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.

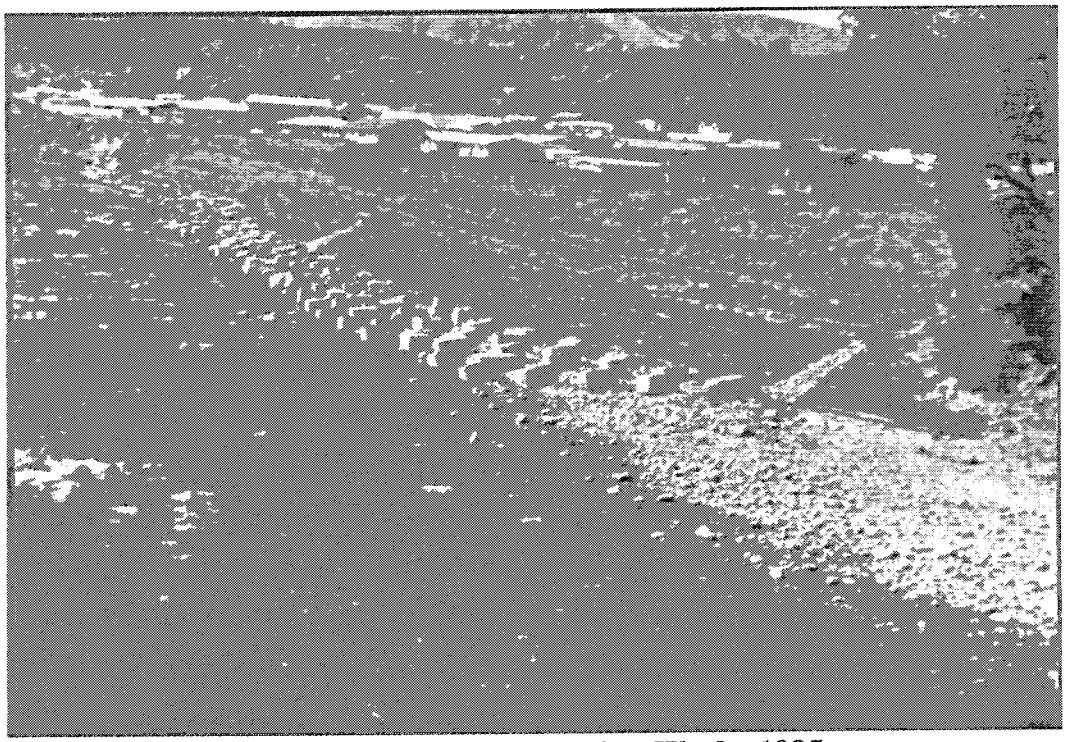

Plate 76: Parkdale Stopbank and Protection Works 1985. Source: WRC photo.

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

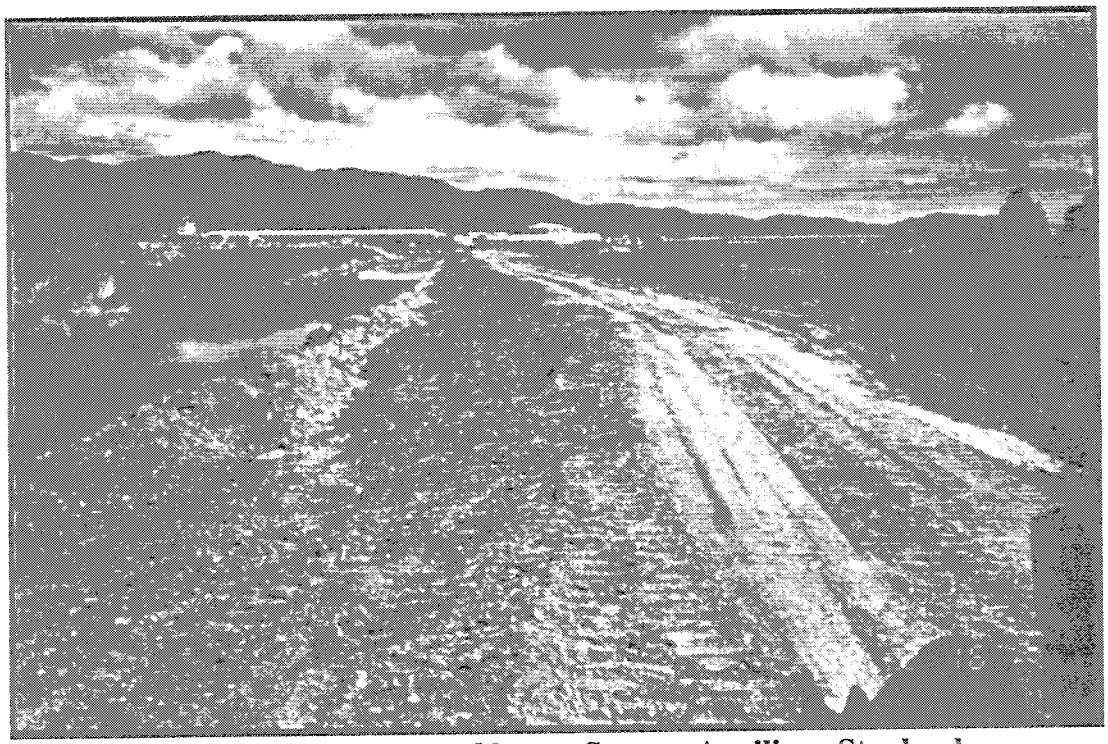

Plate 77: Reconstruction of the Okoutu Stream Auxiliary Stopbank.
Source: WRC photo

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.

