3.0 Study Design and Site Investigation

3.1 Study Design

The detail of the study design is set out in Appendix C, which is in turn based on the Study Design and Sampling Protocol prepared for the investigation (PDP, 2002).

The study brief required the basic target of the study to be 2,3,7,8-TCDD, and assumed that its presence would be an indication of escape from the manufacturing process, whether through fugitive emissions, the 1986 incident or release of TCDD from the incineration of waste (this release may be from breakthrough of TCDD contaminated waste or from TCDD formation and release during incineration). The study design was therefore based on the assumptions that:

1. The former IWD plant was the principal source of 2,3,7,8-TCDD present in the soil in the area;
2. Contamination occurred via discharges to air with subsequent deposition over the residential neighbourhood, and
3. Sampling was to be focused on residential properties, specifically, properties to the east and south of the factory. The industrial or reserve land to the north or west of the factory were not to be sampled unless residential properties were identified within the industrial areas, in which case sampling of those properties would be considered.

The intent of the study was to measure general 2,3,7,8-TCDD concentration trends within surface soil (defined as 0 – 75mm) within the residential area. The general expectation was for a trend of decreasing concentration further from the site, and higher concentrations to the east of the site than to the south as a result of the prevailing wind direction. It was recognised that there could also be local concentration variations as a result of particular wind conditions or topographic variations. However, it was not the intention of the study to establish the fine detail of localised concentration “highs” or “lows”, which would have required a much higher density of sampling. In addition, high-concentration “hotspots” from aerial discharge and deposition over particular small areas were not expected, and there was no information to suggest that particular locations should be targeted.

Secondary aims were to determine 2,3,7,8-TCDD concentrations 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 vegetable gardens within properties from which surface soil samples had been taken. Both the deeper and garden samples were to be collected from sites distributed about the study area. A further aim was to examine the relationship between 2,3,7,8-TCDD and the full dioxin profile, by analysing some samples for the full profile.

The study design considered areas of likely maximum deposition through a review of meteorological data, topography, age and location of residential areas and results of the

earlier dioxin soil investigations. However, given the considerable community interest in Paritutu, it was important that the study considered not just the likely areas of maximum dioxin deposition, but also the broader residential areas around the plant.

The primary study area was defined as 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 (Figure 1). In addition, following community consultation, it was decided to take samples from residential areas up to 2.5 km in the predominant downwind directions, and from within or close to any residential land to the north or north east of the plant.

In developing the study design, no attempt was made to calculate dioxin emission rates or to differentiate between the various sources over time. It was considered that the current dioxin concentration in soil would represent the majority of the dioxin deposited over the period of manufacture, given its slow degradation in soil (half-life of 25 – 100 years (Paustenbach *et al.*, 1992, as reported in Buckland *et al.*, 2000)). Further, it was assumed that the measured concentrations would be typical of concentrations that occupants may have been exposed to over at least the last 15 years, since 2,4,5-T manufacturing stopped at the plant.

3.2 Site Selection

It was decided to sample on a curved grid (Figure 2). The detail of the grid design is given in Appendix C. Sites were then selected as close as possible to each grid point based on a set of selection criteria;

- The occupant had lived there for as long as possible, preferably since 1960;
- The samples were to be from areas of soil that had not been excavated, filled, or otherwise disturbed, since the Dow plant was established (lawn areas were considered the best targets);
- Sample locations were away from the lee of buildings or large trees, and at least 5 m from obstructions (buildings, high fences, large trees);
- Sample locations were at least 5 m away from wooden structures that may have been treated with pentachlorophenol, e.g. poles, fences and sleepers used for landscaping;
- The sampling area was large enough to allow a number of sub-samples to be taken over a several square metre area so that the resulting composite would be representative of the location.

Figure 2: Predetermined sampling grid and additional sampling sites

The sites to be sampled as part of the main sampling grid (labelled 01 to 27 on Figure 2) were first identified as a desktop exercise. The information used to determine the suitability of the sites included reference to aerial photos, a topographical map overlay, drainage plans and building permit dates. This information was then passed onto the TRC, who visited each of the properties with a checklist of desirable attributes, with this information subsequently used by PDP to determine the optimum sites. The TRC visit included questioning occupants on their duration of residence.

The final sites sampled were largely as identified by the TRC, with a few exceptions, where occupants could not be contacted, information was incomplete or it was considered that a more suitable site was required.

As a result of community consultation on the study design, additional sites at nominal distances of 1 km, 1.5 km and 2 km east of the Dow plant, were sampled. These sites (labelled 28 to 31 on Figure 2) were given nominal grid locations prior to the fieldwork, but were finally selected in the field. These sites were to meet the general site-selection criteria, except they were to be on public land where possible (to avoid having to get permission from private owners at short notice) and road reserves were also to be avoided. The actual sites were between 80 m and 130 m from the nominal pre-defined grid locations because of a lack of suitable public land closer to the grid points.

