

MERCURY AT PUHIPUHI

March 2016

Mercury ore (known as cinnabar) occurs naturally around Puhipuhi. Small amounts of cinnabar were mined during the early 20th century. Initial mining focused on alluvial cinnabar deposits that were discovered in streams. The alluvial deposits were formed by erosion from silica-rich rocks known as sinters, formed in ancient hot springs. Mercury is also known to occur at Puhipuhi within iron sulphide minerals such as marcasite as well as iron hydroxide precipitates.

Outlined below is a summary of findings from various sources, about the presence of mercury in surface water, stream sediments and soils at Puhipuhi. The distribution of mercury in water, stream sediments and soils is shown in the maps attached to this fact sheet.

Mercury in Stream Water Samples

Various monitoring surveys¹ carried out by several university researchers, consultants and Northland Regional Council (NRC) have shown that mercury is either undetectable or at very low concentrations in active stream water at Puhipuhi.

All recorded stream water samples from the Puhipuhi area have been found to meet NZ Drinking Water Standards for mercury (less than 7 parts per billion of mercury) (*Figure 2*).

All stream water samples have also been found to meet Australian and New Zealand Environment Conservation Council (ANZECC) guidelines for protection of natural ecosystems, which specify less than 0.6 parts per billion of mercury for 95% protection of aquatic species. Further, most of these samples also meet the default ANZECC guideline for 99% protection of aquatic species (less than 0.06 parts per billion) (*Figures 2 & 3*).

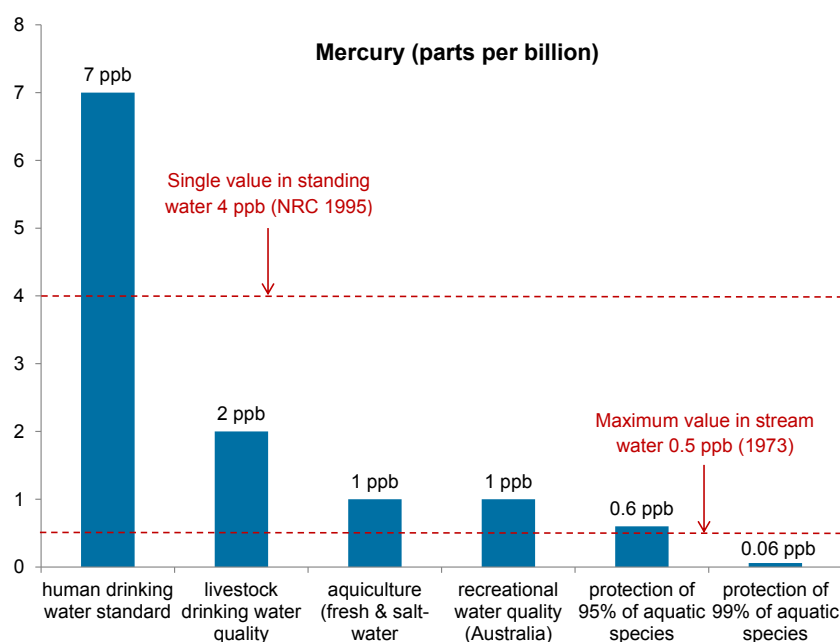


Figure 2: Mercury in Puhipuhi Water – Comparison to NZ and Australian Water Quality Guidelines

¹ Monitoring surveys by Northland Regional Council/Ngati Hau (1995, 2013-2014), Bioresearches (2012) and university studies (Hoggins & Brooks 1973, Craw et al 2000, Craw et al 2002, Craw 2005, Gionfriddo et al 2015)



Figure 1: Cinnabar (opaque red mineral) in banded sinter from Mine Road quarry (Mt Mitchell)

Key points

- Mercury ore (known as cinnabar) occurs naturally around Puhipuhi.
- Various monitoring surveys show Puhipuhi stream water samples meet NZ Drinking Water Standards for mercury and ANZECC guidelines for protection of natural ecosystems.
- Studies indicate that most of the mercury present in Puhipuhi stream sediments is naturally occurring.
- Mercury occurs naturally in the Puhipuhi soils in zones where the soil has formed from underlying cinnabar-rich rocks.
- There are justifiable community concerns re the possibility of mercury being released into the environment following any disturbance of sulphidic rocks.
- Evolution will be conducting an environmental baseline study addressing mercury-related questions. Results will be used to develop environmental management strategies and will be available via our website.
- If Evolution is unable to identify a way to conduct our activities safely and without harm to the environment, we will not proceed.

