Environment Waikato Technical Report 2002/12

Waikato and Waipa Rivers Flood Event 6-16 July 2002

Final Technical Report

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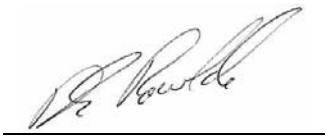
Scott Fowlds Signature  Date 22/10/2002

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Brendon Morris Signature  Date 22/10/2002

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1 Introduction

This report examines the key aspects of the **"Waikato and Waipa Rivers Flood Event of 6-16 July 2002"**. It has been produced as part of Environment Waikato's internal reporting requirements.

The report provides a comprehensive overview of the flood event that resulted in very high river levels in the western and southern parts of the region as a result of heavy and persistent rain in the six weeks prior to the main event. The opportunity has been taken to pull together a wide range of information and findings from both internal and external sources, including:

- Hydrological data (rainfall totals and river levels)
- Flood Management Strategies
- Environment Waikato (EW) Response
- Key decision points
- Performance of the Flood Warning Network and Protection Scheme
- Comparison to previous events
- Lessons learnt (opportunities for improvement)

Recommendations (where to from here) follow at the rear of the report.

2 Hydrological Information

2.1 Rainfall

Rainfall recorded in this event was not considered exceptional. It was the cumulative effect of successive north to northwest rainfall bands passing over the region in the six weeks prior to the main event that saturated soils and raised river levels above normal. The majority of the rainfall fell in the western and southern parts of the region (Table 1).

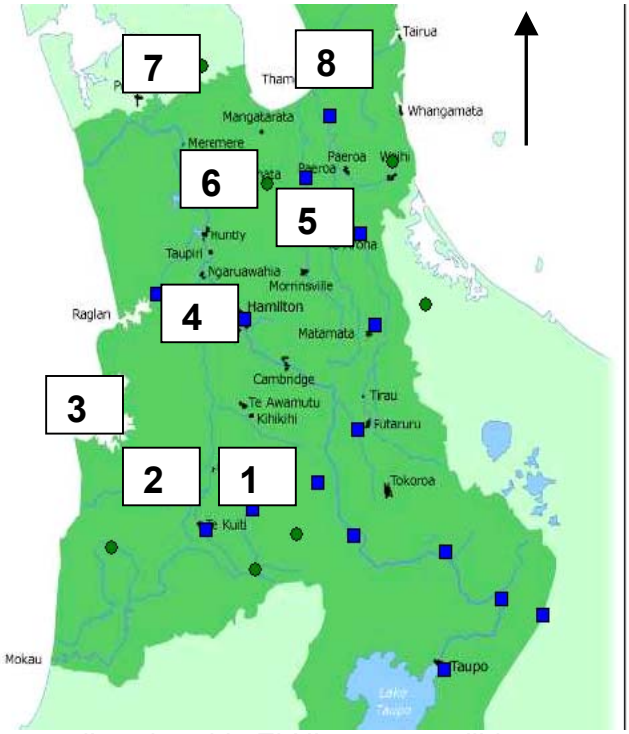
Table 1: Regional Rainfall Totals

Location (numbers correlate to map below)	Event Total 1 – 13 July	July Mean	+ / - Mean
1. Ngaroma	240 mm	225 mm	+ 7%
2. Te Kuiti	156 mm	156 mm	equal
3.Kawhia	177 mm	149 mm	+ 19%
4. Hamilton	97 mm	123 mm	- 20%
5. Te Aroha	170 mm	150 mm	+ 13%
6. Maungakawa	130 mm	153 mm	- 15%
7. Mangatangi*	225 mm	235 mm	- 4%
8. Pinnacles	306 mm	490 mm	- 37%

**90 mm of the event total was attributable to an 11th hour rainstorm (on 12 July).*

July Climate Update

According to the July climate update from NIWA, rainfall in the northern and eastern regions of the North Island was well above normal (as were river flows). Flooding occurred at Te Awamutu on 5 July, Te Kuiti and Mangakino on 8 July, and Mercer on 12 July when the Waikato River flooded farmland already saturated by weeks of wet weather.



August to October Climate Outlook

An El Nino event in the tropical Pacific is now in place, but its duration and magnitude still remain uncertain. It is likely to be much weaker than the 1997/98 episode when there was lower than normal rainfall in many east coast areas, and severe drought in some localities. At this stage it is not possible to predict what this El Nino event will have on the New Zealand climate in spring. However, rainfall is expected to be near normal over much of the country, but may be above average in eastern North Island regions (same for river flows).

2.2 Severe Weather Warnings (SWW)

Severe Weather Warnings (SWW) are released by the MetService when, in the opinion of duty forecasters, rainfall totals from approaching rainfall systems are expected to exceed certain criteria (e.g. 100mm in 24 hours).

There were over eight weather watches and/or warnings released during this event (Appendix A). They generally predicted a large area of thundery rain and showers to pass over the region from the eastern Tasman Sea and it was expected to bring further bursts of heavy rain to already saturated catchments.

Aside to the warnings, regular contact was made between Environment Waikato's Emergency Management duty officers and the lead forecasters at MetService. The Auckland weather radar was also used to full advantage so staff could pin point where the rain was falling in real time.

2.3 River Level and Flow Information

Very high river levels were sustained in the Waipa and lower Waikato Rivers over a long duration (Table 2). This was due to successive rainfall storms, saturated catchments, and already swollen river levels. The Waipa River was responsible for well over half the peak flows recorded at Ngaruawahia.

Right: The Waikato and Waipa Rivers meeting at Ngaruawahia.

Except for hampering clean up and remedial work operations associated with the Weather Bomb event (which occurred on June 21), no major problems or issues were reported on the Waihou and Waitoa Rivers - which were also above alarm in this event.

Table 2: River Level Data Summary

River	Site Name	Peak Level	Mean Level	Peak Flow (cumecs)	Return Period	+ / - 1998
Mangaokewa	Te Kuiti	52.02 m	48.67 m	100	5 – 10 yr	- 0.70 m
Waipa	Otewa	4.57 m	2.12 m	240	10 yr	- 0.58 m
	Otorohanga	33.21 m	28.74 m	380	20 – 50 yr	- 0.17 m
	Whatawhata	18.95 m	11.06 m	745	10 – 20 yr	- 0.61 m
	Puniu	13.50 m	9.56 m	180	2 - 5 yr	- 0.48 m
Waikato	Hamilton	15.32 m	12.90 m	560	5 yr	- 1.39 m
	Ngaruawahia	12.88 m	9.95 m	1170	20 yr	- 0.90 m
	Huntly	10.39 m	7.74 m	1190	20 yr	- 0.85 m
	Rangiriri	8.34 m	6.14 m	1160	20 yr	- 0.72 m
	Mercer*	5.55 m	2.58 m	1380	50 yr	- 0.60 m
Mangatangi	Lower Weir*	-	-	12	-	-
	SH2	12.65 m	-	74	-	-
Mangatawhiri	Lower Weir*	2.09 m	-	62	-	-
Waihou	Te Aroha	9.93 m	8.11 m	135	<Mean annual	- 0.78 m
Waitoa	Mellon Road	8.26 m	6.27 m	40	Mean annual	- 0.26 m

- The flow at Mercer increased from what would have been a 20 year event to that of a 50 year event due to an 11th hour rainstorm which dumped another 90 mm over the lower catchment.

* Data kindly provided by Watercare Services Limited.

3 Flood Warnings

Approximately 45 alarms were issued by Environment Waikato's flood warning system in this event. Alarms are triggered when pre-determined rainfall intensities or river levels are exceeded. The system then automatically notifies the incumbent Level 1 Emergency Management Officer (EMO) and/or external customers via pager, fax, or email. The EMO then acts according to a set of procedures as defined within the Flood Warning Procedures Manual and the Flood Rules (in consultation with MRP).

Key recipients included district councils, landowners and key agencies. The first warning was issued on Thursday 4 July, with the last one issued on Saturday 13 July. About 12 media releases (Appendix B) were issued in support of the warnings (in some cases up to three a day).

No major problems with the flood warning system were reported. However, predictions of flood peak travel times were made difficult due to continuing rainfall, long travel times and slow attenuating peaks.

4 Community Gate Operations

The Te Onetea, Lake Waikare, and the Whangamarino Control gates (Figure 1) all performed well and were opened and closed in accordance with flood management guidelines. As a general rule, the Lake Waikare (northern outlet) and Whangamarino

control gates are closed when the level of the Waikato River is greater than the water level in the Whangamarino wetland. Closing the gates is necessary to prevent backflow from the river into the wetland. Under 'normal' flow conditions, when the river level is below the wetland level, the gates remain open and natural through flow occurs between Lake Waikare, the Whangamarino and the Waikato River.

The Lake Waikare and Whangamarino gates are closed and opened in unison. However, while the Whangamarino gate is opened as soon as the river level drops below the wetland level, the Lake Waikare gates are opened and closed to control lake levels between R.L. 5.5 m and 5.65 m, depending on the season as set in a protocol. Figure 1 below shows the location of the community gates and water flow directions through the system.

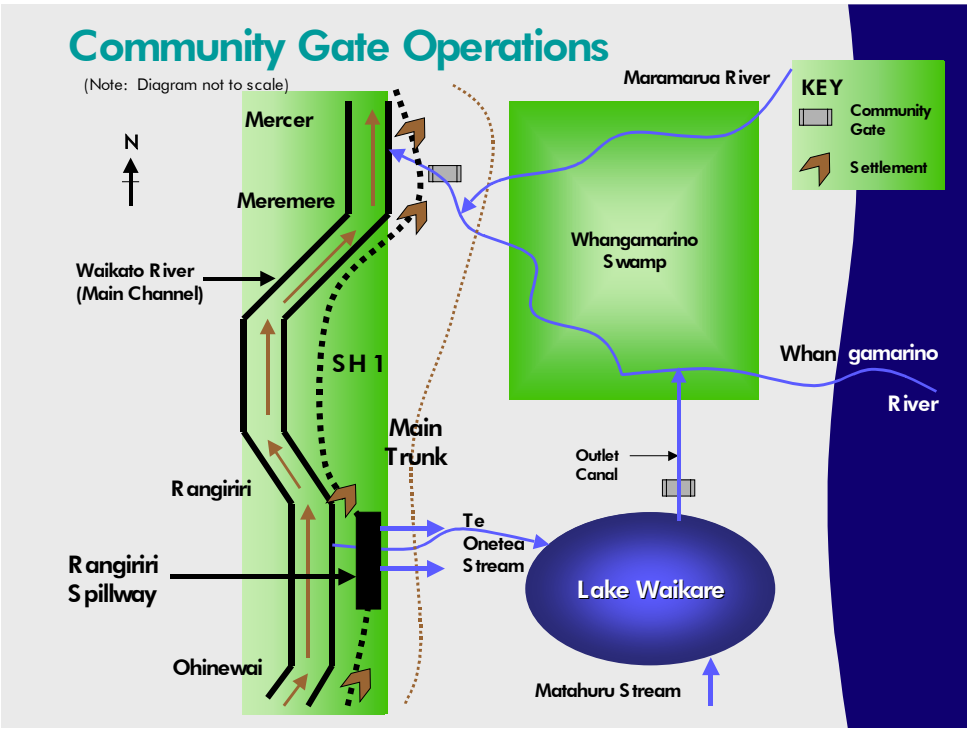


Figure 1: The location and operating design of the Lower Waikato Community Gates.

