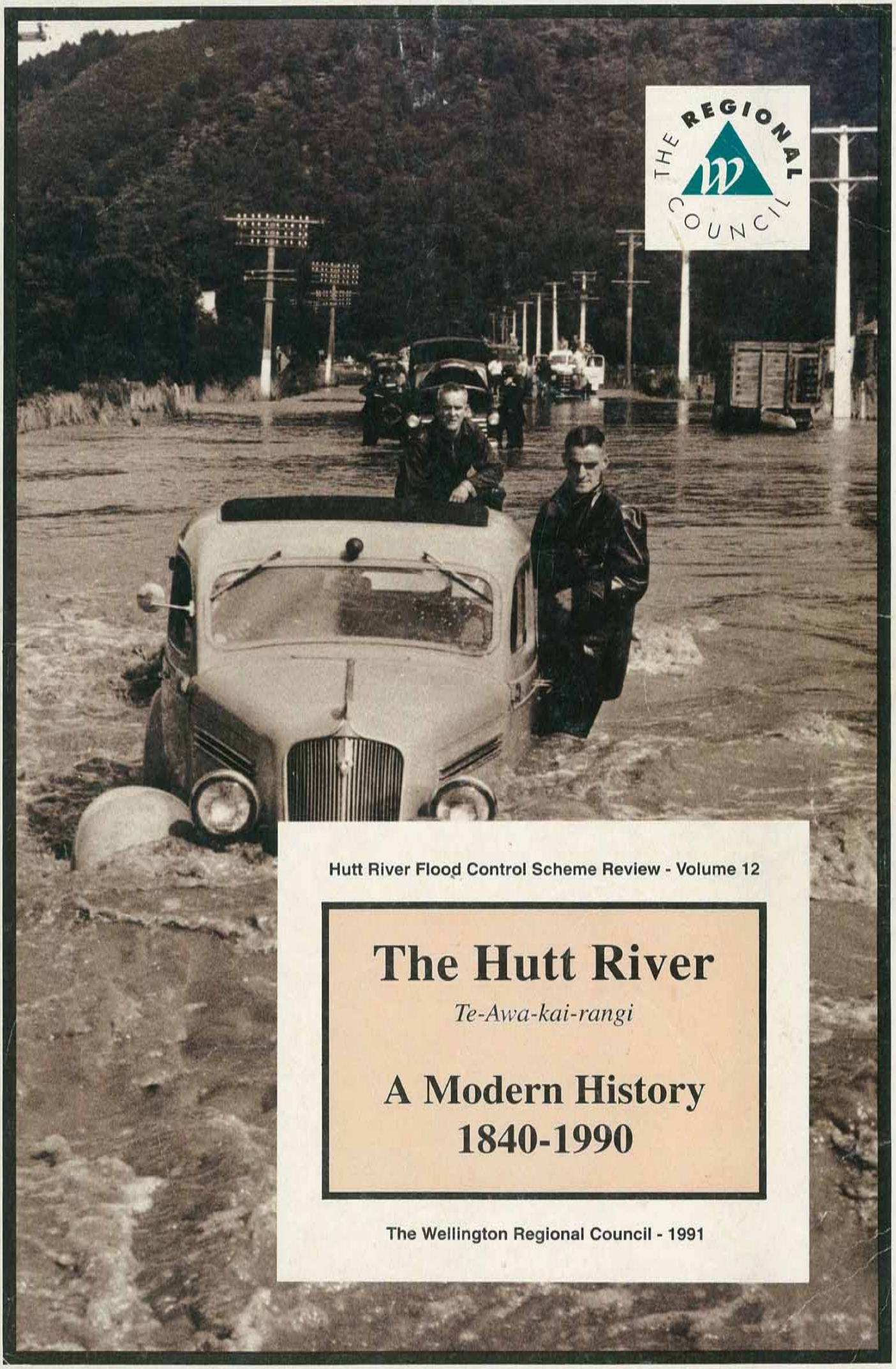

THE REGIONAL COUNCIL

Hutt River Flood Control Scheme Review - Volume 12

The Hutt River

Te-Awa-kai-rangi

A Modern History 1840-1990

The Wellington Regional Council - 1991

Cover photograph taken during the 1955 flood.
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The Hutt River

Te-Awa-kai-rangi

A Modern History 1840-1990

by John Easther

Hutt River Flood Control Scheme Review
Volume 12
A History of River Management

This History is to be maintained as a current document by frequent review. If you have knowledge of the Hutt which you feel should be included in the next printing please contact the Wellington Regional Council.

ISBN 0-909016-09-7

First printed 1991

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PO Box 11-646, Wellington
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Table of Contents

INTRODUCTION

Plate 1: Hutt River near Molesworth's farm, 1847.
Source: Alexander Turnbull Library, S C Brees, ref. PL 14/42.

The Hutt River Flood Control Scheme

The control of flooding has been essential for the development of the Hutt River flood plain. Today the lives of most of the residents of the Hutt Valley would be seriously affected should the flood control scheme fail.

Flood control works frequently encourage rapid development on the adjacent flood plain. Often the development is so rapid that the original flood control works, usually funded by a small riparian community, are seen to be inadequate by the new flood plain immigrants. The investment in flood control soon lags behind the investment in capital asset on the protected flood plain. The time taken to construct and commission works is such that growing communities are not provided with adequate levels of protection by the time works are completed. Accordingly, risks are often higher than they should be. To maintain a level of risk acceptable to a changing community, the systems of flood control require constant review.

The last formal review of the Hutt River Flood Control Scheme took place in the 1950s. The final works to complete the revised scheme were completed in 1973. Modifications and commissioning works continued until 1985.

In 1990 the river managers were again advising the community to review the level of protection offered by the "scheme of works". Recent experience during moderate flooding has shown that the system is vulnerable. As the density of the population increases, so do the consequences of scheme failure. The level of risk the residents of the Valley are now exposed to was determined by the post-war community. Is it still acceptable to the current generation or for their children? Has the relative level of protection decreased and have the assumptions made by past designers proved correct?

An understanding of the value of the existing scheme is difficult without some knowledge of the climatic, physical, political and engineering background leading to the scheme construction. This history serves to illustrate the gradual development of the Hutt River and will help answer the "How, Where, and Why?" questions for the existing and earlier control works. It is intended as a directory and summary of the engineering archives but does not purport to replace the original material which should be referred to for specific details.

Historical Brief

The Brief for this History of the Hutt River was to provide a detailed record of the various major works which form the Hutt Scheme. The Brief required that the record should include:

> *A description of the extent, approximate date and location on the river of major works, minor works .... associated protection or training works .... isolated protection or training works, the cost of various other works at that date and indexed to current .... degradation of the channel .... performance and effectiveness of the various works .... damage in floods and cost for repairs if appropriate.*

Chronology of Events

1855	Seismic uplift and new Estuary Regime
1858	"Old-man" Flood - 9 lives lost.
1871	Flood - destroyed Third Hutt Bridge
1879	First Hutt River Board formed.
1881	Last meeting of the First Hutt River Board
1887	First Hutt River Board goes into permanent recess
1893	Flood - "the valley a desolate scene"
1894	Petone Stopbank constructed
1898	Two large floods swept the whole valley
1899	Second Hutt River Board formed
1899	Consultants commissioned to prepare a scheme of conservation
1901-03	Scheme for Conserving the Hutt River constructed
1906	Gear Island protective works contract
1910	HRB District extended to include Normandale, Taita, pt. Belmont
1913	Flood - problems with shingle movement
1915	Flood - control works rebuilt
1915	HRB District extended to include Epuni
1921	Rating on a uniform scale (without classification)
1924	Shingle Industry successfully restructured
1931	Flood - nearly led to stopbank failure
1933	First stopbank raising (Moera section)
1939	Flood - Largest this century
1944	First Scheme Review commenced
1947	HRB District extended to include Petone
1952-53	Scheme extension and upgrading approved
1955	Flood - Severe in Upper Hutt
1956	HRB District extended to include Upper Hutt
1956-57	Stopbank raising (Pipe Bridge to Ewen Bridge)
1959-60	Melling Diversion Cut - First Stage
1960-61	Melling Diversion Channel - Second Stage
1960-61	Stopbank raising - Ewen Bridge to Melling
1962-64	New stopbank Fraser Park/Mabey Road. Raising bank Taita to Fraser Park
1964	Melling Diversion Cut - Third Stage
1964	Stopbank raising Melling Road to Mills Road
1964-65	Haywards Settlement stopbank construction
1964-65	Whakatiki Street to Maoribank stopbanking
1966-69	Whakatiki Street to Heretaunga Golf Club stopbank
1965-66	Flattening stopbank slope at Hutt Valley High School
1966-67	Auxiliary stopbank construction, Gibbons Street
1966-71	The Silverstream Cut
1967	Channel alignment - Hudson Avenue
1967	Eastern Hutt road channel realignment
1968	Totara Park stopbanks - Stage I
1969	Stopbank construction - Boulcott to Mabey Road
1971-73	Model study of the River Mouth
1972	Maoribank Reserve drainage channel
1972	Regrading drainage channel - Clouston Park to Ebdentown Road
1972	Regrading the stopbank - Boulcott Golf Club
1972	Stopbank reshaping south of Melling Station
1972-73	Okoutu Stream (Black Creek) Auxiliary Stopbank
1973	Amalgamation of HRB to Wellington Regional Water Board. Regional Rating.
1976	Hutt Valley main sewer river crossing Silverstream
1980	Amalgamation of the WRWB into the Wellington Regional Council
1980-81	Protection of State Highway 2 Embankment at Te Marua
1980-81	Stokes Valley Stream outlet stopbank reconstruction
1981	Totara Park stopbanks - Stage II
1981	Te Marua river metal extraction
1981-86	Wellington Golf Club - Heretaunga - river control works
1981-87	Maoribank groynes and planting programme
1981-88	Protection of stopbank and river bank Alicetown
1983	Totara Park stopbanks - Stage III
1983-84	Parkdale subdivision stopbank and associated protection works
1983-84	Concrete cycle track facility
1984	Stopbank reconstruction at Woollen Mills (Moera)
1985	Current Scheme Review commenced
1984-86	Bank stabilisation trial - Estuary section
1984-89	Totara Park bank protection and stabilisation
1984, 1990	Pomare Bridge protection and bank stabilisation
1984-90	Okoutu Stream outlet improvements
1985-86	Bank stabilisation at the Ewen Bridge
1985-87	Bank stabilisation - Harcourt and Haukaretu parks
1985-88	Stopbank repairs at Croft Grove
1985-88	Upper Hutt Bypass - river works
1989	Ewen Bridge area temporary stabilisation works
1989	Stopbank reconstruction at Ewen Park/Melling Reserve
1990	Croft Grove - Black Creek bench construction and rip-rap placement

Archive Table 1: Chronology of Events.

Archive Sources

To an author attempting a technical history in New Zealand it is clear that the retention of engineering files has traditionally been accorded a low priority. Fortunately the work of our artists and photographers has been treated with greater respect. Throughout this volume their work has been used extensively to portray the physical changes and construction works otherwise unrecorded. Look carefully at the photographs or refer to the originals held at the Wellington Regional Council Library. The backgrounds often contain a wealth of comparative detail.

The principal technical archive sources are the engineering files of Seaton Sladden and Pavitt, the Engineers to the Hutt River Board from 1924 to 1973. These also contain files for the major works undertaken between 1900-1972, and copies of correspondence and the Engineer's monthly reports.

The National Archives have provided access to the Public Works Department and Soil Council correspondence with the Hutt River Board and provide an insight into the Government's involvement in the River Scheme.

Board minutes and a few correspondence files are all that remain of the Hutt River Board records. The minutes provide the only reference to Board activities from 1876-1924. The history of the early occupation and settlement of the Valley has been drawn from historical publications commissioned by Petone Borough, Lower Hutt City and Hutt County.

Technical information covering the period 1972 to the present is held by the Records Section of the Wellington Regional Council. Archive plans and Hutt River Board files (including Seaton Sladden and Pavitt files) can be accessed through the Wellington Regional Council Library. Copies of the relevant National Archives material and prints of the photographs reproduced within this report are also held with the Wellington Regional Council library.

Acknowledgements

The following histories have been referred to extensively and as for all aspects of this report the reader is encouraged to refer back to the source archives. The references provide valuable background reading of interest to any resident of the Hutt Valley. The right to copy material and benefit from the research of other writers is gratefully acknowledged.

Lower Hutt Past & Present, Lower Hutt Borough Council 1941.

Once Upon A Village - A History of Lower Hutt 1819 - 1965, David P Millar, New Zealand University Press for the Lower Hutt City Corporation, 1972.

Petone: A History, Susan Butterworth, Petone Borough Council in association with Ray Richards Publisher, 1988.

Petone's First Hundred Years, W B Nicholson ed., Petone Borough Council, 1940.

Rugged Landscape: The Geology of Central New Zealand, Graeme R Stevens, A H and A W Reed Ltd, 1974, Reprinted by DSIR Publishing, 1990.

The Hutt River - Its History & Its Conquest, C A L Treadwell, Harry H Tombs Ltd, 1959.

The Pictorial Reference Section of the Alexander Turnbull Library, National Library (abbreviated to ATL where space is tight) has been particularly helpful in processing upward of 150 prints. Photographs have been obtained from the following libraries.

Alexander Turnbull Library, Photographic Collection.

National Museum, Photographic Collection.

Wellington Maritime Museum, Photographic Collection.

Wellington Regional Council, Rivers Department, photographic collection reproduced by Monochrome Studios.

Lower Hutt Memorial Library photographic collection reproduced by Monochrome Studios.

An important part of this history has been to quantify the changes in the river alignment over the last 150 years and to present this record in an accessible format. Historical alignments contained on archive photographs and plans were transposed for plotting over current orthophoto aerial surveys. The Land Resources Department of the Wellington Regional Council digitised into computer files all river alignment archives that could be located. These can now be retrieved and rescaled as required. Their assistance in this lengthy process is gratefully acknowledged. The co-operation and assistance of the staff of the Department of Survey and Land Information in the final presentation of the fold-out photographs and plans has been invaluable.

Structure of the Report

The history is divided into two parts. Part One contains eight chapters, each covering a period of the River's history. Part Two is the technical section containing a "Project Report" for each major work. A Photographic Archive containing enlarged copies of the text plates, and photographs not included in the report, is held with the Wellington Regional Council Library.

Appendix C contains a location plan for the Hutt Catchment. Parts or "Windows" are reproduced at a larger scale in Appendix A. The windows provide the location of the historical features referred to throughout the report, both in terms of the current river survey and with respect to 1985 (lower valley) and 1988 (upper valley) aerial photography. Parts of these windows have in turn been copied to illustrate the changes in river alignment as recorded by aerial photography taken in 1936, 1951, 1967 and 1974. These are contained in Appendix B.

Archive Directory

Each chapter includes inset "Archive Tables" containing abbreviated extracts from, or references to the archive documents. The key to abbreviations is contained in Archive Table 2 below.

ABBREVIATIONS	
ATL	Alexander Turnbull Library Pictorial Reference Section.
PAH	*Petone : A History* by Susan Butterworth, published by Petone Borough Council, 1988.
LHPP	*Lower Hutt Past And Present*, published by Lower Hutt Borough Council, 1941.
OAV	*Once Upon A Village* by David P. Millar, published by the Lower Hutt City Corporation, 1972.
NA	Documents held in National Archives on behalf of the various Government departments. PWD Public Works Dept., MOW Ministry of Works, HD Housing Dept., SC Soil Council, MWD Ministry of Works and Development, (MWD, MOW, PWD also referred to as "Works").
HRB	Hutt River Board files. Board minutes are held in the Lower Hutt Memorial Library and by the WRC. Other Board documents now held by the WRC (but not files ex-Seaton Sladden and Pavitt) have been renumbered under the WRC classification system, with a HRB prefix. SOA refers to HRB Statements of Accounts.
SSPHRB	The series of files maintained by Seaton Sladden and Pavitt, as Engineers to the HRB, which cover HRB matters. The files are held by the WRC.
UHB(C)	The Upper Hutt Borough (Council), now Upper Hutt City (Council).
UHCC	Upper Hutt City Council
HCC	Hutt County Council
WRWB	The Wellington Regional Water Board files now held by the WRC.
WRC	The Wellington Regional Council file series.
cusecs	Imperial measurement of water discharge (rate of flow). Cubic feet of fluid passing a point per second.
cumecs	Metric equivalent of cusec. One cubic metre per second (cumec) = 35.3 cusecs.

Archive Table 2: Abbreviations used within the Archive Tables

How to Use the Archives

Wherever possible, the location of historical features has been shown on the set of current aerial photographs included in Appendix A. To locate the features with respect to the current river survey, current river cross sections have been shown. (Note that the cross section number is a label and does not refer to river centreline measurement.) Items referred to in the archive tables have been located by reference to the nearest river cross section or have been identified on the photographs either by name or by using the alphanumeric code which precedes each table entry. The location of the works described within the Project Reports are identified with a "PR" prefix, indicating the extent of the works.

Chapter One

THE INFLUENCE OF EARTH MOVEMENTS AND CLIMATIC CHANGE B.C.-1855

Extracts from *Rugged Landscape The Geology of Central New Zealand* by Graeme R Stevens, A H and A W Reed Ltd, 1974. Reprinted by DSIR Publishing, 1990.

To understand the present day river characteristics it is essential to appreciate that the river flows through a geologically new environment and is still responding to recent and major physical changes in the wake of earth movements, climatic change, and the exploitation of the Valley's natural resources.

If the exploitation of the forest and shingle resource had not taken place the river would now follow a course largely dictated by its geological and climatic history. The river would naturally flow within material deposited relatively recently, on a course determined by the extent and characteristics of earth movements, and by forest growth and the frequency of extreme events.

As a result of the arrival of the European immigrants and the immediate resource exploitation, the River now flows through ancient, deeper formations, controlled by man to an alignment based on the course it followed at the time of deforestation.

G R Stevens has provided a detailed account of the geological changes that led to the formation of New Zealand and, in particular, to the development of the Wellington basin in his publication *Rugged Landscape : The Geology of Central New Zealand*, A H and A W Reed Ltd, 1974; reprinted DSIR Publishing, 1990. The reader is also referred to Hutt River Flood Control Scheme Review 1990, Volume 2, *Climatology and Hydrology*, and Volume 5, *Paleohydrology*, I E Whitehouse, 1990, Land Resources Division, DSIR.

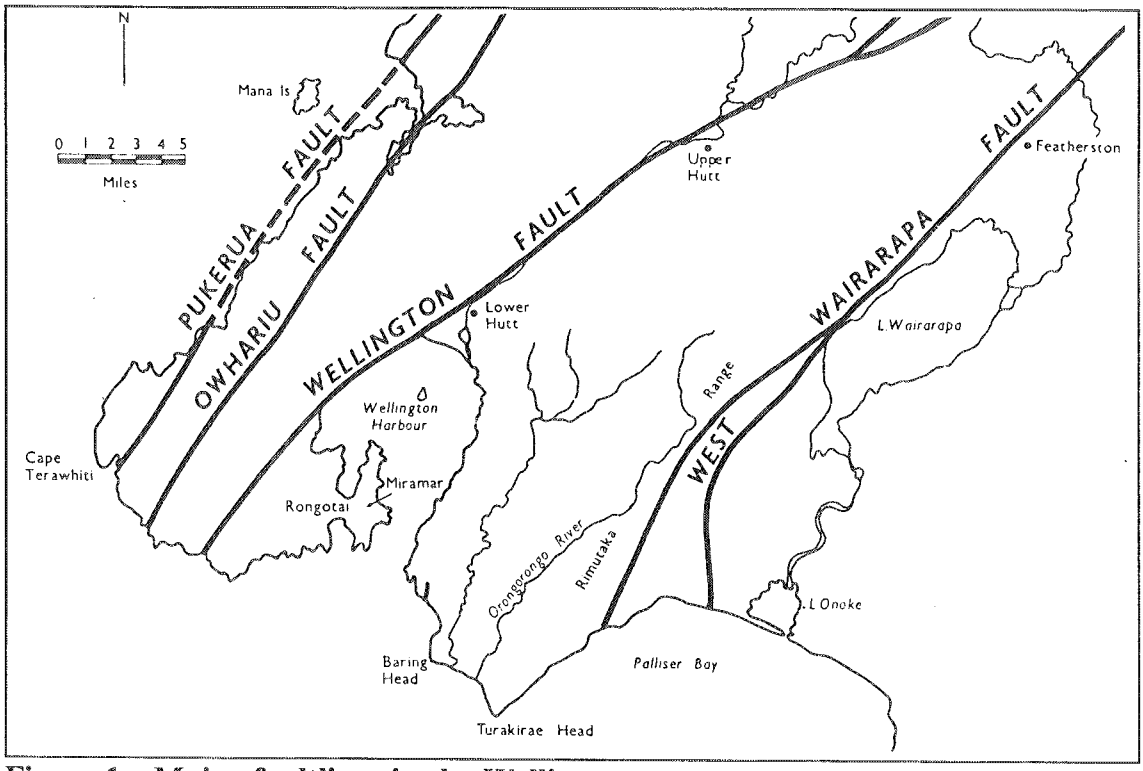


Figure 1: Major faultlines in the Wellington area.

Source: G R Stevens, *Rugged Landscape*, fig. 4.19.

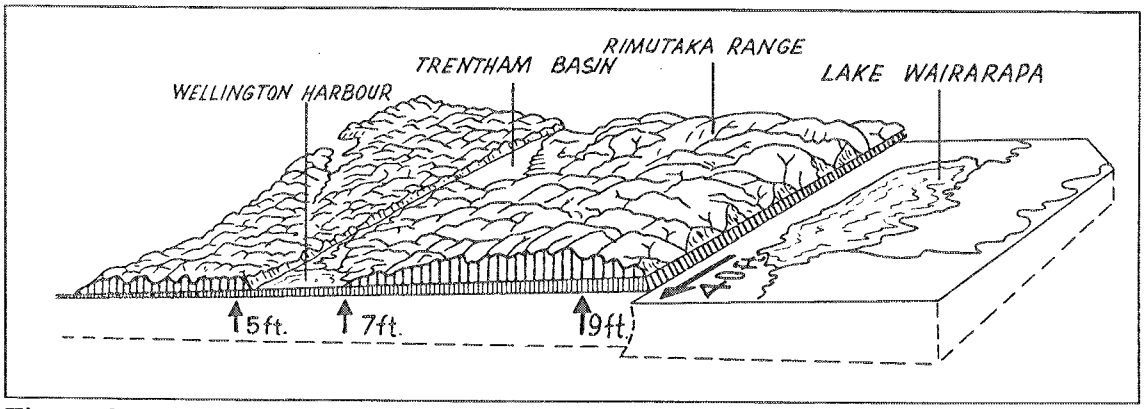


Figure 2: Fault movement, 1855 earthquake.

Source: G R Stevens, *Rugged Landscape*, fig. 13.2.

Geological Structure

The Hutt Valley floor is part of a large block, bounded to the east by the West Wairarapa Fault and to the west by the Ohariu Fault.

The block has been moving gradually upwards, tilting about the western (Ohariu) fault in a series of discrete movements. The "stepped" profile of headlands along Wellington's south coast chart the upward progress of the block and illustrate the massive displacements which have occurred in earlier times. Evidence of recent movements can be found on the raised beaches, seen clearly on the undisturbed foreshore at Turakirae Head (east of the Orongorongo River mouth), in the Petone area and beneath the roads following the Harbour perimeter. The last great movement occurred on the West Wairarapa Fault in 1855. This movement, of 2.7 m vertically and 12.2 m horizontally at the faultline, tilted the entire Wellington Region (see figure 2, p. 10) so that the Hutt Valley was raised by 1.5 m. This process of uplift is expected to continue indefinitely.

Movements along the Wellington Fault (figure 1, p. 10) have also contributed to the overall uplift of the Wellington Region. The most recent movement of the Wellington Fault occurred about 700-900 years ago and the breakage of the ground that took place at this time is visible as a scarp line running parallel to the Hutt Road (e.g., corner of Hutt Road and Wakefield Street, Petone) and traversing the terraces to the north of the northern arm of California Drive, Totara Park.

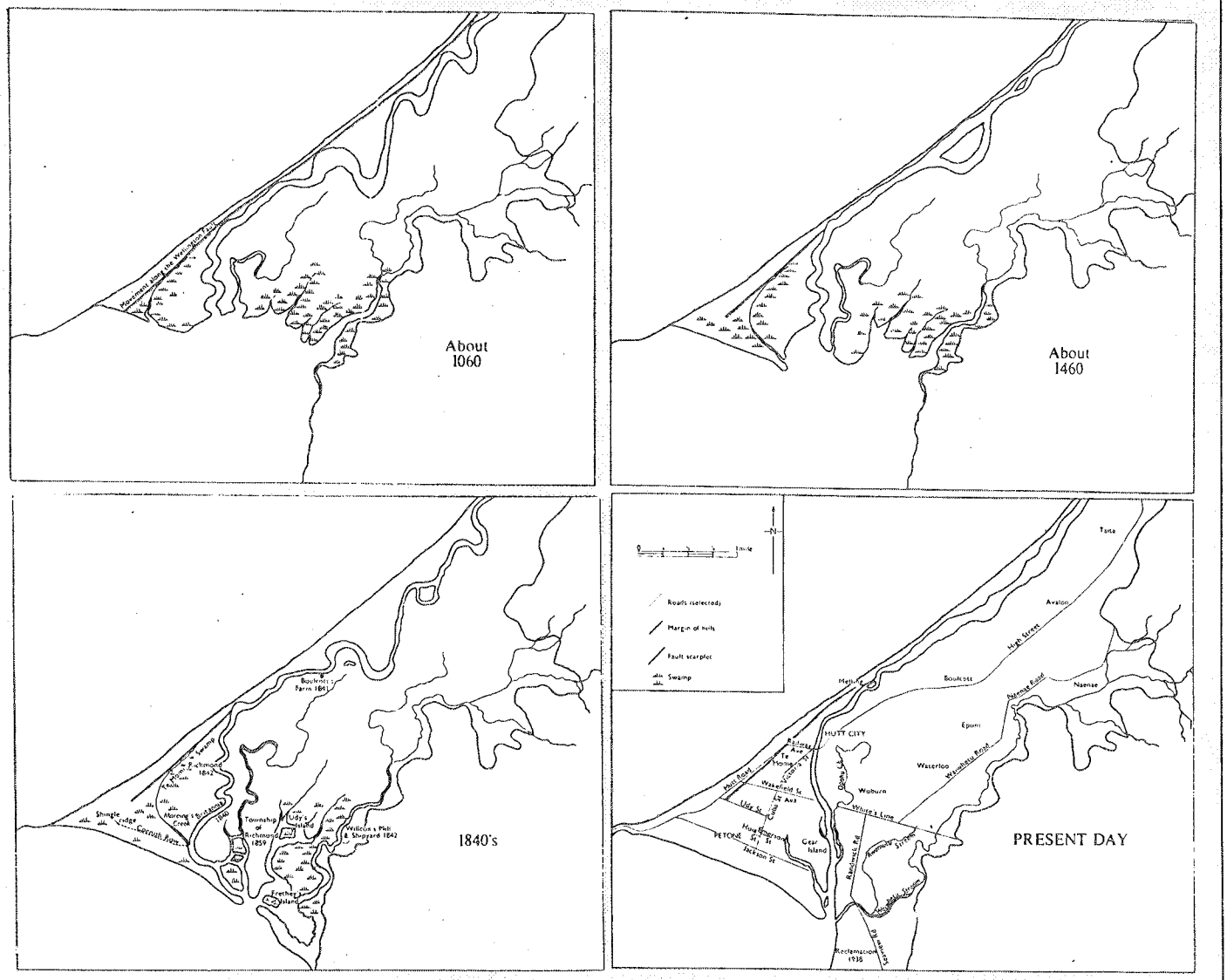
Not surprisingly, this fault activity has contributed towards determining the current river regime. Firstly, the tilting has tended to keep the river in its western course. Secondly, at each uplift the channel lengthens. The newly uplifted portion, previously the submerged river delta, becomes the river mouth. The regrading and reshaping of the old and new sections then takes place, accompanied by the creation of a new foreshore regime.

In addition to the uplift that accompanied the 1855 earthquake, recent uplifts have been dated circa A.D. 1460 (the "Hao-whenua" earthquake and formation of the Miramar Peninsula) and 300 B.C. (uplift of the Miramar flats). The changes in the Petone foreshore as a result of recent uplifts are shown in figure 3, p. 12.

Climatic Variations

Glaciation, in combination with the uplift process, led to the redirection of the watercourse from its ancient western course, through the Porirua Harbour, to its current southerly outfall (refer to figure 4, p. 14).

Before the formation of the Hutt Valley by downward movements along the Wellington Fault a number of rivers drained from the eastern mountain blocks (Rimutaka and Tararua Ranges) across the Western Hutt Hills (then extensive plainland) into the Porirua-Pauatahanui Basin (figure 4). However, all of this drainage became diverted towards the south (and into Wellington Harbour) in the



The diagrams show the evolution of the Lower Hutt Valley over the period AD 1000 to the present day. The 1060 movement on the Wellington fault produced a breakage of the ground surface as far south as Udy Street, where the shoreline was at that time. Between 1060 and 1460 material brought down by the Hutt River moved the delta front southwards to the position shown in 1460. At this time the Hao-whenua earthquake raised the harbour floor and left stranded the beach forming at that time to produce "The Rise" in Cuba Street. The foreshore had developed into swamp and tidal inlets by the 1840s when the Hutt River and Waiwhetu Stream were navigable for some distance and shipyards were established on their banks. The 1855 earthquake raised the Hutt Delta some 1.8-2.1 m, drained some of the swamps, reduced the depth of the rivers and extended the shoreline southwards. From G R Stevens, *Rugged Landscape*, p. 268-269.

Figure 3: Petone foreshore and Hutt River estuary in recent time.

Source: G.R. Stevens *Rugged Landscape*, figs 15.2 to 15.5

wake of formation of the Hutt Valley depression, beginning about 2 million years ago. During the Ice Age or Pleistocene Period, between 2 million years ago and 10,000 years ago (figure 5, p. 14), severe climates produced accelerated erosion on the valley side slopes and in the mountains.

Vast thicknesses of sedimentary materials were laid down in the Hutt Valley depression and remnants of the higher levels of these deposits are now seen as valley side terraces, particularly in the Upper Hutt Valley.

The coarse materials (rock debris, cobbles, gravel, etc.) that were laid down along the axes of both Lower and Upper Hutt Valley during the glacial phases of the Ice Age now form major layers of underground permeable zones, through which substantial flows of water pass in a down valley direction.

At the end of the Ice Age, 10,000 years ago, climate returned to that of the present day and sea level rose to its modern position. The Hutt Delta, that the Hutt River had built out into the head of Wellington Harbour during the Ice Age, became densely vegetated with lowland podocarp forest and swamp plants.

Between 5,000-4,000 years ago the earth's climate became warmer and wetter than that of today and in response to this climatic change sea level rose to 2 m above its modern position. During this warm phase (the Post-glacial Climatic Optimum) sea flooded in across the seaward edge of the Hutt Delta, overwhelming the existing forest and depositing a thick layer of silt, clay and peat that now forms the impermeable capping bed of the Hutt artesian system.

The ancient forest that lived on the Hutt Delta before the Climatic Optimum has been preserved as fossilised logs and stumps. Before the construction of the Melling Cut fossil forest materials were visible in the base of the river bank upstream from Melling Bridge (see plate 2, p. 15).

The Hutt artesian system has provided a reliable and high quality water supply that assisted in the industrial development of Petone. The artesian system is graphically illustrated in figure 6 (p. 16), and plate 3 (p. 15) shows one of the first commercial exploitations of the aquifer. Plates 4, 5 and 6 (pp. 17, 18, and 18) illustrate the dense lowland forest which covered the valley floor at the time of European settlement.

The current river regime is the subject of two separate Scheme Review Volumes: **Volume 5, *Sedimentation and River Characteristics***, and **Volume 6, *River Channel management and Protection Works***. **Volume 2, *Climatology and Hydrology***, includes a study of the Hutt River paleohydrology, and consideration of past and future climatic variations.

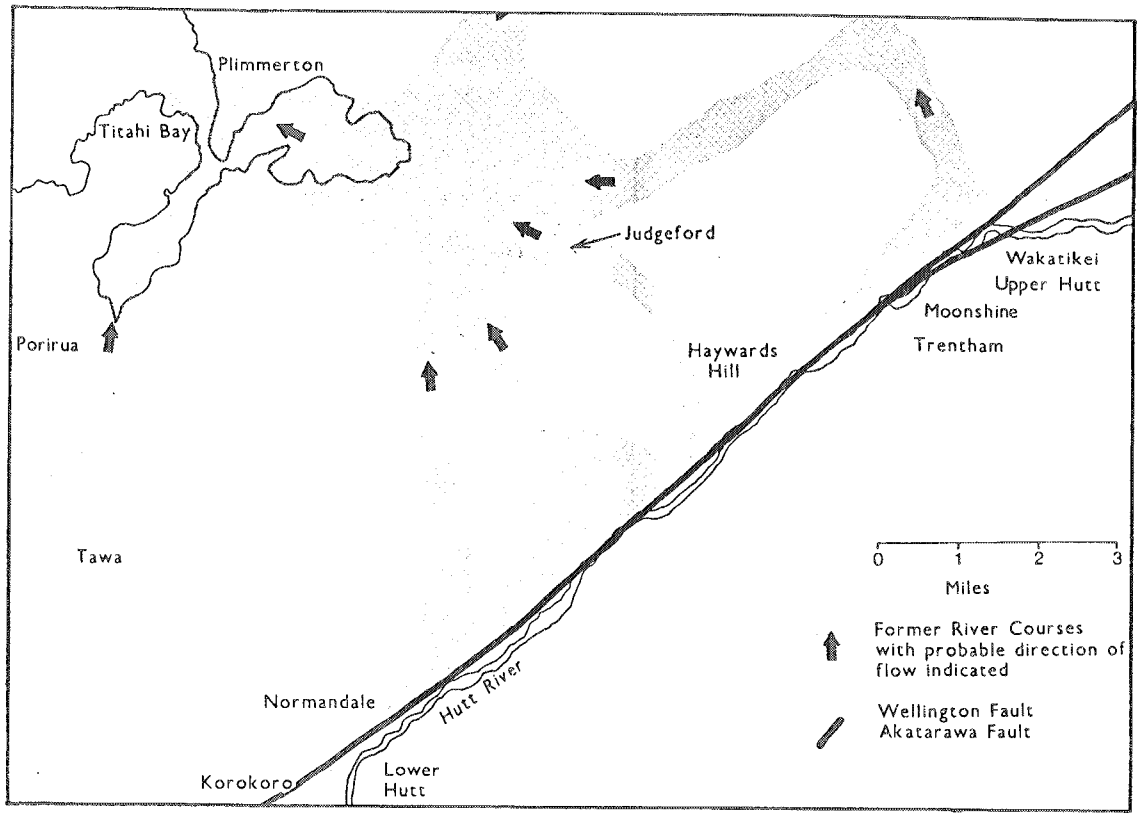


Figure 4: River courses across the Western Hills.
Source: G R Stevens, *Rugged Landscape*, fig. 3.6.

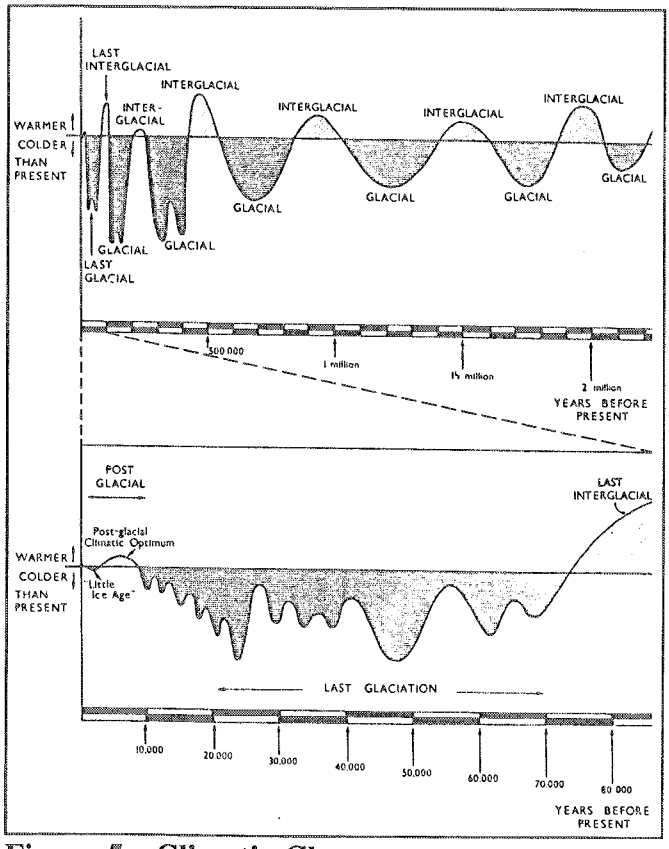


Figure 5: Climatic Changes.
Source: G R Stevens, *Rugged Landscape*, fig. 8.1.

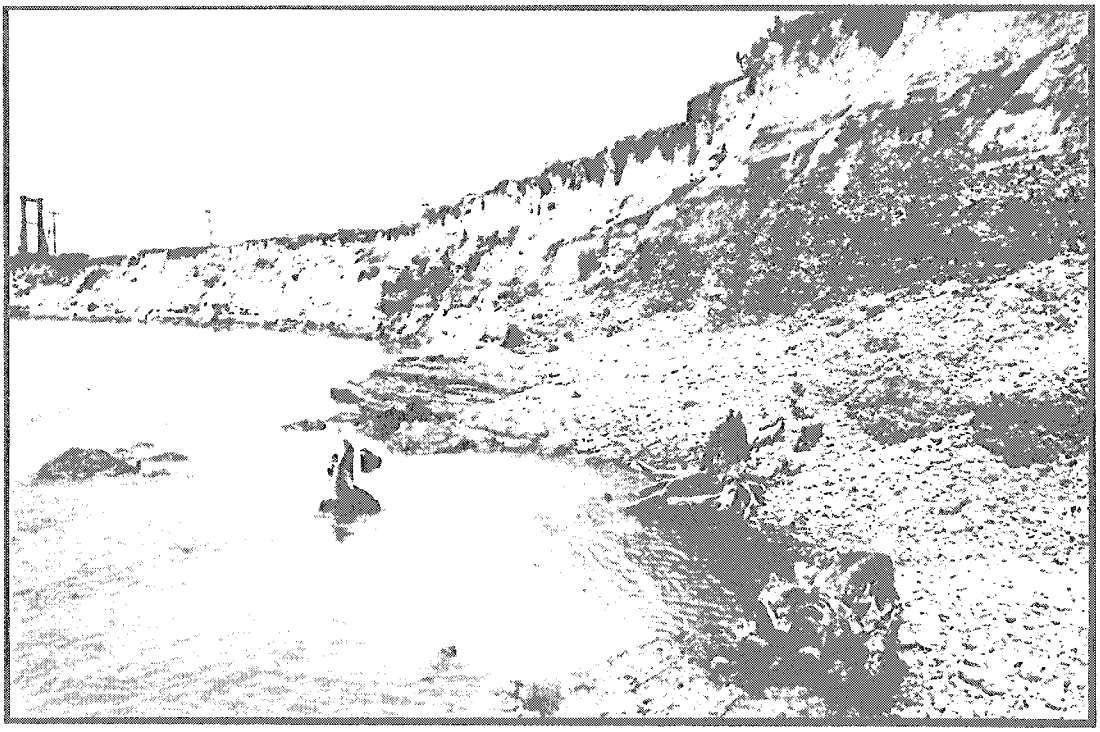


Plate 2: Ancient forest remnants.
Source: G R Stevens, "Rugged Landscape", fig. 10.4, p. 208.

Plate 2 shows the fossilised logs and stumps exposed at the base of the Melling Terrace. Age: 4,300-4,500 years ago. Photograph taken in 1954. The artesian bores shown in Plate 3 are probably located at the eastern end of Jackson Street, Petone.

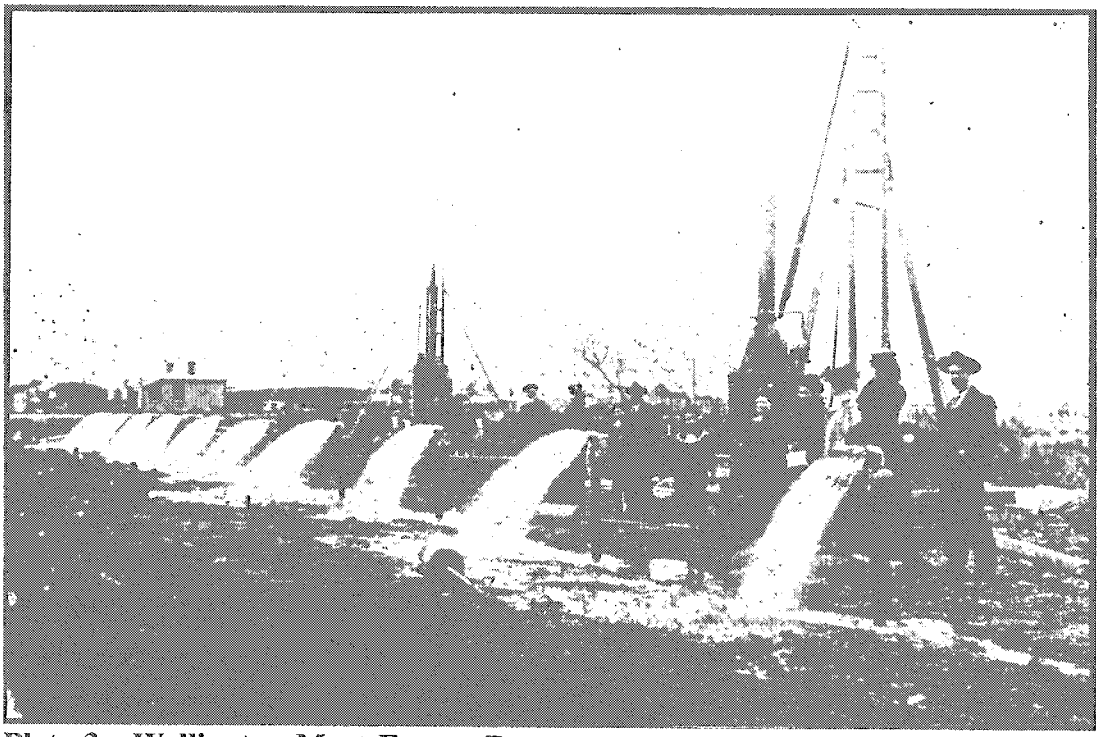


Plate 3: Wellington Meat Export Bores
Source: National Museum neg. B11444

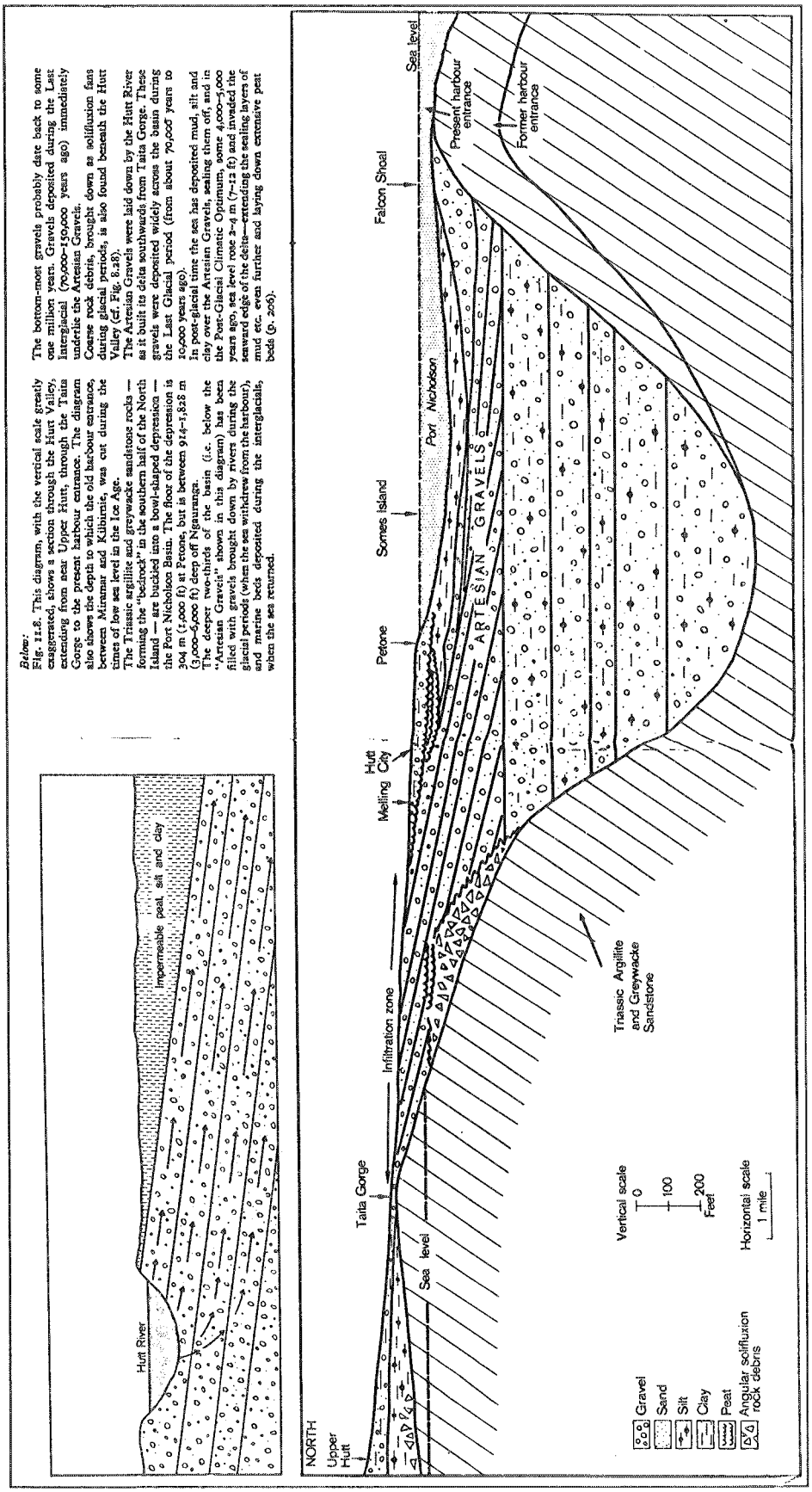


Figure 6: Hutt Valley Artesian System.

Source: G R Stevens, *Rugged Landscape*, fig. 11.8

Plate 4: Port Nicholson from the Hills above Petone, 1847.
Source: Alexander Turnbull Library, Charles Heaphy, ref. Art Room P919 31

Left: Figure 6 is a diagrammatic representation of the lower Hutt Valley and Wellington Harbour to illustrate how seepage from the bed of the Hutt River percolates downwards to become trapped under impermeable layers to produce the Hutt Valley artesian systems.

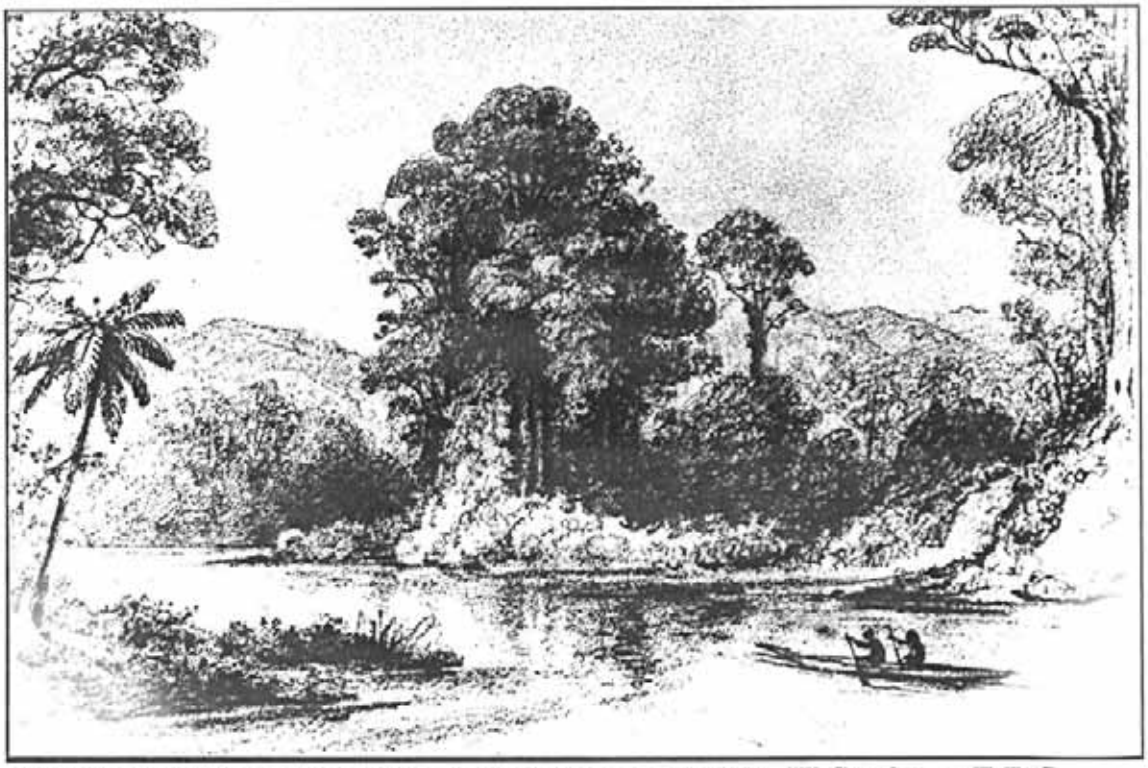


Plate 5: Hutt River near the mouth 1843, sketched by W Swainson F.R.S.
Source: Wellington Maritime Museum neg.

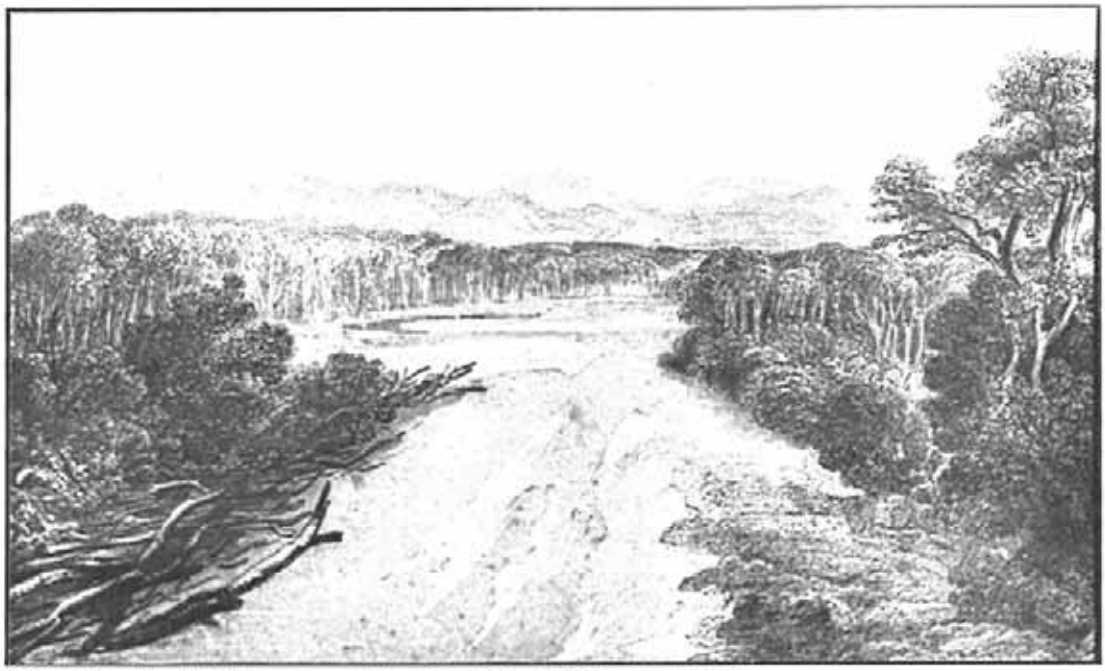


Plate 6: Hutt River near Central Hutt City, c. 1840.
Source: From a sketch held by the War Memorial Library, Hutt City, Artist unknown.

Chapter Two

SETTLEMENT, STAGNATION AND GROWTH

1840 - 1899

At the time of European settlement the lands of the Hutt Valley were recently (c. 1833) Te Ati Awa, a tribe related to the earlier occupants Ngati Mutunga and Ngati Tama, who had displaced the Ngati Ira (a branch of the Ngati Kahungunu from the East Coast) c. 1825. This ended the Ngati Ira occupation which had continued from the 17th century. Under threat from the Ngati Ira (Wairarapa) and from Te Rauparaha (Kapiti) the largest proportion of the Ngati Mutunga and Ngati Tama people fled the area in 1835 to take over the Chatham Islands from the Moriori. The principal settlements which remained were at Ngau-ranga (Chief Te Wharepouri), Pito-one (Chief Te Puni) and at Hikoikoi (Chief Te Puwhakaawe). From *Petone: A History*, Susan Butterworth. The Ngati Ira Pa at Waiwhetu was also occupied, as were sites in the Upper Valley.

In comparison with the rapid growth of Wellington City, the Hutt Valley remained a remote agricultural settlement, poorly developed and underfunded by absentee landowners. Although the 1855 uplift improved access to Wellington, commuting was impractical until the construction of the rail and road links between 1875 and 1880. Land speculation by the original owners of New Zealand Company blocks - individuals who enjoyed wide political influence - remained the principal deterrent to progress. Later industrial development on the Petone wastelands led to a powerful commercial lobby with the wealth to proceed regardless of the political opportunism within Lower Hutt Borough.

Plate 7: "Warepori, or Dark House"

Source: Sketch c. 1845 published in Illustrations to *Adventure in New Zealand* by Edward Jerningham Wakefield. Alexander Turnbull Library neg. F313MNZ.

Plate 8: Honiana Te Puni.

Source: Sketch c. 1877 published in "Barrauds New Zealand". Alexander Turnbull Library neg. 127180.

The dominant Chiefs of the lands surrounding Port Nicholson at the time of the European colonisation. Both men were instrumental in the peaceful transition from Maori to European rule.

Maori Settlement

Although there are accounts of Maori habitation of the Wellington area as far back as the 13th century [refer G R Stevens, *Rugged Landscape* p. 246] the climatic, geographical and tactical limitations of the Wellington basin discouraged widespread permanent settlement.

The Maori population appears to have grown to significant numbers around 1820 as intertribal conflict forced Maori to move from the Taranaki, Manawatu, and Wairarapa regions.

Settlements dotted the perimeter of the Harbour and occupied tactical positions in the Upper Hutt Valley, and in the western areas towards the more heavily populated Porirua Harbour and Kapiti Coast.

Protected by its remoteness the virgin state of the Hutt Valley was left unchanged by Maori. As Maori made no attempt to modify or control the river system discussion of the Maori history has not been included in this Volume. **Hutt River Flood Control Review Phase 1 - Environmental Investigations, Maori Component** contains a detailed history of Maori of the Hutt Valley, prior to and during the European settlement, and subsequently during the period of accelerated flood plain development which forced most of the original inhabitants to abandon their lands.

European Settlement

There seems little doubt that Europeans were the first to attempt to settle on the river plains or to try to win this land from the river. Although their first occupation evidenced a remarkable ignorance of rivers and their propensity to flood, their continued occupation is an indication of the desperation for titled land that existed during the first 10-20 years of the European migration.

An absorbing account of the early settlement of Petone is contained in ***Petone: A History*** **by Susan Butterworth, Petone Borough Council (1988).** The early history of Lower Hutt is well documented in ***Once Upon a Village*** **by David P Millar, Lower Hutt City Council (1961),** and both the Boroughs' centennial histories: ***Petone's First Hundred Years*** **W B Nicholson ed., Petone Borough Council 1940**, and ***Lower Hutt Past and Present*****, Lower Hutt Borough Council, 1941**. A modern history of the Upper Hutt Valley has yet to be written.

Contained below and drawing heavily on these sources is a brief description of the events directly influencing the river plain development. A knowledge of this early time is necessary in order to understand the constraints on development in the Valley in earlier years. For example, why did it take 60 years to construct stopbanks costing only half of the speculative profit made on the subdivision of just one of the original "100 acre" riparian blocks?

Plate 9: Looking across the Hutt River to All Saints Church, Taita, 1894.

Source: Alexander Turnbull Library, H M Gore, Art Room ref. Rack 221.

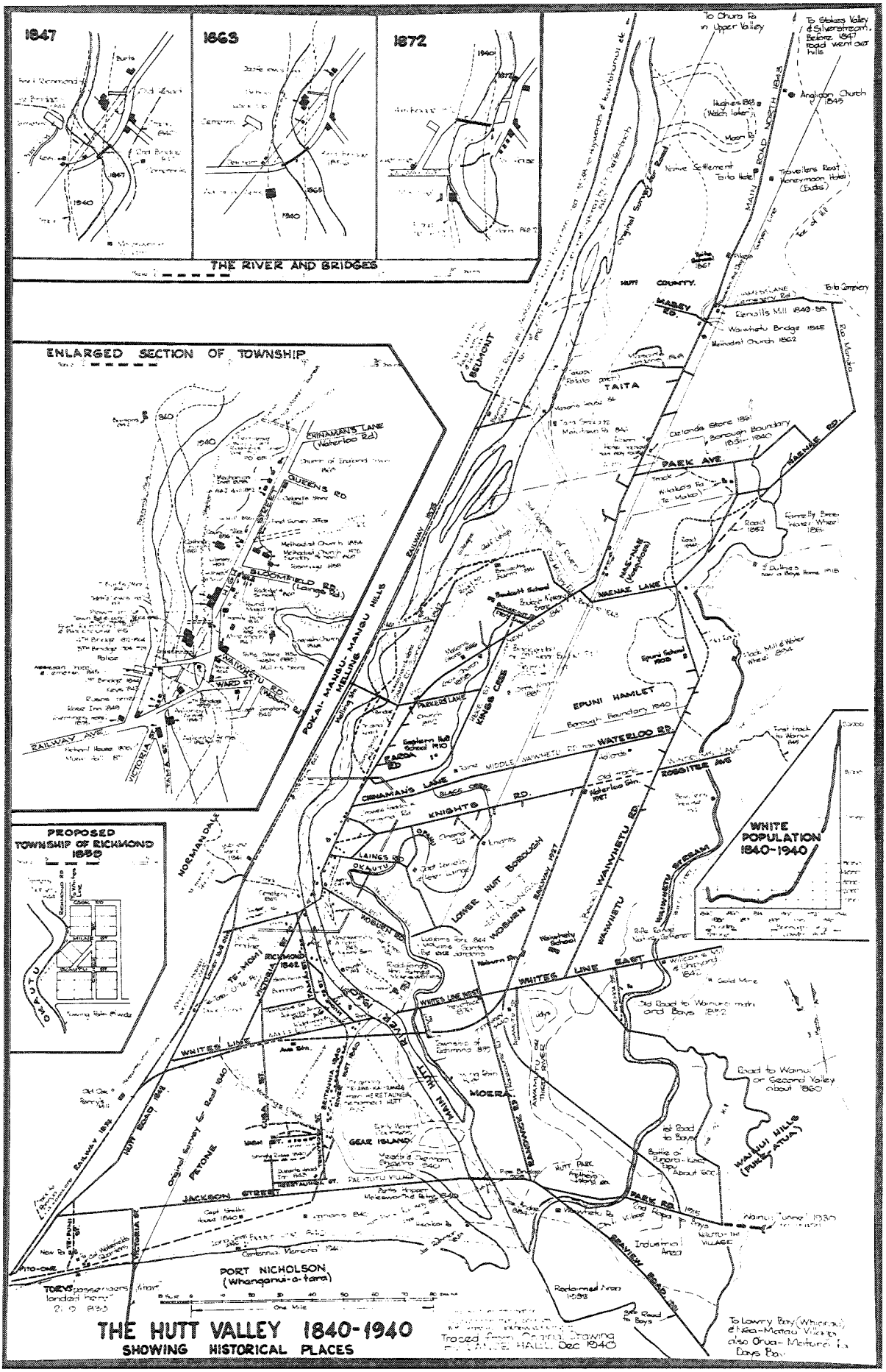


Plate 10: The Hutt Valley 1840-1940. Lance Hall, December 1940, Lower Hutt Memorial Library.

The Valley in 1840

In 1840 the Valley was much as it had been for 400 years. Prior to the 1855 uplift the foreshore followed the line of Adelaide Street (see figure 3, p. 12).

> *The village lay, as its maori name (Pitone or "End of the Sand") implied, at the western end of the sandy beach, which is about two miles long. The main river falls into the sea at the eastern end, about a quarter of a mile from the hills which bound the valley to the east, and is called the Heretaonga. A merry, brawling stream, called the Korokoro, or "throat", flows between the village and the western hills. The valley seems to preserve an average width of two miles to a considerable distance, bounded on either side by wooded hills from 300 to 400 feet in height. It was covered with high forest to within a mile and a half of the beach, when swamps full of flax, and a belt of sand-hummocks intervened.* E J Wakefield, op. cit., vol. 1, p. 74, from *Petone: A History*, Susan Butterworth p. 22

On the valley-side shoulders flanking both the western and eastern hills the Maori population had established root and cereal crop patches which their owners were later to expand into market gardens to provide the bulk of the Region's produce for years to come. There were well developed tracks to all the surrounding districts but in the lower valley the river was the main transport route.

The European arrivals in the summer of 1839/40 had come under the auspices of the New Zealand Company, a public company with the aim of establishing a unique and profitable colony in New Zealand. The company obtained its support by promising a politically egalitarian society and by offering land speculation opportunities in the form of advance land orders; a £101 package of one town acre plus a local 100 acre rural block. This was an attractive price for the town acre alone and the initial release of 1,000 orders was taken up within a month, well before land had been purchased.

The New Zealand Company negotiated the right to settle within the Wellington/ Hutt Valley area from the Te Ati Awa Maori during the September 1839 visit by Colonel Wakefield, the Company's "Principal Agent" (and, note, not a representative of the British Government). Wakefield left instructions for vegetable gardens and temporary shelters to be established in the Thorndon area of Wellington for the impending arrival of the first of the Company sponsored immigrants.

Wakefield had inspected the Hutt and was aware that the Valley flooded but apparently considered the land would be habitable following the construction of drainage and flood control works.

> *This river is 7 or 9 feet deep at its mouth where it spreads itself over a large extent, forming a lagoon, influenced by the tide. It has also made for itself 3 other streams, which divide at a distance of many miles from the mouth and increase the extent of inundated land.* Colonel W Wakefield, op. cit., p. 85 from *Petone: A History*, Susan Butterworth

Although there appears to have been some doubt about the extent of land available in the Wellington area, and particularly of the extent of the Hutt Valley, Wakefield realised that it could not provide the 110,000 acres required by the New Zealand Company. He left Wellington on 4 October 1839 in order to find other land and a site for a second, agricultural settlement.
Shortly after his departure (4 June 1840) the Company's surveyor, Captain Mein Smith arrived with instructions to set out the model township as planned in London.

Although Wakefield had left instructions to survey a town at Thorndon, the surveyor found that the land at Thorndon could not accommodate the model plan and considered it impractical for the settlers to be separated from their country acres by a harbour crossing. He considered it impractical for the settlers to be separated from their country acres by a harbour crossing which was often-times a treacherous sea passage. Although the passage was short, it cost many lives as poorly equipped and overloaded boats foundered in heavy squalls. The alternative was to follow the track along the base of the "Nga-uranga" cliff which became impassable at high tide and crossed three large streams.

Because of the commuting difficulties and the limited area of flat land at Thorndon, Captain Mein Smith set about surveying the township in the Hutt Valley. Captain Smith also noticed signs of flooding and:

> *... made many enquiries of the natives ... whether these rivers ever overflowed their banks. They assured me they did not. I therefore proceeded with my plan of the town site cutting lines about six feet wide for the lines of the streets which tho' necessary was a very tedious operation on account of the extreme density of the forest.* W M Smith, jour. qms, SMI vol. 3, 5/1/1840, ATL, from *Petone: A History*, Susan Butterworth, p. 31.

The survey had not proceeded far by the time Wakefield returned. Wakefield, although concerned at the change of site, felt disinclined to order another change until pressure from a group of settlers, led by a Dr Evans, forced him to reconsider. In April 1840 Wakefield requested a report from his surveyor.

> *... asking for his assessment of the merits of the two sites; he was particularly to consider whether the Hutt Valley could be made secure against flooding within the financial means at his disposal ... Smith replied ... that the flooding nuisance could be overcome by clearing the watercourse of snags and cutting flood channels, but probably not within the £2000 allowed by the directors for such purposes. He still preferred the Hutt site and suggested that the land-order holders should tax themselves £5 per town acre to bridge the deficit.* *Petone: A History*, Susan Butterworth, p. 39.

Acting on this advice Wakefield wrote to Evans:

> *... the town was to be at Britannia (Petone), that the swamps would be thrown out and that the survey would proceed as rapidly as possible.* *Once Upon A Village*, David P Millar, p. 32

This was not received well by Evans who replied:

> *in the event of a selection being made (where now proposed) on the banks of the river, a very large proportion of the colonists, both land owners and labourers have made up their minds to abandon the undertaking altogether.* G S Evans to Colonel Wakefield, March 15 1840, quoted by John Millar *Early Victorian New Zealand*, p. 46, and *Once Upon A Village*, David P Millar, p. 32.

On 5 April the colonel agreed to move the town to Thorndon:

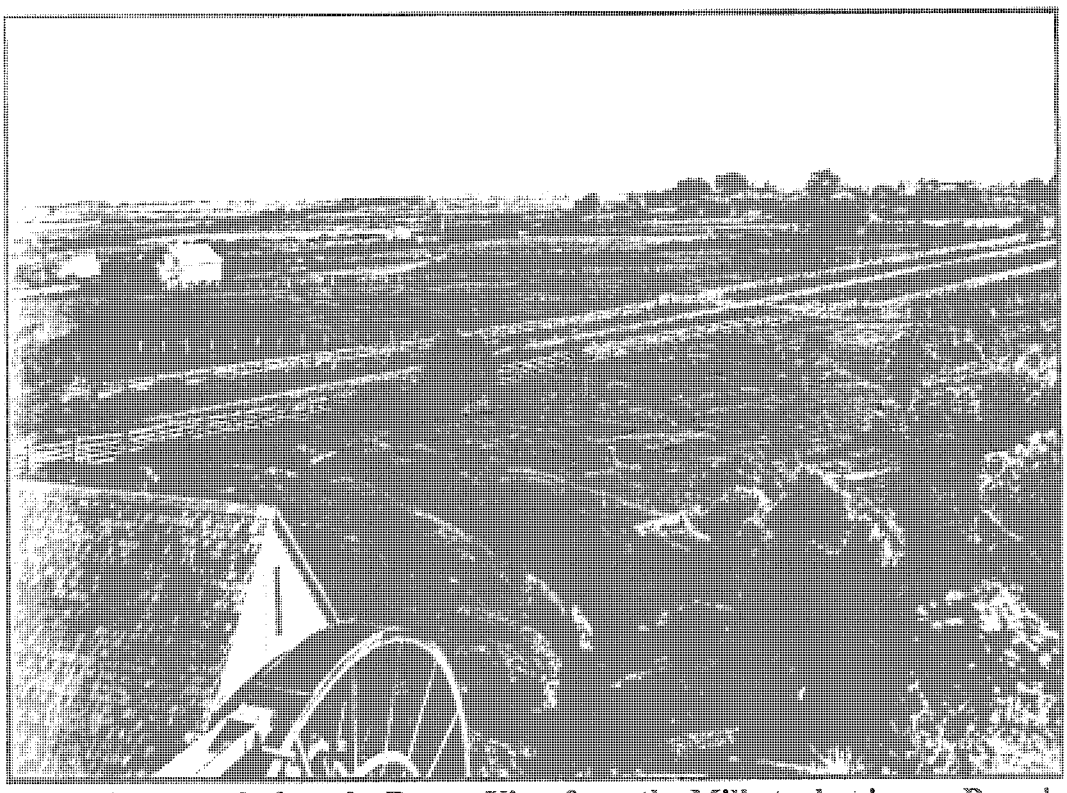


Plate 11: Petone before the Boom. View from the Mill at what is now Percy's Reserve. Source: Alexander Turnbull Library, James Bragge, neg F13373.

> *If, after persisting till the winter, we should then be obliged to give up the plan, such a retreat would amount to a disaster ruinous to the Colony.* *Petone: A History*, Susan Butterworth.

For the next 10 years Petone remained a halfway house for the new arrivals while they found a place to live. Most settled in the Wellington City area with only a small population of farmers, sawyers, boat builders and traders occupying the Hutt Valley.

First European Settlement

Between 1848 and 1875 Petone was virtually deserted. Prior to the 1855 earthquake and accompanying uplift, "what was not beach was swamp" and thereafter the land was poor and badly drained, being an undulating sea bed area with hillside creeks wandering through it. By 1872 there was only the Maori community and 13 settler families within the Petone Borough.

> *Petone in those days was divided up into 100 acre sections. White's Line, the boundary of these sections up the valley, used to be a swamp in winter, making access to them almost impossible, but it was fairly dry in summer. There was little grazing ground in Petone of much value. Over the paddocks there grew rushes flax and toi-toi. Not a great deal of farming was done that returned a great return to the owner. Mr Buick, who was believed to have paid a pound an acre for his land, grazed a few sheep and other property owners had cattle, but the land was so poor that it took about two acres to keep a cow. Streams ran down from the hills, and at times covered Petone, down as far as the present site of Jackson Street, with water.*

Plate 12: Petone c. 1843, S C Brees. Bridge across Moreing's Creek (now culverted), Alicetown.
Source: Alexander Turnbull Library Art Room B31/2

> *On the present site of the tobacco factory of Messrs W D & H O Wills, [Richmond Street] there would be about four feet of water all winter. During one or two exceptional floods, the whole of Petone was covered, with the exception of some of the raised portions of the ground....*
> *Evening Post* (Wellington), 1 August 1935, interview E Maidment, from *Petone: A History*, Susan Butterworth.

By contrast the population of Lower Hutt (and similarly the Upper Valley) continued to grow, although slowly, being less than 1,000 at the turn of the century.

The establishment in 1840 of the township of Britannia (now the suburb of Alicetown) coincided with an "unseasonable" deluge of rain and many houses were moved to higher ground or were rebuilt on poles. One colonist recorded:

> *Our fire-place, which was in the open air, had a joint of pork roasting before it, and the pudding was boiling in the pot, when, by degrees, the water approached...Ember after ember was put out, and the meat half roasted, the half boiled.* The New Zealand Journal, April 24, 1841. From *Once Upon A Village*, David P. Millar, p. 29.

Again on 2 March 1840 a larger flood inundated houses to some depth. As a result about 40 settlers moved to high ground in "Cornish Row", while others returned to the foreshore and eventually to Thorndon or to other settlements.

In 1842 it is reported that the river banks were overtopped 7 times. By then the stripping of the forest had allowed the Hutt to erode the land and change course as never before. The history of the Aglionby Arms (also referred to as "Valentines" after its owner) illustrates the extent of bank erosion.

Plate 13: Alicetown in the 1880s. Source: Alexander Turnbull Library, Edgar Williams bequest, neg. G25575

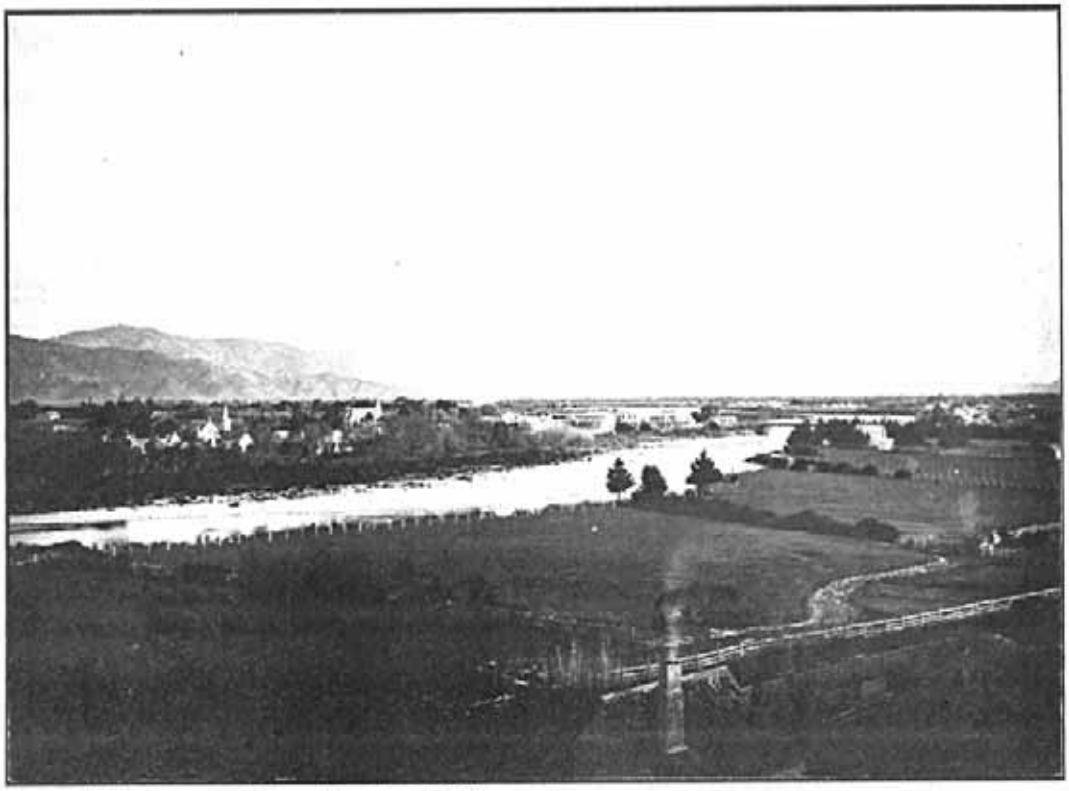


Plate 14: Lower Hutt in the 1880s. Source: Alexander Turnbull Library, Edgar Williams bequest, neg. G25584

The building was isolated by the river on three occasions before its timbers were finally used in the construction of the Railway Hotel, a block further away from the river bank.

It is difficult to tell which of the many impediments was dominant in retarding the development of the Hutt. Although flooding in the 1840s was a regular occurrence it appears to have been regarded with a resigned acceptance.

> *The flooding of the river was a regular occurrence. The river overflowed about half a dozen times every winter, although on only few occasions was its flooding disastrous. A heavy rain always meant a future flood, and in at least one house, that of James Brown, the downfall was a sign that food had to be cooked to last three days, and plenty of wood put aside in a dry place for use after the waters had receded. As an additional precaution, most people acquired a canoe, which they kept permanently tethered on a lead by the doorway.* *Once Upon A Village*, David P Millar, p. 52.

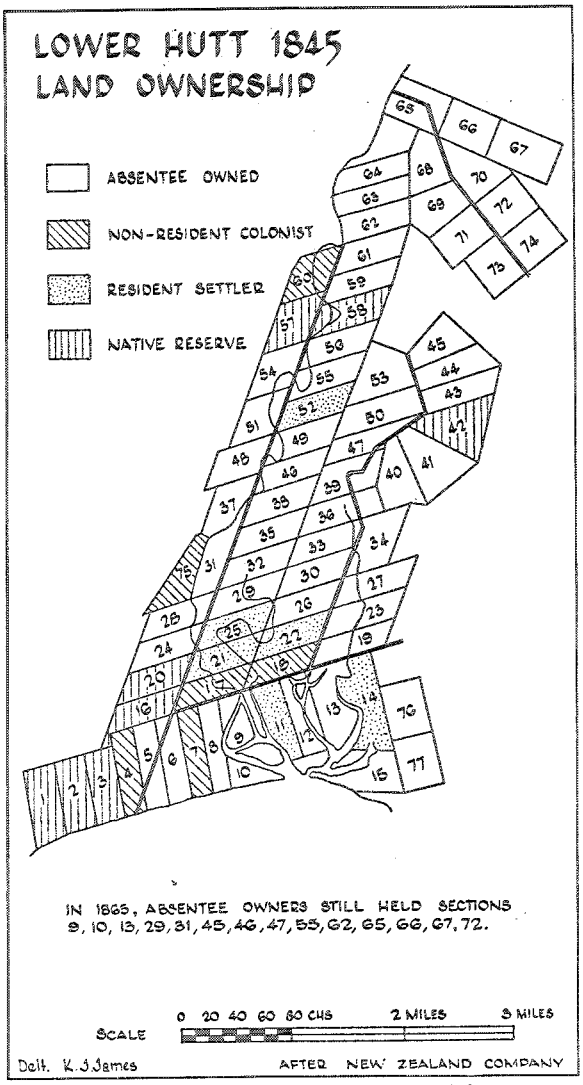


Figure 7: Land ownership in 1845.
Source: *Once Upon a Village*, P. Millar, p.47.

The lack of local employment opportunity, or if work could be found in Wellington the difficulty of commuting, reduced residential demand for Hutt land. However, land ownership problems restricted development most and certainly deferred the containment of the river until catastrophic flooding had occurred several times. Absentee (or local and idle) landlords starved the settlers of capital and land.

> *In 1845 not less than 64% of Hutt land was locked up in unproductive persons - absentee or otherwise - and it was still as high as 47% ten years later."....."You absentees ought to do more than feel anxious about the prosperity of Wellington - you should aid in it; as it is you are content to sit by the fire-side and speculate upon the advance which will take place... Not only do you not contribute to our prosperity, but your agents ask higher terms for selling or leasing lands than demanded by settlers.* *Letters from settlers and labouring immigrants.* p. 24-5, from *Once Upon A Village*, David P Millar, p. 46.

The First Natural Disasters

In a manner repeated throughout the Hutt River's history a decade of mild weather in the 1840s was followed by a period of moderate flooding, including probably the greatest flood until then observed in the Hutt River. In 1858 the true flood potential of the Hutt was to be revealed to settlers still shaking from the great 1855 earthquake.

Throughout the 1850s flooding became more serious. The river became choked with forest strippings as the plain and river banks were cleared of the protective cover. The river was free to meander into the surrounding land and to rediscover ancient waterways.

The flood of 1849 was to be the first of the "old man" floods of last century. The "heaviest flooding for years" took place with people losing much livestock - one settler lost 180 sheep. There is a flood recorded in December 1852 and following the great earthquake of 23 January 1855 a winter flood rose 2 feet higher than had ever been known before. This event completed the demolition of the Hutt Bridge, destroyed in the earthquake, and carried away 300 sheep.

There is little recorded of the direct effect that the January 1855 earthquake and accompanying uplift had on the river regime. Modern assessments of the ground movement indicate that the grade of the river was marginally increased although the grade upstream of the upper limit of the estuarine area (vicinity of the Melling Bridge) remained essentially the same.

Our current knowledge of the river hydraulics suggest that in the now elevated (previously estuarine) areas the finer bed material laid down under tidal conditions would have been too fine and the bed gradient too flat to resist the scour of the higher velocity flows of an upstream reach. Similarly, the old mouth and delta would have been prone to severe scour during the first major flood. How this regrading and realignment developed is difficult to assess: the river grade and alignment was also affected by the mass clearing of the river berms and hillside forests, and by the enormously increased bedload carried from the upper reaches.

The river engineers of the time did not have to wait long to observe the river's response (the records of the Provincial Council show the theories of river mechanics received considerable attention from the Council Engineers [see *Petone: A History*, Susan Butterworth, p. 82]) for on 17 January 1858 an enormous flood swept the Valley.

Plate 15: Timber groynes erected after the 1858 flood.
Source: Alexander Turnbull Library, W H Davis, neg. F52880.

HISTORICAL FLOODS 1840-1899

(Abbreviations refer to Archive Table 2, p. 7)

A1: 2 Mar 1840: OAV: Houses flooded to some depth. As a result about 40 settlers moved to Cornish Row; others returned to the foreshore.

A2: Winter 1849: OAV: Heaviest flooding for years. People losing much livestock. One settler lost 180 sheep.

A3: Dec 1852: OAV: Flood

A4: Winter 1855: OAV: 300 Sheep lost. River 2' higher than had ever been known before. Completed the demolition of the Second (Percy's) Hutt Bridge, which had already been destroyed by the January 1855 earthquake.

A6: Jan 1858: OAV: Largest flood yet - burst its banks and flowed into the second river (Black Creek). The Aglionby Arms rendered uninhabitable - surrounded by water on 4 sides. A number of sawyers in Upper Hutt narrowly escaped death. Road through Hutt Valley gouged deep in several places. New bridge damaged. 9 people in the vicinity of the Barley Mow Inn, Taita, drowned. Heavy livestock losses.

"The New Zealand Spectator": Continued raining on Sunday evening and continued through to the following evening. Very rapid rise - people had not enough time to move to other ground. Level to the height of the bridge deck at 1.00 pm Tuesday. On Wednesday morning bodies were recovered. Meeting held a few days after 26 January 1858. Reference to damage caused by previous floods.

A7: 17 Jan 1858: LHPP: 9 lives lost. Many acres farmland lost at Taita and 90 acres belonging to Mr Speedy at Belmont.

A8: Sep 1958: OAV: Another flood, but not as bad as January. Swept away half of Carters Bridge (Third Hutt Bridge) and eroded west bank.

A9: Jun 1859: OAV: River becoming increasingly choked with trees dumped into it by settlers hoping the river would carry them away. Throughout the 195Os flooding increased in seriousness

A10: 1868: A jam of logs lifted the Third Bridge off its foundations.

A11: Mar 1871: OAV: Flood swept away 100 ft of the Hutt Bridge, caused by a log jam. During the reconstruction of the Fourth Hutt Bridge, completed in 1872, 3 heavy floods washed away material, equipment and the construction punt. The contractor built 5 timber groynes and filled them with boulders. A small strip of river frontage bought by the Provincial Government was then planted with willows. Within weeks all the groynes were reported to have slipped out of position and considerable repair work was needed. Floods of 1871 caused abandonment of the third Aglionby Arms, situated to the southwest of the Hutt Bridge. Its timbers went into the Railway Hotel in 1872. The first Aglionby Arms washed out in c. 1845-6. The second Aglionby Arms (c. 1847) was situated in the middle of the present river bed.

A12: 1878: OAV: Two old man floods which swept the valley from side to side.

A13: Mar 1880: OAV: A heavy flood spilled out over many fields, covering them with several inches of water. A child was swept to his death.

A14: 1887: OAV: Spring rain brought another flood to the valley.

A15: Mar 1893: LHPP: Flood: considerable damage. Prompted Petone to negotiate with Lower Hutt to build stopbanks. Negotiations broke down and Petone proceeded independently.

A16: Mar 1893: OAV: Flood: Hutt residents going to Wellington had trouble getting traps through.

A17: Aug 1893: OAV: The lower valley a desolate scene with vast sheets of water covering paddock after paddock.

A18: 1895: OAV: The council had to erect breakwaters to protect the school below the Hutt Bridge from further heavy erosion.

A19: Feb 1896: OAV: A flood brought down an immense amount of timber. The stability of the Hutt Bridge threatened. Alicetown (alleged to have) suffered badly as the Petone stopbank, built after the first 1893 flood, banked up water. Individuals began protecting their own properties with wooden groynes and willows.

A20: 1898: LHPP: Two tremendous floods, June 1898 and 18 November 1898. In one of these floods the waters covered the valley from hill to hill: the greatest flood for 40 years.

A21: 17 Jun 1898: OAV: The worst flood since 1858; water to within 9" of the Hutt Bridge decking. Water knee deep in the township. Did a great deal of damage to McNab's gardens. Ground floor of house and gardens covered in a sea of mud. Led to sale of gardens in 1901.

A22: 17 Jun 1898: NA PWD96/298000 21/9/54 SCHNACKENBERG. High Street, Lower Hutt under 3 ft water - other parts to a greater depth. Parts of Petone to depths of 8-10'.

Archive Table 3: Historical Floods 1840-1899

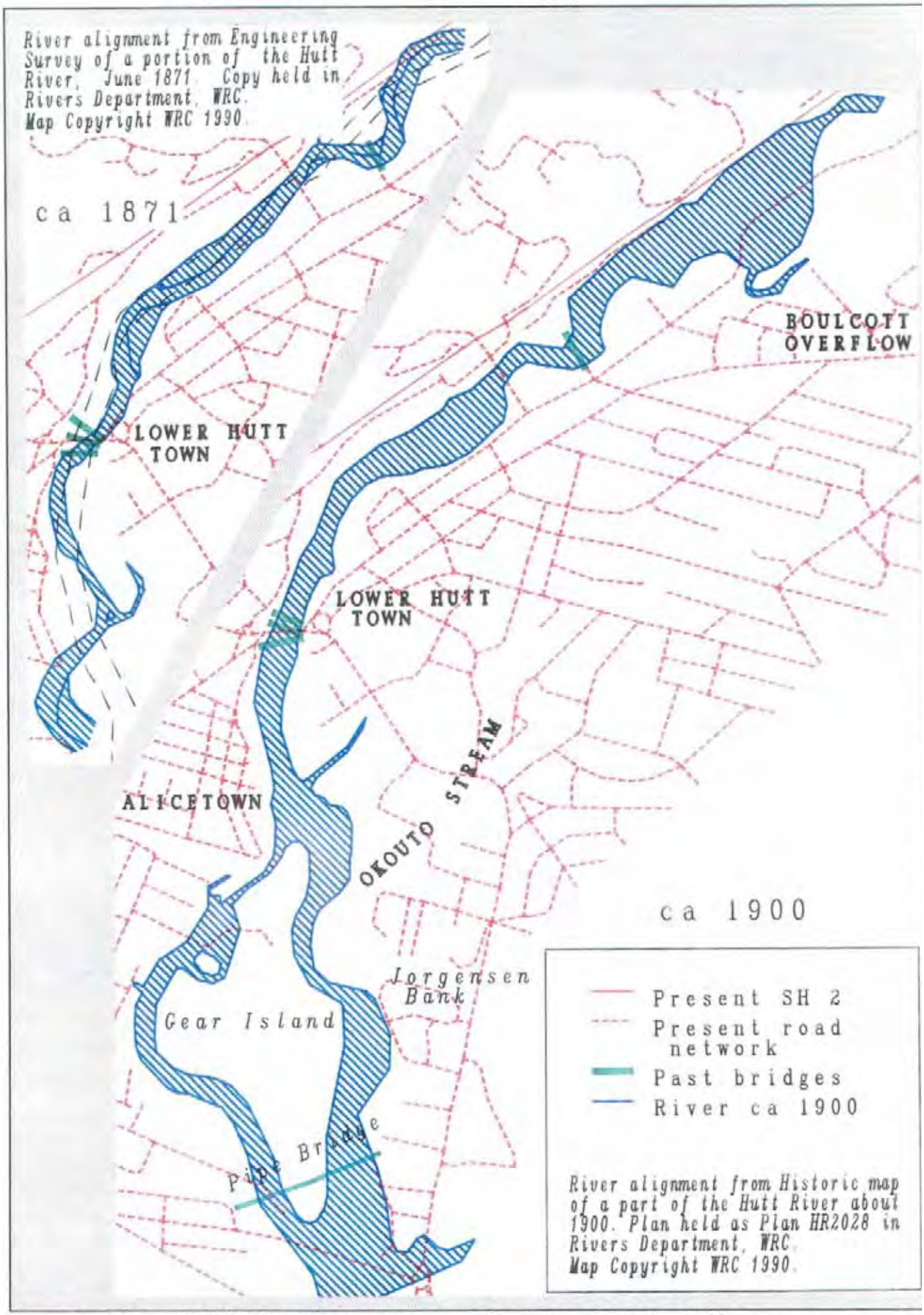


Figure 8: 1871 and 1900 River alignments between Melling and Estuary Bridge.

This was followed in September of the same year by a slightly smaller event, and again with lighter flooding in February and July 1859. The graphic accounts of the January flood do not include engineering comment, however, by comparing the description of the flood in the Taita area with those of the 1931 flood it is likely that the 1858 flood is the largest that has been witnessed, at least in pakeha recorded history.

As descriptions of the 1858 flood bring home the scale of a disaster that could still affect the Hutt Valley (should the embankments fail or be overtopped), the leader carried in the New Zealand Spectator not long after the flood is copied here as figure 9 overleaf. When thinking of a comparable event today it is worth remembering that intensive development on the river plains has increased the flood plain population from about 1,000 to 100,000. The original protection works funded by 1,000 ratepayers now form the basis of the current works downstream of Melling, protecting a population of about 60,000.

The Industrialisation of Petone

From the mid-1870s development of the Petone and Lower Hutt areas followed different patterns, in part due to the more severe flooding which affected Lower Hutt, but principally due to industrial development on the Petone wastelands.

Through the employment offered by the Gear Meat Works, the New Zealand Railways workshops (originally located to house the special locomotives required to climb the Rimutaka Incline), the woollen mills, and service industries to these, Petone surged ahead.

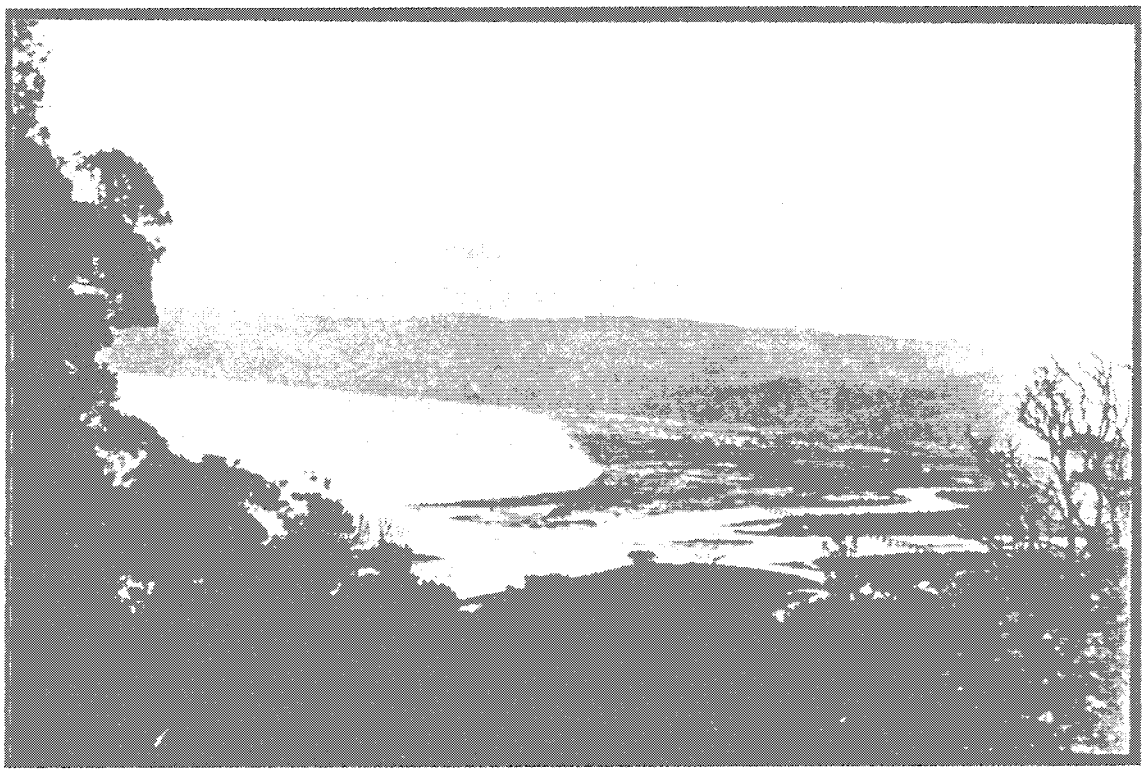


Plate 16: Petone in the 1880s, viewed from the Wainuiomata Hill Road.
Source: Wellington Maritime Museum neg.

THE FLOOD OF 1858

"The later rains have caused a very heavy flood at the Hutt which, we are sorry to learn, has occasioned very serious damage and loss to persons living in the district. It commenced raining on Sunday evening, and continued without intermission until the following evening. The river rose to a greater height than has been known before, the water entering many houses that have been above the level of previous floods. Immense trees were brought down by the flood and left in different parts of the road, which is broken up in several places, and has become quite impassable. Butler's house is entirely washed away, and the river has broken through still further in that direction. Corbett's—the Aglionby Arms—is rendered uninhabitable, the river having swept away half the house and made a fresh course for itself, so as to leave the remainder of the building standing as an island in the middle of the stream. Mr Corbett had incurred an expense of £100 the week previous driving pile sand forming a breastwork to protect the house against future freshes. With great difficulty he contrived to save the furniture from the upper rooms. The river had broken the bank away on both sides, which is now impassable; when the flood was at its height it was level with the floor of the bridge, many of the iron fastenings and cross sleepers of which had been carried away. Heavy losses have been incurred in the valley by the destruction of fences and other property, and the loss of sheep and other valuable animals which have been drowned by the flood. The damage to the road at Butler's and the parts adjacent caused by the previous flood has been further increased by that of Monday; very much of this, it is said, might have been prevented if timely precautions had been taken by the Provincial Government who never interfere in these matters until after the mischief is done.

To the above account of losses and destruction of property caused by the flood, we are concerned to add that news has this morning been brought of lamentable loss of life, the bodies of seven persons have been recovered, several other persons are reported to be missing. The unfortunate sufferers are, it is said, mostly newcomers who have recently settled in the district.

In our last we gave such details of the disastrous flood which had occurred in the Hutt as had reached us. We now furnish the following particulars which we believe may be relied on as being substantially correct. The number of bodies actually recovered at present is nine, namely, Mrs Hagan and infant, and Mrs Price; the other persons known to be missing are the husband of Mrs Stanway, and three more of his children, who were all seen to be washed away together. The particular locality where this awful loss of life occurred was nearby the 'Barley Mow Inn,' at the Upper Valley of the Hutt.

When the flood was at its height (about 1 a.m. Tuesday) the force of the water at this point is described by an eye-witness as being terrific. The water was seen rushing along like an immense wave, crashing and roaring, carrying everything before it: huge trees, portions of buildings, timber, furniture, and debris of every description, were borne away by the force of the current. To witness the havoc and destruction which the flood had caused is most painful and baffles all description. Many acres of land which only a few hours before to all appearances promised a plentiful crop, are now covered with sand and shingle, and not a particle of vegetation remains. The quantities of drift timber, in many instances large solid trees, which have been deposited by the flood, is perfectly incredible, and will take many months to remove. The unfortunate persons who have lost their lives by this sad calamity are mostly late arrivals in the country. Mrs Hagan (a daughter of Mr Dew, an old settler at the Hutt) was living in a small wooden building near the first gorge; Mrs Price and a man named Charles Hartley were also residing in the house. Upon seeing the waters rising so rapidly some fear was entertained for the safety of the building, and the survivor Hartley proposed to go for a rope to secure the house; when he left the water was up to the window, and the house was actually shaking. He almost lost his footing, and was swimming with the current for nearly half a mile, until he succeeded in getting up a tree, where he remained for 14 hours, until rescued by some passers-by on the following day. From the position which he occupied he could see everything around him; he states that he soon saw the house borne away with the current: the inmates Mrs Hagan (who was only confined that morning) and the nurse Mrs Price, were climbing on to the roof of the house; they passed close to where he was in the tree, and he describes the shrieks of the women as fearful; a minute after the house turned over, and nothing more was seen of them. The bodies were recovered about a mile from the spot on Wednesday morning; the infant was found firmly locked in the dying grasp of its poor mother, the nurse was found close to her, the body was very much mangled. The bodies were removed to the house of Mr Dew, and an inquest held on them, when a verdict of accidentally drowned was returned. The husband of Mrs Hagan is absent in the country and, of course, is ignorant of the desolation of his home. Mrs Price, who was much respected, and who arrived here by the *Ann Wilson*, leaves a family of young children behind her: her husband was absent from home at the time. The other family, Mr Stanway, wife and family were all seen together on the roof of their house; the water rose rapidly and submerged the whole of them, and they were seen to sink one after the other. The blacksmith Sollers with his wife and infant perished in a similar manner; they imagined themselves secure, but the house was borne away with the current, and he was heard by persons on the hills to say 'good-bye'. The bodies were found mostly together, one completely buried in the sand. A man and his wife living near to Mr Dew were saved after remaining on top of a building for many hours whilst nearly all around them was borne away. To give anything like a detailed account of the losses sustained by residents at the Hutt would be impossible; we may, however, state a few of the most important particulars of individual loss of which we have been informed:—Mr D. Riddiford has lost about 120 sheep; Mr Barton has also lost a large number of sheep; Mr Thomas Mason a number of cattle; Mr Arnott cattle and sheep; Mr John Leverton has lost entirely 50 acres of crops, and a large number of cattle: Mr C. Mabey lost a number of sheep, and also a large quantity of fenced and cropped land; Mr Buckridge, of the Albion Hotel, has had his crops destroyed and the river has taken a course completely through his property: at William Tandy's the river now runs through his ground and has destroyed a large amount of property; Mrs Speedy's land is completely cut up in all directions by the different channels the rain has made, in many cases large fissures 12 feet deep have been formed; Mr Still has lost a number of sheep, etc.; Mr John Russell 10 head of cattle; Mr Dew, an old settler, estimates his loss at not less than £500; a property which was worth many hundreds of pounds is now comparatively worthless, five acres of grassland have been completely swept away. A large number of men had volunteered to assist in removing a shingle bed which had been thrown up, and which prevents the river from taking its old channel, and nearly all the residents of the Hutt were endeavouring to contribute either in labour or otherwise to this object. The destruction of the roads between Poad's public house and the Taita is almost incredible, scarcely a vestige remains at some places of the original road: at one place (a bridge near M'Donald's creek) the river runs right through the road making it very dangerous for passengers at night; the banks descend abruptly to the depth of 15 feet; other dangerous places occur along the whole line of the road. The Waiwhetu and Second River Bridge have both been carried away. It is to be hoped that the Provincial authorities will lose no time in removing the large quantities of drift timber now lying on the roads, and in making it again passable.

A public meeting, called by notice posted in the most public places within the district, was held at the Hutt Mechanics' Institute last night (26 January 1858), to consider the best steps to be taken under the circumstances. About 200 people were present at one time during the evening. Mr Braithwaite was in the chair. Great regret was expressed at the non-attendance of any person to represent the Provincial Government. Mr Ludlam, as one of those who had signed the notice calling the meeting, opened the proceedings by explaining his objects in so doing. The following resolutions were unanimously carried, after considerable discussion, in which, besides the movers and seconders, Messrs Lynch, M'Hardie, M'Dowell, Corbett, W. Milne, Jillett, Renall, Bruce, and D. Hughey took part. The meeting ended at about eleven o'clock. Moved by Mr Ludlam, seconded by Mr Hart—That this meeting is of opinion that immediate and energetic action is required in order to repair the serious public damage done by the recent inundation of this valley, and in order to guard against the recurrence of the attendant calamities as far as human means can avail. Moved by Mr Wakefield, seconded by Mr Jillett:—That the following gentlemen be requested to form a committee for the purpose of communicating with the Government on the subject, and of obtaining accurate information as to the causes of the damage and means of remedy and of collecting subscriptions towards the necessary expenses, viz., Messrs Ludlam, Hart, Corbett, Phillips, Wilcock, David Hughey, Lynch, Mason and Wakefield.

Moved by Mr Hart, seconded by Mr Riddiford:—That the Committee be requested to open a separate subscription list for the purpose of relieving serious cases of private distress among the sufferers by the recent inundation.

An inquest was duly held upon the bodies of the decease dand a verdict of accidentally drowned was returned in respect of each person."

Description of the flood carried in the "New Zealand Spectator" shortly afterward. National Library of New Zealand.

Figure 9: The 1858 "Great Flood"

Most of these industries occupied the less badly flooded perimeter" area of Petone, however, despite the appalling drainage problems within the residential area of Petone, the population increased from 7,500 in 1881 to 20,000 by 1886.

The industrial entrepreneurs were attracted to the advantages Petone offered with its rail link, cheap flat land, abundant fresh water, and in the case of The Gear, the absence of neighbours to offend. Petone became the nation's industrial showpiece, although slum housing blighted the Borough and left a legacy which still remains. It was not until the mid-1890s that steps were taken to drain the land, to prevent regular flooding, and to control housing standards.

Lower Hutt Borough

In comparison to Petone the remainder of the Valley was an agricultural backwater. Lower Hutt was known mainly for its market gardens and recreational picnic areas. McNab's (Bellevue) and Mason's gardens were popular during the Victorian era when picnicking was fashionable. They provided an escape from the less attractive conditions of Wellington and Petone.

The Lower Hutt township had been settled in an unfortunate position. Being further up the valley, and with the river at a level close to its eastern flood plain, Lower Hutt experienced floods as a destructive, life threatening force, the river at times occupying the entire valley floor. Old river courses became active, flowing through Alicetown to the Dead Arm, from Boulcott into Okoutu Stream (Black Creek or The Second River) and from Taita to the Waiwhetu (The Third River). The velocity of the flood waters crossing the plains would have been dangerously high: there are frequent reports of streets being left rutted and impassable after floods had subsided. Large numbers of stock were lost, fences were ruined and thousands of cubic metres of gravel were dumped onto good pasture some distance from the river. Paddocks belonging to riparian owners could disappear overnight. Mr Speedy, a farmer in the Avalon area, lost 90 acres in the 1858 flood.

