Executive Summary

A substantial database exists on water quality after **aerial** 1080 possum and rabbit poisoning operations in New Zealand (see Appendix 1). However, no water quality investigations have been undertaken to assess the effect of a **ground-**based 1080 poisoning operation. This is due to the perception that manual application of toxic bait is less likely to result in significant quantities of bait entering watercourses compared to aerial application.

A meeting with Dr Gillian Durham, the then Director of Public Health, at the Ministry of Health on 19 February 1999, discussed model permit conditions, in particular the requirements for drinking water supplies and monitoring. At the meeting it was agreed that the perceived risk from ground applications of 1080 was much lower than from aerial applications and that was why statutory requirements were much less involved for the former. It was agreed that the Wellington Regional Council (WRC) would monitor a ground 1080 operation and report on water quality effects, so that the Ministry could promulgate national advice on the appropriate approach to ground application of 1080.

The WRC subsequently designed a study to investigate a "worst case" scenario. A 14-ha catchment in the Wairarapa was poisoned with 1080 cereal baits (0.15% 1080 w/w) on 26 November 1999. Baits were hand-broadcast at approximately 10 kg/ha.

Duplicate water samples were collected during and after bait application, and during subsequent rainfall events. Sample collection was automated using a Manning Sampler, with sampling intervals set for 15 or 30 minutes.

A total of 52 samples were analysed for 1080 by the Landcare Research laboratory at Lincoln. None contained detectable concentrations of 1080.

This study provides support for the assertion that **ground-**based 1080 possum-poisoning operations do not have a measurable effect on water quality.

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Date: July 2000

Figures and Tables

1. Introduction

A substantial database exists on water quality after **aerial** 1080 possum and rabbit poisoning operations in New Zealand (see Appendix 1). However, no water quality investigations have been undertaken to assess the effect of a **ground-**based 1080 poisoning operation. This is due to the perception that manual application of toxic bait is less likely to result in significant quantities of bait entering watercourses compared to aerial application (see Appendix 1; Eason et *al*. 1992).

In March 1998 results of research commissioned by the Animal Health Board and the Department of Conservation on the toxicological data requirements for registration of 1080, a controlled pesticide, were released (Eason et *al*. 1998). The data raised concerns (Eason et *al*. 1994) and prompted the Ministry of Health to adopt a precautionary approach to the use of 1080 baits. In light of the new toxicological information (Eason et *al*. 1999), and as an interim measure until the 90-day toxicity studies are completed (by June 2000) and a further risk assessment has been undertaken, additional controls as a precautionary measure were advised.

The Medical Officer of Health grants permits for the application of 1080. The Ministry of Health supplies advice on how the permit conditions are to be applied.

In particular, direction/advice from the Ministry of Health was given in memos to Medical Officers of Health and Health Protection Officers on 27 March 1998 and 27 April 1998, which indicated that:

- *an exemption should not be granted to apply 1080 in any catchment from which water is drawn for human consumption (refer Regulation 12(f) of the Pesticides (Vertebrate Pest Control) Regulations 1983), unless it is possible to avoid use of water from that catchment until the chemical analysis of the water demonstrates a level of less than 2 ppb and for affected residents to be provided with an alternative drinking water source. For example, if there are multiple supplies of water, one source could be treated and then segregated until the level of 1080 in the treated water source is less than 2 ppb.*
- *If the catchment to which 1080 is applied is the only source of the drinking-water supply, mandatory monitoring of 1080 concentration in the water should be required as a condition of the permit to drop or lay 1080 bait. Depending on the circumstances (e.g. the extent to which the water from the treated water catchment is diluted by other water sources), medical officers of health should ensure that an alternative drinking-water supply is available, (e.g. bottled water) until tests on the supply show that the level of 1080 is below 2 ppb. However, we would like to emphasise that a wide safety factor has been used in the calculation of risk and 95% of the water samples tested in the monitoring programme to date contained no detectable 1080.*

    - The conditions relating to drinking water catchments were intended to apply to both aerial and ground baiting operations using 1080. Regulation 12(f) of the Pesticides (Vertebrate Pest Control) Regulations 1983 requires applicants to get approval from the Medical Officer of Health (MOH) and enables the MOH to set conditions relating to both aerial and ground laying operations in various

areas, including drinking water catchments. This was not reflected in the joint media release dated 1 April 1998 because the public interest and concern tend to relate to aerial applications. Conditions relating to aerial applications in areas not covered by regulation 12 are provided for in regulation 13.

However, application of 1080 bait by manual techniques (bait stations, bait on spits, hand broadcasting) is thought to be most unlikely to have any measurable effect on water quality. This assumption is based on the fact that buffer strips 20 m wide along streams (riparian buffers) can be readily established to ensure that bait is not distributed directly into watercourses. The Wellington Regional Council (WRC) volunteered to undertake a water sampling programme, to test the assumption in 1999 so that the Ministry could promulgate national advice on the appropriate approach to ground application of 1080.

2. Objectives

To monitor water quality after a worst-case scenario of ground application of 1080 poison baits in a Wairarapa catchment.

3. Methods

3.1. A Worst-case scenario

A ground-based control programme was designed that maximised the probability of 1080 entering a watercourse. The following factors were controlled to ensure this investigation represented a "worst-case" scenario. Clearly it is always possible to find more adverse conditions such as steeper terrain, and more adverse soil moisture profiles. However, we believe that the scenario we have used represents a realistic worst case.

1. Bait was hand-broadcast. Unlike bait station or spit baiting regimes, hand-broadcast baits can not be retrieved or "turned in" to the soil. The density of bait on the ground is highest with the hand-broadcast method.

