INTERNAL REPORT

CHRISTCHURCH
THE GARDEN CITY
The city that shines

FLOODING IN THE HEATHCOTE RIVER

VOLUME 1 - A HISTORY AND DATABASE

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CONTENTS

SUMMARY

This document which includes a database and map series describes the nature and extent of flooding in the flood plain of the Heathcote River. It forms part of the Heathcote Floodplain Management Plan, a joint project between the Christchurch City Council and the Canterbury Regional Council, which when completed will be implemented through the new Christchurch City Plan, scheduled for completion to draft stage by the middle of 1993.

Volume 1

Part I is a short history of the significant flood events of the Heathcote River since 1930. Although major floods were reported in earlier years, notably 1925, the data on rainfall and flood levels is too poor to be of use in any study. Eight floods are described in terms of the duration and location of the rainfall, antecedent ground conditions and the extent and duration of flooding especially with respect to tide levels in the lower reaches of the river. A description of measures taken and proposed to alleviate flooding is also made. This includes the construction of the Woolston Cut and the proposed Wigram East Retention Basin.

Part II describes the past methods of collection and storage of flood data and presents a new system (HEATHCOTE FLOODMAP) for the storage and retrieval of new and existing information based on a computer database and a series of maps. The database programme with operating instructions is contained in the Appendix.

Volume 2

This contains a full set of the floodmap series reduced to A3 size.

ACKNOWLEDGEMENTS

Production of this report with its associated database and floodmap series would not have been possible without the valuable assistance of many people. The efforts of the following City Council staff are acknowledged.

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I. FLOODING ON THE HEATHCOTE RIVER

1. Catchment Development

The Heathcote River (Figure 1) has a gentle bed slope characteristic of its swampy origins falling 12.29 metres over 25.5 kilometres from rural Wigram to Ferrymead Bridge. Its baseflow is largely derived from extensive springs of the shallowest rainfed Canterbury Plains aquifer. Lesser contributions to this flow come from more variable springs of the steep Port Hills tributaries such as Hoon Hay Valley, Cashmere Valley, Bowenvale, Sibleys Drain and the Heathcote Valley streams and drains.

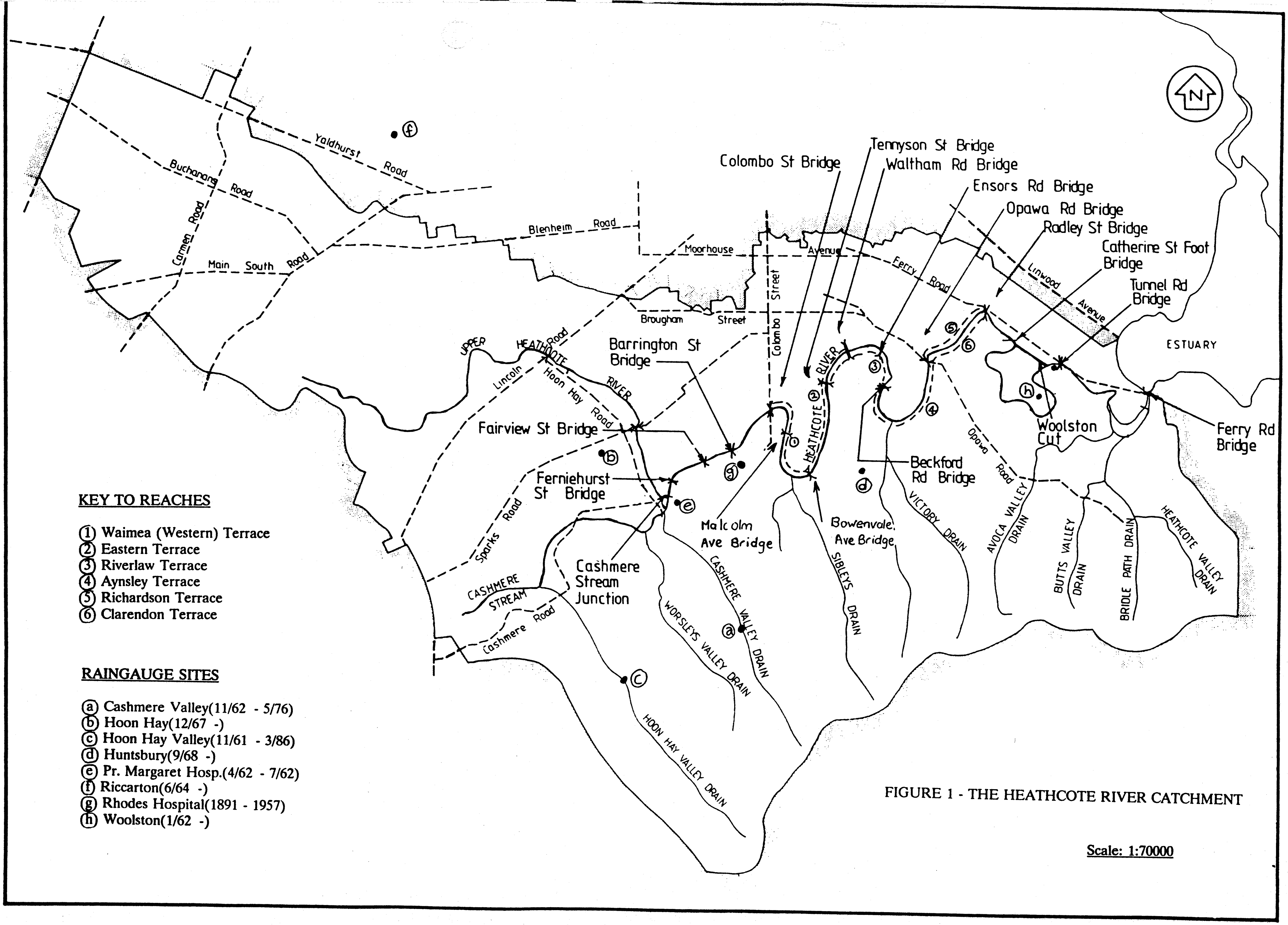
Rainfall runoff in the pre european landscape was soaked up in the extensive swamps and caused few problems to the Maori who valued the river they knew as Opaawaho as mahinga kai, an area where many kinds of fish and birds could be taken as food. Then the urbanisation and agriculture of the european from the mid 19th century onwards saw the rapid removal of the remaining forest cover of the Port Hills, drainage of the swamps and the confinement of the river and its main tributaries into discrete channels.

With the spread of the urban area, the rainfall has encountered increasingly large areas of impervious roofing, concrete and asphalt with the ever greater volumes of stormwater being channelled to the nearest watercourse. This has caused increasing flood problems for the settlements of the lower reaches of the Heathcote as the river struggles to cope with the growing waves of runoff.

Major bottlenecks of flow and thus flood problems developed at the junction with the main tributary of the river, the Cashmere Stream, at critical points on the meanders such as the true left bank at the lower end of Waimea (Western) Terrace, above bridges and the lower reaches along Eastern, Aynsley, Riverlaw, Richardson and Clarendon Terraces where the tidal backwater impedes drainage and bed gradients are at their most gentle.

In addition, attempts to drain the swamps in the rural Cashmere Stream catchment were hampered by the shallow basin topography and peat soils. The persistent high watertable, when combined with the backwater effects from the main river during floods still causes extensive ponding in the Hoon Hay/Cashmere rural area. The release of this water maintains elevated levels downstream for long periods after the peak of a flood. It is clear that flood levels in the Heathcote below its confluence with the Cashmere Stream would be far higher if this rural land was to be drained more effectively or developed for urban expansion. For this reason, it has been the longstanding policy of the Christchurch Drainage Board(CDB) and its successor since 1989, the enlarged Christchurch City Council to oppose any modification of the area that will reduce this flood retention role.