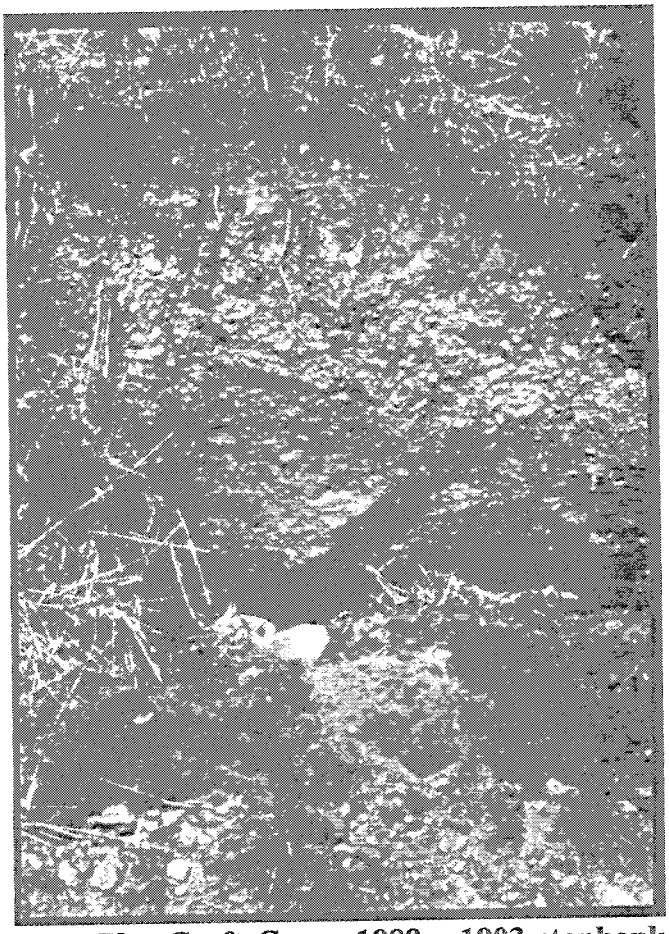

Plate 78: Croft Grove 1988. 1903 stopbank overlaid by 1956 reconstruction. Face slumping into river. Source: WRC photo.

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.