The Upper Valley

"The Upper Valley" was the general description given to the area north of Boulcott (the northern boundary of Lower Hutt Borough with Hutt County), which remained as remote forest and farm land until the 1900s. The reach from Boulcott to Silverstream was regarded as a natural extension of Lower Hutt and the need to control the river as far as the gorge was recognised from the time of the first Hutt River Board.

In Upper Hutt, north of Taita Gorge, river terraces tend to confine the river to the Western Hills, leaving the eastern side of the valley flood free. There are accounts of forestry workers being trapped in rising flood waters, and of stock losses and fence damage, but it was not until the 1940s that the pressure of development required the construction of publicly funded river control works.

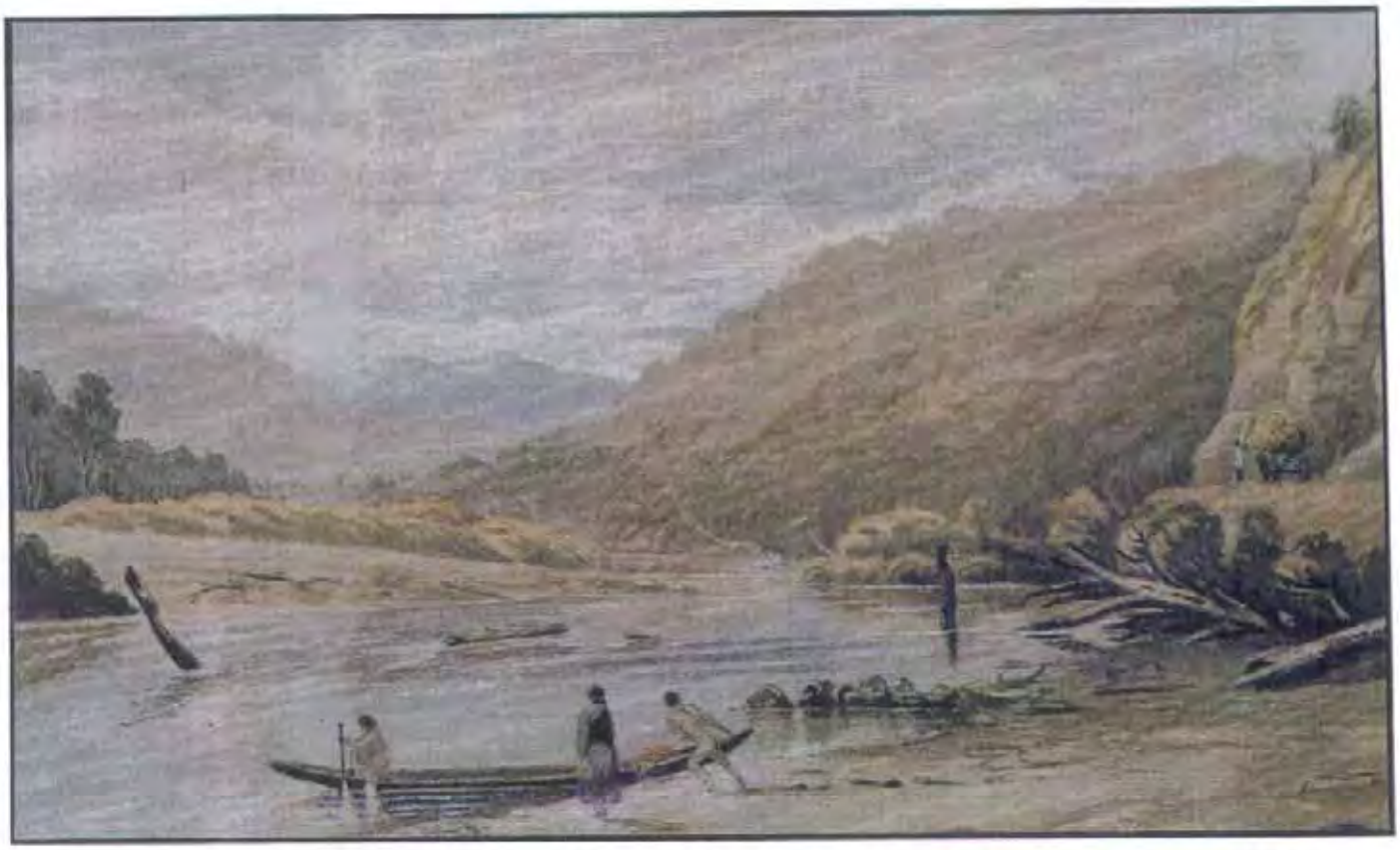


Plate 17 is a water colour by C C Clarke painted in the early 1850s and probably portrays a scene set downstream of the confluence with Stokes Valley Stream. Refer Alexander Turnbull Library Art Room No. B30/1.

Plate 18, the lower print, is described as a "view looking towards Wellington, from the Hutt Road, at the gorge separating the lower from the upper district" and was painted by Samuel Brees circa 1845. Refer Alexander Turnbull Library Art Room No. B31/29. This impression may show the headwaters of the "Third River", now the Waiwhetu Stream (also referred to as the Taita Overflow) as a major branch of the River, although it may only be the temporary bifurcation shown in plate 19. Most evidence points to the Waiwhetu originating from a bend in the vicinity of the Taita Hotel (extension of section 910).

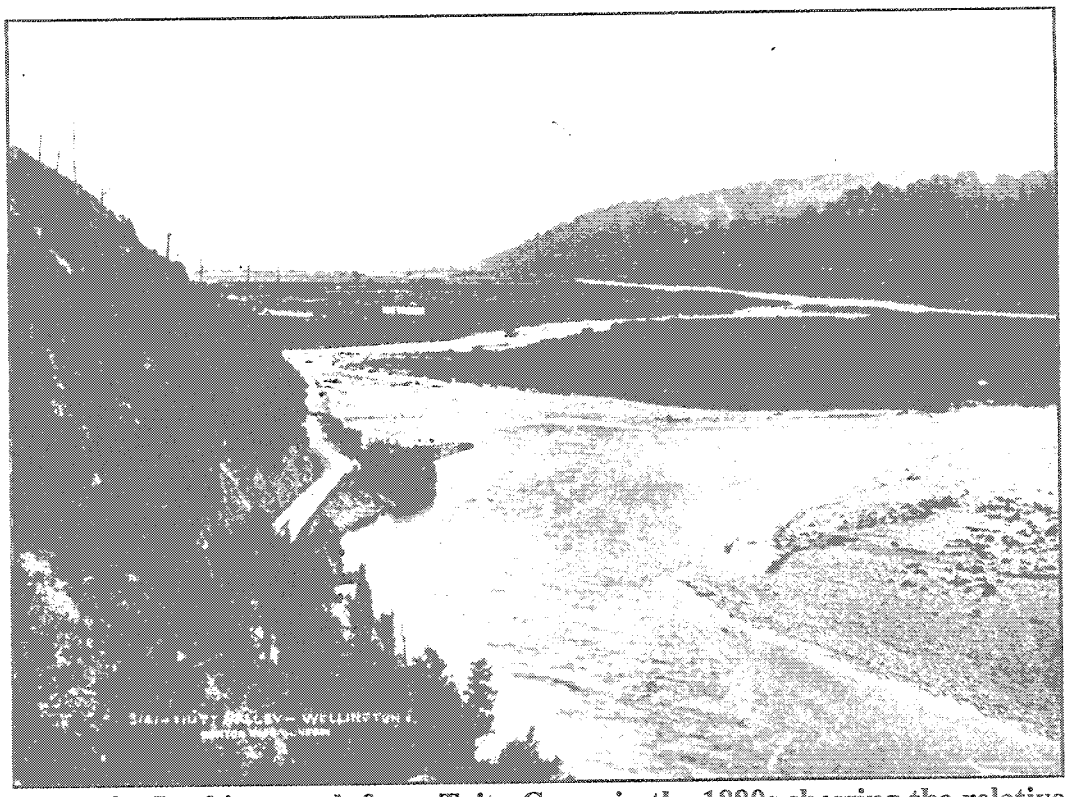


Plate 19: Looking south from Taita Gorge in the 1880s showing the relative levels of the riverbed and flood plain.
Source: Alexander Turnbull Library, Burton Bros, neg. GB3141

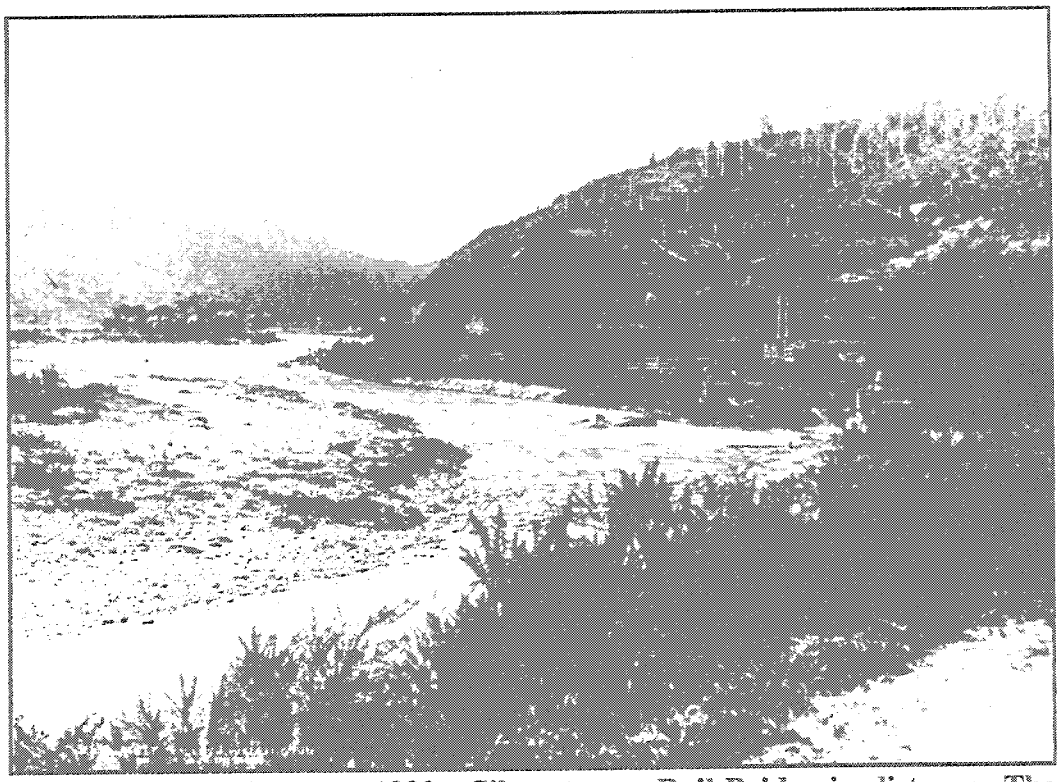


Plate 20: Taita Gorge c. 1880s. Silverstream Rail Bridge in distance. The view shows river works constructed by the first Hutt River Board for Hutt County. Source: Alexander Turnbull Library neg. GB3140

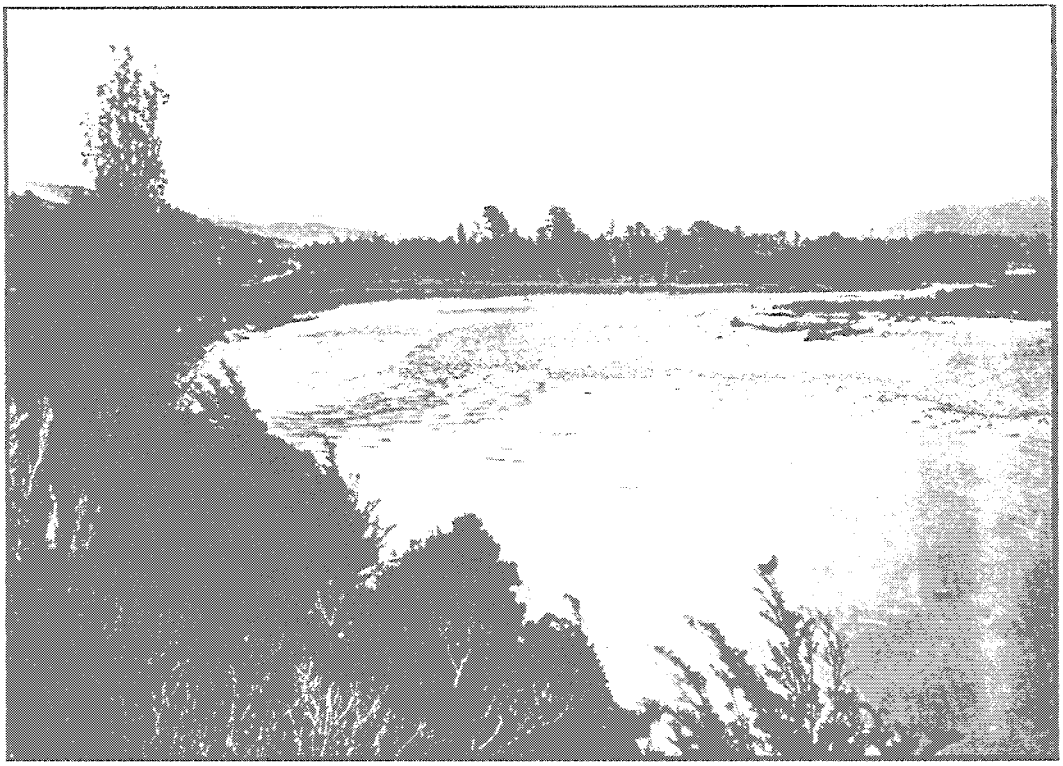


Plate 21: Looking south from the "Fern Ground" (Maoribank), 1876.
Source: Alexander Turnbull Library, James Bragge, neg F10845.

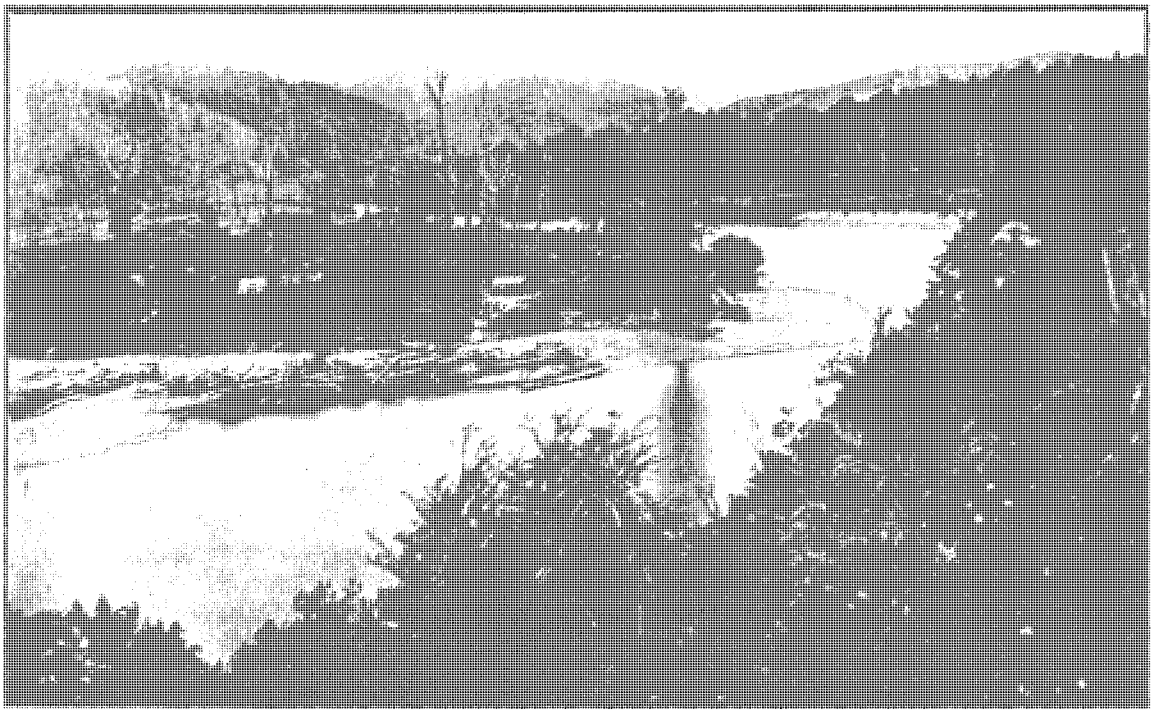


Plate 22: View north from the "Fern Ground" (Maoribank), 1876.
Source: Alexander Turnbull Library, James Bragge, neg F2660.

The pioneer families lived with the river [refer to the McCurdy Collection at the ATL] and constructed isolated works to protect their lands. There was no attempt by the community to manage the upper river until 1960 [refer to chapters 7 and 8]. The following pages contain a number of prints of the "The Upper Valley" (below the Taita Gorge), of the Gorge itself, and of Upper Hutt.

First Attempts at Control

The 1860s appear to have produced few large floods, although the regular winter floods continued. In March 1871 a flood caused a log jam on the Hutt Bridge, isolating the Aglionby Arms Hotel situated to the southwest. The flood swept away part of the bridge and during the construction of its replacement (the Fourth Hutt Bridge) three heavy floods swept away materials, equipment and construction plant. As part of the bridge construction contract, the builder erected five shingle filled timber groynes, but within months these had shifted out of position and required repair.

Throughout the 1870s the frequent flooding was of serious concern to residents. After two "old man" floods inundated the valley in 1878 the first Hutt River Board was formed on 12 November 1879. This Board is recorded as ineffectual, although it carried out work which reduced the frequent damage caused to the Hutt Bridge and its approaches. It was founded at the start of the great 1880s depression and had little power to raise money other than by rating, a difficult task from absentee landlords. From the Board minutes it appears it also lacked a mandate from resident owners to engage in substantial works. Directing public concern to the support of public works was not easy, despite tragic events such as the flood of March 1880 when a child was swept to his death in a heavy flood that spilled out over many fields. A mix of poverty, lack of political power, and settler individualism, led to an apathy for public affairs. The Hutt River Board was only one of many authorities hampered by lack of financial and ratepayer support, even when the benefits to be gained from modest expenditure were obviously high. Petone Borough ratepayers, for example, repeatedly failed to support loan polls to relieve the severe annual flooding of the Borough.

Spring rains of 1887 brought a large flood, and another occurred in 1893, large enough to make it difficult for Hutt residents to commute to Wellington. This flood inundated all but the few Petone Borough properties on high ground. The property of Petone Mayor R C Kirk flooded to the height of the boundary fence and it was he who pressed the Council "for security in the shape of a stopbank." In August of the same year the lower valley was again "a desolate scene with vast sheets of water covering paddock after paddock." From *Petone: A History*, Susan Butterworth.

Efforts were made by Petone to combine with Lower Hutt Borough in the construction of an embankment to protect Petone and the Lower Hutt suburb of Alicetown (at this time as many Lower Hutt ratepayers lived on the western bank as did on the eastern bank). The political will and financial backing could not be found within Lower Hutt to support the proposals and in 1893 Petone proceeded to protect its own territory. The reasons behind Petone's unilateral action are not clear but it may have been because Petone was not prepared to be involved in flood control works on the eastern bank which might have led to higher flood levels in Petone. Lower Hutt Borough politics may not have been able to support a project that would only benefit western bank

ratepayers. Possibly the politics of land ownership and class prejudice (Petone was seen as a lower class area by Lower Hutt) led to the Borough separatism, as occurred with the 1905 replacement of the Fourth Hutt Bridge and other proposed joint venture projects.

Although the "Petone" stopbank, built in 1894, was not the first river control work in the valley, nonetheless it must have demonstrated how easy it was to obtain some relief from the flooding nuisance. There is little detail on the construction and funding of this bank which ran from the Hutt Road/Wakefield Street intersection to skirt the Recreation Ground and then to tie in with the old foreshore sand and gravel bank at Kensington Street (see figure 10, p. 43).

A number of river control works were carried out during this period, mainly associated with the development of the valley's transport infrastructure, the closure of old river channels, or the protection of isolated assets [refer Archive Table 4, p. 44]. Most of the works were minor, isolated works and did not conform to a comprehensive scheme or concept of river management. For example, in 1895 the Lower Hutt Borough Council erected breakwaters to protect school property (below the Hutt Bridge) from heavy erosion.

In February 1896 the stability of the Hutt Bridge was again threatened by the immense amount of timber brought down by flood waters. The 1896 flood was the first to follow construction of the Petone Stopbank. Alicetown is reported to have suffered as a result of the embankment. During this and subsequent floods:

> .... *Alicetown residents, armed with picks and shovels, attempted to break down the bank so that the water could take its old course through Petone. To combat this Petone organised a patrol, and when a flood was signalled by the ringing of a bell, the patrol took up its duties of doing sentry-go along the length of the bank. Sentry boxes were erected for their protection.* from *Petone: A History*, Susan Butterworth, p. 127, from *Petone's First Hundred Years*, W B Nicholson ed., 1940.

In 1898 two great floods filled the entire valley floor. The larger, on 17 June, was described as the greatest flood for 40 years. Water was knee deep in the town and trapped dancers at the Oddfellows Hall, forcing them to spend the evening on the stage. A great deal of damage was done in Lower Hutt's renowned McNab's Gardens (later Bellevue) flooding the house and covering the gardens with a sea of mud. At the peak the waters were 9 inches below the decking of the Fourth Hutt Bridge. The 1898 flood has been captured on a panorama of Alicetown and Lower Hutt, and is reproduced as plate 26 (p. 45). To the left of the photograph and in the far distance can be seen the "Boulcott Overflow" in heavy flood. In the centre right is the high land to which the original Cornish settlers moved after the flooding in the early 1840s (Cornish Row). In the centre is Railway Avenue. The Fourth Hutt Bridge is obscured by the trees surrounding the cemetery at the corner of Bridge and Marsden Streets.

Following a repeat flood in November, with dancers again being trapped in the Oddfellows Hall, (plate 25, p. 44) a new River Board was elected, replacing the first Hutt River Board which had not met since 1881.

Within 8 years the new Board commissioned works which effectively freed the lower valley from flooding.

Plate 25 shows the flood waters receding after the 1904 flood, a relatively small event probably a quarter of the volume of the 1898 floods. By 1904 the stopbank construction on the eastern bank was largely complete, however, a portion of the works had been postponed pending the construction of the replacement Hutt Bridge. In the previous "old man" floods High Street had been submerged by up to 1.2 m and was left rutted and scoured.

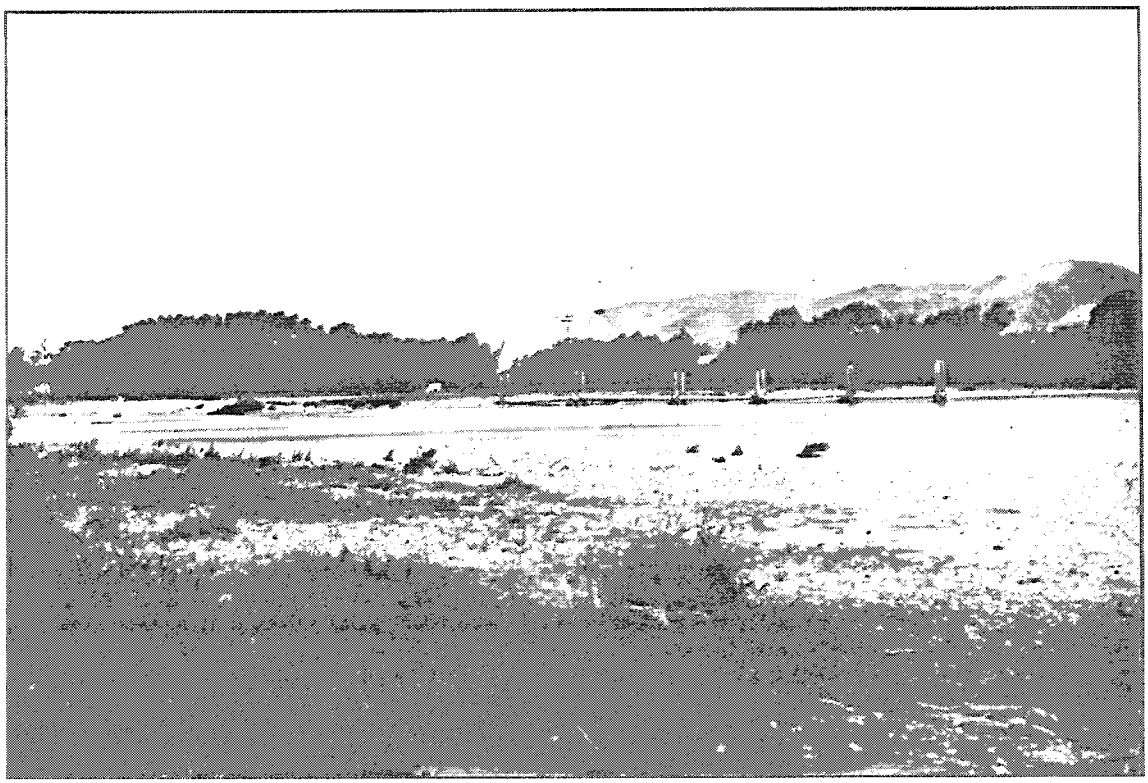


Plate 23: Floating Boom Groyne, Lower Hutt, c. 1870s. Source: Alexander Turnbull Library, Davis col., neg. F52877.

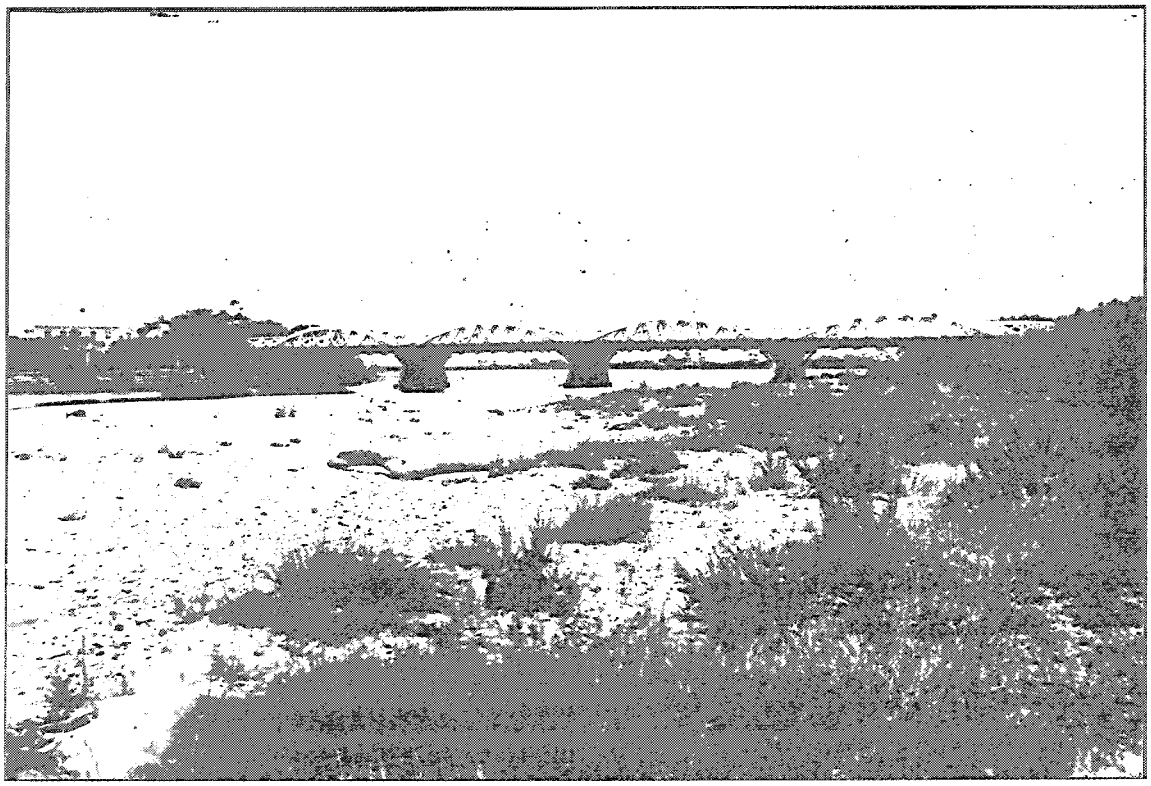


Plate 24: Fourth Hutt Bridge c. 1880s showing timber groynes (see also plate 15).
Source: Alexander Turnbull Library, Davis col., neg. F52879.

The 1894 stopbank ran from the intersection of Hutt Road and Wakefield Street, east along Wakefield Street for about 50 m then ESE for 400 m to Udy Street at the Petone Recreation Ground; along Udy Street 165 m to Kensington Street; south down Kensington Street 340 m to Huia Street; through the properties on the north side of Huia Street and the south side of Emerson Street to Hardham Street and the Western Arm of the Hutt River; south for 200 m to the intersection of Hardham Street and Heretaunga Street.

The section from Kensington Street to the Te Mome Drain made use of a natural gravel ridge which ran parallel to the foreshore about 150-200 m north of Jackson Street. The ridge is identified as a storm beach ridge formed over 2000 years ago. The section of stopbank from Udy Street to the ridge crosses a general depression that extends from the Hutt Road to the western arm with its northern boundary roughly outlined by Wakefield Street and the Wairarapa Railway Line.

Figure 10: 1894 Petone Stopbank

Plate 25: High Street, Lower Hutt, 1904. Source: From a "newspaper cutting", neg. held by the War Memorial Library, Hutt City.

River Works 1840 to 1900

(Abbreviations refer to Archive Table 2, p. 7)

B1: 1851: HRBSSP21: 250-330
Plan showing old course of river at Alicetown.

B2: 1874-75: OAV
Construction of the Western Railway, Melling to Silverstream: the contractor found that there was little flat land between the river and the hills. Fill disappeared with frightening speed. Where it was impossible to use fill concrete walls were erected and the river was diverted with several thousand sand bags.

B3: 12 Sep 1879: HRBminutes
Hutt Bridge protective works. Four separate contracts let during September & October, for £311, to protect the Hutt Bridge.

B4:18 Feb 1880: HRBminutes
Tenders called to extend the "floating dam" above the Hutt Bridge; (to control floating debris).

B5: 3 Mar 1880: HRBminutes: 840
Breakwater constructed at "Taita", value £79. Additional £21 paid to contractor for the construction of a floating dam at Clay Point - Mason's property, Taita (Tennyson Ave/Mabey Road area).

B6: 2 Mar 1881: HRBminutes: 1200-1240
Bank protection Taita Gorge, value £20.

B7: 2 Apr 1881: HRBminutes
Hutt Bridge protective works - Engineer instructed to lower logs in floating dam.

B8: by 1890: OAV
Milling of timber moved from the valley to the hills. The river deposited vast quantities of soil and shingle along the lower banks and the mouth.

Archive Table 4: River Works 1840 to 1900.

Plate 26: 1898 Flood, Lower Hutt. Source: Lower Hutt Memorial Library

Chapter Three

THE FIRST SCHEME Flood Control for the "lower" Hutt Valley

1900-1924

The first Hutt River Board was responsible for a number of small protective works and was successful in maintaining the security of the Fourth Hutt Bridge, built in 1872 and lasting 32 years (plate 24). It also constructed an embankment and breakwater in the Taita area (of unknown size and position) and provided grant assistance to a number of property owners to build their own minor works.

Although the Board consisted of capable local politicians, it was unable to come to grips with the major problem of widespread flooding. The reasons for its failure to promote effective flood control works are not easily identified. Contemporary accounts of local authority activities indicate that community commitment was often lacking, due to divergent objectives and insufficient financial resources. In 1883 the First Board went into abeyance, providing only minor grant assistance in 1885 before going into permanent recess in 1887.

The Second River Board enjoyed the full support of the residents of Lower Hutt Borough, being formed on 14 February 1899 at the end of a decade of phenomenal flooding. Quoting from the Hutt and Petone Chronicle of 22 June 1898:

> *We do not for a moment suggest that a perfect remedy is at present possible, but what we are certain of is that a scheme of river conservation unselfishly pursued would make the Hutt Valley the garden of New Zealand.* (from *Once Upon a Village*, David P Millar, p. 108)

Not surprisingly Petone residents felt disinclined to contribute to the new authority, despite this call, and Petone continued to remain outside the rating district until 1940.

For the period 1900-1945 the Hutt River Board principally pursued the interests of Lower Hutt Borough and the river was effectively managed for the benefit of this community.

The First Scheme of Works

In 1899 the Hutt River Board sought the assistance of the engineering partnership of Meason and Marchant to devise a scheme for the protection of Lower Hutt Borough. The firm was experienced in the design and construction of successful river control works for the Geraldine and Levels County Councils (South Island). Funds for stopbank construction were offered by private companies but the Board declined these offers in favour of raising an inscribed loan of £18,000.

Mr G Laing-Meason, a senior partner of Meason and Marchant, considered a number of options, including dredging the main channel and the construction of overflow banks and weirs, before recommending that the river be lined with embankments, complete with coffer dam work, concrete culverts and flap valves for land drainage.

> *The approaches to the Hutt Bridge they thought should be faced with sheet piling. The then present bridge did not allow a maximum flood through, being far too low and as its condition was decidedly bad, they recommended the construction of a new and wider bridge. The estimate for the flood control work was £13,900 ($(1990)1,600,000).*
>
> *The next problem was money. A deputation went to (Prime Minister) Seddon to ask for financial help, claiming the cause of flooding lay with the felling of forests and the erection of bridges north of the River Board District. Seddon declined on the grounds that public money used on such a construction would result in the increase of land values, an increase from which only the Hutt would benefit. In this he was proved correct.*
>
> *The Board proceeded to rate the district according to the liability of land to suffer flooding. The heaviest rate was to be paid by those with lands "liable to great actual damage", and a moderate rate by those with "lands indirectly liable to damage". The rates were levied to pay the interest on the loan of £18,000 the Board had been authorised to raise.* (From *Once Upon A Village* David P Millar, pp. 109-110)

Archive Table 6, p. 53, backgrounds the rating systems used by the Hutt River Board. Figure 11, p. 52, shows the changes to the rating district between 1900 and 1972, when rating was changed to a regional basis.

There was considerable opposition to the River Board and its proposals. The Ratepayers' Protective Association challenged the Board's validity in the Supreme Court, delaying the classification of the district. Legal action was also threatened by the Gear Meat Company, representing the concerns of the people of Petone. It was feared that the proposed eastern stopbank would result in higher flood levels rising against the Petone stopbank. Consideration was given to terminate the works at Whites Line with the banks returning to higher ground along this road. Proposals were also prepared for the stopbanks to follow their present alignment through Gear Island, but these were initially rejected as they increased the cost from £18,000 to £21,000. Only continued pressure and the threat of legal action from the Petone area led to the later (1906) construction of a new stopbank through Gear Island.

Once agreement on the scheme alignment had been reached delays were encountered with the replacement of the Fourth Bridge. Final agreement on the waterway and position of the Fifth Hutt Bridge led to local increases in stopbank height of 3 ft (900 mm) to allow for heading associated with the undersize waterway. Further details of the Scheme of Works are contained in Archive Table 5 below and in the following project reports contained in Part Two of this history.

Project Report 1: Scheme for Conserving the Hutt River. 1900-1904. Stopbanking works from the river mouth to Boulcott, on the eastern bank, and from the Petone Stopbank to Melling on the western bank.

Project Report 2: Gear Island Stopbank. 1906. Stopbank from Whites Line (west) to Waione Street along the eastern side of Gear Island.

Scheme for Conserving the Hutt River

(Abbreviations refer to Archive Table 2, p. 7)

C1: 15 Jun 1899: HRBminutes
Meason and Marchant tender of £75 to survey (lower) Hutt River accepted. Leslie Reynolds' tender £131.5.0

C2: 20 Aug 1899: HRBminutes
Rate Payers Protective Assn challenged validity of HRB in Supreme Court. Classification of district (for rating) rescinded for second time as due process of tendering for a Classifier had not been followed. Royalty on river metal considered for the first time. Plans received from Meason and Marchant.

C3: 7 Nov 1899: HRBminutes
Arrangements made to survey land required for stopbank - preliminary to entering into negotiations for purchase.

C4: 14 Dec 1899: HRBminutes
Laing-Meason's scheme adopted. Plans and engineer's report circulated to all ratepayers. Meeting of ratepayers 21/12/99 approved scheme.

C5: 11 Jan 1900: HRBminutes
Mr Laing-Meason instructed to take measurement "at not less than three points, above the point of overflow" [undefined] to verify his estimate of the volume of water to be provided for in stopbank scheme. Deputation to government for new bridge.

C6: 8 Feb 1900: HRBminutes
Gear Meat hold HRB responsible for damage Gear Meat might sustain as a result of construction of new stopbank west of Gear Island.

C7: 8 Mar 1900: HRBminutes
Chairman again asks Laing-Meason to confirm that adequate provision has been made for protection south of "ridge" on Mudgeway's land and Gear Meat property in Section 10.

C8: 13 Mar 1900: HRBminutes
Meason and Marchant considered the Petone Stopbank high enough. Estimate that cost of works to protect Petone stopbank against erosion greater than £250. Laing-Meason to report on relocation of proposed stopbank alignment to east side of Gear Island rather than through Mudgeways - HRB think new alignment will silence opposition.

C9: 3 Apr 1900: HRBminutes
Report from Engineer on realignment at Gear Island. Motion to extend scheme to include this work at a total cost of £21,000 lost in favour of calling a poll for a loan of £18,000 to cover works with the western bank finishing at the Petone Stopbank (and to cover land purchase, compensation, and engineering fees).

C10: 7 Jun 1900: HRBminutes
Offers from various brokers in Wellington to provide loan monies. Declined in favour of an inscribed loan under the terms of the "Government Loans To Local Bodies Act". Meason and Marchant to proceed with detailed survey.

C11: 1 Aug 1900: HRBminutes
Option to terminate scheme at Whites Line - to avoid difficulty with land purchase - discussed.

C12: 8 Nov 1900: HRBminutes
PWD Engineer-in-Chief approves works.

C13: 17 Jan 1901: HRBminutes
Engineer recommends to raise stopbanks at the Hutt Bridge by 3 ft to allow for (hydraulic) choke. Recommends that new Hutt Bridge construction and stopbank construction be coordinated.

C14: 1901-03: HRBminutes
Construction of the Hutt River Board's first stopbanks under the 1899 "Scheme for Conserving the Hutt River". Stopbanks ran from Boulcott Golf Course to Seaview Road on the left bank, and from the Melling Bridge to the Ava Bridge on the right bank. (All place names in present day terms).

C15: 8 May 1902: HRBminutes
Observation recorded that the concrete wall north of the Hutt Bridge is constructed across an old pond.

C16: 30 Apr 1903: HRBminutes
Engineer's report on extension of District circulated to ratepayers.

C17: 1906: HRBminutes
Extension (and completion) of stopbanking scheme from Ava Bridge to Jackson Street on the right (western) bank.

C18: 17 Jan 1907: HRBminutes
Cross sections supplied to Wellington City Engineer for use in design of the new Pipe Bridge (at the Estuary).

Archive Table 5: Scheme for Conserving the Hutt River 1899-1907

Plate 28: Construction of the first stopbanks - the borrow pit. Source: Alexander Turnbull Library, York studios, neg. F28348

Construction of the "Scheme for Conserving The Hutt River" 1901-1903. The stopbanks were constructed using shingle loaded by hand into half cubic yard trays (0.45 cu.m.) from selected river deposits. Compaction was achieved by directing the loaded drays along the embankments. The drays were unloaded using a steam powered crane and the shingle was spread by hand and horse drawn levelling bars. See also the Report rear cover for other photographs in this series.

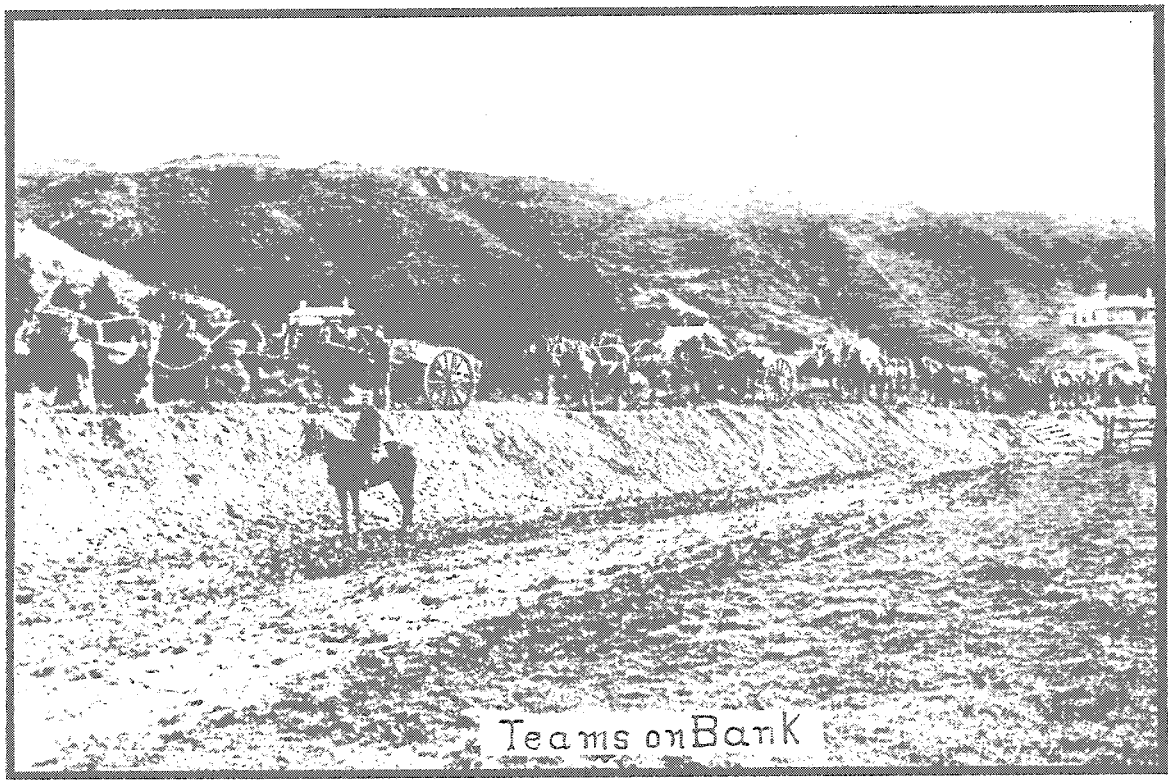


Plate 27: Construction of the first stopbanks - compaction. Source: Alexander Turnbull Library, York Studios, neg. F28346

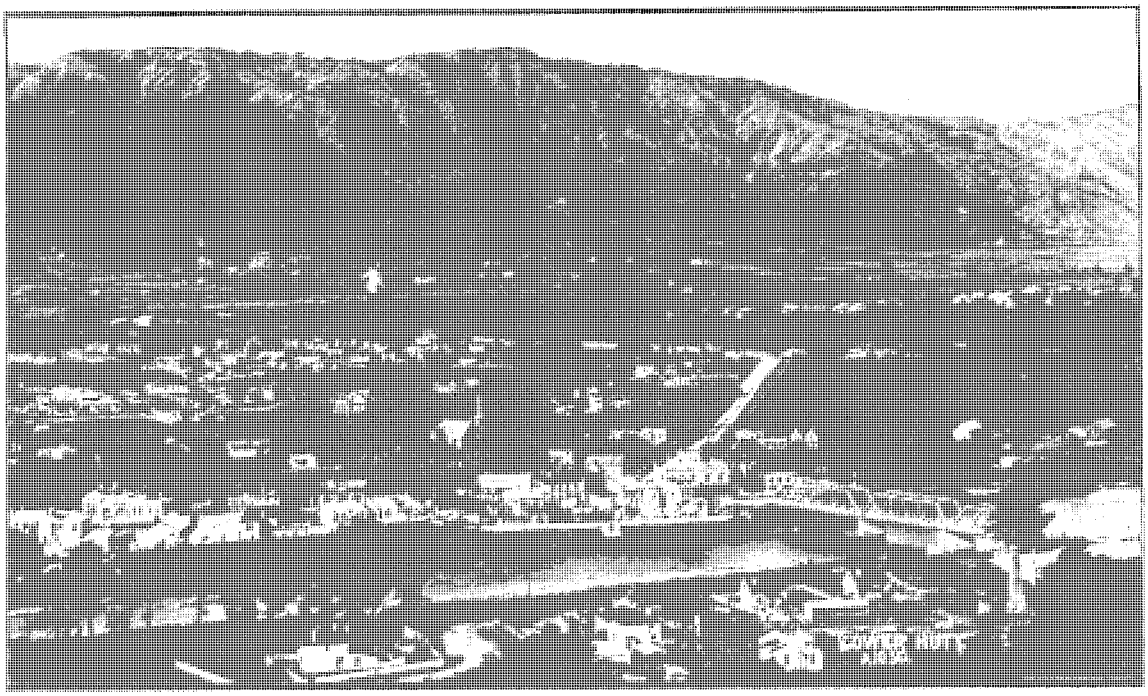


Plate 29: Lower Hutt c. 1907
Source: National Museum, neg. B16526

Plates 29 and 30 show the stopbanks not long after their construction. In Plate 29 notice the undeveloped Strand Park, and the Waiwhetu farmlands in the background. This low-lying area or "Third River" is recorded as taking overflows from the Taita area during the large floods of the 1800s. In plate 30 the dark line across Strand Park and Gear Island shows the position of the river in the 1870s.

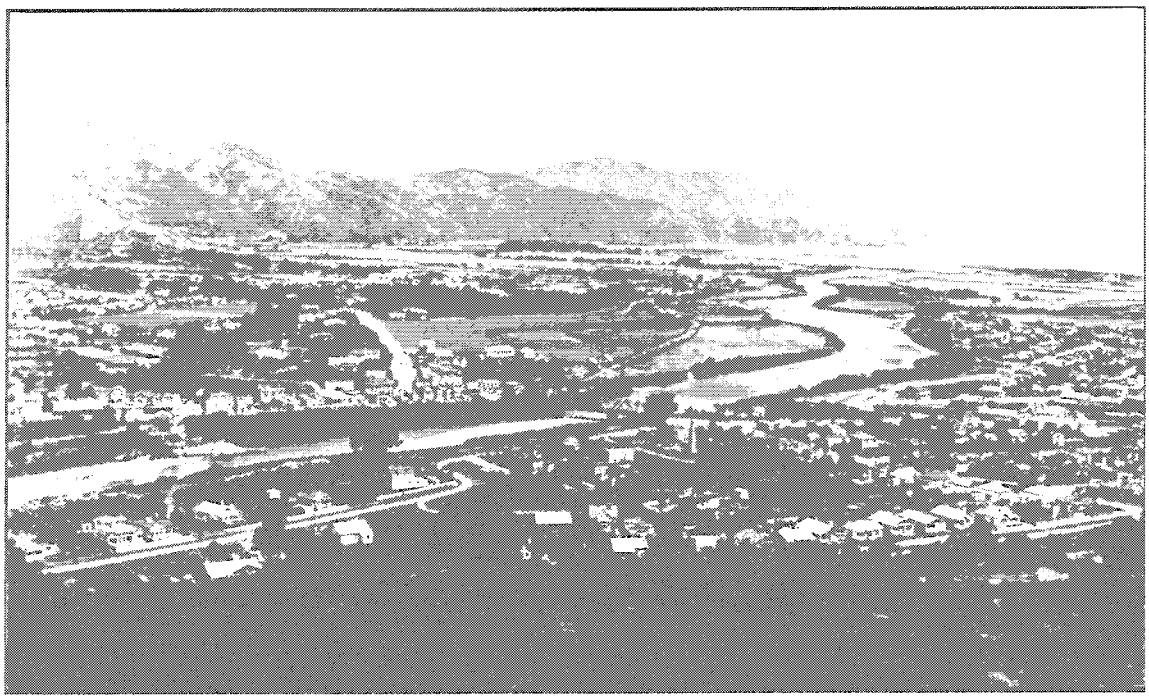


Plate 30: Lower Hutt c. 1920.
Source: Alexander Turnbull Library, W.Thorley col., neg F70101

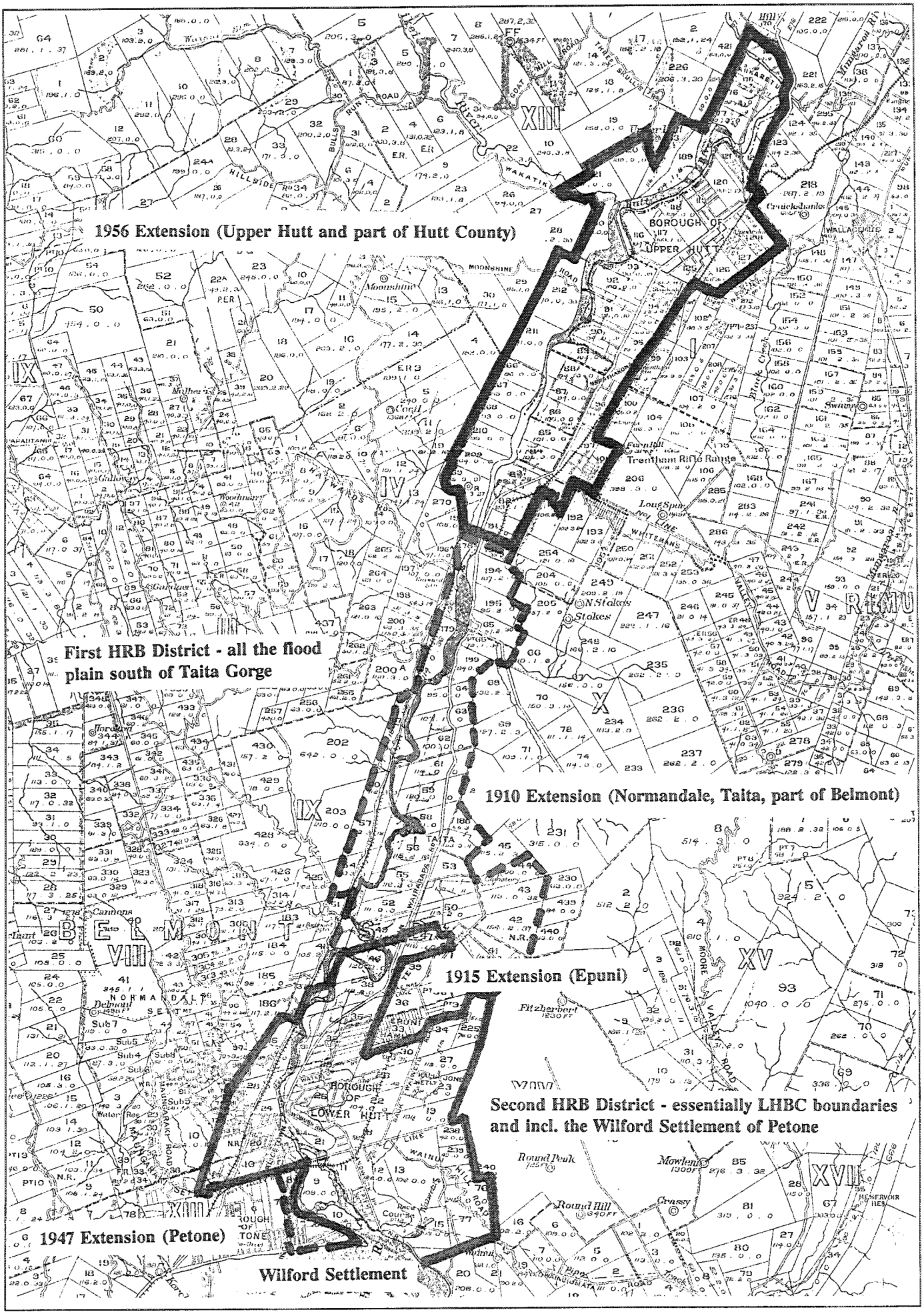


Figure 11: Hutt River District Boundaries. Source: 1954 Extension Proposals SSPHRB8

THE HUTT RIVER BOARD DISTRICT

The first Hutt River Board was established in 1878 under the Rivers District Ordinance of the Wellington Provincial Council.

At the expiry of the Board's first term in office in 1885 the Board's affairs were effectively in abeyance through lack of ratepayer interest and support (population of Lower Hutt less than 1000). No election was held as the elected Board could continue in office and its operations continue under the provisions of the River Boards Act of 1884. The Board went into permanent recess in 1887.

The **First River District** included all the area to Silverstream with the exception of the hill sections of Normandale and Belmont and the areas adjacent to Epuni.

The **Second River District** was constituted on the 14 February 1899 and included only the Lower Hutt Borough, with the exception of the Normandale area and the area around Epuni. At this stage the northern Lower Hutt boundary with Hutt County crossed the valley near Park Road but did not include the Belmont area on the western side of the river, from about the present position of the Firth plant northwards.

As a result of a petition in 1910, the district was extended to include the Normandale area, the Taita area (including the gorge) and part of Belmont. In 1915 the River Board sought the inclusion of Epuni and Petone, however only Epuni was included at that time. Petone remained outside the area until a further, successful petition by the Board in 1947.

The Hutt River Board requested the Local Government Commission to order the extension of the district to include the upper valley in 1955 and an Order In Council to that effect was subsequently issued in March 1956. The extension was at the request of the Upper Hutt Borough Council and Hutt County Council, and allowed for a Board consisting of nine members; five representing the Lower Hutt subdivision, two representing the Petone subdivision and two, the Upper Hutt subdivision. Prior to this date the Board had consisted of six members; two from the Petone subdivision and four from the remainder of the River District.

RATING/REVENUE

Until about 1921 the Hutt River Board rated under a classification system based on three classes of flood risk, derived essentially from an interpretation of contour information.

In about 1921 permission was given by the Minister of Internal Affairs, pursuant to provisions of section 9 of the River Boards Amendment Act 1913, to rate on a uniform scale without classification. In 1922 this rate was 3/20 of 1 penny per pound capital value.

By 1948 the general rate was 85/1000 of 1 penny per pound capital value, but by this time three additional classes of special rates were levied.

The additional rates were collected to reflect benefit from the 1950s scheme upgrading and were:

Class One 21/1000 of 1 penny per pound
Class Two 14/1000 of 1 penny per pound
Class Three 7/1000 of 1 penny per pound

Upon the inclusion of the upper valley into the district the Department of Internal Affairs was of the opinion that the Board were incorrectly relying on the 1921 proviso as a perpetual authority to levy rates. The Department considered that the rating approval should have been given annually. As a consequence the Board instructed its legal advisers to draft a local bill which was subsequently passed as the Hutt River Empowering Act, 1957 (Local No. 8). Section three of that Act authorised the Board to make and levy a special rate where a loan was raised for the benefit of part of the district; being a uniform rate on that part of the district benefitting. This rating process continued until the Hutt River Board functions were taken over by the Wellington Regional Water Board in 1973.

From 1973 funding for river works was obtained as part of the Water Board levy on the constituent Local Authorities. From 1980 funding has been from Wellington Regional Council general rating.

Substantial Government subsidies administered by the Soil Conservation and Rivers Control Council have been granted for Hutt River control works.

Government support for river control works commenced in 1956 with 50 percent subsidies on the Major Scheme works in Lower and Upper Hutt. Subsidies of from 30-66 percent were given for various parts of the scheme. Government support also extended to the general area of catchment resources management, and is continuing for flood plain management studies. Since 1986 subsidy support for new works has been gradually phased out as it is directly linked to the size of a Region's rating base which, for the Hutt Valley, is large by New Zealand standards.

Archive Table 6: The Hutt River Board Rating District.

Commissioning of the First Scheme

The construction of the stopbanks defined for the first time a River Zone. The Hutt River Board of Conservators now had to face the real challenge of containing the river within this zone, a challenge which they failed to meet, leading to the resignation of the Board's chairmen in 1912, 1920 and 1923.

From early engineering correspondence it is clear that Board members did not appreciate the consequences of confining a large, steep river. Although their Engineer called for a scheme of river management, their experience related principally to flooding - now presumably solved by the stopbanks. They had no call to closely observe the processes of bed erosion and deposition, and there is no record of discussion of the major problems to be anticipated following the confinement of the flood flows. Some of the members must have been aware of the power of the river to erode large areas of land overnight, but they appear to have remained silent.

Although the Hutt River had a history of widespread flooding, its course was relatively stable - it was not a wide braided river subject to wild fluctuations. The stability was almost certainly due to the relief provided by the Boulcott and Taita overflow channels. As flood volumes increased, water spilled across the plains into the "Second" (Okoutu) and "Third" (Waiwhetu) rivers. This reduced the flood flows in the central channel, reduced flood levels and the depth of flood flows.

The direct consequence of closing the overflow routes was to significantly change the scour and deposition processes within the central channel. Flood flow velocities and depths were increased by up to 50 percent; in terms of bed load transport, increasing the potential to scour and redeposit bed material by perhaps 300 to 500 percent.

The first 20 years of river management involved much trial and error, and effective management techniques for the development and control of the central channel were not established until 1924. A further 20 years of experimentation were required before the channel in the lower valley approximated a satisfactory alignment. During this period maintenance expenditure reached almost 10 times the cost of the original capital works.

Tables I and II, "River Works Expenditure 1907-1990", p. 58, have been prepared from the Hutt River Board Statement of Accounts to illustrate the expenditure required to establish the initial scheme works, and later to extend and upgrade the scheme. The level of debt carried by 1921 is indicative of the problems encountered during the early years.

River Management 1900-1924

1900 to 1924 were formative years for the Hutt River Board. The construction and commissioning of the first scheme of works developed the policies and practices which the Board followed until its demise in 1972. The initial heavy burden of debt accrued in the first two decades also left a lasting conservatism, reflected in the cautious attitude taken towards the extension of the Scheme in the 1950s.

River alignment works, the development of Gear Island, the establishment of a river extraction industry, and the removal of forest debris were the major projects to occupy the Board. A summary of the river works undertaken during the 1900-1924 period is contained in Archive Table 7, Rivers Control 1900-1924, p. 59. These included the construction of heavy timber groynes, railway iron breastwork, boulder filled netting weirs and groynes, and the establishment of willow plantations. Most of the works were constructed to Laing-Meason's 1902 specification for the scheme of management and to his specifications for additional works required after the large floods of 1913 and 1915. Examples of this work are still in evidence in the lower river.

It is only possible to guess at the scope of much of this work. The period 1900-1924 is poorly recorded, the only source of information being the Hutt River Board Minute Papers. The few detailed engineering files that have been retained are those of Laing-Meason's successor, Hubert Sladden of the Seaton, Sladden and Pavitt partnership. Although these do not start until 1924, limited references to the 1900-1924 period and some original documents are included. These references can be assumed to be accurate as H Sladden was an engineering cadet with Laing-Meason. Sladden had also been appointed as stand-in during Laing-Meason's illness before the Engineer's death in 1924 and was appointed as Engineer shortly thereafter.

The full extent of ongoing management services provided by Laing-Meason are not recorded, although the Hutt River Board Minute papers of 6 November 1902 note that he was required to formulate a scheme for the maintenance of the works. His report apparently included recommendations for the River District to be extended from the Borough boundary to the Taita Gorge. This illustrates his appreciation of the need to manage the overall river alignment and shingle resource, and of the continuing threat posed to Lower Hutt Borough by the Taita and Pomare overflows.

From 1899 to 1911 Laing-Meason was in regular attendance at the Board meetings and was presumably responsible for the management and maintenance of the scheme. Political changes between 1911 and 1912 led the Board to dispense with the services of the Engineer and Solicitor, with Board members taking over the direct operation of the Scheme. The changes in Board membership resulted in the resignation of the Chairman in May 1912, along with a disclaimer of responsibility from Laing-Meason. Laing-Meason continued to be requested to provide advice on specific issues but was not involved in the general operation or development of the Scheme. In 1922 Laing-Meason once again became a regular advisor following a further change in Board membership, and the failure of the Board's dredging enterprise (refer chapter 4).

The other major projects to occupy the Board prior to 1924 were development of Gear Island, establishment of a river shingle extraction industry, and removal of forest debris.

The "delogging" of the river, as the removal of the forest debris was termed, was an ongoing operation which lasted well into the 1930s. Throughout the latter half of the 19th century settlers had used the river as a dumping ground for unwanted forest clearance waste. By the turn of the century the bed was littered with large logs buried within the vast accumulation of shingle and erosion deposits. Many of the logs were large enough to divert the central channel flow and to trigger the deposition of flood borne debris. With each large flood the logs, silt, and shingle were repositioned and the

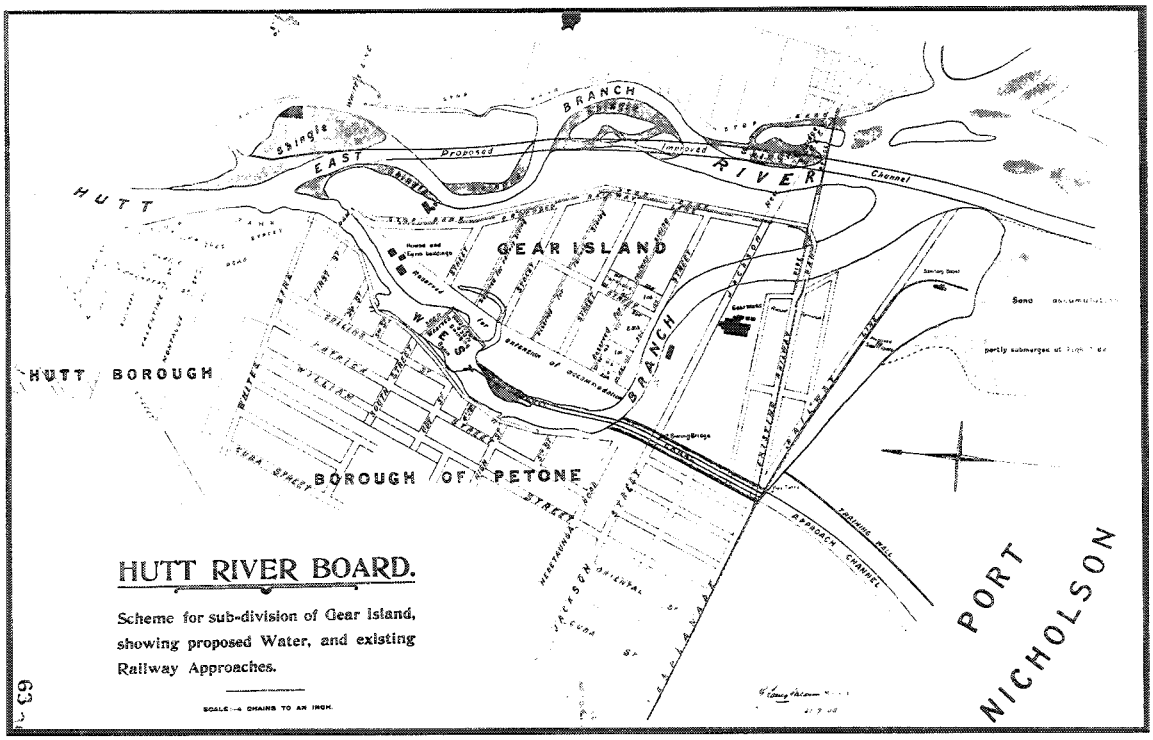


Plate 31: Gear Island Proposals 1913
Source: Wellington Maritime Museum neg. 6623

central channel alignment altered. To achieve Laing-Meason's "Ultimate Channel Alignment", the central feature of the 1902 Scheme of Management, it was necessary to remove the forest debris. Delogging the river was a major item of Board expenditure throughout the first 20 years, and continued with the removal of the fossilized forest remnants that were exposed as the bed levels dropped and the river cut into the deposits laid down during the post-glacial period.

The establishment of the shingle industry marked the turning point in the development of a controllable central channel alignment. The shingle business is the major concern recorded in the Board Minutes for the 1910-1920 period as the Board struggled to control the moving shingle deposits. Thereafter the business provided the bulk of the Board's income until the involvement of central Government in the 1940s. A discussion of the development of the shingle extraction industry is the subject of chapter 4. The business was pivotal to the establishment of the central channel alignment and to the fortunes of the Hutt River Board and the residents of the Lower Valley.

For an account of the debate which followed the development of Gear Island the reader is referred to *Petone: A History* by Susan Butterworth. Plate 31 shows one Hutt River Board scheme for the area. The Board investigated the development of a Hutt Valley port on a number of occasions in an attempt to stimulate growth in the Hutt Valley and to earn revenue. The proposals were abandoned at each attempt as the anticipated trade volumes could not support the capital outlay.

Tables I and II : River Works Expenditure 1907-1990

Year to 31/3/**	Total An. Expend. Works, Invest. & Admin	Works & Maint. Works on Revenue	Loan Works Works on Loan	Rates Income River rates HRB district	Value of Assets Nett total incl. land	Value of land Land holdings	Public Debt Value of outstanding loans	Consumer Price Index	Const. Cost Index
All Values expressed as Pounds Sterling									
1907	4974	670	3800	500	-3860	5611	35,712	235	
Public debt comprised 18,000 for the original scheme works, 1,800 as 10% additional thereto, followed by 15,000 + 1,500 for extension of the works within the district, for compensation, for land purchase, and for the construction of initial protection and training works.									
1908	5946	1040	4350	718	-2054	5611	40,872	235	
1909	2975	1175	1232	543	1584	5766	46,035	232	
Loan of 10,000 raised for additional costs relating to the initial scheme works.									
1910	2326	722	1045	733	1924	6688	47,563	234	
1911	1708	700	450	520	1796	6688	47,563	233	
1912	1898	780	600	503	1320	6688	47,563	240	
1913	2282	1760	31	459	925	6288	47,563	245	
1914	2214	844	871	511	976	6288	48,587	252	
Loan of 1,000 to cover expenditure on repairs and training works required after the 1913 flood (but not built until after the 1915 flood).									
1915	1896	1232	137	630	507	6288	48,587	271	
1916	2658	800	1324	532	-245	6288	48,587	291	
1917	1949	573	613	534	2355	6288	51,587	315	
1918	2622	683	1358	497	2977	6288	53,587	341	
Loan of 5,000 to cover expenditure on repairs and training works required after the 1915 flood.									
1919	1679	974	127	568	2421	6288	53,587	366	
1920	2082	1050	188	581	1479	6288	53,587	409	
1921	6552	971	4500	516	6218	6288	62,587	415	
Loan of 9,000 to cover the establishment of the shingle dredging operation - dredge, machinery, crusher and commissioning. Started operation in 1922. Costs and revenue were contained in the general account. The profit from the shingle business made up the difference between annual expenditure and income (rates & loans).									
1922	8914	2035	3300	1049	6705	6563	62,587	382	
1923	9168	3656		792	6481	6573	62,587	385	
1924	8388	2656		690	4812	7188	62,587	395	
1925	5755	2985		693	5251	7378 (revaluation of Gear Island)	62,587	403	
1926	4911	1900		832	5949	21,160	62,587	405	
1927	6080	2700		945	5301	21,930	62,587	402	
1928	5087	1000		1130	6509	22,200	62,587	404	
1929	6546	2950		1417	4350	23,595 (purchase Waiwhetu Pa)	62,587	403	
1930	7368	3235		2825	4787	24,270	62,587	394	
Liability for the original scheme loans cease, stopbank raising (unemployment relief work) and 1931 flood damage repairs, 1931 - 1945.									
1931	5796	2372		2704	7348	24,495	57,434	364	
1932	7226	3459	850	2618	6773	24,445	52,277	336	
1933	5835	1886	1721	2628	7907	24,445	47,131	319	
1934	5089	2172	737	2881	9019	24,445	41,972	324	
1935	4898	2119	520	3413	10,202	24,645	30,330	336	
1936	5668	2825	298	3383	10,913	22,705	30,330	347	
1937	6570	2947	200	3420	9310	22,705	28,283	370	
1938	7117	2679	748	2530	7818	22,705	28,007	382	
1939	5909	3070	845	2807	9560	22,705	27,718	397	
1940	6651	3284	168	2587	10,630	22,905	26,393	415	
1941	5664	2969		2016	10,010	22,905	26,079	431	
1942	7664	4570		2367	9967	22,355	20,745	445	
1943	5949	3319		2966	11,009	22,330	15,258	455	
1944	5979	2948		2964	13,424	22,330	9752	464	
1945	6971	3180		3053	14,779	23,080	4427	470	
1946	6311	2901		3227	17,528	23,080	4039	474	100

Tables I and II : River Works Expenditure 1907-1990

Year to 31/3/**	Total An. Expend. Works, Invest. & Admin	Works & Maint. Works on Revenue	Loan Works Works on Loan	Rates Income River rates HRB district	Value of Assets Nett total incl. land	Value of land Land holdings	Public Debt Value of outstanding loans	Consumer Price Index	Const. Cost Index
1947	7515	4633		3386	19,333	23,080	3636	488	102
1948	12,839	8327		4287	17,019	23,080	3214	527	110
Extensive bulldozing in the Fraser Park / Mabey Road areas following the June 1947 flood and the May 1948 flood.									
1949	13,035	8000			14,369	23,080	(2500)	536	112
1950	10,019	5203		8962	21,858	23,080	2317	566	120
1951	13,263	5193		9473	24,978	23,080	1839	629	141
1952	14,048	6312		9254	78,992	21,695	1341	678	150
1952 Sale of river land (previously not valued as an asset) to the Crown. 1954 Edmund Creek diversion. From 1956 includes work carried out in Upper Hutt.									
1953	15,349	6792		9832	85,543	21,605	821	709	160
1954	29,660	7391		9842	80,057	27,534		741	167
1955	24,437	7945	1268	10,472	87,073	29,198		760	172
1956	33,399	18,380	4682	10,465	83,507	29,189		786	180
1957	79,797	11,080	48,281	14,769	56,838	62,745		803	186
1958	52,295	11,500	18,000	21,157	61,609	63,320		839	191
1959	51,466	21,000	4095	20,581	74,544	63,320		871	199
1960	73,841	21,464		19,417	69,236	98,825		877	208
1961	78,027	53,607		19,937	69,421	105,030		893	215
1962	67959	45,841		22,225	75,337	104,670		916	220
1963	79,194	21,798		22,254	75,337	124,090		935	223
1964	41,288	16,827	1800	24,318	189,115	124,940		967	229
1965	146,082	38,446	87,807	25,844	171,087	130,705		1000	245
1966	100,268	46,811	22,117	24,913	165,020	145,465			253
1967	167,099	71,604	58,802	23,809	93,581	165,695			265
Remaining values all expressed in terms of decimal currency. Make allowance when undertaking CPI / CCI adjustments.									
1968	280,947	112,726	69,821	52,110	158,782	352,590			270
1969	184,193	58,649	67,751	68,228	197,120	456,870	89,000		295
1970	213,820	95,260	70,439	67,640	221,763	454,870	87,000		317
1971	231,849	83,721	73,681	63,477	224,046	454,870	86,000		375
1972	181,322	124,702		78,262	175,432	452,700	83,000		412
1973	229,483	147,798		55,829	136,355	625,250	81,000		436
In 1973 the functions of the Hutt River Board were incorporated into the Wellington Regional Water Board, and in 1984, the Wellington Regional Council functions. Rates and assets were amalgamated and cannot be simply related to the HRFCS.									
1974	152,782	133,000					79,000		484
1975	243,694	130,000					77,000		587
1976	284,174	79,000					75,000		720
1977	256,926	51,000					71,000		824
1978	(200,000)	68,000					69,000		927
1979	154,534	55,600					66,000		1027
1980	184,388	89,600					63,000		1318
1981	275,524	80,900					60,000		1590
1982	322,834	112,500	13,000				56,000		1870
1983	587,474	161,250					53,000		2010
1984	866,043	449,500	153,500				48,000		2040
1985	1,037,555	425,200	36,400				44,000		2320
1986	1,270,446	485,200					40,000		2630
1987	1,513,336	493,800	107,900				35,000		2770
1988	1,401,939	628,200	34,700				231,000		2980
1989	2,194,500	903,000	132,500				1,872,000		3120
1990		1,923,900	882,200				4,366,000		3270

Rivers Control 1900-1924

(Abbreviations refer to Archive Table 2, p. 7)

B9: 6 Sep 1900: HRBminutes
Purchase of 35 ton of rail from NZR for protective works.

B10: 6 Nov 1902: HRBminutes
Engineer to formulate a scheme for the maintenance of the river. His recommendations included "best means of removing shingle from the bed of the river". Also recommended extension of the Board's District to Taita Gorge.

B11: 1900-1920: Various
General references to log removal operations in the lower channel.

B12: Jan 1905: HRBminutes : position not known
HRB desires to proceed with works at Taita. HCC agreed Feb 1905 and works constructed at day rates under Engineer's supervision.

B13: Sep 1905: HRBminutes
Mr Welch complained that the embankment at Taita was causing ponding on his property. Marchant (Meason's partner) inspected the embankment and observed that it was of no value in stopping overflow as placed. Foreman to lay 18" pipe through bank.

Meason's comments to HRB:
(1) At the time the embankment constructed the river much higher than at present.
(2) Evidence of comparatively recent overflow.
(3) Pipes were intended but accidentally omitted.

B14: Oct 1905: HRBminutes : 140
Foreman to effect any necessary repairs to Jorgensen's embankment and to use the heaviest netting available.

B15: 7 Feb 1907: HRBminutes
Diversion cuts through Riddiford's land (260-300) opposite Alicetown and through Board property at Gear Island (170-200) - value £242

B16:Oct 1909: HRBminutes
6 additional boom groynes built, 66 x 30' turpentine poles purchased.

B17: 6 Mar 1910: HRBminutes
Re extension of scheme: time taken to obtain necessary ratepayers' signatures excessive and the matter deferred until Act of Parliament changes requirements.

B18: Jul 1910: HRBminutes
Encroachment of river onto Welch and Hewe's properties at Taita (just upstream of the Taita Hotel). Something would have to be done to prevent loss of land and flooding of Lower Hutt. Referred to Engineer. HRB to pay share of works built by HCC under direction of Engineer after inclusion of HCC into district. HRB refuse to do work in Belmont - outside district.

B19: 8 Dec 1910: HRBminutes
Delogging of river - logs to be cut into sections and sold as firewood.

D20: 19 Jan 1911 to Mar 1912: HRBminutes
River control passes from Engineer directly to Board. In Jan 1911 Engineer and Solicitor instructed not to attend Board meetings. On 2 May Dilnot Sladden (chairman) resigns.

B21: 14 Mar 1912: HRBminutes
Groyne at Melling Bridge. Boulder sills at Masons (720). Channel cut at Pitcaithley's shingle works - Taita area (880).

B22: 6 Jun 1912: HRBminutes
Boom groynes constructed downstream of Silverstream Bridge. Cut through spit at Stokes Valley opposite damaged road (1150-1170).

B23: 12 Sep 1912: HRBminutes: 850
Protective works on Native Land, Taita.

B24: Aug 1914: HRBminutes
Engineer's report on river works from Hutt Bridge to the sea (after 1913 flood) required works of £2840. Additional work of £1680 proposed by overseer. Board resolves to raise loan.

B25: 7 May 1919: HRBminutes
Pampas grass and bamboo considered for protective works.

B26: 12 Oct 1921: HRBminutes
Truebridge to survey from Main Bridge to Silverstream for £80 and from Main Bridge to the sea for same rate per mile.

B27: Feb 1922: HRBminutes
Engineer's report for work for the next 5 years. Groynes 16/- per foot, reducing to 9/- per foot if birch walings used. A tender for £4.15.5 per bay being accepted.

B28: Apr 1922: HRBminutes
Diversion cut at Seagars.

B29: Jun 1922: HRBminutes
Estuary reclamation and river improvement scheme approved by Minister. Hutt River Improvement and Reclamation Bill passed 1922

B30: 31 Aug 1922: SSPHRB6
Contract for construction of open boom groynes 152 bays in 27 locations (27 groynes) along both banks of the river for 3.5 miles upstream of the Hutt Bridge as shown on plan series 1.

B31: Jan 1923: HRBminutes: 740
Iron breastwork at Belmont proceeded with - value £275.

B32: May 1923: HRBminutes: 730
Boulder groynes behind Masons Gardens - value £175.

B33: 21 Nov 1923: HRBminutes
During Laing-Meason's illness Sladden appointed temporarily as Engineer. April 1924 Laing-Meason attending to Board matters. 14 May 1924 Laing-Meason dies. July 1924 Sladden appointed as Engineer.

Archive Table 7: River Works 1900 to 1924.

Flooding 1900-1924 : The First Scheme Trials

Records of flooding in this period are scarce. From 1904 it was the overseer's responsibility to record flood levels in his day book (at predetermined locations). As with most Hutt River Board records, these have been misplaced. The floods of 1904, 1907, 1911, 1912, 1913 and 1915 are referred to in the Board Minute Papers. Engineering comment was included in separate Engineer's reports that are now no longer attached to the minute papers. It is therefore necessary to rely on the general comments included in the minutes.

The March 1907 flood is described as "heavy" and caused damage to the Pipe Bridge, and erosion at Mason's Gardens, Taita. The only record of the 1904 flood is the photograph of High Street after the event, plate 25, p. 44.

Floods occurred on 13 April 1909 and 6 April 1911 and in July 1911. Laing-Meason considered it imperative that he inspect the river after the July 1911 flood, indicating that it must have been a significant event. The Board declined his services and Laing-Meason disclaimed responsibility for subsequent damage.

In December 1912 the overseer was required to proceed with protection works following a November 1912 flood and in May 1913 the chairman took personal responsibility for reporting the flood. Again the best record is the photograph of the flood, plate 32, below.

Following the 1913 flood Laing-Meason was employed to report on river works from the Hutt Bridge to the sea (refer WRC plan HR2040). These were not constructed until after a larger flood occurred in July 1915, described later by H Sladden as being computed at 45,550 cusecs (1286 cumecs). Interestingly Sladden described the 1915 flood as the largest known to that time.

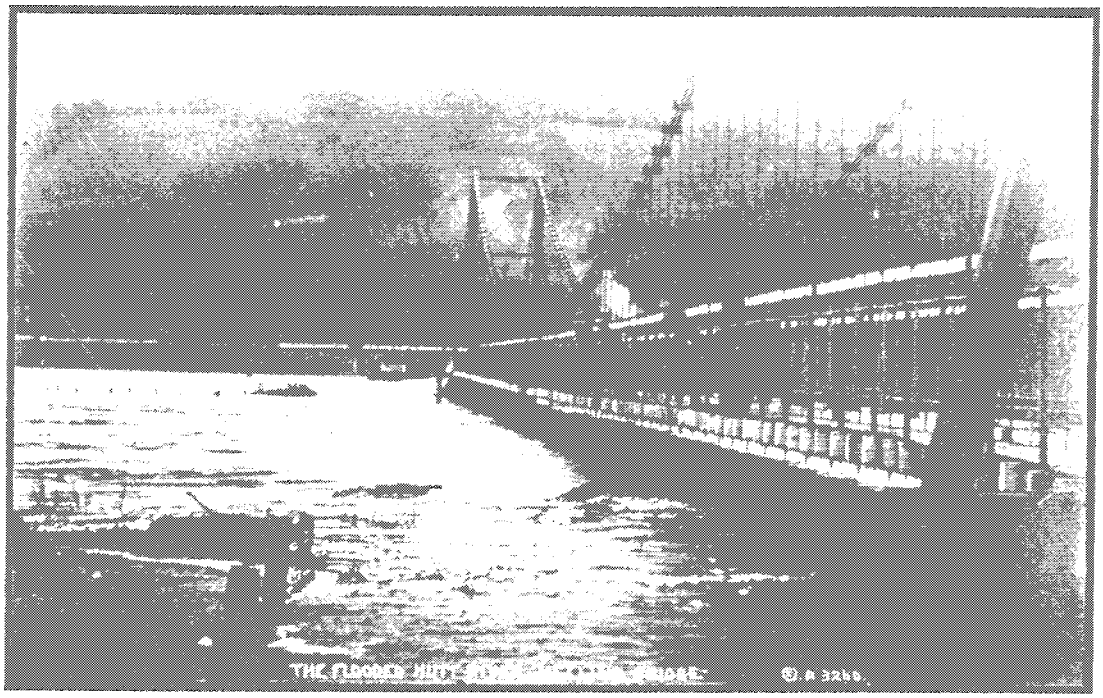


Plate 32: 1913 Flood viewed from Melling Suspension Bridge. Note the freeboard to the train in the background. Source: Hutt City Memorial Library.

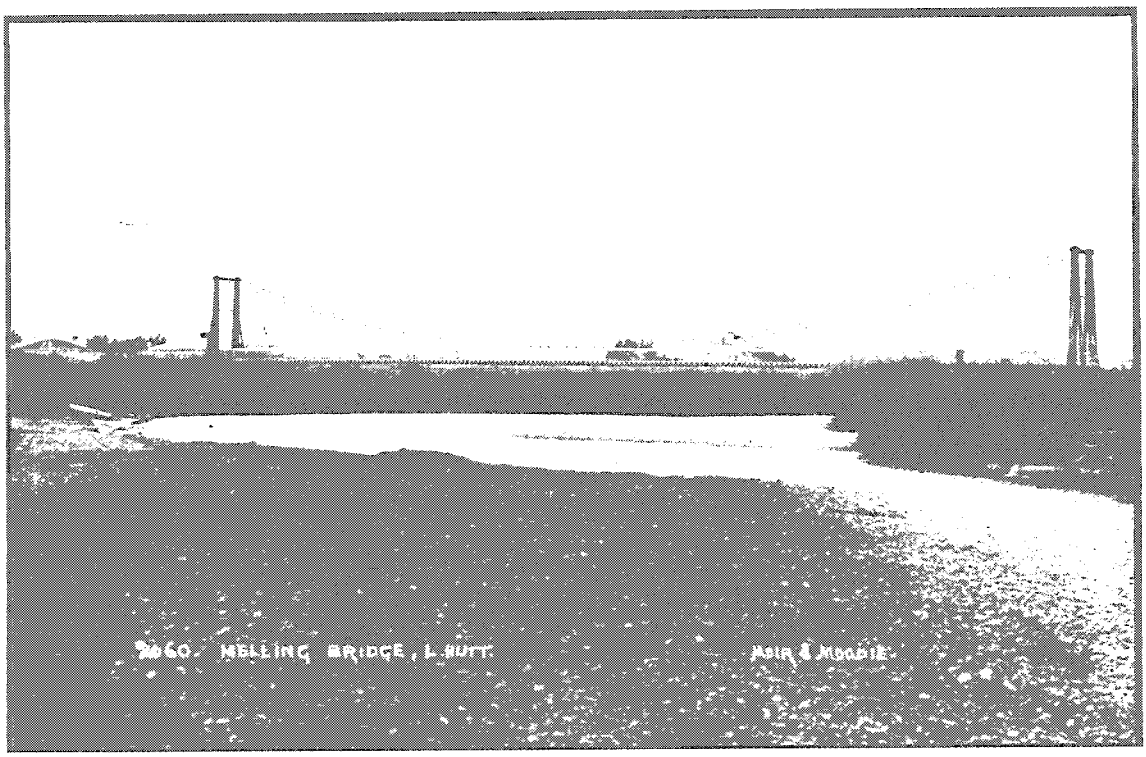


Plate 33: The Melling Suspension Bridge. Source: National Museum neg. B11953

Plates 32 and 33

The photograph in plate 32 was taken from beside the Melling Suspension Bridge eastern support looking across to the Western Hutt Road. The bridge spanned this stable bend from 1909 but was eventually replaced in 1956, at that stage when the bridge was in an advanced state of disrepair. Backing-up of flood water associated with the bend would have been part of the mechanism which resulted in the operation of the Boulcott Overflow. The bend served to prevent the movement of river gravels into the Kingdon's Beach extraction area opposite the present upper car park and was of concern to the Hutt River Board for many years.

Following the completion of the new Melling Bridge the Melling Diversion Cut was excavated through the western approach to the Suspension Bridge. The cut served to increase the channel capacity, and so to reduce flood levels and permit the free movement of the river's bedload (although by the time the cut was made the shingle extraction industry was effectively removing all the bedload from the Belmont and Melling licence areas).

Compare plates 32 and 33 and note the level of the flood waters with respect to the stopbank and dwellings in the background of plate 34.

His meaning is unclear since it appears certain that a flood of the magnitude of the 1898 events would have broken out of the channel at Taita and inundated Lower Hutt. The stopbanking works referred to in the Taita area do not appear to have been large enough to prevent operation of the Taita overflow, and substantial logging of the hillsides at about this time was causing widespread erosion and transport of "vast volumes of silt and mud" into the river, increasing the likelihood of flood waters leaving the river channel at Taita.

Apparent inconsistencies in the assessment of the historical floods has led to a reassessment of these events using original survey data and computer modelling techniques. The reader is referred to **HRFCSR Report, "Reassessment of Historical Floods"**. The results of the report are summarised in the figures and tables of Chapter 8. Archive Table 8, "Flood Archives 1900-1924", p. 62 includes the few flood references for this period.

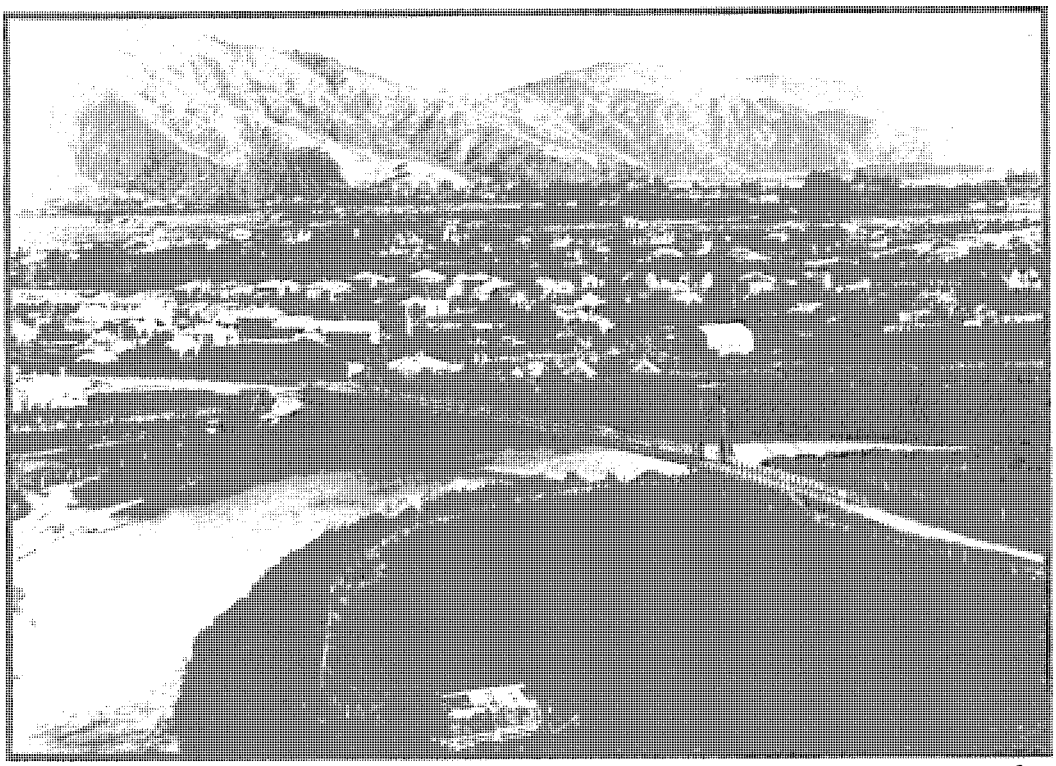


Plate 34: 1910 photo of Lower Hutt illustrates the HRB concern for stopbank failure at Melling. Source: Alexander Turnbull Library, S C Smith col. neg. G22763.

Flood Archives 1900-1924
(Abbreviations refer to Archive Table 2, p. 7)

A23: 2 May 1913: LHPP: 460
Photograph showing flood waters 3' below deck of Melling Bridge.

A24: 8 Sep 1904: HRBminutes
Following flood, Engineer instructed to set up levels by which the overseer could gauge the height of floods. Flood levels to be recorded in the overseer's diary.

A25: 19 Mar 1907: HRBminutes : 100
Heavy flood with damage to Pipe Bridge. Engineer reported on urgent works, and extra labour to be employed. Erosion at Masons Gardens, Taita (value £80).

A26: 13 Apr 1909: HRBminutes:
Flood. Works unaffected.

A27: 6 Apr 1911: HRBminutes: Position not known
Flood. Engineer to report on lower reaches. Embankment required at Parimans, Belmont.

A28: 28 Aug 1911: HRBminutes
July flood. Engineer asks if report required - considering it imperative. HRB declines services. Laing-Meason disclaims responsibility for further damage.

A29: 30 Nov 1912: HRBminutes
Overseer to proceed with work resulting from "recent' flood.

A30: 2 May 1913: HRBminutes
Chairman reports little damage with respect to size of flood. HRB has no money to effect repairs. Report on damage in upper reaches to be printed.

A31: July 1915: LHPP
Flood. SSPHRB10 45560 cusecs.

A32: 4 Jul 1921:
Highest flood since 1915. Low lying areas partially flooded.

A33: 2 Mar 1922:
Flood, 11' rise.

A34: 1 Nov 24: SSPHRB6
Flood 10' above normal. With the exception of a small washout (90' LHPP) at Taita Gorge (1140-1170) no damage occurred and channel improved. Recommend: Driven rail protection at Taita Gorge, and cut gorse on island in middle of river to allow scouring.

A35: 18, 19 Dec 1924: SSPHRB6
Flood to within a few feet of the Hutt Bridge. 2.74 ins rain at Kelburn. Remedy - cable of tethered willows against minor scour.

Archive Table 8: Flood Archives 1900-1924.

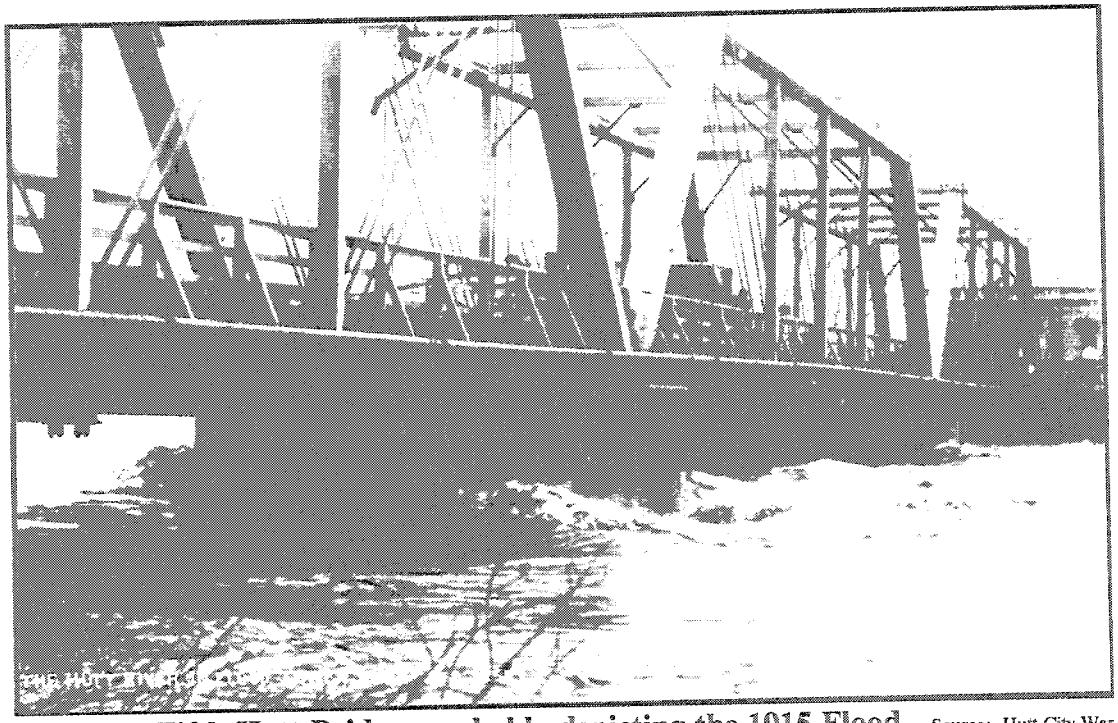


Plate 35: Fifth Hutt Bridge, probably depicting the 1915 Flood. Source: Hutt City War Memorial Library.

Chapter Four

THE EXPLOITATION OF THE SHINGLE RESOURCE

1900-1990

Between 1900 and 1990 private companies and Government and local authority contractors removed more than 4 million cubic meters of shingle and sand from the bed of the Hutt River. Most of this material was taken from the reach downstream of Taita Gorge and led to the lowering of the riverbed from a riverbed which was almost level with the adjoining floodplain to the incised channel we see today.

The 1974 requirements to modify plants to maintain minimum water quality standards forced the closure of most of the small operators. Many of these companies were operated by rugged individuals who had worked the shingle resource for over 50 years. The sole remaining company has had many name and shareholding changes but has been continuously involved in extraction operations since 1904. This followed a successful tender for the right to work the Melling Beach (then Kingdon's Beach, opposite what is now the Lower Hutt City Council northern riverside car park).

The sale of shingle provided funding for the management of the River from 1924 to the mid-1970s. The lowering of the bed led to a substantial increase in the flood carrying capacity of the central channel. Without shingle sales to the Wellington market it is likely that the flood control scheme would have failed through overtopping in both the 1931 and 1939 floods. Without "selective extraction", the process of extracting only those deposits likely to lead to channel misalignment, the cost of maintaining and establishing the central channel would have been many times greater.

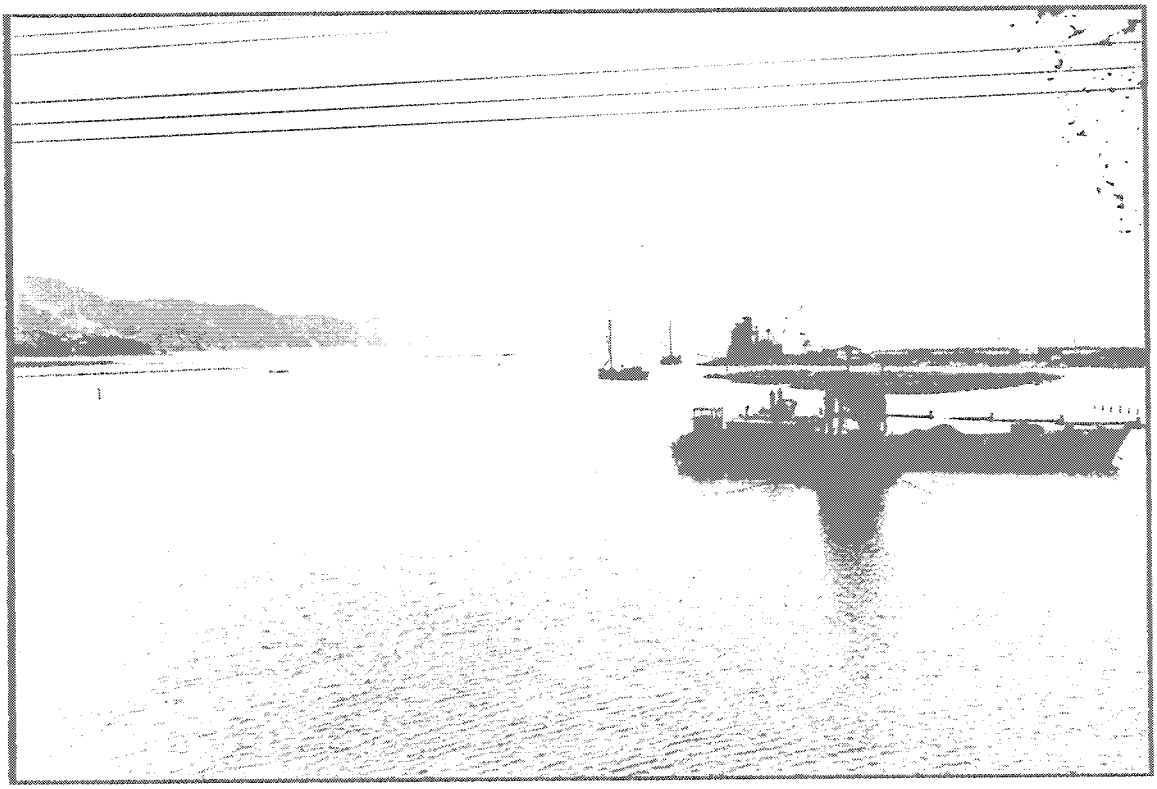


Plate 36: Extraction at the Estuary, 1929. Source: Alexander Turnbull Library, S C Smith col., neg. G49107

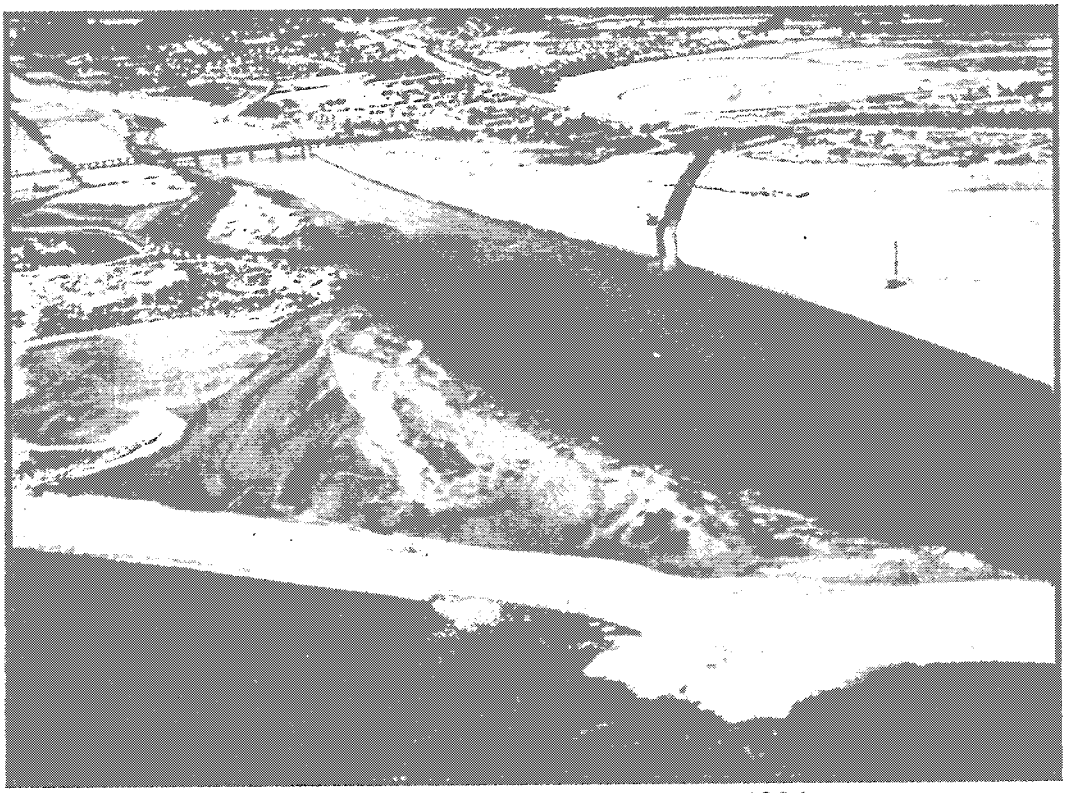


Plate 37: Shingle filling of the First Reclamation, c. 1934. Source: Alexander Turnbull Library, neg. F122250

Dredging the River

The original design report presented by Laing-Meason to the Hutt River Board in 1900 contained reference to a proposal to achieve flood control by dredging the central channel. The construction of embankments was favoured over a dredging option, however, calculations and notations on the original embankment design plans make reference to dredging. It is not clear if Laing-Meason planned on dredging the central channel to increase the channel capacity so that the design flood could be safely passed. This would have been required if the design flood was the maximum likely flood referred to in the Hutt River board's Minute papers.

The control of mining activities to achieve river control objectives was of considerable importance to Laing-Meason and he encouraged the selective extraction of troublesome shingle deposits. During the 1901-1903 stopbank construction period there was a temporary ban placed on extraction to ensure that the most suitable gravels were kept close at hand for use as bulk filling in the stopbank foundations and stopbank core.

From the earliest days of settlement there was commercial interest in the shingle resource, although the volume of demand was at first low and was substantially below the rate of bed load delivery. The extracted volumes did not match the natural rate of supply or permit the lowering or repositioning of the bed until 1924 when the "dragline" system of mining was adopted.

Betwen 1906 and 1924 attempts to extract and market the shingle resource almost bankrupted the Hutt River Board and during the period 1915-1924 the "Shingle Business" dominated Board affairs. Large-scale commercial extraction began in 1902 with the agreement between New Zealand Railways and the Hutt River Board for the establishment of a ballast mining operation at Melling. The agreement permitted other contractors to use the siding, although New Zealand Railways was the largest single extractor until 1920, removing 10,000 to 20,000 cubic metres per year. Licensed extraction from other areas also commenced in 1902, managed in a similar way to the Wellington Regional Council's current operations. This continued until a tendering system was introduced in 1904 whereby bids were called for the right to extract from five specific "beaches" (refer to figure 12, p. 80).

The tendering system for allocationg rights to the resource was used until 1916, however, it failed to achieve the desired rate of extraction and in particular the removal of the "problem" deposits left after each large flood. Misalignment problems caused by these deposits, combined with unacceptable bids for some areas in the 1912 round of bidding, left the Board with the responsibility of managing three of the extraction areas from 1912.

