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THE UNIVERSITY OF AUCKLAND  
ALEXANDRA RESEARCH UNIT

# IRRIGATION IN CENTRAL OTAGO (APPENDICES)



APRIL 1984

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APPENDIX 1

RECENT REPORTS ON IRRIGATION IN CENTRAL OTAGO

✓ Report on Irrigation in Central Otago ✓	MWD Wellington (F Lindup & J D Watt)	March 1954
Engineering Reassessment - ✓ Omakau Scheme	RE Alexandra	June 1971
✓ Engineering Reassessment - ✓ Teviot Scheme	RE Alexandra	August 1971
Engineering Reassessment - ✓ Tarras Ardgour Scheme	RE Alexandra	October 1971
Engineering Reassessment - ✓ Manuherikia Scheme	RE Alexandra	October 1971
Engineering Reassessment - ✓ Ida Valley Scheme	RE Alexandra	October 1971
Engineering Reassessment - ✓ Galloway	RE Alexandra	October 1971
Engineering Reassessment - ✓ Arrow River Scheme	RE Alexandra	November 1971
Engineering Reassessment - ✓ Last Chance	RE Alexandra	January 1972
Engineering Reassessment - ✓ Hawkdun Scheme	RE Alexandra	December 1972
✓ Manuherikia Preliminary Report ✓	MWD	1972
Engineering Reassessment - Earnsclough and Blackmans Scheme	RE Alexandra	May 1973
Engineering Reassessment - ✓ Ripponvale Scheme	RE Alexandra	June 1973
Arrow River - Water Resource (Preliminary)	✓ MWD	1973
Lindis River - Water Resource (Preliminary)	MWD	1973
Tarras Ardgour (Preliminary Reassessment)	✓ MWD	1973
Engineering Reassessment - ✓ Pisa Flats Scheme	RE Alexandra	March 1974

✓ Arrow River Irrigation Scheme - Reassessment Report	✓ W & S Division MWD Dunedin. (J M Blake)	June 1974
✓ Manuherikia Preliminary Feasibility Development Volume 1 MWD	✓	1974
✓ Manuherikia Preliminary Feasibility Development Volume 2 MWD	✓	1974
Engineering Reassessment - Hawea Flat Scheme	✓ RE Alexandra	December 1975
Arrow Junction (Feasibility)	✓ MWD	1975
✓ Coal Creek (Frost) (Feasibility)	✓ MWD	1975
← Lower Shotover (Detailed Feasibility)	✓ MWD	1975
Earnsclough - Blackmans (Reassessment)	✓ MWD	1975
✓ Teviot Irrigation and Frost Control (Reassessment Feasibility)	✓ MWD	March 1976
✓ Teviot Irrigation	✓ MWD	August 1976
✓ Hawea Flat Irrigation Scheme - Pump Augmentation and Review of changes	✓ MWD Dunedin W & S Division (C J Reid)	October 1976
✓ Ida Valley Irrigation Scheme Reassessment	✓ MWD Dunedin W & S Division (C J Reid)	August 1979
← Earnsclough - Blackmans (Report and Recommendation)	✓ MWD	1979
Manuherikia Volume 1 (Feasibility)	✓ MWD	1979
Manuherikia Volume 2 (Feasibility)	✓ MWD	1980
Dunstan Flat (Cost Installation Preliminary Estimate)	✓ MWD	1980
✓ Upper Clutha Valley (Prefeasibility)	✓ Royds Sutherland McLeay	1980
Scheme Charges, Quotes, Management : Central Otago	✓ Englebrecht, Royds Tavendale	1980