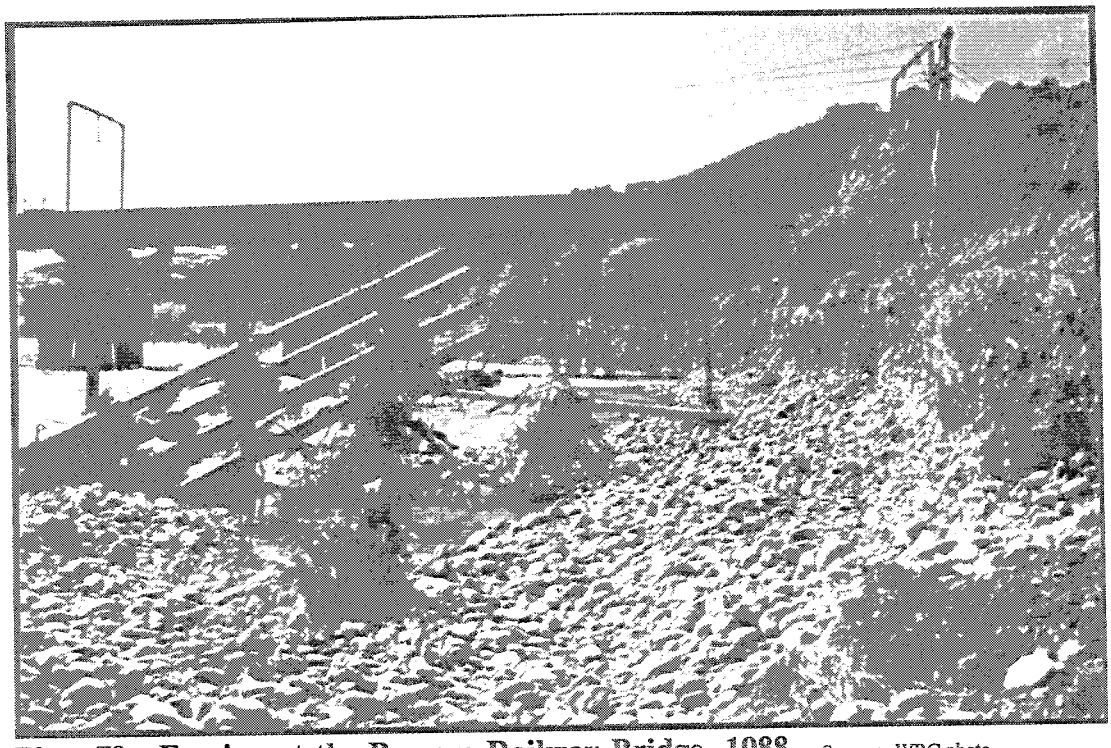

Plate 79: Erosion at the Pomare Railway Bridge, 1988. Source: WRC photo

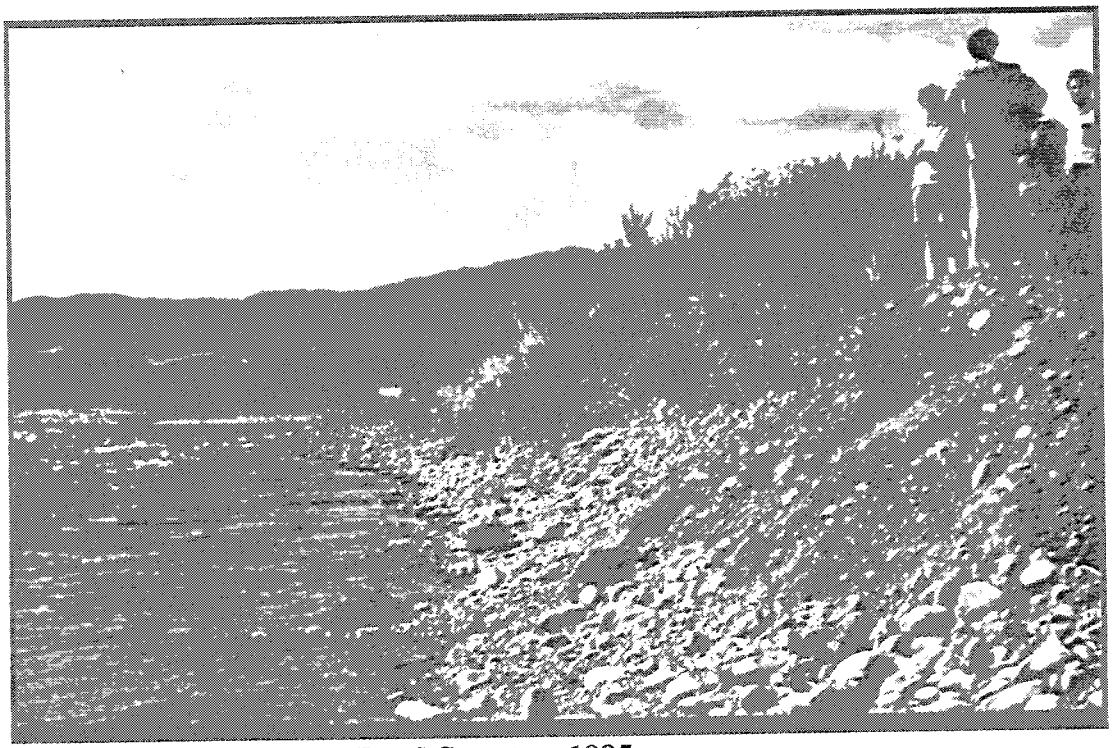

Plate 80: Erosion at McLeod Street c. 1985. Source: WRC photo

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.

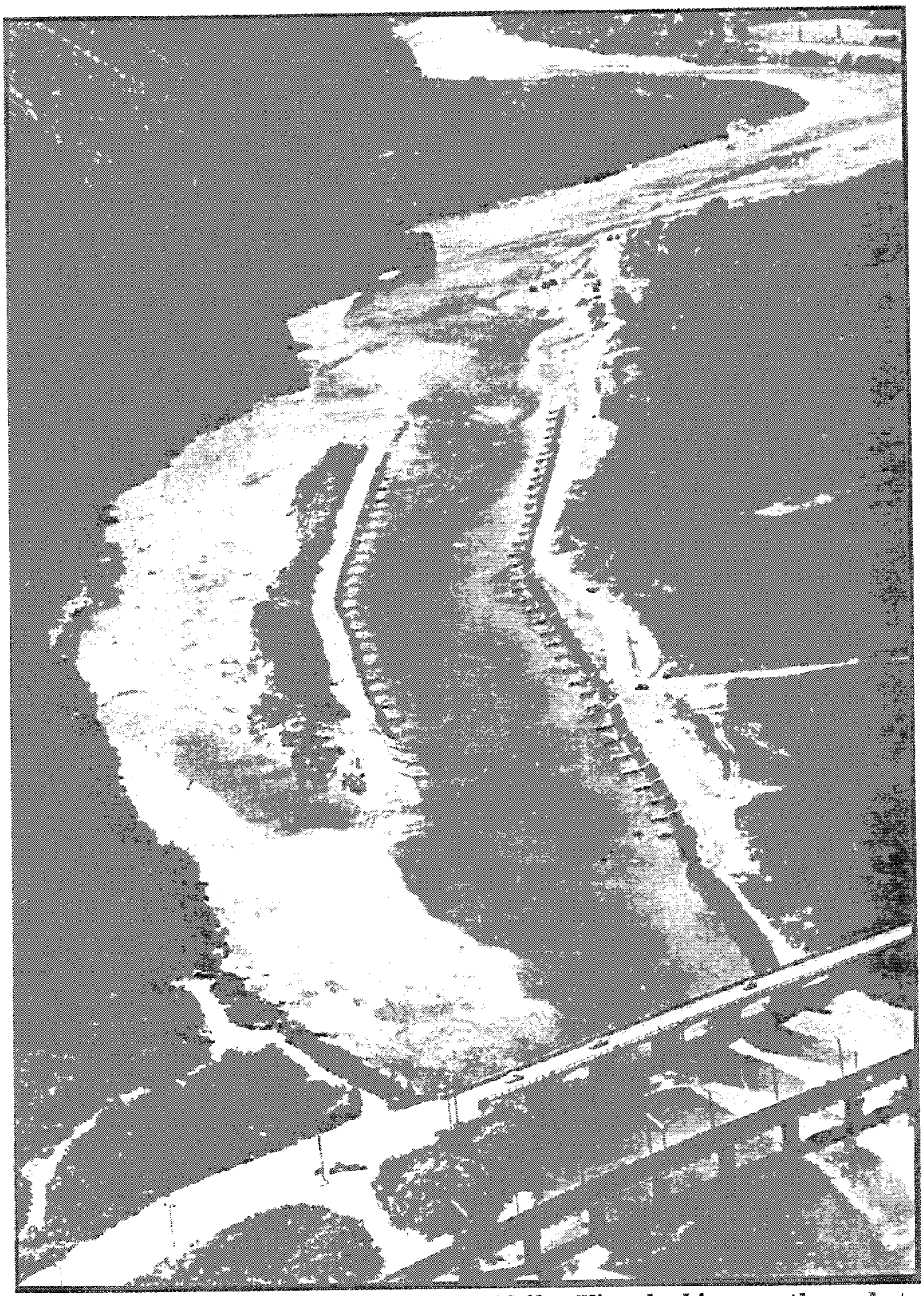

Plate 81: Silverstream Cut 1st Stage, 1960. View looking northwards to Barton's Bush. Source: HRB photo

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.