4.1 Gate Open/Closure Times

The Whangamarino Control and Lake Waikare Gates were closed on Monday 8 July and re-opened at 8am on Sunday 14 July when the Waikato River level and the Whangamarino wetland level were equal – and were continuing to fall. The Te Onetea Gate closed automatically on Saturday 6 July when the Waikato River level exceeded 7.0 metres (RL). It didn't re-open until Tuesday 30 July when the level of Lake Waikare stabilised (that is, its level was consistently below the Waikato River level at Rangiriri).

The Rangiriri spillway did not operate in this event (although the Waikato River level came to within 0.4 m of its operating level of 8.81 m). The spillway was therefore closely monitored by the roading authorities due to adjacent road works associated with the construction of the Waikato Expressway.

5 The Waikato Hydro System

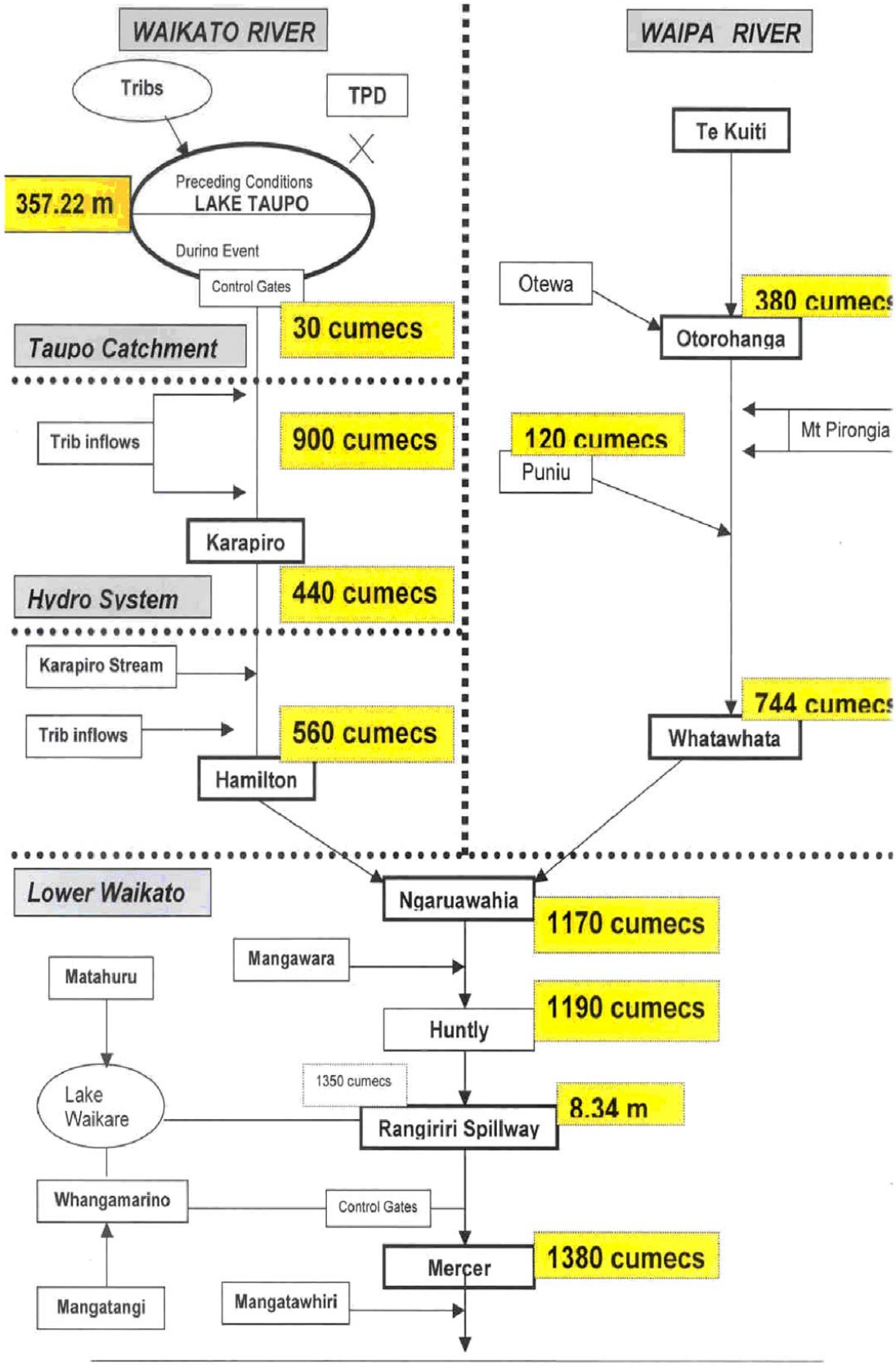
The Waikato River is the longest river in New Zealand (425 km) and drains about 14,250 km^2 of catchment over the central parts of the North Island. Mighty River Power (MRP) owns and operates the Waikato hydro system for the purposes of generating

electricity. The Waikato hydro system consists of the Taupo control gates, eight hydro dams, and nine power stations.

Lake Taupo represents the main storage facility for the system. The Taupo control gates regulate the flow of water down the Waikato River, allowing water to be stored in the lake and released down the river to meet generation requirements and/or for flood management purposes. In this event, Environment Waikato and Mighty River Power (MRP) worked together daily to ensure that (on balance) lake levels and river flows were minimised as much as possible over the entire catchment.

The following schematic depicts an overview of the Waikato/Waipa catchments between Lake Taupo and Mercer, including the operational components of the hydro system and the Lower Waikato Waipa Control Scheme. Peak flows recorded during this event are also presented.

Peak Flows: Waikato/Waipa Flood Event



5.1 Lake Taupo Management

Immediately prior to the flood event (5 July), the level of Lake Taupo was 356.95 m or 30 cm below the winter maximum control level (MCL) of 357.25m. As a result of sustained rainfall and high inflows, the lake rose 27 cm to peak at 357.22m on 9 July (still 3cm below the winter MCL). It remained at the peak level until 5.00am on 11 July before slowly receding. It took another 16 days (until 27 July) for the lake to reach its pre-event level of 356.95m.

The Tongariro Power Development Diversions (TPD), which are owned and operated by Genesis, were turned out on Monday 8 July when Lake Taupo was expected to reach or exceed the winter MCL of 357.25m. This decision was also based on continued high inflows into the lake and forecasts of more rain. Partial reinstatement occurred on Friday 12 July when the western diversions were permitted back in with the situation improving. Full reinstatement occurred on Saturday 13 July when it was deemed that the risk of exceeding the MCL was insignificant. This decision was based on falling inflows, clearing weather, and the passing through of the flood peaks in the lower Waikato.

As a side note, the Tongariro Offset Works Agreement of 1977 requires Genesis to cease diverting foreign water from the Moawhanga, Whangaehu, and Whanganui River catchments when the level of Lake Taupo is expected to reach or exceed the MCL of 357.25m.

The following table summarises the outflow regime from Lake Taupo for this event.

Date	Taupo outflows (in cumecs)	EW Requests	Rainfall (Kiko Rd)
1 July	100	-	10 mm
2-5 July	290 (maximum		70 mm
6 July	70		30 mm
6-7 July	50		64 mm
7-8 July	100		14 mm
8 July	50	Reduce outflows to 50 cumecs Cease TPD diversions (12.00pm)	
9 July	200		4 mm
9-10 July	130		0 mm
12 July	290?	TPD western diversion reinstated	1 mm
13 July	290?	TPD diversions fully reinstated	0 mm

5.2 Karapiro Outflows

In the week leading up to the flood event (1-6 July), Karapiro outflows fluctuated between 200 and 440 cumecs, while inflows between Taupo and Karapiro increased from about 430 cumecs to peak at about 880 cumecs on 8 July (Figure 2). However, in spite of the huge increase in inflows, Karapiro outflows remained steady on 440 cumecs (maximum generation) for the three days between 6-9 July indicating that the hydro-dam system had absorbed a significant amount of floodwaters in this event (Figure 2). Rainfall totals in the dam system ranged between 70 and 160 mm, with most falling between 4-8 July. Tributary inflows between Karapiro and Hamilton averaged about 100 cumecs.

On 8 July, a request was made by Environment Waikato to MRP to reduce the outflows at Karapiro to about 350 cumecs for 12 hours to allow the Waipa River peak to pass through relatively unimpeded.

On 11 July, the Karapiro diversion tunnel was briefly operated for the purposes of real time testing, and to provide storage in the hydro dams with further rain forecasted. The tunnel has a maximum capacity between 50 and 300 cumecs (at 60% opening).

The following table summarises the outflow regime from Karapiro for this event.

Date	Karapiro outflows (in cumecs)	EW Requests
1-6 July	200 - 400	
6-9 July	440 (max. generation)	
9- July	350	Karapiro outflows reduced to 350 cumecs (Aim: to accommodate the Waipa peak)
11 July	500	Karapiro outflows increased to 500 cumecs
		(Aim: to increase storage capacities in the dams in light of more rain being forecasted)

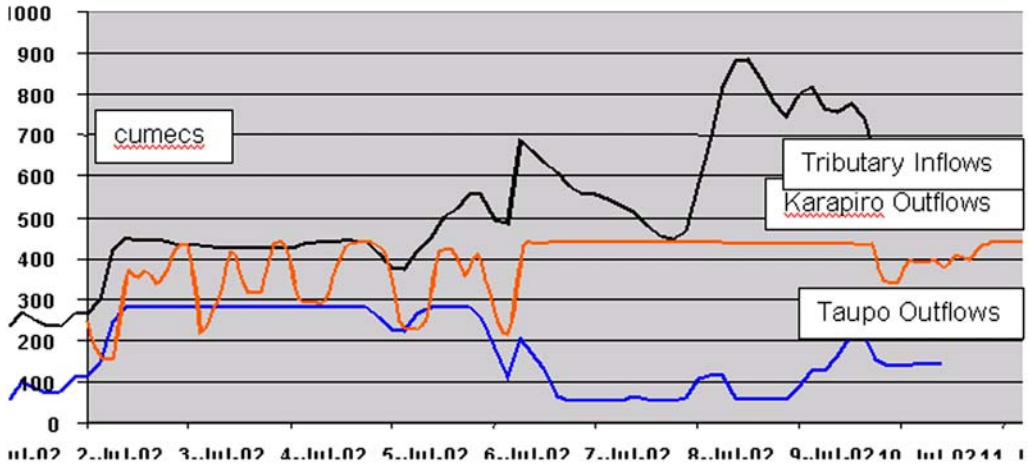


Figure 2: Inflow and ouflow sequences recorded between Taupo and Lake Karapiro.

6 Flood Management Strategies Adopted

This flood event was managed in terms of Environment Waikato's legislative responsibilities, and in terms of established procedural documents and agreements with other agencies. Of particular importance on the Waikato River are the Flood Rules that provide agreement with MRP for the management and use of the hydro dam network to minimise downstream flooding. Preliminary assessments indicate that this management resulted in a reduction of flood flows in the lower Waikato by up to 200-300 cumecs.

