

REPORT ON FLOOD
13th MARCH 1986



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**SOUTH CANTERBURY CATCHMENT
and
REGIONAL WATER BOARD**

**REPORT ON FLOOD
13th MARCH 1986**

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Front Cover

- Top left: Tengawai River at Manahune at height of flood.
- Top right: Opihi River looking towards the coast. Stratheona Huts and Saleyards Bridge in centre left of photo. Note the overtopping of the stopbank extending from left foreground and following the true right bank of the river.
- Centre left: Levels Plains where approximately 3000 ha were inundated. Photograph taken from region of State Highway 1 looking west.
- Centre right: No post today!
- Bottom left: Stopbank failure on Waihao River near Lundy's Ford. Note flow over the bank has eroded the landward toe of the bank.
- Bottom right: Pleasant Point township near the height of the flood.

Back Cover

- Top left: Flooding in the vicinity of State Highway 1 Bridge at Temuka (top of photo).
- Top right: Tengawai River at Manahune.
- Centre left: Haybarn damaged by velocity of the floodwaters.
- Centre right: Debris demolishing handrails of McCulloughs Bridge over the Waihao River.
- Bottom left: Many houses were inundated, the floodwaters causing extensive damage.
- Bottom right: McCulloughs Bridge over the Waihao River was completely demolished by the flood. Note that the level of the bearers supporting the bridge was 6 m above the normal water level. Peak flood level at this site was about 7.5 m.

FLOOD REPORT

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FOREWARD

The 13 March 1986 flood in South Canterbury is likely to be remembered for some time, with good reason.

On the Opihi, Tengawai, Pareora and Waihao Rivers it is probably the largest flood since February 1868.

It was certainly the largest flood this century and greatly exceeded the 21 February 1945 flood.

Flood damage to property, roads, bridges, and river control works including loss of crops and livestock totalled an estimated \$60 million.

Flooding of properties and houses occurred in several locations; notably at Pleasant Point and nearby holiday huts, at Temuka, Orakipaoa and Milford Huts, Levels Plains and Seadown, the Washdyke industrial area, in the Pareora Valley and Pareora Huts and further south in the Waihao Valley, Willowbridge and Morven areas. In total, some 2000 people were evacuated as part of the regional Civil Defence emergency.

Remarkably considering the magnitude of the event, only one life was lost. Had the peak of the flood occurred during the night and not as it happened during daylight hours, the rescue and evacuation of people and property threatened by flood waters would have been much more difficult.

On the credit side, this flood has provided a marvellous opportunity in the form of an extreme test, to evaluate the Board's performance in the management of flood hazard. An assessment of the Board's procedures, policies, performance of staff and constructed works is being undertaken at present, the results of which will provide the basis for improved future efforts. Already considerable improvement in flood alert management has resulted, with particular reference to public warnings, Civil Defence liaison, and utilisation of the Board's resources. The river level flood warning system is being improved, and supplemented by the introduction of telemetered rainfall recording devices. The Board's approach to Town and Country Planning, and other local government administration matters relating to flooding has been reviewed, resulting in a focussing of effort to areas specific to Catchment Authority responsibilities. The opportunity will be taken to improve existing schemes of works in the light of the flooding experienced. It is certain that the Board's capacity to deal effectively with future flood events will be greatly enhanced by the experiences of this event.

Damage recovery is making steady progress. One year after the event, approximately 50% of the damage to the Board's facilities has been restored. Constraints on funding, both local and national, will require that some repair work will be deferred by up to four years in some cases. Much of this work is considered to be of considerable importance locally, and it is far from satisfactory that delays of this magnitude are necessary.

It is absurd that roading and on farm damage was reinstated with 95% grant assistance from Government, while damage to river control works received 80%. Those reporting to Government on damage to river control works have done this region a disservice in failing to achieve assistance equal to that provided for other agencies.

The flood has sharpened the awareness of the Board, and others, as to the magnitude of the flood hazard faced in its district. It is already evident that this has resulted in improved public awareness of the need for flood management measures, both structural, and non structural, which impact on, and often constrain activity.

It is important that this current enhanced public awareness be capitalised on by those responsible for flood hazard management. The flood has provided a basis of hard factual information which could provide a basis for planning and management of future flood events. If early progress is not made in this area, the present public awareness will diminish. Those with prospects of short term personal gain will continue to misrepresent the flood hazard situation facing the district, with tragic future consequences in some cases.

The Board has published a set of flood hazard maps for its district, a project which was initiated in 1982. This represents an element of the first step towards better flood management. The Board will continue to work on improving its performance in this area, however it can only achieve so much on its own. The success of any endeavour to improve the management of flood hazard in the Board's district will depend largely on the support of territorial authorities and, finally, on the support of the public at large. With commitment and cooperation the ideal end objective can be approached, that all individuals who may be affected by flooding, are fully aware well in advance of an event, and have taken effective action to mitigate damage to their interests.

O. A. Stringer,
General Manager.

1.0 INTRODUCTION

The aim of this report is to present a documentation of facts surrounding the 13 March 1986 flood. The emphasis is almost totally in the area of this Board's activity. Very few conclusions are drawn, and discussion is generally descriptive, rather than analytical.

The very necessary process of problem identification in relation to the Board's performance in flood management, and recommended action where required, is seen as being beyond the scope of this report. Assessment of the Board's performance, and facilities, will be an ongoing exercise, and this report will provide a valuable basis for this work.

2.0 WEATHER

2.1 Antecedent Conditions

Rainfall totals recorded for February throughout much of the Board's region were the highest recorded since 1945. Rainfall during the month ranged between 110 mm in the Ashburton coastal district to 250 mm in the Kakahu Forest district; 2-3 times that normally recorded for February.

During the month there were two notable floods which occurred on 17 and 25 February resulting in flows above annual flood magnitude being recorded. On 17 February, a peak flow of 340 m³/s was recorded for the Opihi at Rockwood. On 25 February 210 m³/s was recorded for the Opuha River at Skipton and during the same storm 230 m³/s was recorded in the Waihao River at McCulloughs Bridge. For the Opihi this was the largest flood that had occurred since 1965 and for the Waihao, the largest since 1979.

As a consequence the mean flows for all rivers south of the Rangitata River were much higher than normal reflecting very wet catchments, resulting in a higher base flow contribution to the river systems. Where in February 1985 Opihi at Rockwood averaged a mean flow of 1.06 m³/s, the average for February 1986 was 11.46 m³/s.

With high soil moisture contents, high groundwater levels and higher than normal river flows, this set the scene for the flood of 13 March 1986.

2.2 Weather Situation

On Monday 10 March 1986, a ridge of high pressure extended onto the North Island from the east and a weak cold front over Fiordland was slow moving (Figure 1).

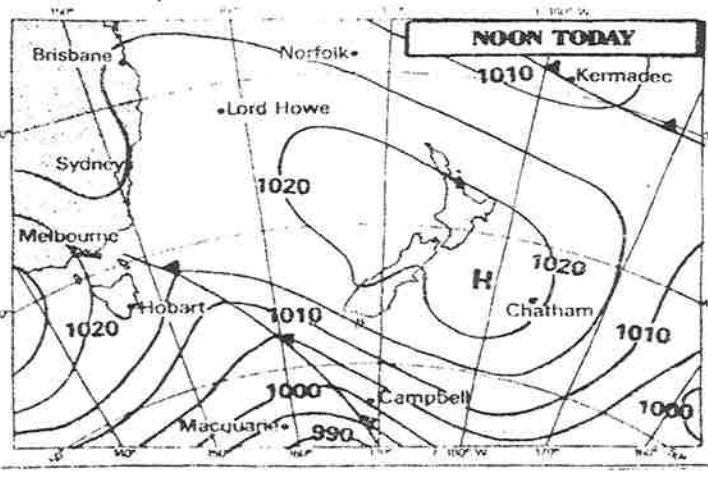
By Wednesday, 12 March 1986 a shallow depression over the central Tasman Sea had intensified and had become almost stationary. This was accompanied by anticyclones centred on Tasmania and to the south east of the Chatham Islands.

Later that day an occluded front had developed within the extensive low pressure system lying over the north Tasman Sea, and a small low pressure centre had formed in Pegusas Bay, north of Christchurch. The effect of this low pressure area was to accelerate the movement of warm moist air from the north into the South Canterbury district.

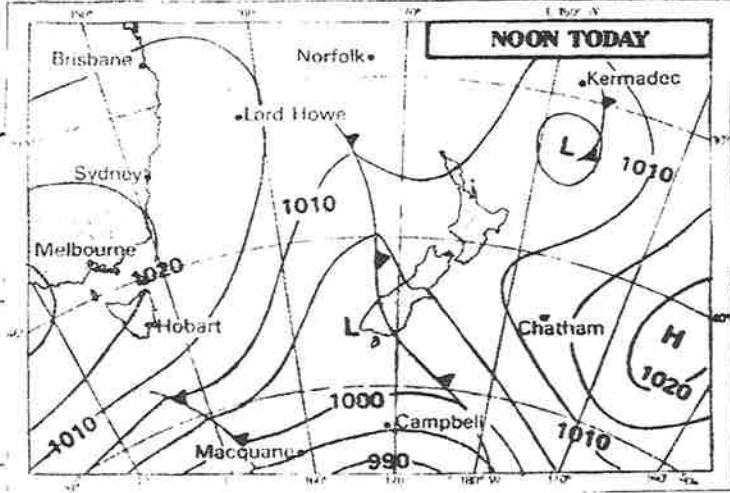
Lifting of the moist air by the frontal activity, together with the orographic influence presented by the South Canterbury foothills resulted in prolonged high intensity rainfall from the north easterly quarter lasting almost 24 hours and concentrated along the physical barriers presented by the Hunters Hills, Two Thumb Range and Four Peaks Range.

This presented the classic situation that has brought widespread flooding to South Canterbury in the past. The well known floods of 1945, 1951, 1961 and 1965 have all resulted from a similar weather pattern.

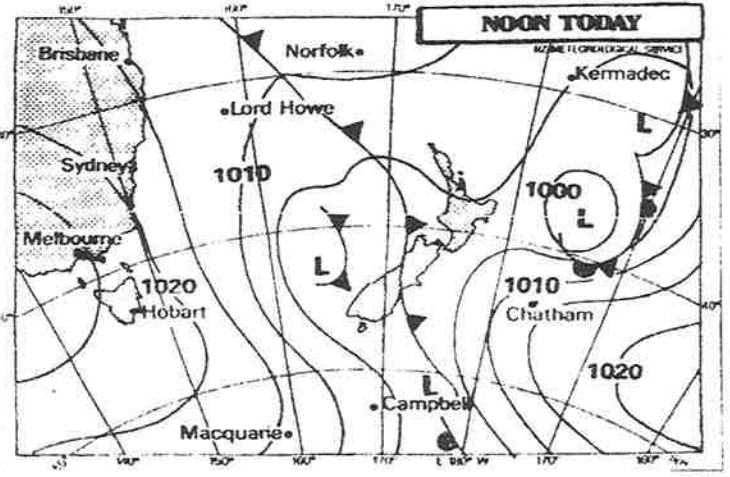
By 14 March the low pressure area had moved away to the north west and activity along the front had weakened bringing low cloud, mist and isolated showers, a situation which continued until 16 March when the weather cleared.



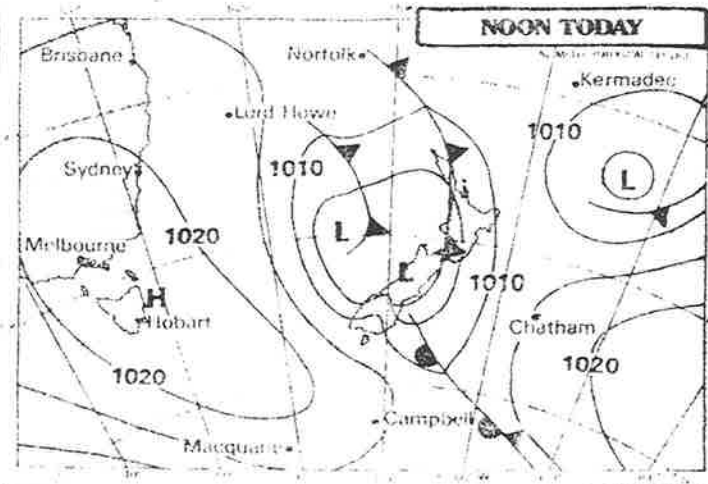
Saturday 8 March



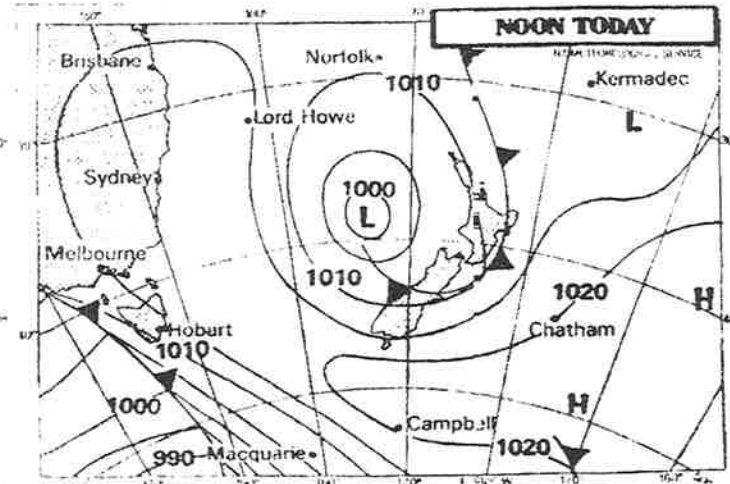
Monday 10 March



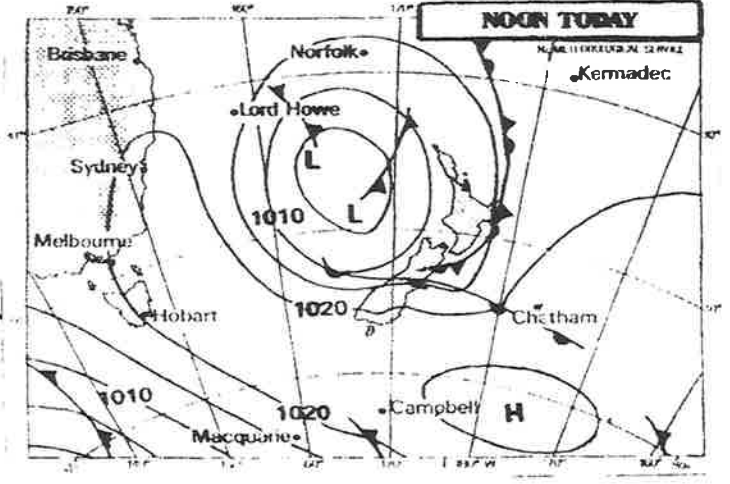
Tuesday 11 March



Wednesday 12 March



Thursday 13 March



Friday 14 March

FRONTS	WEATHER SYMBOLS	
Cold		High pressure or Anti-Cyclone H
Warm		Low pressure or depression L
Occluded		General flow of wind
Stationary		Isobars 1005 (pressure in millibars)
		1016 mb - 30 in. 1 mb - 0.03 in.

FIGURE 1: WEATHER SITUATION

3.0 THE FLOOD ALERT

Small initial rises in river flows occurred on the afternoon of 12 March and triggered alarms on the Board's river monitoring telemetry system. By 5 pm on 12 March alarms had been registered on the Opuha, Opihi and Orari Rivers and the alarm levels were re-set at a higher level to provide warning should the rivers continue to rise during the night. The equipment was set to poll every hour.

Board's staff were called out at midnight when alarms were triggered on the Opuha (2.746 m) and the Te Moana Rivers (1.657 m). The Board's flood control centre was manned continuously from this time until the afternoon of 15 March. Following the midnight alarm, polling of stations was increased to occur every 15 minutes.

By 4.30 am five rivers, the Orari, Opuha, Opihi, Waihao and Te Moana had recorded stage heights above 3.0 metres, indicating that widespread and severe flooding was likely to occur later in the day. Flows at this time were roughly equivalent to a 10 year flood event.

At 04.33 am a flood warning was issued over Radio Caroline.

From 4 am to 7 am the rivers were polled every 30 minutes which provided adequate information without jamming the Board's radio channel.

Flood peaks began to occur from 7 am onwards, starting on the Ashburton River in the north, then progressing south on the Orari and Opuha at 8.30 am. From 6.45 am onwards, heavy rainfall reports were received from farmers throughout South Canterbury. These early reports were helpful in building up a picture of the severity of the storm and its extent.

Telemetry failures began to occur at about this time. Two periods of intense radio interference about 6 am and 8 am locked up the telemetry system. It was later found that physical destruction of flow recorder stations on the Waihi and Pareora Rivers had caused this interference which ceased when the radio sheds were also swept away.

Data acquisition by telemetry continued intermittently up to 10.30 am by which time the Orari and Opuha rivers were falling. By 11 am a complete poll of stations was re-established but only seven of the 11 telemetry stations gave valid readings, and it was subsequently found that three water level recorder towers had been completely destroyed by the flood and the fourth site just simply failed to respond. At this time field observer reports and the telemetered data indicated that at the recorder sites, the river flows were starting to fall.

Field reports from Board staff, Local Authority staff and members of the public, together with the telemetry data continued to provide a reasonably complete picture of the flood as it proceeded towards the coast. Reports at hourly intervals were relayed to Civil Defence in Timaru.

Later in the evening of 13 March (9 pm) the Opihi and Opuha rivers rose again to a substantial secondary peak as a result of heavy showers in the later afternoon.

3.1 Liaison with other Local Authorities and Organisations

The following, taken from the Board's flood log, summarises the times and communications to Local Authorities and other Organisations during the flood event.

13.3.86

- 3.05 am County Engineer (Strathallan County Council) warned of flooding in Te Moana River.
- 4.20 am Town Clerk (Temuka Borough Council) warned of surface flooding in Borough.
- 4.22 am Geraldine Borough advised of flooding in and around Borough.
- 4.25 am Regional Manager (Ministry of Works Development) warned of impending major flooding and possible disruption to roads and bridges.
- 4.27 am SCCB Office (Ashburton) advised of pending flood situation. Message relayed to Ashburton County Engineer.
- 4.33 am General flood warning issued to Radio Caroline advising farmers to shift stock from low lying areas.
- 5.20 am Strathallan County Council updated of flooding situation.
- 5.47 am Waimate County Council informed of impending flooding in their district.
- 5.50 am Mackenzie County Council advised of likely flooding in that area.
- 6.34 am Police updated as to flooding situation.
- 7.34 am Temuka Borough Council advised of Waihi overtopping its banks near Beeby Road and likelihood of flooding in Temuka later in day.
- 7.48 am Waimate County advises Board that Makikihi River has broken out through the village and that a number of County bridges have been destroyed or damaged.
- 8.11 am Police informed of serious flooding in Saltwater Creek area.
- 8.30 am Timaru City Council warned of serious flooding in Saltwater Creek and Washdyke areas and possible need to evacuate some residents.
- 8.33 am Temuka Borough Council telephoned seeking update on the Waihi Temuka river situation.

- 8.49 am Police phone to advise Board of the location of the Police Evacuation Centre.
- 8.51 am Strathallan County updated of flooding situation.
- 9.42 am Geraldine Borough Council informed of possible breakout from the Waihi River upstream from Geraldine.
- 9.42 am Police telephone requesting a Board s staff member attend Civil Defence meeting. Civil Defence informed of likely major flooding along the main rivers still to come.
- 10.02 am Strathallan County Council warned that Pareora River has broken its banks in many places and there could be flooding in Pareora Township and the CFM (Pareora) meatworks.
- 10.12 am Strathallan County Council warned the Tengawai River had overtopped its stop banks and that Pleasant Point could be flooded.
- 10.15 am Civil Defence notified of developments in Pareora and Tengawai Rivers and possible flooding to Pareora and Pleasant Point.
- 10.40 am Radio Caroline updated as to the current flooding situation.
- 10.59 am Strathallan County Council updated regarding further overtopping of stopbanks along the Opihi and Tengawai Rivers.
- 11.21 am Strathallan County Council advised that serious flooding was certain and that occupiers of dwellings in the lower Pleasant Point, Stratheona Huts and Butlers Road Huts will need to be evacuated. Also Waipopo and Milford hutholders should be warned.
- 11.29 am Minister of Civil Defence updated of situation.
- 11.45 am Temuka Borough Council warned that Waihi River had overtopped upstream of Borough boundary and some flooding was likely.
- 11.50 Strathallan County Council updated regarding flooding upstream of Pleasant Point.
- 12.05 pm Waimate County Council advised Makikihi township was sandbagged and flooding in river was abating.
- 12.14 pm Tengawai floodwaters reach Pleasant Point and Stratheona Huts area. Residents evacuated.
- 12.16 pm Civil Defence updated as to Temuka and Pleasant Point situations.
- 12.40 pm Regional Civil Defence Emergency declared.

Local Authorities and Civil Defence continued to be kept informed as reports from the field came to hand.

3.2 Problems related to flood alert management

While an indepth assessment of the management of the flood alert is beyond the scope of this report, it is worth recording briefly some of the problems which arose.

3.2.1 Flood Warnings

It is fair to say that, in general, the conveyance of warnings to the public was less than desirable. Some of the reasons for this were:

1. Radio broadcasts were not monitored by staff. It was assumed that regular warnings were being broadcast as requested.
2. It was assumed that information given to Civil Defence, Police and Territorial Authorities, would be passed on. This was not always the case. In hindsight, the Board should have taken the initiative regarding provision of information to the public.
3. Inadequate field information. Staff were not deployed to isolated areas early enough. Many areas could not be reached due to loss of access. Locals could often not be contacted due to their understandable preoccupation with their own interests.

3.2.2 Communications

1. Telephone communication to much of the rural hinterland was lost during the early hours of 13 March. Farmers in those areas were unable to communicate valuable rainfall and flow information to the Board. Swollen rivers and streams had damaged many bridges closing virtually all roading links, reducing communications to radio telephone traffic only.
2. Difficulties arose with radio telephone reliability due to voice channel corruption by flood warning telemetry. Separate channels for voice and telemetry traffic are essential. This Board is having considerable difficulty with NZPO in obtaining a separate telemetry channel, however efforts will continue until success is achieved.

3.2.3 Civil Defence Liaison

It is fair to say that there was a very poor appreciation, pre flood, of this Board's role in a civil defence emergency. The main reason for this was that there had been virtually no pre event liaison between the Board and Territorial Authorities regarding civil defence. For example, the Aorangi Regional Plan and Waimate District Plan were prepared without consultation with the Board.

This lack of appreciation of respective roles by the Board and affected Territorial Authorities resulted in many unnecessary difficulties. It is beyond the scope of this report to cover this matter in detail, however one example was the difficulty the Board had for a period in gaining access to damaged works, for inspection and restoration purposes due to Civil Defence security arrangements.

4.0 RAINFALL

4.1 Distribution

Appendix 1 summarises the rainfall totals recorded during the period 12-14 March 1986 for rainfall stations throughout the Board's district.

Rainfall for the storm period ranged from 100 mm in the Morven and Ashburton districts to more than 250 mm in the Hunters Hills and Four Peaks Range (Figure 2). For comparative purposes the distribution of rainfall recorded for the 1945, 1951 and 1961 floods are shown in Appendix 2.

4.2 Rainfall Intensities

Light rain and showers (less than 2 mm per hour) continued throughout the day of 12 March with heavy rain setting in at about 10.30 pm. This gradually intensified to a rate of about 15 mm per hour between the hours of 2.00 am and 4.00 am on 13 March. The rain then eased for about two hours followed by another burst of intense rainfall in excess of 15 mm per hour lasting until about 9.00 am when the rain stopped. In Timaru there was little further rain but some heavy showers occurred in the headwaters of the Opihi and Te Moana catchments later that same day.

Figure 3 shows the rainfall intensities recorded at Winchmore, Kakahu Forest, Rocky Gully, Gleniti and Timaru. Two other automatic rainfall recorders located at Waimate and Shenley (headwaters of Tengawai catchment) malfunctioned during the storm event and failed to give a complete record.

Figure 4 shows the accumulative event rainfall for Gleniti Reservoir and compares the March 1986 flood with the February 1945 flood. Unlike the rainfall pattern for the recent flood, in 1945 the high rainfall areas were centred close to the coast and not on the physical barriers presented by the Hunters Hills and Two Thumb Ranges. While the rainfall event appears to have been more prolonged in 1945, the March 1986 flood is noted for its higher rainfall intensities; in particular the 2-6 hour rainfall totals.

Table 1 summarises the maximum rainfall totals recorded for selected time durations for the various recorder stations, while Table 2 shows the rainfall depth/duration/frequency for Gleniti Reservoir and Winchmore (Coulter and Hessell: 1980).

Comparing the Winchmore data in both tables shows that the rainfall event at that site was of little note and less than a one in ten year frequency. At Gleniti however, 1, 2, 6 and 12 hour totals are all in excess of a one in fifty year return frequency. The previous maximum in 12 hours recorded at Gleniti has been 68 mm.

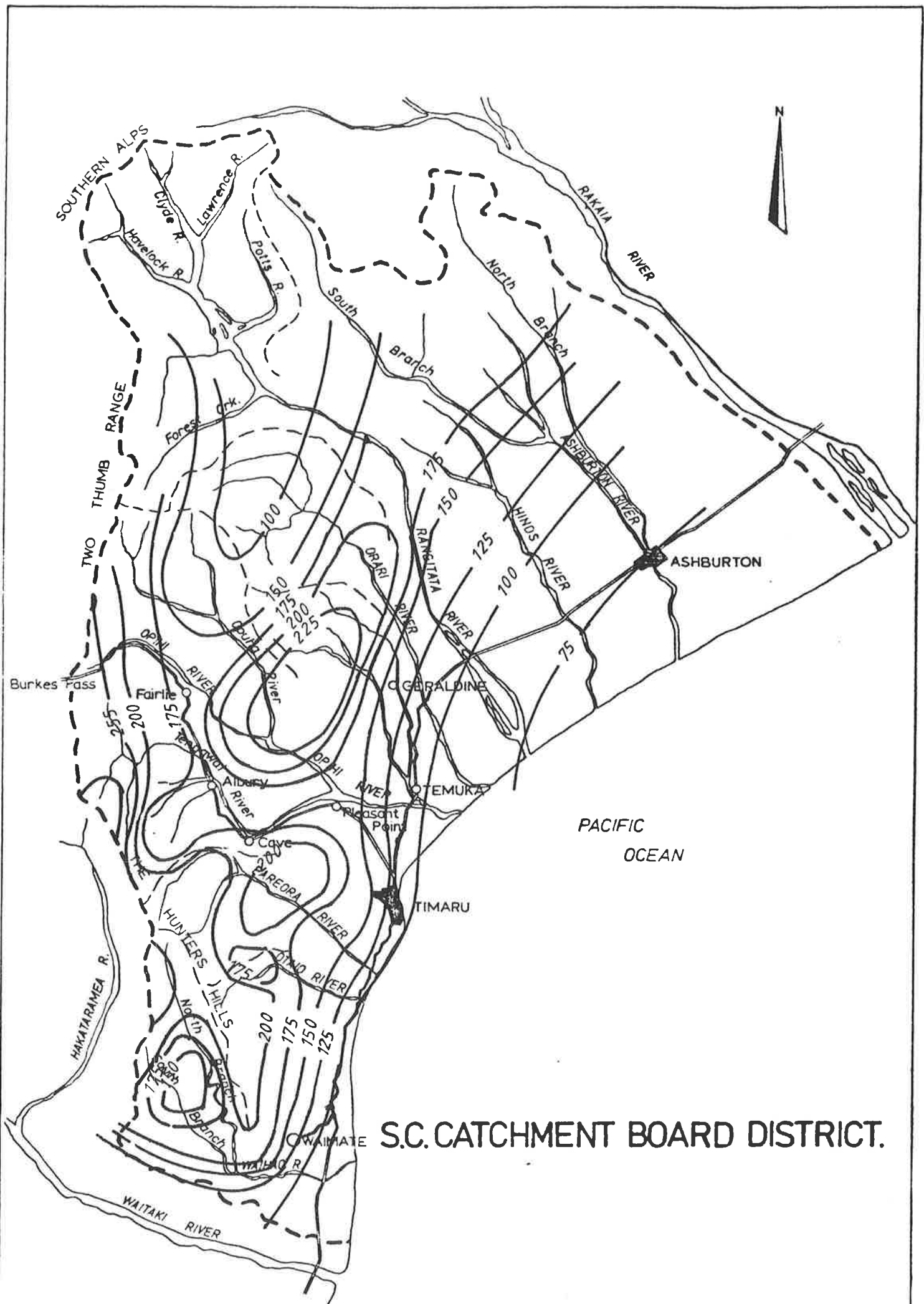
For Kakahu Forest a 12 hour, 1:50 year rainfall is estimated to be about 120 mm. During this rainfall event 145 mm was recorded at Kakahu Forest clearly demonstrating the magnitude of this storm event. With intensities of 29 mm in one hour, 50 mm in two hours and 96 mm in five hours, such intensities are more typical of those experienced on the West Coast rather than South Canterbury.

TABLE 1 - Rainfall recorded for selected time durations

Site	Duration (hrs)				
	1	2	6	12	24
Timaru	15	29	70	94	114
Gleniti (Timaru)	20	37	80	105	124
Kakahu Forest	29	50	106	145	191
Rocky Gully	-	47	108	148	160
Winchmore	9	15	37	58	66

**TABLE 2 - Rainfall depth-duration-frequency analysis
(Coulter and Hessel:1980)**

	Duration (hrs)				
	1	2	6	12	24
Gleniti 1.10 yr	17	23	39	56	80
(Timaru) 1.20 yr	19	25	44	64	91
1.50 yr	22	29	51	74	106
Winchmore					
1.10 yr	16	22	45	63	90
1.20 yr	19	25	52	72	103
1.50 yr	21	28	60	83	120



S.C. CATCHMENT BOARD DISTRICT.

FIGURE 2 : RAINFALL DISTRIBUTION FOR 12 - 14 MARCH 1986.

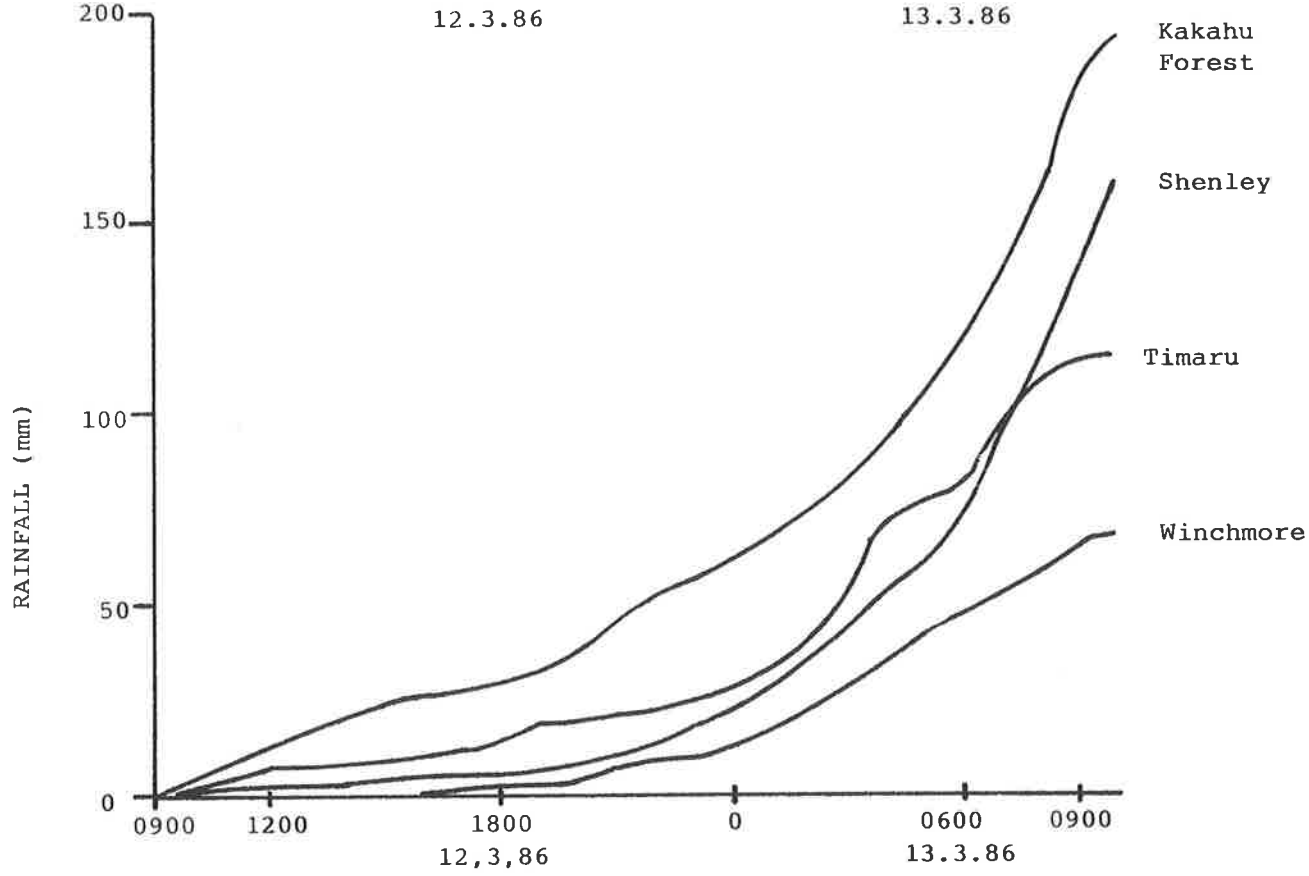
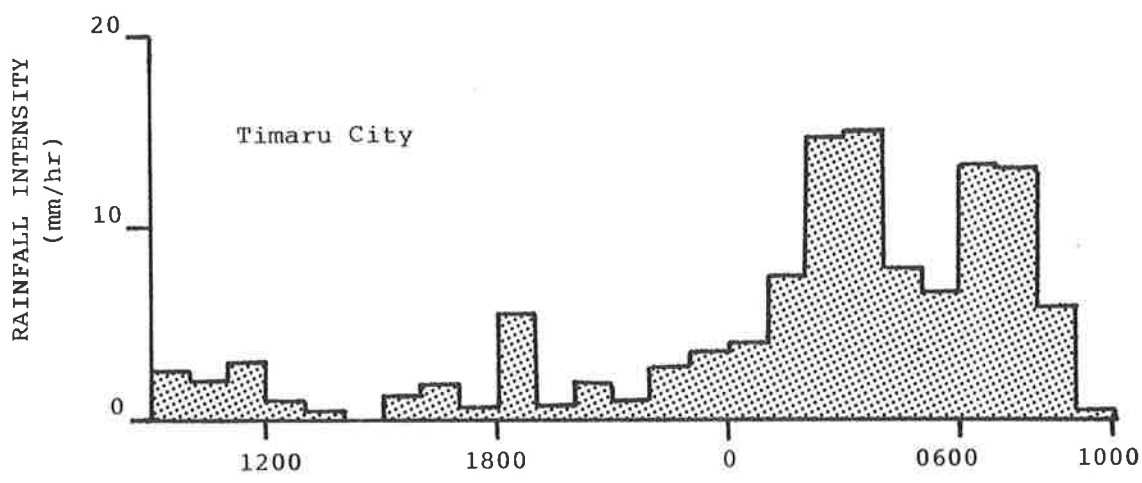
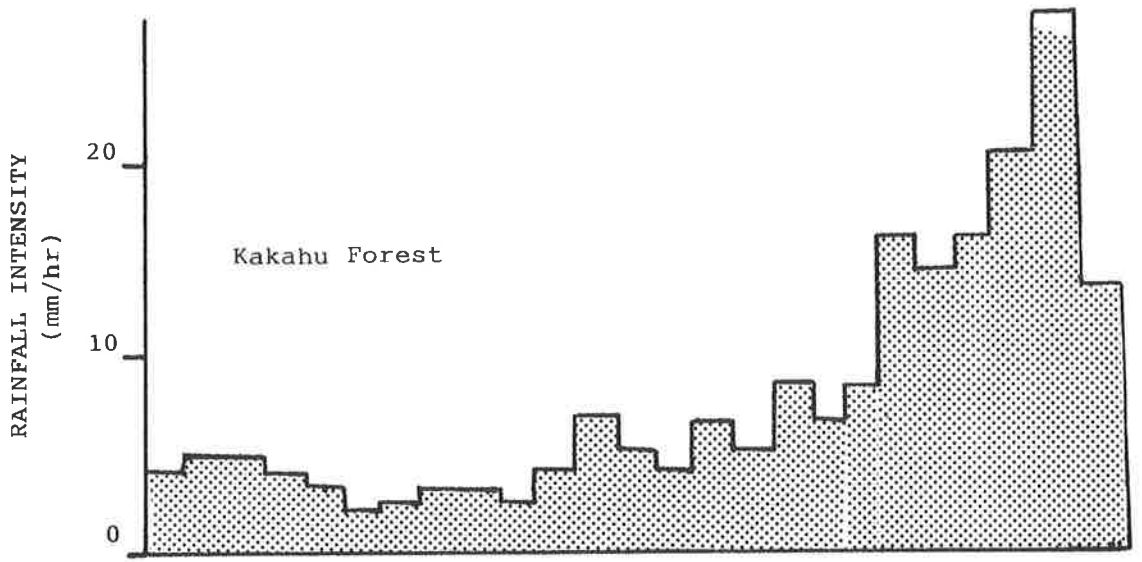


FIGURE 3 : ACCUMULATIVE EVENT RAINFALL AND RAINFALL INTENSITIES FOR RAINFALL RECORDER STATIONS.

