

Dioxin Concentrations in Residential Soil, Paritutu, New Plymouth

∴ Prepared for
The Ministry for the Environment
and
The Institute of Environmental Science and Research
Limited

∴ 26 September 2002



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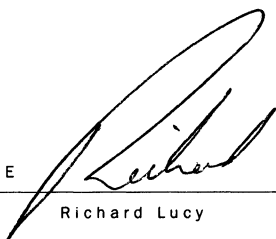
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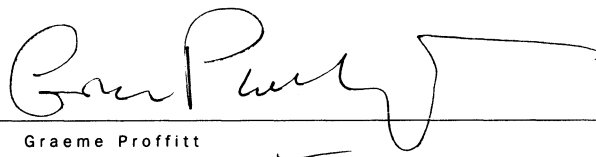
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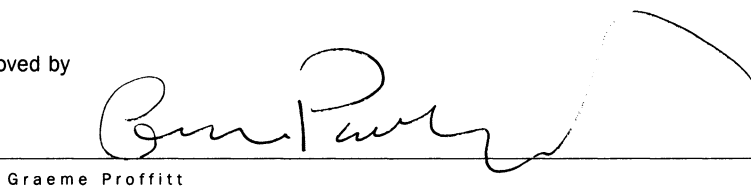
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Graeme Proffitt

Limitations: This report has been prepared on the basis of visual observations, and the testing of 47 samples for 2,3,7,8-TCDD and full dioxin profiles. This information has been used to comment on the soil conditions, but these conditions cannot be guaranteed. The information applies to the times of sampling (28 May to 5 June 2002). With time the site conditions could change so that the reported assessment and conclusions are no longer valid.

The report has been prepared for the Ministry for the Environment and the Institute of Environmental Science and Research Limited, according to their instructions, for the particular objectives described in the report. Any reliance on this report by any other party shall be at such party's sole risk.

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MANATU HAUORA

Environment and Health Statement

Low Levels of Dioxin in Residential Soils at Paritutu in New Plymouth

- **Soils from residences at Paritutu contained less than thirty million millionths of a part of dioxin. The Ministry for the Environment and the Ministry of Health see the risk for current and future residents to be so low as to be negligible.**
- **No clean up of people's lawns, gardens or public use areas is necessary.**
- **This study is a comprehensive assessment of dioxin levels in soil, and no further study of this type is needed.**

Introduction

Pattle Delamore Partners Limited has released a report of a study of the levels of dioxin (more correctly 2,3,7,8-tetrachlorodibenzo-p-dioxin) in soil at residential properties in the New Plymouth suburb of Paritutu.

This Environment and Health Statement explains what the measurements mean for people living in the area.

Background to the study

There have been longstanding community issues with the history of dioxin emissions from the former Ivon Watkins-Dow, now Dow AgroSciences, chemical plant located in Paritutu. There was uncertainty over dioxin levels in the environment.

An initiative to measure the level of dioxin in residential soil was presented to community groups at a meeting of the Paritutu Community Health Liaison Group on 7 March 2002. This proposal received universal support from those present.

How the study was carried out

In February 2002, the Ministry for the Environment appointed the Institute of Environmental Science and Research Limited and Pattle Delamore Partners to carry out the soil study. During April and May, consultation was held with the community over how best to undertake the study. A study proposal was then prepared incorporating, as far as practicable, the views of the community expressed during this consultation. This included the collection of additional soil samples at specific locations identified by the Dioxin Investigation Network.

Sampling was carried out in the last week of May and the first week of June. Forty seven samples were collected from 35 residential properties and public areas. Samples were taken from lawns (at two different depths for some sites), gardens and open spaces. A representative from the Dioxin Investigation Network accompanied Pattle Delamore Partners for all but one of the sites sampled. A second set of samples were taken from each site and provided to the Dioxin Investigation Network.

Chemical analysis was carried out by AgriQuality New Zealand Limited, using a method approved by the United States Environmental Protection Agency for measuring dioxin in soil. Two samples were also analysed by Pace Analytical Services Inc., an independent laboratory in the United States, following discussions and agreement with the Dioxin Investigation Network.

What the study found

This comprehensive study found that there were detectable levels of dioxin in the soils at all sites investigated. The low levels measured mean that any risk to a person's health is negligible.

