MINISTRY OF WORKS

NEW ZEALAND

REPORT

ON

IRRIGATION IN CENTRAL OTAGO

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WELLINGTON,
NEW ZEALAND.

MARCH, 1954.

INTRODUCTION

The following report was prepared, at the direction of the Commissioner of Works, by Messrs. Lindup and Watt in an endeavour to set down in writing some of the personal knowledge and experience gained by these two officers during their long association with the development of irrigation in Central Otago.

It was felt that such a report would be a valuable reference and guide to those who must now take over the control and administration of this work on the retirement of Messrs. Lindup and Watt.

The attached plans were prepared by the staff of the Alexandra Office. The appendices, compiled from data on Head Office and Alexandra Office files, have been included for purposes of ready reference.

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IRRIGATION IN CENTRAL OTAGO

HISTORY

The practice of irrigation in Central Otago commenced in the early gold mining days, when miners found that they could grow good gardens using water from mining water races. A Frenchman named Feraud is credited with the first use of water for farm irrigation in 1865, on his farm Monte Christo, near Clyde. This farm is still irrigated, although not from the original source of supply.

Amendments to mining law regularised the use of mining water for irrigation and made it possible to obtain water rights for both mining and irrigation and for irrigation solely, and as a result all local streams that could be readily developed by adjacent farmers were soon fully taken up by water rights. Water rights operate strictly in priority according to the date of grant and generally so many rights were obtained that in a given stream the later or "inferior" rights could obtain water only in early spring or after the infrequent heavy rain. With the working out of mining areas, farmers purchased early mining rights and converted them to irrigation use, and by around 1900-910 all readily obtainable water was in use for private irrigation, although alluvial mining had by no means finished.

It must be realised that many of the privately owned water races commenced as mining races, and represented a capital development that could not have been faced by the farmers.

There were numerous possibilities that were beyond the capacity of individuals or small groups and the Government commenced investigations and surveys in 1906.

In passing, it may be mentioned that relatively small group ownerships of water rights did occur and some at least still exist.

In 1906 Mr J.H. Dobson, A.E., commenced a survey of the Maniototo Irrigation scheme and later carried out surveys for the Ida Valley and Manuherikia schemes.

The first Government scheme was commenced in Ida Valley in 1912, and was based on the provision of storage to hold the whole annual runoff of the Manorburn watershed, the flow from which had previously been used for mining.

Most of the early Government schemes were based on earlier mining projects, and were not much different from the private conversions from mining to irrigation, the difference being in the size of the project and the concept of state ownership of the water rights and constructed works, and the use of water to give the greatest good for the greatest number.

To this end the Government has over the years pursued a steady policy of acquisition of key water rights, at first by purchase and later by taking over with limited compensation at time of renewal, as provided in the Mining Act.

The policy has not been completely opposed to private ownership in that owners of water rights that are not in excess of their own requirements and do not interfere with proposed Government projects, have been able to obtain renewals and maintain their ownership and use.

The Mining law is complicated and the history of the very numerous water rights is much more complicated and the whole subject is specialised and requires much study and local knowledge.

Mining as such is rapidly nearing extinction and the chief purpose of the Mining Act in Central Otago is to uphold the ramified structure of water rights upon which the production of the district depends.

It is open to question however as to whether some simpler and cheaper method of maintaining the status quo would not be preferable.

It cannot however be emphasised too strongly that the Government irrigation schemes both present and future are at present entirely dependant on the Mining Act, and particularly on the principle of priority, and nothing that will weaken the Crown position should receive consideration, as it can only react to the disadvantage of the 500 odd farms supplied with water on Government Schemes.

This question of water rights is given early prominence in the history of the irrigation schemes because they were commenced, not de novo, but to enlarge the already existing private irrigation, and have had to work under the same laws to obtain water as the private irrigators.

Generally, the acquisition of water rights by the Crown has proved very beneficial to the district as it has provided water to 59,000 acres of new irrigation, and despite acquisitions by purchase, by statute on expiry of the term of private rights, and by special arrangements involving the free supply of some water, the Crown's operations have never resulted in any private land going out of irrigation.

The principle has always been the consolidation and more efficient use of the limited water available, and enlargement of the area irrigated and this has always been achieved.

It is for this reason that the Crown's powers under the Mining Act and other legislation require most careful conservation.

Some of the most valuable early rights came to this Department from the Mines Department, who in turn had obtained some of them from the successors in title to the earliest holders, either by purchase or in liquidation of debt, and as a result the Department holds water race licenses with a succession of ownership dating back as far as 1865.

The Lands Department appears to have appreciated the importance of irrigation and the acquisition of water rights and in the course of acquiring properties for subdivision, obtained some valuable rights that are now incorporated in our schemes.

In 1906 the Crown obtained a considerable number of rights but (at this distance) it is not clear who inspired this, or for what purpose.

Some of the first rights specifically obtained for new irrigation work by this Department date from 1913 and 1914, for the Manuherikia Scheme that commenced operations in 1922.

The following is a list of the Central Otago Irrigation schemes, and the year in which irrigation was commenced:

Ida Valley	1917
Galloway	1920
Manuherikia	1922
Earnscleugh	1922
Last Chance	1923
Ardgour	1923
Teviot	1924
Tarras	1925
Bengerburn	1926

Hawkdun	1929
Arrow River	1930
Conroys	1935
Omakau	1936
Omakau Dunstan section	1938

A short history of each scheme will now be given.

IDA VALLEY IRRIGATION SCHEME

This scheme is shown on the key map and also is map No. 1 of the detail series attached thereto. The water for this scheme was originally supplied by the Manorburn watershed, (Poolburn storage being added later) and the use of Manorburn water dates from 1865, for mining.

Referring to map No. 1, water was carried by the Upper Bonanza race to Hallidays Flat, then by the Lower Bonanza to Lows Saddle, then by Dip Creek down to Galloway (Map 2) where it was used for hydraulic sluicing. A storage reservoir, the Greenland, was built on the Manorburn and is now enclosed and submerged in the present Manorburn Dam.

The Syndicate and Blacks No. 3 races shown were also originally mining races, used for sluicing in the vicinity of Poolburn, and these could only have obtained material quantities of water from the Bonanza Race, dropped down a gully from Lows Saddle, in the same way as the Syndicate race is fed today.

By 1906, the rights and races had fallen into the hands of the Mines Department, who used the system to supply another area in Galloway via the Crawford Hills race (shown on Map 2).

This soon petered out and probably around 1908 the whole system was idle for want of payable ground. There is no doubt that the possibilities for irrigation were recognised by both landowners and Government officers, and it was around this time that surveys were carried out by Mr J.H. Dobson of this Department.

The late Mr F.W. Furkert was District Engineer, Dunedin, from 1908 to 1912, and it was certainly due to his interest in irrigation and his initiative and foresight that Ida Valley Irrigation scheme was developed. It was soon established that a storage reservoir in the Upper Manorburn sufficiently large to equalise the whole run off could be built, and this would completely change the then existing conditions under which the mining races could supply little water in the driest part of the year. The scheme was therefore designed to utilise the averaged run off to irrigate 12,000 acres, and comprised (a) Manorburn Dam (b) Enlargement of the Upper Bonanza race down to Hallidays Flat where water could be dropped into Moa Creek (c) Enlargement of the Lower Bonanza Race (d) Enlargement of the Syndicate and Blacks No. 3 races. (e) Extension of Blacks No. 3 back to Moa Creek (f) Small diverting weirs in Moa and Poolburn Creeks (g) A new race running from Moa Creek to Poolburn Creek and extending on down the east or German Hill side of the valley, and being named accordingly.

With this layout, the Syndicate race is fed by the Lower Bonanza, picking up water dropped from Lows Saddle, while the Blacks No. 3 and German Hill races are fed with water delivered down Moa Creek to Moa Creek weir, and by local stream flow in the Poolburn. Owing to the layout of the land and sections, relatively few distributaries are required and the system worked very satisfactorily except for heavy race losses in the Upper Bonanza due to high water velocities.

The scheme was built between 1912 and 1916, and water was first supplied in 1917.

In 1917 and 1918 there was considerable difficulty in getting irrigators interested and started on irrigation, and it was decided to divert some water to Galloway, since Lows Saddle commands Galloway also. Prior to this it had been proposed to supply Galloway by a difficult and costly race from the Manuherikia Scheme, but it was finally decided to supply from the Manorburn Dam early in 1920.

The combined area irrigated had grown to 5,900 acres by 22/23, and to 13,169 in 26/27, and 13,754 in 31/32.

In 1928 there arose some doubts as to whether the figure of 13,169 for 26/27 was not too great for safety, in view of the original figure of 12,000 and to the fact that gain from creeks as apart from storage had not proved as good as originally estimated. This was confirmed in 29/30 and 30/31, when some rationing had to be applied.

Because of this, and because the labour situation required employment to be found, Poolburn Dam was commenced in November 1929 and completed in April 1931.

It was confidently expected that this new storage which is big enough to store the whole run off, would put the matter beyond doubt, and in fact allow further land to be supplied, and if the water shed run off per square mile was as good as Manorburn, this would have been achieved.

Experience has shown that this gathering ground is not nearly as good as the Manorburn and prior to 1947 it was considered that only a small margin of safety existed.

There had been moderate rationing in 29/30. 30/31 and 41/42, but this had not given much concern to either the farmers or the Department's officers, because it was felt that the overall balance between maximum farm production and safe operation was a reasonable one. Normal operation continued up to 46/47 season, a period of 30 years since supplies commenced, and during this time the farmers had become very prosperous, and a very large production of wool and fat lambs had been achieved. While there is reason to think that even better results could be obtained with subdivision and closer farming, yet the scheme was considered to be completely successful from the aspect of operation and farming.

Then followed a succession of seasons that have tried the farmers and Department most sorely. 1946/47 was a very poor year for run-off, and supplies had to be cut 15% in 47/48. If next year had been normal, no great harm would have been done, but things rapidly became worse. Since then, rationing has had to be applied as follows.

47/48	Supplies reduced by	15%
48/49	" "	" 54%
49/50	" "	" 32%
50/51	" "	" 83%
51/52	" "	" 18%
52/53	" "	" 33%
53/54	Probably	10%

This has occasioned great loss of production and farm earnings and reduction of valuable flocks, and has given great concern to all interested parties.

A great deal of work has been put into investigations of Hope's Creek, the adjacent watershed to the west of Manorburn, in an endeavour to find a method of obtaining additional water at a reasonable cost.

The following are details of the supply system.

Manorburn Dam was completed in 1914, and is a concrete arch, 88 feet above stream bed, crest length 387 feet.

It contains 7,500 c.yd. of concrete and created a storage of 41,310 acre feet, with a maximum reservoir area of 1,745 acres. The whole of the upstream face was gunited in the autumns of 1949 and 1950.

A crack developed some years ago in the right or eastern abutment and repair by means of a new gravity abutment has been commenced but has not been completed because the level of water prevented the completion of the work. It will be finished as early as possible.

Poolburn Dam was completed in 1931, and is a concrete arch, 83 feet above stream bed, crest length 535 feet. It contains 14,000 c.yd, of concrete, and created a storage of 21,000 acre feet, with a maximum reservoir area of 1,120 acres.

Moa Creek Diverting weir is an arched dam 41 feet high and 200 feet long and stores 31 acre feet, which is used for day to day regulation.

Poolburn Diverting weir is an arched dam 37 feet high and 248 feet long and stores 48 acre feet which is used for daily regulation.

There are 73 miles of main race, of which 3 miles is partly concrete, and 29½ miles of distributary races.

The area under irrigation in a normal year is now 12,360 acres, while that portion of Galloway supplied is 1,515 acres, making a total of 13,875 acres from Poolburn and Manorburn reservoirs.

The maximum quantity normally carried in the Upper Bonanza Race is 85 cusecs.

GALLOWAY

This scheme is shown on Map No. 2. It was originally conceived as part of the Manuherikia scheme, but for several good reasons it was finally decided to supply it from Manorburn Dam, and it has received its main supply of water from this source. While its development is based on the original mining, since the original use of Manorburn water was for sluicing in the Galloway area, little use is made of the original mining races after the water leaves Lows Saddle and travels down Dip Creek. The races supplying the lower Galloway area were constructed by the Department.

Construction work was commenced in 1920 and completed in 1923, but some water was supplied in 1919, to land right adjacent to Dip Creek.

The original layout consisted of several small diversions out of Dip Creek for individual farms, and then a main diversion weir which caught all water and diverted it into the Galloway main race and its distributaries. Since then the layout has been added to, although the original race system is substantially unchanged and the following is a brief summary of the additions.

The Manorburn stream, below Manorburn Dam, travels many miles in deep gorges, and finally emerges and joins the Manuherikia River at the south end of the irrigated area of Galloway flat.

The stream flow was too low in level for irrigation use on Galloway, so to obtain it, a diversion dam was built in 1934, largely as a relief work. Although the dam is 52 feet high and has a reservoir area of 70 acres, it is a device to gain height to command the land, only the top three feet being used as working storage. The water from this supply is led northward against the fall of the country, but has proved a very useful contribution to the water available and the reservoir has, although never anticipated when it was built, been of considerable recreational value in winter.

In 1930, an electrically driven pump delivering 10 cusecs was used to supply portion of Galloway Flat from the Manuherikia river, but with the removal of water rationing and because of power shortage, this was stopped, and the equipment transferred to Waitaki Dam which was being constructed at that time.

In 1948 an electrically driven 5 cusec pump was installed in the same general locality and in 1950 a diesel driven 7 cusec pump.

These have been used to help the diminished Upper Manorburn supplies. The Manuherikia River carries a good supply, mostly return flow from irrigation higher up the valley, and Galloway flat is the only area on which it could be utilised. The diesel driven pump was put in because sufficient electric power was not available, but with the completion of the Fraser Power Scheme, the diesel pump will be changed over to electric drive, and a permanent installation of two electric pumps, totalling 12 cusecs, will supply at two levels.

When this is in operation next year, Galloway Flat will be irrigated with return flows from the Manuherikia and the Lower Manorburn, and the Upper Manorburn will be correspondingly relieved, having to supply only the upper portion of Galloway.

These installations are shown on the map, although for clarity the temporary installation is not shown.

Galloway was a particularly bare and barren area before irrigation, and despite the recent shortages of Upper Manorburn water the additional sources of supply have maintained the original progress and today Galloway is an area of good farms, mostly small and intensively farmed.

The following are details of the supply system:

Lower Manorburn Dam is an arched dam with gravity abutments. It is 52 feet above stream bed with a crest length of 378 feet, and has a working storage of 190 acre feet although the total capacity is much greater. It contains 1,604 c.yd. of concrete.

Final pump installation will be a 7 cusec pump driven by a 120 h.p. motor, lifting 105 feet, and a 5 cusec pump driven by a 30 h.p. motor, lifting 30 feet.

The original layout consisted of 10¾ miles of main race and 10 miles of distributaries, to which was added a race of 3 miles from Lower Manorburn Dam. Subsequently, a supply race from the smaller pump was constructed, while the larger pump will feed into the main race, with a supply race 1 mile long.

The peak capacity of the system will be 7 cusecs from Lower Manorburn, 12 cusecs from pumping and 15 cusecs from the Upper Manorburn.

The total area supplied is 2,660 acres.

MANUHERIKIA

This irrigation scheme was the first that was not founded on the remains of mining enterprise, in that the main race system was entirely new, although the scheme does incorporate some mining races and early water rights.

Construction of the scheme commenced in 1917 and was substantially completed in 1922, deliveries of water being commenced that year.

The scheme is shown on Map No. 2 and as will be seen extends from Chatto Creek to Alexandra and Clyde, on the western side of the Manuherikia valley, and on the northern bank of the Molyneux.

Immediately north-east of Chatto Creek there is a large rock barrier across the Manuherikia valley, known as Tiger Hill. The railway and highway climb over, but the river cuts through in a very rough precipitous gorge, deeply cut, but graded steeply between the flatter valleys above and below.

The intake of the Manuherikia main race is in this rough gorge, and leads directly into a tunnel 1,550 feet long through a spur forming an acute bend in the river. The tunnel delivers into a silt trap, which is above flood level, and the construction originally continued as a concrete lined race along an extremely rough sidling until it was possible to get away from the gorge and on to easier country overlooking Chatto Creek. Chatto Creek was crossed with a long twin siphon 1,800 feet long and the race then has no outstanding features, travelling mostly on sidling country above the Chatto Creek-Springvale-Clyde highway, until it crosses it on easy country about 20½ miles from the intake. At this point there are two small equalising reservoirs, and some water is taken along the high terraces towards Alexandra, and the balance is dropped down off the terrace into the Waikeri valley and is split up and distributed over the lower terraces between Clyde and Alexandra. The end of the main race is on the outskirts of Clyde, 22½ miles from the intake.

The concrete lined race on the steep gorge sidling gave much trouble and in 1936/37 the troublesome section was duplicated by a parallel 6' x 4' tunnel set back in solid rock country. When this tunnel, 5181' long was completed, the surface route was abandoned.

The initial section of the main race now consists of Intake tunnel 24 chains, concrete race 60 chains, tunnel 5,181 feet, flume 500 feet, open race 85 chains, and then Chatto Creek Siphon 1,800 feet.

These alterations completely obviated the heavy recurring damage and since 1937 little trouble has been experienced. During recent times the twin steel pipes of Chatto Creek siphon have been renewed with one 3'6" diameter concrete line, and some repairs on the upper 60 chains section of concrete race are impending but not urgent.