✓ Prefeasibility Study on possible Irrigation Development in the Upper Clutha Valley	✓ MWD Royds Sutherland McLeay	January 1981
Survey Report on Irrigation Charges, Water Quotas and Scheme Management in the Older Central Otago Irrigation Schemes	✓ MWD Englebrecht Royds Tavendale & Co Ltd	June 1981
✓ Central Otago Irrigation - Brief Report on Operational and Maintenance aspects Tarras - Ardgour Schemes	✓ MWD RE Alexandra (Gallant/Patterson)	July 1981
Upper Clutha Valley Irrigation Feasibility Investigations (Interim Consolidated Report)	✓ MWD Royd, Sutherland McLeay	September 1981
Earnsclough Flat (Feasibility)	MWD	1981
Upper Clutha (Feasibility)	✓ Royd Sutherland McLeay	1981
Upper Clutha (Prefeasibility)	✓ Royd Sutherland McLeay	1981
Brief Notes on Pisa Irrigation Scheme	✓ MWD RE Alexandra (D Patterson)	1982
Manuherikia Irrigation - Water Race - Central Otago	✓ DSIR NZ Geological Survey	February 1982
Luggate Irrigation Scheme - Water Charges	✓ MWD Royds Sutherland McLeay	June 1982
A Preliminary Economic Report on Irrigation Scheme Proposals Associated with the Upper Clutha Power Development	✓ MAF	September 1982
Central Otago Irrigation - Brief Report on Operational and Maintenance Aspects Ripponvale/Cromwell Flat Irrigation Scheme	✓ MWD RE Alexandra	September 1982
Ripponvale Irrigation Study - Preliminary Report (Draft) (updated October 1983)	✓ MWD Royds Sutherland McLeay	October 1982
Arrow River Irrigation Scheme - Report on Proposals for Scheme Renewal	✓ E R Garden and Partners	March 1983
Manuherikia Irrigation Scheme Social and Economic Impacts Study	✓ Sheppard Rout	September 1983

Working Party Report on the  
Older Central Otago Irrigation Schemes ✓ MWD

October 1983

Arrow River Irrigation Scheme -  
Supplementary Report on Scheme Renewal ✓ Canterbury  
University  
(Kearsley)

October 1983

*Irrigation Dam Review*

APPENDIX 2

CENTRAL OTAGO IRRIGATION SCHEMES  
OPERATING ACCOUNT FOR 1982/83

	Ardour	Arrow River	Bannockburn	Earnsclough/Blackmans	Hawkdun	Idaburn	Ida Valley/Galloway	Last Chance	Manuherikia	Omakau	Pisa Flats	Ripponvale	Tarras	Teviot	Hawea	Total
Sales & Rebates	9376	14824	2094	22872	40848	3304	46654	15216	36112	57147	18362	11853	18920	23791	N11	345873
Working Expenses	53729	50719	2418	68779	230357	6412	212156	89080	109252	172335	48989	45650	49746	90262	58164	1208048
Interest	1847	6738	166	7609	5796	421	15735	5286	14691	14911	4235	4110	7535	4518	7481	101079
Administration	5876	7598	180	6975	32509	784	24254	10811	13515	18310	7449	4421	6426	10994	5393	155495
Provision for Renewals	118	1448	-	610	984	24	770	442	524	336	574	1008	796	990	-	15708
Major Renewals & Repairs	248	3994	-	2672	12166	-	9793	2903	6744	8965	1848	-	4916	6877	2882	64008
% Recovery	15%	21%	74%	26%	15%	39%	17%	14%	25%	26%	28%	21%	27%	21%	32%	22%
Net Loss	52442	55673	670	63773	240964	4337	216054	93306	108614	157710	44733	43336	50499	89850	* N11 #	1271381
Accumulated Loss	402538	1409762	3539	742374	1893261	66605	2797283	937961	2254747	2146029	291063	376038	1166469	1157174	2894485	15929328

68779  
6975  
75754

~~323M~~ \$ 323M  
\$ 1.161M  
\$ 1.143M  
\$  
~~1.304M~~  
9/82  
9/82  
9/82  
\$ 1.627

\* As per District Office instruction no charges have been levied to date.

# Estimated, using the 1981/82 figures for Hawea.

ARDGOUR IRRIGATION SCHEME

The Ardgour Scheme draws a 0.6 cumec flow from the Lindis River to serve 485 ha contained within seven properties. The main race is 21 km and there are 4 km of distributary race. Currently 1 raceman is employed.

The scheme intake is still very solid and while considered at this stage to be in fair condition would need little work on it to make it serviceable for many more decades. The gorge section of the main race is on the left bank of the Lindis River. It comprises open earth or concrete lined race and sections of exposed concrete pipeline, and is the most vulnerable section of the scheme in that it is prone to slips and washouts.

In August 1983 a major slip occurred in the Waterfall Creek area. It cost \$57,000 to reinstate the race. Despite the work done the slip has become more extensive and should it again fail the anticipated major damage it would cause will jeopardise the schemes future.

Within the body of the scheme the races themselves are readily accessible, thus being able to be machine cleaned. There are numerous old minor structures (water distribution outlets and access crossings) which must be replaced. The few pipelines crossing over or under creeks are in fair condition only.