The key objective (by utilising the hydro system as a flood management tool) was to minimise flooding throughout the Waikato System, particularly at Lake Taupo, Hamilton, Ngaruawahia (to avoid the Waipa peak clashing with the Waikato peak) and the lower Waikato. In determining the most appropriate strategy at the time, factors such as catchment wetness, weather forecast, tributary inflows, river flows, and flood risks all had to be taken into account. A decision matrix (Appendix C) was devised for

the TPD diversions as a guideline to determine when the diversions could be reinstated (either partially or fully).

The Waikato and Waipa Rivers are renowned for their slow travel times and long durational peaks that can take days or weeks to run through the system. This can leave the catchment exposed to post-event rainfall episodes that can compound the effects, especially if the rainfall concentrates itself on the area where the primary flood wave is currently passing through. This situation did in fact occur at Mercer towards the tail-end of this event (Table 2, Figure 3).

Staff had the above scenario in mind when turning down a recommendation to open the Whangamarino Community Gate to allow some of the Waikato River flood peak to flow into the Whangamarino swamp (with the aim of lowering levels at Mercer). After much deliberation and technical analysis, it was decided to keep the gate closed on the basis that:

- Downstream farmland would have been inundated anyway.
- The reduction in river level peaks would have been minimal, and
- More farmland (adjacent to the Whangamarino Swamp) would have been placed at risk from flooding if further rainfall eventuated – which did indeed occur.

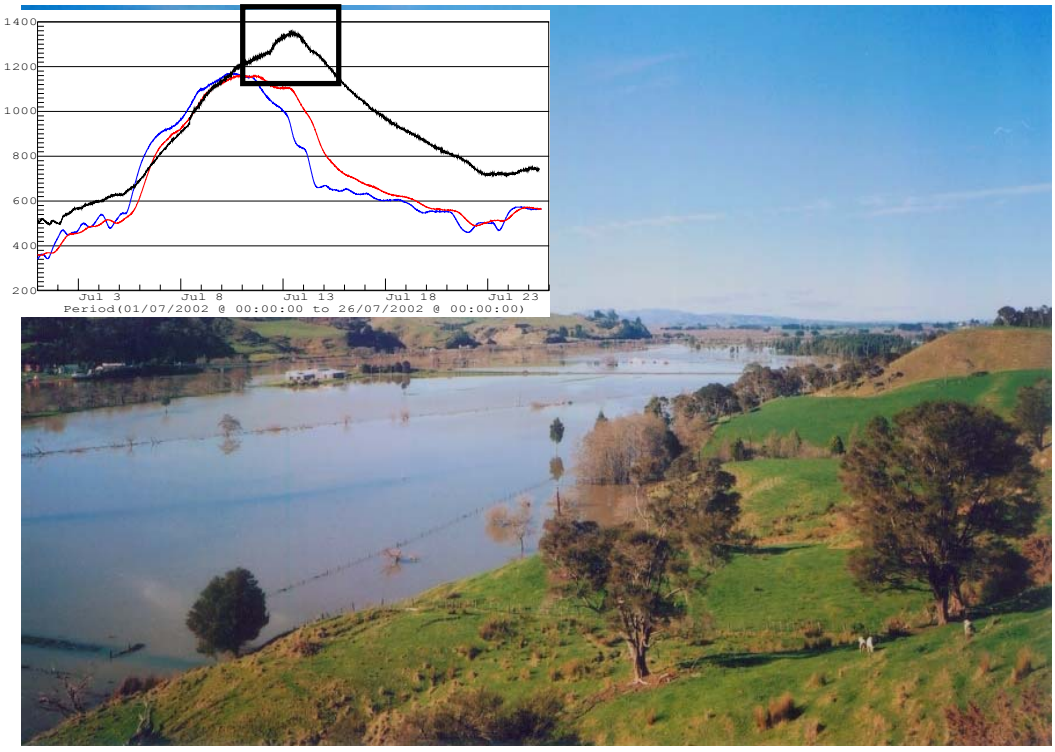


Figure 3: Flooded farmland at Mercer. Inset: Waikato River levels recorded at Ngaruawahia, Rangiriri and Mercer (bottom to top respectively). The 'box' indicates the effect of a last minute rainstorm which coincided with the primary peak.

7 Environment Waikato's Response

Key aspects of Environment Waikato's response include:

- A Flood Operations Centre which was activated for over a week (24 hrs/day in the early stages of the event). It was staffed predominantly by Emergency Management Duty Officers, administrators, hydrologists, engineers, and executive managers.

- Flood gaugings were undertaken at key sites to confirm flow estimates
- An aerial reconnaissance was undertaken to assess extent of flooding and to take photographs of the main Waikato/Waipa river channels from Whatawhata to Mercer
- The Lower Waikato River hydraulic Model was activated and the opportunity was presented to calibrate it against “real time flood data”
- Provision of information and advice to customers and key stakeholders (also responded to inquiries on site)
- Inspected and monitored scheme assets
- Initiated emergency works (e.g. sand bagging, temporary erosion control, earthworks etc)
- Analysed information (including peak water levels, inflows, weather forecasts, and model outputs).

8 Flood Scheme Performance

8.1 Background

The flows at Ngaruawahia in this event exceeded the 20-year return period, while flows at Mercer reached the 50-year event. In Te Kuiti, the Mangaokewa stream flow peaked at 100 m^3/sec which was more than a 10-year event. The Waipa River peak flow at Otorohanga was 380 m^3/sec, which also exceeded a 10-year event.

During the event, Environment Waikato staff, as well as District Council staff, were monitoring the development of the flood and inspecting the works and assets to ensure that the integrity of the assets is intact and assess the performance of the assets during the event.

8.2 The Scheme Design

The Lower Waikato Waipa Control Scheme incorporates stopbanks, floodgates, pump stations, channel excavations and works to provide different levels of protection within Te Kuiti, Otorohanga, Huntly, the Mangawara Valley, Lower Waikato River from Huntly to Rangiriri, Rangiriri to Maioro Bay, the Mangatawhiri Valley and flood storage zones around Lake Waikare and the Whangamarino wetland. The works are designed to provide the following levels of protection:

a. Te Kuiti – The Mangaokewa channel works provide a 50-year event protection within the township, with 300-mm of freeboard.
b. Otorohanga – The scheme works include channel works, stopbanks, pump stations and gravity outlets designed to accommodated a 100-year flood, with 600-mm of freeboard.
c. Huntly – The Scheme works include channel works, stopbanks, pump stations and gravity outlets designed to accommodated a 100-year flood, with 600-mm of freeboard.
d. Mangawara Valley - The Scheme works include channel works, stopbanks, pump stations and gravity outlets designed to accommodated a 50-year flood, with 300-mm of freeboard.
e. Huntly to Rangiriri - The Scheme works include channel works, stopbanks, pump stations and gravity outlets designed to accommodated a 100-year flood, with 300-mm of freeboard.

f. Rangiriri to Maioro Bay - The Scheme works include channel works, stopbanks, pump stations and gravity outlets designed to accommodated a 20-year flood, with 600-mm of freeboard. Within this reach, the Meremere east and Te Kohanga Major and the whole delta reach (Elbow to Maioro Bay) compartments are designed for a 100-year event with 300-mm of freeboard.
g. Mangatawhiri Valley - The Scheme works include channel works, stopbanks, pump stations and gravity outlets designed to accommodated a 20-year flood, with 150-mm to 450mm of freeboard. Compartment 1 of this scheme is designed to be overtopped in a 7-year event.
h. Flood Storage Zones – Two areas are designated as flood storage zones, where flows are controlled by control gates, namely the Waikare Gate and the Whangamarino Gates. Some of the farmland adjacent to these areas are protected by stopbanks, pumps and floodgates up to a 100-year flood event with 300-mm to 600-mm of freeboard.

8.3 River and Protection Scheme Performance

In the upper/middle reaches of the Waikato River (between Cambridge and Hamilton) the river channel performed well with no major issues being reported.

The flood event was lower than the design standard for all areas above Rangiriri and around the flood storage zones. It was also below the design standards for the Meremere East, Te Kohanga and the Delta Reach compartments. The following structures did not perform as designed due to maintenance issues:

- Huntly North Kimihia section – Gun Club- Floodgate leaking, Main Floodgate-gates did not close and Pump outlet undermined. Also, the drainage stopbank needs to be upgraded.
- Wool Scourer to Foster Landing section- Ohinewai Landing – Floodgate no.2, gate did not close.
- Wool Scourer to Foster Landing section- Propane Gas site- Floodgate no. 5 , gate did not close.
- Tickles Compartment- Ponding due to seepage and landowner preference not to operate the pump.
- Minor seepage within Huntly West compartment. This is expected during such events, as the stopbanks sit on deep sand foundations.

Between Rangiriri and the Elbow, the event was just above the design event, but within the freeboard levels.

- Waikokowai- Harvey's Compartment – Pump failed to operate, causing ponding.
- Deroles – Erosion of return bank due to wave action on Lake Whangape (Figure 4).
- Morrison Road- Main Floodgate was overtopped, causing erosion of the fill material.
- Miller Farlane- Pump not efficient- emergency pumps were used.
- Minor seepage within Meremere West and Churchill East compartments. These are normal and expected processes during flood events since the stopbanks rest on deep sand foundations.

Figure 4: Erosion prevention works being installed on the Deroles stopbank, which was damaged from wave effects.

Mangawara Valley – the event was smaller than the design event and the scheme performed to standards with no ponding recorded.

Mangatawhiri – the event was more the design event for compartment 1, but smaller than the design standard for compartments 2, 3 and 4.

- Compartment 1- Overtopped, the event was above the design event.
- Compartment 3- Pumps not efficient, and duty pump is under maintenance, emergency pumps were used.
- Compartment 4- Pump failed during the event, due to maintenance issues.
- Compartment 4- Contour Drain Stopbank- Overtopped and washed away due to settlement and lack of drain and stopbank maintenance.

Due to the overwhelming nature of the flood event in this area, Environment Waikato assisted Franklin District Council by providing staff support, advice, and organising the deployment of temporary flood pump to worst hit areas.

Flood Storage Zones – the event was smaller than the design event.

- Bell Road- Minor leakage through floodgate.

8.4 Flood Profiles

Flood profiles of the Waikato & Waipa Rivers were taken in the 1998 and 2002 flood events (both in July). There are presented in Appendix D.

8.4.1 Flood Event 1998

Because the 1998 flood event was significant, the flood profiles were extended to cover the full reach from Karapiro to the Delta area and on the Waipa River between Ngaruawahia and Te Kuiti.

Pegging of the flood was undertaken at various stages:

Karapiro to Ngaruawahia	pegged from debris levels 1 month after the event
Ngaruawahia to Delta	pegged during the flood event
Te Kuiti to Ngaruawahia	pegged from debris levels 1 month from the event

8.4.2 Flood Event 2002

Mangawara confluence to Delta	pegged during the flood event

8.4.3 Performance

The 2002 flood profile is closely aligned with the 1140 cumec design profile that was reviewed in 1982.

8.4.4 Comments

The 2002 peak flows on the Waipa River at Whatawhata and on the Waikato River at Hamilton and Ngaruawahia were generally lower than the 1998 peak flows (60, 225, 300 cumecs respectively).

Lower flows in the Waikato River during the 2002 event (resulting from inflows being held back in the hydro lakes) meant that Waipa River floodwaters were able to pass directly into the Waikato River relatively unimpeded (as backwater effects were not evident). See Section 5.2 for more details.