Having recognised the significance of the stormwater retention function of the Cashmere Stream catchment, the Council has been investigating a range of measures including on site stormwater soakage and artificial retention basins to reduce the flood level impact of a possible increase in peak runoff from future major residential or industrial expansion into rural areas, especially in the Wigram/Hillmorton area. At the same time, research is being conducted to provide a clearer picture of the local relationship between landuse



KEY TO REACHES

1. Waimea (Western) Terrace
2. Eastern Terrace
3. Riverlaw Terrace
4. Aynsley Terrace
5. Richardson Terrace
6. Clarendon Terrace

RAINGAUGE SITES

(a) Cashmere Valley(11/62 - 5/76)
(b) Hoon Hay(12/67 -)
(c) Hoon Hay Valley(11/61 - 3/86)
(d) Huntsbury(9/68 -)
(e) Pr. Margaret Hosp.(4/62 - 7/62)
(f) Riccarton(6/64 -)
(g) Rhodes Hospital(1891 - 1957)
(h) Woolston(1/62 -)

FIGURE 1 - THE HEATHCOTE RIVER CATCHMENT

Scale: 1:70000

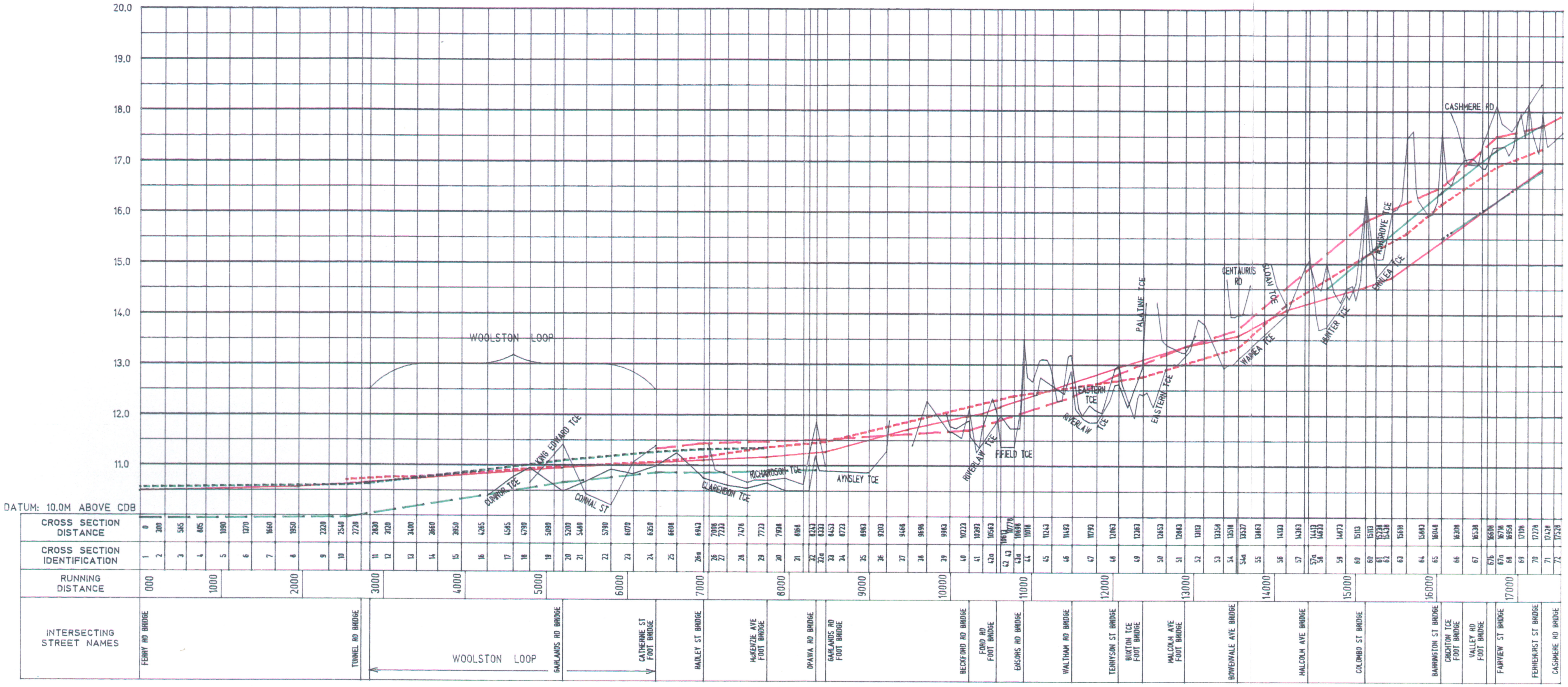
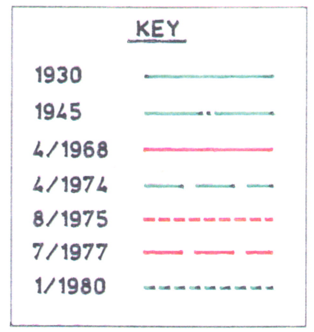


FIGURE 2 - HISTORICAL FLOODING - HEATHCOTE RIVER

(FERRYMEAD TO CASHMERE STREAM JUNCTION)

SOURCE: CDB (1981)



change and runoff patterns.

It is only in the last decade that the pattern of flooding in the upstream reaches especially between Lincoln Road and the Cashmere Stream junction has shown any great similarity to that of the Lower Heathcote. Flooding problems in this shallow narrow channel are a function of

(i) the postwar residential development, which as elsewhere has increased the volume and velocity of runoff, also involved the subdivision of extensive stretches of the floodplain with little or no provision being made for esplanade reserves that would have helped reduce the number of currently vulnerable properties. Apparently beginning in the early 1970s, most heavy rainfall events are followed by section flooding of variable extent and short duration that usually does not cause much property damage beyond wet gardens and slight bank erosion at some addresses. The residents surveyed in April 1992, however suggested that in recent years these regular floods have increased in severity. While this may be so, there is unfortunately no water level recording done in this area aside from the occasional survey of flood debris lines at various sites. The record of the Ferniehurst Bridge site (below the Cashmere Stream junction) is not suitably located to provide evidence for this.

(ii) the obstruction of the river by debris. Several serious floods have occurred when bridge culverts have been blocked by such items as garden furniture and in one case a car. During such events properties far upstream have experienced extensive inundation problems. Also there is a belief that willow roots and weed growth have a consistent effect on river levels which deserves further study for the development of an improved management programme.

(iii) the obstruction of lowlying stormwater pipe outfalls by elevated river levels especially in the Greenpark Street area has caused bad street flooding sufficient to create access problems for some properties near the river.

(iv) the spatial distribution of the rainfall event. When the heaviest rainfall is centred to the western upper end of the catchment around Hornby, Hillmorton, Wigram and Hoon Hay, Upper Heathcote flooding is at its most severe.

Above Lincoln Road, no flooding problems have been identified within the floodplain of the Heathcote. Beyond the reach sustained by a few minor riverbed springs above the confluence of Haytons Drain, the river has in recent years been prone to drying out for extended periods.

'The Woolston Cut'

While there is a firm proposal to build a flood retention structure in rural Wigram and enhancement of the ponding capabilities of the natural basins of the Cashmere Stream has been suggested, the only flood reduction structure in the Heathcote Catchment that has been built is the Woolston Cut commissioned in April 1986. This channel cuts across a two kilometre meander loop of the Lower Heathcote between the end of the Clarendon - Richardson Terrace reach and the Tunnel Road Bridge.

While causing some interesting ecological problems from the upstream advance of the estuarine saltwater prism*, there has yet to be a flood event of sufficient magnitude that will test the design flow specifications of the Cut. Despite this the flood history of the Heathcote must now be interpreted in terms of 'Pre-' and 'Post-' Cut conditions.

* This is to be rectified by the construction of a tidal control structure which will restore the Pre Cut river flow regime via the Woolston Loop during normal conditions.

2. Major Floods

28 July - 6 August 1930

On 28 July snow fell to a depth of 50 to 130mm over the City and the Port Hills followed by a period of intermittent rain that became heavy from the 4th to the 6th August. Rainfall for one site in the Port Hills is shown below.