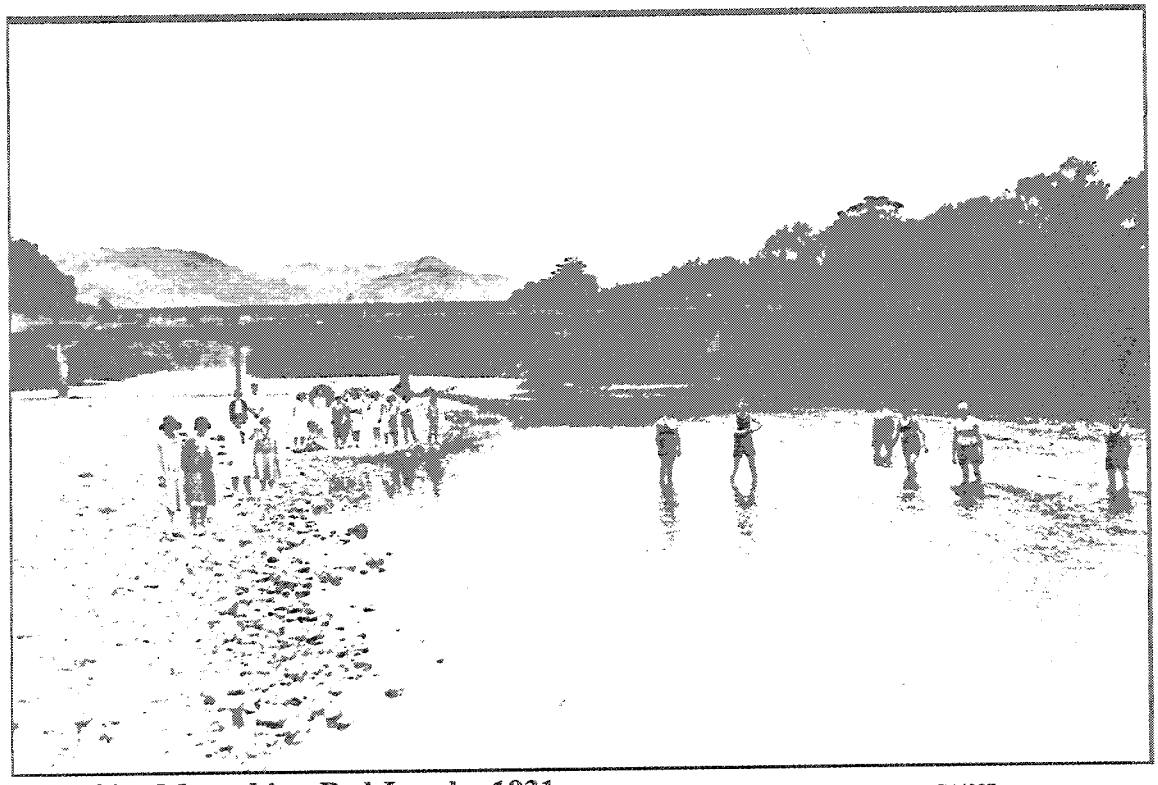

Plate 82: Moonshine Bed Levels, 1931. Source: Alexander Turnbull Library neg. G46227