The other source of supply for the Manuherikia scheme is from Chatto Creek, by a race shown on the map and known as the Borough Race. This race runs right into Alexandra and originally went right to the high banks of the Molyneux.

This race was originally a mining race, granted in 1864, and ultimately was acquired by Alexandra Borough for a town water supply.

It was acquired from the Borough in 1922 in exchange for a delivery of 2 heads at the Borough boundary. This has been

a very satisfactory deal for both parties, for this race is very well situated as a distributary race and to catch return flows and we actually sell more water than we put into it. In practice, the full amount of water available under the rights acquired from the Borough is not lifted at Chatto Creek, but is diverted much higher up and used on part of Omakau Scheme, while the Borough Race is kept replenished at several points from the Manuherikia main race.

We also obtain water from rights in Young Hill and Scrubby Gully creeks.

The main rights in the Manuherikia were obtained for the purpose of this irrigation scheme in 1913 and 1914.

The remainder of the distributary system can be followed fairly readily from the map.

The area irrigated at the present time is 4,900 acres.

In this scheme, on both the better lands, and all the lighter lands except the poorest, results have been quite good. On the very poorest light gravels, very unsatisfactory results were obtained and this type of land has not been irrigated for 20 years.

The principal features of the constructed work are as follows:-

Intake tunnel 6' x 4'6" by 1550' long.

Concrete lined for 300 feet. Discharge capacity when silt trap at lower end is scouring 350 cusecs.

The silt trap is a concrete structure 34' x 20' x 12' deep and was installed because of the mining debris in the Manuherikia River.

Race Tunnel 5,181 feet long, 6' x 3' with concrete invert and sides for 1,222', and fully lined for 2,387', and the balance unlined but 7' x 6' wide. The capacity is 100 cusecs.

There is a total of 1,150 feet in six places, of Lennon type, Armco steel flume, mostly of capacity of 100 cusecs.

Chatto Creek siphon 1,800 feet of 3'6" diameter concrete pipe, maximum pressure head 50 lbs. to square inch.

The main race is 22½ miles long and has a capacity of 100 cusecs, gradually diminishing.

There are 45¼ miles of distributary races of which 90 chains is concrete lined, and 40 chains of steel pipe.

EARNSCLEUGH

This scheme covers an area between Alexandra and Clyde, but on the opposite or south-western side of the Molyneux River.

While this scheme does not today make much use of the early mining construction, except for some distributaries, it is entirely based on valuable water rights purchased by the Crown from mining companies, and is an excellent example of the changeover from mining to irrigation.

The location is shown on the key map and the details on Map No. 2.

The Fraser River emerges from a gorge in the Old Man Range

and runs through the area to the Molyneux River, but it is only in flood time that much water reaches the Molyneux.

In the mining era, Earnscleugh flat was mostly dry and barren although it had on it the homestead of Earnscleugh Run (originally much larger than today and carrying 21,500 sheep in 1871).

The run held the first right in the Fraser of 3 heads, and the rest of the low and medium flows was taken up by mining rights.

The water was used for electric power generation for dredges and for dredge flotation. Around 1900 the Lands Department acquired Earnscleugh for subdivision, including the water right, and allotted shares of two heads of water to sections suitable for fruit growing, and to Earnscleugh run. These water shares are attached to the land, and are still operative. The landowners are referred to as "free water users" and pay no irrigation rate, but do pay maintenance charges, as their water is now delivered through our system.

Then in 1920 the Lands Department bought the rights of the Sandy Point Mining Coy. and in 1923 this Department bought the rights of the Earnscleugh Dredging Coy.

This gave the Crown virtual control of the Fraser River and made the Earnscleugh scheme possible.

The original scheme consists of a system of water races, all originating in the Fraser River where it emerges from the gorge and as shown on Map No. 2.

There are no structures of any importance in the original scheme, the only features apart from the water races being a few low head siphons, put in to avoid rough rocky sidlings when an open channel could not be built without virtually constructing a steel or concrete flume. The siphons were constructed of pipes obtained in the purchase of the Earnscleugh Dredging Company's water rights and races, and are now gradually being renewed in concrete. Construction was commenced in 1922 and completed in 1924.

In 1925 a small additional area of higher level was added to increase the irrigable area of some returned servicemen and this was possible because of the steep fall of the Fraser Gorge, enabling supply to be made by an independant pipeline.

The lowest summer flow of the Fraser is 10? heads or cusecs, but the water available was mostly around 25 cusecs. The area irrigated, including the free water, is 2,065 acres, and because the water at minimum flow was not adequate, although this occurred very seldom, there was some agitation for provision of storage. Because of this, and also to maintain employment Fraser Dam was built in 1935 and 1936.

This reservoir is used to maintain a uniform summer flow which ranges between 40 and 50 cusecs, so that a very good water supply is now available, and in fact there is more water than required by the irrigated land.

During the last year or two, the Department has been selling surplus water to a mining company for dredge flotation, so that the wheel has turned full circle.

An extension of the irrigable area by additional work is under consideration at present and will be referred to later in this report.

The following are the main details of the supply system:-

Fraser Dam is a concrete arch, 97 feet above stream bed and crest length 450 feet. It contains 12,560 c.yd. of concrete and created a storage of 4,120 acre feet. The reservoir area is 114 acres.

There are 10M. 50 Chs. of main race, including 6,600 feet of 24" pipe and 700 feet of 15 inch pipe. There are 17M. 40Chs. of distributary races which includes 2,000' of 9" pipe.

The total area supplied at present is 2,065 acres, and the maximum diversion of water is around 57 cusecs, with a more usual figure of 45.

While not directly connected with irrigation, two power schemes have been installed on the Fraser.

The first, a temporary installation came into operation in 1948, and the permanent installation is nearing completion at the present time. Its intake is below the Fraser Dam and its tailwater returns upstream of the irrigation off-takes, so the water available for irrigation will not be affected.

LAST CHANCE

This scheme is shown on Map No. 3 and was commenced in 1923 and finished in 1924, and with additions in 1924 and 1925.

This scheme is based entirely on the acquisition of early mining rights and races. In the early days miners worked alluvial ground in the Fruitlands area, then known as Bald Hill flat, and this continued up to about 1910. Water was obtained from creeks on the Dunstan or Old Man Range, the chief source of supply being Shingle and Gorge Creeks.

There were a number of parallel race lines, and these were quite high on the range, around the 2,000 foot level.

By 1918 practically all the early priority rights had fallen into the hands of the Crown, but Alexandra records do not show the method by which they were acquired. The only worthwhile right not held by the Crown was one out of Shingle Creek to Commissioner's Flat at Roxburgh, and this has now been acquired in connection with Roxburgh Hydro.

Early in 1923, the Last Chance Scheme was put in hand, and took its name from one of the principal claims at Bald Hill, and its supply race, since this race was adopted as our main supply race. The original scheme was to supply water to farm lands lying between Shingle and Butchers Creeks,(see map) and the principal work was the reconditioning of a continuous line of race along this length.

Owing to the elevation, nearly 2,500 feet at Shingle Creek, this was a summer job and this race has always been difficult to operate and maintain.

In 1924 it was decided to extend over Butchers Creek onto the triangular block of country lying between Butchers Creek, Conroys Creek and Alexandra, and this was completed and water supplied in 1925. Although there is a very large area of land commanded by the Last Chance race, it is mostly steep hillside country and only relatively small favourable areas have been, or ever will be irrigated, as the water available limits the area. In 1936 there was a further extension of the Last Chance system, right at the Alexandra end, and today the scheme extends right to the Molyneux opposite Alexandra.

The Alexandra Borough held two early rights in Butchers Creek totalling five heads and used some of this water for the town water supply. It was brought by water race to a reservoir on the south side of the Molyneux, overlooking the town, and thence by normal pipe reticulation.

An agreement wasconcluded in 1934 with the Borough by which the Crown acquired the 5 head right in Butchers in return for two heads of water delivered into the aforesaid reservoir. The Crown also built a storage reservoir in Butchers Creek, (the Alexandra - Roxburgh section of the State Highway runs alongside portion of it), and the surplus of 3 heads plus the storage has enabled a much improved supply and increased area at the tail end of the Last Chance Scheme.

This final addition came into operation early in 1937.

As mentioned earlier, the Last Chance scheme is spread over a very large area, the gross being about 30,000 acres, but the net area irrigated is only 2,385 acres.

This represents the ultimate development, as neither additional water or storage capacity is available and pumping is not practicable. The soils on which the Last Chance water is used are good, and while the area is sparsely irrigated and is not at all easy to operate and maintain, the results obtained from farming are quite good.

Apart from racelines and pipe siphons and flumes there were no structures in the original scheme, but the construction of Butchers Creek reservoir amended the status as follows:-

Butchers Dam is a concrete arch, 78 feet above stream bed with 225 foot crest length. It contains 2,120 c.yd. concrete and has a working storage of 1,200 acre feet, and a surface area of 88 acres. Water is drawn from it by a 6' x 4' tunnel 2,388 feet long.

The high level main race is 21 miles long, and carries up to 20 cusecs. It includes 6,000 feet of 22 and 24 inch pipe and 3,500 feet of fluming.

There are seven miles of distributary race which includes 2,000 feet of fluming.

ARDGOUR IRRIGATION SCHEME

Map No. 5

This irrigation scheme is based on a Crown water right obtained in 1910, out of the Lindis River. In 1915, proposals to irrigate the area were being considered and while the early records are scanty, it appears that Ardgour irrigation area was subdivided with a view to it being irrigated, and that settlers were on the land with some promise of irrigation before any concrete proposals had been developed. These were finally approved and work was commenced in early 1921, and completed for the 1923-24 season.

The Ardgour scheme, although physically separate from the Tarras scheme, is adjacent, and both schemes are dependant on the Lindis River. Any actions to strengthen the water right position were therefore taken for the benefit of both.

There were two rights prior to the Crown 50 head right of 1910.

One of these for 15 heads was acquired in return for 8 heads of free water. This is a better arrangement than might

appear in that this 8 heads, which is delivered at the lowest part of the area, in Begg's race, is supplied from return flow, and enables 15 heads to be diverted at Ardgour intake. The other right, by agreement with the owner, is operative for 6 heads instead of 12, making six available to the Crown.

With the exception of these two quantities of 6 and 8 heads, which are efficiently used on private lands, the balance of the stream flow is available to Tarras and Ardgour and is just about sufficient to meet commitments in dry times. The Ardgour main race was constructed as a new project, and has no outstanding features beyond some costly race construction and siphons in the upper section getting away from the Lindis River. The distributaries, as shown on the map, are relatively small.

The revenue producing area in Ardgour is 1,300 acres.

The Ardgour main race has a capacity of 20 cusecs and is 13 miles long, of which one mile is concrete lined, and also includes 5,000 feet of 30"steel pipeline.

There is 2½ miles of distributary race.

TEVIOT SCHEME

This scheme is supplied with water by the Teviot River which joins the Molyneux River from the east, as shown on Map No. 4.

The Teviot River was an important source of water as soon as mining commenced, and much ground was worked on the east bank opposite the town of Roxburgh. The stream originates in high upland country south of Manorburn watershed, and this relatively flat country contains a valuable reservoir site that was developed for mining and is known as Lake Onslow. The original masonry dam has been raised 3¾ feet by the Department, and the available storage could be considerably further increased by the construction of a new dam a short distance downstream, if it were ever required. The Teviot runs at a fairly high level until it nears Roxburgh and then plunges down a rough gorge in the last three miles. This feature enabled the miners to bring out water races, (although they were predominantly flumes or pipelines), onto the hill faces overlooking the Molyneux, and approximately 700 feet above it. With this head and with Lake Onslow to augment the summer flow, very effective sluicing was possible and much work was done. By around 1915 the area was substantially worked out and by 1921, the position was that all the water rights were held by three mining companies, one of which owned Lake Onslow, but two of them had finished operations and one was still working. There were prolonged and involved negotiations between the mining companies, the local Power Board and the Government, for there were obvious possibilities for power as well as irrigation. The final result was that the Crown got all the water rights and the usable race construction work, the Mining Companies got some compensation, and the Crown agreed with the Teviot Power Board to install the irrigation scheme in such a fashion that the Board would receive at a powerhouse, 25 cusecs of water under a gross head of approximately 400 feet, the powerhouse to be situated so that the water was re-usable for irrigation.

Construction work commenced on both power and irrigation, and as will be seen on Map No. 4, the layout is as follows. Water was originally lifted from the Teviot River by the last surviving mining race, the initial section being pipeline, but now superseded by a tunnel roughly paralleling the same route.

Today the water reaches the top of the power penstock at elev. 955 above sea level by 5,078 feet of tunnel and approximately 65 chs. of open race.

The penstock carries 45 cusecs down to the powerhouse, where it divides and a maximum of 11 cusecs is carried across the Teviot gorge to what is known as the top race.

Normally about 35 cusecs goes through the turbines, and of this up to 23 cusecs goes through a second siphon over the Teviot to what is now termed the bottom race, the middle race being now supplied by a branch pipeline.

These three races supply all the irrigated land in Roxburgh East as far north as Roxburgh Hydro.

In time of heaviest irrigation demand the powerhouse receives a maximum of 34 cusecs, but in winter may take as much as 37.

This work commenced in 1923 and was substantially completed in 1924. In the original work, there was a very large length of steel siphons, and these were all second hand mining pipe. The highest pipeline, that out of the river, was superseded by tunnel in 1936, and replacements on other lines by reinforced concrete have been made from time to time.

In 1927, what was known as Teviot Extension was commenced. This branches from the supply race on the upper section, not far from the tunnel outlet, and runs south along the hillsides towards Millers Flat, and the irrigation scheme reaches the outskirts of this township. The work was completed early in 1929.

The first five miles of the race utilised an old mining race that supplied water to a claim behind what is now Roxburgh Railway Station.

This length had eight steel siphons totalling 5,170 feet in length and these were renewed in concrete lined steel in 1937.

This addition has given good results on the easy hillside slopes, but the gravel flats between Millers Flat and Roxburgh Railway Station have made little progress.

The original Lake Onslow dam was built of massive stone masonry, and was raised three feet to increase the safe summer flow in 1933, and a further nine inches in 1938. This raising was by means of angle iron frames supporting hardwood sheathing. This type of raising has been carried as far as possible and as the masonry dam, which was built in 1894, leaks at many of the joints, it will be necessary to renew it some day.

There is an excellent site for an economical arch dam a short distance down stream, and it is possible to increase the maximum retention level very considerably.

The following are details of the water reticulation:-

Onslow Dam was raised in 1904 by a mining company to a height of 25 feet high and with a crest length of 140 feet, in schist masonry. It had a storage capacity of approximately 9,000 acre feet, and an area of 845 acres. This was increased by 3,560 acre feet by the addition of timber flash boards permanently set on steel frames to a height of 3'9" in 1933 and 1938.

The maximum lake area is now 1,098 acres.

The diversion tunnel is 5,078 feet long and is completely concrete lined, and is 4'9" x 3'6" inside the concrete. Capacity is 60 cusecs.

The pipeline supplying the power house is 2,100 feet long, and is now a composite line 30" reinforced concrete pipe at the top and 30" steel at the bottom.

The static head is 385 feet and the capacity 45 cusecs.

The line branching off just above the power house and running across the Teviot Gorge to the top race is 2,020 feet of 18" steel pipe and has a capacity of 11 cusecs.

The line taking the power house tailwater is 9,920 feet long of which 3,570' is of 30" and the balance of 24" concrete pipe.

The branch pipe leading from it to the middle race is 1,470 feet long of rivetted steel pipe which is being replaced this year with 18" dia. reinforced concrete pipe. Capacity depends on draw offs at various points of supply but averages 23 cusecs.

The top, middle and lower races each can carry 11, 9 and 14 cusecs respectively and have a total length of eleven miles, while there are six miles of distributaries.

The main race to Teviot Extension is 8 miles long and has 5,170 feet of 22" concrete lined steel pipe and 4,280 feet of rivetted steel pipe of 18" and 15" diameter. Flumes total approximately 4,000'.

There are 7½ miles of distributary races including 800 feet of steel subsidiary siphons, which are in process of renewal.

The area supplied today in the Teviot Scheme is

Original	2,710 acres
Extension	920 acres
Total	3,630 acres

TARRAS

This scheme is shown on Map No. 5.

The upper ten miles of the Tarras main race follows the route of a smaller privately owned race, upon which the owner had spent about £15,000 to bring in water for irrigation. This was acquired for £15,000 in 1923, and work commenced on enlargement, in the process of which the original race was scrapped and obliterated.

The work was substantially complete and supply commenced in October 1925.

The system consists of surface race, some concrete lined, and some large siphons, and distributaries, and has no special features other than the fairly costly work involved in getting clear of the Lindis River. The race purchased carried a water right inferior to the Crown right and the scheme operates on the rights described in the Ardgour section of this statement. This scheme is a troublesome one to maintain and the first seven miles in the gorge has always occasioned heavy maintenance by hand labour.

The water commands some very good land on which good results are obtained, but there are some light poor quality areas on which irrigation has not been successful and which were abandoned in 1929.

The revenue producing area today is 2,680 acres.

The main race has an initial capacity of 70 cusecs and is 21M. 70Chs. long. 5½ miles of the upper section of 7 miles is concrete lined, and this section also contains 4,000 feet of 34" steel pipe, there being 2,000 feet of twin pipe siphon.