TABLE 1: 24 Hour Rainfall - Rhodes Convalescent Home - 1930 Storm

27/7	37.8 mm
28/7	0.0 mm
29/7	7.4 mm
30/7	2.3 mm
31/7	0.0 mm
1/8	0.0 mm
2/8	0.8 mm
3/8	2.0 mm
4/8	33.0 mm
5/8	91.4 mm
6/8	15.4 mm

After Scott (1963)

Flooding began on the 5th and peaked with the 3pm high tide on the 6th. Homes in Waimea, Clarendon, Radley and Richardson Terraces were evacuated as water levels rose to the level of the window sills. Plate 1 shows the state of the river at the southern end of Birdwood Terrace. Some water levels are recorded below. (Datum is 9.043m below mean sea level).

TABLE 2 - Peak Flood Levels at Selected Sites - 6/8/30

Richardson Terrace Pumping Station	11.12 m
Waimea Terrace Pumping Station	14.63 m
Fairview Street Pumping Station	17.03 m
Cashmere Stream Junction	17.28 m

After Scott(1963)

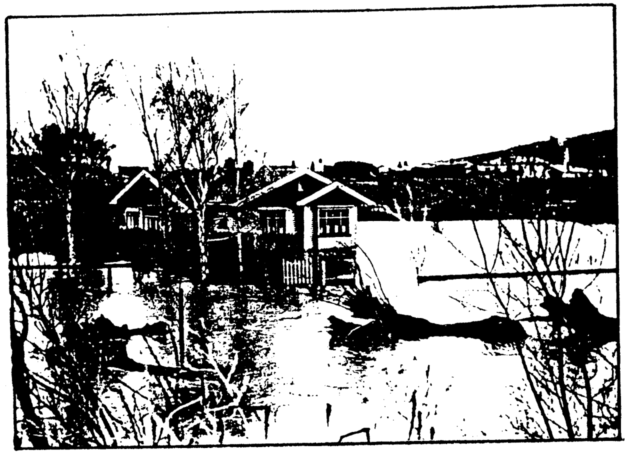


PLATE 1 - July 1930 flood. View of true right bank of the Heathcote River from the lower end of Birdwood Terrace (Photo - Mrs J Smith)

<u>17 - 20 May 1945</u>

While Christchurch experienced major floods in 1936 and 1941, they were not as severe in the Heathcote catchment as they were in the Avon. By contrast, this event in the autumn of 1945 was regarded as the worst yet experienced in the Heathcote especially in the reaches from Spreydon to Woolston as shown by the levels in Table 3. The recorded rainfall of 138.4mm over three days was not especially intense, but water tables were high due to the wet weather of the previous three weeks. Extensive flooding occurred in the tributary catchments such as Wilderness Drain. Plate 2 shows an unusual milk delivery in Fifield Terrace at the Cholmondely Terrace intersection.

TABLE 3 - Peak Flood Levels at Selected Sites - 1945 Storm

Steam Wharf Drain	10.25 m
Bamford Street Pumping Station	10.78 m
Radley Street Bridge	11.09 m
Opawa Railway Bridge	11.24 m
Wilsons Road Bridge	12.65 m
Eastern Terrace Pumping Station	12.95 m
Waimea Terrace Pumping Station	14.88 m

After Scott (1963)

PLATE 2 - August 1945 flood. Milk delivery by boat Fifield Terrace/Cholmondely Ave corner. (Photo - DWMU records)

9 - 12 April 1968 ("Wahine")

Between the storms of the winter of 1945 and Easter 1968 floods in the Heathcote occurred at regular intervals. However none matched the severity of this latter event which was associated with the southward progress of a tropical cyclone that had already caused havoc and loss of life (the sinking of the Wahine) over much of the North Island.

In contrast to the earlier years of rather sparse rainfall information, since 1962 the CDB had commenced the monitoring of a network of seven recording raingauges allowing a more accurate picture of the magnitude, frequency and spatial distribution of storms to be gained. The map of rainfall intensity, Figure 3, and Table 4 produced from data for the Wahine storm shows that the heaviest rainfall occurred in the Port Hills catchments.

TABLE 4 - 24 Hour Rainfall Totals - Wahine Storm

Date	Burwood	St. Albans	Riccar-ton	Botanic Gardens	Woolst-on	Sumner
9/4	16.0 mm	17.5 mm	19.3 mm	18.3 mm	16.3 mm	15.2 mm
10/4	64.8 mm	56.1 mm	51.8 mm	60.5 mm	105.7 mm	88.6 mm
11/4	56.9 mm	54.1 mm	48.0 mm	62.0 mm	105.2 mm	110.5 mm
12/4	7.4 mm	6.1 mm	7.4 mm	13.7 mm	32.5 mm	24.9 mm
13/4	2.0 mm	2.0 mm	2.0 mm	2.0 mm	4.1 mm	2.5 mm
14/4	0.8 mm	1.5 mm	0.5 mm	1.8 mm	1.0 mm	NA
Total	147.8 mm	137.4 mm	129.0 mm	158.2 mm	264.7 mm	241.8 mm

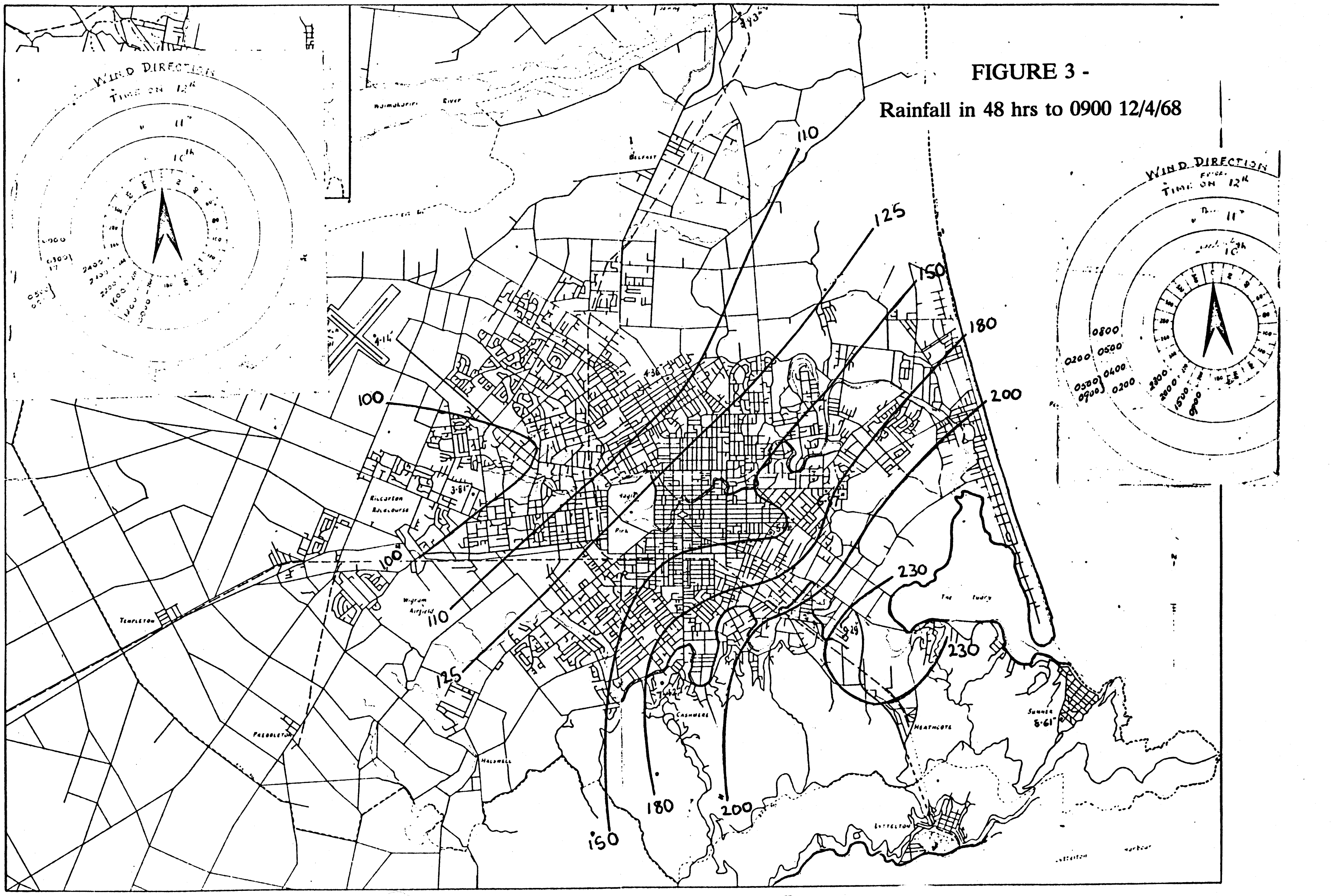
TABLE 4 ctd.

