Manager: Onur Mehmet

Reported:
27-May-16 16:27

ANALYTICAL REPORT FOR SAMPLES

Sample ID	Laboratory ID	Matrix	Date Sampled	Date Received
Ma20694	1604390-01	Tissue	07-Apr-16 00:00	08-Apr-16 11:30
Ma20695	1604390-02	Tissue	07-Apr-16 00:00	08-Apr-16 11:30
Ma20696	1604390-03	Tissue	07-Apr-16 00:00	08-Apr-16 11:30
Ma20697	1604390-04	Tissue	07-Apr-16 00:00	08-Apr-16 11:30
Ma20698	1604390-05	Tissue	07-Apr-16 00:00	08-Apr-16 11:30
Ma20699	1604390-06	Tissue	07-Apr-16 00:00	08-Apr-16 11:30
Ma20701	1604390-08	Tissue	07-Apr-16 00:00	08-Apr-16 11:30
Ma20702	1604390-09	Tissue	07-Apr-16 00:00	08-Apr-16 11:30
Ma20703	1604390-10	Tissue	07-Apr-16 00:00	08-Apr-16 11:30
Ma20704	1604390-11	Tissue	07-Apr-16 00:00	08-Apr-16 11:30
Ma20705	1604390-12	Tissue	07-Apr-16 00:00	08-Apr-16 11:30
Ma20706	1604390-13	Tissue	07-Apr-16 00:00	08-Apr-16 11:30
Ma20707	1604390-14	Tissue	07-Apr-16 00:00	08-Apr-16 11:30
Ma20708	1604390-15	Tissue	07-Apr-16 00:00	08-Apr-16 11:30
Ma20709	1604390-16	Tissue	07-Apr-16 00:00	08-Apr-16 11:30
Ma20710	1604390-17	Tissue	07-Apr-16 00:00	08-Apr-16 11:30
Ma20711	1604390-18	Tissue	07-Apr-16 00:00	08-Apr-16 11:30

Eurofins Frontier Global Sciences, Inc.



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Amy Goodall, Project Manager



Frontier Global Sciences

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425.686.1996 Phone
425.686.3096 Fax

Eurofins MGT (Melbourne)
2-5 Kingston Town Close
Oakleigh VIC, 3164

Project: Freshwater Sediments And Tissues
Project Number: 16/0238 493888
Project Manager: Onur Mehmet

Reported:
27-May-16 16:27

SAMPLE RECEIPT

Samples were received at Eurofins Frontier Global Sciences (EFGS) on 4/8/2016 11:30:00 AM . The samples were received intact, on-ice within a sealed cooler at 2.1 degrees Celsius.

SAMPLE PREPARATION AND ANALYSIS

Samples were prepared and analyzed for total mercury by flow injection atomic fluorescence spectrometry (FI-AFS) in accordance with EPA 1631E.

Samples were prepared and analyzed for methyl mercury by cold vapor gas chromatography atomic fluorescence spectrometry (CV-GC-AFS) in accordance with EPA 1630 (EFGS-070).

Samples were prepared and analyzed for total recoverable metals by inductively coupled plasma mass spectrometry (ICP-MS) in accordance with EPA 1638 (EFGS-054).

ANALYTICAL AND QUALITY CONTROL ISSUES

Method blanks were prepared for every preparation to assess possible blank contribution from the sample preparation procedure. The method blanks were carried through the entire analytical procedure. All blanks fell within the established acceptance criteria with the exception of any items narrated above or flagged and described in the notes and definitions section of the report.

Liquid spikes, certified reference material (CRM) or a quality control samples (QCS) were prepared for every preparation as a measure of accuracy. All liquid spikes, CRMs and/or QCS samples fell within the established acceptance criteria with the exception of any items narrated above or flagged and described in the notes and definitions section of the report.

As an additional measure of the accuracy of the methods used and to check for matrix interference, matrix spikes (MS) and matrix spike duplicates (MSD) were digested and analyzed. All of the matrix spike recoveries fell within the established acceptance criteria with the exception of any items flagged and described in the notes and definitions section of the report.

A reasonable measure of the precision of the analytical methods is the relative percent difference (RPD) between a matrix spike recovery and a matrix spike duplicate recovery and between laboratory control sample recovery and laboratory control sample duplicate recoveries. All of the relative percent differences established acceptance criteria with the exception of any items flagged and described in the notes and definitions section of the report.

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Amy Goodall, Project Manager



Frontier Global Sciences

Sample Receipt Checklist

EFGS Work Order: 1604390Client: Eurofins MGTDate & Time Received: 4/8/16 11:30Date Labeled: 4/15/16 Labeled By: CW

Project: _____

Received By: CWFLabel Verified By: 1 PM# of Coolers Received: 1 Samples Arrived By: Shipping Service Courier _____ Hand _____ Other (Specify: _____)Coolant: ☐ None/Ambient ☐ Loose Ice ☐ Gel Ice ☒ Dry Ice Coolant Required: Y Temp Blank Used: Y for Cooler(s): 1

Notify Project Manager if packages/coolers are received without coolant or with thawed coolant and at a temperature in excess of 6°C. PM notified: Y/N

Cooler Information:	Y/N/NA	Comments
The coolers do not appear to be tampered with:	<u>Y</u>	
Custody Seals are present and intact:	<u>N</u>	
Custody seals signed:	<u>N/A</u>	

TID: <u>5225</u>	CF: <u>-0.2</u> °C	Date/time: <u>4/8/16 11:30</u>	By: <u>CWF</u>
Cooler 1: <u>2.3</u> °C	w/ CF: <u>2.1</u> °C	Cooler 4: _____ °C	w/ CF: _____ °C
Cooler 2: _____ °C	w/ CF: _____ °C	Cooler 5: _____ °C	w/ CF: _____ °C
Cooler 3: _____ °C	w/ CF: _____ °C	Cooler 6: _____ °C	w/ CF: _____ °C

Chain of Custody:	Y/N/NA	Comments
Sample ID/Description:	<u>Y</u>	
Date and time of collection:	<u>Y</u>	
Sampled by:	<u>Y</u>	
Preservation type:	<u>Y</u>	
Requested analyses:	<u>Y</u>	
Required signatures:	<u>Y</u>	
Internal COC required:	<u>Y</u>	

Sample Condition/Integrity:	Y/N/NA	Comments
Sample containers intact/present:	<u>Y</u>	
Sample labels are present and legible:	<u>Y</u>	
Sample ID on container/bag matches COC:	<u>Y</u>	
Correct sample containers used:	<u>Y</u>	
Samples received within holding times:	<u>Y</u>	
Sample volume sufficient for requested analyses:	<u>Y</u>	
Correct preservative used for requested analyses:	<u>NA</u>	

Anomalies/Non-conformances (attach additional pages if needed):



mgt

☒ MELBOURNE

Ph: +61 3 8564 5000

2-5 Kingston Town Close, Oakleigh, Vic 3164
Email: EnviroSampleVic@eurofins.com.au☐ BRISBANE

Ph: +61 7 3902 4600

1/21 Smallwood Place Murarie, Qld 4172
Email: EnviroSampleQLD@eurofins.com.au☐ SYDNEY

W 2066

Email: EnviroSampleNSW@eurofins.com.au

1604390

Page 1 of 2

Purchase Order for External Analysis

Eurofins | mgt Ref: 493888

Eurofins | mgt Purchase Order: 16/0238 493888

Results Required: STD Page: 1 of 2

Receiving Laboratory: Eurofins Frontier Global Sciences

Eurofins | mgt Contact: Onur Mehmet

Address: 11720 North Creek Parkway North Suite 400
Bothell WA 98011 - USAReport results to: EnviroReports@eurofins.com.au ☒Eurofins | mgt, P.O. Box 276, Oakleigh, Vic 3166, Australia ☐

Telephone: Fax:

Send invoices to: EnviroAP@eurofins.com.au ☒

Client ID	Eurofins mgt ID	Matrix	Tests Required
	Ma20694	Other	Total Mercury and Methyl Mercury
	Ma20695	Other	Total Mercury and Methyl Mercury
	Ma20696	Other	Total Mercury and Methyl Mercury
	Ma20697	Other	Total Mercury and Methyl Mercury
	Ma20698	Other	Total Mercury and Methyl Mercury
	Ma20699	Other	Total Mercury and Methyl Mercury
	Ma20700	Other	Total Mercury and Methyl Mercury
	Ma20701	Other	Total Mercury and Methyl Mercury
	Ma20702	Other	Total Mercury and Methyl Mercury
	Ma20703	Other	Total Mercury and Methyl Mercury
	Ma20704	Other	Total Mercury and Methyl Mercury

Total No. Samples: 11 Comments: Please identify samples using Eurofins | mgt ID and Client ID

Chain of Custody

Relinquished by: Tony W Date/Time: 22/03/16

Received by: Conner Foote Date/Time: 4/8/16 11:30

Relinquished by: Date/Time:

Received by: Date/Time:

Sample Receipt Advice (Receiving Lab Use Only)

All Samples Received in Good Condition ☐ Average sample temp on receipt: (°C)

All Documentation in Proper Order ☐

Samples Received with an Attempt to Chill ☐ For all enquires please quote Ref. No.

Samples Received Within Holding Times ☐

Please complete this section and email a scan copy to EnviroReports@eurofins.com.au



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Eurofins MGT (Melbourne)
2-5 Kingston Town Close
Oakleigh VIC, 3164

Project: Freshwater Sediments And Tissues
Project Number: 16/0238 493888
Project Manager: Onur Mehmet

Reported:
27-May-16 16:27

Ma20694
1604390-01

Analyte	Result	Detection Limit	Reporting Limit	Units	Dilution	Batch	Prepared	Sequence	Analyzed	Method	Notes
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Sample Preparation: EFGS-010 KOH/Methanol Hg Digestion

Methyl Mercury (as Mercury)	510	-	8.4	ng/g	2500	F605218	18-May-16	6E23005	21-May-16	EPA 1630 Mod/FGS-070	
-----------------------------	-----	---	-----	------	------	---------	-----------	---------	-----------	-------------------------	--

Sample Preparation: EFGS-011 Nitric/Sulfuric Hg Digestion

Mercury	468	-	17.9	ng/g	500	F605219	18-May-16	6E20006	19-May-16	EPA 1631B	
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Sample Preparation: EFGS-058 Teflon Conc. Nitric Tissue Digestion

Arsenic	0.23	-	0.14	mg/kg	5	F605244	20-May-16	6E23015	20-May-16	FGS-054	
Cadmium	0.120	-	0.007	mg/kg	5	F605244	20-May-16	6E23015	20-May-16	FGS-054	

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Project: Freshwater Sediments And Tissues
Project Number: 16/0238 493888
Project Manager: Onur Mehmet

Reported:
27-May-16 16:27

Ma20695
1604390-02

Analyte	Result	Detection Limit	Reporting Limit	Units	Dilution	Batch	Prepared	Sequence	Analyzed	Method	Notes
Sample Preparation: EFGS-010 KOH/Methanol Hg Digestion											
Methyl Mercury (as Mercury)	1340	-	38.5	ng/g	10000	F605218	18-May-16	6E24016	24-May-16	EPA 1630 Mod/FGS-070	
Sample Preparation: EFGS-011 Nitric/Sulfuric Hg Digestion											
Mercury	728	-	17.2	ng/g	500	F605219	18-May-16	6E20006	19-May-16	EPA 1631B	
Sample Preparation: EFGS-058 Teflon Conc. Nitric Tissue Digestion											
Arsenic	0.22	-	0.19	mg/kg	5	F605244	20-May-16	6E23015	20-May-16	FGS-054	
Cadmium	0.172	-	0.009	mg/kg	5	F605244	20-May-16	6E23015	20-May-16	FGS-054	

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Oakleigh VIC, 3164

Project: Freshwater Sediments And Tissues
Project Number: 16/0238 493888
Project Manager: Onur Mehmet

Reported:
27-May-16 16:27

Ma20696

1604390-03

Analyte	Result	Detection Limit	Reporting Limit	Units	Dilution	Batch	Prepared	Sequence	Analyzed	Method	Notes
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Sample Preparation: EFGS-010 KOH/Methanol Hg Digestion

Methyl Mercury (as Mercury)	923	-	35.7	ng/g	10000	F605218	18-May-16	6E24016	24-May-16	EPA 1630 Mod/FGS-070	
-----------------------------	-----	---	------	------	-------	---------	-----------	---------	-----------	-------------------------	--

Sample Preparation: EFGS-011 Nitric/Sulfuric Hg Digestion

Mercury	679	-	18.1	ng/g	500	F605219	18-May-16	6E20006	19-May-16	EPA 1631B	
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Sample Preparation: EFGS-058 Teflon Conc. Nitric Tissue Digestion

Arsenic	ND	-	0.18	mg/kg	5	F605244	20-May-16	6E23015	20-May-16	FGS-054	U
Cadmium	0.018	-	0.009	mg/kg	5	F605244	20-May-16	6E23015	20-May-16	FGS-054	

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Oakleigh VIC, 3164

Project: Freshwater Sediments And Tissues
Project Number: 16/0238 493888
Project Manager: Onur Mehmet

Reported:
27-May-16 16:27

Ma20697

1604390-04

Analyte	Result	Detection Limit	Reporting Limit	Units	Dilution	Batch	Prepared	Sequence	Analyzed	Method	Notes
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Sample Preparation: EFGS-010 KOH/Methanol Hg Digestion

