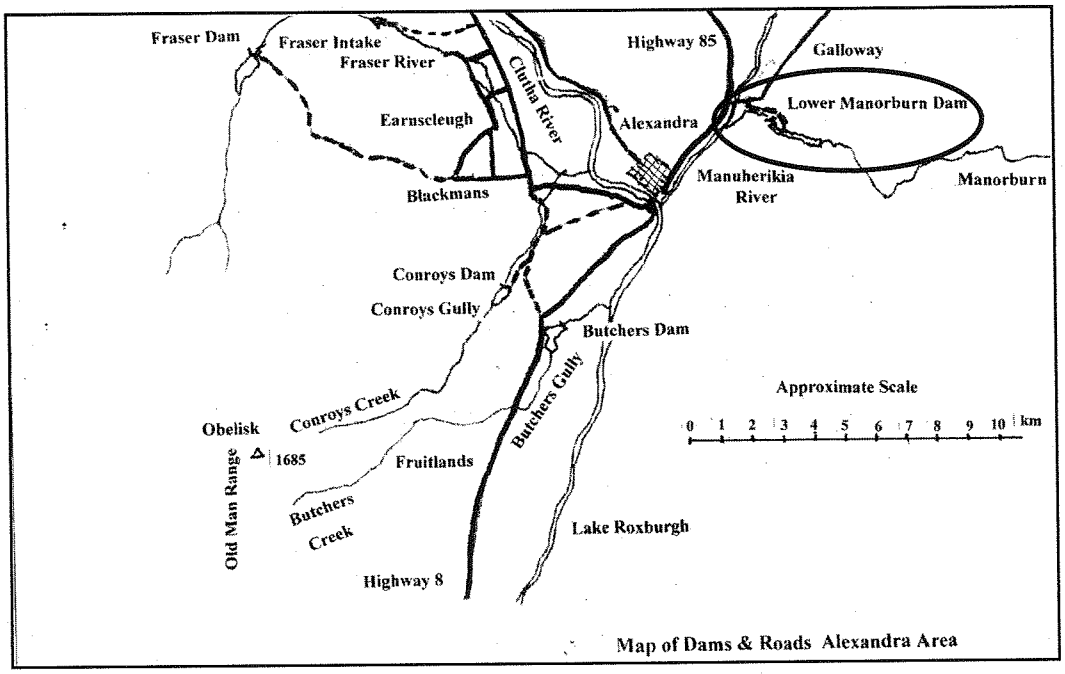
Lower Manorburn Dam

Concrete Arch Dam	1,604 cu yd concrete
Completed	1934
Height Above Stream bed	52ft
Radius of dam	110ft
Length of Crest	378ft