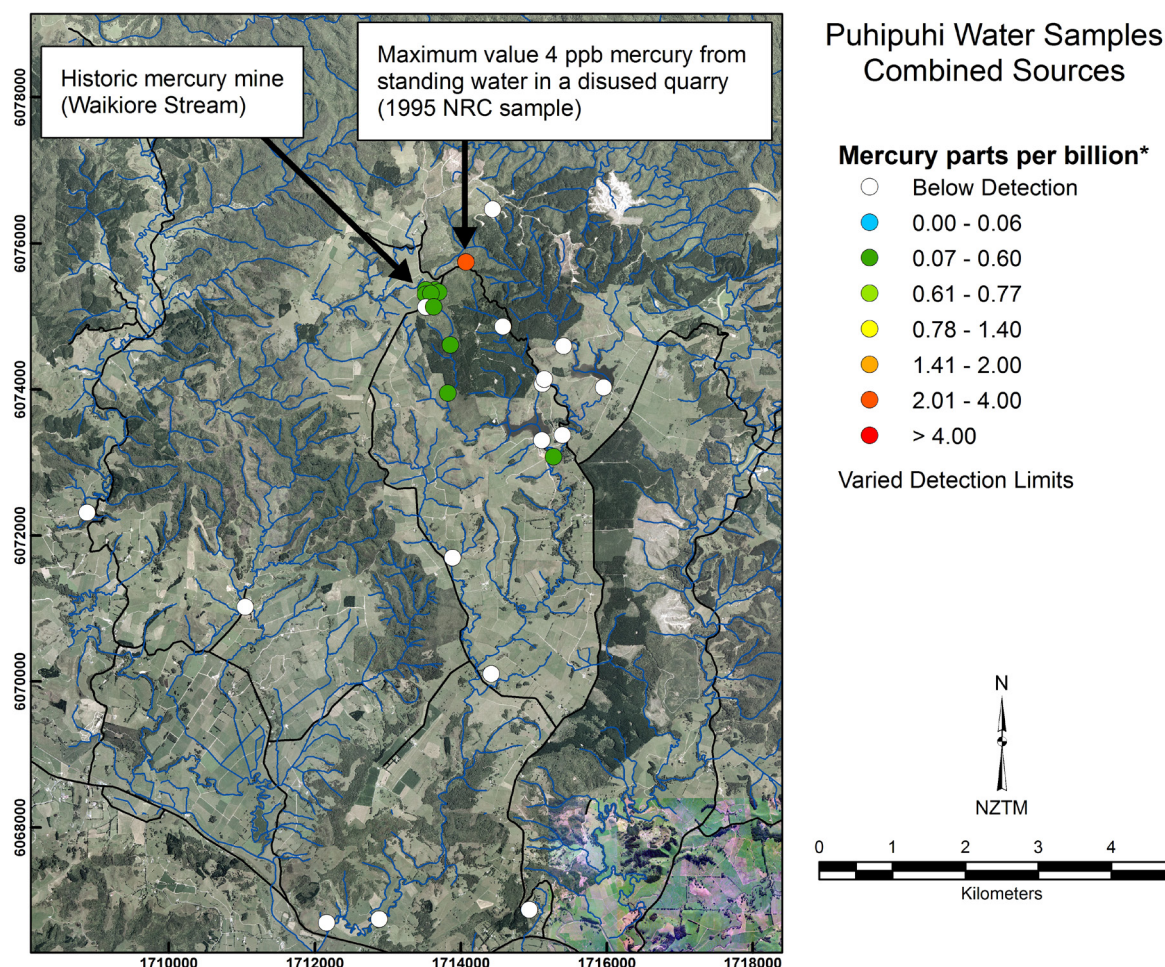


Figure 3: Water samples (125) from the Puhipuhi area 1973 – 2015

Data sources: Hoggins & Brooks 1973 (n=6); NRC 1995 (n=7); NRC 2013-2014 (n=104); Gionfriddo et al 2015 (n=4); Bioresearches 2012 (n=1). Where multiple values are recorded for a single site, an average value is displayed.