The flood of 1915 finally caused the abandonment of the tendering system. April 1916 saw the Board advertise its intention to take over the entire resource management and marketing and call for commission agents in the Wellington City area. It called and accepted unit rate tenders to load and cart shingle to the Hutt Station railway siding. Cartage to Wellington by motor lorry was also permitted and paid for at the same rate as rail cartage.

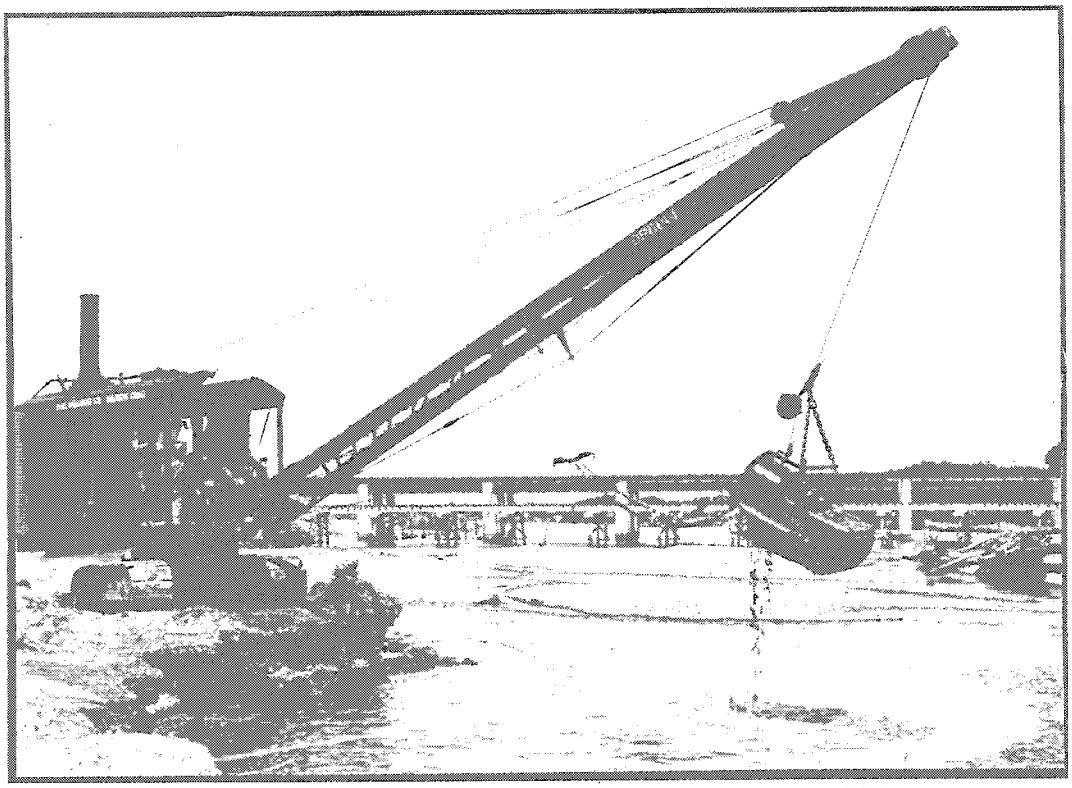


Plate 38: Extraction for Ava Rail Bridge (by dragline), c. 1925. Source: Alexander Turnbull Library, Evening Post col. neg. G EP728

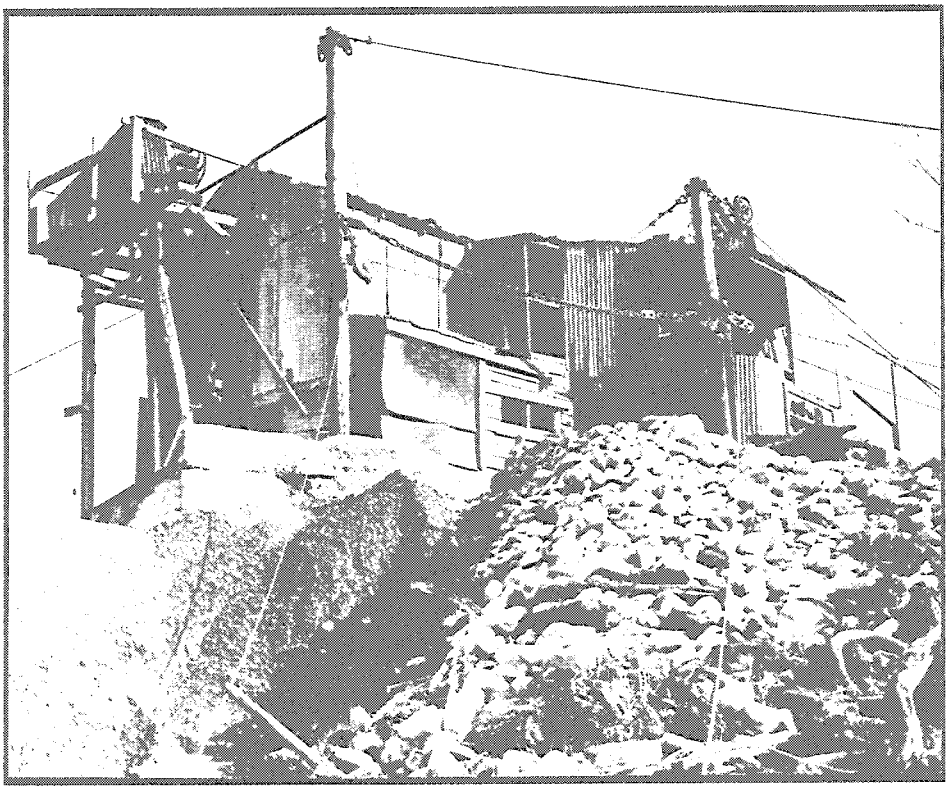


Plate 39: Bognuda, Adams and Blyth crusher erected upstream of Ewen Bridge 1930, photo 1958. Source: Alexander Turnbull Library, Evening Post col. neg. C11329.

Archive Table 9, p. 74, contains extracts from the Board Minute papers which illustrate the difficulty the Board experienced with the shingle business during the 1900 to 1917 period.

Mechanisation of the Industry

By 1919 the Board was seeking ways to mechanise the extraction operations. Survey records indicate that the bed level was dropping slowly (600 mm between 1902 and 1915) but the minute papers still record dissatisfaction with the rate of extraction. It is unclear if the desire to increase the rate of extraction was in response to an increased demand for shingle or was required for channel management reasons.

Advice on the appropriate machinery was sought from Mr Marchant, the Wellington Harbour Board Engineer. Consequent to this advice the chairman and his overseer set about investigating the purchase of a floating suction dredge, as used in the South Island goldfields. In 1920 a £9,000 loan was raised to purchase a second hand floating dredge, a new suction pump, and a crusher and associated machinery. Laing-Meason was appointed to provide plans for the location of the machinery. The components were to be assembled on the river berm in the area of the Melling siding.

Difficulties in assembling the dredge, with claims that parts had been stolen or misplaced, resulted in the appointment of Laing-Meason to supervise and control the dredging enterprise. His initial report estimated the project would go £4500 over budget, the last straw for ratepayers who had watched with alarm the attempts to assemble the machinery. The 1920 loan poll to raise the additional monies to complete the dredge was defeated. In January of the following year the Board members, who had almost single handedly run the Board and its operations since 1915, were voted out of power. These highly motivated, possibly egocentric, men were replaced by a more conservative team who called a halt to the dredge construction and commissioned Laing-Meason to review the shingle operation. Acting on this advice a ratepayers meeting was held in which it was resolved to sell the dredge and to market the gravels by way of a royalty charged on material won from licensed areas.

A dragline based shingle business was soon established at Melling. The Hutt Shingle Company (previously Pitcaithley's and eventually to become River Shingle and Sand/Firths/Winstone Aggregates) won the initial three year lease and has continued to operate in this and the adjoining Belmont areas to the present time.

Although the ownership of the original dragline equipment is not recorded, the Hutt River Board may have been a major shareholder as it appears that it was a Board decision to adopt this method of extraction following the inspection of a grab dredge operating at Patea. Within 10 years, privately owned draglines were operating throughout the Lower Valley and were responsible for the enormous volumes of material removed from the bed.

Archive Tables 9 to 11, pp. 74 to 78 contain extracts which chart the activities of the principal participants in the industry over the 1900 to 1972 period.

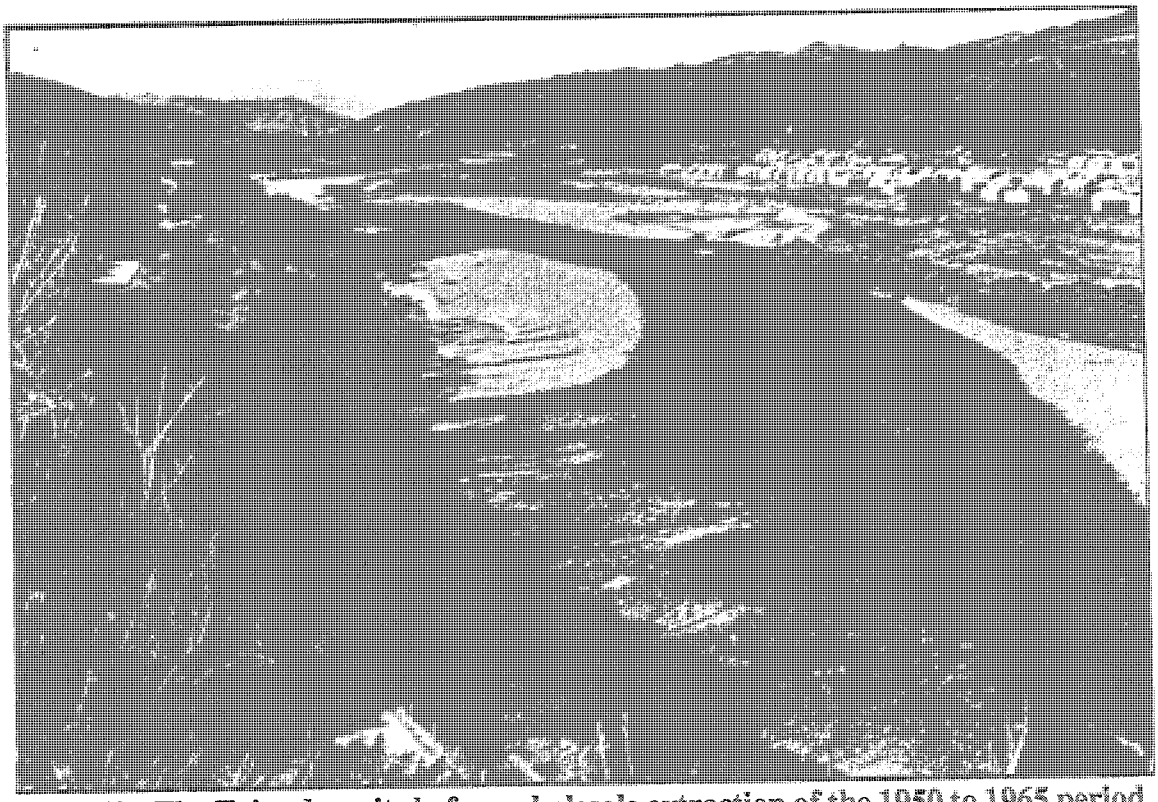


Plate 40: The Taita deposits before wholesale extraction of the 1950 to 1965 period, August 1947. Source: Alexander Turnbull Library, E P Christensen, National Publicity Studios col. neg F19823.

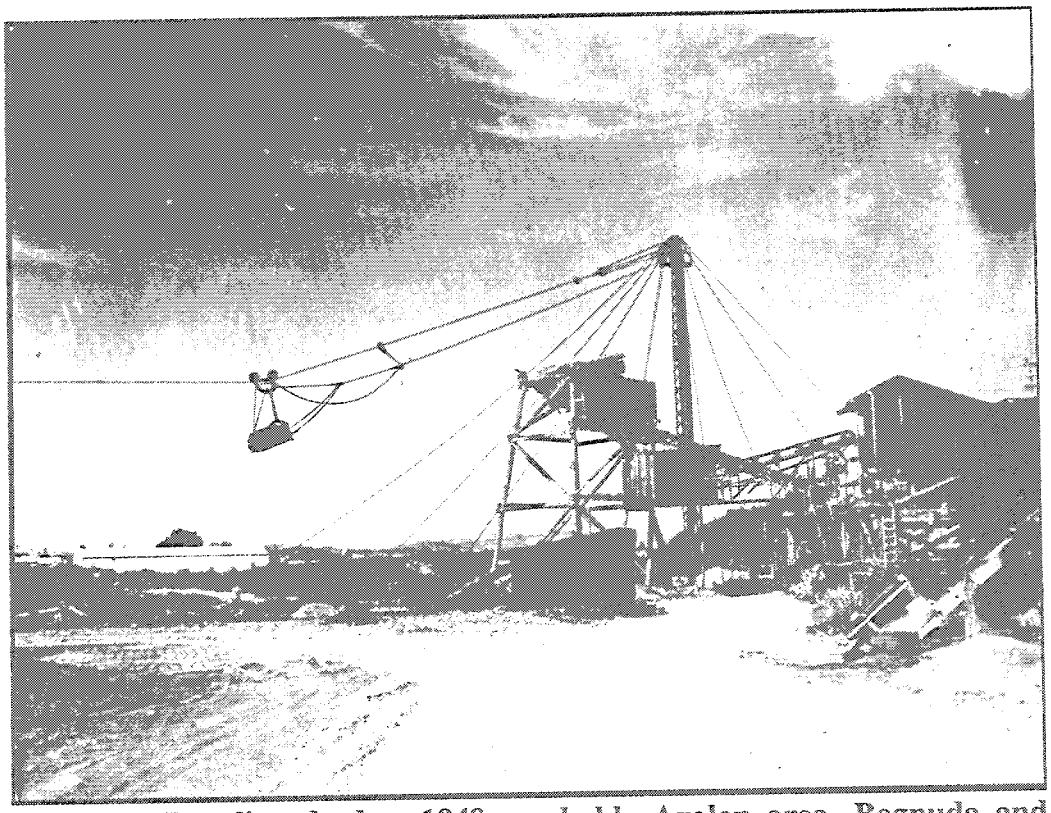


Plate 41: Dragline dredge, 1948, probably Avalon area, Bognuda and Adams. Source: Alexander Turnbull Library, National Publicity Studios col. neg. F19824.

Archive Table 12, p. 79, lists the annual extraction volumes. The volumes extracted between 1900 and 1928 have been estimated by backworking the royalties collected by the Board as recorded in the Statements of Accounts and interpreted by reference to the Board Minute Papers. They should be regarded as approximate. The remaining figures are from industry returns and may not include the large volumes taken for the filling of the Taita housing area in the 1940s and 1950s. Project Report 54 is a summary of a Wellington Regional Council report which identifies volumes and sources of extraction in more detail.

Plates 42 to 49 are aerial photographs of the major plants operating during this period. The "draglines" across the river can be clearly seen. These lines were moved to access the entire bed within a radius of up to 500 m from the plant. The industry impact on the river bed and adjoining berm lands almost precluded any other activity. During the peak years pollution from wash water and from the continual disturbance of the bed turned the river milky for long periods (see plate 49).

By 1931 there were at least 12 plants operating on the river - mostly south of Belmont - and a total of approximately one million cubic metres had been extracted. The first Seaview reclamation was then well under way, with most of the filling being obtained from the river mouth; plate 37, p. 66 (the second stage was carried out in 1956 using material from the PWD quarry at Seaview). The Railways Department had dredged a large volume from the Chapmans Bend area immediately to the south of the Ava Bridge for bridge approaches and other works associated with the Eastern Railway Duplication in the 1924 to 1927 period. There had been extraction by dragline upstream of the Pipe Bridge (about 100 m upstream of the present Estuary Bridge) and from a wharf constructed for extraction on the upstream point of Gear Island . Shingle was dragged for most of the length of Strand Park to a plant operating at the end of Tama Street. Extraction also took place from a point on the tip of the Dead Arm, from beneath the Melling Suspension Bridge, from the Board's main extraction area off Stilling Road (now Pharazyn Street) and at regular intervals from Melling to Barnes' property (now the Taita housing area).

Ownership of extraction plants changed hands from time to time and plants were frequently relocated, both at the Board's direction and by owners seeking more profitable locations. Despite the downturn in demand accompanying the depression, practically the entire reach from Mabey Road, Avalon, to the mouth was dredged at the direction of the Hutt River Board.

Extraction activity peaked in the 1960s, with dredging operations and waste water from the crushing plants having a severe effect on the quality of the river environment. For extended periods the river was heavily silt laden. Despite political influence to maintain the industry (for example, the efforts of the Aurora Group of companies to retain and considerably develop the Melling extraction and processing facility). Public concern led to the hearing of the Hutt Tribunal which considered the effects of the industry activity and imposed minimum water quality standards in 1973.

The minimum water quality standards were imposed as conditions of water rights issued following the Tribunal Hearing. These conditions forced the closure of the non-conforming plants, the cost of compliance beyond the means of most of the small general contracting businesses. Within a few years most of the "characters" quit the

shingle industry, taking with them their plant.

The ruling of the Hutt Tribunal came conveniently after the major period of stopbank building which saw the extension of the flood control scheme from Boulcott to Maoribank. In excess of 100,000 cubic metres were used in the Silverstream to Maoribank reach in stopbank building and foundation works, and large quantities were relocated within the river channel to close off old channels. The industry apparently played an important role in the scheme reconstruction and extension, however, its activities, like most work during the 1960-1972 period, are now poorly documented.

The decisions of the Tribunal focused on water quality. The question of volume of extraction and the sustainable management of the shingle resource was not considered until the late 1970s and even then only in a qualitative manner. Observation of the rapid degradation of the bed in the Upper Hutt reach in the early 1980s, as occurred between 1900 and 1950 in Lower Hutt, highlighted the imbalance between the extracted volumes and the natural rates of bedload movement from the Upper Catchment. A study of the shingle resource is currently being undertaken and is the subject of **Hutt River Flood Control Scheme Review, Volume 5, River Characteristics and Sedimentation.**

The following pages record the growth of the extraction industry, mainly over the period 1924 to 1972. The major changes forced on the industry in 1973 also resulted in the changes to river management which occurred during the scheme commissioning between 1972 and 1990.

Industry activity from 1972 to the present day is covered in chapter 7, "Scheme Refinements 1972-1990".

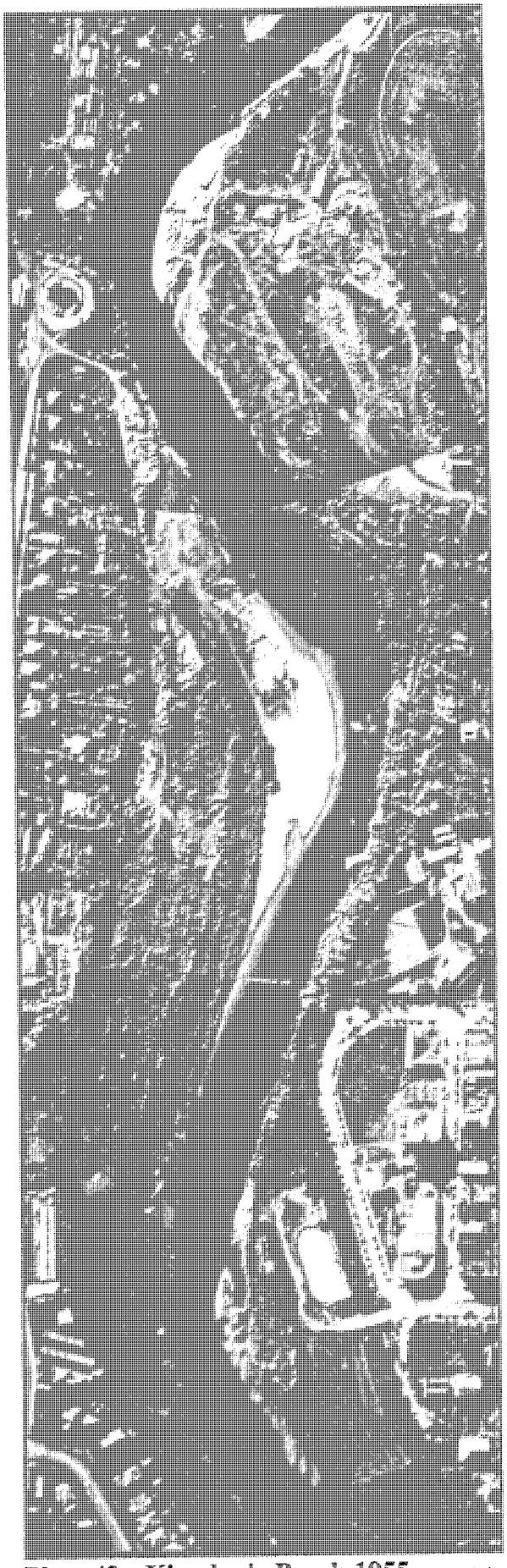


Plate 42: Kingdon's Beach 1955. Mosaic by Air Contracts Ltd.

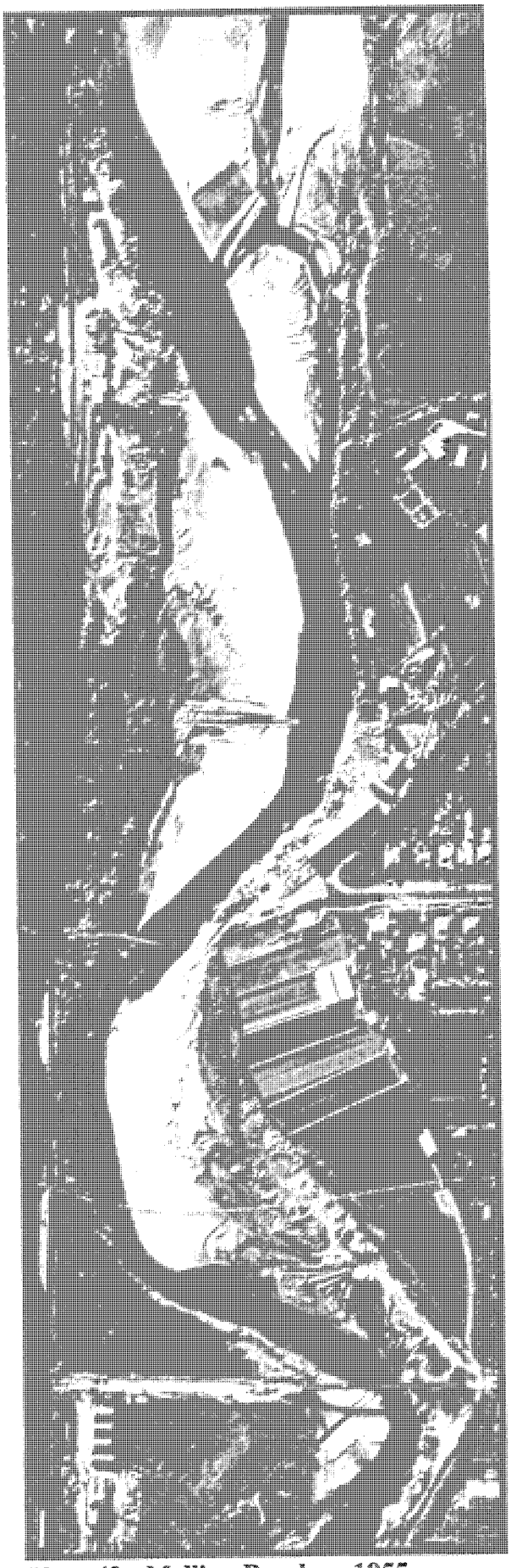


Plate 43: Melling Beaches, 1955. Mosaic by Air Contracts Ltd.

The Shingle Business 1899 to 1972

(Key to abbreviations refer Archive Table 2, p. 7)

D1: 23 Mar 1899: HRBminutes
Wellington Harbour Board sought and granted permission to dredge for boulders and shingle in the Hutt River with a view to opening up trade with Wellington. No royalty to be charged.

D2: 15 Jun 1899: HRBminutes: 300-310
Extraction from beach on eastern side of River below Hutt Bridge.

D3: 7 Sep 1899: HRBminutes
The shingle resource should be thrown open to the public - as much should be removed as possible at no charge.

D4: 15 Jun 1900: HRBminutes: 300-310
Clerk to supervise extraction from beach south of Hutt Bridge.

D5: 13 Apr 1901: HRBminutes
River beaches closed to extraction on Engineer's recommendation. Following submissions by LHBC, PBC and others extraction permitted from Whites Line Beach (210-260).

D6: Oct 1902: HRBminutes: 400-430
Letter from NZR proposing a siding for carting ballast to Wellington. HRB agreed (March 1903) and suggested siding be available for use by other contractors.

D7: Jan 1903: HRBminutes
Shingle beach at Kingdon's licensed to Mr Jones. Continuing extraction at Whites Line. In March 1903 Jones offers to pay royalty in return for HRB putting down a siding.

D8: Mar 1903: HRBminutes: 300-310
HRB build access to beneath Fourth Hutt Bridge to allow extraction. HRB resolve to purchase Kingdon's Beach.

D9: 10 Jul 1903: HRBminutes: 440-540
Road to shingle depot, Section 31, constructed. HRB to acquire rights to road through Section 31.

D10: 8 Sep 1903: HRBminutes: 380-410
Rights given to Gregan to take shingle from Kingdon's Beach.

D11: 5 Nov 1903: HRBminutes: 380-410
Permission given to Coffey and O'Connel to extract from Kingdon's Beach. Mrs Kingdon claiming £1000 plus £21,000 compensation for shingle taken from her land by the HRB. Claim not successful.

D12: 10 Dec 1903: HRBminutes: 170-200
Contractor extracting from Whites Line instructed to move further south.

D13: 4 Feb 1904: HRBminutes
Royalty of 3d per yd charged for material removed from Kingdon's Beach as a temporary measure pending report from Engineer.

D14: 18 Feb 1904: HRBminutes
Instructions to Solicitor to prepare contracts for removal of shingle from 5 specified areas according to Engineer's report. Successful tenderers for beaches (refer figure 22, p. ? and Appendix A for location of beaches): Mr Jones - Beaches 1, 3, 4 and 5 @ £250 p.a. each. Pitcaithley - Kingdon's Beach (No. 2) @ £700 p.a.

D15: 1904: HRBminutes
NZR extract 22,000 cu. yds ballast in 1904.

D16: 1905: HRBminutes
Pitcaithley claim to HRB for large volumes removed from Kingdon's Beach by NZR. NZR agreement to extract 10,000 cu. yd p.a. free of royalty in return for establishment and maintenance of railway siding. NZR to pay 4d royalty for volumes in excess of 10,000 cu. yd p.a.

D17: Mar 1905: HRBminutes
Borough Councils to pay 3d per cu. yd royalty and to desist from taking from road reserve beneath Hutt Bridge. Tenders for beaches: beach 1 £105 (Jones); beach 2 £225 (Pitcaithley); beach 3 £40 (Coffey and Gregan); beach 4 £30 (Coffey and Gregan); beach 5 £60 (Jones).

D18: 1905: HRBminutes
NZR extract 17,500 cu. yds ballast in 1905.

D19: 7 Sep 1905: HRBminutes: 330
Coffey and Gregan claiming 4 d per cu. yd for material taken to complete stopbank at new bridge.

D20: Mar 1906: HRBminutes
Tenders for 3 years (not transferrable): beach 1 £85 (Posse); beaches 2 £225, beach 3 £65, beach 4 £50, and beach 5 £75 (Pitcaithley). Pitcaithley agreed with HRB/NZR that for area 2 the charge for the first 10,000 cu. yds would be free of royalty (i.e., equivalent cost of loading). When the total volume exceeded 10,000 cu. yds the removal charge would be 1/- per yd incl. royalty

D21: Apr 1906: HRBminutes: 200-220
Pitcaithley to discontinue extraction from head of Gear Island.

D22: Jun 1908: HRBminutes
Pitcaithley failed to remove material deposited in 1907 flood. Other arrangements to be made for sale and removal.

D23: Mar 1909: HRBminutes
Tenders for right to extract from beaches: beach 1 £75 (Pitcaithley); beach 2 £232 (Pitcaithley); beach 3 £62 (Pitcaithley); beach 4 £75 (LHBC); beach 5 £75 (Pitcaithley). In July LHBC transfer lease for beach 4 to Pitcaithley.

D24: 8 Dec 1910: HRBminutes: 100
Material taken from No. 5 beach for new Pipe Bridge approaches.

D25: 14 Mar 1912: HRBminutes
Tenders for right to extract from beaches: beach 1 £200 (Haus and Co); beach 2 £61 (King); beach 4 PBC and LHBC @ 4d per yd royalty; and beaches 3 and 5 available to public @ 6d per yd. Haus complains that HRB going into competition and seeks uniform price setting. As a result of negotiation Haus pays £20 for beach no. 3

D26: 4 Jul 1912: HRBminutes: 540-600
Pitcaithley to lay down tramway on No. 1 beach.

D27: 4 Mar 1915: HRBminutes
Agreement for NZR to extract 20,000 yds p.a. free of royalty.

D28: May 1915: HRBminutes
Lease beaches 1-5 to King Bros @ £440 p.a. conditional on PBC and LHBC being permitted to extract @ 4d. per cu. yd royalty.

D29: 18 Apr 1916: HRBminutes
King contract terminated after failure to remove material deposited during 1915 flood. Overseer to report on cost of the HRB undertaking the extraction. As a result of this report the HRB advertised its intention that; (1) HRB to take over the management of extraction, and (2) Commission selling agents required in Wellington. The HRB called tenders to cart and load the shingle. King was successful; To cart and load to railway trucks - (1) from Kingdon's Beach min. order 20 yds @ 1/8 per yd; (2) shovelling into trucks, 1/- per yd; (3) cart gravel from Hutt Bridge to trucks at Hutt Station, 3/- per yd; and (4) cart sand from Whites Line to Hutt Station, 3/- per yd. Cart to Wellington on motor lorries at the same rate as for railway wagons.

D30: Aug 1917: HRBminutes
Pitcaithleys change name to Hutt River Shingle Co.

D31: 2 Apr 1919: HRBminutes
Report sought from Mr Marchant (Engineer to WHB) on methods used in USA for disposal of gravels.

D32: 7 May 1919: HRBminutes
Overseer to prepare a report on removal of gravel from beaches using mechanical means.

D33: 27 Sep 1919: HRBminutes
Chairman and Overseer inspect several dredges in the South Island and return with quotes.

D34: 3 Mar 1920: HRBminutes
Tenders called for secondhand West Coast gold dredging barge, a 60 BHP suction gas engine, a 45 BHP suction gas engine, suction plant, and a 9" crusher and screens. Intention to make a royalty of 4d/yd for volumes of 1000 yds plus in any one job. £9000 raised for the extraction operation. Laing-Meason provided plans to show where the machinery should be located.

D35: 20 Aug 1920: HRBminutes
HRB not prepared to lease any beaches long-term. Short-term leases at 6d/yd.

Archive Table 9: Exploitation of the Shingle Resource, part 1.

Plate 44: Belmont Beaches 1949. Mosaic by Hope Cross and Richardson, Masterton.

Plate 45: Belmont Beaches 1955.
Mosaic by Air Contracts Ltd.

The Shingle Business (continued)

D36: 22 Sep 1920: HRBminutes: 400-430
Approval of new NZR ballast extraction siding at Melling.

D37: 22 Nov 1920: HRBminutes
Laing-Meason appointed to supervise and control dredge enterprise. Gave updated costing requiring further £4500 expenditure. Poll for loan to cover cost defeated on 1/12/20.

D38: 11 Jan 1921: HRBminutes
New Board elected. Submitted to ratepayers that all equipment be sold and the gravel to be marketed by means of licence areas. Licences advertised on 4/5/21. The Hutt River Shingle Co. given 3 year lease for a royalty of: 2/6 per yd from Kingdon's Beach; 1/6 per yd from other places; 6d per yd supplied to Local Authorities; 2/6 per yd for sand.

D39: 25 May 1921: HRBminutes
Advertised prices (by truck to Wellington); unscreened shingle 8/6 per yd; screened shingle 12/- per yd; sand 12/6 per yd. Prices on truck at Melling as above less 4/9 per yd freight.

D40: 1922/23: HRBSOA
Record of sale of shingle and sand (royalties).

D41: Mar 1923: HRBminutes: 7-100
Royalty for material used in Harbour Walls 6d per yd.

D42: Jun 1923: HRBminutes
Demand for shingle greater than shingle business ability to supply. Called tenders for rights to set up crushing plant at Melling. Let to Mr Turner 29/8/23.

D43: 18 Nov 1924: SSPHRB6: 120
Request by Engineer to Board to have a bar removed upstream of the Pipe Bridge on the line of the "Ultimate Channel".

D44: 8 May 1925: SSPHRB6: 170-200
PWD "scooped spoil" for reconstruction of the Ava Rail Bridge from the left bank downstream.

D45: 1925: OAV: 170-200
A dragline was used to obtain filling for the railway extension to Eastern Hutt.

D46: 30 Apr 1926: SSPHRB6: 740
Engineer's recommendation to erect crusher and bins by Melling Shingle Co. (owner probably Dexton) adjacent to land acquired by the HRB from Mr Dickie, Taita.

D47: 8 Apr 1927: SSPHRB6
Hutt River Shingle Co. wrote complaining about lack of sand in current excavations.

D48: 5 May 1927: SSPHRB6: 210-230
Portion of Gear Island north of railway bridge leased to Mr C F Pulley.

D49: 11 Sep 1927: SSPHRB6
Bird and Codling Bros removed shingle for supplies for new Hutt Bridge.

D50: 16 Jul 1927: SSPHRB6 Possibly 760
Whelan and Roberts application for crushing plant site. Site 20 chain north of Pitcaithley's plant approved. Started Nov 1927.

D51: 18 Oct 1927: SSPHRB6
NZR location for extraction for ballast. Extensive bed above "Andrews" opposite Groyne No. 13.

D52: 27 Oct 1927: SSPHRB6
Permission given to Hutt River Shingle Co. to remove sand at the upper reaches at Haywards within certain limits. Not feasible to vary the given limits at Belmont.

D53: 13 Mar 1928: SSPHRB6: 890
Belmont Quarry Co. Ltd. lease of river bed on north side of NZR land opposite Pitcaithleys Siding (just north of Belmont Extension) to a point 10 chains north of the company site on the Western Hutt Road.

D54: 28 Mar 1928: SSPHRB6: 210
McAllum and Tait; erection of wharf and dredge upstream of Ava Railway Bridge (just upstream of the line of Whites Line) on the right bank.

D55: 24 Jul 1928: SSPHRB6: 210
McAllum and Tait works constructed as per plan (plan on file).

D56: 23 August 1928: SSPHRB6 (Engineer's monthly report).
Plant erected to work the Melling shingle bed. Estimated removal of 2-300 cu. yds per day. The "old plant" removed. A dragline erected to remove shingle for the Fifth (Ewen) Hutt Bridge approaches. Crusher foundations completed for Coutts' plant at Alicetown (off end of Montague Street (250)). An electric crane installed in Messrs McArthurs' plant at the Estuary.

D57: 13 Oct 1928: SSPHRB6
Approval to Atkins and Irvine for plant upstream of the Melling Bridge, left bank. Plan on file SSPHRB6.

D58: 15 Dec 1928: SSPHRB6: 400-800
Hutt river Shingle Co. granted an extension of licence for the areas at Melling and Belmont for 21 years. Royalty at 8 pence per cu. yd. Same terms as granted to owners of existing underwater plant. Subject to material being taken by underwater plant to be at the direction of the Engineer. (Underwater plant presumably the dredges operating within the Estuary).

D59: 22 Mar 1929: SSPHRB6: 460
Re Atkins and Irvine beneath the Melling Suspension Bridge; extension of limit of shingle extraction area to the northernmost point of Groyne No. 28, provided alignment reclamation work beneath the Bridge is done first.

D60: 19 Jul 1928: SSPHRB6
Tender by Hutt River Shingle Co. for erection of new bins at Melling and Belmont.

D61: 13 Mar 1929: SSPHRB6: 460
HRB to pay Atkins and Irvine to locate dragline beneath Melling Bridge and to drag out S-bend and win metal. Cost of £150 to be deducted from £200 royalty.

D62: 18 Mar 1929: SSPHRB6
Plan of Hutt River Shingle Co. lease area recorded.

D63: 30 Apr 1929: SSPHRB6: 140-150
Extraction of sand from Jorgensen's Bend (Barber Grove, Moera) - report by H Sladden.

D64: Nov 1929: SSPHRB6: 250
Coutts River Shingle Co. Ltd application to install a scraper to drag metal to the radius of the dragline bucket extension. Location off end of Montague St. Approval given.

D65: 19 Dec 1929: SSPHRB6
Plan showing areas leased to Hutt River Shingle Co.

D66: 21 Dec 1929: SSPHRB6: 160
Plan showing H R Shingle Co. lease and plant area at Strand Park, on right bank halfway between Ava Bridge and Jackson Street. (Implies recent takeover of Coutts by H R Shingle Co.)

D67: 28 Dec 1929: SSPHRB6: 460
Approval sought for a crushing plant by Amalgamated Brick and Pipe Co. Ltd involving transfer of Atkins and Irvines' lease and permission to erect a plant in place of that operated until recently by A and I.

D68: 25 Mar 1930: SSPHRB6: 330
Application by Bognuda, Adams and Blyth Sand and Gravel Supplies Ltd to extract gravel (upstream of Hutt Bridge right bank).

D69: 20 Aug 1930: SSPHRB6
HRB prohibit removal of any sand or material east of the river at the estuary.

D70: 29 Aug 1930: SSPHRB6
Bognuda, Adams and Blyth seeking permission to install a crusher on the north side of existing gravel bins.

D71: 16 Apr 1931: SSPHRB6: 530
Proposal to install dragline upstream of Pipe Bridge.

D72: 4 May 1931: SSPHRB6: 400-430
River Shingle and Sand concern over condition of H.R.B's Melling railway siding rented to RS and S since 1923 at £100 p.a. Request for HRB to repair siding. Mouth dredging: HRB suggest that RS and S erect their plant at the mouth of the river - plant originally at Gear Island on land that was eroded.

D73: 7 Oct 1931: SSPHRB6: 530
Application by River Shingle and Sand to extend plant north.

D74: 17 Nov 1931: SSPHRB10
Letter from H Sladden to "The Dominion": approx. 200,000 cu. yds dredged from the mouth in recent years.

D75: 7 Apr 1932: SSPHRB6
Engineer's Report: shingle plants working reduced time because of lack of demand.

D76: 1 Mar 1934: SSPHRB6: 180
Application by Elsmore for a shingle lease near Berth, Levi and Co downstream of Ava Bridge, on spit of Dead Arm. Aerial dragline dredge - Engineer doubts quantity of extraction but granted approved to proceed.

Archive Table 10: Exploitation of the Shingle Resource, part 2.

Plate 46: Wellington Conc. Pipe Plant, Haywards 1955. Mosaic by Air Contracts Ltd.

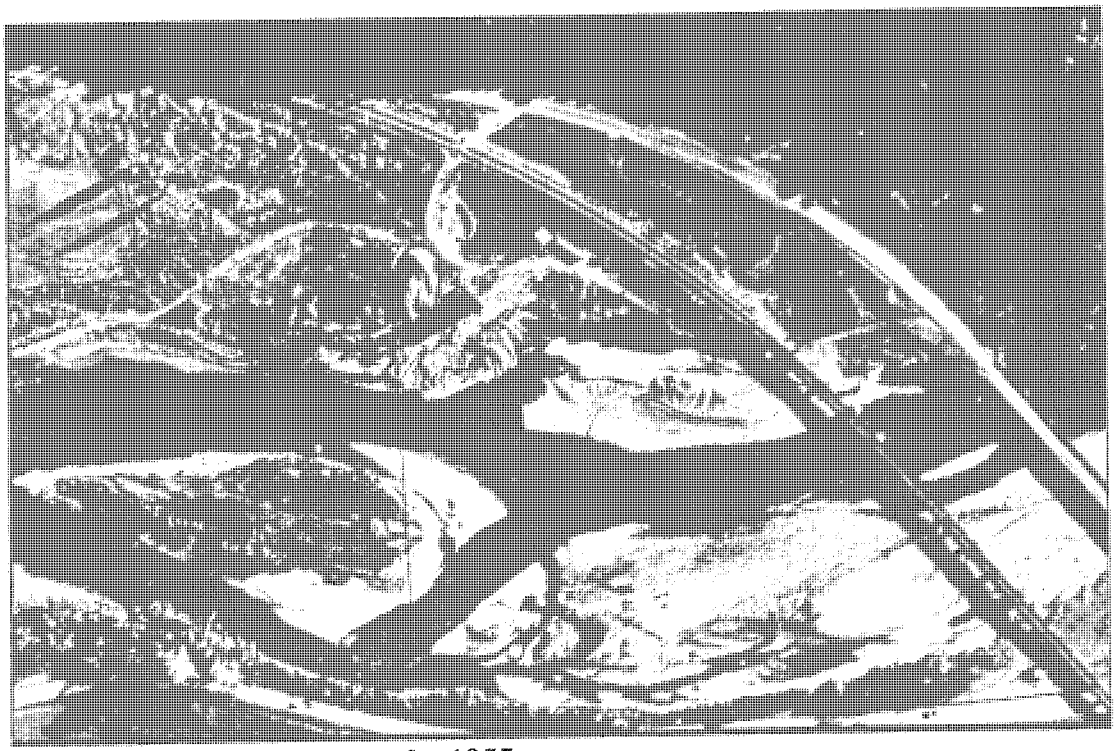


Plate 47: Silverstream Beach, 1955.
Mosaic by Air Contracts Ltd.

The Shingle Business (continued)

D77: 27 Sep 1934: SSPHRB6: 210-240
Extraction area for Tait off the end of Mudie Street. Bounded upstream by Coutts and downstream by Rail Bridge. Reach considered suitable for dredging, although less quantity than there used to be.

D78: 30 Apr 1936: SSPHRB6: 180
Plan for Bevan lease. Overlaps McAllum's lease within the Estuary.

D79: 4 Jun 1936: SSPHRB6
Concrete Co.'s plant (presumably forerunner to the Mill St plant or Firths Melling); new shingle plant erected for dredging the shingle bank below Melling Bridge.

D80: 20 Aug 1936: SSPHRB6: 460
From Wellington Concrete Pipe Co., Melling. Invoice for £75 for making a cut below Melling Bridge. Advice that they are to install crushing and screening plant.

D81: 16 Mar 1939: SSPHRB6
Board Meeting: Extension of Bognuda, Adams and Blyth Sand and Gravel Supplies Ltd lease for further 10 years (prob. 330). Sand removal in the lower reaches - from beaches behind Wool Scour (140-160).

D82: 3 Apr 1939: SSPHRB6: 1020
River Shingle and Sand request for approval in principle to extract from "Barnes Bend" opposite Taita Rock.

D83: 30 Oct 1939: SSPHRB6: 1020
River Shingle and Sand plant at Barnes Bend proposed.

D84: 31 Oct 1938
Extraction figures 1928-38 recorded.

D85: 17 May 1943: SSPHRB6: 740
Bognuda, Adams and Blyth granted a lease to extract from the end of Mabey Road and from Walker's Island (upstream of Belmont Extension).

D86: June, July 1943: SSPHRB6: 730-850
Thousands of cubic yards (volumes not recorded) extracted for Public Works' use from the "Native Lands" (now Fraser Park area) to Mabey Road for the Taita development, a Department of Housing development scheme.

D87: 7 Mar 1944: SSPHRB6: 750
Bognuda and Co. plant at Mabey Road. Plan of Licence Area.

D88: Oct 1944: SSPHRB6
Schedule of shingle, ballast and sand removed from the river between 1928-44.

D89: 21 Sep 1945: SSPHRB6: 720
Lease of land to Central Sand and Shingle Supplies Ltd opposite Charles St, Belmont.

D90: 7 Aug 1946: SSPHRB6
Phillips and Fanning; advice that they are now in a position to operate a 0.5 cu. yd floating grab at the mouth of the Hutt River.

D91: Aug 1946: SSPHRB10
Arrangement with PWD for removing metal from river channel.

D92: 5 Sep 1946: SSPHRB6: 170
Details recorded of extraction by Elsmore of a sand spit at the end of the Dead Arm.

D93: 26 Jul 1948: SSPHRB10: 860-1020
"Spoil for Taita Housing Block" material for stopbank adjustments being obtained from spits in the Taita reach to the advantage of the River.

D94: 27 Sep 1949: SSPHRB10: 890 or 550
5,400 cu. yds extracted with 2:1 subsidy from Pitcaithleys (Belmont Extension). Recommendation by Engineer to put Kingdon's Beach plant back into operation as soon as possible to remove a spit.

D95: 17 Feb 1950: SSPHRB6: 1070-1390
Areas of river bed between Silverstream and Pomare Bridges available for extraction of ballast for NZR. Contract documents for supply of ballast recorded, incl. spec. for ballast; 2.5" circular (i.e.rounded) downwards with not more than 15% passing 1/4" sieve and not more than 95% passing 1.5" sieve. Anticipated volume 100,000 cu. yds between 1950-53. Contract won by Downer and Co.

D96: 21 Aug 1950: SSPHRB10: 1130-1200
Beach at Manor Park extracted for Railway construction. This work was part of remedial works approved by the Soil Conservation and Rivers Control Council following the 1947-48 floods.

D97: 1951: SSPHRB46: 400
Contract to remove shingle from behind Convent, LH (Daly St/ Rutherford St).

D98: 24 Apr 1951: SSPHRB10: 370-390
Extraction of shingle spit on right bank below Kingdon's Beach completed.

D99: 23 Oct 1951: SSPHRB6
Hutt Valley and Wellington Sand, Gravel and Metal Producers' Association meeting at HRB offices on 31 Oct 1951. to express concern over the effect of Public Works Department use of gravel for filling.

D100: 2 Sep 1953: NA 96/298000
Extraction by PWD recorded: (does not include material used for filling) 1945 Taita Housing Block stopbank, 31,000 cu. yds; 1948 Taita Housing Block Stopbank 12,000 cu. yds; 1950 Railway formation 73,000 cu. yds; 1951 Railway formation 72,000 cu. yds; 1952 Railway formation 40,000 cu. yds; 1953 Railway formation 38,000 cu. yds. In addition by Downers for the Railway formation: 1950-2 100,000 cu. yds., and 1953 (anticipated) 25,000 cu. yds..

D101: 17 Mar 1954: HRB8/7: 430
7,000 cu. yds for approach roads to new (Melling) bridge (3,500 per side) requested by LHCC. Proposed to use "all-in" river material from the end of Andrews Ave, above Wellington Concrete Pipe Co. plant on east side and between Kingdon's Beach and Belmont on west side.

D102: 29 Sep 1955: SSPHRB6
7,500 cu. yds taken to pipe factory at Gracefield.

D103: 6 Aug 1956: SSPHRB6
PWD write seeking permission to remove gravel from agreed points for specific jobs.

D104: 24 Oct 1957: SSPHRB83
Legal opinion to HRB re dredging rights.

D105: 5 Aug 1958: HRB8/7/10: 630-770
"Good filling" wanted by LHCC for extension of Taita Drive from Tennyson Ave to Burcham Street. Total of 76,000 cu yds taken from Avalon area: 50,000 cu. yds from speedway (Avalon Bridge); 6000 cu. yds from Central Sand and Shingle Ltd (Mabey Road); 20,000 cu. yds from Hutt, Petone Shingle Supplies Ltd (probably Fraser Park).

D106: 21 Aug 1958: SSPHRB6
Wellington Concrete Pipe Co. Ltd Plan of site for proposed shingle plant, Haywards.

D107: 1961: HRB8/7/10
Letter from HRB to LHCC expressing concern that large volumes (greater than 200 cu. yds) should not be used for filling but conserved for aggregate purposes, following agreement with shingle companies.

D108: 29 Jan 1964: SSPHRB90
Letter from Commissioner of Works to Hutt Valley and Wellington Sand, Gravel and Metal Producers' Assn Inc. Total of 165,000 cu. yds required for the upgrading of the stopbanks. Two cuts will yield 130,000 cu. yds (the cut widths having been reduced to conserve shingle for extractors). The Department (PWD) have no objection to additional material being taken provided the taking does not conflict with river control work and costs do not devolve onto river work. Telegram in reply from HV and Wgtn S, G and Metal Producers Assn; "Hutt Valley and Wellington Metal Producers enter a strong protest at proposed use of large quantity of river shingle for erection of a stopbank in Upper Hutt. A limited quantity of this valuable material is available, and is largely used for housing projects. Association has an undertaking from the HRB that only small quantities of filling would be allowed to be extracted from the river bed.

D109: 30 Jul 1964: NA 96/298000
Letter: Hutt Valley and Wellington Sand, Gravel and Metal Producers' Assn Inc. to HRB: (a) confirming telegram to Minister stating that shingle supplies should be conserved for concrete aggregate; (b) stating that adequate quarry material available; (c) acknowledging receipt of letter from HRB indicating cancellation of licences above Silverstream.

D110:12 Feb 1966: HRB GENERAL
Letter from Wilkins and Davies: concerned with recent restrictions on extraction from the lower reaches of the river. Request permission to take 60-70,000 cu. yds from the road bridge at Kaitoke.

D111: 3 Feb 1967: SSPHRB32 and 54
3,000,000 cu. yds extracted from 1947-67. 200,000-300,000 cu. yds for yr 1967.

1967-1972: Records have not been retained for this period.

Archive Table 11: Exploitation of the Shingle Resource, part 3.

Recorded Annual Extraction Volumes - *Refer Project Report 54*

Totals to 31 March 19** include licence holder returns and other known extractions taken for rivers control or stopbank building purposes. (figures in brackets are estimates)

Year	Volume (cubic metre)	Year	Volume (cubic metre)	Year	Volume (cubic metre)
1905	(37400)	1934	36,000	1963	253,000
1906	(31500)	1935	41,000	1964	283,000
1907	(25200)	1936	54,000	1965	319,000
1908	(21400)	1937	60,000	1966	286,000
1909	(21400)	1938	88,000	1967	196,000
1910	(21400)	1939	98,000	1968	246,000
1911	(29800)	1940	121,000	1969	211,000
1912	(29800)	1941	79,000	1970	234,000
1913	(29800)	1942	81,000	1971	279,000
1914	(29800)	1943	99,000	1972	234,000
1915	(29800)	1944	155,000	1973	226,000
1916	(29800)	1945	137,000	1974	237,000
1917	(29800)	1946	102,000	1975	186,000
1918	(16000)	1947	92,000	1976	152,000
1919	(15300)	1948	91,000	1977	114,000
1920	(16800)	1949	98,000	1978	145,000
1921	(17600)	1950	97,000	1979	110,000
1922	(19900)	1951	99,000	1980	93,000
1923	83,200	1952	126,000	1981	175,000
1924	99,500	1953	131,000	1982	185,000
1925	118,700	1954	(180,000)	1983	145,000
1926	112,000	1955	178,000	1984	175,000
1927	132,000	1956	168,000	1985	161,389
1928	122,000	1957	186,000	1986	118,231
1929	91,000	1958	190,000	1987	109,500
1930	96,000	1959	(195,000)	1988	77,000
1931	57,000	1960	205,000	1989	99,500
1932	64,000	1961	224,000	1990	60,000
1933	42,000	1962	240,000	1990	

Archive Table 12: Annual Volumes of Shingle Extraction; 1900 to 1990.

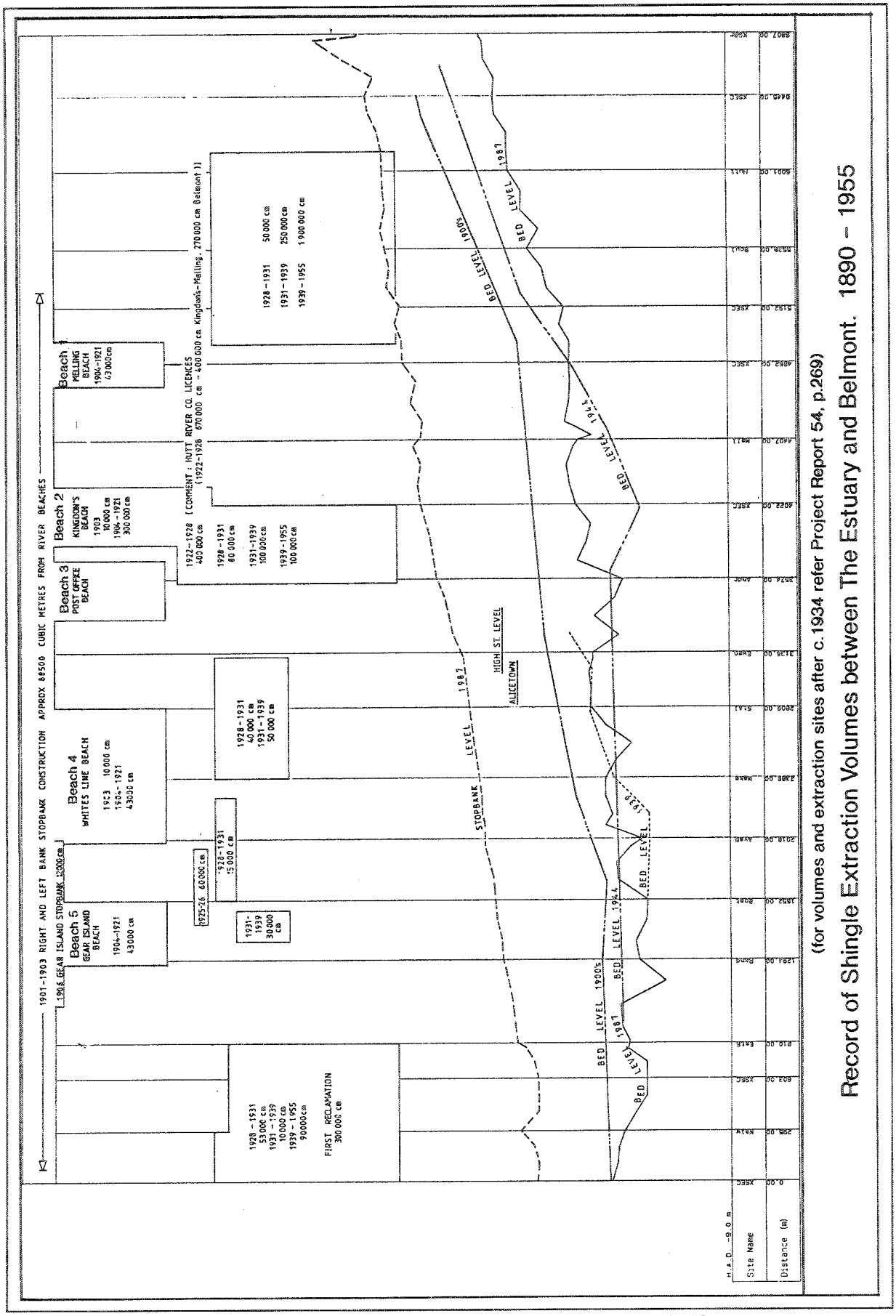


Figure 12: Log of Extraction Activity, Estuary to Belmont, 1900-1955.

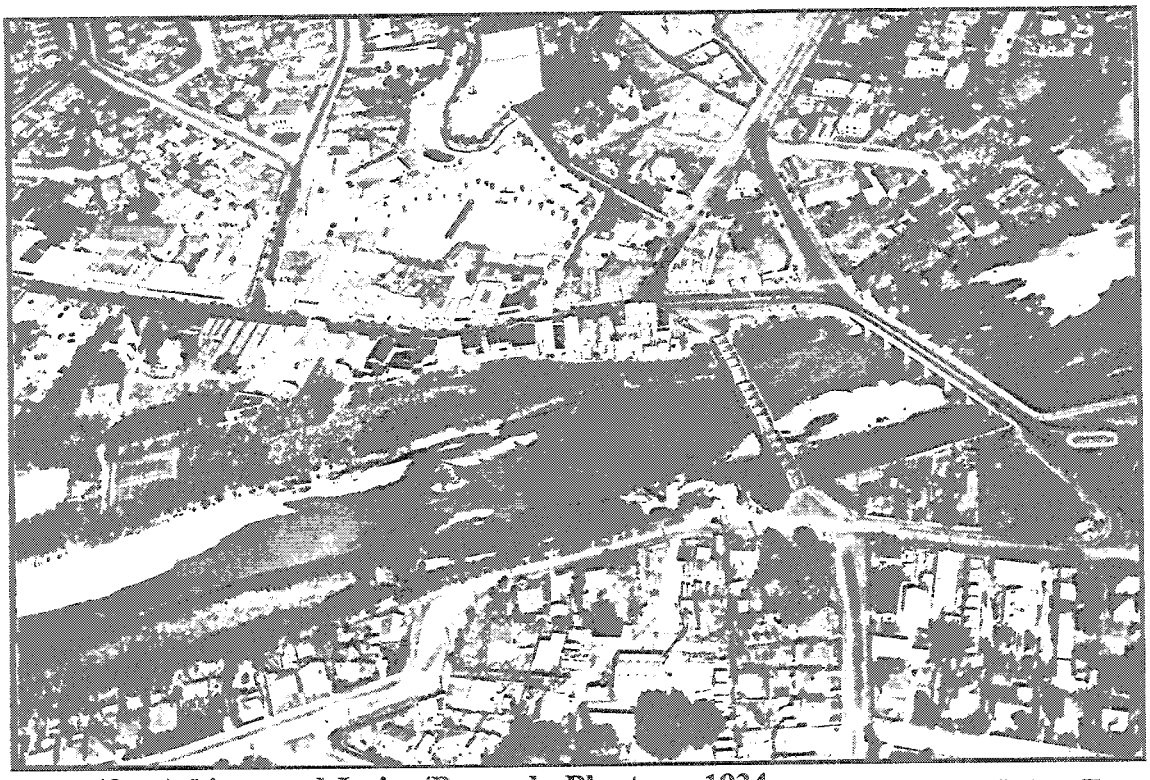


Plate 48: Atkines and Irvine/Bognuda Plant ca. 1934 Source: Evening Post Collection, ATL neg. F122249

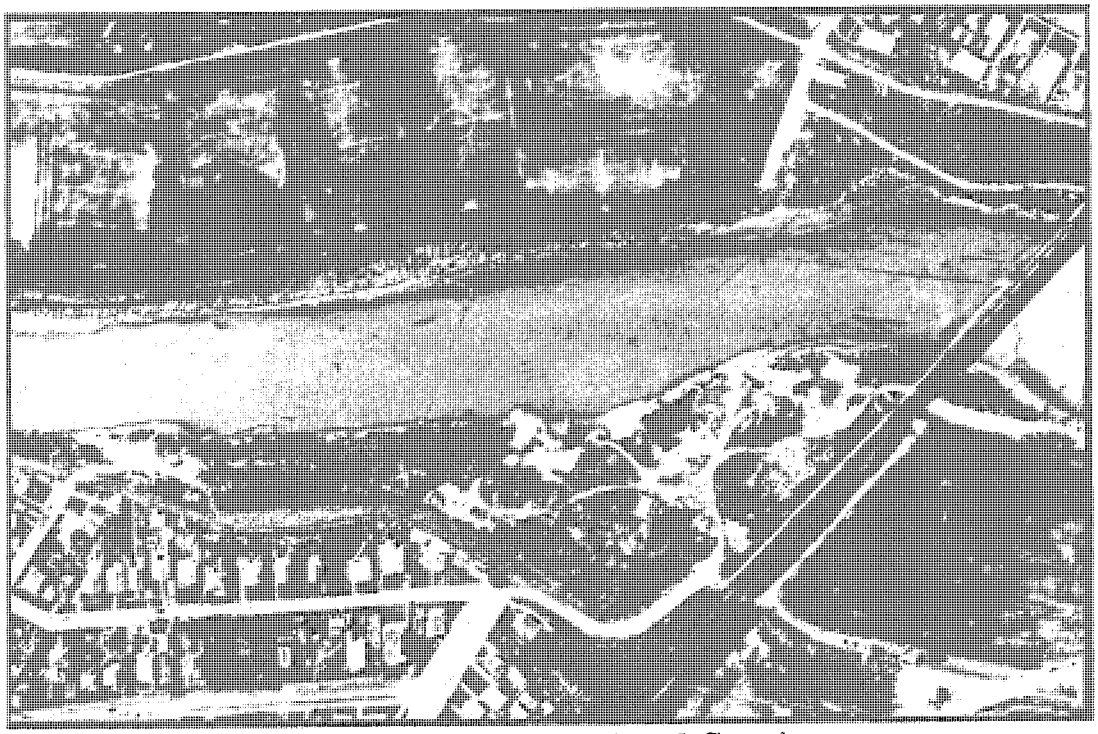


Plate 49: McAllum's Wharf (near Ava Br.) and Coutt's. From mosaic by Hope Cross and Richardson, Masterton.

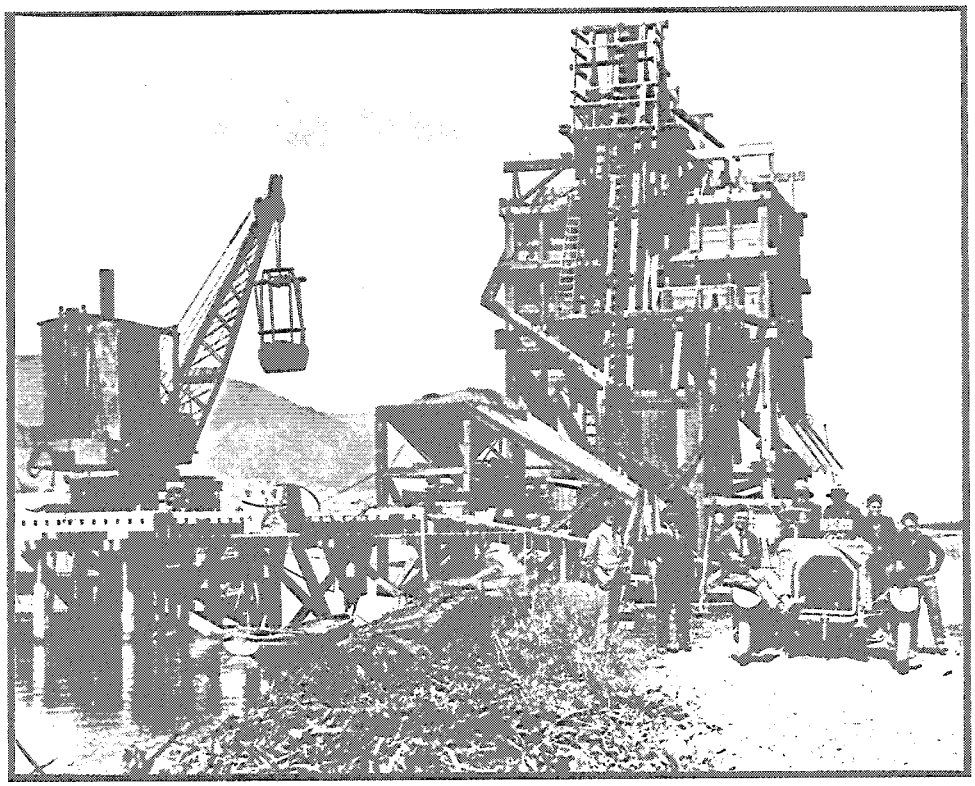


Plate 50: MacArthur Bros Plant, River Mouth 1926. Source: Alexander Turnbull Library, neg. 45111

Chapter Five

RIVERS CONTROL FROM 1924

By 1930 the pattern of development within the Lower Hutt and Petone areas had been firmly established. The river channel from Central Hutt to the Estuary was very similar to the channel of the present day.

North of Melling, however, the River was still very much its own master, the alignment changing dramatically with every large flood. From 1924 the Hutt River Board was forced to move its attention from the essentially stable lower river, to the "upper river" - the river north of Melling.

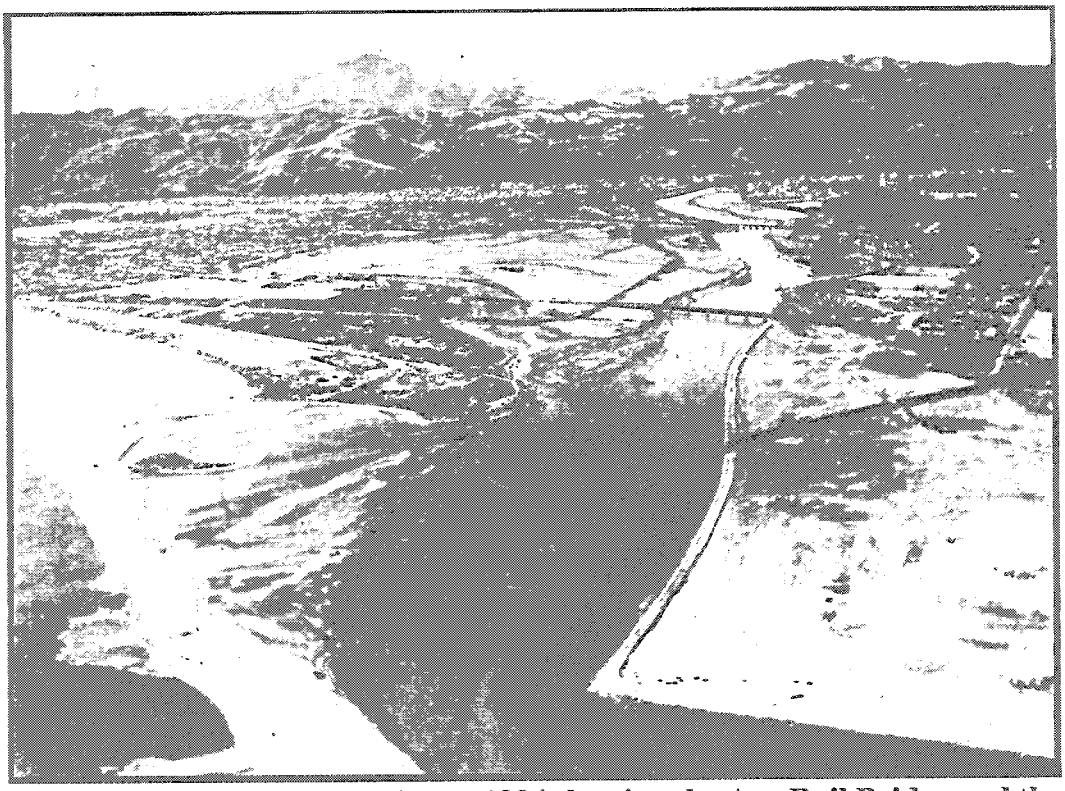


Plate 51: The first reclamation c. 1934 showing the Ava Rail Bridge and the (Jackson Street) Pipe Bridge. Source: Alexander Turnbull Library neg. F122247

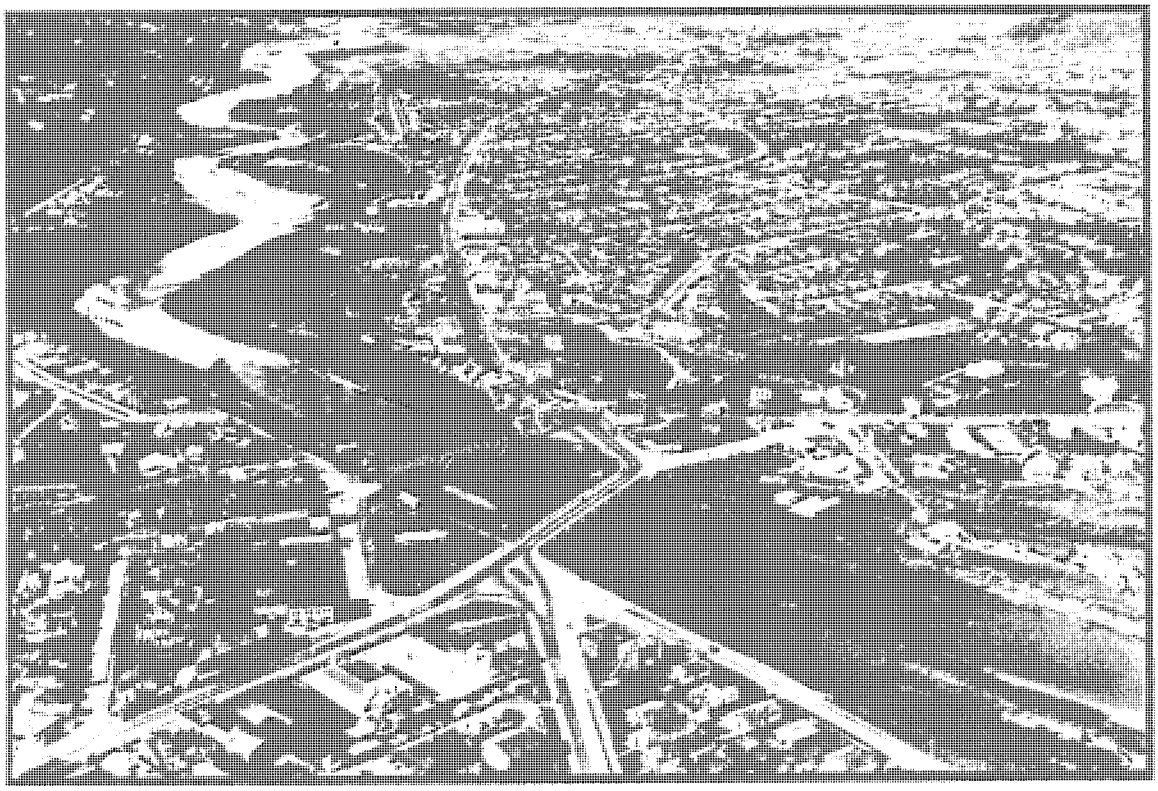


Plate 52: Lower Hutt circa 1934 Source:Alexander Turnbull Library neg. F 122267

A New Era of Security

River management from 1924 is marked by a confidence that was lacking in the early years. Activities within the river zone and the protected flood plain illustrate a conviction that the fight against the river's dominance had been won. This confidence can be attributed to:

(1) A secure financial base.

(2) A scheme which had protected the Borough against the 1913 and 1915 floods - events which otherwise would have resulted in widespread damage and inconvenience.

(3) A successful relationship between the Board and its Engineer, Hubert Sladden, which allowed the river to be managed in a consistent and farsighted manner.

While the "shingle business" had earlier crippled the Board, the successful establishment of the extraction industry provided a financial autonomy not enjoyed by other local authorities. Royalties from the shingle resource exceeded the rating income in 1922 and led to a £15,500 current account surplus by 1945; almost a million dollars in today's terms.

With the exception of an unemployment programme carried out during the depression, all works were constructed from revenue. The Board's desire to retain new works expenditure within the revenue base led to a conflict between the Hutt River Board and central government in the 1950s [refer Archive Table 15, p. 109]. It was also the root cause of the Board's apparent lack of cooperation with the Government sponsored extension of the scheme to include Taita and Upper Hutt.

Developments on the Flood Plain

The record of activity on the protected flood plain for the period 1900 to 1920 is well documented. Immediately following the construction of the embankments land values soared, for example, 26 acres near the railway station sold for £30,000 and part of the Bellevue land, formerly McNab's Gardens, passed in at auction at £11,500 after failing to reach the reserve. The entire Gardens had been purchased in 1900 for £4,000. Between 1900 and 1906 the number of buildings within Lower Hutt Borough doubled from 325 to 656. Land speculation prompted the Government to become involved in the property market to prevent a continuation of the speculative practice of withholding land from sale in order to push up land values, a practice which had dogged New Zealand property development since the establishment of the colony. Between 1901 and 1905 the Government subdivided part of the Epuni area into 44 two acre settlement lots and purchased land in the Moera and Taita areas. As an indication of the profits to be made even by the relatively benevolent Government land developers, a large part of the cost of the Eastern Duplication of the railway line, completed in 1927, was paid for through Government land sales.

Development was not restricted to the Lower Valley. Aerial photographs of the Upper Hutt area (see plates 71 and 72, (pp. 117 and 118), show the eastern, flood free area of the Upper Valley to be well established by the 1950s. Movement into the flood prone "Cottles Block" (Moonshine Bridge area) and McLeods had already started, although these areas were not protected until the 1970s with the extension of the stopbanks to include the Upper Valley.

In Lower Hutt the security offered by the scheme works, and the land sales which followed, increased the confidence and wealth of the community and the standing of the principal political figures. Improvements to public works and the growth of industry followed.

In 1906 the final stages of the Western Hills stormwater diversion were completed and work was gradually put in hand to contain the streams which ran through the eastern half of Lower Hutt Borough (in a similar way as the internal drainage of Petone had followed stopbank construction). Roading was improved and there was pressure to upgrade the bridge links between the two halves of Lower Hutt Borough. In 1904 the Fourth Hutt Bridge was opened followed by the Melling suspension bridge in 1909. The eastern duplication of the Wairarapa railway (the Waterloo Line) was completed in 1927, crossing the River at Ava. The diversion of the main rail route from the western line did not take place until the construction of the Pomare rail bridge in 1954. The second Pipe Bridge to service the eastern estuary area was completed circa 1911.

The Fifth Hutt Bridge had been built by 1927 to carry the heavier loads being transported to the booming Waiwhetu and Seaview industrial areas. Fourteen major industries were established on the reclamation and adjoining areas over the period 1929 to 1950. The third Pipe Bridge (current Estuary Bridge) was constructed in 1956 to divert the heavy transport load away from the town centre. Plans for a replacement Melling Bridge were first mooted in 1931 although it took 25 years before construction commenced. Bridges built in other parts of the valley during this boom period included the Manor Park Bridge (access to Ford Road, Stokes Valley, destroyed in the 1939 flood), the Silverstream Road and Rail Bridges, the Moonshine and Maoribank road bridges and the Akatarawa Road Bridge.

The stopbanks, promoted and funded by approximately 1000 residents in 1900, protected 45,000 in Lower Hutt and 12,000 in Petone by 1950. Petone was included in the Hutt River Board District in 1947 (see Archive Table 6, p. 53). In contrast to the early Board's small group of highly critical ratepayers, Boards after 1924 received the support of a large number of satisfied residents. This was undoubtedly due in part to the very low river rates and the Board's good fortune not to suffer a design flood, however, much of the credit is due to the pragmatic methods of the Board and its Engineer, Hubert Sladden.

Under New Management

Laing-Meason's Scheme to control the Hutt River had been in place for 20 years when Hubert Sladden accepted responsibility as Engineer to the Board. Commissioning of the scheme had effectively been completed and it was now Sladden's responsibility to develop ongoing strengthening and maintenance programmes.

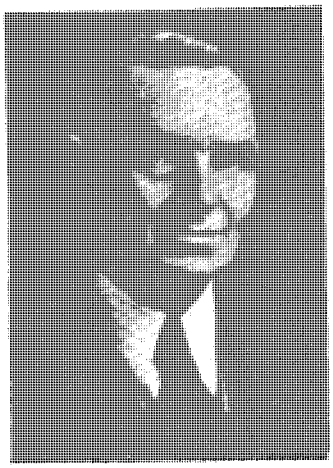


Plate 53: Hubert Sladden. From CAC Treadwell, *The Hutt River - Its History and Its Conquest*, H H Tombs, 1959.

Sladden had served his apprenticeship with Laing-Meason, so it is not surprising that few changes followed his appointment. His reports reflect his confidence in the methods adopted for managing and improving the scheme.

Sladden's success did not stem from new methods but from the good relationship he developed with the Board and the river users. Although few Hutt River Board records now remain, it is clear that in operational matters Sladden enjoyed an autonomy and authority denied to Laing-Meason. For most users the river was managed by Sladden, assisted by the Board Secretary and River Overseer. As a team, they adopted a management style marked by a straightforward, consistent and reliable approach, which although simplistic by today's standards, appears to have served the Hutt Valley well.

Possibly Sladden's greatest contribution was his intuitive appreciation of the dynamics of the natural river system. His "gradual" methods of easing the River into a loosely defined central channel alignment (defined as the "Ultimate Channel" by Laing-Meason in 1903 and extended by Sladden into the Upper Valley) provided the basis for all river control works constructed until 1985.

As can be seen from Archive Table 14, River Management from 1924, p. 99, Sladden built very few large works. The "Ultimate Alignment" was a long-term objective achieved through careful river zone management. Methods used extensively included:

1. **Control of Extraction**

   By capitalising on the high value of the shingle resource. Extractors were required to position their plants to the Board's advantage. The construction of supplementary draglines and dredging for hundreds of metres parallel to the river's course were not unknown.

2 **Construction of Groynes**

   By the use of timber boom groynes. These heavy timber groynes were used throughout the River until as late as 1945. (A pile driving barge was moved up and down the river while the river was in low flood). The groynes were used to cause deposition and to encourage bank erosion in areas where the river was considered too narrow.

3. **Controlled Aggradation**

   By the use of weirs and low embankments to reduce the flow velocity in old flood channels and so encourage deposition.

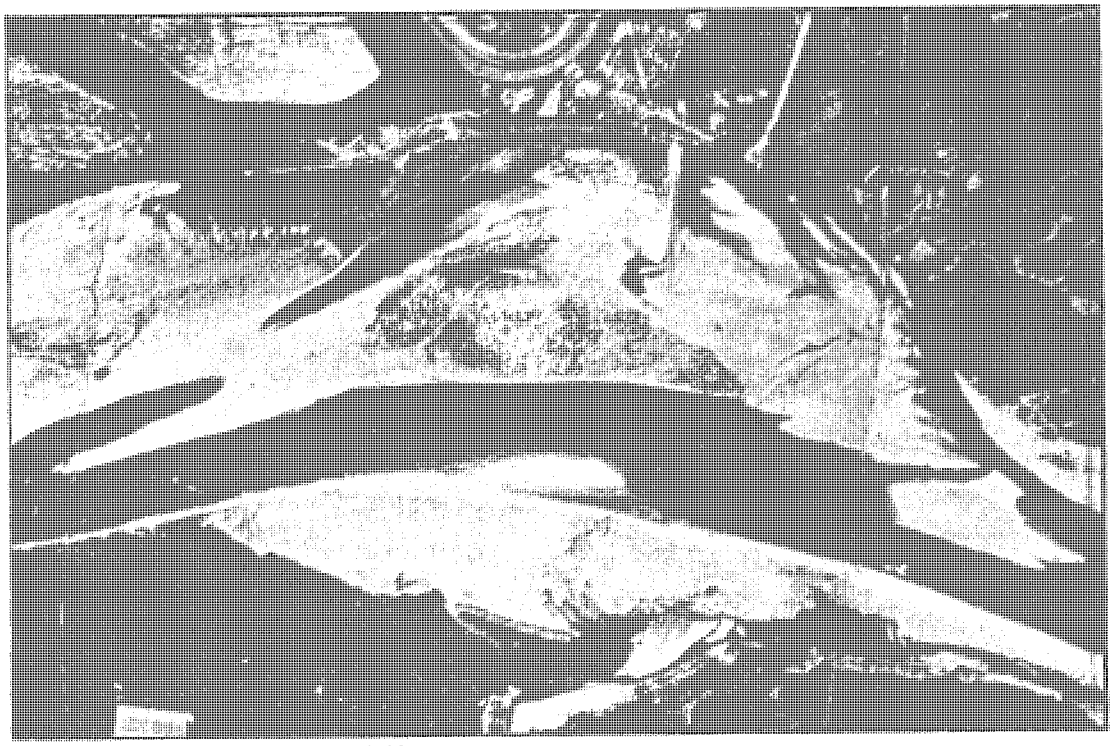


Plate 54: Avalon Area 1949. Source: Mosaic by Hope Cross and Richardson, Masterton.

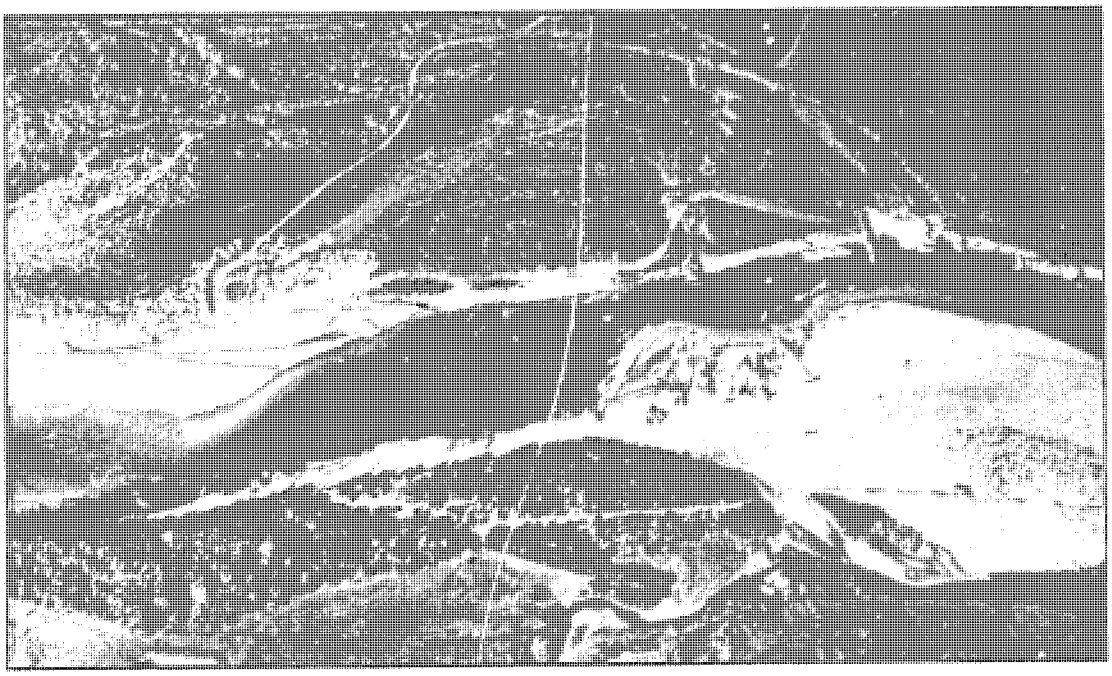


Plate 55: Avalon Area 1955. Source: Mosaic by Air Surveys Ltd.

4. **Isolated Large Works**

   By the use of spur groynes constructed of a variety of materials - mainly rock, concrete blocks, boulders contained in netting and timber boxes infilled with boulders. These were used to reduce flow through old channels and occasionally to redirect flow.

5. **Diversions**

   Through the excavation of pilot cuts (and development of these by blasting) for realignment of the central channel. Sometimes used in association with 3 and 4 above and through the occasional use of cut to fill methods.

6. **Debris Removal**

   Through systematic delogging of the river and removal of stumps, the remnants of the post-glacial forests.

7. **Establishment of Willow Plantations**

   When the river banks reached the Ultimate Alignment, heavy willow planting was carried out with the aim of eventually establishing a continuous belt of willows on both banks. Willow plantings were strengthened during the planting season each winter. New willow plantings were established with the assistance of fascines or tethered plant material held in place with wire, concrete blocks and boulder and netting work.

The development of these works tended to span decades rather than years, with the result that they were often described as "puny" and "ill conceived". For the same reason it is now difficult to locate individual works. For example there is no visible evidence of the substantial works shown in plates 54 and 59.

To appreciate the effectiveness of the Board's river control activities, the development of the river alignment as captured in aerial photographs taken in 1936, 1951, 1967, and 1974 has been recorded in Appendix B. The historical alignments have been copied and rescaled using computer techniques and can be considered as accurate as the original photographic copy. They have been printed over the current (rectified) Scheme Review aerial photography. Distortions copied from the original photography has been accommodated by reference to landmarks. Earlier alignments have also been copied from archive plans and the 1871 and 1903 channels are recorded in figure 8, p. 32. Changes in the river alignment in the lower river prior to 1900 are most probably attributable to natural adjustments following the 1855 uplift, rather than to the activities of the early river Engineers. Archive Table 13, p. 90, Historical River Alignments, contains a schedule of the historical river alignments held in the Wellington Regional Council Land Information computer archives. Figure B.1, Appendix B, is an example of how the alignment data base can be combined with other land information to assist in decision making.

Historical River Alignments

LIST OF DRAWINGS CAPTURED FOR HISTORICAL
PROJECT AND STORED ON THE
WELLINGTON REGIONAL GEOGRAPHIC INFORMATION SYSTEM (WREGGIS)

LOWER HUTT

1871	Gear Island - Melling	Drawing
1899	Estuary - Melling	Drawing
1936	Estuary - Silverstream	Photo mosaic
1950-TOT	Central Hutt only	Drawing
1951-TOT	Estuary - Taita	Photo
1967-TOT	Estuary - Stokes Valley	
1974-TOT	Estuary - Silverstream	Photo
1985-TOT	Works only	Photo

UPPER HUTT

1936	Silverstream - Maoribank	Photo mosaic
1942	Silverstream - Maoribank	Photo
1951	Silverstream - Maoribank	Photo
1967	Silverstream - Maoribank	Photo
1974	Trentham - Maoribank	Photo
1989	Moonshine - Maoribank - Maoribank Works only	

FULL LENGTH

1852	Patchy	Drawing(*)
1867	Patchy	Drawing(*)
1902	Patchy	Drawing(*)
1927	Patchy	Drawing(*)
1989	Riverworks	Photo(##)
1989	Cross Sections and Sight Lines	Photo(+)

BASE DATA

Road alignments, grid lines, etc., available from the WREGGIS

Notes:

(*) = Drawn ny DOSLI onto orthophotos
(##) = Drawn onto 1:2500 orthophotos
(+) = Drawn onto 1:2500 orthophotos and digitised from these

REFERENCE

Archive Table 13: Historical River Alignments

Archive Table 14 (p. 99), River Management from 1924, include reference to the small works undertaken during this period. Many of the small works will be similar to the recent maintenance works carried out by the Wellington Regional Council and detailed in Project Reports 49 to 53 are cross referenced by river section number and also include notations.

The various works referred to in the Archive Tables. The commonly used names for the sections of the river have also been included so that the reader can more readily translate the original archive documents. The Archives are held in the Wellington Regional Council library and are available for reference use.

The major river control works and all stopbanking works are described separately in the project reports contained in Part 2 of this History.

The plates on the following pages show some examples of commonly used training methods. Timber boom groynes were the mainstay protection work from 1870 to 1924 and continued to be used until the late 1960s. Plate 56, p. 92, shows the "floating dams" used to control erosion and damage by flood borne debris. Plates 52, p. 84, and 57, p. 92 show the fixed multibay groynes used throughout the lower River. The Hutt River Board imported quantities of turpentine piles which were driven into the bed using a barge mounted pile driving rig. The rig was used throughout the lower valley and was transported from site to site by dragging it up river during small floods. In this way it was dragged as far north as Taita Gorge.

Plate 58, p. 93, shows the railway iron breastwork used at Gear Island to protect against wavelap erosion. Breastwork such as this was used to line the drainage channel (within the berm areas) and other points of direct attack. The rails were usually lined with manuka "faggots", bundles of manuka wired together as a protective layer. Plate 59, p. 93, shows an example of the extensive netting groynes used in the 1940 to 1972 period. Similar groynes were constructed in Upper Hutt and throughout the Avalon area. Most have either served their purpose and are now buried within the berms, or have failed through abrasion or foundation failure.

Scheme Performance

The first flood to really test the scheme occurred on Good Friday, 18 November 1931 (plate 61, p. 95) Sladden calculated its discharge to be 59,000 cusecs (1666 cumecs), approximately 30 percent larger than the 1915 flood. It is reported that vast quantities of shingle were brought down from the upper reaches, and that damage to the training works was significant, although less than expected. The works were considered to have generally performed well and the channel was considered to have been generally improved by the flood in the sense that it subsequently followed the Ultimate Alignment more closely.

However, there was a near disaster in Lower Hutt. Throughout the night of Good Friday the entire Hutt River Board staff and others battled to secure a willow mattress against the stopbank adjacent to Daly Street (on the eastern bank). The threat to Lower Hutt was sufficiently serious for preparations to be made for a general evacuation, to be signalled by ringing of the town bell.

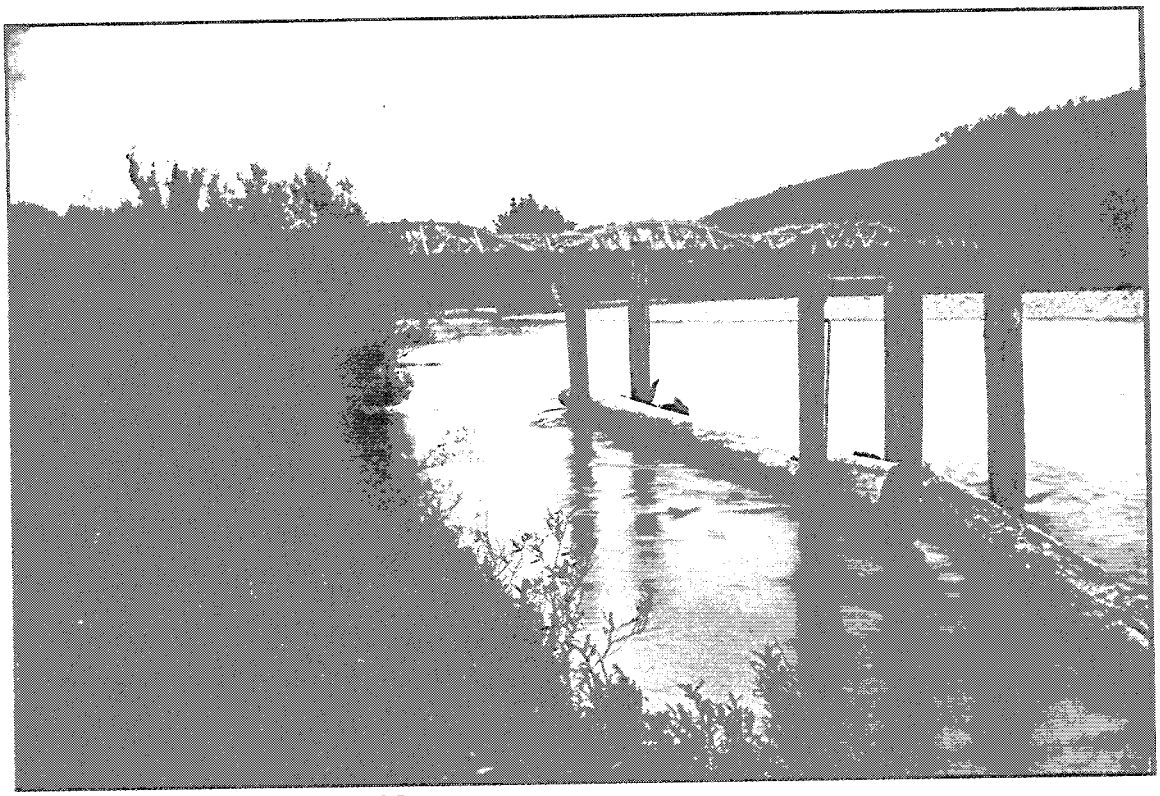


Plate 56: Fourth Hutt Bridge

Source: Alexander Turnbull Library neg. 25983

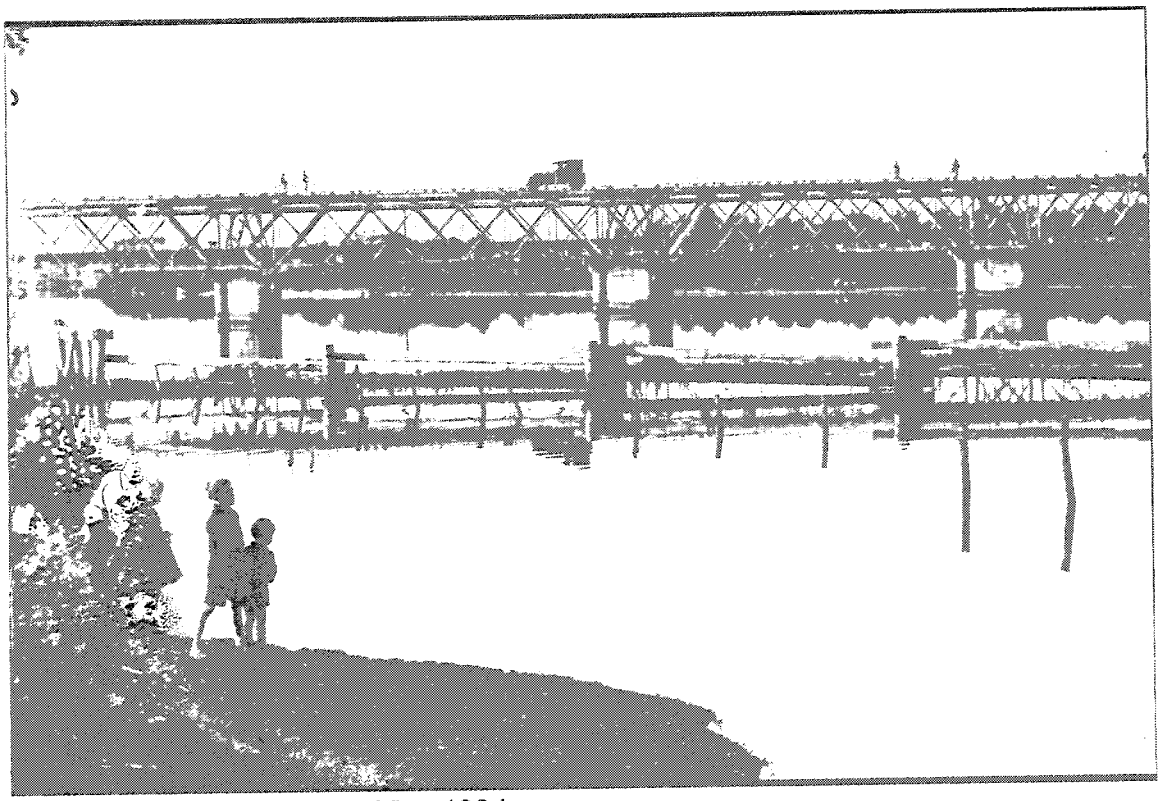


Plate 57: Second Pipe Bridge 1924

Source: Alexander Turnbull Library neg. 48573

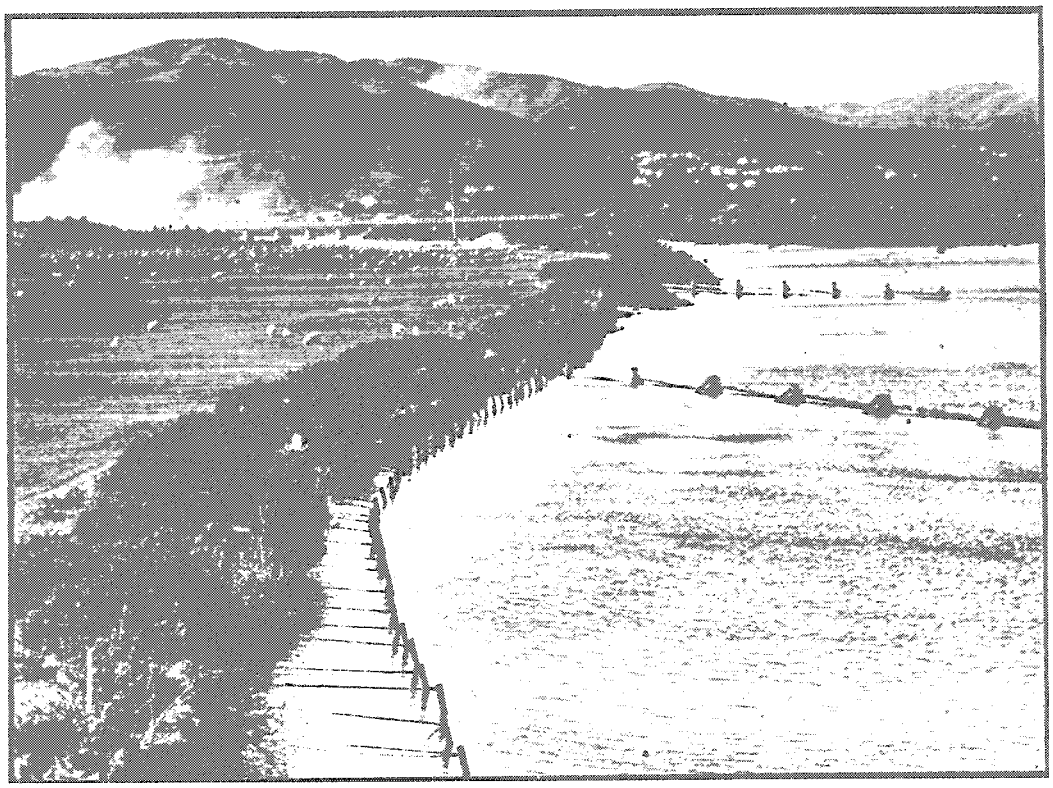


Plate 58: Gear Island c. 1930

Source: Alexander Turnbull Library, neg. C11318 1/1

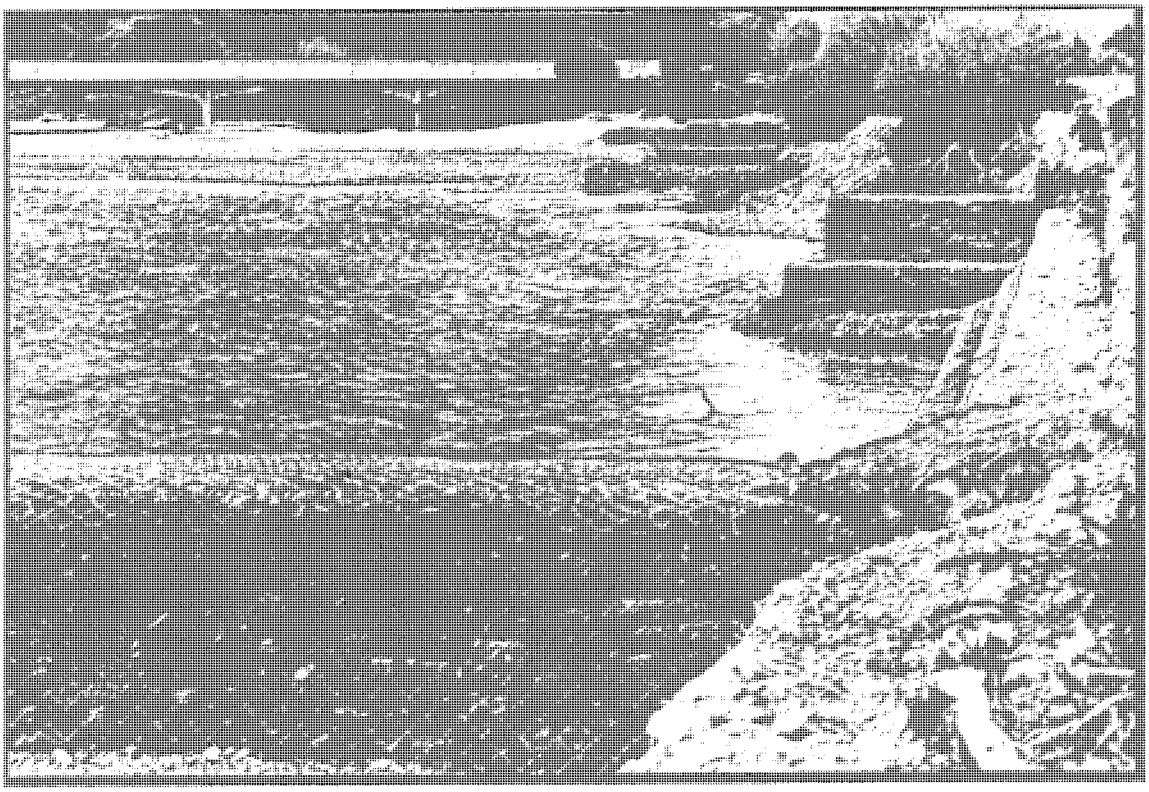


Plate 59: Protection of Eastern Hutt Road c. 1945

Source: Alexander Turnbull Library, neg. C11327

In Moera there was concern as the river rose to within 2 ft (600 mm) of the stopbank crest. Following this flood, repairs to the training works were started immediately, as was an investigation into the raising of the stopbanks from the Hutt Bridge to the estuary. The need to raise the banks was attributed to flood volumes being "much in excess of that estimated when the protective works were designed some twenty years ago."

The Engineer reported that the flood had demonstrated:

(1) *...maximum flood volume has much increased ... as a result of forest denudation ... in the higher reaches.*

(2) *The problem of bed aggradation resulting from moving shingle required careful consideration,*

(3) *The dredging by shingle companies in the lower reaches was of tremendous value.*

Contract documents were prepared for the raising of both banks by 300 to 600 mm from the Hutt Bridge to the Estuary, but with the onset of the Great Depression these did not go to tender. Following requests from the Unemployment Board the proposals were modified to be undertaken by hand, using picks and shovels, horses and drays. For reasons that are not recorded only a small portion of the stopbanks were raised: only 29 chains of stopbank on the east bank south of the Ava Bridge as shown by the 1956 plans HRB 48/3 for stopbank raising in the same reach (see Project Report 3, p. 170).

As in the 1870s and 1890s, a decade of nuisance flooding was followed by an "old man flood" on the 11 March 1939.