2. Bait was applied at a high rate. Normally WRC staff aim to apply bait at 3–5 kg/ha. Bait was applied at approximately 10 kg/ha for this investigation.

3. The width of the riparian buffer was reduced from 20 m to 2 m. This reduced the distance that surface runoff could transport leached 1080, and increased the possibility of baits rolling directly into the watercourse.

4. The concentration of 1080 in the bait was 0.15% 1080 w/w, the highest concentration currently registered for the purpose of possum control.

5. The toxin was applied in a No.7 cereal bait matrix. Cereal baits are commonly used for possum control, and 1080 has been shown to leach from cereal baits substantially quicker than the industry alternative, diced carrot (Bowen et. al. 1995).

6. Bait was applied in a small catchment with a seasonal, and generally low, flow rate. The entire catchment was baited, and the source of water in the stream is primarily surface/subsurface runoff (i.e. no significant contribution from ground water).

7. Any possum carcasses or baits that entered or were located close to the stream were left *in situ*. The presence of possum carcasses or baits in or near the stream was assessed following baiting, but these were not moved or disturbed.

8. The catchment was steep with thin stony soils which would increase the likelihood of baits reaching the watercourse.

9. Sampling was undertaken directly after rainfall and at times when the highest concentration of 1080 was expected to be present.

One aspect of the study which did not conform to a "worst case" criteria, was temperature. The study was undertaken during late spring, when in-stream water temperatures at midday are likely to have been approximately 15^{o}C. The rate of biodegradation of 1080 in soil and water is likely to be higher under these conditions than during the winter season.

3.2. Study area

In consultation with Matthew Morgan (hydrologist, WRC), a catchment was selected adjoining the Kiriwhakapapa Road, Wairarapa, Wellington Region (Figure 1). The centre of the catchment is at New Zealand Map Grid 2725341E 6040976N. A small, unnamed stream with a typical low-flow rate of less than 2 L/s drains the catchment. The catchment comprises 14-ha, and is moderately steep with a mixture of pasture and regenerating native scrub on thin stony soils (Figures 2 and 3). This type of catchment is typical of possum habitat in the Wairarapa, and hand-broadcasting of toxic baits is a standard control technique in this situation. The catchment was first treated with aerial 1080 pellets in 1994 with subsequent drops in 1995, 1996, and 1998.

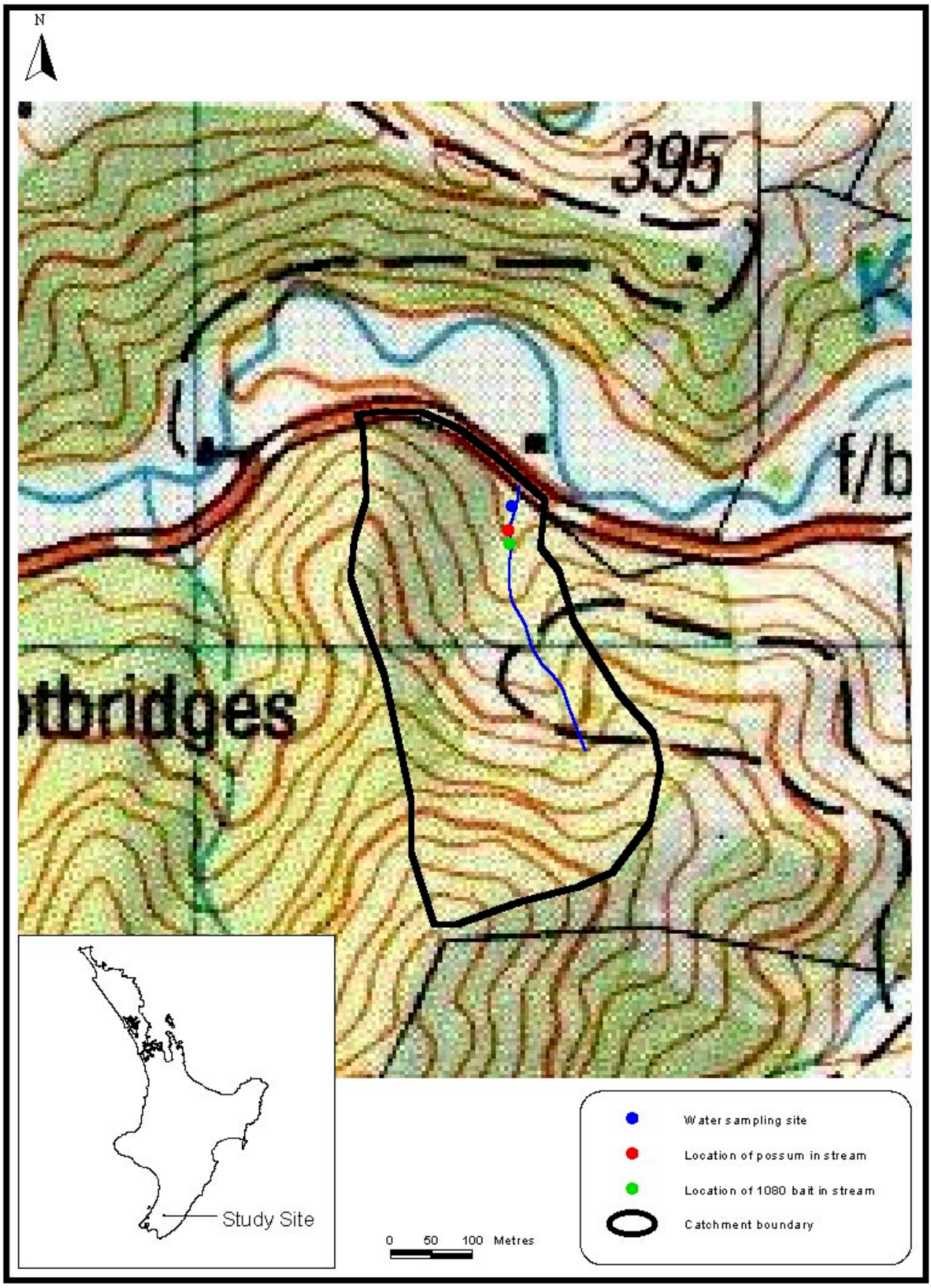

Figure 1 – Location of the catchment at the Kiriwhakapapa Road study site.