Methyl Mercury (as Mercury)	682	-	8.7	ng/g	2500	F605218	18-May-16	6E23005	21-May-16	EPA 1630 Mod/FGS-070	
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Sample Preparation: EFGS-011 Nitric/Sulfuric Hg Digestion

Mercury	690	-	17.9	ng/g	500	F605219	18-May-16	6E20006	19-May-16	EPA 1631B	
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Sample Preparation: EFGS-058 Teflon Conc. Nitric Tissue Digestion

Arsenic	ND	-	0.19	mg/kg	5	F605244	20-May-16	6E23015	20-May-16	FGS-054	U
Cadmium	0.019	-	0.010	mg/kg	5	F605244	20-May-16	6E23015	20-May-16	FGS-054	

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Project: Freshwater Sediments And Tissues
Project Number: 16/0238 493888
Project Manager: Onur Mehmet

Reported:
27-May-16 16:27

Ma20698
1604390-05

Analyte	Result	Detection Limit	Reporting Limit	Units	Dilution	Batch	Prepared	Sequence	Analyzed	Method	Notes
Sample Preparation: EFGS-010 KOH/Methanol Hg Digestion											
Methyl Mercury (as Mercury)	1520	-	36.9	ng/g	10000	F605218	18-May-16	6E24016	24-May-16	EPA 1630 Mod/FGS-070	
Sample Preparation: EFGS-011 Nitric/Sulfuric Hg Digestion											
Mercury	789	-	18.1	ng/g	500	F605219	18-May-16	6E20006	19-May-16	EPA 1631B	
Sample Preparation: EFGS-058 Teflon Conc. Nitric Tissue Digestion											
Arsenic	0.20	-	0.19	mg/kg	5	F605244	20-May-16	6E23015	20-May-16	FGS-054	
Cadmium	0.077	-	0.009	mg/kg	5	F605244	20-May-16	6E23015	20-May-16	FGS-054	

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Project: Freshwater Sediments And Tissues
Project Number: 16/0238 493888
Project Manager: Onur Mehmet

Reported:
27-May-16 16:27

Ma20699

1604390-06

Analyte	Result	Detection Limit	Reporting Limit	Units	Dilution	Batch	Prepared	Sequence	Analyzed	Method	Notes
---------	--------	-----------------	-----------------	-------	----------	-------	----------	----------	----------	--------	-------

Sample Preparation: EFGS-010 KOH/Methanol Hg Digestion

Methyl Mercury (as Mercury)	1850	-	89.9	ng/g	25000	F605218	18-May-16	6E24016	24-May-16	EPA 1630 Mod/FGS-070	
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Sample Preparation: EFGS-011 Nitric/Sulfuric Hg Digestion

Mercury	1320	-	17.3	ng/g	500	F605219	18-May-16	6E20006	19-May-16	EPA 1631B	
---------	------	---	------	------	-----	---------	-----------	---------	-----------	-----------	--

Sample Preparation: EFGS-058 Teflon Conc. Nitric Tissue Digestion

Arsenic	0.19	-	0.16	mg/kg	5	F605244	20-May-16	6E23015	20-May-16	FGS-054	
Cadmium	0.064	-	0.008	mg/kg	5	F605244	20-May-16	6E23015	20-May-16	FGS-054	

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Project: Freshwater Sediments And Tissues
Project Number: 16/0238 493888
Project Manager: Onur Mehmet

Reported:
27-May-16 16:27

Ma20701
1604390-08

Analyte	Result	Detection Limit	Reporting Limit	Units	Dilution	Batch	Prepared	Sequence	Analyzed	Method	Notes
Sample Preparation: EFGS-010 KOH/Methanol Hg Digestion											
Methyl Mercury (as Mercury)	289	-	8.5	ng/g	2500	F605218	18-May-16	6E24016	24-May-16	EPA 1630 Mod/FGS-070	
Sample Preparation: EFGS-011 Nitric/Sulfuric Hg Digestion											
Mercury	235	-	16.9	ng/g	500	F605219	18-May-16	6E20006	19-May-16	EPA 1631B	
Sample Preparation: EFGS-058 Teflon Conc. Nitric Tissue Digestion											
Arsenic	ND	-	0.11	mg/kg	5	F605244	20-May-16	6E23015	20-May-16	FGS-054	U
Cadmium	0.015	-	0.006	mg/kg	5	F605244	20-May-16	6E23015	20-May-16	FGS-054	

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Oakleigh VIC, 3164

Project: Freshwater Sediments And Tissues
Project Number: 16/0238 493888
Project Manager: Onur Mehmet

Reported:
27-May-16 16:27

Ma20702

1604390-09

Analyte	Result	Detection Limit	Reporting Limit	Units	Dilution	Batch	Prepared	Sequence	Analyzed	Method	Notes
---------	--------	-----------------	-----------------	-------	----------	-------	----------	----------	----------	--------	-------

Sample Preparation: EFGS-010 KOH/Methanol Hg Digestion

Methyl Mercury (as Mercury)	172	-	9.3	ng/g	2500	F605218	18-May-16	6E23005	21-May-16	EPA 1630 Mod/FGS-070	
-----------------------------	-----	---	-----	------	------	---------	-----------	---------	-----------	-------------------------	--

Sample Preparation: EFGS-011 Nitric/Sulfuric Hg Digestion

Mercury	127	-	18.1	ng/g	500	F605219	18-May-16	6E20006	19-May-16	EPA 1631B	
---------	-----	---	------	------	-----	---------	-----------	---------	-----------	-----------	--

Sample Preparation: EFGS-058 Teflon Conc. Nitric Tissue Digestion

Arsenic	ND	-	0.19	mg/kg	5	F605244	20-May-16	6E23015	20-May-16	FGS-054	U
Cadmium	0.025	-	0.010	mg/kg	5	F605244	20-May-16	6E23015	20-May-16	FGS-054	

Eurofins Frontier Global Sciences, Inc.

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Amy Goodall, Project Manager

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Project: Freshwater Sediments And Tissues
Project Number: 16/0238 493888
Project Manager: Onur Mehmet

Reported:
27-May-16 16:27

Ma20703

1604390-10

Analyte	Result	Detection Limit	Reporting Limit	Units	Dilution	Batch	Prepared	Sequence	Analyzed	Method	Notes
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Sample Preparation: EFGS-010 KOH/Methanol Hg Digestion

Methyl Mercury (as Mercury)	1220	-	36.2	ng/g	10000	F605218	18-May-16	6E24016	24-May-16	EPA 1630 Mod/FGS-070	
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Sample Preparation: EFGS-011 Nitric/Sulfuric Hg Digestion

Mercury	662	-	17.5	ng/g	500	F605219	18-May-16	6E20006	19-May-16	EPA 1631B	
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Sample Preparation: EFGS-058 Teflon Conc. Nitric Tissue Digestion

Arsenic	0.17	-	0.17	mg/kg	5	F605244	20-May-16	6E23015	20-May-16	FGS-054	U
Cadmium	0.045	-	0.009	mg/kg	5	F605244	20-May-16	6E23015	20-May-16	FGS-054	

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Project: Freshwater Sediments And Tissues
Project Number: 16/0238 493888
Project Manager: Onur Mehmet

Reported:
27-May-16 16:27

Ma20704

1604390-11

Analyte	Result	Detection Limit	Reporting Limit	Units	Dilution	Batch	Prepared	Sequence	Analyzed	Method	Notes
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Sample Preparation: EFGS-010 KOH/Methanol Hg Digestion

Methyl Mercury (as Mercury)	2830	-	87.1	ng/g	25000	F605218	18-May-16	6E24016	24-May-16	EPA 1630 Mod/FGS-070	
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Sample Preparation: EFGS-011 Nitric/Sulfuric Hg Digestion

Mercury	1720	-	36.6	ng/g	1000	F605219	18-May-16	6E20006	19-May-16	EPA 1631B	
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Sample Preparation: EFGS-058 Teflon Conc. Nitric Tissue Digestion

Arsenic	ND	-	0.16	mg/kg	5	F605244	20-May-16	6E23015	21-May-16	FGS-054	U
Cadmium	0.132	-	0.008	mg/kg	5	F605244	20-May-16	6E23015	21-May-16	FGS-054	

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Project: Freshwater Sediments And Tissues
Project Number: 16/0238 493888
Project Manager: Onur Mehmet

Reported:
27-May-16 16:27

Ma20705
1604390-12

Analyte	Result	Detection Limit	Reporting Limit	Units	Dilution	Batch	Prepared	Sequence	Analyzed	Method	Notes
Sample Preparation: EFGS-010 KOH/Methanol Hg Digestion											
Methyl Mercury (as Mercury)	2480	-	91.9	ng/g	25000	F605218	18-May-16	6E24016	24-May-16	EPA 1630 Mod/FGS-070	
Sample Preparation: EFGS-011 Nitric/Sulfuric Hg Digestion											
Mercury	1710	-	34.8	ng/g	1000	F605219	18-May-16	6E20006	19-May-16	EPA 1631B	
Sample Preparation: EFGS-058 Teflon Conc. Nitric Tissue Digestion											
Arsenic	ND	-	0.16	mg/kg	5	F605244	20-May-16	6E23015	21-May-16	FGS-054	U
Cadmium	0.023	-	0.008	mg/kg	5	F605244	20-May-16	6E23015	21-May-16	FGS-054	

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Project: Freshwater Sediments And Tissues
Project Number: 16/0238 493888
Project Manager: Onur Mehmet

Reported:
27-May-16 16:27

Ma20706
1604390-13

Analyte	Result	Detection Limit	Reporting Limit	Units	Dilution	Batch	Prepared	Sequence	Analyzed	Method	Notes
Sample Preparation: EFGS-010 KOH/Methanol Hg Digestion											
Methyl Mercury (as Mercury)	5.9	-	1.9	ng/g	500	F605218	18-May-16	6E24016	24-May-16	EPA 1630 Mod/FGS-070	
Sample Preparation: EFGS-011 Nitric/Sulfuric Hg Digestion											
Mercury	31.5	-	18.8	ng/g	500	F605219	18-May-16	6E20006	19-May-16	EPA 1631B	
Sample Preparation: EFGS-058 Teflon Conc. Nitric Tissue Digestion											
Arsenic	1.81	-	0.14	mg/kg	5	F605244	20-May-16	6E23015	21-May-16	FGS-054	
Cadmium	0.369	-	0.007	mg/kg	5	F605244	20-May-16	6E23015	21-May-16	FGS-054	

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Project Number: 16/0238 493888
Project Manager: Onur Mehmet

Reported:
27-May-16 16:27

Ma20707

1604390-14

Analyte	Result	Detection Limit	Reporting Limit	Units	Dilution	Batch	Prepared	Sequence	Analyzed	Method	Notes
Sample Preparation: EFGS-010 KOH/Methanol Hg Digestion											
Methyl Mercury (as Mercury)	2.2	-	1.8	ng/g	500	F605218	18-May-16	6E24016	24-May-16	EPA 1630 Mod/FGS-070	
Sample Preparation: EFGS-011 Nitric/Sulfuric Hg Digestion											
Mercury	7.95	-	0.731	ng/g	20	F605219	18-May-16	6E20006	19-May-16	EPA 1631B	
Sample Preparation: EFGS-058 Teflon Conc. Nitric Tissue Digestion											
Arsenic	3.56	-	0.16	mg/kg	5	F605244	20-May-16	6E23015	21-May-16	FGS-054	
Cadmium	0.031	-	0.008	mg/kg	5	F605244	20-May-16	6E23015	21-May-16	FGS-054	

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Project Manager: Onur Mehmet

Reported:
27-May-16 16:27

Ma20708
1604390-15

Analyte	Result	Detection Limit	Reporting Limit	Units	Dilution	Batch	Prepared	Sequence	Analyzed	Method	Notes
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Sample Preparation: EFGS-010 KOH/Methanol Hg Digestion

Methyl Mercury (as Mercury)	351	-	8.9	ng/g	2500	F605218	18-May-16	6E23005	21-May-16	EPA 1630 Mod/FGS-070	
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Sample Preparation: EFGS-011 Nitric/Sulfuric Hg Digestion

Mercury	381	-	17.2	ng/g	500	F605219	18-May-16	6E20006	19-May-16	EPA 1631B	
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Sample Preparation: EFGS-058 Teflon Conc. Nitric Tissue Digestion

Arsenic	ND	-	0.25	mg/kg	5	F605244	20-May-16	6E23015	21-May-16	FGS-054	U
Cadmium	ND	-	0.012	mg/kg	5	F605244	20-May-16	6E23015	21-May-16	FGS-054	U

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Project Number: 16/0238 493888
Project Manager: Onur Mehmet

Reported:
27-May-16 16:27

Ma20709

1604390-16

Analyte	Result	Detection Limit	Reporting Limit	Units	Dilution	Batch	Prepared	Sequence	Analyzed	Method	Notes
Sample Preparation: EFGS-010 KOH/Methanol Hg Digestion											
Methyl Mercury (as Mercury)	372	-	9.0	ng/g	2500	F605218	18-May-16	6E23005	21-May-16	EPA 1630 Mod/FGS-070	
Sample Preparation: EFGS-011 Nitric/Sulfuric Hg Digestion											
Mercury	332	-	18.3	ng/g	500	F605219	18-May-16	6E20006	19-May-16	EPA 1631B	
Sample Preparation: EFGS-058 Teflon Conc. Nitric Tissue Digestion											
Arsenic	0.43	-	0.18	mg/kg	5	F605244	20-May-16	6E23015	21-May-16	FGS-054	
Cadmium	0.046	-	0.009	mg/kg	5	F605244	20-May-16	6E23015	21-May-16	FGS-054	