Date	Ch.ch. Airport	Bromley Treat-ment Works	Hoon Hay Valley	Sign Of The Kiwi	Rhodes Conv. Home
9/4	27.9 mm	2.0 mm	17.8 mm	NA	NA
10/4	29.7 mm	18.3 mm	30.0 mm	NA	26.7 mm
11/4	70.6 mm	123.4 mm	73.4 mm	101.6 mm	127.5 mm
12/4	34.5 mm	68.6 mm	71.1 mm	99.1 mm	61.0 mm
13/4	3.8 mm	2.3 mm	7.1 mm	20.32 mm	5.1 mm
14/4	0.5 mm	2.0 mm	2.3 mm	NA	NA
Total	142.0 mm	216.7 mm	201.7 mm	221.0 mm	220.2 mm

This heavy rainfall was preceded by galeforce winds with gusts over 100km per hour that worsened the subsequent flooding by blocking many drains and culverts with debris. In

FIGURE 3 -

Rainfall in 48 hrs to 0900 12/4/68



addition, very high tides caused by the low atmospheric pressure blocked the release of floodwaters into the estuary from both its tributary rivers.

Overtopping of the river banks began well below Colombo Street from just above Birdwood Avenue down to Fisher Avenue. Eastern Terrace was under water and from Fisher Avenue to Waltham Road both roads on either side of the river were inundated. Flooding on the true right bank above and below St Martins Road occurred in Riverlaw Terrace, on the true left bank to some distance below Ford Road and on both banks between Beckford Road and Armstrong Avenue, but with little property damage. Aynsley Terrace was flooded from about 200 metres above Grange Street down to Opawa Road.

The most seriously flooded reaches of the Heathcote were Richardson Terrace(Plate 3), Clarendon Terrace, Cumnor Terrace and Connal Street down to the lower end of Garlands Road where water entered houses and residents were evacuated. Further downstream Ferry road was above flood level, but extensive areas of low lying land on both banks from just below the Tunnel Road bridge to the Estuary were under water.

Crude flood discharge figures calculated by the slope area method for the following reaches are shown below.

TABLE 5 - Calculated Peak Flood Discharges 12/4/68

Below Wilsons Road Bridge	44.8 cumec
Opposite Young St.	11.2 cumec

The lower discharge figure for Young Street reflects the low runoff from the upper part of the catchment. This is due to a combination of the lower rainfall in the largely rural Wigram area and the extensive natural ponding of floodwaters in the Cashmere Stream tributary catchment. A body of water approximately 35 hectares in area and some 1.5 metres deep filled the lower Cashmere Valley.

It must be recognised that the magnitude and frequency of a flood event is largely independent of that assigned to the concurrent rainfall event. The main controls on flood magnitude and frequency in the Heathcote catchment are; (1) Antecedent watertable conditions. ie the more saturated the catchment, the greater the runoff, (2) the spatial distribution of the rainfall, and (3) the duration of the rainfall event. (The longer the duration of rainfall in a storm, the longer the duration of surface runoff once the ground becomes saturated).

Despite these qualifications, it is noteworthy that the 236mm of rainfall recorded in Woolston in the period from 2200 hrs on the 10th to 0500 hrs on the 12th had a probable return period in excess of 100 years. ie less than one percent chance of occurring in any single year. (This is based on return period data compiled at the Botanic Gardens.) This compares with the probable 30 year return period assigned to the 135mm recorded for the same period at the Gardens. As the earliest rainfall records for Christchurch are little more than 100 years old, one cannot be confident in quoting return periods greater than this.

PLATE 3 - April 1968 flood. Traffic patrol in Richardson Terrace.(Photo - DWMU records)

15 - 17 April 1974

Light rain commenced falling at all rain gauge sites at 1600 hrs on the 15th and by midnight this had increased to a steady 2mm per hour which continued becoming heavier after midday until 1700 hrs on the 16th by which time an average of 53 mm had fallen over the city. An increase in the speed of the accompanying south to southwest wind was followed by an intense downpour that lasted from 1600 hrs to 1900 hrs at Burwood, 1800 hrs to 2000 hrs at Hoon Hay and from 1700 hrs to 1900 hrs at St. Albans and the Botanic Gardens. The concurrent rainfall at Huntsbury, Woolston and Sumner was about half that recorded at the other raingauge sites, with a similar reduction to the northwest. This downpour was followed by a period of heavy rain until about 2300 hrs, when a wind shift to the south signalled an easing of the rain which ceased altogether by 0300 hrs on the 18th.

The data from Burwood, St Albans, the Botanic Gardens and Hoon Hay had a probable return period of 50 years for 72 hours and in excess of 100 years for the two hour downpour, compared with figures of between 5 and 10 years for the same periods for Sumner and the southern and hill subcatchments of the Heathcote, Huntsbury and Woolston. Figure 4 shows the isohyetal maps for the 16th and 17th.

The Heathcote River overflowed its banks in Aynsley Terrace, Richardson Terrace and Clarendon Terrace. Peak river levels recorded in the vicinity are shown below.

TABLE 6 - Peak Flood Levels at Selected Sites

Ferrymead Bridge	9.91 m
Long Street	9.94 m
Connal Street	10.72 m
Mackenzie Avenue	10.88 m

Flooding peaked between 2330 hrs on the 16th at Ferrymead and 0130 hrs on the 17th at Mackenzie Avenue which meant that the highest levels had passed before the 0015 hrs high tide at Lyttelton. Peak flow on the Heathcote at Buxton Terrace is estimated to have reached between 20 and 23 cumecs.

Worse flooding was avoided due to the lower rainfall in the Heathcote and the non coincidence of the flood peak with high tide in the lower reaches. As in the Wahine Storm, large amounts of storm debris and fallen leaves exacerbated local drainage problems by blocking drains and culverts.