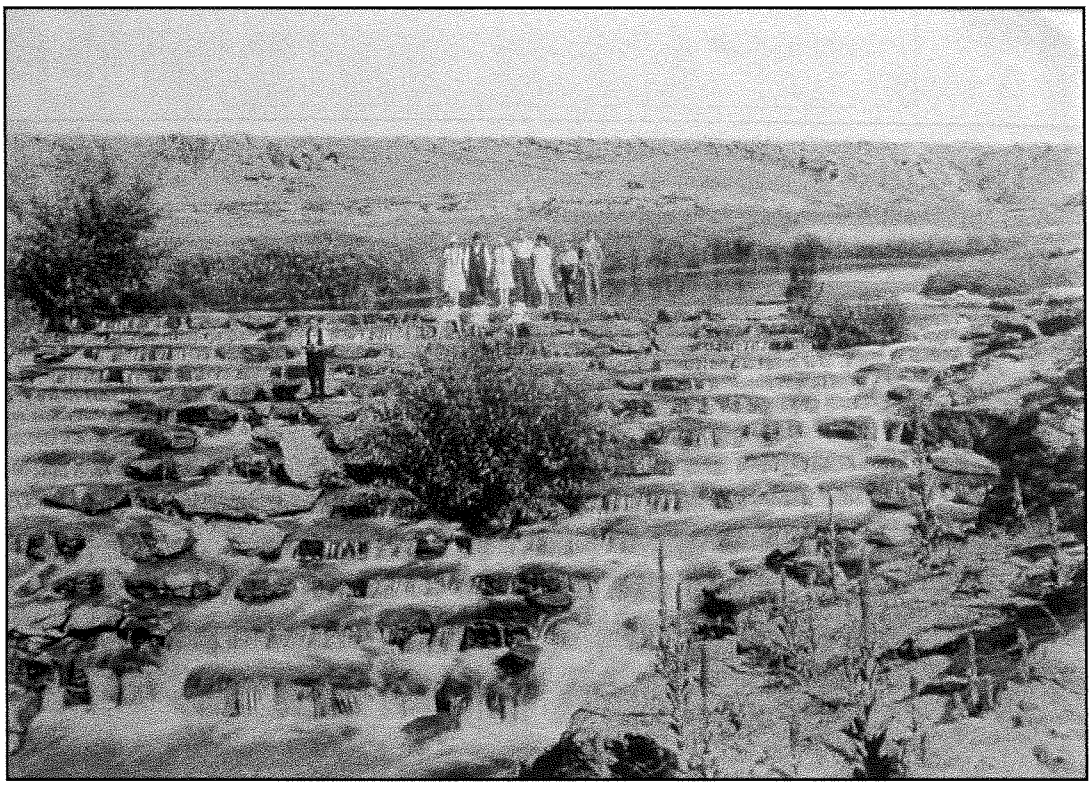


Map of Dams & Roads Alexandra Area

Lower Manorburn Dam

Historical Background

The area above the dam site was subject to gold mining and the proposed sluicing of a claim using water from the Bonanza Race fed from the Upper Manorburn. Below the dam site the river flats were occupied by a nursery and orchard business operated by Howden and Moncrieff. The Government of the day decided to contain the tailings in a weir built across the stream bed some 60ft upstream of the present dam. This was completed in 1909. The sluicing did not go ahead, but the weir soon filled anyway with debris from the catchment runoff. The old weir was submerged by the water held behind the dam built in 1934.



The early weir on the Manorburn Creek. The background shows that the edge of the water in the new dam follows along the rock outcrops. The photograph was taken by W. Hewitt and is thought to be of family and friends on the top of the rock weir.

Reason for building the dam

A Report on Irrigation prepared by F. W. Lindup and J. D. Watt in 1954, stated that the irrigation of the Galloway area was originally conceived as part of the Manuherikia Scheme. However for good reasons, it was finally decided to supply the area with water from the Upper Manorburn Dam. When water was first available it was used in sluicing for gold, but later, as mining became unprofitable, it was distributed across the farm areas. The residual flow of the Manorburn Creek where it emerged at Galloway was at too low a level to be used, so a diversion dam was built in 1934. The dam became part of the Unemployment Board's scheme to provide relief work.

When completed, the water was led northward against the natural fall of the country, and provided a useful contribution to the water available for irrigation at Galloway.

Early proposals

A report written by J. D. Watt of the Alexandra Residency in January 1932 and addressed to the District Engineer, refers to memos in October and November 1929 and relates to more detailed investigation of the two dam sites.

Proposed upper dam site

This was located one and a half miles above the railway bridge which crosses the creek. With good rock abutments present, the race line would follow a rocky gorge and need a considerable length in pipes.

Estimated Cost

Concrete 400 cu yds @ £5		2000
Other costs		500
	Dam	**£2500**
Race and pipe line		3200
	Total	**£5700**

Proposed lower dam site

Located about one mile above the railway bridge. With solid rock abutments, a considerably higher dam would be required in order to divert the water back up the valley.

Estimated cost of the dam **£6300**

On a first cost basis J. D. Watt considered the upper site as the best option. At that stage no records had been kept of the summer flows, but a minimum flow of 2 cusecs in a dry year was anticipated and 3 to 4 cusecs in an average summer.

The report used a wage rate of 12/6 per day, with the project able to absorb 30 to 40 men based on local labour.

Problems with the workmen's pay

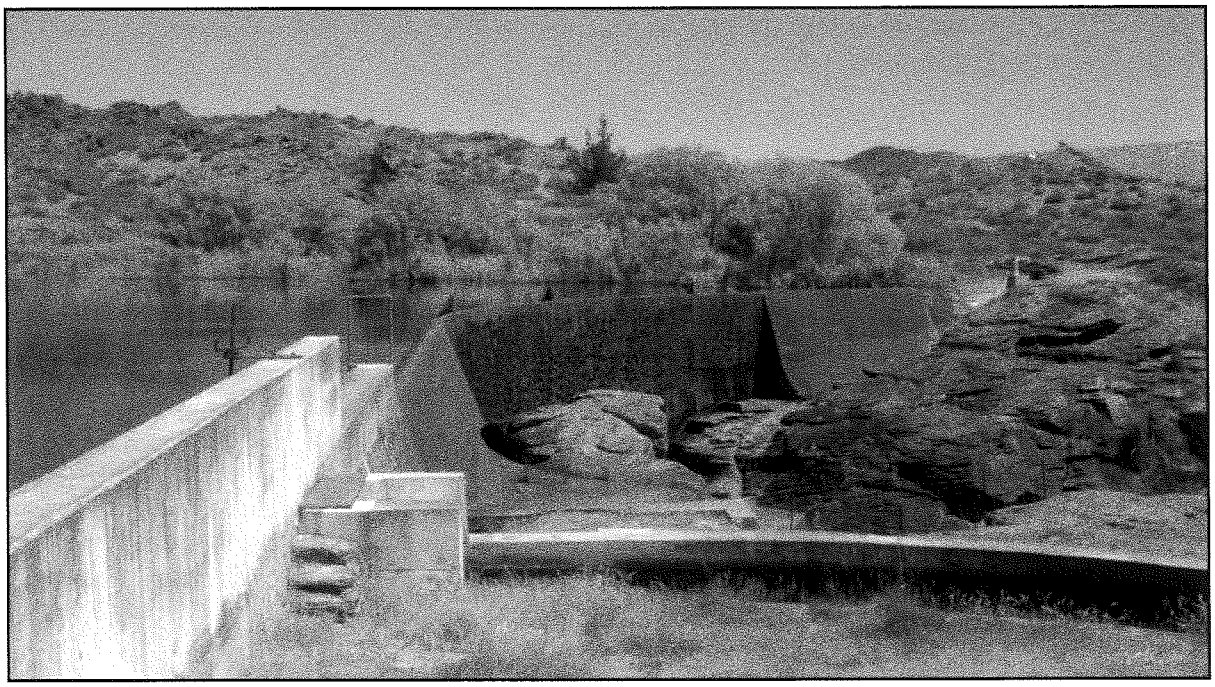
The Resident Engineer, in reply to a memo of 5 December 1932 from the District Engineer, set out the difficulty involved for the wage rates proposed. At 8/- a day for six days it was not attractive to the local unemployed who had not yet joined the Number 5 gold mining scheme. This mining scheme provided the men with 30/- for three days work per week. A man had only to get 3/20th of an ounce of gold per week to be as well off financially, and have a much freer existence.