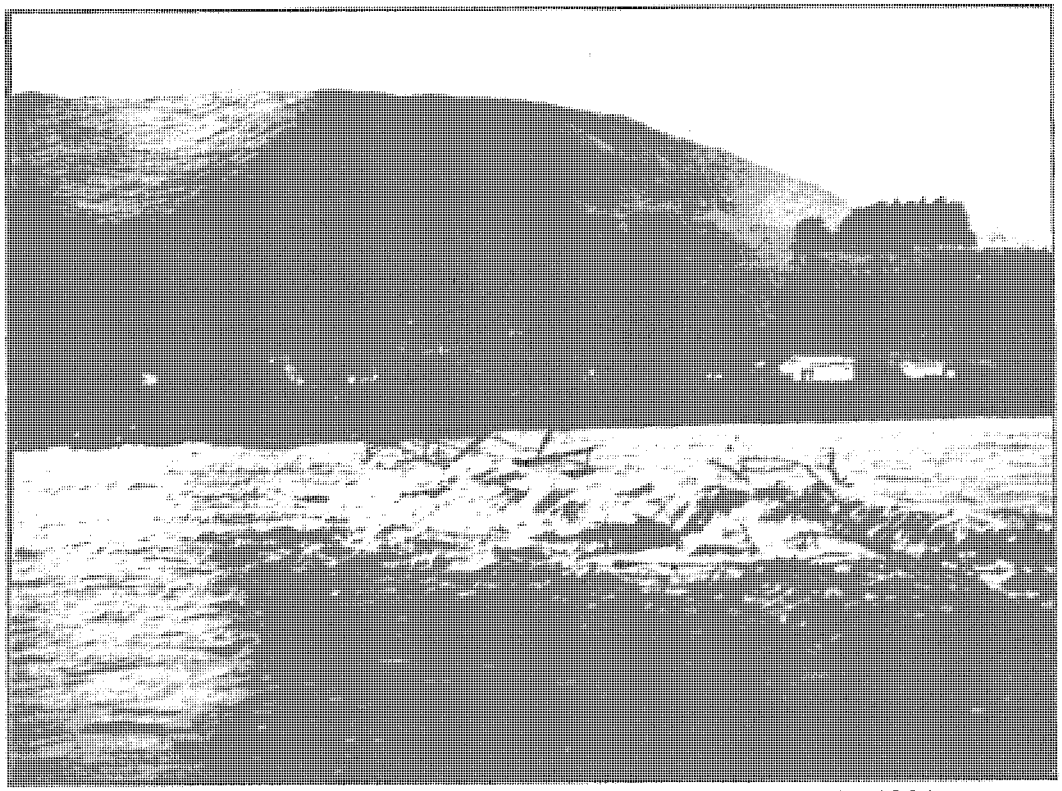


Plate 60: Manor Park Bridge (Ford Road/Georges Bridge), 1931.
Source: Alexander Turnbull Library, Evening Post col. neg. C11331.

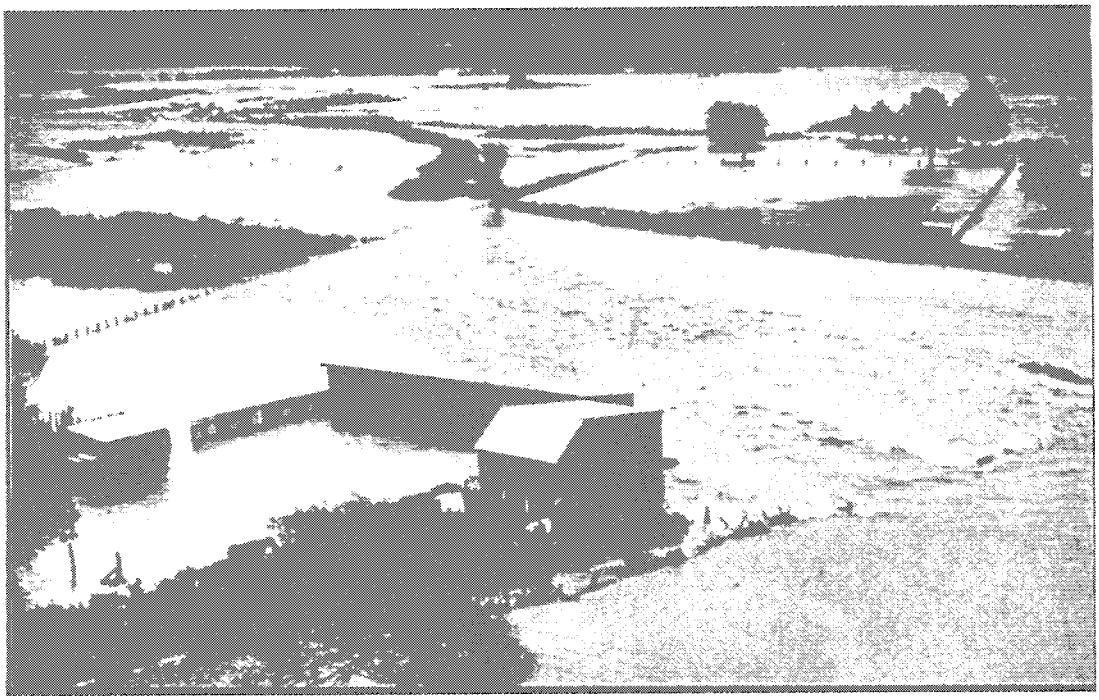


Plate 61: 1931 flood at Silverstream. Source: Treadwell.

Again the flood was described as being the highest on record, computed at 71,000 cusecs, 20 percent higher than the 1931 flood. Lower Hutt escaped flooding by only 150 mm (6") the top of the concrete flood walls at the Ewen Bridge. In many ways the Engineer's reports mirror those on the 1931 flood: improvement to the outlet channel through dredging had apparently allowed a 20 percent larger flood to pass at approximately the same or lower level, there was no damage to stopbanks and generally the damage to training works was no more than could be expected. However, damages in the Belmont reach were severe. For years the riparian owners had argued that the Board's methods were inadequate and for years Sladden had expressed confidence that the gradual process of erosion and deposition would produce a stable channel.

Although the damages in this area are only reported in outline, it is clear that the river reverted to its old eastern channel - close to the present day National Film Unit - for in the following years the Board built a series of substantial spur groynes and breakwaters to help the establishment of new pilot cuts. The Engineer's reports indicate some chagrin at the reversal of control in the area. The adequacy of the stopbanks was again questioned, however, the Engineer reported that:

> *The 2 ft. margin in (the) lower reaches need not be inadequate as the river and channel improvement carried out since 1915 still continues.*

His opinion was that continued extraction would depend on economic factors but that demand was unlikely to decrease. He considered that the channel at the estuary would maintain itself and furthermore he computed the existing banks would contain an additional 10,000 cusecs (282 cumecs) without great risk. Nevertheless he noted that it was desirable to maintain a freeboard of not less than 3 ft above the level of the recent flood. At this time it was the practise to design urban stopbanks with a 3 ft freeboard and 2:1 batters.

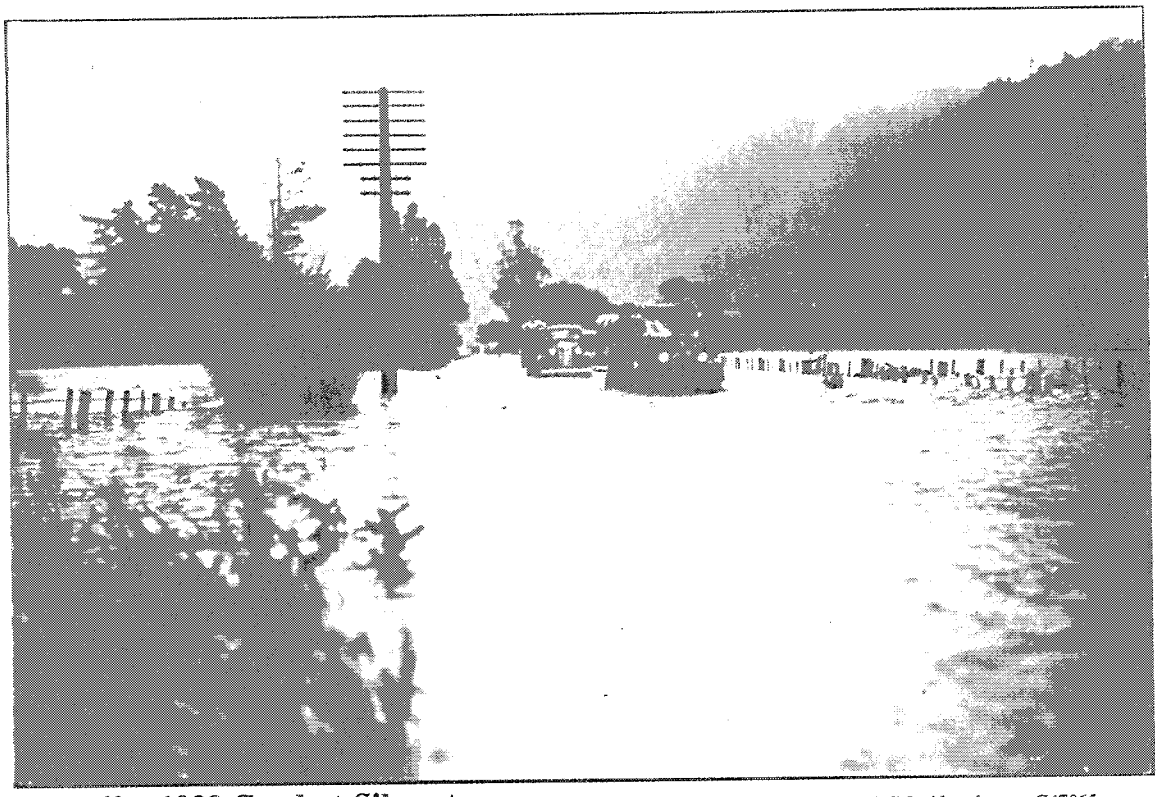


Plate 63: 1939 flood at Silverstream. Source: Alexander Turnbull Library, S C Smith col. neg. G47865.

Plate 62: 1939 Flood at Maoribank. Source: Alexander Turnbull Library neg. G47864

A 2 ft freeboard and 1.5:1 batter was the standard for the protection of agricultural lands.

The Engineer's reports on the 1931 and 1939 floods are paraphrased in Archive Table 19, p. ?, "Flood Observations from 1924". The surprising lack of detail or analytical comment on these and other floods may be due to the Engineer's reliance on observations made by the Overseer or the public. It is possible that Sladden did not observe the high floods as he lived and managed his business from Masterton, outside the River District. Most observations are of receding flood levels in terms of bridge deck levels and other landmarks, and the few quantitative records suggest that the Engineer's conclusions should not be regarded as definitive. Although events recorded after 1941 were monitored by a chart recorder at the position of the Fourth Hutt Bridge (approximately 70 m upstream of the present Ewen Bridge), and later at Maoribank, Taita Gorge, Birchville, Silverstream and Boulcott, discharges which have been assigned on the basis of "rating curves" are unlikely to be accurate due to the rapidly changing bed levels.

Design Standards

From the outset, the design and improvement of the flood control scheme had been pragmatic rather than analytical. The 1900 works appear to have been designed to protect against a repeat of the 1898 floods. The 1933 proposed upgrading was based on the safe passage of the 1931 flood and the engineering response to the 1939 event was similar. Scheme improvements included generous freeboards above the recorded flood profiles so in one sense a conscious allowance was made for larger events.

Prior to the mid-1950s there is no evidence to suggest that an analytical attempt had been made to determine or design for a maximum event. To satisfy his commitment to maintain and improve the scheme Sladden required a knowledge of the flood gradients as measured following the larger floods, and a good quota of engineering intuition. The accurate determination of peak discharge was not required in this era, before cost benefit analyses were necessary to obtain Government assistance.

To gain an appreciation of the comparative size of the historical floods (particularly those of last century) the flood observations and engineer's records have been used to model the historical flood events through computerised river modelling techniques. Table III, p. 150, contains the results of the rerouting study which quantified the observations of the historical floods in terms of our current knowledge of the River Hydraulics.

Chapter Eight, "River Hydrology", contains details of the monitoring and analysis of the Hutt River flood flows undertaken by Sladden. His flood frequency relationship is depicted in figure 21, p. 156, and the rating curve for the Hutt River Board "Hutt Bridge" water level recording site is contained in figure 19, p. 154.

Scheme Improvements 1925-1945

The flood control scheme as designed and implemented by Laing-Meason between 1899 and 1906 remained unchanged until the development of the Taita area in the late 1940s, see Chapter 6, "The 1950s Scheme Review". Until this time the Scheme continued as a flood control system for the Borough of Lower Hutt, with a district extended to Taita Gorge to control river alignment in the rural land north of the Borough.

With the exception of in-channel improvements - and the works required to control the Avalon reach show that these reached major proportion - the only major improvement to the scheme was the raising of the Moera stopbank during the depression years; Project Report 3. The Melling Cut, a diversion cut to remove the dogleg bend at the Melling Suspension Bridge, was considered an essential work but was delayed until the Melling Bridge was replaced in 1956; see Project Reports 5, 6 and 9. It would appear the successful conveyance of the 1939 flood postponed the completion of the stopbank raising as proposed after the 1931 event, and instilled a sense of confidence which delayed further improvements.

Recreational and Residential Developments 1925-1972

As the flood control scheme progressed, large areas of land were vested in the Board for river control purposes. Note the steady increase in assets and land values in the statements of accounts, Tables I and II, p. 58. From the earliest years these lands were made available for sports and recreational use. The Johnsonville Golf Club Links on Gear Island, and Strand Park (NZRFU) were the first, in the mid-1920s. As is the case today, there was intense competition for the use of these "reclaimed" areas. The histories of Petone and Lower Hutt referred to in the Introduction, p. 5, contain detail of the sporting and recreational facilities which quickly occupied the River Zone.

The problems of maintaining river lands and the conflict between recreational users and the underlying rivers control use is also evident. As early as 1926 there are Engineers' reports of vehicle damage to stopbanks and records of complaints of gorse and weed growth. Following World War II an ex-serviceman offered his services using a flame thrower to control rank growth. By the mid-1930s the control of vehicle access to the berms was firmly established.

During this period of rapid urban development the stopbank system was under attack from without, as well as within. Residential developments pushed hard up to the embankments and in a number of cases the stopbanks were excavated and supported with retaining walls. Most of the old retaining walls which now appear to have been constructed to prevent the encroachment of the stopbanks were in fact built long after the stopbanks had been constructed. The granting of authority to permit such encroachment onto an essential public work is an indication of the confidence then placed in the security of the flood control scheme. Archive Table 14 contains reference to some examples of River Zone encroachment which took place during this period.

River Management from 1924

(Codes refer Archive Table 2, p. 7)

B34: 1924: SSPHRB6: 1270-1280
Diversion Cut Contract for 4 chain length of diversion cut 30 ch. downstream of the Silverstream Bridge. 9 ft wide at base with side batters of 1.5 to 1, bottom 6" below water level on gradient of 6" in 66 ft. Approx. 350 cu. yds material.

B35: 1924: SSPHRB6: 40
Waiwhetu outlet channel specification for construction of a timber-lined channel to form the outlet for the Waiwhetu Stream.

B36: 18 Aug 1924: SSPHRB6: 140
Proposal from Engineer to repair a boom groyne at Jorgensen's Bend.

B37: 10 Sept 1924: SSPHRB6 from Engineer's monthly report.
Proposed protection works:
(1) Protection works at Huse's property (1080) near Haywards, including 225 ft long weir to close old channel;
(2) Protection works at McLaren's property at Melling;
(3) Develop Adam's point (430) cut through sale of spoil from top end;
(4) Page's land (1110) - small weir across flood channel;
(5) At downstream end of Dickie's (980), modifications to boom groynes built on contract - lowering at downstream end, shingle must not be removed from between groynes, extractor directed to another beach.

B38: 10 Oct 1924: SSPHRB6 from Engineer's monthly report.
Recommending: (1) Curtail some groyne construction until the following season; (2) Require contractors who screen in the river to place oversize material back into holes at the heads of groynes; (3) Use explosives to loosen areas that the Board wishes eroded.

B39: 14 Nov 1924: SSPHRB6
Plans from Laing-Meason (first Engineer to HRB) estate delivered to SSP from Engineers Mr Silver and Mr Truebridge.

B40: 16 Feb 1925: SSPHRB6: 690
Boom groynes at Stellins (Avalon) to close off old channel.

B41: 16 Nov 1925: SSPHRB6 from Engineer's monthly report: 200
Groynes placed along the bank of Gear Island to encourage erosion no longer required because of P.W.D. excavation for the Ava Rail Bridge.

C20: 21 Jan 1926: SSPHRB6
Gorse growth on stopbanks.

B42: 12 May 1926: SSPHRB6
A report from Mr Smith, Board Member, of the success of Osier species and general plantings.

B43: 7 June 1926: SSPHRB6: 200
In development of the Ultimate Channel at Gear Island the Engineer will be required to mark on the ground where erosion is to be halted by willow planting.

B44: 30 June 1926: SSPHRB6 from Engineer's monthly report: 200
Recommended dismantling of some groynes from Gear Island and storage for later reerection after Railways' borrowings for Ava Bridge construction. Wire and willow work required in several parts of the river.

B45: 4 Aug 1926: SSPHRB6 from Engineer's monthly report: 410-430
Adam's cut to be blasted along entire length. Remove part of railway siding which is no longer in use.

B46: 15 Oct 1926: SSPHRB6: 410-430
Engineer requests permission to scoop Adam's cut after the blasting; 6 ft wide over its length.

B47: 1928: SSPHRB6: 30-330
Plan showing "Ultimate Channel" from old Hutt Bridge to Harbour.

C21: 24 Jul 1928: SSPHRB6: 250
Excavation of stopbank at Clark and Coutts plant for shingle storage bins.

E12: 10 Aug 1928: SSPHRB6: 540-550
Culvert through stopbank from Fry's Lane. Plan on file.

C22: Nov 1928: SSPHRB6: 540-550
Reinstatement of stopbank at Fry's Lane.

E11: 1929: HRB8/7: 320
Completion of sixth and present Ewen Bridge. Note that the previous (fifth) bridge stood for many years before partial removal.

C23: 8 Jan 1929: SSPHRB6: 540-550
Details of stopbank retaining wall - Fry's Lane.

C24: 30 Apr 1929: SSPHRB6: 140
Record of erosion to stopbank downstream of Jorgensen's Bend

E13: 27 Aug 1929: SSPHRB6: 170-200
Outlet from Randwick Road stormwater downstream of Ava Br.

B48: 10 Oct 1929: SSPHRB10:
Reports; disease in willow growth; general works.

E14: 19 Oct 1929: SSPHRB6: 300-310
Stormwater outlet, end of Market St, Lower Hutt.

C25: 1 Dec 1930: SSPHRB6
Potter encroachment on the stopbank near Shearers remedied with a concrete retaining wall.

E15: 30 Dec 1929: SSPHRB6:120-200
Showing location of culverts beneath stopbank between Ava Bridge and Jackson Street, on right bank.

E16: 28 Mar 1930: SSPHRB6
18" culvert south of Ava Bridge, LHBC.

E17: 27 Jan 1931: SSPHRB6
Stormwater from Pirie St subdivision.

C26: 10 Feb 1931: SSPHRB6: 560
Final agreement to lower the stopbank at Troon Cres - Boulcott Farm Subdivision - to 18" above the terrace. H.R.B.previously refused to allow lowering at all. Stopbank originally 5' 6" above terraces.

B49: 19 May 1931: SSPHRB6 and 10
River works to repair flood damage.

C27: June/July 1931: SSPHRB6
Specifications and plans submitted to the Board, by the Engineer, for stopbank raising and repairs to existing concrete flood walls between the mouth and the Hutt Bridge.
(Note, however, that these works were not carried out until in a modified form in 1956 - except for raising the eastern stopbank between Black Creek and the Ava Rail Bridge in 1933.) Estimate for the raising;

Stopbank raising	£4585
Concrete wall	£400
Boom groynes	£1015
Total	£6000

* includes protection work at the Convent - £700

B50: 12 Sept 1932: SSPHRB6: 100-270
Wave lap erosion in lower reaches as result of bed lowering.

E18: 22 Dec 1932: SSPHRB6: 130
Drains from fellmongery and scouring works, Moera.

C28: 1932-33: SSPHRB6: 130-200
Raising of a section of the eastern stopbank, between the Ava Rail Bridge and the Black Creek, using Unemployed Relief Labour.

B51: 1933: SSPHRB8: 1400-1780
Contains detailed description of Hutt River (including works required to achieve channel control) from Silverstream to Moonshine.

B52: 12 May 1934: SSPHRB6: 1180-1400
First plan of Ultimate channel alignment from the Haywards suspension bridge to Silverstream. Prepared by Sladden.

B53: 24 July 1934: SSPHRB6
Report by Engineer re replenishment of materials for boom groynes. 100 poles required at cost of £333.

E19: 10 Jul 1936: SSPHRB6: 110-460
Power cables in stopbank, Melling Bridge to Pipe Bridge.

B54: 10 Apr 1937: SSPHRB6: 380-410
Development of cut (Kingdons beach) through blasting.

E20: 10 Jun 1937: SSPHRB6: 510-520
Power cables in stopbank, Ariki Street to Connelly Street.

Archive Table 14: River Management from 1924. Codes; I.D. : Date : Source File : Section #s.

River Management from 1924

(Codes refer Archive Table 2, p. 7)

B55: 1938: SSPHRB8: 1400-2300
Detailed description of channel from Silverstream to Maoribank.

E21: 10 Feb 1939: SSPHRB6: 250
Strand Park - laying of 15" pipe within original pipe to drain HV High School.

E22: 29 Feb 1940: SSPHRB6: 180
Ministry of Housing - intention to jack new culvert beneath stopbank at Randwick.

B56: 17 Apr 1940: SSPHRB6 from Engineer's monthly report.
Construction of a stone spur on the left bank near the downstream end of the Belmont Diversion Cut (680). A stone spur on the right bank at Belmont (700 or 760). A stone spur at Augusts (900).

B57: 25 July 1940: SSPHRB6: 470
Melling diversion cut first discussed. Dependent on the Lower Hutt Borough Council replacing the (old) Melling Suspension Bridge and the NZR plans to retain the Wairarapa Line on the west bank. The Engineer said the Melling Cut would result in a lowering of flood levels:

(1) Ponding occurring because of the existing bends;
(2) The cut would enable progressive lowering of the bed upstream. Up to now there had been considerable improvement up to Melling but little improvement from there up.

B58: 8 May 1941: SSPHRB6 from Engineer's monthly report.
Re Left Bank between Native Land and Kells' (800-850). Flood waters go in large volumes through low ground to Mabey Road. A small stopbank several chains long advisable. Specification prepared for contract. Another small stopbank advised near Mabey Road across a low area where floods sweep through. The Melling railway siding to be repaired again following flood damage several months previously.

B59: 24 Sept 1941: SSPHRB6 from Engineer's monthly report : 680
Proposed river control work at Stellins.
(1) Low stone weir of about 4 chains required to prevent flood waters that lead into the bead of the golf links.
(2) Engineer hopes that the Board's powers under the Soil Erosion Bill will allow the Board to control destruction of willows where landowners decline to cooperate.

B60: 18 Dec 1941: SSPHRB6 Engineer's report.
The Melling Cut will be required if improvement above Kingdon's Beach to be achieved. Should be done as soon as possible. If delayed, the shingle that will flood down after the cut is made will lead to deterioration in the lower channel. Cost of maintaining the Melling protection works is high.

B61: 2 Sept 1943: SSPHRB6: 850
HRB. request Downers for a price to divert the river at Giesen's, near Belmont - see Plan No. HRB 43/1. Bank erosion following a small fresh was threatening the Certified Concrete Plant: a cut to be carried out immediately to "relieve pressure" on the bank. Certified cast concrete blocks to be placed in a groyne, and paid half cost of works. 5,100 cu. yd. excavation completed 17/11/43 for £255.

B62: 28 Oct 1943: SSPHRB10A
Protection works at Avalon.

E23: 1 November 1943: 100
PWD initiated meetings of engineers to discuss the proposed new pipe bridge at the river mouth.

C29: 27 Mar 1944: SSPHRB6: 340
from Engineer's Monthly Report:
Unauthorised excavations have been carried out into the stopbank behind Munday's (late Gadsby's - southern High Street area) and south to the concrete wall. Recommended that the bank be restored to its original slope as far as possible. Carried out by 24 April 1944.

B63: 3 Nov 1944: SSPHRB6: 1080
PWD construction of embankment and block groynes across old flood channels at Routley's (Taita Block).

C30: 24 Mar 1945: SSPHRB6: 890-1080
from Engineer's Monthly Report:
Flood embankment in conjunction with Housing Department works constructed from Routley's to August Bros, [approx Pomare Bridge to Fraser Park in present day terms] for the purpose of closing off the old flood channels. The works ultimately to be included in the "major scheme" of protective embankments then in preparation.

B64: 21 May 1945: SSPHRB6: 790-870
Cut 3 at Giesons (Belmont). Developed 28/8/45

C31: 28 May 1945: SSPHRB6
Estimate for raising banks from Melling to estuary presented

C32: 10 Sept 1945:
Plan showing occupancy and titles to stopbank area, High Street, Lower Hutt at 10/9/45.

C33: 23 Oct 1945: SSPHRB6 - minutes of Board Meeting.
Discussion of plans for:
(1) stopbank raising from the mouth to Melling,
(2) stopbank construction from Melling to Taita.

Preliminary discussions and survey attended to. Government representatives were of the opinion that the HRB should give thought as to what contribution would be offered by it toward the cost. Estimated cost of works £212,000. All members agreed that the work should be carried out by PWD. The Engineer and Solicitor to be actively concerned with matters of construction and acquisition of land (but not with design or process of purchase - see later entry).

Amount of HRB contribution suggested to be £35,000. A further report to be submitted by the Engineer and Solicitor to a 30 October meeting.

C34: 30 Oct 1945: SSPHRB6 - minutes of Board Meeting.
Mr A P Grant (PWD) stated that as all land would be in the name of the Board, the PWD would welcome the assistance of the Board's legal advisers.

The members resolved to contribute £35,000.

Board's Statement of Accounts shows surplus of £15,500.

C35: 11 Dec 1945: SSPHRB6 - letter from Board Solicitor.
Reply from PWD on Board resolution.
(1) PWD considering the proposed HRB contribution,
(2) PWD want to complete the work over two years. This will make it impossible for the Board to pay for the work out of revenue as desired unless PWD will bear the initial cost and accept payment over a period.
(3) PWD will be pleased to associate with Mr Sladden,
(4) PWD consider it premature to start negotiate land purchase despite two year construction period,
(5) PWD consider the exchange of correspondence.
satisfactory - no formal agreement required.

B65: 1945-1950: WRWB 8/7
PWD report on upper valley scheme, J Hunt Sept 1953

B66: Circa 1945: 1820
Newton St (UH Borough) stopbank. 30 ch to protect land between Newton St and main road. Overtopped frequently. Abandoned when Newton St abandoned. Presumably built by PWD.

B67: Circa 1945: 1880
Low groyne built across Buckletons overflow to prevent flows down old channel.

B68: 1946: 2100
Ebdentown Rd, UH. A new channel constructed and substantial shingle groyne upstream across the old channel. Renewed 1953.

B69: 1946: 2060-2110
McCurdys stopbank. Half mile long on north side of the river opposite Ebdentown Rd. Bisected by flood circa 1948-51

B70: 1946: 1930-1940
Buckletons stopbank. Golders road to Whakatiki Street (now Masefield). 6 ch groyne of stopbank dimensions at right angles to the river and along the bank parallel to the river for a short distance upstream. To prevent shingle deposition and erosion.

C36: 31 Oct 1946: SSPHRB6
Letter from PWD to HRB expressing concern that the initial stopbanks at Taita are being eroded, in what is in effect the position of the future stopbanks. (The location a little to the north of the PWD fitting shop at the Taita Housing Block.) The HRB requested to open the right bank channel and to construct a low but substantial weir across the left bank channel to assist in building up and closing off the channel. The weir to be added to as the infill takes place.

C37: 26 Dec 1946: SSPHRB6
Letter from PWD re Scheme.
Confirming Sladden's opinion that the risk of flooding has not increased but has improved as a whole due to bed lowering, etc. Sladden was of the opinion that increased development warranted increased protection.

Archive Table 14: River Management from 1924. Codes; I.D. : Date : Source File : Section #s.

River Management from 1924

(Codes refer Archive Table 2, p. 7)

B73: 12 Aug 1946: SSPHRB6: 470-480
Hire of bulldozer from Downer and Co for cross blading work at Melling.

B74: Sept 46: SSPHRB32: 400
Bed lowering causing subsidence of banks at Convent, LH.

B75: 22 Sept 1947: SSPHRB6 from Engineer's monthly report
Works carried out after June flood. Repair Work Required: a very large volume of shingle moved by bulldozer in the reach from the Native Land to Mabey Road (750-850). 16 chain of substantially constructed willow and cable work with heavy stone gabions required on the left bank from Bognuda's to Mabey Road (740). Willow planting to 4 chains downstream of Mabey Road. Heavy gabions and willow work at the Belmont Extension (760-790).

B76: 1947/48: SSPHRB41: 550-620
Cut at golf links (Boulcott) 22.5 ch 12,500 cyds.

E24: 10 Mar 1948: HRB8/7: 460
H.R.B. concern over protection of Melling Suspension Bridge. (H.R.B. wanted old bridge demolished to make way for proposed Melling diversion Cut).

B77: 21 June 1948: SSPHRB10 from Engineer's monthly report: 650
A netted boulder groyne 5 chains long built on the boundary of the Golf Club and Stellin's land 550 cu. yds of boulders, 1500 sq yds netting, cost 9.750.

B78: 1948: SSPHRB10: 1170-1270
Subsidised river works at Manor Park Golf Club. Soil Cons and Rivers Control Council/HRB cost split 2:1

(a) reduction of left bank shingle spit £470
(b) netted boulder groynes £900
(c) willows and gabions £825
(d) remainder £515

B79: 24 April 1949: SSPHRB10 from Engineer's monthly report.
All works carried out following floods of 1947-48 are proving satisfactory and all cuts developing well. Reach from Pitcaithleys to Belmont Extension suffered severely in June 1947 flood (750-900).

E25: 27 Sept 1949: SSPHRB6
Alignment of Pomare Bridge piers.

B80: 1949: SSPHRB41
Diversion cut at Melling - long section & cross section. Cut at Pitcaithleys - 19 ch, 5400 cyds.

B71: 1949: 1680-1170
Bartons Bush diversion cut and stopbank. To prevent erosion to Bartons Bush. High enough to contain 100,000 cusec flow in lower end but lower upstream to allow overflow and deposition in the old channel.

E26: 22 May 1950: HRB8/7
HRB approval of Melling Bridge.

B81: 27 Mar 1950: SSPHRB10 from Engineer's monthly report.
Progress made in "snagging-in" the lower reach below Melling (i.e., removing snags).

E28: 24 July 1950: 490
Details recorded of pipeline beneath the stopbank at Mills Street.

B72: Dec 1950: 1900-1940
Contract let calling for the removal of 2/3rds of Buckletons bank and formation of 36 ch radius stopbank. Included partial stabilisation of channel upstream at Whakatiki Shingle.

With the exception of McCurdy's stopbank these works appear to have been built by the PWD. Their failure to prevent continued damage led to UHBC dissatisfaction with PWD measures and led to overall scheme.

B82: 1950-55: SSPHRB52
Re Melling diversion cut.

B83: 3 Jul 1953: SSPHRB6: 830-850
NZR tipping blocks at Giesons (Belmont)

C38: 16 Oct 1953: SSPHRB6: 1050-1080
Housing Construction Div. (PWD) to HRB.
Seeking permission to alter the alignment of the stopbank to permit the extension of Taita Drive North. Alteration to be over 8 chains - maximum shift 34 ft.

E29: 17 Mar 1954: HRB8/7
HRB suggests Melling Bridge be called "Sladden Bridge".

C39: Jan 1955: SSPHRB6
Plan of a proposal by the LHCC for manual floodgates to allow the Andrews Ave ramp to be lower than the stopbank.

B84: 1955: SSPHRB61: 1980
Riverbank protection at McLeod St, UH.

B85: 1955: SSPHRB63: 740
Diversion and pilot cuts, Mabey Rd, LH.

B86: 1955: SSPHRB66: 700-900
Channel alignment at Belmont.

E30: 15 March 1955: 330
Request from HRB to LHCC to remove old Hutt Bridge piers.

B87: 22 Mar 1955: NA96/298000: vicinity 710-810
PWD internal report. Diversion cut and netted boulder weir required near B Webb's shingle plant after recent floods outflanked or destroyed willow work. Willows difficult to maintain.

16 chain diversion cut, involving 13,850 cu. yds @ 2/3 = £1568
Netted boulder weir, approx. 375 cu. yds @ 30/- = £562
Engineering and contingencies = £250
2:1 subsidy approved

E31: 4 Apr 1955: SSPHRB6
11 kV cable to cross stopbank. Plans included.

C40: 8 Jul 1955: SSPHRB6: 130
Elbe Products Ltd - tannery at Moera.
Request permission to build between the stopbank and river. They are aware that the HRB may wish to increase the height of the stopbank and accept that the factory wall adjacent to the stopbank be designed and built as a retaining wall so that the bank may be raised against the building and the windows be bricked up for the same purpose.

C41: 11 Jul 1955: letter from HRB Chairman.

(1) A scheme to raise and strengthen the existing stopbanks has been decided upon,

(2) The channel has deepened by over 12 ft. since 1900. This has been brought about by dredging and realignment,

(3) Notwithstanding this, stopbanks should be strengthened to give a margin of safety should a flood occur which is larger than has been experienced in the past.

(4) Following a request by the HCC and UHBC an application has been lodged to extend the Hutt River District to the Wellington City and Suburban Water Supply Catchment boundary,

(5) In the past river improvement works, including warning devices, had been carried out by the PWD,

(6) During recent months the HRB has been employed by the UHBC to construct protective works in certain areas threatened by erosion. However, these works do not reduce the risk of flooding to houses in low lying areas.

C42: 15 Aug 1955: SSPHRB6
Appointment of Mr Mackie as the Classifier of the HRB's new District.

C43: 13 Oct 1955: SSPHRB6
The HRB accepts the stopbanks constructed by the Dept of Housing at Taita, provided that certain repairs -trimming, topsoiling and grassing - are carried out.

Archive Table 14 cont: River Management from 1924. Codes; I.D. : Date : Source File : Section #s.

River Management from 1924

(Codes refer Archive Table 2, p. 7)

C44: 1 Nov 1955: SSPHRB6
HRB to LHCC re Taita Drive Extension.
Proposed scheme considered premature and should be deferred in the meantime. HRB policy is to refuse to approve permits for building on land subject to flooding. As the Engineer is in consultation with the SC and RCC on the ultimate alignment of the stopbank, the HRB cannot see its way clear to approve the scheme at present.

C45: 1956
Commencement of the first section of the Hutt Scheme; stopbank raising from the Pipe Bridge to the Ewen Bridge.

E32: 13 Jan 1956: SSPHRB6
HRB/HVEB general agreement for laying of cables in stopbanks.

C46: mid-1956: SSPHRB6
Letter to the Commissioner of Crown Lands requesting that land at Taita, including the stopbanks and berms, be vested in the HRB. The ultimate aim is to make the berms available to sports bodies, etc., but in the meantime the river is not under control, and it will be necessary to remove shingle from the area for some time.

C47: 12 Sept 1956: SSPHRB6
MOW to HRB re Taita Gorge Road realignment. Realignment of Taita Gorge Road as a 4 lane highway; request permission to dispose of fill at the mouth of the Stokes Valley Stream, to a level slightly above the 100,000 cusec flood level. Also will have 70,000 cu. yds of fill for use in stopbanks.

C48: 16 Nov 1956: SSPHRB6
Request from LHCC for a river and stopbank cross section upstream of the Ewen Bridge so that it can finalise the southern entrance to the car park.

B88: 1957: SSPHRB68: 2180-2230
Clearing diversion channels at Maoribank.

E33: 1957
Melling Suspension Bridge demolished. New Melling Bridge opened.

C49:11 Feb 1957:HRB8/7: 410-460
LHCC request that stopbank be realigned so that the Melling approach roads can be built.

B89: 1 May 1957: SSPHRB69
Report on Hutt River Control Scheme, Silverstream to Maoribank.

C50: 8 May 1957: HRB8/7
Alterations to approaches to LHCC amenities required after stopbanks raised from Ewen Bridge to estuary.

C51: 8 Oct 1957: SSPHRB6: 280-300
Plan of encroachment of buildings, Mudie Street, Lower Hutt

E35: 27 Jun 1958: HRB8/7: 110-120
Demolition of old Pipe Bridge.

C52: 1 Sept 1958: SSPHRB6
Velocities on berms.

C53: 1959: SSPHRB6: 460-480
Melling Diversion Cut, Stage I; part of the Hutt Scheme.

C54: 29 Jan 1959: HRB8/7
Stopbank alteration, part of Melling Bridge construction.

E36: 29 Apr 1959: HRB8/7
Drainage channels from Fraser Park to river across berms.

B90: 25 May 1959: WRWB 8/7 26/5/77: 460-480
Melling Diversion Cut - Proposal as explained to LHCC.

(1) Carried out in two major stages,
(2) First stage a 50 ft wide pilot cut at normal water level, completed in 10 weeks.
(2) When completed had a minimum width of 200 ft and easy batters.
(3) Excavation was from just north of the (existing) Melling Bridge to a point 24 chains north. Included construction of a weir in the bed of the old channel, and willow planting, to assist in developing the alignment.
(4) The bulk of the material from the first stage was taken by the LHCC for raising the level of council land at Taita Drive. By the 17 August 1959, 22,000 cu. yds taken.

C55: 29 Sept 1959: HRB8/7
Removal of old Melling Stopbank as part of new Melling Bridge construction.

B91: 2 Oct 1959: SSPHRB10
Corporation of Invercargill supplied samples of "Spartina Townsendii" grass for transplanting in the estuary of the Hutt River.

B92: 1960: 460-480
Melling Diversion Cut stage II

C56: 1960: HRB17: 460-480
Melling Diversion Cut, Stage II.

C57: 1960: HRB56: 320-430
Start of stopbank raising from Ewen Bridge to Melling.

E37: 19 Sept 1960: 1080-1090
Letter from NZR seeking information to allow N.Z.R. to specify protection works to piles on the Pomare Bridge, now exposed due to bed lowering.

E38: 6 Mar 1961: HRB8/7: 400
24" culvert Rutherford Street.

E39: 24 May 1961: HRB8/7: not located
Record of stormwater outfall near the northern end of the (Eastern) Hutt Road. Plans missing.

E40: 21 Dec 1961: HRB8/7
LHCC letter re flapgates in manholes

C58: 21 Dec 1962: HRB8/7: 560-660
Request for stopbank on landward side of Boulcott and Hutt golf courses.

C59: 1964: HRB17: 460-480
Melling Diversion cut, Stage III (final).

C60: 1964: HRB109: 460-490
Stopbank raising from Melling Road (opposite Brunswick Street) to Mills Street.

C61: 1964: HRB73
Start of stopbank construction at Haywards Settlement (1150-1230). Start of Upper Hutt Major Scheme; stopbanking from Masefield Street to Maoribank (1900-2260).

C62: 1965: HRB116: 210-270
Stopbank slope flattened at Hutt Valley High School.

C63: 1966: 1620-1900
Upper Hutt stopbanking continued; Masefield Street to Wellington Golf Club.

C64: 1966: 1400-1740
Commencement of the "Silverstream Cut"; channel realignment from Trentham Memorial Park to the Silverstream Bridge (in anticipation of proposed roading works).

C65 :1969: HRB117: 660-740
Stopbank construction form Boulcott Golf Course to Mabey Road.

E41: 4 Jun 1970: HRB8/7: 130-140
25" diameter stormwater from UEB site, Randwick Road.

C67: 16 Feb 1972: HRBgeneral: 2060-2050
Totara Park stopbanks partly accepted.

E42: 11 May 1972: HRBgeneral: 300-330
11 kV/400 V cable in stopbank at Marsden Street.

B93: 31 Oct 1972: HRB GENERAL
Wellington Acclimatisation Society complained that intensified bulldozing in the river bed was disturbing bottom fauna.

B94: 16 Nov 1972: HRB GENERAL reply to B58 from HRB
(1) Most shingle plants operating in Upper Hutt in conjunction with the major scheme.
(2) Belmont to Taita - an even bed must be maintained with normal water level as high as possible to provide as much head as possible on the aquifer; reducing pumping costs and the risk of sea water intrusion.

E43: 21 Dec 1973: WRWB8/7:
LHCC 10" water main across river at Belmont.

E44: 8 Apr 1974: WRWB8/7:
Proposal from HVDB to lay sewer main in the river bank at Harcourt Park, Upper Hutt, within 1 chain of the river.

Archive Table 14 cont: River Management from 1924. Codes; I.D. : Date : Source File : Section #s.

River Management from 1924

(Codes refer Archive Table 2, p. 7)

E45: 2 Dec 1974: WRWB8/7: 1350
Sewer crossing, Silverstream.

B95: 3 Dec 1974: WRWB 8/7: 2270-2390
At Totara Park, upstream of Maoribank Bridge, a 2 chain reserve recommended for erosion protection, plus allowance for a stopbank to cope with an 85,000 cusec flood.

B96: 23 May 1975: WRWB 8/7
Flood damage to the Silverstream Cut (1490). Degradation at Pomare (1080-1090).

E46: 3 Nov 1975: 2750-2770
Mangaroa Bridge Approaches.
MOW calculations for design of waterway and bank protection; details of proposal for approval.

E47: 9 Dec 1975: WRWB8/7: 330
Details of extension of a sewer from Marsden Street into the HVDB main, on right bank upstream of the Ewen Bridge.

E48: 7 Jun 1976: HRB8/7: 230
Fitzherbert St 4' culvert relaid north of Ava Bridge

E49: 6 Sept 1976: WRWB8/7: 90 south
NZPO phone duct along foreshore of reclamation.

E50: 5 Oct 1976: WRWB8/7: 240
Plan of position of LHCC stormwater pipe through stopbank at Wakefield Street/Mudie Street intersection.

E51: 13 Oct 1976: WRWB8/7
Plans showing position of HVDB main sewer through Wellington Golf Club.

E52: Feb 1977: WRWB8/7
Details of stormwater design for Upper Hutt subdivision.

E53: 31 May 1977: WRWB8/7
Plan of 450 mm dia. stormwater north of Pomare Bridge, through stopbank and into river.

E54: 31 May 1977: WRWB8/7
Permission given by WRWB for HVEB to lay a gas main in the top of the stopbank between the Ewen and Ava Bridges as an alternative to laying the pipe in Alicetown streets (not shown on service plans).

E55: 27 Jun 1978: WRWB8/7
Plans of stormwater lines in the berm, associated with roading improvements on Harcourt Werry Drive and Percy Cameron Street.

E56: 14 Jul 1978: WRWB8/7: 190
Record of HVEB 100 mm pipe supplying Petone, crossing Hutt River south of Ava Bridge. Recently exposed and laid back into the river bed. Alterations made to allow this river crossing to be shut down during emergencies.

E57: 28 Aug 1978: WRWB8/7
750 mm stormwater main from Pomare Station Car Park to river. LHCC plans SD2855-2858.

C68: 1980-81: WRC8/31/1: 1160-1190
Stokes Valley Stream outlet channel auxiliary stopbank constructed.

C69: 1983-84: WRC8/7/18: 2560-2590
Parkdale Subdivision stopbank constructed.

B97: 1983-84: 680-1150
Formation of a concrete cycle track on the left stopbank crest.

B98: 1984-90: 3000-3100
Protection works carried out by Te Marua Golf Club.

C70: 1984: WRC8/7/1: 130
Placement of rip-rap to protect the stopbank at the "Woollen Mills", Pirie Cres, Lower Hutt.

B99: 1984-86: 160-200
Trial of bank stabilisation options, Sladden Park.

B100: 1984 and 1990: 1100-1170
Reconstruction of left bank protection works adjacent to the Pomare Bridge.

B101: 1984-89: 2080-2280
Bank protection works, Totara Park, associated with Bypass River Works.

C71: 1984: WRC8/7/1: 150-200
Black Creek auxiliary stopbank upgrading and protective works commenced.

B102: 1984: 1340-1370
Reconstruction of 300 m of eroded bank by regrading and construction of debris fences, willow planting, toe protection.

B103: 1984-89: 610-840
Replanting of willows.

B104: 1984-87: 1760-1860
Establishment of willows and construction of debris fences along Trentham Memorial Park boundary.

B105: 1985-87: 2430-2520
Stabilisation of Haukaretu and Harcourt Parks, Upper Hutt.

1985-86: WRC8/7/1: 320-330
Protective works at the Ewen Bridge (left bank) to protect the stopbank and the bridge.

1985-88: WRC8/7/1: 100-130
Bank stabilisation commenced at Croft Grove, Lower Hutt to protect the stopbank.

1985-86: WRC8/7/1: 1990-2020
Auxiliary Stopbank constructed at Gibbons Street drainage channel outlet.

B106: 1985-89: 1460-1890 and 2080-2420
Upper Hutt Bypass Road river works.

B107: 1985-89: 2670-2710
Willow planting and debris fences, Twin Bridges, Akatarawa.

B108: 1987-89: 640-720
Willow planting and debris fence construction to protect berm beneath Kennedy-Good Bridge.

B109: 1989: 310-360
Reconstruction of timber groynes and rip-rap work upstream of Ewen Bridge.

B110: 1989: 450-460
Removal of trees from stopbank, Melling Reserve.

B111: 1990: 110-130
Placement of rip-rap at Croft Grove.

Archive Table 14 cont: River Management from 1924. Codes; I.D. : Date : Source File : Section #s.

Chapter Six

THE FIRST SCHEME REVIEW

The "Upper Valley"

1945 to 1970

To the early residents of the Hutt the "Upper Valley" commenced at the Lower Hutt Borough's northern boundary -around Avalon. Although the boundary of Hutt River Board responsibility extended slightly further north to Silverstream its interests lay firmly with its ratepayers south of the Borough Line.

1945 saw the beginning of the end of Hutt River Board parochialism, with the involvement of central government in Board affairs. Principally in the guise of the Housing Department and supported by the Soil Conservation and Rivers Control Council (SC and RCC administered by the Public Works Department) the Government assumed authority for the extension of the flood control scheme under the powers of the Soil Conservation Act 1941.

Government interest in the Hutt was in part driven by a nationwide initiative to extend and improve the management of the country's soil and river resources. Of more importance, however, was the need to reduce Government liability for increased flood levels in central Lower Hutt. Failure of the existing Flood Control Scheme was considered a possibility following Government development of the Taita area and the subsequent closure of the Taita Overflow. The 1971 flood shown in plate 73, p. 121, illustrates the minimal freeboards in the Central Hutt Area, even after the 1956 stopbank raising.

Housing Development in the Hutt

In 1935 the Coalition Government instigated a nationwide housing survey in order to address New Zealand's critical housing shortage - a problem which had existed since the 1880 depression and had been exacerbated by the depression of the 1930s. The subsequent national housing plan called for the construction of houses in 150 centres throughout the country. Lower Hutt, Wellington and Orakei (Auckland) were the main areas for this expansion. Through the Department of Housing, formed in 1936 by the newly elected Labour Government, construction started in Waterloo in 1938 and had spread through to Taita, with 5400 dwellings constructed, by 1950.

The new suburbs of Lower Hutt were located on land which as late as 1898 had been major floodways. The land south of the (present) Pomare Bridge was previously known as the Taita Ponding Area, and was a maze of old watercourses still liable to flooding. Parts of Naenae were still swamp. The Epuni Block required special stormwater and surface drainage. The Waddington Block contained sections of permanently waterlogged heavy swamp clays and was subject to inundation by unrestricted stormwater run-off from the eastern hills.

To make the land more suitable for housing the Public Works Department undertook major filling and reclamation and constructed a temporary stopbank at Taita, built in anticipation that it would be upgraded as part of the lower valley stopbanking scheme [refer Project Report 8]. Much of the material used for filling, roading and stopbanking was taken from the river near the developments and accounted for the substantial degrading of this reach [refer to Chapter 4, The Exploitation Of The Shingle Resource].

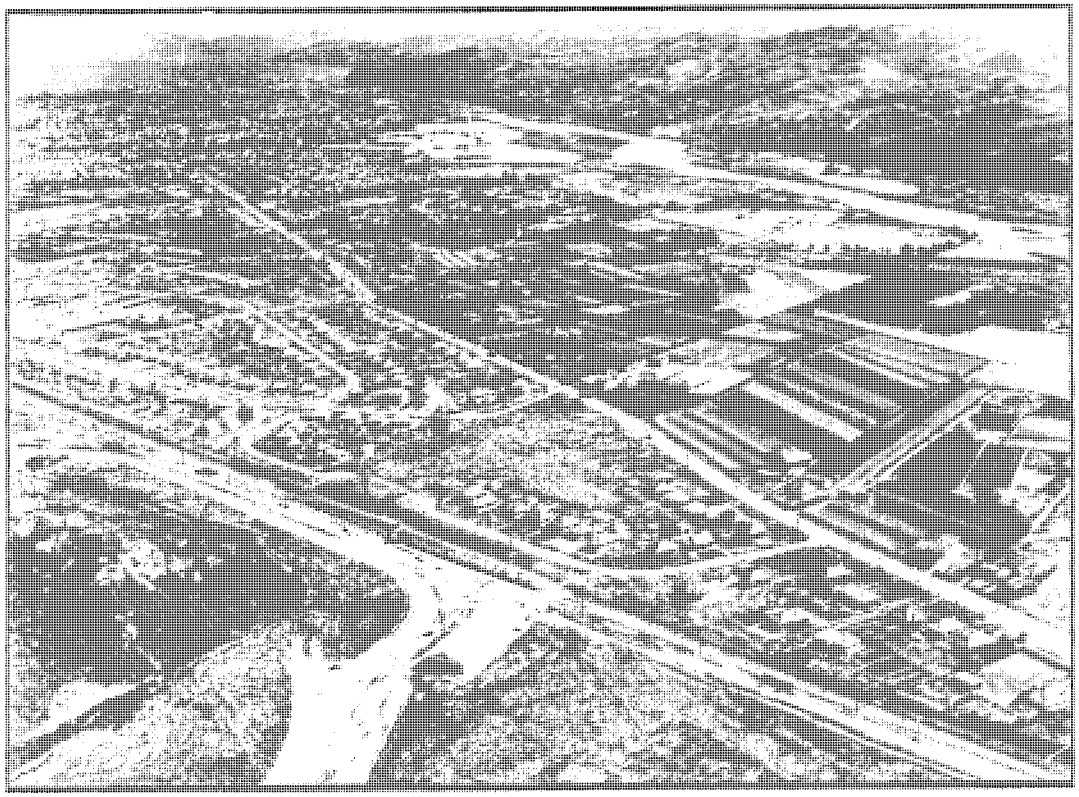


Plate 64: Avalon 1952. Source: Alexander Turnbull Library neg. F61999

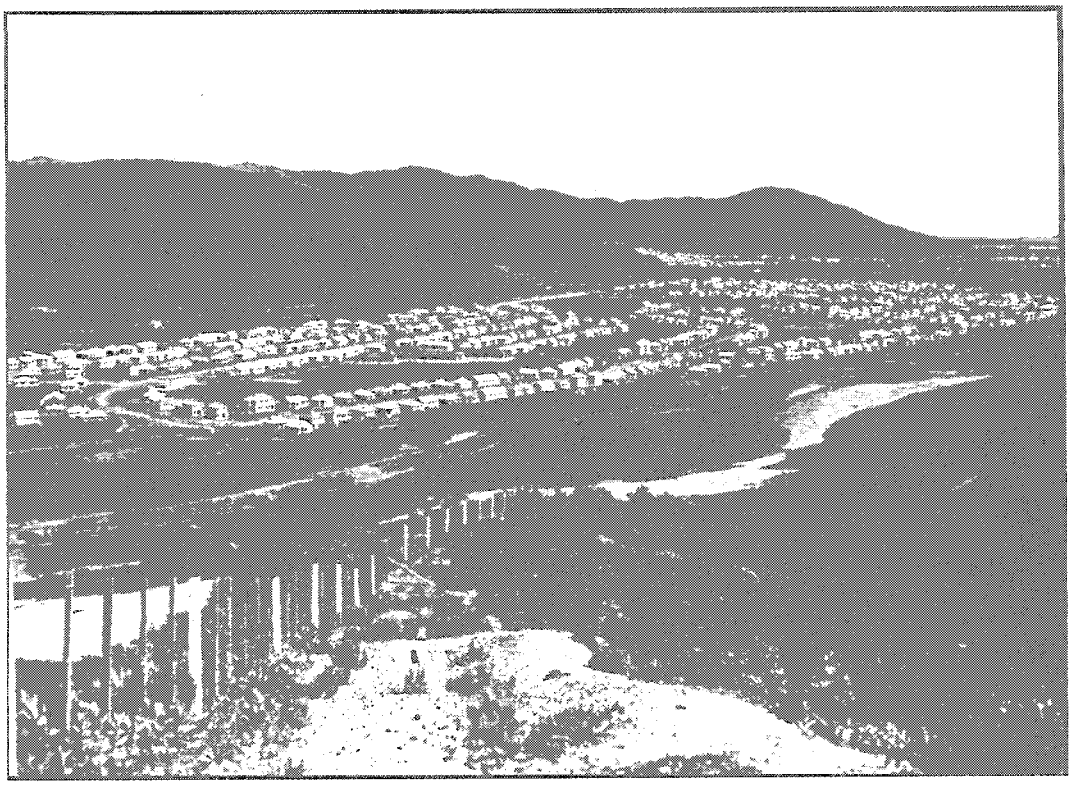


Plate 65: Taita Estate c. 1945. Source: Alexander Turnbull Library neg. G45248

Extending Flood Protection

In 1931 the Hutt River Board suggested to Government that its housing activities in Taita, and the closure of the Taita ponding area, might jeopardise the security of Lower Hutt. From 1933 this led to Government pressure on the Hutt River Board to extend its district north of Taita Gorge and to upgrade the existing stopbanks to cope with the maximum likely flood (refer to Archive Table 16, 1950 Scheme Review, Design Discharge, [p. 111]).

Government pressure for improvements resulted from:

(1) The acceptance by Government that it may be held liable for the failure of the lower river stopbanks. The 1931 flood had come near to overtopping the banks in Lower Hutt. Catastrophic flooding was regarded as a real possibility if the Taita ponding area was to be filled and the overflow to the Waiwhetu Stream closed.

(2) There was a nationwide move by Government to promote major public works to provide employment. Public Works Department regional staff were encouraged to review and report on existing river schemes in their areas.

The review of the Hutt River flood protection works was undertaken by the Trentham Residency of the Public Works Department in 1944. This led to 20 years of Scheme Improvements funded and constructed by the Government and the Hutt River Board. Between 1945 and 1975 major changes took place:

(1) The extension of the Hutt River Board District to include Petone in 1946.

(2) The upgrading of the stopbanks in the lower reaches to the "permanent level" - i.e., the level of the maximum likely flood of 100,000 cusecs, plus freeboard, between 1959 and 1961.

(3) The construction and upgrading of stopbanks from Boulcott to Taita Gorge, and the Haywards stopbank in 1964.

(4) The extension of the Hutt River Board District to include the Upper Hutt Borough and part of Hutt County in 1959.

(5) A poll to raise loan monies to construct stopbanks in Upper Hutt was finally successful in 1962. Construction of stopbanks followed between 1964 and 1969.

The joint venture arrangement between the Hutt River Board and the Government was uneasy for several reasons.

- During its early years from 1899 to 1920 the Hutt River Board had accumulated a significant public debt and had on occasion been unable to carry out work because of a lack of funds. By 1944 the debt had been largely cleared and the Board was beginning to establish a reasonable cash reserve. For nearly 30 years it had controlled the river using revenue from rates and shingle royalties and in this it considered it had been successful. Although river rates were low, municipal rates were high and the Board considered that ratepayers in the established and protected areas would not agree to increased rating for works to protect Government property that was not subject to rating levies.

- The Board's first request for assistance with works to upgrade the scheme amounted effectively to a request for a 5:1 subsidy to ensure that the Hutt River Board contribution would be met from revenue. This proposal was not accepted by Treasury and the Board was forced to accept a 1:1 subsidy on Lower Valley scheme works.

- For reasons that are now unclear the Hutt River Board did not wish to be responsible for the actual construction of the scheme works. Although the Public Works Department Trentham Residency undertook the engineering report which formed the basis of both the lower and upper valley schemes the Hutt River Board seems to have been coerced into responsibility for most of the design and construction (probably as a result of its obligations under the Soil Conservation Act 1941).

By 1952 tension between the partners increased as the Public Works Department started to lose confidence in the Board's ability to see through major construction works. There were lengthy delays (by the Board) in producing the necessary engineering surveys, an economic report, contract documents and in holding polls for the extension of the Board's district.

INTRODUCTION TO THE LOWER VALLEY SCHEME

[Refer to Project Reports 4 to 11, 13, 18 and 20]

On 11 December 1939 the Hutt Valley experienced the largest flood since 1898, with a peak discharge calculated to be 70,000 cusecs (2000 cumecs). This flood came within 150 mm of the top of the stopbanks in some places: between the Hutt Bridge (now the Ewen Bridge) and Pipe Bridge (Estuary Bridge) the freeboard margin did not exceed 0.6 m. It remained within 0.3 m of the peak for 11 hours.

In the 1940s, with increasing residential development in the valley, and in particular with the commencement of the Taita State Housing Scheme - in a known overflow path for flood waters - it became increasingly obvious that the erection of a permanent stopbank at the upper end of the Taita Block was urgently needed to protect both that block and also a large portion of the valley.

In August 1944 discussions were held between the PWD and the HRB and it was agreed that some measure of protection should be provided immediately to the Taita Block as part of the main scheme. Some 260 metres of stopbank were built, using gravel from the river at Taita, at a cost of £7,500. The stopbank was later raised to 6 ft above the May 1948 flood line and extended south to Fraser Park (was raised again in the 1960s as part of the Hutt River Flood Control Scheme).

In the same Period Messrs A P Grant (PWD), H Sladden (Engineer to the HRB) and the Director of Meteorological Services jointly agreed that the design discharge for the proposed Hutt Scheme should be 100,000 cusecs (2800 cumecs). See Archive Table 17, 1950 Scheme Review, Design Discharge, p. 116.

In early discussion it was agreed that because of the size of the project it should be handled through the Minister of Works, and that a comprehensive report should be made by the PWD. The parties considered a report from Mr F W Lindup (PWD) on a limited investigation undertaken in 1943-44 which concluded:

(i) The existing stopbanking in the lower valley only just coped with the 1939 flood.

(ii) The recent Taita Stopbanking had shut off "a large escape and ponding area .. so that a repetition of the 1939 would almost certainly invade the area behind the old stopbanks.

(iii) Evacuation of residents, if required, may be impossible to carry out successfully during a flood.

(iv) Replacement of the previous landscape incorporating fences and hedges with a Government housing area had removed barriers to intrusion of huge volumes of water entering densely populated areas.

In large floods before this time flood waters were diverted out of the river through the low area at Taita and flowed across the valley to the Waiwhetu Stream, to discharge via this stream channel into the harbour.

It is reported that Sladden did not agree that the flooding risk had increased as a result of the housing construction. Rather, the value of the assets liable to flooding had increased, thus making the flood risk less acceptable. He is also recorded (by the District Commissioner of Works) as saying that the HRB banks should have been improved years ago. His own reports following the 1939 flood do not however support this record as he specifically did not advocate the raising or improvement of the banks as he was confident that further improvements to the channel would increase the system's capacity.

In September 1945 the District Commissioner of Works, Wellington forwarded a tentative estimate for of the cost of improving the river and floodway between the mouth and Taita to enable it to carry a maximum flood of 100,000 cusecs (2800 cumecs). The stopbank section proposed was a 10 ft (3 m) top width, 3 to 1 batters on both sides and a freeboard of 3 ft (0.9 m) above the calculated level of the 100,000 cusec flood. The proposals were discussed with the River Board in October 1945: the Board agreed to the proposals, offered a contribution of £35,000 (1/6) toward the total estimated cost of £212,000 and requested that the work be carried out by the PWD. The proposal was eventually referred to Treasury for approval, but on the basis of a HRB contribution of £53,000.

Advancement of the scheme appears to have been left with the PWD for some years, probably on the basis of this resolution. The reasons for the delay until the start of construction in 1956 are not clear. However, a summary of events to that date is:

(i) In 1948 the Engineer to the HRB submitted to the District Commissioner of Works plans for stopbank improvements downstream of the Hutt Bridge. The stopbanks were designed to 100,000 cusecs flood level plus 2 ft. with 2 to 1 batters both sides and a top width of 6 ft.

(ii) The scheme was technically approved subject to top width increasing to 10 ft. Indications from Treasury were that it would require an economic report with cogent reasons in order to approve a subsidy greater than 1:1.

(iii) In 1952 an estimate and economic report requested by the District Commissioner of Works were submitted by HRB Engineer. Included was a request for 2 to 1 subsidy.

(iv) In 1955 the HRB was proceeding with the design of the Melling Diversion Cut, the second stage in the Scheme of Improvements.

(v) Raising of the stopbanks from the Estuary to the Hutt Bridge (stage 1 of the Scheme) started in 1956.

All scheme works were constructed by contract, supervised by the HRB to plans prepared by the HRB.

Archive Table 15: Lower Valley Scheme Review 1945 to 1975

Some of Sladden's work of this period appears to have been of a cursory nature. This may have been due to the Board's reluctance to be forced into a programme with which it was not entirely happy, or it may have been due to illness before Sladden's death in 1952.

The delays may have been unfairly attributed to the Board, as the various Government departments felt it necessary to comment on stopbank height, width, position, batter slopes, design discharge, funding, etc. The archives show that the lengthy process of what in practical terms amounted to design by committee added to the considerable delays.

The Lower Valley (Harbour to Silverstream) Scheme Improvement contracts are described separately as Project Reports in Part Two of this history. The 1950 Scheme Review included the following projects:

Project Report 4: 1956 to 1957. Stopbank raising on both the left and right banks between the Estuary (Pipe) Bridge and Ewen Bridge.

Project Reports 5, 6 and 9: 1959 to 1964. Melling Diversion Cut developed in three stages.

Project Report 7: 1960 to 1961. Raising of stopbanks between Ewen Bridge and Melling.

Project Report 8: 1962 to 1964. Raising of the existing (temporary) stopbank from Taita to Fraser Park and the construction of a new stopbank from Fraser park to Mabey Road.

Project Report 10: 1964. Raising of the original (1903) stopbanks from Melling Road to Mills Road.

Project Report 11: 1964 to 1965. Extension and raising of the existing Haywards Stopbank (originally constructed by the Public Works Department as part of the subdivision).

Project Report 14: 1965 to 1966. Flattening of the city side slope of the stopbank adjacent to the Hutt Valley High School.

Project Report 20: 1969. Construction of a new stopbank from the Boulcott Golf Club to a point opposite Tennyson Avenue, to meet the existing stopbank completed in 1964.

Project Report 24: 1972. Lowering of the original stopbank from Ariki Street to Hathaway Avenue.

Project Report 25: 1972. Stopbank reshaping south of Melling Station.

Project Report 26: 1972 to 1973. Construction of the auxiliary stopbank at the Okoutu Stream (Black Creek, Moera) outlet channel.

1950 Scheme Review Design Discharge

On the basis of the 10 year period from 1941-1951 Sladden produced a flood frequency relationship which is reproduced as fig. 21, p. 156.

Up until the time of the major scheme extension and upgrade (1945-1975) there had been no call to develop a flood frequency relationship, although evidence given in support of the petition to include Petone into the Hutt District (1948) states that a 100,000 cusec flood was likely to occur at least once in every 200 years. Scheme works were generally designed to pass the greatest known (usually the last) flood plus a substantial freeboard, so that a much larger flood could be contained. There appears to have been no pressure to limit the works to a specific design standard, but rather an intention to provide for the maximum flood.

During the design for the upgraded scheme a suitable design standard was considered and agreed by HRB and PWD engineers to be 100,000 cusecs plus a 2 foot freeboard. The hydrological basis for this figure is not known. However events leading to its derivation were:

(1) The 1939 flood was computed at 71,000 cusecs. In addition it was computed that the freeboard above the observed flood levels could contain a further 10,000 cusecs - 80,000 cusecs in total. In 1944 it is recorded that the PWD engineers thought that the HRB "designed" its works to pass 80,000 cusecs.

(2) After the 1939 flood Sladden (HRB) and Grant (PWD) were instructed to agree on a design standard for the new works. They recommended a design discharge of 100,000 cusecs and this was accepted by the government agencies as an extreme event - a standard that was considered warranted in view of the very high value of the developing Taita area. It was recognised that some of the HRB works would have to be upgraded from 80,000 to 100,000 cusec capacity. The freeboard above the design level was originally proposed as 3 feet, but a 2 foot freeboard was eventually agreed upon.

(The Hutt Scheme was the first river scheme designed using computational techniques which permitted the accurate prediction of flood levels corresponding to a specific discharge. The correspondence recognises the experimental nature of the predictions which are more conservative than would be expected today.)

(3) In 1946, at a joint meeting of local body and government engineers, Sladden is recorded as stating that the 1939 flood may possibly have been exceeded in the 60 years before the construction of the scheme. A definite return period was not placed on the 100,000 cusec event. Various references were made to the 100,000 cusec event as a 200 year flood (Sladden, HRB), 90,000 cusecs as 500 year (Furkett, PWD), and 84,000 cusecs as 500 year (Adams, PWD). The 3 ft. freeboard proposed for the upgraded works would allow for a theoretical discharge of 120,000 - 130,000 cusecs, twice the maximum flood recorded.

(4) In an interim report from the District Engineer to the chairman of the Soil Conservation and Rivers Control Council (1949) it is noted "...while the 100,000 + 2 ft level is considered ample provision for the highest floods likely to occur ..."

Throughout the remaining period of the scheme reconstruction (1948-1972) the 100,000 discharge was regarded as an extreme event, with the works constructed to a maximum likely flood standard.

Archive Table 16: 1950 Scheme Review, Design Discharge

1950 Scheme Works - Silverstream to Maoribank

During the 1940s and early 1950s maintenance and control of the Hutt River north of the Silverstream Bridge was largely carried out by the Trentham Residency of the Public Works Department. The work was undertaken on behalf of the Upper Hutt Borough Council and Hutt County Council, with funding contributions from these Councils and from private landowners.

Memories of the 1939 flood (and others) remained with the Upper Hutt Borough Council, Hutt County Council and Residency Engineers, and were of concern as Upper Hutt continued to expand toward the River. River control for the Upper Valley had been considered by Sladden as early as 1937. In 1946 Trentham Residency completed preliminary investigations for flood control. In 1947 the Cabinet acted on this report and approved the purchase of highly floodable properties in the Newton Street subdivision (the area now known as Poets' Park). The land was purchased as the properties could not be protected from flooding as they were so close to the River they would lie within the river zone of any scheme of stopbanking.

Plates 71 and 72, pp. 117 and 118 are copies of the preliminary scheme plans prepared by Trentham Residency and show how development had already extended well into the River Zone. The "100,000 cusec" line marked on the plans defines the area of flood plain considered to be at risk.

Despite an apparent consensus on the need for a publicly funded scheme of works the Upper Valley Scheme was still 20 years away. In the intervening period isolated works were constructed, mostly for erosion control or to protect existing or proposed housing subdivisions and farm lands.

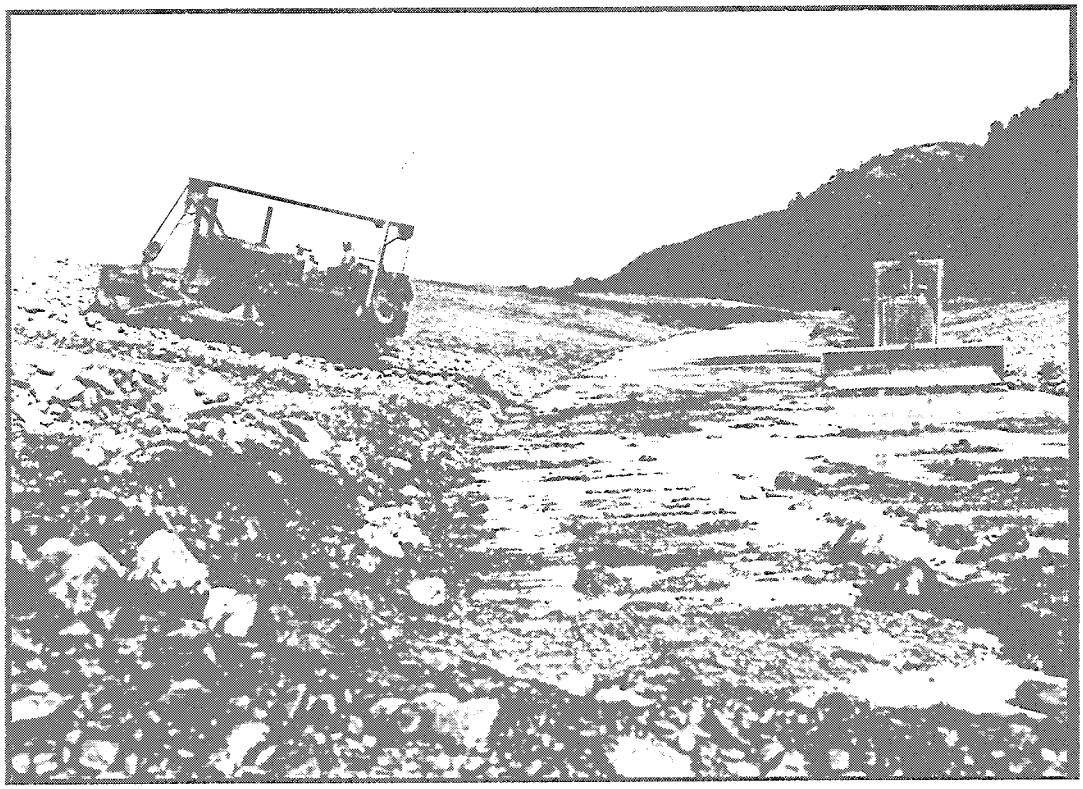


Plate 66: Barton's Bush Diversion 1949. Source: Alexander Turnbull Library, neg. C11330, Evening Post collection.

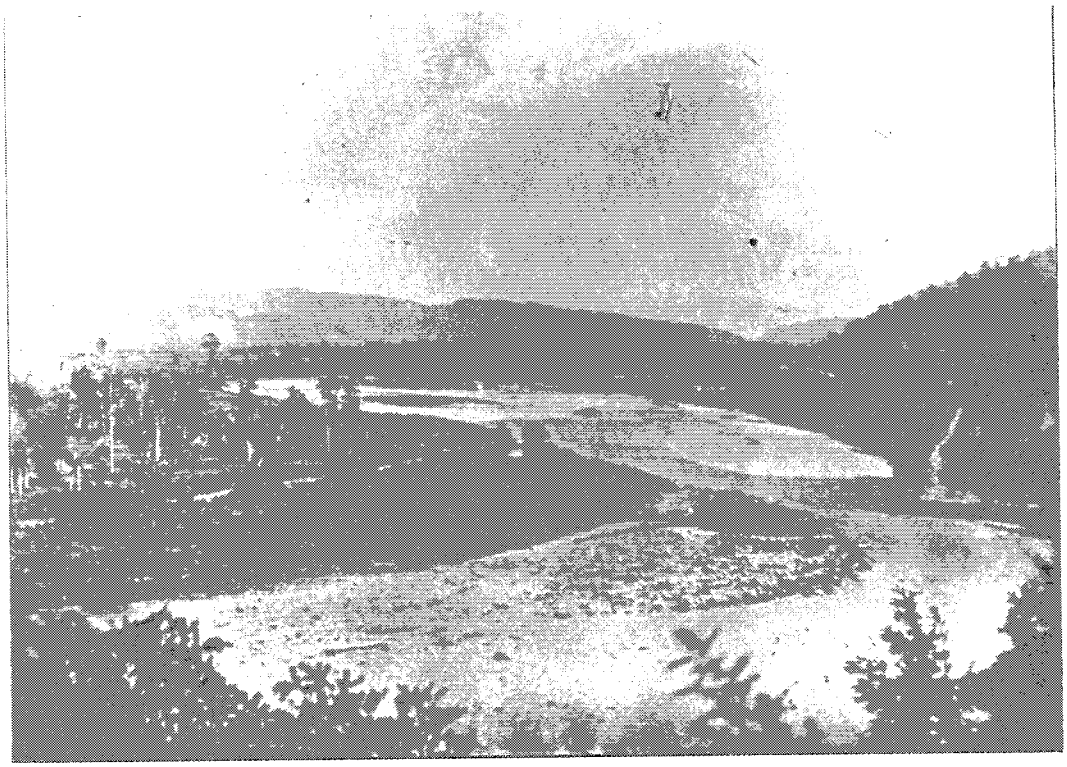


Plate 67: The "Bluff" at Trentham, prior to 1900. Looking south towards the Taita Gorge the river alignment remained similar to this until c.1930.
Source: Alexander Turnbull Library neg. G110598.

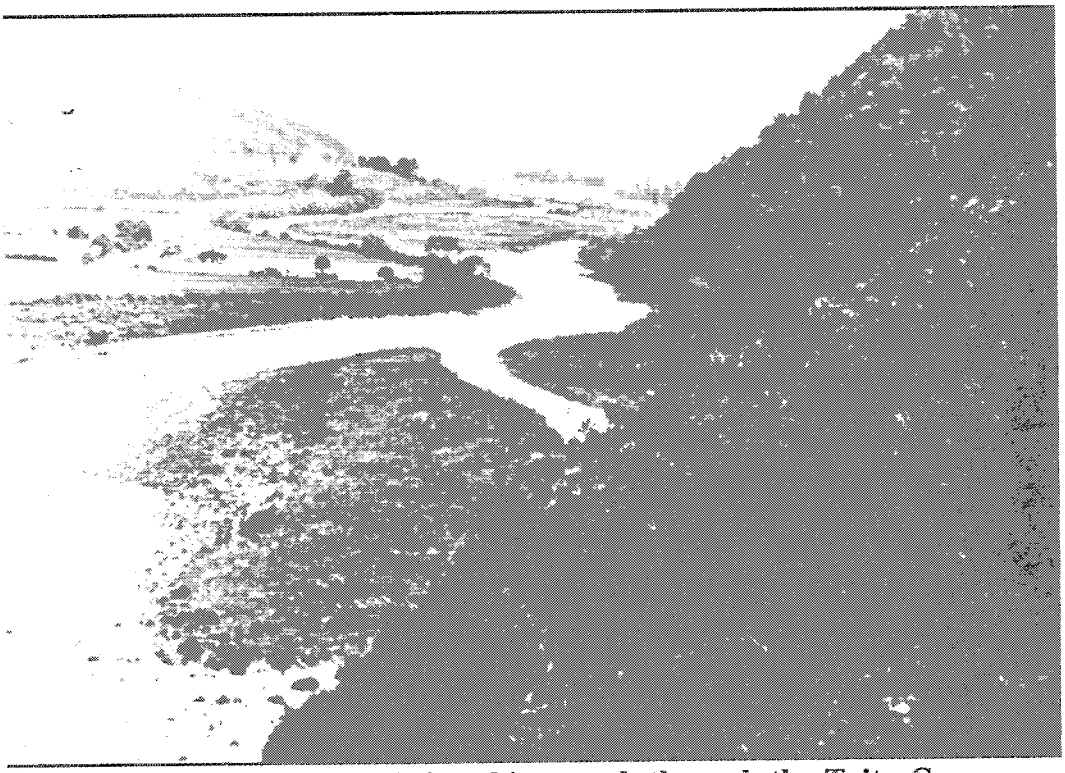


Plate 68: Silverstream c. 1950 looking south through the Taita Gorge.
Source: Alexander Turnbull Library neg. G1007

Plate 69: Moonshine 1931. Source: Alexander Turnbull Library neg G46228

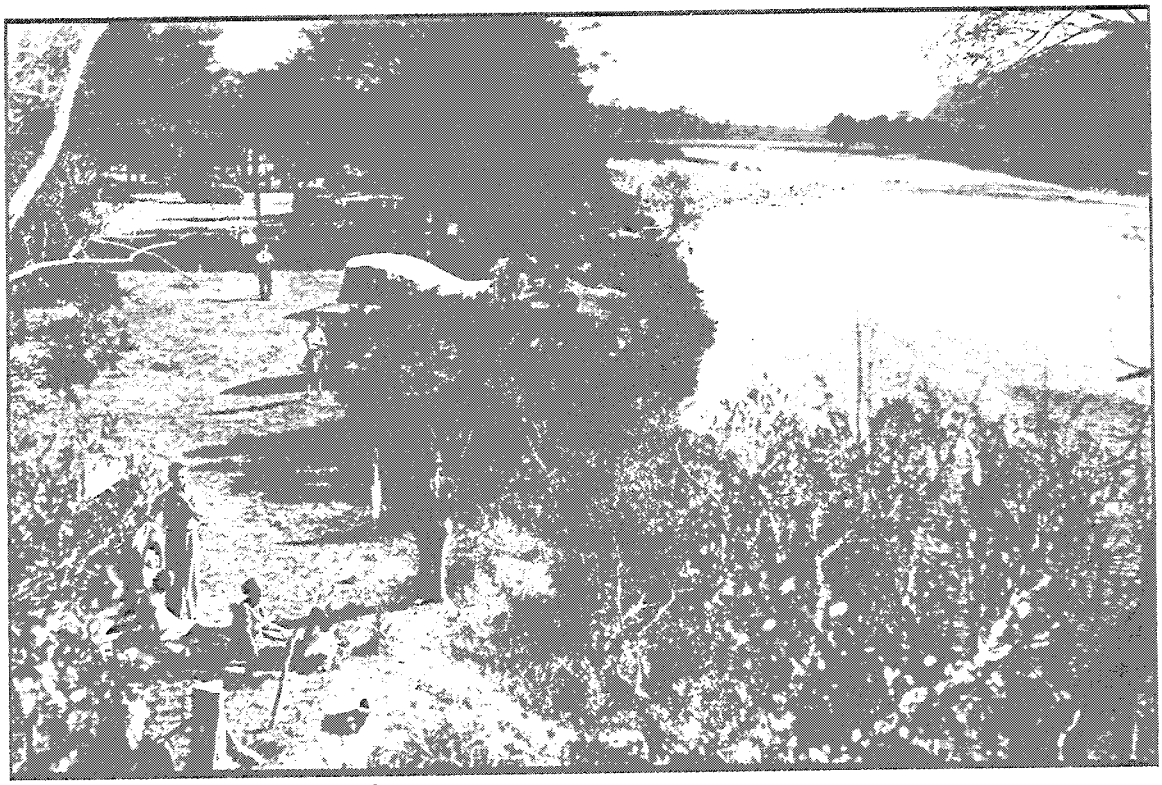


Plate 70: Moonshine 1939. Source: Alexander Turnbull Library neg. G46125

Examples of isolated works identifiable in plates 71 and 72, and referred to in Archive Table 14, p. 99, River Management from 1924, are:

> **McCurdy Stopbank** protecting farm land northeast and west of the (present) Totara Park Bridge.
>
> **Hudson Avenue Bank Protection** providing protection against erosion up to and beyond the line of the present stopbank.
>
> **Newton Street Subdivision Stopbank** a short stopbank perpendicular to the river, constructed by the subdivision's developers to divert berm flows away from the properties.

In October of 1951 a 32,000 cusec (900 cumec) flood did considerable damage to the isolated works and again raised concern about damage to residential properties. The Trentham Residency this time refused the Upper Hutt Borough Council's request to carry out repair works at the Coltman Estate because of a lack of funds. This refusal triggered the Upper Hutt Borough Council to seriously reconsider its options for ensuring the security of Upper Hutt. The Council resolved to petition the Soil Conservation and Rivers Control Council to design and construct a River Control Scheme for Upper Hutt. This was agreed to in 1952, subject to conditions including:

(1) An equal sharing of the costs of the investigation by the Soil Conservation and Rivers Control Council, Hutt County Council and Upper Hutt Borough Council.

(2) The proposed scheme maintenance was to be carried out by the Hutt County Council and Upper Hutt Borough Council.

(3) Representations were to be made to the Hutt River Board to extend its District to include the Upper Valley.

In 1953, at the request of the Soil Conservation and Rivers Control Council, the Trentham Residency produced a preliminary report and plan considering two main flood control options. The report concluded that the Residency had insufficient resources to design and build a stopbanking scheme at that time, and that it would be more appropriate for the work to be carried out by the local authorities.

The Hutt River Board was not opposed to the extension of the River District and had previously declared interest in managing the Upper River. True to form, however, it was responsible only to its classified ratepayers and refused to proceed with investigations in the Upper Valley until the beneficiaries became Hutt River Board ratepayers and, as ratepayers, formally instructed the Board to proceed.

Following representation from the Upper Hutt Borough Council and the Hutt County Council the Hutt River Board requested the Local Government Commission to order the extension of the District to include the Upper Valley. An Order in Council to that effect was subsequently issued in March 1956. Obtaining the support of the Upper Valley ratepayers was not so straightforward and ratepayer opposition, mainly from areas unaffected or marginally affected by flooding, delayed the start of the Scheme Works until 1961.

Promotion of the Upper Valley Scheme

(Abbreviations refer Archive Table 2, p. 7)

F1: 23 Nov 1933: NA96/298000: 1400-1780
Letter from H Sladden to Chairman, HRB
Refers to a petition covering the area between the Silverstream Rail Bridge to the Moonshine Bridge, Includes estimates for alignment of the river, and maintenance. Work envisaged is generally willow and cable, netted stone groynes, and some boom groynes.

F2: 23 Jul 1936: NA96/298000: 1400-2300
PWD commissions "..a complete survey of the Hutt River from the Silverstream Railway Bridge up to Maoribank."

F3: 30 May 1938: Report, Seaton Sladden and Pavitt to Engineer in Chief, PWD
"Hutt River Survey And Control Scheme from Maoribank Downstream To Silverstream". Plans (numbers not recorded), comments and brief cost estimates for training works (but no stopbanking) to control the river between the Silverstream Bridge and Maoribank.

F4: 3 Mar 1952: NA96/298000
Resident Engineer (Trentham) to DCW (Wellington). The (Upper Hutt Flood Control) Scheme on plan T1751 prepared at a few day's notice. "...first time this office has done any accurate fixing of the stopbank position from cross sections and calculations. Former schemes submitted have been based on estimation and judgement."

F5: 1953: HRB32
Report: "Hutt River Investigations". Flood gradient established from 22 levels taken during the 27/11/52 flood of 17,400 cusecs. See plan T2276. Backwater curve calculated from the Silverstream Bridge using cross sections at 1400 ft intervals, and the assumed stopbank alignment.

F6: 22 Nov 1954: from Minutes of Meeting of Hutt County Council and HRB representatives.
(1) Upper Hutt the most urgent problem in the area at this time,
(2) A comprehensive survey and plan has already been prepared by the PWD,
(3) Resolved that the HRB make application to the Local Government Commission to extend the boundary of the HRB District to the Wellington City and Suburban Water Board boundary and further investigate its extension to the Wainuiomata River.

F7: 21 Jun 1955: DCW (Trentham) to Comm. of Works.
It appears that the scheme cannot go ahead until the new boundaries of the Hutt River District are gazetted, and a new controlling authority has classified the area.

F8: 4 Aug 1955: DCW (Trentham) to Comm. of Works re River Control - Silverstream to Maoribank Section.
The HRB not up to tackling the job at present, but must face up to it. Job not likely to be effectively started by the HRB for 3 years. If the MOW assists, they will be taken advantage of by the Local Authorities. The MOW does not have enough staff to take on this extra work.

F9: 1964: HRB111: 1400-2260
Commencement of stopbank construction from Maoribank to Masefield Street.

F10: 1966: HRB112: 1620-1900
Commencement of stopbank construction from Masefield Street to Wellington Golf Club.

F11: 1966: HRB127: 1400-1700
Commencement of channel realignment from Trentham Memorial Park to Silverstream Bridge - "The Silverstream Cut".

F12: 1968: WRC8/7/13: 2050-2250
First stopbanks constructed to protect Totara Park. These extended from the Maoribank Suspension Bridge (now partly demolished) at the Maoribank Bend to the western end of the development. Embankment unfinished west of Totara Park Road until 1977, when it was raised on insistence of the Wellington Regional Water Board along with construction of a main stormwater outlet channel.

F13: 1981: WRC8/7/13: 2250-2350
Construction of the first part of the Totara Park stopbank extension from Maoribank Bridge upstream.

F14: 1983: WRC8/7/13: 2330-2390
Construction of remainder of Totara Park stopbank extension from Maoribank Bridge upstream.

Archive Table 17 : Promotion of the Upper Valley Scheme. Codes : I.D. : Date : Source File : Section #s.

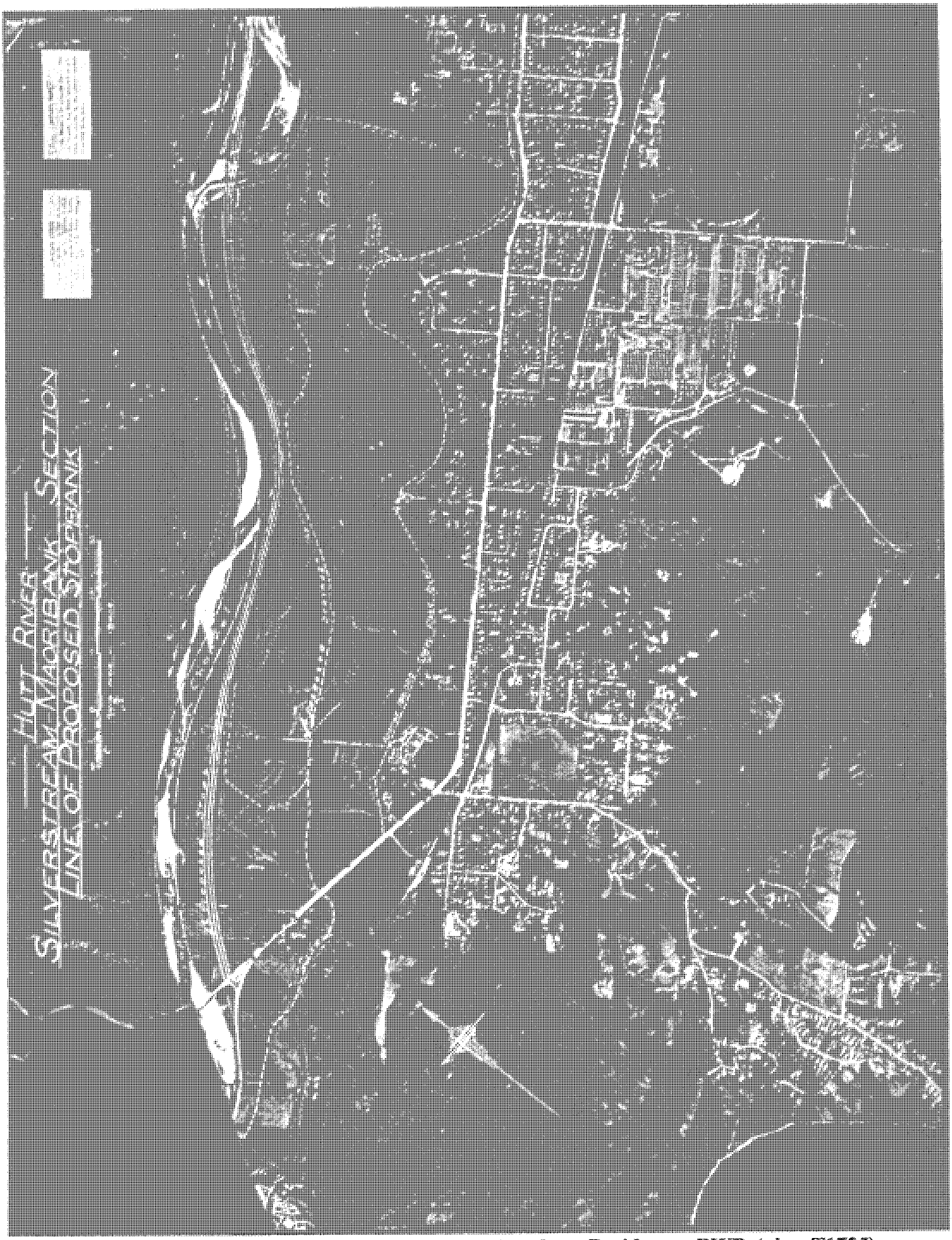


Plate 71: 1953 Upper Valley Scheme proposed by Trentham Residency, PWD (plan T1725).

Plate 72: 1953 Upper Valley Scheme proposed by Trentham Residency, PWD (plan T1725).

In the Upper Valley the river channel is largely confined to the west. Eastwards the flood plain rises towards a terraced margin so that not more than 50 percent of the plain lies below the 100,000 cusec (maximum likely flood) contour. Older residential areas were generally free from flooding and the threat of flooding or erosion to new properties occurred principally because of unwise subdivisional activity.

There was no doubt that stopbanks were a worthwhile investment, in terms of reclaiming land for housing and assisting in the long-term development of Upper Hutt. It is not surprising that the poll, seeking a mandate to raise a loan for stopbank construction, was defeated the first time it was taken in 1958. Ratepayers who were already heavily rated by the Borough feared a repeat of the land speculation which followed the construction of the Lower Hutt scheme and some were concerned that they may be forced from their land by rising land values and rates. Leading this group were St Patrick's College Board and the Board of the Wellington Golf Club who also argued that rising land values would prevent them from continuing their rural activities. During the Hutt River Board 1959 election this group gained strong representation, such that the new Board supported the option of excluding the land south of Barton's Bush from the scheme proposals, a major variation to a scheme where the subsidy support was based on the importance of the continuity of Scheme Works and lines of communication. That the less satisfactory option was accepted by central and local government is an indication of the political power this lobby group enjoyed.

In 1959 a number of small floods affected the area and the poll was repeated. The truncated option received ratepayer support and a start was made immediately on final design and specifications. The first works started at Masefield Street in 1964 and were completed by 1972.

Commissioning works and stopbank extension continued for another 11 years.

The works which comprise the original Upper Valley Scheme (added to in the 1980s with the development of Totara Park and Parkdale - refer Chapter 8) are described separately in the Project Reports, Part 2 of this History, and include:

Project Report 12: 1964 to 1965. Construction of a new stopbank from Whakatiki Street (now known as Masefield Street) to Maoribank.

Project Report 13: 1966 to 1969. Construction of a new stopbank from Whakatiki Street to the Wellington Golf Club.

Project Report 15: 1966 to 1967. Construction of an auxiliary stopbank to improve outlet conditions for the internal drainage channel discharging at Gibbons Street.

Project Report 16: 1966 to 1971. "The Silverstream Cut". Channel realignment between Trentham Memorial Park and the Silverstream Bridge.

Project Report 17: 1967. Central channel alignment adjacent to Hudson Avenue.

Project Report 22: 1972. Construction of an open perimeter drain around Maoribank Park.

Project Report 23: 1972. Regrading of the drainage channel between Clouston Park Road and Ebdentown Road.

Extracts from the archives referring to the promotion of the scheme are included in Archive Table 17, p.116 and the historical river alignments, plotted in Appendix B, illustrate the rapid changes in river alignment that took place between 1945 and 1988.

In terms of its current stage of development, the Upper Valley Scheme should be compared to the Lower Valley Scheme of the 1930s. During the initial Lower Valley Scheme construction the diversion and associated control works were the first works constructed. This was followed by 30 yeras of follow-up works to stabilise the new channel. In view of the history of the Lower Valley Scheme it should not have been a surprise that the frequent flooding of the late 1970s caused extensive damage to the newly constructed Upper Valley Scheme. Reconstruction has (so far) been repeated twice and scheme refinements and commisioning can be expected to continue well into next century. Bed levels have dropped dramatically following river straightening and gravel extraction,. New features have appeared, such as the exposed bedrock at Maoribank and Whakatiki, to determine the new river regime of the 1990s.

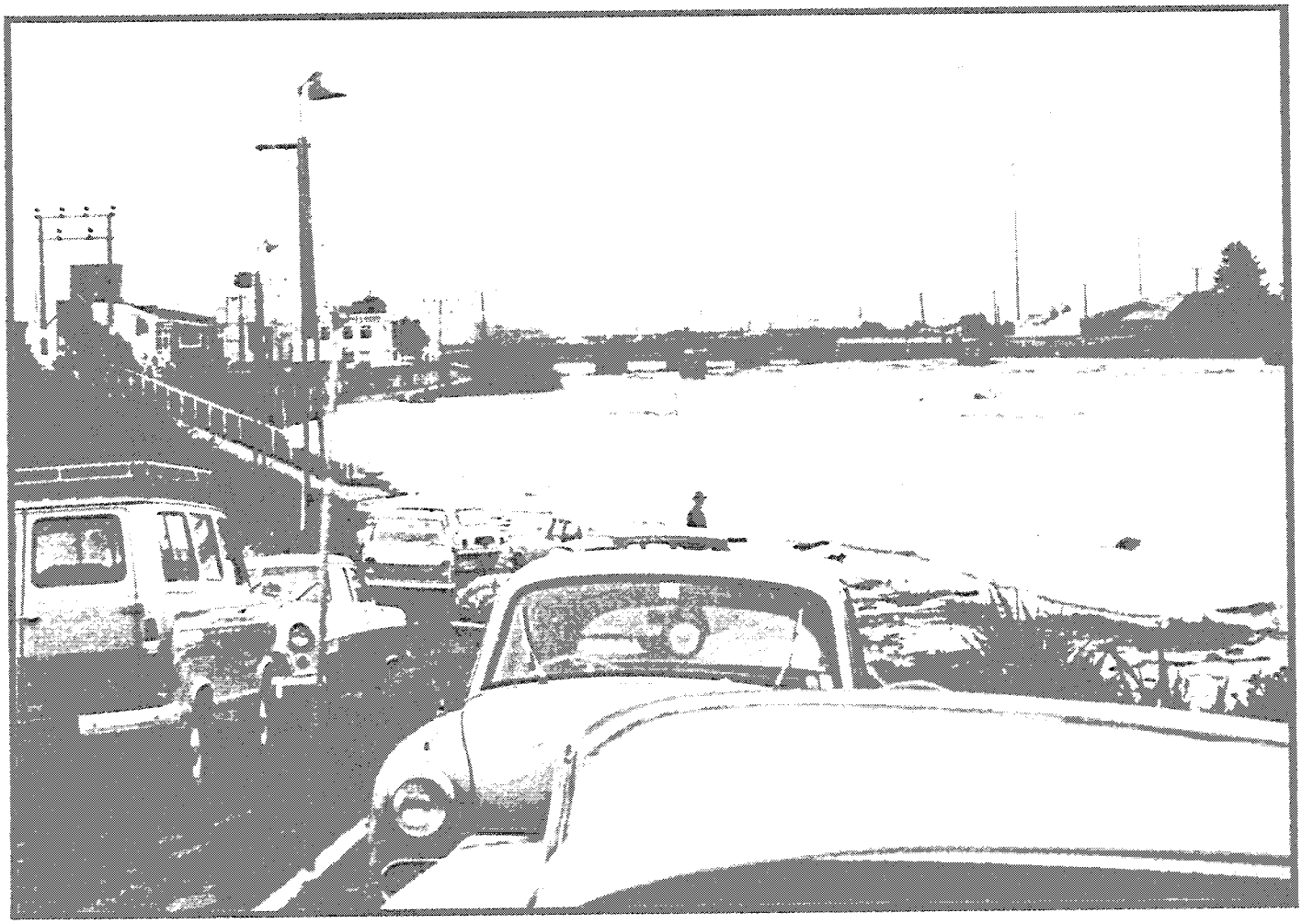


Plate 73: Lower Car Park, Hutt City, 1971. Source: Photo held by WRC

Chapter Seven

SCHEME REFINEMENTS 1972 to 1990

By 1980 the few alignment control works remaining north of Avalon were in a state of disrepair. Isolated clumps of willows clung to each bank but these offered little protection once the flood waters reached the bankfull stage. Plate 80 is representative of thousands of metres bank that was poorly protected.

During the 1981 flood over a kilometre of bank was stripped bare and large areas of bermland were eroded. The river was confined only by the depth of its entrenchment within its own gravels. The security of the stopbank foundations were determined by the width of berm between the central channel and the embankment. The duration of a flood stage above bankfull, a measure of the flood capacity to erode the protective bermland became critical.

The 1950 Scheme Review, like the 1903 Scheme, addressed only the first stage of managing an alluvial river of steep gradient, the construction of civil works. Perhaps the designers assumed, as Laing-Meason did, that the promoters were aware of the rivers control commitment that lay ahead of them. Unfortunately the evidence suggests that, again, little thought was given to the problem of controlling the river within the newly created River Zone.

Although the Scheme refinements include stopbank extensions and some minor regrading, the stopbanks were generally built well and to a generous height.

The challenge of the commissioning years (and beyond) was to reach an understanding of the natural river system and to develop acceptable management techniques which would keep the river how it can best be kept confined within the narrow river zone corridor which remained.

Plate 74: December 1976 Flooding from the Korokoro Stream. Source: Evening Post neg. 4637/76.

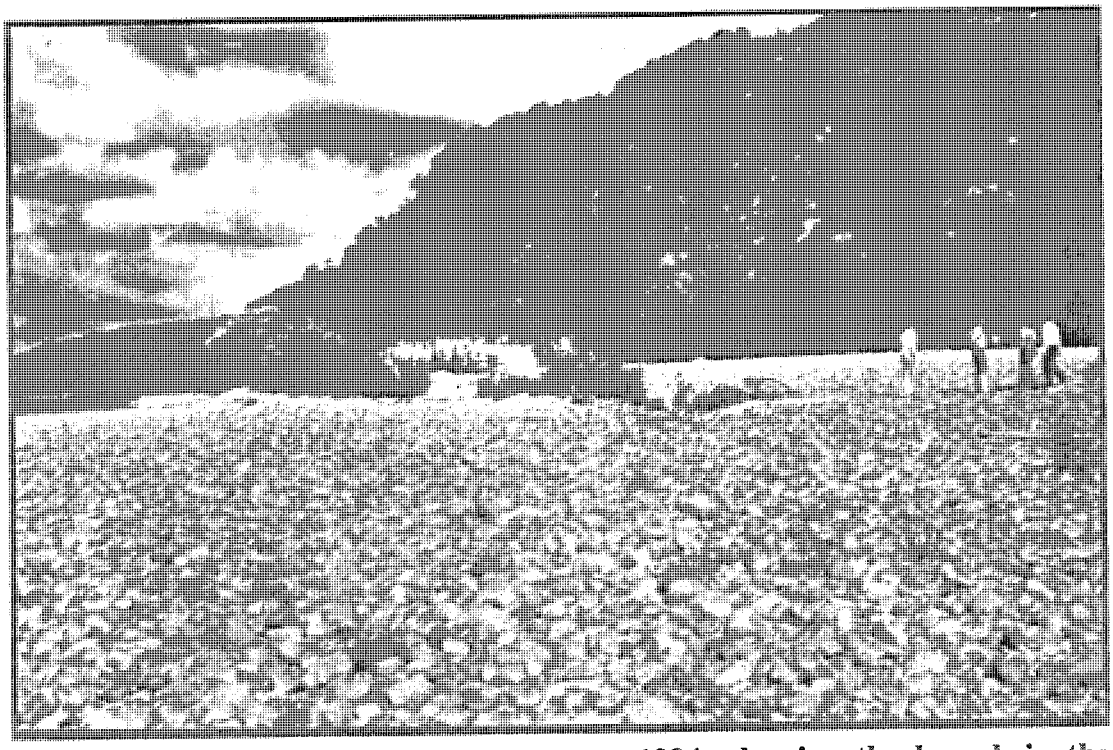


Plate 75: Failure of Silverstream Cut, c. 1984, showing the breach in the western bank protection works and the reactivation of the old western channel.
Source: WRC photo.

1950 Scheme Commissioning

In 1972, by Act of Parliament, the Hutt River Board and the Wellington Municipal Water Supply Authority were amalgamated to form the Wellington Regional Water Board. The demise of the Hutt River Board coincidentally marked the completion of the major scheme rebuilding and extension works initiated in the late 1940s.

The following 18 years saw the development of the Hutt River Board management techniques and the extension of the scheme to protect new residential areas. The construction of the State Highway 2 Upper Hutt Bypass also led to a rethinking of the river training works within the Upper Hutt area. Refinement of the 1950 Scheme design included:

Scheme Works Commissioning: Extension of the embankments, reconstruction of inadequate (internal) drainage channels, replacement of unsafe outlet culverts, and the strengthening of stopbank foundations.

Channel Alignment Control: The extension and establishment of the "Ultimate Alignment" concept within the Upper River.

Improvements to the River Environment: Consideration of the quality of the river environment in terms of the water resource (water quality and underground water), the fishery and recreational potential of the central channel, and the recreational potential of the expanding River Zone lands.

Scheme Works Commissioning

The late 1970s and early 1980s were unusually flood prone. Although during this period the entire Hutt catchment area was not subjected to widespread extreme rainfall, there were a number of localised high intensity storms which caused severe flooding of the smaller streams throughout the Wellington Region. The December 1976 storm will be remembered most clearly, but this was followed by similar less extensive events in 1977, 1980, 1981 and 1982. These events produced only small to moderate floods in the Hutt River but were enough to highlight the limitations (or absence) of the Scheme river training works. More importantly, as significant flood damage was suffered in the smaller catchments, the storms stimulated a renewed public interest in the general inadequacy of the Region's flood control works.