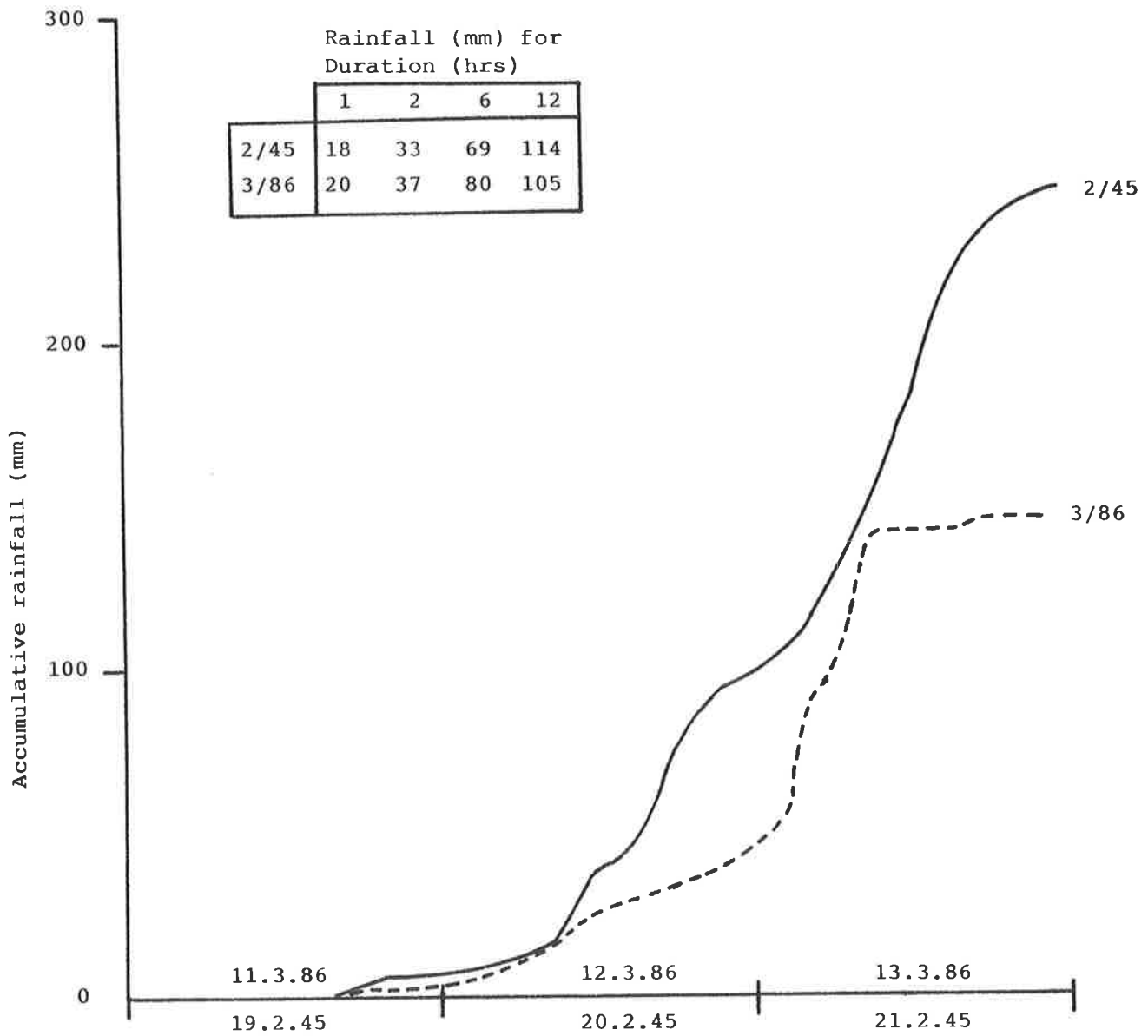


FIGURE 4 : ACCUMMULATIVE EVENT RAINFALL FOR GLENITI RESERVOIR FOR FEBRUARY 1945 AND MARCH 1986 FLOODS.

5.0 FLOOD LEVELS AND RIVER FLOWS

The Board has 12 river flow recorder stations telemetered to its main office in Timaru (Table 3).

Table 3. SCCB Telemetered Water-level Recorder Stations

Site No	River	Location	Map Ref.	Catchment Area (km ³)	Years of operation
68810	N.Ashburton	Old Weir	S81:986523	275	1982-86
68806	S.Ashburton	Mt Somers	S81:820411	540	1967-86
69302	Rangitata	Klondyke	S91:752290	1495	1967-86
69505	Orari	Gorge	S91:734073	520	1965-86
69643	Waihi	Waimarie	S102:706994	40.5	1983-86
69644	Te Moana	Glentohi	S102:656947	77.8	1983-86
69645	Kakahu	Mulvihills	S102:604844	43.7	1983-86
69614	Opuha	Skipton	S101:544901	486	1936-86
69618	Opihi	Rockwood	S101:512792	412	1935-86
69635	Tengawai	Cave	S110:537629	482	1982-86
70105	Pareora	Mt Horrible	S111:615498	425	1982-86
70902	Waihao	McCulloughs Br	S127:545024	480	1982-86

The location of these sites is shown in Figure 5.

At the time of the flood, however, only 11 were operational; the Kakahu at Mulvihills site not having been reinstated after the site was vandalised earlier in the year. Under normal weather conditions the river level data is updated at 4 hour intervals, but during flood events the stations are polled every 15 or 30 minutes.

During the 13 March 1986 flood telemetered data was recorded onto summary sheets at the Board's Timaru office. This data was subsequently used to reconstruct hydrographs for the Waihi, Tengawai and Pareora Rivers where the recorder towers were destroyed and the field data lost.

At all other stations the recorder tapes were changed the following week and processed on the Board's PDP 11/23 computer to provide hydrograph plots (Appendix 3).

At most recorder stations debris lines, seedlines inside the towers (Kakahu) or mudlines on painted tower walls (Opuha and Opihi) were used to verify or correct recorded flood peak levels. These field observations were made within 3 to 5 days immediately following the flood event while the evidence was still clear.

At the same time work commenced on pegging and surveying flood slope reaches on all rivers in the Board's area. This task was largely completed within 2 to 3 weeks and provided the basic data for estimating the flood discharge for each river.

Flood levels were also pegged at bridges and along stopbank systems by engineering staff ready for subsequent surveying. (Table 4).

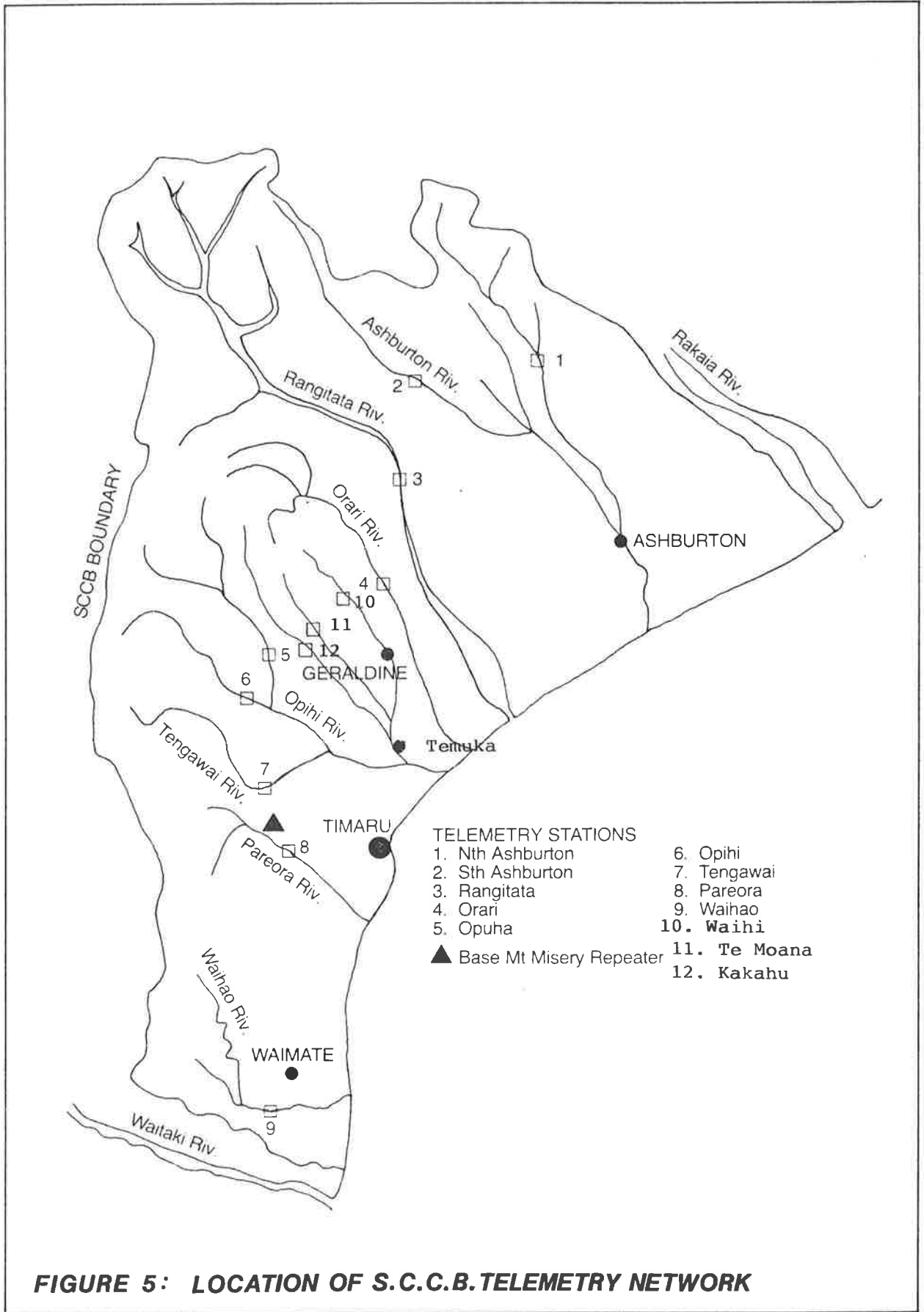


FIGURE 5: LOCATION OF S.C.C.B. TELEMETRY NETWORK

Table 4: Maximum flood Levels at Bridges in South Canterbury

Bridge Location	Level for 13.3.86 (m staff gauge)	Previous Highest Level Level (m)	Date
Hinds R at Black Bridge	7.8	-	
Orari R at SH1	8.52	-	
Orari R at SH72	2.83	-	
Waihi R at Winchster (SH 72)	7.58	-	
Waihi R at Geraldine	9.3	-	
Kakahu R at Barbarafield Br	6.74 approx	4.52	6.5.79
Temuka R at SH1	7.76	7.65	4.51
Washdyke Ck at Footbridge	3.24	1.81	7.78
Opihi R at SH1	1.68	-	
Opihi R at Saleyards Br	63.94	-	
Tengawai R. at Pleasant Point Br	2.8	3.05	19.7.61
Tengawai R at Clellands Br	3.3	1.95	5.72
Pareora R at SH1	9.18	8.47	19.7.61
Pareora R at Holme Station Br	7.77	7.20	8.6.68
Otaio R at SH1	8.08	-	
Hook R at SH1	4.67	4.0	19.7.61
Waihao R at SH1 (Sth Branch)	21.28		
Waihao R at Forks, (Nth Branch)	5.77		

It was fortunate that the weather remained fine for several weeks as this meant that debris lines on the river banks continued to be readily identifiable.

Following the flood, temporary Foxboro recorders were installed to replace lost recorder towers. Over the next 3 months those recorder towers and equipment were reinstated and all other main river stations were overhauled following which the sites were re-rated by flow gauging to provide post-flood rating curves.

5.1 METHODS OF ESTIMATING PEAK DISCHARGE

The magnitude of the flood event was such that flow gauging from traditional bridge sites could not be carried out. With velocities in the range of 3-5 m/s, the flow carried considerable flood debris including large trees which made it unsafe to carry out any bridge flow gaugings. Large boulders being moved along the bed added to the danger.

One attempt was made early in the flood to gauge the Te Moana which resulted in the loss of a current meter and damage to the bridge gauging frame. With reports coming in of bridge approaches being washed out, and bridges being damaged or destroyed, all intentions to carry out flow gaugings were abandoned.

As a consequence much of the flood flow data has been derived using various indirect flood estimation techniques. By cross checking those estimates for any one site it was possible to achieve confidence in the final results obtained.

The methods used to estimate peak flood flows were as follows:

1. Rating Curve Extension

At long established recorder sites it was possible to estimate the flow from extension of the existing rating curve.

2. Area Velocity Extension

For some bridge sites, it was possible to estimate peak discharge by multiplying the measured cross sectional flood area by an estimated mean velocity in section for the site obtained by extrapolation of previous flood flow gauging information.

3. Slope-area computations using Mannings equation

The slope reaches used are generally where the river is reasonably confined. It was noticeable that most rivers had scoured down to bedrock in these reaches. Thus the usual problem of unmeasured cut and fill does not arise. In general the flood debris lines were very clear and numerous observation points were recorded on both banks of each surveyed reach. At most sites four cross-sections were surveyed. Use of the Board's EDM equipment with electronic data storage, expedited this survey work and allowed up to three reaches to be surveyed a day.

At many sites, the surveyed cross sectional area was of such magnitude that any errors arising from identifying the debris line were relatively insignificant.

4. Computer fitting of standard backwater curves

Surveying and calculations were performed for twenty one sites. Where it was possible, the survey results were modelled using standard step backwater curve calculations. This was carried out on the Board's computer using the "CHANEL" and "RIVERS" programs.

To obtain better resistance co-efficients (Mannings 'n' values) for modelling the survey results, previous results from actual gaugings were used and extrapolated to higher flows, with allowances made for any changes in conditions at the higher stage, eg trees along the berms.

5. Modified Mannings Equation

A modified Manning's equation for use with a multi-section reach, (Barnes : 1966). This modified Manning's equation was found to give the best and most consistent results.

Where it was possible the discharges were checked by performing similar calculations on the flood levels surveyed on stopbanked schemes downstream of the slope area sites.

Table 5 is a summary of the flood discharge data for the South Canterbury area. Other relevant data in Table 5 are the time of the flood peak, the recorded level (stage), the surveyed cross section area, and computed mean velocity.

Table 6 sets out data for the 13 March 1986 flood and comparable data for the previous largest flood at each station. It is very apparent that on 13 March 1986 the flood flows greatly exceeded any recorded this century and it is probable that for the Opihi, Tengawai, Pareora and Waihao Rivers this flood is the largest event since February 1868.

5.2 FLOOD HYDROGRAPHS MAIN RECORDER STATIONS

Flood hydrographs for all the main rivers in South Canterbury are tabled in Appendix 3. In several cases e.g. Tengawai and Pareora Rivers, these hydrographs have been reconstructed from telemetered data plus other information obtained after the flood.

The hydrographs are included in this report because of the magnitude of the flood event. Where possible the design discharge for flood control works is marked on the hydrograph plot, as is the peak discharge for previous largest floods e.g. the February 1945 flood.

Notable features of the hydrographs are the very rapid rate of rise to the flood peak, followed by a rapid fall in discharge for the first few hours after the peak (Fig. 6). The sharpness of the flood peaks, and the extremely high peak discharges are attributed to the intense rainfall at the end of the storm. The main part of the flood has a duration of about 20 hours and much of the hydrograph occurs within 12 hours.

For the 1951 and 1961 floods, rainfall was spread over two to three days, producing much broader hydrographs but lower peak discharges.

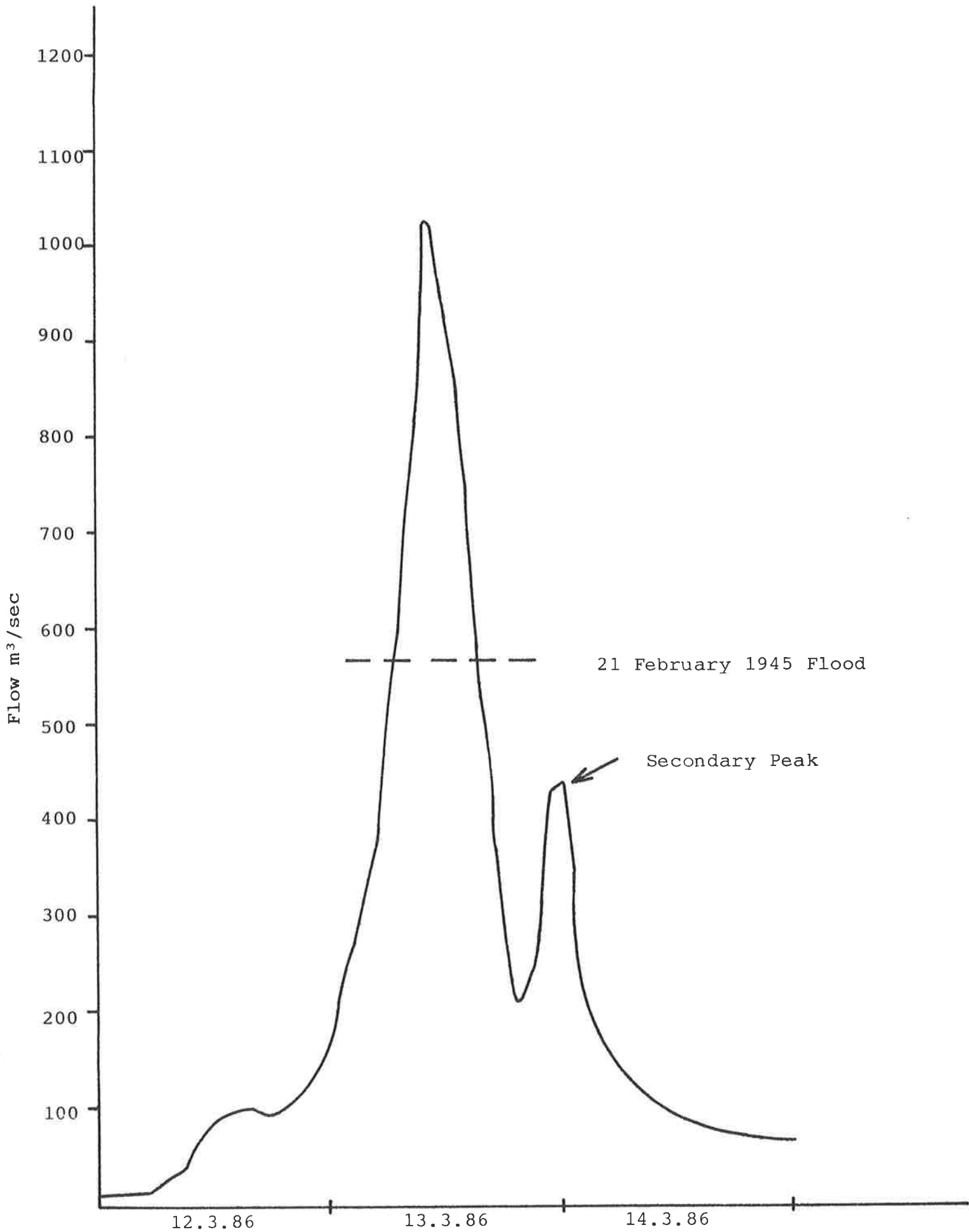


FIGURE 6 : DISCHARGE HYDROGRAPH FOR OPIHI RIVER AT ROCKWOOD.

TABLE 5 Flood Discharge Data for 13 March 1986

5a Main Recorder Stations

River	Site	Catchment Area	Time of Flood Peak	Stage (m)	Area m ²	Mean velocity m/s	Flow m ³ /s
N.Ashburton	Gorge	275	0800	2.54	-	-	185
S.Ashburton	Mt Somers	540	0700	2.12	-	-	128
Rangitata	Klondyke	1495	1400	2.68	-	-	390
Orari	Gorge	520	0830	5.2	175	4.57	800
Waihi	Waimarie	40.5	-	-	-	-	150
Te Moana	Glentohi	77.8	0800	4.35	86	3.6	310
Opuha	Skipton	486	0830	4.7	-	-	630
Opihi	Rockwood	412	1000	5.14	250	4.08	1020
Tengawai	Cave	482	1000	4.7	400	3.75	1500
Pareora	Mt Horrible	425	0930	4.4	750	1.93	1450
Waihao	McCullochs	480	1200	7.51	420	2.98	1250

5b Other Minor Rivers

Dry Creek	RDR	58	-	2.012	-	-	57
N.Ashburton	Thompson Trk	380	-	-	-	-	210
Hinds	Black Br.	285	1815	2.98	69	3.77	260
Kakahu	Barbarafield	166	1230	6.74	-	-	500
Rocky Gully	Rockburn	22.4	0830	2.8	36	3.05	110
Shenley 3	Weir 3	1.28	0715	1.56	-	-	6.28
Washdyke Cr	SH1	96	0900	-	-	-	230
Pareora Nth	Gorge	275	-	-	-	-	1000
Pareora Sth	Maungati Golf	82	-	-	-	-	325
Otaio	Gorge	45	-	-	-	-	180
Makikihi	Hunter Hall	17	-	-	-	-	70
Waimate Cr	Hannaton Rd	75	-	-	-	-	115
Waimate Cr	Gorge	23	-	-	-	-	50
Kapua Drain	Arno Culvert	7	-	-	-	-	15

TABLE 6 Comparison of 13 March 1986 Flood with Previous Events

River	Site	13 March 1986		Previous Flood Events		
		Stage (m)	Discharge (m ³ /s)	Stage (m)	Discharge (m ³ /s)	Date
N.Ashburton	Gorge	2.54	185	2.516	180	21.10.83
S.Ashburton	Mt Somers	2.12	128	2.515	178	20.4.78
Orari	Gorge	5.2	800	-	1250	Feb.1868
Opuha	Skipton	4.7	630	4.938	841	21.2.45
Opihi	Rockwood	5.14	1020	3.85	570	21.2.45
Tengawai	Cave	4.7	1500	-	837	19.7.61
Pareora	Mt Horrible	4.4	1450	3.29	800	21.2.32
Waihao	McCullochs	7.51	1250	5.9	700	19.7.61
Rocky Gully	Rockburn	2.8	110	-	52.5	17.5.72
Dry Creek	RDR	2.01	57	1.4	28.2	21.3.84

5.3 FLOOD HYDROGRAPHS AT OTHER SITES

This section describes how the flood peak discharges for sites downstream of several main recorder stations were developed. Peak discharges calculated after the 13 March 1986 flood are presented in Table 5. Figure 7 shows the times that flood peaks passed known points on the river systems.

5.3.1 Opihi Saleyards Bridge

The flood peaks and distances above Saleyards Bridge of the main recorder stations are shown below:

River	Site	Flood peak m ³ /s	Time	Distance upstream (km)
Tengawai	Cave	1500	10.30	16
Opihi	Rockwood	1020	10.00	19
Opuha	Skipton	630	8.30	26

The best estimate of the speed of the flood waves is between 2 and 3 m/s, with the larger flood waves probably travelling a little faster.

It is probable that the flood wave in the Opuha would have travelled a little slower than those in the Opihi (the Opuha and Opihi combine at Raincliffe, 15 km above Saleyards Bridge) and Tengawai Rivers. The wave formed would be slightly larger than that in the Tengawai River, hence average flood wave speeds would have been very similar for all three tributaries from the recorder sites to Saleyards Bridge. If this is assumed to be the case then the flood wave peaks would have arrived at Saleyards bridge at the times shown below:

Tributary/Wave Speed	2 m/s	3 m/s
Tengawai	12.40pm	12.00pm
Opihi	12.40pm	11.45pm
Opuha	12.10pm	11.00pm

It is therefore probable that the peaks from all three tributaries combined with each other at Saleyards Bridge at about 12.30 pm.

To calculate a final flood hydrograph allowance was made using unit hydrograph techniques to estimate flood flow contributions from Raincliffe, Totara Valley and other similar streams that rise below the major recorder sites. The flood peaks of these were assumed to have passed before the main river peaks arrived.

Also it is assumed there would be little or no attenuation of the flood waves in the river channel as the bulk of the flood waves were confined to the river channels and valleys above the Saleyards Bridge site. The hydrograph at Saleyards Bridge is shown in Figure 8 and the peak discharge is calculated to be about 3,440 m³/s.

5.3.2 Temuka River

There were three tributaries to the Temuka River that have recorder sites. These are the Waihi, Te Moana and Kakahu Rivers.

The flood wave on the Waihi River was closely monitored by Board staff and is estimated to have arrived at Oxford Crossing, near Temuka at about 1.30 pm.

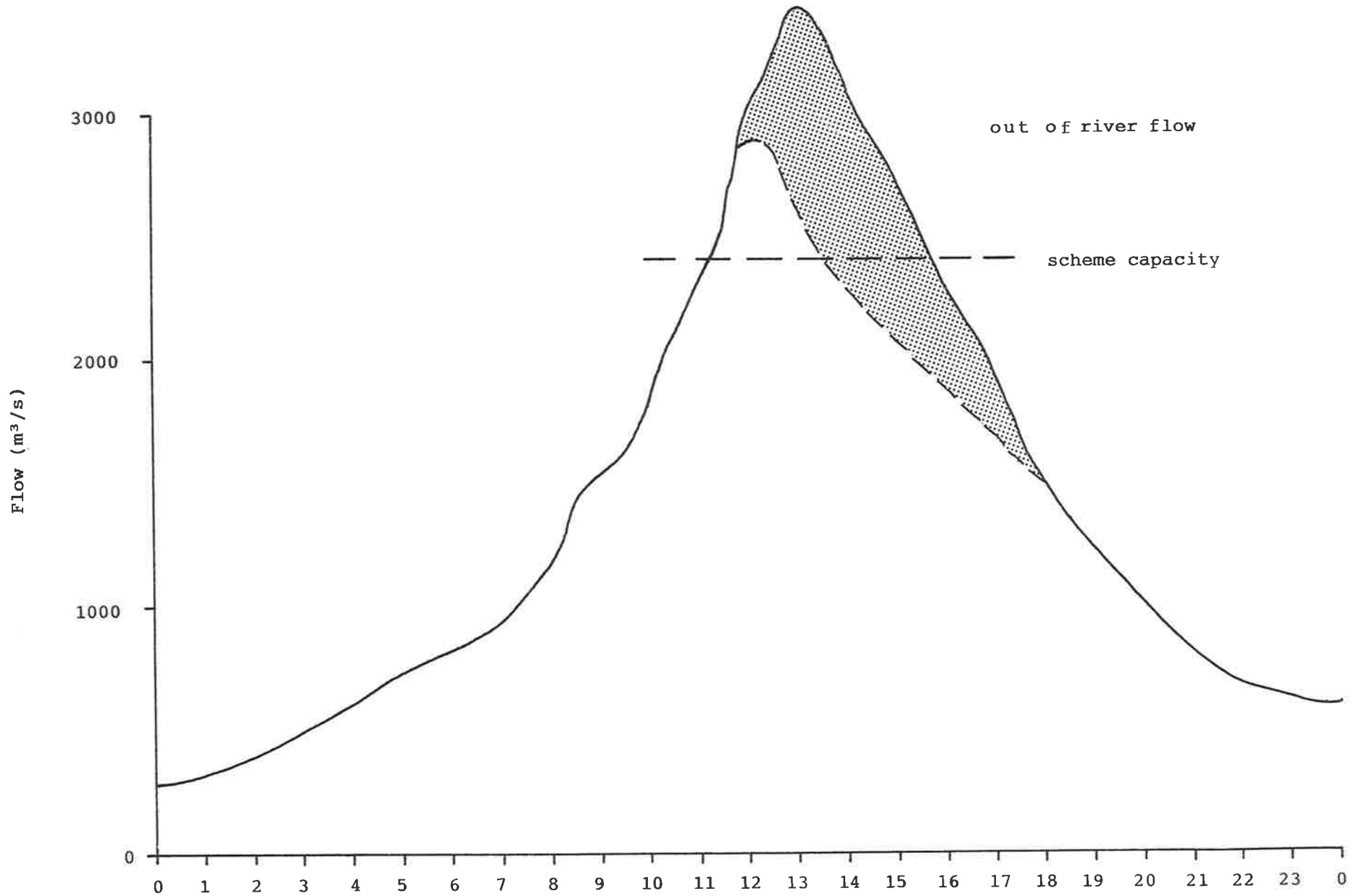


FIGURE 8 Flood Hydrograph - Opihi River at Saleyards Bridge 13.3.86 (Time in hours)

Records are less reliable for the Te Moana. The peak at the recorder site occurred at 8.00 am. From the flood log it is thought the peak reached Toomeys Bridge at 12.00 pm. At a similar wave speed the peak would have arrived at Oxford Crossing at 2.30 pm. Kakahu water enters the river just below Toomeys Bridge. Records for the Kakahu are not available as the recorder malfunctioned. However as this river is flatter and south of the Te Moana its peak would probably have been after the Te Moana.

It is therefore likely that the peak from the Te Moana arrived at Oxford crossing at about 3.00 to 3.30 pm.

From the flood log, the peak of the Temuka at SH 1 is 2.30 pm, hence it is likely the best estimate of the peak time at Oxford Crossing is about 2.00 pm with the flood peaks from all three tributaries almost combining together.

Using the data from Table 4 the peak flows for the Temuka tributaries are estimated to be:

Waihi	Te Awa	300 m ³ /s
Te Moana	Toomeys Bridge	500 m ³ /s
Kakahu	Barbarafield Bridge	500 m ³ /s

It is thought there would be some attenuation as considerable flooding occurred on the Waihi and Te Moana rivers. It is therefore considered that at Temuka, the Temuka River recorded a flood peak of 1,100 - 1,200 m³/s.

5.3.3 Waipopo

From the above discussion the estimated peak discharges and times for the sites above Waipopo are shown below:-

River	Site	Peak m ³ /s	Time	Distance above Waipopo (km)
Opihi	Saleyards Bridge	3440	12.30	15
Temuka	SH1	1100	2.30	4

At 2 m/s wave speed, the peak of the flood wave on the Opihi River at Saleyards Bridge would have arrived at Waipopo at 2.30 pm, with the Temuka River wave peak arriving at 3.00 pm.

These times concur well with the flood log which states that the river at Waipopo was dropping at 2.36 pm.

It is therefore concluded that the peaks of the Opihi and Temuka would have almost combined and that the peak discharge at Waipopo was about 4,400 m³/s. (This figure includes both in river as well as flood plain flows.)

5.4 Flood Frequency

The longest and most reliable flood data series available in South Canterbury is from the Opihi at Rockwood station. This station was established by the Public Works Department and commenced recording on 15 December 1935. The site is relatively stable as a limestone rock bar forms the control downstream from the recorder tower. The annual flood series of instantaneous maximum values, are tabled in

Appendix 4, and have been plotted on Gumbel probability paper using the Gringorten (1963) plotting position formula (Fig 9).

A line of "best-fit" has been fitted by eye to the plotted data. In carrying out this analysis the 13 March 1986 flood was treated as an "historic event" being the largest flood since 1868. Beable & McKerchar (1982) discuss methods for analysing this type of data.

The data plotted on Fig 9 clearly suggests that the 13 March 1986 flood has a return period in excess of 200 years. This is supported by the fact that the previously largest flood, 21 February 1945, with a flow of 570 m³/s and a return period of about 30 years, is only a little over half (56%) of the peak discharge recorded in March 1986.

Another means of examining this problem is to look at the ratio between the flood discharge and the mean annual flood. For Opihi at Rockwood this ratio is 6.75.

Beable and McKerchar's regional flood study (1982) suggests that for South Canterbury the ratio of the 200 yr flood to the mean annual flood is approximately equal to 4.0.

This again suggests that the March 1986 flood is a very large event with a return period in excess of 200 years.

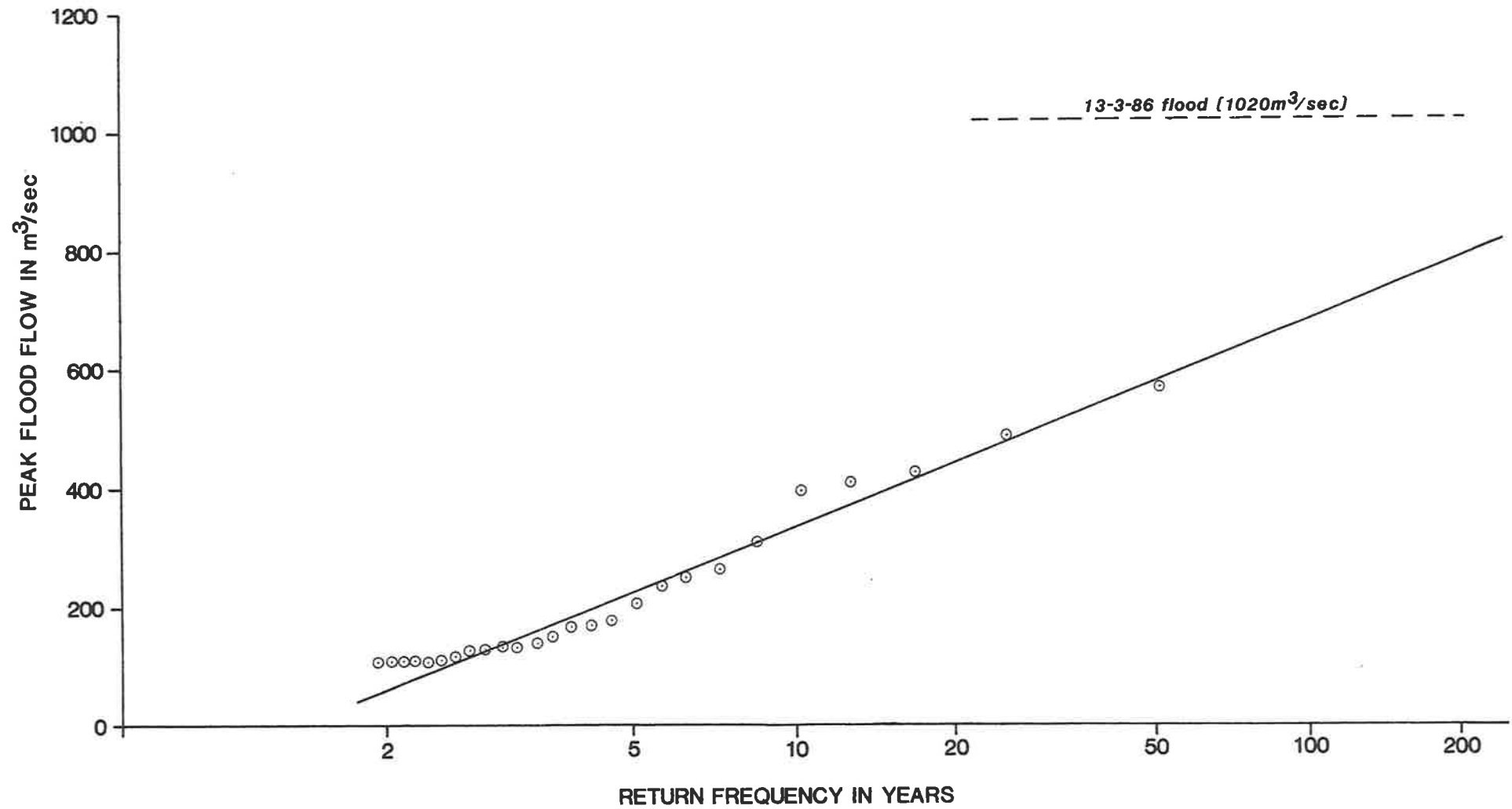


FIG 9: FLOOD FREQUENCY PLOT (GUMBELL)-OPIHI RIVER AT ROCKWOOD

6.0 FLOODING AND SCHEME HYDRAULIC PERFORMANCE

6.1 INTRODUCTION

This section discusses the flooding that occurred in the Boards district, giving an assessment of the river control schemes hydraulic performance during this flood event.

For each river the scheme design hydraulic details and the peak discharge on the 13 March 1986 flood are given. This information is used to develop a picture of the flooding. For the major schemes a more detailed assessment has been carried out using overflows, branches and flood levels. This allows a better assessment of the schemes hydraulic performance and this is shown on the flood hydrographs for various site(s) on each scheme.

Note that in many cases the scheme capacity was enhanced as flood levels were above the stopbanks with spillage occurring over the stopbanks.

A significant feature of the flooding, in valleys such as the Tengawai, Pareora and Waihao, was that floodwaters occupied the entire valley floor between the hills or downlands, completely inundating lower valley floor terraces. This was particularly noticeable in the Tengawai Valley between Cave and Pleasant Point and is shown on the maps in Appendix 5. Maps showing the extent of flooding and the location of damaged Board's river control works are shown in figure 10 and detailed in Appendix 5.

6.2 FLOODING DETAILS

6.2.1 Dry Creek

Design: Grassed waterway channels that have a capacity for about a 10 year event about 20 m³/s and have no outlet at their downstream end.

Flood discharge: 57 m³/s.

The flood overtopped the grassed waterway channels and flooded land adjacent to the channels and downstream of their outlets.

6.2.2 Ashburton River System

The peak discharges on this system were about average annual flows. The river system coped adequately.

6.2.3 Hinds River

Design Discharge: 164 m³/s with 600 mm freeboard (FB)

Flood Discharge: 260 m³/s

Peak discharge passed by scheme: 230 m³/s

The stopbank system almost coped with this event. Overtopping occurred in two places. An overflow of about 30 m³/s occurred on the left bank at Farrells Crossing, causing SH 1 to be blocked. This overflow returned to the river a little below SH 1. A further breakout occurred above Mayfield township on the South Branch on a section that is not stopbanked. Most overflows were returned to

the river above the township. Only a small amount of water passed through the town.

