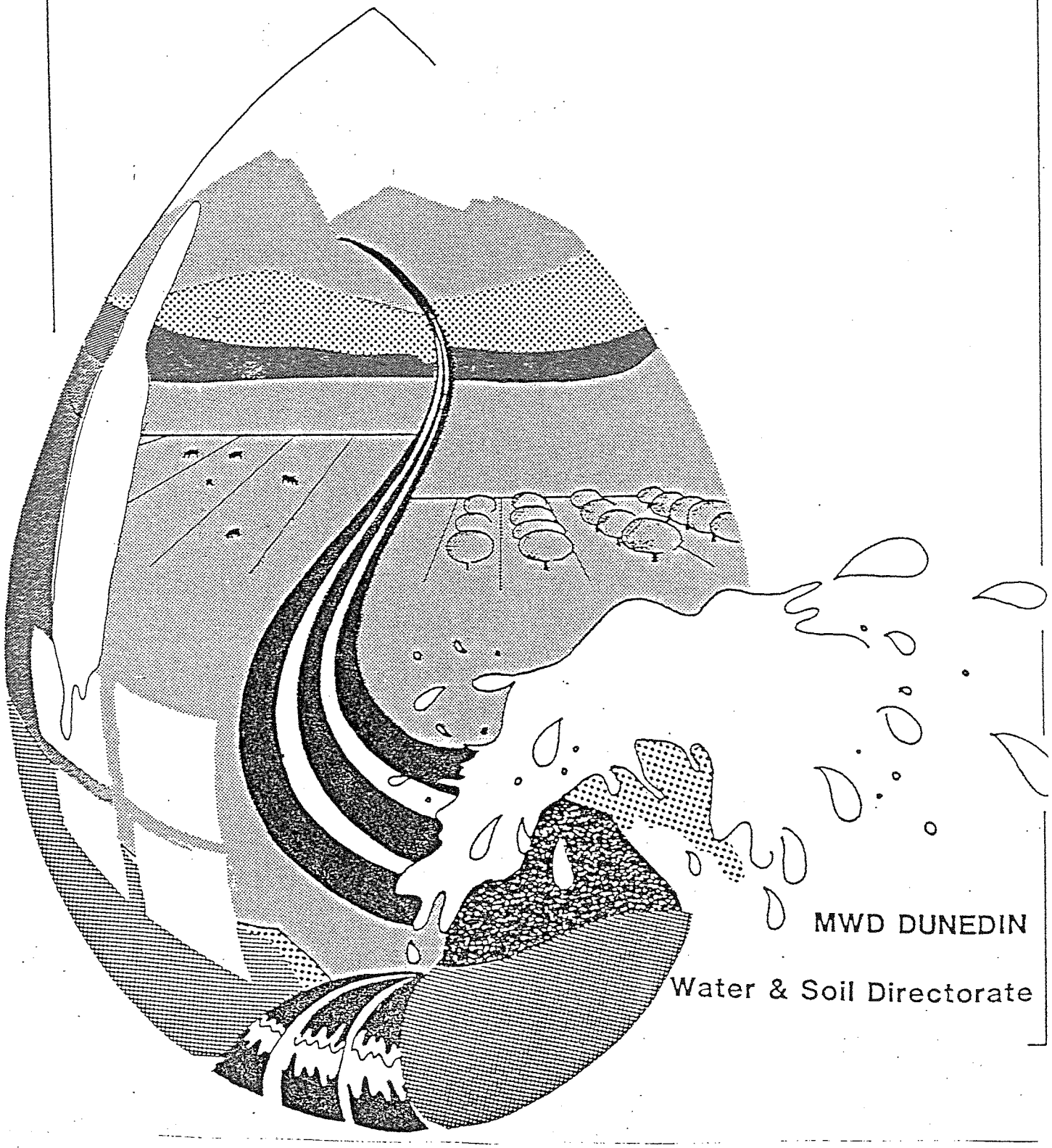
Refurbishment of Old Central Otago Irrigation Schemes

Omakau Scheme Report

FEASIBILITY



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Water & Soil Directorate

OMAKAU IRRIGATION SCHEME FEASIBILITY REPORT

January 26th, 1988

Water and Soil Directorate
Ministry of Works and Development
DUNEDIN

Preface

This feasibility report forms part of a four phase refurbishment programme for the refurbishment of 13 old Central Otago irrigation schemes. The following programme was initiated late in 1984:

Phase 1 Inventory of scheme works

Phase 2 Technical assessment of schemes for funding and programming for refurbishment (completed March 1986)

Phase 3 Feasibility reporting on individual refurbishment proposals

Phase 4 Design and construction of the works

There are two parts to this report:

Part I focuses specifically on the refurbishment of the Omakau Irrigation Scheme;

Part II defines the refurbishment concept, traverses the options considered and summarises the recommendations for all the schemes in the refurbishment package.

The investigations up to the completion of these reports have been funded by government. The feasibility reports have been prepared as support to decisions on the future of individual schemes.

This report is not a statement of government or National Water and Soil Conservation Authority policy.

All estimates of cost that appear in this report are based on the Ministry of Works and Development Construction Cost Index at 30th September 1986 of 2650. The estimates DO NOT include any allowance for Goods and Services Tax (GST).

Acknowledgements

Part I of this report was prepared by Philip Walker of the Water and Soil Directorate, Dunedin, with invaluable inputs from the District Design staff and the staff of the Alexandra Residency irrigation section. Specific parts of the report background were contributed by various people as follows:

Secondary Works

John Anderson and his operating staff in Alexandra provided the estimates - these were collated by Mark Hely of the Water and Soil Directorate.

Primary Works

Peter Mathewson and his staff of the Dunedin District Design team provided civil engineering advice and estimates.

Post Refurbishment Operations

Gary Dent of Water and Soil Directorate modified and collated estimates to fit two possible future operating modes, with background provided by Dale Patterson of Alexandra.

Report production and computer compilation of the reports and estimates ran very smoothly to the credit of Stephen Aldridge and Murray Doak of Water and Soil Directorate. Mark Hely's detailed knowledge of the schemes and technical assessments of problems and Philip Walker's input into the detailed briefing were important contributions to the exercise.

Part II: Summary of Feasibility Studies was prepared by Gary Dent.

Special acknowledgement is accorded to Graeme Martin for his guidance throughout and in particular his comments on the first draft of the reports.

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PART I: OMAKAU SCHEME REFURBISHMENT PROPOSAL

CHAPTER 1 : GENERAL SCHEME DESCRIPTION

1.1 BACKGROUND

The Omakau Irrigation Scheme situated approximately 30 km northeast of Alexandra comprises the Omakau main race system drawing water from the Manuherikia River and a number of smaller creek based race systems. These are Dunstan, Matakanui, Lauder, Clearwater, County, Scott's Creek, Devonshire and Blackstone Hills. The area commanded by the scheme is 14 000 ha of which 5560 ha was considered irrigable under irrigation agreements in the 1986/87 irrigation season.

1.1.1 Scheme Topography

The scheme irrigates the lower slopes of the Dunstan Mountains, to the west of the Manuherikia River, between the Dunstan Creek in the north and the Magdalen Hills (Tiger Hill) in the south. These lower slopes are intersected by numerous mountain streams.

A small area (345 ha) of river flat to the east of the Manuherikia River is irrigated from Blackstone Hills race.

1.1.2 Scheme Layout

Falls Dam on the Manuherikia River, approximately 10 km upstream of the Omakau main intake, provides storage primarily for the Omakau scheme, but also benefits the Manuherikia and Galloway Schemes.

The Omakau main race draws water from the Manuherikia River then swings around the Omakau basin and bywashes just upstream of the Manuherikia Gorge. In addition there is a short pumped extension to the main race over Tiger Hill which uses free power from the Fraser power agreement.

The Blackstone Hills race draws from the Manuherikia River upstream of the Omakau main intake and feeds a farmer operated system on the eastern side of the river.

The Dunstan race skirts the foot of the downlands below the Cambrians area and commands the Becks and middle Lauder Creek sub-areas.

The remaining race systems follow the foot of the Dunstan Range and command ridges and fans of high elevation.

1.1.3 Brief History

This irrigation scheme is notable in that the Omakau Main system uses no old mining races but was built as an irrigation scheme. However some of the 17 water rights now held by the Crown were originally for mining purposes. The Matakanui, Lauder and Devonshire systems use old mining races.

Initial survey and investigation for the scheme was completed by 1931 and water was first supplied in the 1935/36 irrigation season. The Matakanui and Lauder systems, which were already operating, were incorporated into the scheme in 1935/36 and the Dunstan system was added in the 1938/39 season.

In 1955 the crest of the rockfill Falls Dam was raised by 0.6 m to the present 33.5 m above streambed to give a total storage capacity of 10.4 million cubic metres.

1.1.4 Scope of Scheme

Approximately 4 cumecs of water can be supplied from the various intakes on the scheme. This is supplemented at times of low flow by the 10.4 million cubic metres of storage behind Falls Dam.

The storage water is only available to the Blackstone Hills race and the Omakau main race and must also be shared with the Manuherikia and Galloway irrigation schemes. The remaining race systems are 'run of the river' systems.

There are 67 properties supplied under area based irrigation supply agreements, and a total of seven pipe supply agreements.

The annual water quota is a depth of 305 mm over 694ha and 450mm over 4866ha, with extra water being made available as the flows allow. The average water usage over the past nine years was 476 mm (range 300 mm to 687 mm). This extra water usage is primarily due to the fact that the area actually irrigated is substantially greater than the agreement area.

1.2 WATER RESOURCE

The scheme draws water from two resources:

a Manuherikia River

The Manuherikia River carries runoff from the St Bathans, Hawkdun, Dunstan and Raggedy Ridge ranges in a southward direction to join the Clutha River at Alexandra. The resource supplies flow to three government irrigation schemes - Omakau, Manuherikia and Galloway. Low summer flows in the river are supplemented by use of storage in the Falls Dam reservoir in the upper reach of the river.

Water is usually released from Falls Dam reservoir in late December and lasts six to eight weeks without appreciable replenishment. This means that in dry seasons the latter months of the irrigation season may have water shortages.

The Omakau Irrigation Scheme draws flow from the river at two points at the top end of the scheme.

The larger flow (up to 2.1 cumecs) to the main race system is abstracted at a diversion weir through control gates on the true left bank. The main race crosses the river to the right bank and carries flow along the entire length of the scheme.

A smaller flow (up to 0.28 cumecs) is also abstracted on the true left bank and is used to irrigate 345 ha on the eastern bank from the Blackstone Hills Race.

b Dunstan Mountains Water Resource

Several of the larger streams which drain the south eastern side of the Dunstan Mountains are used to supply irrigation flows to the smaller race systems which operate independently of the main race systems. The water from these streams reduce in quantity in the summer and autumn months and can limit supplies substantially. There is no storage backup.

These races irrigate the lighter land running along the foot of the Dunstan Mountains and are known by the names of their respective water sources. Flows in these races are typically between 0.33 cumecs and 0.45 cumecs.

1.2.1 Water Rights

The Crown holds 17 water rights totalling 4.87 cumecs for the Omakau Irrigation Scheme. The priority that each of these holds is not clear and needs to be investigated. It is known that the largest right for 2.27 cumecs from the Manuherikia River is subservient to another right for 2.83 cumecs to the Manuherikia Irrigation Scheme (they are operated together to provide good supplies to both schemes). The Dunstan Creek right for 0.5 cumecs is a "second call" right.

Appendix A contains a schedule of water rights as at 1969.