Since 1950 river engineering techniques and the concepts of scheme "economic viability" have developed as too have the involvement of central Government in regional scheme funding and decision making. By 1977 a review of the Hutt River flood control works was mandatory if Government funding for the maintenance of the previously Government funded works was to continue. The funding of new works was not even to be considered until the review had been completed.

Although it has taken until 1990 for the formal review process to begin (and ironically for Government support of "urban" flood control schemes to be effectively withdrawn), many aspects of the scheme operation were informally reviewed as a necessary response to the floods of the late 1970s. Many of the ideas being incorporated into the current review have their roots in the lessons learnt during the last 20 years of the 1950 Scheme commissioning.

Stopbank Extensions

Stopbank extensions were undertaken to extend flood protection to Totara Park and Parkdale, Upper Hutt, and to protect the properties at the entrance to Stokes Valley. Details are contained in the Project Reports summarised below.

Project Report 19: Totara Park Stopbanks; Stage 1, 1968; Stage 2, 1981, and Stage 3, 1983. The Totara Park embankments were to be constructed by the Totara Park Development Company to standards specified by the Hutt River Board and as such were to be accepted as part of the Scheme following their construction and approval. The construction spanned a period when the design standards for the overall Scheme were reviewed with the result that the Wellington Regional Water Board (successor to the Hutt River Board) became liable for the upgrading of the first stage.

Project Report 29: Stokes Valley Stream Outlet Stopbank Reconstruction, 1980 to 1981. Reconstruction of the Stokes Valley stream outlet channel and dividing bank to prevent Hutt River flood waters backing up the Stokes Valley Stream and causing flooding within the stream's outlet reach. The improvements were initiated by the need to upgrade the Stokes Valley Stream following the 1976 flooding.

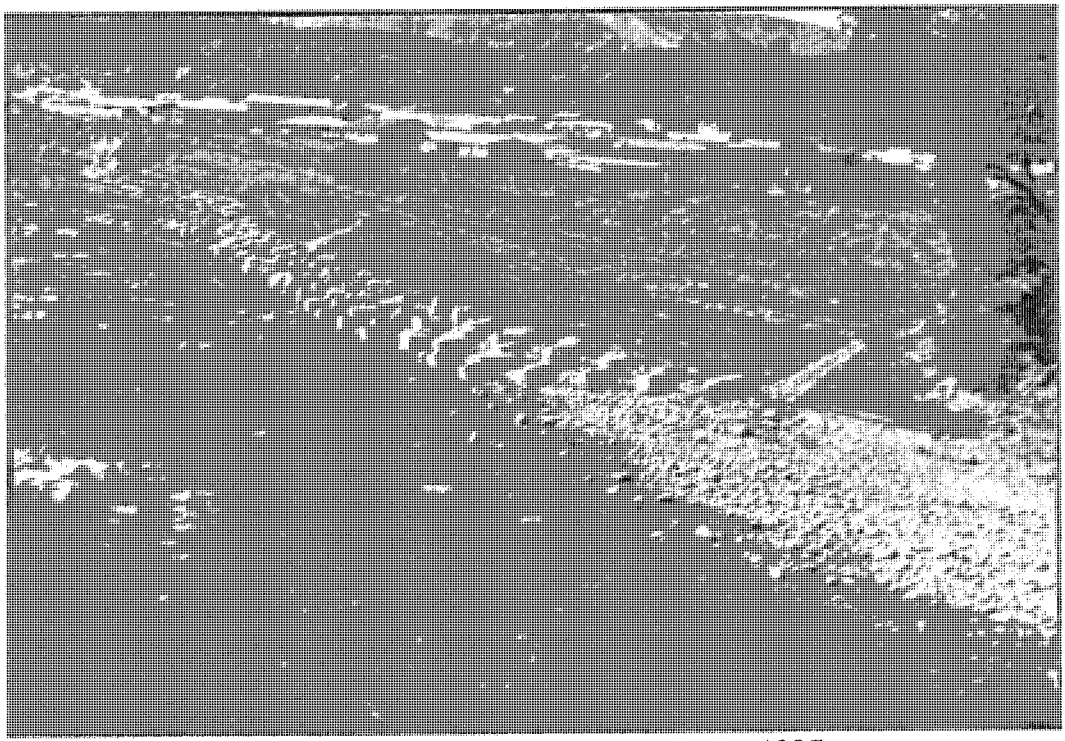


Plate 76: Parkdale Stopbank and Protection Works 1985. Source: WRC photo.

Project Report 34: Parkdale Subdivision Stopbank, 1983 to 1984. During the design of the replacement Akatarawa Bridge it became evident that the lower part of the Parkdale subdivision would be flooded during a Scheme design flood.

Stormwater Improvements

The 1976 storm caused widespread flooding within the stopbanks of central Hutt City due to the inadequacies of the internal drainage system, the Okoutu Stream (also known as the Black Creek and the Second River). The Okoutu Stream flows into the Hutt River through culverts beneath the embankments upstream of the Ava rail bridge. From there the stream follows a course parallel to but separated from the Hutt River by a dividing bank. As with the Upper Hutt drainage channels, the dividing bank is required to allow the flood gates on the outlet culvert to remain open at higher Hutt River flood stages than could be achieved without the bank.

Together with widespread improvements to the stream channel, the 1977 review of the Okoutu Stream recommended the replacement of the outlet culvert and flood gates, and the improvement of the outlet channel and dividing bank. The reconstruction works are detailed in Project Report 41 and include:

Replacement of the Okoutu Stream (Black Creek) Outlet Culverts, 1985 to 1988. The installation of replacement box culvert and flood gates was carried out in 1985. The original culverts were removed later in 1988 to prevent piping failure of the stopbank.

Okoutu Stream Auxiliary Stopbank Reconstruction, 1987

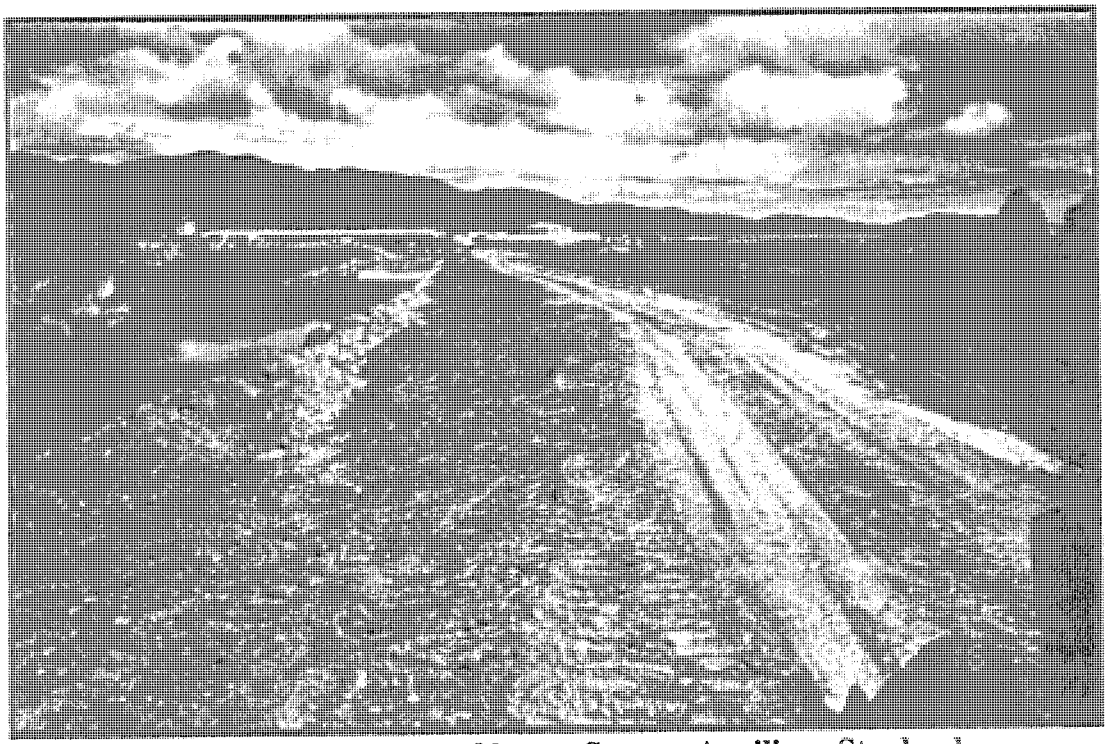


Plate 77: Reconstruction of the Okoutu Stream Auxiliary Stopbank.
Source: WRC photo

Okoutu Stream Outlet Channel Excavation, 1985/6.

The condition of the original Okoutu Stream culverts (built as part of the 1903 embankment) highlighted the need to review the security of the service crossings beneath and within the stopbanks. All stopbank excavations and backfilling around services became rigidly controlled in order to include construction features to minimise the likelihood of piping failure and to reduce the risk of stopbank breach, should a flood occur during the excavation or backfilling operations. All services within the stopbanks are to be identified as part of the current scheme review [refer **Hutt River Flood Control Scheme Review Report Volume 7, "Structural and Geotechnical Assessments/Stopbanks and Structures"**].

The drainage channels in the Upper Valley, built as part of the 1950 works, were improved during the Upper Hutt Bypass "River Road" construction [refer Project Report 45, Upper Hutt Bypass].

Stopbank Integrity

Computer analysis of the hydraulics of the flood channel was initiated in 1976 and has been continued to the present day. The results have confirmed the fear that the central channel velocities in extreme events could lead to the lateral erosion of the berm areas and the stopbank foundations. The risk being particularly high where the thalweg (the line of highest velocity flow) is close to the stopbanks. This potential for failure is increased in the estuarine reach where wave lap erosion and saline conditions prevent the establishment of a vegetative cover.

Stopbank foundation exposure was evident at Moera (adjacent to the old woollen scours), at the Ewen Bridge (leading to the collapse of the southern car park entrance in 1984), and at Maoribank (50 m eroded during the 1981 flood). Other areas in the Lower River, at Alicetown and Pharazyn Street, and in the Upper River at Pomare and McLeod Street were identified as being clearly at risk.

During the 1985 to 1990 period works have been carried out at the points of greatest risk. These works are covered in the following Project Reports.

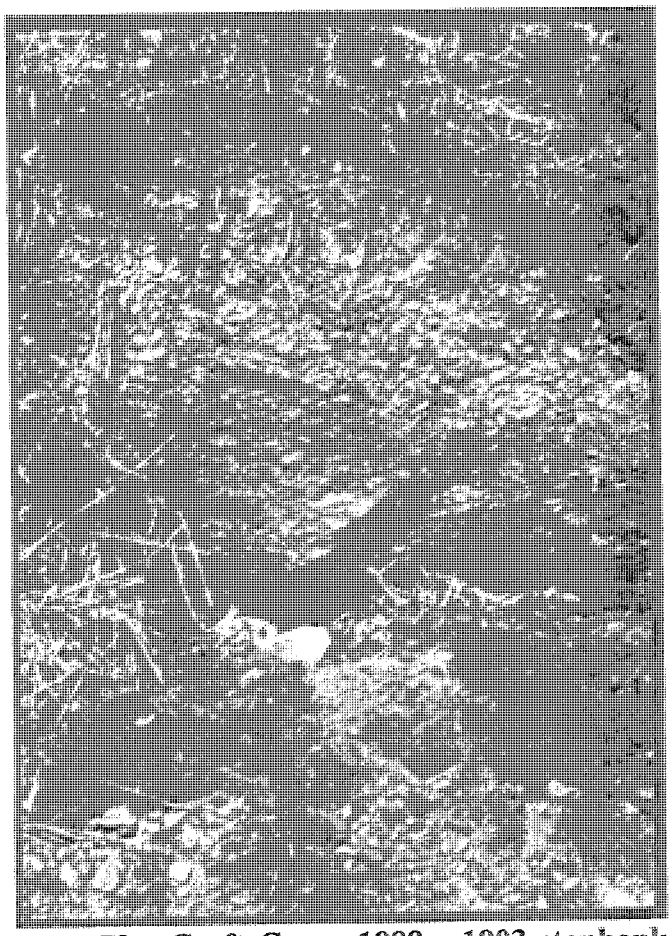


Plate 78: Croft Grove 1988. 1903 stopbank overlaid by 1956 reconstruction. Face slumping into river. Source: WRC photo.

Project Report 31: Maoribank Stopbank Protection, 1981 to 1983. Following the removal of 1.5 ha of berm downstream of the suspension bridge a series of block groynes, boulder mattresses, and "debris fences" were established to reclaim the eroded berm. These were replaced with a cantilevered steel deflector and reinforced concrete wall during the Upper Hutt Bypass construction.

Project Report 40: Pomare Stopbank Protection, 1984-90. Following severe berm erosion in 1980 the berm was reinstated using excavations from the Stokes Valley Stream. A series of timber deflector groynes were constructed. The upper end of this work was replaced with substantial rock groynes in 1990 following further erosion in 1988.

Project Report 34: Parkdale Subdivision Stopbank Protection, 1983 to 1984. The reconstruction and protection of the river reserve in order to construct a new stopbank and to prevent the erosion of the river terrace.

Project Report 37: Stopbank Repair,"Old Wool Scour Mill", Moera, 1984. Experimental work to test the durability of limestone rip-rap and to stabilise the stopbank foundation and to protect its face from erosion.

Project Report 38: Bank Stabilisation Trial at Sladden Park, 1984 to 1986. Various methods were trialled for the prevention of wave lap erosion.

Project Report 41: Okoutu Stream Auxiliary Stopbank Protection, 1985-88. Rock rip-rap protection to replace timber boom groynes last rebuilt in the 1940s.

Project Report 42: Bank stabilisation at Ewen Bridge, 1985-1986. Rock foundation work, reinstatement of the bank, and revegetation work to protect the Ewen Bridge eastern approach, the southern access to the Riverside car park and the High Street flood wall.

Project Report 44: Stopbank Repairs at Croft Grove, 1985-1988. (Eastern bank upstream of the Estuary Bridge). Rock toe protection to prevent wave lap erosion and scour erosion.

Project Report 45: Upper Hutt Bypass Construction, 1985 to 1988. The establishment of State Highway 2 on the river side of the stopbank provided protection to the eroded foundation at both McLeod Street and Maoribank, and instituted the rock lined, fixed meander pattern, central channel alignment .

Project Report 47: Melling Stopbank Reconstruction, 1989. The removal of mature willows from the river face of the Melling stopbank and the reconstruction of the bank.

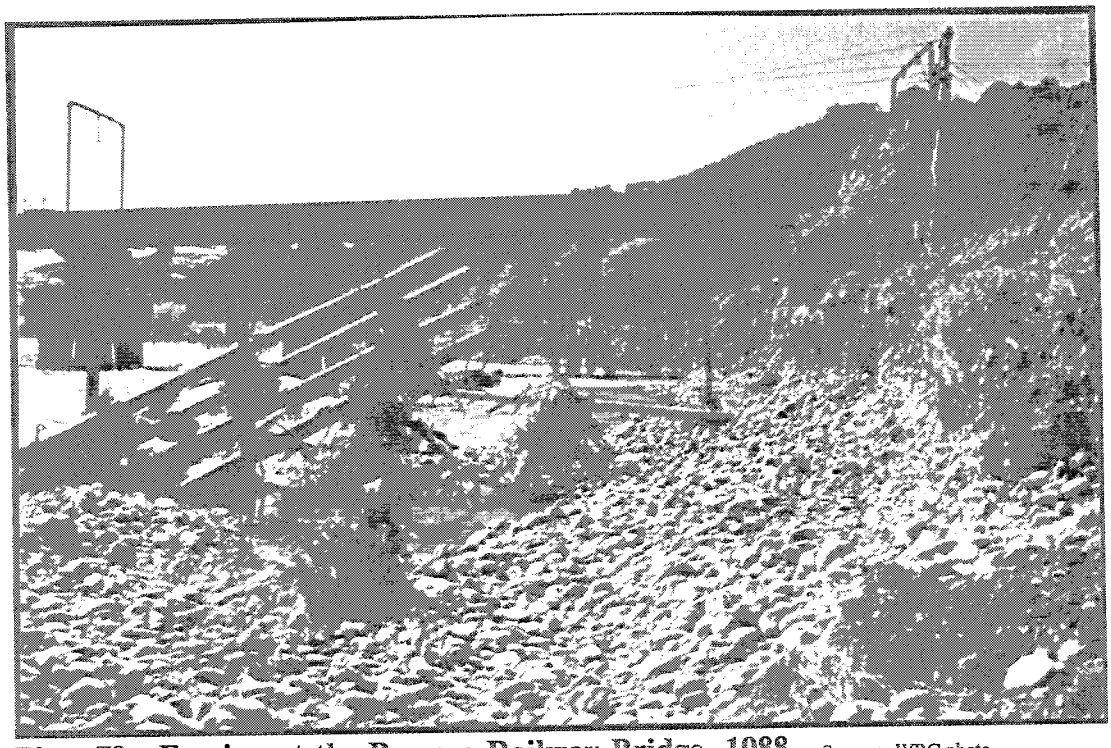


Plate 79: Erosion at the Pomare Railway Bridge, 1988. Source: WRC photo

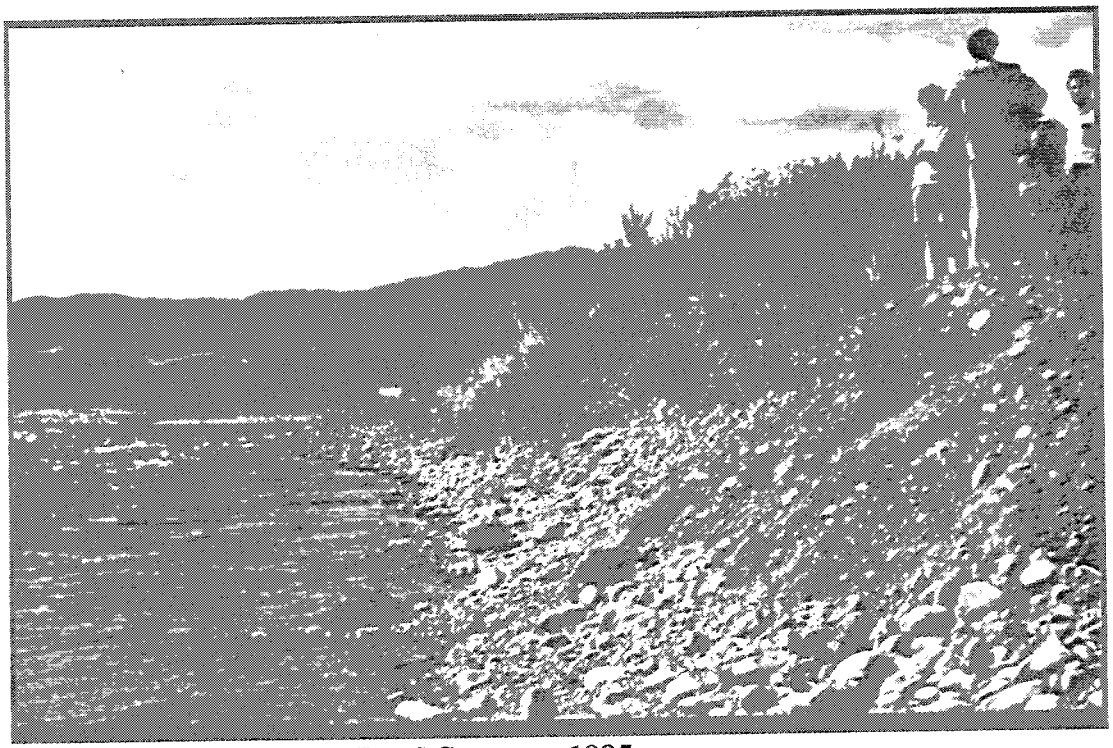


Plate 80: Erosion at McLeod Street c. 1985. Source: WRC photo

Ongoing works which have preceded the formal review process include heavy rock protection at Pomare (to protect the northern end of the Taita stopbank), and interim protection works at Ewen Bridge, identified as urgent work during the Bridge replacement investigations 1988/89. Refer to Wellington Regional Council Rivers Department reports.

Hutt River Flood Control Scheme Review Volume 7, Structural and Geotechnical Assessments/Stopbanks and Structures provides an in depth study of the integrity of the existing stopbank system and its susceptibility to failure through lateral erosion, instability and piping.

Channel Alignment

A significant proportion of the 1950s scheme expenditure for extension of flood protection to Upper Hutt was for the establishment of new river alignment; essentially a northward extension of the Lower Valley's "Ultimate River Alignment". By the early 1980s it was evident that this attempted river realignment had been almost completely unsuccessful.

Between 1980 and 1985 the adoption of new concepts in river training, combined with selective extraction methods, led to the beginnings of a stable central channel alignment. However the 1985-1988 construction of the Upper Hutt Bypass within the river zone offered the opportunity to rethink the options for the control of the central channel alignment and much of this recent training work was replaced.

Why did the approach used in the 1950s scheme fail in the Upper Valley when it had been so successful in the Lower Valley? With the advantage of hindsight, the essential differences between the Upper and Lower Valley can be identified. The reasons for the rapid failure can now be seen; but this was not the case in the late 1970s when every flood resulted in failure of extensive lengths of "established bank protection".

Shingle Management

By 1980 huge shingle beaches had accumulated and acted to direct the River towards the pre-1960 alignment.

As has been established in chapter 5, the extraction industry played a major role in the Lower Valley in maintaining a river alignment through the strategic placement of the drag-line dredges. Although limited extraction did occur in the Upper Valley at Whakatiki Street and Silverstream, the economics of extracting from Upper Hutt were unfavourable while there were still deposits available closer to the Wellington Market. This situation did not change until the late 1970s. By 1980 the economic advantage of the Lower Valley plants had been essentially negated as extraction methods were changed to reduce water pollution (in response to the findings of the Hutt River Tribunal, 1973), and the resource south of Taita Gorge became depleted.

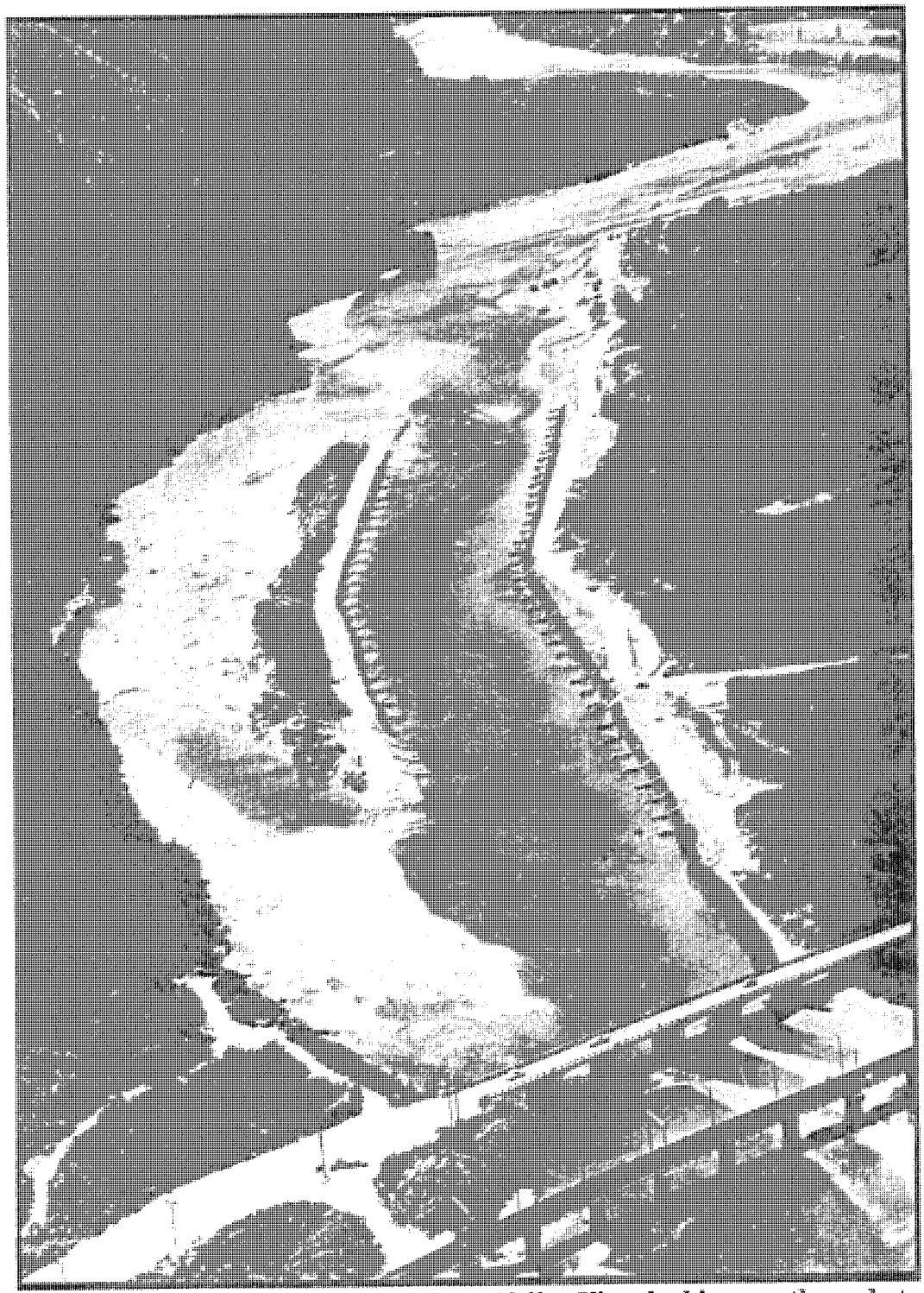


Plate 81: Silverstream Cut 1st Stage, 1960. View looking northwards to Barton's Bush. Source: HRB photo

Shingle Deposits

In the Upper Valley, unlike the Lower Valley, the river bed is partially controlled by a number of bedrock formations. These are most obvious within the gorges upstream of the Moonshine and Maoribank Bridges, but also provide bed level control at the Silverstream Bridge and along the line of the Wellington Fault upstream of the confluence of the Whakatikei and Hutt Rivers.

The opportunity to establish an entrenched central channel does not exist to the same extent in the upper river. In the period 1975-1985 the river has degraded by 1 to 2 metres, to the extent that bedrock has been exposed (in 1975 the bedrock beneath the Maoribank Bridge and downstream of the Whakatikei River was not visible). However, the central channel elevation can still rise to near the level of the surrounding land. The propensity of the river to deposit gravel and to develop braided channels downstream of the gorges may continue to be an obstacle to maintaining effective river control. This is undoubtedly the principal reason for failure of the 1950s scheme works, constructed during the late 1960s, and the repair works constructed in the 1978 to 1984 period.

Previous Works

As can be seen from the 1950s historical river alignment plots of the Lower Valley's Avalon reach, Appendix B, the problem areas in the Upper Valley (downstream of the Moonshine and Birchville Gorges) show a marked similarity. Control of the alignment at Avalon had taken over 50 years. In the period 1930-1960 it was the major river training work carried out by the Hutt River Board and culminated in the formation of the Melling Diversion Cut.

Plate 82: Moonshine Bed Levels, 1931. Source: Alexander Turnbull Library neg. G46227

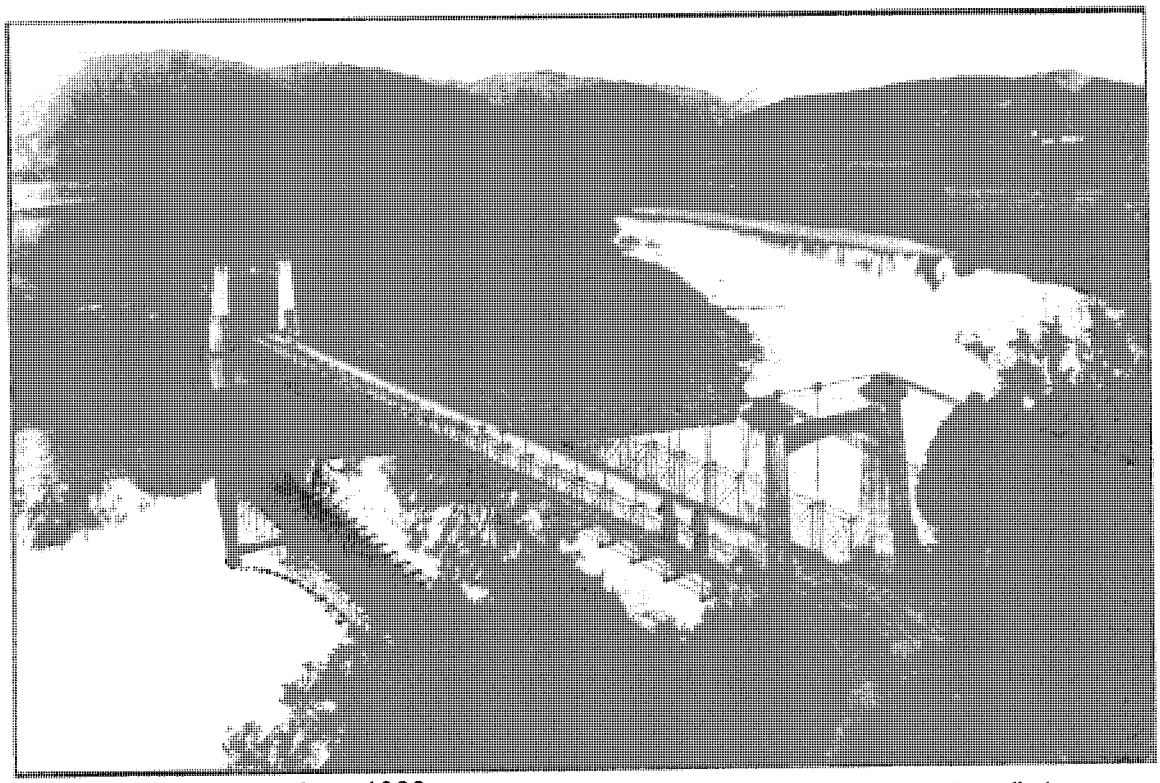


Plate 83: Maoribank c. 1920 Source: Alexander Turnbull Library neg. G EP 830, Evening Post collection.

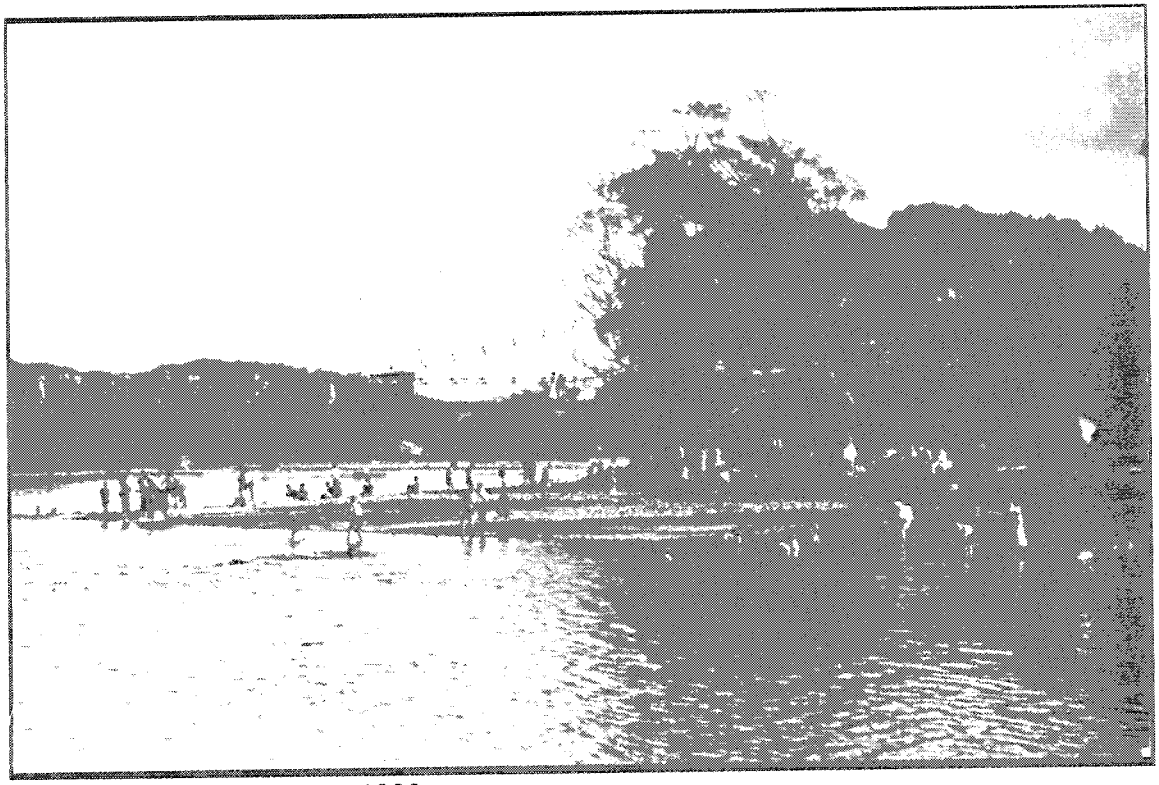


Plate 84: Maoribank c. 1920 Source: Alexander Turnbull Library neg. F20641.

Prior to the 1930s Scheme only a few isolated works, intended to relieve specific effects of berm overflow, had been carried out. Buckleton's and McCurdy's stopbanks (refer plate 71, p. 117 and Archive Table 14, p. 99) are examples, as are the bank protection works including low stopbanks, groynes and planting constructed at Ebdentown Road and McLeod Street. Major stopbanking and diversion works to prevent the erosion of Bartons Bush were completed in 1949 and by 1956 were well established. However, it is likely that the straightening of the river contributed to misalignments which disrupted the river pattern and damaged these downstream areas (Appendix B). In most places in the lower river the accumulated deposition of many years had buried large numbers of groynes, to the extent that more were buried than were controlling the current river alignment. However, in 1950 this "hidden reserve" did not exist north of Silverstream. Lateral erosion, once initiated, was severe.

Maintenance

During the period of the establishment of the Lower Valley river alignment many of the Hutt River Board works were damaged or destroyed but they were immediately rebuilt. This constant attention to the continuity of the relatively frail works, and to the maintenance of the channel to avoid direct attack on the banks, was the key to their success.

It appears that from the mid-1950s the priority given to essential maintenance was transferred to the construction of new scheme works. The tried and true practices of constant strengthening and rebuilding seem to have been shelved presumably under the pressure to complete the new scheme works.

In 1972 responsibility for the river was transferred to the Wellington Regional Water Board. The Board's wider responsibilities (encompassing the entire Wellington Region) inevitably led to changed priorities for the Hutt. River management was transferred from the Hutt River Board's consultants to the Wellington Regional Water Board, with an almost total loss of continuity other than that retained within the works labouring staff. By 1975 the deterioration of the training works was advanced and they were in a poor condition to withstand the following 7 years of moderate flooding.

Design Faults

It is apparent that the 1950s Scheme designers did not appreciate the magnitude of the forces they were unleashing in straightening the Upper River. In most areas the new works were outflanked or subjected to severe river attack: high velocity berm flows could occur behind the works, erode the berms and leave the training works isolated.

In the case of the Silverstream Cut (plate 81, p. 132), essential complementary work was not carried out. The formation of the embankment for the proposed diversion of State Highway 2 - the principal reason for the Cut - on the right (east) bank did not proceed. The old river channel remained unfilled and operated as a diversion during moderate floods. To make matters worse, the old river bed was used as a borrow pit for Ministry of Works and Development roading projects. It was only a matter of time before the River reverted to its original channel.

In the reach adjacent to Totara Park straightening of the river and consequent higher

flood velocities led to a massive redistribution of the shingle beds. Beach deposits as high as the surrounding berms were created, restricting the central channel and forcing a new alignment.

Although the scheme works were extensive, they could not withstand continuous direct river attack caused by central channel misalignment. There is now little evidence of the thousands of blocks which lined both banks in the mid-1960s.

River Works Reconstruction

Between 1979 and 1985 control of the alignment was gradually established through the application of a number of techniques - some new and some adapted from past practice.

River Metal Extraction

In order to reduce the level of water pollution during extraction operations (principally in response to the Hutt Tribunal recommendations of 1974 - see p. 71) the industry began to extract gravel from (dry) beaches using front end loaders and heavy road haulage trucks. The extraction was intended to be undertaken clear of running water by the use of small dams and diversion cuts. As a direct consequence the industry's operations became more mobile. With the establishment of the road haulage infrastructure and the negotiation of extraction charges, it became possible to use extraction more effectively for river control purposes than had been possible for some time.

The extraction of river metal which took place from most of the length between the Estuary and the Hutt Gorge (Te Marua) was managed with the principal aim of improving the river alignment. Permission to extract from the Lower River was withheld from shingle companies if there were deposits requiring more urgent removal in the Upper Valley. As part of this approach the single point extraction at Whakatiki Street was prohibited in favour of selective extraction from the Whakatikei Street to Totara Park reach, plus removal of problem beaches near Barton's Bush, the Totara Park Bridge, the Mangaroa River confluence and at the Te Marua Golf course, among others.

Bank Protection

The "Debris Fence" permeable deflector (plate 85) was developed as an inexpensive means of extending bank protection onto the berms and to prevent outflanking of the river bank deflectors. The objective was to establish a lower velocity, less turbulent zone between the higher velocity flood flows and the highly erodible berm material.

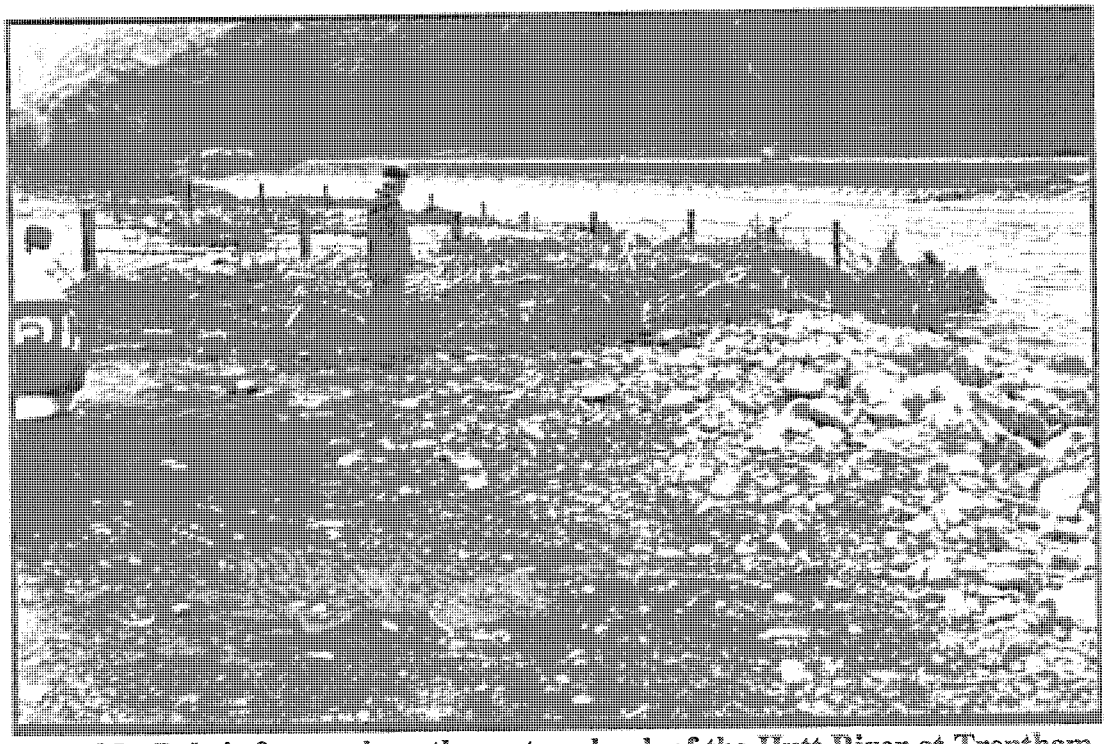


Plate 85: Debris fences along the eastern bank of the Hutt River at Trentham, 1986 (note the "Bluff" in the background refer plate 67). Source: WRC photo

The fences were sited so that when laden with flood debris, they would direct berm overflow back into the main channel. The returning berm flow was then to become a significant factor in keeping central channel flows within the central channel.

The debris fences were effective in regaining control of the River at the entrance to the Silverstream Cut [see Project Report 30] and have been used throughout the new river works associated with the Upper Hutt Bypass development [Project Report 45].

A planting programme was initiated throughout the river to establish a wide band of vigorous live protection in the zone of higher velocity berm flow. All structures and roading, including haul and maintenance roads, had to satisfy the requirement that they must not initiate bank scour.

Examples of these methods now used throughout the river are described in the following Project Reports.

Project Report 43: Bank Stabilisation Works at Harcourt and Haukaretu Parks. Reconstruction and protection of 1.5 km of the left bank immediately upstream of Maoribank. The bank contains the upper valley main sewer. Bank failure was initiated by bed degradation.

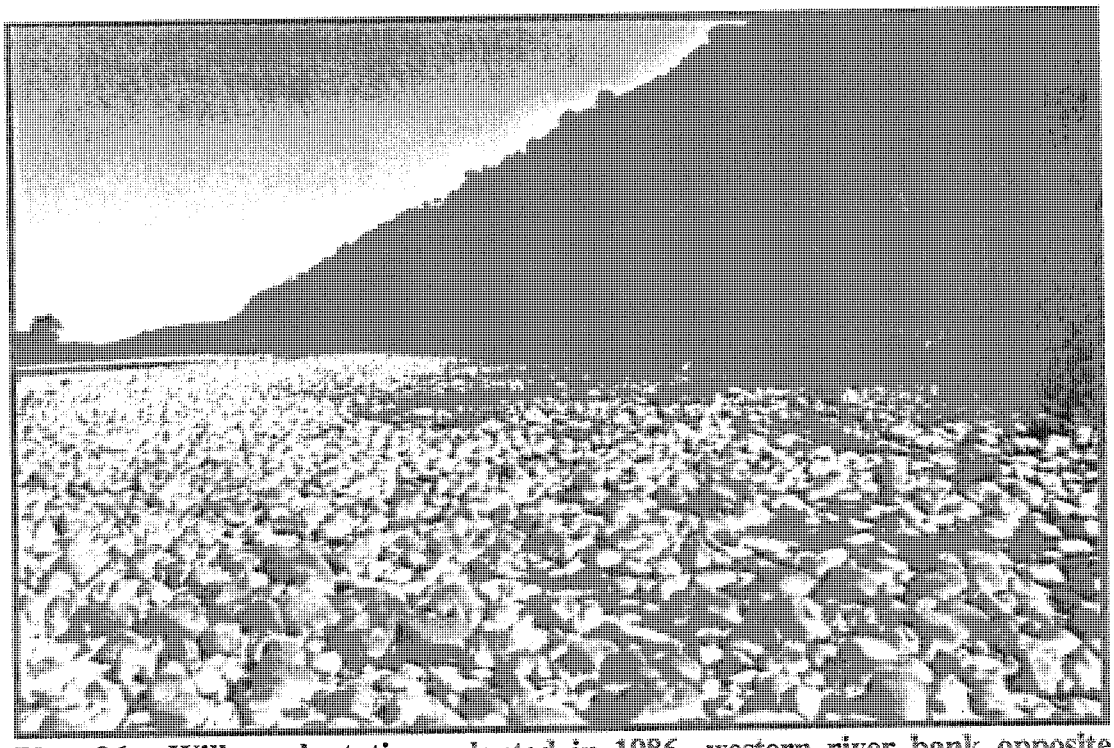


Plate 86: Willow plantations planted in 1986, western river bank opposite Moonshine Park. Source: WRC photo

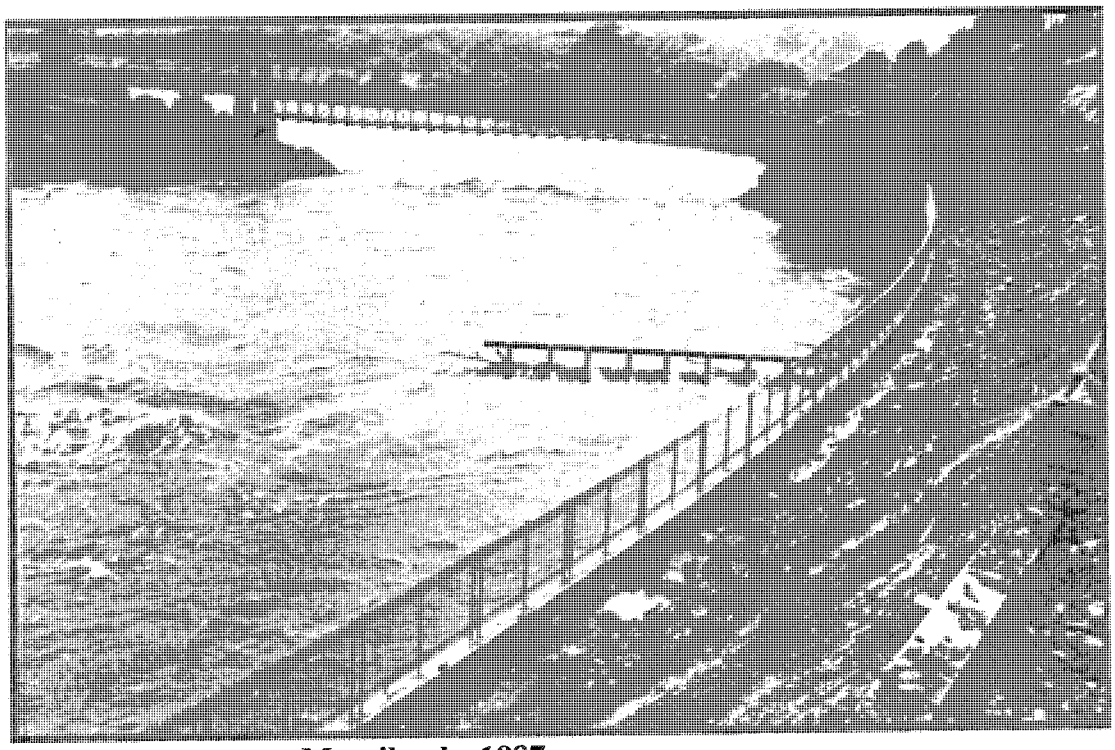


Plate 87: Bypass at Maoribank, 1987. Source: WRC photo

Project Report 30: Channel Alignment, Wellington Golf Club to Silverstream Cut. River misalignment initiated by river straightening upstream and by the river diversion into the old river channel downstream. The first extensive use of debris fence type protection to control river alignment.

The Upper Hutt Bypass

During 1984 surplus funds within the National Roading budget made possible an immediate start on the long awaited Upper Hutt Bypass Road.

Since the mid-1940s the major transport route had been planned to be accommodated within the river zone. Its proposed inclusion in the 1950s scheme was a critical factor in ensuring Cabinet approval of the Upper Valley Scheme, and was the reason for the late 1960s river realignment at Silverstream, "The Silverstream Cut". This cut fell steadily into disrepair until the second major injection of roading capital in 1985.

A precondition for 1984 National Roads Board contributory funding of the Bypass was the completion of all works (and so expenditure of National Roads Board funds) within an 18 month period. Although the civil roading works met this precondition, the "River Works", which by definition included a 20 year maintenance budget, could not. To satisfy the National Roads Board budget requirements, the present value of the proposed River Works (including design, construction and ongoing works including flood damage repair) was determined and the National Roads Board share of the estimated present value was directed to the construction of the initial control and alignment works. To monitor the actual costs of the proposed works and to deal with apportionment of the River Works costs a River Works Agreement between the construction partners, the National Roads Board (Transit New Zealand), Upper Hutt City Council and Wellington Regional Council was signed in 1985.

The River Works Agreement provided for the establishment of a "permanent" river alignment for the reach from the Silverstream Bridge to Maoribank. To achieve this a meandering river alignment was defined and located in position using heavy rock armouring on the outside of the bends. The berms between the bends were planted densely in willow, reinforced with the debris fences discussed in the previous section. After much debate it was agreed that the value of the initial works was going to be similar to the predicted present value of the ongoing maintenance and flood repair works. The Agreement therefore allowed the National Roads Board to make the bulk of its contribution in construction of the initial works, with the other two partners funding the ongoing maintenance. Funding reviews are to be completed at five yearly intervals to ensure equity between the partners.

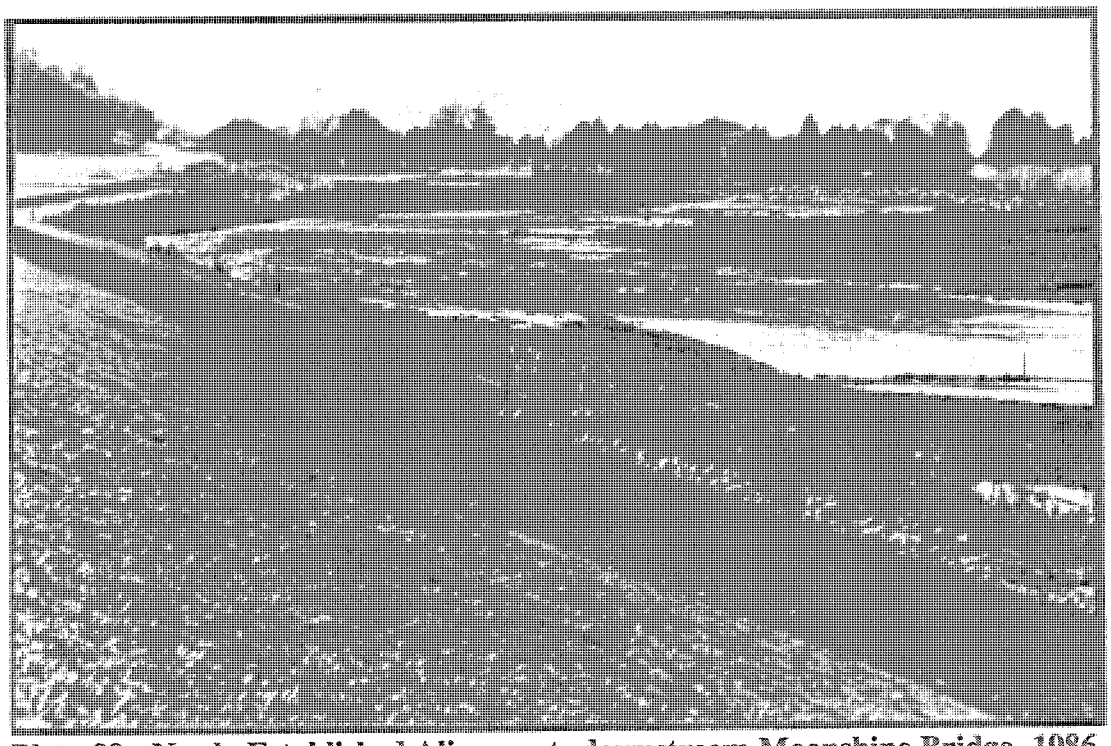


Plate 88: Newly Established Alignment, downstream Moonshine Bridge, 1986.
Source: WRC photo

The works have been assumed to be fully established at the expiry of the 25 year term of the agreement. At that time the agreement allows for the National Roads Board to withdraw from responsibility for river works. The debate which preceded the signing of the agreement centred around the feasibility of the concept of a permanent river alignment, and the security of the rock rip-rap, the essential element of the design. **Volume 6** of the Scheme Review, **"River Channel Management and Protection Works"** includes a study of the as-built River Works and makes recommendations for their ongoing management.

The Upper Hutt Bypass Works are described in detail in Project Report 45.

The River Environment

The last 20 years have brought many major improvements to the New Zealand environment. The scarred hillsides and relics of our last period of growth have gone, and a "green consciousness" determines the present management of our landscape.

The river managers have been part of this greening of our environment. As was mentioned in the introduction to this history, few people now remember the wasteland which was the river zone in the 1960s. The photographs contained in this volume illustrate the condition of the river berms at that time.

Improvements to the river environment were initiated on the recommendation of the Hutt Tribunal (1974), convened under the Water and Soil Conservation Act, 1967, and led to the control of the extraction industry's waste water discharges. At about the same time the "new" river managers, the Wellington Regional Water Board, embarked on a

programme to develop the berm lands. This was followed in the late 1970s by changes to the permitted methods of river extraction to minimise silt loadings in the river. A start was also made on a Catchment Management Plan (yet to be completed) with initial recommendations on minimum low flows to protect the fishery and the underground water resource. By 1980 further concern for water quality, especially during the holiday periods, led to greater controls on river realignment activities such as cross blading by bulldozer.

Following the formation of the Wellington Regional Council in 1980, the parks and recreation function increased and had become an independent department by 1986. Although control of development within the river zone remained with the River Manager, recreational development of the cleared berms was carried out by the end user, usually the local authority in conjunction with the Wellington Regional Council. In 1979 a Joint Landscape Management and Recreation Study was prepared (Boffa Jackman and Associates, 1979) to assist in setting the guidelines for river berm development. The Study was extended by Lower Hutt City Council in the mid-1980s for berm planting and by the landscape architects for the Upper Hutt Bypass in 1985.

The River Environment is the subject of **Review Volume 11, "Environment Assessments"**, however, to complete this history the major steps leading to the state of the current river environment are listed in the following sections.

The Artesian Water Supply, Pollution and Low Flows

Abundant supplies of pure artesian water helped trigger the industrialisation of the Petone area and supported the development of Wellington City. Despite its limited extent and the potential for overexploitation, this source is still an essential part of the Region's water supply.

The underground water system is better understood as "a second underground river" with its headwaters in the Taita area and its mouth beneath the Harbour, in the region of Somes Island.

In the Taita "recharge area" water percolates downwards through the bed of the Hutt River and continues through the ancient river gravel deposits. South of Melling the permeable gravels are overlain by impermeable silts and clays. This sealing off of the permeable gravels has facilitated the development of an artesian system (see figure 6, p. 16). The aquifer, as a supplier of potable water, is a fragile system which could easily deteriorate due to impure source water, perforation of the aquiclude or uncontrolled extraction. Loss of pressure within the system from excessive extraction or a leaking aquiclude could allow a backflow of sea water from the harbour, as has happened in many places throughout the world. Once within the aquifer salt water would be difficult or impossible to remove.

In recent times the aquifer has been threatened on a number of occasions:

- Early in the war years dredging activity near the river mouth punctured the aquiclude with a subsequent loss of water and pressure in Petone. There have been a number of other instances where piles have been driven through the aquiclude (e.g., during the construction of the Estuary Bridge, Morrison, 1954) and where

blow holes have been observed close to wharf building activities. All drilling and piling operations are now closely monitored to ensure that the aquiclude is protected.

- The rate of aquifer recharge is a function of the permeability of the river bed in the recharge zone. Bed permeability can be reduced by high silt loadings in the river. Until the 1970s the shingle companies discharged silt from dredging operations and, in large quantities, in wash water. The silt load in the river was tolerated until 1970 although it caused complete discolouration of the lower river and immediate harbour. Public concern over the loss of water quality led to a convening of the Hutt Tribunal, under the Water and Soil Conservation Act 1967, to consider the problem of shingle plant waste. As a result interim water rights were issued to the offending extraction companies in May 1974, conditional upon proposals being received within 9 months for the treatment of their waste, and the commissioning of additional plant within 2 years.

- The rate of recharge is also affected by the available head of water in the recharge zone, determined by bed elevation and water depth. During periods of drought this head, i.e., the residual flow, is affected by the quantity of water abstracted at the Kaitoke Water Supply Weir. Prompted by public concern over the depletion of the underground water resource, engineers of the Wellington Regional Water Board considered the minimum flow desirable to satisfy recreational, fishery and underground water demands. It was found in 1975 that natural low flows were lower than the "desirable" figure.

  There followed a series of investigations into supplementary reservoirs, and closer investigation of the relationship between river flow and aquifer recharge.

  The costs of low flow augmentation were found to be prohibitive, but the exercise served to establish target minimum low flow levels. Construction of the Te Marua Water Supply Lakes in recent years now allows water supply managers to reduce the Kaitoke intake of water, when necessary, to levels not possible in the 1970s.

- Toxic waste is able to enter the ground water system via the recharge zone, by percolation through the flood plain, upstream of the aquiclude, or through bores operated by industries.

  In 1974 following the opening of the Silverstream Refuse Tip, polluted leachate and run-off entered the Hutt River via Hulls Creek.

  Pressure from the Acclimatisation Society led to the improved management of the tip and the installation of a collector drain which directed pollutants into the Hutt Valley Sewer.

  More recently 76,000 litres of petrol have been lost into the aquifer from the Avalon Service Station. Although some of the petrol has been recovered, most has been lost within the aquifer (and to evaporation). Several observation bores have been installed between the spill site and the Waterloo Pumping Station, but to date there has been no evidence of pollution to the Region's water supply.

Water Quality

Water quality was not of great significance to the Hutt River Board until the classification of the river in December 1969 under the Water Pollution Regulation 1963. This classification was based on the existing use and included the water catchment areas, prohibited discharges, the existing bathing areas (bathing standard) and "the remainder". A natural water quality level was not specified.

The river is now reclassified to remove anomalies among the varying standards within the watercourse. Water quality has been regularly tested since 1974.

Classification of the Hutt River was initiated by central government agencies as part of a nation wide programme to classify all waters and to control the use and quality of water through the water right process.

In addition, there were the two major sources of pollution, the Gracefield industrial area and the shingle extraction industry, which had to be brought under control. By 1976 the shingle plants had either complied with the water right requirements or had closed down and by 1979 the Gracefield Trade Waste Sewer had been commissioned.

The principal remaining source of pollution was from river management. During the 1960 to 1975 period major stopbanking and river training works were carried out over much of the river's urbanised length. The means chosen to stabilise and maintain the new channel alignment was to suppress the formation of a meander pattern and encourage the river to flow essentially parallel to its new banks. The tendency to meander, i.e., to form alternate beaches or bars and pools, was countered by bulldozing beaches into adjacent pools when one or the other developed to an extent thought likely to direct river flow against the banks.

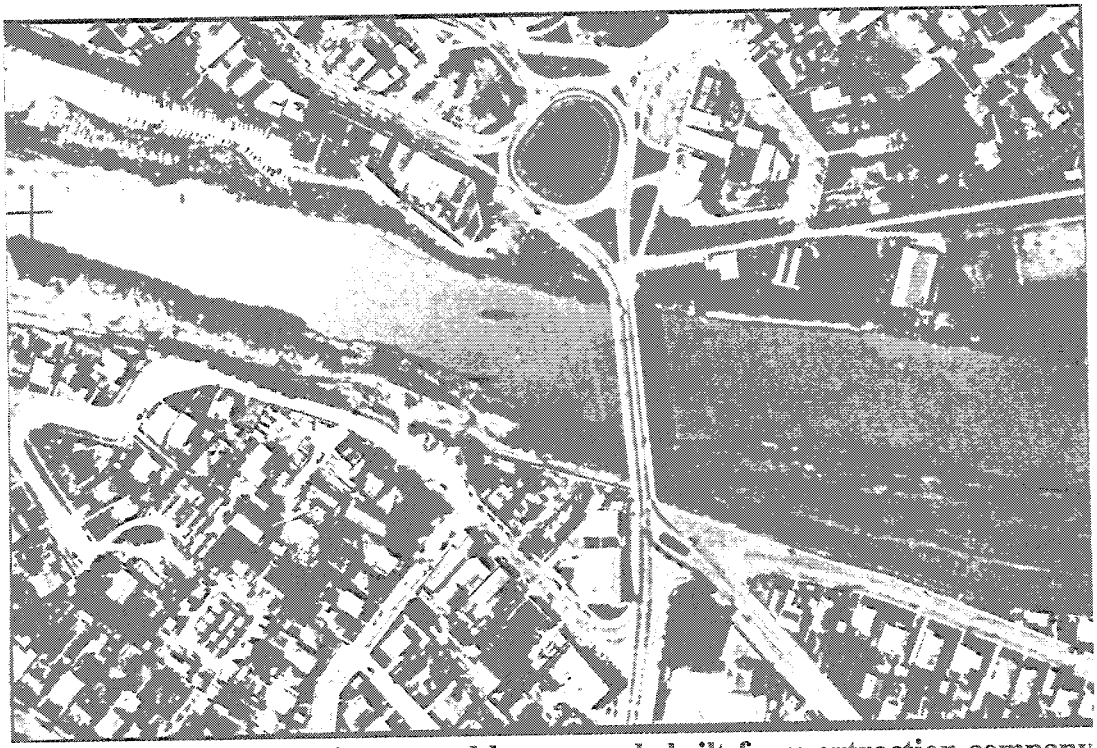


Plate 89: Water pollution caused by suspended silt from extraction company waste, 1967.

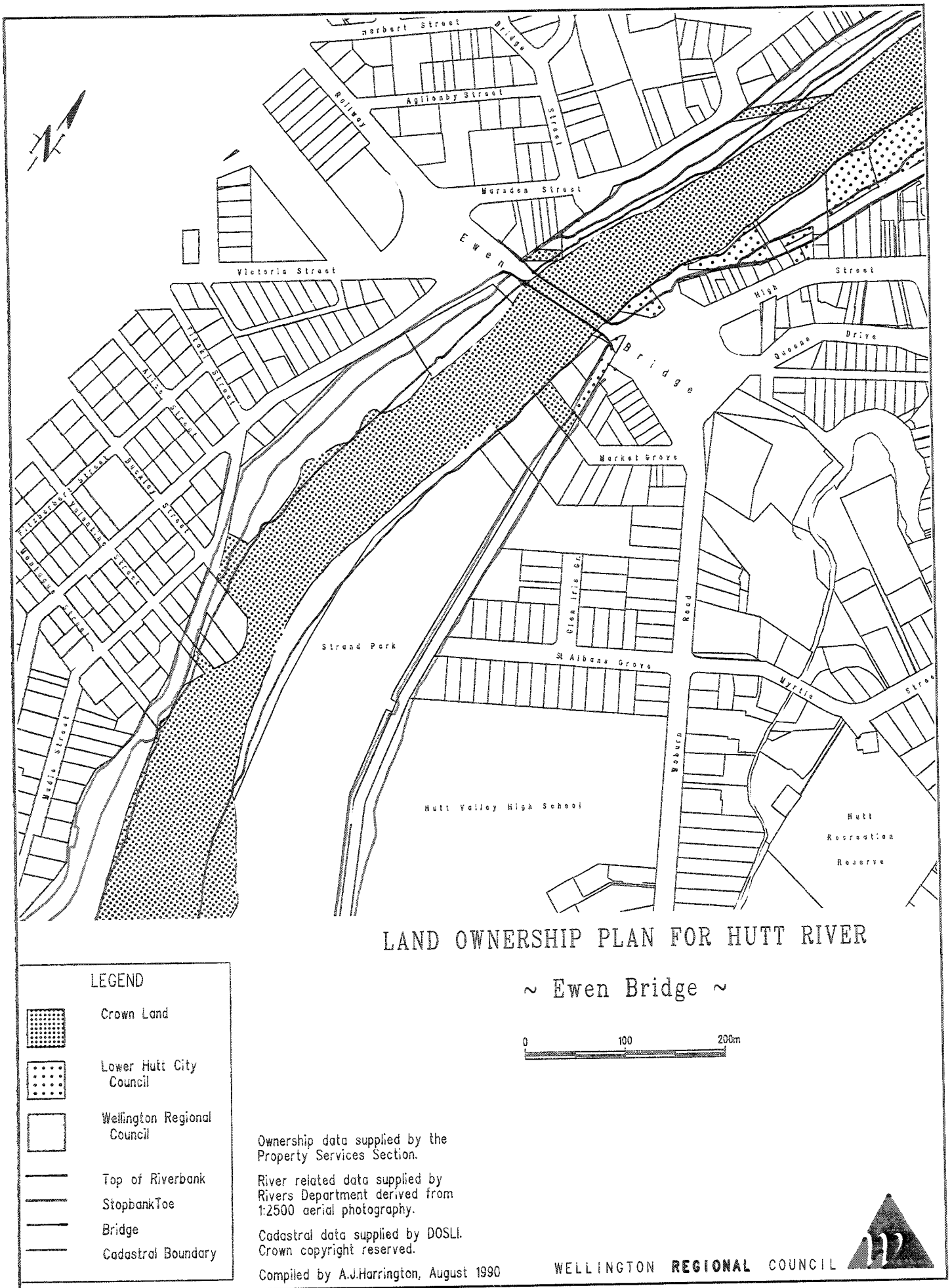


Figure 13: River Zone Information in the Ewen Bridge Area.

Because of the lengths of river to be stabilised it was not uncommon for one or two large bulldozers (frequently Caterpillar D7s or D8s) to spend months "cross blading" entire reaches of the river. High silt loadings became the major cause of poor water quality, affecting both the fishery and bathing. During the flood prone years 1977 to 1982, when extra cross blading became necessary, the effect on water quality became intolerable and led to the present practice of minimising activity in running water by the use of temporary diversions, coffer dams and excavation "in the dry".

Berm Development

Following the completion in 1972 of the 1950 scheme extensions the river managers became responsible for large areas of public land. Except for the developed areas south of Melling, much of the area was wasteland. While there will be some who will have appreciated these wilderness areas for legitimate reasons, the predominant use was for illegal dumping and for fringe activities which could be generally described as covert.

Development of the berms was undertaken in four stages:

Stage 1 : Vehicle Control. Erection of vandal proof barriers to exclude unauthorised vehicle entry.

Stage 2 : Landscaping. To minimise the cost to the river authority of smoothing and filling these waste areas were initially managed as tip sites for clean filling by approved contractors. In return for tipping rights the contractors cleaned the sites of weeds, buried waste (including old machinery previously dumped on the berms) formed haul roads and regraded the areas to specific levels.

Stage 3 : Grassing and Maintenance. The river authority grassed the regraded areas and maintained them as open areas.

Stage 4 : Leasing. As appropriate the areas were leased to sports and recreation groups or to the local Council for sporting use.

Areas for development were selected on the basis of the proximity and volume of the filling available and the value placed on the tipping rights. The first areas to be improved using these techniques were the Avalon and Taita berms: during the 1973 to 1985 period most of the publicly accessible berms in the lower and upper valley were improved.

Berm Development - Mining Operations

Berm development also took pace as a result of berm mining operations. As the shingle resource became progressively depleted between 1982 and 1985, restrictions were placed on the volumes of shingle available for extraction from the river bed. Extractors looked elsewhere to meet the demand and the option to mine the gravels from beneath the berms was proposed. Approval was granted for mining berm areas which were considered unlikely to become part of the river channel in the foreseeable future.

To protect against unforeseen events, extraction was not permitted below the level of the adjacent river bed, or within 10 metres of the adjacent stopbanks or river banks. In a process similar to that for authorised tipping (above) the river metal was extracted and replaced with waste fill, compacted to a minimum landfill standard. Between 1979 and 1985 mining took place mainly in Upper Hutt, on the eastern berms upstream and downstream of the Whakatiki Shingle Company and as part of a private operation on Wellington Golf Club land.

Berm Development - Recreational

The development of the berm lands also offered a potential for recreational and public use development which inevitably led to conflict with the overlying River Zone use. For the recreational user the essential river bank willow plantations and training works force restrictions on the widths available for sports fields; interrupt the river views, and present dangers and obstacles for water sports. To the river managers, proposed and existing club rooms and fences and landscape plantings can initiate undesirable flood flow patterns likely to threaten the integrity of the stopbanks and river control works.

In most instances the river works which have effect the fishermen and cause swimming hazards have been essential to maintain the recreational environment.

The first attempt to coordinate these competing aspirations into an overall plan was made by the Lower Hutt City Council in the late 1970s with the commissioning of a landscape plan for the river lands from the mouth to Silverstream. A similar plan was developed in 1985 for the Upper Hutt berms and was incorporated into the Upper Hutt Bypass.

A firming of policy regarding the construction and maintenance of recreational structures within the river zone has also occurred over the last 10 years.

Triggered by the fire of the Lower Hutt Sports Club buildings in c. 1983 the Wellington Regional Council has followed a policy of declining approval for the rebuilding or extension of existing buildings, or the renewal of river land lease areas. Privately owned land within the river zone is gradually being purchased for river control use: the purchase of Firth Industries' retail concrete product factory and site at Melling being the most recent example.

River Zone lands are now fully defined using the Wellington Regional Council Property Management Geographic and Textual databases. Figure 13 is an example of land information held for the Ewen Bridge area.

Chapter Eight

RIVER HYDROLOGY

Catchment Monitoring and Flood Frequency Analyses

Historical accounts of Hutt floods typically record events with a short duration at high stage, similar to a wave or "bore" moving quickly down the River. The 1955 flood as recorded in figures 14 and 15, p. 148 is a good example. (Photographs of residents trapped in the rapidly rising waters are contained on the front and rear covers of this report). Comparison of the hydrographs shows that in 1955, as today, the river channel from Maoribank to Hutt City (approximately 20 km) had little effect on the shape of the flood hydrograph and led to flood flow velocities averaging 10 km per hour.

This chapter contains brief reference to the engineering hydrology undertaken prior to 1990. Scheme Hydrology is reviewed in Scheme Review Volume 2 "Climatology and Hydrology".

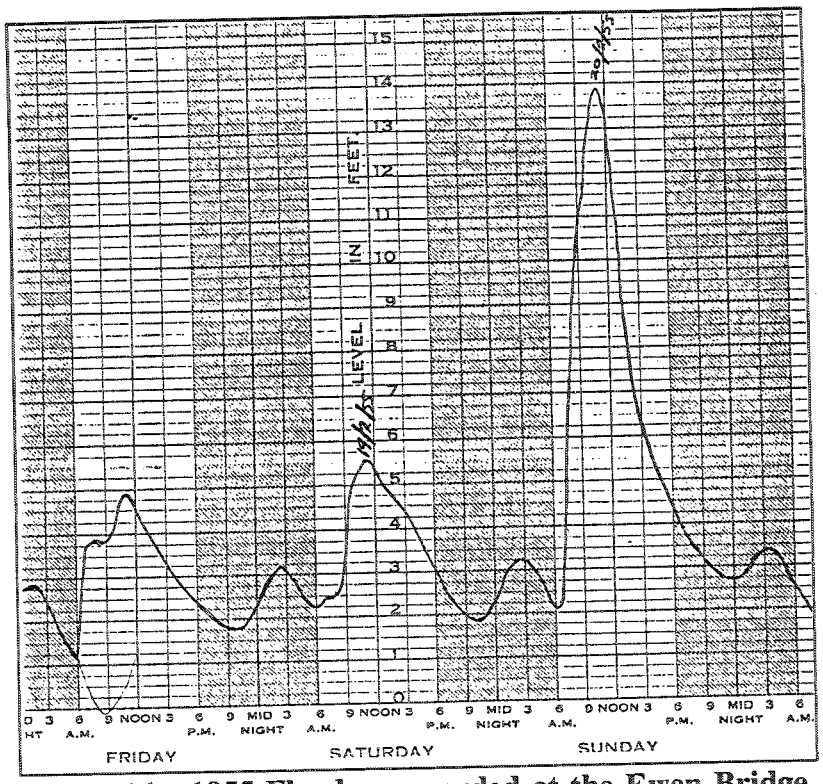


Figure 14: 1955 Flood as recorded at the Ewen Bridge, Hutt City.

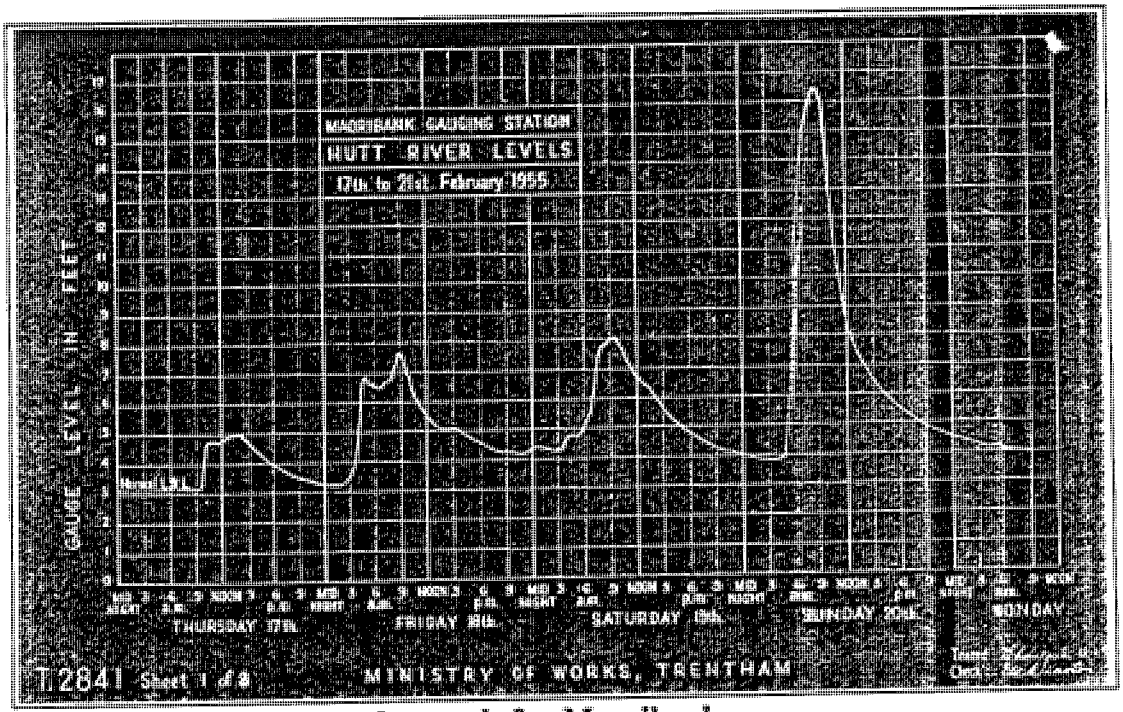


Figure 15: 1955 Flood hydrograph for Maoribank.

Floods and Monitoring Prior to 1940

Scientific monitoring of the Hutt River System commenced in 1941 with the establishment of the Ewen Bridge water level recorder at central Lower Hutt. Accounts of floods prior to 1930 are found scattered throughout the various archives. Table III, p. 150, is a compilation of these general observations, interpreted in terms of our current understanding of the historical river regimes and flood plain topography. (Taken from WRC HRFCS Report "Historical Flood Re-estimation by Channel Modelling", November 1989). Flood observations from 1924 are contained in Archive Table 18, p. 160.

Scientific Monitoring Post - 1940

From 1904 to 1941 the peak rise in flood level was recorded in terms of feet of rise at the Hutt Bridge. Readings were initially taken from the bridge itself but from 1928 were read from a staff gauge located "on the south end of the first pier from the east end of the new Hutt Bridge". Until 1941 floods were not formally recorded and there is no record of the Ewen Bridge recording station ever being rated either before or after the installation of the gauge. The data that has been recorded has been interpreted with reference to other flood observations, as for the pre 1930 data, to produce a synthetic partial series for 1840 to 1990 [refer Table IV, p. 151 and figure 16, p. 152]. The stage discharge relationships for several sections of the lower river and for Hutt Bridge, as generated from the historical backwater models, are included in figures 17 and 18, p. 153.

The Ewen Bridge Recorder was funded by the Soil Conservation and Rivers Control Council (SCRCC) as part of its 1940 nationwide campaign to develop an national hydrological archive. Although the recorder was retained until 1972, in 1951 the SCRCC encouraged its replacement with a new station at Maoribank. Reasons given for its replacement were the unreliability of the Ewen Bridge low flow data because of the tidal influence, and the need for an increased level of flood warning due to the "enormous" recent growth in the population of the Hutt. The historical ratings for the Ewen Bridge and Maoribank stations, effectively used for the design of all current scheme works, are included in figures 19 and 20, p. 154.

The Maoribank water level recording station proved difficult to maintain. The bed degraded, the intake pipes were subject to debris damage, and the cableway was apparently unsafe. Maoribank was in turn replaced as the principal recording and flood warning station by the Birchville Station in 1970. In addition to Birchville, two low flow stations were installed for the Underground Water Authority at Silverstream Bridge (1962-1980) and at Boulcott (1964 to present). In 1979 the Wellington Regional Water Board established an additional station at Taita Gorge to include a larger catchment area.

Table V summarises the past and present water level recorders and their periods of record. Scheme Review Volume 2, "Climatology and Hydrology", contains analysis of the station records and current rating information. It also contains description of the climate stations and consideration of the Hutt paleohydrology and historical climatology.

TABLE III : HISTORICAL FLOODS 1840-1930
(Assigned flows are 1990 reassessments)

Date	Recorded Observations	Assigned Flow (cumecs)
1840	Overflows into the Alicetown area of .3 m leading to general flooding of low lying areas to approx 1 m deep.	1000
1842	General berm overflow into settlement.	800
1849	Heaviest flooding for many years. Sheep lost. Berm overflow.	1000
1852	General overflow. Recurrent event.	600
1855	600 mm higher than the 1849 event.	1500
1858	January flood. To bridge deck level. Flows of 1-1.2 m on high street leaving the road impassable.	2000
	September flood. Removed half of the third Hutt bridge.	1200
1868	Damaged the Hutt bridge.	1200
1871	Damaged the Hutt bridge.	1200
1878	Two floods. Both with widespread bermflow covering the "entire" valley. The second River Overflows through Boulcott operated.	1500
1880	Bankfull with overflows in the lower reaches.	800
1893	March flood. Flooding in central Petone to the top of boundary fences.	1500
	August flood. Flooding made use of the main road to Wellington difficult.	1700
1896	Serious flooding of Alicetown.	1350
1898	June flood. Water level .23 m below the deck of the Hutt Bridge. Alicetown flooded to 2.4-3.0 m. High Street flood to approx .9 m.	2000
	November flood. Water covering the "entire" valley but to a lesser depth than in June.	1500
1904	Flooding of lower berms.	400
1907	Flooding to the base of the embankments.	750
1909	High flood recorded.	750
1911	High flood.	750
1912	High flood.	750
1913	Levels .9 m below Melling suspension bridge.	1300
1915	Level 5.65 at Hutt bridge.	1350 (HRB 1287)
1921	Central channel full to embankments	750
1922	Rise at Hutt bridge 3.35 m..	1000
1924	600 mm below Hutt bridge deck.	1800
1926	Central channel bankfull.	400
1928	Berms covered.	700
1929	Berms covered.	700
1930	Rise at Hutt bridge 2.75 m.	800

TABLE IV : HUTT RIVER SYNTHETIC FLOOD SERIES 1840 TO 1990

Data for Floods up to 1972 has been obtained from observations at Lower Hutt, with the assigned discharge determined from synthetic ratings for the Hutt Bridge site, determined by modelling historical river conditions (refer HRFCSR Report "Historical Flood Re-estimation by Channel Modelling"). For the period 1840 to 1930 general observations have been used. From 1931 to 1941 observations in terms of the staff gauge on the Fifth Hutt Bridge have been used. From 1942 to 1972 automatic recording were taken at Ewen Bridge. It is probable that many of the lower order floods prior to 1930 have not been recorded.

For floods between 1972 and 1979 the flow has been calculated by a regression from the Birchville Flows (Hydrology Centre Rating 1989).

For floods from 1979 the flow is the Taita gorge recording.

date	flow	flow	flow	date	flow	flow	date	flow	flow	flow	flow	date	flow	flow	flow	flow
1840	1000			1880	900		1920					1960				
1841				1881			1921	750				1961	730			
1842	600			1882			1922	1000				1962	1280			
1843				1883			1923					1963				
1844				1884			1924					1964				
1845				1885			1925					1965	880	1300		
1846				1886			1926					1966	620	1180		
1847				1887			1927					1967	620	620		
1848				1885			1928	700				1968	730			
1849	1000			1889			1929	700				1969				
1850				1890			1930	800				1970				
1851				1891			1931	1400				1971	625	665	1050	
1852	600			1892			1932					1972	781			
1853				1893	1500	1700	1933					1973				
1854				1894			1934					1974				
1855	1500			1895			1935	630				1975				
1856				1896	1350		1936	810				1976	614	747		
1857				1897			1937	520				1977	792			
1858	2000	1200		1898	2000	1500	1938	865				1978				
1859				1899			1939	730	1600			1979	568	531	542	
1860				1900			1940	570				1980	1213	741	557	746
1861				1901			1941	570	770	680	740	1981	1298			
1862				1902			1942	625	720			1982	1302	813		
1863				1903			1943	570	625			1983	652	879	648	
1864				1904			1944	530				1984	1012			
1865				1905			1945	590	615			1985	748	790		
1866				1906			1946	590				1986	539			
1867	1200			1907	750		1947	775	850	970	700	1987				
1868				1908			1948	1200				1988	671	858		
1869				1909	750		1949	540				1989				
1870				1910			1950	580				1990	762			
1871	1200			1911	750		1951	530	520	790						
1872				1912	750		1952	535								
1873				1913	1300		1953	570								
1874				1914			1954	550								
1875				1915	1350		1955	535	640	930	1250					
1876				1916			1956	630	650	770						
1877				1917			1957									
1878	1500			1918			1958	520	520	730						
1879				1919			1959	540								

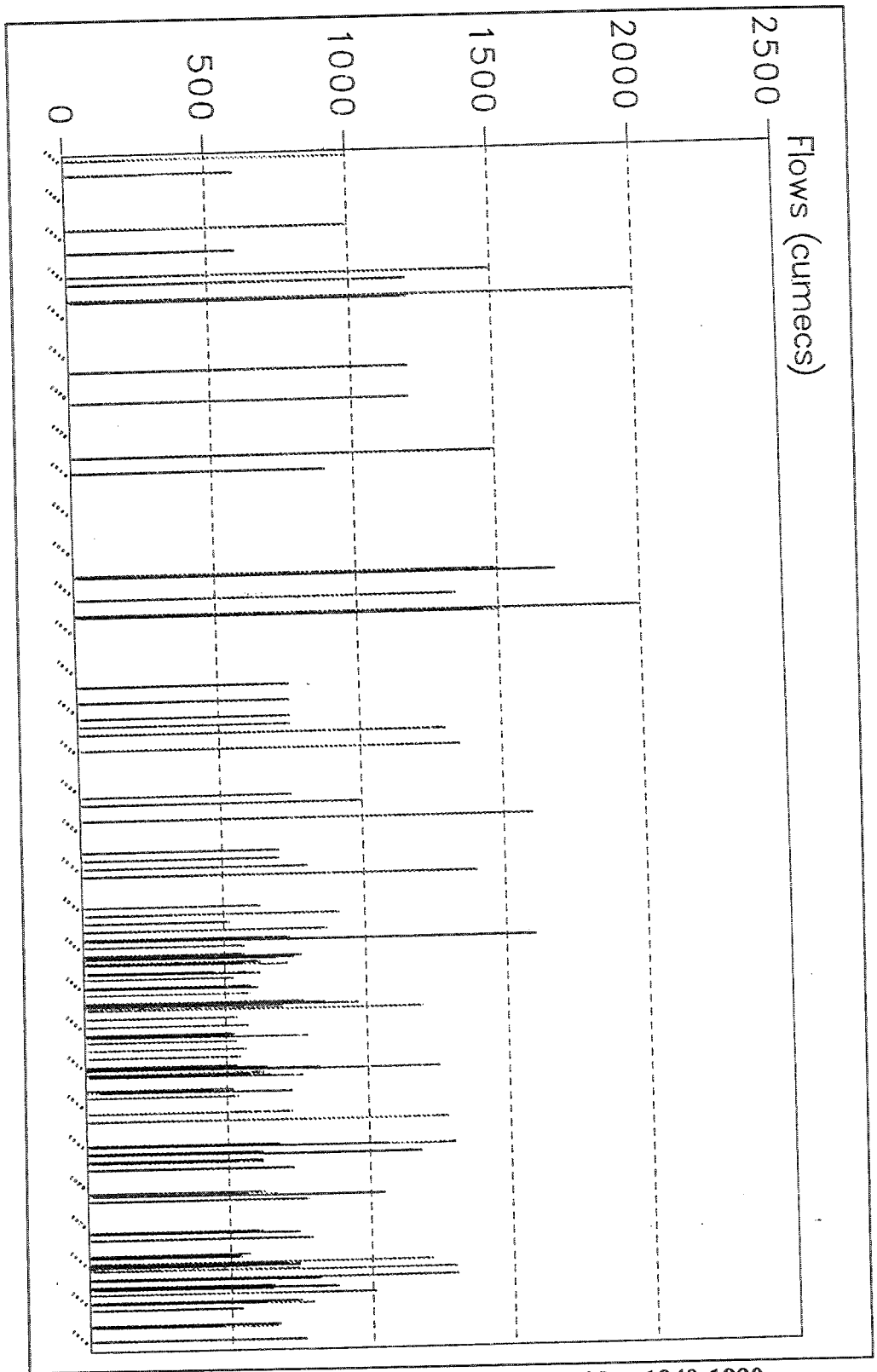


Figure 16: Synthetic Flood Series at Ewen Bridge 1840-1990.

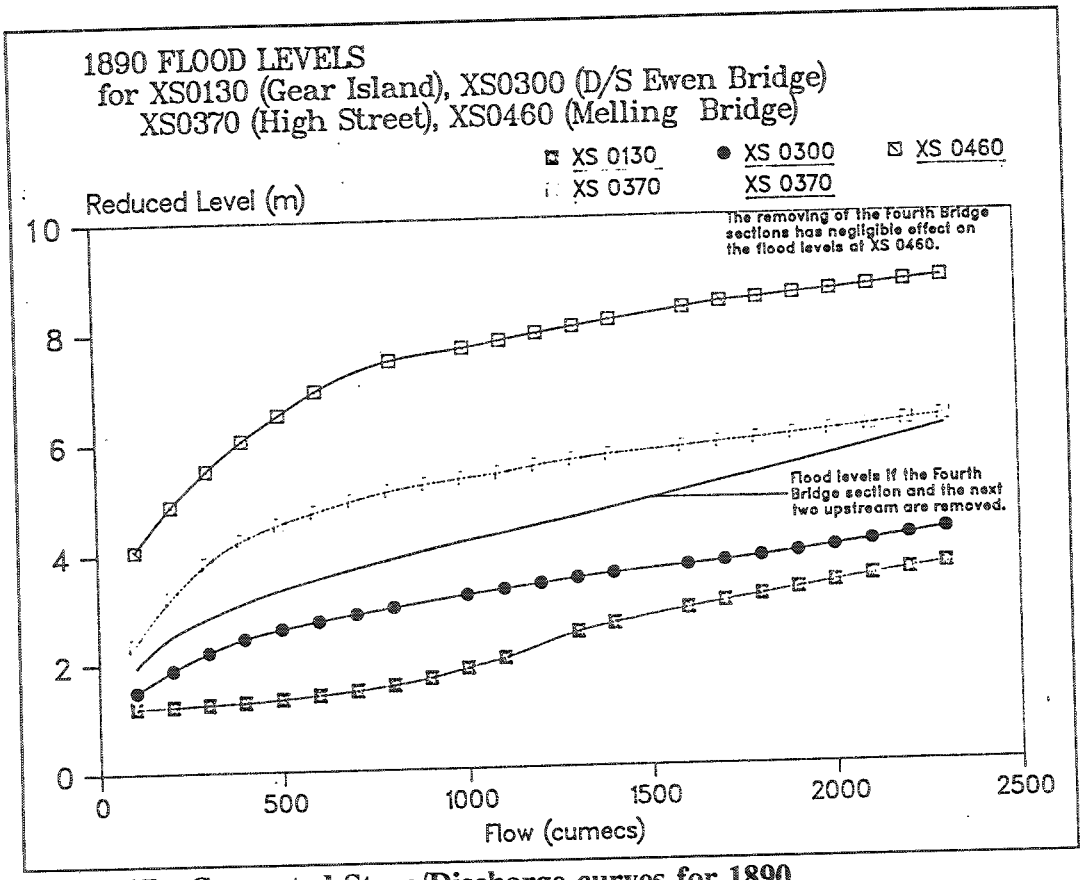


Figure 17: Computed Stage/Discharge curves for 1890

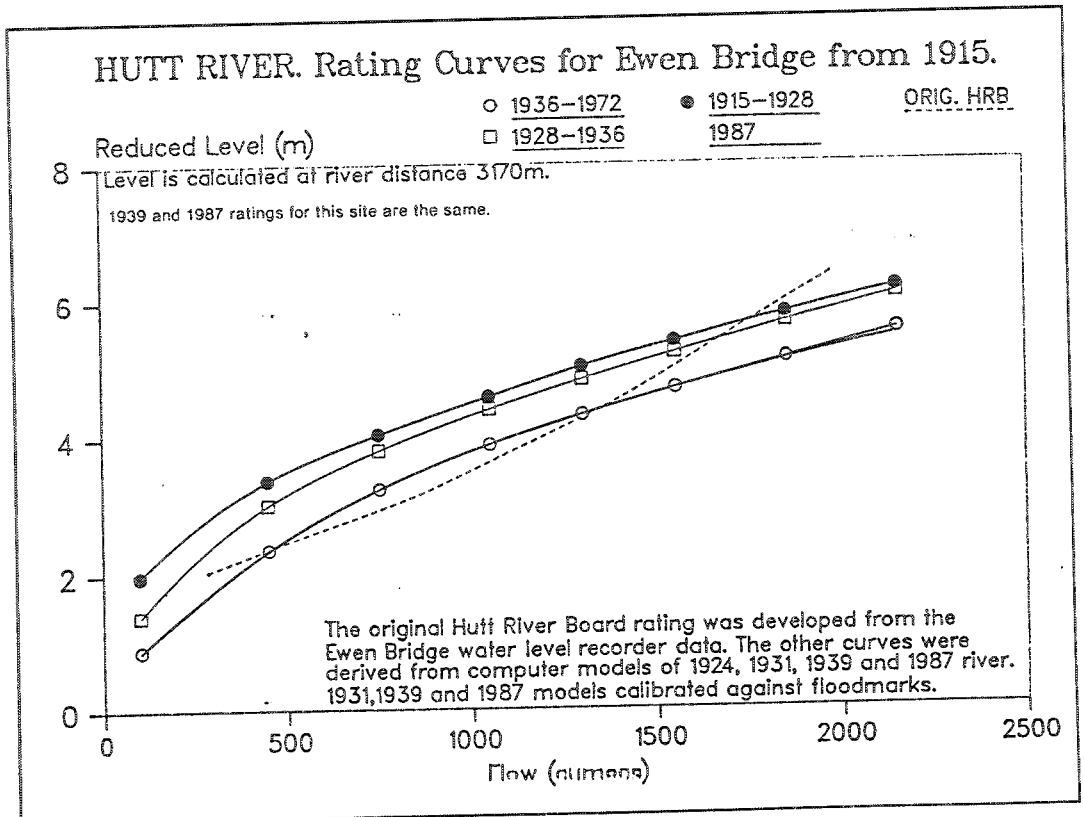


Figure 18: Computed Rating Curves for Ewen Bridge.

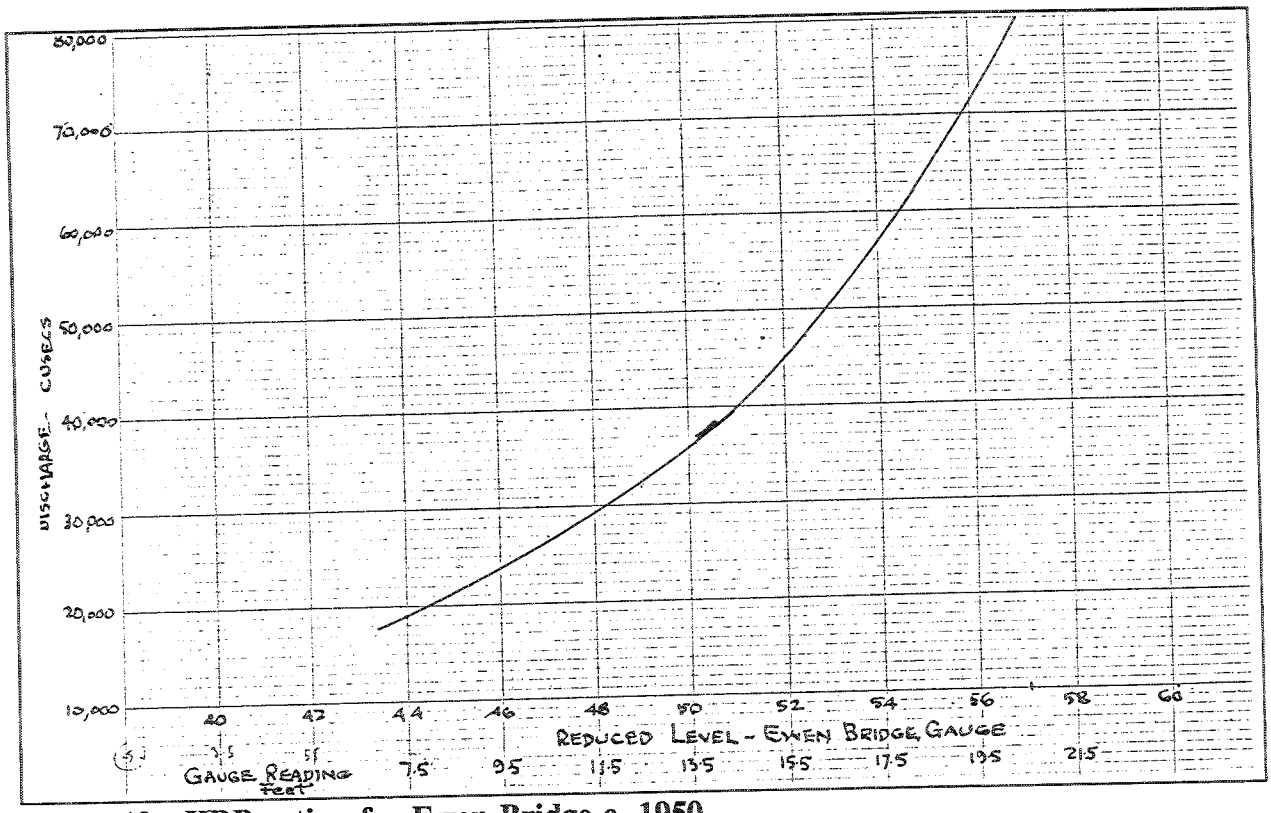


Figure 19: HRB rating for Ewen Bridge c. 1950.

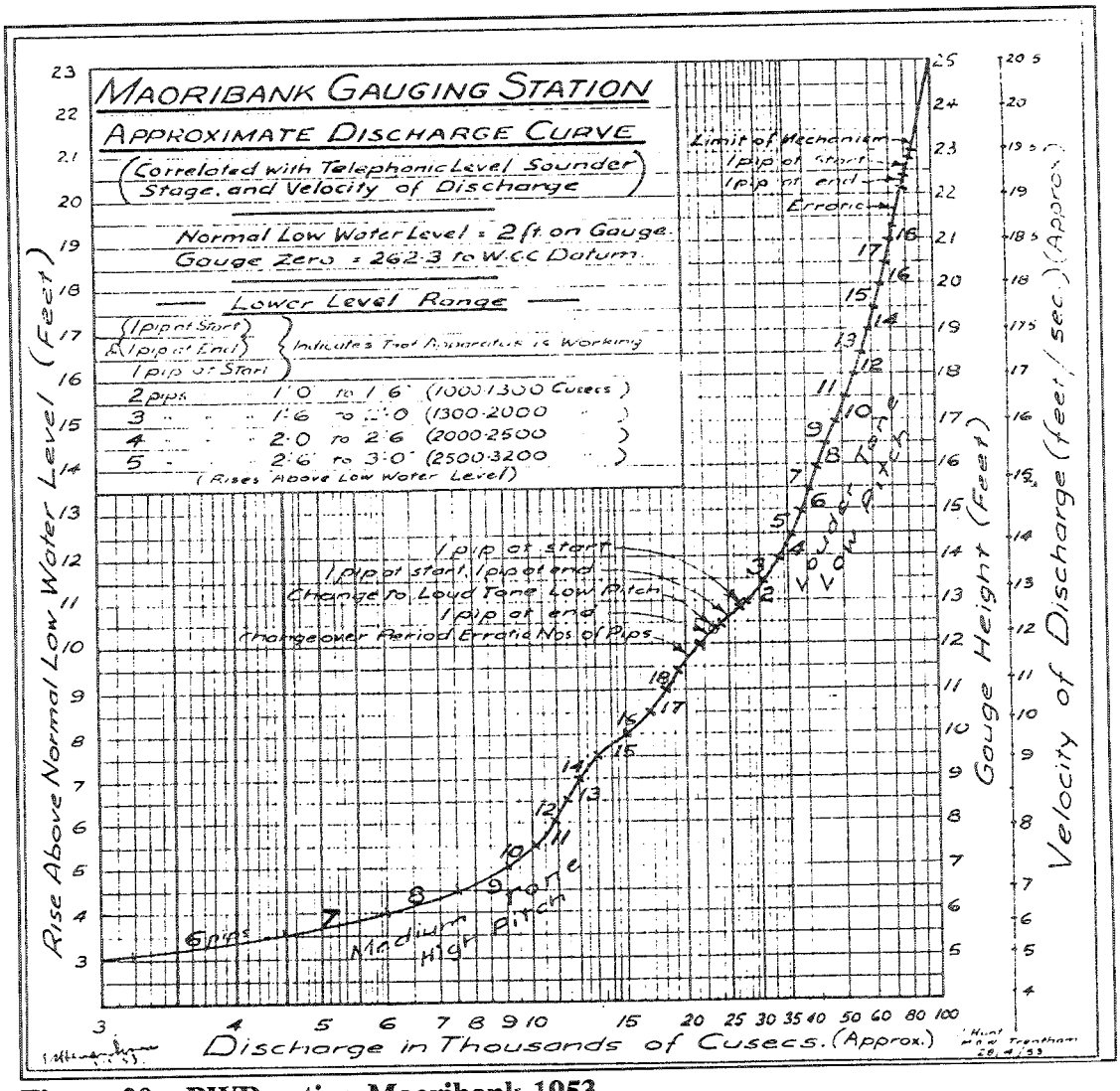


Figure 20: PWD rating Maoribank 1953.

TABLE V : HUTT CATCHMENT MONITORING STATIONS

Number	Name	General Description				Period	
NW&SCA 1987	River,Location	Map Ref yard grid metric grid	Purpose: refer key	Area sqkm	Type: refer key	Begin	End

Key to Abbreviations FC Flood Control invest; FW Flood Warning; WR Water Resources; Ug Underground Water; TR Tidal recording; WS Water Supply Invest; RS Research Area; Rg Regional Catchment; MR Major River; Eric Ericson; Kent Kent; F&P Fischer & Porter; L&S Leupold & Stevens digital; Fox Foxboro; FRev Fischer & Porter Event Raingauge; PSION datalogger; (T) Telemetered.

WRC Water Level Recording Stations

29801	Hutt, Maoribank	N161:628439 R27:860090	FC,FW	427	Eric Kent	52 79
29803	Hutt, Silverstream Replaced by 29809	N160:538392 R27:776050	WR,Ug,FW	547	F&P	62 79
29809	Hutt, Taita Gorge Replaces 29803	N160:525375 R27:764035	WR,Ug,FC,FW	555	L&S(T) Fo	79
29811	Hutt, Boulcott	N160:470327 R27:708992	WR,Ug	604	L&S	64
28816	Hutt, Taita Rock	N160:508365 R27:764034	WR,FC,Ug	557	F&P	74 79
29830	Mangaroa, Te Marua	N161:658453 R26:888103	WR,FW	102	L&S(T)	69
29837	Hutt, Ewen Bridge	N160:448309 R27:692976	FC	610	Kent	41 75
29838	Hutt, Estuary Bridge	N164:450284 R27:693954	FC,TR,Ug,Ws	623	F&P(T)	76
29840	Hutt, Sewer Crossing	N160:535388 R27:773046	Ug,WR	547	F&P	78 79
29841	Whakatiki, Dude Ranch	N161:568469 R26:806118	WR,WS,FW	46	L&S	76
29842	Mangaroa, Black Swamp	N161:618403 R27:849058	RS	11	Fox	77 78
29843	Pakuratahi, Truss Bridge	N161:713418 R27:938069	WR,FW	37	L&S	78
29844	Akatarawa, Cemetery	N161:631463 R26:863112	WR,FW	113	L&S(T)	79
29845	Waiwhetu, Whites Line East	N164:468295 R27:710962	FC	12	Fox PSION	69
29846	Waiwhetu, Bell Rd Bridge	N164:465290 R27:707958	FC	14	Fox	78 80
29847	Hutt, County Lane	N160:540393 R27:778050	WR,FC	547	Fox	64 65
29853	Hutt, Te Marua	N161:673474 S26:902121	Ws	191	Fox PSION	84

DSIR Water level Recorder Sites

29808	Hutt, Kaitoke	N161:716507	Rg,WR,WS,FW	89	L&S(T)	55
29818	Hutt, Birchville	N161:624448	FW,FC,MR	427	L&S(T)	70

WRC Raingauge Sites

59007	Akatarawa, Warwicks altitude 345 m	N157:610620 R26:853252	WR,FW	-	Frev (T)	80
150002	Whakatiki, Putaputaweta altitude 240 m	N160:544554 R26:786198	FW,WR,WS	-	FRev	86
150010	Whakatiki, Blue Gum Spur altitude 335 m	N161:558509	FW,WR,WS	-	FRev (T)	81 86 89
150108	Akatarawa, Cemetery altitude 100 m	N161:631463 R26:863112	WR,WS,FW	-	Aquitel (T)	89
150111	Hutt, Twin Lakes altitude 92 m	N161:669466 R26:899114	WR,WS	-	FRev	84
151202	Pakuratahi, Centre Ridge altitude 440 m	N161:724408 S27:948062	WR,FW	-	FRev (T)	84
152004	Mangaroa, Tasman Vaccine altitude 229 m	N161:555334 R27:790996	WR,FW	-	FRev (T)	80

DSIR Raingauge Sites

150210	Hutt, Phillips altitude 300 m	N161:743516 S26:967158	-	-	FRev (T)	72

Flood Frequency Analyses

Hutt River Board Frequency Analysis Prior to 1951

On the basis of the Ewen Bridge records for the 10 year period from 1941-1951 Sladden produced a flood frequency relationship, reproduced as figure 21. This document is the first frequency relationship referred to in the engineering archives and was probably developed as a result of Soil Conservation and Rivers Control Council prompting. The Hutt River Board had previously designed for the "maximum" event, probably estimated by reference to previous Hutt floods, and by the application of a "Probable Maximum Flood" catchment area relationship.