During the community consultation, the Dioxin Investigation Network (DIN) identified several residential properties, or former residential properties, within the nearby industrial area north-east of the plant. In addition to the normal selection criteria, there was a preference for these sites to be on public land, although two of the four sites that eventuated (labelled 32 to 35 on Figure 2) were on private properties.

Given that the Paritutu area had been progressively developed over a number of years, there was a range of property ages and length of time since the properties had possibly remained undisturbed. The newest areas were developed in the 1970s in the vicinity of Herekawe Drive. Marama Crescent and the streets off Marama Crescent, close to the southern boundary of the Dow Plant, were developed in the mid to late 1960s as worker housing for the construction of the New Plymouth Power Station. The oldest areas were generally along Paritutu Road, Ngamotu Street and around Mount Moturoa.

Most residents had not occupied their properties for as long as was desirable (i.e. 30 to 40 years). This was particularly true of the predominantly rental housing made up of former construction housing in and around Marama Crescent. Few occupants in this area had been there for more than two years.

There was also a general absence of vegetable gardens over the study area, particularly within areas of rental housing close to the Dow plant southern boundary. The garden samples were therefore collected from whatever gardens were available, generally ornamental gardens.

Other departures from the site selection criteria and sampling brief are outlined in the individual property summaries. Such departures were mainly where fences or high

obstacles were closer than 5 m to the sampling location. In such cases, the obstacles were to either side of the sampling location. Other cases were where it was not possible to entirely avoid tree canopies.

3.3 Fieldwork

The fieldwork was carried out on 27 to 31 May 2002, and 4 and 5 June 2002. Weather during the initial sampling period was squally, with periods of heavy rain. The weather during the subsequent period was calmer, with relatively light winds and rain showers.

At least one representative of DIN observed all sampling, with the exception of Site 14 due to a misunderstanding. At each site the optimum sampling location was generally identified in accordance with the sampling brief, but also in agreement with the DIN representative. In some instances it was agreed that, although a site did not comply with all the desired criteria, it was sampled because it was the best option available.

3.3.1 Sampling Equipment

AgriQuality New Zealand Ltd (AgriQuality), Lower Hutt, the primary testing laboratory, supplied the sample jars, acetone, hexane, and Teflon squeeze bottles for the acetone and hexane. The sample jars were 280 ml glass, pre-cleaned, and the lids were supplied pre-lined with cleaned aluminium foil. The analyte free water was supplied in glass bottles by R J Hill Laboratories Limited, Hamilton.

The soil sample corers were new, and had a slightly tapered 75 mm long stainless steel barrel with an inside diameter of 25 mm. The scissors used to cut any long grass, and the tamping rod used to push the samples out of the corer, were made of stainless steel.

3.3.2 Sampling Protocol

Samples were collected as composites of six soil cores from each site, with the soil cores collected on a grid defined by the vertices and mid-points of a 2m equilateral triangle. All samples were collected in duplicate – the duplicate core being taken from within 50 mm of the initial core. The duplicate composite-samples were passed to the DIN representative at the end of each day.

The work at each site followed the pattern:

- Occupant/owner permission obtained, generally at least a day in advance.
- Discussions with the occupant regarding the past history of the site, and any site activities that might affect the choice of sampling locations.
- An appropriate sampling location was selected.
- The grid was paced out with the six sample points marked using flags on wire stems, one at each vertex, and one midway along each side.