1.3 SOILS

Reference 7 should be consulted for detailed information.

The principal land forms are broken terraces and broken fans formed by rivers and creeks. There is little flat terrain. Up to five different terrace levels contribute to a very complex soil pattern.

The soils are of a variable quality being generally sands and sandy loams but having a range of natural fertility from low to high. Almost all soils have an underlying clay pan which impedes drainage over most of the irrigated areas. At lower levels this poor drainage has caused isolated areas of waterlogging with consequent rush growth and salt concentrations. To control these problems either the provision of better drainage or the careful control of irrigation application over a large area is required. However neither of these problems is difficult to overcome.

Water holding capacities of the soils range from below 25 mm up to 75 mm with the average range being around 25-50 mm. This indicates that small frequent irrigation is the most efficient means of applying water in this region.

1.4 LAND USE

Land use on the Omakau scheme is presently limited to pastoral farming with a small amount of cereal cropping. Many of the farms are on hilly country with a small proportion of the total area irrigated. On average 39% of the farm is irrigated.

1.4.1 Pastoral Farming

As with the rest of the region sheep production is the major form of agriculture on the Omakau Scheme.

Farming potential with irrigation is 10-15 stock units per hectare. Where this potential is not being achieved changing farm management methods may improve stocking rates. For example, using smaller paddocks will exert better grazing pressure at critical times of the year.

Irrigation allows reliable production of winter feed while irrigated pasture is also useful for flushing ewes prior to tupping in April and for lamb finishing in February.

There is very little cattle farming around Omakau even though cattle are excellent for the control of rank growth in summer. The area is too far from markets with high transport costs to enable profitable cattle trading.

1.4.2 Cropping

Approximately 10% of the irrigated area is used for cereal crops with oats and barley being the principal crops grown. The nutrient status of the soil is high, but it is the farmer rather than the soil that dictates the success of cropping. Farmers tend to implement cropping as part of their pasture renewal programme. Yields obtained are in the range of three to six tonnes per hectare.

Irrigation is important to crop growth by providing strategic watering at times of critical moisture deficiency particularly around November.

1.4.3 Horticulture

As all the scheme is above an elevation of 320 m the potential for horticultural development is limited. The Corrigal Road to White Road area near Tiger Hill appears to be the only suitable area but even this may not be economically viable because of high frost protection requirements.

1.4.4 Irrigation Methods

The predominant methods of irrigation in the area are wildflood and contour dyking. Farmers are fairly efficient with this method (gaining coverages up to almost 100%) although evenness of watering is not known.

Apart from wildflood and contour dyking there are also small areas of borderdyke irrigation and some areas of spray with about 20 mobile irrigators new to the scheme in the last 5-6 years. Suitable land for borderdyke development is uncommon within the scheme area. Therefore spray is the best alternative irrigation method However an expansion of spray irrigation where power is required is not economic for pasture according to Ministry of Agriculture and Fisheries.

CHAPTER 2 : OFF FARM SYSTEMS

2.1 GENERAL DESCRIPTION

The Omakau Irrigation Scheme off farm system is made up of 100.7 km of main races (49.3 km on the Omakau Main system) and 91.4 km of distributary races. Within these races are 7.3 km of syphons and four concrete lined tunnels totalling 650 m. There is also a pump at Tiger Hill which provides a continual supply from the Omakau main race of 0.142 cumecs over a 7.5 m high saddle.

Structures within the race systems total 1251 at 1109 sites, of which 483 are access crossings, 309 are turnouts, 194 are pipelines or syphons and the remaining 265 are made up of intakes, bywashes, drops and other miscellaneous structures.

2.2 LEVEL OF SERVICE

With Refurbishment

With refurbishment the irrigators can expect a continued reliable supply at present flow capacities.

Without Refurbishment

Without refurbishment silting up of races, slips and structural failure would disable much of the scheme. The level of service to the entire scheme would be reduced. Parts of the scheme have a "life expectancy" of around two to three years, being dependent on the survival of some of the major structures. This is particuarly so for the Omakau main system and the Dunstan system.

The area served from the Dunstan Mountain streams, except the Dunstan system, could continue to operate without refurbishment. The structures and problems are smaller scale and farmers could do sufficient repairs without significant engineering input to keep them operating for many years.

2.3 CURRENT STATUS

The Omakau Irrigation Scheme is in a fairly sound condition. There are however, a number of large structures which are now in a poor state of repair and require replacement in the very near future. A common problem with many of the long concrete pipelines is that of leaking joints. This leakage saturates the surrounding ground causing slumping and cavities. Settlement of the pipe occurs and the leakage increases.

If key structures such as Lauder and Becks syphons fail the irrigation supply to about 50 properties will be cut off. Other major pipelines which could fail within the next five years are Golden Gate Syphon, Huddlestone Syphon, Harley's Syphon, Hamilton's Syphon, Matakanui distrib "A" Syphon and Tiger Hill Pump Rising Main.

Apart from these major problems there are a number of more minor problems scattered throughout the scheme. These comprise old, damaged and ineffective minor structures such as measuring boxes, bridges and culverts.

One item worth special mention is access bridges. Most of these brdges can only handle service loads, usually up to a five tonne limit, but at present they are being subjected to much larger loads of modern farm machinery. The result is that some of the concrete bridges are showing signs of distress.

Another area of concern is that of insufficient control of water at the intakes. This problem is particularly noticeable in schemes fed from the smaller mountain catchments. During a storm these streams rise quickly and the intake gates require immediate adjustment by the raceman to prevent overloading of the races.

CHAPTER 3 : REFURBISHMENT PROPOSAL

3.1 INTRODUCTION

The proposal submitted in this report is the result of a detailed identification of structures in need of refurbishment and an assessment of work required to bring the scheme up to the original or currently accepted level of service. The definition of refurbishment and comparison of the general approach taken in formulating scheme refurbishment proposals is discussed in Part II, sections 2.1 to 2.5.

The initial structure condition and description has been taken from the Phase I Inventory of all scheme structures produced during 1984 and 1985. The structure numbers referred to in this report refer to those in the Phase I inventory. The majority of works have been estimated to Preliminary Assessed Cost standard, however where detailed investigations and estimating have not been possible to date the standard is Rough Order Cost only.

All estimates are based on costs at 30 September 1986 (CCI 2650).

In order to complete this phase of the work efficiently it was found necessary to adopt a slightly different categorisation of structures than was used for the phase 2 exercise. Structures have again been split into two categories called 'Primary Structures' and 'Secondary Structures'.

3.1.1 Primary structures

These are structures in need of refurbishment that are essential to the proper functioning of a significant proportion of the scheme (generally at least 10%) and/or which could cause significant damage if they failed. These structures usually have a significant design input and are usually the more expensive structures on the scheme.

3.1.2 Secondary structures

Secondary structures are the remaining structures in need of attention within the next five years. This may be due to deferred maintenance or because the structure is near to failure. These are low cost structures which would normally only be renewed when they failed or at the end of their life. Failure only results in local damage and inconvenience.

Primary structures that have been refurbished can be expected to function with normal maintenance for at least 15 years. Secondary structures will need normal maintenance and minor repair for the 15 years after their refurbishment. It is assumed that the repair and replacement of those structures not refurbished will be included in the on-going post refurbishment operation and maintenance programme for each scheme.

Structure numbers referred to in this report relate to the scheme inventory (ref 2).

3.2 SCHEME PROPOSAL

3.2.1 Primary structures

Primary structures with the refurbishment works required are listed below:

Falls Dam and Spillway

This is a rock fill dam standing 33.5 metres above the streambed with a reinforced concrete membrane on the upstream side. A morning glory spillway hole takes flood and overflow waters past the dam.

The work required on the dam membrane is concrete repair to alleviate minor cracking and surface damage. Although damage to the membrane is minor, repair work is essential to ensure impermeability of the membrane so that the rockfill is protected.

The spillway requires repairs to the damaged lining. Latex modified concrete is recommended for repair of the bell mouth and at the concrete panel joints between the units making up the circular spillway conduit.

Intake Structure and Pipeline (Omakau Main Race - structures 1 & 2)

Concrete repairs are required to the cracks and holes inside the intake structures. The pipeline requires concrete repairs to the invert, which has worn down to the pipe reinforcing steel, and to some joints.

Control structure (Omakau Main Race - structure 3)

This concrete structure is situated at the end of the intake pipeline. It has ten mechanically operated scour gates in the floor that remove sediment (only three are operational) to the scour channel leading back to the river. There is a measuring weir in the downstream wall of the structure. It is proposed that the sediment removal system be modified including the installation of 'knife' type sluice gates to improve the sluicing ability of the structure.

Becks Syphon (Omakau Main Race - structure 23)

The first section of this pipeline consists of 40 m of 910 mm diameter concrete pipes which leak badly. The remainder of the pipeline is in good order. The leakage in the syphon is aggravated by air being sucked into the line at the intake.

It is proposed that the first 40 m of the syphon be replaced with RCRRJ pipes and that a new intake with improved hydraulic performance be constructed to prevent air entrainment in the pipeline.

Lauder Syphon (Omakau Main Race - structure 56)

This is a 1630 m long syphon with concrete and concrete lined steel pipes. The pipeline has several sections of badly leaking pipes, especially in the first 873 m section of concrete pipeline, which has resulted in slumps and large cavities. The proposal is to replace the first section of pipeline and other pipes where necessary. A contingency has also been allowed for burying the central section of concrete lined steel pipe should this be necessary.

Concrete syphon (Omakau Main race - structure 155)

This syphon is also leaking badly and will need to be replaced. Two options were considered. One was to replace it with another concrete pipeline and the other was to construct an open race approximately 800 m long. The latter option being the cheaper, is the proposed work.

Golden Gate Syphon (Omakau Main Race - structure 170)

The Golden Gate Syphon is a 110 m long, 600 mm diameter concrete pipeline with severe leakage problems. It is proposed that this syphon be replaced with a new RCRRJ pipeline of the same diameter.

Huddlestone Syphon (Omakau Main Race - structure 177)

This syphon is 1151 m long and has a diameter of 600 mm. The major problem with the syphon is severe leakage at the pipe joints along much of its length. Two replacement options were investigated:

1. replacement with a new RCRRJ pipeline at a total cost of $351 000.
2. replacement with an open race and a smaller syphon at a cost of $328 000.

It is proposed that the open race solution be adopted but because the estimates are only 6.5% apart it is recommended that this decision be checked at the design stage.

Tiger Hill Pump Rising Main (Tiger Hill Pump Race - structure 4)

The rising main is a 84 m long, 375 mm diameter pipeline with severe leakage problems. It is proposed to replace it with a new RCRRJ pipeline.

Harley's Syphon (Dunstan Main Race - structure 18)

This syphon bypasses an unstable hillside and is leaking badly. It is proposed to replace this syphon with 210 m of open race.

Hamilton's Syphon (Dunstan Main Race - structure 48)

Many of the joints of this syphon are leaking, especially in the section upstream of the Beck's Creek crossing. The syphon consists of 659 m of 525 mm diameter concrete pipes and 24 m of 525 mm diameter steel pipes. The proposed work is total replacement of the pipeline with RCRRJ pipes at a total cost of $121 000.

Thomson's Creek Syphon (Matakanui Distributary A - structure 1)

Parts of this 244 m long, 375 mm diameter syphon leak very badly and require replacement. The proposal is that the worst 160 m of the syphon be replaced with 375 mm diameter RCRRJ pipes. The life of the remaining section of pipeline is estimated as exceeding 15 years.