*Relevant Mercury Guidelines for Water:

- 0.06 ppb (ANZECC 2000 Default Trigger value for slightly to moderately modified natural ecosystems; 99% species protection)
- 0.6 ppb (ANZECC 2000 Trigger value for slightly to moderately modified natural ecosystems; 95% species protection)
- 0.77 ppb (USEPA 2013 chronic continuous concentration (CCC) for long-term exposure to aquatic organisms)
- 1.40 ppb (USEPA 2013 chronic maximum concentration (CMC) for short-term exposure to aquatic organisms)
- 2 ppb (ANZECC 2000 Upper Limit for Livestock Drinking Water)
- 7 ppb (NZ Ministry of Health 2013 MAV Maximum Acceptable Value for Drinking Water)

The highest levels of mercury recorded in Puhipuhi water samples include one water sample from standing water in a disused quarry in 1995 that was found to contain 4 parts per billion mercury (NRC, 1995) and stream water samples collected by Hoggins and Brooks from Puhipuhi streams in 1973 that were found to contain less than 0.5 parts per billion of mercury. More recent sampling since 2012 has included maximum values of 0.42 ppb mercury from the lower Waiariki River near SH1 (NRC 2013 - 2014) and up to 0.26 ppb in stream water immediately below the historic mercury mine (NRC 2013 - 2014). Of 104 stream water samples collected by NRC/Ngati Hau during 2013 to 2014, 16 contained mercury values above 0.06 ppb, of which the majority (10 of 16) were sampled immediately below the historic mercury mine.

Mercury in Stream Sediment Samples

Stream sediment samples were analysed for mercury as part of gold exploration programmes during the 1980s. This analysis was done because the presence of mercury in stream sediments can indicate that an area is prospective for epithermal gold deposits.

Relevant ANZECC (2000) sediment quality guideline values for mercury in sediment include an ISQG-low value (0.15ppm) and an ISQG-high value (1ppm). Monitoring results¹ indicate that in several locations mercury concentrations in stream sediments exceed the ISQG-high value, including catchments where no historic mining is known to have occurred. Available data at this time indicates that mercury is present in Puhipuhi stream sediments in the form of cinnabar within small rock and soil particles that have washed into the streams from the surrounding district. Mercury may also be associated with iron-sulphide minerals and iron hydroxide precipitates in Puhipuhi sediments. The natural occurrence of cinnabar in stream sediments is referred to in an early Geological Survey Report (A McKay, 1925) which noted that cinnabar was found more readily in the beds of streams than in surface rock exposures at Puhipuhi and that most early mercury mining was of alluvial cinnabar from stream beds.