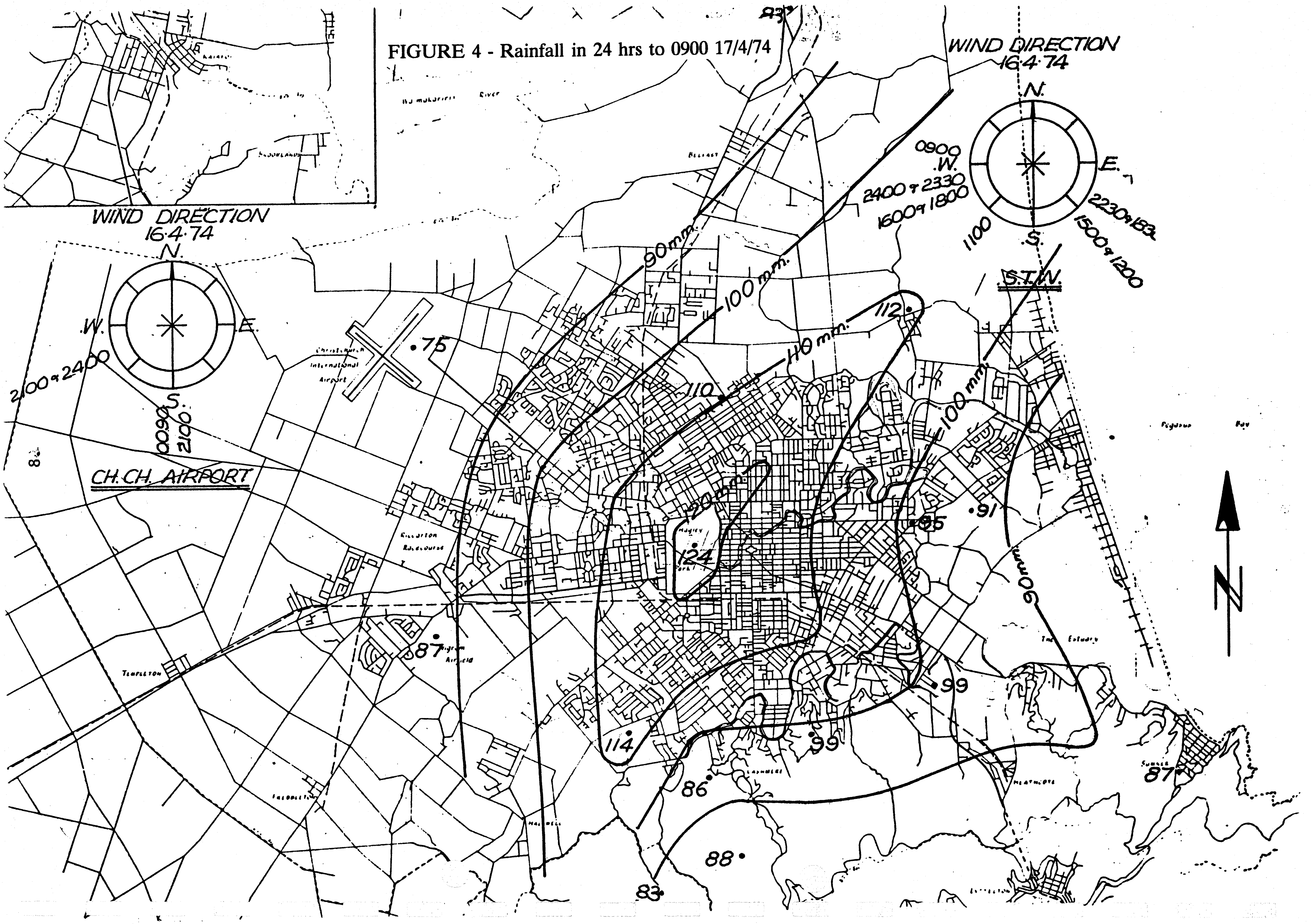


FIGURE 4 - Rainfall in 24 hrs to 0900 17/4/74

<u>19 - 21 August 1975</u>

Although the tail end of Cyclone Allison on the 12th March 1975 brought heavy rainfall to Christchurch City, the resulting flooding problems in the Heathcote were insignificant compared to the damage that this latter event in late winter of the same year caused, especially in the hill catchments.

Almost continuous heavy rain fell from Midnight on the 18th through to the 21st with the most intense period lasting from around 1400 hrs on the 20th to early on the morning of the 21st. Figure 5 shows the distribution of rainfall depth for the 21st.

The prolonged rainfall substantially raised the watertables, so that when the heaviest downpours came, rural runoff response was almost as high as that for the urban areas. Very high flows from the mostly rural hill catchments were accompanied by extensive slope failures on both building sites and undisturbed surfaces. Large quantities of silt from these slips in the Avoca Valley, Upper Bowenvale and the newly subdivided Worsleys Spur area entered the main waterways from where it took a long time to move downstream after this event.

The most severe flooding occurred in areas adjacent to or draining to the Heathcote. Floodwaters entered houses at high tide on the afternoon of the 20th. Table 7 shows that upstream of Radley Park to about Mackenzie Avenue the water level continued to rise for a period after high tide with almost no reduction in level through to low tide whereupon a gradual drop began. According to Oliver (1992) pers.comm. recent work shows that the peak flow of 16 cumec at Buxton Terrace derived from the rating curve corresponds to a probable return period of 13 years.

TABLE 7 - Lower Heathcote Tide Levels for 20 - 21/8/75

Date	Tide	Time	Mackenzie Ave	Time	Maronan St	Time	Ferry Rd Br.
20/8	High	1630	10.97 m	1630	10.88 m	1530	10.42 m
20/8	Low	2230	11.65 m	2230	11.12 m	2230	9.69 m
21/8	High	0430	11.62 m	0430	11.12 m	0330	10.36 m
21/8	Low	1130	11.03 m	1130	10.68 m	1130	9.48 m

People were evacuated from flooded houses in Clarendon Terrace, Richardson Terrace and Waimea Terrace.

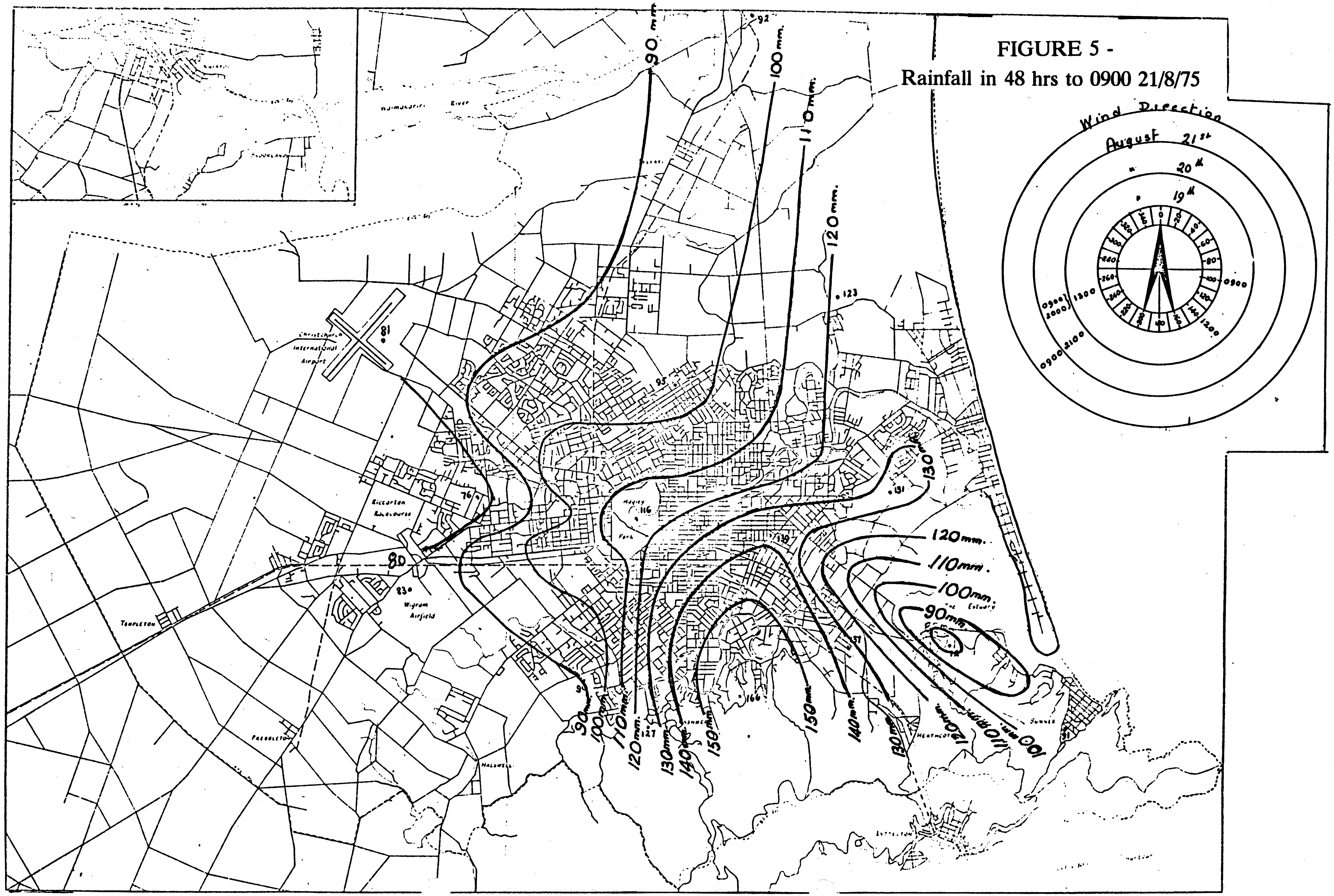


FIGURE 5 -
Rainfall in 48 hrs to 0900 21/8/75

2 - 4 July 1977

During the course of an already wet winter and on a catchment that remained saturated from heavy rain three days earlier storm rainfall began on the 2nd of July. The high rapid runoff from the Port Hills was therefore not unexpected. Figure 6 shows the distribution of rainfall depth for the 48 hours ending 0900 hrs on the 4th of July and Table 8 the rainfall totals measured at selected stations within and outside the Heathcote.