- The sampling equipment, being the soil corer, the tamping rod for sample-core removal, and the grass trimming scissors (if needed), were decontaminated. The decontamination process stepped through: cleaning in tap water; scrubbing using phosphate free detergent; rinsing in tap water; rinsing in analyte free water; rinsing with acetone; and rinsing with hexane (the waste acetone and hexane were collected and returned to AgriQuality). Following decontamination, the tamping rod was normally stored within the corer barrel until needed.
- Where necessary, the grass on either side of the marker flags was trimmed to ground level, taking care not to touch the sampling area with anything but the scissors.
- Two 280-mL sample jars were labelled – both on the side and lid. The jars were then placed in the sampling area, or, where wind or rain caused problems, within some nearby shelter.
- The soil corer was used to collect the sample cores. All six sample cores at each location were collected into a single jar. The six sample cores for the duplicate sample (for DIN) were collected into a separate jar. Both the main and the duplicate sample cores were collected from each of the six coring locations at the same time. The sample cores were eased into the sample jars using the tamping rod to push the core up and out of the tapered corer, ensuring minimal soil residue remained in the corer following sample removal. The first sample core in each jar was normally laid on the tinfoil lined lid to prevent the tinfoil blowing away; the remainder were placed directly into the jars. In cases where the core compressed in the corer resulting in an ill-defined sampling depth, or where little core was recovered, the core was discarded and another core was collected.
- The main sample jar was placed into a resealable plastic bag and placed into an ice filled chilly bin. The duplicate sample jar was either placed into the DIN representative's chilly bin, or the PDP chilly bin pending later collection by the DIN representative.
- If a deeper sample core was to be taken, a spade was used to break out a 200 mm square, 75 mm thick, turf at each of the six shallower core locations. Care was taken to not let the blade of the spade touch the exposed base of the hole left by removing the turf. The procedure for collecting the deeper sample core then followed that outlined above.
- If a suitable garden was observed, a set of garden-sample cores was collected. The procedure followed that outlined above, but no specific location was marked for the cores, with the cores being collected randomly from throughout the garden.
- If a rinsate blank was to be collected, the equipment was cleaned as described, then analyte free water was poured over the corer, and collected into a sample jar.
- If a trip/field blank was to be collected, the jar of analyte-free water was opened for the duration of the sampling at the particular location.

Following the completion of sampling, a plug of new turf was placed in the core holes. The turf was obtained from a commercial turf supplier in Waitara. Photographs were taken, a site sketch made, other sampling details noted, the occupant notified of the completion of sampling, and the site was then vacated. The sampling details for each property are recorded in property information sheets in Appendix E.

3.4 Laboratory Analysis

The laboratory analysis is detailed in Appendix F. The analysis followed United States Environmental Protection Agency (USEPA) Method 1613.

Samples were dried and homogenised prior to analysis. A sample was then taken from each primary sample to be analysed. The primary samples included all surface (0-75 mm) samples collected, a selection of deeper (75-150 mm) samples collected, distributed across the sampling area and a selection of samples taken from gardens, also distributed across the sampling area. All these samples were subjected to analysis for 2,3,7,8-TCDD.

When the results were received eight surface-samples were selected, in consultation with MfE and DIN, for full dioxin profile analysis (the 17 PCDD and PCDF congeners with chlorines at the 2,3,7 and 8 positions and totals for the tetra, penta, hexa and hepta homologue groups). The samples selected for full profile analysis were:

- The sample with the highest TCDD concentration (sample SS#05);
- A sample some distance from the Dow plant that was unexpectedly high (sample SS#27);
- Six other samples distributed across the sampling area to give both a good range of 2,3,7,8-TCDD concentrations and a good spatial distribution (samples SS#04, SS#06, SS#11, SS#13, SS#22 and SS#24).

Two samples were also selected for independent analysis for 2,3,7,8-TCDD on the basis of the initial 2,3,7,8-TCDD results from AgriQuality. These were the sample with the highest concentration (SS#27) and a sample with low, but detectable, 2,3,7,8-TCDD from close to the Dow plant (SS#02). MfE and DIN were consulted on the sample selection.

The two samples selected for independent analysis were split from the previously homogenised samples by AgriQuality and sent to Pace Analytical Services Inc., Minneapolis, USA. Pace was not aware of the original results nor did they have any communication with AgriQuality, other than confirmation that the samples had been received. PDP requested Pace analyse the samples in accordance with USEPA Method 1613, and received the report of the results direct from Pace.

The laboratory analytical certificates are included in Appendix F. In these certificates surface soil samples are identified in the form SS#nn, where nn is the site number. Garden samples have the letter G as a suffix, i.e. SS#nn-G. Deeper soil samples are identified with a suffix 75mm, i.e. SS#nn-75mm.

Note that the laboratory certificates refer to a sample SS#37. This is actually sample SS#27 and was mislabelled in the field. There is no SS#37 and the date of sampling and other information provides certainty that the sample labelled as SS#37 was actually SS#27. No other samples were mislabelled. The sample is referred to as sample SS#27 in all other references in this report.

A summary of all samples taken and analyses carried out is given in Table 1.

3.5 Community Consultation

Community consultation was carried out throughout the preparation of the study design, the carrying out of the fieldwork and the subsequent laboratory analysis and reporting.

As part of preparing the study design, the Paritutu community was consulted, with the draft and final versions of the sampling brief being distributed, and comments incorporated into the study design, as appropriate. A PDP representative attended a meeting of the Paritutu Community Health Liaison Group in New Plymouth in March to explain the proposed study. The opportunity was also taken to visit the Dow plant to be briefed by the general manager of Dow AgroSciences (NZ) Ltd on the operation and layout of the plant, and a meeting was held with DIN and Dioxin Action Group (DIAG) members.