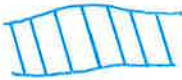
KEY TO SYMBOLS

Plates 1 and 2:



Areas of Flooding

Plates 7 to 18



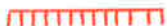
Areas of Flooding



Breached Stopbank



Stopbank Scour



Bank Protection Work



Channel Clearance



Rock Work

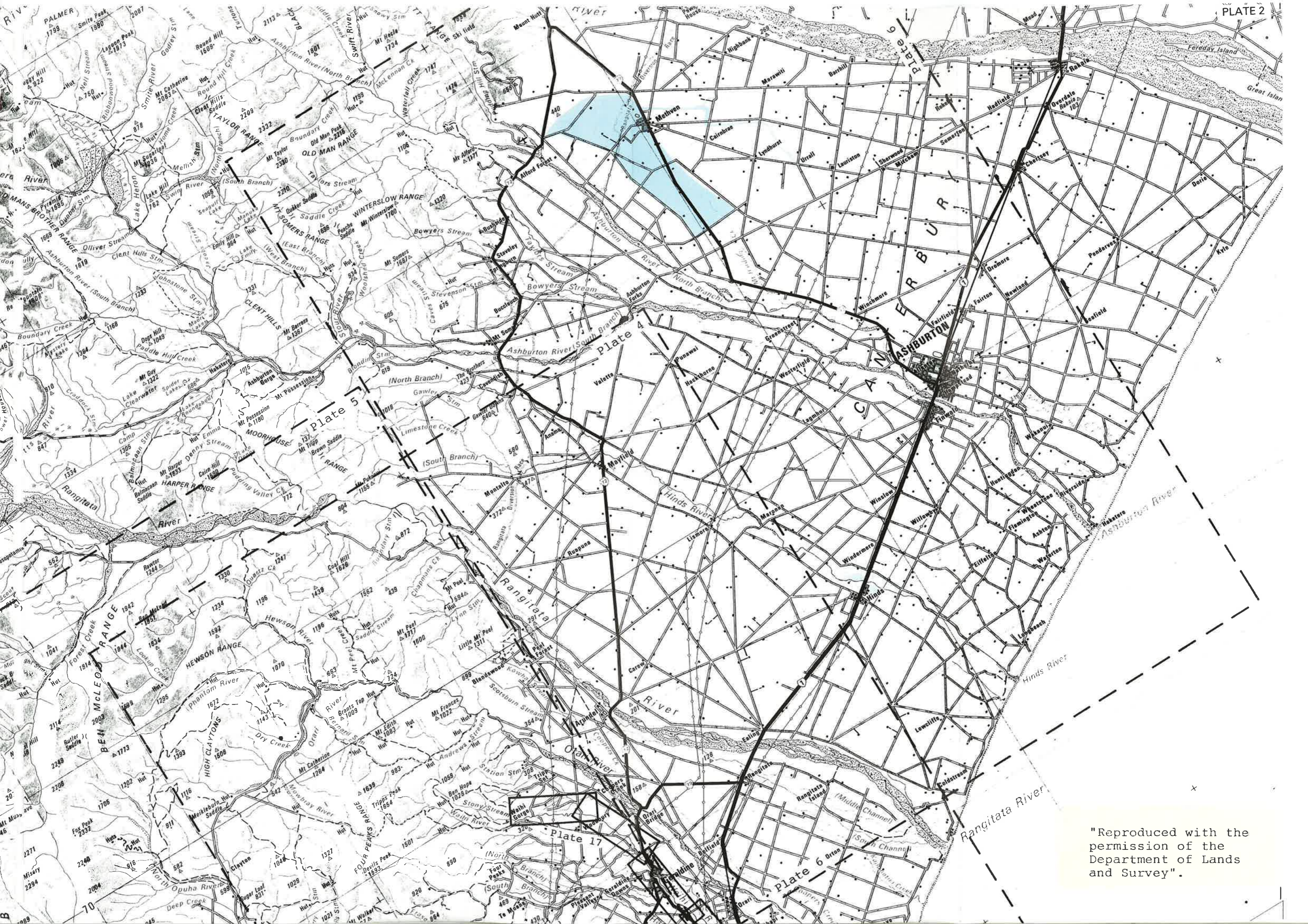


Job No. (Appendix 5A)



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 and Survey".

All aerial photos
 taken 1984 - 1985



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6.2.4 Rangitata River

This river had a small fresh of about quarter the average annual flood.

6.2.5 Orari-Waihi-Temuka Scheme

6.2.5.1 Orari River

Scheme design: 1275 m³/s with 300-750 mm (FB) South Bank
1050 m³/s with no freeboard at Coopers Creek
spillway

Flood discharge: 800 m³/s

Peak flow passed through scheme 800 m³/s.

During the flood freeboards were generally between 1 m and 2 m. In a few places it was less, notably three sites below Badhams Bridge, and on the left bank just below SH 72 Bridge where it was 400 - 500 mm.

Water came to within 400 mm of the Coopers Creek spillway.

Backwater calculations show the reach below Badhams Bridge to have more resistance (larger Mannings "n" value) than originally assumed. The reaches at SH1 and SH72 and the reach above SH 72 all have less resistance (smaller Mannings "n" value) than the Badhams Bridge reach.

Using the freeboards available of the various sites further backwater calculations were done to assess the design capacity of the scheme, and the levels on the recorder when overtopping of the various reaches within this river will occur.

6.2.5.2 Waihi River

Design Discharge: 145-176 m³/s with 600 mm FB

Flood Discharge: 200 m³/s above Barkers Ck confluence

300 m³/s below Barkers Ck confluence

Peak Discharge passed through scheme:

180 m³/s above Barkers Ck confluence

200 m³/s below Barkers Ck confluence

Post flood capacity 80-100 m³/s

Above Barkers Creek confluence a small overflow occurred on the left bank between Gould and Keen Road as a result of afflux cause by the berm reducing in width.

Below the Barkers Creek confluence at Ruakapuka considerable lengths of stopbanks were eroded. However the floodwaters were confined to a terrace about 100 m from the stopbank line and only a small overflow occurred through Geraldine East.

The rest of the flood flow remained in the river passing through Geraldine. Below Geraldine considerable lengths of banks were overtopped with some breaches occurring.

On the true left bank a maximum of 70 - 80 m³/s overflowed from the river with most of this being returned to the river at the Dobies Creek lap bank.



Hinds River within 300mm from top of stopbank between Poplar Road and Surveyors Road (Black Bridge).



Orari River from near Coast looking inland. Photograph taken at peak of flood.



Waihi River. View south from SH72 towards Temuka in background. Winchester township in left foreground. Note the flooding along Dobies Creek to left of main river channel UEB (Waihi) Woollscour complex (centre of photo).

On the right bank a maximum of 30 - 40 m³/s overflowed returning to the river at creek lap banks and the confluence with the Te Moana River.

A peak of 200 m³/s remained in the main Waihi River channel. However the lap bank at Dobies Creek resulted in overflows returning to river and almost all the flood discharge being passed into the upstream end of the Temuka River.

After the stopbanks were breached overflows would have continued until the discharge in the river had receded to about 80 - 100 m³/s.

6.2.5.3 Te Moana River

Design discharge: No scheme.

Flood discharge:	Sheepdip Bridge	310 m ³ /s
	Speechleys Bridge	500 m ³ /s
	Below Kakahu Confluence	900 m ³ /s

This river has no comprehensive scheme. Only localised Boards works are carried out on this river.

A large breakout occurred on the true left bank above Speechleys Bridge with some overflows meeting up with Waihi River overflows.

On the true right bank immediately above Oxford Crossing a considerable length of old stopbank was overtopped and breached resulting in 300 to 400 m³/s bypassing the Temuka River at its upstream end (Oxford Crossing).

6.2.5.4 Temuka River

Design discharge:	Left bank	720 m ³ /s with 600 mm FB
	Right bank	Up to 720 m ³ /s
Flood discharge:		1100 m ³ /s

Maximum discharge passed by scheme	above SH 1 Bridge	800 m ³ /s
	at Confluence	900 m ³ /s

Post flood capacity 200 - 300 m³/s at breaches.

As discussed on the Te Moana River 300 - 400 m³/s bypassed the Temuka River at Oxford Crossing. Freeboards below Oxford Crossing on the true left (Temuka Township) side were about 1.5 m until the Insulator Works where the bend in the river forced part of the breakout water on the right bank back into the river. Here some minor overtopping occurred on the left bank at the rubbish dump and at Manse Bridge. At this point about 200 m³/s was bypassing the river on the true right bank.

Overtopping also occurred on the left bank from about 400 m upstream of the State Highway One Bridge to the railway line. Overtopping and a breach resulted in the south end of Temuka being inundated with water ponding back up from the stopbanks and railway line.

The river passed a peak of about 800 m³/s through the schemes confines. This statement is however a little misleading as to the capacity of the river on the right bank insofar that water was held within the scheme by the flood overflows.

Below the Golf Course considerable overtopping and eventual breaching occurred on the true left bank. A peak flow of 600 - 700 m³/s left the river after breaching, flooding the Orakipaoa Island area.

6.2.5.5 Orari-Waihi Tributaries

These are generally designed for 10 year return period flood events. For the major streams the design discharges and flood estimates based on the flow in the Waihi River are given.

Stream	Design Discharge	Flood Discharge
Barkers Creek	36 m ³ /s	100 m ³ /s
Sweetwater Creek	51 m ³ /s	100 m ³ /s
Scotsburn Creek	21 m ³ /s	50 m ³ /s

6.2.6 Opihi River System

This is done in sections. To obtain a more comprehensive picture of how the flooding developed it is described from the upstream end.

6.2.6.1 Opihi-Bedells Corner to the Tengawai Confluence

Design Discharge: 1,500 m³/s with 300 mm FB
 Flood Discharge: 1,870 m³/s
 Maximum discharge passed through scheme: 1,800 m³/s
 Post scheme capacity: 300 - 500 m³/s at left bank
 1,800 m³/s at right bank

Overflows occurred in several places on this reach, especially where the berm width narrows. One 40 m breach occurred on the left bank. All overflows eventually returned to the Opihi River at the Tengawai River confluence on the right bank and just below Saleyards Bridge on the left bank. The capacity of this reach is greater than the design as the fairway width of river this point (180 m) is wider than the design requirement of 137 m.

6.2.6.2 Tengawai River

Design Discharge: Below Hammonds Road 880 m³/s with 600 mm FB
 Above Hammonds Road it varies from 500 m³/s -
 1,000 m³/s.
 Flood Discharge: Above Totara Valley Stream Confluence -
 1,500 m³/s.
 Below Totara Valley Stream Confluence -
 1,650 m³/s.

Maximum discharge passed by the scheme: 1,100 m³/s.

Post scheme capacity about 300 m³/s right bank
 about 900 m³/s left bank.



Te Moana River from Temuka (right foreground) looking upstream towards Geraldine.



Flood protection along Tengawai River (to left of photo) overtopping and floodwaters inundated Pleasant Point township. Looking towards coast, lower Opihi River in top left.



Washdyke looking north along State Highway 1.

The flood inundated most of the right side of the valley above the major stopbanks.

At Hammonds Road about 100 m³/s completely passed the major scheme stopbank with a further 170 m³/s overtopping the stopbank between its end and where it meets the berm trees. Most of this water subsequently inundated Pleasant Point.

The capacity of the major scheme banks below Hammonds Road was enhanced as water levels were above the stopbank heights for most of this reach, with water overflowing the stopbanks.

6.2.6.3 Opihi Tengawai Confluence to Temuka Confluence

Design Discharge: 2,400 m³/s with 300 mm FB
 Flood Discharge: 3,400 m³/s
 Maximum Discharge passed by the scheme 2,900 m³/s
 Post Scheme Capacity: 500 - 800 m³/s right bank
 2,600 m³/s left bank

Overtopping which developed into a major breach occurred on the right bank from Saleyards Bridge to Mill Road. More overtopping occurred at Kerrytown Road on the right bank and at several places just below Walker Road on the left bank. A peak overflow on the right bank estimated at 1,000 m³/s would have occurred adjacent to this reach when the breaching of stopbanks on the Tengawai and Opihi Rivers were fully developed. Calculations indicate that this would have occurred after the peak discharge. The estimated overflow from the flood hydrograph at Saleyards Bridge can be seen in Figure 8.

Again the capacity of the scheme was greater than the design as the river fairway was wider at about 250 m compared to the design of 152 m. At Saleyards Bridge where the river fairway is narrow, approximately 170 m, the scheme capacity was enhanced as flood levels in the centre of the fairway were higher than the stopbanks.

6.2.6.4 Opihi - Temuka Confluence to the Mouth

Design Discharge: 3,130 m³/s with 300 mm FB
 Peak Discharge: 4,400 m³/s
 Estimated maximum discharge passed through scheme 3,700 m³/s
 Scheme capacity post flood about 1,500 m³/s left bank
 3,700 m³/s right bank

On this reach a major breakout occurred just below the Temuka River confluence on the left bank, while on the right bank a small overflow occurred just above Waipopo Huts as a result of afflux caused by the berm width narrowing sharply in this area.

6.2.7 Washdyke Creek

Scheme Design: 144 m³/s with 600 mm FB
 Flood Discharge: 220 m³/s
 Estimated maximum discharge passed through scheme 185 m³/s
 Scheme capacity after flood 160 m³/s

Overtopping of the scheme occurred above the SH 1 Bridge. While the constriction this bridge forms in the channel has been allowed for in the design, the peak flow on this occasion

exceeded the bridge waterway capacity and the water backed up to overtop the stopbanks on both sides of the channel resulting in severe flooding to the Washdyke industrial section. It is of note the channel was at capacity downstream, as the stopbank was just overtopped immediately downstream of the bridge.

6.2.8 Pareora River

Scheme Design: Holme Station Bridge 400 m³/s with 300 mm FB
SH 1 Bridge 500 m³/s with 300 mm FB

Flood Discharge: Pareora Huts 1,450 m³/s
Estimated maximum discharge passed through scheme 900 m³/s
Post scheme capacity: 200 - 300 m³/s at breaches.

The Scheme was completely overwhelmed with large overflows outside the stopbanks. The first major breakout on the scheme occurred at the Pareora Huts where the stopbank was overtopped by 700 mm and breached. This resulted in a large flood overflow. Further breakouts occurred in many places down the river.

The scheme only served to reduce a small amount of flooding by confining more water between the stopbanks than would have otherwise occurred. Little more areal extent would have been flooded without the scheme as the whole valley floor was filled.

The scheme would have reduced the depth of flooding by confining water, with the resultant saving of soil erosion and subsequent loss.

6.2.9 Otaio River

Design: None. The scheme only maintains bank erosion measures, and has no stopbanking. Flood Discharge: 180 m³/s at the gorge. About 500 m³/s at SH 1.

6.2.10 Makikihi

Scheme Design: To confine a flow of 195 m³/s to a floodway with a fairway width of 45 m.

Flood Discharge: 70 m³/s at Hunter Hall. Estimated to be 300 m³/s at SH 1.

6.2.11 Hook River

Scheme Design: 32 m³/s developing to 66 m³/s. It is estimated to have a present capacity of about 50 m³/s.

Flood Discharge: Estimated 230 m³/s at SH 1.



Pareora River from coast looking west. SIMT Railway Bridge right centre (Courtesy N.Z. Airforce).



Bradshaws Bridge on Waihao River. Flood debris demolishing the handrails. (Courtesy M.E. Bruce).



Waihao River at mouth (right foreground) looking west. River channel follows line of willow trees extending from upper left to right in photo. (Courtesy N.Z. Airforce).

6.2.12 Waimate Creek

Scheme Design: 84 m³/s below Waimate.

Flood Discharge: 50 m³/s in Gorge.

Maximum discharge passed through scheme 110 m³/s at Hannaton Road.

There were considerable overflows of the scheme stopbanks with flooding on both sides of the lower river.

6.2.13 Waihao River

Scheme Design: 710 m³/s with 300 mm FB

Flood Discharge: 1,250 m³/s at McCulloughs Bridge

Maximum discharge passed through scheme: 530 m³/s at Bradshaws Road.

Above the scheme, water broke out just above SH 1 on the left bank with overflows passing through to Willowbridge Creek. On the right bank overflows also bypassed the scheme immediately above the SH 1 Bridge.

Considerable overtopping and breaching of scheme stopbanks occurred on both banks of the river.

On the north side (true left) stopbanks were overtopped and breached below SH 1 and while this water was returned at the Railway Bridge, further overtopping occurred below the Railway Bridge and below Lundies Ford. This flooding was returned to the river above Bradshaws Bridge. A further breakout occurred above Bradshaws Bridge that inundated the paddock to the west of this bridge and blew the stopbank at its downstream end.

On the south side (right bank) overtopping and eventual breaching occurred over most of the stopbanks to just below Bradshaws Bridge.

6.2.14 Dog Kennel Creek

Scheme Design: 54 m³/s

6.3 ESTIMATE OF FLOODING THAT WOULD HAVE OCCURRED WITHOUT THE BOARD'S MAJOR SCHEMES

6.3.1 Ashburton River System

6.3.1.1 North Ashburton River

This is the only river on this scheme that would have had significant flooding. This would have occurred in the Blands area and downstream. The extent of flooding that would have occurred would have varied depending on the effectiveness of the stopbanking in place at the time. This would vary as a result of the effects of the aggradation that is taking place.

The scheme in this reach would have been bank full if the recent (1985) stopbanking had not taken place.

6.3.2 Hinds River

The flood in the river is one of the largest recorded with some overtopping occurring. Had this flood occurred in pre-scheme days the flooding would have been similar to that of 1951 or 1952 with about 2,000 ha of land being inundated.

6.3.3 Orari River

The flood in this river had about the same cross sectional area at the gorge as the 1951 flood. It is likely that the hydrograph peak this time was sharper than in 1951, hence flooding would have been a little less with about 4,500 ha flooded, with some floodwaters entering the Waihi Temuka system.

6.3.4 Waihi River

The peak discharge in this river is estimated to be similar to the 1945 flood, however the flood wave may have had a sharper peak than in 1945. Flooding therefore would have been a little less severe to that in 1945. This would have resulted in about another 2,000 ha of land being inundated.

6.3.5 Temuka River

The discharge in the Te Moana and Kakahu Rivers was above the 1945, and would have balanced the overflow from the Orari River that occurred in 1945, hence flooding would have been similar to that of 1945, with 600 - 900 mm of water through the Temuka Township.

6.3.6 Opihi River System

6.3.6.1 Tengawai River

Above Hammonds Road flooding would have been deeper where it was confined by the valley wall, and may have completely inundated the flat just above Pleasant Point if the scheme works had not been in place.

At Hammonds Road much larger quantity probably 600 - 700 m³/s instead of 270 m³/s would have overflowed into Pleasant Point.

At the confluence with the Opihi about 1,200 m³/s of water instead of a peak of 800 m³/s would have overflowed from the river. This would have increased flood levels by 0.3 - 0.5 m.

6.3.6.2 Opihi River above Tengawai Confluence

A large area of land, to the terrace on the left bank, and well past the Pleasant Point Hanging Rock Road would have been inundated.

6.3.6.3 Opihi below the Tengawai Confluence

The peak overflow pre-scheme would have been over 2,000 m³/s instead of the 1,000 m³/s that occurred. This would have resulted in greater flood depths and probably most of the Level Plains north of SH 8 being inundated.

It is estimated that an extra 12,000 ha of land adjacent to the Opihi River would have been flooded without the scheme.

6.3.6.4 Pareora River

Flooding would have covered little more areal extent pre-scheme, as it was confined by the river valley terraces. However the scheme considerably reduced the depth of flooding, and hence the soil loss on the land that was flooded.

6.3.6.5 Waihao River

The scheme capacity on this river was well surpassed, however scheme stopbanks would have reduced the flood overflows by about 400 m³/s. This would have saved an estimated 500 ha of land from flooding.

7.0 FLOOD DAMAGE

7.1 INTRODUCTION

This section outlines the damages that resulted from the 13 March 1986 flood event.

The damages to scheme works are outlined and their performance is discussed.

7.2 DAMAGES TO SCHEME WORKS

The total cost of damage to SCCB river control works by the 13 March 1986 flood is estimated at \$6.17 million. (MWDCCI 2600).

7.2.1 Dry Creek Shingle Stabilisation Scheme

Damage	Drop structures	\$ 4,000
	Grassed waters	\$10,000
	Snagging	\$1,000

Total capital works installed to date \$135,000 CCI 2600

Most of the damage occurred on a recently constructed grassed waterway which was almost totally destroyed. The cost of repair is about the cost of the original work. Damage to the remainder of the scheme works was slight at 3% considering this is the largest flood since records began in 1963.

7.2.2 Ashburton River System

7.2.2.1 Upper Ashburton Catchment Control Scheme

Stopbank damage	\$4,000
Instream damage to Bank Protection Works	\$115,000
Drop structure damage	\$5,000
Total capital works installed to date	\$1,750,000 CCI 2600

The damage to scheme works was 7% of the total capital works. These rivers received about average annual freshes. Most of the damage resulted from lateral bank erosion.

7.2.2.2 Lower Ashburton River Improvement Scheme

Scheme damage - instream works	\$41,000
Capital works from 1964 to date approx	\$6,280,000

Damage to scheme works are slight considering the river was subjected to about an average annual fresh. This is due primarily to the works being well established. Damage only occurred at local spots as a result of lateral bank erosion. The works damaged were relatively heavy training works that had been recently installed.

7.2.3 Ashburton Hinds Drainage

Shingle removal \$11,500

This damage was due to flood overflows from the Hinds River entering the drains, exceeding their capacity with the resultant bank erosion causing shingle to be deposited in the drains.

7.2.4 Hinds River

Lower River Scheme Damage	Stopbanks	\$5,000
	Instream	\$26,000

Total capital works estimated to date		
	stopbanks	\$700,000
	training works	\$2,100,000

This river control scheme was bank full with overflows occurring in several places. Damage to scheme works is extremely light at 1% of the total capital works. This is the result of the training works being well established and the type of works, mainly anchored willows being able to cope well with the scour depth experienced on this river.

7.2.5 Orari-Waihi-Temuka River Scheme

Summary

Total damage to works	\$1,237,000
Total scheme capital cost to date	\$26,550,000

7.2.5.1 Orari River

Damage to works - instream	\$150,000
Total capital works - stopbanks	\$8,500,000
- training works etc	\$11,000,000

This scheme was subjected to a discharge of 65% of the design flow. The damage caused by lateral bank erosion is very light at 1.4% of the schemes training works.

Damage was almost wholly confined to the reach above SH 72. Here it was mostly to recent fairway edge planting. Some repairs are needed on the old pile and rope retards.

The remainder of the damage consists of snagging and channel improvements over the whole river, and replacement of lost willow protection at one site just below the SH 1 Bridge.

7.2.5.2 Waihi River

Damage to works - stopbanks	\$122,000
- instream	\$366,750

Total capital works - stopbanks	\$1,600,000
- instream	\$1,700,000

This river was subjected to a flood with a peak discharge of 75% above that of the design. Considerable overtopping and erosion of stopbanks and loss of training works occurred.

It is also worth noting that this river in its reaches below the confluence with Barkers Creek was subjected to a flood approaching the design discharge on 25 February 1986. Minor overtopping occurred in several places during this event.

Damage to scheme works is 15% of the total capital works. A further breakdown reveals that repairs to stopbanks are 7.6% of their total cost and repairs to training works was 22% of the total cost.

Approximately 1,000 m or 2.5% of the stopbanks were destroyed with a further 600 m or 1.5% suffering damage from overtopping.

There were two large stopbank repair jobs. These were at Hawke Road where there is a tortuous river alignment and at Ruakapuka where the design only allowed for a 30 m wide fairway, with the stopbank in this reach having very little berm protection (in many places it was just gorse).

Damage to instream works was greater on the upper reaches of the river where it contained a greater discharge and is steeper.

7.2.5.3 Temuka River

Damage to scheme works - stopbanks	\$34,000
- training works	\$92,000
Total capital cost - stopbanks	\$340,000
- training works	\$920,000

This river was passed a discharge of about 20% above design, despite a large portion of the flood flow bypassing the river to the west.

The damage to scheme works was 10% of the total capital cost for both the stopbanks and training works.

The bulk of the stopbank damage occurred over the first 1.5 km above the Opihi confluence, where considerable lengths of stopbank were overtopped and 250 m was breached.

The fairway over this reach is choked with willows and only a very narrow cleared fairway exists. The inadequate waterway caused higher flood levels than what was intended with the design fairway width, resulting in considerable overtopping compared to the other reaches. The other breaches occurred as a result of overtopping upstream of the railway and SH 1 Bridges.

7.2.5.4 Opihi River Left Bank Temuka to Mouth

Damage to works - river stopbanks	\$18,000
- training works	\$42,000
- lagoon stopbanks	\$43,500
Total capital cost scheme works - river stopbanks	\$140,000
- training works	\$670,000

This section of river was subjected to and passed a flow of 20% above the design flow. The stopbank damage on the river was at the Temuka confluence where 250 m was breached. The cause is discussed above in the Temuka river section. However this was compounded at this point by the berm narrowing at this point and having not been planted out. The latter would have resulted in a larger flow than intended in the berm area, which at the downstream end where the berm narrows would not have been able to return to the fairway without considerable afflux.

The training works damaged on this reach included the new rip-rapped bank adjacent to Milford Huts. Its downstream end that angles out into the fairway was overtopped. It also included a large rail and rope groyne and bank opposite Waipopo Huts, that was undermined as the river thalweg channel moved downstream during the flood.

The cost of repairs to this section was 7% of the total capital cost of works in this reach.

Breaching occurred on the lagoon stopbanks. These banks lay in the path of overflows from the Temuka and Opihi Rivers and were overtopped from the landward side.

7.2.5.5 Minor Streams

Total damage	\$ 302,000
Total capital works to date	\$1,703,000

Damage to these streams consists of snagging and bank erosion repairs. Below is itemised a list of damage and the total capital cost of works to date of these minor streams.

Creek or Stream	Damage \$	Total Capital Cost to date \$
Sweetwater	33,250	335,000
Barkers	73,000	330,000
Coopers	42,000	320,000
Scotsburn	50,000	280,000
Ohapi	10,000	57,000
Serpentine	1,500	60,000
Smithfield	5,750	37,000
Dobies	4,500	39,000
Taumatakahu		30,000
Orakipaoa	Contingency item	56,000
Bain	20,000	20,000
Ruakapuka		100,000
Kowhai		5,000
Milford		17,000

The capital works on these creeks are generally to give them a flood capacity to cope with a 10 year flood. The work consisted of stopbanks and training works on the larger streams, while on the smaller streams it was mostly snagging and clearance work.

On the smaller streams mostly clearance and snagging is required to return them to their original state. Damage to the larger creeks is higher at 10-20% of the total capital works as these creeks are narrow being only designed for 10 year events.

The large amount of damage on Scotsburn Creek is for the repair of gravel traps.

7.2.5.6 Upper Catchment Works

Estimated damage to works (uninspected)	\$ 15,000
Total capital value of works to date	\$707,720

At the time of writing there has been no inspection of these works.

7.2.6 Opihi Catchment Control Scheme

Total damage to works \$ 2,650,000

Total capital works \$21,500,000 (includes \$9,500,000)

7.2.6.1 Lower Opihi River

Damage to works - stopbanks	\$239,000
- instream	\$525,000
Capital cost of scheme works - stopbanks	\$2,105,000
- instream	\$6,800,000*

*(includes \$2,500,000 prior to 1971)

A more detailed summary of lower river damage is shown on Table 7.

Almost all the damage to the stopbanks is from overtopping. There were two instances of lateral bank erosion of stopbanks.

In both cases the berm area adjacent to the erosion had not established properly, with the damage being a result of high water velocities against or very close to the stopbanks.

The remainder of the stopbank damage was from either breaching (570 m) most of which occurred on the left bank of the Tengawai, and scour of the outside toe (1,200 m).

Damage to the instream works was mainly confined to the fairway edge protection works. These works were undermined on the falling limb of the flood hydrograph as the new thalweg pattern established. The largest amount of berm lost through lateral erosion was 50 m at one point on the reach above Pleasant Point. At most damage sites the lateral bank erosion extended about 20 m to 30 m into the berm.

From the summary, damage to instream works was approximately proportional to discharge. The high amount of damage on the Opihi - Sea to Temuka confluence, is a result of a narrow fairway and large (5 m) scour depths. The latter had necessitates more expensive training works to be installed to protect the stopbanks, with the resultant higher repair cost.

7.2.6.2 UPPER CATCHMENT WORKS

Damage to scheme works - stopbanks	\$177,000
- training works	\$1,709,000
Total capital cost of works - stopbanks	\$500,000*
- training works	\$10,500,000**

* (installed prior to 1971)

** (includes \$7,000,000 prior to 1971)

Damage to the stopbanks mostly occurred on the Tengawai River below Cave. These banks were 150 mm above the 1951 flood levels and were overwhelmed. In many cases there were no training works adjacent to the stopbanks. This resulted in a very large scour hole when a breach occurred, resulting cost to repair the breach being well in excess of the initial construction cost of the bank over the breached length.

Table 7 Flood Damage to River Control Works

Reach	Maximum Discharge Passed m ³ /s	Length km	Fairway width m	Damage to in-stream (\$)	Damage per km (\$/km)	Damage to stop banks (\$)	Stopbank Damage per km (\$/km)	Total Damage per km (\$/km)
Sea to Temuka	3700	3	120-300	115,500	38,500	23,000	7,600	46,000
Temuka to SH1	2900	4	200-300	79,000	19,750	-	-	19,750
SH1 to Tengawai	2900	11	200-300	230,500	21,000	136,500	12,400	33,400
Tengawai to Bedells	1900	8	150-200	118,750	14,800	45,500	5,600	20,400
Tengawai-Opihi Con. to Hammonds	1100	4	80-130	23,000	5,750	52,000	13,000	28,750

A summary of the damage to training works is as follows:

River	Length km	Damage \$	Damage/km \$
Tengawai Catchment			
Tengawai			
Hammonds to Cave	10	107,500	10,750
Remainder	101	514,400	5,100
Opihi Catchment			
Opihi			
Bedells to Gorge	13	186,750	14,300
Gorge to Horseshoe	20	169,400	8,500
Remainder	92	374,000	4,000
Opuha Catchment	103	282,400	2,700

Damage to stream training works is approximately in proportion to the size of the stream and the discharge that they were subjected to. If \$15,000 can be taken as an average cost to install stream control works per 1 km then the streams on the Tengawai Catchment suffered a 30% loss, Opihi Catchment 25% and Opuha Catchment 18% loss.

Damage to these works is mostly lateral bank erosion. On the smaller stream considerable clearance work is required as many now mature trees have been undermined and now block the stream fairway.

On the larger tributaries, clearance work is also necessary, however the bulk of the cost is in reinstating lost bank protection measures.

The gravel traps in the upper tributary streams of the Tengawai were completely overwhelmed with the gravel stored in them lost downstream. In the Opihi and Opuha Catchments where the flood flows were less severe the gravel traps did not fail however they did suffer considerable damage.

7.2.7 Pareora River

Damage to - stopbanks	\$117,500
- training works	\$247,225
- grassed waterways	\$42,000
Capital cost of works to date - stopbanks	\$370,000
- training	\$1,517,000
- grassed waterways	\$505,023

Damage to the stopbanks was considerable at 30% of their original cost. However only 6% of the banks were lost. This high cost is a result of many banks being unprotected by training works adjacent to them. This results in a large scour hole through the breach as more water is able to flow through it then if the berm land inside was planted.

Damage to the training works was from lateral bank erosion. Only 16% of installed training works were lost, a relatively low figure considering the discharge the scheme was subjected to. As calculated above the scheme works passed only 900 m³/s or 60% of the total flood discharge, this flow being 180% of the design discharge for scheme.

Damage to the grassed waterways was caused by flood waters that had broken out of the scheme works. The waterways crossed the flood plain at right angles to the flows, with the flood waters scouring out holes in the grassed waterway banks. The failures were similar to the stopbank failure discussed above with a large scour hole in each breach and therefore expensive to repair.

7.2.8 Otaio River

Damage to training works \$79,800
 Total capital cost of scheme works \$200,000

Damage to these works is from lateral bank erosion, which is the main objective of the works. It is worth noting that this river was subjected to a large fresh which had occurred earlier in the year. This may have contributed to a very large damage bill (about 40% of the scheme works) by developing bars in the river what were reworked by the 13 March 1986 flood.

Another reason is that bank erosion measures are by there nature expensive to install and maintain especially on this deeper scouring river. Most measures were installed in the 1950's and were very well established, yet they still suffered a large amount of damage.



Overtopping and subsequent breaching of the stopbank at Pareora Huts caused major damage to buildings, roads and services in the area.



Many bridges throughout Strathallan and Waimate Counties sustained major damage. Brasells Bridge built in the early 1900s was extensively damaged.

7.2.9 Makikihi River

Damage to scheme works \$15,000

Total capital cost of scheme works to date \$25,000

Most of the training works have been lost on this scheme. However these works were not well established, having only been installed for four years.

7.2.10 Hook River

Damage to scheme works - stopbanks	\$ 4,000
- training works	\$34,500

Total capital cost of works - stopbanks	\$30,000
- training works	\$71,000

This scheme was completely overwhelmed with the bulk of the flood waters outside it. However considerable damage occurred as a result of lateral bank erosion and stopbank overtopping.

7.2.11 Waimate Creek

Damage to scheme works - stopbanks	\$2,000
- training	\$11,700

Capital cost of works - stopbanks	\$120,000
- training	-

Damage to this scheme was bank erosion of the stopbanks in the lower reaches.

7.2.12 Waihao River

Damage to scheme works - stopbanks	\$155,000
- training works	\$82,250

This scheme was subjected to a flow of 1,250 m³/s or 179% of the design capacity of this scheme. Considerable overtopping of stopbanks occurred on the upper half of the scheme with the resultant breaching 800 m and bank scour 2,100 m of stopbanks.

Damage to the training works was mainly to the fairway edge protection measures, that were undermined as the new thalweg channel reformed after the flood event. This damage was mostly on the upper half of the scheme where works have only been recently established.

7.2.13 Sinclairs Creek

Damage to works	\$ 30,000
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Capital cost of works	\$217,000
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Damage to the scheme works was caused by the floodwaters from the Waihao River. Most of the damage occurred on the donga where considerable lengths of bank were breached as a result of floodwaters discharging out of the mouth that formed through the coastal beach at this point.

7.2.14 Morven Drain

Damage to works	\$ 13,750
Initial capital cost of works	\$380,000

Damage to this grassed waterway channel is mainly bank and bed scour. Some repairs are necessary to fences, culverts and flap valves.

7.3 OTHER DAMAGE

Damage to areas and works outside the Board's schemes have been assessed on a regional basis only to date. It is the intention of Board staff to complete a more detailed investigation for each catchment as this information is extremely important in assessing the economic performance of the schemes and the possibilities of future works.

Details of repair costs available at the time of writing are:

	\$million
Industrial and Commercial Properties	20
Houses and Domestic Properties	10
Estimate of uninsured property (1/3rd of insured losses of \$30 m)	10
Roads and Bridges	19
Farms, stock and crop losses	6.2
Railways	1.0
Water and Sewage Schemes	2.5
Total	\$68.7m

7.4 COMMENT

Overall, considering the magnitude of the 13 March 1986 flood, the Board's river control works functioned extremely well successfully conveying huge volumes of water to the sea. Had the control work not been in place a far greater area of land would have been inundated and areas that were flooded would have been flooded to greater depth. Much of the flooding which occurred arose from the fact that the flood peak discharges greatly exceeded the scheme design discharges, e.g. Tengawai, Pareora and Waihao Rivers. In these situations the flood water simply overtopped the stopbanks which acted like side-spill weirs, remaining essentially intact.

Major breaches of stopbanks were relatively few. The most significant were:

- (i) on the Temuka River near its confluence with the Opihi River where a peak flow of 600-700 m³/s left the river and flooded the Orakipaoa-Milford area.
- (ii) on the Tengawai River and at the Opihi River confluence, where over a considerable length of river, a peak overflow of about 1,000 m³/s occurred on this reach after the stopbanks were breached, resulting in widespread flooding on Levels Plains and in the Seadown area.

- (iii) on the Pareora River at and below the Pareora Huts where the scheme was overwhelmed with 500-600 m³/s flooding farmland in the valley.
- (iv) on the Waihao River where a peak overflow of 550 m³/s occurred on the south bank flooding the Maori Road area.

8.0 LAND DAMAGE

8.1 Damage Assessment

The type and extent of land damage resulting from the storm was assessed in a variety of ways.

- (a) Reconnaissance ground and aerial inspections during and immediately following the storm provided visual damage assessment and oblique 35 mm photographic records.
- (b) A systematic ground assessment by SCCB staff surveyed sample sites within known damaged areas for type of damage (erosion/deposition), extent of damage, landform, possible rehabilitation measures.
- (c) Systematic vertical aerial photographic coverage of the major rivers and adjoining flood plain areas using 120 colour negative film.
- (d) Vertical aerial video coverage of sample areas of known damaged areas.
- (e) Collation of SCCB requested data in a MAF questionnaire used on all farms reporting storm damage. The requested data included in the questionnaire is shown in Appendix 6.
- (f) Observations by SCCB staff based on subsequent normal farm visits.

8.2 Results of Land Damage Assessments

The type and extent of land damage varied throughout the district depending on land type (landform, geology, vegetation, ground cover, soil depletion), storm rainfall, surface runoff/inundation and land use.

8.2.1 Type of Land Damage

Table 8 gives the broad land types and associated damage.

Table 8: Land Types and Damage

Land Type	Type of Land Damage
(a) Steep (>20 deg) non arable (tussock grasslands on hill and mountain lands, rough pasture/scrub on steep downlands facings - mixed lithologies)	Slip, Gully, Streambank, Streambed, Deposition, Slump
(b) Undulating to strongly rolling (4-20 deg), arable (cultivated downlands under pasture and crop mainly on loess)	Rill, Deposition, Streambank, Slip, Gully, streambed
(c) Flat to undulating (0-7 deg) arable (crop and pasture land on alluvium - old to modern flood plain)	Soil Loss (Scour), Deposition, Streambank, Streambed/Riverbed



Stopbank (true right bank) immediately upstream from Saleyards Bridge (Opihi River) demonstrating process of stopbank failure. Flow overtopping the bank erode the stopbank from the top back towards the river side of the bank (mid photo) until eventually the bank is totally breached (top left photo).



Shingle deposited onto farmland carried by flow through the breach in the stopbank (mid photo).



Out-of-channel flows caused major soil loss with some paddocks adjacent to the stopbanks being stripped completely bare down to the underlying shingle material.

8.2.2 **Extent of Land Damage** - Table 9 summarises the extent of damage as collated from the SCCB requested data in the MAF questionnaire.