During or since construction of the scheme individual farmers were allowed too many outlets and crossings; there are many structures in some paddocks resulting from the departments races being used as farmers headraces. To reduce the scheme refurbishment costs a policy of limiting the number of such structures each farmer may have would be essential. Such a policy will meet with resistance from some farmers because they must pay directly for the water distribution systems on their farms.

BEGGS SECTION (a tail end appendage to the Ardgour Scheme)

This section draws a 0.2 cumec supply from the lower reaches of the Lindis River and supplies water free of charge to a group of farmers in the Bendigo area; this being one of the conditions the department agreed to in order to obtain a 0.43 cumec water right for the Ardgour Scheme.

The department maintains the intake and a 4 km section of open earth lined race.



The intake is very unstable and has needed constant attention. The Lindis River has been steadily degrading since the 1978 floods.

Details summarised from the Operating Account and Balance Sheet for the year ended 31 March 1983 are:

Income for the year	\$9400
Gross annual cost	\$61800
Income/Gross annual cost	15%
Accumulated losses	\$402500

ARROW RIVER IRRIGATION SCHEME

The Arrow River Irrigation Scheme draws up to 1.75 cumec from the Arrow River. This water is conveyed through a 5.4 km steel pipeline down the river gorge to the 1100 ha area serviced. A 61 km distributary race system (which includes 6 km of pipe syphons) supplies 60 properties of which a mere (20) odd make any significant use of the water. For the remainder the Arrow scheme is not used to any extent but is treated as a security scheme.

The scheme headworks which include a concrete intake, 200 m concrete flume, gravel trap and gorge pipeline are still serviceable but are in a poor condition.

It is the heavy cost of replacing the gorge pipeline (this alone has rough order cost - \$4 million) and securing the other headworks items together with the lack of use made on the scheme which resulted in the decision for the May 1984 closure. Subsequent representations by the irrigators and reports (economic and engineering) prepared by the departments consultants have to date resulted in a one year deferrment of the closure date while these are being further considered.

Within the distribution system the Thurlby Domain race and much of the Bendimeer Race is no longer functional and could not be made so without disproportionately expensive repair works.

Many of the smaller structures are serviceable and would remain so for many years. However following the 1979 announcement that the scheme would close in May 1984 only minimal maintenance works have been done to retain supply to the bulk of the scheme.

The scheme is now operated by two racemen.

Details summarised from the Operating Account and Balance Sheet for the year ended 31 March 1983 are:

Income for the year	\$14800
Gross annual cost	\$70500
Income/Gross annual cost	21%
Accumulated losses	\$1410000

EARNSCLEUGH/BLACKMANS IRRIGATION SCHEMES

The Earnscleugh and Blackmans schemes were developed separately but are now operated as a single schme under the direction of one raceman.

There are 87 properties served by the combined schemes, some landholders having different parts of their properties served from each.

In the last year the operational manpower has been reduced to one raceman.

The Earnscleugh Scheme is a joint irrigation (MWD)/power generation (Otago Central Electric Power Board) scheme. The Fraser Dam in the upper Fraser River (30 m high, storage 5060 MI) is the key to the scheme. The outflows effected by the OCEPT (under the direction of the MWD during the summer period) are used for power generation before being diverted into the various irrigation intakes. The 845 irrigable hectares are serviced through a 42 km race network. The maximum diverted flow is 1.6 cumec but 1.3 cumec is more the usual figure.

In the Earnscleugh Scheme the intakes and the Redbank pump are in good condition as are the headraces. Significant improvements have been made in the access over the last five years.

The Blackmans Scheme is supplied from a number of intakes on the Omeo Stream. There is no storage within this scheme. The 305 irrigable hectares are serviced through a km race network.

In the Blackmans Scheme the various gravel barrage creek intakes have been subjected to continual flood damage over recent years. Floods have removed much of the gravel from the main intake location and have deposited it over the lower intakes. Subsequent flood inflows into the lower races have been an area of real concern to irrigators.

The Blackmans pump is in good condition but the rising main is poor. The sodden ground has provided insufficient support for the pipes and the consequent pipe movement has resulted in pipe failures. Considering the protracted history of such damage replacement with a steel line appears most appropriate.