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Project Number: 16/0238 493888
Project Manager: Onur Mehmet

Reported:
27-May-16 16:27

Ma20710

1604390-17

Analyte	Result	Detection Limit	Reporting Limit	Units	Dilution	Batch	Prepared	Sequence	Analyzed	Method	Notes
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Sample Preparation: EFGS-010 KOH/Methanol Hg Digestion

Methyl Mercury (as Mercury)	6.0	-	1.9	ng/g	500	F605218	18-May-16	6E24016	24-May-16	EPA 1630 Mod/FGS-070	
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Sample Preparation: EFGS-011 Nitric/Sulfuric Hg Digestion

Mercury	14.1	-	0.704	ng/g	20	F605219	18-May-16	6E20006	19-May-16	EPA 1631B	
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Sample Preparation: EFGS-058 Teflon Conc. Nitric Tissue Digestion

Arsenic	2.02	-	0.18	mg/kg	5	F605244	20-May-16	6E23015	21-May-16	FGS-054	
Cadmium	0.368	-	0.009	mg/kg	5	F605244	20-May-16	6E23015	21-May-16	FGS-054	

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Project Number: 16/0238 493888
Project Manager: Onur Mehmet

Reported:
27-May-16 16:27

Ma20711

1604390-18

Analyte	Result	Detection Limit	Reporting Limit	Units	Dilution	Batch	Prepared	Sequence	Analyzed	Method	Notes
Sample Preparation: EFGS-010 KOH/Methanol Hg Digestion											
Methyl Mercury (as Mercury)	2.1	-	1.8	ng/g	500	F605218	18-May-16	6E24016	24-May-16	EPA 1630 Mod/FGS-070	
Sample Preparation: EFGS-011 Nitric/Sulfuric Hg Digestion											
Mercury	7.78	-	0.719	ng/g	20	F605219	18-May-16	6E20006	19-May-16	EPA 1631B	
Sample Preparation: EFGS-058 Teflon Conc. Nitric Tissue Digestion											
Arsenic	1.52	-	0.17	mg/kg	5	F605244	20-May-16	6E23015	21-May-16	FGS-054	
Cadmium	0.033	-	0.008	mg/kg	5	F605244	20-May-16	6E23015	21-May-16	FGS-054	

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Project: Freshwater Sediments And Tissues
Project Number: 16/0238 493888
Project Manager: Onur Mehmet

Reported:
27-May-16 16:27

Quality Control Data

Analyte	Result	Detection Limit	Reporting Limit	Units	Spike Level	Source Result	%REC	%REC Limits	RPD	RPD Limit	Notes
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Batch F605218 - EFGS-010 KOH/Methanol Hg Digestion

Blank (F605218-BLK1)					Prepared: 18-May-16 Analyzed: 21-May-16						
Methyl Mercury (as Mercury)	ND	-	2.0	ng/g							U
Blank (F605218-BLK2)					Prepared: 18-May-16 Analyzed: 21-May-16						
Methyl Mercury (as Mercury)	ND	-	2.0	ng/g							U
Blank (F605218-BLK3)					Prepared: 18-May-16 Analyzed: 21-May-16						
Methyl Mercury (as Mercury)	ND	-	2.0	ng/g							U
Blank (F605218-BLK4)					Prepared: 18-May-16 Analyzed: 21-May-16						
Methyl Mercury (as Mercury)	ND	-	1.2	ng/g							F-03, U
Blank (F605218-BLK5)					Prepared: 18-May-16 Analyzed: 21-May-16						
Methyl Mercury (as Mercury)	ND	-	1.2	ng/g							F-03, U
Blank (F605218-BLK6)					Prepared: 18-May-16 Analyzed: 21-May-16						
Methyl Mercury (as Mercury)	ND	-	1.0	ng/g							F-03, U
Blank (F605218-BLK7)					Prepared: 18-May-16 Analyzed: 21-May-16						
Methyl Mercury (as Mercury)	ND	-	1.2	ng/g							F-03, U
Blank (F605218-BLK8)					Prepared: 18-May-16 Analyzed: 24-May-16						
Methyl Mercury (as Mercury)	ND	-	2.0	ng/g							U
Blank (F605218-BLK9)					Prepared: 18-May-16 Analyzed: 24-May-16						
Methyl Mercury (as Mercury)	ND	-	2.0	ng/g							U
Blank (F605218-BLKA)					Prepared: 18-May-16 Analyzed: 24-May-16						
Methyl Mercury (as Mercury)	ND	-	2.0	ng/g							U

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Project: Freshwater Sediments And Tissues
Project Number: 16/0238 493888
Project Manager: Onur Mehmet

Reported:
27-May-16 16:27

Quality Control Data

Analyte	Result	Detection Limit	Reporting Limit	Units	Spike Level	Source Result	%REC	%REC Limits	RPD	RPD Limit	Notes
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Batch F605218 - EFGS-010 KOH/Methanol Hg Digestion

LCS (F605218-BS1)					Prepared: 18-May-16 Analyzed: 21-May-16						
Methyl Mercury (as Mercury)	313.6	-	7.8	ng/g	330.28		95.0	70-130			
LCS Dup (F605218-BSD1)					Prepared: 18-May-16 Analyzed: 21-May-16						
Methyl Mercury (as Mercury)	338.6	-	7.9	ng/g	330.28		103	70-130	7.66	25	
Duplicate (F605218-DUP2)					Source: 1604390-02RE1 Prepared: 18-May-16 Analyzed: 24-May-16						
Methyl Mercury (as Mercury)	1281	-	35.5	ng/g		1342			4.68	35	
Matrix Spike (F605218-MS1)					Source: 1604390-03 Prepared: 18-May-16 Analyzed: 21-May-16						
Methyl Mercury (as Mercury)	577.8	-	8.7	ng/g	34.637	691.1	-327	65-130			QM-02
Matrix Spike (F605218-MS2)					Source: 1604390-09 Prepared: 18-May-16 Analyzed: 21-May-16						
Methyl Mercury (as Mercury)	197.6	-	8.9	ng/g	35.496	171.8	72.7	65-130			
Matrix Spike Dup (F605218-MSD1)					Source: 1604390-03 Prepared: 18-May-16 Analyzed: 21-May-16						
Methyl Mercury (as Mercury)	709.9	-	9.2	ng/g	36.667	691.1	51.2	65-130	-274	35	QM-02, QR-07
Matrix Spike Dup (F605218-MSD2)					Source: 1604390-09 Prepared: 18-May-16 Analyzed: 21-May-16						
Methyl Mercury (as Mercury)	183.5	-	8.6	ng/g	34.399	171.8	34.0	65-130	72.5	35	QM-02, QR-07

Batch F605219 - EFGS-011 Nitric/Sulfuric Hg Digestion

Blank (F605219-BLK1)					Prepared: 18-May-16 Analyzed: 19-May-16						
Mercury	ND	-	0.800	ng/g							U
Blank (F605219-BLK2)					Prepared: 18-May-16 Analyzed: 19-May-16						
Mercury	ND	-	0.800	ng/g							U

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Project: Freshwater Sediments And Tissues
Project Number: 16/0238 493888
Project Manager: Onur Mehmet

Reported:
27-May-16 16:27

Quality Control Data

Analyte	Result	Detection Limit	Reporting Limit	Units	Spike Level	Source Result	%REC	%REC Limits	RPD	RPD Limit	Notes
Batch F605219 - EFGS-011 Nitric/Sulfuric Hg Digestion											
Blank (F605219-BLK3)					Prepared: 18-May-16 Analyzed: 19-May-16						
Mercury	ND	-	0.800	ng/g							U
Blank (F605219-BLK4)					Prepared: 18-May-16 Analyzed: 19-May-16						
Mercury	ND	-	0.613	ng/g							F-03, U
Blank (F605219-BLK5)					Prepared: 18-May-16 Analyzed: 19-May-16						
Mercury	ND	-	0.645	ng/g							F-03, U
LCS (F605219-BS1)					Prepared: 18-May-16 Analyzed: 19-May-16						
Mercury	8.416	-	0.800	ng/g	8.0160		105	75-125			
LCS (F605219-BS2)					Prepared: 18-May-16 Analyzed: 19-May-16						
Mercury	330.1	-	39.5	ng/g	382.50		86.3	75-125			
LCS Dup (F605219-BSD1)					Prepared: 18-May-16 Analyzed: 19-May-16						
Mercury	8.311	-	0.800	ng/g	8.0160		104	75-125	1.25	24	
Duplicate (F605219-DUP1)					Source: 1604390-02 Prepared: 18-May-16 Analyzed: 19-May-16						
Mercury	695.3	-	17.5	ng/g		728.5			4.66	24	
Matrix Spike (F605219-MS1)					Source: 1604390-03 Prepared: 18-May-16 Analyzed: 19-May-16						
Mercury	980.4	-	18.0	ng/g	359.71	679.3	83.7	71-125			
Matrix Spike (F605219-MS2)					Source: 1604390-09 Prepared: 18-May-16 Analyzed: 19-May-16						
Mercury	471.7	-	16.9	ng/g	337.84	126.6	102	71-125			
Matrix Spike Dup (F605219-MSD1)					Source: 1604390-03 Prepared: 18-May-16 Analyzed: 19-May-16						
Mercury	971.5	-	17.6	ng/g	352.11	679.3	83.0	71-125	0.855	24	

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Project: Freshwater Sediments And Tissues
Project Number: 16/0238 493888
Project Manager: Onur Mehmet

Reported:
27-May-16 16:27

Quality Control Data

Analyte	Result	Detection Limit	Reporting Limit	Units	Spike Level	Source Result	%REC	%REC Limits	RPD	RPD Limit	Notes
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Batch F605219 - EFGS-011 Nitric/Sulfuric Hg Digestion

Matrix Spike Dup (F605219-MSD2)

Source: 1604390-09

Prepared: 18-May-16 Analyzed: 19-May-16

Mercury	486.3	-	18.2	ng/g	364.30	126.6	98.7	71-125	3.39	24	
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Batch F605244 - EFGS-058 Teflon Conc. Nitric Tissue Digestion

Blank (F605244-BLK1)

Prepared & Analyzed: 20-May-16

Arsenic	ND	-	0.20	mg/kg							U
Cadmium	ND	-	0.010	mg/kg							U

Blank (F605244-BLK2)

Prepared & Analyzed: 20-May-16

Arsenic	ND	-	0.20	mg/kg							U
Cadmium	ND	-	0.010	mg/kg							U

LCS (F605244-BS1)

Prepared & Analyzed: 20-May-16

Arsenic	8.81	-	0.20	mg/kg	10.000		88.1	85-115			
Cadmium	7.620	-	0.010	mg/kg	8.0000		95.2	85-115			

LCS Dup (F605244-BSD1)

Prepared & Analyzed: 20-May-16

Arsenic	8.87	-	0.20	mg/kg	10.000		88.7	85-115	0.663	20	
Cadmium	7.613	-	0.010	mg/kg	8.0000		95.2	85-115	0.0831	20	

Matrix Spike (F605244-MS1)

Source: 1604390-04

Prepared & Analyzed: 20-May-16

Arsenic	8.88	-	0.19	mg/kg	9.3458	ND	95.0	80-120			
Cadmium	7.399	-	0.009	mg/kg	7.4766	0.019	98.7	75-125			

Matrix Spike (F605244-MS2)

Source: 1605156-01

Prepared & Analyzed: 20-May-16

Arsenic	7.80	-	0.16	mg/kg	7.9694	0.06	97.1	80-120			
Cadmium	6.287	-	0.008	mg/kg	6.3755	0.014	98.4	75-125			

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Project: Freshwater Sediments And Tissues
Project Number: 16/0238 493888
Project Manager: Onur Mehmet

Reported:
27-May-16 16:27

Quality Control Data

Analyte	Result	Detection Limit	Reporting Limit	Units	Spike Level	Source Result	%REC	%REC Limits	RPD	RPD Limit	Notes
---------	--------	-----------------	-----------------	-------	-------------	---------------	------	-------------	-----	-----------	-------

Batch F605244 - EFGS-058 Teflon Conc. Nitric Tissue Digestion

Matrix Spike (F605244-MS3)		Source: 1604390-04			Prepared & Analyzed: 20-May-16						
Arsenic	19.91	-	0.19	mg/kg	19.335	ND	103	80-120			AS
Cadmium	2.186	-	0.010	mg/kg	1.9335	0.019	112	75-125			AS
Matrix Spike (F605244-MS4)		Source: 1605156-01			Prepared & Analyzed: 20-May-16						
Arsenic	21.15	-	0.20	mg/kg	19.716	0.06	107	80-120			AS
Cadmium	2.305	-	0.010	mg/kg	1.9716	0.014	116	75-125			AS
Matrix Spike Dup (F605244-MSD1)		Source: 1604390-04			Prepared & Analyzed: 20-May-16						
Arsenic	7.03	-	0.15	mg/kg	7.5301	ND	93.3	80-120	1.85	20	
Cadmium	5.835	-	0.008	mg/kg	6.0241	0.019	96.6	75-125	2.21	20	
Matrix Spike Dup (F605244-MSD2)		Source: 1605156-01			Prepared & Analyzed: 20-May-16						
Arsenic	8.04	-	0.17	mg/kg	8.5587	0.06	93.2	80-120	4.07	20	
Cadmium	6.567	-	0.009	mg/kg	6.8470	0.014	95.7	75-125	2.76	20	
Matrix Spike Dup (F605244-MSD3)		Source: 1604390-04			Prepared & Analyzed: 20-May-16						
Arsenic	19.97	-	0.19	mg/kg	19.335	ND	103	80-120	0.315	20	AS
Cadmium	2.193	-	0.010	mg/kg	1.9335	0.019	112	75-125	0.301	20	AS
Matrix Spike Dup (F605244-MSD4)		Source: 1605156-01			Prepared & Analyzed: 20-May-16						
Arsenic	20.63	-	0.20	mg/kg	19.716	0.06	104	80-120	2.49	20	AS
Cadmium	2.217	-	0.010	mg/kg	1.9716	0.014	112	75-125	3.91	20	AS

Eurofins Frontier Global Sciences, Inc.