Table 9a Orari Catchment

Number of farms surveyed	8
Approximate total farm area (ha)	37459
Approximate total farm area flooded (ha)	135
Approximate number of slips/gullies	1
Approximate total area covered by slips/gullies (ha)	3

Class	Depth (mm)	DEPOSITION		
		Gravel (ha)	Silt (ha)	Total
1	<100			
2	100-199		3	3
3	200-399			
4	400-599			
5	600-799			
6	800-1000			
7	>1000	1		1
Unknown depth				

TOTAL (ha)		1	3	4
AVERAGE DEPTH (mm)		1000	150	363

Class	Depth (mm)	SOIL LOSS (HA)				Total
		Under Crop	Under Pasture	Cultivated land	Unknown	
1	<100			3		3
2	100-199		14			14
3	200-399					
4	400-599					
5	600-799					
6	800-1000					
7	>1000					
Unknown depth						
Unknown depth of rilling						

TOTAL (ha)			14	3		17
AVERAGE DEPTH (mm)			150	50		132

Table 9b Waihi-Te Moana River Catchment

Number of farms surveyed	25
Approximate total farm area (ha)	12,115
Approximate total farm area flooded (ha)	613
Approximate number of slips/gullies	317
Approximate total area covered by slips/gullies ha)	29

Class	Depth (mm)	DEPOSITION		
		Gravel (ha)	Silt (ha)	Total
1	<100	1	23	24
2	100-199		1	1
3	200-399	5	10	15
4	400-599	9		9
5	600-799	1		1
6	800-1000			
7	>1000	1		1
Unknown depth		1	2	3
TOTAL (ha)		18	36	54
AVERAGE DEPTH (mm)		456	126	236

Class	Depth (mm)	SOIL LOSS (HA)				Total
		Under Crop	Under Pasture	Cultivated land	Unknown	
1	<100	1		5		6
2	100-199	2	3	4	1	10
3	200-399	3	11			14
4	400-599					
5	600-799					
6	800-1000					
7	>1000					
Unknown depth			4		14	18
Unknown depth of rilling						
TOTAL (ha)		6	18	9	15	48
AVERAGE DEPTH (mm)		208	268	94	150	200

Table 9c Opihi Catchment

Number of farms surveyed	133
Approximate total farm area (ha)	91,729
Approximate total farm area flooded (ha)	5,736
Approximate number of slips/gullies	1,375
Approximate total area covered by slips/gullies (ha)	189

Class	Depth (mm)	DEPOSITION		
		Gravel (ha)	Silt (ha)	Total
1	<100	1	141	142
2	100-199	39	161	200
3	200-399	81	56	137
4	400-599	46	6	52
5	600-799	21	2	23
6	800-1000	52		52
7	>1000	46		46
Unknown depth		5	1	6
TOTAL (ha)		291	367	658
AVERAGE DEPTH (mm)		562	143	327

Class	Depth (mm)	SOIL LOSS (HA)				Total
		Under Crop	Under Pasture	Cultivated land	Unknown	
1	<100	99	39	1		139
2	100-199	103	57	52	1	213
3	200-399	25	38			63
4	400-599	5			2	7
5	600-799			4		4
6	800-1000	2	4			6
7	>1000	2	18			20
Unknown depth		25	14	12		51
Unknown depth of rilling		1	50		2	53
TOTAL (ha)		262	220	69	5	556
AVERAGE DEPTH (mm)		145	279	187	383	198

Table 9d Washdyke Creek Catchment

Number of farms surveyed	8
Approximate total farm area (ha)	1,229
Approximate total farm area flooded (ha)	330
Approximate number of slips/gullies	0
Approximate total area covered by slips/gullies (ha)	0

Class	Depth (mm)	DEPOSITION				
		Gravel (ha)	Silt (ha)	Total		
1	<100		10	10		
2	100-199	1		1		
3	200-399		1	1		
4	400-599		2	2		
5	600-799					
6	800-1000					
7	>1000					
Unknown depth						

TOTAL (ha)		1	13	14		
AVERAGE DEPTH (mm)		150	138	139		

Class	Depth (mm)	SOIL LOSS (HA)				
		Under Crop	Under Pasture	Cultivated land	Unknown	Total
1	<100					
2	100-199	13	11	2		26
3	200-399	16	9	15		40
4	400-599			8		8
5	600-799					
6	800-1000					
7	>1000					
Unknown depth						
Unknown depth of rilling						

TOTAL (ha)		29	20	25		74
AVERAGE DEPTH (mm)		233	218	352		269

Table 9e Pareora Catchment

Number of farms surveyed	25
Approximate total farm area (ha)	9,799
Approximate total farm area flooded (ha)	1,558
Approximate number of slips/gullies	347
Approximate total area covered by slips/gullies (ha)	220

Class	Depth (mm)	DEPOSITION		
		Gravel (ha)	Silt (ha)	Total
1	<100		2	2
2	100-199	4	4	8
3	200-399	16	9	25
4	400-599		1	1
5	600-799	18		18
6	800-1000			
7	>1000	8		8
Unknown depth		5		5
TOTAL (ha)		51	16	67
AVERAGE DEPTH (mm)		565	244	482

Class	Depth (mm)	SOIL LOSS (HA)				Total
		Under Crop	Under Pasture	Cultivated land	Unknown	
1	<100	15	28	33		76
2	100-199	14	2	6	9	31
3	200-399		173	8		181
4	400-599					
5	600-799					
6	800-1000					
7	>1000	7	4			11
Unknown depth			3			3
Unknown depth of rilling			16			16
TOTAL (ha)		36	226	47	9	318
AVERAGE DEPTH (mm)		274	278	105	150	247

Table 9f Otaio to Waimate Catchment

Number of farms surveyed	38
Approximate total farm area (ha)	23,452
Approximate total farm area flooded (ha)	1,612
Approximate number of slips/gullies	98
Approximate total area covered by slips/gullies (ha)	36

Class	Depth (mm)	DEPOSITION		
		Gravel (ha)	Silt (ha)	Total
1	<100		129	129
2	100-199	10	8	18
3	200-399	53	10	63
4	400-599	15		15
5	600-799	1		1
6	800-1000	16	10	26
7	>1000	5		5
Unknown depth		1	1	2
TOTAL (ha)		101	158	259
AVERAGE DEPTH (mm)		450	125	252

Class	Depth (mm)	SOIL LOSS (HA)				Total
		Under Crop	Under Pasture	Cultivated land	Unknown	
1	<100		1			1
2	100-199	10	1			11
3	200-399	3	14	10	6	33
4	400-599					
5	600-799					
6	800-1000		1			1
7	>1000	8	6			14
Unknown depth			21			21
Unknown depth of rilling						
TOTAL (ha)		21	44	10	6	81
AVERAGE DEPTH (mm)		495	491	300	300	442

Table 9g Waihao Catchment

Number of farms surveyed	20
Approximate total farm area (ha)	35,630
Approximate total farm area flooded (ha)	690
Approximate number of slips/gullies	77
Approximate total area covered by slips/gullies (ha)	8

Class	Depth (mm)	DEPOSITION		
		Gravel (ha)	Silt (ha)	Total
1	<100	2	7	9
2	100-199	3		3
3	200-399	3	1	4
4	400-599	7		7
5	600-799	12		12
6	800-1000	2		2
7	>1000			
Unknown depth		1		1
TOTAL (ha)		30	8	38
AVERAGE DEPTH (mm)		522	81	427

Class	Depth (mm)	SOIL LOSS (HA)				Total
		Under Crop	Under Pasture	Cultivated land	Unknown	
1	<100	11		2		13
2	100-199			1		1
3	200-399	1		20		21
4	400-599					
5	600-799	4				4
6	800-1000	1				1
7	>1000					
Unknown depth		2			1	3
Unknown depth of rilling		2				2
TOTAL (ha)		21	20	3	1	45
AVERAGE DEPTH (mm)		268	300	83		270

Table 9h All Catchments

Number of farms surveyed	257
Approximate total farm area (ha)	211,413
Approximate total farm area flooded (ha)	10,674
Approximate number of slips/gullies	2,215
Approximate total area covered by slips/gullies (ha)	485

Class	Depth (mm)	DEPOSITION		
		Gravel (ha)	Silt (ha)	Total
1	<100	4	312	316
2	100-199	57	177	234
3	200-399	158	87	245
4	400-599	77	9	86
5	600-799	53	2	55
6	800-1000	70	10	80
7	>1000	61		61
Unknown depth		13	4	17
TOTAL (ha)		493	601	1094
AVERAGE DEPTH (mm)		533	139	315

Class	Depth (mm)	SOIL LOSS (HA)				Total
		Under Crop	Under Pasture	Cultivated land	Unknown	
1	<100	126	68	44		238
2	100-199	142	88	65	11	306
3	200-399	48	265	33	6	352
4	400-599	5		8	2	15
5	600-799	4		4		8
6	800-1000	3	5			8
7	>1000	17	28			45
Unknown depth		27	42	12	15	96
Unknown depth of rilling		3	66		2	71
TOTAL (ha)		375	562	166	36	1139
AVERAGE DEPTH (mm)		194	283	186	234	235

The MAF questionnaire provided the most comprehensive assessment of land damage available to the Board. However the questionnaire was conducted by a variety of MAF officers, was based on farmer observation and only covered farms reporting damage. It must therefore be recognised that the quality and quantity of the data summarised in table 9 is variable and the extent of damage must be regarded as a minimum. This applies particularly to land type (a) (steep non arable land) where the extent of described damage is known to grossly underestimate the actual damage in many locations.

8.3 General Comments

The type and extent of land damage described in Table 9 has large variation within each land type.

8.3.1 Steep non arable land

The pattern of land damage is strongly associated with total storm rainfall (and probably rainfall intensity). Locations known to have received rainfall in excess of 200 mm suffered greater land damage than locations receiving lower storm rainfall. In high storm rainfall locations, old erosion scars were often reactivated, some fresh slips or gullies were initiated and extensive degradation of streambeds occurred. The net result has been:

- (1) Large volumes of sediment being supplied from the upper catchment areas to the lower river;
- (2) additional large quantities of gravels perched on slopes and in channels ready for reworking in future storms; and
- (3) the risk of future mass movement of slopes as a result of lowered streambeds and consequent reduction of toe slope support.

"On slope" failures (slips, gullies, slumps) were relatively rare unless storm rainfall was in the vicinity of 250 mm or more (eg in the south branch of the Hae Hae Te Moana River; Two Peaks area, Mawaro; Upper Tengawai catchment). With high storm rainfall (>250 mm) slope failures occurred irrespective of factors such as type and extent of ground cover.

Areas receiving slightly lower storm rainfall (200-250 mm) had greater incidence of gullying when vegetative cover was incomplete and subsoils exposed. The general consensus of Soil Conservation staff was that the upper catchment areas generally withstood the storm better than might have been expected. However the damage assessment support the principle that catchment condition (expressed as extent and type of vegetation and erosion) is important as a predisposing factor to future slope erosion.

Watercourses were one of the most devastated zones in the upper catchments. These commonly degraded 1 to 2 m irrespective of the extent of slope erosion and sediment supply upstream. This phenomenon suggests sediment starvation for the flows experienced in this storm. It is doubtful whether stronger watercourse vegetation (eg scrub or trees instead of tussocks

and grasses) could have withstood these flood flows but riparian zone management of all watercourses (permanent and ephemeral) in upper catchment areas must be given more consideration in future.

Steep slopes in the downland zone with a regolith of loess overlying gravels or tertiary rocks also experienced fresh slipping, slumping and gullyng. The extent of fresh erosion varied depending on rainfall, landform and geology but it is noticeable that many forested areas were much more stable than adjoining areas in pasture. More emphasis on sustainable land uses is required in this zone.

8.3.2 Undulating to strongly rolling arable land

Storm rainfall on this land type was generally less than the steep non arable land and the occurrence of fresh slips, slumps and gullies was much less. The main type of land damage was soil loss caused by rilling and sheet wash on sloping cultivated paddocks. The evidence for these types of erosion was frequent after the March storm but a lot of this erosion occurred during earlier rainstorms in February and March.

Much of the land damage experienced could be reduced or avoided by the adoption of management practices which reduce the risk of soil rilling and sheet wash (eg reduced cultivation, contour cultivation, stripp cropping, conservation tillage, maintaining drainage channels in grass).

8.3.3 Flat arable land

This land type suffered the greatest economic land damage and the soil loss and deposition components of Table 9 refer primarily to this land type. In certain areas deep fertile soils were altered to gravel riverbed during the storm.

Large areas of this land type experienced surface flooding but serious land damage was confined to those areas subjected to high velocity flood flows mainly from river breakouts. These damaged areas are recent soils on flood plains and have been recognised as being prone to flooding in the past. This hazard recognition has perhaps been overlooked to some degree more recently due to flood protection works. Flood prone areas should be managed to take account of this hazard. This is supported by an analysis of land use and subsequent land damage in these flood hazard zones which is presented in table 10.

Table 10. Land Use and occurrence of Soil Loss on Flooded Flat Areas.

Catchment	Approx. Area Flooded (ha)		Approx. Area of Soil Loss (ha)		Approx. % soil loss area flooded	
	Pasture	Crop	Pasture	Crop	Pasture	Crop
Orari	95	40	14	3	15	8
Waihi-Te Moana	430	185	14	15	3	8
Opihi	4015	1720	155	290	4	17
Washdyke Cr	200	130	20	53	10	40
Pareora	1280	280	206	80	16	29
Otaio/Waimate Creek	1290	320	23	31	2	10
Waihao	540	150	20	19	4	13
TOTAL	7850	2825	452	491	6	17

A considerable margin of error is likely in Table 10. However the figures indicate that cropped areas (standing crop - cultivated ground) are three times more likely to suffer soil loss than pasture when these areas are subject to flooding.

8.4 Conclusions

The storm has resulted in major costs and hardships for many people. However there are many lessons to be learned which can provide guidance and advice for future management to reduce damage from similar events. This should be one of the main positive response to the March 1986 storm. Some of the lessons are:

- (1) Re-emphasis of the value of hazard mapping. The storm confirmed where many flood hazard areas are, highlighted some unrecognised flood hazard areas and increased the public's perception and understanding of the use of hazard identification.
- (2) Re-emphasis of the value of ground cover to reduce on-site erosion and off-site deposition. Most upper catchment areas suffered little hill slope erosion. Unfortunately, many permanently flowing water courses in the upper catchment areas scoured 1-2 m in depth producing debris and instability in lower channels. Degraded channels result in reduced toe slope support and increase the risk of future slope instability. Stream bed scour may have been inevitable given the flows experienced but water course management to strengthen resistance to scour might have been beneficial.
- (3) The major land damage occurred on arable land in extensive flood plain areas. Inundation of these areas may be inevitable but damage mostly occurred as a result of soil scour in one paddock and deposition below. Well grassed paddocks suffered less soil scour but obviously are prone to deposition. Soil scour occurred most frequently on paddocks which were cultivated or recently cultivated. Management practices which reduce the exposure of soil to flowing water will reduce the risk of soil scour.

- (4) Extensive slipping occurred on many steep facings under pasture. Similar areas under forest experienced very little erosion. This highlights the need for appropriate land uses to achieve sustainable land use.
- (5) Depleted upper catchment areas and old erosion scars were a major source of sediment to the lower river.

9.0 DISCUSSION

The South Canterbury flood of 13 March 1986 was similar to other historic floods, e.g. February 1868 and February 1945, which occurred in summer months. The storm rainfall varied from 100 mm at the coast up to 225 mm further inland. A notable feature of this storm was the concentrated burst of high intensity rainfall at the end of the storm.

This heavy rainfall, falling on thoroughly wet catchments, produced the very sharp flood peaks and massive flood peak discharges.

River flow records in South Canterbury are continuous from 1936 at two stations, Opihi at Rockwood and Opuha at Skipton and include the large flood of 21 February 1945. Because of its magnitude and the fact that annual flood records only date from 1936 (50 years) it is difficult to assign a frequency to this extreme event. The 13 March 1986 flood is clearly the largest flood event this century, and for the Opihi, Tengawai, Pareora and Waihao rivers, is probably the largest flood since February 1868.

Flood frequency analysis for Opihi at Rockwood suggests a return period of around 200-300 years.

Considering the magnitude of the flood flows, the Board's river control works functioned very well and conveyed huge volumes of water to the sea coast. Most of the flooding occurred because the flood peak discharges greatly exceeded the scheme design flows and flood water simply overflowed the stopbanks.

Total damage to the Board's flood control works is estimated to be \$6.17 million, which is quite small considering the magnitude of the flood and in relation to the \$60 million of damage done to property, roads, bridges, crops and livestock.

SCCB flood-warning telemetry system worked well throughout the flood, in spite of losing three stations near the peak of the flood. Staff were alerted by the system at midnight and flood warnings were issued to the public by Radio Caroline at 4.33 am.

Incoming telemetered data gave a clear picture of the progress of the flood when used in conjunction with reports from field staff, rainfall data telephoned in by farmers and updated weather forecasts from N.Z. Meteorological Service.

Telemetered rainfall data would improve the Board's ability to assess flood situations and considerably increase the lead-time available for flood warnings to be issued to the public.

In conclusion, considering the magnitude of the flood flows and the \$60 million worth of damage incurred in South Canterbury, it was remarkable that only one person lost his life. The fact that the flood occurred in daylight hours and in reasonably fine weather conditions greatly facilitated the rescue and evacuation of approximately 2,000 people during the Regional Civil Defence emergency.

10.0 BIBLIOGRAPHY

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- McKerchar, A.I. 1980. The Frequency of High Intensity Rainfall in N.Z. Part II Point Estimates N.Z. Meteorological Service Miscellaneous Publication No 162, 76 pp

11.0 ACKNOWLEDGEMENTS

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APPENDIX 1:

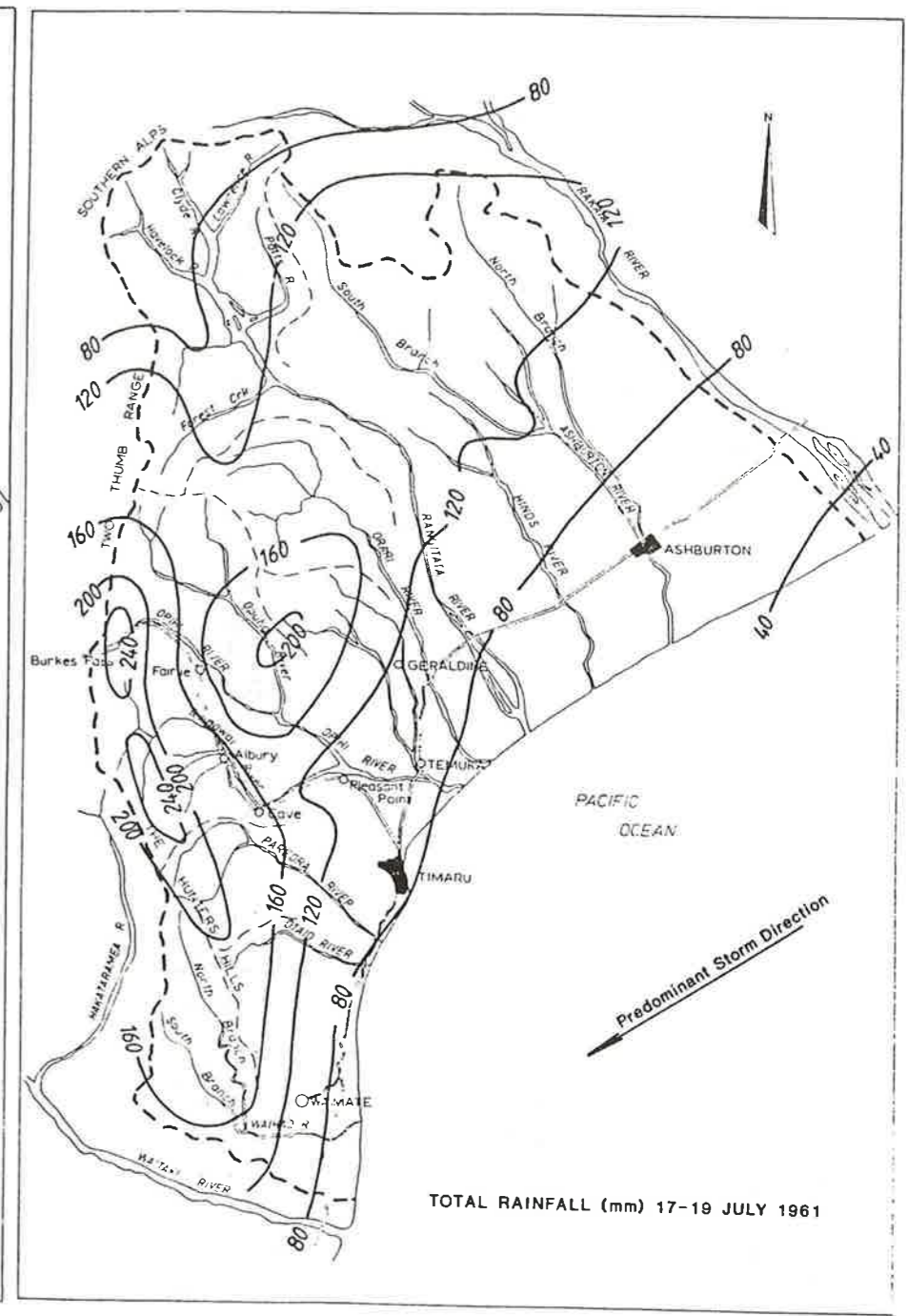
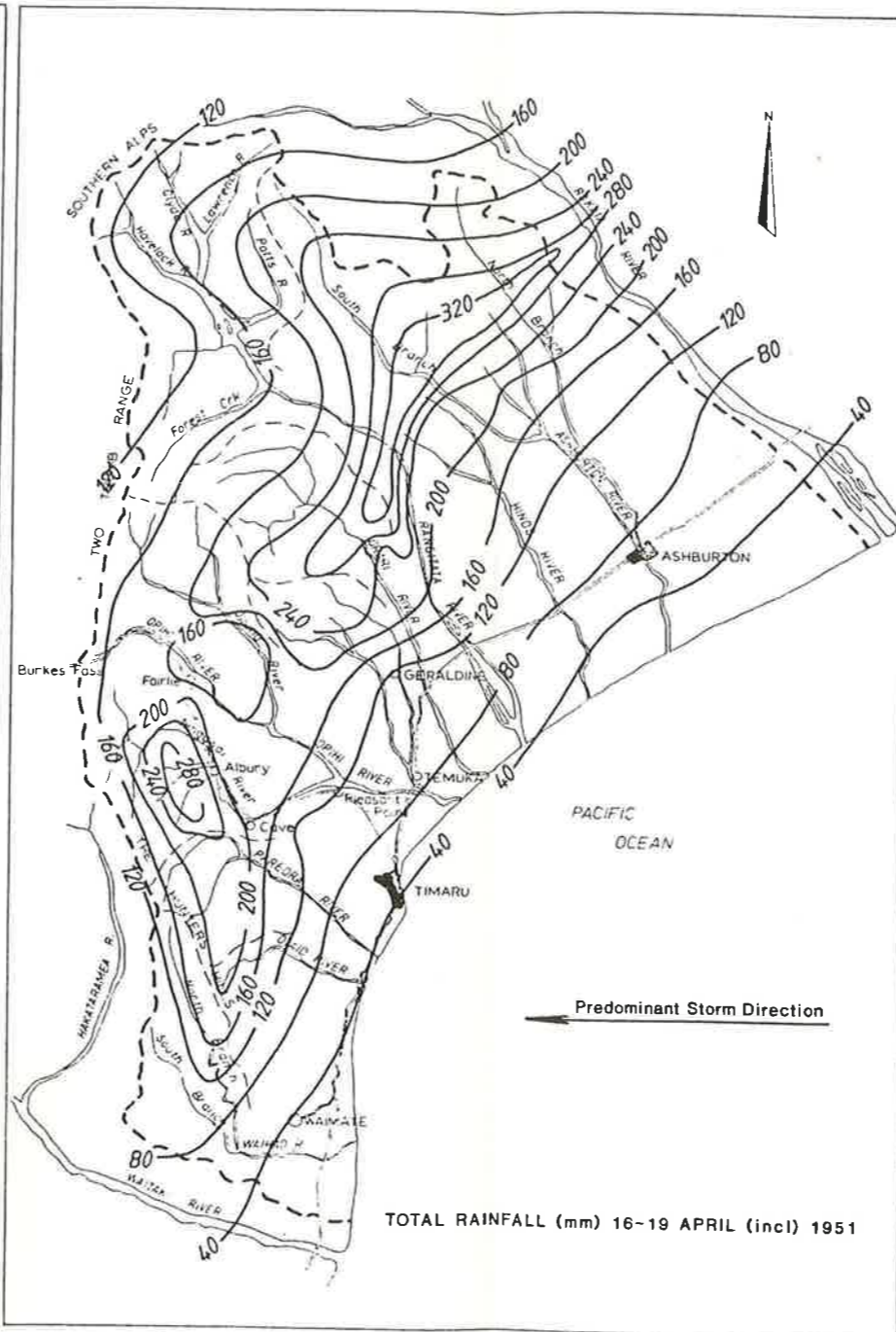
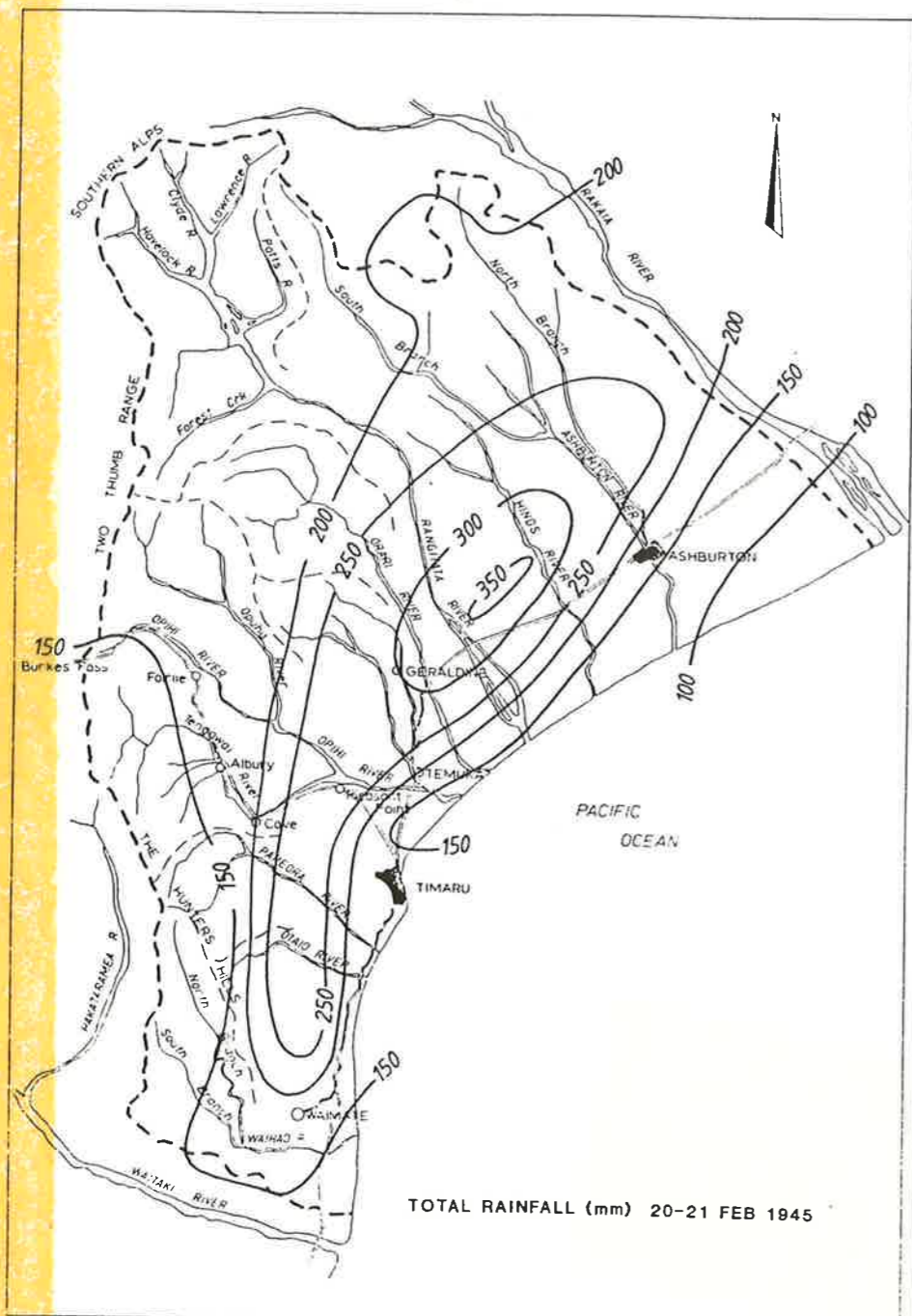
RAINFALL TOTALS FOR PERIOD 12-14 MARCH 1986

OBSERVER	DATE				TOTAL (mm)
	11	12	13	14	
Pareora (Henshaw)		-	-	-	165
Waihao (Hulston)		-	-	-	146
Highcliffs (Waihao)		23	93	24	140
Albury Park		30	89	78	197
Timaru (Harbour)		27	69	3	99
Timaru (Gardens)		14.8	85.5	4.3	104.6
MT Dalgety		25.4	127	76.2	228.6
Airies (Munro)		63	88	72	223
Te Puni (Williams)		24	95	22	141
Alaska (Jessep)		43	113	4	160
Erewhon (Urguhart)		5.5	27.4	48.6	81.5
Ashburton (Gardens)		10.7	46	21	77.7
Wairere		53.7	103	22	178.7
Springburn (Smith)		33.4	102.6	14.6	150.6
Orari Gorge (Dent)		43	122	45	210
Dalzell (Milne)		22	128	24	174
Lochaber (Allan)		26.5	101.6	9.6	137.7
Melford Hills (Gardner)		15.8	130	21.4	167.2
Geraldine (Forest Service)		23	102.2	4.1	129.3
Morven (Young)		49	28.5	3.5	81
Sherwood Downs (Bell)		-	-	-	107
" " (Run)		-	-	-	150
Three Springs (Page)		-	-	-	155
" " (Run)		-	-	-	197
Albury (Rose)		18.5	94	26.4	138.9
Cave (Ulrich)		25	132	19	176
Claremont (Weller)		33.5	143.8	1.3	178.6
Maungati (Ford)		14.2	115.2	43.5	172.9
Temuka (Domain)		16.5	97.2	4.2	117.9
Fairlie (M.A.F)		-	-	-	165
MT Gay (Carter)		41	140	41	221
Hunter (Meehan)		15.4	126.3	34.8	176.5
Peel Forest (L's)		47	135.8	8 0.3	191.1

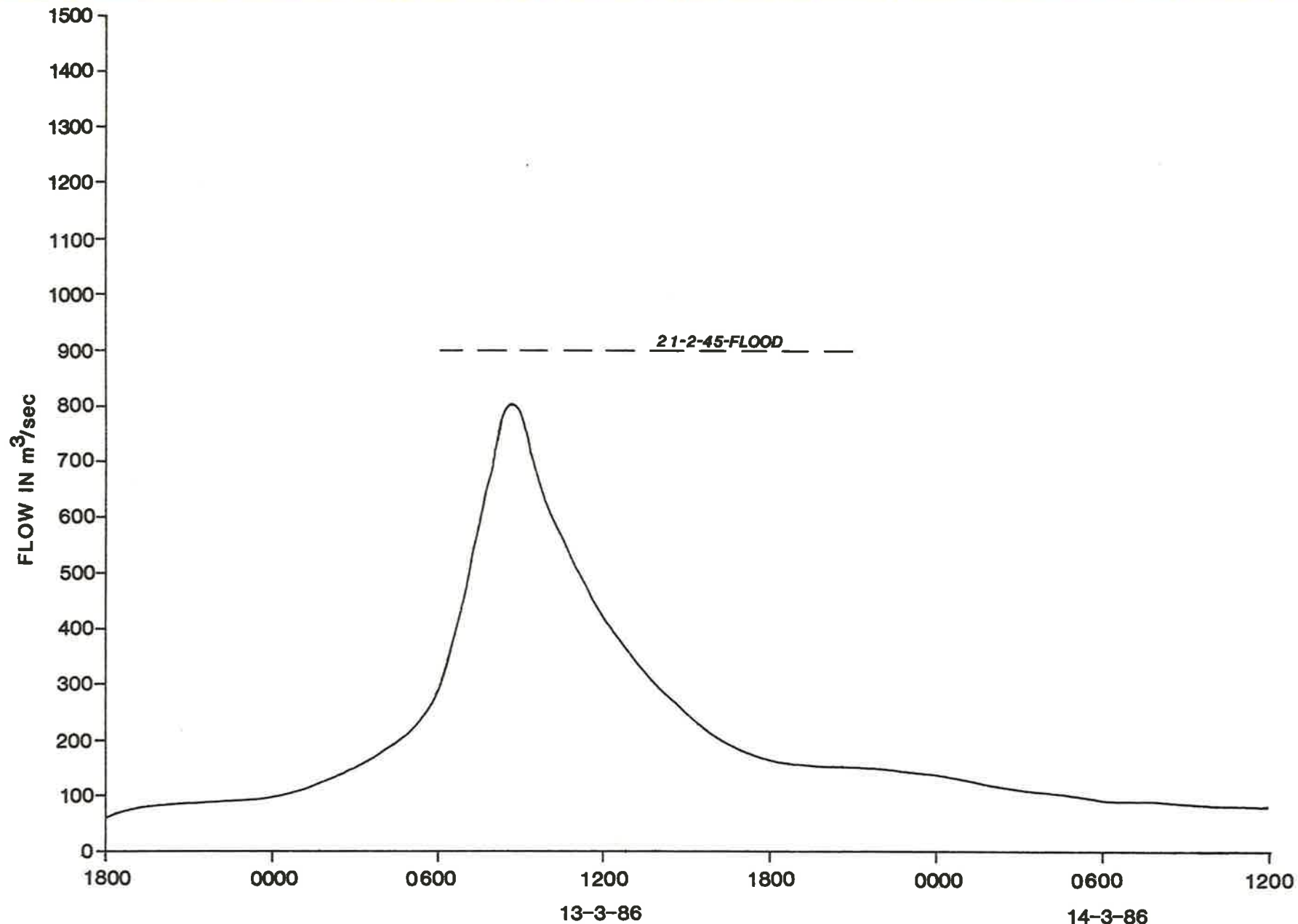
APPENDIX 1:

RAINFALL TOTALS FOR PERIOD 12-14 MARCH 1986

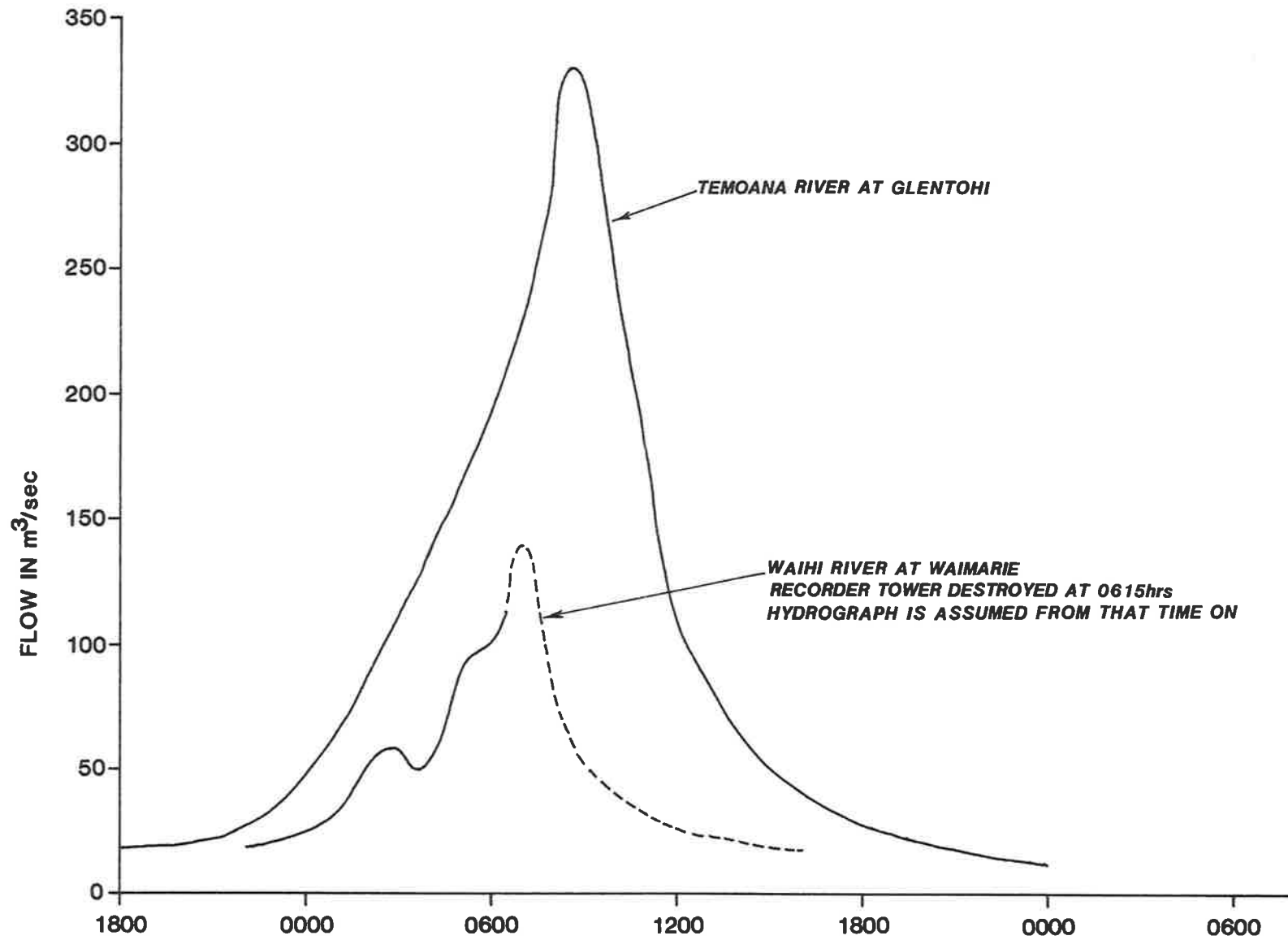
OBSERVER	DATE				TOTAL (mm)
	11	12	13	14	
Shenley (Recorder)		-	-	-	274
Kimbell (Davis)	41.1	39.1	69.1	24.4	173.7
Glentohi (Marshall)	-	-	-	-	127
Waihi (McAtamney)		44.5	203	-	247.5
The Brothers (Henderson)		-	-	-	334
Temuka (Jackson)		-	-	-	122
Stratheona Huts (Cox)		91	48	-	139
Salisbury (Black)		29.2	91.4	5.1	125.7
MT Horrible (Hayward)		17	214	-	231
Arno (Hedges)		-	-	-	190
Springbrook (Midgley)		-	-	-	135
Fairview (Shewan)		-	-	-	170
Waipopo (Anglem)		-	-	-	94
Levels (Cochrane)	13	130	6.5	1.0	150.5
Orari (Aker)		17.8	107	3.3	128.1
Rockburn (Aker)		21	140	10	171
Peel Forest (Rathbone)	34	110	13	4	161
Skipton (Christie)		55.9	172.7	6.4	235
Winscombe (Fairlie)		44.7	115.6	16.5	176.8
Gleniti (Reservoir)		-	124.3	4.5	128.8
Temuka (Booth)	19.8	22.6	89.4	11.9	143.7
Kakahu Forest (Airstrip)	4.04	94.95	135.93	-	234.9
" " (Helipad)		120.9	126.6	-	247.5
Landsborough Road (Harris)		12.5	5	-	130
Acacia Drive (Henderson)		13.5	113	5	131.5
Cave (Heddrington)		-	165	-	165
Sterndale Valley (Blackler)		-	157.4	6.1	163.5
Gapes Valley (Shears)		27.4	88.6	23.4	139.4
Pareora Gorge (McKercher)		19	167	21.5	207.5
Daisy Hill (Donohue)		16	127	32	175
Rosewill (Foote)		-	-	-	173
Horseshoe Bend (Hurst)		6.5	133.1	-	198.1
Waihaorunga (Powell)		31.8	156.2	-	188