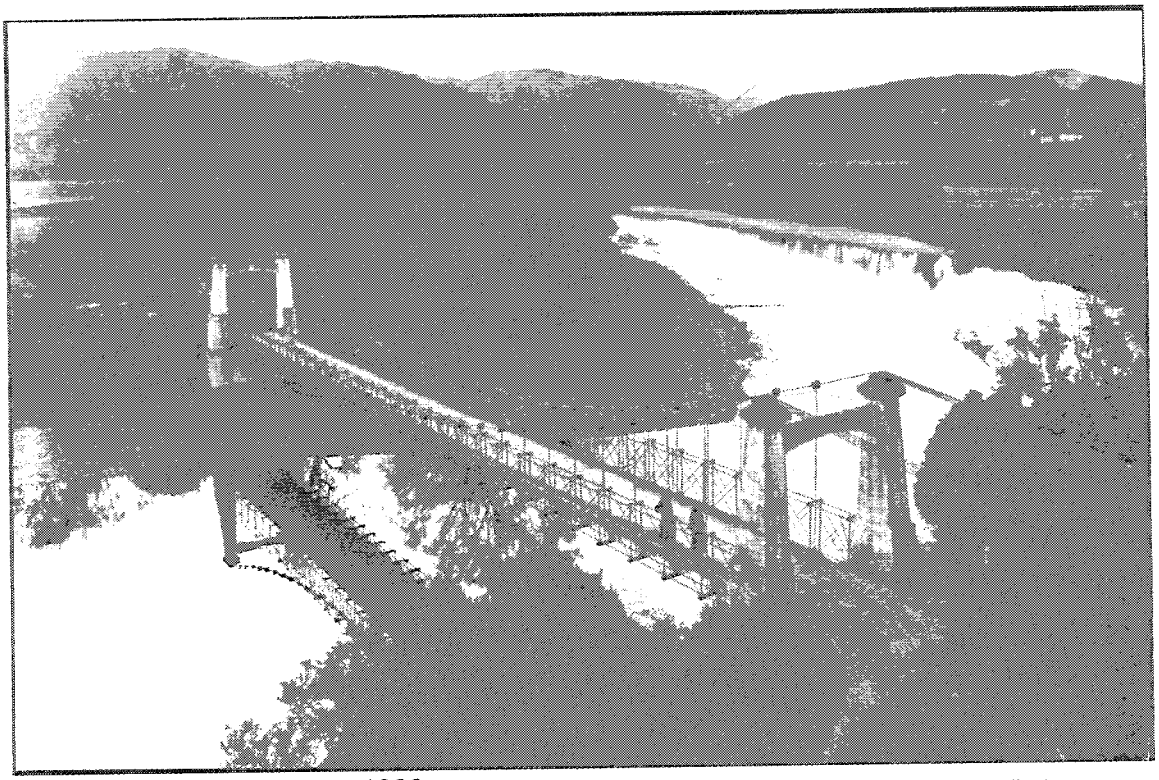

Plate 83: Maoribank c. 1920 Source: Alexander Turnbull Library neg. G EP 830, Evening Post collection.

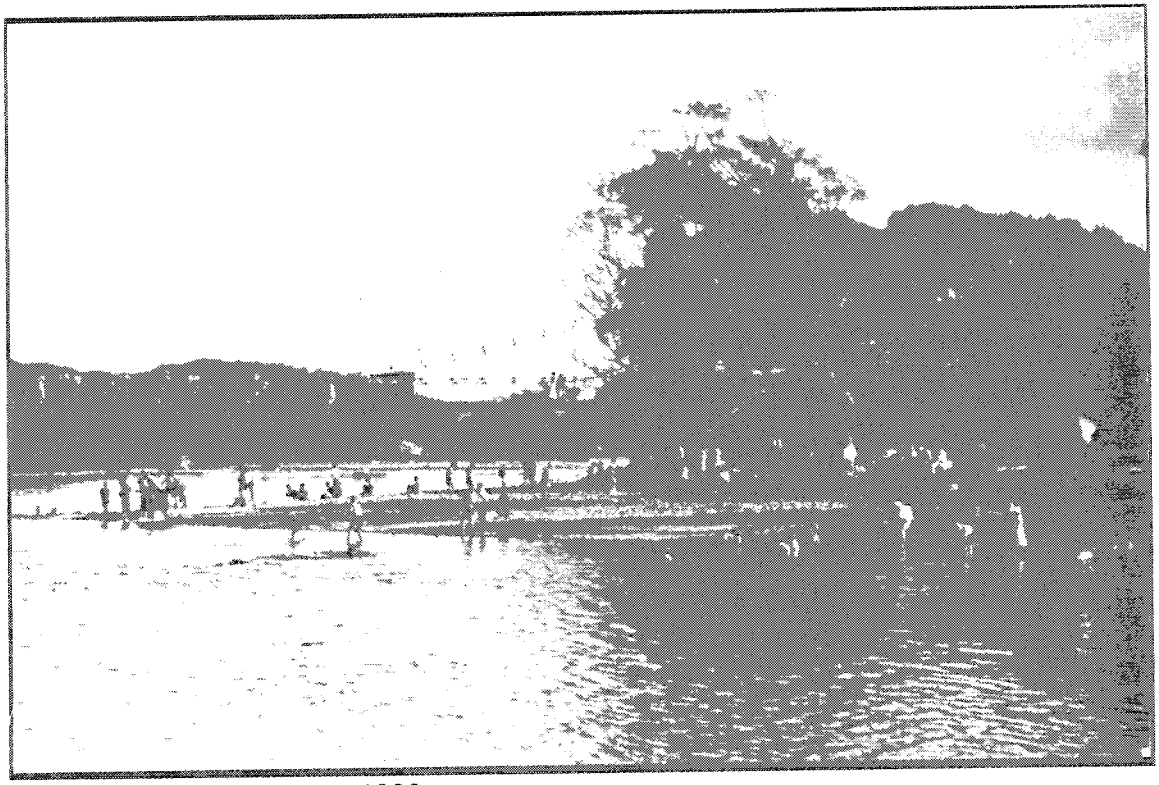

Plate 84: Maoribank c. 1920 Source: Alexander Turnbull Library neg. F20641.

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.