The results in this report only apply to the samples analyzed in accordance with the chain of custody document. This analytical report must be reproduced in its entirety.

Amy Goodall, Project Manager

Eurofins MGT (Melbourne)
2-5 Kingston Town Close
Oakleigh VIC, 3164

Project: Freshwater Sediments And Tissues
Project Number: 16/0238 493888
Project Manager: Onur Mehmet

Reported:
27-May-16 16:27

Notes and Definitions

U	Analyte was not detected and is reported as less than the LOD or as defined by the client. The LOD has been adjusted for any dilution or concentration of the sample.
QR-07	The RPD/RSD value for the matrix duplicate/triplicate was outside of acceptance limits. Batch QC acceptable based on MS/MSD and/or LCS/LCSD RPD values within control limits.
QM-02	The MS and/or MSD recoveries outside acceptance limits, due to spike concentration less than 1 times the sample concentration. The batch was accepted based on LCS and LCSD recoveries within control limits and, when analysis permits, acceptable AS/ASD.
F-03	This method blank is an equipment blank created during the homogenization process of associated samples at the laboratory. For informational purposes only.
AS	This MS and/or MSD is an analytical spike and/or an analytical spike duplicate.
DET	Analyte DETECTED
ND	Analyte NOT DETECTED at or above the reporting limit
NR	Not Reported
dry	Sample results reported on a dry weight basis
RPD	Relative Percent Difference

Eurofins Frontier Global Sciences, Inc.



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Amy Goodall, Project Manager

Certificate of Analysis

Pattle Delamore Partners Ltd
PDP House Level 4, 235 Broadway
Newmarket
Auckland New Zealand 1023



NATA Accredited
Accreditation Number 1261
Site Number 1254

Accredited for compliance with ISO/IEC 17025.
The results of the tests, calibrations and/or
measurements included in this document are traceable
to Australian/national standards.

Attention: Andrew Rumsby

Report 493888-S
Project name
Project ID A02982802
Received Date Mar 15, 2016

Client Sample ID			POX SAMPLE 1	POX SAMPLE 2	PYX SAMPLE 1	PYX SAMPLE 2
Sample Matrix			Other	Other	Other	Other
Eurofins mgt Sample No.			M16-Ma20694	M16-Ma20695	M16-Ma20696	M16-Ma20697
Date Sampled			Not Provided	Not Provided	Not Provided	Not Provided
Test/Reference	LOR	Unit				
Heavy Metals						
Mercury	0.1	mg/kg	See attached	See attached	See attached	See attached
Methyl Mercury			See attached	See attached	See attached	See attached

Client Sample ID			PZX SAMPLE 1	PZX SAMPLE 2	PDX SAMPLE 1	PDX SAMPLE 2
Sample Matrix			Other	Other	Other	Other
Eurofins mgt Sample No.			M16-Ma20698	M16-Ma20699	M16-Ma20701	M16-Ma20702
Date Sampled			Not Provided	Not Provided	Not Provided	Not Provided
Test/Reference	LOR	Unit				
Heavy Metals						
Mercury	0.1	mg/kg	See attached	See attached	See attached	See attached
Methyl Mercury			See attached	See attached	See attached	See attached

Client Sample ID			PVX SAMPLE 1	PUX SAMPLE 1	PUX SAMPLE 2	PAX
Sample Matrix			Other	Other	Other	Other
Eurofins mgt Sample No.			M16-Ma20703	M16-Ma20704	M16-Ma20705	M16-Ma20706
Date Sampled			Not Provided	Not Provided	Not Provided	Not Provided
Test/Reference	LOR	Unit				
Heavy Metals						
Mercury	0.1	mg/kg	See attached	See attached	See attached	See attached
Methyl Mercury			See attached	See attached	See attached	See attached

Client Sample ID			PBX-COCKLE	PTB	PNB	PBX-OYSTER
Sample Matrix			Other	Other	Other	Other
Eurofins mgt Sample No.			M16-Ma20707	M16-Ma20708	M16-Ma20709	M16-Ma20710
Date Sampled			Not Provided	Not Provided	Not Provided	Not Provided
Test/Reference	LOR	Unit				
Heavy Metals						
Mercury	0.1	mg/kg	See attached	See attached	See attached	See attached
Methyl Mercury			See attached	See attached	See attached	See attached

Client Sample ID			PBX-PIPI
Sample Matrix			Other
Eurofins mgt Sample No.			M16-Ma20711
Date Sampled			Not Provided
Test/Reference	LOR	Unit	
Heavy Metals			
Mercury	0.1	mg/kg	See attached
Methyl Mercury			See attached

Sample History

Where samples are submitted/analysed over several days, the last date of extraction and analysis is reported.

A recent review of our LIMS has resulted in the correction or clarification of some method identifications. Due to this, some of the method reference information on reports has changed. However, no substantive change has been made to our laboratory methods, and as such there is no change in the validity of current or previous results (regarding both quality and NATA accreditation).

If the date and time of sampling are not provided, the Laboratory will not be responsible for compromised results should testing be performed outside the recommended holding time.

Description

Heavy Metals

Testing Site

Melbourne

Extracted

Mar 22, 2016

Holding Time

180 Day

- Method: LTM-MET-3030 by ICP-OES (hydride ICP-OES for Mercury)

Company Name: Pattle Delamore Partners Ltd
Address: PDP House Level 4, 235 Broadway
Newmarket
Auckland New Zealand 1023

Project Name:
Project ID: A02982802

Order No.:
Report #: 493888
Phone: 0011 64 9 523 6900
Fax: 0011 64 9 523 6901

Received: Mar 15, 2016 2:29 PM
Due: Mar 22, 2016
Priority: 5 Day
Contact Name: Andrew Rumsby

Eurofins | mgt Client Manager: Onur Mehmet

Sample Detail					Mercury	Methyl Mercury
Laboratory where analysis is conducted						
Melbourne Laboratory - NATA Site # 1254 & 14271					X	
Sydney Laboratory - NATA Site # 18217						
Brisbane Laboratory - NATA Site # 20794						
External Laboratory						X
Sample ID	Sample Date	Sampling Time	Matrix	LAB ID		
POX SAMPLE 1	Not Provided		Other	M16-Ma20694	X	X
POX SAMPLE 2	Not Provided		Other	M16-Ma20695	X	X
PYX SAMPLE 1	Not Provided		Other	M16-Ma20696	X	X
PYX SAMPLE 2	Not Provided		Other	M16-Ma20697	X	X
PZX SAMPLE 1	Not Provided		Other	M16-Ma20698	X	X

Company Name: Pattle Delamore Partners Ltd
Address: PDP House Level 4, 235 Broadway
Newmarket
Auckland New Zealand 1023

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Laboratory where analysis is conducted						
Melbourne Laboratory - NATA Site # 1254 & 14271					X	
Sydney Laboratory - NATA Site # 18217						
Brisbane Laboratory - NATA Site # 20794						
External Laboratory						X
PZX SAMPLE 2	Not Provided		Other	M16-Ma20699	X	X
PZX SAMPLE 3	Not Provided		Other	M16-Ma20700	X	X
PDX SAMPLE 1	Not Provided		Other	M16-Ma20701	X	X
PDX SAMPLE 2	Not Provided		Other	M16-Ma20702	X	X
PVX SAMPLE 1	Not Provided		Other	M16-Ma20703	X	X
PUX SAMPLE 1	Not Provided		Other	M16-Ma20704	X	X

Company Name: Pattle Delamore Partners Ltd
Address: PDP House Level 4, 235 Broadway
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Auckland New Zealand 1023

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Sample Detail					Mercury	Methyl Mercury
Laboratory where analysis is conducted						
Melbourne Laboratory - NATA Site # 1254 & 14271					X	
Sydney Laboratory - NATA Site # 18217						
Brisbane Laboratory - NATA Site # 20794						
External Laboratory						X
PUX SAMPLE 2	Not Provided		Other	M16-Ma20705	X	X
PAX	Not Provided		Other	M16-Ma20706	X	X
PBX-COCKLE	Not Provided		Other	M16-Ma20707	X	X
PTB	Not Provided		Other	M16-Ma20708	X	X
PNB	Not Provided		Other	M16-Ma20709	X	X
PBX-OYSTER	Not Provided		Other	M16-Ma20710	X	X
PBX-PIPI	Not Provided		Other	M16-Ma20711	X	X

Internal Quality Control Review and Glossary

General

1. Laboratory QC results for Method Blanks, Duplicates, Matrix Spikes, and Laboratory Control Samples are included in this QC report where applicable. Additional QC data may be available on request.
2. All soil results are reported on a dry basis, unless otherwise stated.
3. Actual LORs are matrix dependant. Quoted LORs may be raised where sample extracts are diluted due to interferences.
4. Results are uncorrected for matrix spikes or surrogate recoveries.
5. SVOC analysis on waters are performed on homogenised, unfiltered samples, unless noted otherwise.
6. Samples were analysed on an 'as received' basis. 7. This report replaces any interim results previously issued.

Holding Times

Please refer to 'Sample Preservation and Container Guide' for holding times (QS3001).

For samples received on the last day of holding time, notification of testing requirements should have been received at least 6 hours prior to sample receipt deadlines as stated on the Sample Receipt Advice.

If the Laboratory did not receive the information in the required timeframe, and regardless of any other integrity issues, suitably qualified results may still be reported.

Holding times apply from the date of sampling, therefore compliance to these may be outside the laboratory's control.

****NOTE:** pH duplicates are reported as a range NOT as RPD

Units

mg/kg: milligrams per Kilogram

mg/l: milligrams per litre

ug/l: micrograms per litre

ppm: Parts per million

ppb: Parts per billion

%: Percentage

org/100ml: Organisms per 100 millilitres

NTU: Nephelometric Turbidity Units

MPN/100mL: Most Probable Number of organisms per 100 millilitres

Terms

Dry	Where a moisture has been determined on a solid sample the result is expressed on a dry basis.
LOR	Limit of Reporting.
SPIKE	Addition of the analyte to the sample and reported as percentage recovery.
RPD	Relative Percent Difference between two Duplicate pieces of analysis.
LCS	Laboratory Control Sample - reported as percent recovery
CRM	Certified Reference Material - reported as percent recovery
Method Blank	In the case of solid samples these are performed on laboratory certified clean sands. In the case of water samples these are performed on de-ionised water.
Surr - Surrogate	The addition of a like compound to the analyte target and reported as percentage recovery.
Duplicate	A second piece of analysis from the same sample and reported in the same units as the result to show comparison.
Batch Duplicate	A second piece of analysis from a sample outside of the clients batch of samples but run within the laboratory batch of analysis.
Batch SPIKE	Spike recovery reported on a sample from outside of the clients batch of samples but run within the laboratory batch of analysis.
USEPA	United States Environmental Protection Agency
APHA	American Public Health Association
TCLP	Toxicity Characteristic Leaching Procedure
COC	Chain of Custody
SRA	Sample Receipt Advice
CP	Client Parent - QC was performed on samples pertaining to this report
NCP	Non-Client Parent - QC performed on samples not pertaining to this report, QC is representative of the sequence or batch that client samples were analysed within
TEQ	Toxic Equivalency Quotient

QC - Acceptance Criteria

RPD Duplicates: Global RPD Duplicates Acceptance Criteria is 30% however the following acceptance guidelines are equally applicable:

Results <10 times the LOR : No Limit

Results between 10-20 times the LOR : RPD must lie between 0-50%

Results >20 times the LOR : RPD must lie between 0-30%

Surrogate Recoveries : Recoveries must lie between 50-150% - Phenols 20-130%.