Concentrations tend to be highest close to the Dow AgroSciences plant, and drop off rapidly within 800 to 1000 metres from the plant. Concentrations to the east of the Dow plant, towards Mount Moturoa Domain, are higher than to the south of the plant. This is consistent with the prevailing winds in the area.

Dioxin was present in concentrations measured in nanograms per kilogram (ng/kg). One nanogram per kilogram means one gram of dioxin in every million tonnes of soil.

On residential properties nearest to the Dow plant, soil dioxin concentrations were typically in the range 5 to 15 ng/kg of soil, falling to a range of 1 to 5 ng/kg further out. One sample had a concentration of 27 ng/kg. There was 92 ng/kg measured at a non-residential site, on the west-facing slope of Mount Moturoa Domain.

Generally there was little difference between soil dioxin levels in lawn areas compared with gardens on the same property. Typically lawn areas tended to be marginally higher. Similarly, there was little difference in soil dioxin levels between surface soils (that is, between 0 and 7.5 cm deep) and soils sampled at a depth between 7.5 and 15 cm.

A summary of results for the 47 soil samples is shown in Figure 1.

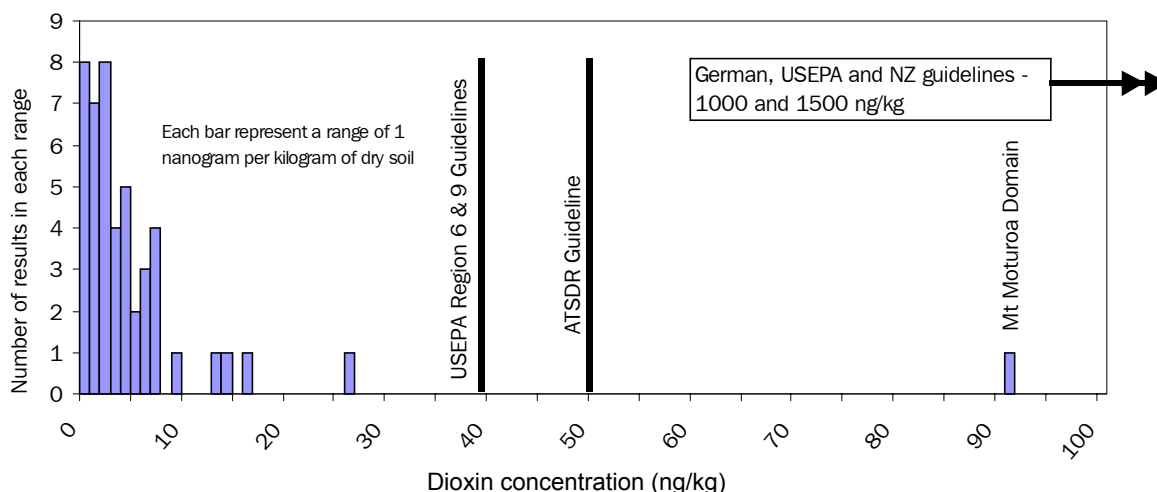


Figure 1. Soil dioxin concentrations, with New Zealand and international guidelines

This figure shows the number of soil samples that had dioxin concentrations within a certain range. For example, there were seven soil samples having a concentration within the range 1–2 ng/kg, and one soil sample having a concentration within the range 9–10 ng/kg. The black vertical lines represent the adjusted (see text) United States Environmental Protection Agency (USEPA) Region 6 and Region 9 guidelines, and the Agency for Toxic Substances and Disease Registry (ATSDR) guideline value for dioxin in residential soil. The guideline values from New Zealand, Germany and the federal United States Environmental Protection Agency are off the scale to the extreme right hand side.

A previous study by the Ministry for the Environment, published in 1998, did not find dioxin in urban soils in any other parts of the country. Although the current study of residential soils consistently measured low levels of dioxin in Paritutu, these levels are not considered to be a health concern.

Our assessment of the results

Guidelines designed to protect people’s health from dioxin in residential soil have been developed in New Zealand, Germany, the United States, and in other countries.