3.2.2 Secondary Structures

The proposed work on secondary structures includes the repair or replacement of 39 measuring boxes, 12 bridges, 2 turnouts, 16 gates, 16 access crossings, 3 drops, 2 flumes, 4 under race pipelines, 8 headwalls, 8 endwalls, 7 culverts, and one bywash. There is also construction of approximately 300 m of open race, installation of drain plugs into four syphons, rock protection for four syphons and other miscellaneous work.

Where syphons are replaced the pipes which are recovered have some salvage value and can be re-used, for example as access crossings. This salvage value has not been taken into account in the estimate for primary works.

It has been claimed by the irrigation scheme committee that the Golden Gate and Huddlestone Syphons are under sized. The difference in cost between replacing the pipeline with 600 mm and 675 mm diameter pipe has been recorded in the estimates.

In the case of Hamiltons Syphon an open race solution was only 10% more in cost. Therefore further investigations of both pipe and open race options should be made before final design.

Various options for the refurbishment of the Omakau Main race intake system were investigated.

1. Replacing the intake structure with one incorporating an overflow weir intake, silt-trap and bywash.

2. Retaining the intake structure and installing a bywash at the control structure. This would bypass excess flow into the extended scour channel.

3. Installing low level knife gates in the wall of the existing measuring weir and the bywash as described above in option 2. The measuring weir would be raised to the level of the side walls.

4. Replacing the present measuring weir with a battery of baffled radial gates. The bywash described earlier could also be used for this option.

5. 'Status quo' option - minor concrete repairs to the intake and pipeline and installation of new sluice gates at the control structure.

The cost of the first four options (excluding the cost of the new silt scour gates) is considerably higher than any operational cost saving over the next 20 years. Thus it is recommended that the 'status quo' option be adopted and that the present means of operation be retained.

Mechanical and Electrical division were asked to assess the condition of the Tiger Hill pump. They recommended that the present pump be retained. The cost of replacing the pump was found to be much higher than the discounted maintenance costs expected over the refurbishment period.

3.3 COST SUMMARY

The estimates presented here are to Preliminary Assessed Cost (PAC) standard and are based on a Ministry of Works and Development Construction Cost Index of 2650 (September 1986). Contingencies are estimated as 15% for both primary and secondary works. For primary works the engineering and administration cost is estimated at 15% and for secondary works at 14%. GST is not included.

Primary structures

	$	
Falls Dam and Spillway	313 300	
Intake Structure	25 700	
Beck's Syphon	26 500	
Lauder Syphon	105 300	
Structure 155(Omakau Main)	34 000	
Golden Gate Syphon	38 000	
Huddlestone Syphon	317 400	
Tiger Hill Pump Rising Main	14 000	
Harley's Syphon	22 650	
Hamilton's Syphon	91 140	
Thomson Creek Syphon (Matakanui distributary A)	20 000	
Contingencies (15%)	151 200	
Lauder Syphon Contingency	210 000	
Engineering & Administration Costs (15%)	205 380	
SUBTOTAL		$ 1 575 340

Secondary structures

Main Race	195 210	
Main distribs	42 110	
Clearwater Main	6 610	
Dunstan Main	52 240	
Dunstan distribs K J JD	18 370	
Lauder Main	20 800	
Lauder distrib D	2 870	
Matakanui Main	17 230	
Matakanui distribs	22 440	
Devonshire	590	
County	4 970	
County distrib 1	930	
Assessed minor works	96 750	
Contingency 15%	72 170	
Engineering & Administration costs 14%	77 570	
SUBTOTAL		$ 630 860
TOTAL REFURBISHMENT ESTIMATE		$2 206 200

NB. A provisional allowance of $500 000 for improvements, and investigation costs up to the completion of the feasibility reports have been included in the estimate for the package of 13 schemes (ref. Part II, Tables A.1 and A.2).

3.4 TIMING OF CONSTRUCTION

It is proposed that refurbishment of both primary and secondary structures should be programmed for completion within the minimum construction time of 5 years. Harley's and Hamilton's syphons on the Dunstan race would be the first primary structures replaced with construction programmed for 1989. Construction on the other primary structures would be undertaken during the years 1991-92.

Figure 3.1 shows the expected pattern of expenditure according to the refurbishment programme shown in Part II, figure 2.1.

Appendix C gives additional cashflow information.

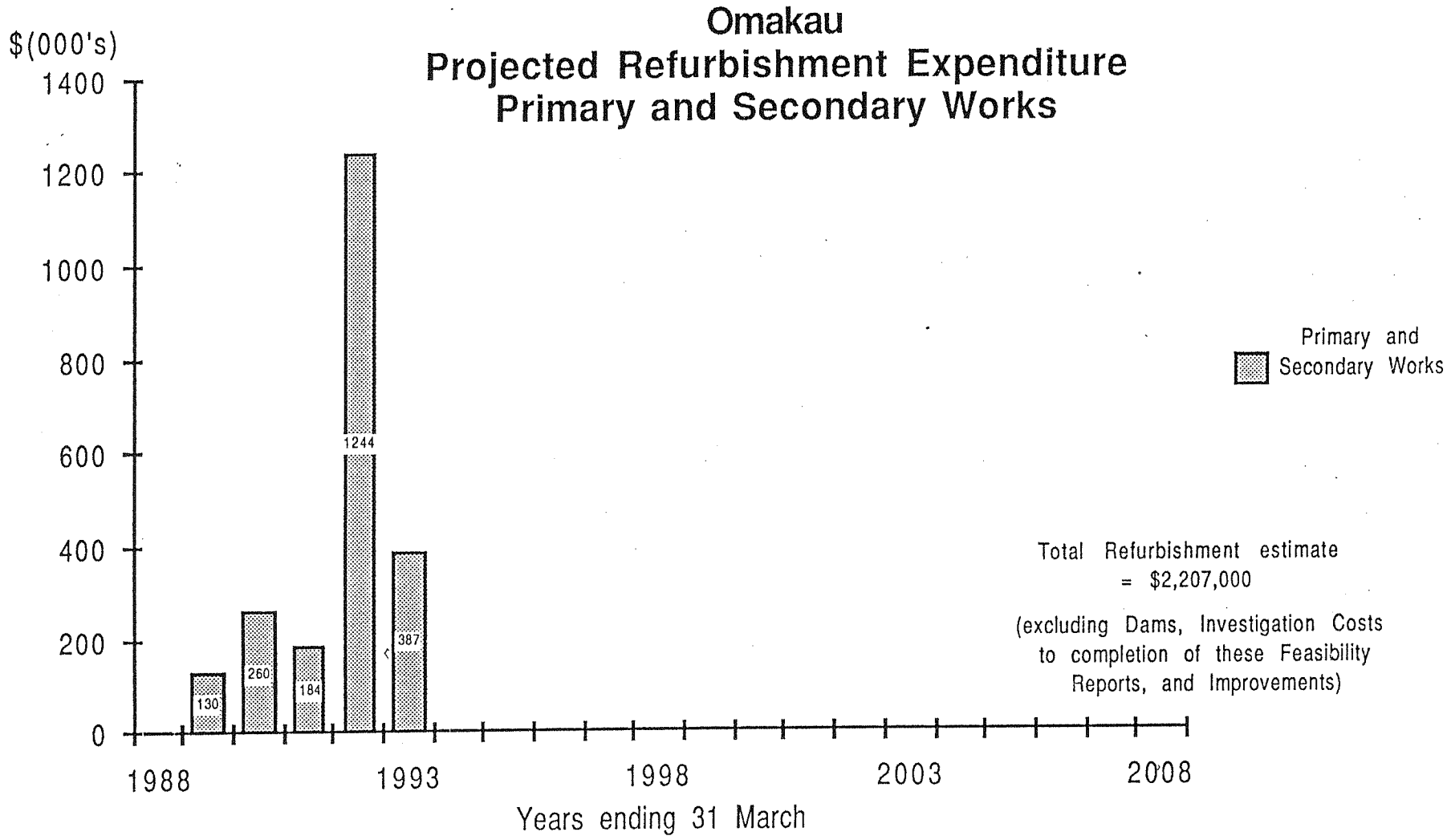

Figure 3.1 Proposed Refurbishment Cashflow

CCI 2650

CHAPTER 4 : POST REFURBISHMENT OPERATION

4.1 INTRODUCTION

The objective of this chapter is to present the information supplied from the operational staff in terms of the resource requirements for operation and maintenance (manpower, plant and materials) in terms of two possible post refurbishment operating modes presented in this chapter.

The two scenarios presented here are:

a. Contract service
b. Contract with free farmer assistance

For a description of operation activities and general comparisons between the possible future modes and the historic modes (pre 1984) refer to Part II Chapter 3 and in particular, Tables 3.1 and 3.2.

Before each of the refurbishment proposals is presented for approval in principle it is recommended that the irrigator committees should be invited to critically examine the current operating mode and redefine the contract services they consider are appropriate. The estimates assume that the schemes have been refurbished.

a. Mode 1 - Contract service

With this mode scheme operation, maintenance, repair and renewal would all be done on a contract basis. Virtually all the turnouts would be operated by the raceman but there would be a minimum of surveillance. The scheme would operate strictly according to supply roster.

b. Mode 2 - Contract with free farmer assistance

With this mode farmers would provide assistance at no cost to the scheme for:

- Operation of secondary distribution structures and all turnouts according to the roster.
- Distribution works operational maintenance (clearing debris and in season race clearing activities).
- Winter handcleaning with farm labour.
- Weedspraying.

The other duties would be done as in mode 1 by contract.

It is recommended that the following areas be reconsidered by the irrigators in terms of the cost and effectiveness of contract services currently available.

Operations

- Farmer operation of turnouts
- Roster operation versus costs of on demand supply mode and implications on water sales recording for irrigation and other water users.
- Farmer operation of distribution and some headworks structures.
- Race surveillance practices.
- Water policing.
- Water supply during the winter season.

Maintenance

- Local availability of farm labour and plant in winter for race cleaning activities.

- Weed spraying activities.
- Supply of materials - spray, tools, vehicles, etc.
- Supervision of works.
- Effectiveness of cleaning activities and their frequency in relation to alternative levels of service.

Repairs and replacements

- The general standard and types of structures especially turnouts and flow modules available.
- Policies on scheme fencing and access.

It is evident from our studies that there is very little readily available information on the service performance of secondary structures, ie, annual repair cost against age, data on the life of exposed and buried concrete pipes, etc.

The assumptions used for the replacement cost predictions are based on comments from Alexandra construction staff and general data on the life of concrete structures. A job recording system interfaced with the existing computerised structure inventory could be employed to provide cost performance data to support future repair and replacement programming and annual estimates.

4.2 PRESENT OPERATION

4.2.1 Scheme operation

This scheme is presently operated on a 'demand' basis with a team of four racemen. Both vehicles and motorcycles are used for operational duties.

Operation involves the monitoring of various creek fed intakes as well as the Main Race intake on the Manuherikia River, control of the Falls Dam storage (in conjunction with operators of the Manuherikia and Galloway schemes down river), water distribution within the race network, operation of a small in race pump (Tiger Hill pump) and arranging water sales to individual irrigators.

4.2.2 Maintenance

This activity includes manual and mechanical race cleaning, water weed control within the race, limited brush control and pump maintenance.

The manual cleaning presently occupies approximately 15 man weeks ($12 500 per annum) and is undertaken by the scheme operators. Mechanical cleaning requires approximately four weeks of machine time and over a 3.5 year cycle 80% of the scheme races are cleaned. Over the last 8 years there has been a progressive improvement in their condition.

Weedspraying takes 4.5 weeks using the schemes own racemen and costs approximately $8 500 per annum.