There are 17M. 55 Chs. of distributaries including 1,200' of pipe lines.

BENGERBURN

This is shown on Map No. 4 and comprises a small orchard area at Ettrick close to Millers Flat Township.

This is a very small irrigation scheme and was reconstructed by the Department out of earlier private rights and races, but is operated and maintained by the water users.

In practice, beyond collecting the water rate to cover construction costs, the Department has very little contact with the scheme, as the use and maintenance of the race system presents no particular difficulty.

This scheme came into operation briefly as follows:-

There were two water rights in the Benger Stream, one being held by a Mr Duncan and the other by Mr Duncan and the Crown in equal shares. The Crown's share arose from the Lands Department acquiring the interest of one Elliot who had been a Crown tenant.

Later Mr Duncan sold a number of areas for orchard establishment with a rather loose arrangement for supply of water from his one and a half water rights. Supplies were not satisfactory and owing to unsatisfactory repair and operation after flood damage, the new orchard community commenced suits for forfeiture of Duncan's rights and sought the Crown's co-operation.

After the usual prolonged negotiations the final arrangement in 1922/23 was that Duncan retained his own right and surrendered the half right to the Crown, and it is on this right, now wholly Crown, that the Bengerburn scheme is established. Work was commenced in 1924 and water was supplied in the 1925/26 season.

The work consisted of reconstruction of the intake and existing race plus some new distributaries. The scheme is not charged for on an acreage basis, but the total area of orchard irrigated is approximately 200.

A proposal has been put forward that the whole scheme be presented to the water users, and is supported by details and there appears to be merit in the recommendation, since the original agreements have now expired, and the total revenue of £40 per annum must easily be swallowed in our accounting and clerical costs.

HAWKDUN IRRIGATION SCHEME

This is shown on Map No. 6.

This irrigation scheme is a latter day development of early mining, and is supplied by a very long race that was constructed for supplying water to the Naseby mining field, also mining at Blackstone Hill. This main race is known as the Mt. Ida Water Race and was operated by the Mines Department for very many years.

Annual reports on its operation appeared in the Mines Statement, the earliest available in Alexandra being 1902, but it is thought that the whole raceline, about 66 miles in length was constructed by the Mines Department, and it was operated in the same way as the water race system at Kumara in Westland.

The works were authorised by Governor's Proclamation on 17th October, 1873, and the route of the race and the streams reserved for its supply are identical with the present day usage. It is not certain by what Department, if any, the race was constructed, as it was in the day of the Provincial Governments.

As an adjunct to the System, the reservoir at East Eweburn was built in 1901-02, and this reservoir, which was a rather bold earth dam of a maximum height of 70 feet, has always been an asset in supplying water, but caused trouble on occasions by slips on the water side, and was strengthened by a heavy stone blanket thickening on the downstream side in 1933/34.

It continues to give good service.

By 1920 there was not enough mining to use the total water available and only the lower end of the system was in use, and the business had become very uneconomic.

As will be seen from the map the race extends over a long stretch of country, and while the race is higher than is suitable for irrigation, it does command irrigable lands in the northern end of Ida Valley, in the vicinity of Blackstone Hill and Oturehua, and also a section of the Maniototo plain, bounded by the townships of Wedderburn, Ranfurly, Kyeburn and Naseby. There is very little stream flow in these areas and some farms were without adequate water for stock. There was a general demand for water in the area and in 1924 arrangements were made with Mines Department to take over their system, and after completely overhauling, and enlarging portions of the main race, for this Department to continue to supply those miners operating and to utilise the balance of the water for irrigation and stock supply. Work was commenced on the main race and farm distribution system in 1926, and the scheme commenced operations in 1929. Owing to the widespread demand for water for irrigation and stock, and the relatively small supply of water available in summer, there was a choice between full irrigation for a few, and some water for the whole area. The latter course was decided upon and the Department has never regarded Hawkdun as more than a partial irrigation scheme and it was put to the farmers and accepted on that basis. It can be fairly said that it has done this, but no more.

There is however no reasonable prospect that it can be improved until the Maniototo Scheme is built. When this is in operation the Hawkdun scheme will be reduced in area and some improvement in the allowance per acre will be possible.

In 1931 a small addition supplying 500 acres was built in the vicinity of Oturehua.

This consists of a small arch dam and supply race and utilises spring flows, (and low return flows in summer) in the Idaburn Stream. The supply race from the dam to the lands supplied has no special features.

The following are details of the reticulation:-

Main Race. 66 miles, all above the 2,000 feet level. The capacity increases as water is accumulated up to 40 cusecs and diminishes again when nearing Naseby.

There are 102 miles of distributary races, and about 6,000 feet of pipeline in the whole system, ranging from 27" down to 15".

The only structure worth mention in the original Hawkdun Scheme is West Eweburn Reservoir.

This is an earth fill dam, 70 feet high above stream bed and 620 feet long on the crest.

The upstream or water face slope is 3 to 1, top width 15 feet, and downstream slope was 2 to 1, and this was flattened to 3 to 1 on all but the top 15 feet in 1933/34.

At the same time the spillway, which is in rock on the west abutment was enlarged and cut down to give a freeboard of 10 feet.

The storage capacity is 1,940 acre feet.

The small dam in the Idaburn built in 1931 is 35 feet high above stream bed and 112 feet long on the crest.

It contains 350 c.yd. of concrete and stores 170 acre feet with a maximum water area of 20 acres. It supplies a race of 7 cusec capacity 8 miles in length.

The rateable area, including the Idaburn section, is 8,900 acres.

ARROW IRRIGATION SCHEME

This scheme is shown on Map No. 7 and is the area between Arrowtown and Lake Wakatipu.

This was first investigated by Mr F.W. Furkert in 1912, and was re-examined by Mr J.R. Marks in 1922. In August 1924 the landowners petitioned the Government to institute an irrigation scheme, surveys were commenced early in 1925, work commenced in 1926, and the work completed and supply commenced for the 1930/31 irrigation season.

This scheme contains a great length of steel siphons, nearly eight miles, and is noteworthy that it was the last one in which the old style rivetted pipe was used. The rivetted pipe has been completely superseded by welded construction and by reinforced concrete.

This scheme was designed as an irrigation scheme without adaption from previous mining, although the Arrow River has been the site of much mining activity right from the earliest days, when phenomenally high returns were obtained. The irrigable area is composed of rolling country and hills, much dissected by glaciation and the Shotover River and the races are mostly on hillsides with connecting siphons. It is most doubtful if this scheme would receive consideration under present day conditions, and it was only after prolonged pressure on the Government with promises to pay £1 per acre that it was authorised.

Subsequently, the irrigable areas and rates were heavily reduced.

This scheme presents a problem in that there will be very heavy renewal costs on the pipelines in not more than about ten years, as the pipelines are 23 years old, and mild steel rivetted pipes have proved to have much shorter life than earlier pipes that were more of the nature of wrought iron.

The Crown acquired some of the early mining rights and obtained a right of 65 cusecs for irrigation in 1926. In practice there are no superior rights and the Crown has unrestricted use of the Arrow River water.

The layout involved commencing high enough in the Arrow Gorge to command the level required, and carrying a pipeline down a rough gorge to where it emerges onto the easier country near Arrowtown.

This pipeline climbs from the mouth of the gorge on to sidling country until it is high enough, and is 30" to 36" diameter, 17,500 feet long, and carries 50 cusecs with a maximum head on most of the middle section of 200 feet. Control is at the upper end to avoid further pressure rise. When the time comes to renew this pipeline it may be necessary to entirely recast the layout of the scheme and utilise pumping to supply high levels which are reached by gravity today only by the head derived from the long gorge pipeline.

The area supplied is 3,000 acres and from the farming angle the scheme has been quite successful.

In addition to the gorge pipeline of 17,500 feet, the scheme contains 22,100 feet of rivetted steel siphons ranging from 36" down to 7".

The main race is 11½ miles long and distributaries total 33 miles.

The intake consists of a weir in the Arrow River about eight feet above stream bed with a crest length of 56 feet.

It is connected by a short length of concrete race to the silt trap which is a reinforced concrete box 60' long x 10' wide x 16' deep with settling hoppers and scour valves. The gorge pipeline commences at the silt trap and there are no other structures of consequence.

CONROYS

There is another small scheme, shown on Map 3 which could have been regarded, for this report, as part of Last Chance Scheme, although it is substantially self contained.

It occupies an area between the Last Chance and Earnscleugh schemes, and dovetails into them, and there are properties which receive water from two schemes.

This little scheme was undertaken because the owners of private rights in Conroy's Creek petitioned Government to build a storage reservoir and regularise their race system, in return for an assignment of the water rights and an appropriate charge for water.

The work was carried out for the relief of unemployment and a very useful storage of water created, which enables about 500 acres, perhaps half of which is orchard, to be irrigated.

The work was carried out in the latter half of 1934, and in 1935, and operated in 1935/36 season.

The principal feature is an arched concrete dam, 67' above stream bed, crest length 200', storage 880 acre feet, and a surface area of 35 acres. The length of race reconditioned was approximately four miles.

OMAKAU IRRIGATION SCHEME

This scheme lies in the Manuherikia Valley and is shown on Map No. 8.

For many years consideration was given to irrigation in this area. Prior to 1910, both mining and private irrigation were active and using most of the available water, but by 1920 mining had declined and the Government had the Manuherikia scheme in hand. Surveys were made between August 1922 and April 1926 for a major scheme covering all the country between Cambrian and Clyde, with the exception of the existing Manuherikia scheme.

This involved a storage reservoir on the Manuherikia at the Falls dam site and a large and very long race, commencing near the dam and running to the Waikeri Valley near Clyde. Much of this race was in difficult country at the particular elevation necessary and the project presented many difficulties and was much more costly per acre than earlier projects, finding little favour, and was not actively sought for because the spread of the scheme was so great that there was no community interest.

The estimate was £1,600,000 for an irrigable area of around 64,000 acres.

This scheme at no time appeared very likely to be authorised.

Attention was turned to some more manageable development and various modifications of the proposals were examined between 1926-30. By that time it appeared that practically all the country as far down as Tiger Hill, that could have been supplied by the major scheme, could be supplied by a smaller scheme with an intake above Becks, where shown on the map.

This was supported by the fact that the Lands Department had bought for subdivision in 1930 all the irrigable land east of the Dunstan Creek, together with a private right adequate to supply it. This meant that we had no demand from lands east of Dunstan Creek, and it further appeared that the lands above the lower race line, but which could have been served by the major development, in the vicinity of Cambrians, could be supplied from the Dunstan and local creeks. This was facilitated by the fact that the Crown had obtained water rights in these streams by transfer and original application.

Another factor was certain transactions with water rights from Lauder, Thompsons and tributaries of Chatto Creek. In 1924 Vincent County acquired a number of valuable early rights on behalf of lands that lie between the foothills and the lower race line, and the Crown had the right to acquire them by repayment of the County's outlay. It was clear, if this were done, that the strip of country between the major and minor developments would be substantially provided for as far down the valley as Tiger Hill, which would be the lower boundary of the lesser development.

The major proposals were therefore dropped, and in December 1930 the survey of the lower race line was commenced, and this was the beginning of the present Lauder scheme.

As will be seen, investigations had spread over a good many years and this account may be a little over-simplified, but any attempt to give a detailed description of all the surveys and negotiations re water rights would only confuse rather than clarify the picture.

By October 1931 the main surveys had been completed and approved, and construction work had been started and the first supply of water was in the 1935/36 season.

This scheme was designed as an irrigation scheme without complications by prior mining layouts and an endeavour was made to construct it in as permanent a manner as possible. No rivetted

pipe was used, practically all pipelines being reinforced concrete, with some welded steel concrete lined.

Permanent structures are in concrete.

During the time the race construction was proceeding, a dam was built at the Falls site.

This is a substantial rockfill 110 feet above stream bed, containing 168,000 cubic yards. It has a reinforced concrete inner face which is designed for a future possible raising of forty feet. The present storage capacity is 8,400 acre feet.

Water is discharged by a balanced needle valve into the spillway tunnel, which is fed by a vertical "morning glory" circular spillway.

This structure has functioned very satisfactorily and with little need for attention since the spring of 1935.

The final step in the Omakau scheme was the addition of the Matakanui County Scheme and the area between Cambrian and Lauder Creek as described earlier in connection with the original planning.

These areas which are above the Omakau main race, are included in Omakau for management and administration.

Matakanui and Lauder were added in 1935/36 and the other area, generally known as the Dunstan section, in 1938/39 season.

This addition required the reconstruction of some old mining race, and the construction of some new distributary race.

The total area supplied in the Omakau scheme is 15,000 acres.

This includes 850 acres on the left bank of the Manuherikia commanded by a race commencing in the Manuherikia about 2½ miles above the Lauder intake.

This right was acquired by the Crown and now supplies an enlarged area upon which the landowners pay rates, but attend to their own distribution and maintenance.

The Omakau scheme was commenced without contracts, with sale of water on demand. Experience soon showed that this was unsatisfactory and seventy-five per cent of the irrigable area is now signed up for under normal irrigation contracts, with sales of water on demand on additional area still permissible. The farming results in the Omakau scheme are quite good.

The following are details of the reticulation.

The scheme operates on water coming over the spillway at Falls Dam, or released through the control valve, plus some stream-flow joining between the dam and main race intake, a distance of approximately nine miles.

The water is diverted out of the Manuherikia on the left bank by a low concrete weir, 270 feet long, by 5 feet high, and passing through control gates, enters a 54" concrete pipe 30 chains long. It emerges into a silt trap, and then travels on as open race to the 2.1 mile point, where it crosses to the right bank of the Manuherikia by means of a siphon that is partly concrete lined steel 36" diameter and partly reinforced concrete 42" diameter, and of a total length of 3,150 feet.

The main race then follows a sidling between Becks and Lauder until it tops the ridge, and then crosses Lauder Creek by a 42" diameter siphon 4,580 feet long, mostly reinforced concrete, but having some concrete lined steel.

From this point the race works away from the river and commences to head around a large basin draining towards Omakau.

Including the siphons already mentioned there is just over 16,000 feet of siphon in the scheme, the balance all being reinforced concrete ranging from 15" to 48" diameter.

There are also four concrete lined waterdrives amounting to 2,120 feet total length. These range between 4'8½" x 3'9" to 4' x 3'.

The length of the main race is 30¼ miles, and distributaries total 15½ miles. There is one area of 500 acres supplied over a saddle at Tiger Hill by a small electric pumping plant of 25' lift.

The Matakanui and Lauder sections mainly utilise old water race, of a total length of approximately 38 miles, and the Dunstan section required the construction of 10½ miles of new main race and 4 miles of distributary races. These sections contain no structures of note.

SCHEMES IN HAND AND UNDER CONSIDERATION

Pisa Flats

This scheme is under construction at the present time and is designed to supply 2,840 acres on flats and low terraces north of Lowburn and shown on Map No. 9.

The principal source of water is the Clutha River, and water will be pumped through 800 feet of 27" diameter concrete pipe, with a lift of 120 feet.

Some water rights in the local creeks will also be used on the higher levels that are too high for economic pumping.

The Lands Department holds the bulk of the land to be irrigated and is preparing it for subdivision and soldier settlement.

Cromwell Flat-Ripponvale

This scheme has been approved in principle and detail arrangements and surveys are in hand. The complete details are set out in 64/103 of 15.10.53 to the Hon. Minister of Works.

Blackmans (Extension to Earnscleugh Scheme)

This proposal, which has been reported on, but not yet finally approved, will add 500 acres to the area now irrigated. This involved the acquisition without cost of all the water rights in Blackman's Creek, both private rights and rights held by Vincent County on behalf of certain lands, and these will be utilised, in conjunction with Fraser River water.

The proposal briefly is to pump Fraser water, with a lift of 82 feet, to supply the lands now mainly watered by Blackman's rights and to utilise these on the adjacent higher area that is dry at present. The dry areas are mostly favourably situated with suitable soil for fruit growing.

This proposal is a good example of the benefits to be obtained by the consolidation of Crown and private rights and the

newly opened possibilities of irrigation pumping and doubtless will be put into final shape and approved at an early date.

Bannockburn Irrigation Scheme

Work is in hand on a major overhaul of this small irrigation scheme, shown on Map 12.

This commenced in 1922 as a semi-private group scheme, financed by a loan raised by Vincent County, and operated and maintained by the water users. In accordance with recent arrangements the Department is repairing and in part reconstructing the race system and will own the races and water rights, and will receive water rates from the irrigators.

The cost of maintenance will be met by the Department out of water rate moneys but the work of maintenance and the supply of water will devolve upon a Board of Control elected by the irrigators.

The weakness of this arrangement is that the Board of Control will have no particular interest in economical maintenance, since the Department will be paying the bills and the settlers' charges are fixed.

However, close attention by the Department to how the Board manages the maintenance may very well establish a satisfactory working arrangement. It will be necessary to watch the position very closely otherwise the Department may find itself in the position of having to undertake the maintenance and distribution, and this would be most undesirable as our labour costs would inevitably be higher because of the difficulty of obtaining suitable casual labour, and the unattractiveness of high level race work to present day labour. It should be mentioned that 22 miles of the main supply race is above 4,000 foot elevation.

It may be necessary to give the local office strong support some time in the future in a stand against all the responsibilities being unloaded on to the Government. Such a stand would be completely justified, since the very considerable Government assistance being given to ensure a new lease of life for this group scheme, has been given on the basis and understanding that the irrigators must help themselves.