Within both schemes the distribution races are in reasonably to fair condition. There is still quite a lot of hand cleaning required because of the poor access. The major pipelines are weak and subject to failure; that on Strode Road is exposed and has failed in three places over the last few years and the Omeo Creek syphon is now exposed. The integrity of Strode Road pipeline is oif very real concern.

There is a lot of work required on minor structures despite the inroads made over recent years.

Over the last two years following the announcement that the schemes were to be reconstructed repair works only have been effected it being considered that refurbished structures would be superseded with a few years.

Details summarised from the Operating Account and Balance Sheet for the year ended 31 March 1983 are

Income for the year	\$22,900
Gross annual cost	\$86,600
Income/Gross annual cost	26%
Accumulated losses	\$742,400

HAWKDUN IRRIGATION SCHEME

The Hawkdun Scheme is supplied by the many creeks and streams draining southwards from the Hawkdun Range. The 100 km long Mt Ida main race (all of which is above the 600 m level) increases in capacity up to a maximum flow of approximately 1 cumec and then diminishes again when nearing Naseby as the collected water is distributed to either subsidiary races or irrigators.

The Eweburn Dam (21 m high, storage 2000 M1) is the only Scheme storage facility.

The 3310 irrigable hectares owned by 65 irrigators are served through a 320 km race network; an additional 25 properties are served by household pipe connections. Five raceman are employed.

The Eweburn Dam is in a very poor state and according to a verbal report by the Seed inspection team it contains almost every engineering fault possible but has remained standing and functioning for decades.

Since 1975 there has been a steady programme of upgrading the access and structures on the Mt Ida Main. At this stage only 13 km is left to complete. There would be a few years of work left on the main race to consolidate the work done primarily by way of installing sufficient in-race flow control structures and replacement of bypassed pipelines; this latter aspect will involve some significant costs but most of that type of work has been completed.

As the level of maintenance/refurbishment/reconstruction work is diminishing attention is being directed towards the distribution system.

Within the irrigated area there is a vast backlog of maintenance/refurbishment work on the scheme. A major start was made on this in 1982 but since the scheme reassessment is very out of date and actual extent is still being realised.

The recent move into significant amounts of summer race cleaning within the body of the scheme has made dramatic improvements to the water available to irrigators. Care will need to be exercised with this cleaning, however, since the races are underlain by coarse free draining gravels. A weedspraying programme will need to be developed to keep the recently cleaned races free flowing.

Details summarised from the Operating Account and Balance Sheet for the year ended 31 March 1983 are:

Income for the year	\$40,800
Gross annual cost	\$281,800
Income/Gross annual cost	15%
Accumulated losses	\$1,893,300

IDABURN IRRIGATION SCHEME

The Idaburn Scheme which services 230 irrigable hectares contained within seven properties is operated as an adjunct to the Hawkdun Irrigation Scheme.

The small Idaburn Dam (11 m high, storage 210 Ml) is the main significant structure. The 0.2 cumec 12 km long race and minor structures are in reasonable condition.

The only problem associated with the scheme over the last five years have been caused by the torrential rainstorms.

During the summer period this scheme is subject to droughts and it is quite usual for irrigators to receive minimal flows only (sufficient only to be treated as "stockwater".)

Details summarised from the Operating Account and Balance Sheet for the year ended 31 March 1983 are:

Income for the year	\$3,300
Gross annual cost	\$7,600
Income/Gross annual cost	43% -
Accumulated losses	\$66,600

IDA VALLEY SCHEME

Water is supplied essentially from the Upper Manorburn and Poolburn Reservoirs but provision exists for diverting flows when available from a number of streams intersected by the races on the east side of the Ida Valley.

The two major dams of the concrete arch type may be summarised as follows:

Manorburn 27 m high, 118 m long, storage 51,000 Ml, Max area 705 ha  
Poolburn 25 m high, 163 m long, storage 25,700 Ml, Max area 450 ha

A total of 166 km races deliver water on demand to (52) properties which contain 5000 irrigable hectares.

Five raceman are employed on the scheme.

The most critical part of the headworks at this stage would be the poor state of the Upper Bonanza race which delivers water from the Manorburn Dam to approximately 40% of the Ida Valley Scheme and to a portion of the Galloway Scheme. The problems of repair are compounded by the poor access and the harsh winter climate (during which period the area is often snowbound.)

There is a lot of work required on the distributary race system (west side especially) despite the significant progress made over the last eight odd years. Access is reasonable but would be vastly improved by refurbishment/replacement of the older style measuring boxes with the newer drive-over type.