Sladden used a slope-area method for the estimation of flood discharges. Until about the time of the installation of the automatic recorder at Ewen Bridge, the estimations were based on an average gradient between levels at the Hutt Bridge and Rail Bridge and on the cross sectional area at the Hutt Bridge. A roughness coefficient of n = 0.03 to 0.035 was used in the velocity determination, giving velocities of the order of 10 ft per second.

For some years after 1941 the gradient was measured between the gauging station and a level at Dudley Street 28.2 chains upstream and was presumably the basis for the "rating" of the Ewen Bridge site.. Later still, the flood discharges were calculated assuming an average velocity of 10 ft/sec at the Hutt Bridge section. There is no recorded attempt to verify these estimations by gauging or other means.

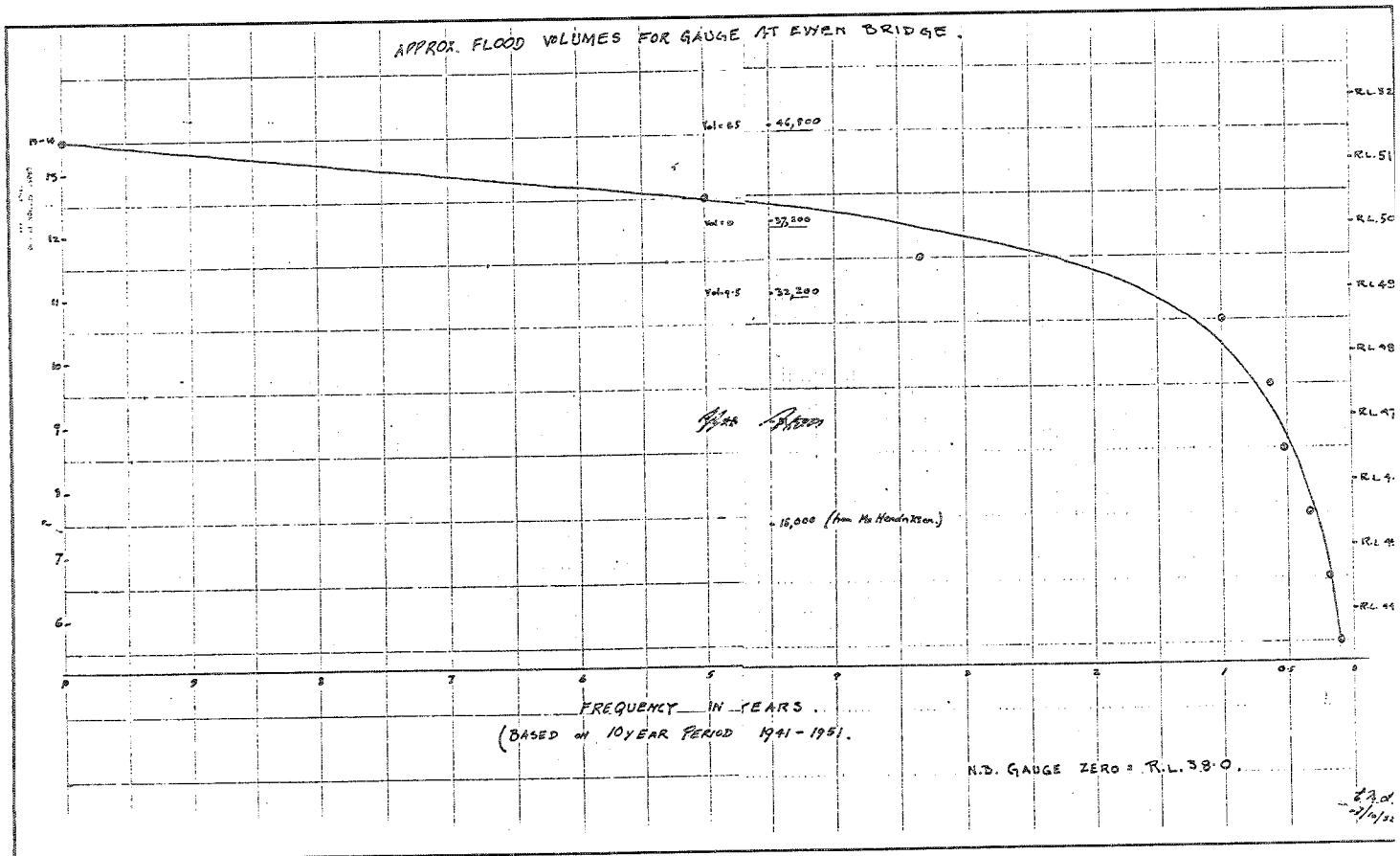


Figure 21: HRB 1951 Flood Frequency Relationship.

It would appear that Sladden used the surveyed flood gradients directly in his calculations and did not compensate for the irregularities in these reaches (although he may have intuitively compensated in the choice of the roughness parameter, selection of flood mark, etc.). At both the Hutt and Ava Bridges heading is required to overcome pier losses. The section at Dudley Street has been variously upstream and downstream of a central channel meander pattern, and the cross sectional areas at the Hutt Bridge, Dudley Street, and Ava Bridge are significantly different.

Sladden's "computed" discharges (copied into this report) should be regarded as approximate only. Preference has been given to the "nett rise" figure quoted in the archives, as it is likely that this figure is correct.

Computational methods based on historical survey and using the "nett rise" have been used to develop the partial series for the period 1840 to 1990.

Hutt River Board/Public Works Department Frequency Analysis 1951-1976

Up until the time of the major scheme extension and upgrade (1945-1975) there had been no call to develop a flood frequency relationship, although evidence given in support of the petition to include Petone into the Hutt District (1948) states that a 100,000 cusec flood was likely to occur at least once in every 200 years. Scheme works were generally designed to pass the greatest known (usually the last) flood plus a substantial freeboard, so that a much larger flood could be contained. There appears to have been no pressure to limit the works to a specific design standard. On the contrary there was the intention to provide for the maximum flood. During the design for the upgraded scheme a suitable design standard was considered and agreed to by Hutt River Board and Public Works Department engineers to be 100,000 cusecs plus a 2 ft freeboard. The hydrological basis for this figure is not known. [Refer Archive Table 17, p. 116.] Although the Public Works Department archives refer to various design floods of various frequencies, there does not appear to have been a formal flood frequency relationship developed until 1976.

Wellington Regional Water Board/Ministry of Works and Development Flood Frequency Relationship 1976-1990

Throughout the remaining period of the scheme reconstruction (1948-1972) the 100,000 discharge continued to be regarded as a highly improbable event and it was considered that the redesigned scheme would be able to pass the maximum flood within the freeboard allowance.

Scheme risk analysis seems to have been introduced sometime in the 1965-1975 period. By 1973 the records of the Wellington Regional Water Board (successor to the Hutt River 1972) assign a 100 year frequency of exceedence to the 100,000 cusec flood. There is no analysis on record to support this concept. The most likely explanation is that, in the absence of detailed engineering records, it was assumed that the Government subsidised works had been built to Government agency standards: in 1975 urban areas were to be protected from the 100 year flood (and, incidentally, were to show an internal rate of return of 8 percent or more - a concept that was not considered in the 1950s during the scheme redesign).

It is not clear why at this time there was a need to relate discharge to frequency of exceedence but it may have been to satisfy the conditions of Treasury/Soilcon for the continued Government support of the Scheme maintenance.

In 1976 the first hydrologically based analysis was completed with the production of the "Hutt River Flood Frequency Report", undertaken by the Wellington Regional Water Board and approved by the Ministry of Works in 1977. The results reduced the "100 year" flood from 100,000 cusecs to 75,000 cusecs. The results of the analysis, which have been used for the approval and design of all works on or associated with the Hutt River from 1976 to the present, are reproduced in figure 23, p. 159.

The derived 100 year floods for Maoribank, using the Jenkinson and Gumbel analyses, were 58,484 cusecs (1,656 cumecs) and 59,486 cusecs (1,684 cumecs) respectively. The reason for increasing Q100 to 65,000 cusecs (1,840 cumecs) is not clear but probably reflects the assessment of error in the analysis. This analysis assigns the 100,000 cusec flood a return period of 600 years.

The frequency analysis was based on an annual series derived from water level data recorded at the Ewen Bridge and Maoribank stations and was compared with data obtained from the new Birchville station. The results of the WRWB analysis were compared to the derived discharges and to the historical floods of 1939, 1931 and 1915 and were considered reasonable.

The 1976 Frequency analysis has now been replaced by the 1990 Scheme Review analysis reproduced from Review Volume 2 as figure 22 below.

Hutt River Network Node	A (km^2)	Q_2	Q_5	Q_{10}	Q_{20}	Q_{50}	Q_{100}	Q_{200}
Hutt at Mouth	639	760	1070	1270	1460	1710	1900	2090
Hutt at Boulcott	608	760	1070	1270	1460	1710	1900	2090
Hutt at Taita Gorge	561	760	1070	1270	1460	1710	1900	2090
Hutt at Silverstream	543	760	1070	1270	1460	1710	1900	2090
Hutt at Birchville	428	670	960	1160	1340	1580	1760	1940
Hutt at Mangaroa	302	450	660	790	920	1090	1220	1350
Hutt at Pakuratahi	170	380	520	620	710	830	920	1010
Akatarawa at Cemetery	115	270	350	410	460	530	580	630
Mangaroa at Te Marua	104	120	180	210	250	300	330	360
Whakatiki at Hutt	93.1	140	185	220	240	280	310	340
Hutt at Kaitoke	87.2	260	340	390	440	510	560	610
Pakuratahi at Hutt	81.4	160	220	260	300	340	380	420
Whakatiki at Dude Ranch	44.4	64	92	110	130	150	170	190
Pakuratahi at Truss Br	38.1	82	100	120	130	150	160	170
Waiwhetu at Hutt	17.9	18	27	32	38	45	50	55
Waiwhetu at White Lines E	11.6	12	15	17	19	22	24	26
Stokes Valley at Hutt	11.3	16	23	27	32	38	42	46

Figure 22: 1990 HRFCS Flood Frequency Relationship. Recommended flood estimates of return periods 2, 5, 10, 20, 50, 100, and 200 years (in cumecs); Hydrology Centre, DSIR.

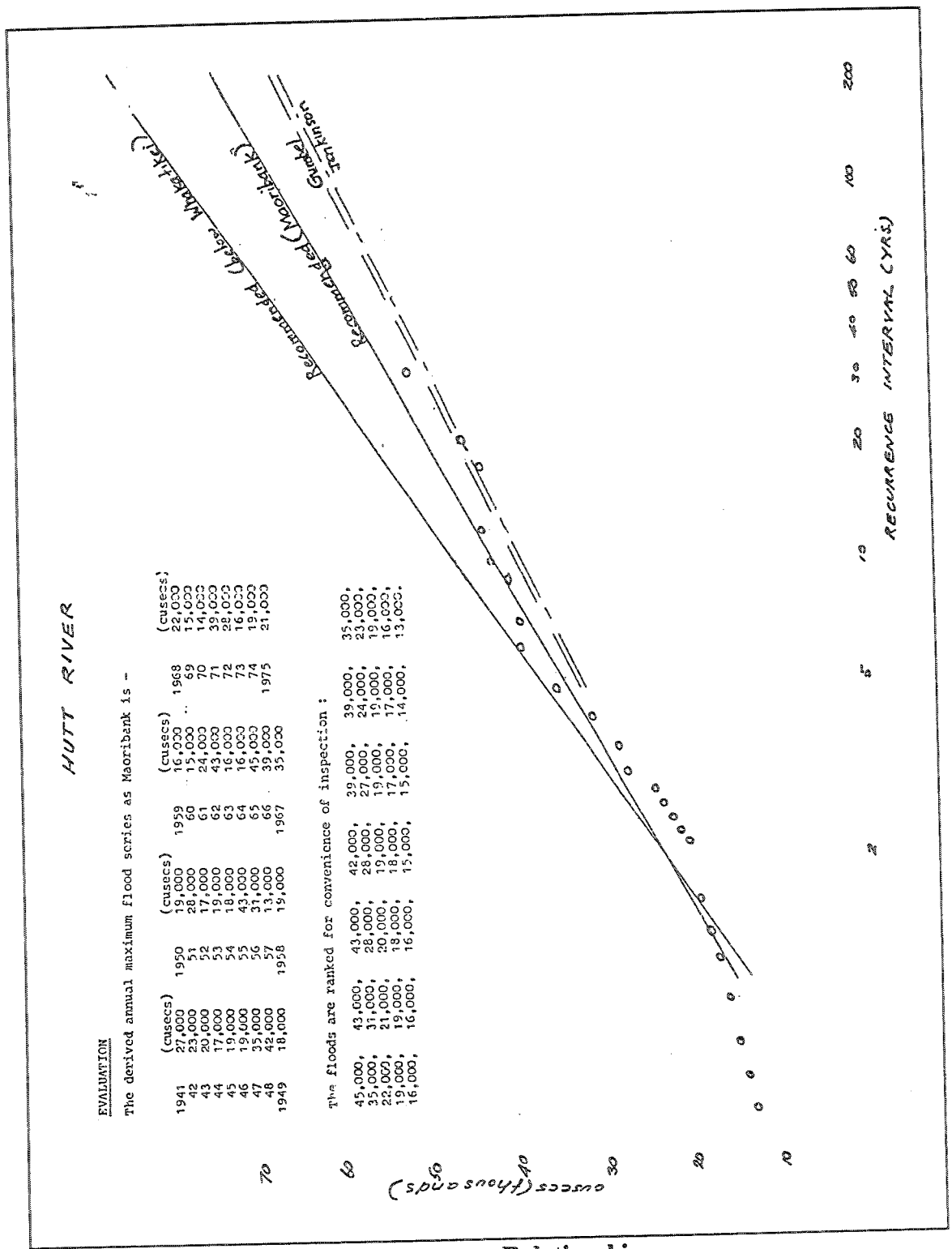


Figure 23:1976 WRWB Flood Frequency Relationship.

Flood Observations from 1924

(Abbreviations refer Archive Table 2, p. 7)

A36: 4 Aug 1926: SSPHRB6
Described as "high flood" by engineer, but "little damage".

A37: 11 Dec 1926: SSPHRB6
Flood; beam level of Mr George's suspension bridge (1180). Flooded main road and surrounding land at Silverstream Railway Bridge (1400-1600). Repair works included new boom groynes (29 piles, 67 booms), replacement of willow work, stone weirs.

A38: Jan 1928: SSPHRB6: 320
Flood levels: LHCC plan of Flood Gauge on new Hutt Bridge, to LHCC datum, recorded. Location of 3 others recorded.

A39: 3,6 May 1928: SSPHRB6
Fairly high floods of short duration. Flood of 3rd May highest for 12 months.

A40: 23 Aug 1928: SSPHRB6
5' rise Thursday and Friday previous. At Stellins (690) and Dickies (880) the position of the river to the west now established.

A41: 1-10 Nov 1928: SSPHRB6
"Big floods" - damage at Routleys (280), Burkes, Huses (1080), Giesens (840) with large volumes of shingle moved. Repairs required - 50 hardwood piles, 150 birch booms.

A42: 25 Aug 1929: SSPHRB6
"High flood" occurring during the previous week. Little damage.

A43: 7 or 8 Sep 1929: SSPHRB6
"Considerable flood",little damage.

A44: 27 Nov 1930: SSPHRB6
High flood of short duration. 9 feet at Ford Road bridge (Stokes Valley) (1180). Deck of Ford Road Bridge submerged. HRB pile driving punt broke free and badly damaged being set up on a groyne. The engine was lost (later found and reconditioned and installed on another second hand barge.) Highest flood since 1913.

A45: Feb 1931: SSPHRB6
A series of small floods that have risen and fallen quickly since the high flood of Nov. No significant damage.

A46: 3 Apr 1931: SSPHRB6&10
The peak occurred at 10pm Good Friday, 17 ft. at Lower Hutt, being 2 ft. higher than the 1915 flood. The river remained high for the following week and a moderate flood occurred on Saturday 11th.

The flood volume "considerably exceeded" the high flood of 1915, previously the highest flood since the inception of the HRB works. "The maximum flood is much in excess of that estimated when the protective works were designed some 30 years ago".

The flood severely taxed the control works which came close to failure in the Convent reach, left bank at the north end of Daly Street (400). The narrow berm was eroded through to the stopbank foundation and complete failure was apparently averted by the efforts of the entire HRB staff and others who worked through the night constructing a protective willow and wire mattress approx 5 ch. (100m) long. The concern was such that preparations were put in hand to ring the town bell and so order an evacuation of the town.

(To the compiler's knowledge the stopbanks have been under direct attack at only two other locations.

1. On the left bank south of Barbers Grove (140) (previously woollen scours and tannery) the stopbank foundation was severely scoured. This led to protective works and the closing off of Jorgenson's (130-160) and Chapman's (170-210) bends - the straightening of the river between the rail and Estuary bridges. The flood damage is undated but probably occurred during the 1913 or 1915 flood.
2. On the left bank south of Maoribank (2230-2260) in 1981. Other areas of severe lateral erosion occurred near MacLeod Street (1960-1970) and Ebdentown Road (2080-2120) prior to the construction of the Upper Hutt stopbanks, and between Taita and Boulcott (620-880), again prior to the construction of the stopbanks.

The damage from the 1931 flood is recorded:

1. Washout of the road at Taita Gorge (1130-1160).
2. Destruction of George's suspension bridge (Ford Road between Manor Park and Stokes Valley) (1180).
3. Washout behind Convent, Lower Hutt City (400).
4. Extensive shingle deposits and berm erosion at Manor Park Golf Course (1130-1290) and on Barnes farm (1030-1080) - now the Taita housing area.
5. Erosion of Kingdon's beach (380-410) railway siding - right bank present Melling Bridge area.
6. Destruction of a large number of boom groynes and willow and cable protection works but "less than expected"
7. In the upper reaches (of then HRB district - Silverstream to Avalon) "great quantities of shingle have been brought down". In the area north of the district - Upper Hutt Borough and Hutt County - there was "considerable damage by erosion and destruction of fences".

The Engineer reported:

1. Necessary to increase the height of the stopbanks from the Hutt Bridge to the estuary.
2. That the maximum flood volume had much increased as a result of forest denudation in the upper reaches.
3. The problem of bed aggrading as a result of moving shingle must be given careful consideration.
4. The dredging by shingle companies in the lower reaches had been of tremendous value. (different plants received damage of varying degree but some were able to go back into operation without much delay.)

The flood level at the northern end of the eastern stopbank (560) was 3 ft 2 in below the top of the stopbank. Residences on the flats near Haywards railway station were inundated. The terraces had never been flooded before and were considered above (maximum) flood level. On Manor Park Golf Course (1130-1290) approx. 18,000 c yds shingle were deposited.

There was a general call for the extension of the scheme to Maoribank.

There followed an engineering report for the raising of the stopbanks. Engineer's reports on SSPHRB10 include schedule of flood damages, Engineer's calculations for the flood discharge, x-sections at Hutt Bridge showing 1915 & 1931 flood levels. In summary;

Max volume approx 59,000 cusecs. Flood volume much above what the works were designed for. Considered highly probable that the max. discharge had "much increased" over the past 30 years. Margin from Hutt Bridge to Pipe Bridge not greater than 2'8" and in some places 18". Engineer also considered it might be necessary to raise small areas upstream of the Hutt Bridge.

Approx 20,000 cu. yds of material required to raise the stopbanks at cost of £3000. Sundry repair works £1904, including £700 behind Convent (400), £800 for extra materials, remainder for wages, plant, etc.

A47: June 1931: SSPHRB6
"during the month there have been a series of floods - some of them high"

A48: Aug 1931: SSPHRB6
Series of floods. 6 feet rises on 12th and 18th. General satisfaction with the line of the channel - "closer to the ultimate alignment than it has ever been".

A49: 2 Oct 1931: SSPHRB6
Largest of a series of small floods in October.

Flood Observations from 1924

(Abbreviations, refer Archive Table 2, p. 7)

A50: 28,29 Aug 1932: SSPHRB6
Largest since Easter 1931.

A51: 21 Sep 1933: SSPHRB6
7 feet rise. Gradient steadily improving.

A52: 10 Jun 1935: SSPHRB6
11 feet rise at Taita Gorge and Hutt Bridge.

A53: 29 Oct 1935: SSPHRB6
Biggest for several years. Flooding across main highway at Silverstream (560-650), flooding of flats in upper reaches and beneficial silt deposits on Manor Park.

A54: 1936-1939: SSPHRB6
Floods recorded 1936-1939
2 Feb 36 13 feet rise
9 Feb 36 8 feet rise
3 Mar 36 10' rise
17 Jun 36 Described as fresh. Flooded Hutt golf links.
11 Aug 36 7' rise at Hutt golf links (560-650).
30 Aug 36 9' rise, short duration, flooded highway at Silverstream.
22 Dec 36 9' rises of short duration.
28 Dec 36
10 Jan 37
28 Jun 37 8'rise.
9 Sep 38 Highest since Dec/Jan 37
18 Sep 38
23 Jun 39 7.5' rise.
18 Aug 39 9' rise.

A55: 11 Dec 1939:
Generally regarded as the greatest flood on record.

> "River rising all day from morning and it increased rapidly from 5pm till 6.30pm bringing down much debris. From 6.30 pm till 4am on 12th Dec it fell about 1 foot and then fell fairly rapidly. High tide was about 5pm on 11th."

The flood was 1"9" higher at Mabey Road (740) and 3' higher at Hutt Bridge than the 1931 flood (59000 cusecs). 13" lower than 1915 flood (45550 cusecs).

Flood volume computed at 70000 cusecs (1980 cumecs).

Stopbank proved adequate although between the Hutt Bridge and Ava railway bridge the margin did not exceed 2' in places.

"Gradient' from the Railway Bridge to the estuary was considerably steeper in Dec 1939 than in 1931 even although 1931 at low tide and 1939 at high tide. This was put down to a substantial increase in the capacity of the channel. [Compilers Note: It may be that the heading required to drive the flood flows through the railway bridge constriction has been included in these calculations. The difference in gradient may have been due to choking of the bridge waterway.]

Engineer's report.
Calculation of flood volume based on measured gradient of 0.0017 between the Hutt Bridge and Railway Bridge. (Measured 5.82 ft. over 53 chains.) Taken n = 0.03, v = 13.33 ft/sec, Q = 70,209 cusecs

A56: 1940-1941: SSPHRB10
Recorded flood observations.
19 Apr 40 small fresh
27 Apr 40 medium fresh
23 May 40 4' rise
24 May 40 4' 6" rise
18 Oct 40 9' rise at Hutt Bridge - quick rise, short duration
25 Oct 40 7'6""
29 Oct 40 4""
21 Jan 41 9'rise
21 Aug 41 4'6" rise
7 Sep 41 5'6" rise

A57: 26 Sept 1941: SSPHRB6
Rapid rise from 12pm to 3pm, to peak at 10' 9" at 6pm and back to normal by 3am on 27th.

A58: 2 Oct 1941: SSPHRB6
Rise over 4am to 10pm to 10' above normal. Fell until 12pm on 4th to 2' above normal.

A59: 9 Oct 1941: SSPHRB6
Short duration rise began 3pm, to peak at 8.30 pm at 10' 6" above normal. Fell to 4' by 3am on the 10th. Rose to 6' 6" at 11am and fell to normal at 6am on the 11th.

Damage: a lot of planting done earlier in the season buried or destroyed. A large volume of timber washed down from the upper reaches. An area on the left bank around the Mabey Road/Taita (750-830) area eroded. Proposed stopbank position revised to prevent overflow.

A60: 1942-1947: SSPHRB6&10
Recorded flood observations.
20 Mar 42 5'above low tide
8 May 42 7'6"rise
25 May 42 6'rise
5 Jul 42 4'9"rise
13 Jul 42 8'3"rise
18 Jul 42 3'10"rise
22 Jul 42 3'9"rise
6 Feb 43 3'2"rise
7 Feb 43 2'rise
11 Feb 43 3'3"rise
16 Feb 43 7'6"rise
19 Jun 43 4'6"rise
5 Sep 43 7'rise
8 Sep 43 3'rise
19 Sep 43 3'6"rise
20 Sep 43 3'3"rise
25 Sep 43 3'9"rise
7 Apr 44 4'rise
5 Aug 45 4'6'rise
4 Feb 46 7'3"rise
9 May 46 5'9"rise
13 Aug 46 7'3'rise
15 Feb 47 8'9"rise

A61: 24&28 June 1947: SSPHRB10
24 Jun 4710'3"rise
28 Jun 478'2"rise
From Engineer's monthly report;
Began to rise 5am on 24th June, to peak at 2pm. Dropped to 2' at 3am on Wed 25th and remained about 2'-4' up until 5pm on 27th.
Began to rise 12.30am on 28th, by 8am 6' above normal for 12 hours.
Damage: severe erosion in places including slumping of berm below stopbank behind Convent (400).

From Engineer's flood report;
Discharge of 37,200 cusecs based on the level at the recorder house and the gradient to Daly Street, 28.2 chains upstream. Gauge at 51.62 ft.

Repair Work Required: a very large volume of shingle moved by bulldozer in the reach from the Native Land (850) to Mabey Road (740). Substantial willow, cable and gabion work required from Bognuda's (250) to the Belmont Extension (810).

A62: 17 Oct 1947: SSPHRB32&10
9'6" rise.
New right channel in the Belmont reach proved effective and silt deposits built up to the height of the new weir. (Compiler's note: weir probably across the old channel along the eastern bank).

Archive Table 18: Flood Observations from 1924

Flood Observations from 1924

(Abbreviations, refer Archive Table 2, p. 7)

A63: 23 May 1948: SSPHRB10
Only two floods of greater volume have occurred in the last 48 years. Discharge of 46,800 cusecs estimated as for June 1947 flood.

> "reached peak at 8 am on Monday 23rd May 11' 6" above normal. Dropped 6' by 8pm on the same day. Volume estimated at 46,800 cusecs.....Volume about 10,000 cusecs greater than flood of June '47.....At the lowest point on the provisional stopbank at the Taita Housing Block (850) the freeboard was 3'6".....The diversion cut (500-540) opposite Certified (Concrete Ltd) upstream of Melling Bridge developed well .... Somewhat greater volume than the flood of 1915, which reached the greatest height of any flood in the last 48 years. However the 23 May 1948 flood was five feet lower than the 1915 flood."

Immediate repairs; block groynes at Mabey Road (760-800) - built of concrete-and-brick blocks used for war-time protection of petrol tanks.[Note: flood of 37,000 cusecs in June 1947 caused large expenditure. Flood of June 1948 did not require similar expenditure.]

A64: 26 Oct 1951: SSPHRB32&10
Flood: 9' rise, volume 32,200 cusecs, based on area at gauge house and velocity of 9.5 ft/sec. No change in channel conditions.

A65: 1952-1953: SSPHRB 32
Undated rating curve for Ewen Bridge - date and derivation unknown. A record of floods in the period 4/7/41 to 7/10/52 and for the period 7/10/52 to 17/5/72 filed. Flood Frequency and Rating Curves recorded for Ewen Bridge (330), based on 10 year period 1941-51. Hydrograph from Maoribank Recorder (2270) for flood of 7-10 Nov 1952. Rating Curve for Maoribank Gauging Station filed.

Flood gradient of 0.0017 from Ava Railway Bridge, obtained from earlier floods, brought up in discussions on improvements to Black Creek (200-210) outlet.

A66: 21 Jul 1954: SSPHRB32
Flood discharge calculation of 27,200 cusecs, based on n = 0.03, v = 8.5 ft/sec, area at gauge 3200 sq. ft.

A67: 17-21 Feb 1955: SSPHP'332
Hydrograph record from Maoribank Gauging Station (2270). Peak discharge of approx. 45,000 cusecs on 20/2/55. Also recorded is a hydrograph for "weir" (probably Kaitoke).

A68: 1955-1958: SSPHRB32
Recorded flood observations.

6 May 55 a rise of 4' in one hour.
19 July 56 9' to 10' rise. Discharge estimated 26,000 cusecs.
26-27 Nov 1957 7'6" rise. Estimated discharge 14,000 cusecs
14 Mar 58 9'3" rise at Maoribank (2270). Estimated discharge 19,000 cusecs.
12 May 58 9'11" rise at Maoribank. Estimated discharge 18,500 cusecs.

A69: 28 May 1958: SSPHRB32
1931 and subsequent flood levels at the Melling Substation (520) recorded. 1931 flood - 104.75 ft. 1939 flood - 103.37 ft. (ground level 101.0 ft.)

A70: 13 Jan 1962: SSPHRB32
Flood: 14' rise at Ewen Bridge.
Approximately the same discharge as occurred on the 23rd May 1948 and 20th February 1955, 47,000 cusecs.

Damage: From the Taita Housing Estate (900) to Melling (450), large volumes of shingle moved; many chains of protective willow and cable bank protection destroyed. McLeod Street Area (1960) - severe attack downstream of protective works constructed in 1955. Hudson Avenue Area (2070) - severe attack downstream of protective works constructed in 1955. Maoribank (2270) to Clouston Park (2170) - severe attack on right bank caused loss of 1/2 chain of bank over several chains. On the opposite bank downstream of Clouston Park Road 7 chains of bank subjected to attack (2130-2160).

Properties Flooded.

Upper Hutt: 2 houses in Clouston Park Road (2180), 1 house in Willow Grove (2040), a butchers shop in McLeod Street (1960). Also recorded that in the 1955 flood approximately 17 houses in the vicinity of Longfellow, Tennyson and Cottle Streets (1760-1840) were flooded above floor level. Since 1955 there had been some channel widening at the bottle neck above the Moonshine Bridge and behind Newton Street (now Poet's Park 1780-1840).

Haywards Settlement (1160): At least one house flooded.

Lower Hutt: One house flooded at Whites Line (220) due to banking up of water from the Okoutu Stream.

Rough estimate of the total cost of damage £14,000.

A72: 7 Nov 1965: SSPHRB32
Largest since December 1939. Duration about the same as in 1939. River 13 ft. or more above normal for 10 hours.

Engineer's Report and Description of Damage:

> "Discharge 50,000 cusecs... Many chains of willow bank protection destroyed... Erosion at the left bank, Upper Hutt, where a deep channel developed... This channel filled by machines and the right bank beach lowered...Weir built on left bank at Maoribank...Erosion to north abutment of bridge repaired with netted crates...Erosion in old channel near access to Mr Price's property...Further erosion could have undermined the stopbank - has since been backfilled... "Concrete block protection" of the new Western Hutt Road stood up well, although on a 3:1 batter....Flood debris was cleared from the Silverstream, Pomare, Melling and Ewen Bridges...Opposite the Car Park (Lower Hutt) a length of willow protection was destroyed and 10-15 ft. of berm eroded. 21 concrete blocks of 5 ton each subsequently placed...At Strand Park, sand up to 12" deep deposited...At Sladden Park, sand up to 2'6" deep deposited.

In Upper Hutt 5 houses flooded at the corner of Shakespeare Ave and Moonshine Road. The kindergarten in Thackeray St (1780) flooded.

In Lower Hutt several houses flooded due to ponding in the Okoutu Stream during floodgate closure.

A71: 26 Apr 1966: SSPHRB32
Flood: levels at Upper Hutt Borough

3.50 a.m. 12'4"
4.30 a.m. 13'2"
5.40 a.m. 14'0"
6.10 a.m. 14'1"
6.30 a.m. 13'6"

Pakuratahi running higher than in 1962.

A73: 17 Aug 1971: HRB GENERAL
Kaitoke rainfall138.3mm in 24 hrs to 8am
Wainui rainfall220.4mm on 16/8/71
73.5mm on 17/8/71 (total 220mm)

A74: 5 Oct 1971: SSPHRB32
Record of flood Hydrograph.

A75: 14 May 1972:
Record of flood Hydrograph.

A76: 16 June 1975: WRWB 8/7
Photographs on file showing flooding at Silverstream and Maoribank.

A77: Nov 1975: WRWB 8/7
Flood photographs filed at this date showing parts of the Hutt River in the Feb. 1955 flood of 47,000 cusecs.

A78: 26 Aug 1976: WRWB 8/7
Flood Frequency Report revising 100 year return period flood, C S Hovey, Design Engineer. Reported to and accepted by MWD.

Part Two

PROJECT REPORTS

1903-1990

A summary and archive reference for each of the major engineering works, and unique minor works, which in total form the Hutt River Flood Control Scheme.

Refer to figures in Appendix A for the location of the works. Project reports are indicated by the prefix "PR".

Table of Contents : Project Reports

PROJECT REPORT 1

SCHEME FOR CONSERVING THE HUTT RIVER

Stopbanking from Section 38 at Boulcott to the Harbour

The first stopbanks built by the Hutt River Board, in response to a disastrous flood in 1898. They ran from Boulcott to the Harbour on the left (east) bank and from Melling to the Harbour on the right (west) bank.

Date: 1901-03

Plan Number: Rivers Control Series 13/21/1 and 2

File: Hutt River Board Minutes (held at LHCC Memorial Library)

Location: Refer Appendix A, figures 2-4

Historical Chainage - S/B C/L
Right Bank 0 mi 0 ch to 1 mi 26 ch
Left Bank 0 mi 0 ch to 3 mi 30 ch

Current River Traverse - river C/L:
Right Bank 2020 m to 4034 m
Left Bank 350 m to Boulcott

Reason for Initiation: In 1898 the largest flood for 38 years caused loss of life and major damage in the Boroughs of Lower Hutt and Petone. Public pressure brought about the election in 1899 of a new Hutt River Board which immediately commenced the process of making the Lower Hutt residential area safe from flooding. An engineering consultant was selected on the basis of his previous flood control work in Geraldine, South Canterbury and within months a "Scheme For Conserving The Hutt River" was placed before the Board. The Scheme involved stopbanking on the present stopbank alignment (except for the left bank section rebuilt to accommodate the approaches to the current Melling Bridge), from just south of the present Melling Station to the Petone Stopbank on the right (west) bank and from Hathaway Avenue to Seaview Road on the left bank. The design capacity of the proposed floodway is not recorded, but was probably the estimated discharge of the 1898 flood plus freeboard.

The original proposal showed the right bank stopbank passing to the west of Gear Island (now the Shandon Golf Course) to leave it unprotected and Petone protected only by its own stopbank. Following strong representation from Petone the Hutt River Board was forced to delay and revise this portion of the work to include Gear Island. In order to protect the island it was necessary to block off the branch of the river to the west of the island, at additional cost. Most of the stopbank construction was carried out from 1901-03. Gear Island was protected by a stopbank extension built separately in 1906 and in the same year the Fourth Hutt Bridge was replaced allowing the completion of the Scheme construction.

Design Capacity: Not recorded. Plans show the use of a varying freeboard (between 4 ft (1.2 m) and 7 ft (2.13 m)) above the "largest known flood" - probably the larger flood (of two) in 1898.

Designer: Laing-Meason and Fulton

Construction: John Thomas Jones, Pleasant Point

Supervision: Laing-Meason

Construction Standards: Not recorded

Construction Materials: Shingle from adjacent river beaches was used because of its availability, proximity and ease of excavation by the methods of the day. It is evident that the Engineers considered the river gravels to be adequate for stopbank filling because a well graded material (reasonable fines content) was available.

Construction Equipment: Photographs show horse and dray teams carried gravels to the stopbank and provided compaction by hoof and wheel trafficking. Loading was by hand shovel. One photograph also shows demountable, gravel filled trays being lifted from the drays and tipped using a steam engine. The material was then presumably spread by hand.

Cash Flow:

1901	£400
1902	£9924
1903	£3926

Subsidy: Application declined.

Comments: Cross sections of the original stopbanks are shown on the following plans for later stopbank raising works:

HRB 31/4: Stopbank Raising, Pipe Bridge to Hutt Bridge (Ewen Bridge)
HRB 107: Stopbank Raising, Melling Bridge to Pipe Bridge
HRB 120: Stopbank Raising, Melling to Mills Street

PROJECT REPORT 2

GEAR ISLAND PROTECTIVE WORKS CONTRACT

A stopbank and associated works to protect Gear Island from flooding in the Hutt River

Date:	1906
Plan Reference:	Plans identified as RC 13/5 (Wellington Regional Council Rivers Department)
File:	HRB Minutes (held in LHCC Memorial Library)
Location:	Refer Appendix A, figure 3. Historical Chainage - S/B C/L Right Bank 1 mi 26 ch to 2 mi 05 ch Current River Traverse - river C/L: Right Bank 1036 m to 2020 m
Reason for Initiation:	The stopbank was the final section of the first Hutt River stopbanking Scheme. Refer Project Report 1. The already completed section of stopbank was continued downstream from Wakefield Street on the current 1990 stopbank alignment to the Estuary Bridge. Drainage from the Dead Arm of the Hutt River (old western channel) blocked off in 1901, was provided by a triple barrel concrete culvert under Waione Street. The culvert is still functioning.
Design Capacity:	Not recorded. Plans show 7 ft (2.13 m) above the "largest known flood' - probably the larger flood (of two) in 1898.
Designer:	Meason and Fulton
Construction:	John Thomas Jones, Pleasant Point
Supervision:	Meason
Construction Standards:	Not recorded
Construction Materials:	As for the 1901-03 works, shingle from adjacent river beaches was used because of its availability, proximity and ease of excavation by the methods of the day. It is evident that the Engineers considered the river gravels to be adequate for stopbank filling because a well graded material (reasonable fines content) was available.
Construction Equipment:	Although construction methods for this work are not recorded it is assumed that the horse and dray teams used to construct the original stopbank were used again here to carry gravels to the stopbank and provide compaction by hoof and wheel trafficking. The drays were loaded by hand.
Subsidy:	None
Comments:	Refer also to Plan Nos RC 13/21/1, 13/21/2.

PROJECT REPORT 3

STOPBANK RAISING MOERA SECTION

Stopbank raising on the left bank only at Moera

Date: 1933

Plan Number: HRB 33/2

File: SSPHRB6 (Engineer's file)

Location: Refer Appendix A, figure 3.

Historical Chainage - S/B C/L:
Left Bank 1 mi 00 ch to 1 mi 29 ch

Current River Traverse - river C/L:
Left Bank 1350 m to 1980 m

Reason For Initiation: Although the first Hutt River stopbanks (1901-03) were never breached by flood waters, floods in 1915 and 1931 came close to overtopping the banks. Although few technical records from this period survive, it appears certain that the early Hutt River Board intended to protect Hutt residents against the maximum possible flood.

A scheme to raise the original stopbanks was proposed in 1931, based on providing a freeboard of 4 ft (1.2 m) above the 1931 flood. It was found necessary to raise the stopbanks from the Estuary Bridge to the Hutt (Ewen) Bridge by 1 to 2 ft (300-600 mm).

The work carried out in 1933 represented only about 1/4 of the 1931 proposal. At the request of the Unemployment Board the Hutt River Board reluctantly modified their proposals so that they could be undertaken by hand. It is assumed that the most appropriate section was selected for the first stage. It is not clear why the work was not continued. Possible reasons are Hutt River Board disinterest and the easing of the depression.

Design Capacity: 1931 flood (approx 59,000 cusec (1666 cumec)) level + 4 ft (1.2 m) freeboard.

Designer: Seaton Sladden and Pavitt

Construction: Unemployed Relief Workers

Supervision: Seaton Sladden and Pavitt

Construction Standards: No construction details are recorded.

Construction Materials: Graded river gravels from Jorgensen's bend, then a closed bend in the river, and now the outlet channel of the Okoutu Stream (Black Creek). This material was used because of its availability, proximity and ease of excavation by hand. It is evident that the Engineer considered the river gravels to be adequate for stopbank filling because a well graded material (reasonable fines content) was available.

Construction Equipment: The Engineer's records refer to four horse and dray teams which, as for earlier constructions, would have been loaded by hand and were probably also unloaded by hand on this job.

Compaction was probably expected to be effected by hoof and wheel trafficking. However, it is not known to what degree benching and stripping of topsoil and vegetation were carried out.

Cash Flow: Not recorded

Subsidy: Unemployment Board paid wages only.

Comments: Cross sections of the original stopbank raising proposal are shown on Plan No. HRB 31/4, from which Plan No. HRB 33/2 was derived.

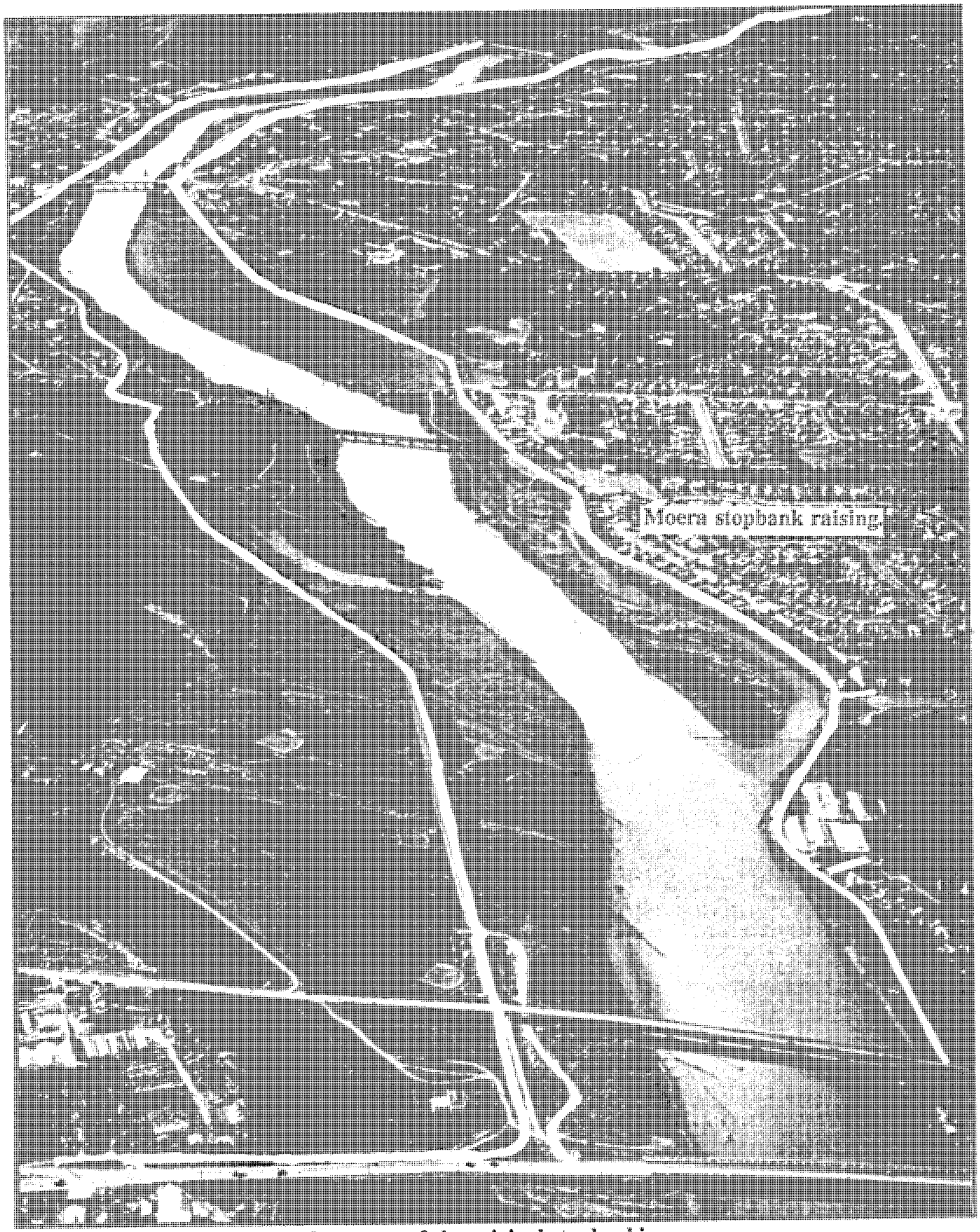


Plate 90: 1956 photo showing the extent of the original stopbanking.

PROJECT REPORT 4

STOPBANK RAISING PIPE BRIDGE TO EWEN BRIDGE

Date:	1956-57
Plan Number:	HRB 48/3
File:	SSPHRB72
Location:	Refer Appendix A, figure 2-3. Historical Chainage - S/B C/L: Right Bank 0 mi 50 ch to 2 mi 06 ch Left Bank 0 mi 48 ch to 2 mi 04 ch Current Traverse - river C/L: Right Bank 830 m to 3105 m Left Bank 800 m to 3140 m
Reason for Initiation:	This stopbank raising work was the first stage in the Hutt River Flood Control Scheme of the 1950s jointly promoted by the Public Works Department and Hutt River Board, and by the Local Councils affected. Refer to Chapter 6 and Archive Table 16.
Design Capacity:	100,000 cusecs (2825 cumecs) with 2 ft (600 mm) freeboard.
Designer:	Seaton Sladden and Pavitt
Construction:	Mr A C Willis with Gaynor Transport Ltd and Olsen Earthworks Ltd
Supervision:	Seaton Sladden and Pavitt
Construction Standards:	Construction was to the standard Seaton Sladden and Pavitt specification (see file 72). This required: (1) Compaction in horizontal layers not exceeding 12 inches (300 mm) loose depth. (2) Each layer separately consolidated as evenly and densely as possible by operating and distributing construction plant. (3) Top and batter of the existing embankment to be scarified.
Construction Materials:	The Contractor's letter of intention submitted with the tender indicates the intention to use material from the Public Works Dept quarry at Gracefield (probably weathered greywacke). Shingle from the River at Melling was also to be used but "reserved for wet or soft spots in foundations and for keeping access roads open.". Ministry of Works files refer to removal of material from the Ministry of Works Gracefield Quarry for stopbank construction, free of charge.
Construction Equipment:	From the tender, the following list of plant was to be on site during the works: Caterpillar diesel traxcavator, Carryall 6.5 cu. yd, 8-9 ton roller, 5, 6 and 8 yd trucks, Grader, Tracked loaders/dozers
Cash Flow:	1956 £17,000 1957 £40,869
Subsidy:	1 for 1
Comments:	Land claims of £28,777 incl. solicitors, etc.

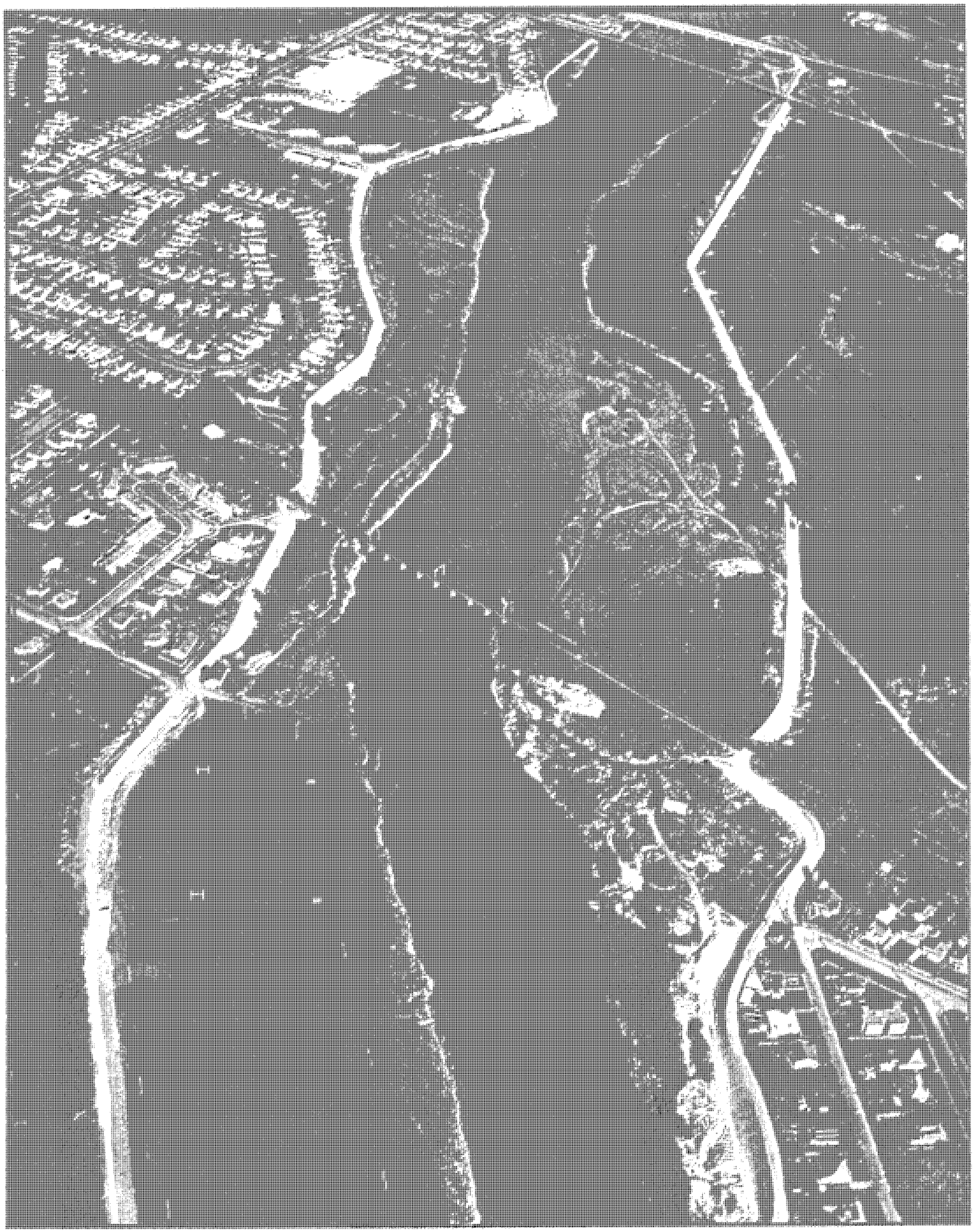


Plate 91: 1956 stopbank works in progress.

PROJECT REPORT 5

MELLING DIVERSION CUT : FIRST STAGE

A realignment of the Hutt River at Melling to remove an incised S bend

Date: 1959-60

Plan Number: HRB 102

File: SSPHRB17

Location: Refer Appendix A, figure 4.

Historical Chainage - S/B C/L:
Right Bank 2 mi 77 ch to 3 mi 7.5 ch
Left Bank 3 mi 11 ch to 3 mi 20.5 ch

Current River Traverse - river C/L:
4500 m to 5000 m

Reason for Initiation: This work was a pilot cut, 50 ft (15 m) wide, on the western side of the proposed 1904 "Ultimate River Alignment". The cut was first proposed in 1940, following the 1939 flood, but could not be made until LHCC had replaced the Melling suspension bridge with a bridge that spanned the full waterway on the Ultimate Channel Alignment.

The cut was proposed because of:

(1) Erosion on the outsides of the two bends and the ongoing cost of protection, described by the Hutt River Board Chairman as a cost which "...probably ran into tens of thousands of pounds." Evening Post 25 November 1953.

(2) Danger to the stopbank.

(3) The need to comply with the "Ultimate Channel Alignment".

(4) To reduce flood levels.

(5) To allow the free movement of bedload through the river system and so prevent aggradation upstream of Melling.

A preliminary plan for the Melling Cut was put to the Board by its Engineer in 1951 - refer to Plan No. HRB 89. The Engineer noted that the channel downstream of the Melling Bridge had been deepened and increased in capacity over many years by planned shingle extraction and river training, however, a steep bed gradient through and immediately above the proposed cut area indicated a very large volume of shingle "perched" above the Melling "S" bend. The Engineer believed that an immediate opening of a full width cut would allow massive shingle movement downstream during a flood, with a possible serious reduction in the capacity of the downstream section.

From an ***Evening Post*** article, 2 December 1953, the river bank, presumably east bank immediately downstream of the Melling (suspension) Bridge approach, was eroded to within feet of the stopbank.

From an ***Evening Post*** article, 8 December 1953, the Hutt River Board Engineer considered that a significant threat of flooding existed - probably from stopbank breaching. He therefore proposed that the cut proceed in stages, starting with a relatively high level pilot cut, to place some control on shingle movement and allow assessment of the extent to which deposition would occur in the abandoned channel areas.

Plate 92: 1955 Flood showing the restriction formed by the Melling bend.

Design Capacity: The minimum considered necessary based on the experience of scour induced diversion development.

Designer: Seaton Sladden and Pavitt

Construction: M L Daly, 138 Martin Square, Upper Hutt

The pilot cut was made through an S bend upstream of the position of the present Melling Bridge. It was intended that the pilot cut, once made, would deepen sufficiently over two to three years to dewater the general area and enable the main cut to be completed more easily. Excavations through the downstream portion of the cut were made in a solid clay. A Public Works Department representative commented that "The material is mostly toughish clay and it seems essential either to excavate gullets through the cuts well below low water level or to loosen the bottom of the cuts with explosives, these would probably have to be shot several times at intervals." T H Nevins, 22 December 1958 (MOW file 96/298000)

The cut was delayed for about two years after the completion of the new Melling Bridge to enable the formalities of legal closure of the old Melling Road (approach to the old bridge) to be made, and the old bridge to be removed.

Excavated clay was trucked to Taita and spread in a low area to the west of Taita Drive, near Mabey Road. Gravels were stockpiled for later use in filling the old river channel.

During the contract an additional 25 ft width was added to the cut. Five thousand cu. yd of this material was stockpiled on site. Three thousand cu. yd was removed to fill at Taita Drive. A netted boulder weir was built at the apex of the eastern S bend to encourage deposition of bed material and filling of the old channel.

Supervision: Seaton Sladden and Pavitt

Construction Equipment: Not recorded, however, an old photograph in Ministry of Works File 96/298000 shows a dragline excavating one portion of the pilot cut, apparently in gravel.

Cash Flow:
1959
£9,500
1960
£3,142
Land purchase of £10,238 required

Subsidy: 1 for 1

PROJECT REPORT 6

MELLING DIVERSION CHANNEL : SECOND STAGE

Widening of the Melling Diversion Cut

Date:	1960-61
Plan Number:	HRB 102 and 113
File:	SSPHRB17
Location:	Refer Appendix A, figure 4. Historical Chainage - S/B C/L: Right Bank 2 mi 77 ch to 3 mi 7.5 ch Left Bank 3 mi 11 ch to 3 mi 20.5 ch Current River Traverse - river C/L: 4500 m to 5000 m
Reason for Initiation:	The pilot cut, opened as Stage One of the Melling Diversion Cut, was to have been left to develop for two to three years. However, the decision was made within about one year to widen the cut because of: (1) The slow rate of siltation of the old channel. (2) Difficulty in maintaining the weir (built in the old channel to promote siltation). The channel was widened a further 60 ft (18.2 m) to make a total width of 135 ft (41 m). Excavated material was deposited in the old channel upstream of the weir.
Design Capacity:	N/A
Designer:	Seaton Sladden and Pavitt
Construction:	V A Draper and Company Ltd
Supervision:	Seaton Sladden and Pavitt
Construction Materials:	22,000 cu. yd removed
Construction Equipment:	Not recorded: probably Dragline.
Cash Flow:	1960 £2,000 1961 £2,118
Subsidy:	1 for 1

PROJECT REPORT 7

STOPBANK RAISING - EWEN BRIDGE TO MELLING

Raising of the original stopbanks, built 1901-03 to conform to the Hutt River Flood Control Scheme of 1945

Date: 1960-61

Plan Number: HRB 107, HRB 75

File: SSPHRB56

Location: Refer Appendix A, figure 3-4.

Historical Chainage - S/B C/L:
Right Bank 2 mi 4.7 ch to 2 mi 71.0 ch
Left Bank 2 mi 7.3 ch to 2 mi 57.7 ch

Current River Traverse - river C/L:
Right Bank 3060 m to 4370 m
Left Bank 3060 m to 4200 m

Reason for Initiation: Part of the 1950s Scheme Review works.

Design Capacity: 100,000 cusecs (2825 cumecs), plus 2 ft (600 mm) freeboard.

Designer: Seaton Sladden and Pavitt

Construction: R Seville Ltd

Supervision: Seaton Sladden and Pavitt

Construction Standards: Standard SSP Specification (see file SSPHRB56) and Project Report 4.

Construction Method: The work included raising of stopbanks, construction of reinforced concrete flood walls upstream of the Ewen Bridge and extension of stormwater pipes. New r.c. walls on the east and west banks were built to Plan No. HRB 75.

East Bank:

Low stone wall 55 m long from Ewen Bridge to car park. R.C. flood wall to varying height alongside old wall. R.C. toe wall to retain city side of stopbank up to Melling Bridge.

West Bank:

New r.c. wall 90 m long alongside old wall. On the east bank, from 2 mi 48 ch to 2 mi 70 ch, the stopbank was moved toward the river by between 20 ft and 80 ft (6 to 25 m) to permit the extension of Rutherford Street from Queens Drive through to Daly Street.

Construction Materials: West Bank:

2 mi 09 ch to 2 mi 64 ch - 28,000 cu. yd site material (silt and shingle)
2 mi 64 ch to 2 mi 71 ch - 4,000 cu. yd "rotten rock"

East Bank:

2 mi 15.68 ch to 2 mi 23.27 ch - 3,900 cu. yd silt and shingle
2 mi 23.27 ch to 2 mi 36 ch - 8,000 cu. yd rotten rock

2 mi 36 ch to 2 mi 46.75 ch - 5,000 cu. yd rotten rock
2 mi 46.75 ch to 2 mi 55.91 ch - 9,000 cu. yd silt and shingle
2 mi 72.92 ch to 3 mi 2.34 ch - 2,800 cu. yd silt and sand

Plant Used: Euclid S-7 motorscraper (ref: letter 29/4/60 from Clyde Engineering to Seaton Sladden and Pavitt)

Cash Flow:

1960	£22,100
1961	£27,908

Subsidy: 1 for 1

PROJECT REPORT 8

NEW STOPBANK AND STOPBANK RAISING NORTH OF MELLING BRIDGE

Raising of the existing stopbank from Taita to Fraser Park and new stopbanking from Fraser Park to Mabey Road

Date:	1962-64
Plan Number:	HRB 117
File:	SSPHRB96
Location:	Refer Appendix A, figure 5 Historical Chainage - S/B C/L: Left Bank 5 mi 10 ch to 7 mi 31.5 ch and extension to 4 m 55 ch Current River Traverse - river C/L: Left Bank 8,050 m to 11,620 m
Reason for Initiation:	In 1944 a low stopbank was built by the Public Works Department on behalf of the Department of Housing to protect the Taita Housing Block. Construction of housing in the block was just commencing. The original stopbank was built of river gravels, generally on the existing stopbank alignment, but slightly further inland in parts. It appears from file correspondence and reports that the bank and earthworks for the housing block were in part designed to block a potential overflow path from the river onto the valley floor, possibly near the present intersection of Taita Drive and High Street. The bank was later raised to 6 ft (1.83 m) above the gradient of the 1948 flood (47,000 cusecs (1327cumecs)) and extended 300 ft (91 m) further south. In 1962 the stopbank was again raised by about 2 ft (600 mm) as part of the Hutt Scheme Review and was extended south to vicinity of Mabey Road.
Design Capacity:	100,000 cusecs (2825 cumecs)
Designer:	Seaton Sladden and Pavitt
Construction:	V A Draper and Company Ltd
Supervision:	Seaton Sladden and Pavitt
Construction Standards:	Standard SSP Specification, see Project Report 4.
Construction Materials:	5 mi 10 ch to 7 mi 31.5 ch Borrowed fill from river berm - 20,000 cu. yds Other borrowed fill - 63,000 cu. yds (referred to in the specification as being available "from the hill face alongside Pomare Railway Station.."). 5 mi 10 ch to 4 mi 55 ch Borrowed fill from river berm - 22,000 cu. yds Other borrowed fill - 10,800 cu. yds
Construction Equipment:	Loader, 2 x D6 dozers, 3 trucks - 6 cu. yd no record of roller
Cash Flow:	1962 £54,000 1963 £8,000 1964 £698 Land acquisition of £7,000
Subsidy:	1 for 1

PROJECT REPORT 9

MELLING DIVERSION CUT - THIRD STAGE

Widening of the Melling Diversion Cut to design width

Date:	1964
Plan Number:	HRB 102, 113, 133
File:	SSPHRB17
Location:	Refer Appendix A, figure 4. Historical Chainage - S/B C/L: 2 mi 77 ch to 3 mi 7 ch Current River Traverse - river C/L: 4500 m to 5000 m
Design Capacity:	100,000 cusecs (2825 cumecs)
Designer:	Seaton Sladden and Pavitt
Construction:	V A Draper and Company Ltd
Supervision:	Seaton Sladden and Pavitt
Construction Materials:	25,000 cu. yds of material was removed from the downstream of the two bends and placed as fill in the Mills Road stopbank raising and in filling the old channel. The total bottom width of the channel was then 205 ft (62 m). It is probable that the cut was carried out in order to win material to completely close the old channel, and to remove tough clay from an apparently limited area: it appears that the upstream pilot cut was in gravels and developed with less requirement for excavation.
Construction Equipment:	17RB and 19RB draglines - 0.75 cu. yd. Four trucks.
Cash Flow:	£5507
Subsidy:	Not recorded but probably 1:1 as for stages one and two, and other Scheme Review Works.

PROJECT REPORT 10

STOPBANK RAISING MELLING ROAD TO MILLS ROAD

Raising of the original (1901) stopbank to meet Scheme Review standards

Date:	1964
Plan Number:	HRB 120
File:	SSPHRB109
Location:	Refer Appendix A, figure 4 Historical Chainage - S/B C/L: Left Bank 3 mi 4 ch to 3 mi 19 ch Current River Traverse - river C/L: Left Bank 4650 m to 4950 m
Reason for Initiation:	Scheme Review works
Design Capacity:	100,000 cusecs (2825 cumecs), plus 2 ft (600 mm) freeboard.
Designer:	Seaton Sladden and Pavitt
Construction:	V A Draper and Company Ltd
Supervision:	Seaton Sladden and Pavitt
Construction Standards:	Not retained on file. However, it is assumed that a standard specification was used. See Project Report 4.
Construction Materials:	Cut and fill from existing stopbank, 1,200 cu. yds. Borrowed fill from stage 3 of the Melling Diversion Cut (ref: letter E M Sladden to District Commissioner of Works 11/12/63) 8,200 cu. yds.
Plant Used:	Not recorded
Cash Flow:	£5,400
Subsidy:	1 for 1

PROJECT REPORT 11

HAYWARDS SETTLEMENT STOPBANK CONSTRUCTION

Extension of an existing stopbank to protect Ministry of Works housing in the Haywards Settlement

Date:	1964-65
Plan Number:	HRB 106
File:	SSPHRB73
Location:	Refer Appendix A, figure 5. Historical Chainage: Not given. Current River Traverse - river C/L: Right Bank 11,500 m to 12,820 m
Reason for Initiation:	Construction of stopbanks was proposed by the Ministry of Works in 1958 to protect a planned extension to the Ministry of Works housing area at the Haywards Settlement. The proposed stopbank was to be a northern extension to an existing stopbank, built by the Ministry of Works, protecting the earlier southern housing block. In 1961 it was proposed by the District Commissioner of Works that the Hutt River Board should "... embody (the stopbank) in the existing stopbank system and share in the cost of the work ..." and this was agreed by the Board. The financial basis for this agreement is not recorded.
Design Capacity:	According to a personal comment by E M Sladden (Engineer to the Hutt River Board) dated 10/9/70, on the above file, the stopbank was built with 3 ft 6 in (1.05 m) freeboard above the (recorded) grade line of the (70,000 cusec) 1939 flood. There is no record as to why the design capacity of 100,000 cusecs, then the standard for other parts of the Hutt River Scheme, was not used. However there is a comment on file that due to river bed lowering since the (70,000 cusec) 1939 flood the channel capacity at Haywards would exceed 70,000 cusecs. It is noted that the northern section of the Haywards stopbank is over a metre higher than the stopbank at the mouth of the Stokes Valley Stream, which was designed in 1980 for a one metre freeboard above a 2124 cumec (75,000 cusec) discharge.
Designer:	Seaton Sladden and Pavitt
Construction:	C A Willis
Supervision:	Seaton Sladden and Pavitt
Construction Standards:	SSP Specification - refer Project Report 4
Construction Materials:	Approved clay or rotten rock obtained from either Horokiwi Quarries Ltd or from the Lower Hutt City Council refuse tip at Wingate.
Construction Equipment:	Caterpillar D6 bulldozer, 3 cu. yd Euclid loader, Case 450, Caterpillar 966 loader, Trucks (6 cu. yd)
Cash Flow:	£30,600
Subsidy:	1 for 1

PROJECT REPORT 12

WHAKATIKI STREET TO MAORIBANK STOPBANKING

Construction of a new stopbank from the street now known as Masefield Street to Maoribank: and the first stage of the Scheme Review in the Upper Valley. Originally known as the Whakatiki Street to Maoribank Stopbanking, but extending from present day Masefield Street to Maoribank

Date:	1964-65
Plan Number:	HRB 118 Other relevant plans: HRB 129 - Diversion Channels HRB 167 - Maoribank Drainage Channel HRB 161 - Regrading Drainage Channel, Clouston Park to Ebdentown Road HRB 144 - Stopbank Construction at Drainage Channel near Gibbons Street
File:	SSPHRB111
Location:	Refer Appendix A, figure 8-9. Historical Chainage - S/B C/L: Left Bank 12 m 70 ch to 15 m 16 ch Current River Traverse - river C/L: Left Bank 19,870 m to 24,200 m
Reason for Initiation:	Scheme Review Works
Design Capacity:	100,000 cusec (2825 cumecs), + 2 ft (600 mm) freeboard
Designer:	Seaton Sladden and Pavitt
Construction:	Green and McCahill Contractors Ltd
Supervision:	Seaton Sladden and Pavitt
Construction Materials:	The stopbank was constructed of river gravel, with a clay capping 1 ft (300 mm) thick and a 6 in (150 mm) topsoil layer. Compaction standards are not recorded. Materials were obtained from the diversion channel opposite Hudson Avenue (124,000 cu. yds), from the drainage channels (8,000 cu. yds), and included clay capping (over river shingle), 27,500 cu. yds and topsoil, 13,700 cu. yds.
Construction Machinery:	38RB dragline, 2 DW21 motorscrapers of 22.5 cu. yd capacity
Cash Flow:	1964 £46,850 1965 £22,854 Miscellaneous items £5342
Subsidy:	2 Government to 1 local share

PROJECT REPORT 13

WHAKATIKI STREET TO HERETAUNGA GOLF CLUB STOPBANK

Second stage of stopbank construction for the upper valley section of the Hutt River Scheme from the street now known as Masefield Street to the Wellington Golf Club. Originally known as the "Heretaunga Golf Club to Whakatiki Street Stopbank", but extended south from the present day Masefield Street

Date:	1966-69
Plan Number:	HRB 124
File:	112
Location:	Refer Appendix A, figure 7-8. Historical Chainage - S/B C/L: Left Bank ll m 5 ch to 12 m 70 ch Current River Traverse - river C/L: Left Bank 17,250 m to 19,870 m
Reason for Initiation:	Scheme Review Works
Design Capacity:	100,000 cusec (2825 cumecs), plus 2 ft (600 mm) freeboard
Designer:	Seaton Sladden and Pavitt
Construction:	Green and McCahill Contractors Ltd
Supervision:	Seaton Sladden and Pavitt
Construction Standards:	SSP Specification - see Project Report 4.
Construction Materials:	"... approved clay and rotten rock ..." supplied by Downer and Company Ltd from a site on the Moonshine Road approximately 400 m beyond the Moonshine Bridge (178,000 cu. yds); from drainage channel excavations (43,000 cu. yds); from "... near the end of Whakatiki Street.." (8,000 cu. yds) spoil - type unrecorded - previously dumped at the site.
Plant Used:	Not recorded but probably as for the previous Upper Hutt stopbank contract.
Cash Flow:	1966 $54,550 1967 $31,600 1968 $69,300 1969 $2,000 $30,154 paid in land compensation
Subsidy:	2 Government for 1 local share

PROJECT REPORT 14

FLATTENING STOPBANK SLOPE AT HUTT VALLEY HIGH SCHOOL

Flattening of the city side slope of the stopbank adjacent to the Hutt Valley High School

Date:	1965-66
Plan Number:	HRB 141
File:	SSPHRB116
Location:	Refer Appendix A, figure 3 Historical Chainage - S/B C/L Left Bank 1 m 39 ch to 1 m 65 ch Current River Traverse - river C/L Left Bank 2160 m to 2600 m
Reason for Initiation:	The stopbank through this area had originally been built with 1.5:1 batters. The 1950s Scheme Review called for all batters to be 3:1 on the river face and 2:1 on the outer face (where feasible).
Design Capacity:	N/A
Designer:	Seaton Sladden and Pavitt
Construction:	W G Kells Ltd
Supervision:	Seaton Sladden and Pavitt
Construction Standards:	Not retained
Construction Materials:	4,900 cu. yds of "approved clay or rotten rock"
Construction Equipment:	Not recorded
Cash Flow:	$2865
Subsidy:	Not recorded

PROJECT REPORT 15

STOPBANK CONSTRUCTION AT THE DRAINAGE CHANNEL NEAR GIBBONS STREET

An auxiliary stopbank to improve outlet conditions for the drainage channel discharging at Gibbons Street. Pipes under the main stopbank had been laid previously under the main stopbank construction contract

Date:	1966-67
Plan Number:	HRB 144
File:	SSPHRB120
Location:	Refer Appendix, figure 8 Historical Chainage; not assigned Current River Traverse - river C/L Left Bank 21,320 m to 21,640 m
Reason for Initiation:	Part of Scheme Review works.
Design Capacity:	To the 100,000 cusec flood level of the main stopbanks.
Designer:	Seaton Sladden and Pavitt
Construction:	Green and McCahill Contractors Ltd
Supervision:	Seaton Sladden and Pavitt
Construction Materials:	Cut to fill from existing channel 1,600 cu. yds. Borrowed fill (unspecified but probably river gravel)18,700 cu. yds. Material (unspecified but probably clay) over channel slopes 500 cu. yds. Topsoil 1500 cu. yds
Construction Equipment:	Not recorded
Cash Flow:	$8025 in 1966 $2800 in 1967
Subsidy:	Not recorded but probably 2:1 as for the main stopbanks.

PROJECT REPORT 16

CHANNEL REALIGNMENT BETWEEN TRENTHAM MEMORIAL PARK AND THE SILVERSTREAM BRIDGE
"The Silverstream Cut"

Realignment of the river channel and training works, from the Wellington Golf Club to the Silverstream Bridge. Part of the Upper Valley Flood Control Scheme

Date: 1966-71

Plan Number: HRB 148, HRB 155

File: SSPHRB127

Location: Refer Appendix A, figure 7

Current River Traverse - river C/L
14,600 m to 17,360 m

Reason for Initiation: During the 1950s a proposal to extend the Western Hutt Motorway (State Highway 2) beside the Hutt River, north of the Silverstream Bridge, was considered in conjunction with the proposed River Control Scheme. A road alignment west of the Hutt River up to the Moonshine Bridge and east of the River to Maoribank (as now in place) was proposed and land for the scheme was purchased by the National Roads Board.

At that time, the Hutt River through the Upper Valley, was generally in private ownership, and was not controlled according to any specific scheme. Localised bank stabilisation and river training works were carried out by the Public Works Department and Hutt River Board, mainly on behalf of the Upper Hutt Borough Council and private landowners. The risk of flooding was recognised and was dealt with in part by small, private stopbanks which appear to have been constructed to mainly prevent scour and deposition.

The Public Works Department had begun the purchase of land for the Upper Hutt section of the Hutt River Scheme in 1947, making provision to acquire sections in Newton Street (west of Shakespeare Street and upstream of the Moonshine Bridge. The Newton Street subdivision had proved to be seriously floodable, despite a stopbank built by the developer at its upstream end.

In the early 1960s it was expected that the State Highway 2 River Road would be extended within a short time and provision for it had therefore been included in the Upper Valley Scheme works. Preliminary river straightening and training works, the "Silverstream Cut", were carried out concurrently with the commencement of stopbank construction between Maoribank and Masefield Street, as scheme works.

Design Capacity: To match the hydraulics of the adjoining reaches.

Designer: Seaton Sladden and Pavitt

Construction: Hired plant - various contractors

Supervision: Seaton Sladden and Pavitt

Comments: The work involved straightening the river, which lay in an inverted "S" swinging toward the Wellington Golf Club in the east and then crossing over to lie against the Western Hills upstream of the Silverstream Bridge. The river works, carried out by the Hutt River Board and subsidised by the National Roads Board placed the river in its "Ultimate Controlled Alignment", an alignment established by the Hutt River Board in 1952.

The works involved excavation of a design channel of trapezoidal cross section, removal of gravels to fill old meanders; and bank protection. Bank protection was achieved by retards formed from about eight tethered 2 tonne concrete blocks, perpendicular to the channel centre line. The retards held down wire cables to which willow poles and fascines were tied. "Boulsters" i.e., stone filled netting "sausages" were also used for weighting the willow fascines.

The "Silverstream Cut" survived in a reasonably functional although deteriorated form until 1984, when it was replaced by the River Works for the Upper Hutt Bypass, refer Project Report 45. Significant deterioration occurred between 1970 and 1984 due to:

(1) Heavy river attack in the years 1976 to 1982.

(2) Lack of maintenance funding from the National Roads Board (and consequently the Wellington Regional Water Board/Wellington Regional Council who were not prepared to commit regional funds if the principal beneficiary (National Roads Board) was not prepared to contribute) following the end of the previously agreed maintenance period in 1976.

(3) A lesser degree of siltation in old meanders than expected, causing a diversion of high velocity flood flows through and around bank protection works with consequent damage to these works.

(4) Removal of gravel from the old channel by the Ministry of Works and Development for road filling.

In 1984 the designers of the Upper Hutt Bypass River Works revised the philosophy, of river stabilisation between Maoribank and Silverstream and the original works on the right bank were completely replaced. Remnants of the left bank works remain.

Plate 93: Closing the channel to direct water through the first stage, Nov 1969.

Evening Post neg. C11328.

Construction Materials:	1110 concrete blocks; 30,000 cu. yds of gravel stockpiled for State Highway 2 upgrading south of Silverstream; 33,000 cu. yds of gravel stockpiled in the old channel for later use in the proposed motorway north of Silverstream; excavation of unsuitable material, probably silt and sand, stockpiled on Wellington Golf Club land near the river.
Cash Flow:	$11,283 in 1966/67 $15,653 in 1967/68 $31,462 in 1968/69 $43,282 in 1969/70 $75,416 in 1970/71
Subsidy:	2 Government (SC and RCC) to 1 local share on 45 percent of the cost of the works. The remaining 55 percent funded by the National Roads Board with no local share levied.

Plate 94: Aerial view of the combined first and second stages of the Silverstream Cut.

PROJECT REPORT 17

CHANNEL ALIGNMENT - HUDSON AVENUE

Date:	1967
Plan Number:	HRB 150
File:	SSPHRB132
Location:	Refer Appendix A, figure 8 Current River Traverse - river C/L 22,050 m to 22,640 m approximately (from opposite Willow Grove to opposite Ebdentown Road)
Reason for Initiation:	The cut was carried out through a central shingle bar to divert the River away from a point of attack on the left bank. Erosion at this point was threatening the stopbank opposite Hudson Ave.
Designer:	Seaton Sladden and Pavitt
Construction:	Feast Contractors Ltd
Supervision:	Seaton Sladden and Pavitt
Construction Materials:	34,250 cu. yds of shingle excavated and placed in low areas in the river bed on the river side of the stopbank (left bank). Forty-eight concrete blocks salvaged and replaced.
Cash Flow:	$7695
Subsidy:	Not recorded.

PROJECT REPORT 18

EASTERN HUTT ROAD CHANNEL REALIGNMENT

Realignment of the Hutt River channel south of Stokes Valley for construction of the Eastern Hutt Road

Date:	1967
Plan Number:	HRB 142 (not found)
File:	SSPHRB118
Location:	Refer Appendix A, figure 6 Current River Traverse approximately 12,000 m to 12,200 m
Reason for Initiation:	Construction of the four lane extension of the Eastern Hutt Road from Pomare to Stokes Valley required an encroachment of some 20 ft (6 m) into the Hutt River.
Designer:	Seaton Sladden and Pavitt
Constructed By:	Camerons Carrying Company Ltd
Supervised By:	Seaton Sladden and Pavitt
Construction:	The river channel was realigned 20 ft (6 m) toward the Manor Park Golf Course, with excavation of 15,700 cu. yds of gravel from the right bank. Although it is not recorded, it is probable that the excavated material was used in filling under the new road. Bank protection was constructed, including placement of quarry forkings on the left bank, 24 ch (480 m) of willow and cable protection (probably on both banks) and 20 tethered concrete blocks.
Construction Equipment:	Not recorded
Cash Flow:	$6200 in March 1967
Subsidy:	No record

PROJECT REPORT 19

TOTARA PARK STOPBANKS

The Totara Park stopbanks, constructed in three stages, commencing in 1968, 1981 and 1983 respectively

Dates: Stage I 1968, Stage II 1981, Stage III 1983.

Plan Number: Stage I plans in Upper Hutt City Council Files 323/3/160
Stage II Truebridge Callendar Beach Ltd 73/10
Stage III refer Truebridge Callendar Beach Ltd

File: WRWB 8/7/13 and UHCC Files 323/3/160

Location: Refer Appendix A, figure 9

Current River Traverse - river C/L
Stage I 22,440-23,140 m
Stage II 23,140-24,680 m
Stage III 24,680-25,230 m

Reason for Initiation: Stage one construction, from the western (downstream) end to the Maoribank Bend was constructed by the Totara Park Development Company, designed by Rayward and Gilkison Ltd (surveyors and consultants to the developers) to meet the requirements on the subdivisional development by the Hutt County Council which included: "Production of a satisfactory assurance from the Hutt River Board that the work (the company) proposes to carry out along the east and south boundaries of the property will be sufficient to protect from flooding the area comprised in the scheme plan to the same extent as the case on the south side of the Hutt River."

Design Capacity: 100,000 cusec (2825 cumecs)

Construction: The Hutt County Council was requested by Truebridge Callender Beach Ltd to accept a bond on uncompleted stopbank works in October 1968 and in turn requested that the Hutt River Board ".. provide an assurance that the areas are adequately protected from flooding." The Hutt River Board provided a plan (copy held on file Wellington Regional Water Board 8/7/13) showing the area considered to be protected (by this stopbank) against the 100,000 cusec flood and indicated that the stopbank would be taken over as soon as topsoiling and grassing were complete. The area considered to be protected encompassed the whole of Totara Park as now existing. A file note contained on the Hutt County Engineer's files, dated 30/10/68 states that "... a stopbank would be required at the top end to stop a flood sweeping through the entire subdivision ...", however, this does not appear to have been communicated to the Hutt River Board.

The Hutt River Board was asked to "... clarify the situation with respect to the stopbank ..." in November 1971. At this time the stopbank ran from the Maoribank Bridge to the western (downstream) end of Totara Park, but was not complete from a point 22 ch (440 m) west of Totara Park Road. The Hutt River Board's response is not recorded.

Plans for construction of a stopbank on the eastern side of Totara Park (to protect an eastward expansion of the development) were presented to the Wellington Regional Water Board for approval in 1977. At this time, as a result of a recent computer study of channel hydraulics the Wellington Regional Water Board noted that a portion of the existing bank might have to be raised.

This was later confirmed and the raising was incorporated into the new stopbank construction contract.

The eastern stopbank was raised in two sections. The first, incorporating raising of 200 m of existing bank and construction of 300 m of new bank was built in 1981. The cost of raising the existing bank was carried by the Wellington Regional Water Board. The remaining 550 m section was built in 1983. By agreement between the Wellington Regional Water Board, Upper Hutt City Council and Totara Park Developments Ltd the cost was met in full by the Wellington Regional Water Board and Upper Hutt City Council (with Soilcon subsidy) as it was accepted that Totara Park Development Ltd had insufficient funds to meet construction costs.

Designer: Stage I, Rayward and Gilkison
Stage II, Truebridge, Callender, Beach
Stage III, Truebridge, Callender, Beach

Construction: Not recorded

Construction Standards: Not recorded

Cash Flow: Stage I not recorded
Stage II included $19300 from Wellington Regional Water Board
Stage III Wellington Regional Council $30,275/Upper Hutt City Council $60,550/NWASCA $19,937
Totara Park Developments are to repay $61,500 in 1992.

PROJECT REPORT 20

STOPBANK CONSTRUCTION - BOULCOTT TO MABEY ROAD

Construction of a new stopbank from the Boulcott Golf Club to a point opposite Tennyson Avenue, to meet the existing stopbank completed in 1964. Local opposition to the loss of views in the Stellin Street area resulted in the omission of the section south of the Film Unit

Date:	1969
Plan Number:	HRB 125
File:	SSPHRB117
Location:	Refer Appendix A, figure 4-5 Historical Chainage - S/B C/L Left Bank 3 m 32 ch to 4 m 55 ch Current River Traverse - river C/L Left Bank 5660 m to 7340 m
Reason for Initiation:	This was the last section of stopbank to be built in the lower valley, probably because the area was considered to be at lower risk from flooding than previously stopbanked areas. This area was at the southern end of a stretch of bank referred to as the "terraces" , being a length of higher river banks between historic overflow points at Taita and Boulcott. The stopbank was designed and built in accordance with the Hutt River Board's Hutt River Scheme.
Design Capacity:	100,000 cusec, plus 2 ft freeboard
Designer:	Seaton Sladden and Pavitt
Construction:	Hired plant
Supervision:	Seaton Sladden and Pavitt
Construction Standards:	Draft construction specification held on File SSPHRB117. This requires compaction in 6 in (150 mm) layers, minimum of 12 passes with a 4.5 tonne (minimum) sheepsfoot roller, clay or rotten rock, where used, to be placed at optimum moisture content.
Construction Materials:	From draft specification the materials to be used as filling would be "... approved clay or rotten rock..." obtained from either Horokiwi Quarries Ltd or from the Lower Hutt City Council Refuse Tip at Wingate.
Construction Equipment:	Caterpillar D6 bulldozer, 3 cu. yd Euclid loader, Case 450, Caterpillar 966 loader, Trucks (6 cu. yd)
Cash Flow:	$30,600
Subsidy:	1 Government share for 1 local share

PROJECT REPORT 21

MODEL STUDY OF THE RIVER MOUTH

Date: 1971-73

File: SSPHRB114

Location: Refer Appendix, figure 2

River mouth, principally concerned with the reach downstream of the Estuary Bridge.

Reason for Initiation: The principal objective of the model study was to determine the limits of reclamation that could be permitted on the western side of the river without increasing the flood level in the Waiwhetu Stream.

Refer letter from E M Sladden to Dr H P Thorpe, Ministry of Works and Development Central Laboratories, 2 August 1971.

The study was carried out by the Ministry of Works and Development Central Laboratories at a cost of approximately $8000.

PROJECT REPORT 22

MAORIBANK RESERVE DRAINAGE CHANNEL

Construction of the open perimeter drain around Maoribank Park

Date:	1972
Plan Number:	HRB 167
File:	SSPHRB165
Location:	Refer Appendix A, figure 9 Current River Traverse - river C/L Left Bank 23,450 m to 24,000 m
Reason for Initiation:	The drain was required to discharge stormwater from the Maoribank Park and from the growing residential area of Maoribank. It is not recorded why this drain was not constructed at the time of stopbank construction, 1964-67, but it is possible that the requirement for the Hutt County Council to improve drainage from the hillsides and flats above Maoribank Park, refer to Project Report 23, prompted a review of drainage in the Maoribank area.
Design Capacity:	Not recorded
Designer:	Seaton Sladden and Pavitt
Constructed by:	G G Wilkie and P Corrigan
Supervised by:	Seaton Sladden and Pavitt
Construction Standards:	Not recorded
Construction Materials:	4,350 cu. yd of material excavated, 1,250 cu. yd of topsoil placed 6 in (150 mm) thick on batters, twin 42 in concrete culverts with flap-gates constructed under stopbank.
Plant Used:	Not recorded
Cash Flow:	$7948
Subsidy:	Not recorded

PROJECT REPORT 23

REGRADING DRAINAGE CHANNEL - CLOUSTON PARK TO EBDENTOWN ROAD

Date:	1972
Plan Number:	HRB 161
File:	SSPHRB130
Location:	Refer Appendix A, figure 9 Historical Chainage - S/B C/L Left Bank 14 m 13.5 ch to 14 m 39 ch Current River Traverse - river C/L Left Bank 22,500 m to 23,000 m
Reason for Initiation:	The drainage channel was lowered by 3 ft (900 mm) at the upstream end to conform to the invert level of a new 72 in (1.83 m) Upper Hutt City Council stormwater pipe from the Maoribank area (south of Fergusson Drive).
Design Capacity:	Not recorded
Designer:	Seaton Sladden and Pavitt
Construction:	John McLachlan Ltd
Supervision:	Seaton Sladden and Pavitt
Construction Standards:	Not recorded
Construction Materials:	6 in (150 mm) layer of "rotten rock" in channel batters
Cash Flow:	$8535
Subsidy:	Apportionment of costs not recorded

PROJECT REPORT 24

REGRADING THE STOPBANK - BOULCOTT GOLF CLUB

Lowering the stopbank in the Boulcott Golf Course from Ariki Street to Hathaway Avenue

Date: 1972

Plan Number: HRB 168 (held on file HRB 182)

File: SSPHRB182

Location: Refer Appendix A, figure 4

Historical Chainage - S/B C/L
Left Bank 3 m 44 ch to 3 m 66 ch

Current River Traverse - river C/L
Left Bank 5,360 m to 5,750 m

Background: Correspondence on the Engineer's general file, dated 1931, records permission granted to James Stellin, property developer, to lower the stopbank at Troon Crescent, Lower Hutt, to 18 in (450 mm) above the adjoining terraces (a lowering of approx 4 ft (1.2 m)).

The "Boulcott Farm" subdivision was built in two stages with the first part (Frys Lane) constructed in 1928 . Troon Crescent extended along what is now Hathaway Avenue to meet the stopbank where it ends at the Terrace. (Note that half the subdivision is built below the Terrace). Prior to the construction of the stopbanks the area between Military Road and Ariki Street had been known as the Boulcott overflow and was the entry to the top of the Black Creek or Second River. The stopbanks had been continued to Military Road in order to close the Boulcott Overflow. It is not known why the stopbank grade finished 5-6 ft. above the terrace level other than to allow the northern area to act as an overflow spillway and so ensure the integrity of the banks, should a super design event occur.

Stellin, who was an energetic property developer throughout the Wellington and Hutt Valley area, had been pressuring the Hutt River Board since the mid-1920s to allow the removal of the stopbank and had enlisted the support of Lower Hutt City Council. The Hutt River Board resisted this pressure until the 1931 flood was measured at 3 ft 2 in below the top of the bank.

Reason for Initiation: As part of the Scheme upgrading the existing banks were to be strengthened and regraded to the 100,000 cusec + 2 ft. flood profile. In this area the stopbank was lowered by 1 ft 9 in to 3 ft 6 in to establish a top width of 1O ft (3 m), with 3:1 batters.

Design Capacity: N/A

Constructed by: G G Wilkie and P Corrigan

Supervised by: Seaton Sladden and Pavitt

Construction Standards: Not recorded

Construction Materials: 2,100 cu. yd excavation, 400 cu. yd topsoil

Cash Flow: $4550

Subsidy: Not recorded

PROJECT REPORT 25

STOPBANK RESHAPING SOUTH OF MELLING STATION

Date:	1972
Plan Reference:	HRB 170
File:	185
Location:	Refer Appendix A, figure 4 Historical Chainage - S/B C/L Right Bank 2 m 49 ch to 2 m 69 ch Current River Traverse - river C/L Right Bank 3935 m to 4350 m
Reason for Initiation:	The existing stopbanks from the Melling Railway Station south for approximately 400 m had been left on a 1.2:1 batter so as not to encroach on an area leased to a shingle crushing plant. Material from the reconstruction of State Highway 2 had been stockpiled at the site for berm and stopbank upgrading, and was used to flatten the batters to 3:1.
Design Capacity:	N/A
Designer:	Seaton Sladden and Pavitt
Construction:	John McLachlan Ltd
Supervision:	Seaton Sladden and Pavitt
Construction Standards:	Not recorded
Construction Materials:	5,750 cu. yds of material from improvements to State Highway 2. Type of material not known, but likely to have been rotten rock and clay.
Cash Flow:	$3958
Subsidy:	Not recorded

PROJECT REPORT 26

OKOUTU STREAM (BLACK CREEK) AUXILIARY STOPBANK

Construction of the auxiliary stopbank at the Okoutu Stream (Black Creek) outlet channel

Date:	1972-73
Plan Number:	HRB 164
File:	SSPHRB162
Location:	Refer Appendix A, figure 3. Current River Traverse - river C/L Left Bank 1,950 m to 2,120 m
Reason for Initiation:	The stopbank was constructed to reduce the effect on the Okoutu Stream of high water levels in the Hutt River and thus to reduce ponding behind the main stopbank in floods of the magnitude of the 1939 flood. The backwater effect of the Ava Bridge was recognised as affecting the Okoutu Stream outlet.
Design Capacity:	". to 1939 flood level ." (Evening Post, 27/11/72)
Designer:	Seaton Sladden and Pavitt
Construction:	John McLachlan Ltd
Supervision:	Seaton Sladden and Pavitt
Construction Standards:	Not known - work carried out by hired plant supervised by Seaton Sladden and Pavitt
Construction Materials:	Imported filling, type unknown, 2,200 cu. yd
Construction Equipment:	TD8 bulldozer, E211 motorscraper, Grader, H65 loader, H90 loader, 6 cu. yd trucks, Dragline - for stream clearing
Cash Flow:	1972 $ 6,223 1973 $ 3,287
Subsidy:	Not approved for subsidy

PROJECT REPORT 27

HUTT VALLEY MAIN SEWER RIVER CROSSING - SILVERSTREAM

Date: 1976

Plan Numbers: Hutt Valley Drainage Board Plans A1-3064 to A1-3076
WRC Plans HR2208, HR2224

File: Now held by Lower Hutt City Council

Location: Refer Appendix A, figure 6.

Current River Traverse - river C/L
Left Bank 14,208 m

Reason for Initiation: The main sewer from Upper Hutt previously crossed the river via a siphon attached to the old railway bridge, which was located at approximately this point. (The Silverstream Rail Enthusiasts' line at the entry to the Silverstream Landfill is part of the old line north of the old bridge.) Vacuum conditions were maintained in the siphon by a vacuum pumping station. Replacement of the siphon was proposed because:

(1) The siphon and pumping station gave continual trouble, resulting in frequent discharges of raw sewage into the river at a location regularly used by the public.

(2) The Railways Department had given notice of its intention to relocate the bridge.

(3) Replacement of the sewer main could be expected at some time because of the anticipated development of Upper Hutt.

Design Capacity: N/A

Designer: Odlin, Sowry and Company

Construction: Olsen Earthworks Ltd

Supervision: Odlin, Sowry and Company

Construction Method: A previous seismic survey of the Hutt River showed that bedrock at the northern end of Taita Gorge rose close to river level. The site chosen for the crossing allowed the sewer to be founded on rock. Additionally, there was sufficient space on the eastern side of the river to permit diversion of the Eastern Hutt Road during construction.

The construction area was coffer dammed to allow dry working conditions. The structure was built on a keyed tidy slab and consist of a number of pipes covered with reinforced, post-tensioned concrete.

Construction Materials: Coffer dam of cohesive clays, and site backfilled with river gravels on completion.

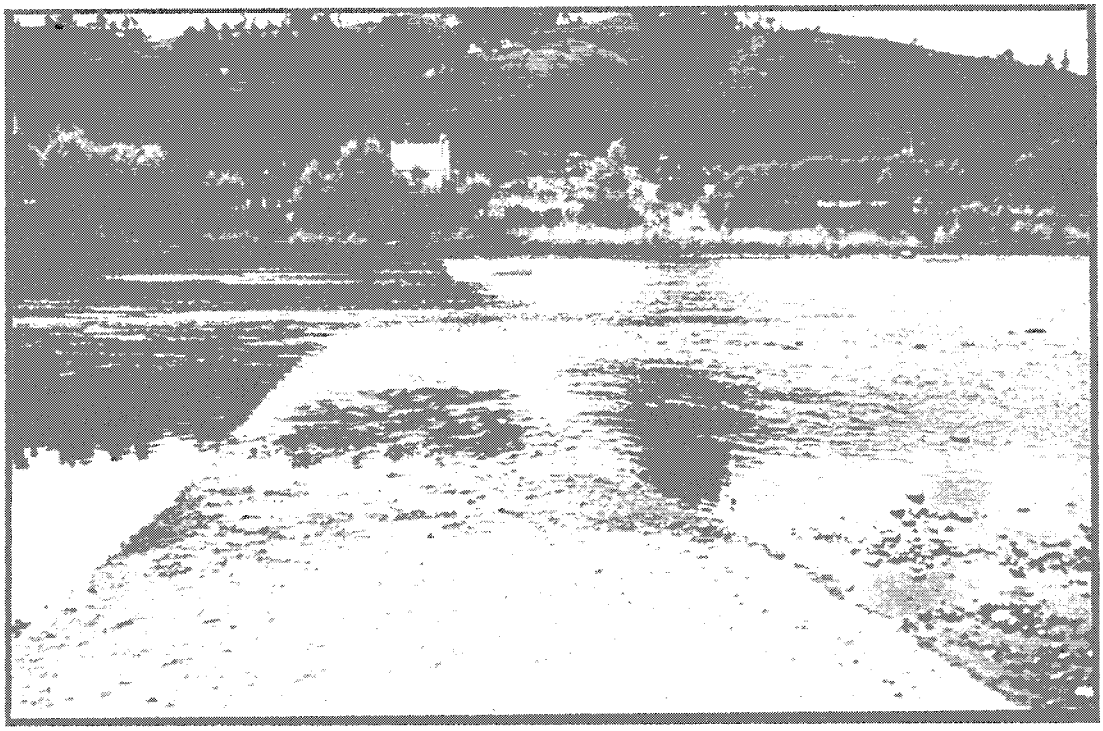


Plate 95: The sewer crossing looking west to east 1989.

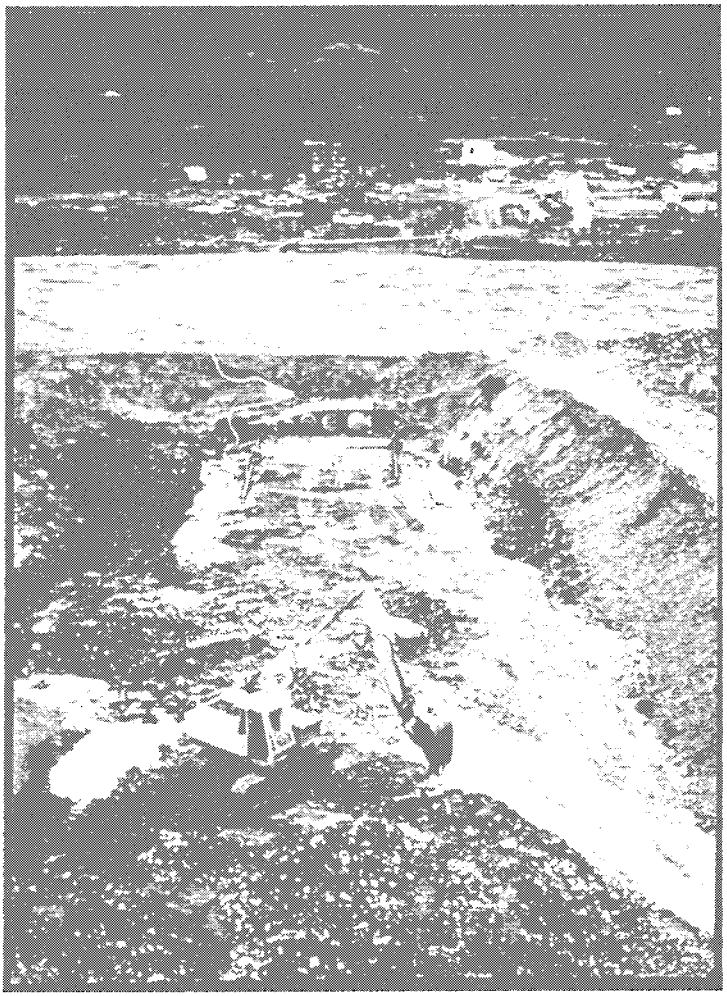


Plate 96: Construction of the sewer crossing 1976. Note the bed depth above the structure.

PROJECT REPORT 28

PROTECTION OF STATE HIGHWAY 2 EMBANKMENT AT TE MARUA

Date:	1980-81
Plan Number:	No plans held by Wellington Regional Council
File:	WRC File 8/7. Main files held in Ministry of Works and Development archives.
Location:	Refer Appendix A, figure 10. Current River Traverse - river C/L Left Bank 29,270 m to 29,450 m
Reason for Initiation:	In the late 1970s the State Highway 2 Bridge over the Mangaroa River was replaced, with an accompanying realignment of some ½ km of highway.
Design Capacity:	To 100 year flood level.
Designer:	Ministry of Works and Development Wellington District Office
Constructed By:	Ministry of Works and Development Trentham Residency
Supervision:	Ministry of Works and Development
Construction:	The objective was to achieve a low cost but effective bank facing and toe protection. This was done by laying a rip-rap toe to the embankment up to normal water level, with a chequer board pattern of concrete blocks cabled together and anchored to deadmen. The spaces between the blocks were filled with large stones, and the top of the batter was planted.
Construction Materials:	Rip-rap, concrete blocks and plants.
Cash Flow:	Not known
Subsidy:	Funded by National Roads Board
Comments:	River metal extraction upstream, and associated bank protection assisted to reduce river attack against the embankment. Attack on the bank by the Hutt River is also reduced by the action of the outflowing Mangaroa River immediately upstream.

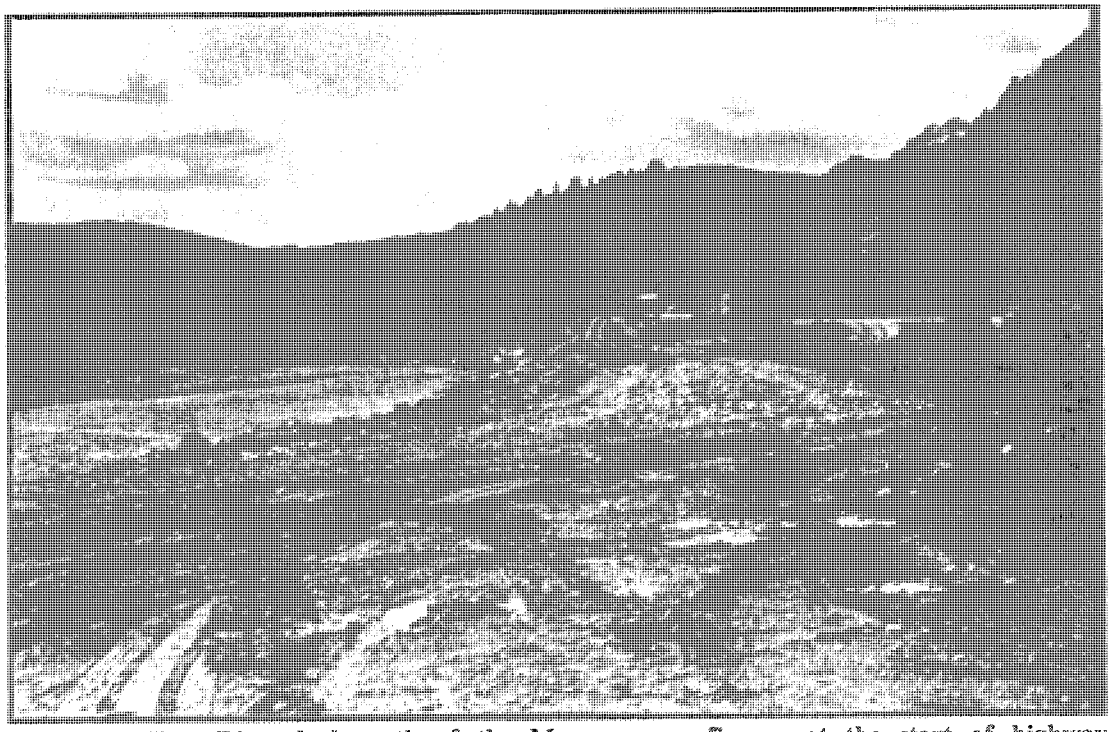


Plate 97: Hutt River bed south of the Mangaroa confluence at the start of highway construction. The river flowed against the highway before the diversion.