FUTURE POSSIBLE EXTENSIONS OF EXISTING SCHEMES

In considering this aspect of irrigation in Central Otago, there are two matters that need some consideration.

The first is that all the schemes that appeared easy, that would serve land whose response was beyond question, and whose cost, both overall and per acre, appeared reasonable, were completed before 1936, and therefore before the immense rise in costs that has occurred since that time.

Even before 1936, the objection to the large projects then possible was the large overall cost, doubts as to whether the land would give the same percentage increase in production, and still stronger doubts as to whether the farmers would give the complete practical support that would be necessary for financial success. While pumping in the Upper Clutha Valley does seem much more capable of success than in 1936, the doubts about the Maniototo still remain, especially because present day wool and sheep prices and labour costs give less incentive than ever to change over from dry farming methods.

The other matter is the great disparity between the price of farm products and the price of irrigation water.

Irrigation rates are about 33% higher than during the depression, while farm returns are about 400% greater, and irrigation operation and maintenance costs have increased threefold.

If new irrigation schemes with charges on the present level are contemplated, then, even with the greatest possible mechanisation, there is no possibility of escaping very large annual losses.

It could almost be said that this district, by its success in retaining low water charges, has made it impossible for anyone to conscientiously recommend any new major projects at prevailing irrigation charges.

In fairness, it must be said that farmers at Ripponvale have agreed to pay £2 per acre to participate in the Cromwell pumping scheme, but the Department has had plenty of experience of farmers agreeing to pay a price commensurate with costs and then obtaining substantial reductions, and has no reason to be over-optimistic that the past will not be repeated.

It may be argued that the same objection does not apply to the fullest possible development of existing schemes, or to new proposals that are smaller and require less capital development and are capable of economical maintenance, and a summary of the position of existing schemes will now be given.

There are certain schemes where all the available summer stream flow is used for irrigation, and where the flow cannot be augmented, either by storage or by bringing in water from another watershed. These are Ardgour, Tarras, Last Chance and Idaburn and Hawkdun.

This statement cannot be seriously challenged and no increase of the irrigable area is possible other than perhaps some negligible figure of a few acres to meet some new set of circumstances.

At Arrowtown there is no scope for new irrigation construction outside the limits of the present scheme. There are lands within the scheme that could be added to the area being irrigated at present, but it would be unwise to do so, the reason being that it will ultimately be necessary to recast this scheme to avoid as much as possible of the very high replacement costs of the existing siphons. Until a detailed investigation and survey of the best amended layout has been made, it would be advisable to leave well alone. This is the only scheme in this condition.

In the Manuherikia, Earnscleugh, Omakau and Teviot schemes, some small additions to the irrigated area are possible, but there is little upon which to base any definite recommendations. Any extensions of area must come out of somewhat slender balances of water available with the present layouts and race capacities, and the water available at the present main race intakes. Any area extensions can only be considered in the light of the water available and the cost involved and on the merits of the particular case.

Generally, extensions within the schemes that do not endanger existing commitments are clearly desirable.

In Earnscleugh a proposal is under consideration at present, and is known as Blackmans Extension. There is water available, the

land is very suitable for the establishment of orchards, and the proposal has considerable merit as it will bring in an area that will be very productive. Apart from this, there is little in sight in Earnscleugh, as the remaining unirrigated land is fairly light.

In Manuherikia there is a proposal taking form, but which has not yet been studied by the local office, or reported upon. There is an area near the town of Alexandra suited for orchards and small fruit, but it will be most difficult to irrigate by orthodox local methods. Either extensive land levelling or spray irrigation would be necessary and it is the latter that is now being suggested.

Although it would involve expenditure for a reservoir, excavated as a "tank" on flat land, and probably requiring gunite lining, and would involve a special high water rate, it does merit close examination and estimates of cost. Most of the remaining unirrigated lands in the Manuherikia scheme are extremely light and poor, being just a skin of soil over very open gravels, and were abandoned after trial twenty years ago. The Department would be unwise to make any move to get them under irrigation.

In Teviot, the unirrigated lands are of the same type and the same comment applies. There has been some general talk of adding areas adjacent to Millers Flat, and over the Molyneux River, between it and the Bengerburn Scheme.

The existing Teviot main race out of the river, and the races leading to Teviot extension, could not carry nearly enough water to supply these areas. It would be necessary to find an entirely new high level route out of the Teviot River, and drop the water down a gully leading towards Millers Flat. An increase in storage at Lake Onslow would also be required. This proposal has never been strongly sought for, or considered, but would be very costly and require a high water rate. No details of the work involved or probable costs are known, and a trial survey would be required to determine a route before any figures could be given.

Omakau Scheme. The area of the Matakanui and Dunstan sections of this scheme, that are fed from stream flow, cannot be enlarged, but there are two areas that could be supplied by pumping from the Omakau main race, totalling about a thousand acres.

This can be supplied from the angle of main race capacity, and there is sufficient water (using the storage of Falls Dam to maintain the stream) but two pumping plants and the duplication of a siphon at the lower end of the main race would be necessary. These possible additions will be investigated and reported on and can be considered on their merits.

The remaining schemes are Ida Valley and Galloway.

In Galloway action has already been taken by pumping return flow from the Manuherikia River and the Manorburn stream, to supply the lower areas of Galloway with little recourse to the Upper Manorburn Storage, but there is practically no scope for any extension of irrigation in this area. In the higher levels of Galloway and in Ida Valley there is a total of, say, 7,500 acres of good irrigable land as yet unsupplied, but the problem in recent years has been when we would be again able to meet our

full commitments to the existing irrigated areas.

As is well known, the question of augmenting the Upper Manorburn supply from the only apparent source, Hopes Creek, has been extensively examined.

The present appreciation of this matter is as follows:-

For many years Manorburn Dam was the principal supply for 12-14,000 acres of irrigated land and everything appeared reasonably reliable and secure. Then came the series of bad years for run-off, and during these, although Manorburn was nominally supplying irrigation water for 12,000 acres, the available water in the worst year from Manorburn itself, was only enough for 2,000 acres.

It is interesting to speculate upon the theory of management that would have prevailed if these bad years had come in the first years after the dam was completed.

Obviously, it would not have been assessed as capable of irrigating 10,000 acres as was initially proposed and actually achieved.

What would have been the position with a dam and race system designed for 10-12,000 acres, and water for only 2,000 acres?

The opinion is held that, if this had happened, the amount of land under irrigation today would be the same as at present. Despite the initial warning, the 25 succeeding years would have offered so much scope for improved farming and increased production that it can be confidently asserted that the risk of recurrence would have been taken, and the full benefits of the scheme obtained.

There is not the slightest doubt that this would have been a justifiable risk, and the additional produce from 9,000 acres of irrigated land for 25 years would have been of great value (probably £1,800,000) and benefit both to New Zealand and the local farmers and townships. Taking the short term view, one must recognise the serious difficulties that have arisen for all concerned in recent years, but taking the long term view appears to be the only method by which the value of irrigation can be fairly assessed.

It would seem therefore that the long term view does not indicate any need to increase the storage for the Ida Valley Scheme, and if anything were done, it would really be in the nature of an insurance against a recurrence of the recent dry years, and it would be most difficult to resist demands in good years, that some or all of this insurance water should be used for still more permanent irrigation.

The writer's view on this matter now is that no action to increase Manorburn water for insurance purposes is justified (and this is most certainly not ignoring the troubles of recent years) and that the only sound justification for new works in this area would be the irrigation of new lands, because any increased supplies would, in the long run, inevitably be used for this purpose.

During the past $3\frac{3}{4}$ years, a weir and recording gauge has been in operation in Hopes Creek, and has shown that in dry years the flow is not good and that any direct use of the summer flow by means of surface racelines, plus a small storage dam, could not provide irrigation for more than 2,000 acres. Viewed either as insurance or for new area, this is not very encouraging.

If the addition of all Hopes Creek water to Manorburn equalising storage by means of a tunnel is considered, then it

appears that the general principle advocated above should apply, that is, the value of Hopes Creek should be assessed on the equalised average gain, and not on the gain or yield of the worst seasons.

The records to date indicate that the run-off per square mile of Hopes Creek watershed is not as good as Manorburn watershed during dry periods, and is nearly as good in wetter periods. It is quite possible that during a cycle of wet years the proportionate run-off would be as good if not better.

Giving careful consideration to the records now available, it appears that a diversion dam in Hopes Creek and a tunnel to Manorburn, plus raising Manorburn Dam, would increase the water available from Manorburn by 60%, or, sufficient when delivered through the race system to irrigate 7,200 acres.

NOTE: See appendix to this section for data re Hopes Creek.

The position therefore is that the summer flow open race from Hopes Creek would supply water for 2,000 acres at a cost of approximately £70,000, or £35 per acre, to which must be added a share of the cost of the present race system.

The larger proposal involving tunnelling and increased storage would supply 7,200 acres at a cost of approximately £360,000, or £50 per acre, plus a share of existing capital costs as above.

These figures can only result in operation at a loss and any decision to carry out one of the alternative possibilities can only be made by the Government after deciding what write off would be justified.

It is not proposed to carry the matter further in this report, beyond saying that these possibilities are the only way by which the irrigated area on the Crawford Hills behind Galloway can be increased, and are the most practical way to increase the irrigated area in Ida Valley.

It is feasible, if Galloway and the existing irrigated land in Ida Valley is considered to have enough provision, to make additions in Ida Valley on lands at present unirrigated and lying between the present Ida Valley scheme in the south end of the valley, and the Hawkdun scheme at the northern end. It has been suggested that this area could be fed with water from an enlarged Falls dam, by pumping over the saddle from the Manuherikia valley. This saddle is very close to Hill's Creek , Map 6, and from this point water would gravitate down to Idaburn Dam, and be used on the area commanded by an enlarged and extended Idaburn Race, Map 6. This would not help the area fed from Manorburn and Poolburn dams, and further would absorb the only water by which the irrigable area in the Manuherikia valley can ever be increased, particularly the Moutere area between Chatto Creek and Clyde, referred to later in this report.

There is room for debate as to whether the water that can be obtained by additional storage at Falls Dam should be used in Ida Valley or the Moutere area, but the most immediate objection to the use in Ida Valley is the pumping lift to Hills Creek saddle, which would be of the order of 310 feet, with 13,000 feet of pipe. This lift appears to rule the proposal out.

It has been said earlier that Arrow River is the only scheme where a general recasting may be necessary when the pipelines are due for renewal.

This is not strictly correct, for at Tarras there is a possibility that the first 7 miles of the main race could be completely modified, although the balance would remain unchanged.

The alterations would not increase the water or area, but would considerably reduce labour costs for maintenance, and costly pipe renewals, at the expense of installing a substantial electric pumping plant and the cost of power.

This proposal involves abandoning the upper seven miles of main race in the Lindis Gorge, and substituting a mile of race on flat country and a lift of 100 feet.

This will require detail examination within the next two or three years, because the alternative will then be to commence renewing siphons in the present gorge race. This will be presented for consideration on its merits in due course. Power would be derived from the block of power available for irrigation pumping in the Upper Clutha.

The above is not an extension of the Tarras Scheme, but this appears the appropriate place to mention it.

This completes the section on possible extension or additions to existing schemes. While it is believed that everything that is possible has been mentioned, it should be remembered that much of it has never reached the stage of trial survey, no detail examination has been made, and the proposals may prove altogether too costly. Doubtless minor alterations or additions to irrigated areas will require to be made from time to time and this report should not be regarded as excluding this possibility.

These minor alterations would have negligible effect on the overall position.

APPENDIX

IDA VALLEY

Average yield from catchments to 30.4.53:

Manorburn Dam (35 years) - 20,030 ac. ft.
" " (21 ") - 19,800 " "
Poolburn Dam (21 ") - 5,150 " "

As the Upper Bonanza Race loses 10% of its flow before delivering the Manorburn water, either into the Lower Bonanza Race or into Moa Creek, the two dams can be regarded as capable of coping with the following proportions of the total area supplied by them, since there are no race losses from Poolburn.

Manorburn Dam	78%
Poolburn Dam	22%

Areas now dependent on the two dams are:-

Ida Valley	12,514 acres
Galloway	1,516 "
	14,030 "

HOPES CREEK

Gaugings near the Stone Hut in Hopes Creek have been kept since 1st February, 1950. Following are comparisons with the Manorburn Catchment:-

Period	A. Nett gain Manorbun Dam ac. ft.	B. Hopes Creek at Stone Hut ac. ft.	C* Hopes Creek at proposed tunnel intake ac. ft.	C/A %
1.2.50 - 30.4.51	7,930	9,400	7,050	89
1.5.51 - 30.4.52	22,290	20,460	15,340	69
1.5.52 - 30.4.53	14,680	10,160	7,620	52
1.5.53 - 31.10.53	15,530	8,550	6,410	41
	60,430	48,510	36,420	Av. 60

* 75% of B - proposed tunnel intake approximately 3 miles upstream from Stone Hut.

PROPOSED RACE BETWEEN HOPES CREEK AND UPPER BONANZA RACE

Intake approximately 1½ miles above Stone Hut

Flows at this intake approximate 85% of Stone Hut flows.

Proposed race capacity = 20 cusecs.

Quantities of water capable of being diverted between October 1 and April 15:-

Season	Stream flows Acre ft.	From storage Dam	Total diverted	Less race losses	Available for sale
1950-51	1,800	1,600	3,400	1,140	2,260
1951-52	4,370	1,600	5,970	1,990	3,980
1952-53	3,270	1,600	4,870	1,620	3,250
	9,440	4,800	14,240		9,490
Average:	3,145	1,600	4,745		3,165

This is capable of irrigating approximately 2,000 acres in Ida Valley without falling below 75% of full supply in the very worst year encountered.

IRRIGATION RATES AND DUTY OF WATER

In the scheme histories, the questions of charges for water and the amount supplied per acre have not been touched.

These, and the area on which rates have to be paid, have always been matters productive of argument, and in some cases serious controversy.

In Central Otago, irrigation contracts have always been referred to as "agreements" and farmers do not use any other name.

The original Government policy, which was not modified for many years, was that agreements should be for the total area in a farm that was commanded by the points on the boundary where the Department supplied water, and was reasonably capable of being irrigated. In many cases this "irrigable area" was and still is, a very large percentage of the gross area, but there are all degrees of quality, slope and roughness, and in some cases the irrigable proportion is quite small. In every case, however, this irrigable area had to be determined and had to be done by inspection and sometimes survey, together with discussion and argument with the individual farmers. It will be realised that there was plenty of scope for differences of opinion.

Agreements provide for a rate per acre on the irrigable area, and this is payable in full each year, regardless of the use made of the water, and the season, and it generally provides that if the Department fails to supply the annual quota, a pro rata reduction is made. This provision does not apply in all schemes.

The annual quota was based on the hypothesis that a steady flow of water is used for a certain period each irrigation season.

A typical agreement provided for a flow of one/one hundred and fiftieth of a cusec for each irrigable acre for one hundred and fifty days during the season. This is of course equivalent to one cusec for one day each year, on each acre.

The cusec or "head" flowing for one day is the unit of volume of water, in irrigation farmers' parlance, and in the typical scheme under consideration, a 50 acre agreement in effect provided for the supply of one day head for each acre, or, 50 day heads per season.

The farmer may use this in ten irrigations of $2\frac{1}{2}$ heads flowing for 48 hours or perhaps with a flow of $\frac{3}{4}$ head flowing for a total of 67 days, or, within reason, in any combination of flow and elapsed time that suits him.

Farmers did not think in terms of acre feet, but since one cusec of water flowing for 24 hours will flood one acre almost exactly 24 inches deep, one head for one hour represents a depth of water of one inch over one acre, and a day head is equal to two acre feet, and these units of water volume are now coming into more general use.

Again, if the farm had 150 acres irrigable, the quota is 150 day heads and since the agreement contemplated a supply during 150 days of an irrigation season, the quota is one head for 150 days on 150 acres. This can, of course, be derived directly from the supply of one/one hundred and fiftieth of a head per acre, for one hundred and fifty days, as stated in the agreement.

A scheme providing water, as above, was therefore referred to as receiving one head to 150 acres, with the unspoken inference

that the flow was for 150 days.

All schemes did not provide the same allowance per acre, and while the usual figure was 1 head to 150 acres, there was, for example, Ida Valley at 1 head to 200 acres, and Hawkdun with 1 head to 300 acres, and in these cases the allowance was $\frac{3}{4}$ and $\frac{1}{2}$ day head per acre, respectively, and the annual quota in day heads was threequarters and half of the agreement acreage respectively.

This method of computation was adopted largely because of the continuous mining history of the area, and the fact that water race licenses are granted for so many heads, and everyone knew what a head meant, in actual practice, if not mathematically.

The chief benefit was that the farmer could relate daily flows to his annual quota and keep check on his usage of water.

This system existed for many years, but because the annual quota for many farms was modified in 1928, and because the day head unit has only a local significance, there has been a partial changeover to thinking in terms of acre feet and inches of water per annum, which informs the farmer what water he will receive without requiring the hypothesis that he will receive water for 150 days in the season. The latest agreements provide for so many acre feet per acre, and from this is derived the total acre feet for each particular farm. The day heads per annum can be directly ascertained by halving the acre foot figure, and since the farmer still orders water from the raceman as a flow of so many heads for some multiple of 24 hours, in practice both farmer and raceman still work in day heads while the Alexandra office uses both day heads and acre feet, depending upon whom they are dealing with, and which system is most intelligible.