8.5 Remedial Works

The following remedial works are necessary to ensure that the scheme will continue to perform to its design standards:

8.5.1 Waikato District Assets

Waikato District Council is responsible for the maintenance and management of the pump stations and floodgates within the Council's boundaries. The assets, which require immediate maintenance and/or refurbishment are the floodgates at Kimihia, gun club, Propane Gas site and Ohinewai landing. The pumpstation outlet pipes and headwall, and stopbank for Kimihia scheme need renewal. The performance of Harvey's pump needs to be assessed, before any work is done. Environment Waikato will audit this pump as part of the structures audit programme this year, and the results will be provided to the District Council to undertake the necessary actions.

Waikato District has since replaced the flap of the floodgate at Ohinewai landing.

8.5.2 Franklin District Assets

Franklin District Council is responsible for the stopbanks, floodgates and pump stations within the Council'' boundaries. The assets, which require immediate maintenance and/or renewal are the pump stations of the Mangatawhiri compartments 3 and 4 and the Miller Farlane compartment. These pumps were audited in June 2002 and the reports will be sent to the District Council for action. Renewal of the Contour Drain stopbank is required and should be undertaken during the summer season.

Franklin District have undertaken emergency remedial works to reinstate the Contour Drain stopbank during the event.

8.5.3 Environment Waikato Assets

Environment Waikato's assets, which require maintenance, are the Deroles return stopbank and the Morrison Road main floodgate embankment.

8.6 Costs and Funding

Initial estimate of the remedial works required is as follows:

Waikato District Council:		
Floodgates	$15,000	Replacement and maintenance
Kimihia pump	$10,000	Outlet pipe and headwall
Kimihia stopbank	$10,000	Topping to design level
Harvey's Pump	$15,000	Refurbishment
Franklin District Council		
Compartment 3 Pump	$20,000	Refurbishment
Compartment 4 Pump	$15,000	Refurbishment
Millar Farlane Pump	$10,000	Refurbishment
Contour Drain Stopbank	$55,000	Renewal.
Environment Waikato		
Deroles Stopbank	$10,000	Ballast for seepage control
Morrison Road Floodgate	$5,000	Erosion protection.
TOTAL	**$165,000**	

The remedial works are generally minor in nature and the current funding for maintenance and capital replacement under Project Watershed allows sufficient funds for these works. Most of these works were actually due to maintenance issues and should have been undertaken anyway. The flood event has highlighted the need for the maintenance and upgrading of the assets concerned.

The erosion at Morrison Road Floodgate, Deroles Stopbank, Kimihia pump outlet and the Mangatawhiri Contour Drain Stopbank can be considered as actual flood damage. Therefore, **the flood damage cost is approximately $80,000** not including the costs of actual works during the event (approximately $25,000) and losses in farm productivity.

8.7 Approximate Areas Inundated

The Lower Waikato area affected by the flood includes the unprotected land and a small part of the protected land, which was flooded due the reasons explained above. The approximate areas of inundated land during the event were as follows:

River Channels	2,500 ha
Wetlands	10,500 ha
Lakes	4,500 ha
Productive Farmland (Lower Waikato)	700 ha
Productive Farmland (Waipa)	~3500 ha
TOTAL	**21,700 ha**

(Note: about 40,000 ha were flooded in the 1998 event)

8.8 Summary of River and Protection Scheme Performance

- The flood event of 6-16 July 2002 was generally lower than the design flood of the Lower Waikato Waipa Control Scheme. It has been assessed as being a 20 – 50 year return period event.

- The Waikato River channel (outside the scheme area) performed very well by accommodating high flows over a long duration

- The Scheme performed to its design standard, with minor areas not performing adequately due to maintenance issues in some elements of the scheme.

- The most affected areas were the Mangatawhiri scheme and unprotected flood plains.

- The scheme flood damage costs are estimated at $80,000, excluding emergency works undertaken during the event, and losses to farm productivity.

- The assets requiring maintenance and/or upgrade were identified and should be refurbished during this year.

- Project Watershed funding provisions are adequate to carryout these works.

8.9 Operational Improvements

8.9.1 Flood Warning Network Review

Telemetered monitoring systems are normally a compromise between being installed at a sufficient density to meet the needs of an organisation for real time monitoring data and the financial and technical resources the organisation can afford to install, operate and maintain the monitoring systems.

The Environment Waikato telemetry network is classed as a medium density network that is supplemented with data from power companies and MetService stations.

The siting of rain gauges normally tends to be in the headwaters of catchments so that maximum warning time of heavy rainfall events is given. Water level recorders are normally sited on the main stem of a river system, its main tributaries, major flood storage areas such as lakes and wetlands and low lying and coastal areas.

Whether a network has too many or not enough stations is normally determined after some years of operational experience. Changing circumstances such as better flood protection in an area may negate the need for information on flood levels or conversely, land use changes may require a greater level of information on water levels.

8.9.2 Comments by area

8.9.2.1 Taupo Basin

Historically, flood events in the Taupo Basin that impact on the Waikato River as a whole has largely been monitored by obtaining information from power companies (particularly inflows and outflows at Lake Taupo). Recently, however, there has been an expectation from communities to provide more detailed local flood event information that cannot be provided from EW's existing network.

Rainfall stations
The EW network is sparse in this area but with the recent addition of rainfall information from Genesis Power in the Tongariro River catchment it will be possible to obtain a better assessment of rainfall. Tapping into rainfall stations operated by NIWA in the Taupo and surrounding districts will also be considered.

The existing rain gauge network could be supplemented with additional stations but they are generally expensive to install and maintain in this area and the cost is unlikely to be justified given the availability of the Genesis Power data and the existing NIWA network.

River level stations
EW has only one water level station in this area but this data will be supplemented by Genesis Power data from it's Tongariro River water level stations. However, the water level information provided mainly provides broad brush information on inflows to Lake Taupo and is not sufficiently detailed to provide site specific local information with the exception of the Tauranga Taupo River.

It is unlikely that EW would want to intensify its Taupo Basin network to try and provide site-specific information due to the high installation and operational costs.

8.9.2.2 Waipa/ Awakino

Rainfall stations
The rainfall information provided by rain gauges sited in the headwaters of the Waipa and Awakino Rivers generally provides adequate warning of heavy rainfall events. However, with a recent trend towards high intensity/duration rainfall events in the lowland areas of the Waipa Catchment which are not monitored at present, the installation of a rain gauge in the Te Awamutu area may be warranted.

River level stations
The water level information provided stations on the Waipa and Awakino Rivers provides adequate warning of flood events. However, a lack of a station in the Pirongia area has presented difficulties when trying to estimate the time of travel for a flood wave to pass from Otorohanga to Whatawhata. There have been calls by technical staff to have the station at Pirongia re-instated but it would be necessary to examine the cost/ benefit of doing this. Alternative options such as modelling will be considered.

8.9.2.3 Upper/Middle Waikato

Rainfall stations
The EW rainfall network in this area is sparse. However, there is an increased expectation from the public and local councils for more specific real time rainfall data due to more-frequent high intensity/duration events that have an impact on local drainage systems and smaller Waikato/Waihou River tributaries.

The requirement for lowland rainfall information can be relatively easily met by adding rainfall sensors to existing water level recorder installations particularly in the vicinity of Putaruru, Tirau, and Tokoroa.

River level stations
Due to the incised nature of the Waikato River in this area, no river level recorders are required. However, some of the major tributaries are monitored by Mighty River Power for the purpose of hydro generation (such as the Pokaiwhenua, Waipapa, and Mangakino Streams). There may be an opportunity for Environment Waikato to "tap" into this network. For the purpose of monitoring low flow and water quality, Environment Waikato has an existing recorder on the Oraka Stream near Putaruru and it may be feasible to install telemetry equipment at this site.

8.9.2.4 Lower Waikato.

Rainfall
The EW rainfall network in this area is also sparse but this does not seem to have presented any great technical difficulties when warning of or monitoring flood events. However, there is an increased expectation from the public for more specific real time rainfall data due more-frequent high intensity/duration events - which have a strong impact on local drainage systems and smaller Waikato River tributaries.

The requirement for lowland rainfall information can be relatively easily met by adding rainfall sensors to existing water level recorder installations particularly in the Mercer and Mangawara areas.

Editor's Note: a rainfall gauge in the Mercer area is currently being installed.

River level stations
Generally, the monitoring network in this area provides adequate information but a requirement for site specific water level data at Mercer may require the installation of an additional water level station in the area of the Mercer Bridge. The present method of monitoring the Waikato River level from a recorder at the Whangamarino Control Structure cannot provide the precise water level information required by landowners in the Mercer area. This is due to the differential water level gradients that occur between the Control Structure and Mercer that are dependent upon relative hydraulic conditions at the time.

The Huntly recorder needs relocation to ensure it can monitor the highest flood levels as the present Genesis Power site is under threat of inundation when river levels approach the 1998 flood levels.

Discussions are also taking place with Watercare Services Limited to provide flood warnings on the Mangatawhiri Dam (similar to recently implemented arrangements on the Mangatangi Dam).

8.9.2.5 Other proposed enhancements

Predictive modelling
The existing time series software used by Environmental Modelling has a modelling module available. This module, once calibrated at an estimated cost of $30,000 could generate predicted levels and flows for the lower reaches of rivers in the Waikato Region. Normally models use rainfall data to start with to predict levels/flows and then adapt the predictions using actual flow data as it occurs in the river system.

Whangamarino Gate operation
The Hydrotel system can generate an alarm when water levels in the Waikato River and Whangamarino River approach the same level in either a rising or falling mode to alert duty staff to the need to operate the Whanagamarino Control Gate. It is suggested that a 50mm trigger gap be used to give staff time to make arrangements to operate the gate.

GIS "smart maps"
GIS smart maps that indicate areas that are inundated at certain river levels could be linked in with the telemetry system. Presently this type of information is held in manuals or obtained verbally from various staff.

Flood Operations Room
It is intended to use an asset management office as a technical control room. It is essential to have reliable computing equipment configured with Hydrol, Hydrotel, Email/Internet and access to phones and fax. Summary flood data can be transferred to the Waikato room as necessary.

Editor's Note: this office is now fully operational.

SCADA (Flood pumps)
Investigate moving communication links for flood pump SCADA to cell phones to free up telemetry radio link that carries a heavy data traffic load during flood events.

Updating the Flood Manual
A major review of the Flood Warning Procedures Manual will be undertaken, including:

- Updating contact and ringing lists, return periods, and flood wave travel times, and alarm configurations
- Confirming notification procedures
- Determining extent of flooding (high risk areas)
- Inserting catchment maps to provide an overview of the flood warning network and key protection features (for easy reference during an event)
- Confirm local arrangements, and

- Link to other documents (such as the flood rules).

Other suggestions received include:

1. Clarifying the 0832 Infolines instructions

2. Removal of references to section numbers in the flood manual (a tie-over from the old manual)

3. Putting additional sites (such as Tauranga-Taupo rainfall) on the EW Internet page

4. Removing references to old terminology such as Flood Condition A etc

5. Combine the Waipa/Waikato warning stations in the manual for easy reference (to enable staff to follow them as go through the system)

6. Use a SITREP (flow diagram) for all catchments so it can be easily marked up every couple of hours. It provides an immediate overview (snapshot) of flows etc over the total system.