All the men centered on Alexandra would not take work at the Manorburn when it was offered. There is no unemployment in the district, in that the mining scheme provided for all, and as shown above was satisfying the local needs. W. Bodkin MP expressed the opinion that it should be possible to increase wages to 10/- and was prepared to make representations to this effect.

In support of this proposal Lindup said this wage would suit some of the Alexandra men as an alternative to working at Omakau on the irrigation scheme. He also said that from the relief of unemployment view point, there was no need to start the Lower Manorburn Dam. However from the point of conserving water supplies, it would be desirable to build it.

In addition the Unemployment Board's project to employ large numbers gold mining between Lows Saddle on the Crawford Hills and Ophir certainly required the building of this dam to enable water to be released to them from the Upper Manorburn Dam.

Lindup recommended that instead of six days at 8/- a day, the work should be done on a five day week at 10/- per day. This would be comparable with the mining scheme of 30/- for 3 days. It appeared that W. Bodkin was unfavourably disposed to the mining scheme, but the Unemployment Board was satisfied with the result and wished to extend the scheme. Lindup concluded by saying that he was considering the Unemployment Board as a State activity that did not require competition but co-operation.



A recent view of the dam showing the outlet race in the foreground. The two gravity sections and the centre arch are clearly visible.

Approval for the dam

On 27 February 1932 the District Engineer T. M. Ball advised Lindup that the Unemployment Board had agreed to the employment of men out of work on the construction of the Lower Manorburn Dam. The terms of employment were the payment of 37/6 for every man working a three day week, and 50/- for men on a four day week. Men were to be engaged at the Alexandra Bureau provided they were eligible for relief work under the rules laid down by the Board. The Commissioner of Unemployment stated that there were only five 3 day men and four 4 day men registered at Alexandra but he would make arrangements to obtain more if required.

On 12 March the District Engineer advised the Alexandra Residency that the Unemployment Board had decided, that because of the difficulty of making out co-operative contracts to include men at different rates of pay, all married men were to receive 8/- per day for industrious work. As many men as possible were to be working under co-operative contracts and where this was not possible, wages were to be shown at a lump sum of 1/- per hour in contract payments and the sum of 8/- a day was not to be made public knowledge. The Unemployment Board also did not wish any man to lose his daily wage on account of wet weather. When it was deemed it was too wet to work payment would be made at 1/- per hour. The rate was to apply to all men living in Alexandra or camping on the job. The men would work the usual time of 47 hours per week.

Proposed works

On 4 April 1932 the Resident Engineer, Lindup sent plans of the proposed work of diverting the Manorburn Stream onto the Galloway Flat to the District Engineer. He reported that the lower dam site had so many advantages in the case of operation and lower maintenance that there was no question as to which site should be adopted. The proposal was for a concrete arch dam with gravity abutments. The design was based on a concrete stress of 470 lbs/sq in and he said there would be no difficulty in obtaining a safety factor of six for the concrete.

No provision was made in the design for steel reinforcement because in Lindup's opinion, it added very little to the security of the structure unless a large percentage was put in, more for instance than was put in the Idaburn Dam.

The rock at the site was particularly dense solid schist, and it would not be necessary to cut in more than sufficient to get a good bond at the foundation. The stream bed was heavy boulders and the depth to rock had not been measured. However the width at the base was only 20ft so a little extra depth would have little effect on the cost. A section for the gravity abutments was shown and it was proposed to use a portion of these as a spillway. The arch section shown had been designed for a depth of 2.25ft of water over the crest.

This section had not been finalised in case Head Office wished to modify it. If splitter blocks were placed on the crest, flood flows should jump clear.

The proposal was to build the abutments largely of stone laid in cement mortar, within boxing, and with 2ft of concrete on both the upstream and downstream faces.

As the maximum height at the abutments was only 20ft, and the dam would always be full, any special expansion joint system did not appear necessary, and it was proposed to build the dam without expansion joints. A drain would be put behind the cut off wall in the gravity section to prevent uplift.