The Tiger Hill pumps are in reasonable order and an annual allowance of approximately $3000 for mechanical and electrical repairs has been sufficient to cover maintenance.

4.2.3 Repairs and renewals

At present 17 man weeks are allocated to this activity.

Input to repairs and renewals varies from year to year. The cost of this work over the last three years adjusted to CCI 2650 is as follows.

1983/84	$14 100
1984/85	$18 100

1985/86	$36 700

Attention to repairs and maintenance on this scheme has been deferred for many years in favour of repairs on other schemes.

4.2.4 Scheme costs and charges

An indication of the financial position of the scheme is given by scheme accounts for 1985/86, the last year for which full accounts are available. Expenditure excluding interest on capital and administration charges was as follows:

Racemen	$107 668
Plant Hire	58 128
Materials	88 968
Total	$ 254 764

Scheme charges for this season were for a 300 mm water depth as a basic supply.

Basic supply	$24.49
Extra water	$6.76

Scheme revenue for the same season amounted to $175 052. Revenue for 1986/87 should come close to equalling the expenditure.

4.3 FUTURE OPERATION

Following refurbishment it is probable that the full annual operating costs will have to be met by the irrigators.

The estimates for the two proposals put forward cuts the annual operating costs to a practical minimum and assumes respectively minimal and maximum levels of assistance from the irrigators. Should a more comprehensive service than defined for mode 1 be required by the community then the costs and charges would inevitably be higher. Alternatively, the community may wish to take on more operation and maintenance duties themselves. The desired balance of contract and farmer input is expected to eventually lie somewhere between these two modes.

Suggestions for scheme improvements are also made with some indication of the saving that would result.

4.3.1 Mode 1 - Contract Service

4.3.1.1 Scheme operation

Racemen

This scheme requires 6.3 days of racemans time to operate per week.

Transport would be by motorcycle with vehicle support being available. Efficient organisation of daily duties would be required to reduce the amount of travel required.

Roster

It would be necessary for a roster to be introduced at least when storage is being drawn upon from Falls Dam. However a roster operating for the whole of the season would have the advantage of more efficient use of manpower. This would allow the scheme to operate with only two men using

assistance from the irrigators opening and closing turnouts between the racemans normal rounds. If an 'on demand' contract service is preferred then the water management cost will be higher than that estimated for the contract service mode. However, if the farmers operated the distribution system then the water management cost could be reduced to that for the 'free farmer assistance' mode.

Telemetry

The monitoring of the various creek intakes is a time consuming task. The installation of telemetric equipment to measure flows at creek intakes as a means of saving racemans time and travel is considered worthwhile.

Telemetric controls on the Tiger Hill pumps would enable the raceman to regulate the supplied subsection of the scheme while attending to other duties. Full telemetric control is estimated to cost $10 000 - $15 000 with an ongoing annual cost of $1 500. This is not included in the refurbishment estimate in Chapter 3, but could be considered as an improvement if the economics are acceptable.

Bywash facilities and flood controls

With a reduced staff there would be limited ability to attend to problem areas when flooding occurs. It is proposed to improve the in race flood controls and bywash facilities in all creek fed races and on the Main Race to protect against the effects of future flood damage to the race system.

4.3.1.2 Maintenance

It is proposed to continue the practice of summer machine cleaning which is quicker and less damaging to the races than winter cleaning. Machine cleaning programmed is for 2 weeks in summer and 4 weeks in winter.

The total future labour requirement for handcleaning and weedspraying is expected to be much as at present (secton 4.1.2).

4.3.1.3 Repairs and renewals

A total of 17 man weeks would be required to complete the annual repair and renewal work.

The proposed level of spending after refurbishment is higher than has occured over the past few years. In recent years with limited funds the condition of structures has been gradually allowed to run down. Thus after refurbishment is complete a higher level of spending will be required to maintain the condition of the scheme. Many of the measuring boxes are light walled and although sound now can be easily damaged by heavy stock and will need replacing in the period 5-15 years.

Flood provision

The scheme is prone to flooding in the creek intakes. It is estimated that in the long term an average of $15 000-20 000 per annum would be required to cover flood damage.

It is proposed that a flood damage fund should be established.

4.3.1.4 Management Services

Figure 3.3 in Part II of this report shows a proposed organisation structure for providing management services to Central Otago irrigation schemes. Costs to individual schemes have been based on this.

This service would coordinate the various resource inputs required to operate and maintain the scheme. This includes management of the water resource, programming and control of financial expenditure and arranging technical advice and engineering supervision where necessary.

4.3.1.5 Water Charge Costs

These are the estimated costs of operating a scheme account including sending individual invoices twice per annum, receiving payment and preparing financial reports for audit.

4.3.1.6 Projected costs and charges

Given the above mentioned changes and improvements to scheme operation then the projected annual costs post refurbishment are as follows:

	Year 1994 $	Year 2008 $
Replacements	0	108 900
Repairs	47 500	60 000
Maintenance	79 900	79 900
Operations		
water management	66 100	66 100
operational maint.	26 400	26 400
water charge costs	4 700	4 700
Administration	4 400	4 400
Total	$229 000	$350 400

NB Provision for flood damage is included in the estimate for repair.

4.3.2 Mode 2 - Contract service with free farmer input.

It is feasible to reduce direct costs by farmer input into the following activities:

	Potential saving ($ per annum)
Farmer maintenance, handcleaning and weedspraying	29 000
Farmer operation of turnouts according to roster and and some secondary distribution structures	14 900
Operational maintenance within the hill subschemes and distribution system	8 100
TOTAL ANNUAL SAVING	$52 000

4.3.3 Concluding Remarks

The Contract Service mode 1 and Contract Service with Free Farmer Assistance mode 2 represent opposite ends of the spectrum in terms of the cost required to provide the proposed level of service based on rostered supply. Assuming that schemes adopt the roster approach to water distribution the post refurbishment operational costs should fall somewhere between these modes depending on the degree to which free farmer assistance is forthcoming.