Figure 2– Looking uphill from the centre of the catchment.

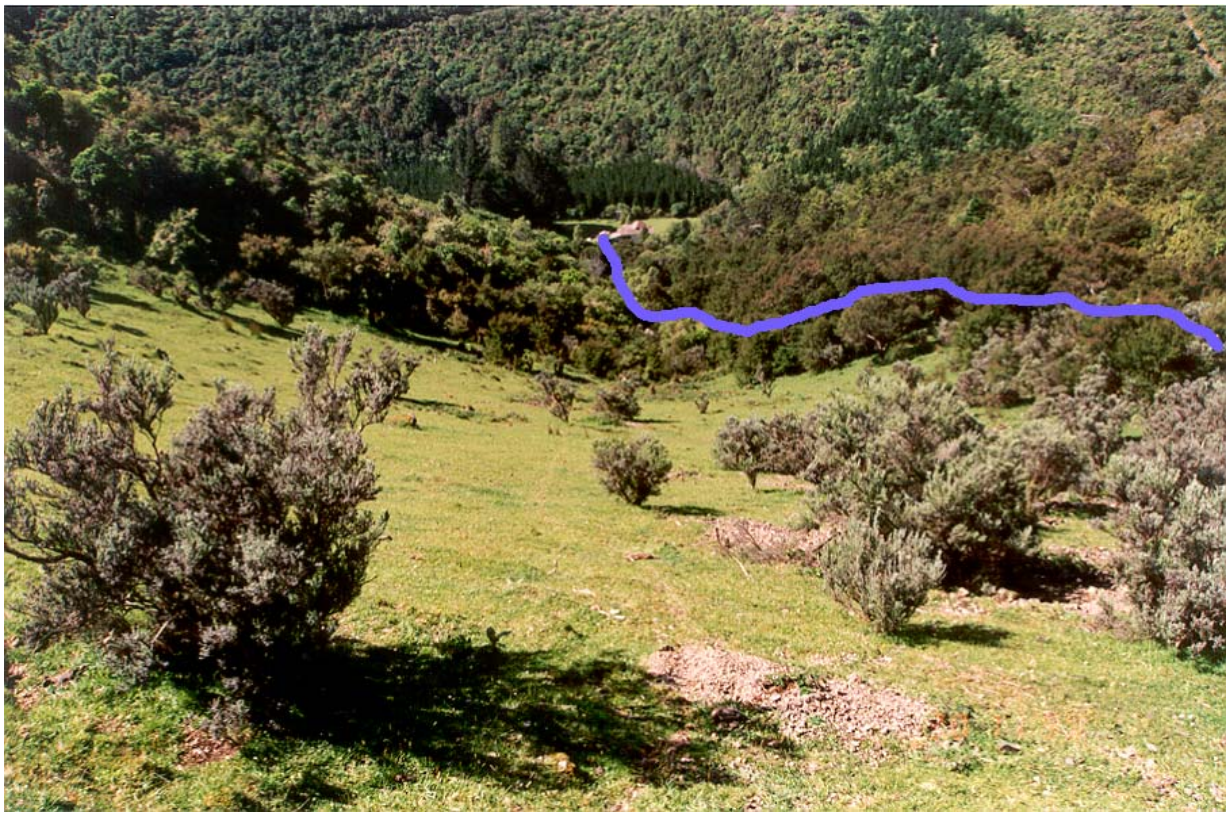

Figure 3 – Looking downhill from the centre of the catchment (Approximate location of main stream channel marked in blue).

3.3. Bait application

Cereal 1080 possum baits (No. 7) with a nominal toxic loading of 0.15% (normal parameters 0.141-0.160%) 1080 w/w were obtained from the Animal Control Products factory at Waimate (Donna Gardner pers. Comm.). The Animal Control Products (ISO 9000 accredited) laboratory quantified the 1080 at 0.158% 1080 w/w as part of their routine quality assurance procedures. Each bait had a diameter of 16 mm, and weighed approximately 5 g. Baits were dyed green and contained a cinnamon lure.

Bait was applied to the study site by three WRC staff using the hand-broadcast method between 11.00 a.m. and 3.15 p.m. on 26 November 1999. The weather was fine with low winds and no rainfall predicted for the next 24 hours.

A total of 150 kg of bait was applied to the 14-ha catchment (mean 10.7 kg/ha).

Following the cessation of water sampling, and after 85 mm of rainfall, two samples of weathered baits were collected and analysed to determine their residual 1080 content.

3.4. Water sampling

A sampling site was established in the stream at the bottom of the study site, immediately below the lowest point of bait application. Refer to table 2 for a summary of the sample collection times and analysis.

Samples were collected automatically at specified times (see Table 1) and intervals using a Manning Sampler (serial number D050) obtained from NIWA Instruments, Christchurch. The Manning Sampler is self-purging and priming, and is able to take 24 samples of 400 mL each at pre-programmed time intervals. Sampling cycles can be initiated either manually, or by a switching mechanism connected to a flow or water-level meter. The sampling cycles on the day and night of bait application were manually initiated, while the sampling cycles associated with subsequent rainfall events were set to be automatically triggered by a 20 mm rise in the water level of the stream at the sampling location.