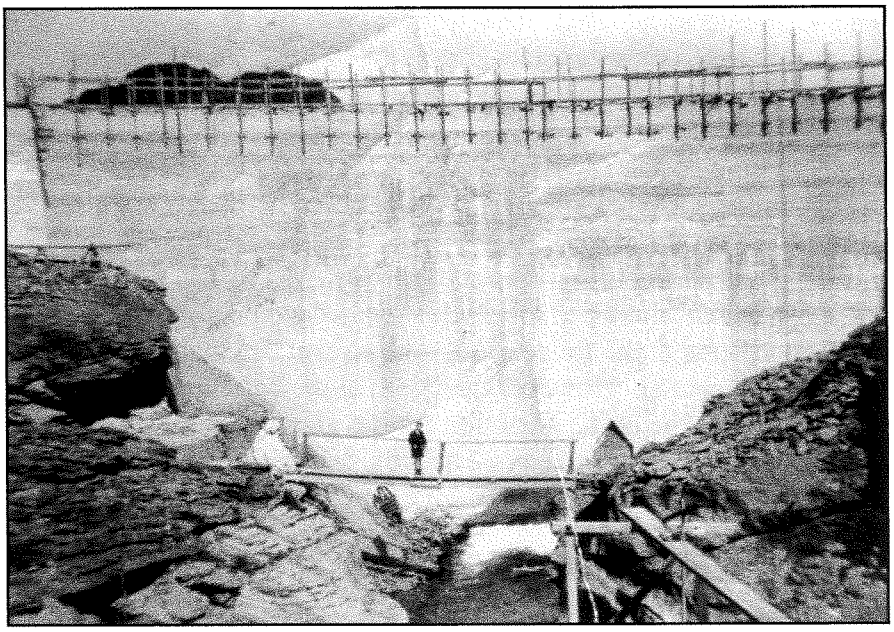
The storage provided for was only 1ft with the dam crest being 1ft higher than the water level of the race.

The spillway was to provide for a flood of 3000 cusecs and the area over which the water would travel on the downstream side, when the full width was in operation, was all sound rock.

It was proposed to make the race capacity 6 cusecs on account of the 380 acres commanded.

Estimate of the cost of the work based on 8/- per day labour rate:

Dam	950 cu yds concrete gravity section @ £3		2,850
	510 cu yds concrete arch section @ £4		2,040
	Plant and accommodation		200
	Foundation excavation 300 cu yds 27/6		112
	Diversion		100
	Outlet gate		20
		Dam	**£5,322**
Race	140 chains @ £2		280
	Crossings		300
	Additional outlet boxes		50
	4 chains flume @ £25 chain		100
	Supervision		450
	Contingencies		498
		Total	**£7,000**



Nearing completion of the new dam. The discharge pipe is yet to be installed, and on the right at the end of the access plank is the hole left in the wall during the construction to allow the creek to pass the dam. A young Keith Taylor-Cannon is standing on the walk way.

Comment on the dam design by Head Office

On 26 April 1932 the District Engineer advised that Head Office had replied to the questions raised in Lindup's letter.

The proposals were approved generally, with the exception of the arch section of the dam which needed to be strengthened. The base was to be 8ft 3inches thick tapering to 2ft 6 inches thick at 47ft from the base and the same thickness to the crest 18ft higher. Horizontal joints in the arch were to be avoided as much as possible and the alternative sections of the dam built up or separated by gaps, which could be concreted in later as was done at the Poolburn Dam. Where the arch section met the gravity section sufficient strong concrete needed to be placed in the gravity section to transfer the arch stresses to solid rock.

The spillway section of the dam was to be designed to give maximum discharge with the least rise in water level as was done at Idaburn.

F. W. Furkert, the Engineer in Chief in a postscript, commented that the centre section of the dam should be left to last. T. M. Ball asked Lindup to forward completed plans and details of construction.

On 2 May F. W. Lindup replied to the District Engineer T. M. Ball. On account of the increased yardage of concrete for the thicker dam the cost of the dam would be higher he said.

Lindup replied to Furkert's postscript as follows

'The requirement that the arch dam be built in alternative sections makes the construction very difficult with a thin section. It undoubtedly increased the cost of the Poolburn Dam where the gaps were relatively small and could be bridged over, but the omission of large gaps at the Manorburn will involve some method of hoisting the concrete. I would submit that the method used at the Idaburn Dam, would be quite satisfactory in this case also. The dam was built in three foot lifts, without any horizontal sealing strips, and is quite watertight, and shows absolutely no signs of distress.

Vertical copper sealing strips were used at three vertical joints, but in this case, where the water will not fall more than one foot below the crest once the dam is full, there is reason to suggest that vertical joints are also unnecessary. The arch will always be under load and the variation in temperature will necessarily be very small.

I have not been able to devise any more economical or efficient way of placing concrete than that used at Idaburn, where the concrete was deposited from a bottom dump truck running inside the vertical frames of the boxing. As long as the present dam can be built in three foot lifts or thereabouts, it is admirably suited for the same method of construction, and in fact, my estimate is based on using this method. To concrete the arch in alternate sections of about 35 feet means that the gap cannot be bridged for running out with a truck, and the concrete can only be placed by some form of simple tower, or by an independent trestle parallel with the dam. In the latter case or if small gaps are used, there arises the difficulty of a satisfactory method of filling the gaps, large or small, from the finished height. The only method that appears to permit ready placement of the concrete is the mast hoist, for which the job is too small.