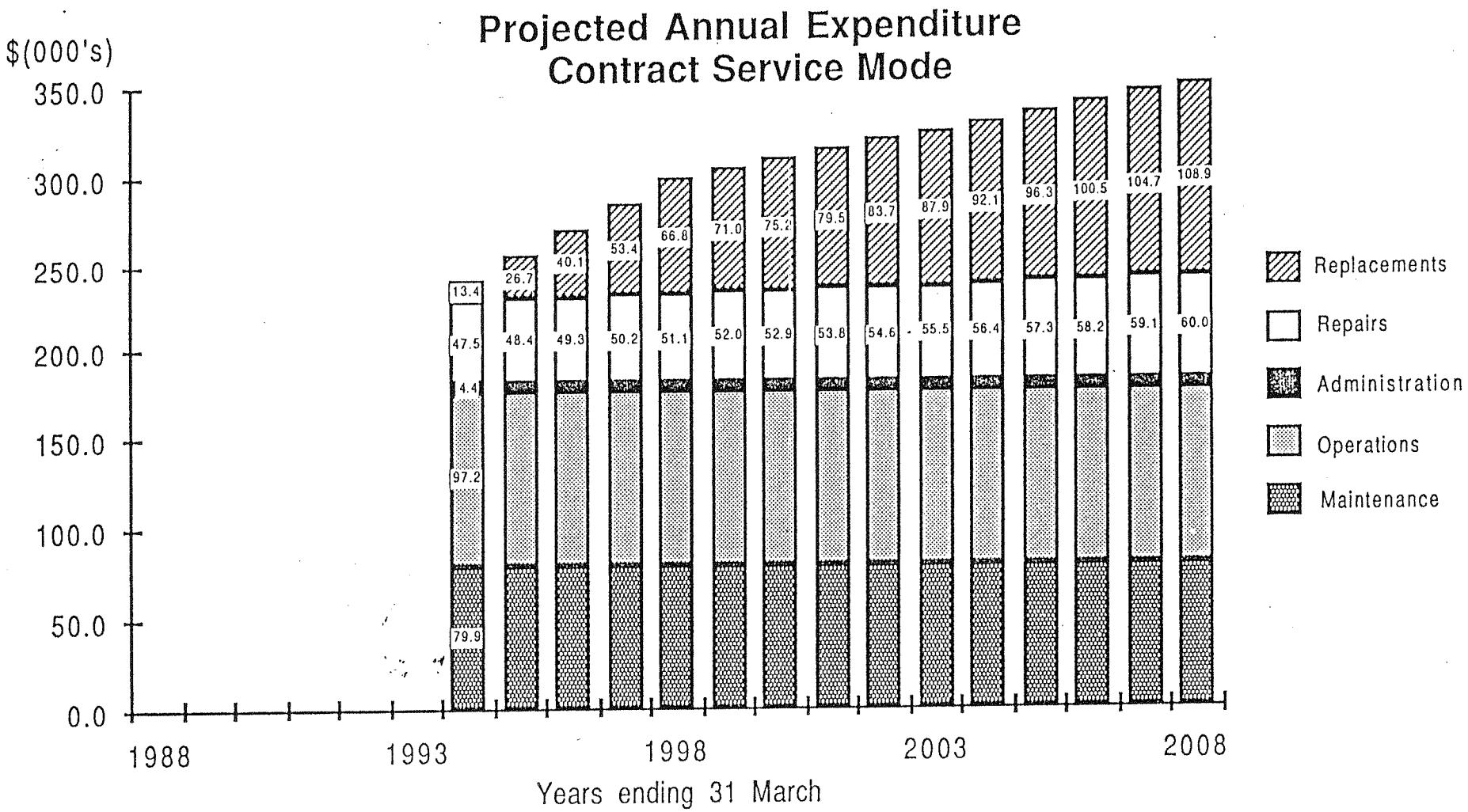

Figure 4.1 Omakau CCI 2650

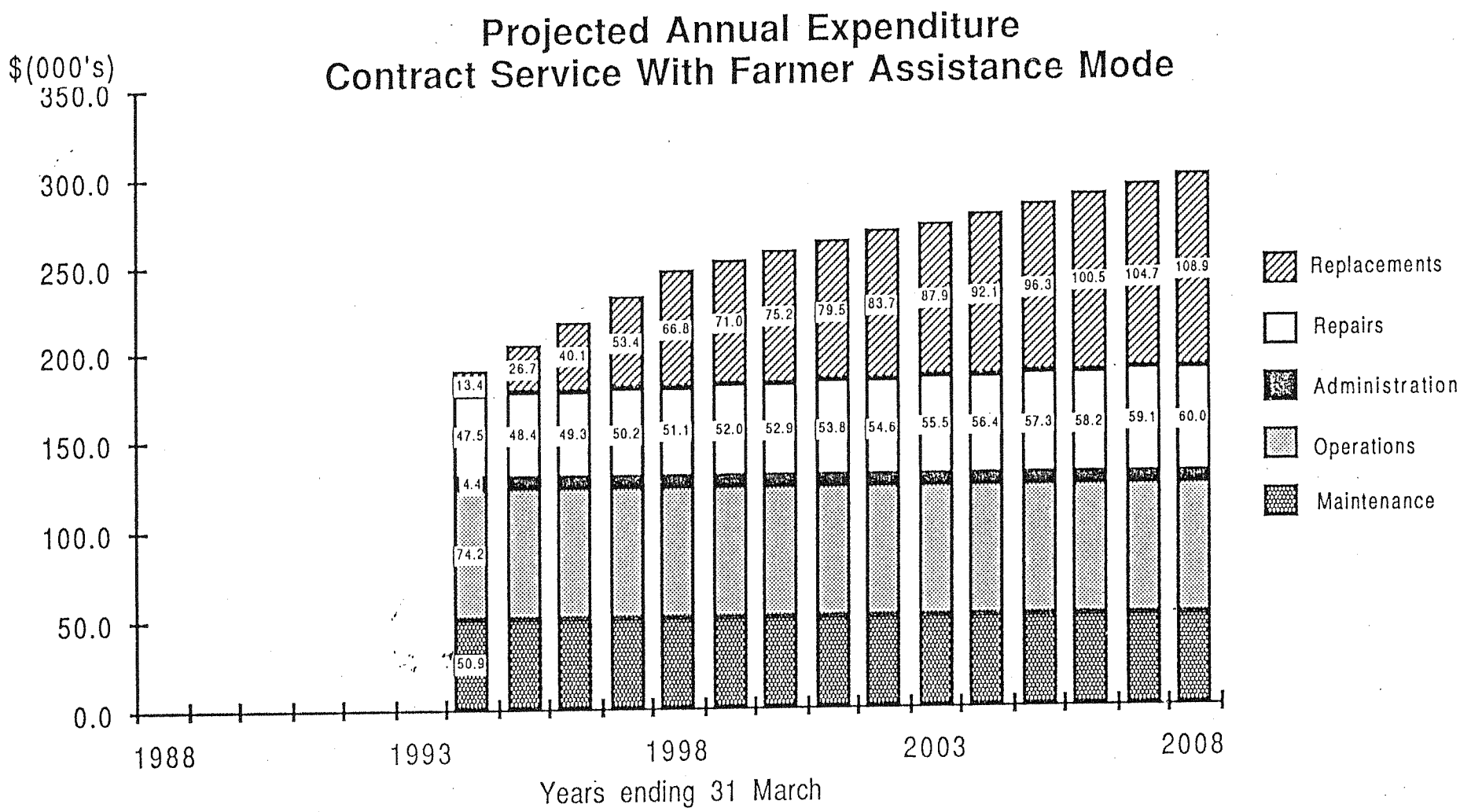

Figure 4.2 Omakau CCI 2650

CHAPTER 5 : CONCLUSIONS

There are a number of major structures on this scheme, mainly long syphons, that are now in a poor state of repair and have a high risk of failure in the medium term. The loss of these key structures would result in large areas losing irrigation supply and require costly repairs.

The races and secondary structures are generally in reasonable condition although deferred maintenance over the last few years means that there are a substantial number of minor repairs required to maintain the present level of service to the scheme.

The proposed refurbishment work would enable the present level of service to be maintained for the next 15 years without further major injection of funds. The scheme would be well placed to cover its own expenditure at a reasonable cost to the farmers and be on a sound footing for contract operation.

SCHEME REPORT DATA SHEET

Irrigation Scheme .....Omakau.....

Date of Construction ..1934-35.....

Area Commanded ..14 000..ha Irrigable Area..5560 ha (1986/87)

Number of Racemen ....4 plus 1 handyman....(1986/87).....

Water Users:

Irrigators .....67.....(1986/87).....
Pipe Supplies.....7.....(1986/87).....

Length:

Main Race .....100.7..... km
Distributaries ...91.4..... km

Principal Water Sources:

Storage .....10.4..... million m3
Run of River .....4..... m3/s
Pumped .....0.14..... m3/s
Storage shared by Omakau, Manuherikia and Galloway irrigation schemes and feeds the Manuherikia River. Therefore schemes are storage augmented "run of the river" schemes. Extension of Manuherikia main race over Tiger Hill

Water Quota .305 (694 ha)..450 (4866 ha)..mm

Water Usage MWD Records 1975/76 - 1982/83:

Average .....476..... mm
Range .....305-687..... mm

Land Use	Pasture	Horticulture	Cropping
%	90	0	10
Irrigators	79	0	0

Irrigation Methods: Predominantly contour dyke/wild flood with some.. borderdyke and spray.....

Accumulated Loss to 15 May 1986 $...2 678 190.....

Average O&M 1970/71-1985/86

(CCI = 2650) $..366 632..... ($.....66...../ha)

Refurbishment Capital Cost (CCI = 2650)

Primary Works	$ 1 575 340
Secondary Works	$ 630 860
TOTAL	$ 2 206 200
	($ 400 /ha)

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3. RICHARDS D W and WALSH I G (1984) Manuherikia Valley Irrigation Scheme - Prefeasibility Report on Civil Engineering Aspects of Irrigation Options; Civil Design, MWD, Dunedin.

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7. McCRAW J D (1964) Soils of Alexandra District; Soil Bureau Bulletin 24; DSIR.

Appendices

This section contains the following appendices:

- "Appendix A. Selected Scheme Data" on page 27.
- "Appendix B. Refurbishment Estimates" on page 33.
- "Appendix C. Omakau Operational Cost Estimates" on page 56.

Appendix A. Selected Scheme Data

A.1 Race lengths and capacities

Race names	Length (km)	Capacity cusecs (=hds)	Capacity m3/hr	
Blackstone Hill Race	0.7	10	1000	
Main Race	49.3	75	7500	
A race	0.8	1	100	
SR I	0.8	2	200	
SR II	0.7	2	200	
SR III	0.5	2	200	
B race	7.5	10	1000	
distrib 1	1.0	2	200	
distrib 2	1.0	2	200	
distrib 2a	0.4	2	200	istrib 2
distrib 3	0.5	2	200	
SR IV	0.7	2	200	
SR V	0.8	2	200	
C race	3.8	10	1000	
distrib 1	3.2	4	400	
distrib 1a	0.3	1	100	istrib 1
distrib 2	0.1	1	100	
D race	4.2	10	1000	
distrib 1	1.9	3	300	
distrib 2	0.2	1	100	
SR VI	0.4	3	300	
SR VII	0.7	3	300	
E race	4.7	10	1000	
distrib 1	0.3	3	300	
distrib 2	0.1	3	300	
distrib 3	1.7	3	300	
distrib 4	0.6	3	300	
SR VIII	0.2	1.5	150	
F race	1.6	5	500	
SR IX	0.4	2	200	
SR X	0.4	2	200	
Cloustons distrib	0.4	2	200	
Pattersons race	1.8	4	400	
distrib 1	0.4	2	200	
SR XI	0.3	2	200	
Grass flume	0.6	1	100	
Tiger Hill pumped race	0.2	5	500	
distrib	0.1	3	300	
SR XII	0.03	3	300	
TOTAL LENGTH	92.63km			

Clearwater	7.4	8	800
Distrib 1	0.2	1	100
Distrib 2	1.2	2	200
Distrib 3	0.02	2	200
Distrib 4	0.3	4	400
TOTAL LENGTH	9.12km		
Dunstan Race	3.5	15	1500
Shaws race	0.2	3	300
Mees race	0.8	1	100
Distrib R1	0.02	1	100
Kanes race	2.4	4	400
distrib 1	0.8	2	200
distrib 2	0.7	2	200
Spur race	2.0	4	400
distrib 1	0.4	2	200
Distrib RII	1.1	1	100
Distrib RIII	0.1	1	100
Georges race	0.8	2	200
Jacks race	0.7	3	300
distrib (Dougs race)	0.8	2	200 e)
TOTAL LENGTH	14.32km		
Lauder Creek Race	16.8	12	1200
Distrib B	3.1	3	300
Distrib C	3.0	3	300
Distrib D	3.3	4	400
distrib D1	1.2	3	300
distrib D2	0.8	3	300
TOTAL LENGTH	28.2km		
Matakanui Race	12.4	16	1600
Distrib A	4.8	3	300
Distrib B	4.9	6	600
distrib C	2.3	2	200
distrib 2	1.8	3	300
Shannons distrib	3.1	2	200
Berrys race	0.8	2	200
Distrib D	1.0	2	200
Distrib E	0.2	2	200
Distrib F	1.7	2	200
Distrib G	0.9	2	200
distrib G1	0.5	2	200
Distrib H	0.6	2	200
TOTAL LENGTH	35.0km		

Scotts Race	1.9	1	100
Devonshire Race	1.8	2	200
County Race	7.6	5	500
Distrib 1	0.8	2	200
TOTAL LENGTH	8.4km		

TOTAL LENGTH OF ALL RACES = 192.1km

A.2 Water Rights

Description	River, Creek or Dam	Map Series 177, 177A Co-ordinates Map No.	N	E	Authority	Maximum Usage (Cusec Summer	Winter	Di
OWAKAU SCHEME								
Dam	Falls Dam	S 125	391550	361450				
Intakes	Manuherikia River	S 125	382760	356350	WR 4363	12	2	
	Manuherikia River	S 134	379650	353180	WR 5785	80	-	
	Becks Creek	S 134	376500	348450	P.W. Act	2	-	
	Thompsons Creek	S 134	372420	336720	P.W. Act	3	-	
	Thompsons Creek	S 134	378060	332720	WR 1464, 3033, 289, 295	15	3	
	Thompsons Creek	S 134	375520	335800	P.W. Act	1	1	
	Dunstan Creek	S 125	386920	349630	WR 5784	18	-	
	Lauder Creek	S 125	380240	338930	WR 513	15	-	
	Muddy Creek	S 134	376210	337700	WR 219	1	-	
	Blackbush Creek	S 134	372100	332470	P.W. Act	2	1	
	Middle Creek	S 134	371180	327650	WR 518	3	1	
	Coal Creek	S 134	370870	326610	WR 516	1	-	
	Scotts Creek	S 134	372350	328350	WR 515	2	1	
	Devonshire Creek	S 134	372660	328910	WR 301	1	-	
	Thompsons Creek	S 134	369600	336280	WR 306, 1240	10	3	
	Blackbush Creek	S 134	373580	331460	P.W. Act	2	-	
	Becks Creek	S 134	377780	348310	P.W. Act	4	-	
Bywashes	No.1 to Manuherikia River	S 125	391550	361450				
	No.2 to Manuherikia River	S 134	377460	350840				
	No.3 Becks Creek	S 134	376500	348450				
	No.4 Lauder Creek	S 134	371700	344380				
	No.5 Drybread Tailings	S 134	373880	338760				
	No.6 Thompsons Creek	S 134	373410	336640				
	No.7 Sludge Channel	S 134	372950	333580				
	No.8 Manuherikia River	S 134	362350	334900				
	No.9 Becks Creek	S 125	382230	346680				
	No.10 Miller Creek	S 125	380900	344140				
	No.11 Woolshed Creek	S 125	383530	348200				
	No.12 Muddy Creek	S 134	376000	337670				
	No.13 Blackbush Creek	S 134	373580	331460				
	No.14 Coal Creek	S 134	370870	328610				
	No.15 Devonshire Creek	S 134	372660	328910				
	No.16 Thompsons Creek	S 134	368480	335980				
	No.17 Thompsons Creek	S 134	364900	335670				
	No.18 Thompsons Creek	S 134	363620	335600				

Appendix B. Refurbishment Estimates

OMAKAU IRRIGATION SCHEME

BASE RATE ASSUMPTIONS

	Item	Rate
LABOUR		
	ex Alexandra Residency Irrigation Staff	$25 /hr
PLANT		
	D5 Bulldozer	$70 /hr
	D7 Bulldozer	$90 /hr
	8 cubic metre Tip Truck	$60 /hr
	Backhoe	$50 /hr
MATERIAL		
	Concrete (ex Alexandra yard)	$90 /m3
	500mm Measuring box (ex Alexandra yard)	$1000 ea
	750mm Measuring box (ex Alexandra yard)	$1700 ea
	Sealing material	$15 /m3
PIPES (RCRRJ)	(x 2.44m length)	
	375mm	$115 (includes ring)
	450mm	$145 " "
	525mm	$175 " "
	600mm	$215 " "
	675mm	$285 " "
	750mm	$370 " "
	825mm	$410 " "
	900mm	$530 " "
	1075mm	$690 " "
	1200mm	$845 " "
	1350mm	$985 " "
	1600mm	$1205 " "