9 Summary of Impacts

The event resulted in the following impacts/effects being reported:

- Flooding of farmland adjacent to the Waipa River fringes. Note - Otorohanga District Council has sent in an application for funding/consent for works where the flood has affected or increased the vulnerability of their roads.

- Flooding of unprotected land in the Lower Waikato (including Lake Whangape).

- Localised ponding occurred in Huntly (particularly in Parry Street).

- The lower Waikato area affected includes unprotected land and a small part of protected land, which was flooded due to pump failures, erosion, and seepage.

- Approximate areas inundated were:

River channels	2,500 ha
Wetlands	10,500 ha
Lakes	4,500 ha
Farmland	~4,200 ha
Total	**21,700 ha**

- Total cost of damage = $80,000 (this excludes $25,000 spent during the event for emergency works and losses to productivity on unprotected farmland).

- Most issues raised related to the flood scheme (e.g. overtopping of the Mangatawhiri low standard stopbanks and a number of pump/flood gate operational problems).

10 Local Initiatives

To keep residents informed of the developing situation, the Waikato District Council produced a phamplet for each household covering the following aspects:

- District council staff were in their area to monitor river levels and ponded areas

- Any damage would be repaired as soon as possible

- Latest peak predictions and weather forecast

- Recommending residents to peg peak water heights for later surveying

- Advising residents to notify the council if water rises to within 500mm of their foundations or if they face danger by being cut off by the flood waters, and

- Appropriate contact details.

11 Where to from here

To ensure Environment Waikato progressively improves its performance in responding to flood events, the organisation has identified the following initiatives:

- Collate and file information (e.g. rainfall and river levels, damage, costs, log entries, SITREPs, etc)

- Produce a final technical report to trap lessons learnt, suggestions for operational improvements, basis for actions taken, and rationale behind key decisions (this report)

- Review the flood warning telemetry network, including:
  - Effectiveness of existing coverage
  - Identify gaps
  - Manually switching the system into Alert Mode upon release of severe weather warning so data can be updated (refreshed) more regularly in the early stages of the event

- Review the Waikato Flood Rules (with MRP)

- Convene a regional technical debrief with key agencies on Friday 26 July to :
  - Explain the flood response strategies adopted while outlining the flood scheme components
  - Receive and collate information from other agencies involved
  - Obtain an overall impression on how the event was managed
  - Trap lessons learnt and experience gained
  - Identify actions for improvement

- Undertake and complete remedial works (flood damage repairs)

- Investigate the potential impact of climate change on the frequency and magnitude of flood events

- Implement Project Watershed and scheme maintenance programmes.

12 Summary and Conclusions

The July 2002 Waikato/Waipa Flood event was a significant event, but it wasn't the biggest that could be experienced. It has generally been assessed at being a 20 year return period event (except for Mercer which increased to a 50 year event due to an 11^{th} hour rainstorm). Peak river levels were (on average) about 0.70 m below the 1998 flood levels (the last major event recorded).

Throughout the event, Environment Waikato provided widespread communication of flood information, liaison with key agencies, engineering advice and support, and the carrying out of immediate emergency works.

This flood event resulted from:

- Successive northwesterly rainfall bands passing over the region six weeks prior to the main event
- Saturated catchments
- Already swollen river levels
- Steady rainfall between 4 and 8 July
- An 11th hour rainstorm in the lower Waikato which coincided with the primary peak passing through the area

Key points that can be taken from this event are:

- The flood warning system performed exceptionally well with no major problems being reported (most alarms reached their intended recipients with minimal delay)
- Tactics and strategies adopted during the event (in consultation with MRP and district councils) generally met their targets
- Local and national media interest was high throughout the event (with staff being interviewed daily by TV networks, radio stations, and newspapers)
- This event was generally lower than the flood scheme design
- The river channel and protection scheme performed to design standard, with some areas under performing due to maintenance issues (these are being addressed)
- The worst affected areas were the Mangatawhiri scheme, unprotected flood plains near Mercer, and farmland adjacent to the Waipa River
- The assets requiring maintenance and/or upgrade were identified and should be refurbished later this year. Project Watershed funding provisions are adequate to carry out these works within present annual budgets
- Staff have received very positive feedback from external agencies involved in the event

Appendix A: Severe Weather Warnings

Issue 1: 6:00pm 7 July

URGENT - IMMEDIATE BROADCAST IN:
WAIKATO WAITOMO TAUMARUNUI TAUPO TAIHAPE TARANAKI

ANOTHER BURST OF HEAVY RAIN LIKELY ABOUT THE CENTRAL NORTH ISLAND HIGH COUNTRY AND TARANAKI

A large area of thundery rain and showers lies in the eastern Tasman Sea, and MetService expects it to bring another burst of heavy rain to saturated catchments of the central North Island overnight Sunday/Monday. Residents of the area between Te Kuiti, Taupo, and Raetihi are warned to expect 50 to 70mm of rain in the 14 hour period from 7pm Sunday and 9am Monday. Heavy rain is also expected to affect Mt Taranaki.

There may be a further burst later Monday.

MORE DETAILED INFORMATION FOR EMERGENCY MANAGERS AND TECHNICAL USERS FOLLOWS:

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HEAVY RAIN WARNING
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AREA/S AFFECTED: THE CENTRAL NORTH ISLAND HILL COUNTRY BETWEEN TE KUITI, TAUPO,AND RAETIHI, ALSO MT TARANAKI

FORECAST

THE CENTRAL NORTH ISLAND HILL COUNTRY BETWEEN TE KUITI, TAUPO, AND RAETIHI

In the 14 hours from 7pm Sunday to 9am Monday, expect a further 50 to 70mm of rain. Intensities may reach 15mm per hour in thunderstorms. There may be another burst of heavy rain Monday evening.

Issue 2: 7:34am on 8 July

URGENT - IMMEDIATE BROADCAST IN:
WAIKATO WAITOMO TAUPO TAUMARUNUI TARANAKI

SEVERE WEATHER WARNING

SOME FURTHER HEAVY RAIN POSSIBLE FOR PARTS OF CENTRAL NORTH ISLAND

The sodden parts of the central North Island are expected to receive further rain today, and some heavy falls are likely. MetService is warning that in the 15 hours from 9am to midnight Monday, another 30 to 50mm is likely in the hill country between Te Kuiti,Taupo, and Raetihi. Not much rain has occurred on Mt Taranaki, and although there may be some heavy falls during the day, amounts are not expected to reach warning criteria.

MORE DETAILED INFORMATION FOR EMERGENCY MANAGERS AND TECHNICAL USERS FOLLOWS:

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HEAVY RAIN WARNING
==========

AREA/S AFFECTED: THE CENTRAL NORTH ISLAND HILL COUNTRY BETWEEN TE KUITI, TAUPO,AND RAETIHI

FORECAST:

In the 15 hours from 9am to midnight Monday, expect another 30 to 50mm rain.Intensities may reach 10 to 15 mm per hour in a few thunderstorms.

Issue 3: 4:22pm on 8 July

URGENT - IMMEDIATE BROADCAST IN:
WAIKATO WAITOMO TAUMARUNUI TAUPO

SEVERE WEATHER WARNING

RISK OF HEAVY DOWNPOURS IN CENTRAL NORTH ISLAND HAS NOW EASED

MetService advises that the warning of heavy rain about the central North Island hill counry between Te Kuiti, Taupo and Raetihi has now been lifted. Any further showers in this area are now expected to be light.

MORE DETAILED INFORMATION FOR EMERGENCY MANAGERS AND TECHNICAL USERS FOLLOWS:

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WARNINGS NO LONGER IN FORCE
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HEAVY RAIN WARNINGS HAVE BEEN LIFTED FOR:

THE CENTRAL NORTH ISLAND HILL COUNTRY BETWEEN TE KUITI, TAUPO AND REATIHI.

NO FURTHER WARNINGS WILL BE ISSUED FOR THIS EVENT FOR THE ABOVE AREAS.

Issue 4: 9.02am on 11 July

URGENT - IMMEDIATE BROADCAST IN:
WAIKATO BAY OF PLENTY

SEVERE WEATHER WARNING

HEAVY RAIN EXPECTED FOR COROMANDEL PENINSULA AND THE KAIMAI RANGES

Rain is expected to set in tonight as northeast winds pickup, and will probably not ease to showers until Friday afternoon. A total of about 75mm is likely.

MORE DETAILED INFORMATION FOR EMERGENCY MANAGERS AND TECHNICAL USERS FOLLOWS:

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HEAVY RAIN WARNING
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AREA/S AFFECTED: COROMANDEL PENINSULA AND KAIMAI RANGES

FORECAST:

Showers are expected to turn to rain this evening. In the 12 to 15 hours from about 11pm Thursday, 75mm is expected peaking at 10 to 15mm/hr on Friday morning.

Issue 5: 12.24pm on 11 July

URGENT - IMMEDIATE BROADCAST IN:
WAIKATO BAY OF PLENTY GISBORNE

SEVERE WEATHER WARNING

HEAVY RAIN FORECAST FOR COROMANDEL PENINSULA AND KAIMAI RANGES

MetService expects rain to spread over Northland and Auckland today, and bring 75mm to Coromandel Peninsula and the Kaimai Ranges tonight and Friday morning.

Forecasters advise that the rain band is likely to slow down as it moves over the remainder of Bay of Plenty and Gisborne during Friday. Farmers, travellers and recreational users of the rivers should be prepared.

MORE DETAILED INFORMATION FOR EMERGENCY MANAGERS AND TECHNICAL USERS FOLLOWS:

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HEAVY RAIN WARNING
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AREA/S AFFECTED: COROMANDEL PENINSULA AND KAIMAI RANGES

FORECAST:

COROMANDEL PENINSULA AND KAIMAI RANGES
Showers are expected to turn to rain this evening. In the 12 to 15 hours from about 11pm Thursday, 75mm is expected peaking at 10 to 15mm per hour on Friday morning.

Issue 6: 7.49pm on 11 July

URGENT - IMMEDIATE BROADCAST IN:
WAIKATO BAY OF PLENTY GISBORNE HAWKES BAY

SEVERE WEATHER WARNING

HEAVY RAIN FORECAST ABOUT EASTERN PARTS OF THE NORTH ISLAND.

MetService is continuing to warn of a period of heavy rain about parts of Coromandel Peninsula, Bay of Plenty and Gisborne overnight and on Friday, and has now extended the Heavy Rain Warning to include Hawkes Bay.

Up to 80mm of rain is expected about Coromandel Peninsula and the Bay of Plenty ranges overnight and Friday morning.

Forecasters warn residents, travellers and other users of the eastern hills and ranges from Coromandel to Hawkes Bay to be aware of the forecast heavy rain, and to watch for rising river levels.

MORE DETAILED INFORMATION FOR EMERGENCY MANAGERS AND TECHNICAL USERS FOLLOWS:

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HEAVY RAIN WARNING
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AREA/S AFFECTED: COROMANDEL PENINSULA AND THE KAIMAI RANGES

FORECAST:

FOR COROMANDEL PENINSULA:
A period of heavy rain is expected overnight. In the 12 hours from 9pm Thursday to 9am Friday, up to 80mm of rain is likely. Heaviest falls are expected overnight, with rainfall rates of 10-15mm/hr.