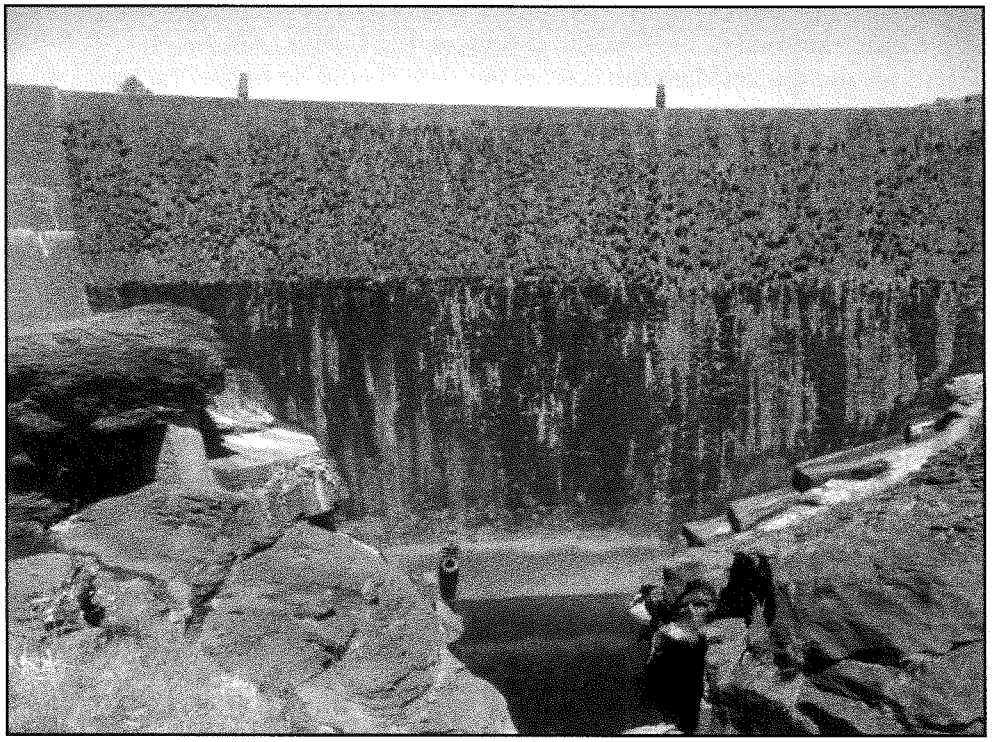
I would further suggest that the alternate section or gap method is not required at all and the method used at Idaburn is just as effective in relieving temperature stress. I have never heard it put forward that the gap or alternate section method did anything more than allow cooling, and therefore shrinkage, before the dam was keyed at the gaps, thereby minimizing the deflection under load and preventing tensile stresses. As long as the two sections are severed it appears immaterial whether the gap is four feet or one inch, and no visible gap at all, provided any subsequent cooling shrinkage can be taken up. The provision of double vertical sealing strips and facilities for grouting the joints appears to be all that is necessary.

I therefore propose that the arch be built on the same general lines as at the Idaburn Dam, with lifts of approximately three feet, and with three vertical joints, to permit grouting to take up any temperature shrinkage. These joints would act subsequently as temperature variation expansion joints, but as mentioned above, I would expect this effect to be negligible owing to the dam being always full.

I would be glad to receive approval of this, and would point out that this procedure is comparable with the latest practice in arch bridges.

The above proposals are for vertical copper only. I consider however that copper seals in the horizontal joints is unnecessary and that sealing to within 25 feet of the crest is sufficient, and that above this a tight joint can be obtained without copper.

On receipt of your decision regarding these points, I can provide the completed plan and further details of construction methods that are required.'