In all cases, the levels of dioxin in residential soil in Paritutu are below the New Zealand and German criteria, and are below the guidelines set by the United States Environmental Protection Agency and the United States Agency for Toxic Substances and Disease Registry. These levels are also below guidelines set by local United States Environmental Protection Agency offices (when adjusted to account for differences in their method of derivation compared to the New Zealand guidelines), including those set by United States Environmental Protection Agency Region 6 and Region 9.

Consequently, the levels of dioxin measured in soil in residences at Paritutu are not considered to be a health concern.

The comparison of the dioxin levels measured in this study with these guidelines is illustrated in Figure 1.

The result for Mount Motorua Domain is above the “trigger” level of the United States Environmental Protection Agency (Region 6 and Region 9) and the United States Agency for Toxic Substances and Disease Registry guidelines. “Trigger” levels, if exceeded, trigger a more detailed assessment, rather than being a level at which health effects will occur. When the result for the Domain is considered in the context of how a person may be exposed to dioxin (for example, how long a person may spend on the Domain on any day), it is concluded that, at the level of dioxin measured in this study, there is a negligible health risk to recreational users of the Domain.

We can be confident with the results

There are several ways in which the quality of the data from this study can be measured. One way is to compare the results from the New Zealand laboratory with those obtained from the United States laboratory. Here we find that the levels of 2,3,7,8-TCDD measured by these two independent laboratories are very similar. This, and other quality assurance procedures that were implemented throughout the sampling and analytical work, tells us that we can be very confident about the quality of the information and the findings of this study.

Is health at risk and is a clean-up necessary?

The Ministry for the Environment and the Ministry of Health consider that the concentration of dioxin in the soil is so low that there is negligible health risk to current and future Paritutu residents.

Dioxin contaminated land can only present a health risk if there is actual exposure to the contaminant. People can be exposed by eating contaminated soil or foods (such as meat, milk or eggs) from animals raised on the contaminated land and, to a lesser extent, by eating homegrown vegetables, breathing in dust, and skin contact with contaminated soil. If exposure does occur, many factors, such as how much dioxin the person is exposed to and for how long, influence whether this actually affects health.

Given the study design and the consistency of the results, the Ministry for the Environment and the Ministry of Health believe that these soil results are representative of residential properties in Paritutu. Therefore, we consider that the risk to the health of current and future Paritutu residents from dioxin contaminated soil is negligible.

Because dioxin is very stable in the environment, levels measured now are considered to be an accurate reflection of historical levels when the Dow plant was manufacturing pesticides.

The community has many criteria for deciding if a clean up is required. If the levels of dioxin found in the soil are used as the yardstick, these levels do not indicate a requirement for clean up.

Do further studies need to be undertaken?

The current study covered a broad cross-section of residential properties in Paritutu. It is the single largest environmental study for dioxin of residential properties undertaken anywhere in New Zealand. We consider that this study provides comprehensive information on dioxin soil levels throughout Paritutu. The findings of this study support the results of earlier measurements of dioxin in residential soils in Paritutu, which have been made over the past decade. No further study of this type is warranted.

The Government continues to fund other studies on dioxin exposure and possible health effects in New Plymouth. A serum survey to determine the current amount of dioxin stored in the body of potentially highly exposed Paritutu residents is in the planning phases. Planning has taken longer than anticipated, but it is important that the methodology for this serum study is as robust as available information permit. Completion of the planning for the serum study has also been dependent on publication of the results of the Ministry for the Environment's soil study, so that these results can be used to assist in deciding how best the serum study should be carried out.

How to obtain more information

Further information on this study is available to all members of the public.

From libraries and councils: A copy of the Pattle Delamore Partners report and of this Environment and Health Statement has been provided to local libraries in Paritutu, and to the central New Plymouth library. In addition, a copy of the report has been provided to the Taranaki District Health Board's public health service, the New Plymouth District Council and the Taranaki Regional Council.

From the internet: A copy of the Pattle Delamore Partners report, the Environment and Health Statement and all other relevant documents (for example, the initial study design) are available from the Ministry for the Environment's web site at www.mfe.govt.nz.

If you seek further information, please write to:

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Executive Summary

Introduction

Agricultural chemicals, including the herbicide 2,4,5-trichlorophenoxyacetic acid (2,4,5-T), were historically manufactured in a plant, currently owned by Dow AgroSciences Ltd (Dow), located in the New Plymouth suburb of Paritutu. Dioxin, or more precisely 2,3,7,8-tetrachlorodibenzo-p-dioxin (2,3,7,8-TCDD), was a manufacturing contaminant of 2,4,5-T. 2,3,7,8-TCDD is recognised as a human carcinogen, and may cause a variety of other adverse health effects.