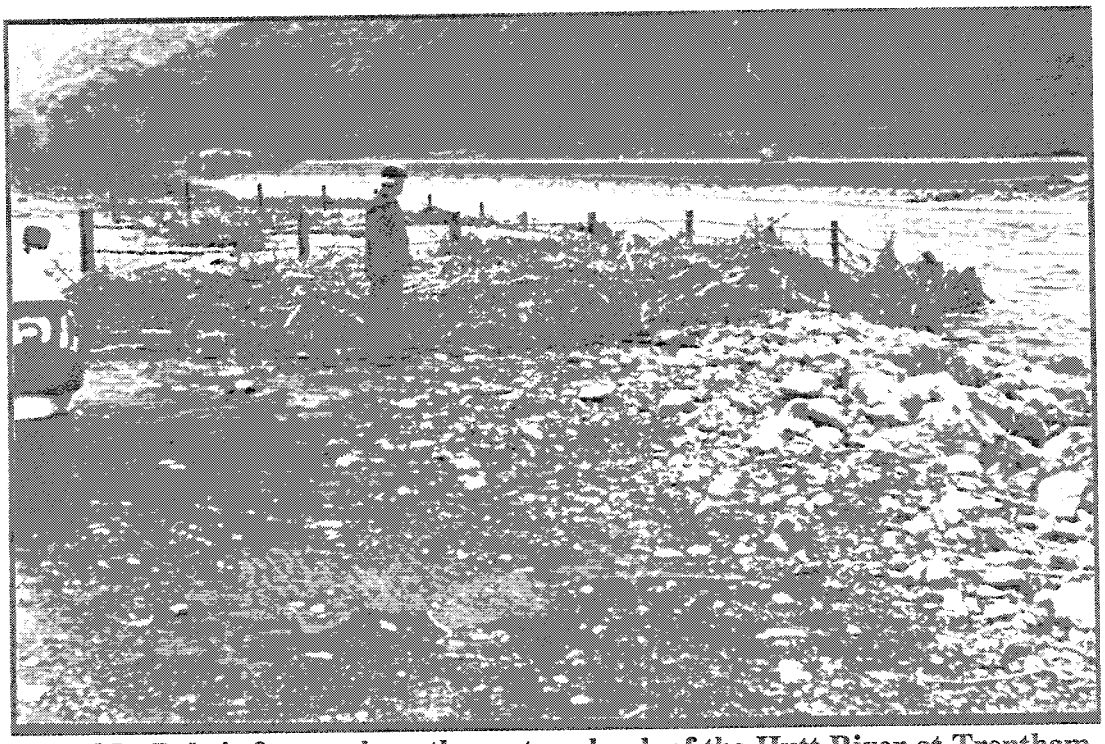

Plate 85: Debris fences along the eastern bank of the Hutt River at Trentham, 1986 (note the "Bluff" in the background refer plate 67). Source: WRC photo

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.

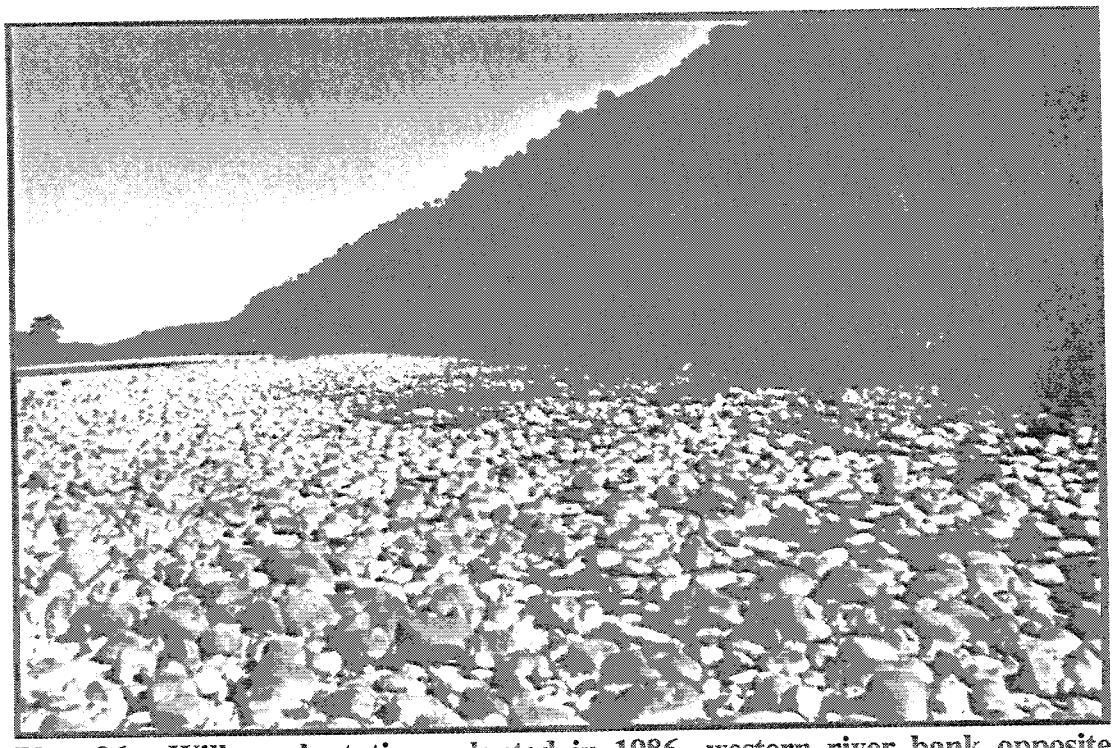

Plate 86: Willow plantations planted in 1986, western river bank opposite Moonshine Park. Source: WRC photo