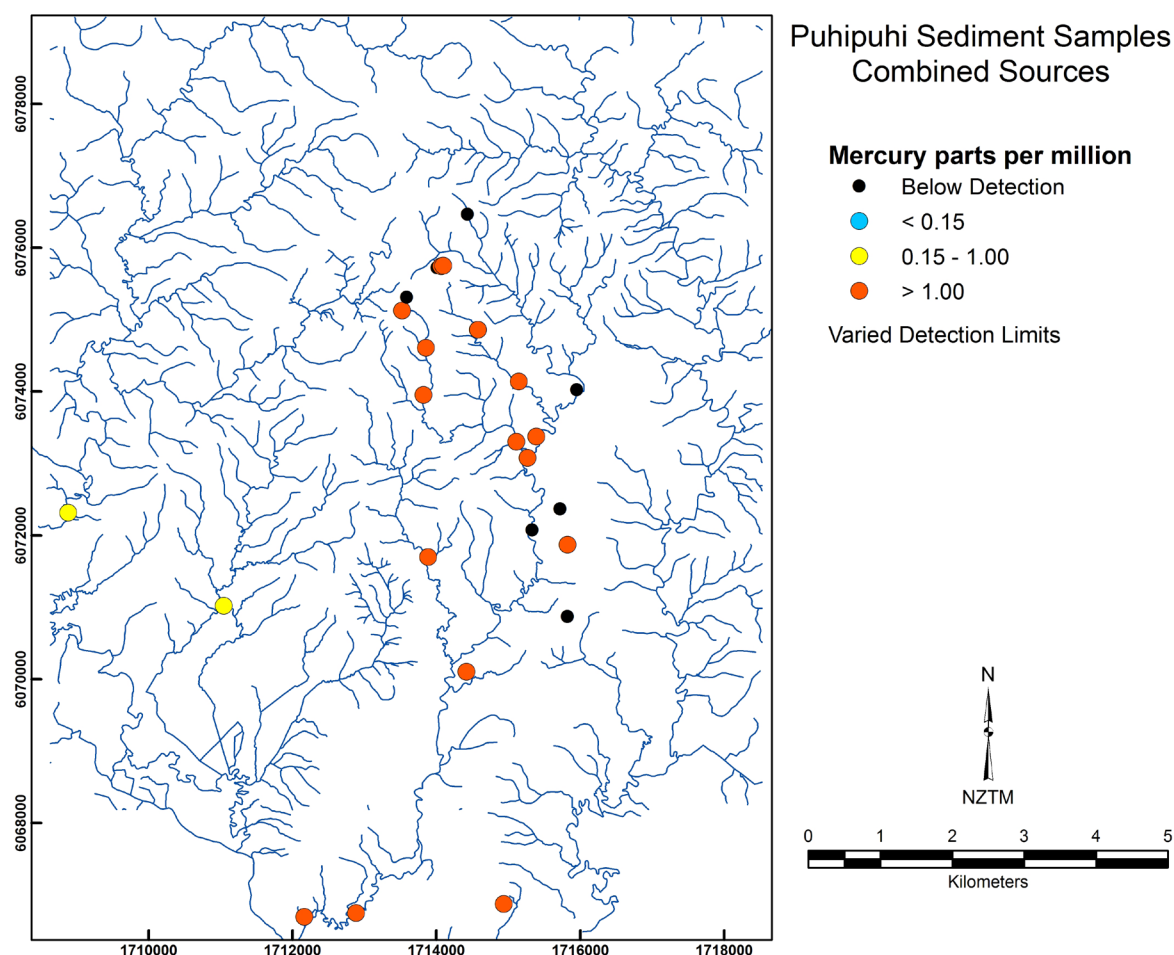


Figure 4: Stream Sediment Mercury Values from Puhipuhi Monitoring Surveys 1973 – 2015. Numerous samples exceed the ANZECC ISQG-high value of 1ppm, including the upper reaches of Pukekaikiore Stream, which has no history of mercury mining.

There is no evidence to suggest that the elevated levels of mercury in stream sediments is having an adverse effect on macro-invertebrates in the Puhipuhi area. For example, a study by Bioresarches in 2012 found that a single site within one of the main streams in this area, the Waiariki, has elevated levels of mercury in the stream sediment but scores higher than average for Northland streams in terms of the general aquatic diversity (NRC's State of Environment Monitoring 2011).

Mercury in Soil Samples

The distribution of mercury in Puhipuhi soils reflects the underlying geology (the rock formations below the surface of the ground).

Soil samples have been collected and analysed for mercury during various gold exploration programmes in the past. The presence of mercury in soil can indicate that there may be underlying epithermal gold deposits located at greater depth. Mercury occurs naturally in the Puhipuhi soils in zones where the soil has formed from underlying cinnabar-rich rocks.

A study by Gionfriddo et al in 2015 indicated that there are also concentrations of mercury in the soil immediately surrounding an old mercury processing plant in the upper catchment of the Waikiore Stream, described in the following section.