QC Data General Comments

1. Where a result is reported as a less than (<), higher than the nominated LOR, this is due to either matrix interference, extract dilution required due to interferences or contaminant levels within the sample, high moisture content or insufficient sample provided.
2. Duplicate data shown within this report that states the word "BATCH" is a Batch Duplicate from outside of your sample batch, but within the laboratory sample batch at a 1:10 ratio. The Parent and Duplicate data shown is not data from your samples.
3. Organochlorine Pesticide analysis - where reporting LCS data, Toxaphene & Chlordane are not added to the LCS.
4. Organochlorine Pesticide analysis - where reporting Spike data, Toxaphene is not added to the Spike.
5. Total Recoverable Hydrocarbons - where reporting Spike & LCS data, a single spike of commercial Hydrocarbon products in the range of C12-C30 is added and it's Total Recovery is reported in the C10-C14 cell of the Report.
6. pH and Free Chlorine analysed in the laboratory - Analysis on this test must begin within 30 minutes of sampling. Therefore laboratory analysis is unlikely to be completed within holding time. Analysis will begin as soon as possible after sample receipt.
7. Recovery Data (Spikes & Surrogates) - where chromatographic interference does not allow the determination of Recovery the term "INT" appears against that analyte.
8. Polychlorinated Biphenyls are spiked only using Aroclor 1260 in Matrix Spikes and LCS.
9. For Matrix Spikes and LCS results a dash " - " in the report means that the specific analyte was not added to the QC sample.
10. Duplicate RPDs are calculated from raw analytical data thus it is possible to have two sets of data.

Comments

Metals: Eurofins | Frontier Global Sciences, report number 1604390.

Sample Integrity

Custody Seals Intact (if used)	N/A
Attempt to Chill was evident	Yes
Sample correctly preserved	Yes
Appropriate sample containers have been used	Yes
Sample containers for volatile analysis received with minimal headspace	Yes
Samples received within HoldingTime	Yes
Some samples have been subcontracted	Yes

Authorised By

Onur Mehmet	Analytical Services Manager
Emily Rosenberg	Senior Analyst-Metal (VIC)



Glenn Jackson

National Operations Manager

Final report - this Report replaces any previously issued Report

- Indicates Not Requested

* Indicates NATA accreditation does not cover the performance of this service

Uncertainty data is available on request

Eurofins | mgt shall not be liable for loss, cost, damages or expenses incurred by the client, or any other person or company, resulting from the use of any information or interpretation given in this report. In no case shall Eurofins | mgt be liable for consequential damages including, but not limited to, lost profits, damages for failure to meet deadlines and lost production arising from this report. This document shall not be reproduced except in full and relates only to the items tested. Unless indicated otherwise, the tests were performed on the samples as received.

27 May 2016

Onur Mehmet
Eurofins MGT (Auckland)
35 O Rorke Road Penrose
Auckland, NEW ZEALAND 1061
RE: Freshwater Sediments And Tissues

Enclosed are the analytical results for samples received by Eurofins Frontier Global Sciences. All quality control measurements are within established control limits and there were no analytical difficulties encountered with the exception of those listed in the case narrative section of this report.

If you have any questions concerning this report, please feel free to contact me.

Sincerely,



Amy Goodall
Project Manager



Frontier Global Sciences

11720 Northcreek Pkwy N, Suite 400
Bothell, WA 98011
425.686.1996 Phone
425.686.3096 Fax

Eurofins MGT (Auckland)
35 O Rorke Road Penrose
Auckland NEW ZEALAND, 1061

Project: Freshwater Sediments And Tissues
Project Number: Freshwater Sediments And Tissues
Project Manager: Onur Mehmet

Reported:
27-May-16 16:22

ANALYTICAL REPORT FOR SAMPLES

Sample ID	Laboratory ID	Matrix	Date Sampled	Date Received
PIX SAMPLE 1	1605156-01	Tissue	16-Apr-16 00:00	29-Apr-16 14:00
PIX SAMPLE 2	1605156-02	Tissue	16-Apr-16 00:00	29-Apr-16 14:00
PKX SAMPLE 1	1605156-03	Tissue	16-Apr-16 00:00	29-Apr-16 14:00
PJX SAMPLE 1	1605156-04	Tissue	16-Apr-16 00:00	29-Apr-16 14:00
PJX SAMPLE 2	1605156-05	Tissue	16-Apr-16 00:00	29-Apr-16 14:00
PJX SAMPLE 3	1605156-06	Tissue	16-Apr-16 00:00	29-Apr-16 14:00
PJX SAMPLE 4	1605156-07	Tissue	16-Apr-16 00:00	29-Apr-16 14:00

Eurofins Frontier Global Sciences, Inc.

The results in this report only apply to the samples analyzed in accordance with the chain of custody document. This analytical report must be reproduced in its entirety.

Amy Goodall, Project Manager



Frontier Global Sciences

11720 Northcreek Pkwy N, Suite 400
Bothell, WA 98011
425.686.1996 Phone
425.686.3096 Fax

Eurofins MGT (Auckland)
35 O Rorke Road Penrose
Auckland NEW ZEALAND, 1061

Project: Freshwater Sediments And Tissues
Project Number: Freshwater Sediments And Tissues
Project Manager: Onur Mehmet

Reported:
27-May-16 16:22

SAMPLE RECEIPT

Samples were received at Eurofins Frontier Global Sciences (EFGS) on 4/29/2016 2:00:00 PM. The samples were received intact, on-ice within a sealed cooler at 2.0 degrees Celsius.

SAMPLE PREPARATION AND ANALYSIS

Samples were prepared and analyzed for total mercury by flow injection atomic fluorescence spectrometry (FI-AFS) in accordance with EPA 1631E.

Samples were prepared and analyzed for methyl mercury by cold vapor gas chromatography atomic fluorescence spectrometry (CV-GC-AFS) in accordance with EPA 1630 (EFGS-070).

Samples were prepared and analyzed for total recoverable metals by inductively coupled plasma mass spectrometry (ICP-MS) in accordance with EPA 1638 (EFGS-054).

ANALYTICAL AND QUALITY CONTROL ISSUES

Method blanks were prepared for every preparation to assess possible blank contribution from the sample preparation procedure. The method blanks were carried through the entire analytical procedure. All blanks fell within the established acceptance criteria with the exception of any items narrated above or flagged and described in the notes and definitions section of the report.

Liquid spikes, certified reference material (CRM) or a quality control samples (QCS) were prepared for every preparation as a measure of accuracy. All liquid spikes, CRMs and/or QCS samples fell within the established acceptance criteria with the exception of any items narrated above or flagged and described in the notes and definitions section of the report.

As an additional measure of the accuracy of the methods used and to check for matrix interference, matrix spikes (MS) and matrix spike duplicates (MSD) were digested and analyzed. All of the matrix spike recoveries fell within the established acceptance criteria with the exception of any items flagged and described in the notes and definitions section of the report.

A reasonable measure of the precision of the analytical methods is the relative percent difference (RPD) between a matrix spike recovery and a matrix spike duplicate recovery and between laboratory control sample recovery and laboratory control sample duplicate recoveries. All of the relative percent differences established acceptance criteria with the exception of any items flagged and described in the notes and definitions section of the report.

Eurofins Frontier Global Sciences, Inc.

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Amy Goodall, Project Manager

Sample Receipt Checklist

EFGS Work Order: 1605156

Client: Eurofins M&T Auckland

Date & Time Received: 4/29/16 14:00

Date Labeled: 5/14/16 Labeled By: LM

Project: _____

Received By: LM

Label Verified By: WF

of Coolers Received: 1 Samples Arrived By: _____ Shipping Service _____ Courier _____ Hand _____ Other (Specify: _____)

Coolant: ☐ None/Ambient ☐ Loose Ice ☐ Gel Ice ☒ Dry Ice Coolant Required: Y/N Temp Blank Used: Y/N for Cooler(s): _____

Notify Project Manager if packages/coolers are received without coolant or with thawed coolant and at a temperature in excess of 6°C. PM notified: Y/N

Cooler Information:	Y/N/NA	Comments
The coolers do not appear to be tampered with:	<u>Y</u>	
Custody Seals are present and intact:	<u>N</u>	
Custody seals signed:	<u>N</u>	

TID: <u>5225</u>	CF: <u>-12°C</u>	Date/time: <u>4/29/16 14:00</u>	By: <u>LM</u>
Cooler 1: <u>2.2</u> °C	w/ CF: <u>2.0</u> °C	Cooler 4: _____ °C	w/ CF: _____ °C
Cooler 2: _____ °C	w/ CF: _____ °C	Cooler 5: _____ °C	w/ CF: _____ °C
Cooler 3: _____ °C	w/ CF: _____ °C	Cooler 6: _____ °C	w/ CF: _____ °C

Chain of Custody:	Y/N/NA	Comments
Sample ID/Description:	<u>Y</u>	
Date and time of collection:	<u>N</u>	
Sampled by:	<u>N</u>	
Preservation type:	<u>MA</u>	
Requested analyses:	<u>Y</u>	
Required signatures:	<u>Y</u>	
Internal COC required:	<u>N</u>	

Sample Condition/Integrity:	Y/N/NA	Comments
Sample containers intact/present:	<u>Y</u>	
Sample labels are present and legible:	<u>Y</u>	
Sample ID on container/bag matches COC:	<u>Y</u>	
Correct sample containers used:	<u>Y</u>	
Samples received within holding times:	<u>Y</u>	
Sample volume sufficient for requested analyses:	<u>Y</u>	
Correct preservative used for requested analyses:	<u>MA</u>	

Anomalies/Non-conformances (attach additional pages if needed):

☒ AUCKLAND

Ph: +64 9579 2669
35 O'Rorke Road Penrose
1061 Auckland, New Zealand
Email: EnviroSampleVic@eurofins.com.au

Purchase Order for External Analysis

Eurofins | mgt Ref: _____ Eurofins | mgt Purchase Order: 16/0 Results Required: STD Page : 1 of 1

Receiving Laboratory: Eurofins Frontier Global Sciences

Eurofins | mgt Contact: Onur Mehmet

Address: 11720 North Creek Parkway North Suite 400
Bothell WA 98011 - USA

Report results to: EnviroReports@eurofins.com.au ☒

Eurofins | mgt, P.O. Box 276, Oakleigh, Vic 3166, Australia ☐

Telephone: _____ Fax: _____

Send invoices to: **EnviroAP@eurofins.com.au** ☒

[illegible]

Total No. Samples: 7

Comments: Please identify samples using Eurofins | mgt ID and Client ID

Chain of Custody

Relinquished by: Swati Shahaney Date/Time: 26/04/16
 Received by: [Signature] Date/Time: 4/29/16 14:00
 Relinquished by: _____ Date/Time: _____
 Received by: Lars Muffet LFAR Date/Time: _____
No Seal 20°C

Sample Receipt Advice (Receiving Lab Use Only)

All Samples Received in Good Condition ☐ Average sample temp on receipt: (°C) _____
 All Documentation in Proper Order ☐ _____
 Samples Received with an Attempt to Chill ☐ For all enquires please quote Ref. No. _____
 Samples Received Within Holding Times ☐ _____
Please complete this section and email a scan copy to EnviroReports@eurofins.com.au



Frontier Global Sciences

11720 Northcreek Pkwy N, Suite 400
Bothell, WA 98011
425.686.1996 Phone
425.686.3096 Fax

Eurofins MGT (Auckland)
35 O Rorke Road Penrose
Auckland NEW ZEALAND, 1061

Project: Freshwater Sediments And Tissues
Project Number: Freshwater Sediments And Tissues
Project Manager: Onur Mehmet

Reported:
27-May-16 16:22

PIX SAMPLE 1
1605156-01

Analyte	Result	Detection Limit	Reporting Limit	Units	Dilution	Batch	Prepared	Sequence	Analyzed	Method	Notes
---------	--------	-----------------	-----------------	-------	----------	-------	----------	----------	----------	--------	-------

Sample Preparation: EFGS-010 KOH/Methanol Hg Digestion

Methyl Mercury (as Mercury)	99.9	-	8.7	ng/g	2500	F605246	20-May-16	6E26012	26-May-16	EPA 1630 Mod/FGS-070	
-----------------------------	------	---	-----	------	------	---------	-----------	---------	-----------	-------------------------	--

Sample Preparation: EFGS-011 Nitric/Sulfuric Hg Digestion

Mercury	115	-	18.7	ng/g	500	F605275	24-May-16	6E26004	25-May-16	EPA 1631B	
---------	-----	---	------	------	-----	---------	-----------	---------	-----------	-----------	--

Sample Preparation: EFGS-058 Teflon Conc. Nitric Tissue Digestion

Arsenic	ND	-	0.20	mg/kg	5	F605244	20-May-16	6E23015	20-May-16	FGS-054	U
Cadmium	0.014	-	0.010	mg/kg	5	F605244	20-May-16	6E23015	20-May-16	FGS-054	

Eurofins Frontier Global Sciences, Inc.