Prior to the fieldwork commencing, a letter drop was carried out in Paritutu, explaining the purpose of the study and providing brief details of the proposed sampling. A copy of the letter may be found appended to the Study Design and Sampling Protocol (PDP, 2002).

A draft study design and sampling protocol was provided to MfE, ESR, MoH, TRC, and DIN and DIAG for their comment prior to finalising the document. The final document was provided to all these organisations, as well as the New Plymouth District Council, the Taranaki District Health Board and Dow AgroSciences (NZ) Ltd.

Individual property occupiers were approached prior to the commencement of the fieldwork to obtain information about their properties and to explain the sampling. The occupiers were again telephoned just prior to the sampling. At each property, the occupant was requested to sign a consent form. The consent form authorised the collection of the soil samples, and the reporting of the site's address in this report. The resident could grant the former authorisation, but the owner's consent was required for the latter permission where the site was a rental property. A copy of the consent form may be found in the Study Design and Sampling Protocol (PDP, 2002). Where permission to report the address was not given, an alternative site was selected if possible. Property occupiers and owners received a copy of their individual results prior to the release of this report.

Table 1: Samples collected [1] and analyses carried out [2, 3, 4]

Site no.	Address	Date Sampled	Surface (0-75 mm)	Deeper (75-150)	Garden	Rinsate Blank	Trip Blank
01	36 Marama Crescent	31 May	✓❖		✓		
02	12A Tahora Place	28 May	✓❖ P	✓❖			
03	42 Paritutu Road	4 June	✓❖		✓❖	✓	
04	11 Simons Street	30 May	✓❖✪	✓❖	✓❖		
05	Mt Moturoa Domain	30 May	✓❖✪P				
06	52A Marama Crescent	31 May	✓❖✪				
07	28A Simons Street	29 May	✓❖				
08	29 Scott Street	28 May	✓❖				
09	19 Port View Road	29 May	✓❖	✓❖	✓❖		
10	12 Tohu Place	30 May	✓❖				
11	8 Tumai Place	31 May	✓❖✪	✓❖			
12	12A Paritutu Road	28 May	✓❖		✓❖		
13	36 Simons Street	30 May	✓❖✪		✓		
14	7 Findlay Place	31 May	✓❖		✓❖		
15	19 Rangitake Place	31 May	✓❖				
16	79 Ngamotu Road	29 May	✓❖	✓❖	✓		
17	58 Ngamotu Road	30 May	✓❖		✓		
18	9 Catherine Crescent	31 May	✓❖		✓	✓❖	✓
19	Onuku Taipari Domain	29 May	✓❖				
20	133 Ngamotu Road	4 June	✓❖				
21	20 Rospeath Crescent	29 May	✓❖				
22	55A Ngamotu Road	30 May	✓❖✪				
23	37 Ngamotu Road	30 May	✓❖	✓❖	✓❖		
24	108 Pioneer Road	5 June	✓❖✪				
25	Ngamotu Domain – 81 Pioneer Road	4 June	✓❖				
26	Ngamotu Domain – 53 Pioneer Road	4 June	✓❖				
27	AW [5]	5 June	✓❖✪				
28	81 South Road	4 June	✓❖				
29	cnr Whiteley & Breakwater	4 June	✓❖				
30	70 Banks Street	4 June	✓❖				
31	St Josephs School, Calvert Road	4 June	✓❖				
32	105 Centennial Drive	5 June	✓❖				
33	151 Breakwater Road	5 June	✓❖				
34	AW [5]	5 June	✓❖			✓	✓
35	100 Centennial Drive – NPDC Domain	5 June	✓❖			✓	

1. ✓ = sample collected
2. ❖ = sample analysed for 2,3,7,8-TCDD by AgriQuality Ltd.
3. ✪ = sample analysed for dioxin congener profile by AgriQuality Ltd.
4. P = sample independently analysed for 2,3,7,8-TCDD by Pace Analytical.
5. AW = Address withheld. Permission to release address refused

As noted in Section 3.3, above, a DIN representative observed the sampling and received duplicate samples.

Following receipt of the 2,3,7,8-TCDD results from AgriQuality, DIN was consulted on the samples to be selected for full profile analysis, as required by the MfE study brief. DIN was also consulted on the two samples selected for confirmatory analysis by Pace Analytical Services, USA.

Simultaneous with the release of this report, a further letter drop was made to all Paritutu residents, providing a summary of the findings. This letter drop included a copy of the Environmental Health statement that has been released by the MfE and MoH. Copies of this report will be deposited in public libraries in the area.