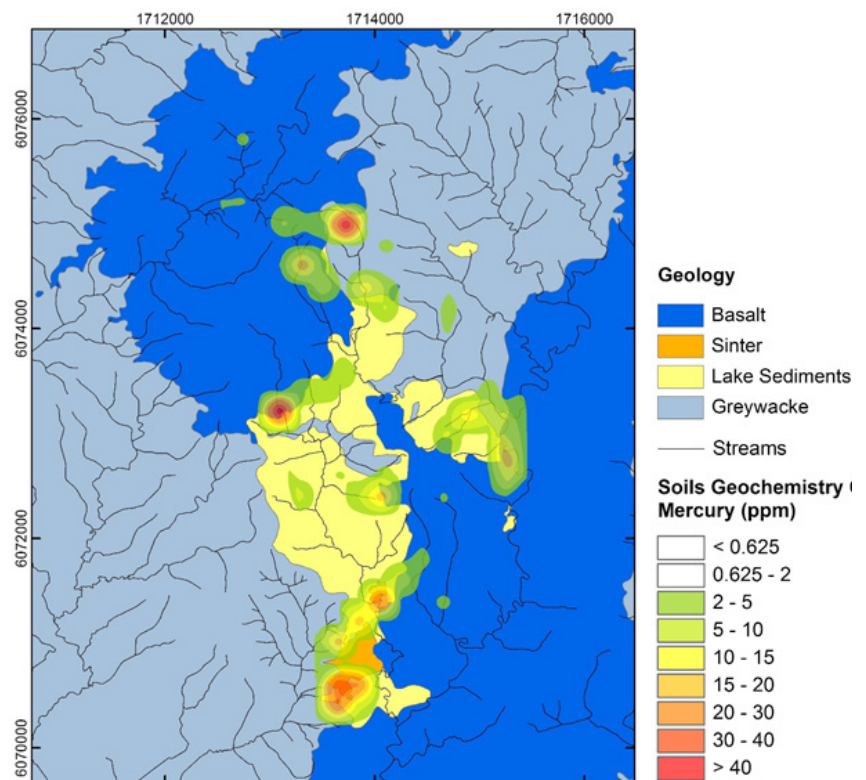


Figure 5a: contoured mercury in soil (ppm), shown on geology map of the Puhipuhi area

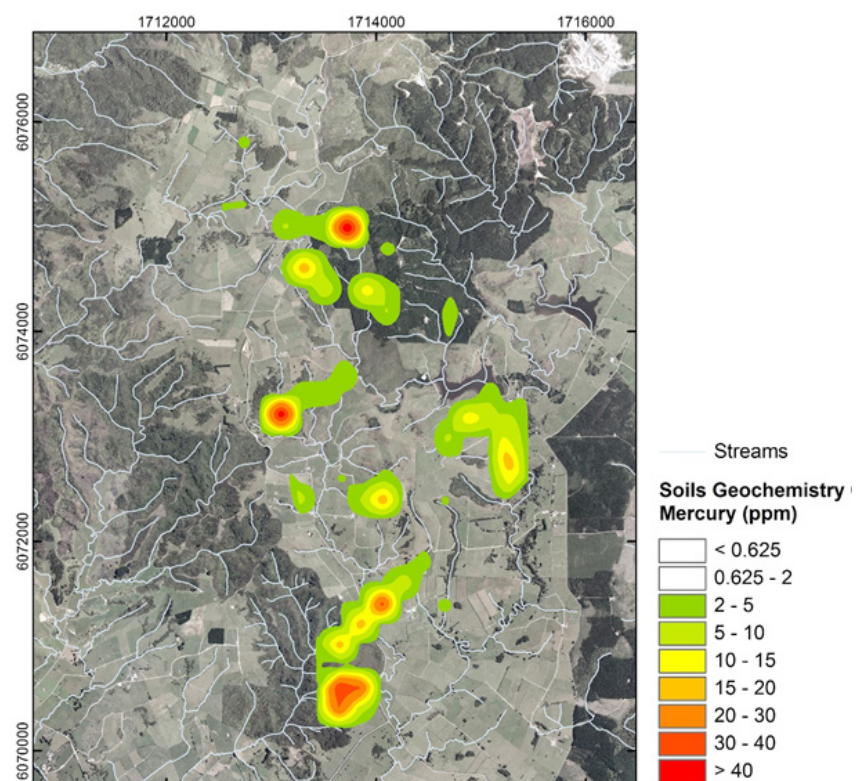


Figure 5b: contoured mercury in soil (ppm), shown on satellite image of the Puhipuhi area

Past practices

Mining and processing of mercury at Puhipuhi

Mining and processing of mercury took place at several Puhipuhi locations from the early 20th Century until the 1940s, including in the upper reaches of Waikiore Stream and at Mt Mitchell (on Mine Road). Elevated mercury levels recorded in stream water and soils in the immediate vicinity of historic mine workings and immediately downstream in stream sediments may be related to historic mining, however naturally-occurring high mercury levels cannot be differentiated from mercury contamination related to historic mining without further investigation.

ANZECC Guidelines for determining the significance of any sediment contamination recommend a staged investigation process to determine the natural background levels that are relevant to a site.