PROJECT REPORT 29

STOKES VALLEY STREAM OUTLET STOPBANK RECONSTRUCTION

Reconstruction of the Stokes Valley Stream Outlet Dividing Stopbank in conjunction with stream upgrading works

Date:	1980-81
Plan Reference:	WRC series AI-6935 and various amended and annotated plans held by the Rivers Department
File:	Wellington Regional Water Board 8/36, 8/36/1
Location:	Refer Appendix A, figure 6 Current River Traverse - river C/L Left Bank 12,200 m to 12,500 m
Reason for Initiation:	In 1980 the Wellington Regional Water Board commenced a contract to improve the capacity of the Stokes valley Stream, following major residential property damage from flooding in December 1976. During the works the existing dividing stopbank at the Stokes Valley Stream exit, built by the Hutt River Board to improve outlet conditions, was to be raised to 1 m above the grade line of the 2124 cumec (75,000 cusec) flood. This flood was established by the Wellington Regional Water Board in 1976 to be the 100 year return period flood in the Hutt River below the Whakatiki River, and the design flood for future scheme works. Immediately before stopbank construction commenced a flood in the Hutt River severely eroded the existing stopbank, necessitating its reconstruction before the raising could continue.
Design Capacity:	2124 cumec(75000 cusecs)
Designer:	Wellington Regional Water Board
Construction:	Feast Contractors Ltd - earthworks Wellington Regional Water Board - bank protection
Supervision:	Wellington Regional Water Board
Construction Materials:	A mixture of river gravels and clay. Approximately ⅔ by volume was river gravel taken from the Hutt River by scraper, and ⅓ was clay from a cutting in George Street, Stokes Valley.
Construction Equipment:	Bulldozer, Scrapers, Trucks
Cash Flow:	$26,500 (stopbank and protection work only)
Subsidy:	1:1 on 60 percent. Remainder paid by Lower Hutt City Council

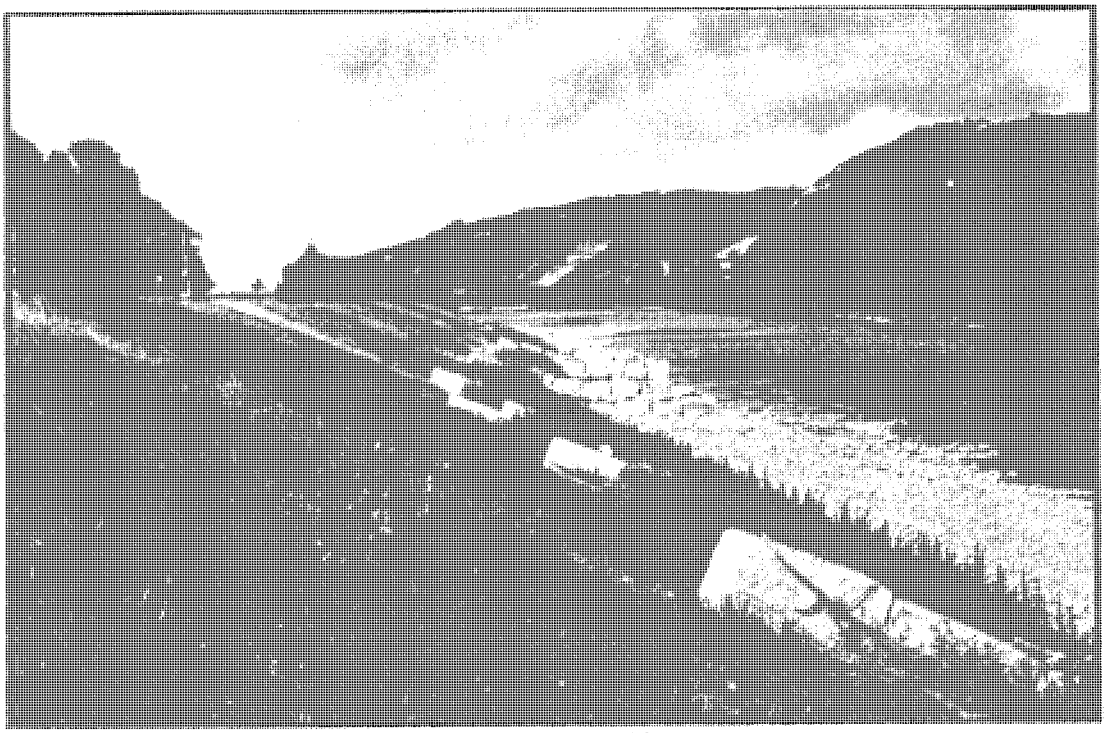


Plate 98: Stokes Valley Stream dividing stopbank 1982.

PROJECT REPORT 30

WELLINGTON GOLF CLUB - HERETAUNGA - RIVER CONTROL WORKS

Date:	1981-86
Plan Numbers:	HR3114, HR3198, HR3222, HR3224
Files:	8/7, 8/7/2
Location:	Refer Appendix A, figure 7 Current River Traverse - river C/L Left Bank 15,940 m to 17,430 m
Reason for Initiation:	Prevention of active erosion and stabilisation of the Silverstream Cut.
Design Capacity:	N/A
Designer:	Wellington Regional Water Board/Wellington Regional Council
Constructed By:	Wellington Regional Water Board/Wellington Regional Council
Supervision:	Wellington Regional Water Board/Wellington Regional Council
Construction:	The left bank of the river adjacent to the Wellington Golf Club was stabilised with standard design debris fences and willow plantings. These were subsequently removed and replaced with rip-rap as part of the Upper Hutt Bypass Riverworks Contract. In addition, the golf club made arrangements with local contractors to dump an estimated 30,000 cu. m of fill (including bricks, demolition material, concrete blocks, asphalt and clayey basecourse) in a depression on golf club land outside the course boundaries. River gravels had previously been mined from this area at the club's instigation.
Cash Flow:	Not known

PROJECT REPORT 31

MAORIBANK GROYNES AND PLANTING PROGRAMME

Date:	1981-87
Plan Number:	HR3116
File:	8/7
Location:	Refer Appendix A, figure 9. Current River Traverse - river C/L Left Bank 23,930 m to 24,220 m
Reason for Initiation:	During the May 1981 flood a 1.5 ha area was eroded, in effect bringing the river bed to within the line of the stopbank foundation.
Design Capacity:	N/A
Designer:	Wellington Regional Council
Construction:	PEP (Project Employment Programme - Department of Labour) labour and Wellington Regional Council
Supervision:	Wellington Regional Council
Construction Standards:	Following the 1981 flood two groynes were constructed of 10 tonne concrete blocks on foundation mattresses. Planting between the groynes was carried out. The blocks had not been cabled together and nor had the second groyne been tied into the southern stopbank. During a flood in December 1982 some of the blocks were pushed out of position on both groynes, with some erosion occurring around the inside end of the second groyne. The leading edge of the upstream mattress was rolled back on to itself. The cost to complete the groynes and repair the damage was approximately $20,000. The upstream of the two groynes was removed as part of the Upper Hutt Bypass construction. Part of these works involved construction of debris fences through the willow planting to protect the planting. Ongoing maintenance of the mattresses and willows has continued.
Cash Flow:	1983/1984 $20,000 (programmed) 1984/1985 $4,000 1985/1986 Nil 1986/1987 Minor

PROJECT REPORT 32

PROTECTION OF STOPBANK AND RIVER BANK, ALICETOWN

Date:	1981/1988
Plan Number:	No plan
File:	8/7/1
Location:	Refer Appendix A, figure 3. Current River Traverse - river C/L Right Bank 2550 m to 2750 m
Reason For Initiation:	Even though the Hutt River below Ewen Bridge is shaped by the influence of the tidal cycle and salt water intrusion the flow velocities during floods still cause scour and erosion of the banks. At approximately 350 m south of the Ewen Bridge the river turns to the right and in the vicinity of Buckley and Montague Streets has developed a deep thalweg close to the right bank. In March 1981 this reach was identified as a high risk area requiring a more substantial berm between the stopbank and river. Derelict wooden groynes (built by the Hutt River Board c. 1924) remain in place but now have no discernable effect in arresting bank erosion.
Design Capacity:	Not Applicable
Designer:	Wellington Regional Council
Constructed by:	Wellington Regional Council
Supervised by:	Wellington Regional Council
Construction:	The existing berm was only sufficiently wide to allow a tractor to pass between the stopbank toe and river bank. This berm was widened to 5-7 m by adding and consolidating a working bench of fill (obtained free of charge from local contractors).
Cash Flow:	Not known
Comments:	The intention was that this work be the first stage of a three stage programme. Subsequent work was to involve installation of prefabricated groynes made from telegraph poles and the planting of suitable plant species on the riverbank. If rock or rubble was available free, then this was to be placed at the toe of the bank. The estimated cost of this work was $6,000 (March 1981), including the planting over this reach of river. In preparation for future work to be done along this section concrete blocks are stored locally. The cost to date of block purchase has been $15,000 (1987/1988) and $9,000 (1988/1989).

PROJECT REPORT 33

TE MARUA RIVER METAL EXTRACTION

Date:	1981, 1989
Plan Number:	HR4042, HR4048, HR4050
File:	8/7/18, N/3/10/4
Location:	Refer Appendix A, figure 10 Current River Traverse - river C/L 29,536 m to 29,998 m
Reason For Initiation:	For extraction of accumulated river gravels and re-direction of river flows so as to minimise erosion of river banks on Teasdale property on the true right bank and the Te Marua Golf Club on the true left bank upstream of the confluence of the Hutt and Mangaroa rivers. Debris fences were also constructed to offer protection to the banks
Design Capacity:	N/A
Designer:	Wellington Regional Council
Constructed By:	Wellington Regional Council, with hired plant
Supervised By:	Wellington Regional Council
Construction:	In 1980/81 an estimated 48,000 cu. m of river gravel was removed, on trucks working in combination with bulldozers and motorscrapers. Again in 1988/89 29,000 cu. m was extracted. A number of associated works (mostly construction of debris fences and plantings) have been carried out over a period of time in conjunction with the extraction.
Materials Used:	Extensive use of willow plantings to offer bank protection
Cash Flow:	1980-81 $6,000 1988-89 $16,000 (figures based on information from files)

PROJECT REPORT 34

PARKDALE SUBDIVISION STOPBANK
And Associated Protection Works

Date:	1983-84
Plan Number:	Plans held on file
File:	WRWB 8/7/18, 8/7/19
Location:	Refer Appendix A, figure 9. Current River Traverse Left Bank, cross sections 2560 to 2590
Reason for Initiation:	In 1976 following recently completed investigations into flood levels in the Hutt River the proposed Parkdale Subdivision was found to be at risk from flooding at 100 year return period frequency. After site investigations for the proposed new bridge over the Hutt River to the Akatarawa Valley the Wellington Regional Water Board advised that flood levels should be revised upwards for safety and that stopbanking would definitely be required to protect the subdivision. In 1979, after further investigation and final design of the bridge, the Wellington Regional Water Board advised the height of stopbank required. This was over 3 m at its greatest height, immediately upstream of the bridge. By agreement with the Upper Hutt City Council, stopbank design and construction were carried out by the Council and protection was designed and built by the Wellington Regional Water Board/Wellington City Council.
Design Capacity:	Designed to computed flood profile for a 48,600 cusec (1,400 cumec) flood, plus 0.5 m freeboard, plus allowance for log rafts on the Akatarawa Bridge.
Designer:	Wellington Regional Council - hydraulics, bank protection Upper Hutt City Council - earthworks, drainage
Construction:	Regan - earthworks, drainage Wellington Regional Council - bank protection
Supervision:	Upper Hutt City Council, Wellington Regional Council
Construction Standards:	Fill placed in 200 mm thick layers within 2 percent of optimum moisture content. Not less than 6 passes of a suitable sheepsfoot roller.
Construction Materials:	The stopbank was built with highly weathered clay material extracted from a hillside cut on the Mangaroa Hill Road. Bank protection consisted of a chequer board pattern of tethered concrete blocks as toe scour protection in the river, woven plastic fabric anchored into the face of the bank as erosion protection, and willow planting.
Construction Equipment:	Plant for compaction was a 12 tonne sheepsfoot roller.
Cash Flow:	$150,000 stopbank and drainage; $70,000 bank protection.
Subsidy:	40 percent on Wellington Regional Council share. Total subsidy approximately $33,000.

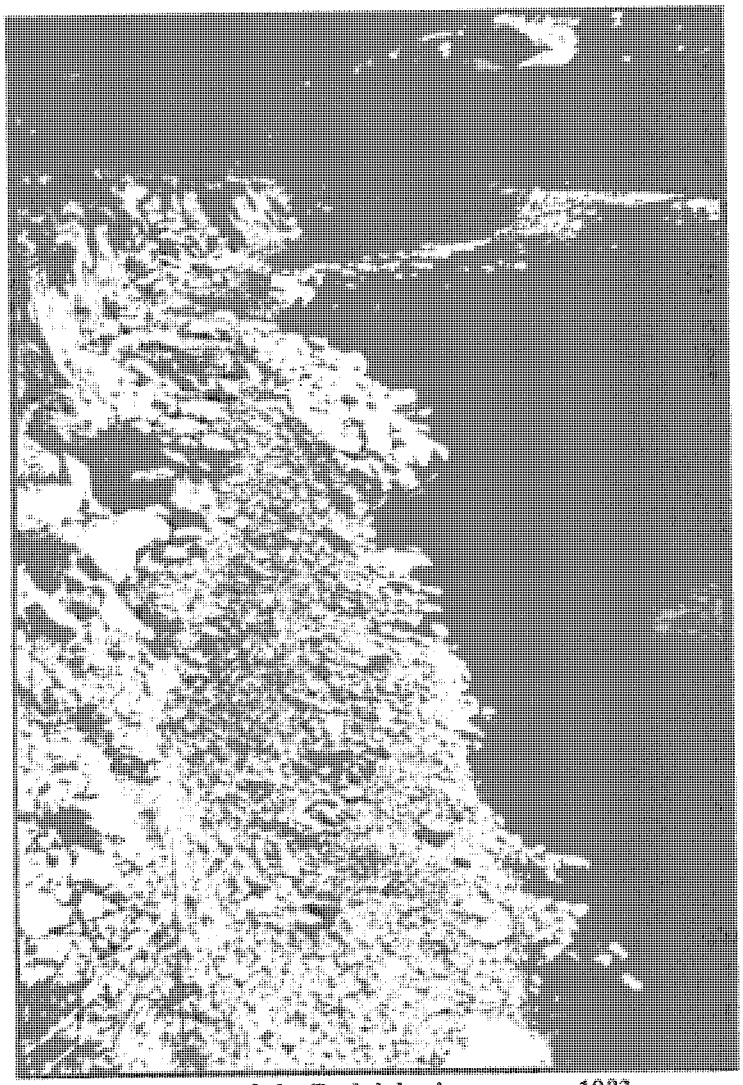


Plate 99: Erosion of the Parkdale river reserve 1983.

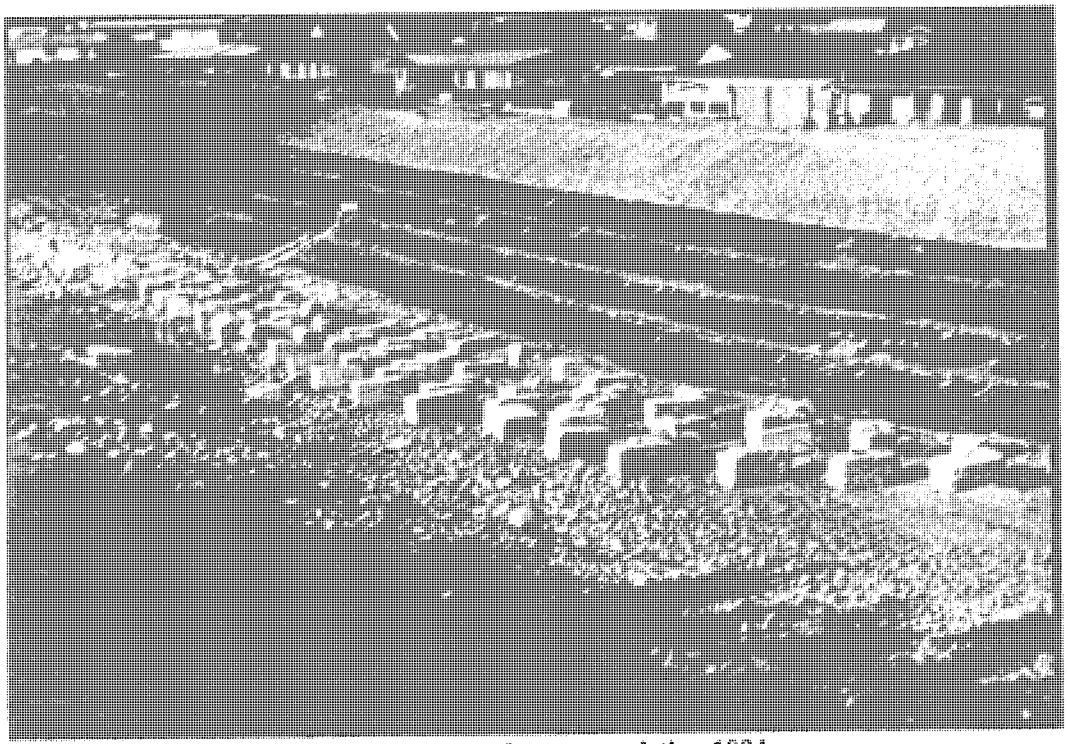


Plate 100: Stopbank and stabilisation works on completion 1984.

PROJECT REPORT 35

CONCRETE CYCLE TRACK FACILITY

Date:	1983/1984
Plan Number:	Not held by Wellington Regional Council
File:	8/7
Location:	Refer Appendix A, figure 3-5. Current River Traverse - river C/L Left Bank 6,800 m to 11,520 m
Reason For Initiation:	To provide high quality public access, particularly for use by cyclists, while at the same time minimising damage to an existing stopbank.
Design Capacity:	N/A
Designer:	Wellington Regional Council
Constructed By:	PEP (Project Employment Programme) labour
Supervised By:	PEP Co-ordinator
Construction:	The cycle track begins at Kennedy-Good Bridge on the left and runs on top of the stopbank as far as Pomare Bridge (river distance 6,800 m to 11,320 m) then under Pomare bridge and along the toe of the stopbank to the main road (river distance 11,320 m to 11,520 m). The track is 1 m wide, formed of unreinforced concrete.
Cash Flow:	In the order of $300,000 with Wellington Regional Council share being approximately $100,000

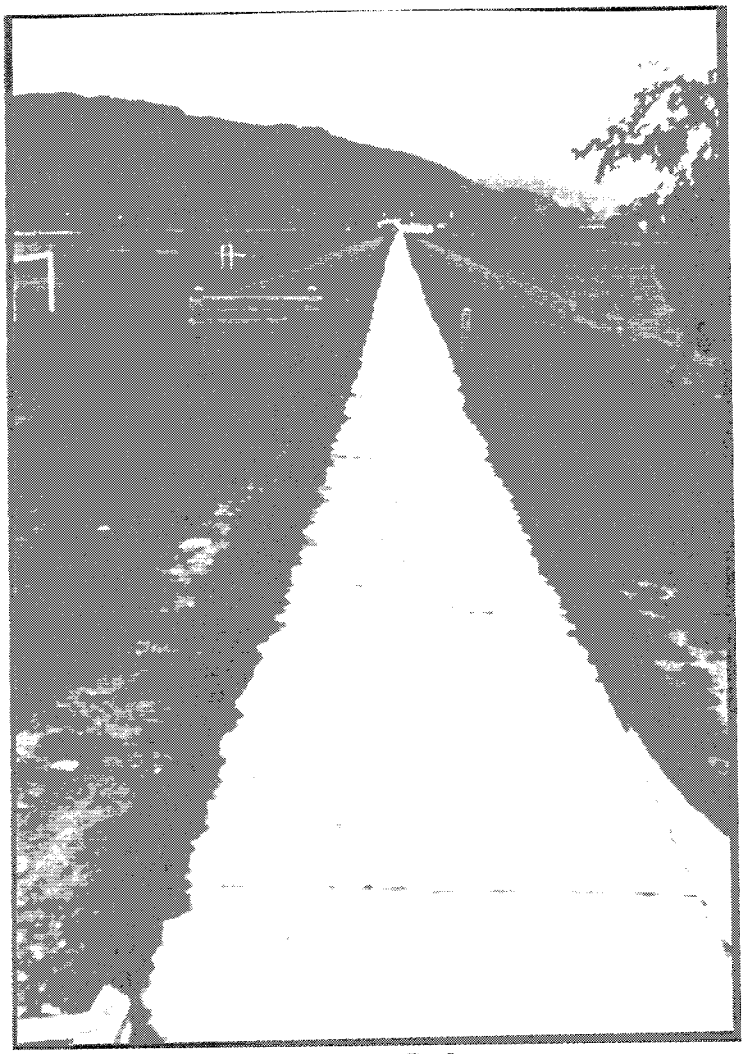


Plate 101: Cycle track at Fraser Park.

PROJECT REPORT 36

TE MARUA GOLF CLUB PRIVATE WORKS FOR BANK STABILISATION AND PROTECTION

Date:	Since 1983/84
Plan Number:	N/A
File:	
Location:	Refer Appendix A, figure 10 Current River Traverse - river C/L Left Bank 30,048 m to 31,102 m
Reason For Initiation:	To minimise the effects of erosion of the riverbanks and subsequent loss of golf club fairways
Design Capacity:	N/A
Designer:	Te Marua Golf Club, with assistance from Wellington Regional Council staff
Constructed By:	Voluntary labour from the membership of the Te Marua Golf Club
Supervised By:	Te Marua Golf Club
Construction:	Extensive use of willow plantings as necessary along reach. Bank protection consisting of tyres, concrete blocks, debris arrestors and willows over the reach 30,431 m to 30,561 m. A large debris groyne at or about 30,700 m in behind the Club's Pro Shop.
Materials Used:	Willows, railway irons, cable, tyres, concrete blocks and poles.
Cash Flow:	Unknown, as done as a private work with next to no labour costs.
Subsidy:	Not applicable
Comments:	It is also planned at the time of writing to remove a substantial island of gravel over the reach 30,694 m to 30,954 m. The objective is to direct the river away from an alignment hard against the left bank. This work will done by the Te Marua Golf Club with overall supervision by Wellington Regional Council. The cost sharing will be between the golf club and the property opposite on the right bank belonging to the Teasdale family.

PROJECT REPORT 37

STOPBANK REPAIR AT WOOLLEN MILLS (MOERA)

Experimental stopbank repair at Randwick Woollen Mills, immediately downstream of Okoutu Stream (Black Creek) mouth

Date:	1984
Plan Number:	No plan
File:	WRC 8/7/1
Location:	Refer Appendix A, figure 2. Current River Traverse - river C/L Left Bank 1,150 m to 1,180 m
Reason for Initiation:	This was an experimental work, to test the durability of limestone rip-rap from a Wairarapa quarry. The work involved stabilisation of the toe of a section of stopbank immediately downstream of the Okoutu Stream mouth, where the stopbank protrudes into the river. Large blocks of concrete rubble were dumped in deep water below low tide level, with limestone rip-rap (median diameter 0.5 to 0.6 m) placed on the existing stopbank.
Design Capacity:	2,140 cumec
Designer:	Wellington Regional Council
Construction:	Wellington Regional Council
Supervision:	Wellington Regional Council
Construction Materials:	See above
Construction Equipment:	Supply by truck from Wairarapa. Placement by long-reach digger.
Cash Flow:	$9000
Subsidy:	35 percent

PROJECT REPORT 38

BANK STABILISATION TRIAL - ESTUARY SECTION
Location : river banks at Sladden Park

Date: 1984-86

Plan Reference: Plans held on file.

File: WRC 8/7/1

Location: Refer Appendix A, figure 3

Current River Traverse - river C/L
Right Bank 1660 m to 2000 m

Reason for Initiation: Wave lap erosion in the lower river had been recognised as a problem as early as the late 1920s. As willows could not be established in this area the Hutt River Board experimented with grasses and various types of armouring.

In 1982 it had become apparent that upgrading of existing bank protection works was required and that bank protection in place, and in use in other parts of the river were unsuitable. This was because:

(1) Plants generally used for soil stabilisation do not tolerate the salt water entering this section.

(2) Existing bank protection relied heavily on dumped rubble, which was aesthetically unpleasant to the increasing numbers of recreational users of the river berms.

The purpose of the trial was to investigate the effectiveness of several methods of stabilising river banks in this estuarine reach. These were:

(1) Rebuilding old "boom groynes" (i.e., timber pile and cross-members) remaining from Hutt River Board works.

(2) Placement of rip-rap.

(3) Weighted filter cloth placed as a soil surface stabiliser.

(4) Weighted filter cloth placed in conjunction with salt tolerant native reed plantings.

(5) Planting of native reed and other native species without filter cloth.

It was intended that the results of the trial would be used in stabilising and beautifying up to 6 km of river bank in the tide-affected zone; predominantly downstream of the Ewen Bridge. A major factor in the trial was the attempt to establish a durable plant cover in the inter-tidal zone with species which would not (by reason of invasiveness or otherwise) become a nuisance.

Designer: Wellington Regional Council

Constructed By: Wellington Regional Council

Supervised By: Wellington Regional Council

Construction Standards: Not relevant

Construction Materials:	Rip-rap, reinstatement of "boom groynes" (timber groynes built by the Hutt River Board in 1927-28, UV stabilised polypropylene filter cloth, salt tolerant native plants.
Cash Flow:	$50,000
Subsidy:	60 percent
Comment:	The trial has demonstrated that native plants can be established in the upper part of the intertidal zone (and higher), but generally in sheltered areas of limited extent only. The usefulness of exotic plants is yet to be gauged quantitatively.

PROJECT REPORT 39

TOTARA PARK BANK PROTECTION AND STABILISATION

Date: 1984-1989

Plan Number: No specific plans pertaining to this work but for general design of debris fences refer WRC Plans HR316, HR3158.

File: 8/5, 8/7/2, 8/7/14

Location: Refer Appendix A, figure 9

Current River Traverse - river C/L
reach 20,840 m to 22,800 m

Reason For Initiation: Predominantly as part of protection works for the Upper Hutt Bypass Construction. To offer protection to the bypass road on the left bank and protection against bank erosion on the right bank.

Design Capacity: N/A

Designer: Wellington Regional Council

Constructed By: Wellington Regional Council

Supervised By: Wellington Regional Council

Construction:

1986/87 Right Bank (21,240 m to 21,570 m) - 6 permeable groynes and extension of debris fences
1986/87 Right Bank (21,995 m to 22,385 m) - 5 permeable groynes and extension of debris fences
1986/87 Left Bank (22,500 m to 22,700 m) - 4 permeable groynes and debris fences
1986/87 Right Bank (22,700 m to 22,800 m) - 2 permeable groynes and debris fences
1987/88 Left Bank (20,840 m to 21,943 m) - supplementary rock rip-rap
1987/88 Right Bank (21,140 m to 21,240 m) - 1 debris fence and 2 permeable groynes to strengthen and extend existing work
1987/88 Right Bank (21,843 m to 21,943 m) - install 3 groynes at the end of some existing debris fences
1988/89 Left Bank (22,500 m to 22,700 m) - Erosion occurred about permeable groynes and debris fences with resulting willow loss. Batter banks and plant willows.

Cash Flow:

1984/1985	$3,000
1985/1986	$13,000
1986/1987	$43,000
1987/1988	$94,000
1988/1989	$43,000
1989/1990	$11,000 (to 31/3/90)

Subsidy: Carried out as part of the River Works Agreement.

PROJECT REPORT 40

POMARE BRIDGE PROTECTION AND BANK STABILISATION

Date: 1984, 1990

Plan Number: HR2142, HR2166, HR2262, HR2270.
No plans relating to maintenance works.

File: 8/7, 8/7/4/5, N/3/10/2, N/3/12/6

Location: Refer Appendix A, figure 6

Current River Traverse - river C/L
Left Bank 11,076 m to 11,708 m

Reason For Initiation: The Pomare rail bridge over the Hutt River is located at a significant bend in the river. The main channel normally aligns itself with the left bank posing a constant threat to the bridge and stopbank. Historically work in the Region has consisted of maintenance with willow and poplar plantings, construction of wooden and concrete deflectors and cross blading in order to redirect the main channel.

A substantial area of river berm was removed by the January 1980 flood. As a result 20,000 cu. m of fill was placed to reinstate the river alignment away from the Taita stopbank. Low cost protection works were subsequently constructed. A fresh in the river on 13/14 September 1988 caused a 15 m width of river berm and protection works to be eroded away affecting a 200 m length and leaving a raw vertical bank.

Design Capacity: Protection works - 100 year flow, 2075 cumecs

Designer: Wellington Regional Council

Constructed By: Maintenance carried out by Wellington Regional Council

Supervised By: Morrison Cooper Ltd

Construction: Proposed Works Contract 1001 - Construction of four rock groynes on the left bank of the Hutt River in the vicinity of the Pomare Rail Bridge. The formation of groyne cores using *in situ* materials, the placing of filter aggregates over the core and the placing of an outer rip-rap "skin".

Contract Materials: Part Contract 130 - Supply of 5,425 tonnes of grade B and 1,016 tonnes of grade C rock from Pongaroa in the Wairarapa. Gradings defined by Wellington Regional Council standard rip-rap grading curves.

Contract 130A - Supply of 6,000 tonnes of grade C rock by Mintech New Zealand out of Collingwood.

Cash Flow:

1984/1985	$3,000
1985/1986	$9,000
1986/1987	$18,000
1987/1988	$2,000
1988/1989	$20,000
1989/1990	$288,000 (to 31/3/90)
1989/1990	$448,000 (1/4/90 to 30/6/90) rock supply only

Total estimated costs, including overheads for the Pomare Groynes Project, is $ 1,500,000

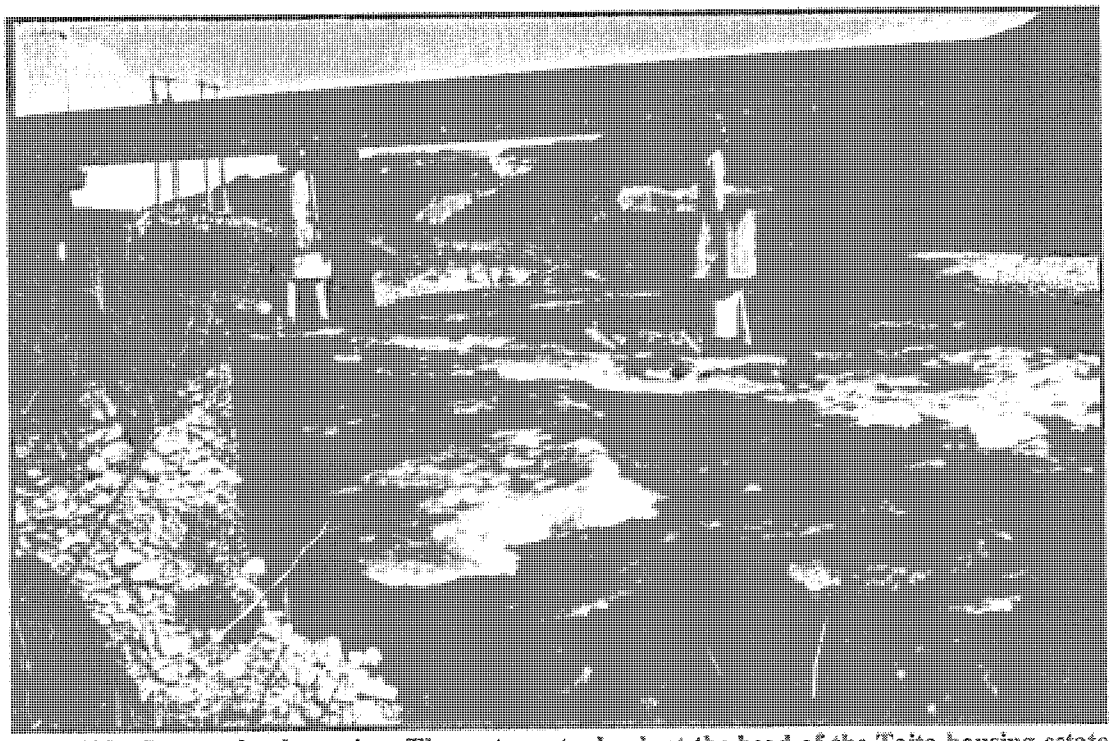


Plate 102: Pomare bank erosion. The eastern stopbank at the head of the Taita housing estate can be seen in the background.

Subsidy: New Zealand Railways contribution of $100,000-$300,000, depending on assessed degree of security. Not yet known.

PROJECT REPORT 41

OKOUTU STREAM (BLACK CREEK, LOWER HUTT) OUTLET WORKS UPGRADING

Replacement of the outlet (stopbank) culvert, excavation of the river berm outlet channel and reconstruction and strengthening of the outlet channel auxiliary stopbank

Date:	1984-present
Plan Number:	Held on file WRC 8/7/1
File:	WRC 8/7/1, N/3/10/2
Location:	Refer Appendix A, figure 3 Current River Traverse - river C/L Left Bank 1325 m to 1970 m
Reason for Initiation:	The replacement of the (1903) stopbank outlet culverts, the improvement of the conveyance of the outlet channel within the river berm, and the consequential strengthening of the auxiliary stopbank which protects the outlet from moderate river stages, were recommendations of the Lower Hutt City Council commissioned review of the Black Creek stormwater system.
Culvert Replacement:	In 1985 Lower Hutt City Council replaced the two original cast in situ concrete culverts with a single barrelled precast concrete culvert and flapgate structure. It was the original intention to seal and leave the 1903 culverts beneath the stopbank. The culverts were found to be in a deteriorated condition and both were later removed by the Wellington Regional Council in 1988.
Culvert Design and Construction:	Refer LHCC and WRC 8/7/1
1903 Culvert Replacement:	Wellington Regional Council - refer WRC N/3/10/2
Auxiliary Stopbank:	The auxiliary stopbank at the outlet of the Okoutu Stream, constructed in the 1920s to provide relief to the stream outlet during rises in the Hutt River, was by the early 1980s seen to be inadequately protected from river erosion. Although the remnants of the timber groynes remained, reerected after the extraction for the New Zealand Railways eastern duplication in 1927, these provided no effective erosion control. Bank erosion, principally by wave lap, was advancing and was threatening to remove part of the auxiliary stopbank.
Construction:	Silty fill from the New Zealand Railways' workshops site was brought in to raise, widen and extend the dividing bank to approximately River Distance 1350 m (at the present stream mouth). The material was dumped and allowed to consolidate for 18 months. The central stream channel was enlarged with cuttings stockpiled for use in the auxiliary stopbank. Rip-rap was placed on the Hutt River side of the extension to stabilise the toe of the bank. Two tonne concrete blocks and large blocks of concrete rubble were placed or dug into the river bed (as appropriate) below low tide level.
Design and Construction:	Wellington Regional Council

Cash Flow:	1984-85 $ 87,000 culvert construction and channel excavation 1985-86 $101,000 $51,000 auxiliary stopbank, $50,000 culvert construction 1986-87 $32,000 auxiliary stopbank 1987-88 $70,000 1903 culvert removal 1988-89 $25,000 1903 culvert removal
Subsidy:	35 percent. Cost sharing of 1:1 with Lower Hutt City Council for works within the stopbank.

PROJECT REPORT 42

BANK STABILISATION AT THE EWEN BRIDGE

A maintenance work to protect the stopbank and bridge approaches upstream of the Ewen Bridge

Date:	1985-86
Plan Number:	Plans held on file WRC 8/7/1
File:	WRC 8/7/1
Location:	Refer Appendix A, figure 3. Current River Traverse - river C/L Left Bank 3150 m to 3230 m
Reason for Initiation:	This work was to fill and stabilise an eroded section of the left bank, upstream of the Ewen Bridge, which was threatening to undermine: (1) The concrete flood wall (part of the stopbank system). (2) The Ewen Bridge approaches. (3) Access to the adjacent Lower Hutt City Council river bank car park.
Design Capacity:	2140 cumecs(75000 cusecs)
Designer:	Wellington Regional Council
Construction:	Wellington Regional Council, with hired plant.
Supervision:	Wellington Regional Council
Construction Standards:	Compaction to staff engineer's direction
Construction Materials:	Rock was dumped into the river on its angle of repose up to 0.3 m above high tide level to bring the bank to a desired line. The bank above was built up from compacted clay taken from a road cutting in Normandale. The bottom 2 m of clay was protected with turf slabs, secured with plastic windbreak cloth and anchored wires. Poplar poles were planted during filling.
Construction Equipment:	Sheepsfoot roller towed by tracked machine
Cash Flow:	$40,000

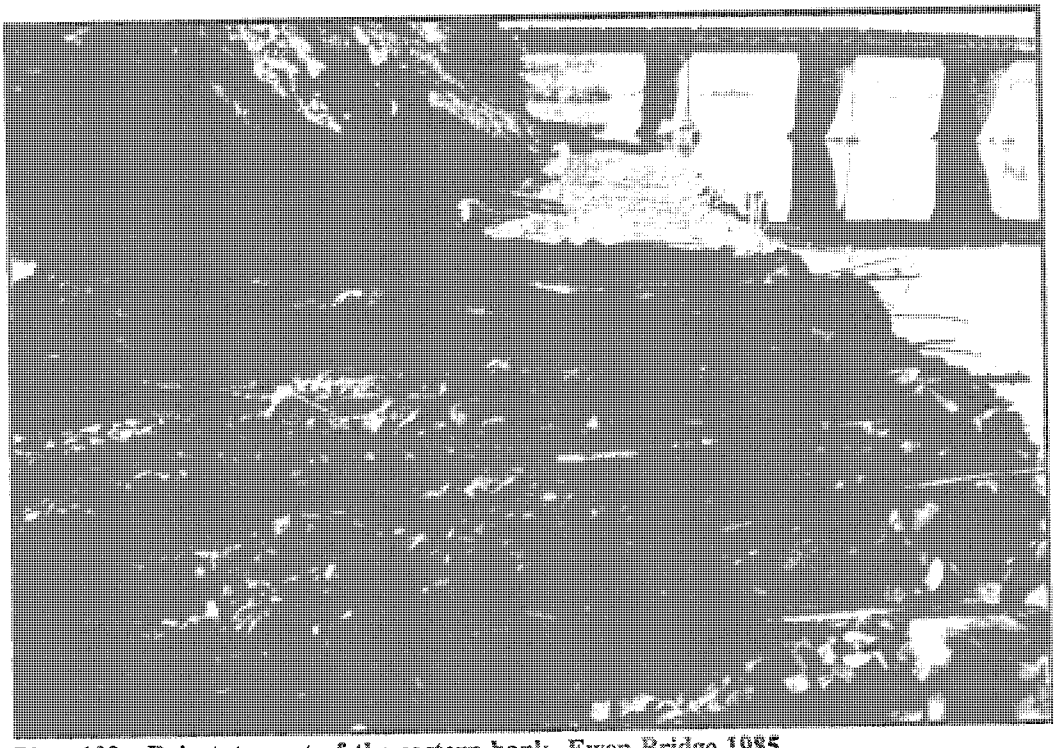


Plate 103: Reinstatement of the eastern bank, Ewen Bridge 1985.

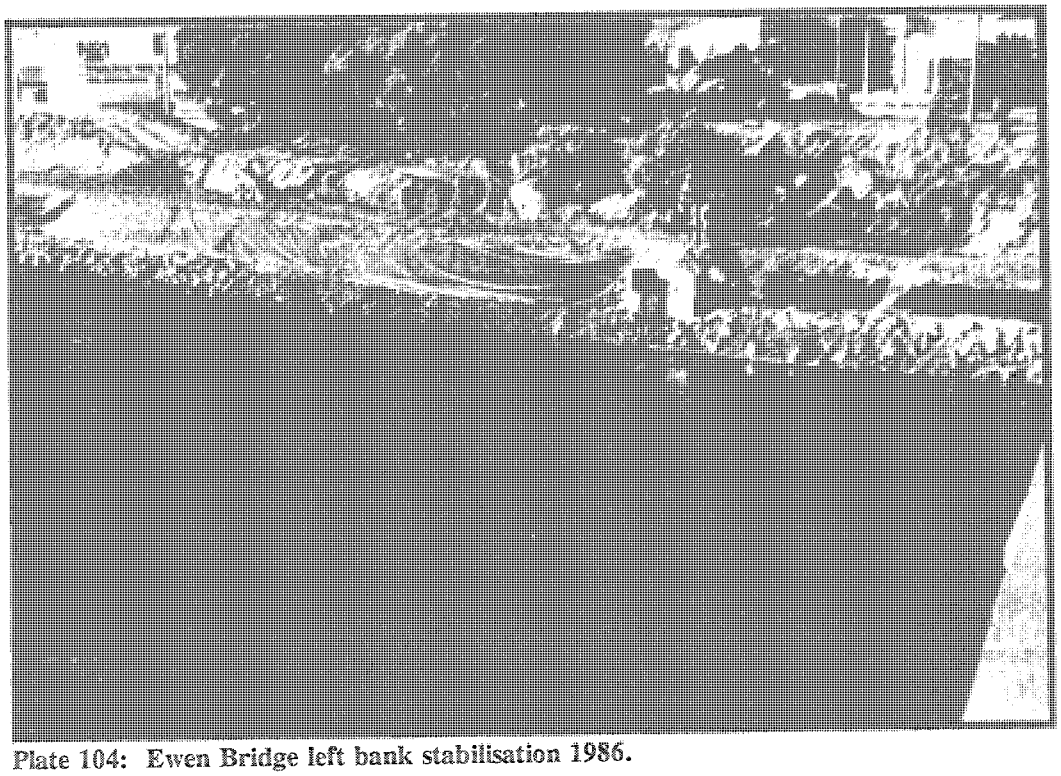


Plate 104: Ewen Bridge left bank stabilisation 1986.

PROJECT REPORT 43

BANK STABILISATION - HARCOURT AND HAUKARETU PARKS

A scheme work to stop erosion at Harcourt and Haukaretu Parks

Date:	1985-87
Plan Number:	Plans held on file
File:	WRC 8/7/2
Location:	Refer Appendix A, figure 9. Current River Traverse - river C/L Left Bank 24 370 m - 25,200 m
Reason for Initiation:	The Wellington Regional Council was requested by the Upper Hutt City Council and Hutt Valley Drainage Board to remedy bank erosion on the left bank of the Hutt River alongside Harcourt Park and Haukaretu Park. The erosion was threatening the riverside road within the park and the Hutt Valley Drainage Board sewer.
Design Capacity:	N/A
Designer:	Wellington Regional Council
Constructed by:	Wellington Regional Council
Supervised by:	Wellington Regional Council
Construction:	A variation of the railway iron breastwork used by the HRB at Hudson Avenue and at other locations to prevent the erosion of the foundation of an otherwise stable bank formation.
Construction Materials:	Two rows of railway irons were driven along the bank, parallel to the river. To these were tied willow poles and netting which retained gravel infill, with provision to accommodate scour.
Cash Flow:	$147,000 in equal shares by Wellington Regional Council, Upper Hutt City Council and Hutt Valley Drainage Board
Subsidy:	$42,000 being 30 percent of Wellington Regional Council and Upper Hutt City Council contribution

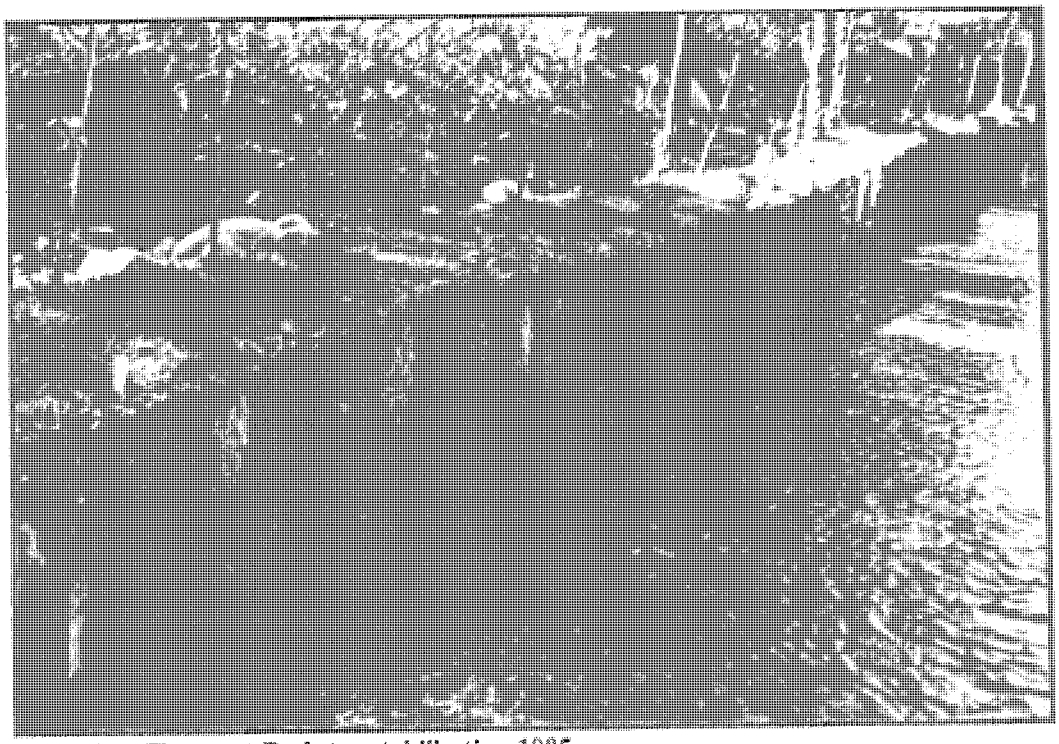


Plate 105: Harcourt Park toe stabilisation 1985.

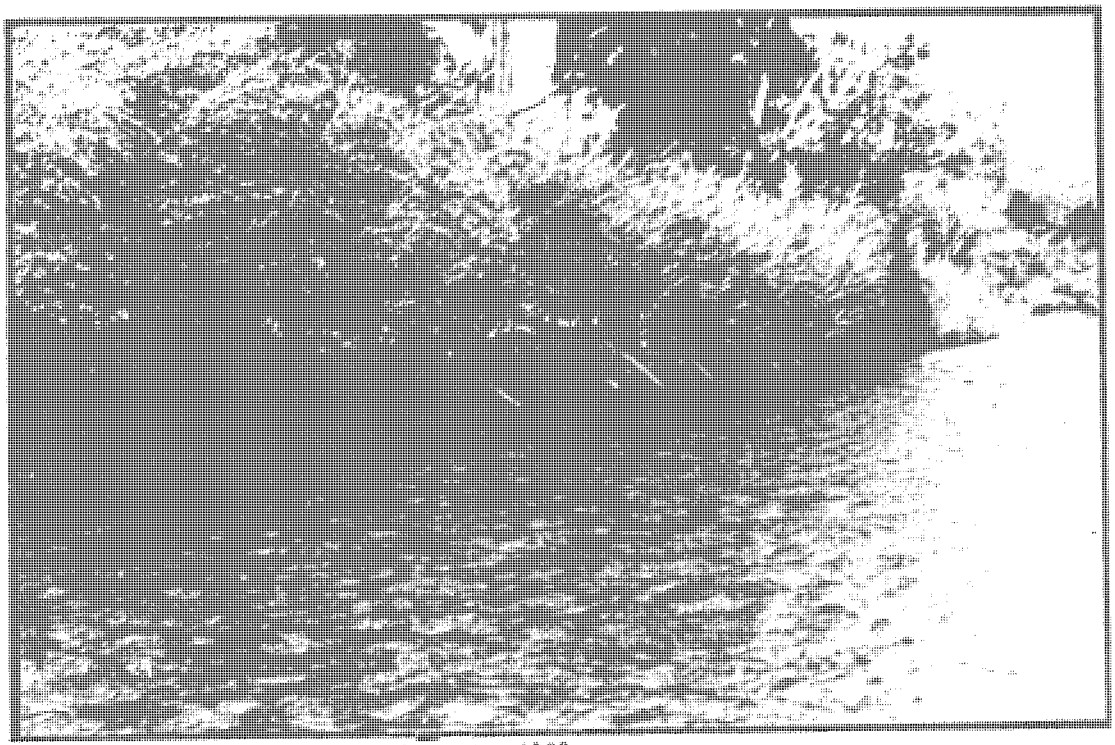


Plate 106: Harcourt Park toe stabilisation 1989.

PROJECT REPORT 44

STOPBANK REPAIRS AT CROFT GROVE

Date:	1985-88
Plan Number:	Plans held on files.
File:	WRC 8/7/1, N/3/10/2
Location:	Refer Appendix A, figure 2. Current River Traverse - river C/L Left Bank 870 m to 1150 m
Reason for Initiation:	Damage to banks in the estuarine section of the river, primarily by a combination of high flows and wave action, had been apparent for some years. At Croft Grove erosion was encroaching on and undermining the stopbank toe.
Design Capacity:	2140 cumecs
Designer:	Wellington Regional Council
Construction:	Wellington Regional Council
Supervision:	Wellington Regional Council
Construction Materials:	The eroded areas were filled with large blocks of rubble below low water level and above this with rip-rap (median diameter 0.3 m) to form a 3 m wide bench 1 m above high tide. The stopbank was refaced with soil and grassed. The work was done in two stages which were approximately: 870 m to 1080 m in 1985-86 1080 m to 1150 m in 1987-88
Cash Flow:	1985-86 $42,000 1986-87 $7,000 1987-88 $27,000
Subsidy:	30 percent

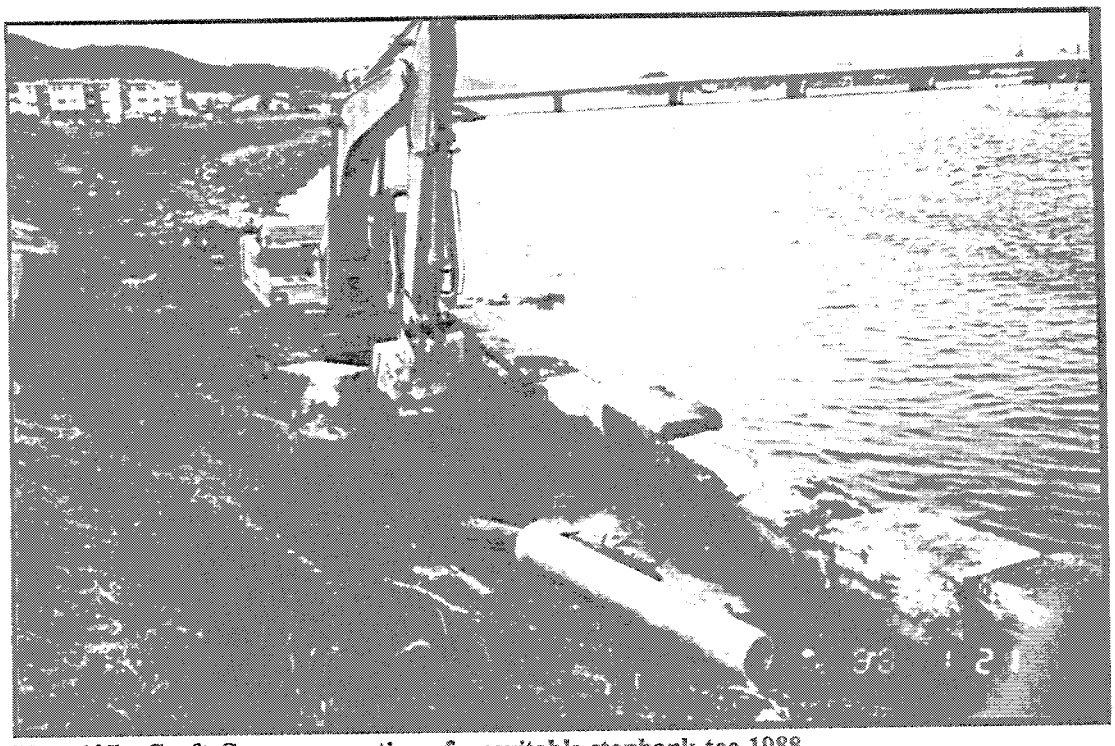


Plate 107: Croft Grove excavation of unsuitable stopbank toe 1988.

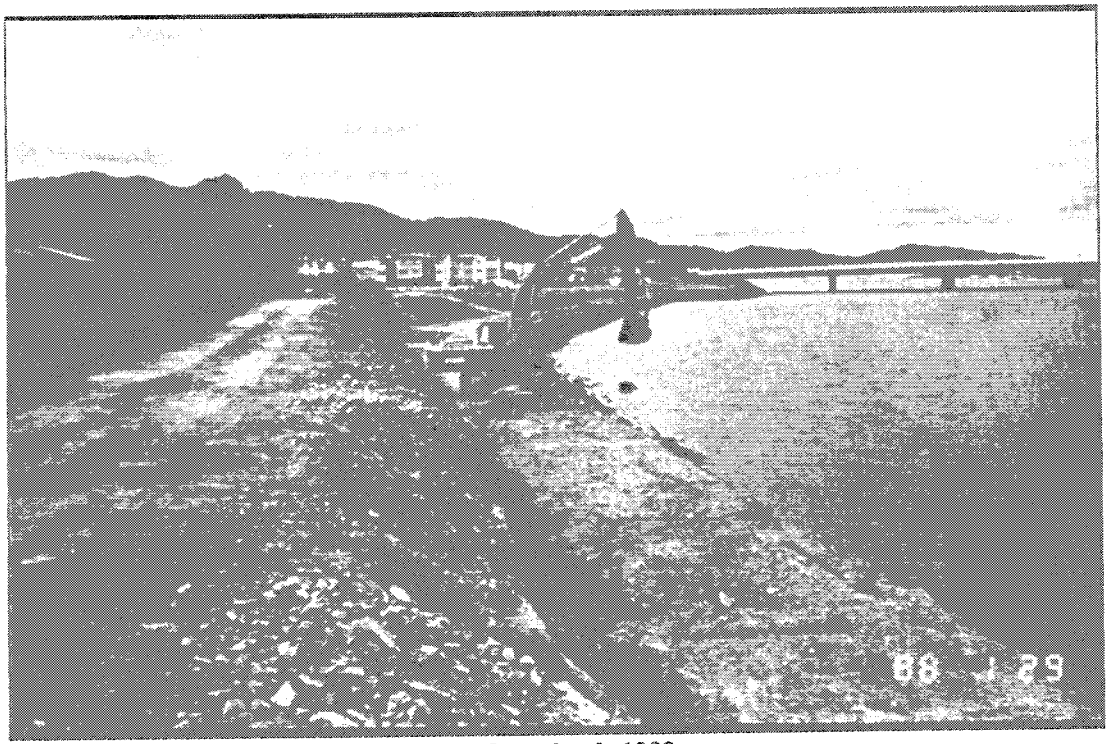


Plate 108: Croft Grove reconstruction of stopbank 1988.

PROJECT REPORT 45

UPPER HUTT BYPASS - RIVER WORKS

River realignment and training works in conjunction with the Upper Hutt Bypass Road

Date: 1985-88

Plan Number: MWD plans held under WRC Rivers Control 9 and 10 series.

File: WRC 8/7/14, N/60/2/1. Refer Upper Hutt Bypass River Works Report

Location: Refer Appendix A, figure 7-9

Current River Traverse - river C/L
14,600 m to 18,900 m and 20,800 m to 24,200 m

Reason for Initiation: Construction of a motorway extension on the banks of the Hutt River north of Silverstream to bypass Upper Hutt had been considered since the late 1940s. From 1966 to 1971 channel realignments and training works were carried out by the Hutt River Board on behalf of the National Roads Board in preparation for the proposed road construction.

Because of the deteriorated state of existing river training works, and due to the need to make adequate provision for protection of the Bypass Road a new river training scheme was designed by the M.W.D.

Previous Work: Refer Project Report 16.

Construction: In 1985 the Ministry of Works and Development and Upper Hutt City Council commenced construction of the Upper Hutt Bypass Road and associated River Works.

The River Works were designed to maintain the channel in a stable meander pattern of dimensions (width, wavelength, etc.) calculated to approximate the River's natural pattern. The pattern was reinforced with rock at the outsides of bends and by retards and willow planting in other places.

Works south of the Moonshine Bridge were carried out by the Ministry of Works and Development and works north of Gibbons Street were the carried out by the Upper Hutt City Council. Costs were shared by the Upper Hutt City Council, National Roads Board and Wellington Regional Council.

Design Capacity: Roadway at 20 year return period flood level, Protection works designed for 100 year return period (2124 cumec) flood, with detailed provisions for ongoing maintenance.

Designer: Road Works:
Ministry of Works and Development for MWD section 14,600 m to 18,900 m
Upper Hutt City Council for UHCC section 20,800 m to 24,200 m

Construction: Ministry of Works and Development section 14,600 m to 18,900 m
Upper Hutt City Council section 20,800 m to 24,200 m
Wellington Regional Council - for all willow planting and retards

Supervision:	By party responsible for construction
Cash Flow:	Capital cost of River Works $3,043,000 shared by the National Roads Board and Upper Hutt City Council
	Annual maintenance commitment of $(1988)93,000 from the Wellington Regional Council for 25 years.
	Cost sharing agreement for "Disaster Damage".

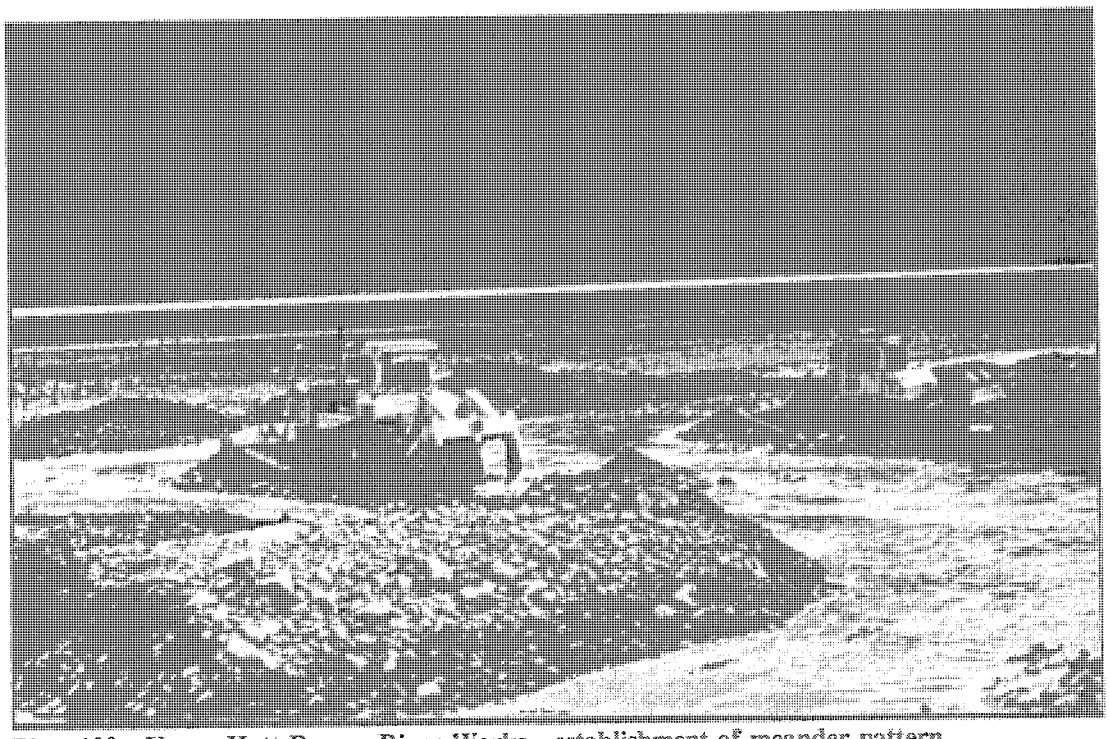


Plate 109: Upper Hutt Bypass River Works - establishment of meander pattern.

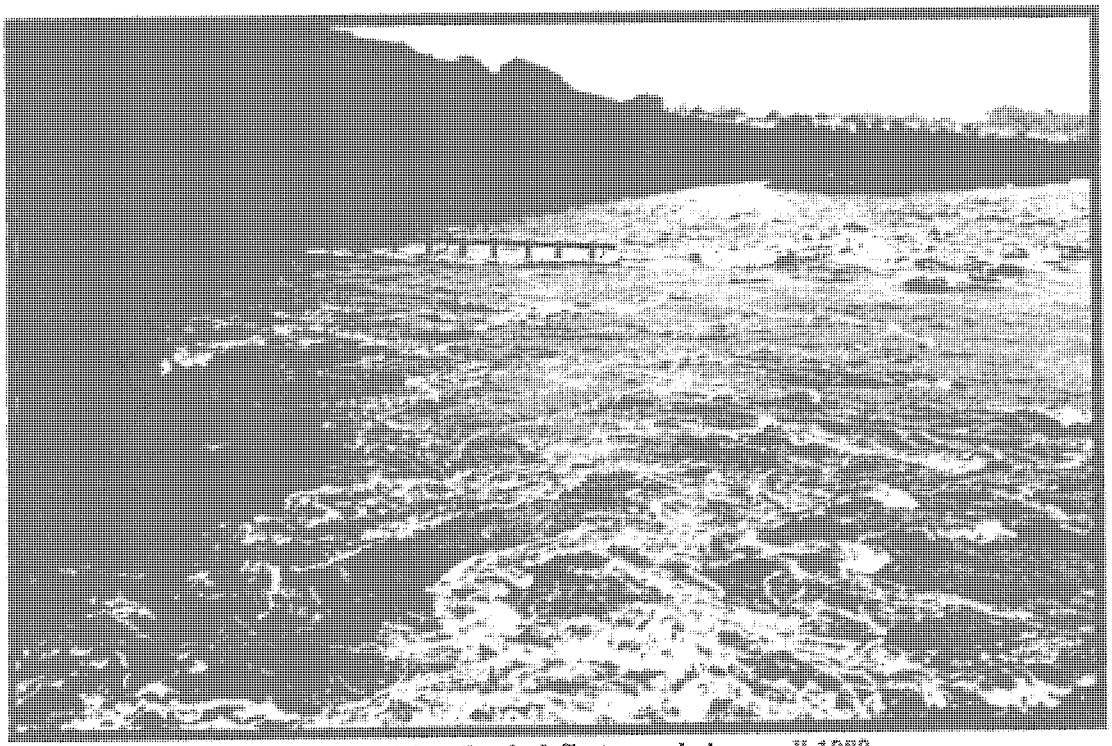


Plate 110: Upper Hutt Bypass - Maoribank deflector and river wall 1989.

PROJECT REPORT 46

EWEN BRIDGE AREA - TEMPORARY STABILISATION WORKS

Date:	1989
Plan Number:	No plan
File:	N/3/10/2, N/3/13/18, N/3/13/22
Location:	Refer Appendix A, figure 3 Current River Traverse - river C/L 3,165 m to 3,605 m
Reason For Initiation:	This work originates out of the Channel Management Report commissioned for the Ewen Bridge Gateway Study and was identified as urgent works required as a temporary measure to complement existing works and prevent potential loss of the bank and remaining berm by high velocity flood flows.
Design Capacity:	N/A
Designer:	G and E Williams Consultants Limited
Constructed By:	Wellington Regional Council
Supervised By:	Wellington Regional Council
Construction:	Left Bank Protection - 3,265 m to 3,320 m Clearing of existing bank batter, bank shaping utilising river gravels from exposed beach opposite Andrews Avenue Lower Hutt, placement of 50 lineal metres of rock lining on the left bank immediately downstream from the riverbank car park. Right Bank Protection - 3,165 m to 3,605 m Construction of two timber groynes on the western bank opposite Andrews Avenue. Located downstream of another timber groyne which was constructed in the 1920s. In addition to the timber groynes, rock was placed in the area. Eight rock snub groynes proposed to be constructed between the timber groynes and the Ewen Bridge.
Construction Materials:	Left Bank - 1,000 tonnes of Grade B rip-rap from Pongaroa in the Wairarapa and as specified in Contract 130. Right Bank - Eight timber poles and 3,200 tonnes of rock as above.
Cash Flow:	1989/1990 $240,000 (to 31/3/90)
Comments:	Much of the rock placed will be reused once a permanent solution to bank protection has been implemented.

PROJECT REPORT 47

TREE REMOVAL AND STOPBANK REINSTATEMENT AT EWEN PARK/MELLING RESERVE

Date:	1989
Plan Number:	HR2272 Plan held in Rivers cabinets
File:	N/3/10/2
Location:	Refer Appendix A, figure 4 Current River Traverse - river C/L Left Bank 4,492 m to 4,585 m
Reason For Initiation:	To remove the silver poplars growing on a steep riverside edge of the left stopbank in the Ewen Park area (upstream of Melling Bridge) The poplar stands were preventing maintenance and posing a risk to stopbank stability.
Design Capacity:	N/A
Designer:	Wellington Regional Council
Constructed By:	Wellington Regional Council, with hired plant
Supervised By:	Wellington Regional Council
Construction:	After removal of the silver poplars the stopbank was reinstated by benching and placement of imported fill with compaction by roller.
Construction Standards:	All testing of material and construction was carried out by Material Advisory Services. A "New Zealand Heavy" compaction test was carried out on the source material to establish the optimum number of roller passes. Materials Testing and Advisory Services tested compaction at a number of locations and found an average of 98.4 percent of maximum dry density.
Materials Used:	The cleared site was reinstated with quarry overburden from Firths Quarry at Belmont. The existing stopbank material was silty with a substantial amount of construction rubble. This necessitated extensive cut back with 3,294 cubic metres of fill being placed. Material from the site clearing operation was used as topsoil with no additional topsoil required to be imported.
Cash Flow:	$ 29,000
Subsidy:	N/A

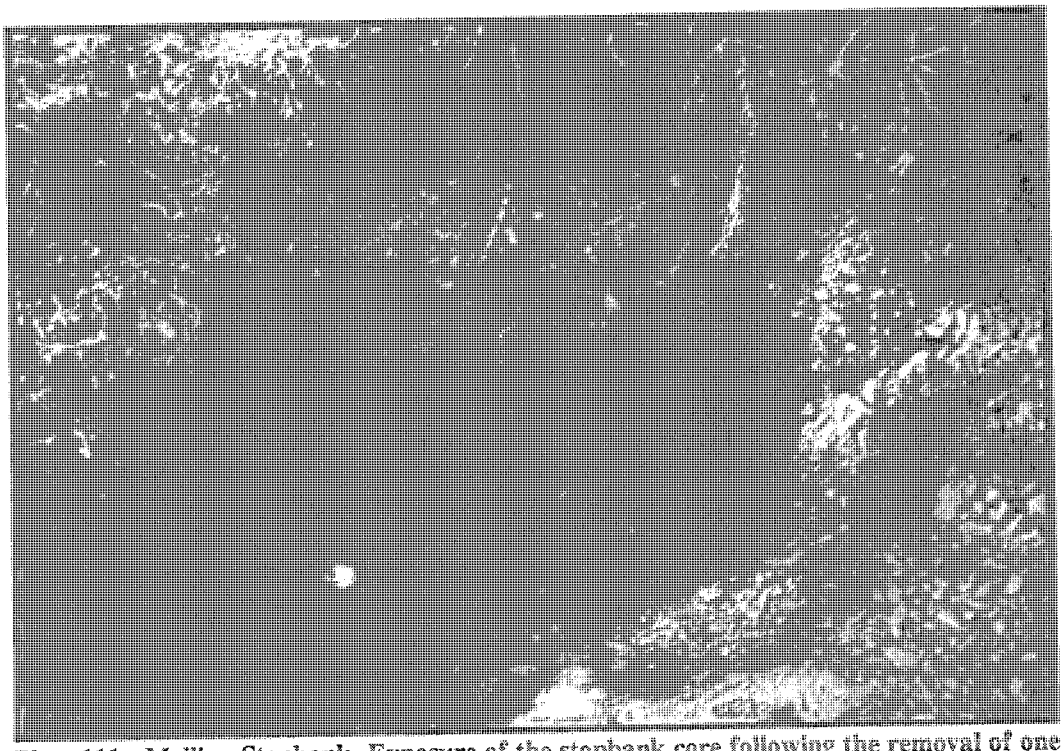


Plate 111: Melling Stopbank. Exposure of the stopbank core following the removal of one willow stump.

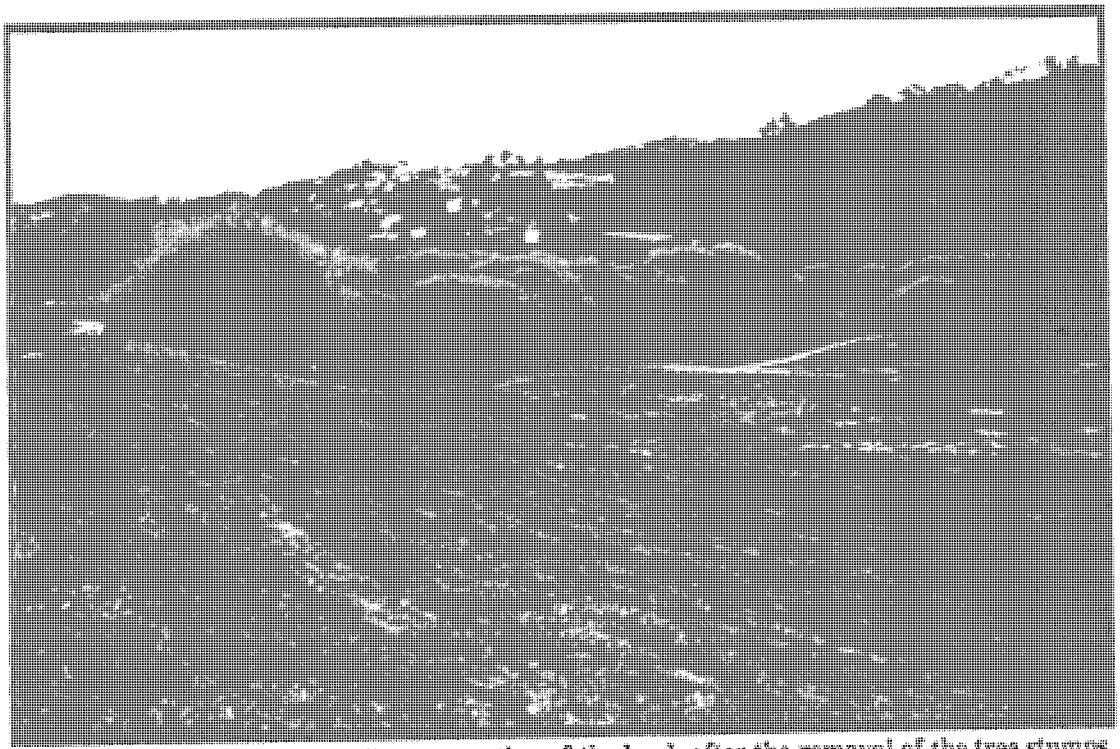


Plate 112: Melling Stopbank. Reconstruction of the bank after the removal of the tree stumps.

PROJECT REPORT 48

CROFT GROVE POINT TO BLACK CREEK OUTLET
BENCH CONSTRUCTION AND RIP-RAP PLACEMENT

Date: 1990

Plan Number: HR2274

File: N/3/10/2

Location: Refer Appendix A, figure 2

Current River Traverse - river C/L
Left Bank 1,148 m to 1,334 m

Reason For Initiation: The left (east) stopbank from Estuary Bridge to Black Creek outlet is vulnerable to attack since there is little or no berm protecting the stopbank from flood water.

The flow constriction at the Woollen Mills point (Cross Section No. 0130, 1,173 m) causes substantial increases in flow velocity. Scour depths adjacent to the stopbank near this point are up to 6 m below mean tide level.

Prior to this work the situation was exacerbated by a steep batter which was in a bad state of repair and could not be maintained.

Design Capacity: Top of bench and rip-rap at 2-5 year flood level

Designer: Wellington Regional Council

Constructed By: Wellington Regional Council, with hired plant

Supervised By: Wellington Regional Council

Construction: Rip-rap and concrete blocks were placed around the point in 1984 - refer Project Report 37 - but the river had since scoured under the concrete blocks creating an unstable overhang. The limestone rip-rap used was also not considered sufficiently durable to remain.

The section from Estuary Bridge to the downstream side of the point at 1,173 m was benched and rip-rapped early 1988. This project completed the reach to the Black Creek outlet with secure, durable rip-rap and reinstated and repaired the stopbank to facilitate proper maintenance, and provided a bench to further protect the stopbank toe in the reach upstream of the point.

Construction Materials: Grade A and B rock as specified in Contract 130 (Supply of Rock Rip-rap). Rip-rap grades to Wellington Regional Council standard rip-rap specification. Rip-rap placed in three distinct zones of grade A, B and mixture of A and B rock. Rip-rap used : Grade A - 1200 tonne, Grade B - 2300 tonne.

Rip-rap was placed on rock fill (1,400 cu. m) imported from Winstone's Quarry. Overburden (600 cu. m) was trucked in and used in reinstating the stopbank.
TENSAR reinforcing mesh was used over a 60 m length of the stopbank

to protect the lower 2.25 m of the stopbank toe giving protection up to R.L 2.6 m which is above the "100 year flood" at this location.

Cash Flow:	1989/90	$223,000 (to 31/3/90)
Subsidy:	N/A	
Comments:	Also refer to Project Report Nos 37, 44	

PROJECT REPORT 49

TWIN BRIDGES DEBRIS FENCES, GILLESPIES ROAD BANK PROTECTION AND AKATARAWA BRIDGE PROTECTION

Date: 1985-1989

Plan Number: Refer to files

File: 8/5, 8/7/2, 8/7/18

Location: Refer Appendix A, figure 9

Current River Traverse - river C/L 26,720 m to 27,100 m

Reason For Initiation: Twin Bridges - An area of established willows was being attacked by moderate flows in the Hutt River. A secondary river channel was forming through the area and posing an erosion threat to a significant riverbank at the rear of residential properties along Bridge Road.

Gillespies Road - In response to a letter from a local resident. Local erosion of esplanade reserve on right bank upstream of bridge over Hutt River at Akatarawa.

Akatarawa Bridge Protection - Local protection works

Design Capacity: N/A

Designer: Wellington Regional Council

Constructed By: Wellington Regional Council

Supervised By: Wellington Regional Council

Construction: Twin Bridges - Construction of four debris fences across the secondary channel along with some layering of large willows. Followed by additional willow plantings with a more vigourous species in the season following construction.

Construction Materials: Twin Bridges - Debris fences constructed of driven railway irons at 3 m centres 4 wire ropes per fence.

Cash Flow:

Twin Bridges:	
1987/1988	$4,000
1988/1989	$3,000
Gillespies Road:	
1985/1986	$1,000
1986/1987	$5,500
Akatarawa Bridge:	
1986/1987	$3,000

Comments: These works were undertaken as part of the River Control, Mabey Road Operations programme of works.

PROJECT REPORT 50

KENNEDY-GOOD BRIDGE PROTECTION WORKS

Date: 1987-1989

Plan Number: No plans

File: 8/5

Location: Refer Appendix A, figure 4

Current River Traverse - river C/L
Left Bank 6,610 m to 7,250 m

Reason For Initiation: The Hutt River channel at this location widens and the bed slope flattens resulting in river metal deposition and misalignment of the channel. To correct this, regular cross blading has been required at an estimated to cost in the order of $100,000 in 4 years.

In October 1986 a fresh in the river caused considerable bank erosion with large bands of willows being attacked over a 200 m reach. Subsequent cross blading received adverse publicity and so a more permanent solution was sought.

Design Capacity: N/A

Designer: Wellington Regional Council

Constructed By: Wellington Regional Council

Supervised By: Wellington Regional Council

Construction: Involved extension of the width of the existing willow band and establishing willows in the river bed. Willow plantings are protected by 20 debris fences (nominally 15 m long, constructed of driven railway irons at 3 m spacings with 4 strands of wire rope).

Cash Flow:

1987/88	$16,000
1988/89	$24,000

Comments: The function of the debris fences is to offer protection to the establishing willows and will not be required once sufficient growth has occurred.

These works were undertaken as part of the Rivers Control, Mabey Road Operations programme of works.

PROJECT REPORT 51

TRENTHAM MEMORIAL PARK - BANK PROTECTION WORK

Date: 1984-87

Plan Number: No specific plan pertaining to this work, but for general design of debris fences refer WRC plans HR3156, HR3158.

File: 8/7/2

Location: Refer Appendix A, figure 7

Current River Traverse - river C/L
Left Bank 17,596 m to 18,583 m

Reason For Initiation: Some bank protection work was done in this reach prior to the commencement of construction for the Upper Hutt Bypass Road in 1985. This was followed by Upper Hutt Bypass River Works in 1986/87.

Design Capacity: N/A

Designer: Wellington Regional Council

Constructed By: Wellington Regional Council

Supervised By: Wellington Regional Council

Construction: Left Bank (17,596 m to 17,920 m) - This reach is the beach adjacent to the outlet of the Trentham Memorial Park outlet drain. Existing fences were re-erected and any gaps filled in. Four new debris fences were erected.

Left Bank (18,260 m to 18,583 m) - This was the first beach on the left bank and downstream of the Moonshine Bridge. Eleven debris fences were erected.

All fences were of a standard design with railway irons at 3 m spacings and four strands of wire rope. Fences were constructed at 45 degrees to the river centre line (facing downstream).

Cash Flow:

1984/1985	$9,000
1985/1986	$ Nil
1986/1987	$ 12,000

Subsidy: Carried out as part of the Hutt River subsidised works, maintenance and repairs.

PROJECT REPORT 52

BELMONT (RIGHT BANK) BANK PROTECTION WORK

Date: 1984-1989

Plan Number: N/A

File: 8/7

Location: Refer Appendix A, figure 5

Current river Traverse - river C/L
Right Bank 6,100 m to 8,430 m

Reason For Initiation: Over this reach of the Hutt River from 600 m downstream to 1500 m upstream of Kennedy-Good Bridge there has been substantial urban development.

Downstream of the residential development in the vicinity of Owen Street (7380 m to 8190 m) there are large areas of berm predominantly used for recreation purposes.

Upstream of Owen street area State Highway 2 is close to the river with little berm as a buffer.

The Hutt River main channel is hard against the riverbanks at a number of locations along the reach. Protection against bank and berm erosion has been done as preventative maintenance.

Design Capacity: N/A

Designer: Wellington Regional Council

Constructed By: Wellington Regional Council

Supervised By: Wellington Regional Council

Construction: Predominantly willow and poplar plantings, with some small areas of fill.

Cash Flow:

1984/1985	$2,000	
1985/1986	$16,000	
1986/1987	$15,000	
1987/1988	$34,000	
1988/1989	$25,000	
1989/1990	$20,000	(to 31/3/90)

PROJECT REPORT 53

MANOR PARK GOLF COURSE - RIVER BERM AND BANK PROTECTION

Date:	1984
Plan Number:	No relevant plans
Files:	8/7, 8/7/1
Location:	Refer Appendix A, figure 6 Current River Traverse - river C/L Right Bank 13,430 m to 13,660 m
Reason For Initiation:	Continuing bank erosion along the river berm was highlighted by a fresh in November 1983 in which approximately 300 m of bank (up to 2 m high) was affected with up to 3 m of lateral erosion. Willow trees were also lost.
Design Capacity:	N/A
Designer:	Wellington Regional Council
Constructed By:	Wellington Regional Council
Supervised By:	Wellington Regional Council
Construction:	Works involved battering of the river bank, construction of debris fences, toe protection and plantings. General riverbank erosion protection involved planting of willows in a band nominally 20 m wide throughout susceptible areas.
Cash Flow:	1984/1985 $14,000

PROJECT REPORT 54

RECORDED ANNUAL EXTRACTION VOLUMES HUTT RIVER 1928-1987

The following pages copy a Wellington Regional Council report identifying the location of the sources of river shingle on the Hutt River for the period 1928-1987. The sites are also marked on the Historical Works location plans, figures 2 to 10, Appendix A using the same notations.

Sources prior to 1928 are referred to in Archive Tables 9 to 11, "Explanation of the Shingle Resource", and in figure 22, "Log of Extraction Activity, Estuary to Belmont, 1900 - 1955".

Refer to the Wellington Regional Council Rivers Department for sources after 1987.

THE WELLINGTON REGIONAL COUNCIL COPY

22 February 1988
File: 8/7/3/4 (ajw:160)
cc 8/7/10
8/28

GRAVEL EXTRACTIONS FROM THE
HUTT RIVER 1928-1987

Gravel Extractions - for each company are shown on the following pages. The positions of the companies have been shown on the Series of the Lower Hutt Valley aerials (1-9) with red half circles - Plan No. 304, 1985. Ref Aerials Filed 8A/68. Firth returns from 1980 specify a point of removal as their licence covers an extensive reach of the river. These have been shown on the same aerial prints with pink 120° segment and numbered as shown on the forms. HR 2256

An aerial photo reference number for each company appears at the bottom of the page.

References used:

Hutt River Board Files	54,155
Wellington Regional Council Files	2/3/2
	8/7/9/2
	8/7/10
	8/28
	86

- Shingle Removal Schedules
  + 1963-1979 summary included in schedule files.

- WRC Chief Engineer's Report 1974-84.

SHINGLE EXTRACTION (IN M^3) 1

COPY

	Butt-Petone Shingle Supplies (Gear Is.)	White's Line Shingle Co. To MES Ltd	Bognuda Adams Blythe Marsden St.	Rivers, Sand Single – total for 4 sites	Draper	Wellington Concrete Pipe Co.	P.W.D. (Site Unknown)	Unaccounted for	Yearly Total
1928/29				12,671				78,122	90,793
1929/30				11,815				84,674	96,489
1930/31				37,570				19,712	57,282
1931/32			5,501	33,988		5,038		19,344	63,871
1932/33			2,116	3,739		2,372		33,611	41,838
1933/34			3,377	8,214		5,474		18,679	35,744
1934/35	1,491		4,198	19,664		7,271		8,579	41,203
1935/36	7,413		7,157	25,051		7,745		6,934	54,300
1936/37	7,327		14,338	20,864		10,008		7,014	59,551
1937/38	5,094	535	13,751	20,395		20,811		26,930	87,516
1938/39	11,575	6,307	14,484	28,215		25,214		12,350	98,145
1939/40	8,406	18,173	17,790	31,171		30,202		15,007	120,749
1940/41	5,655	11,692	11,874	22,318		14,221		12,885	78,645
1941/42	5,446	8,701	14,426	28,073		11,919		12,553	81,118
1942/43	7,158		25,155	33,621	5,848	18,423		9,123	99,328
1943/44	6,148		20,523	45,961	3,463	22,470	43,388	13,473	155,426
1944/45	9,522		29,127	29,841	3,463	14,978	32,409	17,378	136,718
Aerial Photo Reference	(1)	(2)	(3)	(5)	(7)	(8)			

SHINGLE EXTRACTION (IN M^3) 2

COPY

	MRS Ltd	Bognuda Marsden Street	RSS Mills Road	River Sand & Shingle Melling	River Sand & Shingle Belmont	Sand Supplies	Central Sand & Shingle	Bognuda Mabey Road	Hutt Petone Taita	V A Draper & Co.	RSS Hutt	Wgtn Concrete Pipe	Roads Metal	PWD	Wheka-tiki	Misc	Yearly Total
1945/46	639	12362	528	3538	22977		2883	15691	17160		3537	10757		2006		10185	102263
1946/47	2625	7078	6232	2479	16774		16700	9580	6689	4218	5798	4622				8967	91763
1947/48	1499	6844	6122	666	15153		16598	12727	4762	6944	7735	8850		1953		1595	91448
1948/49	2251	7773	5263		19589		13867	11209	3523	2128	8040	12320				12028	97991
1949/50	2314	7854	7821	89	17802		16288	11106	4155	6471	5217	11512				6602	97231
1950/51	1962	7527	7389	5832	16192		17666	12278	4077	6418		17582				2205	99128
1951/52	1924	9472	7749	4344	19246		29636	15521	3312	9490	3587	19841				2051	126173
1952/53	)																130693
1953/54	)																
1954/55	)																178157
1955/56	)- YEARLY TOTALS ONLY																168157
1956/57	)																185945
1957/58	)																189677
1958/59	)																
1959/60	2021		14253	12933	52642	26649	28250	13150	18079	2021		16066	4314	2366	11444	632	204820
1960/61	945		19488	9372	58982	29277	24535	15695	25698	677		20739	3574	1323	13715	119	224139
1961/62			20628	13468	75283	21341	25077	12050	32246			25384	1514		12679	731	240401
1962/63			12083	8516	86413	24920	30546	11533	36629	5795		19519	1179		15232	421	252786
Aerial Photo Ref.	(2)	(3)	(4)	(5)	(5)	(6)	(6)	(6)	(6)	(7)	(7)	(8)			Upper Valley		

SHINGLE EXTRACTION (IN M^3) 3

	River Shingle & Sand	Sand Supplies	Central Sand & Shingle	Bognuda Adams & Blythe Mabey Road	Butt Petone Shingle Supplies Taita	V A Draper & Co.	Wgtn Concrete Pipe Co.	Road Metals	Downer Silverstream to 1970 then Upper Butt	Whakatiki	Misc.	Yearly Total
	To Firth 1979											
1963/64	128,004	29,093	36,074	8,692	32,936	3,648	27,163	3,182		12,930	1,101	282,803
1964/65	105,574	26,311	37,056	10,720	43,405	3,772	38,145	73	50,938	13,074	272	319,340
1965/66	69,132	19,392	27,809	8,961	49,276	845	41,289	23,827	29,751	15,446	297	286,025
1966/67	28,972	17,210	22,430	9,385	25,745		33,927	24,755	26,704	6,346	297	195,771
	to			v	a syndicate							
1967/68				198,546) North of					47,674		75	246,295
1968/69				160,049) Silverstream					50,734		62	210,845
1969/70				177,321) Bridge					56,198		45	233,564
1970/71				228,292) Heretaunga					50,646		86	279,024
1971/72				193,169) Golf Course					34,353		6,583	234,105
1972/73				190,188) Totara Park				Webb Sand Supplies Mouth	36,215		115	226,518
Aerial Photo Reference	(5)	(6)	(6)	(6)	(6)	(7)	(8)		Upper Valley +9	Upper Valley		

SHINGLE EXTRACTION (IN M^3) 4

	River Shingle & Sand	Sand Supplies	Central Sand & Shingle	Rogunda Adams & Blythe Mabey Road	Butt Petone Shingle Supplies Taita	V A Draper & Co.	Wgtn Concrete Pipe Co.	Road Metals	Downer Silverstream to 1970 then Upper Butt	Whakatiki	Misc.	Yearly Total
1973/74	59,794	8,587	11,705				38,414	67,113	52,377		242	237,232
1974/75	41,922	6,077	9,445				5,675	65,641	57,116			185,876
1975/76	51,219							56,531	44,283			152,033
1976/77	29,143							52,106	32,775			114,024
1977/78	67,207							46,835	31,397			145,439
1978/79	32,497							45,464	32,016			109,977
1979/80	FIRE 31,308							39,473	22,468			93,249
Aerial Photo Reference	(5)	(6)	(6)	(6)	(6)	(7)	(8)		Upper Valley +9	Upper Valley		

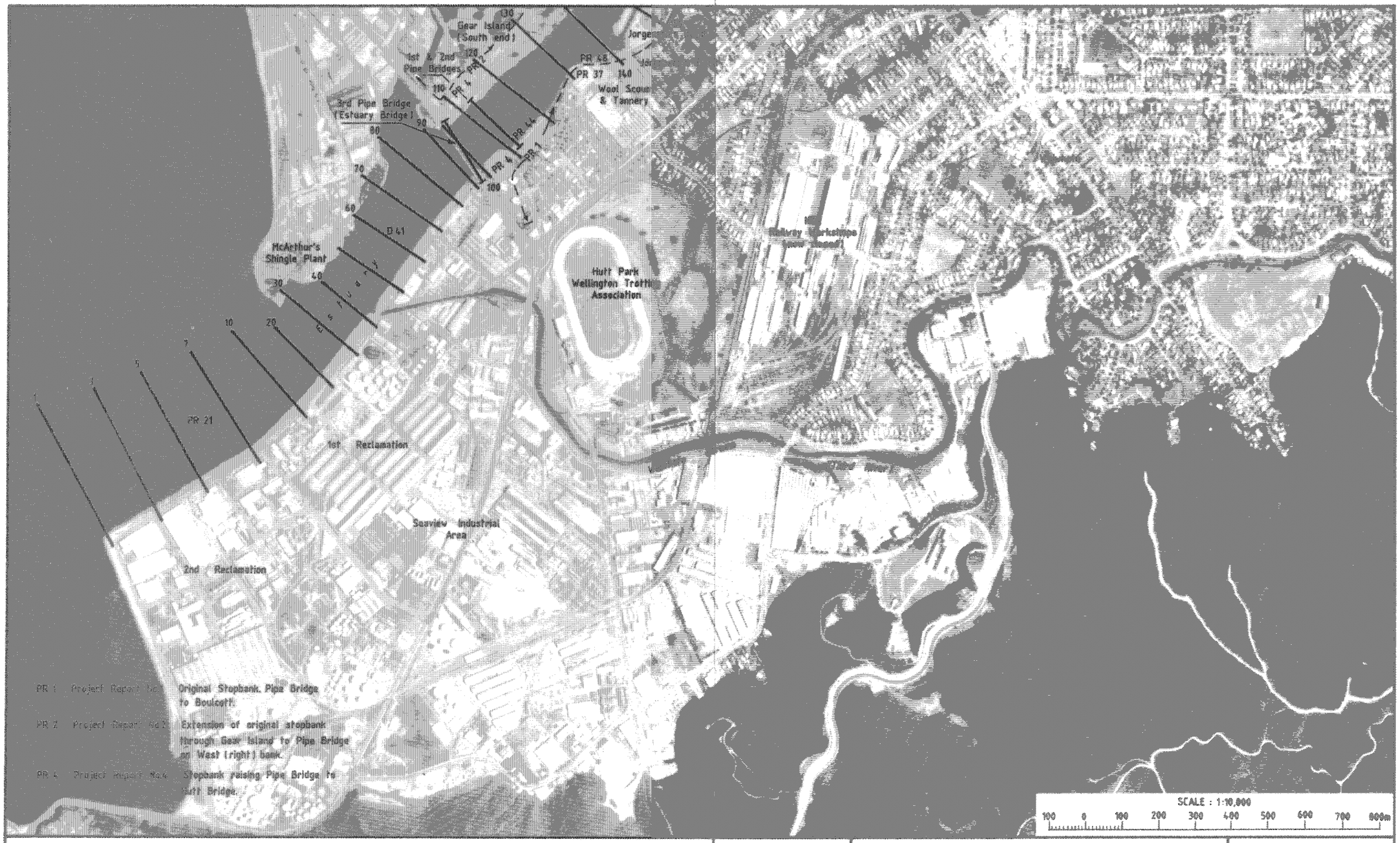
SHINGLE EXTRACTIONS (IN M^3) 5

*Breakdown of Firth Extracts from 'Belmont'

	WEBB	FIRTH* Belmont	DONNER	Yearly Total	Estuary* Bridge	Belmont School	Belmont Beach	Kennedy Good Bridge	Golf Club	Certified Beach	Post Office Beach	Memorial Park	Avalon	Opposite Quarry	Melling	Owen St	Harcourt	Connoly Street	Taita Drive	Mabey Road	Liverton Road	Possare Beach	Welcon Beach	Silver-stream Bridge	Totara Park	Unaccounted For
1980/81	54,295	89,311	31,661	175,267		10,084			20,022	3,260													20,237			35,908
1981/82	58,566	94,941	31,453	184,960	2,697	25,463			10,398	5,819	15,604	15,028	1,614										17,272	1,046		
1982/83	42,228	60,635	42,432	145,295								17,584	18,797		4,695									4,899	14,650	
	FIRTH-MOUTH																									
1983/84	44,269	93,506	37,614	175,389	4,396	5,696					11,445		17,118			9,865		14,287	11,274		725		1,808			21,111
1984/85	38,417	60,538	62,434	161,389			8,495			4,747	5,925		6,239		3,687	7,089					2,386	11,047	746			10,177
1985/86	37,085	36,203	44,943	118,231	6,389			3,831		8,577	1,668				207		5,088		5,270	5,043						
1986/87	34,760	52,225	20,625	108,260		7,879	1,514	2,962		4,346	4,601		3,020	6,902	826		12,420		122				7,298			
Aerial Photo Reference	(1)		Upper Valley		(1) No. 1	(5) No. 4	(5) No. 3	(5) No. 5	(5) No. 2	(4) No. 2	(3) No. 1	(2) No. 1	(5) No. 6	(7) No. 3	(4) No. 1	(6) No.2	(6) No. 3	(5) No. 1	(7) No. 2	(6) No. 1	(7) No. 1	(8) No. 1	(7) No. 4	(9) Upper Valley No. 1		

APPENDIX A

LOCATION OF HISTORICAL WORKS



KEY

230

Line & number indicates the position of current (1985) river cross sections. Refer WRC plans

ALPHANUMERIC CODE

Codes PR 12 indicate the approximate location of works referred to in the archive tables. Refer to archive table index, in table of contents.

PLACE NAMES

Place names are those used by the Hutt River Board to identify reaches of the river as referred to within the archives.

SHEET 1

HUTT CITY

The Estuary

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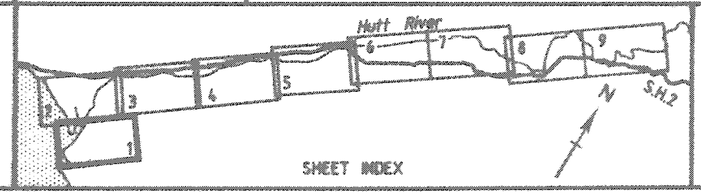
HUTT RIVER FLOOD CONTROL
SCHEME REVIEW 1990
LOCATION OF HISTORICAL WORKS

Figure 2

Appendix A



SHEET INDEX

RECTIFIED PHOTO SHEET
The photobase is a halftone enlargement.
A best mean fit has been obtained from scaling data.
The photographic image is not orthogonal and some displacement of image may occur as a result of differences in ground elevations.

Aerial Photography SN 8457 Flown 28/1/85

KEY

230

Line & number indicates the position of current (1985) river cross sections. Refer WRC plans

ALPHANUMERIC CODE

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PLACE NAMES

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SHEET 2

HUTT CITY

Petone to Lower Hutt Central

WELLINGTON REGIONAL COUNCIL

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HUTT RIVER FLOOD CONTROL

SCHEME REVIEW 1990

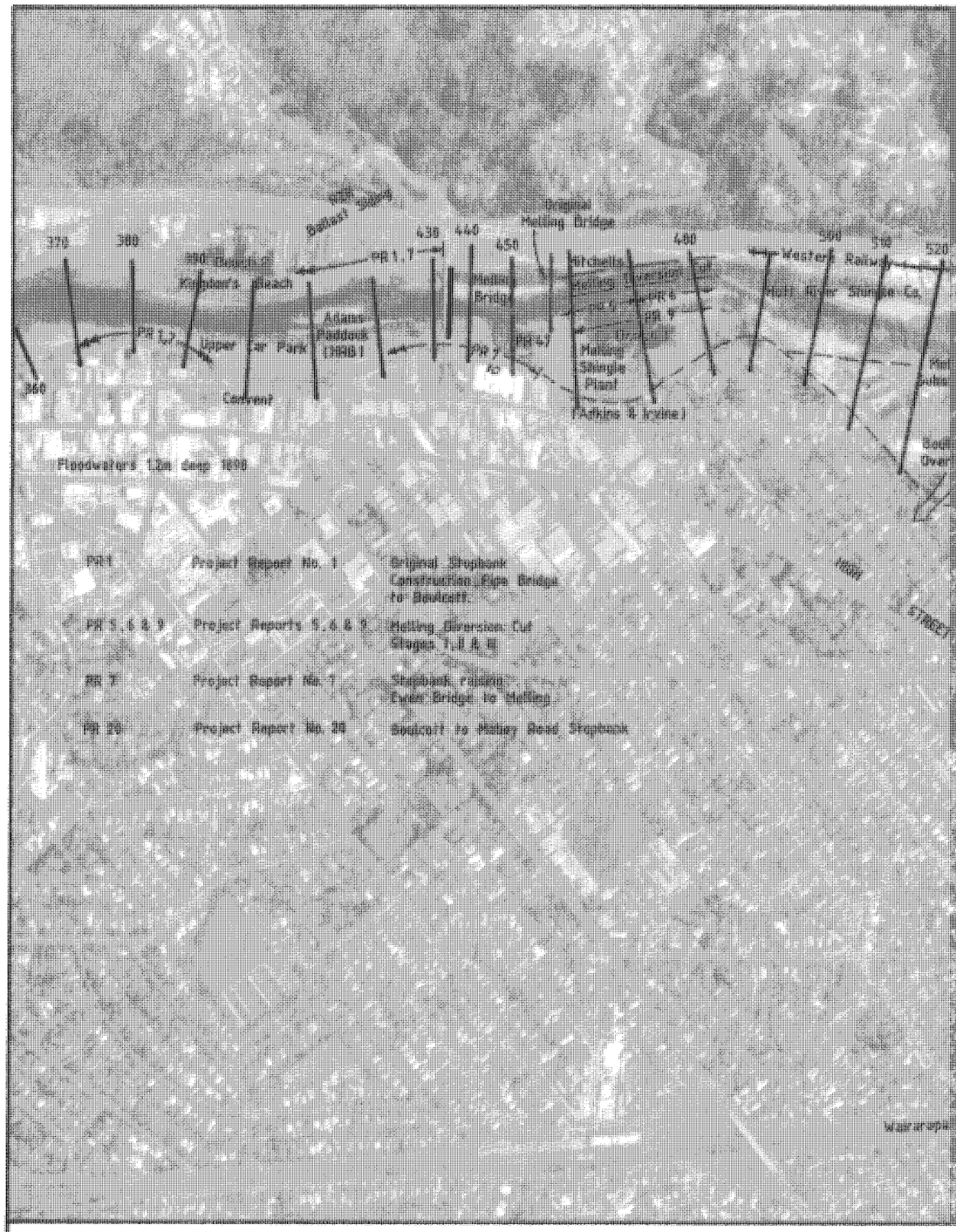
LOCATION OF HISTORICAL WORKS

Figure 3

Appendix A

SHEET INDEX

RECTIFIED PHOTO SHEET
The photobase is a halftone enlargement.
A best mean fit has been obtained from scaling data.
The photographic image is not orthogonal and some displacement of image may occur as a result of differences in ground elevations.
Aerial Photography SN 8457 Flown 28/1/85



KEY

230

Line & number indicates the position of current (1985) river cross sections. Refer WRC plans.