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Amy Goodall, Project Manager

Eurofins MGT (Auckland)
35 O Rorke Road Penrose
Auckland NEW ZEALAND, 1061

Project: Freshwater Sediments And Tissues
Project Number: Freshwater Sediments And Tissues
Project Manager: Onur Mehmet

Reported:
27-May-16 16:22

PIX SAMPLE 2

1605156-02

Analyte	Result	Detection Limit	Reporting Limit	Units	Dilution	Batch	Prepared	Sequence	Analyzed	Method	Notes
---------	--------	-----------------	-----------------	-------	----------	-------	----------	----------	----------	--------	-------

Sample Preparation: EFGS-010 KOH/Methanol Hg Digestion

Methyl Mercury (as Mercury)	102	-	8.6	ng/g	2500	F605246	20-May-16	6E26012	26-May-16	EPA 1630 Mod/FGS-070	
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Sample Preparation: EFGS-011 Nitric/Sulfuric Hg Digestion

Mercury	125	-	18.3	ng/g	500	F605275	24-May-16	6E26004	25-May-16	EPA 1631B	
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Sample Preparation: EFGS-058 Teflon Conc. Nitric Tissue Digestion

Arsenic	ND	-	0.20	mg/kg	5	F605244	20-May-16	6E23015	21-May-16	FGS-054	U
Cadmium	0.013	-	0.010	mg/kg	5	F605244	20-May-16	6E23015	21-May-16	FGS-054	

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Amy Goodall, Project Manager



Frontier Global Sciences

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Eurofins MGT (Auckland)
35 O Rorke Road Penrose
Auckland NEW ZEALAND, 1061

Project: Freshwater Sediments And Tissues
Project Number: Freshwater Sediments And Tissues
Project Manager: Onur Mehmet

Reported:
27-May-16 16:22

PKX SAMPLE 1

1605156-03

Analyte	Result	Detection Limit	Reporting Limit	Units	Dilution	Batch	Prepared	Sequence	Analyzed	Method	Notes
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Sample Preparation: EFGS-010 KOH/Methanol Hg Digestion

Methyl Mercury (as Mercury)	311	-	7.9	ng/g	2500	F605246	20-May-16	6E26012	26-May-16	EPA 1630 Mod/FGS-070	
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Sample Preparation: EFGS-011 Nitric/Sulfuric Hg Digestion

Mercury	301	-	17.5	ng/g	500	F605275	24-May-16	6E26004	25-May-16	EPA 1631B	
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Sample Preparation: EFGS-058 Teflon Conc. Nitric Tissue Digestion

Arsenic	0.61	-	0.17	mg/kg	5	F605244	20-May-16	6E23015	21-May-16	FGS-054	
Cadmium	0.425	-	0.009	mg/kg	5	F605244	20-May-16	6E23015	21-May-16	FGS-054	

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Amy Goodall, Project Manager

Eurofins MGT (Auckland)
35 O Rorke Road Penrose
Auckland NEW ZEALAND, 1061

Project: Freshwater Sediments And Tissues
Project Number: Freshwater Sediments And Tissues
Project Manager: Onur Mehmet

Reported:
27-May-16 16:22

PJX SAMPLE 1

1605156-04

Analyte	Result	Detection Limit	Reporting Limit	Units	Dilution	Batch	Prepared	Sequence	Analyzed	Method	Notes
Sample Preparation: EFGS-010 KOH/Methanol Hg Digestion											
Methyl Mercury (as Mercury)	684	-	9.2	ng/g	2500	F605246	20-May-16	6E26012	26-May-16	EPA 1630 Mod/FGS-070	
Sample Preparation: EFGS-011 Nitric/Sulfuric Hg Digestion											
Mercury	803	-	17.3	ng/g	500	F605275	24-May-16	6E26004	25-May-16	EPA 1631B	
Sample Preparation: EFGS-058 Teflon Conc. Nitric Tissue Digestion											
Arsenic	ND	-	0.17	mg/kg	5	F605245	20-May-16	6E23015	21-May-16	FGS-054	U
Cadmium	0.021	-	0.009	mg/kg	5	F605245	20-May-16	6E23015	21-May-16	FGS-054	

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Amy Goodall, Project Manager

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Auckland NEW ZEALAND, 1061

Project: Freshwater Sediments And Tissues
Project Number: Freshwater Sediments And Tissues
Project Manager: Onur Mehmet

Reported:
27-May-16 16:22

PJX SAMPLE 2

1605156-05

Analyte	Result	Detection Limit	Reporting Limit	Units	Dilution	Batch	Prepared	Sequence	Analyzed	Method	Notes
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Sample Preparation: EFGS-010 KOH/Methanol Hg Digestion

Methyl Mercury (as Mercury)	536	-	8.2	ng/g	2500	F605246	20-May-16	6E26012	26-May-16	EPA 1630 Mod/FGS-070	
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Sample Preparation: EFGS-011 Nitric/Sulfuric Hg Digestion

Mercury	612	-	17.5	ng/g	500	F605275	24-May-16	6E26004	25-May-16	EPA 1631B	
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Sample Preparation: EFGS-058 Teflon Conc. Nitric Tissue Digestion

Arsenic	ND	-	0.15	mg/kg	5	F605245	20-May-16	6E23015	21-May-16	FGS-054	U
Cadmium	0.016	-	0.008	mg/kg	5	F605245	20-May-16	6E23015	21-May-16	FGS-054	

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Amy Goodall, Project Manager



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Project: Freshwater Sediments And Tissues
Project Number: Freshwater Sediments And Tissues
Project Manager: Onur Mehmet

Reported:
27-May-16 16:22

PJX SAMPLE 3

1605156-06

Analyte	Result	Detection Limit	Reporting Limit	Units	Dilution	Batch	Prepared	Sequence	Analyzed	Method	Notes
Sample Preparation: EFGS-010 KOH/Methanol Hg Digestion											
Methyl Mercury (as Mercury)	557	-	8.8	ng/g	2500	F605246	20-May-16	6E26012	26-May-16	EPA 1630 Mod/FGS-070	
Sample Preparation: EFGS-011 Nitric/Sulfuric Hg Digestion											
Mercury	682	-	16.8	ng/g	500	F605275	24-May-16	6E26004	25-May-16	EPA 1631B	
Sample Preparation: EFGS-058 Teflon Conc. Nitric Tissue Digestion											
Arsenic	ND	-	0.14	mg/kg	5	F605245	20-May-16	6E23015	21-May-16	FGS-054	U
Cadmium	0.029	-	0.007	mg/kg	5	F605245	20-May-16	6E23015	21-May-16	FGS-054	

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Amy Goodall, Project Manager

Eurofins MGT (Auckland)
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Auckland NEW ZEALAND, 1061

Project: Freshwater Sediments And Tissues
Project Number: Freshwater Sediments And Tissues
Project Manager: Onur Mehmet

Reported:
27-May-16 16:22

PJX SAMPLE 4

1605156-07

Analyte	Result	Detection Limit	Reporting Limit	Units	Dilution	Batch	Prepared	Sequence	Analyzed	Method	Notes
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Sample Preparation: EFGS-010 KOH/Methanol Hg Digestion

Methyl Mercury (as Mercury)	514	-	8.7	ng/g	2500	F605246	20-May-16	6E26012	26-May-16	EPA 1630 Mod/FGS-070	
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Sample Preparation: EFGS-011 Nitric/Sulfuric Hg Digestion

Mercury	527	-	17.3	ng/g	500	F605275	24-May-16	6E26004	25-May-16	EPA 1631B	
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Sample Preparation: EFGS-058 Teflon Conc. Nitric Tissue Digestion

Arsenic	0.32	-	0.20	mg/kg	5	F605245	20-May-16	6E23015	21-May-16	FGS-054	
Cadmium	0.058	-	0.010	mg/kg	5	F605245	20-May-16	6E23015	21-May-16	FGS-054	

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Amy Goodall, Project Manager

Eurofins MGT (Auckland)
35 O Rorke Road Penrose
Auckland NEW ZEALAND, 1061

Project: Freshwater Sediments And Tissues
Project Number: Freshwater Sediments And Tissues
Project Manager: Onur Mehmet

Reported:
27-May-16 16:22

Quality Control Data

Analyte	Result	Detection Limit	Reporting Limit	Units	Spike Level	Source Result	%REC	%REC Limits	RPD	RPD Limit	Notes
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Batch F605244 - EFGS-058 Teflon Conc. Nitric Tissue Digestion

Blank (F605244-BLK1)

Prepared & Analyzed: 20-May-16

Arsenic	ND	-	0.20	mg/kg							U
Cadmium	ND	-	0.010	mg/kg							U

Blank (F605244-BLK2)

Prepared & Analyzed: 20-May-16

Arsenic	ND	-	0.20	mg/kg							U
Cadmium	ND	-	0.010	mg/kg							U

LCS (F605244-BS1)

Prepared & Analyzed: 20-May-16

Arsenic	8.81	-	0.20	mg/kg	10.000		88.1	85-115			
Cadmium	7.620	-	0.010	mg/kg	8.0000		95.2	85-115			

LCS Dup (F605244-BSD1)

Prepared & Analyzed: 20-May-16

Arsenic	8.87	-	0.20	mg/kg	10.000		88.7	85-115	0.663	20	
Cadmium	7.613	-	0.010	mg/kg	8.0000		95.2	85-115	0.0831	20	

Matrix Spike (F605244-MS1)

Source: 1604390-04

Prepared & Analyzed: 20-May-16

Arsenic	8.88	-	0.19	mg/kg	9.3458	ND	95.0	80-120			
Cadmium	7.399	-	0.009	mg/kg	7.4766	0.019	98.7	75-125			

Matrix Spike (F605244-MS2)

Source: 1605156-01

Prepared & Analyzed: 20-May-16

Arsenic	7.80	-	0.16	mg/kg	7.9694	0.06	97.1	80-120			
Cadmium	6.287	-	0.008	mg/kg	6.3755	0.014	98.4	75-125			

Matrix Spike (F605244-MS3)

Source: 1604390-04

Prepared & Analyzed: 20-May-16

Arsenic	19.91	-	0.19	mg/kg	19.335	ND	103	80-120			AS
Cadmium	2.186	-	0.010	mg/kg	1.9335	0.019	112	75-125			AS

Matrix Spike (F605244-MS4)

Source: 1605156-01

Prepared & Analyzed: 20-May-16

Arsenic	21.15	-	0.20	mg/kg	19.716	0.06	107	80-120			AS
Cadmium	2.305	-	0.010	mg/kg	1.9716	0.014	116	75-125			AS

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Amy Goodall, Project Manager

Eurofins MGT (Auckland)
35 O Rorke Road Penrose
Auckland NEW ZEALAND, 1061

Project: Freshwater Sediments And Tissues
Project Number: Freshwater Sediments And Tissues
Project Manager: Onur Mehmet

Reported:
27-May-16 16:22

Quality Control Data

Analyte	Result	Detection Limit	Reporting Limit	Units	Spike Level	Source Result	%REC	%REC Limits	RPD	RPD Limit	Notes
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Batch F605244 - EFGS-058 Teflon Conc. Nitric Tissue Digestion

Matrix Spike Dup (F605244-MSD1)		Source: 1604390-04			Prepared & Analyzed: 20-May-16						
Arsenic	7.03	-	0.15	mg/kg	7.5301	ND	93.3	80-120	1.85	20	
Cadmium	5.835	-	0.008	mg/kg	6.0241	0.019	96.6	75-125	2.21	20	
Matrix Spike Dup (F605244-MSD2)		Source: 1605156-01			Prepared & Analyzed: 20-May-16						
Arsenic	8.04	-	0.17	mg/kg	8.5587	0.06	93.2	80-120	4.07	20	
Cadmium	6.567	-	0.009	mg/kg	6.8470	0.014	95.7	75-125	2.76	20	
Matrix Spike Dup (F605244-MSD3)		Source: 1604390-04			Prepared & Analyzed: 20-May-16						
Arsenic	19.97	-	0.19	mg/kg	19.335	ND	103	80-120	0.315	20	AS
Cadmium	2.193	-	0.010	mg/kg	1.9335	0.019	112	75-125	0.301	20	AS
Matrix Spike Dup (F605244-MSD4)		Source: 1605156-01			Prepared & Analyzed: 20-May-16						
Arsenic	20.63	-	0.20	mg/kg	19.716	0.06	104	80-120	2.49	20	AS
Cadmium	2.217	-	0.010	mg/kg	1.9716	0.014	112	75-125	3.91	20	AS

Batch F605245 - EFGS-058 Teflon Conc. Nitric Tissue Digestion

Blank (F605245-BLK1)		Prepared: 20-May-16 Analyzed: 21-May-16									
Arsenic	ND	-	0.20	mg/kg							U
Cadmium	ND	-	0.010	mg/kg							U
LCS (F605245-BS1)		Prepared: 20-May-16 Analyzed: 21-May-16									
Arsenic	8.83	-	0.20	mg/kg	10.000		88.3	85-115			
Cadmium	7.609	-	0.010	mg/kg	8.0000		95.1	85-115			
LCS Dup (F605245-BSD1)		Prepared: 20-May-16 Analyzed: 21-May-16									
Arsenic	8.84	-	0.20	mg/kg	10.000		88.4	85-115	0.112	20	
Cadmium	7.487	-	0.010	mg/kg	8.0000		93.6	85-115	1.62	20	

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Amy Goodall, Project Manager

Eurofins MGT (Auckland)
35 O Rorke Road Penrose
Auckland NEW ZEALAND, 1061

Project: Freshwater Sediments And Tissues
Project Number: Freshwater Sediments And Tissues
Project Manager: Onur Mehmet

Reported:
27-May-16 16:22

Quality Control Data

Analyte	Result	Detection Limit	Reporting Limit	Units	Spike Level	Source Result	%REC	%REC Limits	RPD	RPD Limit	Notes
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Batch F605245 - EFGS-058 Teflon Conc. Nitric Tissue Digestion