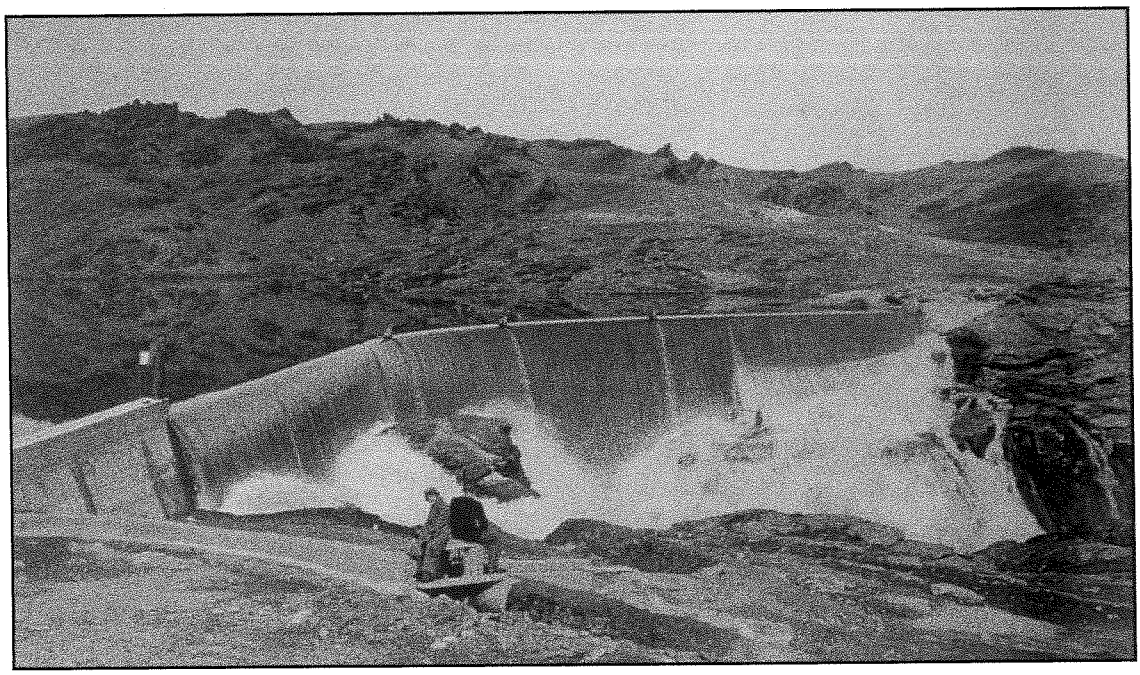
A recent view of the downstream face of the arch section. The growth on the concrete would indicate that it has been sometime since there was a flood.

Employment position at Alexandra

In a letter to the District Engineer on 5 May Lindup reported that he has looked at the local employment position and saw no immediate need for the commencement of the dam at the Manorburn. Locally there was strong effort being made to get local and Dunedin men placed in mining, while Alexandra's unemployed were engaged in a definitely useful piece of work, raising and strengthening the walls of the Borough reservoir. This work involved the reservoir being low and for this reason could not be done in the spring when the reservoir needed to be kept full to meet the demands for gardens and orchards.

The water supply was one of the town's chief assets, and any improvement was useful work that would increase local production. The work in hand could absorb any unemployed for two or three months. Lindup continued that starting work at the Manorburn at this stage would compete with the mining scheme, that the Government appeared keen to get underway for the unemployed, and he considered it better to wait until the mining scheme collapsed before starting on the dam. He preferred to have local men who could travel from their homes, with the consequent reduction in accommodation being provided for out of town workers. Lindup concluded that he saw no reason for why work should not proceed, but from the aspect of providing employment, there appeared to be no urgency.

On 27 November 1932 the District Engineer T. M. Ball advised Lindup that the men working on the construction of the dam were to be paid 10/- a day. Of this 8/- would be paid by the Unemployment Vote and the balance from the Irrigation Vote. This had come about because there was a difficulty in getting men to work for the 8/- rate.



An early view of the dam spilling water during a flood. The irrigation take off race is in the foreground and is yet to be filled with water. The splitters on the spillway are intended to make the water discharge freely over the crest.

In response to a question from District Office, J. D. Watt advised by telegram that work on the dam had started on 13 January 1933.

By 4 February J. Gilkison was providing a report on the strength of concrete samples from the dam, using his laboratory at Falls Dam.

Lindup produced a new estimate for the dam. With the increase in the concrete to 950 cu yds for the gravity sections and 600 cu yds for the arch because of the design change, the cost of the dam increased from £5,332 to £6,112.

Tenders were called for the supply of aggregates from the Manuherikia river bed and this was awarded to G. D. Bowler of Alexandra on the 14 February 1933.

Pit run gravel	2/6
4500 yds screened aggregate over ½ inch	3/9 yd
350 yds under ½ inch	2/6

A request for two married carpenters to be obtained at a rate of 1/6 per hour, for a full week, was made to the District Engineer.

There were continuous reports on concrete tests from J. T. Gilkison at Falls Dam.

A large amount of correspondence was in the file regarding obtaining of a donkey boiler from the Railways Department. Finally one was hired at £4 per month and it was proposed that the boiler should be purchased to save costs. The donkey boiler was used over the winter to heat water for concrete in the dam and steam curing.