Concern has been expressed within the community that dioxin may be present in the soil within residential areas of Paritutu, as a result of air emissions from the Dow plant during the manufacture of 2,4,5-T, between 1960 and 1987. 2,3,7,8-TCDD is a very stable compound and could be expected to remain in the soil for many decades. Earlier soil studies have shown 2,3,7,8-TCDD in and around the plant, but a comprehensive survey of residential soils had not been carried out prior to this study.

Pattle Delamore Partners Limited (PDP) was engaged to carry out soil sampling and analysis for dioxin in residential areas of Paritutu, on behalf of the Ministry for the Environment (MfE). The objective of the work was to measure dioxin concentrations in residential properties close to the Dow plant, establishing soil concentrations both laterally and with distance from the plant. The assumptions of the study were that:

- The former IWD plant was the principal source of 2,3,7,8-TCDD present in the soil in the area.
- Contamination occurred via discharges to air with subsequent deposition over the residential neighbourhood.

This report sets out the background to the study, describes the study design, sampling protocols and fieldwork, and presents the concentrations of dioxins measured. The results are compared with previous soil sampling carried out in the area, with studies elsewhere in New Zealand, and with New Zealand and overseas guidelines for 2,3,7,8-TCDD in soil.

Community Consultation

Community consultation was an important part of this study. During the preparation of the study design, the Paritutu Community Health Liaison Group was consulted, and a draft version of the study design was provided to local action groups and central and local government agencies. The Dioxin Investigation Network (DIN) was consulted at key stages of the laboratory analysis programme.

Property owners and/or occupiers were approached individually to obtain information about their property, to explain the sampling and obtain their consent.

Property occupiers and owners received a copy of their individual results prior to the release of this report. Simultaneous with the release of this report a further letter drop

was made to all Paritutu residents, providing a summary of findings and a copy of the Environment and Health statement (also bound into this report), jointly prepared by the Ministry for the Environment and the Ministry of Health. Copies of the report have been deposited in public libraries in the area.

Study Design and Sampling

The study focused on residential properties to the east and south of the Dow plant, but a small number of residential properties to the north-east of the factory were also sampled. The study design considered areas of likely maximum dioxin deposition through a review of meteorological data, topography, age and location of residential areas and results of the earlier soil investigations. However, given the considerable community interest in Paritutu, it was important that the study considered not just the likely areas of maximum deposition, but also the broader residential areas around the plant.

The primary study area is the arc of residential properties running from Maui Place and Rangitake Drive to the south-west of the Dow plant, to the residential properties in Findlay and Catherine streets and Ngamotu Road, adjacent to the industrial land to the east. A limited number of samples were taken from residential areas up to 2.5 km in the predominant downwind (eastward) direction, and from within or close to four residential, or former, residential properties within the industrial area close to the plant.

The study was to measure 2,3,7,8-TCDD concentration trends within surface soil (defined as 0 – 75mm) within the residential area. It was recognised that there could be local variations arising from particular wind conditions or topography, but it was not the intention of the study to establish the fine detail of localised concentration “highs” or “lows”. Secondary aims were to determine the 2,3,7,8-TCDD concentration within a further depth increment (75 – 100 mm) immediately below the surface sample locations, in selected properties, and also 2,3,7,8-TCDD concentrations in soil from a number of gardens.

The sampling was carried out on a curved grid, centred about the Dow plant. Sites were selected as close as possible to each pre-defined grid point based on:

- ✦ The occupant having lived there for as long as possible, preferably since 1960;
- ✦ Sampling soil that had not been disturbed since the Dow plant was established (lawn areas were considered the best targets);
- ✦ Sample locations were away from obstructions (buildings, high fences, large trees);
- ✦ Wood that may have been treated with pentachlorophenol (PCP) was avoided, because dioxin is known to be associated with PCP chemicals;
- ✦ The sampling area was large enough to allow a number of sub-samples to be taken.