Collection bottles in the Manning Sampler had approximately 8 g of table salt added to ensure a 2% w/w NaCl concentration in the sample immediately following collection and prior to freezing. Geoff Wright, Manager of the Landcare Research, Lincoln laboratory recommended this, as an alternative to addition of bleach, to slow biological activity that can cause degradation of any 1080 present in the samples. The analytical method adds NaCl to 2% as part of the normal procedure.

Sampling times were chosen to include the period of toxic baiting, and 17 hours following treatment. Further sampling was scheduled to occur during subsequent rainfall events. Rainfall was monitored using an on-site recorder (0.5 mm tipping-bucket, with a punch-tape recorder), with back-up data available from a permanent WRC rainfall telemetry site at Mt Bruce (0.5 mm tipping-bucket, with an OTA data-logger), 5 km to the north of the sampling site. Rainfall data from the Mt Bruce site is presented, as the on-site recorder failed to function. The Mt Bruce site is in an area of similar rainfall pattern and mean annual rainfall (M. Morgan, pers. comm.).

Samples were collected at 15-minute intervals for all sampling cycles, except for the cycle commencing 26/11/99 at 20.04, and finishing on 27/11/99 at 8.04, where samples were collected at 30-minute intervals. The increase from 15 to 30 minutes between sample collection times enabled samples to be collected throughout a 12-hour night period following the day of bait application.

Following a sampling cycle, samples were transferred to 200 mL PET containers (duplicate) and frozen within 1 hour of collection to ensure complete cessation of biological activity. Figure 4 shows samples being transferred into sample bottles prior to freezing.

Figure 4 – Manning Sampler at Study site

3.5. Water sample analysis

Not all samples were analysed. A subset of samples was selected for analysis. Four samples were analysed individually, and a further 48 samples were aggregated in consecutively sampled groups of three prior to analysis.

The decision to aggregate samples was a compromise between analysing as many samples as possible within budget constraints, and to maximise the probability of detecting a brief "spike" of 1080 in the watercourse, and minimising dilution of samples to ensure that measurable quantities of 1080 would be detected.

The 48 samples aggregated sequentially in groups of three, were selected as follows:

- Cycle 1 – Three samples randomly selected from the set (excluding the four samples individually analysed, see above).
- Cycle 2 – Three samples randomly selected from the first half of the sampling cycle, and three from the second.
- Cycle 3 – Three samples randomly selected from the first half of the sampling cycle, and three from the second.
- Cycles 4 and 5 – All 30 samples collected between 2.08 p.m. and 10.06 p.m. on 28/11/99, as these coincided with the period of greatest rainfall during these sampling cycles.

The Drinking Water Standards for New Zealand 1995 has a provisional maximum acceptable value (PMAV) of 5 ppb. The standards require that whenever a determinand is present at more than 50% of the PMAV, additional sampling be carried out until it has been established that its concentration does not exceed the PMAV. Two parts per billion is used as an approximation of 50% of the PMAV of 5 ppb. The interim standard for 1080 in potable water is 2 ppb continuously.

The effective limit of detection of 1080 in any aggregate sample (assuming only one sample in the aggregate group contains 1080) would be 0.3 ppb rather than 0.1 ppb. The interim standard for 1080 in potable water of 2 ppb is therefore approximately 7 times higher than the effective limit of detection of 0.3 ppb for the aggregated samples.

The four samples analysed individually were collected at 15-minute intervals following the time that a 1080 pellet was located in the stream (see section 4.2, Table 1). This was, in our opinion, the most likely time when a brief spike of 1080 may have been detected.

The Landcare Research (IANZ accredited) laboratory quantified the 1080 content of the samples by gas chromatography with electron capture detection. The active ingredient in 1080 (sodium monofluoroacetate) in the water sample was acidified with hydrochloric acid and converted to the dichloroaniline derivative with N,N'-dicyclohexylcarbodiimide (DCC) and 2,4-dichloroaniline (DCA) using ethyl acetate as the solvent. The derivative was cleaned on a silica solid phase extraction cartridge to remove excess derivatising agent, eluted with toluene, and quantified by gas chromatography on a BP-5 capillary column with electron capture detection (Geoff

Wright pers. comm.). The limit of detection of 1080 in water is 0.0001µg/mL and the uncertainty (95% c.i. is +/-12%) (Appendix 2).

4. Results

None of the water samples analysed contained detectable quantities of 1080 (Appendices 1 and 2).

The two weathered bait samples collected after 85 mm of rain contained 0.013% and 0.018% 1080 by weight. Figure 5 shows the estimated pattern of rate of decline of 1080 in the baits over the duration of the investigation.

4.1. Bait application

Diederik Meenken and Bronwyn Johnson assessed the bait distribution at approximately 4.00 p.m. on 26 November 1999. Bait distribution was adequate, with bait being distributed to within approximately 2 m of the edge of the stream, and evenly distributed throughout the area. There was one patch approximately 30 m by 30 m in the middle of the catchment where no bait was present, but this was not unusual given the nature of the application technique.

4.2. Water sampling

Rain started to fall at approximately 7.00 p.m. on 27 of November 1999, and continued until 8.00 a.m. on 28 of November 1999. During this period 85 mm of rain fell (Figure 1, Table 1). The flow rate of the stream draining the study site catchment was quantified at 1.5 L/s prior to rainfall, and at 6 L/s at 8.00 a.m. on 29 November 1999. Flow rates between these known points were crudely estimated in relation to the rainfall data (Figure 1, Table 1).