******* ALL COSTS EXCLUDE GST *******

MATERIAL INDEX

Abbreviation	Material
A	Armco
AC	Asbestos Cement
B	Butynol
C	Concrete
E	Earth or Sod
P	Polythene
PVC	Polyvinyl Chloride
R	Rock, Stone or Masonry
S	Steel, Tin or Galvanised Iron
W	Wood

CONDITION INDEX

Abbreviation	Condition
B	Bad, Very Bad, Major or Minor
F	Fair
G	Good
O	Okay
P	Poor, Very Poor, Suspect or Rough

TYPE INDEX

Abbreviation	Type of Structure	Abbreviation	Type of structure
AB	Anchor Block	RL	Race Lining
AT	Abutments	RX	Road Crossing
AX	Access Crossing	SC	Surge Chamber
BR	Bridge	SK	Skimming Board
BY	Bywash	SN	Screen
CH	Chute	SP	Supports
DA	Dam	ST	Stop
DR	Drop	SW	Spillway
EX	Expansion Joint	SY	Syphon
FL	Flume	TO	Turnout
FX	Fence Crossing Race	TU	Tunnel
GT	Gate	UN	Under Race Structure
IN	Intake	VL	Valve
MB	Measuring Box	WE	Endwall
OV	Over Race Structure	WH	Headwall
PL	Pipeline	WR	Weir
PU	Pump	WW	Walkway

OMAKAU IRRIGATION SCHEME

SECONDARY WORKS DATE PREPARED: 28 November, 1986

RACE: MAIN AREA SERVED: 3348 HA

DESCRIPTION	LAB $	PLANT $	MATL $	TOTAL $	RACE/ SCHEME	STRUC NO	DIST	C	USE	MATL	LEN	DIA	WID	D'TH	COMMENT
Replacement of one drop	2000	550	1020	3570	OMA/M	9-17									
Replacement of drop	2000	550	1020	3570	OMA/M	18	2360	G	DR	C			5800	600	44
Renew head and end walls	2000	550	1020	3570	OMA/M	20.2	2840	G	WH	C		1220			47-49
					OMA/M	20.3	2840	G	WE	C		1220			47-49
Renew measuring box	380	200	1210	1790	OMA/M	22	3200	F	MB	C			375		52
Renew head and end walls	2000	550	1150	3700	OMA/M	27.1	4750	G	WH	C		1070			62-63
					OMA/M	27.2	4750	G	WE	C		1070			62-63
Gabions and rock protection for syphon	5040	2850	5110	13000	OMA/M	29	5170	F	SY	C	14.6	1070			65-66/BECKS RD
Install M/B	380	200	1320	1900	OMA/M	30	5225	G	TO	S/C	0	300			67
Bridge - ex MIS	760	1440	6600	8800	OMA/M	32	5290	G	BR	W	0		2400		69-69
Slip - trees	0	3380	15400	18780	OMA/M	32-33									
New gate	190		440	630	OMA/M	34	5980	G	PL	C	0	450			71
Intake concrete work	1000	250	610	1860	OMA/M	38.1	7130	G	TU	C	329		1220	1370	76-77
Renew head wall	3650	1500	3080	8230	OMA/M	39.1	7660	G	WH	C		1070			78-80
Renew end wall	3650	1500	3080	8230	OMA/M	39.2	7660	G	WE	C		1070			78-80
Allow for drain	380	400	220	1000	OMA/M	41	8520	G	SY	C	23.8		1070	1070	83-84
Concrete work on outlet and inlet and drain in syphon	2380	950	1380	4710	OMA/M	45	9490	F	SY	C	9.8	1070			88-89
					OMA/M	45.1	9490	G	WH	C		1070			88-89
					OMA/M	45.2	9490	G	WE	C		1070			88-89
M/B 500 mm	380	200	1320	1900	OMA/M	46	9740	F	MB	C			500		90
M/B 500 mm	380	200	1320	1900	OMA/M	47	9980	P	MB	C			500		91

M/B 500 mm	380	200	1320	1900	OMA/M	48	10200	P	MB	C			500	92/TO DIST A
Bridge decking	1930		1100	3030	OMA/M	49	10260	F	BR	W	0		2440	93
Construct drainhole	380	400	220	1000	OMA/M	61	13950	F	SY	C	254	1070		113
Under race pipe 375 mm	1540	2000	1650	5190	OMA/M	64	14730	P	UN/SY	C	0	375		117
Under race pipe 375 mm	1540	2000	1650	5190	OMA/M	67	15140	P	UN/SY	C	0	375		120
Tunnel outlet concrete work	2000	550	1150	3700	OMA/M	75.2	16010	G	WE	C			0	0 134-135
Bridge decking	2380	950	1380	4710	OMA/M	77	16200	F	BR	W	0		1500	137
Replace with concrete bridge ex MIS	760	1440	6600	8800	OMA/M	79	16740	P	BR	C	0		3960	139-141
Drain	190		110	300	OMA/M	85	17750	G	PL	C	73.2	1220		151-153
3 × 1800 mm pipes ex MIS	1590	2100	3430	7120	OMA/M	89	18700	B	BR	C	0		3960	158-160
3 × 1800 mm pipes ex MIS	1590	2100	3430	7120	OMA/M	93	19390	B	BR	C	0		3960	165
3 × 1800 mm pipes ex MIS	1590	2100	3430	7120	OMA/M	106	22810	B	BR	C	0		3960	170-172
M/B 500 mm	380	200	1320	1900	OMA/M	107	23240	F	MB	C			500	
2 Gates	1930		1070	3000	OMA/M	109.3	23690	B	MB	C			750	TO C DISTRIB
					OMA/M	109.4	23690	B	MB	C			750	TO C DISTRIB
Timber	190		110	300	OMA/M	111	28320	F	BR	W	0		2440	
Gate on berm at boundary	380		220	600	OMA/M	118	24800	G	MB	C			750	
2 Gates	1930		1070	3000	OMA/M	119	24940	F	MB	C			750	TO D DISTRIB
					OMA/M	119.1	24940	F	MB	C			750	175/TO D DISTRIB
3 × 1800mm pipes	1590	2100	3430	7120	OMA/M	121	25080	B	BR	C	0		3960	176
M/B 500 mm	380	200	1320	1900	OMA/M	128	26930	B	MB	C			500	TO SR6 & SR7 DISTRIB
Rock protection	1000	2600		3600	OMA/M	129								
M/B 500 mm	380	200	1320	1900	OMA/M	137	28700	F	MB	C			500	
Repairs to bridge	190		220	410	OMA/M	141	29400	B	BR	W	6		2440	
Under race culvert	0			0	OMA/M	146	30090	B	UN/PL	C	0	900		
					OMA/M	146.1	30090	G	WH	C		900		
					OMA/M	146.2	30090	G	WE	C		900		
M/B 500 mm	380	200	1320	1900	OMA/M	152	31160	B	MB	C			500	TO SR 8 DISTRIB

1 Gate	1250		1380	2630	OMA/M	161	33180	F	TO	C/S	0	375			188-189
Sheep winch for headgate	190		550	740	OMA/M	170	35110	G	BY	C	2.44		1800	600	AUTO BYWASH
M/B 500 mm	380	200	1320	1900	OMA/M	186	39270	P	MB	C			500		
M/B 500 mm	380	200	1320	1900	OMA/M	202	42930	F	MB	C			500		TO GRASS FLUME
M/B 500 mm	380	200	1320	1900	OMA/M	204	42980	F	MB	C			500		
M/B 500 mm	380	200	1320	1900	OMA/M	206	43490	F	MB	C			375		
M/B 500 mm	290	150	1210	1650	OMA/M	217	44705	F	MB	C			500		
M/B 500 mm	290	150	1210	1650	OMA/M	229	46300	F	MB	C			500		
M/B 500 mm	290	150	1210	1650	OMA/M	232	46820	G	MB	C			500		
M/B 500 mm	290	150	1210	1650	OMA/M	235	47500	B	MB	C			500		
Replace pipe with open race	950	3300	5440	9690	OMA/M	239-240									

SUBTOTALS	56240	39310	99660	195210

OMAKAU IRRIGATION SCHEME

SECONDARY WORKS DATE PREPARED: 10 December, 1986

RACE: MAIN DISTRIBS AREA SERVED:

DESCRIPTION	LAB $	PLANT $	MATL $	TOTAL $	RACE/ SCHEME	STRUC NO	DIST	C	USE	MATL	LEN	DIA	WID	D'TH	COMMENT
PVC pipe drop	1000	1240	3630	5870	OMA/M/B	63	7475	B	MB	C			500		
					OMA/M/B	64	7475	B	FL	E	250				GRASS
Gate pipe	50	150	550	750	OMA/M/C	15	1850	P	TO	S/C	1.8	375			
Replace 500 mm M/B	290	150	1210	1650	OMA/M/C	15.1	1850	P	MB	C	2		500		
Inlet requires support Buildup embankment	500	120	170	790	OMA/M/C	23.1	2605	G	PL	S	21	375			255-256/OVER STAFFOR
					OMA/M/C	23.2	2605	O	SP	W				#2	255-257
Renew access 450mm × 4.9m	250	350	410	1010	OMA/M/C/1	14.1	2530	P	AX	C	2.4	450			
Gated pipe 375mm	50	150	550	750	OMA/M/C/2	1.1	25	P	ST/GT	C/S	0	375			
Renew access 375mm × 4.9m	250	350	330	930	OMA/M/C/2	2	70	P	AX	S	9.8	375			
Replace access	250	350	410	1010	OMA/M/D	11	1950	P	AX	C	2.44	450			
					OMA/M/D	11.1	1950	P	WH	R		450			
					OMA/M/D	11.2	1952	P	WE	R		450			
Replace 500 M/B	290	150	1210	1650	OMA/M/D	21	3500	G	MB	C			500		
Gated pipe 375mm	50	150	550	750	OMA/M/D	21.1	3500	G	TO	C/S	0	450			TO CLEARWATER FEEDER
Gated pipe 375mm	50	150	550	750	OMA/M/E	19.1	1740	O	ST	S/W			950	800	
Replace access 375mm × 4.8 m	250	350	330	930	OMA/M/E	50	3970	F	AX	S	3.8	340			