Flood has been a major problem in the Valley over the few wet years and the races have tended to collect the run-off. Insufficient or inadequate bywash facilities have resulted in numerous problems within the scheme both for the scheme and irrigators. In a water scarce area such controls would not normally be needed.

The east side of the scheme is generally in much better condition than the west having been the area which over recent years has received most attention. Access is good and many of the minor structures are in a reasonable condition.

In the past water shortages have been a problem and a rationalised method of determining in advance the supplies to be made available would greatly assist farmers in their irrigation management.

Operational costs could be greatly reduced by the installation of radio controlled gates and controo/flow monitoring stations within the scheme. At present 1½ racemen are employed 7 months of the year controlling flow from the inaccessible dams, each man costing approximately \$30,00/man year.

IDA VALLEY SCHEME Continued.....

The Ida Valley/Galloway Scheme details summarised from the Operating Account and Balance Sheet for the year ended 31 March 1983 are:

Income for the year	\$46,700
Gross annual cost	\$262,700
Income/Gross annual cost	18%
Accumulated losses	\$1,797,300



GALLOWAY IRRIGATION SCHEME

The Galloway Scheme drains its water supplies from three separate points being:

- (i) 0.33 cumec pumped from the Manuherikia River on the north end to serve 305 irrigable hectares through a 19 km race network.
- (ii) 0.33 cumec supplied at Lows Saddle, ex the Upper Manorburn Dam in the Ida Valley Scheme. This serves 607 irrigable hectares through a 7 km race network (within the Galloway Scheme.), and
- (iii) 0.2 cumec fed from the Lower Manorburn weir on the south end of the scheme to serve 165 irrigable hectares through a 5 km race network.

A total of 25 properties are served. One raceman is employed on the scheme.

The supply race from the Manuherikia River to the pumphouse was remodelled in 1983 and is in good condition as are the pumps. The flow is diverted into this channel by a gravel barrage which has to be reformed every year.

The Crawford Hill race (supplied via Lows Saddle) is in good condition having been reconstructed/refurbished during 1983. The various intakes of Dip Creek are generally old but in good condition.

Within the distribution system there has been a lot of refurbishment and reconstruction work over the last two years. One more years input will result in this scheme being almost completely refurbished and capable for the first time since original construction of being able to supply significantly higher water flows to farmers. There is expected thereafter that the direct annual maintenance costs will be greatly reduced.

No cost details for this scheme are available since they are included with those for the Ida Valley Scheme.

LAST CHANCE IRRIGATION SCHEME

This scheme is primarily served by various mountain streams with intakes and headraces sited approximately 750 m above MSL on the Old Man Range, the two chief sources of water being the Shingle and Gorge Creeks. A lower section was developed some 15 years after completion of the main scheme based on Butchers Creek; this included the construction of the 24 m high Butchers Dam.

Although the races command an area of over 12000 ha only 965 ha involving 40 properties are serviced. Three racemen are employed.

The mountain intakes and races are sited in oversteep has country which have since the 1978 floods suffered significant ground instability problems following 5 successive 'wet' years.

It is difficult to improve or extend access in the more critical areas without creating further instability problems. However, from a race maintenance viewpoint (or where large failures need repairing) the cheapest option has been to "dig in" accepting that there will be subsequent land movement - the access will however be available to make later repairs. To pipe across a race failure or slip without adequate access is to accept the high capital cost of purchasing and placing steel pipes and the likelihood of losing them down the hillside in a later failure with no cheap way to recover them.

Within the 34 km headrace system and 11 km distributary race network there are numerous structures which must be replaced.

In the headrace system the steel flumes are in most urgent need of attention. In most cases a combination of open race and steel pipes appears to be the best replacement option since most are sited in the easier contoured country.

The major steel syphons are in good condition having been refurbished over the last three years.

Most of the distribution races are readily accessible and can be machine cleaned. The "mountain" supply races however have a lot of inaccessible race which must be hand cleaned.

CONROYS SECTION

This occupies an area between the Last Chance and Earnsclough schemes and is substantially self contained. The scheme was undertaken because holders of private rights in the

Conroys Creek had petitioned the Government to build a reservoir and regularise their race system in return for an assignment of their water rights and payment of appropriate water rates.

The operation and maintenance of the race system is conducted by the individuals themselves.

The primary feature is the 20 m high Conroys Dam the outflow from which is controlled by one of the Last Chance scheme racemen.