By 10.00 a.m. on 28 November 1999 the stream level had not risen by 20 mm as the catchment substrate had absorbed the majority of the 40 mm of rainfall that had fallen overnight. The Manning Sampler was manually initiated, as substantial rainfall had occurred, and there was a noticeable, though not large, increase in the flow rate of the stream. It is unfortunate that the stream level had not risen adequately to trigger the Manning Sampler, as some samples should ideally have been collected in the early phase of the rainfall period.

Several inspections of the watercourse were undertaken, to establish the presence or absence of toxic pellets, and/or poisoned vertebrate carcasses. One toxic pellet was located about 40 m upstream from the sampler during the afternoon of 26/11/99. This area was baited at approximately 11.30 a.m. that day, and the pellet is likely to have rolled down the adjoining steep bank into the stream (J. Rodgers, pers. comm.). One possum carcass was found in the stream at 9.00 a.m. on 27/11/99, the morning following bait application. This possum is likely to have died from 1080 poisoning in the early hours of 27 November 1999.

Table 2 shows the time and date of all samples collected, and identifies which samples were analysed.

Table 1 – Summary of events at study site

Date & Time	Cumulative time (Hours)	Cumulative rainfall (mm)	Estimated flow rate (L/s)	Sampling cycle no. (blank if no sampling)	Concentration of 1080 in bait	Toxic bait applied	Comments
11/26/99 08:00	0.00	0	1.5		0.15		
11/26/99 09:00	1.00	0	1.5		0.15		
11/26/99 09:07	1.12	0	1.5	1	0.15		
11/26/99 10:00	2.00	0	1.5	1	0.15		
11/26/99 11:00	3.00	0	1.5	1	0.15	Yes	
11/26/99 11:30	3.50	0	1.5	1	0.15	Yes	Likely time pellet entered stream 40 m upstream from sampler
11/26/99 12:00	4.00	0	1.5	1	0.15	Yes	
11/26/99 13:00	5.00	0	1.5	1	0.15	Yes	
11/26/99 14:00	6.00	0	1.5	1	0.15	Yes	
11/26/99 15:00	7.00	0	1.5	1	0.15	Yes	
11/26/99 15:07	7.12	0	1.5	1	0.15	Yes	
11/26/99 15:08	7.13	0	1.5		0.15	Yes	
11/26/99 15:34	7.57	0	1.5		0.15		
11/26/99 15:35	7.58	0	1.5	2	0.15		
11/26/99 16:00	8.00	0	1.5	2	0.15		
11/26/99 17:00	9.00	0	1.5	2	0.15		
11/26/99 18:00	10.00	0	1.5	2	0.15		
11/26/99 19:00	11.00	0	1.5	2	0.15		
11/26/99 19:45	11.75	0	1.5	2	0.15		
11/26/99 19:46	11.77	0	1.5		0.15		
11/26/99 20:04	12.00	0	1.5	3	0.15		
11/26/99 20:00	12.07	0	1.5	3	0.15		
11/26/99 21:00	13.00	0	1.5	3	0.15		
11/26/99 22:00	14.00	0	1.5	3	0.15		
11/26/99 23:00	15.00	0	1.5	3	0.15		
11/27/99 00:00	16.00	0	1.5	3	0.15		
11/27/99 01:00	17.00	0	1.5	3	0.15		
11/27/99 02:00	18.00	0	1.5	3	0.15		
11/27/99 03:00	19.00	0	1.5	3	0.15		
11/27/99 04:00	20.00	0	1.5	3	0.15		
11/27/99 05:00	21.00	0	1.5	3	0.15		
11/27/99 06:00	22.00	0	1.5	3	0.15		
11/27/99 07:00	23.00	0	1.5	3	0.15		
11/27/99 08:00	24.00	0	1.5	3	0.15		
11/27/99 08:04	24.07	0	1.5	3	0.15		
11/27/99 08:05	24.08	0	1.5		0.15		
11/27/99 09:00	25.00	0	1.5		0.15		possum carcass found 35 m upstream from sampler
11/27/99 10:00	26.00	0	1.5		0.15		
11/27/99 11:00	27.00	0	1.5		0.15		
11/27/99 12:00	28.00	0	1.5		0.15		
11/27/99 13:00	29.00	0	1.5		0.15		
11/27/99 14:00	30.00	0	1.5		0.15		
11/27/99 15:00	31.00	0	1.5		0.15		
11/27/99 16:00	32.00	0	1.5		0.15		
11/27/99 17:00	33.00	0	1.5		0.15		