Matrix Spike (F605245-MS1)		Source: 1605156-04			Prepared: 20-May-16 Analyzed: 21-May-16						
Arsenic	7.39	-	0.16	mg/kg	7.7979	ND	94.7	80-120			
Cadmium	6.016	-	0.008	mg/kg	6.2383	0.021	96.1	75-125			
Matrix Spike (F605245-MS2)		Source: 1605156-04			Prepared: 20-May-16 Analyzed: 21-May-16						
Arsenic	18.02	-	0.17	mg/kg	17.194	ND	105	80-120			AS
Cadmium	1.974	-	0.009	mg/kg	1.7194	0.021	114	75-125			AS
Matrix Spike Dup (F605245-MSD1)		Source: 1605156-04			Prepared: 20-May-16 Analyzed: 21-May-16						
Arsenic	7.05	-	0.15	mg/kg	7.7328	ND	91.2	80-120	3.80	20	
Cadmium	5.944	-	0.008	mg/kg	6.1862	0.021	95.8	75-125	0.367	20	
Matrix Spike Dup (F605245-MSD2)		Source: 1605156-04			Prepared: 20-May-16 Analyzed: 21-May-16						
Arsenic	18.01	-	0.17	mg/kg	17.194	ND	105	80-120	0.0893	20	AS
Cadmium	1.957	-	0.009	mg/kg	1.7194	0.021	113	75-125	0.831	20	AS

Batch F605246 - EFGS-010 KOH/Methanol Hg Digestion

Blank (F605246-BLK1)					Prepared: 20-May-16 Analyzed: 26-May-16						
Methyl Mercury (as Mercury)	ND	-	2.0	ng/g							U
Blank (F605246-BLK2)					Prepared: 20-May-16 Analyzed: 26-May-16						
Methyl Mercury (as Mercury)	ND	-	2.0	ng/g							U
Blank (F605246-BLK3)					Prepared: 20-May-16 Analyzed: 26-May-16						
Methyl Mercury (as Mercury)	ND	-	2.0	ng/g							U
Blank (F605246-BLK4)					Prepared: 20-May-16 Analyzed: 26-May-16						
Methyl Mercury (as Mercury)	ND	-	1.6	ng/g							F-03, U

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Auckland NEW ZEALAND, 1061

Project: Freshwater Sediments And Tissues
Project Number: Freshwater Sediments And Tissues
Project Manager: Onur Mehmet

Reported:
27-May-16 16:22

Quality Control Data

Analyte	Result	Detection Limit	Reporting Limit	Units	Spike Level	Source Result	%REC	%REC Limits	RPD	RPD Limit	Notes
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Batch F605246 - EFGS-010 KOH/Methanol Hg Digestion

Blank (F605246-BLK5)					Prepared: 20-May-16 Analyzed: 26-May-16						
Methyl Mercury (as Mercury)	ND	-	1.5	ng/g							F-03, U
Blank (F605246-BLK6)					Prepared: 20-May-16 Analyzed: 26-May-16						
Methyl Mercury (as Mercury)	ND	-	1.3	ng/g							F-03, U
Blank (F605246-BLK7)					Prepared: 20-May-16 Analyzed: 26-May-16						
Methyl Mercury (as Mercury)	ND	-	1.5	ng/g							F-03, U
LCS (F605246-BS1)					Prepared: 20-May-16 Analyzed: 26-May-16						
Methyl Mercury (as Mercury)	270.3	-	7.9	ng/g	330.28		81.8	70-130			
LCS Dup (F605246-BSD1)					Prepared: 20-May-16 Analyzed: 26-May-16						
Methyl Mercury (as Mercury)	287.5	-	7.9	ng/g	330.28		87.0	70-130	6.17	25	
Duplicate (F605246-DUP1)					Source: 1605156-01 Prepared: 20-May-16 Analyzed: 26-May-16						
Methyl Mercury (as Mercury)	100.2	-	8.8	ng/g		99.9			0.376	35	
Matrix Spike (F605246-MS1)					Source: 1605156-01 Prepared: 20-May-16 Analyzed: 26-May-16						
Methyl Mercury (as Mercury)	113.2	-	8.9	ng/g	35.750	99.9	37.2	65-130			QM-02
Matrix Spike Dup (F605246-MSD1)					Source: 1605156-01 Prepared: 20-May-16 Analyzed: 26-May-16						
Methyl Mercury (as Mercury)	128.3	-	8.5	ng/g	34.164	99.9	83.2	65-130	76.4	35	QR-08

Batch F605275 - EFGS-011 Nitric/Sulfuric Hg Digestion

Blank (F605275-BLK1)					Prepared: 24-May-16 Analyzed: 25-May-16						
Mercury	ND	-	0.800	ng/g							U

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Auckland NEW ZEALAND, 1061

Project: Freshwater Sediments And Tissues
Project Number: Freshwater Sediments And Tissues
Project Manager: Onur Mehmet

Reported:
27-May-16 16:22

Quality Control Data

Analyte	Result	Detection Limit	Reporting Limit	Units	Spike Level	Source Result	%REC	%REC Limits	RPD	RPD Limit	Notes
Batch F605275 - EFGS-011 Nitric/Sulfuric Hg Digestion											
Blank (F605275-BLK2)					Prepared: 24-May-16 Analyzed: 25-May-16						
Mercury	ND	-	0.800	ng/g							U
Blank (F605275-BLK3)					Prepared: 24-May-16 Analyzed: 25-May-16						
Mercury	ND	-	0.800	ng/g							U
Blank (F605275-BLK4)					Prepared: 24-May-16 Analyzed: 25-May-16						
Mercury	ND	-	0.590	ng/g							F-03, U
Blank (F605275-BLK5)					Prepared: 24-May-16 Analyzed: 25-May-16						
Mercury	ND	-	0.600	ng/g							F-03, U
LCS (F605275-BS1)					Prepared: 24-May-16 Analyzed: 25-May-16						
Mercury	8.370	-	0.800	ng/g	8.0160		104	75-125			
LCS (F605275-BS2)					Prepared: 24-May-16 Analyzed: 25-May-16						
Mercury	336.1	-	39.4	ng/g	382.50		87.9	75-125			
LCS Dup (F605275-BSD1)					Prepared: 24-May-16 Analyzed: 25-May-16						
Mercury	8.288	-	0.800	ng/g	8.0160		103	75-125	0.989	24	
Duplicate (F605275-DUP1)					Source: 1605156-01 Prepared: 24-May-16 Analyzed: 25-May-16						
Mercury	123.1	-	17.9	ng/g		114.8			6.99	24	
Matrix Spike (F605275-MS1)					Source: 1605156-01 Prepared: 24-May-16 Analyzed: 25-May-16						
Mercury	452.1	-	17.8	ng/g	356.51	114.8	94.6	71-125			
Matrix Spike Dup (F605275-MSD1)					Source: 1605156-01 Prepared: 24-May-16 Analyzed: 25-May-16						
Mercury	435.9	-	17.3	ng/g	346.62	114.8	92.6	71-125	2.10	24	

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Amy Goodall, Project Manager

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35 O Rorke Road Penrose
Auckland NEW ZEALAND, 1061

Project: Freshwater Sediments And Tissues
Project Number: Freshwater Sediments And Tissues
Project Manager: Onur Mehmet

Reported:
27-May-16 16:22

Notes and Definitions

U	Analyte was not detected and is reported as less than the LOD or as defined by the client. The LOD has been adjusted for any dilution or concentration of the sample.
QR-08	The RPD value for the MS/MSD was outside of acceptance limits. Batch QC acceptable based on matrix duplicate and/or LCS/LCSD RPD values within control limits.
QM-02	The MS and/or MSD recoveries outside acceptance limits, due to spike concentration less than 1 times the sample concentration. The batch was accepted based on LCS and LCSD recoveries within control limits and, when analysis permits, acceptable AS/ASD.
F-03	This method blank is an equipment blank created during the homogenization process of associated samples at the laboratory. For informational purposes only.
AS	This MS and/or MSD is an analytical spike and/or an analytical spike duplicate.
DET	Analyte DETECTED
ND	Analyte NOT DETECTED at or above the reporting limit
NR	Not Reported
dry	Sample results reported on a dry weight basis
RPD	Relative Percent Difference

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Amy Goodall, Project Manager

Certificate of Analysis

Pattle Delamore Partners Ltd
PDP House Level 4, 235 Broadway
Newmarket
Auckland New Zealand 1023



NATA Accredited
Accreditation Number 1261
Site Number 1254

Accredited for compliance with ISO/IEC 17025.
 The results of the tests, calibrations and/or
 measurements included in this document are traceable
 to Australian/national standards.

Attention: **Andrew Rumsby**

Report **498255-S**
 Project name
 Project ID A02982802
 Received Date Apr 26, 2016

Client Sample ID			PIX SAMPLE 1	PIX SAMPLE 2	PKX SAMPLE 1	PJX SAMPLE 1
Sample Matrix			Other	Other	Other	Other
Eurofins mgt Sample No.			M16-Ap23670	M16-Ap23671	M16-Ap23672	M16-Ap23673
Date Sampled			Not Provided	Not Provided	Not Provided	Not Provided
Test/Reference	LOR	Unit				
Sample Comment			See attached	See attached	See attached	See attached

Client Sample ID			PJX SAMPLE 2	PJX SAMPLE 3	PJX SAMPLE 4
Sample Matrix			Other	Other	Other
Eurofins mgt Sample No.			M16-Ap23674	M16-Ap23675	M16-Ap23676
Date Sampled			Not Provided	Not Provided	Not Provided
Test/Reference	LOR	Unit			
Sample Comment			See attached	See attached	See attached

Sample History

Where samples are submitted/analysed over several days, the last date of extraction and analysis is reported.

A recent review of our LIMS has resulted in the correction or clarification of some method identifications. Due to this, some of the method reference information on reports has changed. However, no substantive change has been made to our laboratory methods, and as such there is no change in the validity of current or previous results (regarding both quality and NATA accreditation).

If the date and time of sampling are not provided, the Laboratory will not be responsible for compromised results should testing be performed outside the recommended holding time.

Description	Testing Site	Extracted	Holding Time
-------------	--------------	-----------	--------------

Company Name: Pattle Delamore Partners Ltd
Address: PDP House Level 4, 235 Broadway
Newmarket
Auckland New Zealand 1023

Project Name:
Project ID: A02982802

Order No.:
Report #: 498255
Phone: 0011 64 9 523 6900
Fax: 0011 64 9 523 6901

Received: Apr 26, 2016 2:00 PM
Due: May 3, 2016
Priority: 5 Day
Contact Name: Andrew Rumsby

Eurofins | mgt Analytical Services Manager : Onur Mehmet

Sample Detail						Methyl Mercury	Sample Comment
Melbourne Laboratory - NATA Site # 1254 & 14271							X
Sydney Laboratory - NATA Site # 18217							
Brisbane Laboratory - NATA Site # 20794							
External Laboratory						X	
No	Sample ID	Sample Date	Sampling Time	Matrix	LAB ID		
1	PIX SAMPLE 1	Not Provided		Other	M16-Ap23670	X	X
2	PIX SAMPLE 2	Not Provided		Other	M16-Ap23671	X	X
3	PKX SAMPLE 1	Not Provided		Other	M16-Ap23672	X	X
4	PJX SAMPLE 1	Not Provided		Other	M16-Ap23673	X	X
5	PJX SAMPLE 2	Not Provided		Other	M16-Ap23674	X	X
6	PJX SAMPLE 3	Not Provided		Other	M16-Ap23675	X	X

Company Name: Pattle Delamore Partners Ltd
Address: PDP House Level 4, 235 Broadway
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Order No.:
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Sample Detail						Methyl Mercury	Sample Comment
Melbourne Laboratory - NATA Site # 1254 & 14271							X
Sydney Laboratory - NATA Site # 18217							
Brisbane Laboratory - NATA Site # 20794							
External Laboratory						X	
7	PJX SAMPLE 4	Not Provided		Other	M16-Ap23676	X	X
Test Counts						7	7

Internal Quality Control Review and Glossary

General

1. Laboratory QC results for Method Blanks, Duplicates, Matrix Spikes, and Laboratory Control Samples are included in this QC report where applicable. Additional QC data may be available on request.
2. All soil results are reported on a dry basis, unless otherwise stated.
3. Actual LORs are matrix dependant. Quoted LORs may be raised where sample extracts are diluted due to interferences.
4. Results are uncorrected for matrix spikes or surrogate recoveries.
5. SVOC analysis on waters are performed on homogenised, unfiltered samples, unless noted otherwise.
6. Samples were analysed on an 'as received' basis. 7. This report replaces any interim results previously issued.

Holding Times

Please refer to 'Sample Preservation and Container Guide' for holding times (QS3001).

For samples received on the last day of holding time, notification of testing requirements should have been received at least 6 hours prior to sample receipt deadlines as stated on the Sample Receipt Advice.

If the Laboratory did not receive the information in the required timeframe, and regardless of any other integrity issues, suitably qualified results may still be reported.

Holding times apply from the date of sampling, therefore compliance to these may be outside the laboratory's control.