TABLE 8 - Rainfall Totals at Selected Sites 28/6/77, 2 - 4/7/77

Date	Hoon Hay	Huntsbury	Bot. Gard.	Riccarton	Woolston
28/6	29.9	29.5	24.5	31.5	21.2
2/7	20.3	36.7	18.4	16.3	45.1
3/7	42.7	71.0	50.7	45.0	85.5
4/7	63.4	36.9	45.4	49.2	40.0
Total	126.4	144.6	114.5	110.5	170.6

For the storm the following return period values were calculated.

TABLE 9 - Calculated Return Periods - July 1977 Storm

Site	6 Hours	12 Hours	24 Hours	48 Hours
Hoon Hay	2 - 5 y	10 - 20 y	10 - 20 y	10 -20 y
Huntsbury	2 - 5 y	5 - 10 y	10 - 20 y	20 - 50 y
Botanic Gard.	2 - 5 y	5 - 10 y	5 - 10 y	5 - 10 y
Riccarton	< 2 y	2 - 5 y	5 - 10 y	5 - 10 y
Woolston	NA	5 y	10 - 20 y	> 50 y

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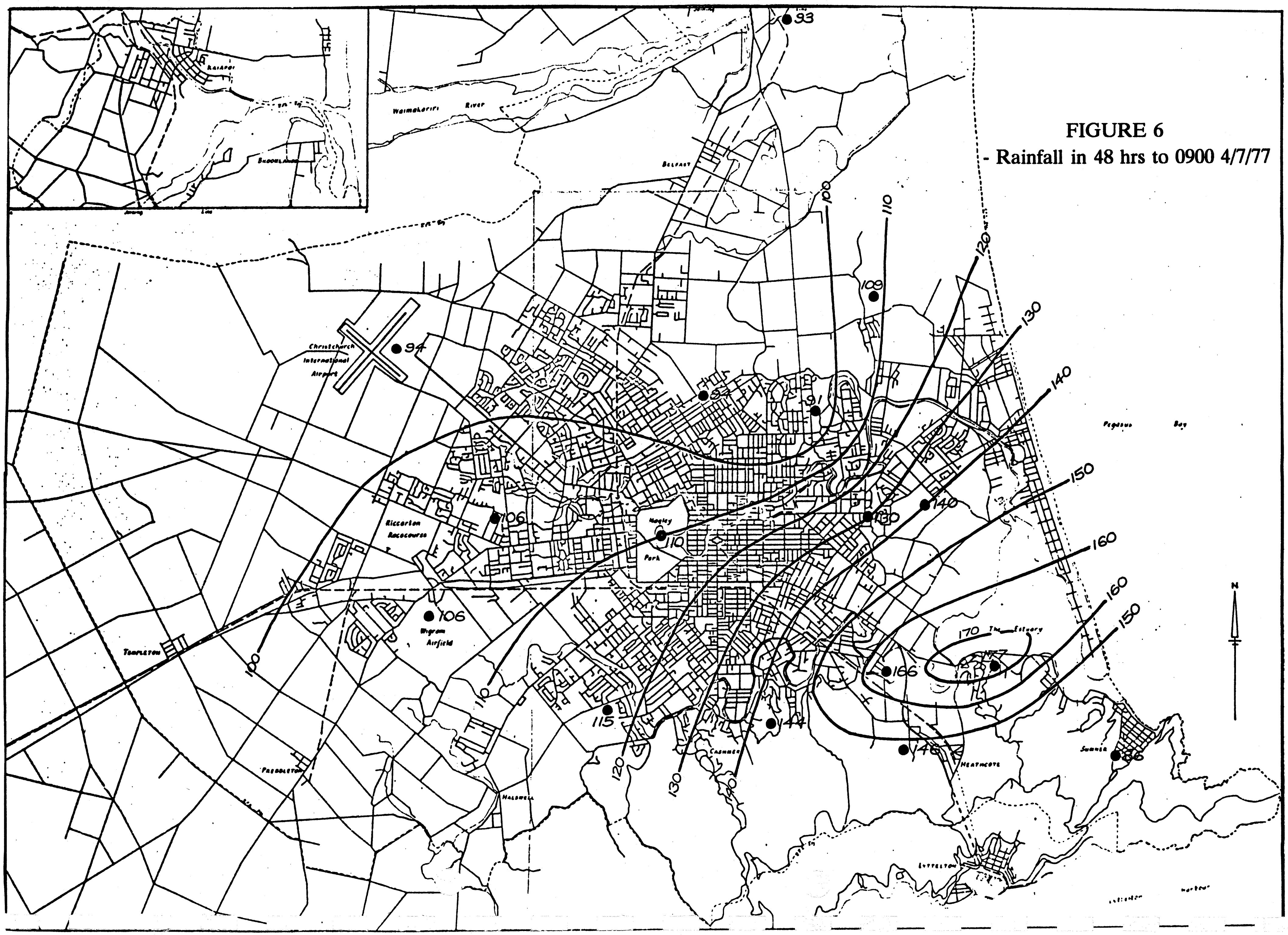


FIGURE 6
- Rainfall in 48 hrs to 0900 4/7/77

The combined effects of the rainfall, ground saturation and a very high tide on the 3rd of July produced the recorded river levels below.

TABLE 10 - Lower Heathcote Tide Levels for 2 - 4/7/77

Date	Tide	Time	Maronan St.	Time	Tunnel Rd Bridge
2/7	Low	0230	9.42 m	0230	9.01 m
2/7	High	0730	10.82 m	0700	10.52 m
3/7	Low	1300	10.04 m	1400	9.22 m
3/7	High	1930	10.97 m	1930	10.62 m
4/7	Low	0200	11.09 m	0200	9.69 m
4/7	High	0830	11.29 m	0730	10.55 m

During this storm a waterlevel of 17.62 m, the highest ever recorded at Smarts Bridge (aka. Ferniehurst St. Bridge) below the confluence of the Heathcote and the Cashmere Stream was reached. This corresponds to a peak flow of 23.5 cumec which according to Oliver (1992) op.cit. has a return period in the order of 100 years! Some Hoon Hay Road riverside properties in the Upper Heathcote immediately above the Cashmere Stream junction are known to have experienced significant section flooding for the first time, but apparently no water entered houses or garages.

Houses were evacuated in Barrington Street, Fairview Street, Waimea Terrace, Eastern Terrace, Opawa Road, Ford Road, Aynsley Terrace, Clarendon Terrace, Richardson Terrace and Mackenzie Avenue. Plate 4 shows the severity of this event in the Clarendon/Richardson Terrace reach.