Table 1 Continued…

Date & Time	Cumulative Time (Hours)	Cumulative Rainfall (mm)	Estimated Flow Rate (L/s)	Sampling cycle no. (blank if no sampling)	Concentration of 1080 in bait	Toxic Bait Applied	Comments
11/27/99 18:00	34.00	0	1.5		0.15		
11/27/99 19:00	35.00	0.5					
11/27/99 20:00	36.00	4					
11/27/99 21:00	37.00	9	2				
11/27/99 22:00	38.00	13					
11/27/99 23:00	39.00	17					
11/28/99 00:00	40.00	21			0.1		
11/28/99 01:00	41.00	27.5	3				
11/28/99 02:00	42.00	30.5	3.5				
11/28/99 03:00	43.00	32					
11/28/99 04:00	44.00	34.5					
11/28/99 05:00	45.00	37	4				
11/28/99 06:00	46.00	38.5					
11/28/99 07:00	47.00	38.5					
11/28/99 08:00	48.00	39			0.07		
11/28/99 09:00	49.00	39.5	4				
11/28/99 10:00	50.00	39.5	4				
11/28/99 10:08	50.13	39.5		4			
11/28/99 11:00	51.00	39.5	4	4			
11/28/99 12:00	52.00	39.5	3	4			
11/28/99 13:00	53.00	39.5	3	4	0.07		
11/28/99 14:00	54.00	42.5	5	4			
11/28/99 15:00	55.00	46	5	4			
11/28/99 15:58	55.97	46		4			
11/28/99 16:00	56.00	49	5				
11/28/99 16:35	56.58	49					
11/28/99 16:36	56.60	49	6	5			
11/28/99 17:00	57.00	51.5	6	5			
11/28/99 18:00	58.00	54	7	5			
11/28/99 19:00	59.00	55.5	7	5			
11/28/99 20:00	60.00	60		5	0.04		
11/28/99 21:00	61.00	66		5			
11/28/99 22:00	62.00	66.5	8	5			
11/28/99 22:36	62.60	66.5		5			
11/28/99 22:37	62.62	66.5					
11/28/99 23:00	63.00	67	7.8				
11/29/99 00:00	64.00	68					
11/29/99 01:00	65.00	71					
11/29/99 02:00	66.00	71.5					
11/29/99 03:00	67.00	75	8				
11/29/99 04:00	68.00	79					
11/29/99 05:00	69.00	81					
11/29/99 06:00	70.00	83	8				
11/29/99 07:00	71.00	84					
11/29/99 08:00	72.00	85	7.8		0.015		

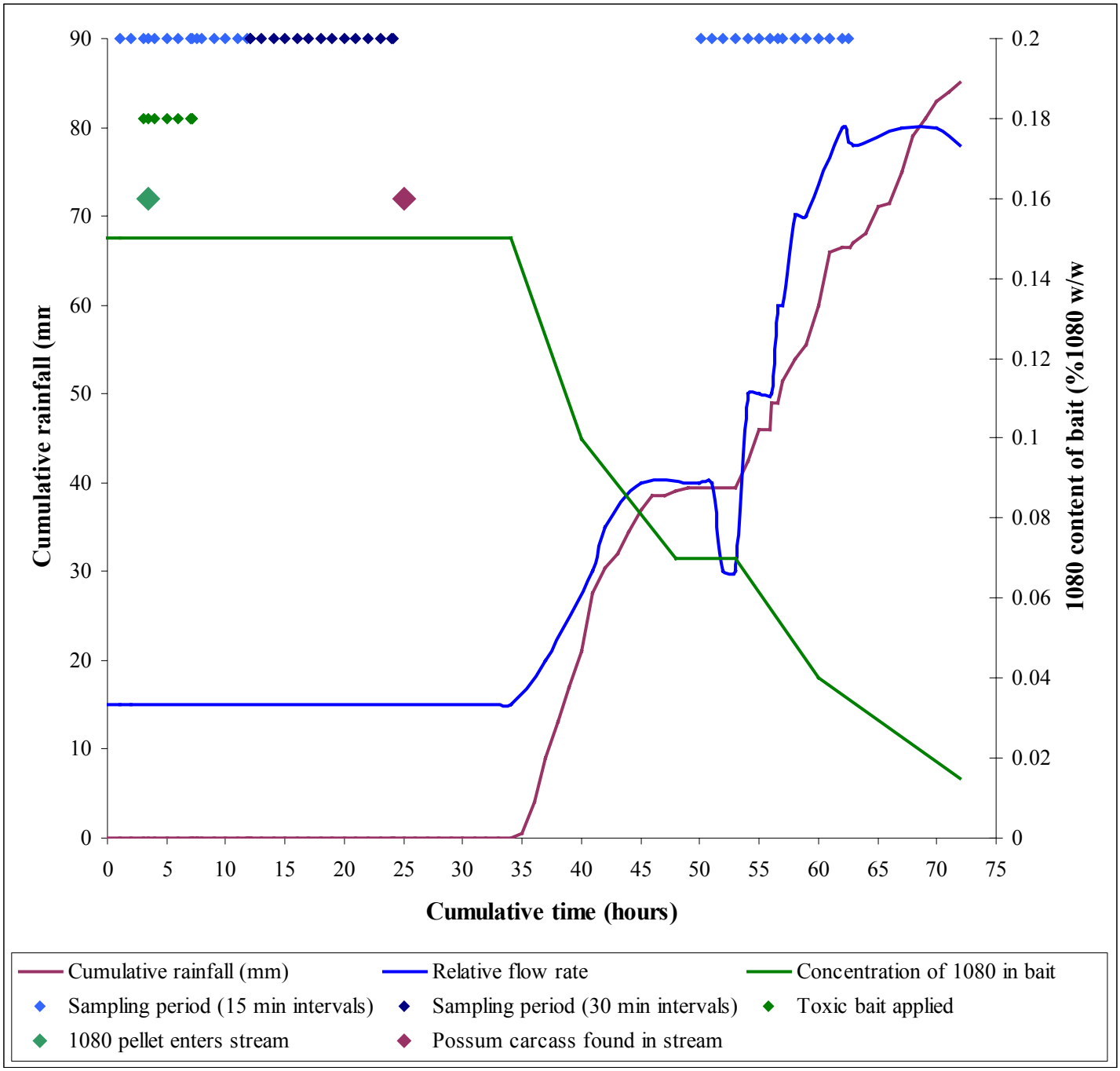

Figure 5 – Summary of water sampling following 1080 ground-baiting at Kiriwhakapapa, Wairarapa.