FOR THE KAIMAI RANGES
A period of heavy rain is expected on Friday morning. In the 12 hours from midnight Thursday to midday Friday, up to 75mm of rain is likely. Heaviest falls are expected around dawn, with rainfall rates of 10-15mm/hr.

Issue 7: 8.53am on 12 July

URGENT - IMMEDIATE BROADCAST IN:
WAIKATO BAY OF PLENTY GISBORNE HAWKES BAY

SEVERE WEATHER WARNING

HEAVY RAIN FORECAST FOR THE EASTERN NORTH ISLAND RANGES

MetService is continuing to warn of a period of heavy rain about the eastern North Island ranges from Coromandel Peninsula to Hawkes Bay.

A further 30-50mm of rain can becoming expected on the Coromandel Peninsula and Kaimai ranges this morning, but the rain should ease in these areas by early afternoon.

Strong gusty easterly winds are also expected to affect these areas for a time.

Forecasters warn residents and travellers within these areas to be aware of the forecast heavy rain, and to watch for rising river levels.

MORE DETAILED INFORMATION FOR EMERGENCY MANAGERS AND TECHNICAL USERS FOLLOWS:

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HEAVY RAIN WARNING
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AREA/S AFFECTED: COROMANDEL PENINSULA AND THE KAIMAI RANGES

FORECAST:

FOR COROMANDEL PENINSULA:
The heavy rain should ease by midday, however in the 3 hours from 9am to midday today (Friday), up to 30mm of rain is likely in some areas.

FOR THE KAIMAI RANGES
In 6 hours from 8am to 2pm today (Friday), up to 50mm of rain is expected.

Issue 8: 1.08pm on 12 July

URGENT - IMMEDIATE BROADCAST IN:
WAIKATO BAY OF PLENTY GISBORNE HAWKES BAY

SEVERE WEATHER WARNING

HEAVY RAIN FORECAST FOR THE EASTERN NORTH ISLAND RANGES

MetService is continuing to warn of a period of heavy rain about the eastern North Island ranges from Coromandel Peninsula to Hawkes Bay.

The heavy rain which has been affecting the Coromandel and Kaimai ranges should ease this afternoon, but another 30-40mm of rain can be expected between 1pm and 6pm today.

Forecasters warn residents and travellers within these areas to be aware of the heavy rain, and to watch for rising river levels and possible surface flooding.

MORE DETAILED INFORMATION FOR EMERGENCY MANAGERS AND TECHNICAL USERS FOLLOWS:

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HEAVY RAIN WARNING</b
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AREA/S AFFECTED: COROMANDEL PENINSULA AND THE KAIMAI RANGES

FORECAST:

FOR COROMANDEL PENINSULA:
The rain is now expected to ease late this afternoon. In the 3 hours from 1pm to 4pm today (Friday), up to 30mm of rain is still likely in some areas.

FOR THE KAIMAI RANGES
The rain is now expected to ease around dusk. In 5 hours from 1pm to 6pm today (Friday), up to 40mm of rain can be expected.

Appendix B: Media Releases

July 5, 2002 - 6.pm

Flood Team Ready for Wet Weekend

Environment Waikato's Flood Response Team is on alert this weekend for expected heavy rain, which could cause flooding in the Waikato and Waipa catchments.

The Waikato has had steady rain for several weeks, leaving the area soggy and rivers full. Late today alarms were being set off along the Waikato and Environment Waikato expects flows to increase over the weekend, with high flows by Sunday in the lower Waikato.

More rain is forecast throughout the weekend, peaking again on Sunday and localised flooding is already being experienced in low lying areas and walking paths in Hamilton City. The Council is working closely with Hamilton City Council to keep an eye on river paths and other areas prone to flooding.

July 6, 2002 - 9.30am

More Rain Predicted for Soaked Waikato

Three homes were evacuated near Te Awamutu last night as ground became saturated from continual rain.

More rain is predicted over the weekend on an already soaked Waikato Region. Environment Waikato's Flood Response Team is on alert for heavy rain predicted for tonight and Sunday, which could cause flooding in the Waikato and Waipa catchments.

The Region has had steady rain for several weeks, leaving the ground soggy and rivers full. With more rain forecast throughout the weekend flooding and ponding is already visible in low lying areas and walking paths in Hamilton City and around Te Awamutu, where stormwater drains are already full.

The Mangapiko and Mangahoe streams have already been overtopped in places.

Rivers and streams around Otorohanga and Te Kuiti are remaining high. On the Waikato River system levels at Ngaruawahia, where the Waipa meets the Waikato, and at Rangiriri levels are steadily rising.

Lake Taupo is holding at 240mm below its maximum and tributaries around the Lake are being watched carefully with more heavy rain predicted there this afternoon and evening. Winds are likely to rise and heavier rain is predicted for tomorrow.

Flood Manager Scott Fowlds said parts of the lower Waikato River system were likely to be affected over the next few days as flood peaks travelled through the system.

July 8, 2002 - 9.30am

Flood Teams Gear Up for Another Wet Week

Environment Waikato's Flood Response Team and district council emergency managers in the Waikato are gearing up for another wet week after weeks of rain.

Rivers are full and land throughout the Region is saturated, with more heavy rain in Otorohanga, Te Kuiti and Lake Taupo areas over the weekend.

Ponding and localised flooding is visible in low lying areas of the King Country and Te Awamutu, where three homes were evacuated late last week because stormwater drains were full.

Part of the road has been washed away on State Highway Three near Otorohanga, and police were told that a dam had burst in the Ngutunui area.

A slip has blocked the south-bound lanes of the State Highway, just south of Waitomo, and flooding is affecting the same highway six kilometres south of Te Kuiti.

River walking paths in Hamilton City are under water in places. At Rangiriri the river has reached a one in two year flood event level. The Waikato River has stayed high over the weekend and more water is coming through from Lake Taupo and the hydro dams over the next day or two.

Flood Manager Scott Fowlds said Environment Waikato staff would be checking stopbanks in vulnerable areas throughout the day and keeping in close contact with district emergency management officers.

The MetService is warning that in the 15 hours from 9am to midnight today, another 30 to 50mm is likely in the hill country between Te Kuiti, Taupo, and Raetihi.

Areas such as Ngaroma and Otewa on the Waipa River had had 180mm of rain over the past four days while Hamilton had had 65mm in the same time. While the falls were not large rain had been constant and the cumulative effect was causing problems.

In Hauraki the Piako River was rising and the Waihou appeared to have peaked, he said.

July 8, 2002 - 6pm

Flood Team Watches River Over Night

Environment Waikato's Flood Response Team is keeping a close eye on the Waikato River as several days of rain flows through the system.

The Waikato is expected to reach its highest water level at Whatawhata at 6pm tonight at about 19.1 metres – almost double its usual level of about 10 metres. The river will peak at Ngaruawahia at 6am tomorrow about 3.5 metres higher than normal, and again at Huntly about 10am, Rangiriri at 2pm and Mercer at 8pm tomorrow night. At Mercer the level is likely to be 5.3 metres when the river normally runs at between 2 and 2.5 metres.

Environment Waikato Emergency Management Officer Brendan Morris said the peaks were not likely to result in serious overtopping of stopbanks but there was likely to be flooding in unprotected areas and localised ponding.

The Council is working closely with the two power companies, Genesis and Mighty River Power to store water in the hydro system to reduce levels downstream. Lake Taupo is also full and still rising. The forecast over the next few days is for showers easing and fine intervals with isolated showers continuing over the next three days.

July 9, 2002 - 9.30am

More Rain Worries Flood Managers

More rain predicted for later this week is worrying Environment Waikato's Flood Response Team as it makes the most of a lull between two troughs today.

Rain eased overnight, but heavy rain predicted on Thursday and Friday is likely to cause more problems as water is managed through the full Waikato River system.

Today, river levels on the Waipa are falling slowly and power company Mighty River Power held some water back in the hydro system at Karapiro to reduce flood levels downstream. However as the flood peaks from the past few days of heavy rain push through the system, flooding is expected at Mercer from tonight and over the next 48 hours.

The river is expected to come close to the top of stopbanks in places and localised ponding and flooding is expected as long flat peaks move slowly northwards. Farmers should moving stock in low lying areas.

The MetService has predicted a new low on Thursday, bringing significant rain from Ruapehu north for the next few days. Unprotected areas are already flooding. Lake Taupo is also full and still rising.

July 10, 2002

Council Makes Use of Weather Break

Environment Waikato is making the most of a brief break in the bad weather to assess the flooding throughout the Waikato and Waipa river systems.

With more rain expected late tomorrow and Friday as a new front hits the country, long fine breaks today will provide an opportunity to move water through the slow systems to the sea. However, low lying areas in the lower Waikato can expect to be flooded as water travels north.

The Regional Council's Flood Response Team has been on alert for several days as constant rain added to already soggy catchments and full rivers and lakes. It is working closely with Genesis and Mighty River Power to control as much water as possible flowing through the hydro dams to reduce downstream flooding, and create a little storage room to accommodate expected rain.

Lake Taupo is holding steady just below its maximum control level. Flood control manager Scott Fowlds said the system is slow moving and it would take several days to a week for the river to drop one metre following the peak, even if there was no more rain. With more rain expected, low lying areas could expect some localised flooding and ponding as waters were still rising at Ngaruawahia, Huntly, Rangiriri and Mercer.

Hamilton City Council had been informed that the river was peaking through the city today and river walking paths have been closed as many are under water.

July 10, 2002 - 5pm

Council Moves Water as River Peaks Drop

Slightly more water will be moved through the middle of the Waikato River overnight to make the most of a brief break in the bad weather before more rain tomorrow.

More rain is expected late tomorrow and Friday as a new front hits the country, and as levels slowly drop the amount allowed to flow out of Karapiro power station will be slightly increased overnight. The amount is kept low to ensure there will not be problems for low lying areas of Hamilton City and the lower Waikato area tomorrow as the water reaches city boundaries.

The Regional Council's Flood Response Team has been working closely with Genesis and Mighty River Power to control some of the water flowing through the hydro dams to reduce downstream flooding, and create a little storage room to accommodate the expected rain.

River levels in the lower Waikato are expected to reach highest levels about 50 to 100 mm higher than they are now over the next 36 hours, and levels and Huntly and Ngaruawahia are expected to recede slowly, if no more significant rain falls.

The MetService has issued a weather watch for the Coromandel Peninsula and predicts another 15 – 25 mm over the Waikato from tomorrow and into the weekend. Because the rain is likely to hit the top half of the North Island, levels are being held steady throughout the river system to ensure space to accommodate more water.

Environment Waikato Flood Control Manager Scott Fowlds said the forecast of rain and heavy showers did not give much comfort for the lower Waikato River areas, which were already experiencing surface flooding and ponding.

July 11, 2002 - 9.30am

Flood Scheme Holding as More Rain Looms

The Waikato and Waipa River Flood Scheme is performing as designed, as the Region prepares for more rain over the next two days.

A new front is expected to hit the Region later today and over the weekend, after a day of respite from constant water throughout the catchment.

The break has given Environment Waikato's Flood Response Team and the hydro power stations a brief window to push a little more water through the system to create some storage space for what is likely to come.