PLATE 4 - July 1977 flood. Richardson Terrace from Clarendon Terrace.(Photo - DWMU records)

2 - 3 January 1980

A very heavy rainstorm occurred from the 2nd to the 3rd of January which caused serious flooding in parts of both the lower and upper Heathcote catchment. Figure 7 shows the distribution of rainfall depth in the 24 hours to 0900 hrs on the 3rd. It does not include data from a short thunderstorm in the Sockburn - Hornby areas of the catchment that struck mid afternoon on the 2nd. This dumped 23 mm of rain in 1 hour resulting in severe localised flooding. It is excluded from the map as its spatial extent was not reliably determined. Another similar short deluge in the Hoon Hay area in which 23.2 mm fell from 2000 hrs to 2100 hrs on the evening of the 2nd was also not included for the same reason.

The bulk of the rainfall was concentrated in the west and southwest with eastern areas receiving only about half as much. Table 11 shows rainfall totals for the Botanic Gardens and the monitoring sites within the Heathcote catchment.

TABLE 11 - Rainfall Totals at Selected Sites for 2 - 3/1/80

Bot. Gard.	Huntsbury	Hoon Hay	Riccarton	Woolston
119.3 mm	138.6 mm	139.0 mm	139.2 mm	101.6 mm

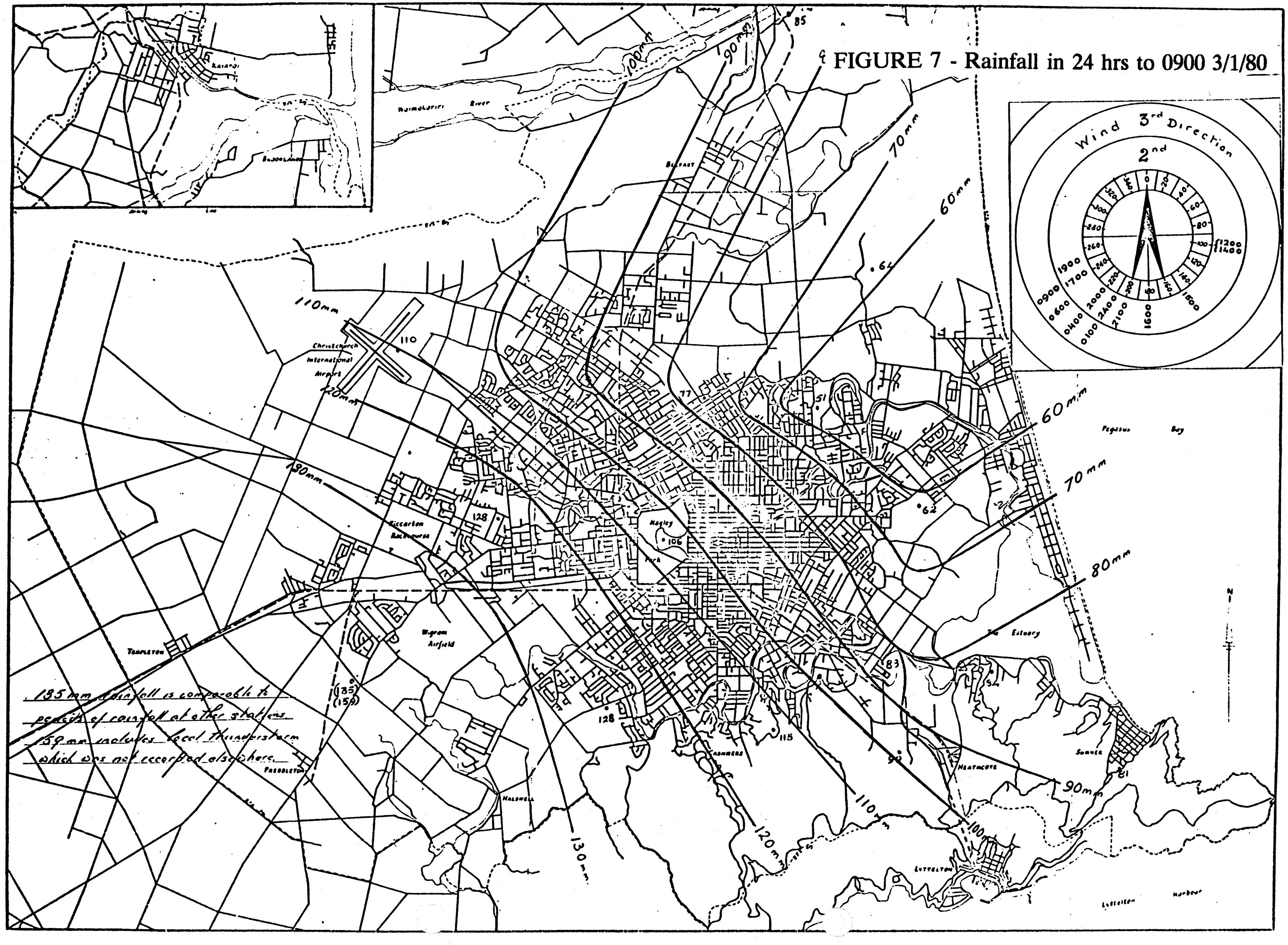
The intensity of the main storm in the Halswell area may be gained from Table 12 which bases its assessment of return period on data from the Botanic Gardens record.

TABLE 12 - Calculated Return Periods for Halswell Rainfall during 2 - 3/1/80

Duration	Total Rainfall	Intensity (mm/hr)	Return Period (y)
12 min	21.4 mm	107.0	>100
24 min	24.0 mm	60.0	70
36 min	24.0 mm	40.0	40
1 hr	30.8 mm	30.8	60
2 hr	45.4 mm	22.7	>100
3 hr	56.0 mm	18.7	>100
6 hr	93.6 mm	15.6	>100
12 hr	132.0 mm	11.0	>100
24 hr	161.6 mm	6.7	>100
48 hr	172.2 mm	3.6	>100
72 hr	172.2 mm	2.4	>100

The localised nature of the very heavy showers that characterised this storm makes it hard to give an average return period for the whole event, but a figure in excess of 50

FIGURE 7 - Rainfall in 24 hrs to 0900 3/1/80



years would not be unreasonable for the rainfall in the western and upper part of the Heathcote catchment. The corresponding figure for the eastern part of the catchment would be much lower.

The worst flooding occurred in and adjacent to the river with water entering three houses in Waimea Terrace, one in Palatine Terrace and eight in the Clarendon(Plate 5), Richardson and Aynsley Terrace areas. Overall flood levels in the lower reaches of the river were comparable to those of the Wahine Storm. In addition, riverside properties in the Upper Heathcote nearly as far as Lincoln Road were seriously flooded for the first time, although water did not enter houses. The rating curve derived peak flow figures for Smarts Bridge and Buxton Terrace of 15.5 cumec and 31.8 cumec respectively, correspond to a return period of approximately 12 years for the event.

Table 13 shows peak tide levels with selected corresponding figures from 7/77 for comparison. The high levels for the 1980 storm were mainly the result of a combination of strong winds that reached 100 kilometers per hour and the low atmospheric pressure.

TABLE 13 - Lower Heathcote Peak Tide Levels

Site	2 - 3/1/80	2 - 4/7/77
Ferrymead	10.59 m	-
Tunnel Road Bridge	10.64 m	-
Garlands Road Bridge	10.80 m	-
Connal Street	11.14 m	-
Radley Bridge	11.12 m	11.35 m
Opawa Road	11.24 m	11.48 m

Stormwater drainage was again hindered by flood debris in culverts and creeks.

PLATE 5 - January 1980 flood. Jetboat rescue for Clarendon Terrace.(Photo - DWMU records)

26 August 1981

The wind and rain of the 26th of August occurred in a catchment still very wet from rainfall on the 24th and as a consequence, the runoff from the Port Hills was rapid and heavy. Table 14 shows the rainfall totals for the 24th to the 26th and Figure 8 the rainfall isohyetal map of the storm.