The fieldwork was carried out in late May and early June 2002, with a total of 35 sites sampled. From these, 35 surface-soil samples, six deeper samples and six garden samples were collected. Both the deeper and garden samples were collected from sites distributed across the study area. The sampling was carried out in accordance with

rigorous sampling protocols to avoid any possibility of contamination between samples. Samples were collected as composites of six soil cores from each site to ensure they were representative of the site. A DIN representative observed the sampling and was provided with a duplicate set of samples, to store or analyse as they saw fit.

Laboratory analysis was carried out in accordance with the United States Environmental Protection Agency (USEPA) Method 1613, by AgriQuality New Zealand Limited, Lower Hutt. A total of 47 soil samples were analysed for 2,3,7,8-TCDD from the 35 sites. Eight of these samples, distributed across the study area, were analysed for full dioxin profiles, including the sample with the maximum concentration of 2,3,7,8-TCDD. The full profiles allowed the calculation of toxic equivalents (TEQ), a method of representing the toxicity of the dioxin congener mixture relative to 2,3,7,8-TCDD. Two samples were selected for independent analysis for 2,3,7,8-TCDD by Pace Analytical Services Inc., Minneapolis, USA, for confirmatory analysis. The results of the independent verification were excellent.

Dioxin Concentration Results

Surface Soil Samples

2,3,7,8-TCDD was detected in all 35 surface soil samples at concentrations ranging from 0.71 to 92 ng/kg (parts per trillion). The majority (31 out of 35) had 2,3,7,8-TCDD concentrations less than 10 ng/kg and 23 results were less than 5 ng/kg. TEQ concentrations for the eight full profiles ranged from 2.6 to 79 ng/kg. The TEQ value calculated from the congener profile is dominated by the 2,3,7,8-TCDD concentration.

The eight full dioxin profiles showed a close similarity with profiles obtained in earlier MfE soil studies of other urban areas in New Zealand, except for the presence of 2,3,7,8-TCDD in the current study. 2,3,7,8-TCDD was not detected in any of the 22 MfE urban soil samples from other centres, but was detected in the two New Plymouth samples. The dioxin profiles from this study and the two early New Plymouth samples (and Paritutu) results are typical of other towns and cities in New Zealand except there is an "overlay" of 2,3,7,8-TCDD and to a lesser extent 1,2,3,7,8-pentachlorodibenzo-p-dioxin.

The spatial distribution of 2,3,7,8-TCDD in surface soils reflects the prevailing wind direction, from the west, and the topography. Concentrations to the east of the Dow plant, towards and beyond Mount Moturoa, are higher than to the south of the plant. In addition, land that slopes towards the plant, in particular Mount Moturoa, shows higher concentrations relative to flat or away-sloping areas. The steep-sided valley running between Ngamotu and Pioneer roads shows distinctly lower concentrations. Concentrations are higher at the plant boundary and drop off rapidly within 800 – 1000 m from the plant. To the east, 2,3,7,8-TCDD can still be detected 2.5 km from the plant.

Deeper Samples

The concentration of 2,3,7,8-TCDD in deeper samples (75 – 150 mm) ranged from 0.71 to 17 ng/kg. There is a good relationship between the surface and corresponding deeper samples, with the 2,3,7,8-TCDD concentration in the deeper samples being about 70% of the surface samples. A rapid drop-off in TCDD concentration with depth is expected, as TCDD binds very strongly to soil and has a low solubility. However, the results indicate vertical migration has occurred to at least 150 mm. The extent of deeper migration is not clear from this study.

Garden Samples

Concentrations of 2,3,7,8-TCDD in six soil samples taken from gardens ranged from 2 to 7.3 ng/kg. The garden samples also show a good relationship with the corresponding surface samples, with one exception, averaging approximately 80% of the corresponding lawn-soil samples. The garden soil concentrations are higher than would be expected to result from garden cultivation mixing in deeper “clean” soil. Possible factors include:

- ∴ Soil mixing has been relatively shallow, perhaps less than 200 mm.
- ∴ 2,3,7,8-TCDD has reached deeper in the soil column than expected.
- ∴ Deposition of 2,3,7,8-TCDD onto lawns has been added to gardens as grass clippings, either directly or as compost.