Slightly more water was moved through the middle of the Waikato River overnight from Karapiro. The amount was kept low to avoid further problems for low lying areas of Hamilton City and the lower Waikato area today, and has now been pulled back.

The Regional Council's Flood Response Team has been working closely with Genesis and Mighty River Power to control some of the water flowing through the hydro dams to reduce downstream flooding.

The MetService has issued a severe weather warning for the Coromandel Peninsula today and predicts another 30 mm widespread over the Waikato into the weekend.

Regional Civil Defence Controller, Environment Waikato deputy Chief Executive Bob Priest said the flood protection scheme was performing just as expected after being under constant pressure for several weeks.

Some properties in low lying areas of the lower Waikato could expect to be flooded in any event, as the land was on a flood plain.

He said Project Watershed, the Council's newly approved policy to address soil conservation, flood protection and river management in the greater Waikato – Waipa catchment, would ensure a proper funding base for maintaining existing protection works and providing new works identified by the community.

July 12, 2002 - 10am

Uncertain Forecast for Weekend Rain

Environment Waikato's Flood Response Team is hoping for a let-up in the rain this weekend as an uncertain forecast keeps them on alert.

Rivers are still high but falling slowly after a small amount of rain overnight in the Waikato and Waipa catchments, while heavy rain fell in the Coromandel, with more expected today.

The MetService has forecast a weather warning for the Coromandel, Gisborne and the East Coast with 50-60mm expected today. For the Waikato Region about 30mm of rain is expected, with slightly less in western areas. There is concern that the low pressure system could stall over the country today and take time to dissipate.

More rain in the east will give some respite to the full Waikato and Waipa rivers, and hydro company Mighty River Power has created some storage space in the system to accommodate more water over the weekend. However areas in the east, still recovering from a civil defence emergency a couple of weeks ago, are concerned at dealing with more water.

Environment Waikato has also briefed its staff civil defence management team on the situation in case they are needed over the next few days.

Several river-based recreational events are planned for the weekend, and Environment Waikato is warning users to be aware that the river is high, with maximum flows in places, and that submerged objects could pose a hazard in safely using the water.

Waikato people are facing yet another wet weekend, after a June rainfall that was 35 percent up on normal and July's normal rainfall already having fallen by earlier this week.

July 12, 2002 - 5pm

Heavy Rain A Concern for Mercer, Coromandel

Heavy rain over several hours today has caused localised problems at Mercer and over the Coromandel Peninsula.

Two small areas of State Highway One have water lapping at the edges south of Meremere power Station and north of Mercer where the road dips lower. Heavy rain has fallen in the Hunua Ranges and the Mangatawhiri stream has overflowed, with more rain expected over the next four to six hours.

The rain band has stalled over the northern Waikato between Paeroa and Mercer bringing 5 to 10mm an hour to the area.

Environment Waikato's Flood Response Team is keeping watch tonight, using pumps to shift water from low lying areas near Mangatawhiri and organising sand bagging for areas at risk near the highway.

The Coromandel and Kaimai Ranges are also experiencing heavy rain. The Waihou, Kauaeranga and Ohinemuri Rivers are rising slightly.

In the upper Waikato River system rain has eased and hydro company Mighty River Power has created considerably more storage space in the system to accommodate rain over the weekend.

Flows from Karapiro will be eased back to reduce flows to the lower river.

Environment Waikato is warning recreational river users to be aware that the river is high, with maximum flows in places, and that submerged objects could pose a hazard in safely using the water.

July 13, 2002 - 10am

Fine Weather Gives Break for Flooded Waikato

After hours of heavy rain yesterday, a fine day is giving a break to flood battered Waikato and Coromandel residents.

Heavy rain yesterday caused localised problems at Mercer and over the Coromandel Peninsula, with land going under water in several parts around Mercer and Mangatawhiri. Flood pumps are being used to move water from flooded areas.

State Highway One was down to one lane north of Mercer, but water levels are expected to drop over the next 24 hours. Environment Waikato's Flood Response team is examining seepage on some stopbanks after weeks of rain.

Fine weather is forecast for the next couple of days, but with a new rain band due in the north on Tuesday, the team is preparing the Waikato River system to accommodate more water.

Mighty River Power has cut back flows from Karapiro to reduce flooding downstream and with Lake Taupo and the Waipa rivers dropping steadily more storage is being created. Even with no rain the system takes several days to move water through to pre-flood levels.

On the Hauraki Plains and Coromandel the Kauaeranga and Ohinemuri Rivers are dropping quickly after rising rapidly yesterday. The Waihou and Waitoa Rivers have overflowed in places and are still rising slightly. Flood Control manager Scott Fowlds said a couple of rain-free days would give some respite for flooded residents and a chance to move water through the system.

"But we may have more to come mid-week and we need to ensure there is storage room for whatever is ahead."

Appendix C: TPD Diversion Matrix (guideline only)

Factor	Key criteria		Rising/falling	
Lake Taupo	MCL			
Catchment wetness	High			
Rainfall				
• Forecast (Taupo)	50 mm			
• Forecast (catchment)	50 mm			
• Long term	Wet/above normal			
Hydro dam status	Phase I			
	Phase II			
Tributary inflow (Taupo – Karapiro)	440 cumecs (including Taupo outflow)			
Flooding levels downstream				
• Waipa	570 cumecs (Whatawhata)			
• Lower Waikato	860 cumecs (Ngaruawahia)			

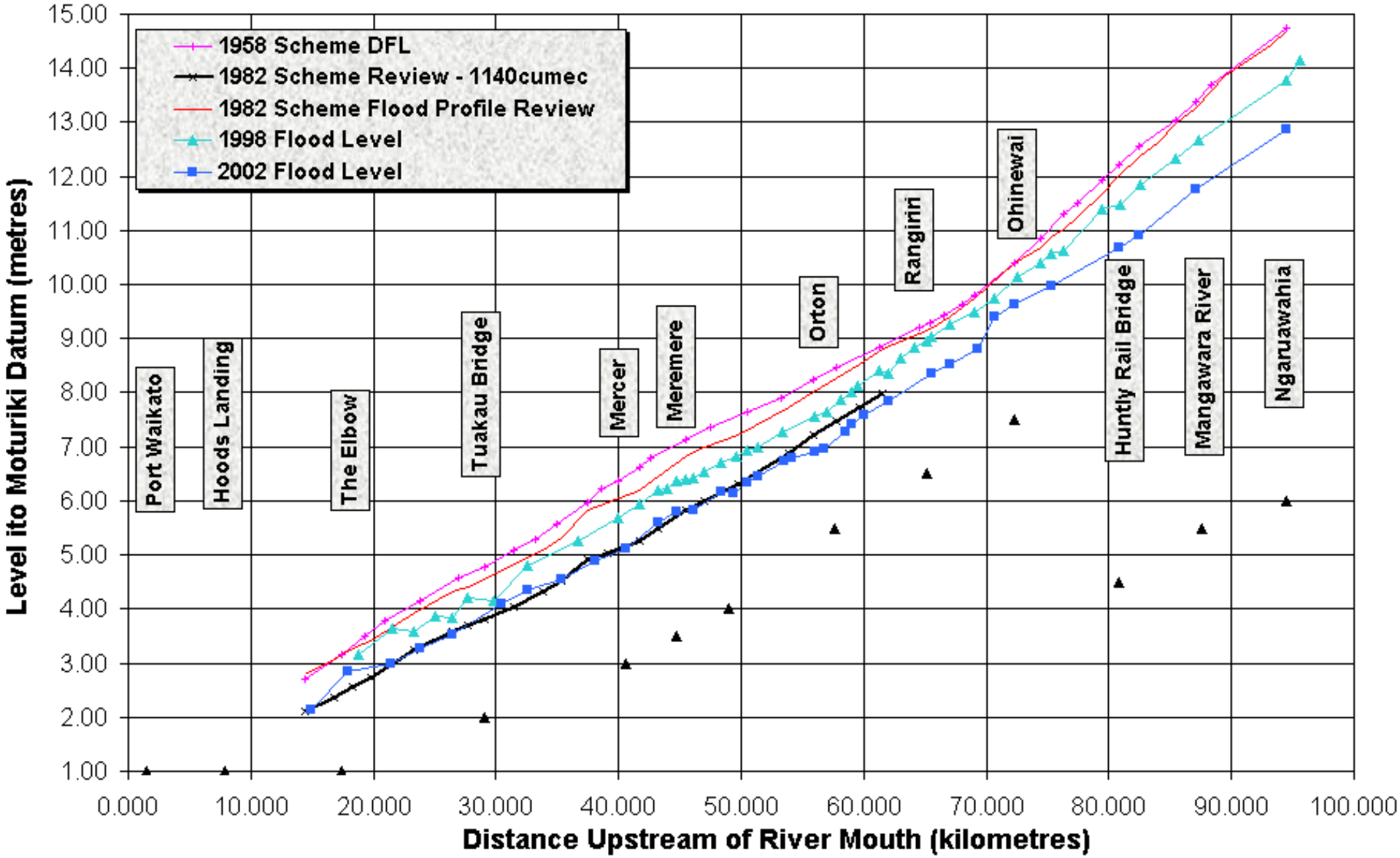
Options

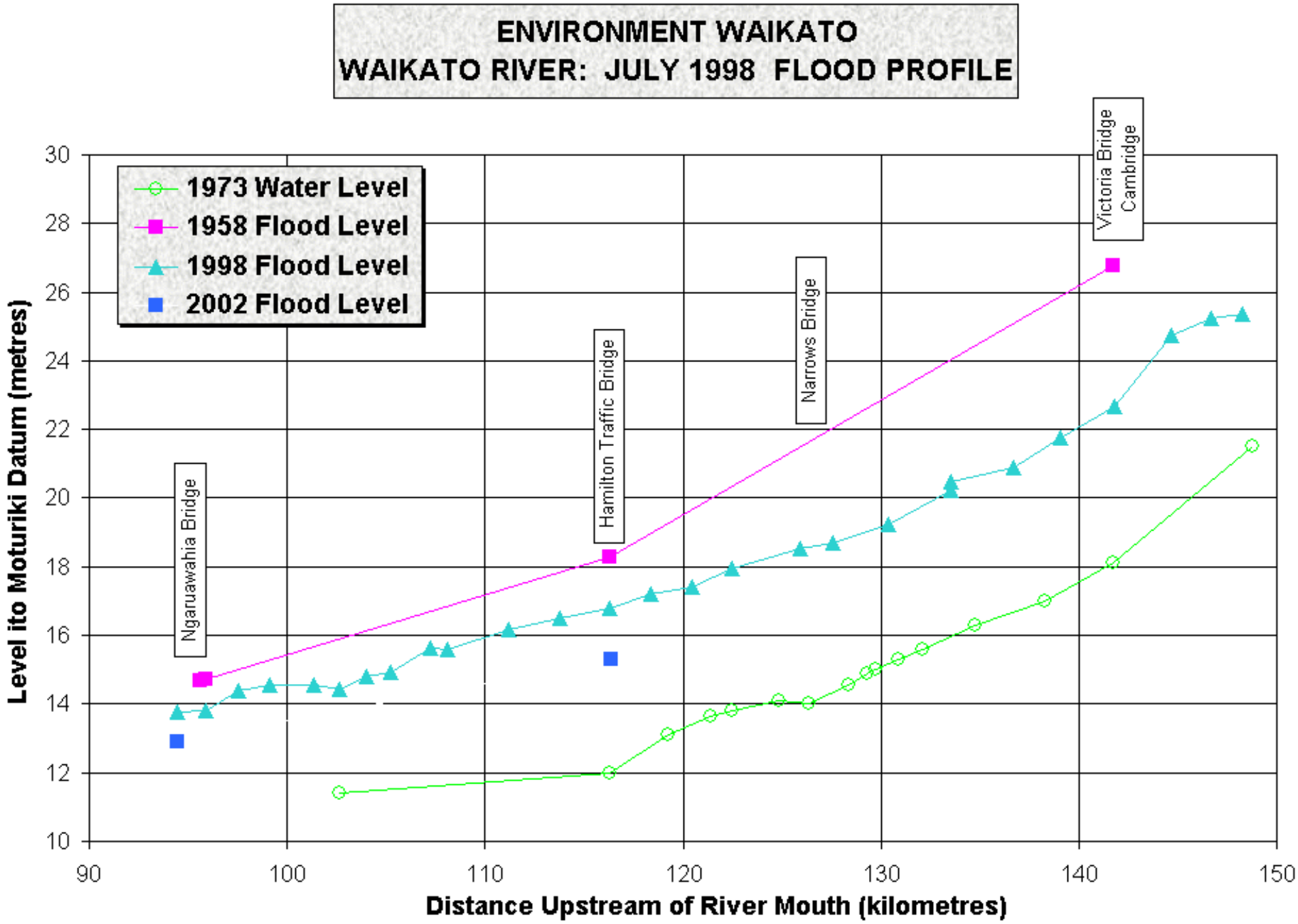
- Diversion turnout
- Partial turnout (eastern diversion off)
- Restored (maximum diversion)