Details summarised from the Operating Account and Balance Sheet for the year ended 31 March 1983 are:

Income for the year	\$15,200
Gross annual cost	\$108,500
Income/Gross annual cost	14%
Accumulated losses	\$938,000

MANUHERIKIA IRRIGATION SCHEME

This was the first communal irrigation scheme whose race network was not founded on the remains of earlier mining enterprises. The main water sources are the Manuherikia River (2.40 cumec) and Chatto Creek (0.3 cumec).

The scheme supplies water to approximately 150 irrigators and irrigates 1960 ha. There are a further 50 odd domestic pipe supply holders.

The first 6 km of the Main Race (ex Manuherikia River) are considered to be the headworks, little of which can be considered to be in better than fair condition. This section includes:

- i) the intake - old but sound since following the repairs of two years ago but in need of attention to the steelwork. The river is directed towards the intake by a gravel weir.
- ii) the first tunnel 0.5 km long partially lined with a badly eroded invert. This is capable of carrying 2 - 3 times the amount of water needed for the scheme.
- iii) the desilter which has a badly eroded floor and is in urgent need of repairs. There are some large unsightly leaking construction joints which also need attention.
- iv) the concrete lined or piped gorge race which has a long history of remedial work - clearing annual slips. It is a particularly vulnerable section of the scheme.
- v) the second tunnel is 1.6 km long, also partially lined but the lining is in good condition despite the occasional crack in the crown.
- vi) the "Chinky Gully" flume is an old structure comprising 140 m of semicircular Armco fluming supported on a light timber trestle. This structure must be considered weak, even although at the last inspection the timber itself was sound.
- vii) the Chatto Creek syphon. This is a 550 m x 1.15 m  $\emptyset$  exposed concrete pipeline. It is in very poor condition. There is significant leakage at many of the pipe joints, some of the supports in the Chatto Creek have settled and when subjected to lateral loading during flood conditions the then submerged pipeline could well be broken.

The remaining 30 km of Main Race and 73 km of distributary races is in the main readily accessible and in good condition. There are many minor structures which while serviceable will require replacement.

The major problem with the body of the scheme is the extent of the rural/residential subdivisions in the Clyde/Alexandra area. These require a disproportionate amount of operational input - one of the four racemen is employed full time to service a few hundred hectares.

Details summarised from the Operating Account and Balance Sheet for the year ended 31 March 1983 are:

Income for the year	\$36100
Gross annual cost	\$144700
Income/Gross annual cost	25%
Accumulated losses	\$2255000

OMAKAU IRRIGATION SCHEME

The Omakau Scheme, sited in the Upper Manuherikia Valley, is served by a 1.6 cumec flow from the Manuherikia River and an approximate accumulative flow of 1.2 cumecs from the Dunstan, Matakanui and Lauder creeks which together with a number of other smaller creeks service the higher ground above the main race.

A total 6125 irrigable hectares within 80 properties (this includes a 345 hectare area on the north end of the scheme which is supplied water but which is operated and maintained by the farmers themselves) and four households having pipe connections are serviced by the five racemen employed to operate the scheme. There are a total of 180 km of race.

Taken overall the major structures including intakes and pipelines are in fair condition only and would be very expensive to repair. The Manuherkia River Intake and adjacent pipeworks and controls and the major Lauder Creek syphon most urgently need major repairs. Many other pipelines also need attention but not quite so urgently.

The Falls Dam itself is now more waterproof, following sealing work a few years ago, than at any stage since its completion. The "Glory Hole" spillway, however, is in urgent need of attention. This work which was expected to have been done in \$978 was initially deferred, then delayed while the Dam face was being sealed and since has been inaccessible - spilling summer and winter.

Within the body of the scheme there is a lot of work needed on the races and minor structures. Access provisions have been vastly improved over the last 10 years making refurbishment work so much simpler. While a lot of work has been done it will be many years at the current rates of refurbishment before any real gains will have been made.

Details summarised from the Operating Account and Balance Sheet for the year ended 31 March 1983 are:

Income for the year	\$57,100
Gross annual cost	\$214,900
Income/Gross annual cost	26%
Accumulated losses	\$2,146,000

PISA IRRIGATION SCHEME

The primary water source 0.75 cumec is pumped through a 32 m lift from the Clutha River into the main race. A 0.1 cumec 20 m secondary pump lift drawing from this race serves approximately 10% of the scheme area. Further water supplies (up to approx 0.5 cumec) are drawn from the Tinwaldburn and Locharburn Creeks to service the higher terraces and northern end of the scheme.