Replace access 450 mm × 2.4 m	250	300	200	750	OMA/M/E/2	1	10	B	AX	S	0.9	480		
Gated pipe 375 mm	50	150	550	750	OMA/M/E/3	1	50	F	ST/GT	C/S	1.3	375		SERVES SOD T/O
Gated pipe 375 mm	50	150	550	750	OMA/M/E/3	3	300	F	ST/GT	C/S	1.4	375		SERVES SOD T/O
Gated pipe 375 mm	50	150	550	750	OMA/M/E/3	6	675	F	ST/GT	C/S	1.3	375		
Gated pipe 375 mm	50	150	550	750	OMA/M/E/3	14	1390	P	ST/GT	C/S	1.3	375		SERVES SOD T/O
New gate required	190		440	630	OMA/M/F	4	690	F	ST/GT	C/S	5	375		SERVES SOD T/O
New gate required	190		440	630	OMA/M/F	5	910	F	AX/GT	C/S	2.8	300		SERVES SOD T/O
Replace with Armco flume	1500	540	6930	8970	OMA/M/CL	1	0	P	PL	S	120	300		
Gated pipe 375 mm	50	150	550	750	OMA/M/P	1	0							
Replace access 375 mm × 4.8 m	250	350	330	930	OMA/M/P	2	100	F	AX	S	4.4	420		
Renew gate	190		440	630	OMA/M/P	6	1440	F	AX/GT	C/S	3.7	375		
Gated pipe 375 mm	50	150	550	750	OMA/M/P/1	2	280	F	ST/GT	C/S	1.3	375		SERVES SOD T/O
Renew access	250	350	330	930	OMA/M/GF	1	500	F	AX	C	3.7	375		FROM #202 MAIN RACE
Replace culvert	2500	1300	2750	6550	OMA/M/GF	3	560	F	PL	E	14	300		
Gated pipe 375 mm	50	150	550	750	OMA/M/T/1	4	110	F	TO	C/W			570	350
SUBTOTALS	8950	7550	25610	42110										

OMAKAU IRRIGATION SCHEME

SECONDARY WORKS — DATE PREPARED: 3 December, 1986

RACE: DUNSTAN MAIN — AREA SERVED: 869 HA

DESCRIPTION	LAB $	PLANT $	MATL $	TOTAL $	RACE/ SCHEME	STRUC NO	DIST	C	USE	MATL	LEN	DIA	WID	D'TH	COMMENT
Dump large rocks below weir	580	6000		6580	OMA/DU	1	0	G	WR	S			0	0	320-323
Construct open race crossing and headwalls	5300	10200	2310	17810	OMA/DU	3	250	B	CH	C	213		1200	600	324
Reconstruct headwalls	2000		1150	3150	OMA/DU	4	400	G	WR	C			0	0	325-326/TO GAUGE 15
Repairs to bywash	1000	1000	1100	3100	OMA/DU	4.3	400	G	BY	S	0	0			
New gate	190		440	630	OMA/DU	5	1440	G	TO	C/S	5	450			TO SHAWS RACE
Construct slot-board control	2000		440	2440	OMA/DU	21	4450	B	TO	E			0	0	
Replace outlet	1500	1040	1460	4000	OMA/DU	37.3	7220	G	WE	C		600			
Renew culvert 600 mm dia x 10 metres	2880	1500	3080	7460	OMA/DU	51	10100	O	RX	C	7.3	600			Under Mee Road
Replace M/B	290	150	1210	1650	OMA/DU	69	12680	O	MB	C			500		
Replace pipes	250	350	330	930	OMA/DU	76	13550	O	AX	C	4.9	375			
Replace pipes	250	350	330	930	OMA/DU	77	13725	O	AX	C	4.9	375			
Replace pipes	250	350	330	930	OMA/DU	80	14450	O	AX	C	4.9	375			
Gated pipe	50	150	550	750	OMA/DU	91	16080	G	ST/GT	C/S	1.3	375			SERVES SOD T/O
Add pipe	50	50	130	230	OMA/DU	94	16325	O	ST/GT	C/S	1.2	375			
Replace 500 mm M/B	290	150	1210	1650	OMA/DU	96	17000	G	MB	C			500		TO JACKS RACE
SUBTOTALS	16880	21290	14070	52240											

OMAKAU IRRIGATION SCHEME

SECONDARY WORKS DATE PREPARED: 10 December,1986

RACE: DUNSTAN DISTRIBS AREA SERVED:

DESCRIPTION	LAB $	PLANT $	MATL $	TOTAL $	RACE/ SCHEME	STRUC NO	DIST	C	USE	MATL	LEN	DIA	WID	D'TH	COMMENT
Gate required	190		440	630	OMA/DU/K	10	1180	F	ST/GT	S/C	3.6	375			
Gated pipe 375 mm	50	150	550	750	OMA/DU/K	17	1850	O	TO	S/C	0	300			TO KANES DIS. 2
Gated pipe 375 mm	50	150	550	750	OMA/DU/K	20	2250	O	AX	S	2	380			
PVC liner, headwalls and endwalls	1000	120	350	1470	OMA/DU/K	21	2300	P	PL	C	51	300			
Gated pipe 375 mm	50	150	550	750	OMA/DU/J	1	50	G	ST	C/W			760	560	TO DOUGS RACE
Gated pipe 375 mm	50	150	550	750	OMA/DU/J	2	60	G	ST	C/W			760	560	
Replace drop	1500	490	4730	6720	OMA/DU/JD	3.1	230	F	DR	E			0	0	
Renew culvert 375 mm × 7.3 m	2500	1300	2750	6550	OMA/DU/JD	3.2	550	F	RX	C	5	375			UNDER HAMILTON RD
SUBTOTALS	5390	2510	10470	18370											

OMAKAU IRRIGATION SCHEME

SECONDARY WORKS — DATE PREPARED: 3 December, 1986

RACE: LAUDER MAIN — AREA SERVED: 391 HA

DESCRIPTION	LAB $	PLANT $	MATL $	TOTAL $	RACE/ SCHEME	STRUC NO	DIST	C	USE	MATL	LEN	DIA	WID	D'TH	COMMENT
Replace gate	250		1320	1570	OMA/L	1.1	45	F	IN/GT	S			500	500	
Add gate	500	240	1540	2280	OMA/L	3.3	175	G	WR	C			1500	1220	355-357
M/B	290	650	1980	2920	OMA/L	31	5490	O	MB	C			750		TO LAUDER DISTRIB D
Regrade race	0			0	OMA/L	31-32									
500 mm M/B	290	150	1210	1650	OMA/L	34	5900	P	MB	C			500		
Replace 525 mm dia pipes	760	1740	1920	4420	OMA/L	39	6550	F	RX	S	16.6	380			364/UNDER GLASSFORD
500 mm M/B	290	150	1210	1650	OMA/L	46	7180	P	MB	C			500		
Replace culvert	500	500	770	1770	OMA/L	51	7430	P	AX	S	4.5	520			
Replace part of culvert	2500	500	1540	4540	OMA/L	53	7500	G	AX	C	5	450			365
SUBTOTALS	5380	3930	11490	20800											

OMAKAU IRRIGATION SCHEME

SECONDARY WORKS DATE PREPARED: 10 December, 1986

RACE: LAUDER DISTRIBS AREA SERVED:

DESCRIPTION	LAB $	PLANT $	MATL $	TOTAL $	RACE/ SCHEME	STRUC NO	DIST	C	USE	MATL	LEN	DIA	WID D'TH	COMMENT
Renew access 450 mm × 4.4 m	250	350	410	1010	OMA/L/D	4	575	F	AX	S	4.4	480		
Renew access 450 mm × 2.4 m	250	350	250	850	OMA/L/D	6	850	F	AX	S	2.4	480		
Renew access 450 mm × 4.4 m	250	350	410	1010	OMA/L/D	7	860	F	AX	S	4.4	480		
SUBTOTALS	750	1050	1070	2870										

OMAKAU IRRIGATION SCHEME

SECONDARY WORKS DATE PREPARED: 3 December, 1986

RACE: MATAKANUI MAIN AREA SERVED: 709 HA

DESCRIPTION	LAB $	PLANT $	MATL $	TOTAL $	RACE/ SCHEME	STRUC NO	DIST	C	USE	MATL	LEN	DIA	WID	D'TH	COMMENT
Intake weir - repairs and rock protection	3000	6200	330	9530	OMA/MK	1	0	F	WR	C			10		370-373/CURVED WEIR
Replace 750 mm M/B Relocate	680	350	1980	3010	OMA/MK	7	1310	O	MB	C			750		TO MATAKANUI DISTRIB
Replace 500 mm	290	150	1210	1650	OMA/MK	26	5340	F	MB	C			500		
Gated 375 mm pipe	50		580	630	OMA/MK	43	7370	F	ST/GT	S/C	1.2	300			CONTROL
Replace planks	110		330	440	OMA/MK	47	7750	P	BR	W	0		2250		
Install 450 mm culvert	110	250	610	970	OMA/MK	55	8860	O	BR	W	0		4100		
Miscellaneous Plant	0	1000	0	1000											
SUBTOTALS	4240	7950	5040	17230											

OMAKAU IRRIGATION SCHEME

SECONDARY WORKS DATE PREPARED: 3 December, 1986

RACE: MATAKANUI DISTRIBS AREA SERVED:

DESCRIPTION	LAB $	PLANT $	MATL $	TOTAL $	RACE/ SCHEME	STRUC NO	DIST	C	USE	MATL	LEN	DIA	WID	D'TH	COMMENT
Replace 375 mm dia pipe with gate	500	100	830	1430	OMA/MK/A	2	710	P	AX	C	2.2	375			
Replace pipes	110	100	360	570	OMA/MK/A	7	2870	P	AX	C	2.3	375			
Replace 500 mm M/B	290	150	1210	1650	OMA/MK/B	17	2540	O	MB	C			750		385-387
Replace with PVC pipe and mud-tank	500	500	840	1840	OMA/MK/B	17.2	2540	P	PL	S	12	420			
					OMA/MK/B	17.3	2540	B	FL	S	24	820			385-387
					OMA/MK/B	17.4	2540	O	SC	C	0		0	0	400 GALLON TANK
Replace	290	150	1210	1650	OMA/MK/B	21	2830	B	MB	C			500		
Replace	290	150	1210	1650	OMA/MK/B	22	3430	P	MB	C			500		
Add gate	250		440	690	OMA/MK/B	24	3525	F	TO	C	0.7	375			
Add gate	190		440	630	OMA/MK/B	28	4340	P	TO	C/S	0.65	375			
	190		440	630	OMA/MK/B	28.1	4340	P	TO	C/S	0.65	375			
	190		440	630	OMA/MK/B	28.2	4340	P	ST/GT	C/S	1.4	375			
Renew M/B	290	150	1210	1650	OMA/MK/BC	2	70	P	MB	C			500		
Renew access	250	350	330	930	OMA/MK/BC	4	250	B	AX	C	2.7	375			
Protect syphon	500	1300		1800	OMA/MK/BC	8	1100	O	SY	C	46	375			391-393/THOMPSONS CR
Renew M/B	290	150	1210	1650	OMA/MK/B2	5	1620	B	MB/ST	C			500		CONTROL

Gate required	190		440	630	OMA/MK/SN	3	1975	F TO	C	0.7	375		
Gate required	190		440	630	OMA/MK/SN	4	2050	F TO	C	0.7	450		
Gate required	190		440	630	OMA/MK/SN	5	2150	F TO	C	0.7	450		
Replace M/B	290	150	1210	1650	OMA/MK/SN	7	2255	B MB	C			500	
Gated pipe 375 mm	50	150	550	750	OMA/MK/F	6	1110	B ST	C/W			759	300
Gated pipe 375 mm	50	150	550	750	OMA/MK/F	7	1290	B ST	C/W			750	300

SUBTOTALS	5090	3550	13800	22440

OMAKAU IRRIGATION SCHEME

SECONDARY WORKS DATE PREPARED: 10 December, 1986

RACE: DEVONSHIRE AREA SERVED: 16 HA

DESCRIPTION	LAB $	PLANT $	MATL $	TOTAL $	RACE/ SCHEME	STRUC NO	DIST	C	USE	MATL	LEN	DIA	WID	D'TH	COMMENT
Rock protection D/S of dam	250	340		590	OMA/DV	1	50	G	DA	R					
SUBTOTALS	250	340	0	590											