Figure 6: Wetland developed in dammed area above a historic mercury processing site at Puhipuhi. The wall of the historic mercury mine is in the background, now overgrown with native vegetation.

Use of mercury-bearing rock for road gravel

Rock from Puhipuhi is rich in quartz and therefore hard compared to surrounding soft, clay-rich rocks. As a result, Puhipuhi rock was quarried from the 1960s to the late 1980s by the Whangarei District Council for use as gravel on public and private roads in the area.

This road gravel contained sulphide minerals that can oxidise in rainwater, leading to acidic runoff in stormwater drains.

In 1994 complaints were made to Northland Regional Council when stormwater drains overflowed during high rainfall events causing discharge of acidic runoff from roadsides onto pasture. Patches of dead grass and some dead trees were observed and these were found to contain sediments (silt and clay) deposited from the stormwater runoff. Studies by Craw et al (2002)¹, Craw (2005)¹ and by the Northland Regional Council (1995)¹ found elevated levels of arsenic and mercury in the runoff sediments, however concluded that the damage to grass and trees was likely to have resulted from the acidity of the runoff water from the oxidised road gravel rather than any metal content in the sediment.

Extensive sealing of the roads and installation of concrete guttering was undertaken to prevent further discharges into waterways.

This incident raised justifiable concerns within the community about the possibility of mercury and arsenic being released into the environment following any disturbance of sulphidic rocks.



Figure 7: Puhipuhi quarry excavated in sulphide-bearing rock

Further investigations planned by Evolution

Evolution understands that some members of the local community have a high level of concern about the environmental impact of our exploration activities and any potential future mining should the project ever proceed to that phase. In particular, concerns have been expressed around the potential release of mercury into waterways, given the high levels of naturally occurring mercury in the Puhipuhi area and legacy issues relating to past mining and quarrying practices in the region.

In order to better understand the behaviour and distribution of mercury at Puhipuhi, Evolution recently commissioned a review of existing Puhipuhi mercury data by independent government researchers (Stucker and Christie, GNS, 2015). The review has been used to create map-based compilations of all available data, which are now available on Evolution's New Zealand website.

Recent evidence presented by Hudson (2016) to the Treaty of Waitangi Tribunal on behalf of Ngati Hau included the following summary of heavy metal contamination in the Wairua catchment:

"Concentrations of heavy metals in sediments and the overlying water column in reaches of the upper Wairua River catchment exceed trigger thresholds of the ANZECC guidelines for lowland streams. These indicate that additional investigation is warranted, rather than suggesting that toxic conditions exist. These metals occur naturally as a result of the geology of the region. Historical mining and land management practices may have altered the concentrations and availability of these metals to biota. The ecological and human health significance of these concentrations requires knowledge of concentrations at reference sites, other sites where these metals occur naturally, hapū/whānau consumption patterns and the concentrations of metals in biota such as *tuna* (freshwater eels), *kēwai* (freshwater crayfish) and *kākahi* (freshwater mussels). Supporting information is required, such as the habitat status, and assessment of the macroinvertebrate community, before the significance of available metal data may be fully understood."

An environmental baseline study which commenced in February 2016 is being undertaken at Puhipuhi by an independent consultancy commissioned by Evolution. Mercury-related questions that will be addressed as part of this study include:

- Potential for mercury contamination of groundwater as a result of drilling through rocks or soils that have elevated levels of mercury
- Potential for release of mercury and other metals from rocks and soils to waterways
- Potential for downstream dispersion of contaminants
- Characterisation of soils, including vertical distribution of mercury and other metals within the soil profile
- Potential effects on food webs, including presence of mercury within food sources such as eels
- Characterisation of mercury species in sediments and soils

The baseline study will address the recommendations made by Hudson (2016) to the Waitangi Tribunal by providing supporting information such as water and sediment quality and habitat assessment at each of a number of sites that are sampled for bioaccumulation in tuna. Evolution will continue to investigate methods to improve understanding of the distribution and behaviour of mercury and other metals that may be present at Puhipuhi.

The results of these studies will be used to develop environmental management strategies for future exploration activities such as drilling and will be made available to the community via the website.

If Evolution is unable to identify a way to conduct our activities safely and without harm to the environment, we will not proceed.

Contact us

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