It will be seen, therefore, that while the day head system is somewhat confusing to people outside the district, it is not possible to abandon it entirely.

Water is measured to individual farmers by means of gauge boxes set in the race banks. These boxes were developed originally to measure water for mining purposes and their dimensions and capacities for various openings are laid down in the Mining Act or Regulations.

The agreements for the schemes existing prior to 1928 were as follows:-

Scheme	Supply	Net Rate per Acre	Extra water per dayhead
Arrow River	1 cusec to 200 acres	20/-	26/8
Earnscleugh	Proportion of total water	4/8 plus maintenance rate	Free
Galloway	1 cusec to 150 ac.	15/-	15/-
Hawkdun	1 " " 300 "	10/6	In practice, Nil
Ida Valley	1 " " 200 "	First 7238 acres at 10/-, balance at 15/-.	13/4 20/-
Last Chance	1 " " 200 "	11/-	Free
Manuherikia	1 " " 150 "	16/-	16/-
Ardgour	1 " " 150 "	15/-	15/-
Tarras	1 " " 150 "	15/-	15/-
Teviot	1 " " 150 "	16/-	16/-

NOTE: 1/150 = 24" water; 1/200 = 18"; 1/300 = 12".

Between 1925 and 1928 there developed considerable dissatisfaction with the water allowances and charges, and finally a well organised attack on the Government's policy was made, and an Irrigation Commission was set up and reported in September 1928.

This Commission did not agree with the principle of a uniform water allowance and charge per acre within a scheme, and made recommendations for each property, and as their recommendations were adopted, the result was a great multiplicity of rates per acre and water allowances.

These are set out in the Commission's report but are much too extensive to quote.

In almost all cases, rates were reduced and water allowances increased, and in many cases the irrigable area was reduced.

While the reduction of rates was justified during the depression years, they have been too low since the recovery, and during more recent times have been obviously out of step with all other costs and with returns from farm produce.

On the other hand, the reductions of area were fairly well justified. In more recent times some of the borderline acreage could have been brought in and would have paid to do so, but the chief difficulty was, the increased allowances of water had substantially used up the water available.

In other words, the water saved by cutting out some of the irrigable land, was, under the Commission's findings, applied to the land under irrigation and it is not practicable to get it back.

The increased allowances of water have also been fairly well justified by results, but the Commission's recommendations were based more on a desire to get existing irrigation farming on its feet, rather than extension of the farming area, in existing schemes.

Because the Commission specified extra water free or at very cheap rates, improvement of existing pastures was facilitated, but with better times, the cost of extra water became so small a proportion of farm costs that there has been no incentive for economy. The outsize example is that of an orchardist who cheerfully paid for a depth of <u>ten feet</u> on his irrigated land in one growing season.

Because there was little brake on the money side, the farmer naturally did his farm as well as possible, but it must be confessed that in very many cases it is difficult to say just what reduction in use could be made without materially affecting production.

The Department carried on under the Commission's findings until the existing agreements came up for renewal and new agreements and rates were approved by the Government and in most cases signed in 1952. Under the Commission's findings the average revenue per acre irrigated was approximately 10/-. Under the new agreement rates it will be approximately 13/3.

Under the new agreements, minor modifications to eliminate some of the numerous variations of rates and water allowances have been made, and a few anomalies corrected, but generally, the rateable areas and the water allowances are substantially unchanged. There is an average increase of 3/3 on all irrigated areas, and an increase in the cost of extra water.

The following table sets out the position under the new agreements:-

Present allowances and nett charges

	Water allowances	Nett rates (per acre)	Extra water (per dayhead)
Arrow	24" to 36"	13/3	6/8 & 10/-
Earnscleugh	36"	13/3	Free
Galloway	20" to 30"	9/9 - 15/3	4/- Galloway Flat 8/- Crawford Hills
Hawkdun	12"	11/3	Nil
Idaburn	18"	16/-	Nil
Ida Valley	18"	10/- & 17/3	13/4 & 24/-
Last Chance	18" & 24"	12/9 - 14/9	Variable. Free to 3/-
Manuherikia	24" to 36"	10/3 - 16/3	5/3
Tarras	24"	11/3 - 18/3	3/3
Ardgour	24"	13/3 - 16/3	3/3
Teviot River	27" to 36"	11/3 - 17/3	2/-
Omakau	12"	6/3	12/-

It will be noted that the rates for extra water are still lower than the originals (with the exception of Ida Valley, where the extra water charge has always produced the same revenue per day head as the acreage charge).

Under the Commission rates the maximum rate was 2/- per day head, this obtaining from 1928 to 1942, so a move upward has been made, and this should be persisted in.

At this point it might be said that the writers fully approve of high rates for extra water on established schemes where the water supply is adequate. Where the irrigable area (and the irrigable area under the worst conditions is the area upon which charges are made) is governed not by average but by minimum stream flow, then the supply of free extra water becomes relatively unimportant, always provided, of course, that the minimum flows are efficiently used, and cover the maximum area that can be maintained in good order in dry times. Where water is produced by costly storage or pumping, there is no justification for cheap extra water, except to assist the farmer in the difficult task of establishing a properly laid out productive farm, which is in line with the customary reduction in acreage rates for the first few years granted for the same reason.

FUTURE IRRIGATION DEVELOPMENTS

The remaining section of this report deals with the field for expansion of irrigation by new schemes.

This comprises, pumping schemes in the Upper Clutha Valley, the Maniototo scheme, and provision of water for an area known as the Moutere area, and lying between Tiger Hill and Clyde and above the main race of the Manuherikia Scheme.

Upper Clutha Valley

The area upon which water can be supplied depends upon the pumping lifts to be installed and has been provisionally estimated at 14,000 acres. The general key map shows this area but no

details are available yet for most of it because no surveys have been made and the major design decisions have yet to be made.

Work has been confined to two sections recently approved, Pisa Flats and Cromwell Flat. These are shown on Map No. 9. These are for pumped supplies to 2,300 acres at Pisa and 1,020 acres at Cromwell (including Ripponvale).

Consolidation of water race licenses will add 500 acres above the pumping level at Pisa Flats.

Since Pisa is under construction, and agreements with settlers and final plans for approval are in hand for Cromwell Flat, there appears no reason for repeating the details here.

The general position therefore is that work to irrigate the 3,800 acres is in hand or about to commence, and no details are available for the remaining dry 10,200 acres. These details can only be supplied after surveys.

The chief matter for further mention is rate of progress. In these pumping schemes the speed at which the land will develop and the response is not known with certainty, but in the unsurveyed areas it is certain that the landowners will be looking for some guidance from results from the two areas in hand. It is recommended that the Government should adopt the same attitude and base its decisions on further installations on the results obtained with the two schemes soon to commence.

Maniototo

Shown on Map No. 10.

It is not possible in the time available to give any summary of the extremely large amount of data on file. There are no really difficult problems in the construction work, and the final proposals are for a scheme that would undoubtedly operate very well from the angle of supply of water.

The real problems in this large proposal, which could irrigate up to 68,000 acres, are economic ones arising from the changeover from dry to irrigation farming.

These will be briefly outlined.

The scheme, either whole or in part, will cost about £25 per acre, and even with present day costs, should break even on operating at approximately 27/6 per acre, provided all the irrigable area is revenue producing. This allows for a full interest return of 3½% on total capital cost. The difficulty lies, not in the 27/6 per acre, but in the proviso.

All the area in the Maniototo scheme is held in such sizes that the owners have always been able to make an adequate living, and in recent years farming has been very remunerative, especially as there has always been a strong tendency for properties to remain in a family ownership, with some tendency to land aggregation.

The average Maniototo property is not troubled with high rental or interest on mortgages. The dry sheep farming practised is easily one of the best modes of farming today for its ease of management and freedom from high operating costs, and, like Canterbury, there is little or no incentive to change it for intensive irrigation farming. There is no doubt that even as dry farms, a small amount of irrigation could be efficiently utilised, and would be acceptable to the farmers, but the percentage of area would be small, and quite inadequate to justify the construction work.

The problem of obtaining subdivision and irrigation on the full area is the major one, and added to it is the fact that the percentage increase of production is not likely to be as good as in the older schemes.

The area as a whole will doubtless present technical farming problems, some arising from irrigation, but these are not seen as presenting any particular difficulty from the engineering angle.

The most obvious physical difficulty to the engineer is the sweep of the wind and the very great deficiency of trees and windbreaks.

It will be seen that the requirement here is an assessment of the scheme from the viewpoint of other Departments, and from farmers themselves, as well as from that of the Ministry of Works, and the preparation of a policy acceptable to the Government. It is thought that any local demand for this scheme will be intermittent and without any consistent aim, and upon detail examination will prove to be for a quite inadequate area, and that initiation by the Government under the present ownership would be quite unless, if quick results and economical operation is desired.

It would appear that the Ministry of Works has brought this proposal up to the point where the co-operation of other Departments is necessary. It is understood that this is being handled by an Inter-Departmental Committee set up in 1946 to examine and report on possible methods of subdivision.

Possible Moutere Scheme

Shown on Map No.11.

There is little data for a report on this area. As mentioned in an earlier section, this area comprises the lower half of a large proposed scheme that was originally designed to serve all the northern side of the Manuherikia Valley, from Becks to Clyde, and for which a main race survey was made.

The Omakau Scheme, with its attendant areas fed from local streams, Matakanui and Dunstan sections, superseded all the upper half of the proposals and the question now is how to handle the lower half which lies between Tiger Hill and Clyde. The higher levels of this potential area are fixed by the level at which it is possible to supply, and the lower edge is defined by the main race of the existing Manuherikia Irrigation Scheme. The water for the area can come from only one source.

It would be physically possible to pump water from the Molyneux River near Clyde, and run the main race back towards Tiger Hill, but the high lift of many hundreds of feet, perhaps 600, appears to rule this out.

The only other source of supply is water released from increased storage at Falls Dam, since all the stream flows between Falls Dam and Clyde are fully committed for irrigation now, and all dam sites in Thompsons, Lauder and Dunstan Creeks have proved bad sites with very little storage behind them.

The problem is how to get the water released down the Manuherikia River from Falls Dam onto the area, and at what level should this water arrive at Tiger Hill. The original survey was for a gravity race commencing in the Manuherikia and running at a level higher than the present Omakau Main Race.

Since then, ideas and standards of race work have changed and it is doubtful if the original survey has any value at all for deciding the layout for the lower section. It will be necessary to start de novo, and the most obvious method of attack would be

to tentatively locate a raceline from Tiger Hill to Clyde, at a lower level than originally, with a view to supplying it by a low level pumping lift at Tiger Hill, drawing water from an enlarged Omakau Main Race.

Surveys would be required to confirm or reject this idea for something better, and there is no prospect of being able to make any commencement with them. In addition, there is no demand from the landowners, and while there is 10,000 to 12,000 acres of irrigable land, some very good, the whole lot is held by five owners, either as freehold or as S.G.R. Runs. When this situation is considered, with its implications, together with the fact that previous surveys and estimates indicate a construction cost of around £50 an acre, there is not much encouragement for investigation.

If means are devised to deal with the subdivision of Maniototo lands, they would be applicable here also, but unless this machinery is likely to be available, there is not much point in carrying out detail surveys.

There is no doubt that the land, from its quality and location in the area where water gives excellent results, and proximity to Clyde, Alexandra and Chatto Creek railway stations, is, from the engineer's viewpoint, very well suited for subdivision and irrigation, and merits examination on the same lines as Maniototo.

The potential increase in irrigated lands is therefore:-

Upper Clutha	14,000 acres
Moutere	12,000 "
Maniototo	68,000 "
	94,000

The potential additions to existing schemes are:-

Earnscleugh (Blackmans Extension)	500 acres
Manuherikia Spray irrigation	100 "
Omakau	1,000 "
Teviot	Nil (not likely)
Ida Valley (Hopes Creek)	Nil (7,200 possible)
	1,600 acres

The Hopes Creek proposal in Ida Valley is the only possible large addition to existing schemes and apart from it, the only likely additions amount to 1,600 acres, so the increase in this manner is not likely to make much alteration to the present situation.

The potential area in new schemes is 94,000 acres, and if it could be achieved, there would be additional production of £10-12 per acre at present day prices, so the potential exportable surplus is very substantial, around one million pounds per annum. Irrigation is established beyond any doubt as a successful method of farming and the only serious obstacles to expansion of irrigation in Central Otago up to the extent indicated, are:-

(1) The difficulties arising from the change of methods of farming, and the essential requirement of subdivision.

(2) The disparity between irrigation charges and the value of the increased production.

Regarding these, the first is regarded as the most important, because the volume of production is dependant on the degree of success and substantial success will mean so much production that some loss on working could be endured.

The second is, however, a very important matter, for if some better system of charging could be devised, the irrigation schemes could be operated without loss.

For instance, if irrigation rates had varied in proportion with wages and the value of wool, lambs, fruit and butter since 1928, when figures were established acceptable to the farmers and upon which they weathered the depression, then the irrigation schemes would have shown a profit instead of a loss right through, and no crippling amount of farm earnings would have been taken in water charges, as the ratio between water charges and farm earnings would have remained substantially constant.

In the same way, new schemes would not have the objections that now arise.

The average rate of 10/- per acre that obtained in the depression could by now be around 30/- on the basis of the general price rise, and at this rate existing irrigation schemes would have shown a profit, since they would break even with a rate of approximately 26/-.

With all farm produce being sold through centralised marketing channels, it should not be at all impossible to assign yearly values to local products, and slide the water rate in proportion.

Recessions in prices and wages would be looked after automatically, and the chief talking point against high water rates would have no further value. These matters are recommended for consideration, but under the system of agreements that are in operation on existing schemes, any sliding scale charge could only be introduced at the time of renewal or on a new scheme.

CONCLUSION

The establishment of the existing irrigation works and farms in Central Otago has now been reviewed. The overall picture is one where all stream flow is fully utilised in dry times, the only exceptions being the Molyneux River and the Nevis River, and the Nevis would be used if it were practicable. Apart from relatively minor additions to existing schemes, there is no possibility of any further irrigation fed by natural stream flow, and all new schemes will be dependant on large storages, or on pumping from the Molyneux River.

The only future sources of water are the Upper Taeri River and reservoir as yet unbuilt, and the raising of the Falls Dam, and Onslow Dam, plus additions to the Manorburn system by diversion from Hopes Creek. There is of course unlimited water in the Molyneux, but the areas upon which it can be economically used are limited to strips adjacent to the river.

In existing schemes, the future work, as it has been for some years past, is minor additions, maintenance and renewals of steel pipelines. The present practice is to renew in reinforced concrete spun pipe whenever possible.

The maintenance work presents no new problems, and the existing ones are inseparable from the layouts in use and accepted as part of the job. Difficulties do arise with procuring adequate competent labour, which cannot be done without, because the layout, much on hillsides, and the size of races, makes it impossible to use labour saving machines.

The varied topography of Central Otago ranging from easy slopes to rough hills and gorges, makes the use as well as the supply of water often quite difficult. There are sprawling networks of supply races requiring considerable skill in management,

and operating conditions bear very little resemblance to those in Canterbury.

In the same way, irrigating a single farm is often a complicated exacting job for the farmer, on top of his other work, and errors of timing in ordering or delivering water can have serious consequences for crops. As a result, there is nothing impersonal about the relations between the farmers and the Department's staff, and a close working understanding as well as knowledge is necessary, and has built up over the years. In considering the duties and responsibilities of the engineering staff of the Alexandra sub-district, it has to be recognised that a close personal relationship with the farmers is an essential and sometimes onerous part of the work.

The irrigated farms are undoubtedly successful, and while there is much of Central Otago that is barren because enough water at sufficient elevation does not exist, irrigation has completely transformed the economic and social life of the district, as can be realised from the fact that all production other than run sheep depends on water. Without irrigation Central Otago would be as sparsely populated as the valleys of the Upper Waitaki basin.

If the obstacles to further development can be overcome, there is no reason why irrigation should not make very large additional contributions to the welfare of Otago and New Zealand.