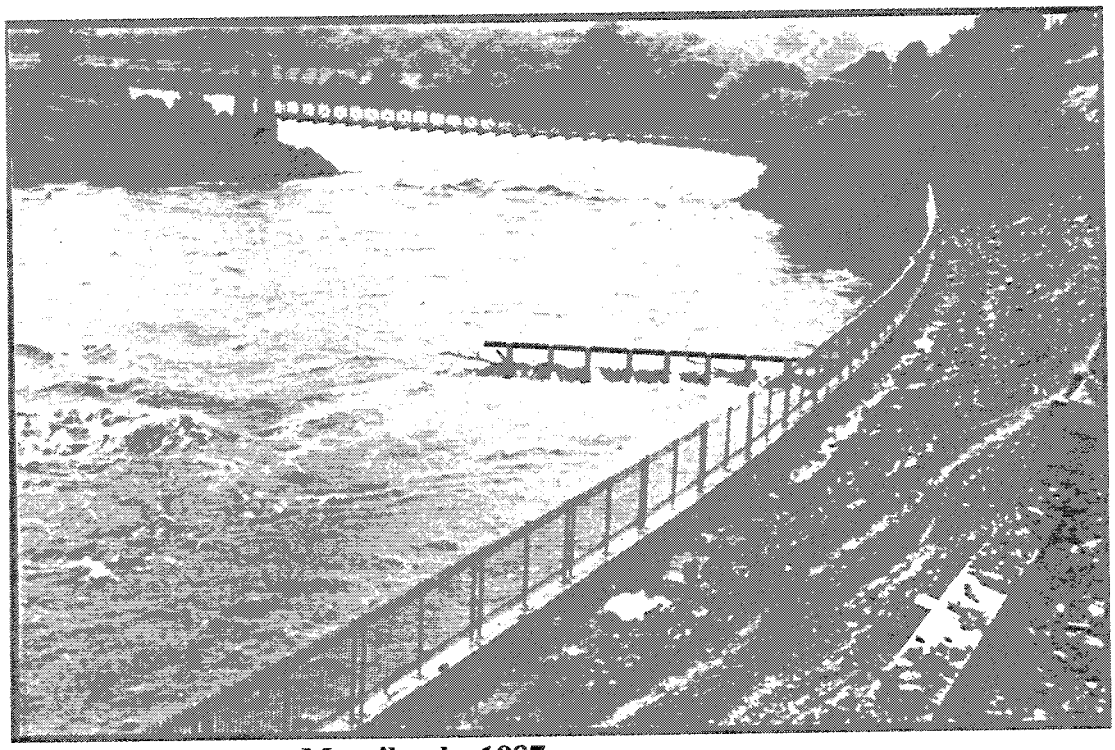

Plate 87: Bypass at Maoribank, 1987. Source: WRC photo

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.

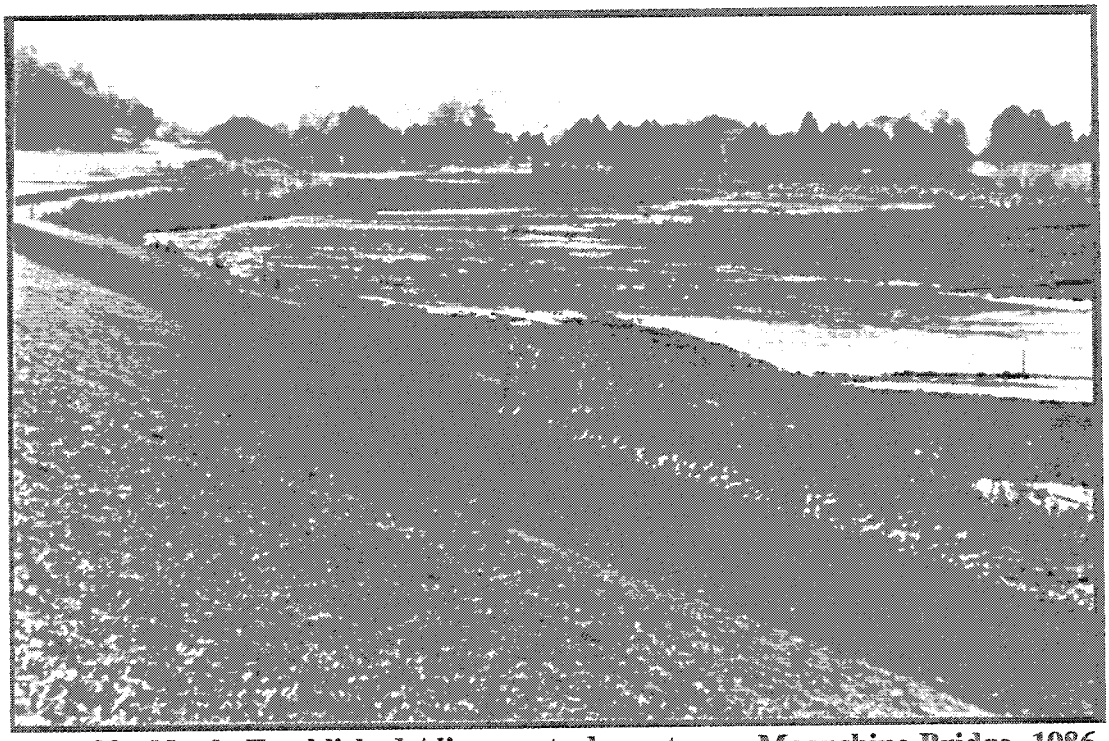

Plate 88: Newly Established Alignment, downstream Moonshine Bridge, 1986.
Source: WRC photo

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.