APPENDIX 2: RAINFALL PATTERNS FOR PREVIOUS MAJOR FLOODS

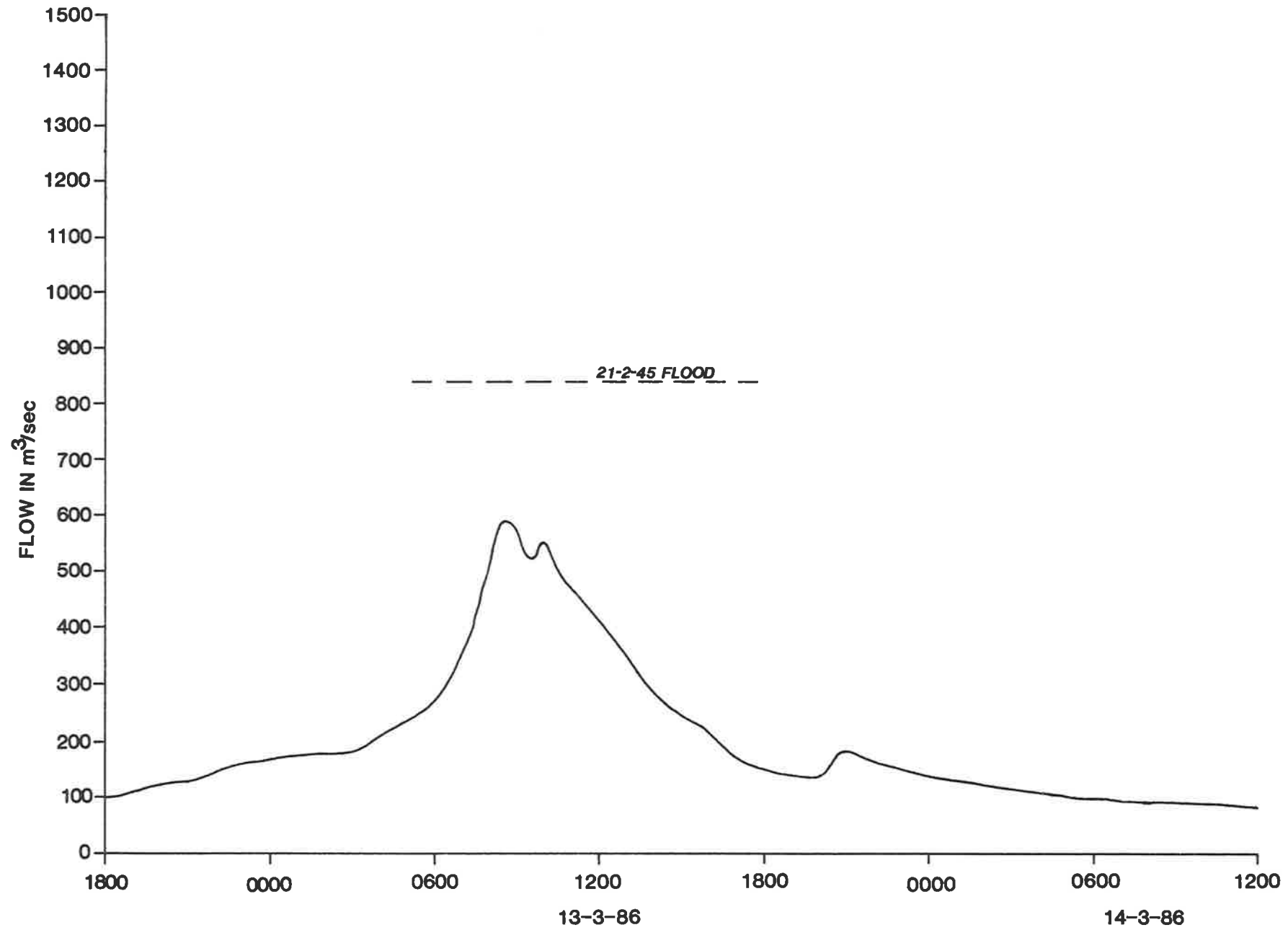


APPENDIX 3 FLOOD HYDROGRAPH - ORARI RIVER AT GORGE

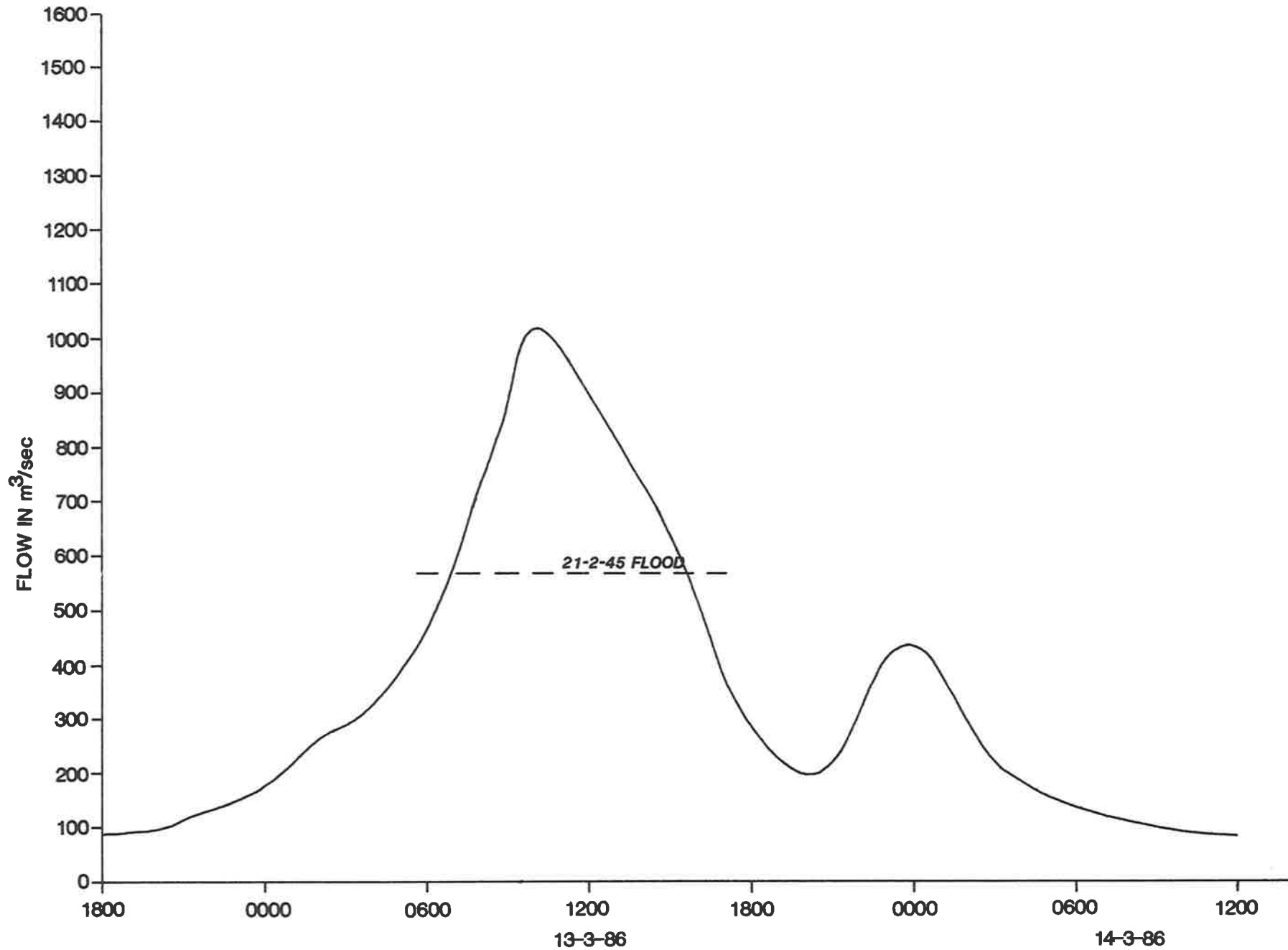


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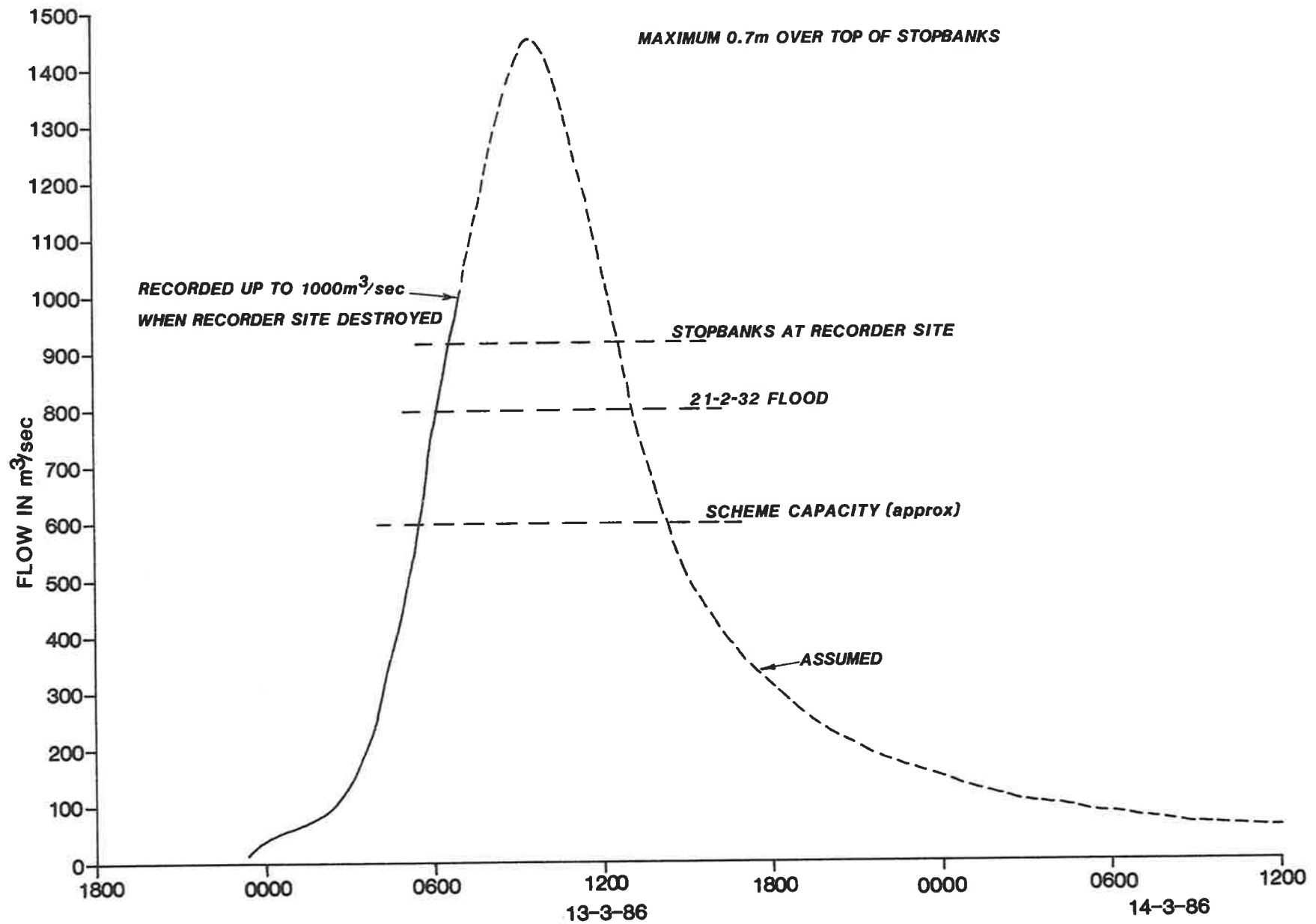
APPENDIX 3 FLOOD HYDROGRAPHS - TEMOANA RIVER AT GLENTOHI & WAIHI RIVER AT WAIMARIE



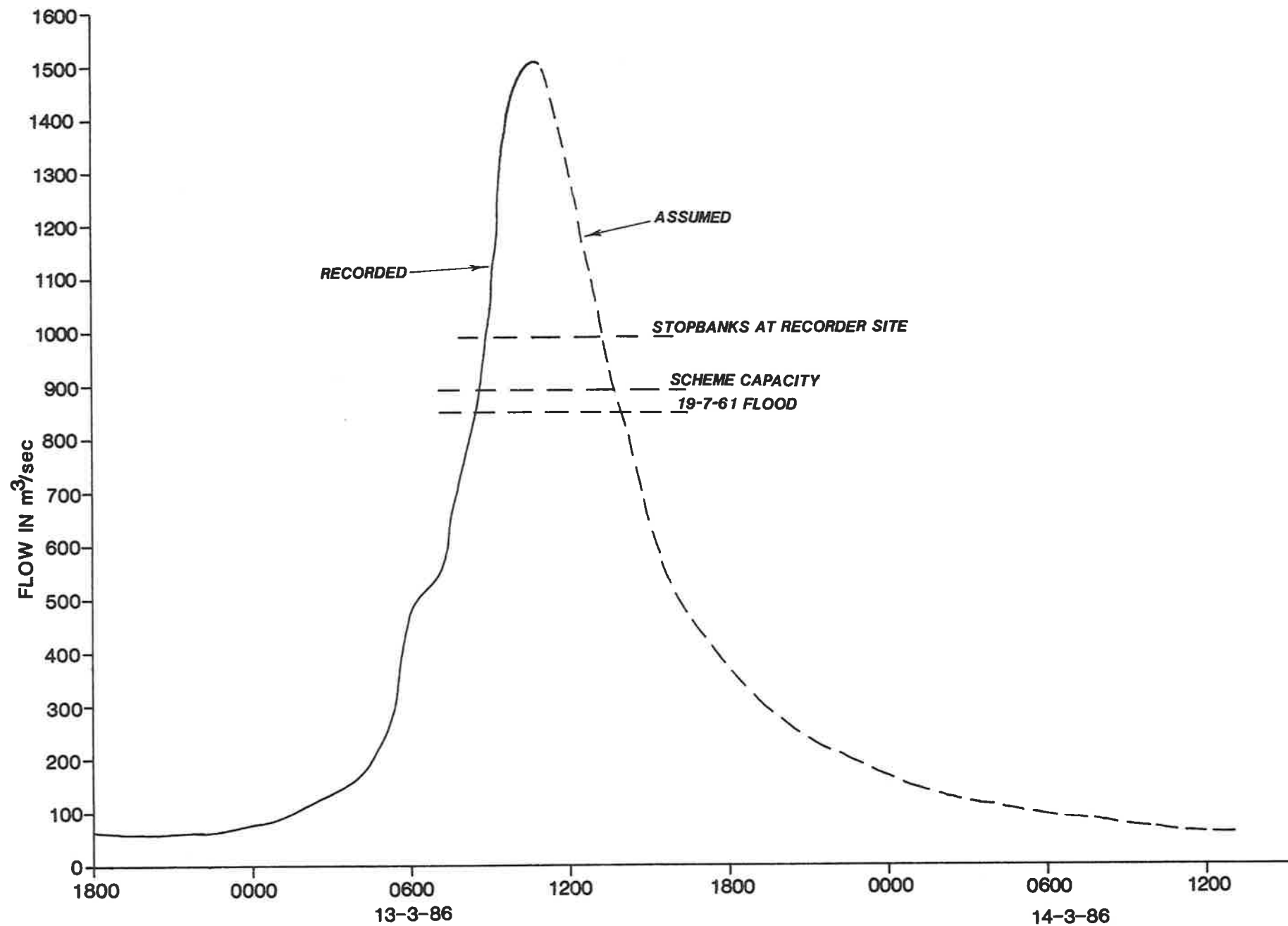
APPENDIX 3 FLOOD HYDROGRAPH - OPUHA RIVER AT SKIPTON



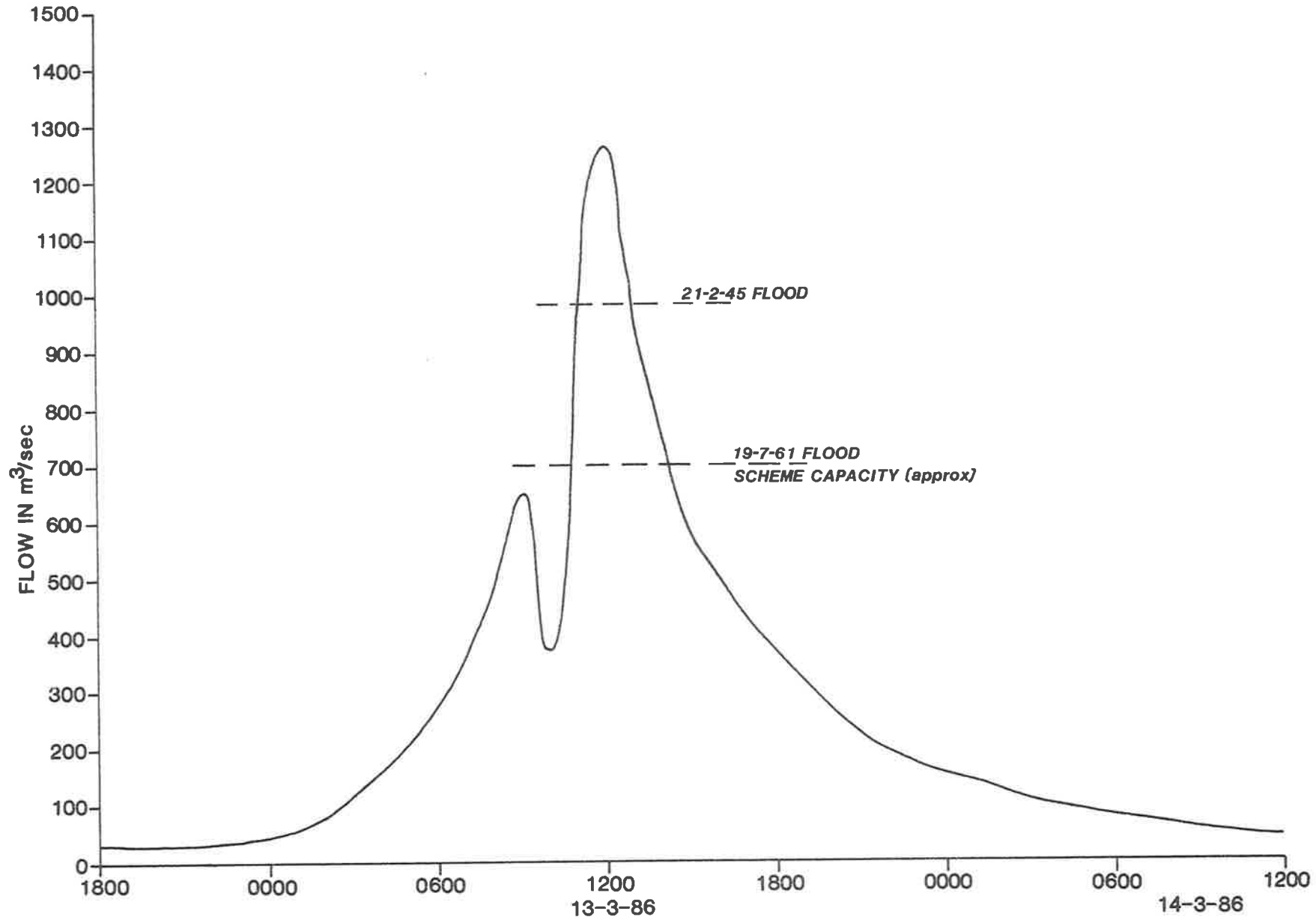
APPENDIX 3 FLOOD HYDROGRAPH - OPIHI RIVER AT ROCKWOOD



APPENDIX 3 FLOOD HYDROGRAPH - PAREORA RIVER AT MT HORRIBLE



APPENDIX 3 FLOOD HYDROGRAPH - TENGAWAI RIVER AT CAVE



APPENDIX 3 FLOOD HYDROGRAPH - WAIHAO RIVER AT McCULLOUGH'S BRIDGE

Appendix 4: Annual Maximum Flood for Opihi River
at Rockwood 1936-1986

OPIHI AT ROCKWOOD

DATE	STAGE	PEAK DISCHARGE (m ³ /s)
3/ 3/1936	1.905	129
19/ 5/1937	1.337	62
15/ 4/1938	1.521	82
27/11/1939	1.03	33
8/ 5/1940	1.781	112
19/ 3/1941	1.813	117
24/10/1942	2.683	262
10/ 9/1943	1.77	111
17/12/1944	1.77	111
21/ 2/1945	3.85	570
24/ 9/1946	1.148	43
14/ 1/1947	1.030	33
17/ 1/1948	1.102	39
28/ 4/1949	1.222	50
21/ 8/1950	1.222	50
18/ 4/1951	3.566	484
8/11/1952	2.224	178
29/ 3/1953	1.355	64
12/12/1954	1.399	69
16/ 2/1955	.977	29
9/11/1956	1.399	69
19/ 5/1957	2.354	201
23/ 2/1958	1.768	111
11/ 4/1959	1.466	76
9/ 9/1960	1.768	111
19/ 7/1961	3.269	397
2/11/1962	1.441	73
16/ 7/1963	2.605	248
15/ 5/1964	1.114	40
31/ 1/1965	3.292	403
30/ 7/1966	1.905	129
27/11/1967	1.668	99
8/ 6/1968	1.980	140
1/ 2/1969	1.364	65
24/ 9/1970	1.762	110
5/ 7/1971	1.582	89
17/ 5/1972	2.910	311
14/ 8/1973	1.103	39
17/ 4/1974	2.047	150
28/ 2/1975	1.946	135
19/10/1976	1.328	61
5/ 1/1977	1.489	79
21/ 4/1978	2.551	238
6/ 5/1979	1.946	135
6/ 6/1980	2.194	173
15/ 6/1981	1.145	43
2/ 4/1982	1.002	31
27/ 6/1983	2.165	168
22/12/1984	1.236	51
26/12/1985	1.621	93
13/ 3/1986	5.140	1,023

***APPENDIX 5: EXTENT OF FLOOD INUNDATION
AND DAMAGE TO BOARDS RIVER WORKS
Plates 3 - 18 inclusive***

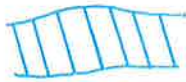
KEY TO SYMBOLS

Plates 1 and 2:



Areas of Flooding

Plates 7 to 18



Areas of Flooding



Breached Stopbank



Stopbank Scour



Bank Protection Work



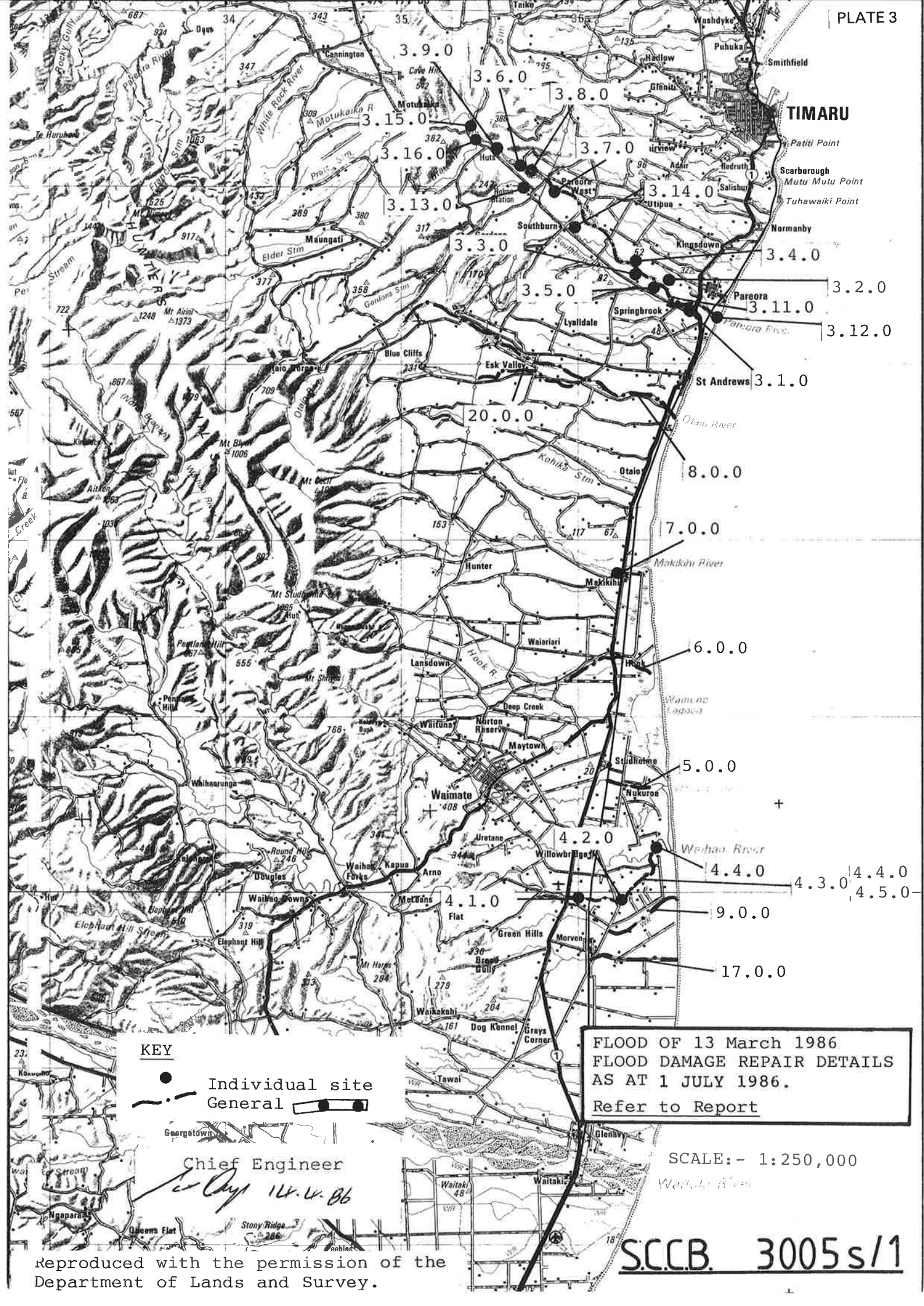
Channel Clearance



Rock Work



Job No. (Appendix 5A)



TIMARU

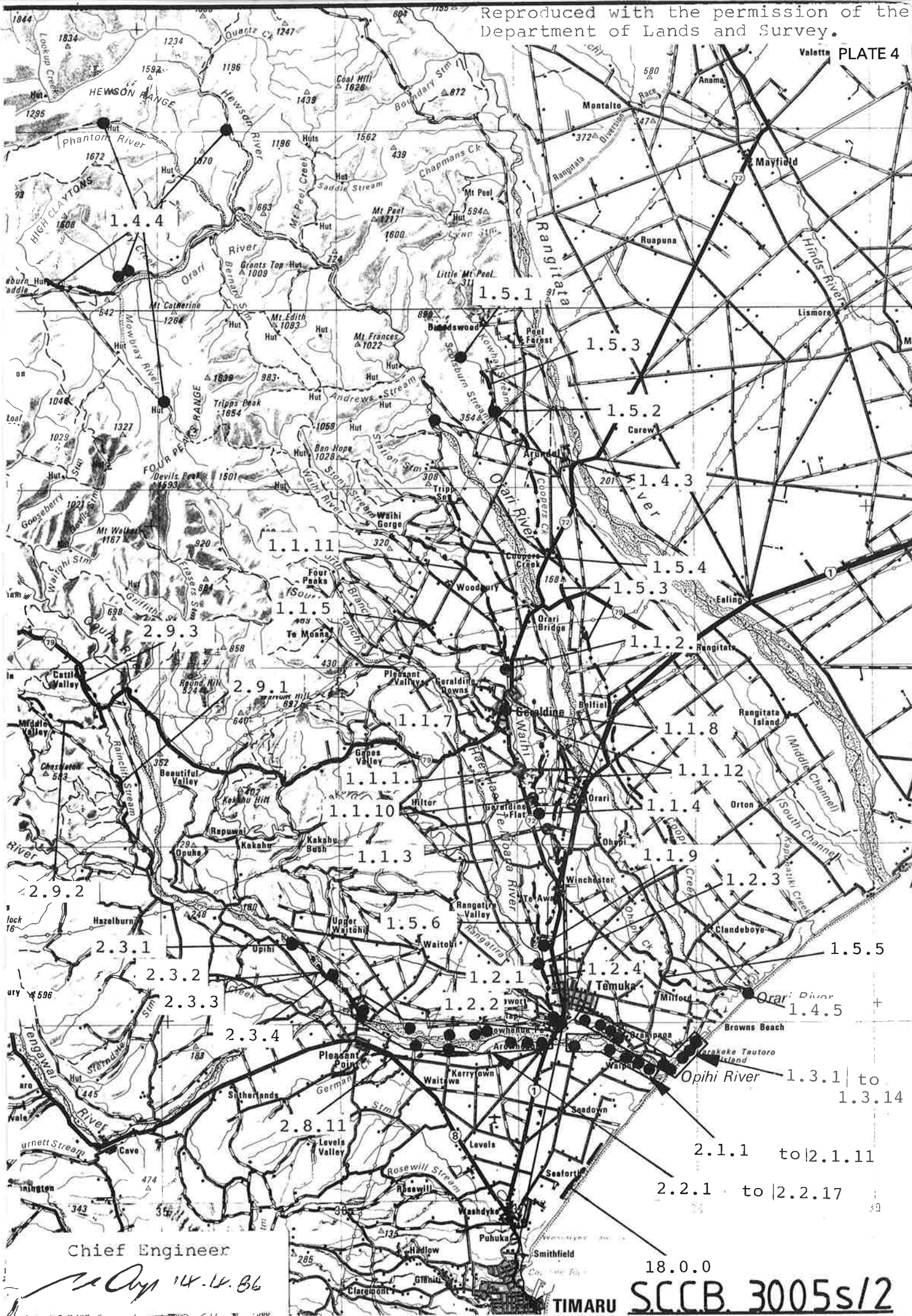
FLOOD OF 13 March 1986
 FLOOD DAMAGE REPAIR DETAILS
 AS AT 1 JULY 1986.
 Refer to Report