There are 15 properties within the scheme containing 1030 irrigable hectares, 11 km of main race and 5 km of distributary races, and 12 km of creek supplied races.

One raceman is employed.

The major maintenance problems have primarily been associated with the main pumps. The causes for the cavitation problems in the impellers have never been fully determined. Recently the discovery of a New Zealand patternmaker and the subsequent supply of new impellers has completely changed the outlook for the pumps. Previously impellers were being "patched" as very high cost; the alternative was to import impellers from England - again at very high cost. Further difficulties have been experienced in obtaining "Imperial" seals and electrical items; these problems can only get worse.

In a few years serious consideration will have to be given to replacing the pumps if the scheme is to continue operating.

The main race is now in good condition and with a little more work the total distribution system will be capable of supplying higher flows to the irrigators than at any time since scheme construction.

The creek intakes are generally sound and give few problems. The bulk of the tidying-up work on the races will be completed by the end of the \$984/85 year. The only work which will then be outstanding will be the need to refurbish the Smiths Race (supplies the north end of the scheme.)

Pipelines are in reasonable condition.

Details summarised from the Operating Account and Balance Sheet for the year ended 31 March 1983 are:

Income for the year	\$18,400
Gross annual cost	\$63,100
Income/Gross annual cost	20%
Accumulated losses	\$291,100

RIPPONVALE IRRIGATION SCHEME

A 0.34 cumec flow, drawn from the silty Kowarau River, is pumped through a 65 m lift to the main race. A secondary lift drawing from a distributary race pumps 0.13 cumec a further 40 m to provide water to the higher more productive soils. The 11 km race system supplies 377 irrigable hectares of land contained in 30 properties; in addition three households are provided with house supply pipe connections.

The major problem in this scheme is the very high maintenance requirements for the pumps, this being caused by the extremely abrasive Kowarau silts borne in the water. When the pumps are resited following filling of Lake Dunstan it is expected that the impellor abrasion problems will be significantly reduced since 'ponded' water will be pumped.

Because of the continual deposition of silt in the races all have to be cleaned annually.

The races are in reasonable condition and in genral only minimal maintenance work is required on the races or within-race structures.

Because of the overall condition the one raceman employed is often used in the winter period to assist with the maintenance works on other schemes.

Details summarised from the Operating Account and Balance Sheet for the year ended 31 March 1983 are:

Income for the year	\$11900	(\$31.56/ha)
Gross annual cost	\$55200	
Income/Gross annual cost	22% of	
Accumulated losses	\$376,000	

$$\begin{array}{r} 166 \\ 360 \overline{) 60000} \\ \underline{360} \\ 2400 \\ \underline{2580} \\ 2400 \end{array}$$

$\$60,000 \approx \$165/ha$

375 ha

15000 m<sup>3</sup> FF/day

ed m m 257

25000 m<sup>3</sup>



TARRAS IRRIGATION SCHEME

The Tarras Scheme draws a 1.2 cumec flow from the Lindis River to serve 1103 ha within 18 properties some of which are supplied with household pipe supplies only.

There is 30 km of main race and 28 km of distributary race. Currently one raceman is employed.

The intake structure is old but very sound and will remain in a good serviceable state for many years without much further alteration; a little extra stop-back work would however, be very worthwhile.

The section of main race through the Lindis Gorge is generally in reasonable condition but there are the odd weak points which will have to be repaired/reconstructed if the water supply is to be ensured.

The concrete race sections have cracked in a few places and over some sections the invert needs replacing. The concrete pipes have been left exposed and the extreme weather conditions have drastically reduced the life of these. They also now limit the flow carrying capacity of the whole system as do the three old steel flumes. To date the level of Operation and Maintenance funding has not been sufficient to effect necessary renewals, the steel flumes especially should be replaced as quickly as possible. The two main river crossings are in very good condition.

Within the distribution system the races are generally good but the extremities are constructed in the very light gravels and with the lower flow rates water losses tend to be high. Vehicle access is reasonable but could greatly be improved to allow increased operation efficiency. There is a heavy backlog of old minor structures (measuring box outlets, steel and concrete crossings) which must be replaced in the near future.