APPENDIX A

CENTRAL OTAGO IRRIGATION SCHEMES

SUMMARY OF STATISTICAL DATA

Scheme	Year Irrigation Commenced	Irrigable area, limited by water available (acres)	Capital Cost		Terms of Agreements				
			Total	Per Acre	Water Quota	Contract Rate per Ac.	Extra Water per ac.ft.	Period (years)	Expiry Date
Ida Valley	1917	12,360	£317,898	£21.0	18"	No.1 - 10/-	6/8	50	31.8.74
						No.2 - 14/-	9/4	21	31.8.45
Galloway	1920	2,660			20"-30"	9/9 - 15/3	2/- & 4/-	21	14.9.72
Manuherikia	1922	4,900	266,736	54.5	24"-36"	10/3 - 16/3	2/7½	21	14.9.72
Earnscleugh	1922	2,065	80,197	38.8	36"	13/3	Free	21	31.8.44
Last Chance)	1923	2,385	63,788	22.1	18"-24"	12/9 - 14/9	- to 1/6	21	14.9.72
Conroys)	1935	500							
Ardgour	1923	1,300	33,763	25.9	24"	13/3 - 16/3	1/7½	21	31.8.72
Teviot	1924	3,630	79,464	21.9	27"-36"	11/3 - 17/3	1/-	21	31.8.72
Tarras	1925	2,680	136,932	51.0	24"	11/3 - 18/3	1/7½	21	31.8.72
Bengerburn	1926	200	1,150	5.7	(Operated by settlers who pay an annual contribution of approx. £44 towards capital cost)				31.8.45
Hawkdun	1929	8,400	73,891	8.8	12"	11/3	Nil	21	14.9.72
Idaburn	1931	565	6,739	11.9	18"	16/-	Nil	21	14.9.74
Arrow River	1930	3,000	145,242	48.5	24"-36"	13/3	3/4 & 5/-	21	14.9.72
Omakau	1936	15,000	317,080	21.1	12"	6/3	6/-	21	14.9.72
Total (Operating Schemes)		59,645	£1,522,880	25.5					

Schemes in Hand or Approved

Bannockburn	(renovation)	800	Est. £ 3,500	4.4		25/-		(Prelim. assessment)
Pisa Flats	(in hand)	2,840	" 54,500	19.2	24"	20/-	6/-	(approved)
Cromwell-Ripponvale	(approved)	1,860	" 75,000	40		40/-		(Prelim. assessment)
Blackmans Extn.	(approved)	700	" 14,750	21	24"	20/-	6/-	(proposed)

CENTRAL OTAGO IRRIGATION

APPENDIX B

Details of Ardgour Scheme

SHEET 1

Basis of Supply	Number of Irrigators	Area under agreement or normally irrigated (acres)	Terms of present agreement: Water Quota (inches)	Rate per Acre	Extra Water per ac.ft.	Operating data (average of last three seasons): Approx. area irrigated (acres)	Ac. ft. of water supplied: Under Quota	Extra Water	Total	Equivalent depth of application (inches)
Under Agreement	4	185	24"	13/3	1/7½	1,299	2,591	1,316	3,907	36"
	1	412	24"	15/9	1/7½					
	5	702	24"	16/3	1/7½					
On Demand	Nil									
Free Water	Nil									
Totals:	* 8	1,299								

* 2 irrigators have 2 different rates

Water Source

Area	Supplied From	Normal Min. Quantity Available: Stream flow (cusecs)	Storage (acre ft.)
1,299 acres	Lindis River	16	Nil

CENTRAL OTAGO IRRIGATION — APPENDIX B

Details of Arrow River Scheme — SHEET 2

Basis of Supply	Number of Irrigators	Area under agreement or normally irrigated (acres)	Terms of present agreement: Water Quota (inches)	Rate per Acre	Extra Water per ac.ft.	Operating data (average of last three seasons): Approx. area irrigated (acres)	Ac. ft. of water supplied: Under Quota	Extra Water	Total	Equivalent depth of application (inches)
Under Agreement	30	2,106	24	13/3	5/-	3,014	4,824	439	5,263	21¼"
	1	100	28.2	13/3	5/-					
	19	868	36	13/3	3/4					
On demand	Nil									
Free water	Nil									
Totals:	* 49	3,074								

* One irrigator has 24" supply on one area and 36" on another.

	Area	Supplied From	Normal Min. Quantity Available: Stream flow (cusecs)	Storage (acre ft.)
Water source	3,074 acres	Arrow River	30	Nil

CENTRAL OTAGO IRRIGATION — APPENDIX B

Details of Earnscleugh Scheme — SHEET 3

Basis of Supply	Number of Irrigators	Area under agreement or normally irrigated (acres)	Terms of present agreement: Water Quota (inches)	Terms of present agreement: Rate per Acre	Terms of present agreement: Extra Water per ac.ft.	Operating data (average of last three seasons): Approx. area irrigated (acres)	Ac. ft. of water supplied: Under Quota	Ac. ft. of water supplied: Extra Water	Ac. ft. of water supplied: Total	Equivalent depth of application (inches)
Under Agreement	49	1,732	proportion of total water available	13/3	free	2,064	6,192	7,174.5	13,366.5	77½"
Under Agreement	10	343	"	5/3	free					
On demand	Nil									
Free water	Nil									
Totals:	* 50	2,075								

* Nine irrigators have 2 supplies

Water Source

Area	Supplied From	Normal Min. Quantity Available: Stream flow (cusecs)	Normal Min. Quantity Available: Storage (acre ft.)
2,075 acres	Fraser River	18	-
	Fraser Dam	--	4,200

CENTRAL OTAGO IRRIGATION — APPENDIX B

Details of Galloway Scheme — SHEET 4

Basis of Supply	Number of Irrigators	Area under agreement or normally irrigated (acres)	Terms of present agreement: Water Quota (inches)	Rate per Acre	Extra Water per ac.ft.	Operating data (average of last three seasons): Approx. area irrigated (acres)	Ac. ft. of water supplied: Under Quota	Extra Water	Total	Equivalent depth of application (inches)
Under Agreement	3	115	24	9/9	2/-	2,655	4,212	2,056	6,268	28.3
	1	200	19.8	10/3	4/-					
	1	600	21.2	10/3	4/-					
	2	158	24	10/3	4/-					
	1	62	24	11/3	free					
	1	91	24	12/3	2/-					
	1	500	30	12/3	4/-					
	5	142	24	13/3	2/-					
	4	245	24	13/3	free					
	3	41	24	14/3	2/-					
	2	106	24	14/3	free					
	6	397	24	15/3	2/-					
On demand	Nil									
Free water	Nil									
Totals:	* 22	2,657								

* Two irrigators have 2 rates one has 3 rates and five have 2 supplies.

Water Source	Area	Supplied From	Normal Min. Quantity Available: Stream Flow (cusecs)	Storage (acre ft.)
	(1) 760 acres	Manuherikia River	10 (pumped)	-
	(2) 1,484 "	Manorburn Dam	-	2,650
	(3) 413 "	Lower Manorburn Dam	5	190

CENTRAL OTAGO IRRIGATION — APPENDIX B

Details of Hawkdun Scheme — SHEET 5

Basis of Supply	Number of Irrigators	Area under agreement or normally irrigated (acres)	Terms of present agreement: Water Quota (inches)	Rate per Acre	Extra Water per ac.ft.	Operating data (average of last three seasons): Approx. area irrigated (acres)	Ac. ft. of water supplied: Under Quota	Extra Water	Total	Equivalent depth of application (inches)
Under Agreement	70	8,334	12	11/3	free	8,334	7,892	-	7,892	11.4"
On demand	3	NOT KNOWN	Approved rate 7/6		per ac.ft. used			117		
	1	" "	" " 3/3					70		
Free Water	Nil									
Totals:	74									

Water Source

Area	Supplied From	Normal Min. Quantity Available: Stream flow (cusecs)	Storage (acre ft.)
8,334 acres	Main supply from various creeks listed along the 70 mile length of main race (Hawkdun Range)	13	-
	Plus Eweburn Dam	-	1,240

CENTRAL OTAGO IRRIGATION — APPENDIX B

Details of Idaburn Scheme — SHEET 6

Basis of Supply	Number of Irrigators	Area under agreement or normally irrigated (acres)	Terms of present agreement: Water Quota (inches)	Rate per Acre	Extra Water per ac.ft.	Operating data (average of last three seasons): Approx. area irrigated (acres)	Ac. ft. of water supplied: Under Quota	Extra Water	Total	Equivalent depth of application (inches)
Under Agreement	8	565	18	16/-	free	565	848	552	1,400	29.75"
On demand	Nil									
Free water	Nil									
Totals:	8									

Water Source

Area	Supplied from	Normal Min. Quantity Available: Stream flow (cusecs)	Storage (acre ft.)
565 acres	Idaburn Stream	2	-
	Idaburn Reservoir	-	192

CENTRAL OTAGO IRRIGATION — APPENDIX B

Details of Ida Valley Scheme — SHEET 7

Basis of Supply	Number of Irrigators	Area under agreement or normally irrigated (acres)	Terms of present agreement: Water Quota (inches)	Rate per Acre	Extra Water per ac.ft.	Operating data (average of last three seasons): Approx. area irrigated (acres)	Ac. ft. of water supplied: Under Quota	Extra Water	Total	Equivalent depth of application (inches)
Under Agreement	35	7,237	18	10/-	6/8	12,358	10,314	-	10,314	10"
	37	5,120	18	14/-	9/4					
On demand	1	Unknown	Approved rate 9/4 per ac. ft. used					17		
Free water	Nil									
Totals:	* 62	12,357								

* 11 irrigators have supplies at both rates

Water Source

Area	Supplied From	Normal Min. Quantity Available: Stream Flow (cusecs)	Storage (acre ft.)
12,357 acres	Manorburn Reservoir	-	10,500
	Poolburn "	-	2,650

CENTRAL OTAGO IRRIGATION

Details of Last Chance Scheme

APPENDIX B

SHEET 8

Basis of Supply	Number of Irrigators	Area under agreement or normally irrigated (acres)	Terms of present agreement: Water Quota (inches)	Rate per Acre	Extra Water per ac.ft.	Approx. area irrigated (acres)	Operating data (average of last three seasons): Ac. ft. of water supplied: Under Quota	Extra Water	Total	Equivalent depth of application (inches)
Under Agreement	5	740	proportionate share	12/9	-	2,356	4,072	902	4,974	25.3
	6	434	18	13/9	free					
	6	74	24	13/9	free					
	2	132	24	13/9	1/6					
	1	236	27	13/9	1/-					
	8	705	18	14/9	free					
	8	214	proportionate share	10/6	free					
Fixed Rate	Alexandra Borough Council pays £261. 0. 0 per annum for a supply of 1,220 acre feet.									
Free Water	9	237	entitled to proportionate supply of water available from Conroys Dam free.							
	2		entitled to 1¼ to 2¼ cusecs							
	1	64	" " 96 ac.ft.							
Totals:	32	2,836								

Water Source

Area	Supplied From	Normal Min. Quantity Available: Stream flow (cusecs)	Storage (acre ft.)
(1) 442 acres	Butchers Dam	-	1,200
(2) 1,879 "	Gorge Creek, Butchers Creek, Conroys Creek, Shingle Creek	7	-
(3) 500 "	Conroys Dam	-	880

CENTRAL OTAGO IRRIGATION — APPENDIX B

Details of Manuherikia Scheme — SHEET 9

Basis of Supply	Number of Irrigators	Area under agreement or normally irrigated (acres)	Terms of present agreement: Water Quota (inches)	Rate per Acre	Extra Water per ac.ft.	Operating data (average of last three seasons): Approx. area irrigated (acres)	Ac. ft. of water supplied: Under Quota	Extra Water	Total	Equivalent depth of application (inches)
Under Agreement	3	360	30	10/3	2/7½	4,688	12,405	3,280	15,685	40
	2	100	33	10/3	"					
	11	1,660	36	10/3	"					
	1	150	33	11/3	"					
	1	50	36	11/3	"					
	12	688	30	12/3	"					
	13	268	33	12/3	"					
	4	211	36	12/3	"					
	2	125	30	13/3	"					
	3	195	33	13/3	"					
	1	262	34.5	13/3	"					
	1	12	24	14/3	"					
	1	13	27	14/3	"					
	10	315	30	14/3	"					
	6	132	30	15/3	"					
	2	24	24	16/3	"					
	7	66	30	16/3	"					
	1	5	33	16/3	"					
	1	45	30	10/3	Free					
		4,681								
On demand	5	not known	Approved rate 4/1½		per ac. ft. used	Drew an average of 645 for last three seasons				
	9	not known	" " 6/3			Drew " " " 343 " " " "				
Free Water	Nil									
Piped	18	not known	pay £124.9.6 for pipe supplies							
Totals:	98 *									

* Note: 6 irrigators have 2 rates and 2 irrigators have 3 rates.
7 irrigators have both pipe and race supply.

Water Source

Area	Supplied From	Normal Min. Quantity Available: Stream flow (cusecs)	Storage (acre ft.)
4,688 acres	Manuherikia River	60	-
	Falls Dam	-	8,294
	Chatto Creek	2	-

CENTRAL OTAGO IRRIGATION — APPENDIX B

Details of Omakau Scheme — SHEET 10

Basis of Supply	Number of Irrigators	Area under agreement or normally irrigated (acres)	Terms of present agreement: Water Quota (inches)	Rate per Acre	Extra Water per ac.ft.	Operating data (average of last three seasons): Approx. area irrigated (acres)	Ac. ft. of water supplied: Under Quota	Extra Water	Total	Equivalent depth of application (inches)
Under Agreement	73	14,275	12	6/3	6/-	14,242	13,763	6,172	19,935	16.8"
Capital charge only	10	800 (approx)	Irrigators pay annual fixed charges of £412. They do own maintenance and distribution.							
On demand	Nil									
Free Water	Nil									
Totals:	83	15,075								

Water Source

Area	Supplied From	Normal Min. Quantity Available: Stream flow (cusecs)	Storage (Acre ft.)
(1) 9,825 acres	Manuherikia River	60	-
	Falls Dam	-	8,294
(2) 2,105 "	Dunstan Creek	12	-
(3) 1,130 "	Lauder Creek	9	-
(4) 2,015 "	Thompsons Creek	6	-

CENTRAL OTAGO IRRIGATION — APPENDIX B

Details of Tarras Scheme — SHEET 11

Basis of Supply	Number of Irrigators	Area under agreement or normally irrigated (acres)	Terms of present agreement: Water Quota (inches)	Rate per Acre	Extra Water per ac.ft.	Approx. area irrigated (acres)	Operating data (average of last three seasons): Ac. ft. of water supplied: Under Quota	Extra Water	Total	Equivalent depth of application (inches)
Under Agreement	(1)	100	24	11/3	1/7½	2,676	5,020	1,732	6,752	30.3"
	1	100	"	12/3	"					
	2	130	"	13/3	"					
	1	150	"	14/3	"					
	4	1,137	"	15/3	"					
	5	1,075	"	16/3	"					
	2	4	"	18/3	"					
On demand	Nil									
Free Water	Nil									
Totals:	* 15	2,696								

* One irrigator has areas at 13/3 and 16/3

	Area	Supplied From	Normal Min. Quantity Available: Stream flow (cusecs)	Storage (acre ft.)
Water Source	2,696 acres	Lindis River	25	Nil

CENTRAL OTAGO IRRIGATION

APPENDIX B

Details of Teviot River Scheme

SHEET 12

Basis of Supply	Number of Irrigators	Area under agreement or normally irrigated (acres)	Terms of present agreement: Water Quota (inches)	Rate per Acre	Extra Water per ac.ft.	Operating data (average of last three seasons): Approx. area irrigated (acres)	Ac. ft. of water supplied: Under Quota	Extra Water	Total	Equivalent depth of application (inches)
Under Agreement	3	257	36	11/3	1/-	3,508	7,558	1,322	8,880	30.4
	2	197	36	12/3	"					
	1	105	27	13/3	"					
	3	431	33	13/3	"					
	1	18	36	13/3	"					
	1	70	27	14/3	"					
	16	478	33	14/3	"					
	3	73	36	14/3	"					
	4	325	27	14/9	"					
	1	10	30	14/9	"					
	3	519	33	14/9	"					
	1	177	30	15/3	"					
	1	376	33	15/9	"					
	2	439	33	16/3	"					
	7	33	33	17/3	"					
On demand	Nil									
Free water	Nil									
Totals	* 43	3,508								

* Six irrigators have supplies at two rates

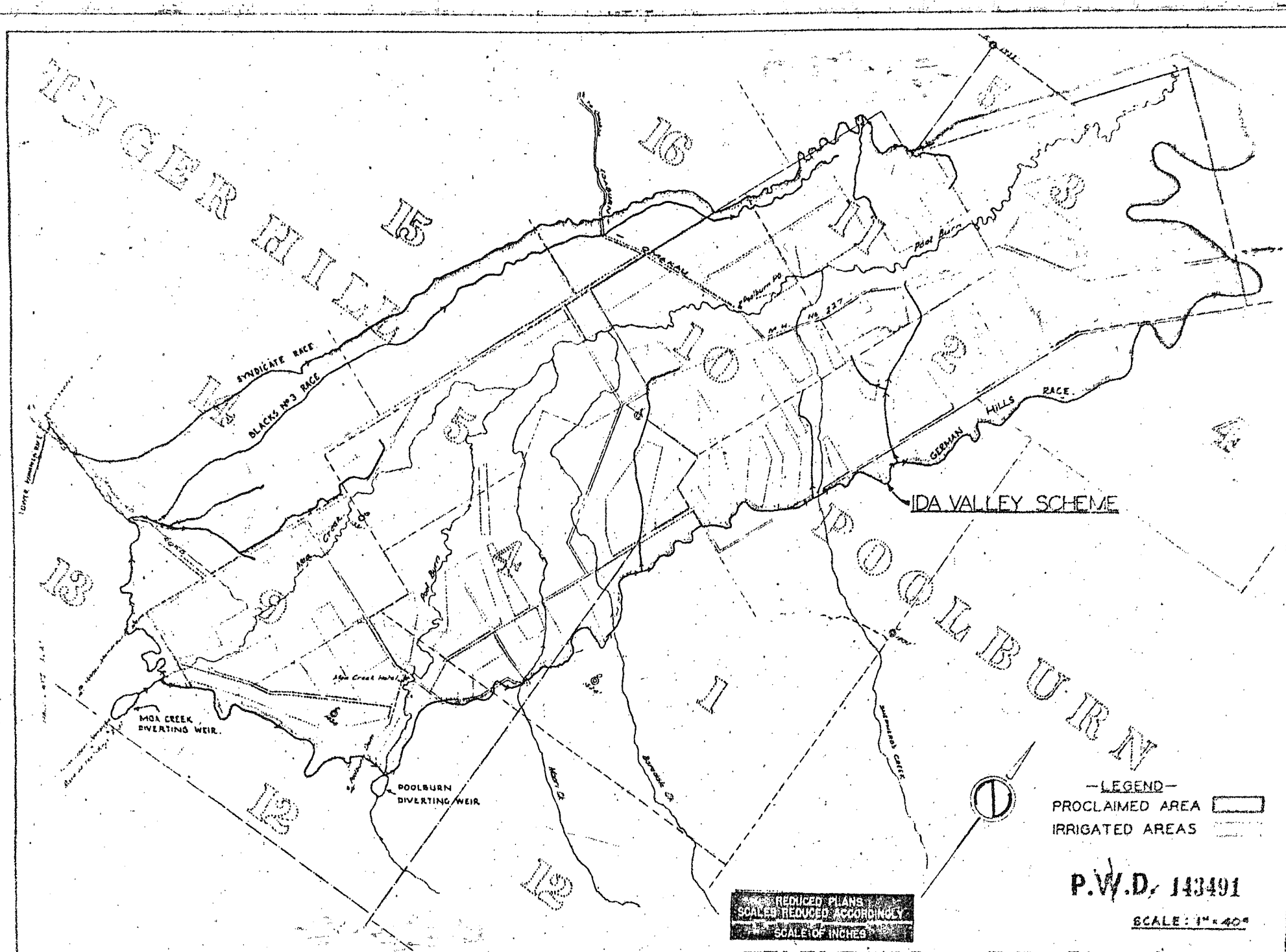
	Area	Supplied From	Normal Min. Quantity Available: Stream flow (cusecs)	Storage (acre ft.)
Water Source	3,508 acres	Teviot River	42	-
		Lake Onslow Reservoir	-	9,674