KEY
 ● Individual site
 — General

Chief Engineer
[Signature] 14.4.86

SCALE:- 1:250,000

S.C.C.B. 3005 s/1

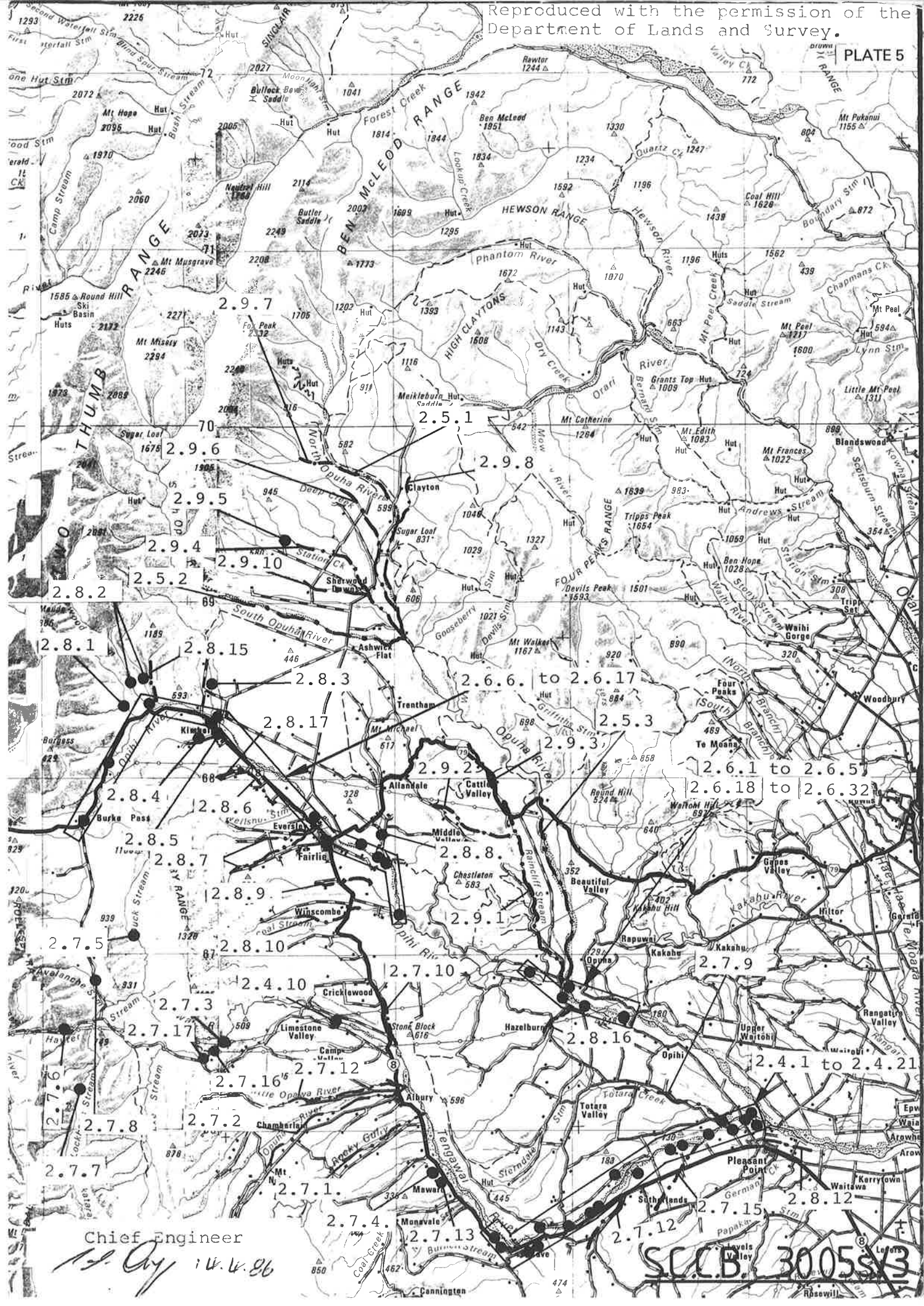


Chief Engineer

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18.0.0

TIMARU SCCB. 3005s/2



Chief Engineer

A. J. Coy 14.4.86

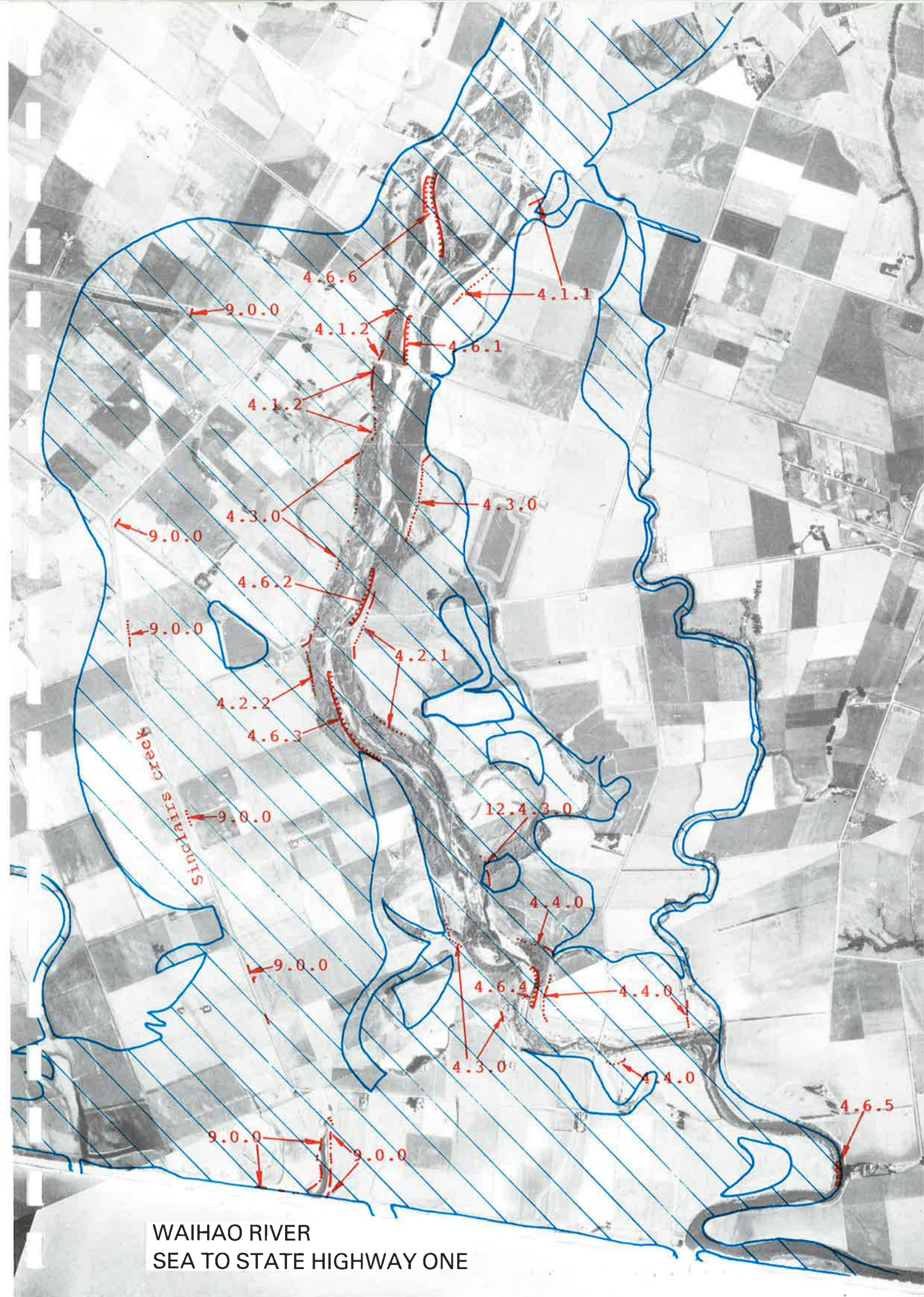
S.C.C.B. 30058/3



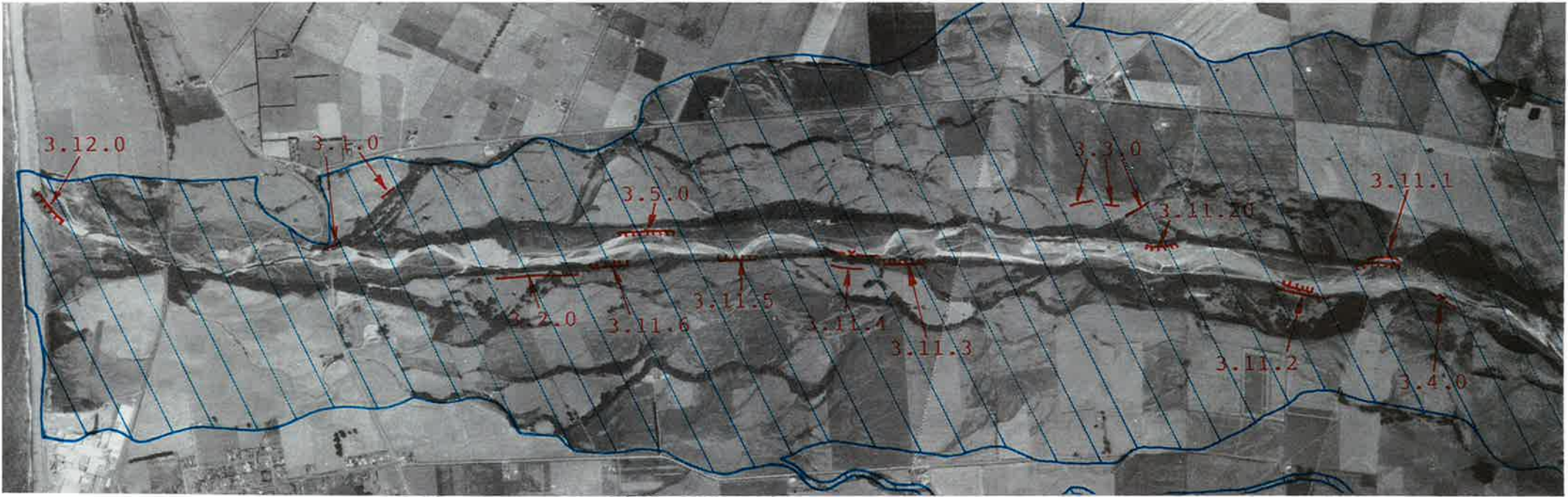
Chief Engineer

[Handwritten signature] 1st. 4. 86

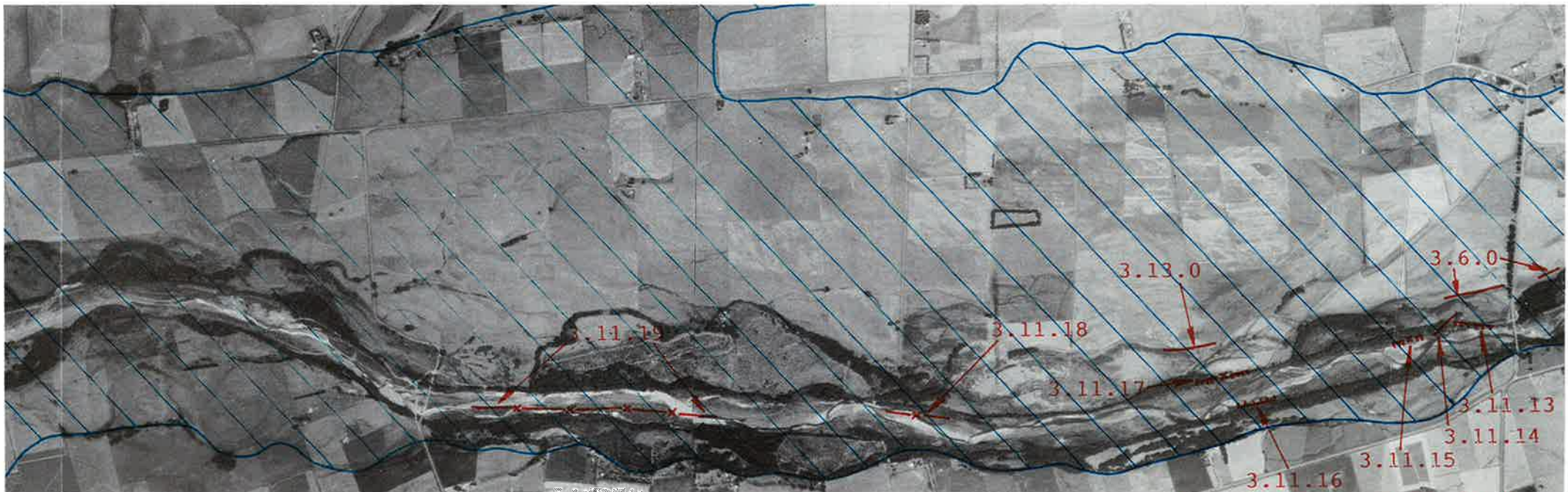
S.C.C.B. 3005s/4



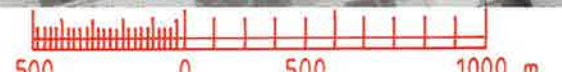
WAIHAO RIVER
SEA TO STATE HIGHWAY ONE

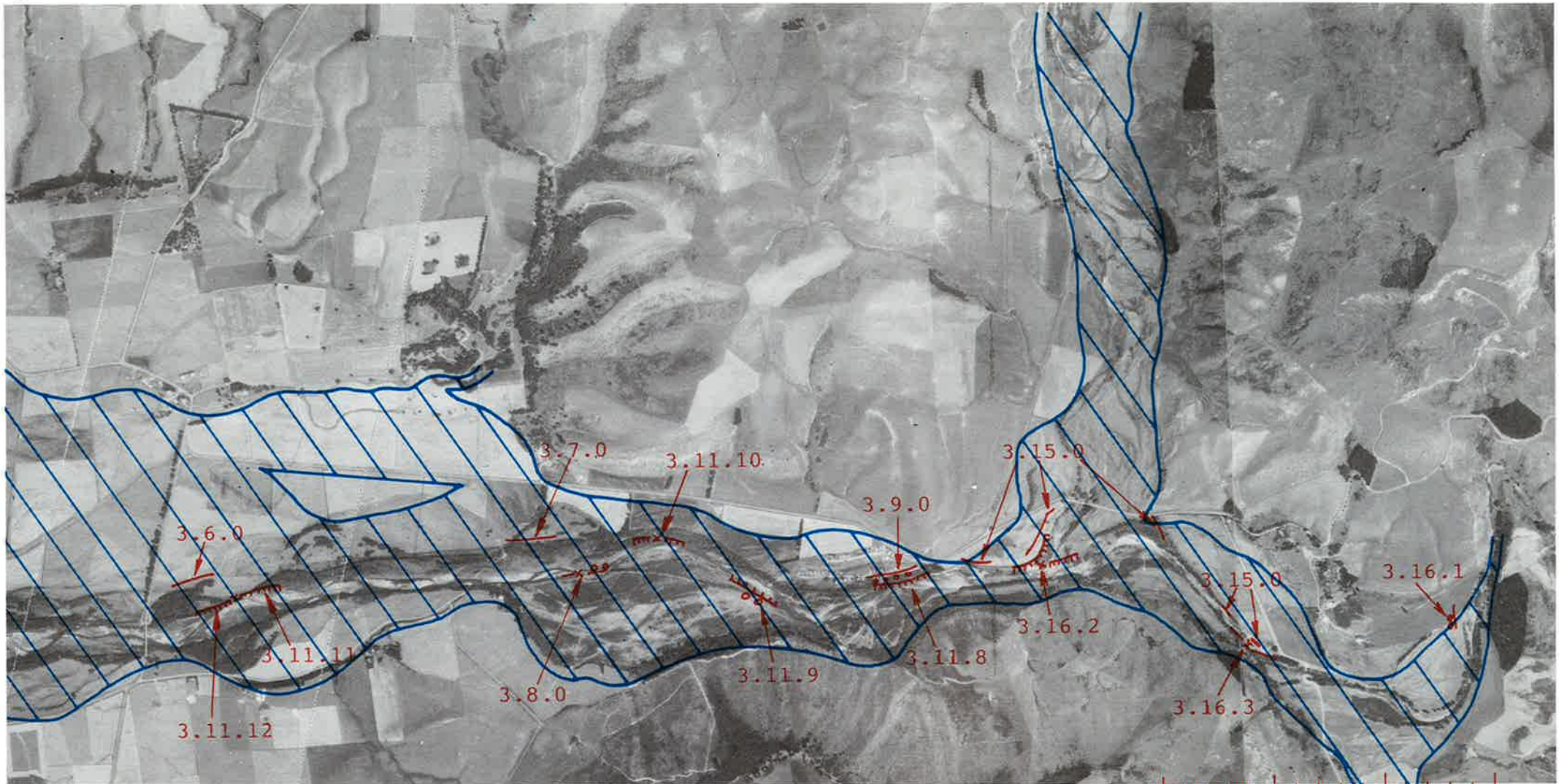


PAREORA RIVER — SEA TO BELOW BRASELLS BRIDGE

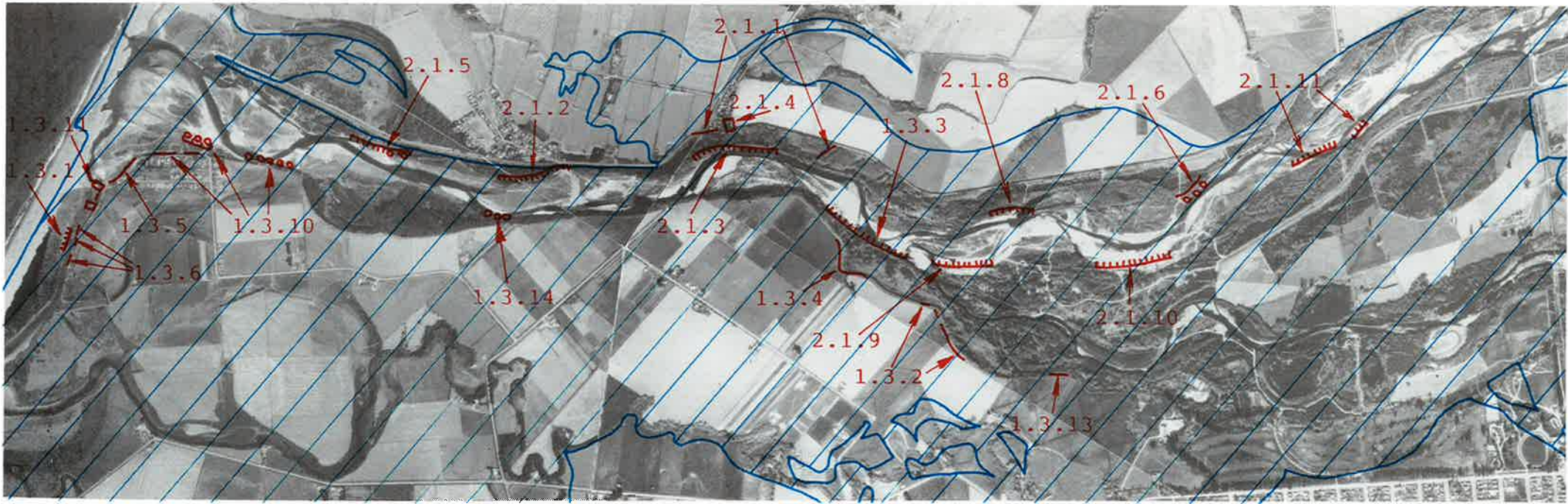


PAREORA RIVER — BELOW BRASELLS BRIDGE TO HOLMESTATION BRIDGE

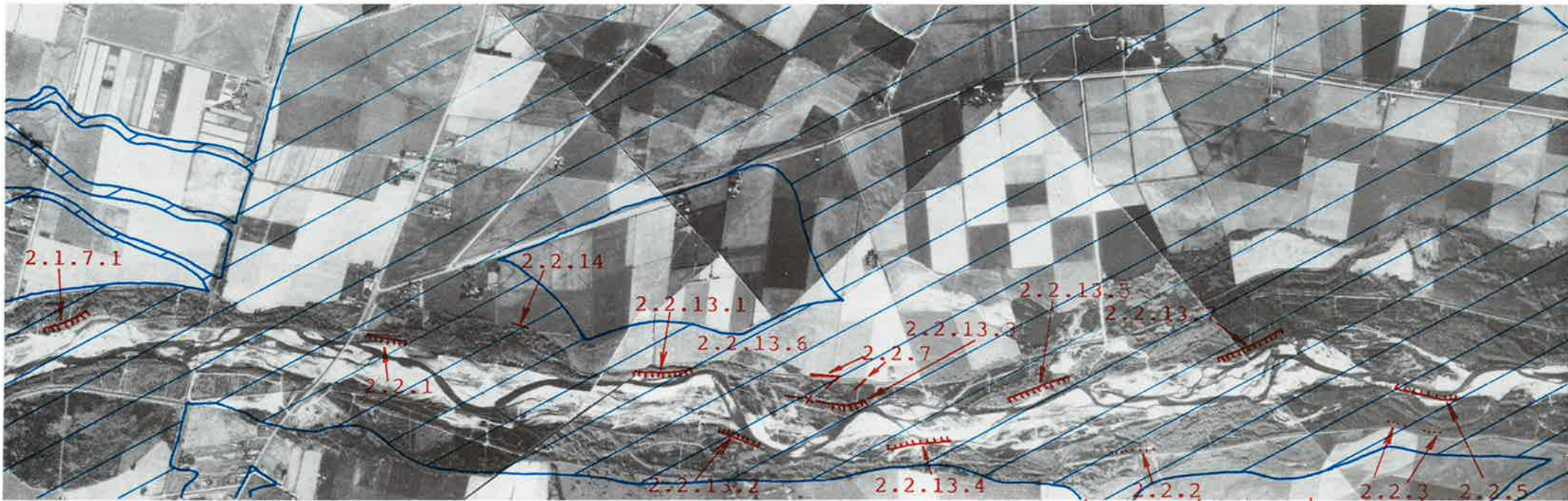




PAREORA RIVER — HOLMESTATION BRIDGE TO EVANS CROSSING

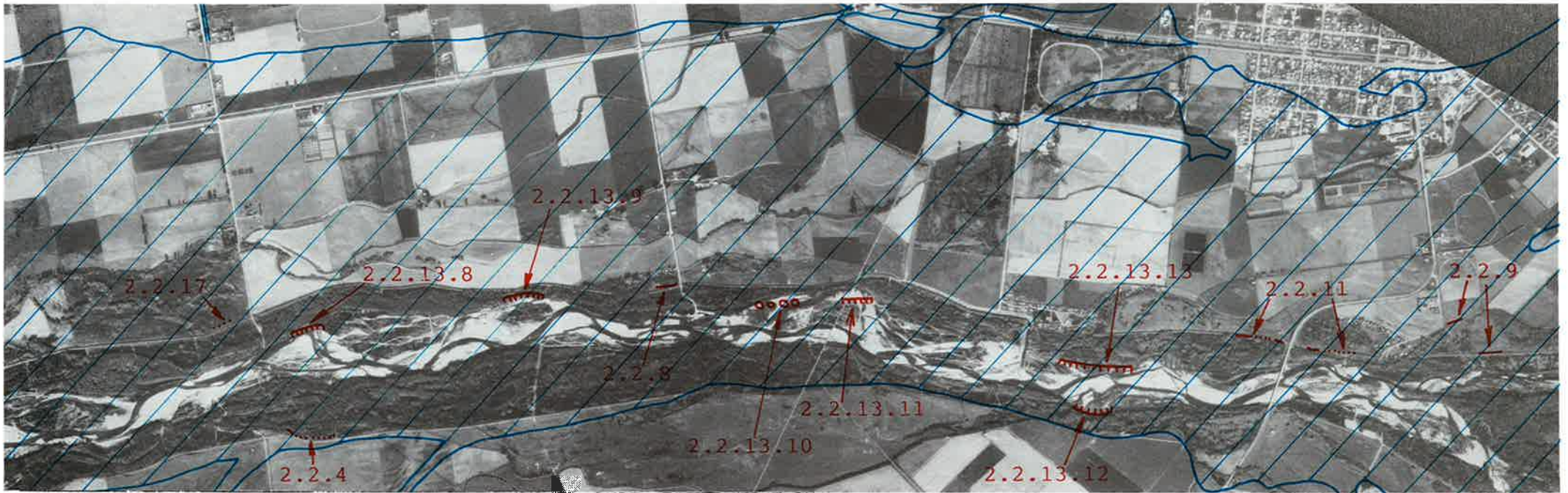


OPIHI RIVER — SEA TO RAILWAY BRIDGE

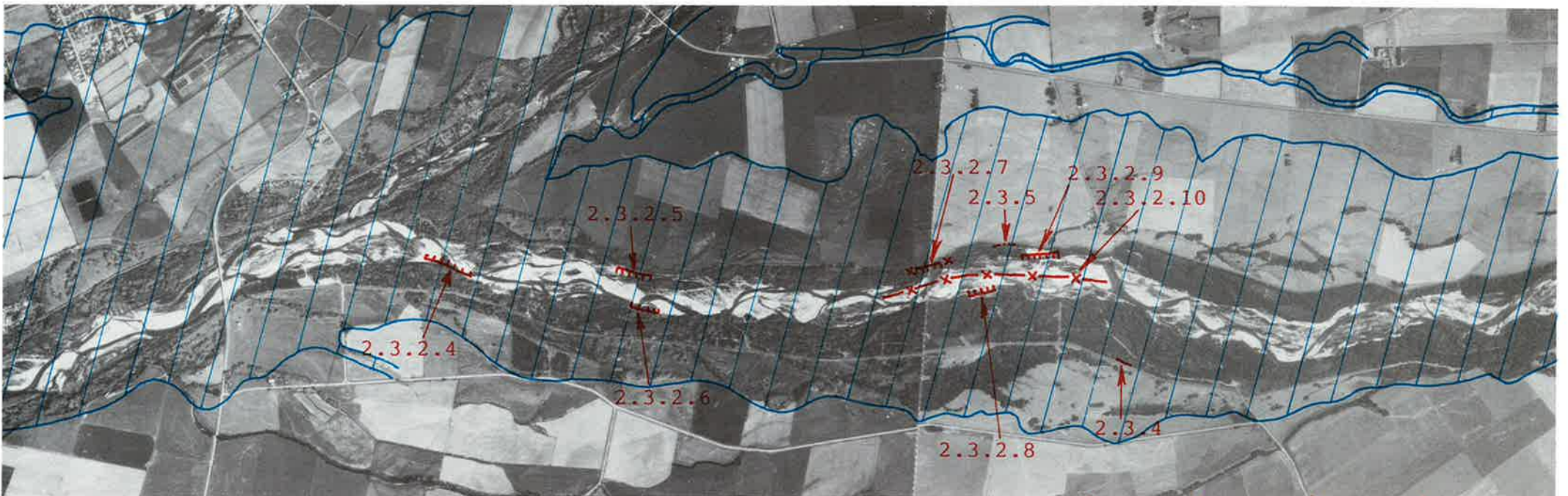


OPIHI RIVER — RAILWAY BRIDGE TO KERRYTOWN ROAD



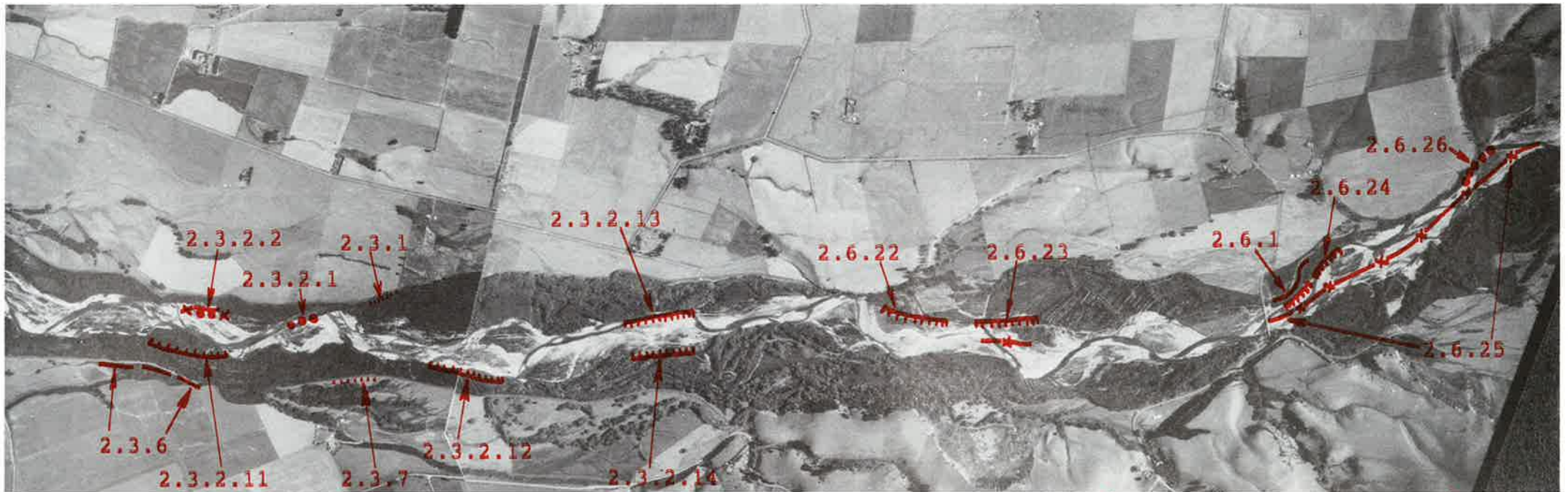


OPIHI RIVER — KERRYTOWN ROAD TO PLEASANT POINT



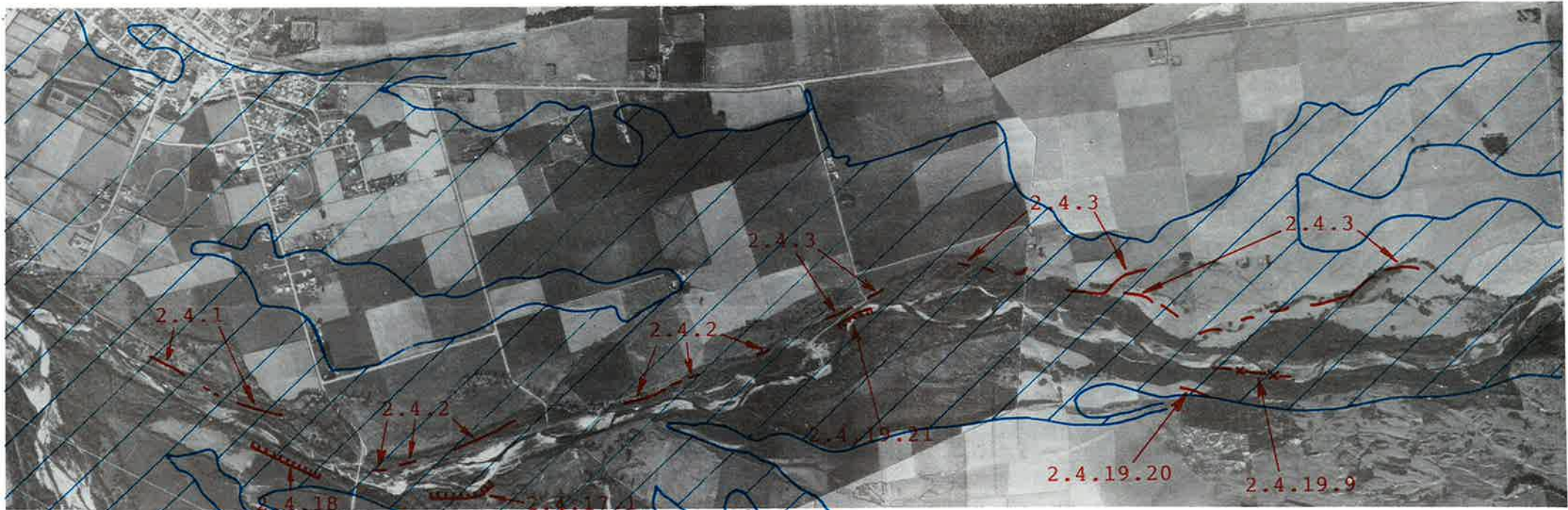
OPIHI RIVER — PLEASANT POINT TO RIVER ROAD



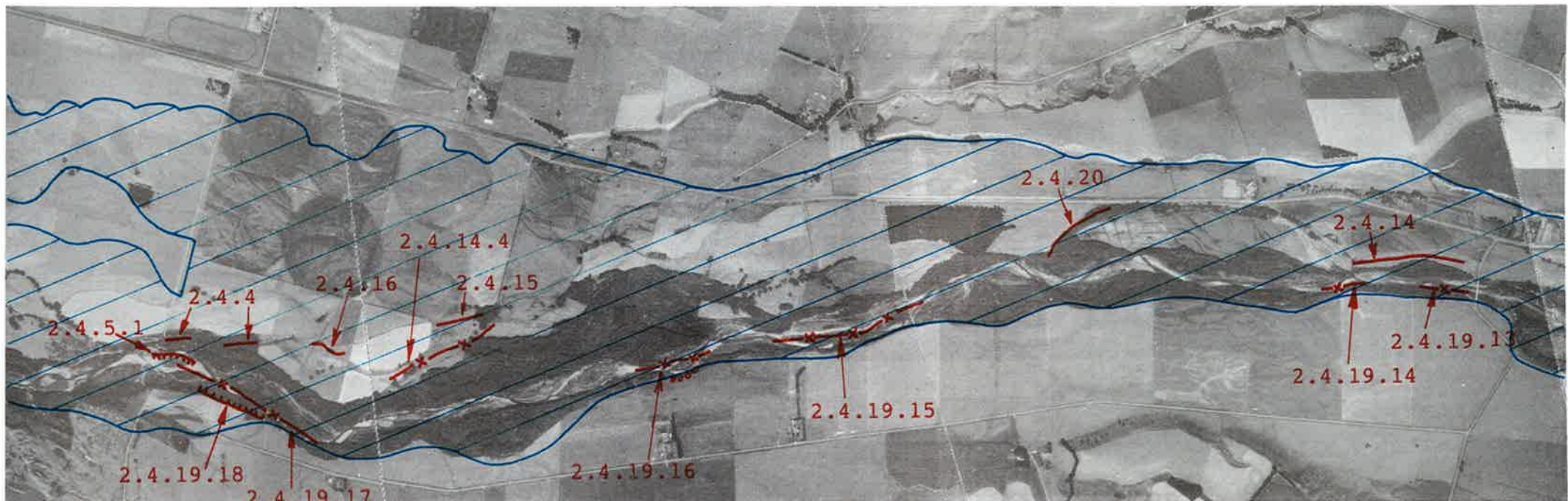


OPIHI RIVER — RIVERROAD TO HANGING ROCK BRIDGE



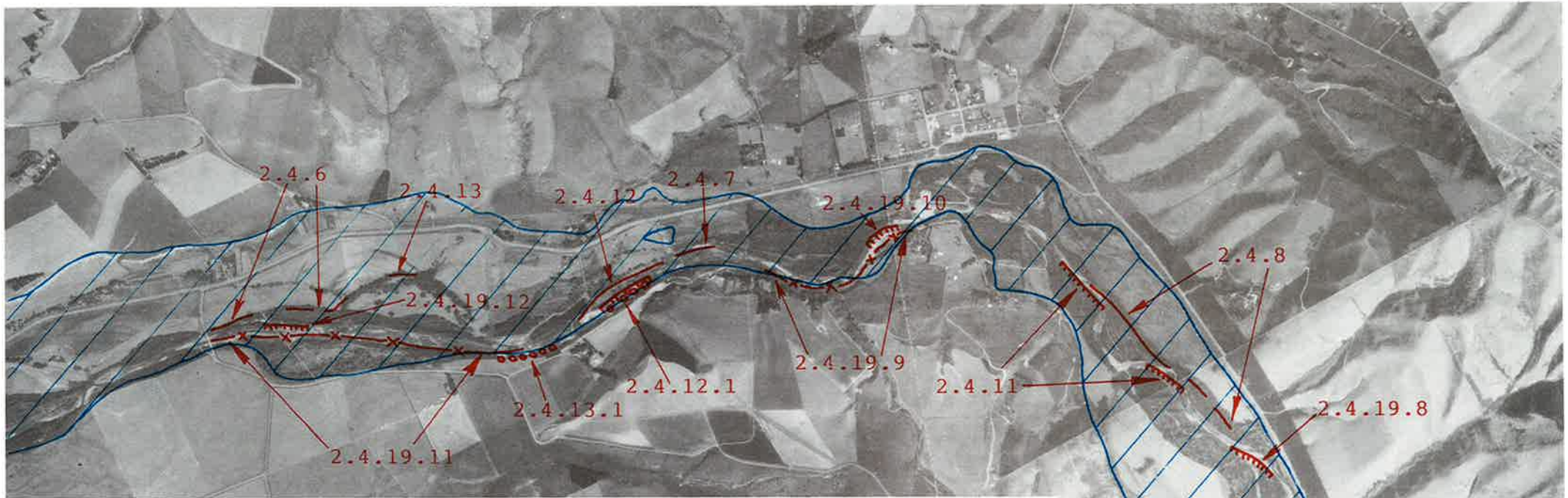


TENGAWAI RIVER — PLEASANT POINT TO CROSS ROAD

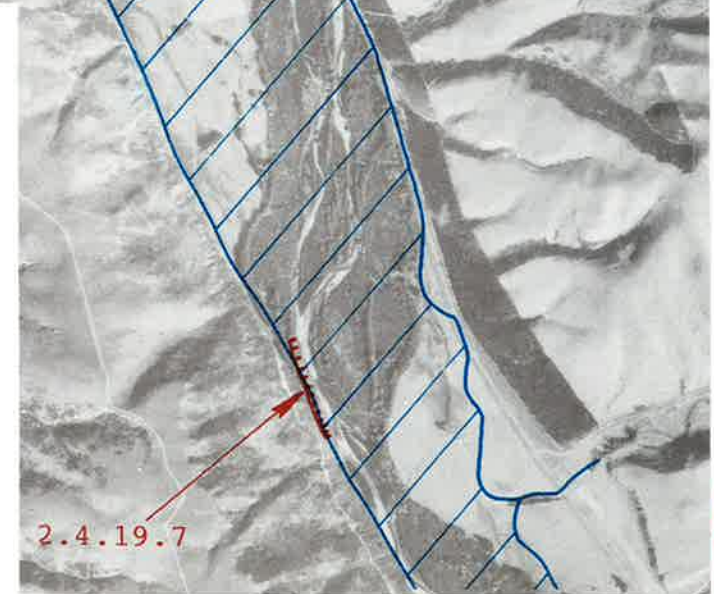
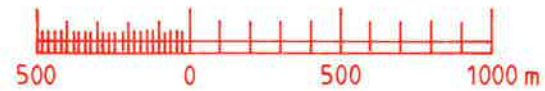


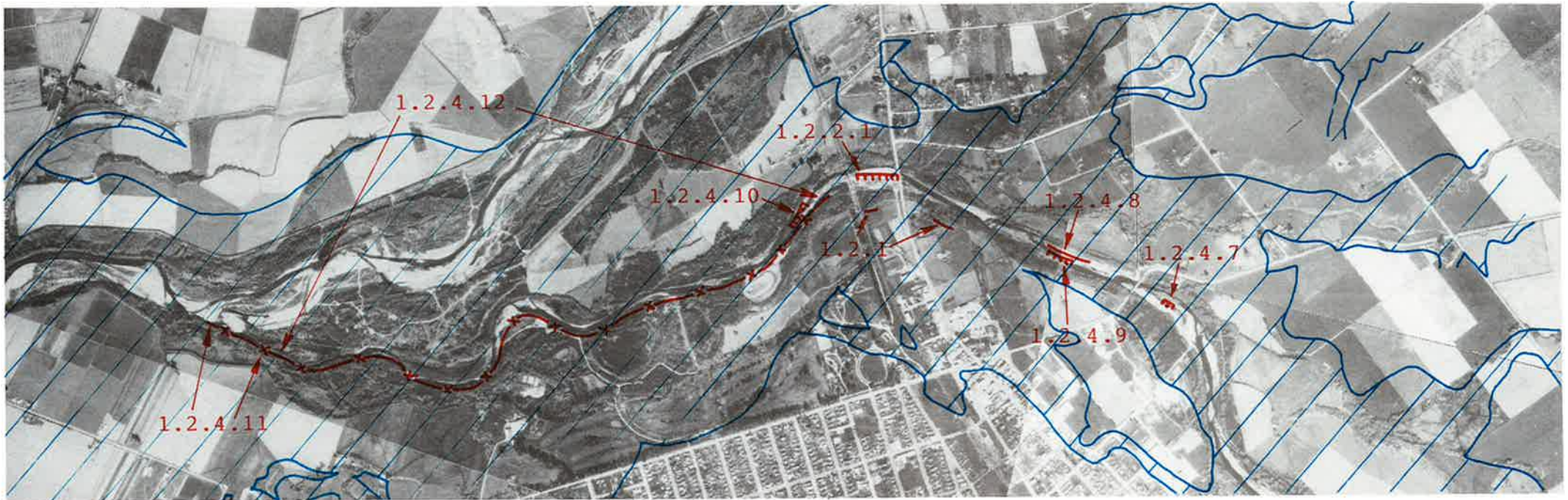
TENGAWAI RIVER — CROSS ROAD TO CLEALANDS BRIDGE





TENGAWAI RIVER — CLEALANDS BRIDGE TO NELSONS ROAD

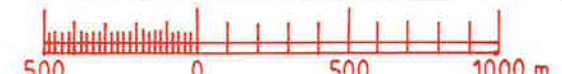




TEMUKA RIVER — WAIPOPO ROAD TO INSULATOR WORKS

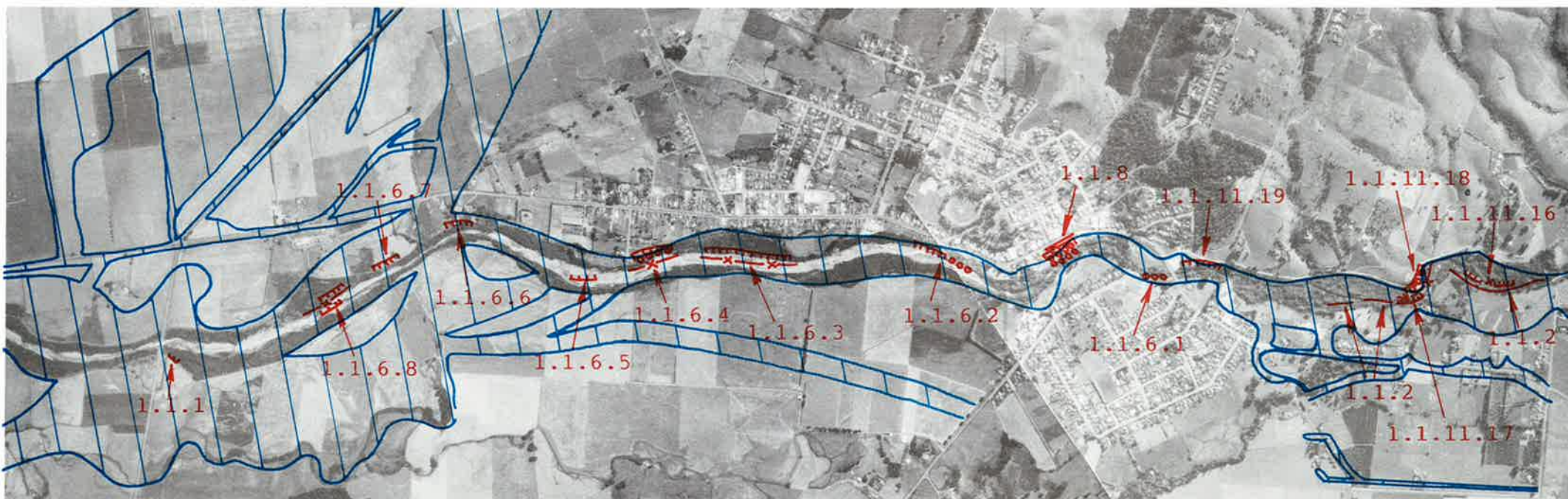


TEMUKA-WAIHI RIVER — INSULATOR WORKS TO WINCHESTER





WAIHI RIVER — WINCHESTER TO COACH ROAD



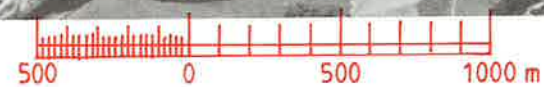
WAIHI RIVER — COACH ROAD TO BENNETT ROAD