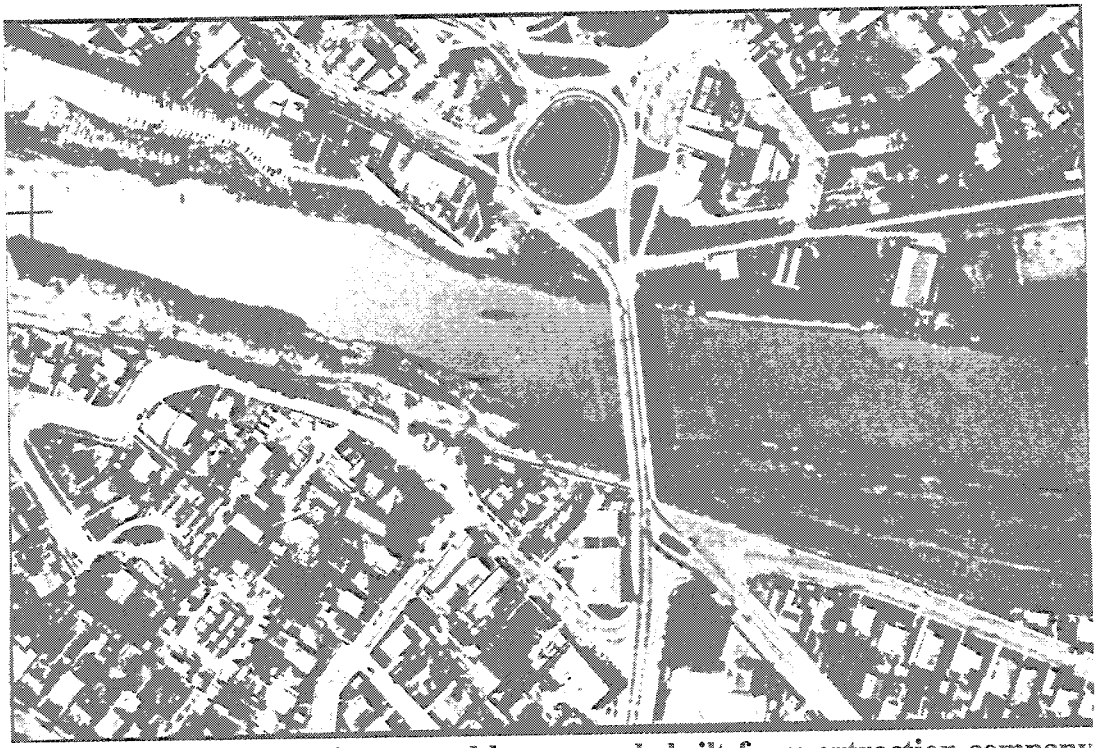

Plate 89: Water pollution caused by suspended silt from extraction company waste, 1967.

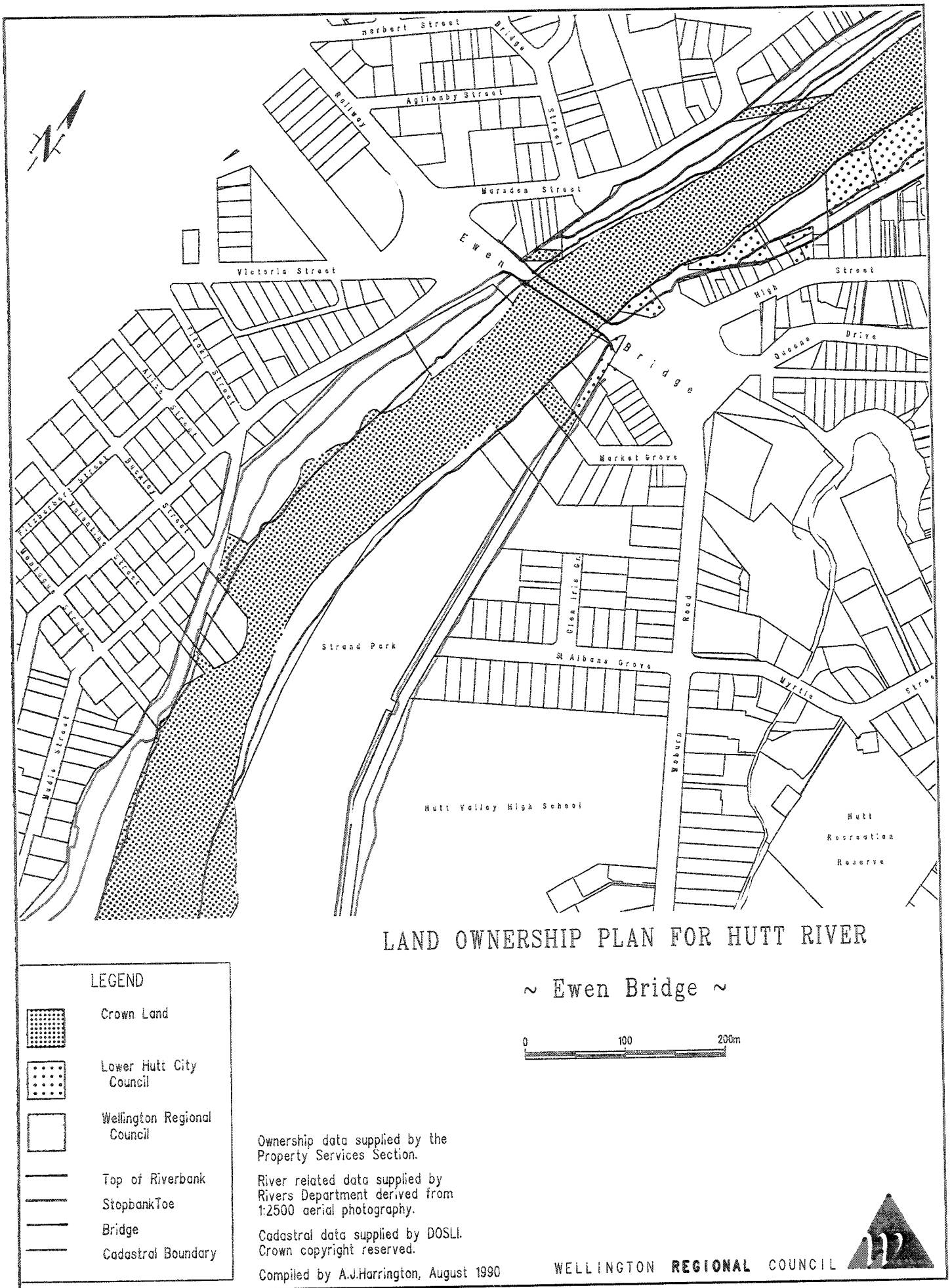

Figure 13: River Zone Information in the Ewen Bridge Area.

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.