Details summarised from the Operating Account and Balance Sheet for the year ended 31 March 1983 are:

Income for the year	\$18,900
Gross annual cost	\$69,400
Income/Gross annual cost	27%
Accumulated losses	\$1,164,500

TEVIOT RIVER IRRIGATION SCHEME

The Teviot Scheme which is supplied from the Teviot River makes joint use of the water; irrigation being provided by the department and hydro electric power being generated by the Otago Central Electric Power Board.

The irrigation scheme is divided into two portions being north and south of the Teviot River.

A 0.5 cumec flow services the south side which has 477 irrigable hectares and is supplied through a 26 km race network. The north side draws a 0.9 cumec flow across the Teviot River in two pipelines to serve 987 irrigable hectares through a 28 km race network.

Three racemen service the 80 properties supplied water of which 30 are household pipe supplies.

Under the terms of a now expired agreement with the OCEPB 0.6 cumec of the water sent to the north end of the scheme is first passed through a power station.

The original MWD Lake Onslow Dam was drowned approximate months ago by a new structure built and operated by the OCEPB. The OCEPB have built two further power stations, reconstructed or provided new races and provided new control structures. The control of the key structures and Lake Onslow storage has been "taken over" by the OCEPB and the issue of a renewed joint MWD/OCEPB agreement has still to be resolved. In the meantime in the absence of such an agreement no difficulties have arisen since the new Lake Onslow was spilling in its first winter and there has been no shortage of water since. A very high priority should, however, be given to concluding the joint agreement.

The numerous departmental pipelines and flumes within the scheme are in a very poor state and in order to make effective repairs very large sums of money will be needed. Most of the syphons are in the south section of the scheme.

Probably the single most important section at this stage is the concrete pipeline servicing the original OCEPB powerhouse. Loss of this line would cut all irrigation supplies to the north end of the scheme and leave the department in the unenviable position of being unable to honour its commitments with the OCEPB contained in the expired agreement.

Within the body of the irrigation scheme there is a vast backlog of deferred maintenance work.

For a scheme which supplies water to the OCEPB and is required to service well established pastoral and horticultural developments the current poor state of the scheme can only be wondered at. It is understood that the area under horticulture is to be vastly expanded on the north side in the near future, the part of the scheme at this stage most vulnerable.

TEVIOT RIVER IRRIGATION SCHEME Continued.....

Details summarised from the Operating Account and Balance Sheet for the year ended 31 March 1983 are:

Income for the year	\$23,800
Gross annual cost	\$113,600
Income/Gross annual cost	21%
Accumulated losses	\$1,157,200

HAWEA FLAT IRRIGATION SCHEME

The Hawea Scheme draws its water from Lake Hawea either through an inverted syphon or pumps depending upon the level of the lake, this being determined totally by the NZED hydro power generation requirements. The syphon operates between full lake level (346 m) to 340 m, supplying a flow in the order of 0.9 cumec. Below the 340 m level the pumps are used, these can supply a maximum flow of 0.7 cumec but this drops very quickly with reducing lake levels.

Whenever the irrigation demand is greatest (in very dry years) the lake level is below syphon level and the pumps have to be used. Invariably at such times there is considerable agitation by the irrigators to have additional pumping facilities provided. When pumps are used the power costs are a direct charge against the scheme operational costs and since the lake level is determined solely by NZED power generating strategies there has been a reasonable amount of local pressure to have part or all of these power costs met by NZED. (NZED has in the past taken a sympathetic view and has contributed towards the costs of providing additional temporary pumping facilities.)

The 40 km of races supply water to 943 ha of irrigable ground owned by 19 farmers.

One raceman is employed.

The races, pumps and syphon are generally in very good condition and give few problems.

Of all structures only the West Side Race syphon (length 112 m) is of real concern. It is being forced sideways by a slow moving slip and eventually it will probably be necessary to realign the pipeline.

The major problems in the scheme are caused by the very intensive rain storms. The floodwaters are caught by the races and since these have insufficient flow controls and bywash facilities major problems have occurred for landholders downrace. Recent piping work in the two worst problem areas being Hospital Creek and a normally dry depression on the north east end of the scheme should greatly reduce these problems.

Details summarised from the Operating Account and Balance Sheet for the year ended 31 March 1983 are:

Income for the year	\$24,500 (Estimated)
Gross annual cost	\$73,900
Income/Gross annual cost	33%
Accumulated losses	\$284,500