Table 2– Sample collection and analysis

Sampling Cycle	Sample	Date	Time	Random Group	Analysed (B=bulk sample)	1080 Content of Sample (mg/kg)
1	1	26/11/99	9:22			
1	2	26/11/99	9:37			
1	3	26/11/99	9:52			
1	4	26/11/99	10:07			
1	5	26/11/99	10:22			
1	6	26/11/99	10:37			
1	7	26/11/99	10:52			
1	8	26/11/99	11:07			
1	9	26/11/99	11:22		Single	Not Detected
1	10	26/11/99	11:37		Single	Not Detected
1	11	26/11/99	11:52		Single	Not Detected
1	12	26/11/99	12:07		Single	Not Detected
1	13	26/11/99	12:22	R1	B1	Not Detected
1	14	26/11/99	12:37	R1	B1	Not Detected
1	15	26/11/99	12:52	R1		
1	16	26/11/99	13:07	R1		
1	17	26/11/99	13:22	R1		
1	18	26/11/99	13:37	R1	B1	Not Detected
1	19	26/11/99	13:52	R2		
1	20	26/11/99	14:07	R2		
1	21	26/11/99	14:22	R2	B2	Not Detected
1	22	26/11/99	14:37	R2	B2	Not Detected
1	23	26/11/99	14:52	R2		
1	24	26/11/99	15:07	R2	B2	Not Detected
2	1	26/11/99	15:50	R3		
2	2	26/11/99	16:05	R3	B3	Not Detected
2	3	26/11/99	16:20	R3		
2	4	26/11/99	16:35	R3		
2	5	26/11/99	16:50	R3		
2	6	26/11/99	17:05	R3	B3	Not Detected
2	7	26/11/99	17:20	R3	B3	Not Detected
2	8	26/11/99	17:35	R3		
2	9	26/11/99	17:50	R4	B4	Not Detected
2	10	26/11/99	18:05	R4		
2	11	26/11/99	18:20	R4	B4	Not Detected
2	12	26/11/99	18:35	R4		
2	13	26/11/99	18:50	R4		
2	14	26/11/99	19:05	R4		
2	15	26/11/99	19:20	R4		
2	16	26/11/99	19:35	R4	B4	Not Detected
2	17	26/11/99	19:50	R4		
3	1	26/11/99	20:19	R5	B5	Not Detected
3	2	26/11/99	20:49	R5	B5	Not Detected
3	3	26/11/99	21:19	R5		
3	4	26/11/99	21:49	R5		
3	5	26/11/99	22:19	R5		
3	6	26/11/99	22:49	R5		
3	7	26/11/99	23:19	R5		
3	8	26/11/99	23:49	R5		
3	9	27/11/99	0:19	R5	B5	Not Detected
3	10	27/11/99	0:49	R5		
3	11	27/11/99	1:19	R5		
3	12	27/11/99	1:49	R5		

Note: Limit of Detection for 1080 in water is 0.0001 mg/kg, or 0.1 ppb.

Table 2 Continued…

Sampling Cycle	Sample	Date	Time	Random Group	Analysed (B=bulk sample)	1080 Content of Sample (mg/kg)
3	13	27/11/99	2:19	R6		
3	14	27/11/99	2:49	R6		
3	15	27/11/99	3:19	R6		
3	16	27/11/99	3:49	R6	B6	Not Detected
3	17	27/11/99	4:19	R6		
3	18	27/11/99	4:49	R6		
3	19	27/11/99	5:19	R6		
3	20	27/11/99	5:49	R6		
3	21	27/11/99	6:19	R6		
3	22	27/11/99	6:49	R6		
3	23	27/11/99	7:19	R6	B6	Not Detected
3	24	27/11/99	7:49	R6	B6	Not Detected
4	1	28/11/99	10:08			
4	2	28/11/99	10:23			
4	3	28/11/99	10:38			
4	4	28/11/99	10:53			
4	5	28/11/99	11:08			
4	6	28/11/99	11:23			
4	7	28/11/99	11:38			
4	8	28/11/99	11:53			
4	9	28/11/99	12:08			
4	10	28/11/99	12:23			
4	11	28/11/99	12:38			
4	12	28/11/99	12:53			
4	13	28/11/99	13:08			
4	14	28/11/99	13:23			
4	15	28/11/99	13:38			
4	16	28/11/99	13:53			
4	17	28/11/99	14:08		B7	Not Detected
4	18	28/11/99	14:23		B7	Not Detected
4	19	28/11/99	14:38		B7	Not Detected
4	20	28/11/99	14:53		B8	Not Detected
4	21	28/11/99	15:08		B8	Not Detected
4	22	28/11/99	15:23		B8	Not Detected
4	23	28/11/99	15:38		B9	Not Detected
4	24	28/11/99	15:53		B9	Not Detected
5	1	28/11/99	16:51		B9	Not Detected
5	2	28/11/99	17:06		B10	Not Detected
5	3	28/11/99	17:21		B10	Not Detected
5	4	28/11/99	17:36		B10	Not Detected
5	5	28/11/99	17:51		B11	Not Detected
5	6	28/11/99	18:06		B11	Not Detected
5	7	28/11/99	18:21		B11	Not Detected
5	8	28/11/99	18:36		B12	Not Detected
5	9	28/11/99	18:51		B12	Not Detected
5	10	28/11/99	19:06		B12	Not Detected
5	11	28/11/99	19:21		B13	Not Detected
5	12	28/11/99	19:36		B13	Not Detected
5	13	28/11/99	19:51		B13	Not Detected
5	14	28/11/99	20:06		B14	Not Detected
5	15	28/11/99	20:21		B14	Not Detected
5	16	28/11/99	20:36		B14	Not Detected
5	17	28/11/99	20:51		B15	Not Detected
5	18	28/11/99	21:06		B15	Not Detected
5	19	28/11/99	21:21		B15	Not Detected
5	20	28/11/99	21:36		B16	Not Detected
5	21	28/11/99	21:51		B16	Not Detected
5	22	28/11/99	22:06		B16	Not Detected
5	23	28/11/99	22:21			
5	24	28/11/99	22:36			

Note: Limit of Detection for 1080 in water is 0.0001 mg/kg, or 0.1 ppb.