OMAKAU IRRIGATION SCHEME

SECONDARY WORKS — DATE PREPARED: 10 December, 1986

RACE: COUNTY — AREA SERVED: 45 HA

DESCRIPTION	LAB $	PLANT $	MATL $	TOTAL $	RACE/ SCHEME	STRUC NO	DIST	C	USE	MATL	LEN	DIA	WID	D'TH	COMMENT
Gated pipe 450 mm	50	150	580	780	OMA/CN	19	5210	F	TO	C	1	525			
Renewal of flume 12 m x 560 mm dia	750	350	2460	3560	OMA/CN	21	5260	F	FL	S	12	560			ACROSS SCOTT'S CK
Gate required	190		440	630	OMA/CN	29	6990	P	AX/ST	C/S	1.3	375			TO DIST. #1
SUBTOTALS	990	500	3480	4970											

SECONDARY WORKS — DATE PREPARED: 10 December, 1986

RACE: COUNTY DISTRIBS — AREA SERVED:

DESCRIPTION	LAB $	PLANT $	MATL $	TOTAL $	RACE/ SCHEME	STRUC NO	DIST	C	USE	MATL	LEN	DIA	WID	D'TH	COMMENT
Replace culvert 2.7 m x 375 mm dia	250	350	330	930	OMA/CN/1	2	570	B	AX	S	2.7	360			
SUBTOTALS	250	350	330	930											

OMAKAU IRRIGATION SCHEME

SECONDARY WORKS — DATE PREPARED: 10 December, 1986

RACE: CLEARWATER — AREA SERVED: 194 HA

DESCRIPTION	LAB $	PLANT $	MATL $	TOTAL $	RACE/ SCHEME	STRUC NO	DIST	C	USE	MATL	LEN	DIA	WID	D'TH	COMMENT
Gated pipe 450mm	50	150	580	780	OMA/CW	9	1130	O	MB	C			480		TO BYWASH
Gated pipe 450mm	50	150	580	780	OMA/CW	11.1	1530	P	ST	C/W			900	500	303
Gated pipe 375mm	50	150	550	750	OMA/CW	14	2040	P	TO	C	1.9	300			TO CLEARWATER DIST 1
Gated pipe 600mm	300	150	1540	1990	OMA/CW	14.1	2040	P	AX	C	2.5	600			
Gated pipe 450mm	50	150	580	780	OMA/CW	19	3470	F	TO	C/W			1000	350	
Gated pipe 450mm	50	150	580	780	OMA/CW	20.1	3510	O	WR	C	1.2				
Renew with gated pipe	50	150	550	750	OMA/CW	34	5750	P	AX	S	0.9	375			SERVES SOD T/O
SUBTOTALS	600	1050	4960	6610											

OMAKAU IRRIGATION SCHEME

SECONDARY WORKS DATE PREPARED: 3/2/87

ASSESSED MINOR WORKS

DESCRIPTION	UNIT	QTY	RATE	TOTAL $
Headgates	EA	75	370	27750
Measuring boxes	EA	30	150	4500
Pipes	LS			15000
Backhoe	HOUR	300	50	15000
M/B complete	EA	30	250	7500
Stops, etc	LS			9000
Fencing / gates	EA	90	200	18000

SUBTOTALS	96750

MINISTRY OF WORKS AND DEVELOPMENT
OFFICE: ALEXANDRA

SUMMARY FILE: 15/24

STATUS: PRELIMINARY ASSESSED COST
PURPOSE: APPROVAL IN PRINCIPLE

ESTIMATE PREP'D CHECKED

QUANTITIES
MWD CCI 2650 RATES/EXTENSIONS

RECOMMENDED: APPROVED:

OMAKAU IRRIGATION SCHEME

SECONDARY WORKS

DATE PREPARED: 10/12/86
UPDATED: 14/4/87

RACE	LAB $	PLANT $	MATL $	TOTAL $
Main	56240	39310	99660	195210
Main Distribs	8950	7550	25610	42110
Dunstan	16880	21290	14070	52240
Dunstan Distribs	5390	2510	10470	18370
Lauder	5380	3930	11490	20800
Lauder Distribs	750	1050	1070	2870
Matakanui	4240	7950	5040	17230
Matakanui Distribs	5090	3550	13800	22440
Devonshire	250	340	0	590
County	990	500	3480	4970
County Distribs	250	350	330	930
Clearwater	600	1050	4960	6610
Assessed Minor Works				96750
SUBTOTAL	105010	89380	189980	$481,120

Contingency	15%	$72,170
		$553,290
Engineering Supervision, and Administration	14%	$77,460
TOTAL		$630,750

MINISTRY OF WORKS AND DEVELOPMENT
OFFICE: DUNEDIN

SUMMARY FILE: 15/24

STATUS: PRELIMINARY ASSESSED COST
PURPOSE: APPROVAL IN PRINCIPLE

ESTIMATE

MWD CCI 2650

OMAKAU IRRIGATION SCHEME

PRIMARY WORKS DATE PREPARED: 17/12/86

RACE	TOTAL $
Main Race (str.155)-Replace syphon with open race	39000
Main Race (str.170) - Replace Golden Gate syphon	43700
Main Race (str.177) - Replace Huddlestone syphon	365000
Main Race - Tiger Hill pump rising main	16000
Dunstan Race (str.18) - Replace Harleys syphon with open race	26000
Dunstan Race (str.48) - Replace Hamiltons syphon	105000
Matakanui distrib A (str.1) - Replace syphon under Thomsons Creek	23000
SUBTOTAL	$617,700
Engineering On-costs 12.5%	$77,200
Administration costs 2.5%	$15,440
TOTAL	$710,340

OMAKAU IRRIGATION SCHEME

SUMMARY OF REFURBISHMENT WORKS

MINISTRY OF WORKS AND DEVELOPMENT, DUNEDIN & ALEXANDRA

MWD CCI 2650

PURPOSE: APPROVAL IN PRINCIPLE

DATE PREPARED: 17/12/86 FILE: 15/24
UPDATED: 14/4/87

RACE	TOTAL $
Main	789200
Main Distribs	55200
Dunstan	219100
Dunstan Distribs	24100
Lauder	27300
Lauder Distribs	3800
Matakanui	22600
Matakanui Distribs	55900
Devonshire	800
County	6500
County Distribs	1200
Clearwater	8700
Assessed Minor Works	126800
Headworks as per the Civil Report	865000
TOTAL - ALL STRUCTURES	$ 2,206,200

Appendix C. Omakau Operational Cost Estimates

ANNUAL EXPENDITURE ($000's)	OMAKAU																				
CONTRACT SERVICE MODE	MWDCCI - 2650																				
Prepared 4/6/87																					
Revised 12/6/87	Years ending 31 March																				
	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	TOTAL
REFURBISHMENT - Construction		87.9	246.4	100	1146.2	350.6																1931.1
Engineering on-costs		34.4	7	65.8	80.7	29.9																217.8
Administration costs	1.9	8.1	6.3	18.1	16.8	6.1																57.3
TOTAL REFURBISHMENT COST	1.9	130.4	259.7	183.9	1243.7	386.6																2206.2
(excl. costs to Mar '88)																						
REPLACEMENTS (S)							9.2	18.3	27.5	36.6	45.8	45.8	45.8	45.8	45.8	45.8	45.8	45.8	45.8	45.8	45.8	595
(P)							4.2	8.4	12.6	16.8	21.0	25.2	29.4	33.7	37.9	42.1	46.3	50.5	54.7	58.9	63.1	505
Subtotal							13.4	26.7	40.1	53.4	66.8	71.0	75.2	79.5	83.7	87.9	92.1	96.3	100.5	104.7	108.9	1100
REPAIRS							47.5	48.4	49.3	50.2	51.1	52.0	52.9	53.8	54.6	55.5	56.4	57.3	58.2	59.1	60.0	
MAINTENANCE							79.9	79.9	79.9	79.9	79.9	79.9	79.9	79.9	79.9	79.9	79.9	79.9	79.9	79.9	79.9	
OPERATIONS							66.1	66.1	66.1	66.1	66.1	66.1	66.1	66.1	66.1	66.1	66.1	66.1	66.1	66.1	66.1	
Water management							26.4	26.4	26.4	26.4	26.4	26.4	26.4	26.4	26.4	26.4	26.4	26.4	26.4	26.4	26.4	
Operational maintnce							4.7	4.7	4.7	4.7	4.7	4.7	4.7	4.7	4.7	4.7	4.7	4.7	4.7	4.7	4.7	
Water charge admin.							97.2	97.2	97.2	97.2	97.2	97.2	97.2	97.2	97.2	97.2	97.2	97.2	97.2	97.2	97.2	
Subtotal																						
ADMINISTRATION (Legal,Policy)							4.4	4.4	4.4	4.4	4.4	4.4	4.4	4.4	4.4	4.4	4.4	4.4	4.4	4.4	4.4	
TOTAL OPERATION COST							242.4	256.6	270.9	285.1	299.4	304.5	309.6	314.8	319.8	324.9	330.0	335.1	340.2	345.3	350.4	
CONTRACT SERVICE WITH FREE FARMER ASSISTANCE MODE																						
	MWDCCI - 2650																					
Prepared 4/6/87																						
Revised 12/6/87	Years ending 31 March																				
	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	TOTAL
REFURBISHMENT - Construction		87.9	246.4	100	1146.2	350.6																1931.1
Engineering on-costs		34.4	7	65.8	80.7	29.9																217.8
Administration costs	1.9	8.1	6.3	18.1	16.8	6.1																57.3
TOTAL REFURBISHMENT COST	1.9	130.4	259.7	183.9	1243.7	386.6																2206.2
(excl. costs to Mar '88)																						
REPLACEMENTS (S)							9.2	18.3	27.5	36.6	45.8	45.8	45.8	45.8	45.8	45.8	45.8	45.8	45.8	45.8	45.8	595
(P)							4.2	8.4	12.6	16.8	21.0	25.2	29.4	33.7	37.9	42.1	46.3	50.5	54.7	58.9	63.1	505
Subtotal							13.4	26.7	40.1	53.4	66.8	71.0	75.2	79.5	83.7	87.9	92.1	96.3	100.5	104.7	108.9	1100
REPAIRS							47.5	48.4	49.3	50.2	51.1	52.0	52.9	53.8	54.6	55.5	56.4	57.3	58.2	59.1	60.0	
MAINTENANCE							50.9	50.9	50.9	50.9	50.9	50.9	50.9	50.9	50.9	50.9	50.9	50.9	50.9	50.9	50.9	
OPERATIONS							51.2	51.2	51.2	51.2	51.2	51.2	51.2	51.2	51.2	51.2	51.2	51.2	51.2	51.2	51.2	
Water management							18.3	18.3	18.3	18.3	18.3	18.3	18.3	18.3	18.3	18.3	18.3	18.3	18.3	18.3	18.3	
Operational maintnce							4.7	4.7	4.7	4.7	4.7	4.7	4.7	4.7	4.7	4.7	4.7	4.7	4.7	4.7	4.7	
Water charge admin.							74.2	74.2	74.2	74.2	74.2	74.2	74.2	74.2	74.2	74.2	74.2	74.2	74.2	74.2	74.2	
Subtotal																						
ADMINISTRATION (Legal,Policy)							4.4	4.4	4.4	4.4	4.4	4.4	4.4	4.4	4.4	4.4	4.4	4.4	4.4	4.4	4.4	
TOTAL OPERATION COST							190.4	204.6	218.9	233.1	247.4	252.5	257.6	262.8	267.8	272.9	278.0	283.1	288.2	293.3	298.4	

Table C.1 : Cashflow of Scheme Expenditure (excluding Dams)

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