CENTRAL OTAGO IRRIGATION SCHEMES — APPENDIX C

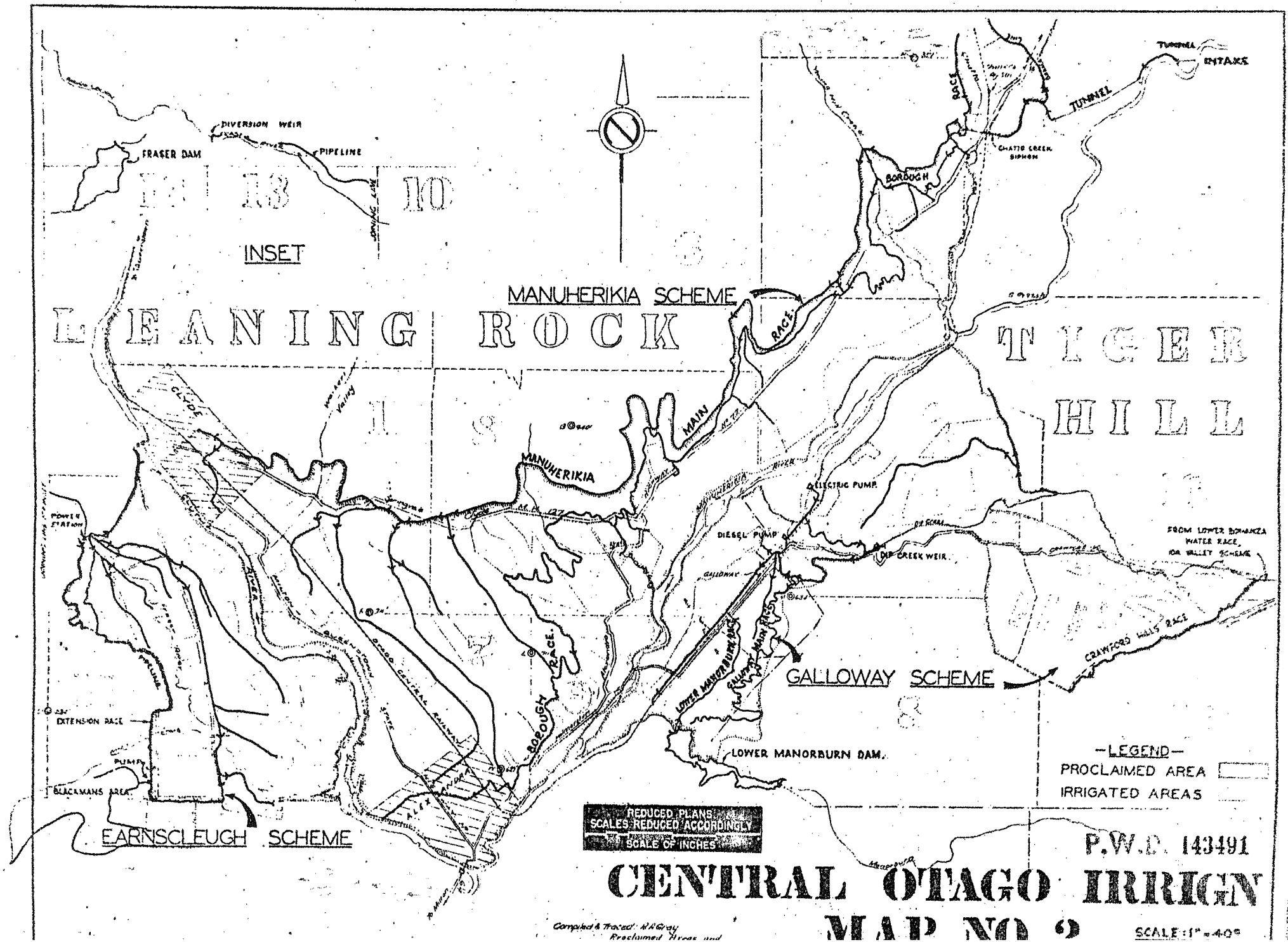
	Working Expenses (excluding Interest and Depreciation Reserve)									Total Revenue		
	1950/51			1951/52			1952/53					
	Operation and Mtce.	Major Renewals	Total	Operation and Mtce.	Major Renewals	Total	Operation and Mtce.	Major Renewals	Total	1950/51	1951/52	1952/53
Ardgour	1,090		1,090	939		939	1,005		1,005	1,221	1,134	1,176
Arrow River	3,438	23	3,461	4,121		4,121	3,790		3,790	2,197	2,185	2,273
Bengerburn	(Operated and maintained by settlers)									52	52	35
Earnscleugh	1,295		1,295	2,010	700	2,710	2,077	200	2,277	1,475	1,651	1,666
Hawkdun Idaburn	6,727		6,727	9,504		9,504	8,824	442	9,266	4,961 366	5,144 367	5,069 366
Ida Valley	5,292		5,292	6,719	7,332	14,051	7,988	8,463	16,451	938	5,971	5,105
Galloway	2,603		2,603	3,860		3,860	4,180		4,180	820	1,557	1,481
Last Chance	2,239		2,239	3,562		3,562	4,637	2,250	6,887	2,032	2,079	2,069
Manuherikia	6,616	10,920	17,536	6,777	3,700	10,477	6,765		6,765	3,692	3,681	3,438
Omakau	5,326		5,326	6,815		6,815	7,339		7,339	7,108	6,087	5,949
Tarras	2,841		2,841	4,248		4,248	4,143		4,143	2,246	2,200	2,240
Teviot	2,335		2,335	2,310		2,310	2,537	800	3,337	2,760	2,583	3,200
Totals:	£39,802	10,943	50,745	50,865	11,732	62,597	53,285	12,155	65,440	29,868	34,691	34,067

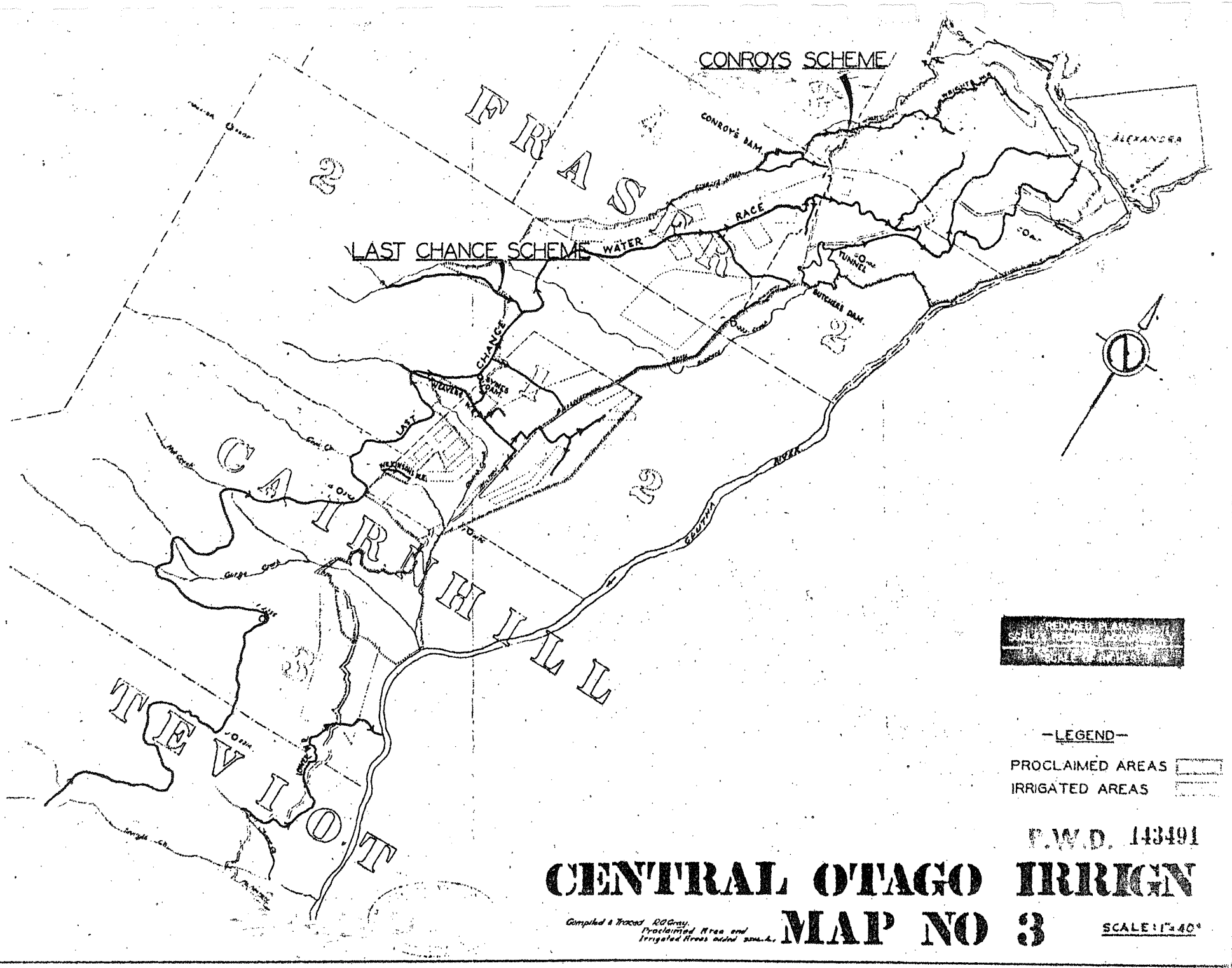
Summary of Operating Accounts

	1934/44	1944/45	1945/46	1946/47	1947/48	1948/49	1949/50	1950/51	1951/52	1952/53	
Operation & Maintenance								39,802	50,865	53,285	
Major Renewals								10,943	11,732	12,155	
Total Working Expenses	217,434	27,944	28,584	31,431	34,083	44,165	47,143	50,745	62,597	65,440	
Revenue	255,564	24,958	26,144	28,832	26,926	23,758	26,926	29,868	34,691	34,067	
Operating profit or loss	£+38,130	-2,986	-2,440	-2,599	-7,157	-20,407	-20,217	-20,877	-27,906	-31,373	



CENT OTAGO IRRIGN MAP NO 1


INSET
DIVERSION WEIR
FRASER DAM
PIPELINE
LEANING ROCK
TIGER HILL
MANUHERIKIA SCHEME
RACE
TUNNEL
INTAKE
BORBOUGH
CHATTO CREEK SIPHON
MAIN
MANUHERIKIA
ELECTRIC PUMP
DIESEL PUMP
DIP CREEK WEIR
FROM LOWER BOMMAZA WATER RACE FOR VALLEY SCHEME
CRAWFORD HILLS RACE
GALLOWAY SCHEME
LOWER MANORBURN DAM.
POWER STATION
CLYDE
EXTENSION RACE
PUMP
BLACKMANS AREA
EARNSCLEUGH SCHEME
BORBOUGH RACE.
REDUCED PLANS SCALES REDUCED ACCORDINGLY SCALE OF INCHES
—LEGEND—
PROCLAIMED AREA
IRRIGATED AREAS
P.W.D. 143491
CENTRAL OTAGO IRRIGN
MAP NO 6
SCALE: 1" = 40"
Compiled & Traced: N.A.Gray
Proclaimed Areas and