WAIHI RIVER — BENNETT ROAD TO BURDON ROAD



WAIHI RIVER — BURDON ROAD TO GORGE





LEVELS PLAINS AREA

18.0.0



SOUTH CANTERBURY CATCHMENT BOARD
 FLOOD OF 13 MARCH 1986
 REVISED (14/7/86) SCHEDULE OF FLOOD DAMAGE

ITEM	RIVER LOCATION/DESCRIPTION	Priority	OFFICIAL
			NEW ESTIMATE COST \$
1.0	ORARI - WAIHI - TEMUKA		
1.1	Waihi River		
1.1.1	Coach Road - Stopbank repair	2a:	\$10,000
1.1.2	Rakapuka - Stopbank repair	2a:	\$50,000
1.1.3	Beeby's Road - Stopbank repair	2a:	\$5,000
1.1.4	Pembertons Road - Stopbank repair	2a:	\$50,000
		3:	
1.1.6	In river - Miscellaneous	2b:	
		4:	
1.1.6.1	McKENZIE ST d/s traffic bridge TLB HBP	3:	\$2,500
1.1.6.2	MOTELS (Brechins) TRB Groynes HBP	2:	\$11,250
1.1.6.3	BELOW PINES TO HORRELLS TRB ABP CI	2:	\$9,750
1.1.6.4	HORRELLS TRB Groynes CI	2:	\$13,500
1.1.6.5	A. YOUNG TLB by sewerage works GBC	2:	see GBC
1.1.6.6	RUTLANDS TRB HOUSE BELOW SEWERAGE WK ABP	3:	\$8,500
1.1.6.7	NZED PYLONS & LINE CROSSING TRB ABP	3:	\$3,500
1.1.6.8	YOUNGS 200m BELOW NZED PYLONS TL&RB ABP Snag.	3:	\$3,750
1.1.6.9	JUST BELOW COACH ROAD BDGE TRB HBP Groynes	3:	\$9,750
1.1.6.10	1ST BEND BELOW COACH ROAD BDG TRB HBP CI	3:	\$12,500
1.1.6.11	WARNER TLB CI Snagging	2:	\$4,000
1.1.6.12	D/S 2ND BEND BELOW COACH ROAD TRB HBP CI	2:	\$5,500
1.1.6.13	TAYLOR D/S OF ABOVE TRB ABP CI Snagging	3:	\$3,750
1.1.6.14	ABOVE HAWKE ROAD TRB ABP	2:	\$2,500
1.1.6.15	BELOW HAWKE ROAD TIFFEN-HEWSON TLB RK Groynes	2:	\$12,500
1.1.6.16	GREENALL TRB ABOVE BEEBYS ROAD CI ABP	3:	\$3,750
1.1.6.17	HUTS AT PINE PLANTATION TRB HBP CI	3:	\$4,500
1.1.6.18	HARRISONS TRB long straight b4 bdge ABP CI	3:	\$3,500
1.1.6.19	OTTLEYS BELOW TE AWA BDGE TLB HBP CI Snagging	2:	\$9,500
1.1.6.20	FEMBERTONS above oxford crossing TLB ABP CI	2:	\$8,500
1.1.6.21	J.DAVIES TLB Oxford crossing TLB ABP CI Snag	2:	\$9,500
1.1.8	Geraldine Borough Commercial Area Rk Groynes	1:	\$50,000
1.1.9	Te Awa - Stopbank repair	3:	\$5,000
1.1.10	Hawke - Coach Rd Stopbank repairs	3:	
1.1.11	Upper Waihi - Various	2b:	
	- Bank Protection	3:	
1.1.11.1	MALLINSON TLB ABP CI	2:	\$11,000
1.1.11.2	BELOW BURDONS BRIDGE (100m) TLB ABP CI	3:	\$5,650
1.1.11.3	McKENZIE TRB HBP CI	2:	\$10,750
1.1.11.4	McKENZIE (500m) below bdg TRB CI Groynes	2:	\$13,000
1.1.11.5	1st BEND BELOW BDGE TLB CI Groynes Snagging	4:	\$7,500
1.1.11.6	BELOW 1st BEND BELOW BRIDGE TLB 1.HBP Groynes	2:	\$11,000
1.1.11.7	BELOW 1st BEND BELOW BRIDGE TLB 2. HBP	3:	\$5,850
1.1.11.8	BELOW GOULDS ROAD TRB S/B repairs CI Snagging	3:	\$9,750
1.1.11.9	FURTHER BELOW GOULDS ROAD TLB 1 HBP CI	3:	\$3,000
1.1.11.10	FURTHER BELOW GOULDS ROAD TLB 2 HBP CI	3:	\$3,250
1.1.11.11	FURTHER BELOW GOULDS ROAD TLB 3 HBP CI	2:	\$3,750
1.1.11.12	FURTHER BELOW GOULDS ROAD TRB 4 Rock Groynes	3:	\$9,500
1.1.11.13	FURTHER BELOW GOULDS ROAD TRB 5 ABP Groynes	3:	\$9,750
1.1.11.14	CUMMINGS TLB ABP CI In Strm Bank	2:	\$4,500
1.1.11.15	McKENZIE TLB opp homestead crossing ABP CI	3:	\$4,500
1.1.11.16	LOWENS TLB HBP CI	2:	\$20,000
1.1.11.17	LOWENS CENTRE OF PROPERTY TLB HBP CI	2:	\$15,000
1.1.11.18	LOWENS CENTRE OF PROPERTY TRB CI Groynes	2:	\$8,000
1.1.11.19	CLARKES ABOVE TRAFFIC BRIDGE TRB ABP	3:	\$3,500
1.1.11.20	McKENZIE SUNDRUM ABP CI	3:	\$10,000
1.1.11.21	McATAMANYS-BURDONS BRIDGES General	3:	\$5,000

 \$486,750

1.2.0	TEMUKA		
1.2.1	State Highway 1 - Stopbank repair	1:	\$4,000
1.2.2	State Highway 1 - In river work	3:	
1.2.2.1	SH1 - SIMT RLWY TRB	4:	\$4,000
1.2.3	Oxford Crossing - Stopbank repair	2a:	\$18,000
1.2.4	Inriver - Miscellaneous	:	
1.2.4.1	W. McCULLOUGHES TRB rechannel river	2A:	\$7,500
1.2.4.2	W. McCULLOUGHES TRB S/B repairs	2A:	\$25,668
1.2.4.3	OXFORD CROSSING-WAIHI CONFLUENCE TRB HBF & CI	2A:	\$12,500
1.2.4.4	KEMFORD FARMS TRB 500m d/s OXFORD XNG. ABP CI	2A:	\$12,500
1.2.4.5	KEMFORD FARMS TRB 400m below above ABP & CI	3:	\$7,000
1.2.4.6	EVANS PARK TLB lap banks repair	3:	\$2,500
1.2.4.7	KEMFORD FARMS TRB u/s MANSE BRIDGE ABP	3:	\$3,500
1.2.4.8	KELMAN TRB d/s MANSE BR S/B REPAIRS	2A:	\$4,000
1.2.4.9	KELMAN TRB d/s MANSE BR ABP	3:	\$4,250
1.2.4.10	M SCANNELLS TRB opp car club H.B.P	3:	\$3,500
1.2.4.11	MOUTH TLB TRB C.I.	3:	\$3,000
1.2.4.12	SH1 TO MOUTH General snagging	3:	\$2,000
1.2.4.13	A. LYON stopbank repairs to 3 gaps	3:	\$8,000

\$121,918

1.3.0	OPIHI RIVER		
	TLB TEMUKA RIVER TO COAST		
1.3.1	Rooneys - Bank Protection	3:	\$5,000
1.3.2	Milford Raes - Stopbank repairs	1:	\$18,000
1.3.3	Milford Breens- Bank protection	2b:	\$14,000
1.3.4	Milford -Breen-Stopbank repairs	1:	\$18,000
1.3.5	Milford Huts - Stopbank repairs	1:	\$20,000
1.3.6	Tarrants - Stopbank repairs	1:	\$5,000
1.3.7	In river - Miscellaneous	2b:	
		3:	
1.3.8	In river - Miscellaneous	-:	
1.3.9	K. Rooney Milford Lagoon-s/b repair	1:	\$12,500
1.3.10	Milford Huts - Groyne repairs	3:	\$10,000
	-Berm s/b repairs + rock rip rap	3:	\$20,000
1.3.11	Milford Lagoon - Culvert repairs	3:	\$2,500
1.3.12	Instream - Miscellaneous	:	
1.3.13	K. Rooney Stopbank Repairs	1:	\$15,000
1.3.14	KELMANS TLB ABP Rock Groynes	2:	\$12,000

\$152,000

ITEM	RIVER LOCATION/DESCRIPTION		NEW ESTIMATE COST \$
1.4.0	ORARI RIVER		
1.4.1	Gorge to Coast general snagging & C.I	2b:	\$10,000
	- In river miscellaneous	4:	
1.4.2	Gorge to Coast in river misc.	-:	
1.4.2.1	POPLAR FLATS ORARI GORGE STATION C.I & HBP	3:	\$12,500
1.4.2.2	ORARI GORGE STATION ABOVE INTAKE TRB ABP & CI	2:	\$17,500
1.4.2.3	WATER INTAKE TLB ABOVE & BELOW ABP & CI	3:	\$5,000
1.4.2.4	C INGLIS TLB HBP	3:	\$11,000
1.4.2.5	ABOVE BURDONS ROAD TRB HBP & CI	3:	\$9,000
1.4.2.6	Gorge-Burdon Rd Orari Gorge Stn TRB HBP	3:	\$3,500
1.4.2.7	Gorge-Burdon Rd DC line-Burdon Rd ABP & CI	3:	\$9,000
1.4.2.8	(a)Burdon-Gould Rd groynes ,HBP,ABP & CI	3:	\$9,500
1.4.2.9	(b)Burdon-Gould Rd groynes ,HBP,ABP & CI	3:	\$7,500
1.4.2.10	(a)Goulds Rd-SH72 groynes ,HBP,ABP & CI	3:	\$9,000
1.4.2.11	(b)Goulds Rd-SH72 groynes ,HBP,ABP & CI	3:	\$8,500
1.4.2.12	D/S SH1 TLB 1st bend d/s Rd fwy protection	3:	\$7,500
1.4.3	Orari Gorge Station TL&RB bank protection	3:	\$20,000
1.4.4	Upper Orari - Miscellaneous	2b:	\$5,000
	repair - (not inspected)	:	\$10,000
1.4.5	Orari Mouth - Bank protection	:	\$10,000

			\$164,500

1.5.0	O.W.T. TRIBUTARY STREAMS		
1.5.1	Scotsburn - Drop Structures & bank protection	3: -:	
1.5.1.1	COOPERS CK FARRA CI ABP Groynes Gravel Traps	3:	\$50,000
1.5.2	Scotsburn - Thatchers Ford - Drop Structure	: :	
1.5.2.1	COOPERS CK THATCHERS FORD CI Drop Str. repair	3:	\$3,500
1.5.3	Scotsburn - Miscellaneous groynes & Bank protection	3: -:	
1.5.3.1	COOPERS CK SOWERBY/SCOBIE CI HBP S/B Replace	3:	\$10,000
1.5.4	Sweetwater Creek - Drop Structures - Bank protection & stop banks	2a: -:	
1.5.4.1	SWEETWATER CK MOUTH CI ABP	3:	\$1,250
1.5.4.2	SWEETWATER CK WILSONS CI HBP Snagging	3:	\$17,500
1.5.4.3	SWEETWATER CK JENSEN CI ABP	3:	\$1,500
1.5.4.4	SWEETWATER CK SANDERS CI ABP Snagging	3:	\$3,250
1.5.4.5	SWEETWATER CK CALLAHAN CI ABP Snagging	3:	\$2,500
1.5.4.6	SWEETWATER CK HORSEMAN ESTATE CI ABP Snagging	3:	\$1,250
1.5.4.7	SWEETWATER CK ADAMSON CI ABP Snagging	4:	\$2,500
1.5.4.8	SWEETWATER CK WEBB CI ABP Snagging	3:	\$3,500
1.5.5	Ohapi - Bank protection	:	\$10,000
1.5.6	Smithfield - Bank protection	:	\$5,000
1.5.6.1	SMITHFIELD MOUTH CI Snagging	3:	\$750
1.5.7	Coopers Creek-Ellery return river back to original course	2b: :	\$20,000
1.5.7.1	COOPERS CK MOUTH TO ORARI CI FLOOD GATE Snag.	3:	\$750
1.5.7.2	COOPERS CK G. LESLIE CI Snagging	3:	\$3,500

1.5.7.3	COOPERS CK GOULD CI ABP Snagging	3:	\$2,000
1.5.7.4	COOPERS CK PETERSON CI ABP	3:	\$1,000
1.5.7.5	COOPERS CK MILLAR CI ABP	3:	\$1,000
1.5.7.6	COOPERS CK METCALF CI ABP	3:	\$2,500
1.5.7.7	COOPERS CK ELLERY CI	3:	\$3,000
1.5.7.8	COOPERS CK BELOW SH.79 CI	3:	\$4,500
1.5.7.9	COOPERS CK MCKENZIE CI Stopbank repair	3:	\$3,750
1.5.7.10	COOPERS CK BELOW SH.72 CI	3:	\$2,750
1.5.7.11	COOPERS CK ABOVE PEEL FORREST RD CI ABP	3:	\$4,500
1.5.7.12	COOPERS CK SCOTT CI ABP	3:	\$3,000
1.1.5	Barkers Creek - Miscellaneous	4:	\$30,000
1.1.5.1	BARKERS MOUTH CI	3:	\$900
1.1.5.2	BARKERS BELOW SERCOMBES ROAD CI ABP	3:	\$2,500
1.1.5.3	BARKERS ABOVE SERCOMBES ROAD CI ABP	3:	\$4,000
1.1.5.4	BARKERS PRATTLEYS/JOHNSTON CI ABP	3:	\$10,000
1.1.5.5	BARKERS PARRS/PRATTLEYS CI ABP	3:	\$12,500
1.1.5.6	BARKERS WOODINGS CI ABP	3:	\$4,000
1.1.5.7	BARKERS J.PARR CI ABP	3:	\$7,500
1.1.5.8	BARKERS MCKEON CI ABP	3:	\$4,500
1.1.7	Other tributaries - Miscellaneous	-:	\$20,000
1.1.7.1	SERPENTINE CK-BLOGGS-GERALDINE BC Bank Pro Re	4:	\$1,500
1.1.12	Dobies, Warners - Bank Protection	:	\$30,000
1.1.12.1	WARNERS NEUTZE CI ABP Fence repairs	3:	\$2,250
1.1.12.2	WARNERS GEMMELL CI ABP Fence Repairs	3:	\$2,250
1.1.12.3	WARNERS MOUTH HEWSON CI Snagging	3:	\$900
1.1.12.4	DOBBIES RACECOURSE CI Snagging	3:	\$2,000
1.1.12.5	DOBBIES D. BUTLER CI ABP S/B Repair Snagging	2:	\$2,500

\$302,050

TOTAL - ORARI - WAIHI
- TEMUKA - SCHEME

\$1,227,218

ITEM	RIVER LOCATION/DESCRIPTION		NEW ESTIMATE COST \$
2.1.0	OPIHI CATCHMENT CONTROL SCHEME		
2.1.0	Opihi River - Coast - Sh1		
2.1.1	Waipopo - Stopbank & lapbank repair	3:	\$5,000
2.1.2	Waipopo TRB- Bank protection - Huts	2b:	\$16,000
		3:	
2.1.3	Waipopo TRB - Upstream Huts P&R Groynes	3:	\$27,500
2.1.4	Various - Culvert repair	2b:	\$2,500
		3:	
2.1.5	Petersons TRB - Groyne repair	3:	\$27,500
2.1.6	Grassy Banks TRB - Banks protection	:	\$25,000
2.1.7	In River - Miscellaneous	2b:	
		-:	
2.1.7.1	GRASSY BANKS TRB Pile & Rope Groynes	3:	\$11,000
2.1.8	McCULLYS TRB Maori fence -extend CI	:	\$14,500
2.1.9	SCANNELLS TLB replant	3:	\$7,000
2.1.10	SCANNELLS TLB s/b base H.B.F	3:	\$7,500
2.1.11	SCANNELLS TLB AT PYLONS H.B.F	3:	\$14,000

			\$157,500

2.2.0	OPIHI RIVER - SH1 - PLEASANT POINT		
2.2.1	TRB above Sh1-Bridge approach HBP	3:	\$5,000
2.2.2	TLB Lyons - Stopbank repair	4:	\$3,000
2.2.3	TLB Moores - Stopbank repair	4:	\$8,000
2.2.4	TLB Various - Stopbank repair	4:	\$3,000
2.2.5	TLB Walkers Lyons - Bank protection	3:	\$15,000
2.2.6	TLB Saleyards Bridge s/b repair	1:	\$20,000
2.2.7	Scott-Russell s/b & lapbank repair	1:	\$26,000
2.2.8	Mill Road - Stopbank repair	1:	\$5,000
2.2.9	Saleyards Bridge - Stopbank repair	1:	\$27,000
2.2.10	Pleasant Point Creek lapbank repair	3:	\$5,000
2.2.11	Pleasant Point - Stopbank repair	3:	\$10,000
2.2.12	In River - Miscellaneous	2b:	
		3:	
2.2.13	In River - Miscellaneous	-:	
2.2.13.1	H RUSSELLS TRB HBP	2:	\$37,000
2.2.13.2	R LYON TLB HBP	2:	\$17,500
2.2.13.3	Gerard SCOTTS TRB d/s Dalys Rd HBP	3:	\$16,000
2.2.13.4	LYONS TLB HBP	3:	\$12,000
2.2.13.5	SCOTT Joe TRB d/s roaring camp rd HBP	3:	\$14,000
2.2.13.6	SCOTT-RUSSELL TRB CI Lap Bank repair	2:	\$17,000
2.2.13.7	GERMAN CREEK OUTLET TRB HBP	2:	\$8,000
2.2.13.8	CARTWRIGHTS TRB 500m d/s pylons HBP Planting	3:	\$11,000
2.2.13.9	CARTWRIGHTS TRB opposite pylons HBP Planting	3:	\$8,500
2.2.13.10	JACKSONS TRB Butlers-mill roads CI Rock Groyne	2:	\$27,000
2.2.13.11	IRRIGATION OUTLET TRB ABP Maori Fence	3:	\$12,500
2.2.13.12	ABOVE BUTLERS ROAD TLB ABP	3:	\$7,000
2.2.13.13	ABOVE MWD IRRIGATION INTAKE TRB ABP	3:	\$7,000
2.2.14	Russells - Stopbank repair	-:	
		1:	\$3,000
2.2.15	Cones Rd TLB - Bank protection	3:	\$11,000
2.2.16	Kerrytown Rd.-TRB stopbank repairs	2a:	\$15,000
2.2.17	TRB J.W Scott-Stopbank repairs	2a:	\$15,000

			\$365,500

ITEM	RIVER LOCATION/DESCRIPTION		NEW ESTIMATE COST \$
2.3.0	OPIHI RIVER		
	PLEASANT POINT - BEDELLES CORNER		
2.3.1	TRB Boakes stopbank repair	2a:	\$3,000
		4:	
2.3.2	In river - Miscellaneous	2a:	
	Colletts-u/s of s/b job	-:	
2.3.3	In River - Miscellaneous	-:	
2.3.2.1	COLLETTS-BOAKES-upper site Rock Groynes	2A:	\$17,500
2.3.2.2	COLLETTS-BOAKES-lower site CI Rock Groyne Sna	1:	\$35,000
2.3.2.3	AT TENGAWAI CONFLUENCE TRB CI HBP repair	3:	\$2,500
2.3.2.4	CONES TLB AWP	3:	\$4,000
2.3.2.5	WESTAWAYS TRB AWP	3:	\$3,500
2.3.2.6	CONES TOP-PEARCES TLB CI AWP	3:	\$3,000
2.3.2.7	COLLETTS TRB east end CI ABP	3:	\$2,750
2.3.2.8	AGNEWS TLB opposite Colletts ABP	4:	\$1,750
2.3.2.9	COLLETTS MAIN JOB ADJ TO S/B REP. CI HBP Rock	2A:	\$25,000
2.3.2.10	BOAKES-COLLETTS-DOWNLAND-PEARCES Snagging	2A:	\$2,500
2.3.2.11	DOWNLANDS WATER CROSSING TLB CI HBP Snagging	2A:	\$4,750
2.3.2.12	ROBERTSON-GARDINER TLB CI HBP	2A:	\$9,000
2.3.2.13	MAIN BEDDELLES RAMP TRB HBP	3:	\$4,750
2.3.2.14	MAIN BEDDELLES RAMP TLB opp above HBP	3:	\$2,750
2.3.4	TLB Rifle range - Stopbank repair	1:	\$5,000
2.3.5	Collets-stopbank	1:	\$25,000
2.3.6	Pearce-Stopbank repairs	2a:	\$10,000
2.3.7	GARDINER TLB S/B Scour repair Planting	3:	\$2,500

\$164,250

ITEM	RIVER LOCATION/DESCRIPTION		NEW ESTIMATE COST \$
2.4.0	TENGAWAI RIVER PLEASANT POINT TO SOURCE		
2.4.1	TRB Saleyard (new) stopbank repair	1:	\$22,000
2.4.2	TRB Dog Kennels - Stopbank repair	1:	\$10,000
2.4.3	TRB Robins - Stopbank repair	1:	\$27,000
2.4.4	TRB Cross Roads-s/b repair(2breaks)	1:	\$14,000
2.4.5	Cross Roads instream miscellaneous	4:	
2.4.5.1	ABOVE CROSS ROADS TRB Pile & rope groynes	3:	\$11,000
2.4.6	TRB Clellands Bridge s/b repair	2a:	\$16,000
2.4.7	TRB Below Cave - Stopbank repair	2a:	\$10,000
2.4.8	TRB Above Cave - Stopbank repair	4:	\$10,000
2.4.9	TLB Fowlers - Bank protection	3:	
2.4.10	TRB O'Sullivan(u/s Sh8)bank protn.	3:	
2.4.10.1	LEON O'SULLIVAN TLB top job CI HBP	2:	\$10,000
2.4.10.2	LEON O'SULLIVAN TRB bottom job CI HBP Ins.B	2:	\$11,000
2.4.11	TRB Smiths- Bank protection	4:	\$5,000
2.4.12	TRB Murrays - Stopbank repairs	2a:	\$10,000
		-:	
2.4.12.1	MURRAYS TRB H.B.P.	2:	\$29,000
2.4.13	TRB Ulrich - Stopbank repairs	2a:	\$6,000
		-:	
2.4.13.1	ROCK FARM TLB (ULRICH) Rip Rap & rep. berm	3:	\$10,000
2.4.14	TRB d/s Clellands Bridge s/b repair	2a:	\$18,000
2.4.15	TRB Diamond - Stopbank repairs	2a:	\$6,000
		-:	
2.4.16	TRB Lund - Stopbank repairs	2a:	\$5,000
2.4.17	TLB Totara Valley - Stream mouth - Log jam CI	2b: -:	\$5,000
2.4.17.1	TOTARA VALLEY MOUTH TLB Bank protection	2:	\$5,000
2.4.18	TLB Westaways - Bank protection	4:	\$13,000
2.4.19	Instream - Miscellaneous	2b: -:	
2.4.19.1	ANDREW HOPE TLB above top bridge CI & HBP	3:	\$6,500
2.4.19.2	BELOW SH8 TRB CI HBP	1:	\$3,250
2.4.19.3	J. FRANCE TLB Cricklewood stm mth CI & ABP	3:	\$1,400
2.4.19.4	OPPOSITE RICHARDSONS ROAD TRB CI & HBP	3:	\$1,750
2.4.19.5	MOUTH OPAWA STREAM TRB CI & ABP	3:	\$1,500
2.4.19.6	MOUTH ROCKY GULLY TRB CI & ABP	3:	\$1,500
2.4.19.7	KERR TLB Top end of property CI & HBP	2:	\$10,000
2.4.19.8	STUD HORSE PROPERTY TRB CI & ABP	3:	\$6,500
2.4.19.9	BELOW KERRS BRIDGE TO RECORDER TRB CI & Snag.	3:	\$2,250
2.4.19.10	KERRS TLB below Belmont bridge CI & HBP	3:	\$1,750
2.4.19.11	ULRICH'S-CLELLAND'S TRB TLB CI & Snagging	3:	\$2,100
2.4.19.12	ABOVE CLELLANDS BRIDGE TRB HBP	3:	\$10,500
2.4.19.13	CLELLANDS BRIDGE TRB (LYNDSAYS) CI Layering	2A:	\$1,750
2.4.19.14	LYNDSAYS TRB stone groyne by hut CI & Snag.	2:	\$1,500
2.4.19.15	FRASERS TRB Dirty Dan's Diversion Snag & Cut	2:	\$6,500
2.4.19.16	EAST END RYANS TLB Rock,CI Fwy clearance	2:	\$15,000
2.4.19.17	RYANS HOLE DOWN TO CROSS RD. CI & Snagging	3:	\$3,500
2.4.19.18	IVAN FOWLER TLB CI,ABP & Snagging	2:	\$6,000
2.4.19.19	FOWLER'S-NED ROBINS TRB Snag. & Fwy clearance	3:	\$1,500
2.4.19.20	BLAKEMORE-ROBINS BDRY. TLB Stopbank repairs	:	\$10,000
2.4.19.21	HAMMONDS ROAD TLB TRB CI,ABP & Groynes	2:	\$15,000
2.4.20	Lyndsays-Stopbank repairs east end	2a:	\$15,000

\$377,750

2.5.0	OPUHA RIVER		
2.5.1	North Opuha-Variou-Bank protection	2b:	
		-:	
2.5.1.1	NTH BR. E. TAYLOR ABOVE SETT. BDG TRB CI ABP	2:	\$3,650
2.5.1.2	NTH BR. TRB PLANTATION RD-RAYNES CK CI Snag.	2:	\$9,000
2.5.1.3	NTH BR. JOFF HAYES TRB CI ABP Snagging	3:	\$5,750
2.5.1.4	NTH BR. WILLIAMS TLB (CORA LYNN) CI ABP	3:	\$4,000
2.5.1.5	NTH BR. J.GALWAY TLB CLAYTON BDG. CI HBP	2:	\$5,275
2.5.1.6	NTH BR. BRAY TRB CI ABP Snagging	3:	\$1,500
2.5.1.7	NTH BR. R.RAYNE TLB CI ABP	3:	\$1,500
2.5.1.8	NTH BR. D. BRAY TRB ABOVE CLAYTON BR CI ABP	3:	\$1,750
2.5.1.9	NTH BR. A ORBELL TLB CI ABP Snagging	3:	\$1,250
2.5.1.10	NTH BR. BUTTERS TRB PLANTATION RD CI ABP	2:	\$3,500
2.5.1.11	NTH BR. U/S RAYNES CK-SKI FLD BDG CI ABP Snag	3:	\$1,750
2.5.2	South Opuha - Various - Bank protection	2a:	
		-:	
2.5.2.1	STH BR. GENERAL MOUTH-HILLS CI general Snag.	2:	\$6,750
2.5.2.2	STH BR. BENNETT TRB CI ABP	3:	\$2,150
2.5.2.3	STH BR. JOFF TLB CI ABP	3:	\$2,000
2.5.2.4	STH BR. MITCHELL TLB CI HBP Snagging	3:	\$2,250
2.5.2.5	STH BR. JONES TRB CI HBP	3:	\$2,250
2.5.2.6	STH BR. SWANN TLB CI HBP Stopbank repair	2:	\$10,000
2.5.3	Mainstream Opuha bank protection	2b:	
		-:	
2.5.3.1	MAINSTRM PARRS TLB CI HBP Snagging	3:	\$5,750
2.5.3.2	MAINSTRM LINTONS-GUDEX TRB CI ABP Snagging	2B:	\$15,000
2.5.3.3	MAINSTRM INMAN TRB pump house CI HBP Snagging	2:	\$17,500
2.5.3.4	MAINSTRM GENERAL TRB TLB CI Snagging	2B:	\$6,000

\$108,575

ITEM	RIVER LOCATION/DESCRIPTION	NEW ESTIMATE COST	\$
2.6.0	OPIHI RIVER ABOVE BEDELLS CORNER		
2.6.1	TRB Gould(u/s Hanging Rock) s/b rep	3:	\$15,000
2.6.2	TLB Talbot(d/s Raincliff)bank protn	3:	\$10,000
2.6.3	TRB Hanging Rock - Carters HBP	2a:	\$8,000
2.6.4	TRB Below Raincliff-Carter (a)+(b)	2a:	
2.6.4.1	CARTER R TRB d/s bridge BREAKOUT Stopbank rep	2:	\$15,000
2.6.4.2	CARTER R TRB d/s bridge INSTREAM CI HBP	2:	\$15,000
2.6.5	TLB Above Raincliff-Quantocks s/b	2a:	\$10,000
2.6.6	TRB Coal Creek Mouth bank protn.	3:	
2.6.6.1	J WATT TRB Coal Creek Mouth CI HBP	3:	\$3,500
2.6.7	TRB O'Connors - Bank protection	3:	
2.6.7.1	F O'CONNOR TRB CI Snagging	2A:	\$1,500
2.6.8	TRB Allandale Bridge bank protn.	4:	
2.6.8.1	ALLANDALE SAWMILL TLB ABP Planting	4:	\$1,500
2.6.9	TLB Above Kerrs Crossing bank protn.	4:	
2.6.9.1	V JONES Main job TLB Replace S/B	2:	\$10,000
2.6.9.2	V JONES Main job TLB HBP	2:	\$15,000
2.6.10	Above Gorge Instream	2b:	

- Miscellaneous			
2.6.10.1	EX N HOARE TLB u/s gorge CI HBP	3:	\$7,500
2.6.10.2	ADAMS TLB d/s Talbot Rock CI HBP Replant	3:	\$3,500
2.6.10.3	GENERAL SNAGGING	3:	\$3,750
2.6.10.4	FAIRLIE TOWNSHIP CREEK MOUTH TRB CI ABP	4:	\$1,500
2.6.10.5	DOBSON NO1 TLB CI HBP	3:	\$4,500
2.6.10.6	DOBSON NO2 TLB CI HBP	3:	\$4,000
2.6.10.7	EVERSLEY CROSSING TLB NO2 ABP	3:	\$2,400
2.6.10.8	ALLANDALE BR.-KERRS CROSSING General Snagging	3:	\$3,000
2.6.10.9	JONES TLB u/s Kerrs Crossing CI Planting	3:	\$2,000
2.6.10.10	NZED TOWER TRB CI HBP	3:	\$7,500
2.6.10.11	UPSTREAM OF NZED LINE @ TLB CI ABP	3:	\$1,750
2.6.10.12	PAGES 6 (Pines) TRB CI HBP	6:	\$7,500
2.6.10.13	PAGE 100m U/S OF ABOVE TRB	6:	\$2,500
2.6.10.14	JONES 200m U/S above pines TLB CI ABP	3:	\$1,750
2.6.10.15	GILES-JONES BDY. TLB CI HBP Maori fence	3:	\$2,000
2.6.10.16	OPPOSITE OLD LIME WORKS TRB CI HBP	3:	\$2,750
2.6.10.17	UPSTREAM TLB CI ABP	3:	\$2,000
2.6.10.18	O'CONNOR-GALLAGHER BDY. TLB CI ABP instrm bk	3:	\$2,500
2.6.10.19	OPPOSITE KIMBELL TOWNSHIP TLB CI Snagging	3:	\$2,000
2.6.10.20	OPPOSITE KIMBELL TOWNSHIP TRB CI ABP	3:	\$4,250
2.6.10.21	SEDDONS ROAD CROSSING Centre River CI Snaggin	3:	\$1,500
2.6.10.22	KERRS CROSSING-SEDDONS RD general CI Snagging	3:	\$2,250
2.6.10.23	BELOW GUERINS HOUSE TLB CI ABP	3:	\$1,750
2.6.10.24	ABOVE STONELEIGH CROSSING TRB CI ABP Snagging	4:	\$2,000
2.6.10.25	ABOVE POWER LINE CROSSING (500m)TRB CI ABP	3:	\$2,500
2.6.10.26	JONES (upper) TLB CI Groynes	3:	\$8,000
2.6.10.27	BELOW GUERINS (300m) CI ABP	3:	\$2,750
2.6.10.28	OPPOSITE 3 SPRINGS WATER INTAKE CI HBP st S/B	2:	\$17,500
2.6.10.29	U/S OPPOSITE 3 SPRINGS WATER INTAKE Snagging	3:	\$1,000
2.6.10.30	HORSESHOE BEND TO McINTOSH STR TLB CI Snaggin	3:	\$2,500
2.6.10.31	KERRS CROSSING-SHB BRIDGE Snagging	3:	\$3,000
2.6.10.32	McINTOSH STREAM OUTLET TLB CI ABP	3:	\$3,250
2.6.10.33	RONA ST FRONTAGE (WHARTON) TLB CI ABP	3:	\$3,500
2.6.10.34	PADDYS MARKET STREAM MOUTH TLB CI ABP Snaggin	3:	\$3,250
2.6.11	TRB O'Connor - Bank protection	3:	
2.6.12	TLB Taylor - Bank protection	3:	
2.6.13	TRB Guerin - Bank protection	-:	
2.6.13.1	OPPOSITE GUERINS HOUSE TRB CI HBP	2:	\$15,000
2.6.14	Stoneleigh Stream Mouth-Bank protn.	4:	
2.6.14.1	STONELEIGH OUTLET TO SEDDONS RD TRB Snagging	3:	\$2,000
2.6.15	Hurst - Bank protection	4:	\$10,000
2.6.16	Munro's - Bank protection	4:	
2.6.16.1	AIRIES STATION TLB TRB MUNROES CI HBP	3:	\$5,250
2.6.17	Burkes Pass - Bank protection	4:	
2.6.17.1	BURKES PASS TOWNSHIP TLB TRB CI Snagging	3:	\$3,750
2.6.18	Baxters-stopbank CI Stopbank repair	2a:	\$15,000
2.6.19	Baxters-instream HBP Replanting	2b:	\$15,000
2.6.20	Bruce-stopbank repairs	2A:	\$10,000
2.6.21	Carters-u/s raincliffe(in stream) CI HBP Snag	2b:	\$15,000
2.6.22-30	BEDELLS TO GORGE INSTREAM	:	
2.6.22	NORTON John TRB just above cliff CI HBP	3:	\$5,250
2.6.23	OUT FROM J NORTONS HOUSE TRB CI HBP	3:	\$3,500
2.6.24	GOULD U/S Hanging Rock bridge TRB CI HBP	2:	\$9,000
2.6.25	RAINCLIFFE-HANGING ROCK Centre Riv CI Snag	2:	\$5,000
2.6.26	GOULDS under limestone bluffs Rock Groyne rep	3:	\$3,000
2.6.27	MILNE TRB 3mile bush stream mouth HBP Bank-st	2:	\$13,000
2.6.28	ROCKWOOD-RAINCLIFFE BRIDGES Riv Centre Snag.	2B:	\$2,500
2.6.29	Bruce TRB above rockwood bridge CI HBP	2A:	\$7,500
2.6.30	SHALLARD H.B.P. Rip Rap	3:	\$10,000

\$377,650

ITEM	RIVER LOCATION/DESCRIPTION		NEW ESTIMATE COST \$
2.7.0	TENGAWAI TRIBUTARIES		
2.7.1	Rocky Gully - Bank protection	2b:	\$5,000
		3:	\$20,000
2.7.1.1	ROCKY GULLY Misc.	3:	\$10,000
2.7.1.2	ROCKY GULLY-MOUTH-DESTOCK ZONE CI ABP Snag.	3:	\$6,000
2.7.1.3	ROCKY GULLY-GLASS CI ABP	3:	\$3,000
2.7.1.4	ROCKY GULLY-KIDD CI ABP	3:	\$3,500
2.7.1.5	ROCKY GULLY-O'NEILL CI ABP	3:	\$4,000
2.7.2	Opawas - Bank protection	2b:	\$10,000
		3:	\$90,000
2.7.2.1	OPAWA Misc.	3:	\$20,000
2.7.2.2	OPAWA TLB TRB-FRANCE BY SHB CI ABP	3:	\$7,500
2.7.2.3	OPAWA TLB SMITH ice rink CI ABP Planting	3:	\$5,000
2.7.2.4	OPAWA TLB TRB- J. STEWART CI ABP Planting	3:	\$10,000
2.7.2.5	OPAWA TLB TRB-IRVING ESTATE CI ABP	3:	\$5,000
2.7.2.6	OPAWA TLB TRB-GLASS OPAWA ROAD CI ABP	3:	\$6,000
2.7.2.7	OPAWA TL&RB-SIMPSON WILFRED RD CI ABP S/B REP	2:	\$10,000
2.7.2.8	OPAWA LONG GULLY B J GLASS CI ABP	3:	\$1,500
2.7.3	Manahune - Bank protection	3:	\$10,000
2.7.4	Mawaro Stream - Bank protection	4:	\$10,000
2.7.4.1	MAWARO Misc.	3:	\$5,000
2.7.4.2	MAWARO-WS WREFORD TLB TRB CI ABP	3:	\$6,000
2.7.4.3	MAWARO-A. RODGERS TRB ABP	3:	\$5,000
2.7.4.4	MAWARO-RODGERS TRB CENTRE JOB HBP	3:	\$1,750
2.7.4.5	MAWARO-RODGERS TLB ABOVE SCHOOL CI HBP	3:	\$2,250
2.7.4.6	MAWARO-SCHOOL ABOVE BRIDGE CI ABP	3:	\$2,500
2.7.4.7	MAWARO-BELOW BRIDGE CI	3:	\$1,500
2.7.4.8	MAWARO-PRESTAGE CI ABP	3:	\$4,500
2.7.5	Duck Stream-Bank protection fence repairs	3:	\$30,000
2.7.6	McKenzie Pass - Flood gates	2b:	\$1,000
		4:	
2.7.6.1	McKENZIE PASS Gravel Trap Flood Gates Fencing	4:	\$27,500
2.7.7	Locharts Creek - Flood gates	2b:	\$1,000
		4:	\$2,000
2.7.7.1	LOCHARTS CI ABP fence repairs	4:	\$25,500
2.7.8	Upper Tengawai-Mt Dalgety bank pro.	4:	\$10,000
2.7.9	Totara Valley Stream - (not inspected)	2a:	\$20,000
		4:	\$80,000
2.7.9.1	TOTARA VLY STRM. WESTAWAY-BLAKEMORE CI ABP	2:	\$6,500
2.7.9.2	TOTARA VALLEY STRM. BLAKEMORE CI ABP	3:	\$6,000
2.7.9.3	TOTARA VALLEY STRM. WESTAWAY CI ABP	2:	\$7,500
2.7.9.4	TOTARA VALLEY STRM. LAMBIES D/S HWY CI ABP RO	3:	\$20,000
2.7.9.5	TOTARA VALLEY STRM. LAMBIES U/S BDG CI RK. Sn	3:	\$2,500
2.7.9.6	TOTARA VALLEY STRM. R. PAUL CI ROCK Snagging	3:	\$5,000
2.7.9.7	TOTARA VALLEY STRM. THICKETT CI ABP Stopbank	3:	\$9,500
2.7.9.8	TOTARA VALLEY STRM. McKEON CI ABP Stopbank	3:	\$15,000
2.7.9.9	TOTARA VALLEY STRM. FRAZER CI ABP	3:	\$6,000
2.7.9.10	TOTARA VALLEY STRM. GEARY CI ABP	3:	\$2,750
2.7.9.11	TOTARA VALLEY STRM. STEWART CI ABP	3:	\$3,500
2.7.9.12	TOTARA VALLEY STRM. LATIMER CI ABP	3:	\$3,500
2.7.9.13	TOTARA VALLEY STRM. Misc.	3:	\$10,000
2.7.10	Cricklewood Stream France bank pro.	4:	\$10,000
2.7.10.1	CRICKLEWOOD- J. FRANCE CI ABP	3:	\$5,000
2.7.10.2	CRICKLEWOOD- HANDY TUBB CI ABP	4:	\$1,500
2.7.10.3	CRICKLEWOOD- COLES Grassed waterway repair	3:	\$2,500