****NOTE:** pH duplicates are reported as a range NOT as RPD

Units

mg/kg: milligrams per Kilogram

mg/l: milligrams per litre

ug/l: micrograms per litre

ppm: Parts per million

ppb: Parts per billion

%: Percentage

org/100ml: Organisms per 100 millilitres

NTU: Nephelometric Turbidity Units

MPN/100mL: Most Probable Number of organisms per 100 millilitres

Terms

Dry	Where a moisture has been determined on a solid sample the result is expressed on a dry basis.
LOR	Limit of Reporting.
SPIKE	Addition of the analyte to the sample and reported as percentage recovery.
RPD	Relative Percent Difference between two Duplicate pieces of analysis.
LCS	Laboratory Control Sample - reported as percent recovery
CRM	Certified Reference Material - reported as percent recovery
Method Blank	In the case of solid samples these are performed on laboratory certified clean sands. In the case of water samples these are performed on de-ionised water.
Surr - Surrogate	The addition of a like compound to the analyte target and reported as percentage recovery.
Duplicate	A second piece of analysis from the same sample and reported in the same units as the result to show comparison.
Batch Duplicate	A second piece of analysis from a sample outside of the clients batch of samples but run within the laboratory batch of analysis.
Batch SPIKE	Spike recovery reported on a sample from outside of the clients batch of samples but run within the laboratory batch of analysis.
USEPA	United States Environmental Protection Agency
APHA	American Public Health Association
TCLP	Toxicity Characteristic Leaching Procedure
COC	Chain of Custody
SRA	Sample Receipt Advice
CP	Client Parent - QC was performed on samples pertaining to this report
NCP	Non-Client Parent - QC performed on samples not pertaining to this report, QC is representative of the sequence or batch that client samples were analysed within
TEQ	Toxic Equivalency Quotient

QC - Acceptance Criteria

RPD Duplicates: Global RPD Duplicates Acceptance Criteria is 30% however the following acceptance guidelines are equally applicable:

Results <10 times the LOR : No Limit

Results between 10-20 times the LOR : RPD must lie between 0-50%

Results >20 times the LOR : RPD must lie between 0-30%

Surrogate Recoveries : Recoveries must lie between 50-150% - Phenols 20-130%.

QC Data General Comments

1. Where a result is reported as a less than (<), higher than the nominated LOR, this is due to either matrix interference, extract dilution required due to interferences or contaminant levels within the sample, high moisture content or insufficient sample provided.
2. Duplicate data shown within this report that states the word "BATCH" is a Batch Duplicate from outside of your sample batch, but within the laboratory sample batch at a 1:10 ratio. The Parent and Duplicate data shown is not data from your samples.
3. Organochlorine Pesticide analysis - where reporting LCS data, Toxaphene & Chlordane are not added to the LCS.
4. Organochlorine Pesticide analysis - where reporting Spike data, Toxaphene is not added to the Spike.
5. Total Recoverable Hydrocarbons - where reporting Spike & LCS data, a single spike of commercial Hydrocarbon products in the range of C12-C30 is added and it's Total Recovery is reported in the C10-C14 cell of the Report.
6. pH and Free Chlorine analysed in the laboratory - Analysis on this test must begin within 30 minutes of sampling. Therefore laboratory analysis is unlikely to be completed within holding time. Analysis will begin as soon as possible after sample receipt.
7. Recovery Data (Spikes & Surrogates) - where chromatographic interference does not allow the determination of Recovery the term "INT" appears against that analyte.
8. Polychlorinated Biphenyls are spiked only using Aroclor 1260 in Matrix Spikes and LCS.
9. For Matrix Spikes and LCS results a dash " - " in the report means that the specific analyte was not added to the QC sample.
10. Duplicate RPDs are calculated from raw analytical data thus it is possible to have two sets of data.

Comments

Metals: Eurofins | Frontier Global Sciences, report number 1605156.

Sample Integrity

Custody Seals Intact (if used)	N/A
Attempt to Chill was evident	Yes
Sample correctly preserved	Yes
Appropriate sample containers have been used	Yes
Sample containers for volatile analysis received with minimal headspace	Yes
Samples received within HoldingTime	Yes
Some samples have been subcontracted	Yes

Authorised By

Onur Mehmet

Analytical Services Manager



Glenn Jackson

National Operations Manager

Final report - this Report replaces any previously issued Report

- Indicates Not Requested

* Indicates NATA accreditation does not cover the performance of this service

Uncertainty data is available on request

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Appendix D

PDP Fish Passage Letter



memorandum

TO Jackie Hobbins FROM Patrick Lees
Evolution Mining NZ Pty Ltd DATE 1 June 2016
RE Waiariki River Waterfall Fish Passage Assessment

1.0 Introduction

Pattle Delamore Partners Ltd (PDP) has been engaged by Evolution Mining NZ Pty Ltd (ENZ) to provide a fish passage assessment of the Waiariki River waterfall. The purpose of this memo is to outline the extent of the barrier and whether the waterfall is having an effect on the upstream movement of both shortfin (*Anguilla australis*) and longfin (*Anguilla dieffenbachia*) eels into the upper Puhipuhi catchment.

Further fish biomonitoring data will be presented in the Programme 2: Aquatic Biota report currently being prepared by PDP.

2.0 Field Report

The Waiariki River waterfall was surveyed by ENZ staff on the 20th May 2016, a short field report (including photographs) was completed and sent through to PDP to assess the extent of the fish passage barrier posed by the waterfall (Appendix A: Daily Field Report).

The Waiariki River waterfall is located within a steep-sided gorge (at approximately NZTM E: 1713795; N: 6068090) which broadens into a river valley 150 m downstream. The waterfall is characterised by significant undercutting of the face on the lower third, while the upper two thirds of the waterfall face is sheer. Overall, the waterfall is 15 m high, with a base width of 20 m and a crest width of 15 m. The overtopping water separated into two chutes that extended ~ 0.5 m away from the waterfall face during normal flow conditions observed at the time of the site visit. There was no evidence of small continuous rivulets or wet areas in contact with the waterfall.

Of interest, is a steep narrow washout that has formed on the south east side of the waterfall. This will most likely channel water during extreme high flow events only, and is currently overgrown and choked with non-native weed species. The washout did not appear to allow any continual or residual pooling of water.

3.0 Assessment of Fish Passage

Fish species captured and identified downstream of the Waiariki River water fall during the PDP and ENZ fish surveys include crans bully (*Gobiomorphus basalis*); shortfin eel (*Aquilla australis*) and longfin eel (*A. dieffenbachia*), and gambusia (*Gambusia affinis*). No fish were captured in the Puhipuhi catchment upstream of the Waiariki River waterfall during the PDP and ENZ fish surveys. Of the species identified downstream of the waterfall shortfin and longfin eels undertake diadromous migration. Diadromous species are more likely to be affected by instream barriers as they need to migrate upstream throughout the catchment and downstream to the marine environment at specific times to complete lifecycle stages.

Juvenile shortfin and longfin eels are known to have excellent climbing ability when they are < 100 mm length, this climbing ability tends to decline as eels grow greater than 110 mm in length (Jellyman and Arai, 2016). Juvenile eels generally overcome barriers by climbing up the splash zone of waterfalls and climbing the vertical damp surfaces via surface tension. Climbing will generally be undertaken at night as elevated daytime temperatures may be fatal (Jellyman and Arai, 2016).

Larger eels (> 110 mm) have a reduced climbing ability compared to smaller eels (Jellyman and Arai, 2016), and will generally bypass stream barriers by leaving the water completely and traversing overland. This behaviour is high risk and involves the eel being exposed to increased desiccation and predation pressure. Leaving the water to navigate around a fish passage barrier is only likely to be undertaken if there is substantial migratory pressure to overcome the barrier (e.g., limited available habitat within downstream reaches and adjacent catchments), and if a path around the barrier is easily accessible (e.g., saturated low lying ground after flooding).

Both eel species are thought to have a maximum length (age) when they cease upstream migration; Jellyman (1977) detailed that in the Waikato region this is generally around 300 mm. Of the eel species captured downstream by PDP the bulk of the captured individuals were between 450 – 650 mm long. Eels in this size range are likely to be resident eels that had ceased migrating upstream.

The Waiakiri River waterfall is characterised by significant undercutting to the lower third with the top two thirds being particularly sheer. The overhang, overall vertical height and limited resting and wetted areas are likely to combine to make the Waiakiri River waterfall a complete barrier to juvenile shortfin and longfin eels. The waterfall is also likely to be a complete barrier to larger eels due to the position of the waterfall at the head of a steeply incised gorge, with no easy pathway around the waterfall.

4.0 Conclusion

The Waiakiri River waterfall was visited by ENZ staff, who provided a field report of the waterfall to PDP. PDP has assessed the field report to ascertain the likelihood that the waterfall poses a barrier to upstream fish migration, particularly shortfin and longfin eels.

The Waiakiri River waterfall is located in a steep sided gorge and is characterised by a large overhang and a sheer face. There were no apparent wetted margins or resting areas on the face of the fall or on the sides, and the overtopping water was restricted to two chutes that projected away from the face of the waterfall.

It is likely that the waterfall is a barrier to both smaller juvenile (< 100 mm) and larger (>110 mm) shortfin and longfin eels. The absence of both these species upstream of the waterfall during aquatic biota biomonitoring (conducted by PDP), supports the conclusion that the falls are impeding the upstream migration of eels to habitat within the Puhipuhi catchment.

5.0 References

- Jellyman, DJ. and Arai, T. 2016. Juvenile Eels: Upstream Migration and Habitat use. In: Biology and Ecology of Aquilid Eels. Editor Takomi Arai. 2016. CRC Press. Taylor and Francis Group
- Jellyman, DJ. 1977. Summer upstream migration of juvenile freshwater eels in New Zealand. New Zealand Journal of Marine and Freshwater Research, 11:1, 61-71.

Prepared by



Patrick Lees

Environmental Scientist

This memorandum has been prepared by Pattle Delamore Partners Limited (PDP) on the basis of information provided by Evolution Mining NZ Pty Ltd. PDP has not independently verified the provided information and has relied upon it being accurate and sufficient for use by PDP in preparing the memorandum. PDP accepts no responsibility for errors or omissions in, or the currency or sufficiency of, the provided information.

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Appendix A: ENZ field report

Daily Field Report: Waiariki waterfall:

Date:	20/05/2016 Friday	Tenement:	51985 (Puhipuhi)
Name:	RB Theron; J Hobbins	Project:	
Samples:		Stations:	

Observations, conclusions, recommendations:

Waiariki waterfall:

E1713795_N6068090 (NZTM2000) combination of GPS (~30m error; and map estimate)

Elevation: ~120m asl, map estimate

The Waiariki Waterfall is an overhanging waterfall with approximately height of 15m, a crest-width of 15m and a base-width of 20m (Fig. 1). The upper two-thirds of the face is shear, while the base of the face is significantly undercut above the plunge pool (Fig. 1). The crest of the waterfall trends NW-SE. The current flow (normal to low-flow conditions?) is divided into two chutes formed at the NW and SE edges of the fall (Fig. 1).

The waterfall occurs within a steep-sided gorge which rapidly broadens into a river valley setting 150m downstream of the waterfall (Fig. 2).

The water flow projects at least 0.5m from the face at the top of the undercut section. There do not appear to be continuous rivulets or wet areas in contact with the face from top to bottom of the fall (Fig. 3).

A steep, narrow washout has formed on the SE margin of the waterfall which would probably channel water during extreme flow events. The washout is choked with talus and weeds but does not allow water to pool (Fig. 4). The NW margin of the waterfall remains shear (Fig. 5)

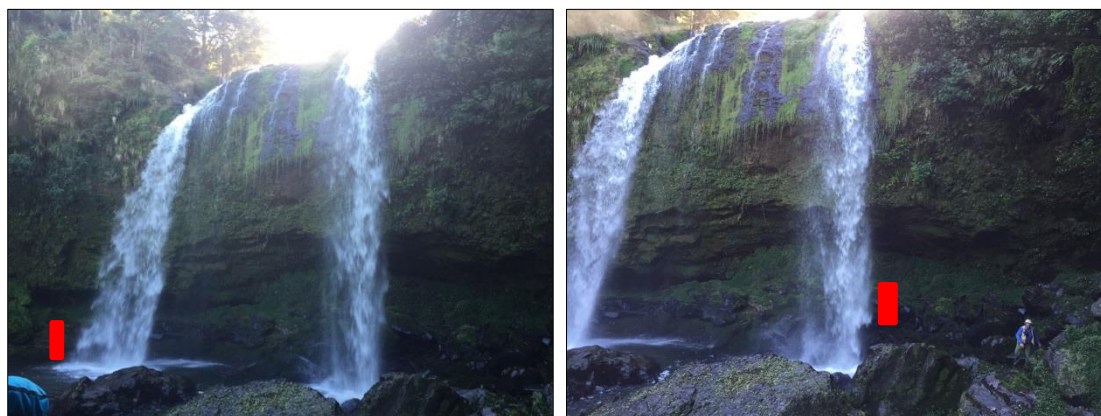


Fig. 1 Waiariki Falls viewed to NE (two main water chutes NW – left and SE – right) showing shear upper face and undercut lower face. Red scale bar: 2m



Fig. 2 View to N showing steep-sided gorge. Plunge pool in foreground. Waterfall on right edge of photo. Red scale bar: 2m



Fig. 3 View along upper shear face and lower undercut of Waiariki Waterfall showing flow of water projecting away from face and undercut. View to NW. Red scale bar: 2m



Fig. 4 Overgrown washout at SE margin of waterfall. Red scale bar: 1m



Fig. 5 NW margin of waterfall. No evidence of secondary channels. Red scale bar: 2m