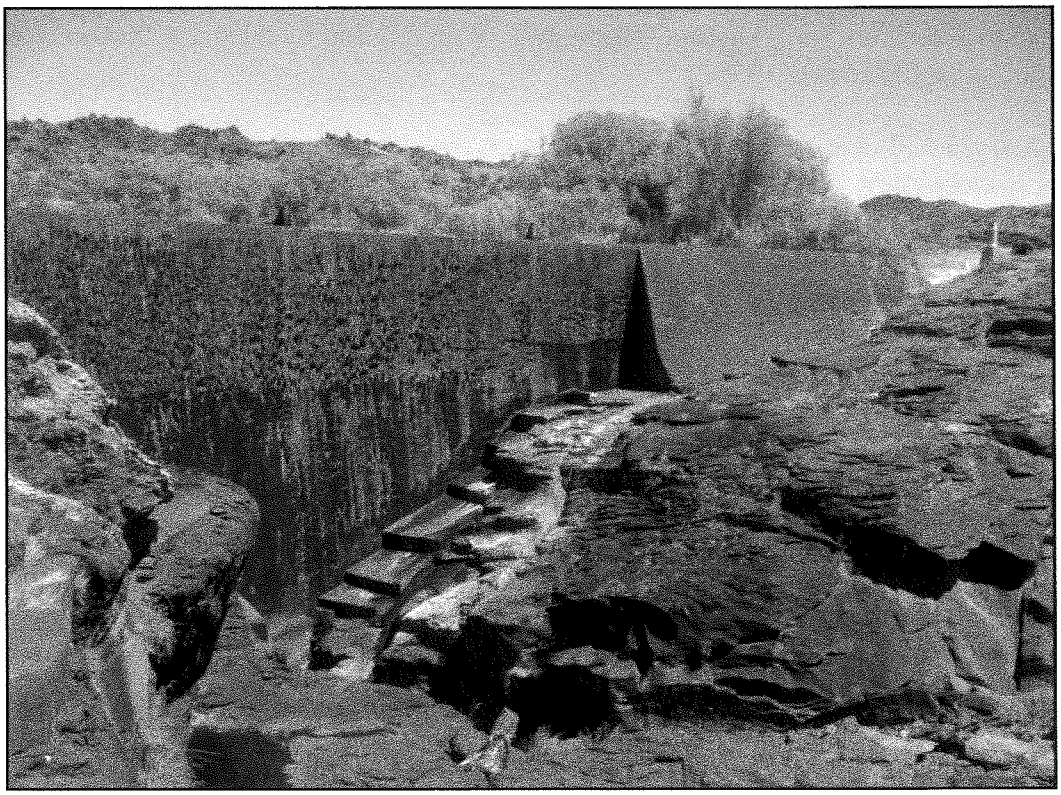
A report indicates that the dam was nearing completion on 5 December 1933. District Office approval was given to pay five day workmen for Christmas Day, Boxing Day and New Years Day.

Cost of the completed dam

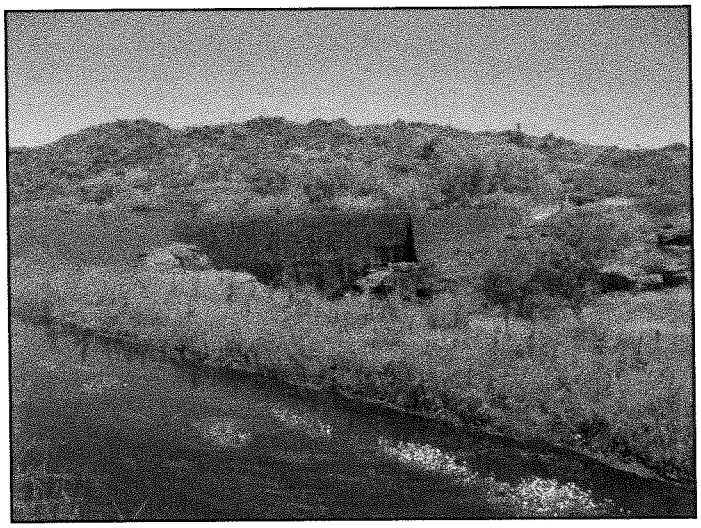
At 31 March 1934 all work on the dam was completed with the exception of the grouting of contraction joints.

Cost Summary

Excavating foundations	578 cu yds	583	
Diversion and access		88	
Establishment		173	
			844
Concreting the dam			
Arch section	655 cu yds	1,830	
Gravity abutments	949 cu yds	1,953	
			3,783
Race Construction			
Excavation	150 chains	391	
Concrete pipes and crossings		600	
Outlet weir etc		100	
Overhead costs			1,091
		Total	**£5,718**



A view of the left abutment. Concrete was placed at a later stage to protect the rock when the dam was spilling over the arch section.



A recent view of the race delivering water to the irrigation system. In the background is the dam with the arch section between the two gravity abutments.

Construction Report

The dam consists of a central arched section 126ft long with an upstream radius of 110ft. The minimum thickness is 2ft 6 inches and the maximum height above the foundations is 65ft. The arch section is flanked by two tangential gravity sections, the north end being 178ft long and the south end 74ft long. The first 20ft adjacent to the arch was constructed of concrete with a fair proportion of 'plums'. The remaining lengths were composed of core rubble masonry faced with approximately 2ft of concrete. Porous drains were installed under the deeper portions of the gravity sections. The arch section was provided with five contraction joints with copper sealing strips 6 inches wide, near the upstream and downstream faces. Provision had been made for the grouting of these joints during the winter. Two of the joints were at the junction between the arch and gravity sections.

Most of the concrete was placed in 3ft lifts from a bottom dump truck running between the timber studs and copper sealing strips were used between each lift, to within 25ft of the crest of the dam. No copper was used in the gravity sections.