2.7.11	Miscellaneous - unreported	2b:	\$10,000
2.7.12		4:	\$10,000
2.7.12.1	LITTLE OPAWA Misc	3:	\$10,000
2.7.12.2	LITTLE OPAWA- REYNOLDS TLB TRB CI ABP	3:	\$7,500
2.7.12.3	LITTLE OPAWA TLB TRB-GALLEN CI ABP	3:	\$5,250
2.7.12.4	LITTLE OPAWA TLB TRB-CULLEN CI ABP	3:	\$1,500
2.7.12.5	LITTLE OPAWA TLB TRB-J. ANDERSON CI ABP	3:	\$7,500
2.7.13	DAVIDSON CK BISHOP CI ABP	3:	\$1,000
2.7.14.1	ROBINSONS ABOVE SH.8 CI	3:	\$1,250
2.7.14.2	ROBINSONS BELOW SH.8 CI	3:	\$5,250
2.7.14.3	ROBINSONS DAVIDSON CI	2:	\$3,750
2.7.14.4	ROBINSONS LUNDS CI	2:	\$3,250
2.7.15.1	SUTHERLANDS LUNDIES D/S CROSS RDS WRWY BK REP	2:	\$3,250
2.7.15.2	SUTHERLANDS LUNDS CROSS RDS-SH.8 WRWY BK REP	3:	\$3,750
2.7.16	ANDERSON/GALLEN TRB CI ABP Snagging	3:	\$3,500
2.7.17	ANDERSON/PATTERSON TRB Rock Groynes	2:	\$10,000

\$665,500

2.8.0	OPIHI TRIBUTARIES		
2.8.1	McIntosh Creek-Gravel trap repair	4:	
2.8.1.1	MacINTOSH STREAM LOWER END CI ABP Snagging	4:	\$1,750
2.8.1.2	MacINTOSH STREAM DESTOCK AREAS Fence repairs	4:	\$6,500
2.8.2	Firewood, Cowan Stream-Bank protn.	4:	
2.8.2.1	FIREWOOD LOWER END CI ABP Snagging	3:	\$3,000
2.8.2.2	FIREWOOD GRAVEL TRAPS	4:	\$13,800
2.8.2.3	FIREWOOD MISC	3:	\$1,500
2.8.3	Stoneleigh Stream Tiffens-Bank pro.	4:	\$7,500
2.8.3.1	STONELEIGH- CHISHOLM CI ABP Snagging	3:	\$2,500
2.8.4	Stanton Stream-Drop Structure rep.	3:	
2.8.4.1	STANTON- HOPE BROTHERS CI Drop Structure	2:	\$5,000
2.8.5	Kimbell Stream - Bank protection CI	4:	
2.8.5.1	KIMBELL- TOWNSHIP Bank Protection & CI	3:	\$2,500
2.8.6	Punaroa Stream - Bank protection CI	4:	\$5,000
2.8.7	Fairlie Creeks - Bank protection	2a:	
	and Stopbank repair	-:	
2.8.7.1	IRISHMAN CREEK- J. MURPHY CI ABP Snagging	3:	\$2,500
2.8.7.2	IRISHMAN CREEK- A. TROTTER CI ABP Snagging	2:	\$750
2.8.7.3	IRISHMAN CREEK- GRASS ROAD CI ABP Snagging	3:	\$3,500
2.8.7.4	IRISHMAN CREEK- D/S GILLINGHAM EST. CI ABP	3:	\$2,500
2.8.7.5	WELLSHOT CREEK- J. MURPHY CI ABP	3:	\$3,500
2.8.8	Allandale Creek - Drop Structure	:	
	repair - Bank protection	4:	
2.8.8.1	ALLANDALE STREAM ADAMS TLB TRB CI ABP Snaggin	3:	\$2,000
2.8.8.2	ALLANDALE STREAM RD TAYLOR CI Drop Struc rep	3:	\$7,000
2.8.8.3	ALLANDALE STREAM ADAMS U/S TONDROS CI ABP Sna	3:	\$2,500
2.8.8.4	ALLANDALE STREAM CALLAGHAN U/S SH79 CI ABP Sn	4:	\$1,750
2.8.9	Strathconan Creek-Bank protection	4:	
2.8.9.1	STRATHCONNA CREEK-P O'CONNOR TRB CI ABP Snag.	3:	\$3,650
2.8.9.2	STRATHCONNA CREEK-R. SHAND TL&RB CI ABP Snag.	3:	\$6,400
2.8.9.3	STRATHCONNA CREEK- K. O'NEILL CI ABP	:	\$2,500

2.8.10	Coal Creek - Bank protection	4:	
2.8.10.1	COAL CREEK-J. WATTS MOUTH CI ABP Snagging	3:	\$8,500
2.8.10.2	COAL CREEK- BELL CI Snagging	2:	\$4,750
2.8.10.3	COAL CREEK- WILLETTS CI	3:	\$3,000
2.8.10.4	COAL CREEK- RODGERS CI Snagging	3:	\$1,000
2.8.10.5	COAL CREEK- N. ANDERSON CI Grass waterway rep	3:	\$7,500
2.8.11	German Creek - Grassed waterway	2a:	
	- Drop structure repair	4:	
2.8.11.1	GERMAN CK MOUTH AT SCOTTS CI Snagging	2:	\$1,000
2.8.11.2	GERMAN CK J SCOTTS CI Snagging	2:	\$1,000
2.8.11.3	GERMAN CREEK Misc.	:	\$10,000
2.8.11.4	GERMAN CREEK C. BRUCE CI Snagging	2:	\$1,750
2.8.11.5	GERMAN CREEK CARTWRIGHT Grass Wrwy repair	3:	\$1,750
2.8.11.6	GERMAN CREEK JACKSON Grrass Wrwy repair	3:	\$1,250
2.8.11.7	GERMAN CREEK ARMSTRONG Grass Wrwy repair	3:	\$750
2.8.11.8	GERMAN CREEK ABOVE SH.8 Grass Wrwy repair	3:	\$2,500
2.8.11.9	GERMAN CREEK CLARKE-SMRT-MUN RD GR WRWY REP	3:	\$2,500
2.8.11.10	GERMAN CK CLARKE U/S SMT-MUN RD GR WRWY REP	3:	\$5,000
2.8.11.11	GERMAN CREEK LUNDY Drop Str. rep. Gr Wrwy rep	3:	\$4,500
2.8.11.12	GERMAN CREEK BELOW SMT-MUN RD CI Drop Str rep	3:	\$5,250
2.8.13	Miscellaneous - (uninspected)	-:	
2.8.12	Miscellaneous - (uninspected)	2b:	
2.8.12.1	PLEASANT PT CK C. BRUCE CI S/B rep Snagging	2:	\$5,750
2.8.12.2	PLEASANT PT CK CARTWRIGHT CI S/B rep Snagging	2:	\$2,500
2.8.12.3	PLEASANT PT CK JACKSON CI Snagging	2:	\$1,000
2.8.12.4	PLEASANT PT CK O'SULLIVAN GOLF CRSE CI Snag.	3:	\$1,500
2.8.12.5	PLEASANT PT CK ARMSTRONG CI Snagging	3:	\$1,000
2.8.12.6	PLEASANT PT CK PLSNT. PT TOWNSHIP CI ABP Snag	3:	\$3,000
2.8.14	BLIND CK CALLAGHAN(Allandale?) CI ABP	3:	\$2,000
2.8.15.1	CLOUDY PEAKS LOWER END CI ABP Snagging	3:	\$3,000
2.8.15.2	CLOUDY PEAKS GRAVEL TRAP Flood Gates Fence	4:	\$15,100
2.8.15.3	CLOUDY PEAKS MISC CI PROTECTION TO SLOPE TOE	4:	\$2,000
2.8.16.1	THREE MILE BUSH ENTIRE LENGTH CI Snagging	3:	\$3,750
2.8.16.2	HAZELBURN LOWER REACHES CI Snagging	3:	\$3,000
2.8.17	THREE SPRINGS- MOUTH TO HILLS CI Snagging	3:	\$3,450

\$196,650

ITEM	RIVER LOCATION/DESCRIPTION		NEW ESTIMATE COST \$
2.9.0	OPIHA TRIBUTARIES		
2.9.1	Raincliff Stream - Bank protection	4:	
2.9.1.1	RAINCLIFFE STRM. McHAFFIES CI	2:	\$6,250
2.9.1.2	RAINCLIFFE STRM. QUANTOCKS U/S BDG CI Snag.	3:	\$5,000
2.9.1.3	RAINCLIFFE STRM. PARR & TRIB STRM CI ABP Snag	2:	\$7,250
2.9.1.4	RAINCLIFFE STRM. PARR-STATE FOREST CI ABP Sna	3:	\$4,250
2.9.1.5	RAINCLIFFE STRM. GUILFORD CI ABP Snagging	3:	\$3,250
2.9.1.6	Middle Valley-Parr Stopbank repair	2a:	\$10,000
2.9.1.7	RAINCLIFFE STRM. QUANTOCK/PARR CI ABP Snaggin	3:	\$11,000
2.9.1.8	RNCLIF.STRM. QUANTOCK BDG-MID VLY BDG CI ABP	2:	\$10,000
2.9.1.9	RAINCLIFFE STRM.-Quantock s/b repairs	3:	\$30,000
2.9.2	Middle Valley Creek - Bank protn.	4:	
2.9.2.1	MID. VLY. STRM WILLIAMS/REYNOLD CI ABP Snag	3:	\$1,500
2.9.2.2	MID. VLY. STRM. JOHNSTON CI ABP RK Drop. Snag	3:	\$8,750
2.9.3	Cattle Valley Creek-Bank protection	4:	
2.9.3.1	CATTLE VALLEY INMAN-KING CI ABP Snagging	3:	\$5,500
2.9.3.2	CATTLE VALLEY NELSON SCARLET CI ABP Snagging	3:	\$2,750
2.9.3.3	CATTLE VALLEY M.J. KIRKE CI ABP	3:	\$3,500
2.9.4	Station Stream, Ribbonwood Stream	2a:	
	-Bank protection and stopbank rep.	4:	
2.9.4.1	STATION STREAM Misc.	3:	\$10,000
2.9.4.2	STATION STREAM P HAYES CI ABP Snagging	3:	\$5,000
2.9.4.3	STATION STREAM C. ANDERSON CI Snagging	3:	\$3,250
2.9.4.4	STATION STREAM F.RAYNE FOX'S PK CI ABP Snag	3:	\$6,250
2.9.5	Glenshiel Stream - Bank protection	2b:	
		4:	
2.9.5.1	GLENSHIEL FENCE REPLACEMENT	2:	\$5,000
2.9.5.2	GLENSHIEL GRAVEL TRAP REPAIRS	3:	\$5,000
2.9.6	Deep Creek - Bank protection and stopbank repairs	2a:	
		4:	
2.9.6.1	DEEP CREEK MUNROE CI ABP Destock fence	3:	\$3,750
2.9.6.2	DEEP CREEK GENERAL CI ABP	3:	\$2,500
2.9.7	North Opuha Tributaries-Bank protn.	4:	\$7,150
2.9.7.1	RAYNES CREEK ABOVE PLANTATION RD CI ABP Snag	3:	\$2,850
2.9.8	Clayton Stream - Bank protection	4:	\$1,500
2.9.8.1	CLAYTON STREAM A. DRBELLS CI Snagging	3:	\$3,500
2.9.9	Uninspected - Miscellaneous	2b:	\$10,000
		4:	\$40,000
2.9.10.1	RIBBONWOOD STREAM Misc.	3:	\$10,000
2.9.10.2	RIBBONWOOD STREAM C. ANDERSON CI ABP Fencing	3:	\$2,750
2.9.10.3	RIBBONWOOD STREAM SWANN CI ABP Fencing Snag	3:	\$3,250
2.9.10.4	RIBBONWOOD STREAM C.SMITH CI Fencing Snaggin	3:	\$3,750

\$234,500

TOTAL - OPIHI CATCHMENT
CONTROL SCHEME

\$2,647,875

ITEM	RIVER LOCATION/DESCRIPTION		NEW ESTIMATE COST \$
3.0.0	PAREORA RIVER		
3.1.0	Sh1 - School - Stopbank repairs	2a:	\$15,000
3.2.0	Pookes-Collins - Stopbank repairs	3:	\$10,000
3.3.0	Midgely-Brassells-Stopbank repairs	3:	\$5,000
3.4.0	Brosnahans - Bank protection	3:	
	TLB ex Jackson Prop. CI Replanting	3:	\$6,250
3.5.0	Murrays-Hines - Bank protection	3:	\$17,500
3.6.0	TRB Home Station-Scott s/b repair	3:	\$20,000
3.7.0	Henshaws - Stopbank repairs	3:	\$5,000
3.8.0	TLB - Caird - Bank protection	4:	
	TLB old rock groynes	3:	\$12,500
3.9.0	Pareora Huts -Stopbank repairs	1:	\$37,500
3.10.0	In Stream Various - Miscellaneous	2a:	
		4:	
3.11.0	In Stream Various - Miscellaneous	-:	
3.11.1	MIDGLEY TRB (TOP END) Berm Lap Bank	3:	\$9,000
3.11.2	BELOW MIDGLEYS SHINGLE DUMP TLB CI 2 Groynes	3:	\$10,500
3.11.3	POOKES-COLLINS BDRY. TLB CI 2 P&R Groynes	3:	\$10,000
3.11.4	COLLINS TLB about bend in river CI HBF S/B	2:	\$7,500
3.11.5	COLLINS TLB 500m d/s of above CI Groynes	2:	\$12,500
3.11.6	COLLINS TLB 300m d/s of above CI HBF Groynes	2:	\$17,500
3.11.7	MANCHESTER GIBSON CI Grass Waterway repair	3:	\$3,000
3.11.8	PAREORA HUTS TRB CI HBF Rock armouring	2A:	\$20,000
3.11.9	CAIRDS-EVANS BDRY. TLB CI HBF Rock Groyne	3:	\$15,000
3.11.10	HENSHAWS TRB below duck pond CI ABF	3:	\$3,650
3.11.11	JW SCOTT TRB 500m u/s Holme stn br1{ CI ABF &	3:	\$17,500
3.11.12	JW SCOTT TRB 500m u/s Holme stn br2{Rk Groyne	3:	pt. above
3.11.13	JW SCOTT TRB d/s Holme stn bdg a HBF ROCK	3:	\$9,750
3.11.14	JW SCOTT TRB d/s Holme stn bdg b Lap Bank	3:	\$6,650
3.11.15	JW SCOTT TRB d/s of above CI HBF	3:	\$4,275
3.11.16	GEORGES TLB opp. Holme stn creek HBF Groynes	3:	\$7,500
3.11.17	A. KERR TRB CI ABF	4:	\$2,750
3.11.18	KERR-JEFFCOATS ROAD TRB ABF Planting	4:	\$2,150
3.11.19	AITCHESONS TO BRASSELLS BRIDGE CI Snagging	3:	\$4,250
3.11.20	Below Midgelys access road TRB	2:	\$12,500
3.12.0	Blanchards - Mouth - Bank prot.	4:	\$5,000
3.13.0	Home Station Stream - Drop structure, Grassed waterway repair	2a: 4:	\$22,000 \$10,000
3.14.0	Southburn - Drop structure - Grassed Waterway repair	: 3:	 \$10,000
3.15.0	Evans-stopbank repairs	2a:	\$30,000
3.16.0	Evans-instream works	2b:	
3.16.1	W R EVANS TRB below gorge CI ABF	4:	\$4,750
3.16.2	W R EVANS TRB Little Pareora Mouth CI HBF Pln	3:	\$3,750
3.16.3	W R EVANS Picnic ground CI	3:	\$6,500

\$396,725

ITEM	RIVER LOCATION/DESCRIPTION		NEW ESTIMATE COST \$
4.0.0	WAIHAO RIVER		
4.1.0	Snodgrass, below Sh1	2c:	
4.1.1	Small TLB Stopbank repair	2c:	\$12,500
4.1.2	Creanes TRB u/s railway s/b repairs	2c:	\$12,500
4.2.0	Lundies Ford, 2 @ Stopbank repair	2c:	
4.2.1	Bruces TLB- Stopbank repair	2c:	\$22,500
4.2.2	Hughes TRB-Stopbank repair	:	\$22,500
4.3.0	General - Stopbank repair	2c:	\$50,000
4.4.0	Fletcher & Richardson s/b repair	2c:	\$35,000
4.5.0	General-Fairway clearance+snagging	3:	\$30,000
4.6.0	BANK PROTECTION	-:	
4.6.1	CREANE TRB CI ABP	3:	\$8,500
4.6.2	LUNDY TLB ABOVE FORD CI ABP	3:	\$7,500
4.6.3	FORSYTH TRB BELOW FORD ABP Groyne replacemnt	3:	\$7,500
4.6.4	E. FLETCHER TLB BELOW FORD CI Groyne repair	3:	\$8,500
4.6.5	W D HAYMAN TLB BY HOUSE Rock Rip Rap	3:	\$7,750
4.6.6	SNODGRASS TLB ISLAND SOUTH SIDE CI P&R Groyne	3:	\$10,500

			\$235,250

5.0.0	LOWER WAIMATE CREEK		
5.1.0	- Bank re-instatement and clean	3:	
5.1.1	LAMINGS BRIDGE AREA ABP Planting	3:	\$25,000
5.1.2	M. LAMING NEARER MOUTH S/B repair Rip Rap	2:	\$3,850
5.1.3	ABOVE HANATONS ROAD CI Snagging	3:	\$2,850

			\$31,700

6.0.0	HOOK RIVER		
6.1.0	- Fairway clearance, edge	2a:	\$5,000
6.2.0	replacement, stopbanks	2c:	
6.3.0		-:	
6.3.1	FENWICKS TRB (Ryans) CI HBP Replanting	2:	\$7,750
6.3.2	RYANS TRB CI Gabion & Groyne repair	3:	\$6,500
6.3.3	McKERCHAR TLB TRB CI ABP	3:	\$5,500
6.3.4	TAYLOR TRB CI ABP	3:	\$5,750
6.3.5	H B L JOHNSTON TLB TRB CI S/B repair	3:	\$8,000

			\$38,500

ITEM	RIVER LOCATION/DESCRIPTION		NEW ESTIMATE COST \$
7.0.0	MAKIKIHI RIVER	2b:	
	- Bank protection	-:	
7.1.0	WHOLE FRONTAGE MAKIKIHI CI ABP Snagging	2B:	\$15,000

			\$15,000

8.0.0	OTAID RIVER		
8.1.0	- Miscellaneous - Bank protection	2a:	\$5,000
8.2.0	& planting, stopbanks	2b:	
8.3.0		-:	
8.3.1	WARD TLB above school bridge CI ABP	3:	\$4,500
8.3.2	ABOVE COUNTY PUMP HOUSE TRB CI ABP	3:	\$3,500
8.3.3	McILWEEES CROSSING TLB TRB CI	3:	\$5,000
8.3.4	HENDERSON TRB CI Replant	3:	\$1,900
8.3.5	DRINAN TRB below bridge CI ABP	3:	\$4,150
8.3.6	J. LITTLE TRB CI ABP Instream Bank	2:	\$14,500
8.3.7	OPPOSITE J. LITTLE TLB COLES CI ABP	2:	\$8,500
8.3.8	DRINANS BRIDGE CHURCH FORD TLB TRB Snagging	2:	\$3,500
8.3.9	O'SULLIVANS TLB above church ford CI ABP	2:	\$4,000
8.3.10	JOHNSON U/S & D/S GRAYS FORD CI ABP Groyne re	3:	\$7,500
8.3.11	BELOW SIMT RAILWAY CI	3:	\$1,750
8.3.12	A. SHIELDS TLB Grays ford-SH1 CI Snagging	3:	\$6,000
8.3.13	I.J. DALY CI HBP	3:	\$10,000

			\$79,800

9.0.0	SINCLAIRS CREEK	2c:	\$15,000
		-:	\$15,000

			\$30,000

ITEM	RIVER LOCATION/DESCRIPTION	NEW ESTIMATE COST	\$
10.0.0	MINOR WORKS		
	Still to be scheduled	2a:	\$136,200
10.0.1	Orari Gorge Station 5505,5517	2a:	\$20,000
10.0.2	Te Moana-Dempster 5549	2a:	\$10,000
10.0.3	Hook Stream-Fenwick	2a:	\$7,500
10.0.4	Maori Creek-Gascoyne BP CI 5543	2a:	\$1,500
10.0.5	Saltwater Creek MOUTH OPENING	2a:	\$2,000
10.0.6	Saltwater Creek stopbank repair	2a:	\$5,000
10.1.1	TE MOANA RIV. W.R GIRVAN & ORS S/B BP 5537	2a:	\$6,000
10.1.2	TE MOANA RIV. GREGAN 5538	2a:	\$5,000
10.1.3	TE MOANA RIV. S. WOODS R16	2a:	\$20,000
10.1.4	TE MOANA RIV. S/ LATIMER S/B BP CI 5567	2a:	\$10,000
10.1.5	TE MOANA RIV. S.E. MORRIS 5541	2a:	\$20,000
10.1.6	TE MOANA RIV. GORDON GREER R3	2a:	\$20,000
10.1.7	TE MOANA RIV. B. HAMMOND A42	2a:	\$100
10.1.8	TE MOANA RIV. MARKHAM BROS.	2a:	\$3,000
10.1.9	TE MOANA RIV. R. ROBINSON	2a:	\$15,000
10.1.10	TE MOANA RIV. H. BRUCE	2a:	\$5,000
10.1.11	TE MOANA RIV. NTH BR E.C. HARPER	2a:	\$5,000
10.1.12	TE MOANA RIV. MR HILL BP CI 5559	2a:	\$2,000
10.1.13	TE MOANA RIV. C.J. EBBERT 5540	2a:	\$20,000
10.2.1	KAKAHU RIV. A. OMELVENA A15 S/B Gravel 5566	2a:	\$10,000
10.2.2	KAKAHU RIV. K. POW A12	2a:	\$5,000
10.2.3	KAKAHU RIV. J. MULVIHILL & SONS R31	2a:	\$12,000
10.3.1	HORSESGHOE LOGOON R. STEVENSON R1	2a:	\$1,500
10.4.1	MAORI CREEK H. GASCOYNE A20 5543	2a:	\$2,000
10.5.1	HAZELBURN CUT big drain A. GEARY R6	2a:	\$500
10.6.1	UNNAMED CREEK G. SUGRUE	2a:	\$2,000
10.7.1	ELWORTHY'S STRM. G. EGGLEINGTON BB4	2a:	\$1,000
10.8.1	PAREORA RIVER A. RAWLEY A21	2a:	\$15,000
10.8.2	PAREORA RIV. AR & MN MCKENZIE A23	2a:	\$12,000
10.9.1	MOTUKUIKA RIV. A. RAWLEY A21 5524	2a:	\$2,000
10.10.1	CANNINGTON CK. J. SQUIRE	2a:	\$1,500
10.10.2	BURNETTS CK. B. LITTLE R12	2a:	\$2,000
10.10.3	BURNETTS CK. E. McMASTER 5530	2a:	\$1,000
10.10.4	BURNETTS CK. J.G. LITTLE	2a:	\$1,000
10.10.5	BURNETTS CK. R.W. KELYNCK	2a:	\$3,000
10.11.1	KOHIKA STREAM J.G. COLES R7	2a:	\$500
10.11.2	KOHIKA STREAM A. COLE	2a:	\$1,000
10.12.1	UNNAMED CK. (MAKIKIHI AREA) WALLACE	2a:	\$5,000
10.13.1	ORARI STN. CK. ORARI GORGE STN	2a:	\$25,000
10.14.1	HOOK RIVER J. FENWICK R11 5513	2a:	\$5,000
10.14.2	HOOK RIVER D. BUTLER A29 5514	2a:	\$4,000
10.15.1	STONEY CREEK J. ROBERTS A41	2a:	\$1,000
10.16.1	TUSSOCK CREEK P.A. BRADLEY BB8	2a:	\$1,000
10.17.1	DRY CREEK R.O. PRIDIE 5533	2a:	\$5,000
10.17.2	DRY CREEK G. MANGIN 5553	2a:	\$5,000
10.17.3	DRY CREEK G. COPPARD 5552	2a:	\$1,500
10.18.1	BUCCLEUGH STM. J. LEWTHWAITE	2a:	\$1,000
10.19.1	UNNAMED CK (MANGATUI) J. PRITCHARD	2a:	\$3,000
10.20.1	ELDERS STREAM N. PIRIE	2a:	\$5,000
10.21.1	BEAUTIFUL VALLEY S. SHEEN	2a:	\$2,000
10.22.1	SEADOWN DNG. AREA I. OLDFIELD	2a:	\$2,000
10.23.1	MAKIKIHI RIV. P. GEANEY	2a:	\$2,500
10.23.2	MAKIKIHI RIV. K. BOWIE	2a:	\$20,000
10.23.3	MAKIKIHI RIV. C. W. CLARKE	2a:	\$500
10.23.4	MAKIKIHI RIV. J. TIFFEN	2a:	\$4,000
10.23.5	MAKIKIHI RIV. F.H. COLES	2a:	\$1,000
10.23.6	MAKIKIHI RIV. LW & DA ROBERTSON	2a:	\$5,000

10.23.7	MAKIKIHI RIVER TRIB. P.GEANNEY	2a:	\$3,000
10.24.1	TEASCHMAKER STRM. P. GOULD	2a:	\$1,000
10.24.2	TEASCHMAKER STRM. O.A. HENDERSON	2a:	\$1,000
10.24.3	TEASCHMAKER STRM. I. JEFFRIES	2a:	\$2,000
10.25.1	PETERS CK. I.F. WATSON	2a:	\$500
10.26.1	SOUTHBURN CK PAREORA L. ANDERSON	2a:	\$5,000
10.27.1	NELSONS CK. WB & RR NELSON	2a:	\$3,000
10.28.1	OTAIO AREA B. STOWELL	2a:	\$500
10.28.2	TRIB OTAIO RIV E. WARD 5526	2a:	\$6,000
10.29.1	ESK VALLEY CK. L. DONEHUE	2a:	\$10,000
10.29.2	ESK VALLEY CK. G.E. WRIGHT 5529	2a:	\$6,000
10.29.3	ESK VALLEY CK. P.R. RATHGEN 5525	2a:	\$6,000
10.29.4	ESK VALLEY CK. R. HEWSON 5519	2a:	\$5,000
10.30.1	OPUHA RIV TRIB A. ORBELL	2a:	\$1,000
10.31.1	WAITUNA STREAM J.R. RATTRAY	2a:	\$750
10.32.1	BROAD GULLY BURNETT ESTATE 5522	2a:	\$2,500
10.33.1	MEYERS PASS STRM PENTLAND HILLS STN 5518	2a:	\$5,000
10.34.1	STH BR. WAIHAD T. MEEHAN	2a:	\$2,000
10.34.2	STH BR. WAIHAD R.L. LESLIE 5523	2a:	\$3,000
10.35.1	TOTARA VALLEY TRIB R. KELLAND	2a:	\$2,000
10.36.1	WAIMATE CREEK A.G. HARRISON 5547	2a:	\$5,000
10.37.0	TOTARA DOWNS AGNEW	2a:	\$2,000
10.38.0	McKENZIE STREAM MT.PEEL HOMESTEAD 5561	2a:	\$5,000
10.39.0	ORARI TRIB C. INGLIS 5532	2a:	\$7,500
10.40.0	WAIHAD M. DICKSON 5506	2a:	\$10,000
10.41.0	WAIMATE CREEK L. LEIGHTON 5507	2a:	\$8,000
10.42.0	WAIMATE CREEK D.R. HARRIS 5508	2a:	\$6,000
10.43.0	PAREORA P. MOYNIHAN 5509	2a:	\$10,000
10.44.0	PAREORA RIV. TRIB. W.I.SCOTT Grass Wtrwy 5511	2a:	\$3,000
10.45.0	PAREORA RIV. W.I.SCOTT ABP CI 5512	2a:	\$3,000
10.46.0	ESK VALLEY CK. J.DRINNAN CI Layering 5515	2a:	\$2,000
10.47.0	HOOK RIV. TRIB. J.CAMPBELL ABP CI 5516	2a:	\$3,000
10.48.0	WAIMATE CK. P.A. THOMPSON CI Groyne rep. 5510	2a:	\$1,000
10.49.0	WASHDYKE CK. Miss D. GRANT Floodgates 5521	2a:	\$3,000
10.50.0	OTAIO RIVER TRIB W.J.COCKS Grasswrwy rep 5520	2a:	\$1,500
10.51.0	WAIHAD RIVER TRIB IL & PL MEHRTENS CI 5531	2a:	\$500
10.52.0	HOOK RIVER D.R. KINGSBURY CI Willow pro 5527	2a:	\$2,500
10.53.0	HOOK STREAM J.R. RATTRAY CI 5528	2a:	\$750
10.54.0	Te Moana (Hare Riv.) A.E. WOODING ABP CI 5535	2a:	\$5,000
10.55.0	BARKERS CK J.PARR Fencing s/b B.P 5534	2a:	\$1,000
10.56.0	WAIHI (SUNDRUM) JLD WALLACE S/B Rep. BP 5539	2a:	\$2,000
10.57.0	TE MOANA AJ & LJR PRATTLEY WBP CI 5542	2a:	\$1,000
10.58.0	HOOK RIV. IS & CI BUCKINGHAM BP CI 5544	2a:	\$2,000
10.59.0	WAIMATE CK R. MILLAR CI 5545	2a:	\$1,500
10.60.0	HOOK RIV. P. SLEIGH ABP CI 5546	2a:	\$2,500
10.61.0	WAIHAD RIV (STH BR) H.WILSON S/B Rep ABP 5548	2a:	\$3,200
10.62.0	RAUPD CK KW & LJ GOULD Drop str+wrwy rep 5550	2a:	\$6,000
10.63.0	BLACKS CK W.J. LAPHORNE S/B ABP CI 5551	2a:	\$2,000
10.64.0	HOOK RIVER B.G BUTLER CI BP 5554	:	\$1,500
10.65.0	HOOK RIVER I.A KELYNECK CI BP 5555	:	\$3,000
10.66.0	PAPAKA STREAM H.B STYLES CI 5556	:	\$2,500
10.67.0	KAKAHU RIVER PE & RP FINCH S/B BKSCOUR 5557	:	\$4,500
10.68.0	PAREORA (STH BR) J.J FORD S/B INSTREAM 5558	:	\$10,500
10.69.0	WAIMATE CREEK T.S RICHARDS GROYNES CI 5562	:	\$4,000
10.70.0	WAIMATE CREEK GM & DL SMITH S/B GROYNE 5563	:	\$13,000
10.71.0	MAKIKIHI RIVER G. ROONEY ABP 5564	:	\$6,000
10.72.0	TE MOANA S. ASKIN BP CI 5565	:	\$3,000
10.73.0	MAKIKIHI MAKIKIHI TRANS. LTD. ABP CI RR 5568	:	\$3,500
10.74.0	WAIHI RIVER A. MORRISON B.P 5569	:	\$1,500
10.75.0	TE MOANA O.A GOULD BP S/B 5570	:	\$14,000
10.76.0	SWEETWATER CREEK E.G ADAMSON BP CI 5571	:	\$2,500
10.77.0	WAIHI RIVER G.J COULTER BP CI 5575	:	\$500
10.78.0	TE MOANA O.S BLISSETT BP CI 5560	:	\$2,000
10.79.0	MOTUKAIKA STRM. A.G SCOTT BP CI S/B 5576	:	\$1,500

10.80.0	TE MOANA D. WADDINGTON BP 5577	:	\$500
0.81.0	TE MOANA A.I MARSHALL CI BANK REPAIR 5578	:	\$1,000
0.82.0	HOOK RIVER JOHN FOX BP CI 5579	:	\$4,000
10.83.0	TE MOANA WOODS & EBBETT BP CI S/B 5580	:	\$8,000
0.84.0	TE MOANA KIM HECK ABP CI 5581	:	\$2,500
0.85.0	SUTHERLANDS CK. (TRIB) H.A McPHERSON S/B 5583	:	\$300
10.86.0	TE MOANA O.A GOULD FENCING 5585	:	
10.87.0	LUSCOMBE STREAM L.J PYE DROP STR. Rep 5586	:	\$1,200
0.88.0	PAREORA RIVER S.D McKENZIE ABP 5588	:	\$3,000
0.89.0	PAREORA/BURNETTS CK. D. GRAY CI PLANTING 5589	:	\$3,000
10.90.0	ESK VALLEY CK. F.J DALY ABP CI SNAGGING 5590	:	\$1,000

TOTAL

\$750,000

ITEM	RIVER LOCATION/DESCRIPTION		NEW ESTIMATE COST \$
11.0.0	LOWER HINDS RIVER		
11.1.0	Lowes - Bank protection	1:	\$5,000
11.2.0	F. Fletchers - Bank protection	1:	\$6,000
11.3.0	Black Bridge - Bank protection	1:	\$5,000
11.4.0	Black Bridge - Stopbank repair	1:	\$5,000
11.5.0	In River SNAGGING & BANK PROTECTION	3:	\$10,000

			\$31,000

12.0.0	UPPER HINDS CATCHMENT CONTROL		
12.1.0	North Branch, Griggs bank protection	4:	\$3,000
12.2.0	South Branch, Murdochs	-:	\$3,000
12.3.0	Instream SNAGGING	4:	\$5,000

			\$11,000

13.0.0	UPPER ASHBURTON CATCHMENT CONTROL		
13.1.0	Sth Branch-RA Burnett bank protectn	4:	\$15,000
13.2.0	Sth Branch, D. Riley bank protectn.	3:	\$12,000
13.3.0	Pudding Hill Stream drop struct rep	4:	\$5,000
13.4.0	Pudding Hill Stream bank protection	4:	\$5,000
13.5.0	Taylor's Stream-Smith-Wightman bkpro	1:	\$12,000
13.6.0	Boyers Stm-Lockhead, Moodie, Gray bpro	2b:	\$15,000
13.7.0	Sth Branch-Lawn- Bank protection	3:	\$10,000
13.8.0	Boyers Stm-Muckles-Bank protection	4:	\$25,000
13.9.0	Boyers Stm-Symes-Bank protection	4:	\$5,000
13.10.0	Miscellaneous - Uninspected	-:	
13.10.1	CAVE STREAM	3:	\$9,000
13.10.2	SNAGGING -VARIOUS LOCATIONS	4:	\$2,000
13.10.3	TAYLORS STREAM S/B REPAIRS	2B:	\$4,000
13.11.0	A.C.C. intake repairs	-:	\$5,000

			\$124,000

ITEM	RIVER LOCATION/DESCRIPTION		NEW ESTIMATE COST \$
14.0.0	LOWER ASHBURTON RIVERS		
14.1.0	Sth Branch-N. Lowe bank protection	2b:	\$20,000
14.2.0	Mainstream-Cross sect 19 bank prot.	-:	\$8,000
14.3.0	Nth Branch-K. Lowe bank protection	3:	\$7,000
14.4.0	Miscellaneous bank prot. & snagging	-:	\$5,000

			\$40,000

15.0.0	MT. HARDING CREEK		
15.1.0	Various -snagging & bank protection	-:	\$5,000

			\$5,000

16.0.0	DRY CREEK SHINGLE STABILISATION		
16.1.0	Y Creek-McLeods-Drop structure area	2a:	\$2,000
16.2.0	Y Creek-O'Hara's-Instream clearance	2b:	\$1,000
16.3.0	Y Creek-Groundwater-Grassed waterwy	3:	\$10,000
16.4.0	Y Creek-Jessop-Drop structure rep.	3:	\$1,000

			\$14,000

17.0.0	Morven Drain-Waterwy,Flood gate rep	4:	
17.1.0	COONEY Reshape Replant Floodgate Flapvalve	3:	\$1,750
17.2.0	J. HAY Reshape Replant Floodgate Flapvalve	3:	\$1,750
17.3.0	KEEN Reshape Replant Floodgate Flapvalve	3:	\$1,500
17.4.0	BECKINGSDALE Reshape Replant Floodgate Flapva	3:	\$1,750
17.5.0	MARSHALL Reshape Replant Floodgate Flapvalve	3:	\$1,750
17.6.0	R. SEW HOY Reshape Replant Floodgate Flapvalve	3:	\$3,500
17.7.0	MOUTH Reshape Replant Floodgate Flapvalve	3:	\$1,750

			\$13,750

ITEM	RIVER LOCATION/DESCRIPTION		NEW ESTIMATE COST \$
18.0.0	Seadown Drain - Stopbank repairs	1: 3:	
			\$5,000
			----- \$5,000 -----
19.0.0	Ashburton - Hinds Drainage Scheme - Shingle removal	1:	\$10,000
			----- \$10,000 -----
20.0.0	Esk Valley Creek		
20.1.0	- Miscellaneous - Bank	2b:	\$5,000
20.2.0	Protection and Planting	-:	
20.2.1	MRS TOOHEY CI ABP	3:	\$4,750
20.2.2	HEWSON CI ABP	3:	\$4,750
20.2.3	COPELAND CI ABP	3:	\$8,000
			----- \$17,500 -----
21.0	Damage to Hydrological Stations		\$40,000
			----- \$40,000 -----
	TOTAL		===== \$5,763,318 =====
	CONTINGENCY (7%)		----- \$403,432 -----
	TOTAL		===== \$6,166,750 =====

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Appendix 6: Portion of MAF Storm Damage Questionnaire
relating to Land Damage

Soil Erosion/Deposition

A Slips

No _____ and/or Area _____ ha

Proportion of Farm Affected _____ %

B Deposition

Area Affected by Silt _____ ha Estimated Depth _____ mm

Area Affected by Gravel _____ ha Estimated Depth _____ mm

No of Paddocks Affected _____

C Soil loss

No of Paddocks Affected _____

Area	_____ ha	Depth lost	_____ mm	Ground cover before	_____
	_____ ha	or rilling	_____ mm	flood (eg Crop or	_____
	_____ ha		_____ mm	recently sown)	_____
	_____ ha		_____ mm		_____

D Restoration

(Cost Estimate)

		Seed	Fertilizer	Cultivation	Dozing	Other
Deposition Restorable Area	_____ ha	_____	_____	_____	_____	_____
Non Restorable Area	_____ ha					
Soil Loss Restorable Area	_____ ha	_____	_____	_____	_____	_____
Non Restorable Area	_____ ha					
Slips Restorable Area	_____ ha	_____	_____	_____	_____	_____
Non Restorable Area	_____ ha					
Rilling	_____ ha	_____	_____	_____	_____	_____