TABLE 14 - Rainfall Totals for 24 - 26/8/81

Date	Hoon Hay	Huntsbury	Botanic Gardens	Riccarton	Woolston	Halswell
24/8	35.9 mm	33.9 mm	33.9 mm	34.8 mm	28.6 mm	44.4 mm
25/8	6.0 mm	8.3 mm	6.2 mm	5.9 mm	8.3 mm	5.6 mm
26/8	56.6 mm	55.7 mm	44.8 mm	52.1 mm	54.6 mm	38.2 mm
Total	98.5 mm	97.9 mm	84.9 mm	92.8 mm	91.5 mm	88.2 mm

This caused levels (Table 15) in the Heathcote to rise quickly and the resultant flooding of Richardson Terrace, Clarendon Terrace, Aynsley Terrace, Eastern Terrace, and Waimea Terrace was made worse because the period of peak runoff coincided with high tide. However the rain eased and the runoff abated before any houses were flooded. The derived peak flows for Smarts Bridge and Buxton Terrace correspond to approximate return periods of 9 years and 6 years respectively.

TABLE 15 - Peak Flood Levels for August 1981 Storm

Site	Peak Level
Tunnel Road Bridge	10.34 m
Connal Street	10.66 m
Opawa Road	10.95 m
Buxton Terrace	12.40 m
Smarts Bridge	17.18 m
Ballantines Drain *	17.40 m
Penruddock Rise *	17.80 m
Hendersons Drain *	18.14 m
Hoon Hay Drain *	19.05 m

(* = Cashmere Stream Catchment)

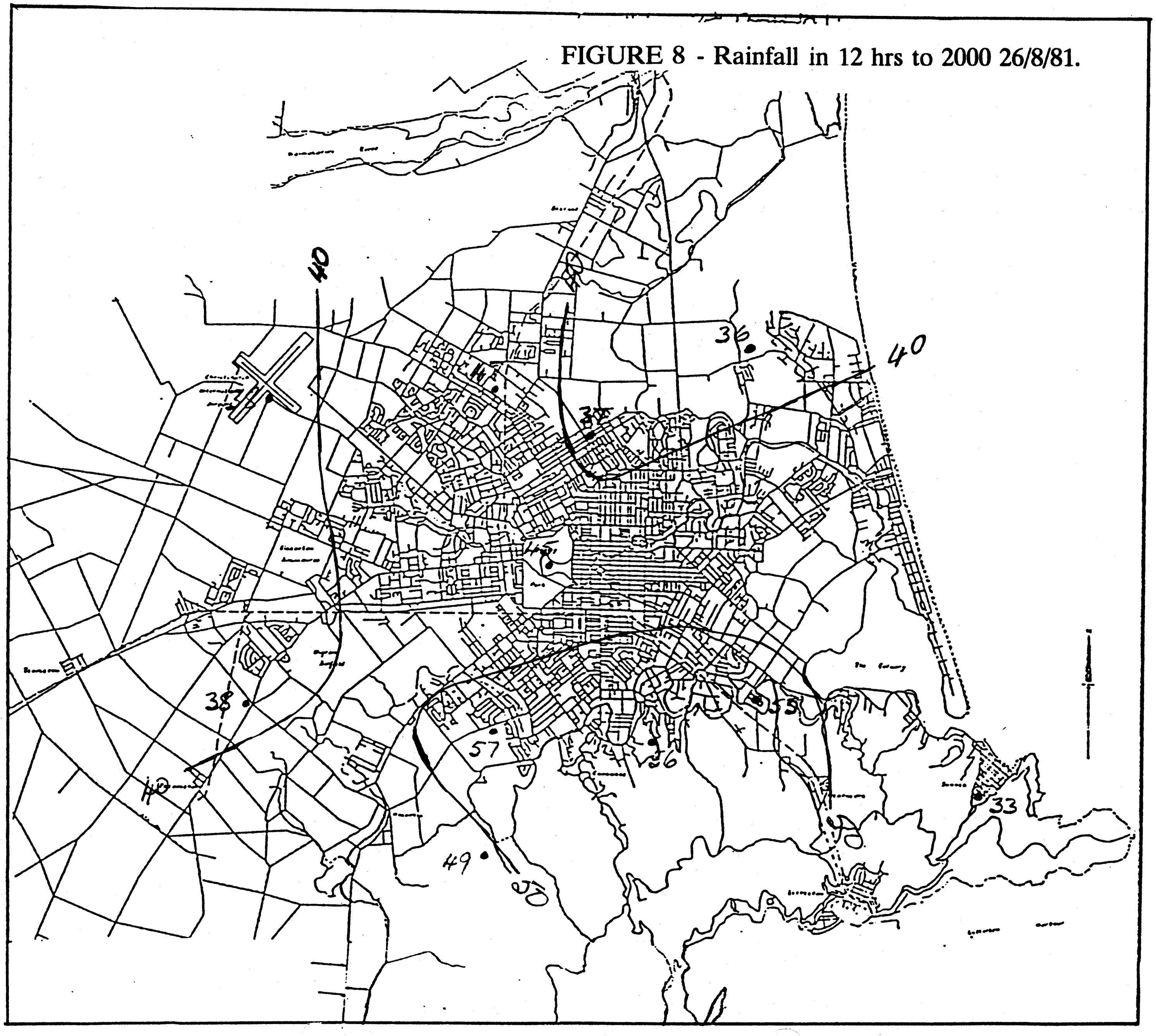


FIGURE 8 - Rainfall in 12 hrs to 2000 26/8/81.

Post 'Cut'

Since the completion of the Woolston Cut on the 23rd of April 1986, there have been no floods in the Heathcote catchment of magnitude or duration comparable to those that preceded construction of the channel, which means that there has yet to occur any real test of its design capabilities.

The most significant storms from April 1986 occurred in July 1986, November 1986 and June 1991. Return periods for rainfall in the Heathcote associated with these events is no greater than 2 to 5 years and associated flooding was minor, except for the usual extensive inundation of the Cashmere Stream natural flood basins.

3. Extraordinary Events

Some serious localised flooding in the Heathcote is caused by extraordinary events and and its magnitude is usually out of all normal proportion to the amount of rainfall. As mentioned in the introduction, the Upper Heathcote is vulnerable to obstructions of the narrow channel at bridge culverts. There is also the potential for problems from the encroachment of willow root mass which according to some residents entraps flood debris.

On the night of the 4th February 1978 during heavy rain, a car crashed into the river from Cashmere Road adjacent to the intersection with Bengal Drive and drifted down stream to block the flow under the Ferniehurst Street Bridge. Conditions were such that it was not able to be removed until the next day and this resulted in floodwaters backing up the river for some distance. Although unprecedented street flooding was reported in Ferniehurst Street as far as Palmside Street, no serious flooding of upstream properties was reported as may have been the case had the rainfall event been larger.

A similar situation occurred on the 3rd January 1980, when during the latter stages of this major storm described earlier in this report, a large piece of flood debris became stuck under the Rose Street Bridge. The resulting body of water caused worse than expected flooding and access problems for riverside properties the full length of Greenpark Street.

4. Discussion

Because of the relative paucity of information on flooding, especially with respect to river flow data, it cannot be yet concluded that floodlevels in the Heathcote River will increase with the spread of urban development. Research efforts may yet provide evidence for this.

Although construction of the Woolston Cut has at some environmental cost lowered water levels in the most seriously affected areas of the Lower Heathcote, there has yet to occur a storm comparable to those of the pre Cut era that will seriously test the capabilities of this channel.It must also be stressed that the Woolston Cut, the yet to be constructed Wigram East Retention Basin and the establishment of the on site roof stormwater to soakage area are only part of the long term solution to flooding problems of the whole catchment. The remainder of this document with its database and associated floodmaps will attempt to raise the consciousness of Heathcote residents and those associated with management of the catchment, that flooding of this river will remain a problem into the future for as long as people wish to expand the urban area and still enjoy the benefits of occupying a narrow shallow floodplain of low bed gradient.

In addition, the possible impact of rising sea levels driven by natural or man induced causes cannot be ignored by planners and occupants of any lowlying land in proximity to the estuary.

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