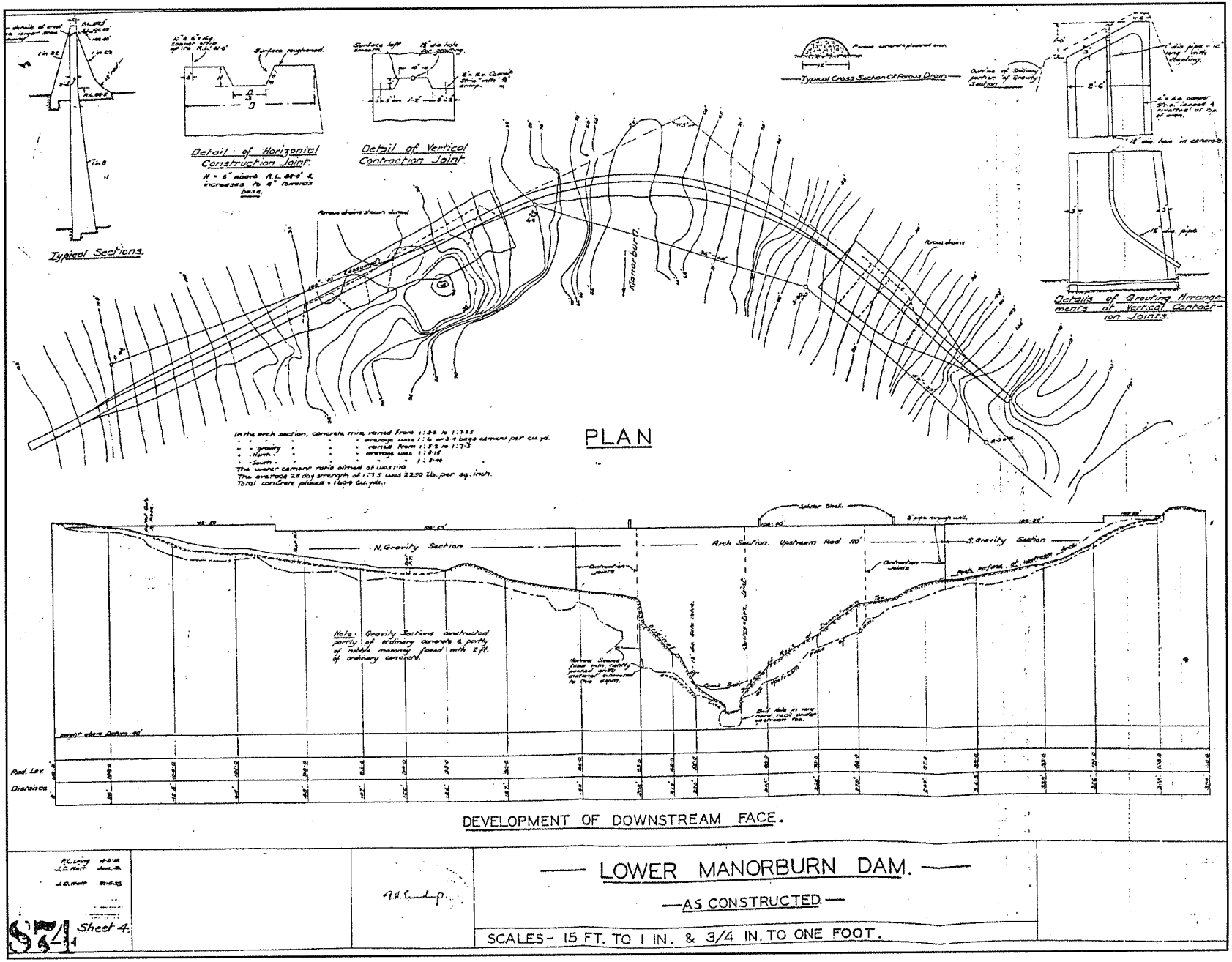
Timber Boxing

The studs used in the dam were 4 inches by 2 inches at 1ft 10 inch centres, and the sheathing was 6 inch by 1 inch rimu dressed on three sides. No. 8 gauge galvanized wire ties were used between the studs. This type of timbering was found quite suitable for 4feet lifts even on the upper parts of the arch section.

Aggregate and concrete

Quartz gravel from the Manuherikia River bed served as the aggregate. As this gravel contained an excess of fines a proportion of screened gravel above ½ inch was added. The average of the arch section mix was 1 to 6 or 3.4 bags of cement per cubic yd of concrete. The north gravity section averaged a ratio of 1 to 8.15 and the south 1 to 8.4.

A water cement ratio of 1 to 10 was aimed at, and the average 28 day strength of the 1 to 7.5 mixes was 2250 lbs/square inch. Steam curing of the concrete was carried out during the coldest of the winter months. The mixing water was also heated, and concrete placed in the forms at a minimum temperature of 50° F.


Typical Sections.
Detail of Horizontal Construction Joint.
Detail of Vertical Contraction Joint.
Typical Cross Section Of Porous Drain
Details of Grouting Arrangements of Vertical Contraction Joints.
PLAN
N. Gravity Section
Arch Section. Upstream Rad. 110'
S. Gravity Section
Note: Gravity Sections constructed partly of ordinary concrete & partly of rubble masonry faced with 2 ft. of ordinary concrete.
DEVELOPMENT OF DOWNSTREAM FACE.
LOWER MANORBURN DAM.
AS CONSTRUCTED.
SCALES - 15 FT. TO 1 IN. & 3/4 IN. TO ONE FOOT.
S74
Sheet 4.