Comparison with Previous Paritutu Studies

A number of less extensive studies have previously been carried out in Paritutu. Comparing the results of the earlier studies with the current studies is problematic, because of uncertainties in sampling techniques, locations and basis for reporting, and differences in analytical techniques. However, sampling carried out by Taranaki Regional Council in 2001 and by MfE in 1996 appears to be consistent with the current study. Two samples analysed on behalf of a community group in 2001 are within the range of concentrations measured in this study, although the precise locations of these samples are not known.

Making comparison with samples taken in 1985 and 1986, by Dow and the then Department of Health is of uncertain validity, because of the uncertainties associated with these data. Overall, samples from residential areas are the same order of magnitude as the current study, but some results are higher than the current study.

While the earlier studies provide additional confidence in the results of the current study, they do not allow a definitive assessment of whether residents may, in the past, have been exposed to higher average concentrations. However, based on a half life for 2,3,7,8-TCDD of the order of 25 – 100 years for soil below the top few millimetres, it is not expected that soil concentrations in residential areas would have been markedly higher than those currently measured.

Comparison with International Guidelines

A variety of international soil criteria have been developed against which the results of this study may be compared. In this study, guidelines for a soil in residential areas from New Zealand (1,500 ng TEQ/kg), Germany (1000 ng TEQ/kg) and three different guidelines from the United States have been used. The most conservative criteria are from the United States; 39 ng/kg (2,3,7,8-TCDD) derived from guidelines issued by the Region 6 and Region 9 offices of the USEPA and 50 ng TEQ/kg by the United States Agency for Toxic Substances and Disease Registry (ATSDR). These US criteria are "screening levels" which if exceeded trigger further investigation at a site. Exceeding a screening level does not immediately imply there is a health risk. Any risk will be relative to the exposure assumed in the derivation of the guideline and the exposure likely in the actual situation.

All but one of the results for the samples collected fell within the most conservative residential guidelines used for comparison in this study (the USEPA Region 6 and 9 and ATSDR screening levels). All values fell within the higher New Zealand and German criteria by large margins. The single result that fell outside the USEPA Region 6 and 9, and ATSDR values, is the 2,3,7,8-TCDD concentration of 92 ng/kg in the sample collected from the west-facing slope of Mount Moturoa Domain.

It is concluded that residential properties of Paritutu, with the possible exception of a few properties backing onto the north-west slopes of Mount Moturoa, will have 2,3,7,8-TCDD soil concentrations (and TEQ values) less than the most conservative of the international risk-based residential guidelines currently in force. This is on the assumption that soil concentrations will not be markedly different between sample locations.

Within Mount Moturoa Domain, and on the north-west slopes of Mount Moturoa, 2,3,7,8-TCDD concentrations could be between about 20 and 90 ng/kg. Concentrations will be lowest on the lower slopes. Considering the likely exposure of recreational users of the Domain, a screening level of at least an order of magnitude greater than the residential guideline is considered appropriate. Similarly, the standard residential guideline is not appropriate for the high-density residential properties on the north-west side of Mount Moturoa, given the amount of paving on these properties. A screening level of at least twice the residential value is appropriate.

Conclusion

The results demonstrate that 2,3,7,8-TCDD is present at detectable but generally low concentrations in surface soil over the complete study area. The soil concentrations generally reflect distance from the Dow plant and the prevailing wind directions, with some variation apparent as a result of the topography. Comparatively higher concentrations were found on and around Mount Moturoa, immediately to the east of the Dow plant.

All soil sample results were below the New Zealand soil guideline for 2,3,7,8-TCDD, and with one exception, complied with all risk-based international guidelines. The exception,

in Mount Moturoa Domain, is considered acceptable for the expected recreational use of that land. The results indicate further investigation of soil in residential areas of Paritutu is not warranted.

Previous studies have not found 2,3,7,8-TCDD in other urban areas elsewhere in New Zealand. The profile of dioxin contamination in Paritutu, and in particular the detection of 2,3,7,8-TCDD, is consistent with the nature of contamination associated with 2,4,5-T production. The findings of this study corroborate earlier investigations of the Dow plant being the source of 2,3,7,8-TCDD in the area.

Acknowledgements

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Taranaki Regional Council (Brian Calkin and Gary Bedford) assisted with the site selection process by carrying out preliminary site inspections and interviewing owners. New Plymouth District Council (René Laan) assisted with providing aerial photographs and mapping information.

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