5. Discussion

The high rainfall (85 mm) experienced over a short (37 hour) time frame following the baiting was fortunate. This type of rainfall event has a maximum probability of causing leached 1080 to enter watercourses for several reasons:

1. Surface run-off is enhanced following saturation of the substrate with the initial rainfall (approximately 40 mm in this instance).

2. There is minimal time for biological degradation of 1080 in the bait and soil around the bait.

The combination of rainfall conditions, and the management of variables within our control (refer section 3.1) has ensured that this investigation represents a worst-case scenario. The worst-case scenario was further enhanced by the presence of a toxic bait, and a poisoned possum carcass in the stream.

The absence of 1080 in the water samples at or above the detectable limit is consistent with results from previous investigations in the Wellington Region, which found no detectable 1080 in watercourses following aerial application of cereal 1080 baits for possum control (Meenken and Eason 1995).

It is expected that aerial application of 1080 possum bait will have a higher probability of 1080 entering watercourses, as baits directly enter watercourses situated under forest canopy.

This study found one toxic bait pellet in the stream following baiting. This highlights the low probability of baits entering watercourses with manual application techniques, especially as the distance of baiting from the stream was reduced from 20 m to 2 m for this study.

Surface run-off is unlikely to introduce significant quantities of 1080 into waterways as control operations are planned to coincide with periods of dry weather, and some defluorination by micro-organisms on the decaying bait and in the soil around bait is probable, particularly if the baits become moist. Soil microorganisms, such as *Pseudomonas* species, (Walker and Bong 1981, King et *al*. 1994) have been shown to defluorinate sodium monofluoroacetate.

6. Conclusions

The theoretical likelihood of 1080 entering watercourses following manual application of 1080 bait is low, as baits are unlikely to enter watercourses directly.

This study has determined that, in a worst-case scenario of manual bait application, no measurable quantities of 1080 are likely to enter the watercourses.

7. Recommendations

1. That Medical Officer's of Health approvals relating to manual baiting with 1080 retain the following condition:

"All necessary and practicable steps shall be taken to prevent contamination with the controlled pesticide of all areas within 20 metres of the intakes and identifiable feeder water sources such as springs, streams, rivers, lakes, ponds, or reservoirs for drinking water supplies".

2. That the Ministry of Health accepts this study to confirm the previously assumed low risk of water contamination associated with manual baiting techniques.

3. That Medical Officer's of Health approvals relating to manual application of 1080 baits impose no conditions requiring water testing.

4. That the Ministry of Health distribute a copy of this report (or summary thereof) to all Medical Officers of Health.

5. That the Ministry of Health advises the National Possum Control Agencies Committee of any policy directives arising from this investigation.

8. Acknowledgements

The authors thank Graham Bensemann, for assistance with sample collection; Geoff Wright for sample analysis, and technical advice; John Rodgers and his operational team for applying the bait to required specifications; Matthew Morgan and Matthew Rowland for assistance with hydrological aspects, and provision of the rainfall data; and Christine Bezar for editorial assistance.

The Wellington Regional Council funded this research.

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10. Appendices

10.1. Appendix 1

Water analysis after major 1080 operations. Further water sampling and residue analyses are anticipated as part of standard operating procedures enforced by Medical Officers of Health when granting approvals for aerial 1080 operations.

Location	Date	Total number of samples taken in operation area	No. with residues	Highest concentrations (Φg/L or ppb)
Waipoua	1990	36	0	-
Rangitoto	1991	20	0	-
Blackstone Hill	1992	23	11	0.6
Mt Taranaki	1993	125	15	<0.3
Woodside	1993	55	0	-
Hunua Range	1994	136	7	0.7
Mt Taranaki	1994	63	0	-
Marlborough Sounds	1994	26	5	3.4
Wairarapa	1994	31	0	-
Hawke's Bay	1994	15	0	-
Ohakune	1994	6	1	0.2
Whangarei	1994	18	0	-
Karioi	1994	10	1	0.8
Manawatu	1994	21	0	-
Waimakariri	1995	4	1	0.2
Manawatu	1995	48	0	-
Hawke's Bay	1995	8	1	0.3
Ohakune Erua Forest	1995	3	0	-
Tongariro National Park	1995	8	0	-
Northland	1995	11	0	-
Tararua Ranges	1995	11	0	-
Hawke's Bay	1995	9	0	-
Waimarino Forest	1995	4	0	-
Wairarapa	1996	7	0	-
Pirongia	1996	7	0	-
Raukumara Ranges	1996	37	1	0.2

Waikato	1996	4	0	-
Levin Buffer	1996	8	0	-
Manganuiateao	1996	3	1	3.5
Waitohu	1996	4	0	-
Wairokau Stream	1997	4	0	-
Raukokore Stream	1997	12	0	-
Ohakune	1997	10	0	-
Pareora River, Timaru	1997	2	0	-
Rangataua Forest	1997	40	0	-
Te Whaiau Spillway	1997	3	1	2.4
Opotiki	1997	9	1	0.5
Oronui Stream	1997	12	0	-
Warawara Forest	1997	4	0	-
Mt Bruce/Mikimiki	1998	10	0	-
Kuharua Tb	1998	1	0	-
Totals		868	46	

(from Eason et al. 1999)

10.2. Appendix 2

See over.