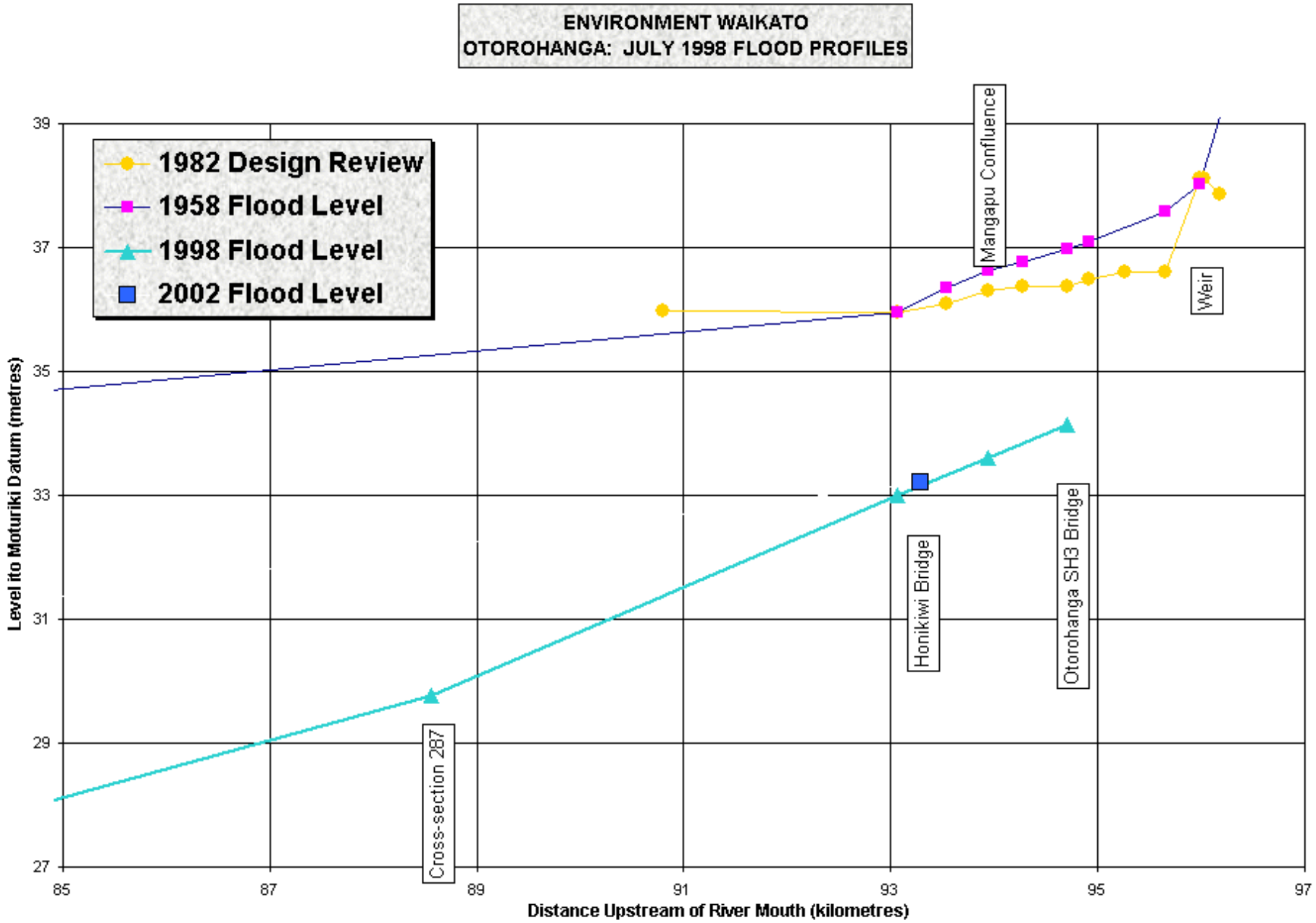
	Maximum	Average	
		Winter	**Summer**
Eastern Diversion			
Western Diversion			
Total	**68 cumecs**	**32 cumecs**	**21 cumecs**

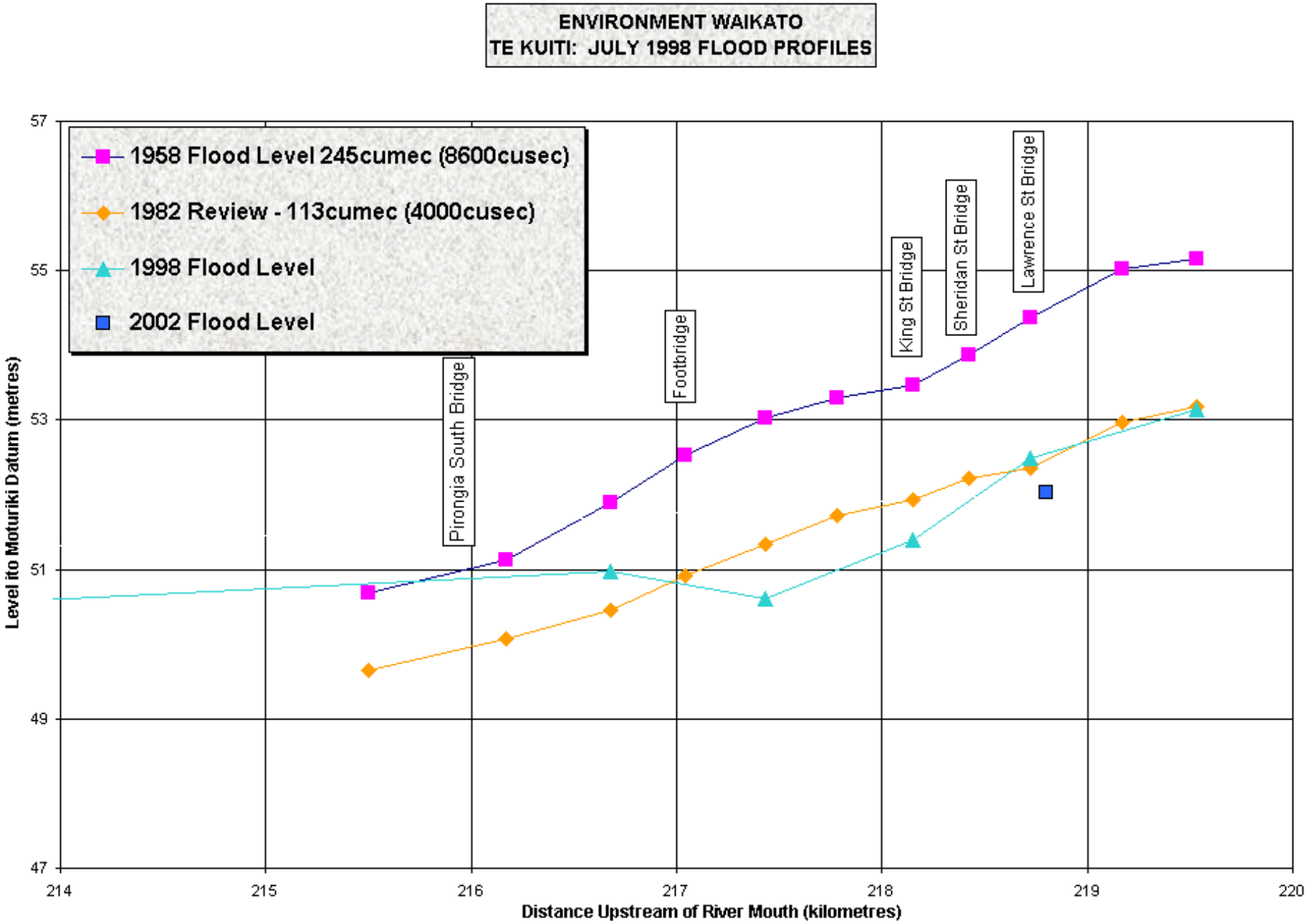
Appendix D: Waikato and Waipa River Flood Profiles

ENVIRONMENT WAIKATO
WAIKATO RIVER: JULY 1998 & 2002 FLOOD PROFILES




ENVIRONMENT WAIKATO
WAIKATO RIVER: JULY 1998 FLOOD PROFILE
1973 Water Level
1958 Flood Level
1998 Flood Level
2002 Flood Level
Ngaruawahia Bridge
Hamilton Traffic Bridge
Narrows Bridge
Victoria Bridge Cambridge
Level ito Moturiki Datum (metres)
Distance Upstream of River Mouth (kilometres)
30
28
26
24
22
20
18
16
14
12
10
90
100
110
120
130
140
150


ENVIRONMENT WAIKATO
OTOROHANGA: JULY 1998 FLOOD PROFILES
1982 Design Review
1958 Flood Level
1998 Flood Level
2002 Flood Level
Mangapu Confluence
Weir
Honikiwi Bridge
Otorohanga SH3 Bridge
Cross-section 287
Level ito Moturiki Datum (metres)
Distance Upstream of River Mouth (kilometres)
39
37
35
33
31
29
27
85
87
89
91
93
95
97


ENVIRONMENT WAIKATO
TE KUITI: JULY 1998 FLOOD PROFILES
1958 Flood Level 245cumec (8600cusec)
1982 Review - 113cumec (4000cusec)
1998 Flood Level
2002 Flood Level
Pirongia South Bridge
Footbridge
King St Bridge
Sheridan St Bridge
Lawrence St Bridge
Level ito Moturiki Datum (metres)
57
55
53
51
49
47
214
215
216
217
218
219
220
Distance Upstream of River Mouth (kilometres)