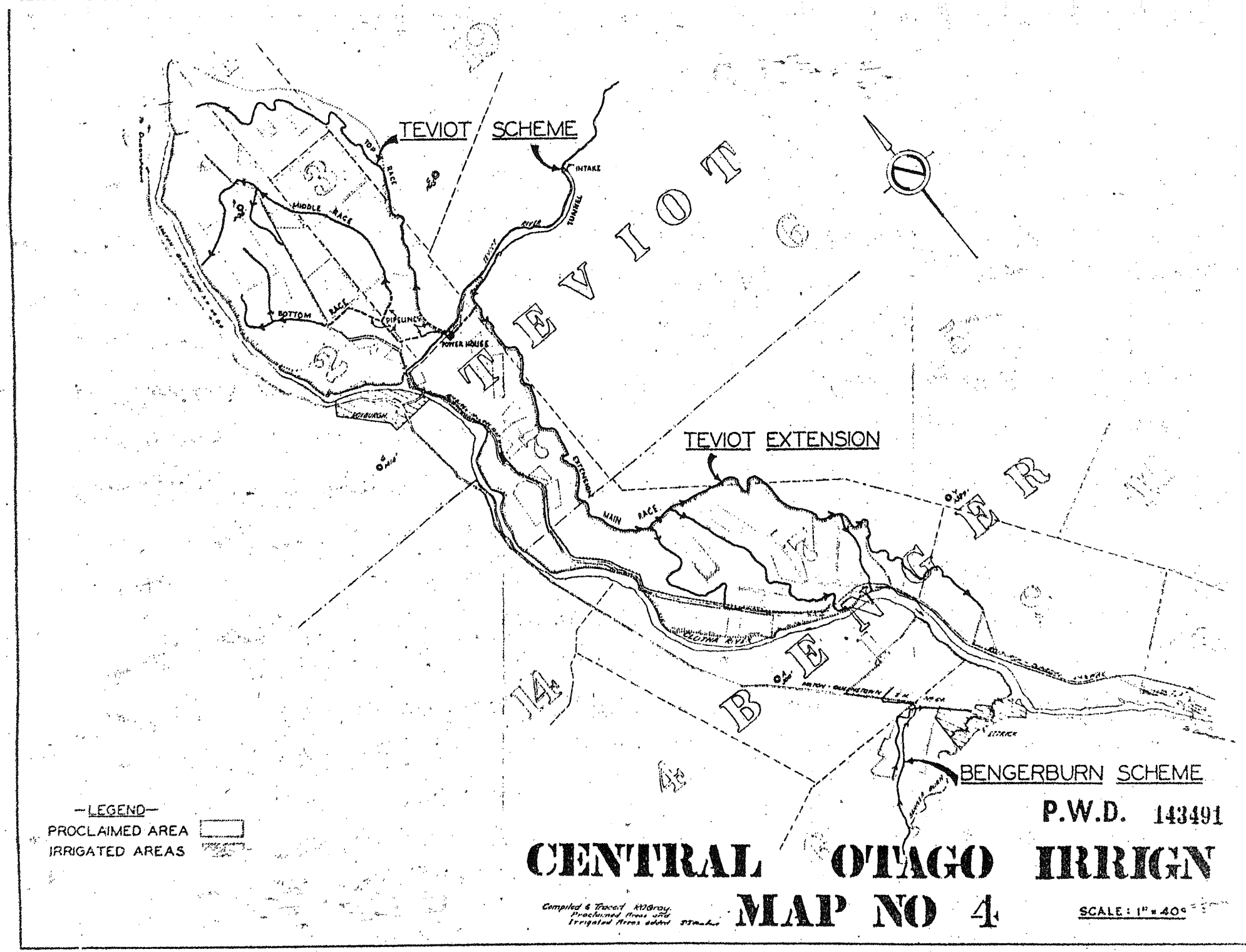
P.W.D. 43491

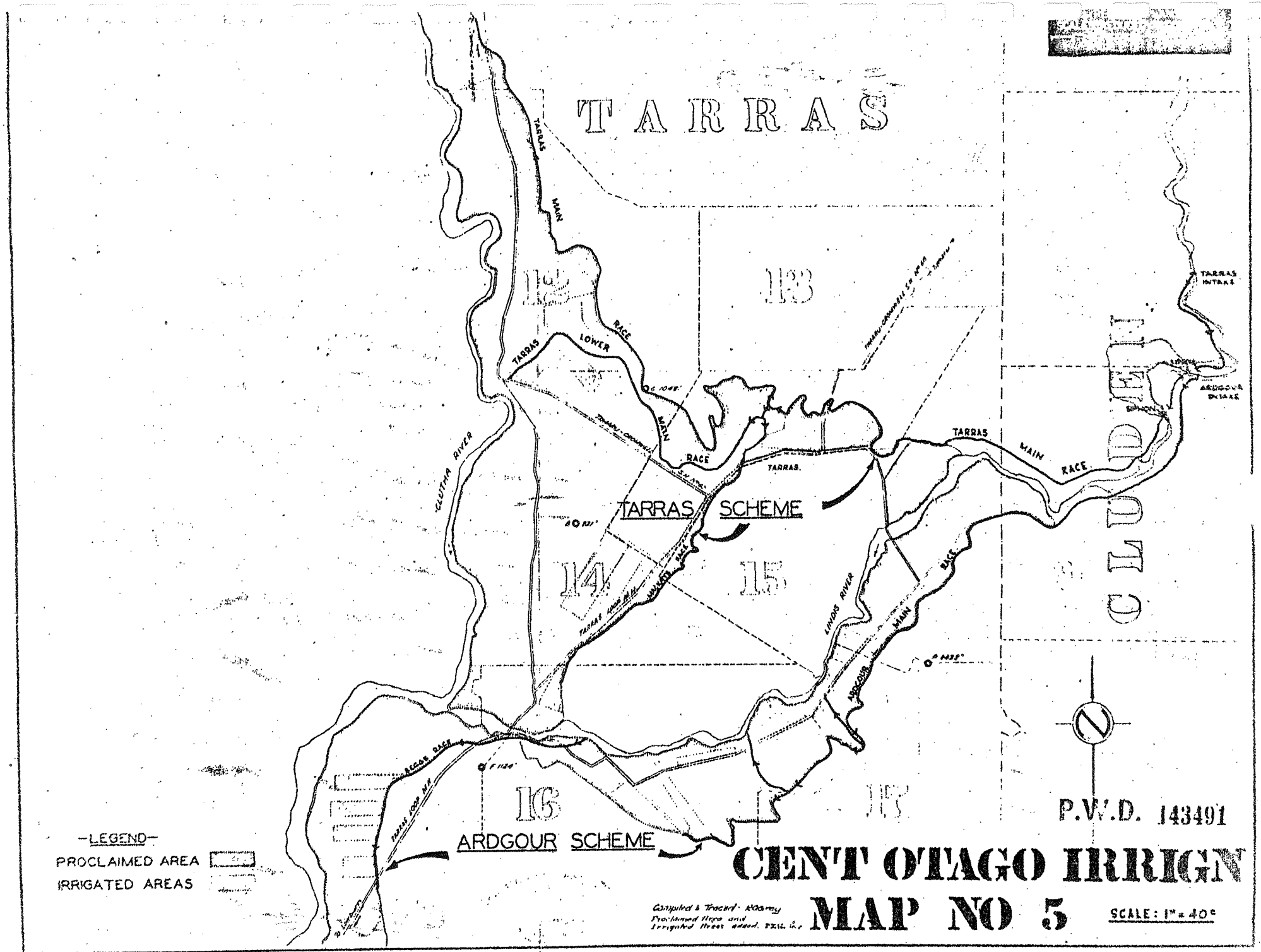
CENTRAL OTAGO IRRIGN

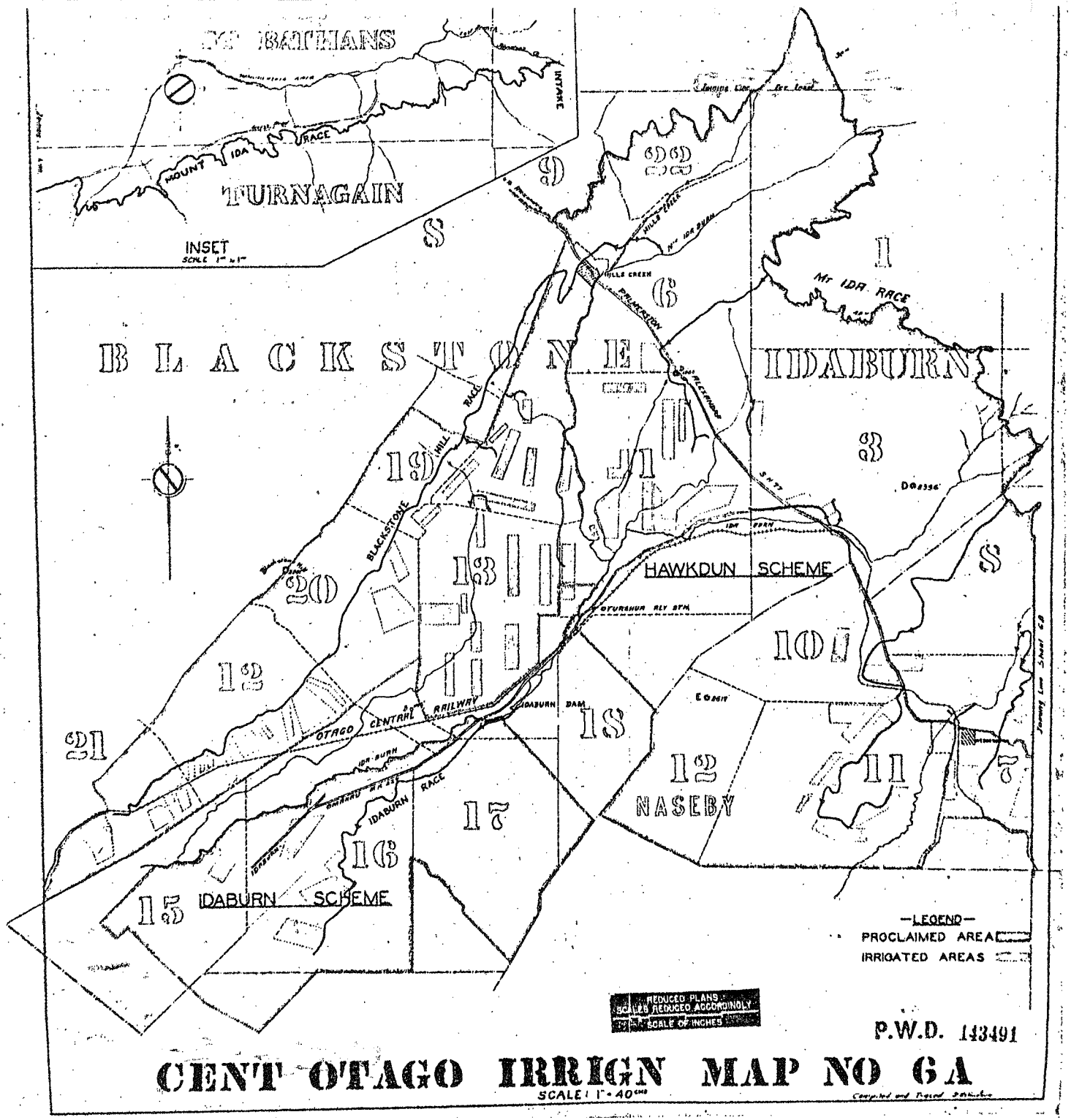
Compiled & Traced R.O.Gray. Proclaimed Areas and Irrigated Areas added 20.11.6.

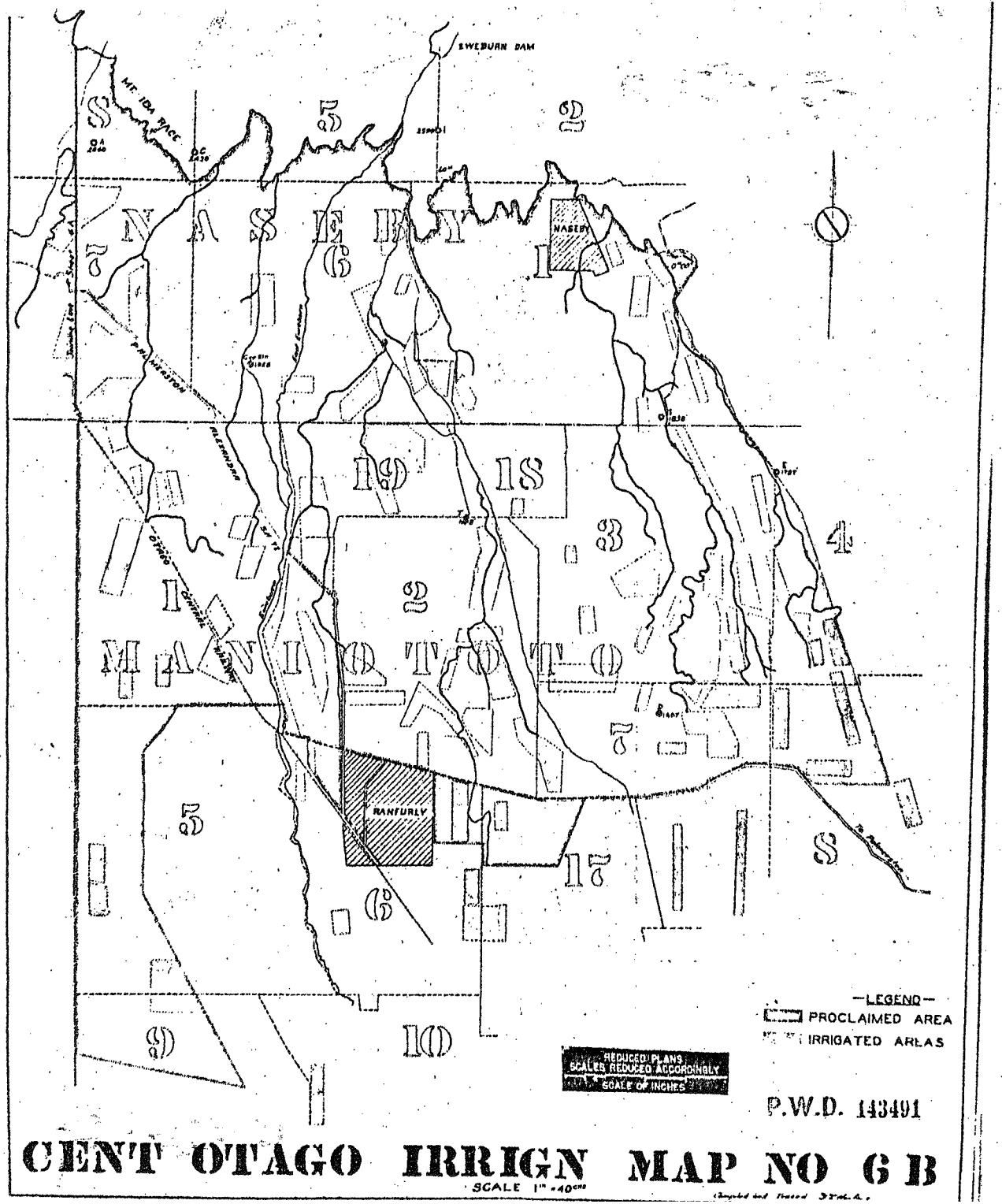
MAP NO 3

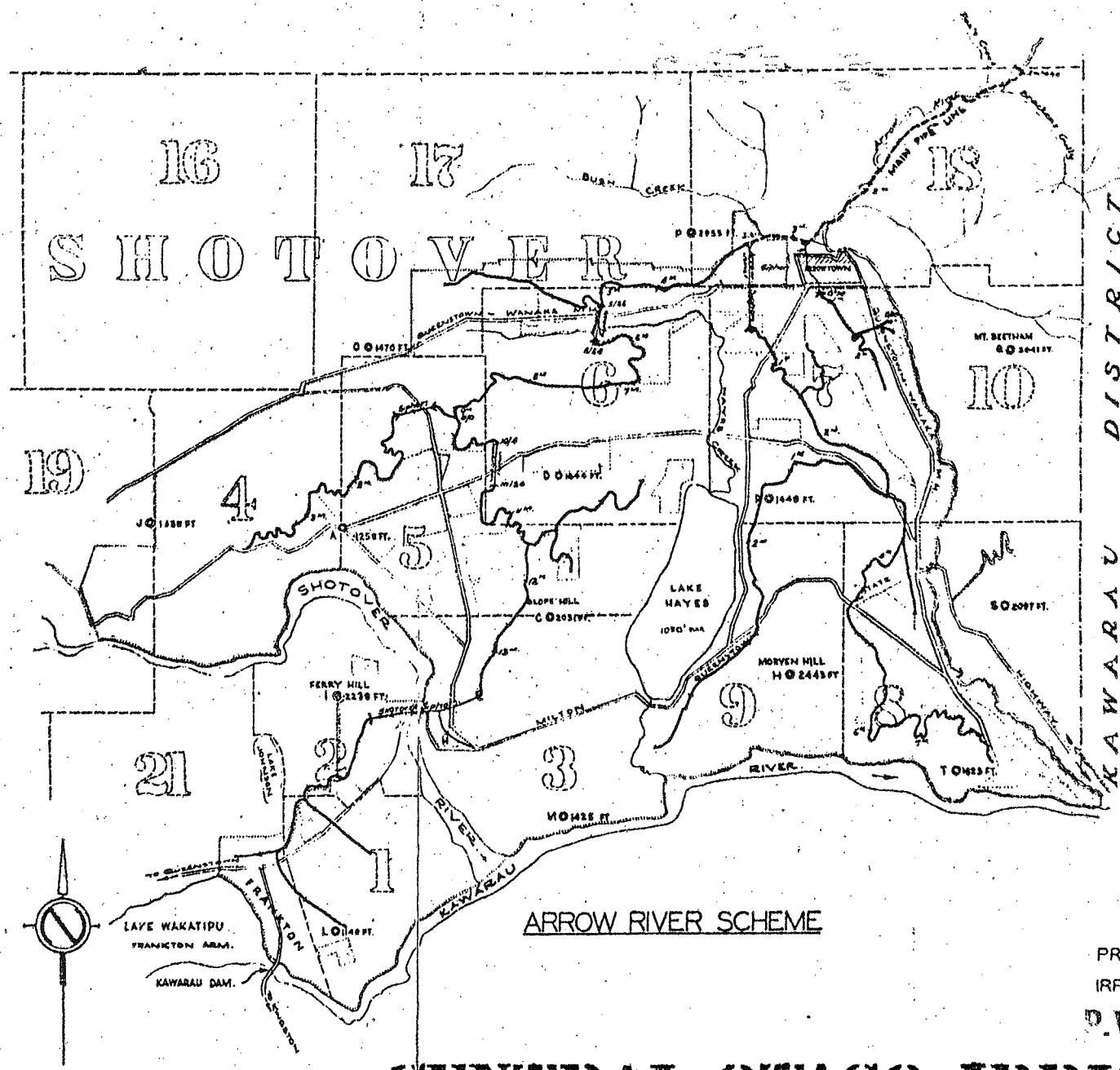
SCALE: 1"=40'


TEVIOT SCHEME
INTAKE
TUNNEL
RIVER
TOP RACE
MIDDLE RACE
BOTTOM RACE
PIPELINE
POWER HOUSE
ROXBURGH
TEVIOT
TEVIOT EXTENSION
EXTENSION
MAIN RACE
CLUTHA RIVER
BENGERBURN
BENGERBURN SCHEME
-LEGEND-
PROCLAIMED AREA
IRRIGATED AREAS
P.W.D. 143491
CENTRAL OTAGO IRRIGN
MAP NO 4
Compiled & Traced N.D.Gray.
Proclaimed Areas and
Irrigated Areas added
SCALE: 1" = 40 CHAINS


TARRAS
TARRAS MAIN RACE
TARRAS LOWER RACE
CLUTHA RIVER
TARRAS MAIN RACE
TARRAS SCHEME
LINDIS RIVER
ARDGOUR MAIN RACE
ARDGOUR SCHEME
TARRAS INTAKE
ARDGOUR INTAKE
CLUDEN
12
13
14
15
16
17
-LEGEND-
PROCLAIMED AREA
IRRIGATED AREAS
P.W.D. 143491
CENT OTAGO IRRIGN
MAP NO 5
SCALE: 1" = 40 c


ST BATHANS
INTAKE
MOUNT IDA RACE
TURNAGAIN
INSET
SCALE 1" = 1"
BLACKSTONE
IDABURN
MT IDA RACE
HILLS CREEK
PRESTON
RACE
BLACKSTONE HILL
HAWKDUN SCHEME
OTAGO CENTRAL RAILWAY
IDABURN DAM
IDABURN RACE
IDABURN SCHEME
NASEBY
LEGEND
PROCLAIMED AREA
IRRIGATED AREAS
REDUCED PLANS
SCALES REDUCED ACCORDINGLY
SCALE OF INCHES
P.W.D. 143491
CENT OTAGO IRRIGN MAP NO 6A
SCALE 1" = 40 CHS


SWEDBURN DAM
MT IDA RACE
NASEBY
RANFURLY
MANUHERIKIA
—LEGEND—
PROCLAIMED AREA
IRRIGATED AREAS
REDUCED PLANS
SCALES REDUCED ACCORDINGLY
SCALE OF INCHES
P.W.D. 143491
CENT OTAGO IRRIGN MAP NO 6 B
SCALE 1" = 40 CHS



ARROW RIVER SCHEME

LEGEND

PROCLAIMED AREA

IRRIGATED AREAS

P.W.D. 143491

CENTRAL OTAGO IRRIGN

MAP NO 7

Compiled & Traced: P.J.Gray.
Proclaimed Area and Irrigated Areas added W.T.M.R.

SCALE: 1" = 40'