ALPHANUMERIC CODE

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PLACE NAMES

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SHEET 3

HUTT CITY

Melling to Avalon

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HUTT RIVER FLOOD CONTROL
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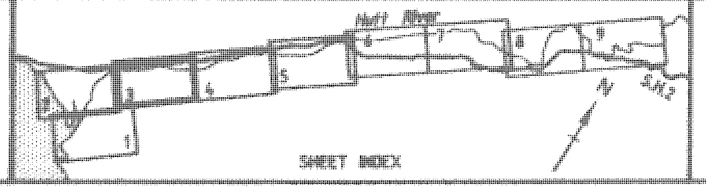
LOCATION OF HISTORICAL WORKS

Figure 4
Appendix A



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The photobase is a halftone enlargement.
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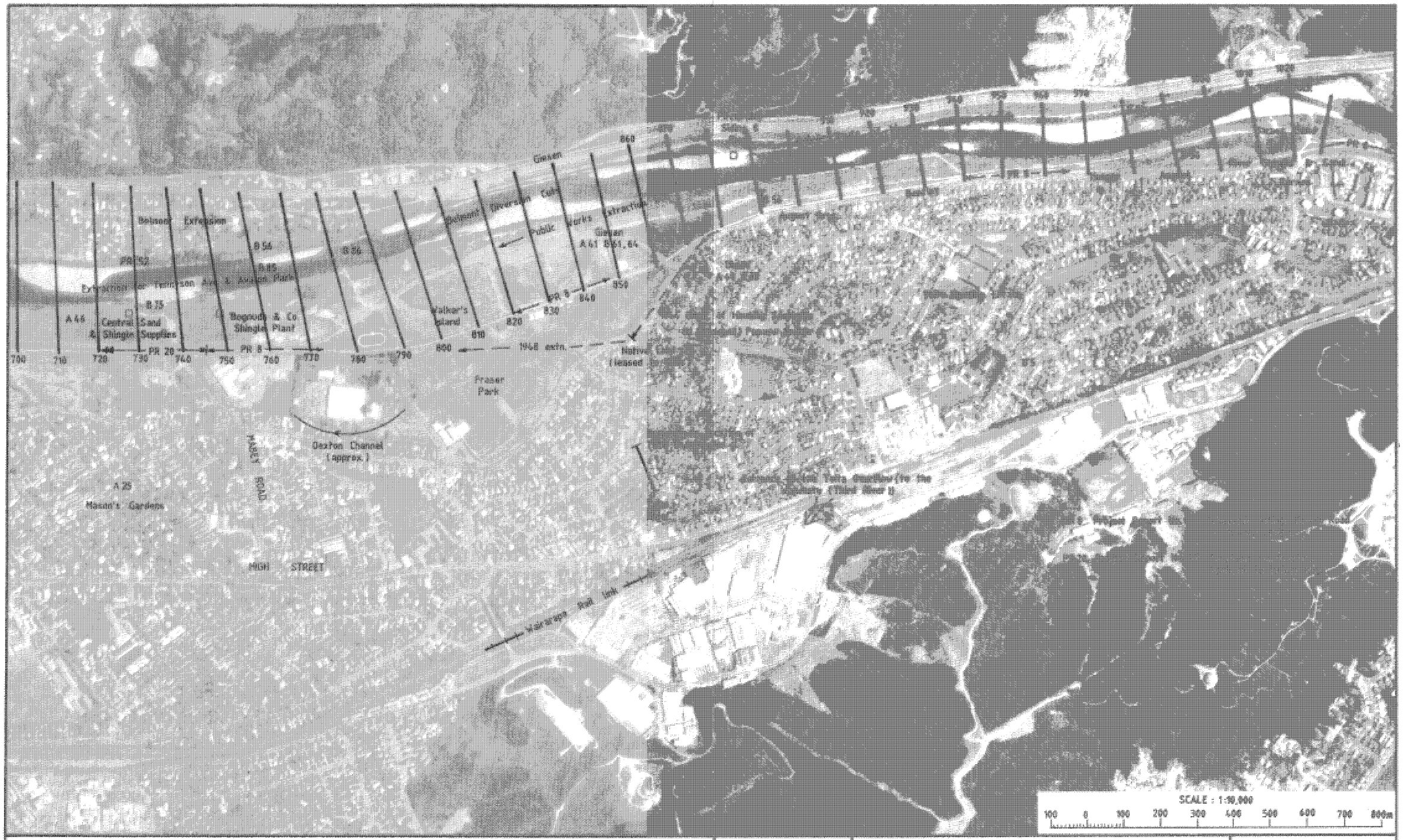
The photographic image is not orthogonal and some displacement of image may occur as a result of differences in ground elevations.
Aerial Photography SN 8457 Flown 28/1/85



KEY

230

Line & number indicates the position of current (1985) river cross sections. Refer WRC plans

ALPHANUMERIC CODE

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PLACE NAMES

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SHEET 4

HUTT CITY

Taita

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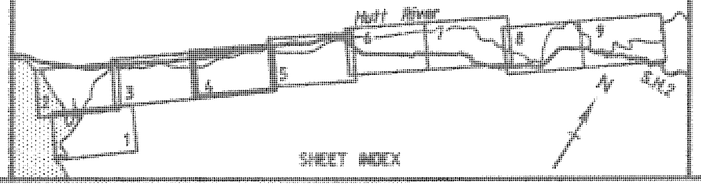
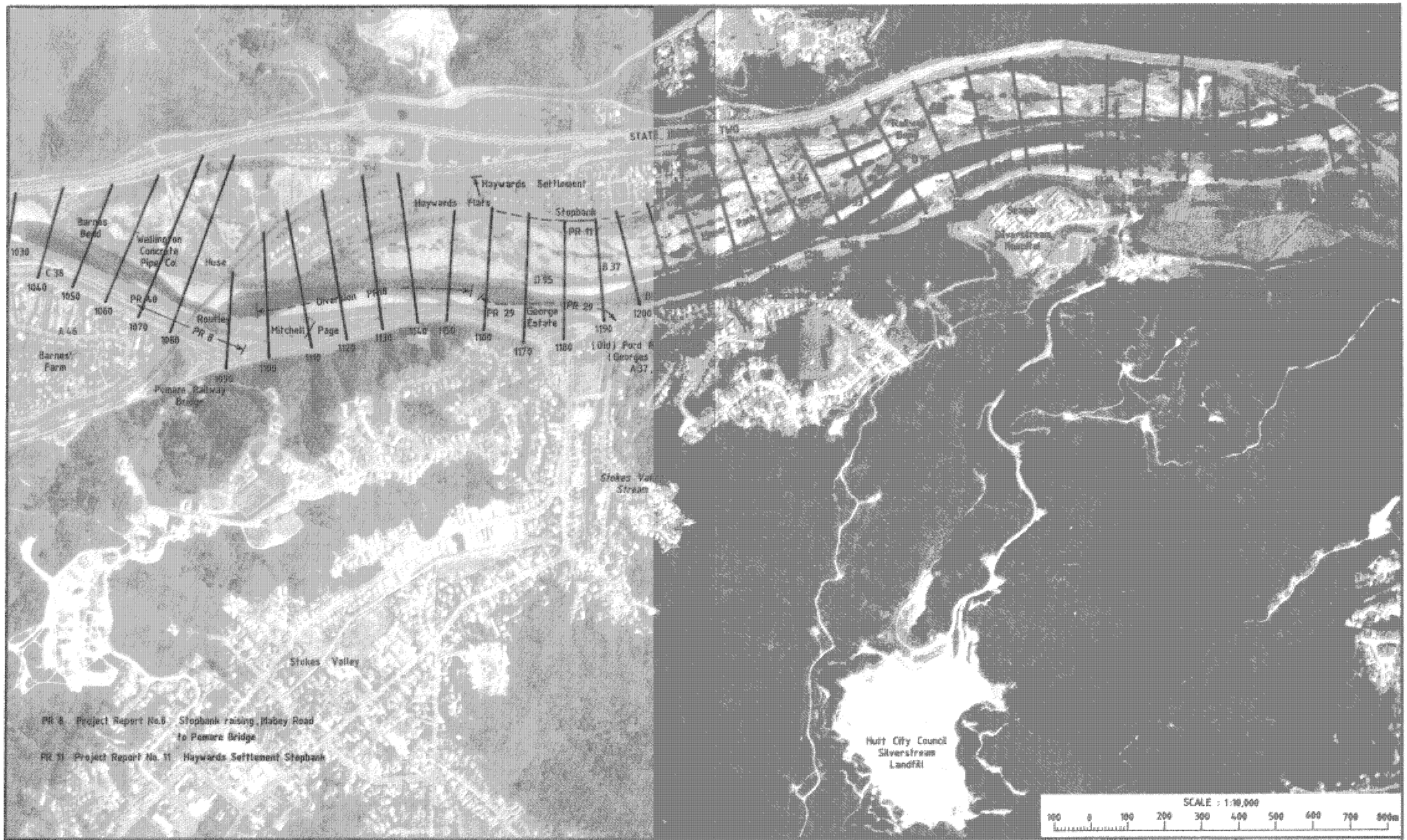
HUTT RIVER FLOOD CONTROL
SCHEME REVIEW 1990
LOCATION OF HISTORICAL WORKS

Figure 5
Appendix A



RECTIFIED PHOTO SHEET
The photobase is a halftone enlargement.
A best mean fit has been obtained from scaling data.
The photographic image is not orthogonal and some displacement of image may occur as a result of differences in ground elevations.

Aerial Photography SN 8457 Flown 28/1/85



KEY

230

Line & number indicates the position of current (1985) river cross sections. Refer WRC plans

ALPHANUMERIC CODE

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PLACE NAMES

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SHEET 5

HUTT CITY

Taita Gorge

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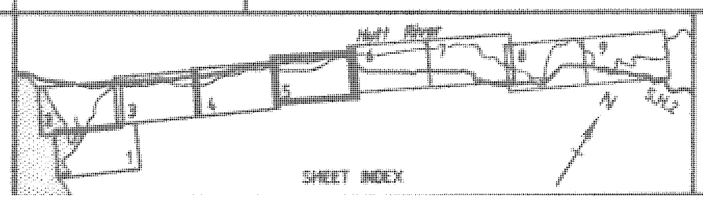
HUTT RIVER FLOOD CONTROL
SCHEME REVIEW 1990
LOCATION OF HISTORICAL WORKS

Figure 6
Appendix A



RECTIFIED PHOTO SHEET
The photobase is a halftone enlargement.
A best mean fit has been obtained from scaling data.
The photographic image is not orthogonal and some displacement of image may occur as a result of differences in ground elevations.
Aerial Photography SN 8457 Flown 28/1/85

KEY

230

Line & number indicates the position of current (1985) river cross sections. Refer WRC plans

ALPHANUMERIC CODE

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PLACE NAMES

Place names are those used by the Hutt River Board to identify reaches of the river as referred to within the archives.

SHEET 6

UPPER HUTT CITY

Silverstream to Barton's Bush

Overlay produced from WREGGIS Database by C Strachan Land Resources Dept.
Photographic base from DOSLI and N.Z. Aerial Mapping.

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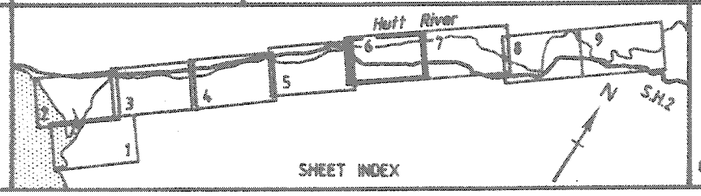
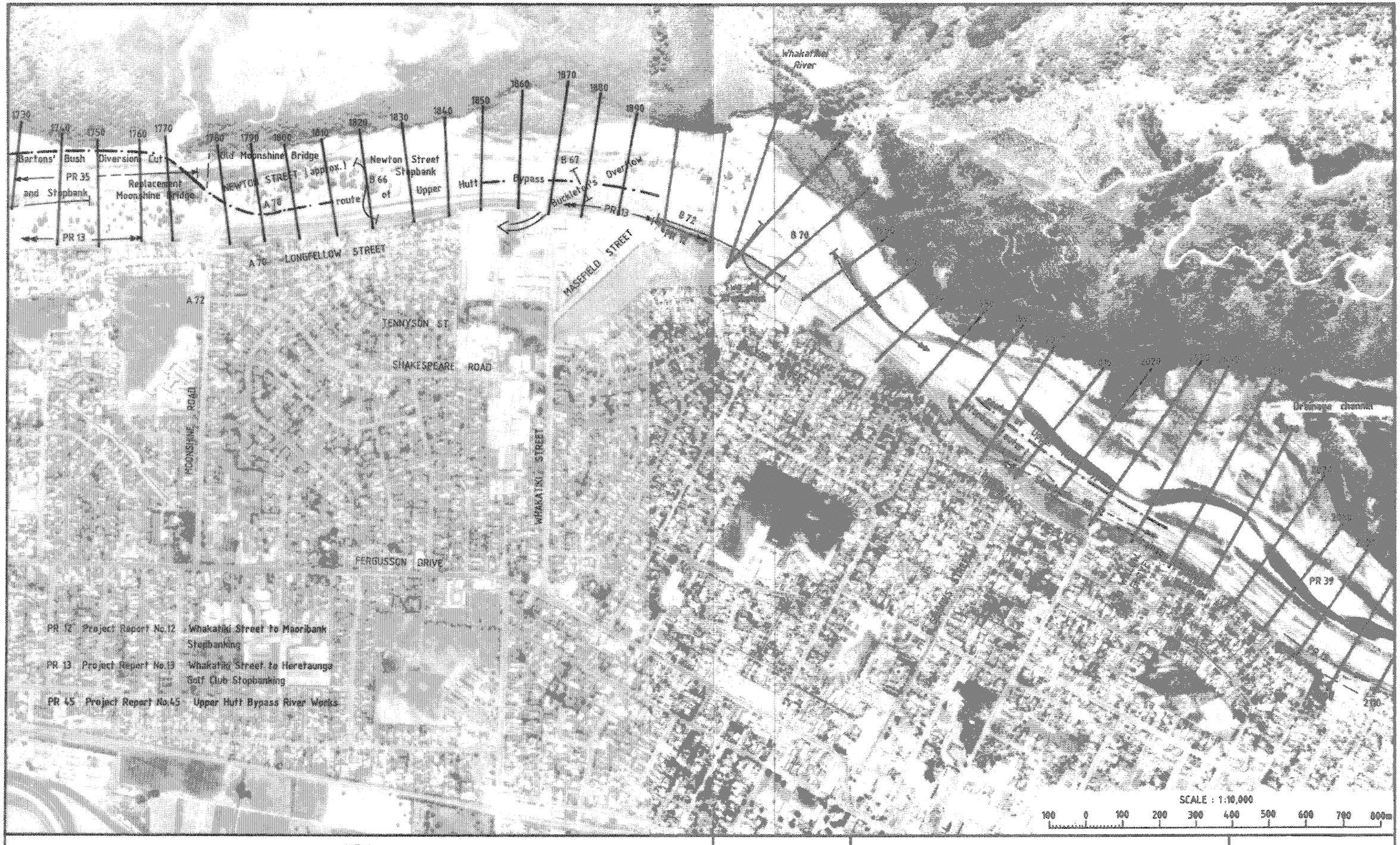
HUTT RIVER FLOOD CONTROL
SCHEME REVIEW 1990
LOCATION OF HISTORICAL WORKS

Figure 7
Appendix A



ORTHOPHOTO SHEET
This orthophotomap is a differentially rectified aerial photo, the photo detail conforms to normal mapping accuracies.

Level Datum; Wellington Datum 1953
New City Datum (M.S.L. 0)
Orthophoto from Aerial Survey No. SN 8909 Flown 16/1/88.



KEY

230

Line & number indicates the position of current (1985) river cross sections. Refer WRC plans

ALPHANUMERIC CODE

Codes PR 12 indicate the approximate location of works referred to in the archive tables. Refer to archive table index, in table of contents.

PLACE NAMES

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SHEET 7

UPPER HUTT CITY

Moonshine to Totara Park

WELLINGTON REGIONAL COUNCIL

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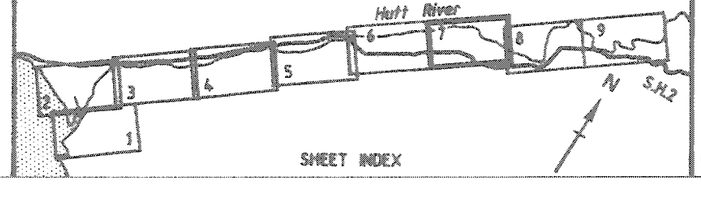
HUTT RIVER FLOOD CONTROL SCHEME REVIEW 1990

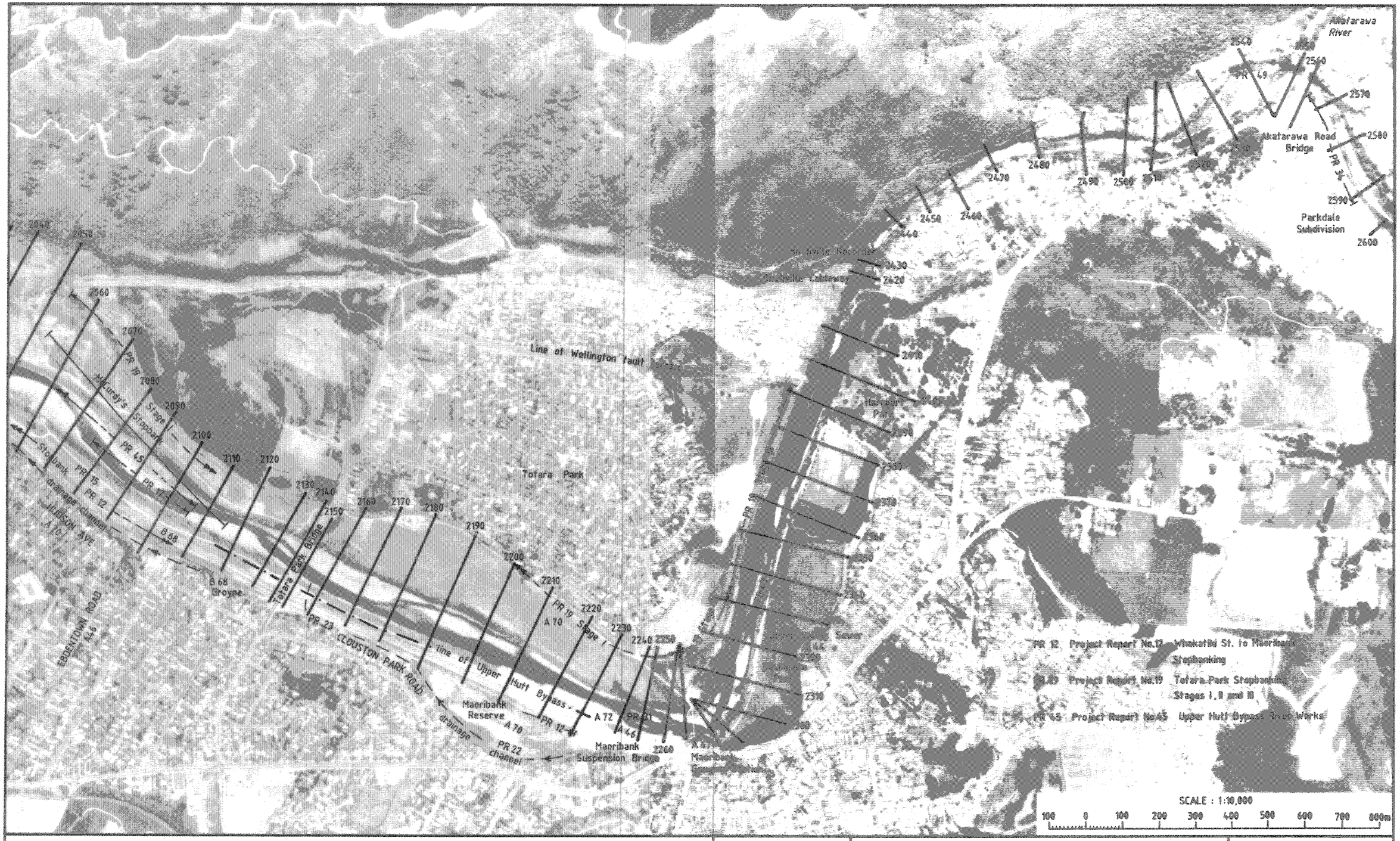
LOCATION OF HISTORICAL WORKS

Figure 8
Appendix A



ORTHOPHOTO SHEET
This orthophotomap is a differentially rectified aerial photo, the photo detail conforms to normal mapping accuracies.

Level Datum : Wellington Datum 1953
New City Datum (M.S.L. 0)
Orthophoto from Aerial Survey No. SN 8909 Flown 16/1/89.



KEY

230

Line & number indicates the position of current (1985) river cross sections. Refer WRC plans

ALPHANUMERIC CODE

Codes PR 12 indicate the approximate location of works referred to in the archive tables. Refer to archive table index, in table of contents.

PLACE NAMES

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SHEET 8

UPPER HUTT CITY

Maoribank

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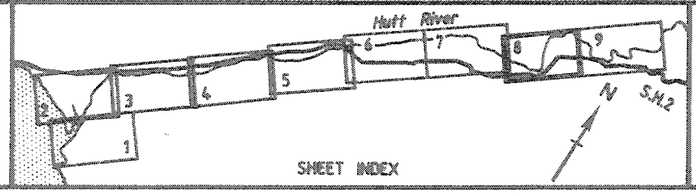
HUTT RIVER FLOOD CONTROL
SCHEME REVIEW 1990
LOCATION OF HISTORICAL WORKS

Figure 9
Appendix A



ORTHOPHOTO SHEET
This orthophotomap is a differentially rectified aerial photo, the photo detail conforms to normal mapping accuracies.

Level Datum: Wellington Datum 1953
New City Datum (M.S.L. 0)
Orthophoto from Aerial Survey No. SN 8909 Flown 16/1/88.

KEY

230

Line & number indicates the position of current (1985) river cross sections. Refer WRC plans

ALPHANUMERIC CODE

Codes PR 12 indicate the approximate location of works referred to in the archive tables. Refer to archive table index, in table of contents.

PLACE NAMES

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SHEET 9

UPPER HUTT CITY

Parkdale to Te Marua

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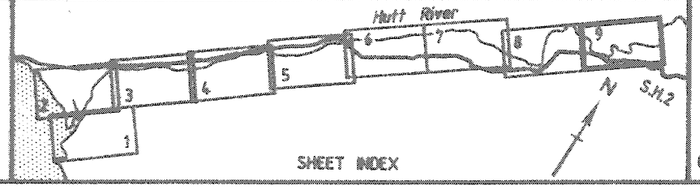
HUTT RIVER FLOOD CONTROL
SCHEME REVIEW 1990
LOCATION OF HISTORICAL WORKS

Figure 10
Appendix A

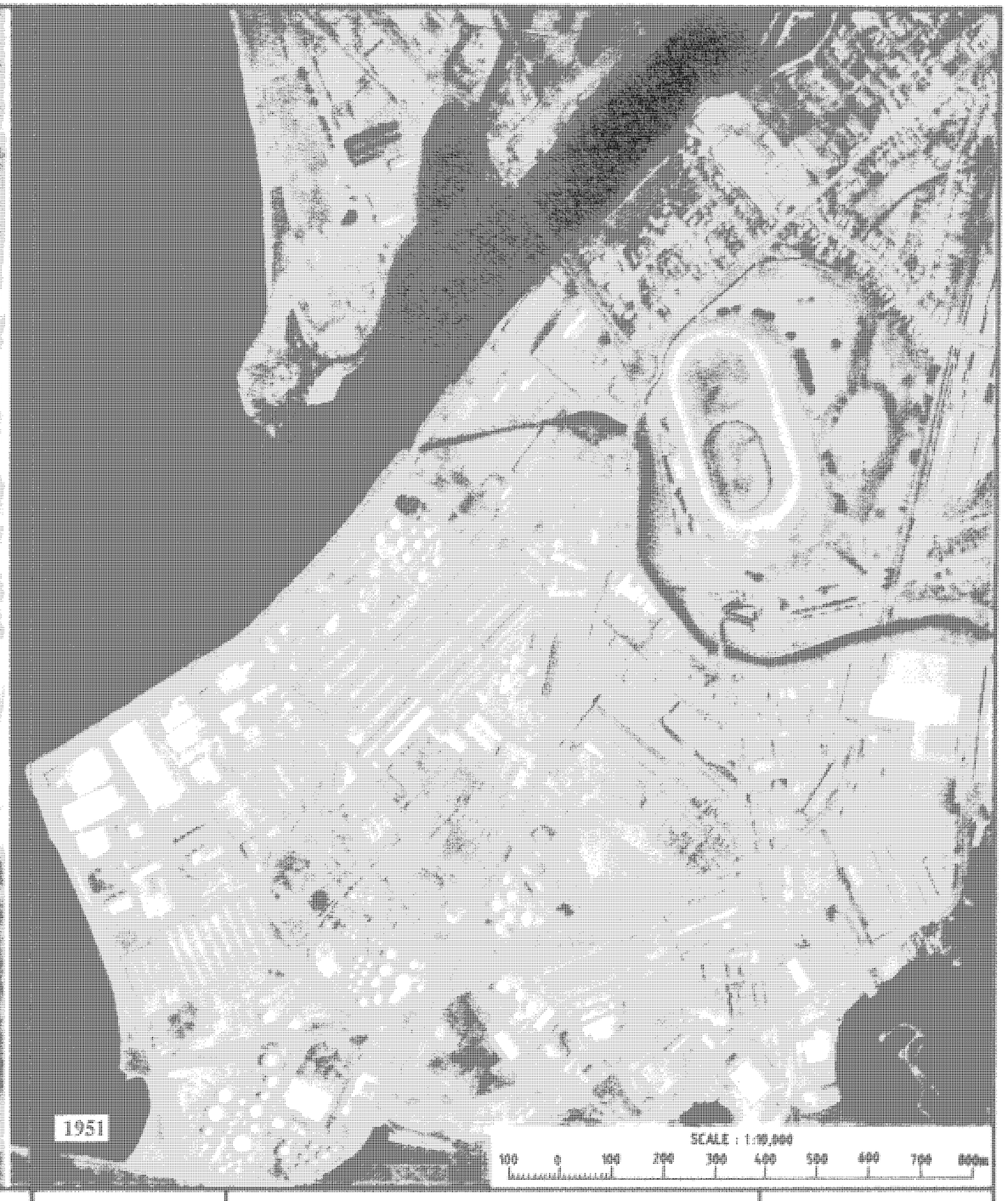


ORTHOPHOTO SHEET
This orthophotomap is a differentially rectified aerial photo, the photo detail conforms to normal mapping accuracies.

Level Datum : Wellington Datum 1953
New City Datum (M.S.L. 0)
Orthophoto from Aerial Survey No. SN 8909 Flown 16/1/88.

APPENDIX B

HISTORICAL RIVER ALIGNMENTS



ALIGNMENT I 1936

taken from a non rectified mosaic of Aerial contact prints.
N.Z. Army 1936

ALIGNMENT II 1951

taken from a rectified mosaic of Aerial contact prints.
N.Z. Aerial Mapping Ltd.
Hastings N.Z. 1951

KEY

Shingle banks

River channel

SHEET 1

HUTT CITY

The Estuary

River alignment data from historical maps and photos held by Rivers Department.
Photographic base from DOSLI and N.Z. Aerial Mapping.
River alignment overlays produced by Land Resources Department using WREGIS.
Map data copyright WRC 1979.

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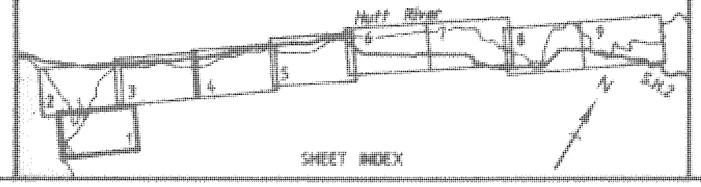
HUTT RIVER FLOOD CONTROL
SCHEME REVIEW 1990
HISTORICAL RIVER ALIGNMENTS

Appendix B



RECTIFIED PHOTO SHEET
The photobase is a halftone enlargement.
A best mean fit has been obtained from scaling data.
The photographic image is not orthogonal and some displacement of image may occur as a result of differences in ground elevations.

Aerial Photography SN 8457 Flown 28/1/85

ALIGNMENT I 1967
taken from Aerial contact prints
Aerial Surveys Ltd.
Nelson N.Z. 1967

ALIGNMENT II 1974
taken from Aerial contact prints
N.Z. Aerial Mapping Ltd.
Hastings N.Z. 1974

KEY
Shingle banks
River channel

SHEET 1
HUTT CITY
The Estuary

River alignment data from historical maps and photos held by Rivers Department.
Photographic base from DOSLI and N.Z. Aerial Mapping.
River alignment overlays produced by Land Resources Department using WINSTAMS.
Map data copyright WRC 1990.

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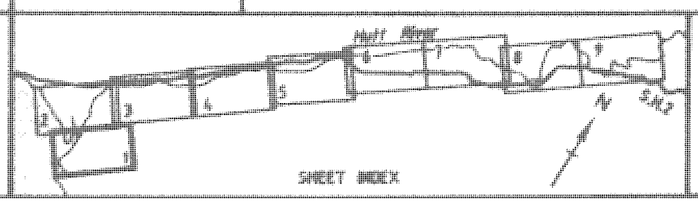
HUTT RIVER FLOOD CONTROL
SCHEME REVIEW 1990
HISTORICAL RIVER ALIGNMENTS

Appendix B



RECTIFIED PHOTO SHEET
The photobase is a halftone enlargement.
A best mean fit has been obtained from scaling data.
The photographic image is not orthogonal
and some displacement of image may occur
as a result of differences in ground elevations.
Aerial Photography SN 8457 Flown 25/1/88

1936

1951

SCALE : 1:10,000

100 0 100 200 300 400 500 600 700 800m

ALIGNMENT I 1936

taken from a non rectified mosaic of Aerial contact prints.
N.Z. Army 1936

ALIGNMENT II 1951

taken from a rectified mosaic of Aerial contact prints.
N.Z. Aerial Mapping Ltd.
Hastings N.Z. 1951

KEY

Shingle banks

River channel

SHEET 2

HUTT CITY

Petone and Lower Hutt Central

River alignment data from historical maps and photos held by Rivers Department.
Photographic base from DOSLI and N.Z. Aerial Mapping.
River alignment overlays produced by Land Resources Department using WINCIGIS.
Map data copyright WRC 1990.

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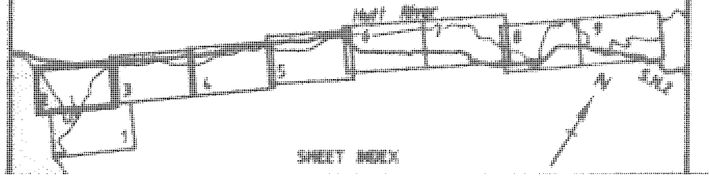
HUTT RIVER FLOOD CONTROL

SCHEME REVIEW 1990

HISTORICAL RIVER ALIGNMENTS

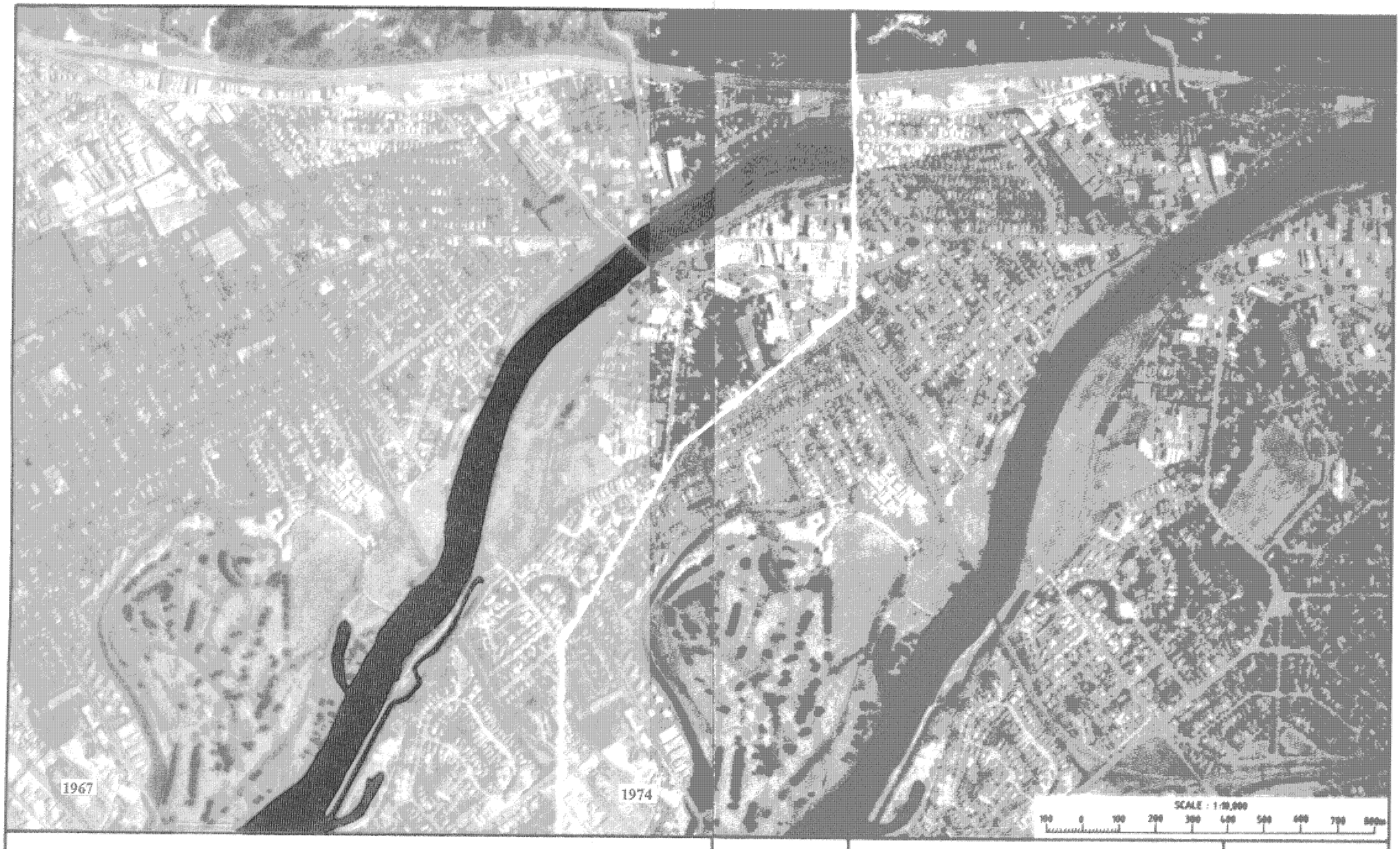
Appendix B



RECTIFIED PHOTO SHEET

The photobase is a halftone enlargement.
A best guess fit has been obtained from scaling data.
The photographic image is not orthogonal and some displacement of image may occur as a result of differences in ground elevations.

Aerial Photography SN 8457 Flown 28/1/85



SCALE : 1:10,000

100 0 100 200 300 400 500 600 700 800m

ALIGNMENT I 1967
taken from Aerial contact prints
Aerial Surveys Ltd.
Nelson N.Z. 1967

ALIGNMENT II 1974
taken from Aerial contact prints
N.Z. Aerial Mapping Ltd.
Hastings N.Z. 1974

KEY
- Shingle banks
- River channel

SHEET 2
HUTT CITY
Petone and Lower Hutt Central

River alignment data from historical maps and photos held by Rivers Department.
Photographic base from DOSLI and N.Z. Aerial Mapping.
River alignment overlays produced by Land Resources Department using WAVEDATA.
Map data copyright WRC 1990.

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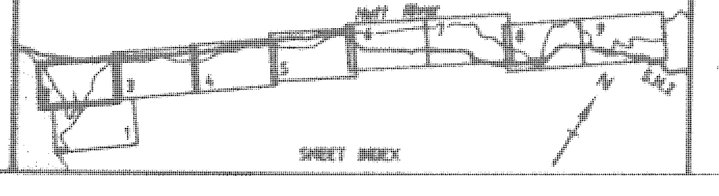
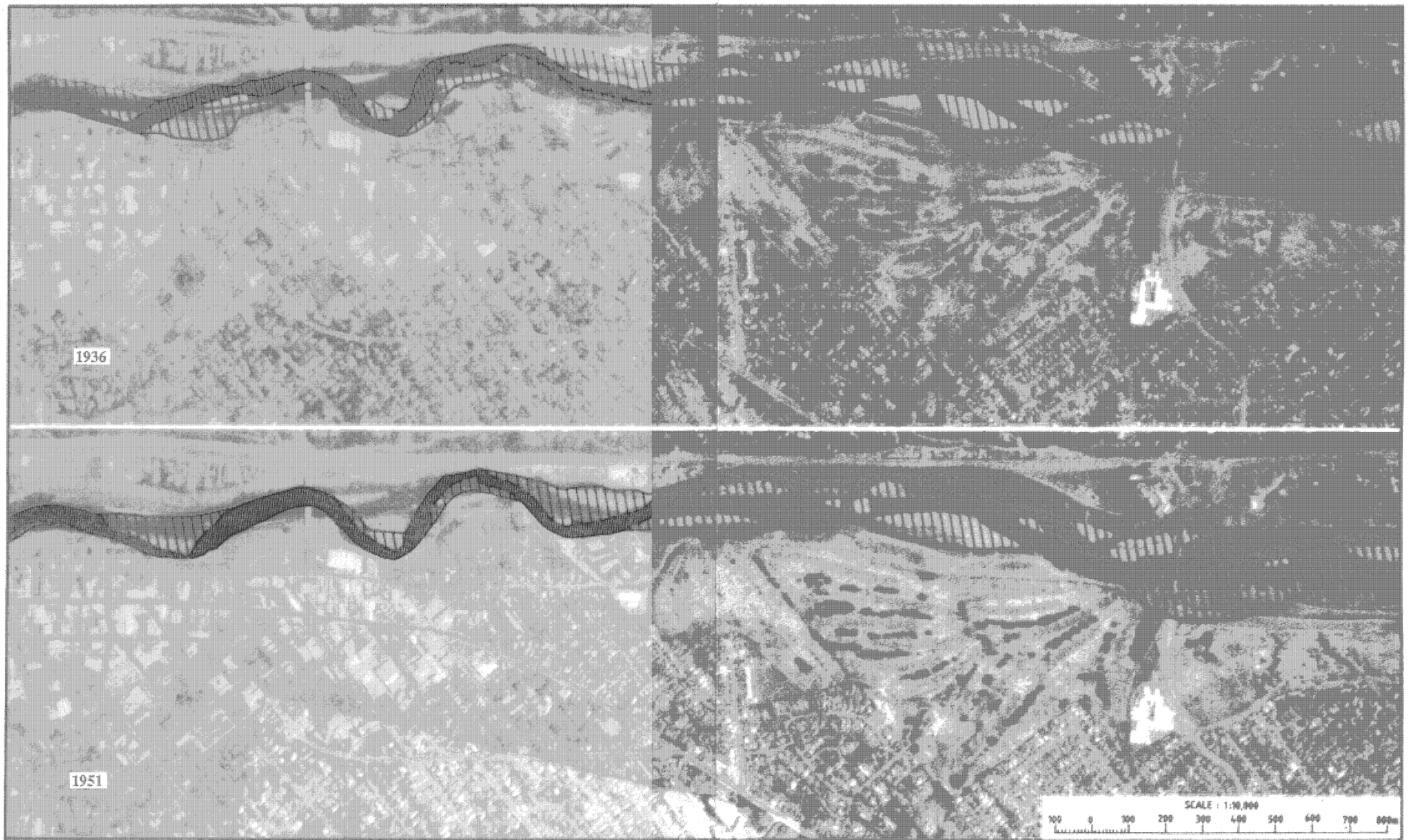
HUTT RIVER FLOOD CONTROL
SCHEME REVIEW 1990
HISTORICAL RIVER ALIGNMENTS

Appendix B



RECTIFIED PHOTO SHEET
The photobase is a halftone enlargement.
A best mean fit has been obtained from scaling data.
The photographic image is not orthogonal
and some displacement of image may occur
as a result of differences in ground elevations.

Aerial Photography SN 8457 Flown 30/1/85



ALIGNMENT I 1936

Taken from a non rectified mosaic of Aerial contact prints. N.Z. Army 1936

ALIGNMENT II 1951

Taken from a rectified mosaic of Aerial contact prints. N.Z. Aerial Mapping Ltd. Hastings N.Z. 1951

KEY

Shingle banks

River channel

SHEET 3

HUTT CITY

Melling to Avalon

River alignment data from historical maps and photos held by Rivers Department. Photographic base from DOSLI and N.Z. Aerial Mapping. River alignment overlays produced by Land Resources Department using WRENSIS. Map data copyright WRC 1999.

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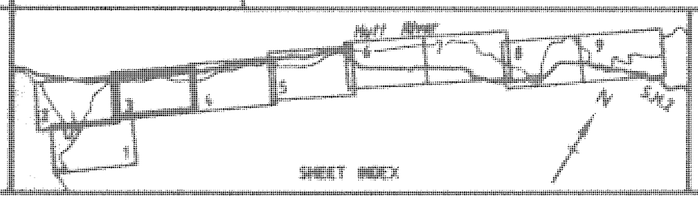
HUTT RIVER FLOOD CONTROL

SCHEME REVIEW 1990

HISTORICAL RIVER ALIGNMENTS

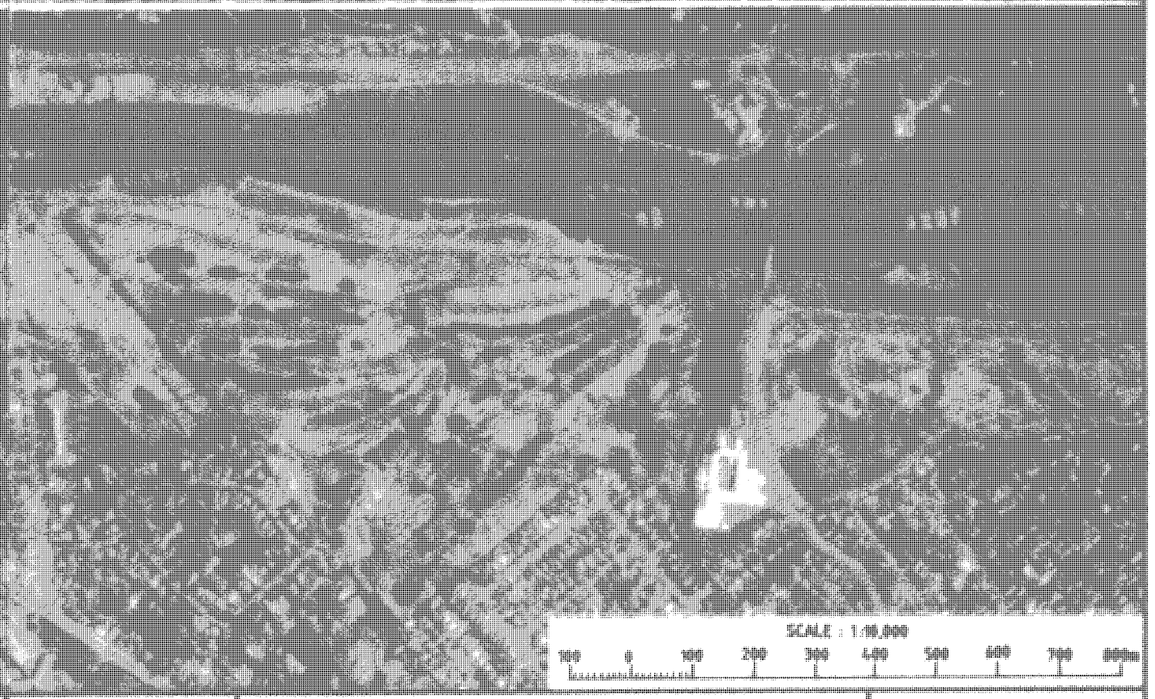
Appendix B



RECTIFIED PHOTO SHEET

The photobase is a halftone enlargement. A best guess fit has been obtained from scaling data. The photographic image is not orthogonal and some displacement of image may occur as a result of differences in ground elevations.

Aerial Photography SN 8457 Flown 28/1/65



ALIGNMENT I 1967
taken from Aerial contact prints
Aerial Surveys Ltd.
Nelson N.Z. 1967

ALIGNMENT II 1974
taken from Aerial contact prints
N.Z. Aerial Mapping Ltd.
Hastings N.Z. 1974

KEY
Shingle banks
River channel

SHEET 3
HUTT CITY
Melling to Avalon

River alignment data from historical maps and photos held by Rivers Department.
Photographic base from DOSLI and N.Z. Aerial Mapping.
River alignment overlays produced by Land Resources Department using WIRECOGS.
Map data copyright WRC 1990.

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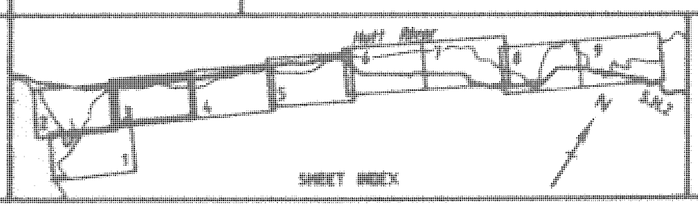
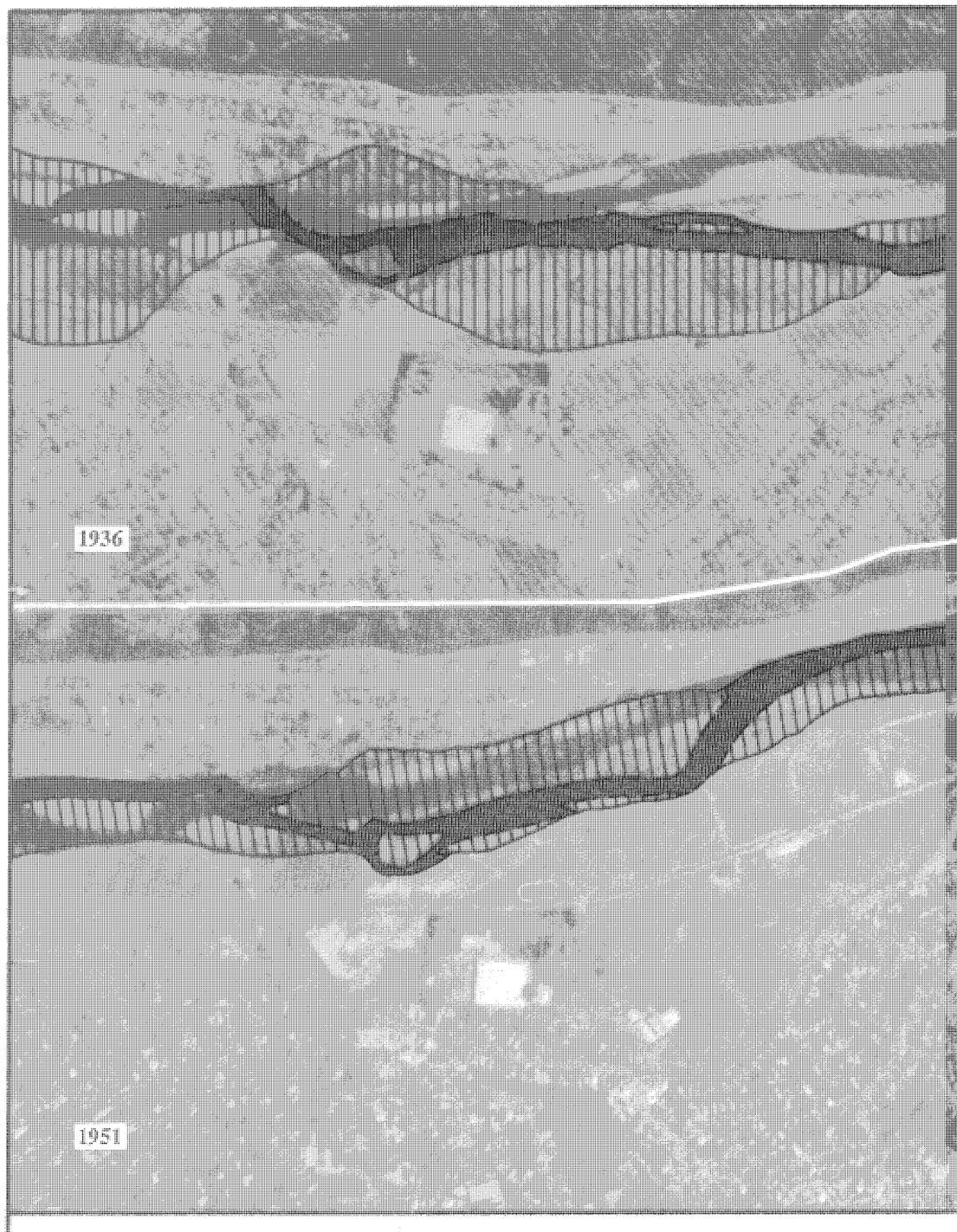
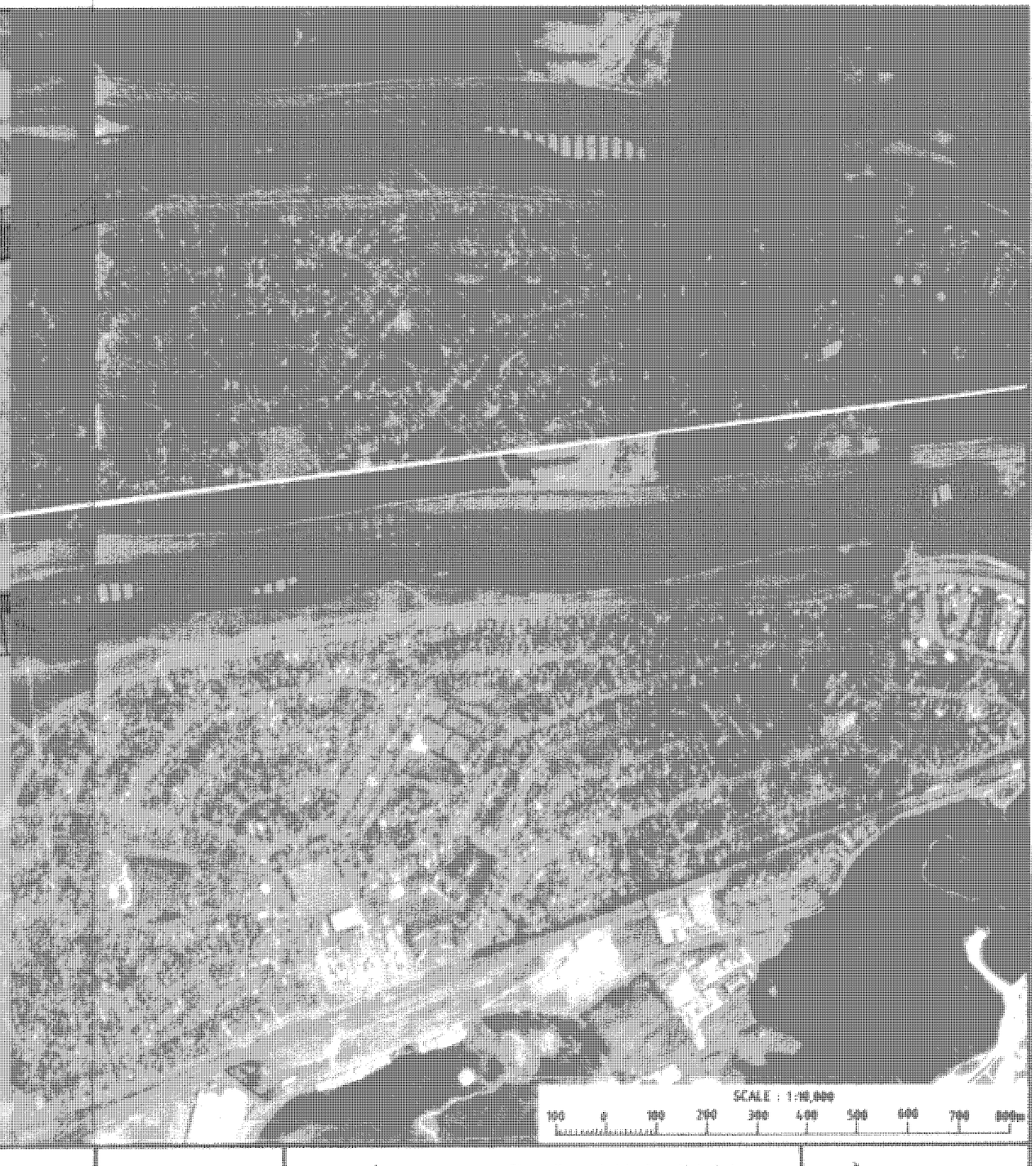
HUTT RIVER FLOOD CONTROL
SCHEME REVIEW 1990
HISTORICAL RIVER ALIGNMENTS

Appendix B



RECTIFIED PHOTO SHEET
The photobase is a halftone enlargement.
A best scale fit has been obtained from scaling data.
The photographic image is not orthogonal and some displacement of image may occur as a result of differences in ground elevations.
Aerial Photography SN 6437 Flown 28/1/65





ALIGNMENT I 1936

taken from a non rectified mosaic of Aerial contact prints.
N.Z. Army 1936

ALIGNMENT II 1951

taken from a rectified mosaic of Aerial contact prints.
N.Z. Aerial Mapping Ltd.
Hastings N.Z. 1951

KEY

Shingle banks

River channel

SHEET 4

HUTT CITY

Taita

River alignment data from historical maps and photos held by Rivers Department.
Photographic base from DOSLI and N.Z. Aerial Mapping.
River alignment overlays produced by Land Resources Department using WRENSGIS.
Map data copyright WRC 1998.

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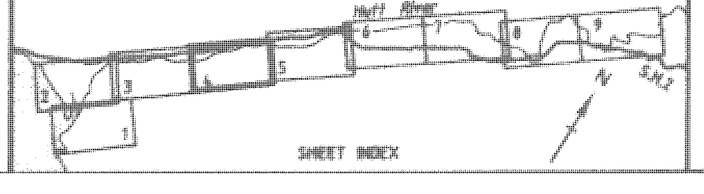
HUTT RIVER FLOOD CONTROL

SCHEME REVIEW 1990

HISTORICAL RIVER ALIGNMENTS

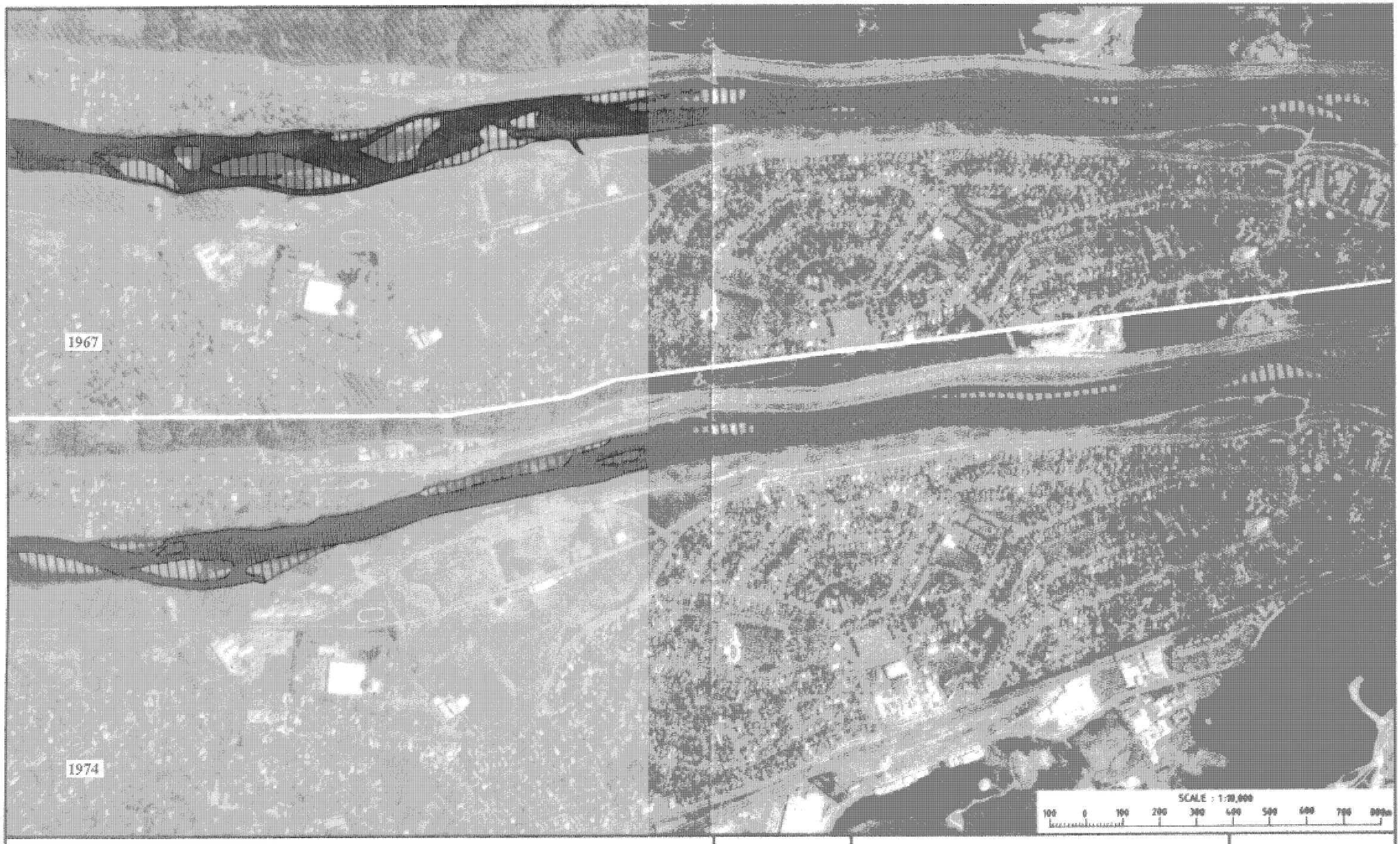
Appendix B



RECTIFIED PHOTO SHEET

The photobase is a halftone enlargement.
A best mean fit has been obtained from scaling data.
The photographic image is not orthogonal and some displacement of image may occur as a result of differences in ground elevations.

Aerial Photography SN 8457 Flown 28/1/65



ALIGNMENT I 1967
taken from Aerial contact prints
Aerial Surveys Ltd.
Nelson N.Z. 1967

ALIGNMENT II 1974
taken from Aerial contact prints
N.Z. Aerial Mapping Ltd.
Hastings N.Z. 1974

KEY
Shingle banks
River channel

SHEET 4
HUTT CITY
Taita

River alignment data from historical maps and photos held by Rivers Department.
Photographic base from DOSLI and N.Z. Aerial Mapping.
River alignment overlays produced by Land Resources Department using WRESBAS.
Map data copyright WRC 1990.

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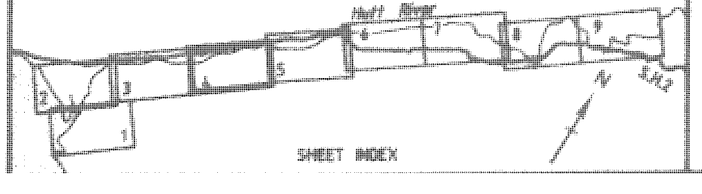
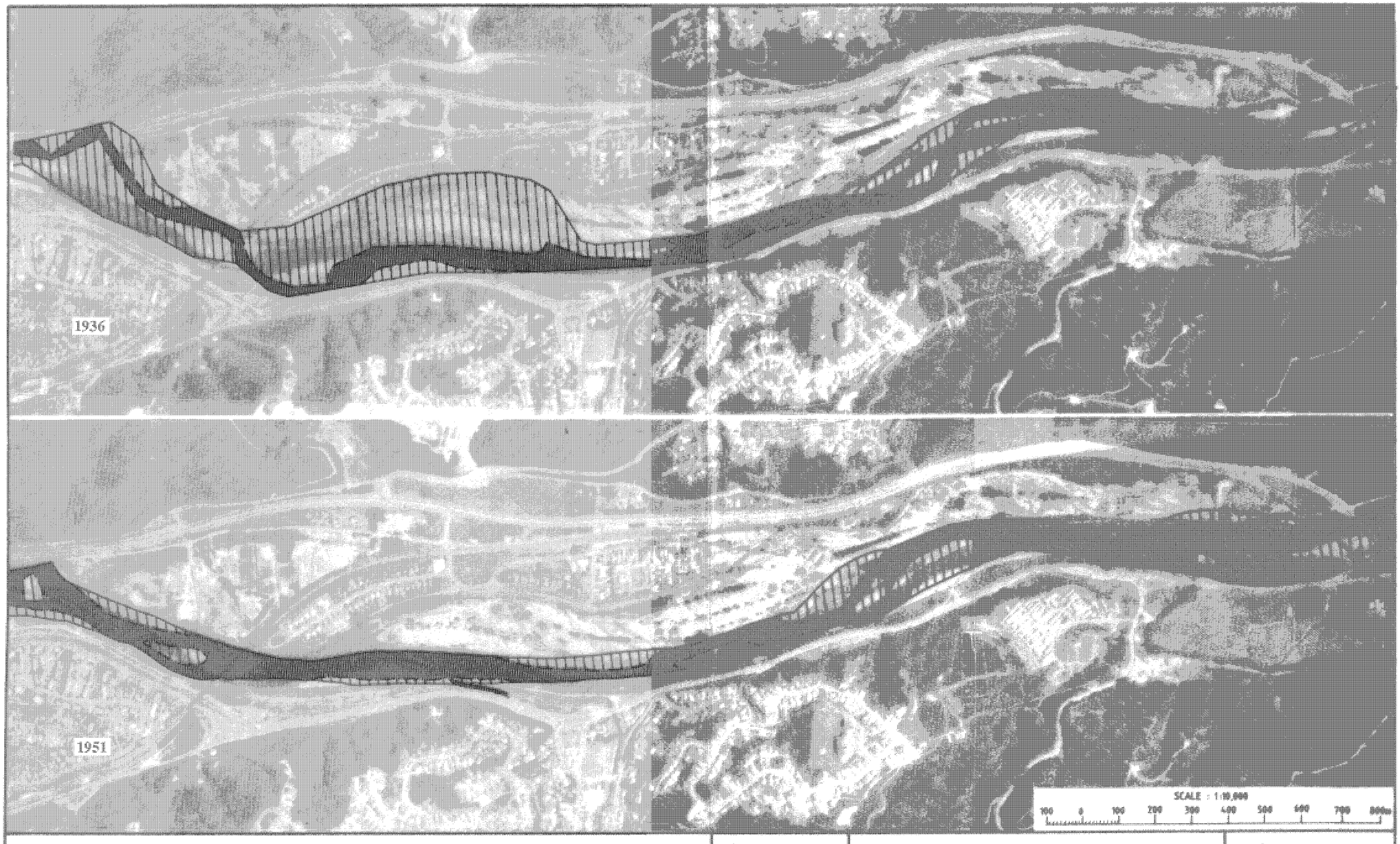
HUTT RIVER FLOOD CONTROL
SCHEME REVIEW 1990
HISTORICAL RIVER ALIGNMENTS

Appendix B



RECTIFIED PHOTO SHEET
The photobase is a halftone enlargement.
A best mean fit has been obtained from scaling data.
The photographic image is not orthogonal and some displacement of image may occur as a result of differences in ground elevations.
Aerial Photography SN 8457 Flown 28/1/65



SCALE : 1:10,000

100 0 100 200 300 400 500 600 700 800m

ALIGNMENT I 1936
taken from a non rectified mosaic of Aerial contact prints.
N.Z. Army 1936

ALIGNMENT II 1951
taken from a rectified mosaic of Aerial contact prints.
N.Z. Aerial Mapping Ltd.
Hastings N.Z. 1951

KEY
Shingle banks
River channel

SHEET 5
HUTT CITY
Taita Gorge

River alignment data from historical maps and photos held by Rivers Department.
Photographic base from DOSLI and N.Z. Aerial Mapping.
River alignment overlays produced by Land Resources Department using WINGEMOS.
Map data copyright WRC 1998.

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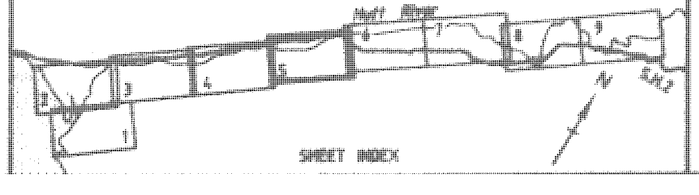
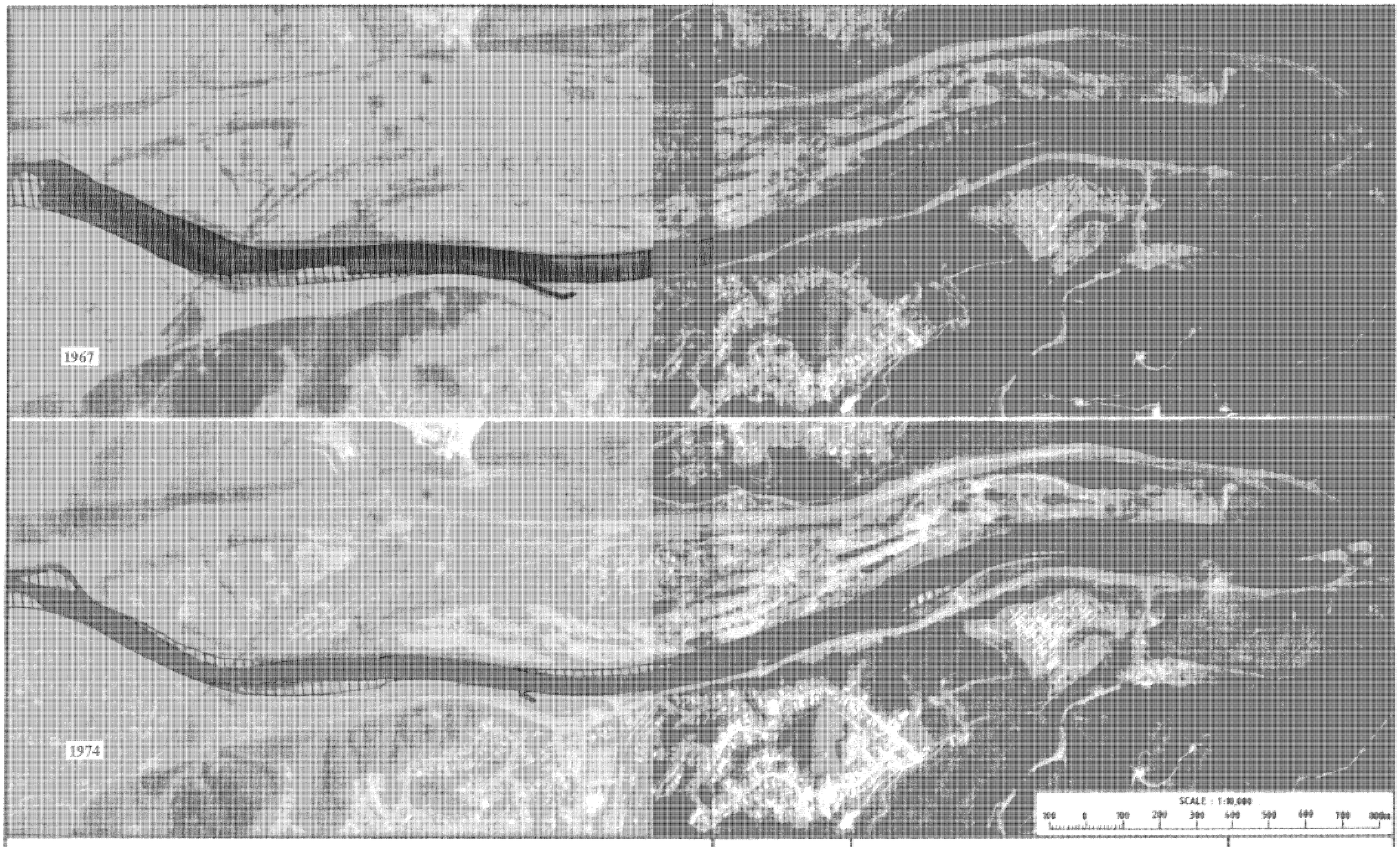
SCHEME REVIEW 1990
HISTORICAL RIVER ALIGNMENTS

Appendix B



RECTIFIED PHOTO SHEET
The photobase is a halftone enlargement.
A best mean fit has been obtained from scaling data.
The photographic image is not orthogonal and some displacement of maps may occur as a result of differences in ground elevations.

Aerial Photography SN 8437 Flown 28/1/85



SCALE : 1:10,000

100 0 100 200 300 400 500 600 700 800m

ALIGNMENT I 1967

taken from Aerial contact prints
Aerial Surveys Ltd.
Nelson N.Z. 1967

ALIGNMENT II 1974

taken from Aerial contact prints
N.Z. Aerial Mapping Ltd.
Hastings N.Z. 1974

KEY

Shingle banks

River channel

SHEET 5

HUTT CITY

Taita Gorge

River alignment data from historical maps and photos held by Rivers Department.
Photographic base from DOSLI and N.Z. Aerial Mapping.
River alignment overlays produced by Land Resources Department using WREGIS.
Map data copyright WRC 1990.

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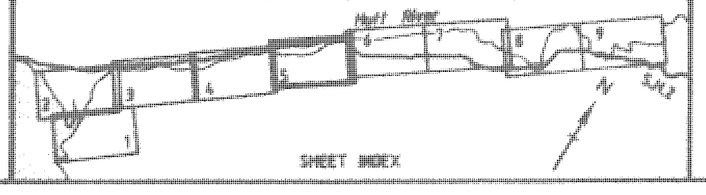
HUTT RIVER FLOOD CONTROL

SCHEME REVIEW 1990

HISTORICAL RIVER ALIGNMENTS

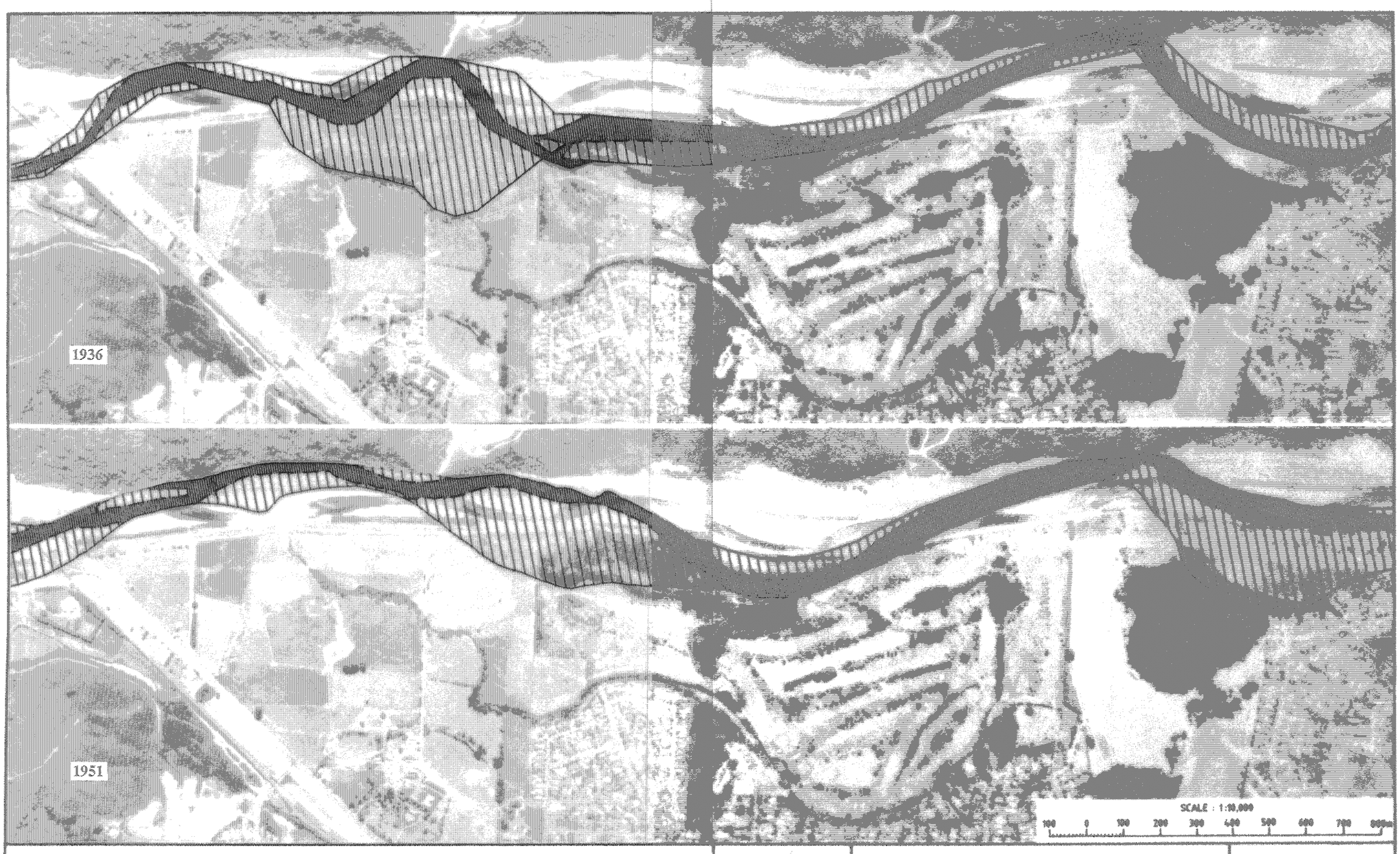
Appendix B



RECTIFIED PHOTO SHEET

The photobase is a halftone enlargement.
A best mean fit has been obtained from scaling data.
The photographic image is not orthogonal
and some displacement of image may occur
as a result of differences in ground elevations.

Aerial Photography SN 8457 Flown 28/1/65



ALIGNMENT I 1936

taken from a non rectified mosaic of Aerial contact prints.
N.Z. Army 1936

ALIGNMENT II 1951

taken from a rectified mosaic of Aerial contact prints.
N.Z. Aerial Mapping Ltd.
Hastings N.Z. 1951

KEY

Shingle banks

River channel

SHEET 6

UPPER HUTT CITY

Silverstream to Barton's Bush

River alignment data from historical maps and photos held by Rivers Department.
Photographic base from DOSLI and N.Z. Aerial Mapping.
River alignment overlays produced by Land Resources Department using WIREGIS.
Map data copyright WRC 1990.

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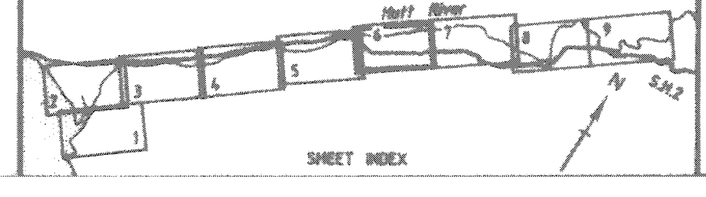
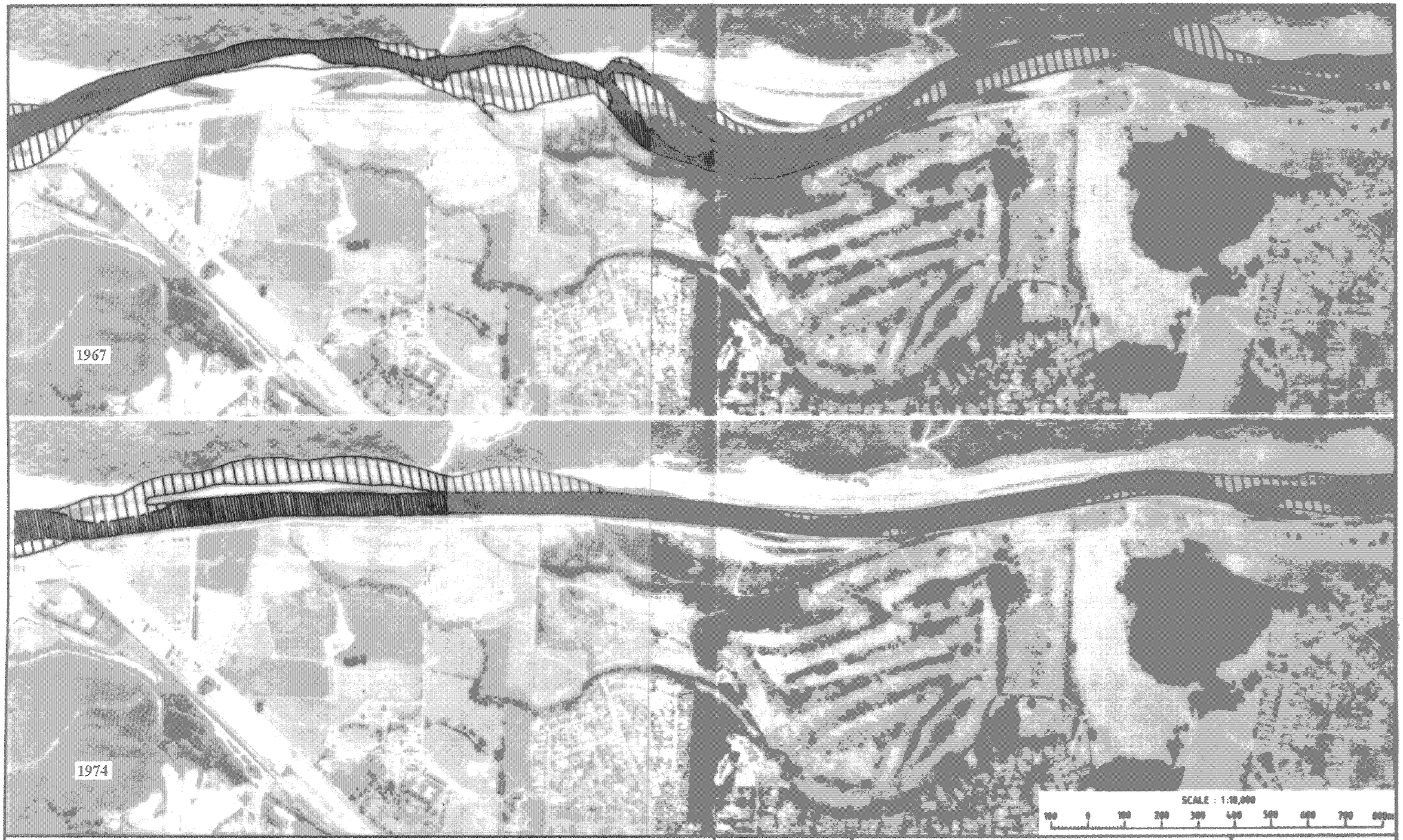
HUTT RIVER FLOOD CONTROL
SCHEME REVIEW 1990
HISTORICAL RIVER ALIGNMENTS

Appendix B



ORTHOPHOTO SHEET
This orthophotomap is a differentially rectified aerial photo, the photo detail conforms to normal mapping accuracies.

Level Datum ; Wellington Datum 1953
New City Datum (M.S.L. 0)
Orthophoto from Aerial Survey No. SN 8909 Flown 16/1/89.



ALIGNMENT I 1967
taken from Aerial contact prints
Aerial Surveys Ltd.
Nelson N.Z. 1967

ALIGNMENT II 1974
taken from Aerial contact prints
N.Z. Aerial Mapping Ltd.
Hastings N.Z. 1974

KEY
Shingle banks
River channel

SHEET 6

UPPER HUTT CITY

Silverstream to
Barton's Bush

River alignment data from historical maps and photos held by Rivers Department.
Photographic bases from DOSLI and N.Z. Aerial Mapping.
River alignment overlays produced by Land Resources Department using WREGIS.

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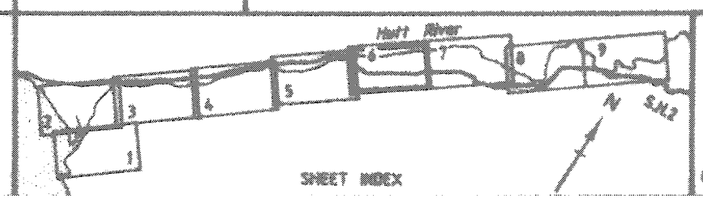
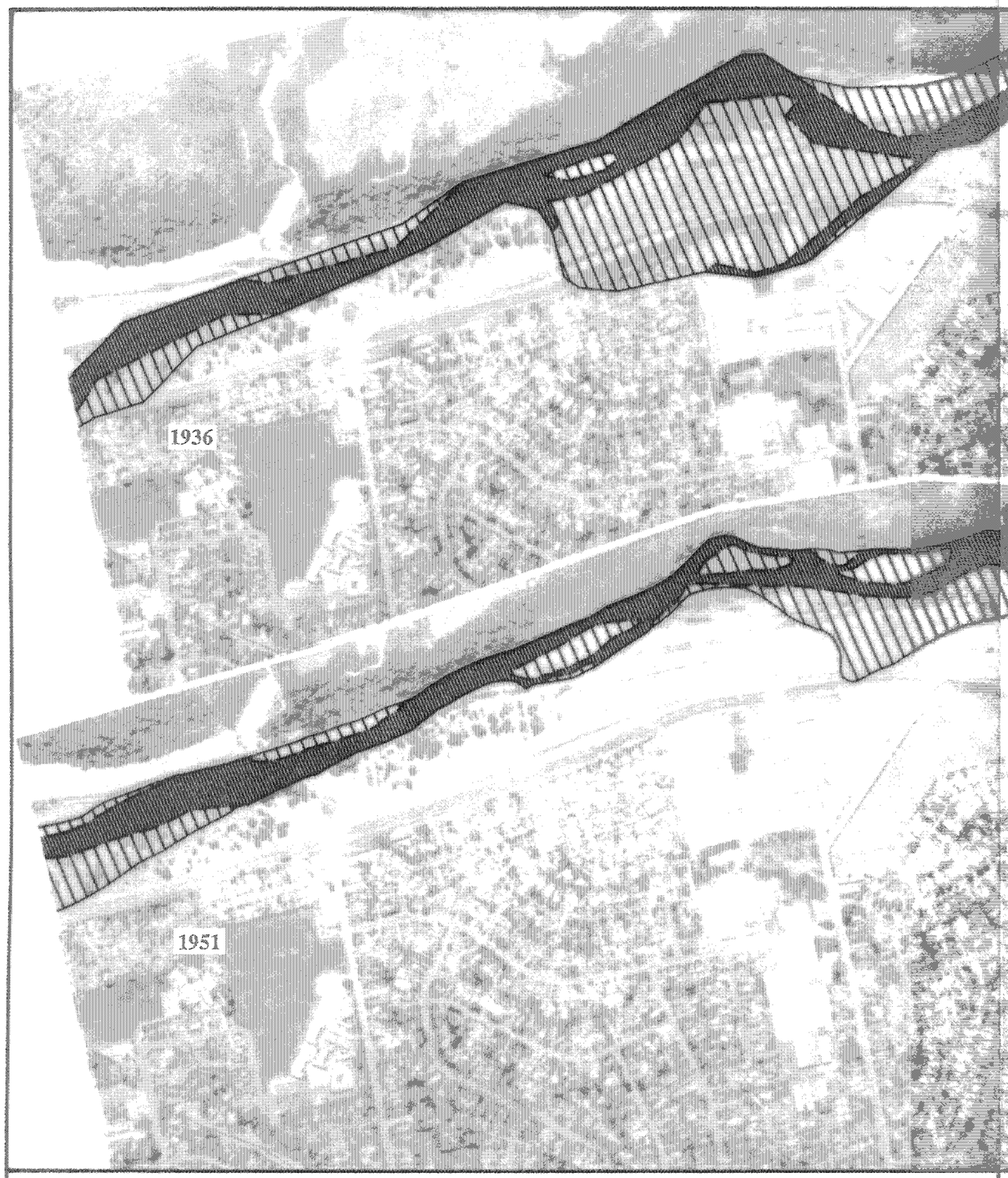
HUTT RIVER FLOOD CONTROL
SCHEME REVIEW 1990
HISTORICAL RIVER ALIGNMENTS

Appendix B



ORTHOPHOTO SHEET
This orthophotomap is a differentially rectified aerial photo, the photo detail conforms to normal mapping accuracies.

Level Datum : Wellington Datum 1953
New City Datum (M.S.L. 0)
Orthophoto from Aerial Survey No. SN 8909 Plan 16/1/90.



ALIGNMENT I 1936

taken from a non rectified mosaic of Aerial contact prints.
N.Z. Army 1936

ALIGNMENT II 1951

taken from a rectified mosaic of Aerial contact prints.
N.Z. Aerial Mapping Ltd.
Hastings N.Z. 1951

KEY

Shingle banks

River channel

SHEET 7

UPPER HUTT CITY

Moonshine to Totara Park

River alignment data from historical maps and photos held by Rivers Department.
Photographic base from DOSLI and N.Z. Aerial Mapping.
River alignment overlays produced by Land Resources Department using WREGRIS.

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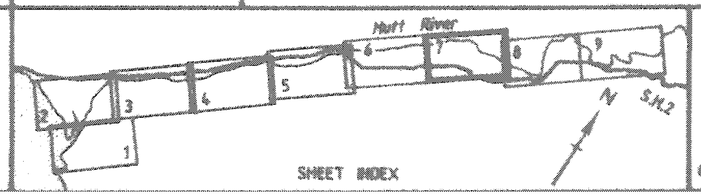
HUTT RIVER FLOOD CONTROL
SCHEME REVIEW 1990
HISTORICAL RIVER ALIGNMENTS

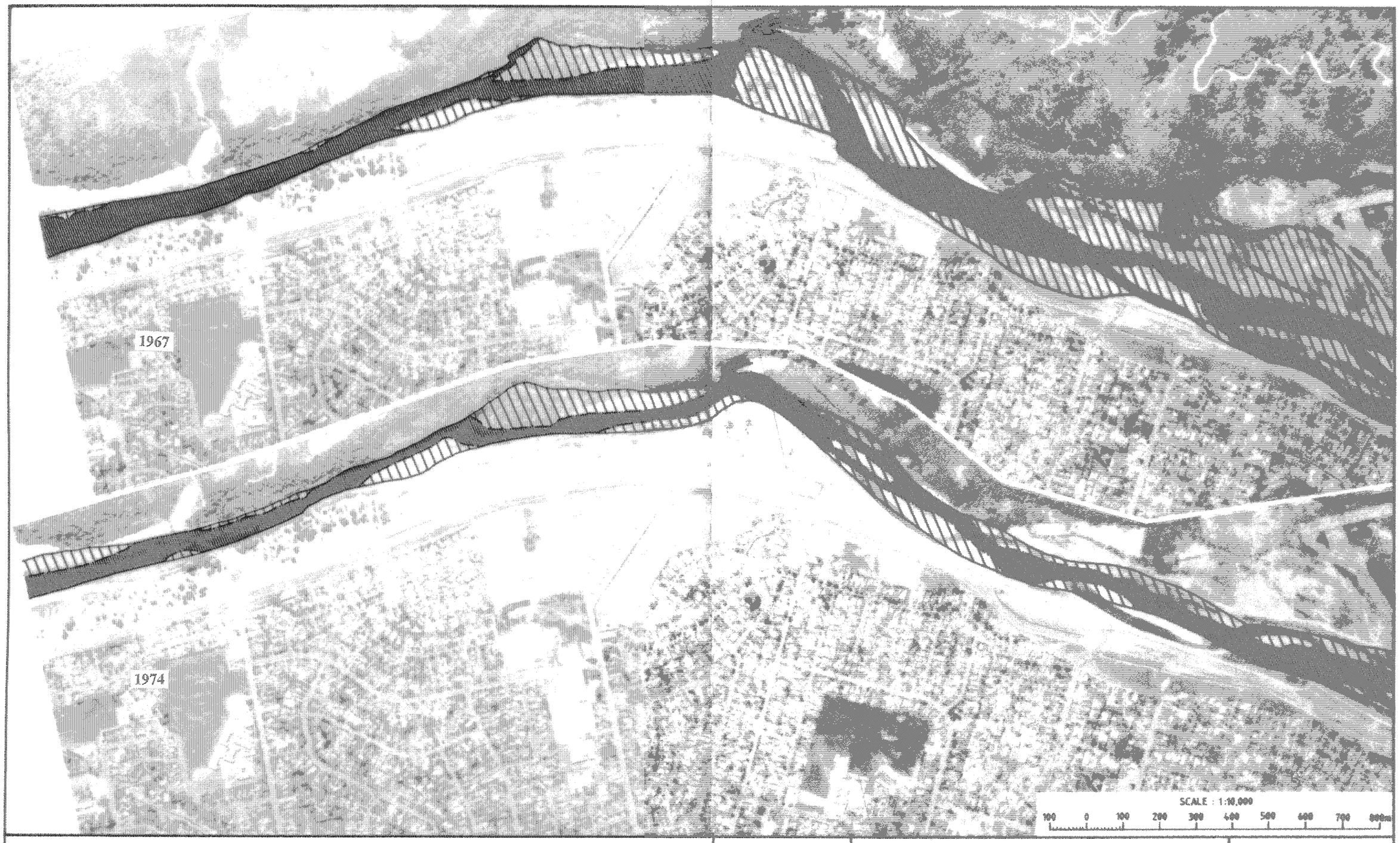
Appendix B



SHEET INDEX

ORTHOPHOTO SHEET
This orthophotomap is a differentially rectified aerial photo, the photo detail conforms to normal mapping accuracies.

Level Datum ; Wellington Datum 1953
New City Datum (M.S.L. 0)
Orthophoto from Aerial Survey No. SN 8989 Flown 16/1/89.



SCALE : 1:10,000

100 0 100 200 300 400 500 600 700 800m

ALIGNMENT I 1967
taken from Aerial contact prints
Aerial Surveys Ltd.
Nelson N.Z. 1967

ALIGNMENT II 1974
taken from Aerial contact prints
N.Z. Aerial Mapping Ltd.
Hastings N.Z. 1974

KEY

Shingle banks

River channel

SHEET 7

UPPER HUTT CITY

Moonshine to
Totara Park

River alignment data from historical maps and photos held by Rivers Department.
Photographic base from DOSLI and N.Z. Aerial Mapping.
River alignment overlays produced by Land Resources Department using WREGGIS.

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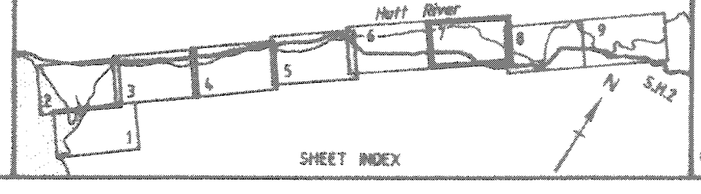
HUTT RIVER FLOOD CONTROL
SCHEME REVIEW 1990
HISTORICAL RIVER ALIGNMENTS

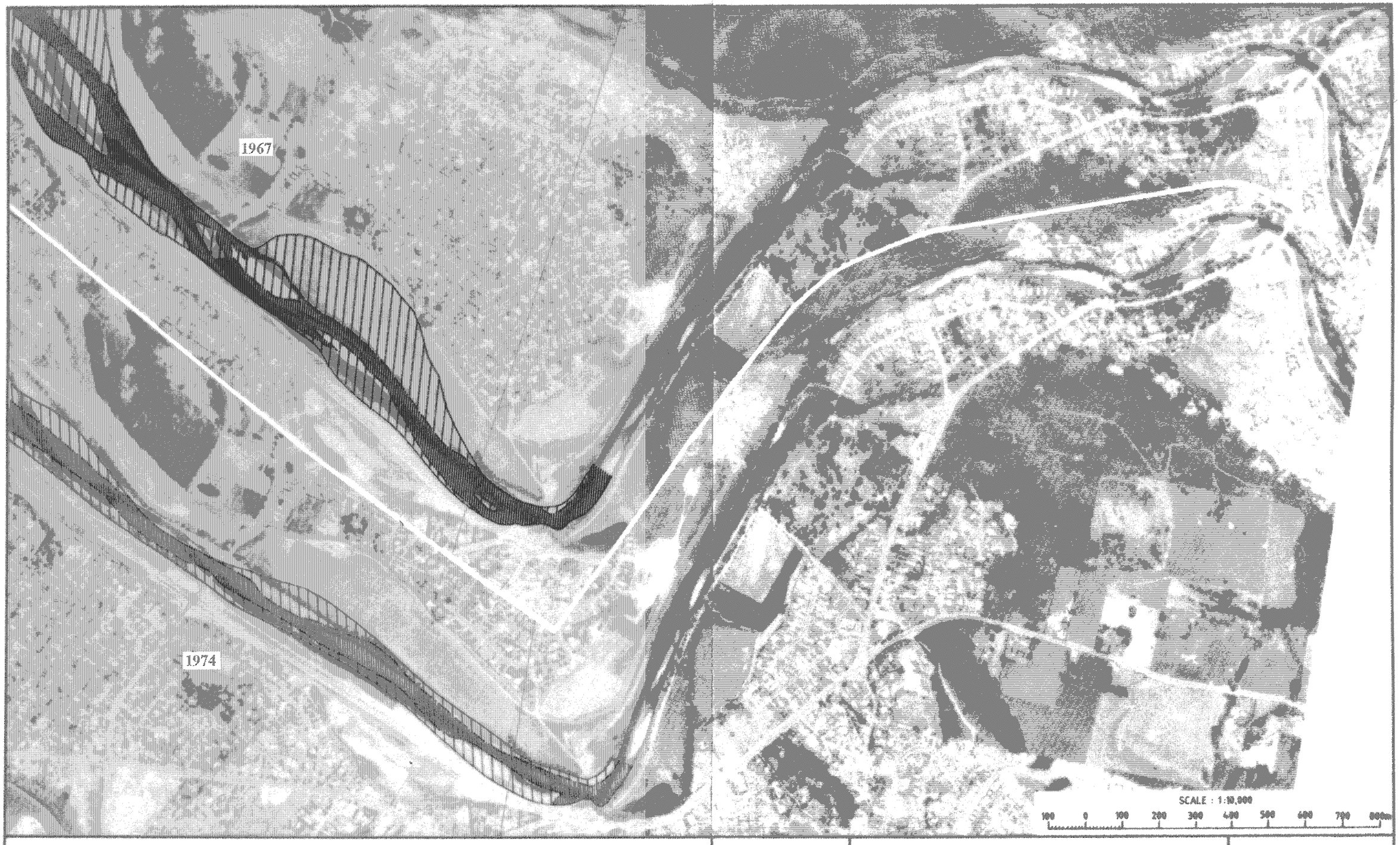
Appendix B



SHEET INDEX

ORTHOPHOTO SHEET
This orthophotomap is a differentially rectified aerial photo, the photo detail conforms to normal mapping accuracies.

Level Datum : Wellington Datum 1953
New City Datum (M.S.L. 0)
Orthophoto from Aerial Survey No. SN 8909 Flown 16/1/89.



ALIGNMENT I 1967
taken from Aerial contact prints
Aerial Surveys Ltd.
Nelson N.Z. 1967

ALIGNMENT II 1974
taken from Aerial contact prints
N.Z. Aerial Mapping Ltd.
Hastings N.Z. 1974

KEY
Shingle banks
River channel

SHEET 8
UPPER HUTT CITY
Maoribank

River alignment data from historical maps and photos held by Rivers Department.
Photographic base from DOSLI and N.Z. Aerial Mapping.
River alignment overlays produced by Land Resources Department using WREGGIS.
Map data copyright WRC 1990.

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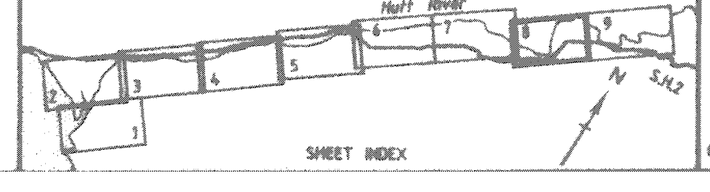
HUTT RIVER FLOOD CONTROL
SCHEME REVIEW 1990
HISTORICAL RIVER ALIGNMENTS

Appendix B



ORTHOPHOTO SHEET
This orthophotomap is a differentially rectified aerial photo, the photo detail conforms to normal mapping accuracies.

Level Datum : Wellington Datum 1953
New City Datum (M.S.L. 8)
Orthophoto from Aerial Survey No. SN 8909 Flown 16/1/90.

SCALE : 1:10,000

100 0 100 200 300 400 500 600 700 800m

ALIGNMENT I 1936

taken from a non rectified mosaic of Aerial contact prints.
N.Z. Army 1936

ALIGNMENT II 1951

taken from a rectified mosaic of Aerial contact prints.
N.Z. Aerial Mapping Ltd.
Hastings N.Z. 1951

KEY

Shingle banks

River channel

SHEET 8

UPPER HUTT CITY

Maoribank

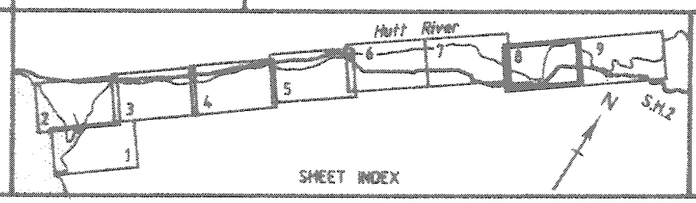
River alignment data from historical maps and photos held by Rivers Department.
Photographic base from DOSLI and N.Z. Aerial Mapping.
River alignment overlays produced by Land Resources Department using WREGGIS.
Map data copyright WRC 1990.

infomap
Department of SURVEY AND LAND INFORMATION

Catchment Engineering
CONSULTING ENGINEERS
Phone (04) 689 626 Fax (04) 689 288

HUTT RIVER FLOOD CONTROL
SCHEME REVIEW 1990
HISTORICAL RIVER ALIGNMENTS

Appendix B



SHEET INDEX

ORTHOPHOTO SHEET
This orthophotomap is a differentially rectified aerial photo, the photo detail conforms to normal mapping accuracies.

Level Datum : Wellington Datum 1953
New City Datum (M.S.L. 0)
Orthophoto from Aerial Survey No. SN 8989 Flown 16/1/90.

APPENDIX C

CATCHMENT PLAN

Appendix C

Hutt Catchments

SCALE 1:100,000

refer inset

Western Hutt

Eastern Hutt

Akatarawa

Upper Whakatiki

Kerekere

Water Works

Lower Whakatiki

Te Marua

Lower Pakuratahi

Upper Hutt

Pinehaven

Mangaroa

Upper Pakuratahi

Stokes Valley

Korokoro

Lower Hutt

LOWER HUTT

WATER LEVEL RECORDER SITES

1 Hutt River - Taita Gorge
2 Mangaroa River - Te Marua
7 Hutt River - Boulcott
13 Wainuiomata Stm - Whites Line East
18 Hutt River - Estuary Bridge
20 Korokoro Stm - Mill weir
31 Akatarawa Stm - Cemetery
32 Whakatiki Stm - Dude Ranch
40 Hutt River - Te Marua
41 Pakuratahi Stm - Truss Bridge

DSIR WATER LEVEL RECORDER SITES

10 Hutt River - Birchville
21 Mill Creek - Papanui
36 Hutt River - Kaitoki

RAINGAUGE SITES

3 Mangaroa
25 Korokoro
33 Whakatiki - Putaputaweta
34 Twin Lakes
35 Akatarawa
42 Pakuratahi
58 Whakatiki - Bluegum Spur

DSIR RAINGAUGE SITES

37 Hutt - Phillips

GROUNDWATER RECORDER SITES

Lower Hutt Basin
4 Taita Intermediate
5 Bell Park
6 Mitchell Park
27 Petone Memorial
28 McEwan Park
29 Hutt Memorial Tech
30 Hutt Recreation Ground
54 Randwick Reserve
55 Port Road

LAKE GAUGING SITES

38 Lake one - Te Marua
39 Lake two - Te Marua

■ Rainfall recorders (WRC)
▲ Rainfall recorders (DSIR)
● River level recorders (WRC)
○ River level recorders (DSIR)
▲ Lake level recorders

River alignment from NZMS 270 maps, reproduced under licence from DOSLI
Location of recorders from Water Resources Dept
Map produced by Land Resources Dept, WRC, using WREGGIS

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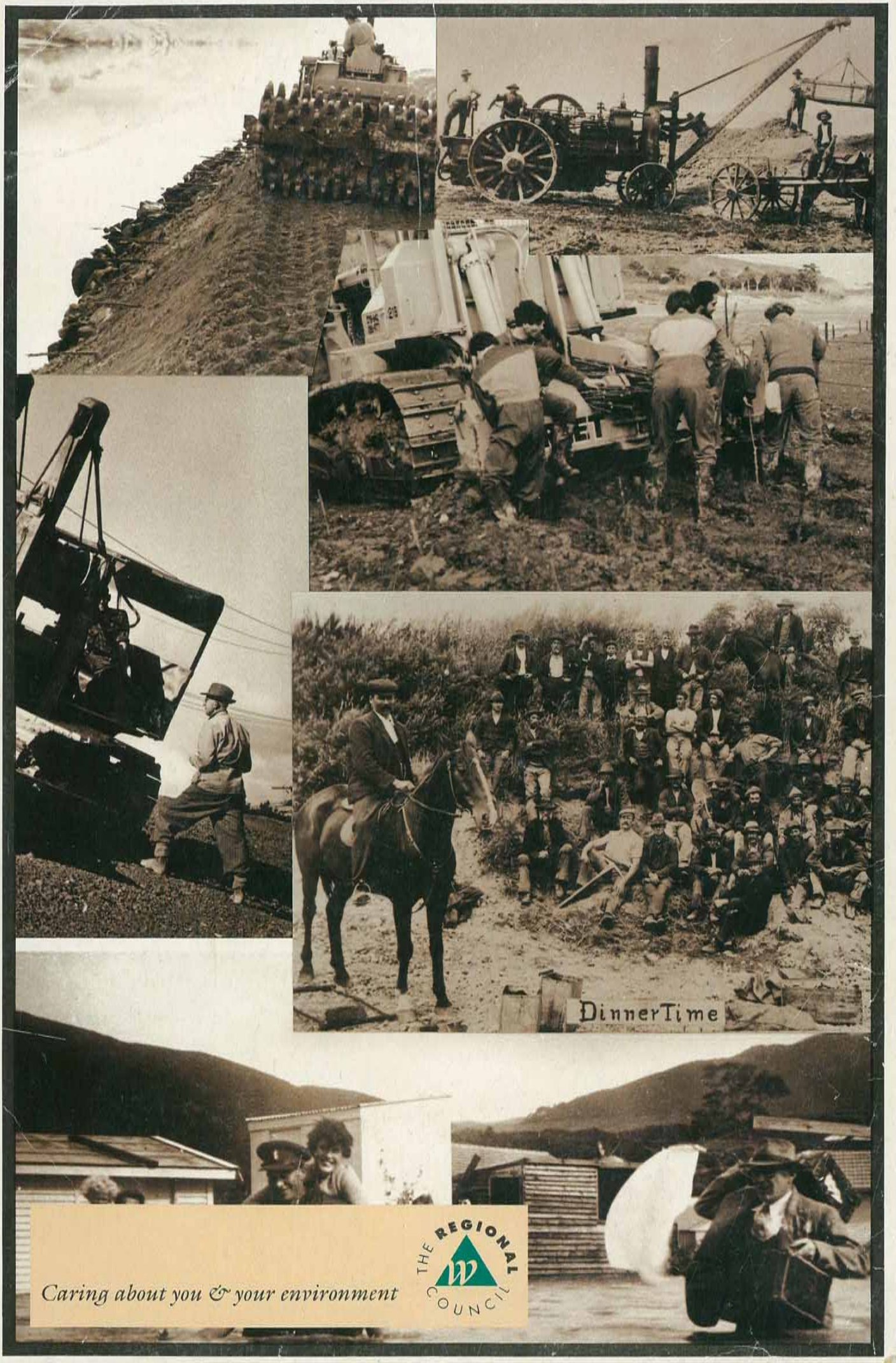
stopbank raising
Strand Park, c.1956
HRB photo.

Stopbank constructors 1902
(ATL neg F28354)

Feb 1955 Flood
(Evening Post neg 294-55)

<u>*Photographs included in the back cover mosaic.*</u>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