Ministry of Works
Dunedin

MANUHERIKIA RIVER — CATCHMENT №752630
WATER RESOURCES

PRELIMINARY REPORT
ON IRRIGATION DEVELOPMENT

VOLUME 1

Water & Soil Division

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MINISTRY OF WORKS
DUNEDIN

MANUHERIKIA RIVER - CATCHMENT NO. 752630

WATER RESOURCES

PRELIMINARY REPORT ON IRRIGATION DEVELOPMENT

VOLUME 1 (of 2)

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District Commissioner of Works
DUNEDIN.

ABSTRACT

Irrigation development in the Manuherikia Valley is reviewed with particular reference to the water resource available and the efficiency of its utilisation.

A scheme is proposed after brief consideration of economics and recommendations are made for a further line of investigation.

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January 1974

NOTES ON UNITS

No excuse is offered for mixing imperial and metric units other than the following:-

1. Elevations and heights are expressed in feet for convenience of reference to topographic and contour plans produced at present in feet.

2. Depths (application, precipitation), areas, volumes and their time dependent differentials are expressed in metric units of mm, m, km, ha, km^2, l and Ml where appropriate.

3. Low flows quoted from "historical" data remain in c.f.s. (cusecs), as the units give an indication of the accuracy of the estimation.

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1. INTRODUCTION:

Objects of the Report

This report sets out to view the Manuherikia water resource as a whole in terms of the flow data available and to indicate the extent to which this resource could be utilized for irrigation in the valley, within the various restraints imposed.

After description of and consideration of the climatological and other conditions pertaining, a total approach to the problem of equalisation and distribution of the available resource is taken without entering into much engineering detail.

Previous approaches have been of the "take an area; can we irrigate it cheaply?" type, whereas this report takes a look at the problem from the "here's the water; where can we use it best?" angle. Other possible demands are fully considered and discussed.

The basic data available are flow records at various sites and at various periods in time. From this a very simple flow model is postulated; this being considered quite satisfactory for consideration of total resource at this stage, and from this base, various alternatives are progressively isolated and subjected to a brief economic comparison. The results are clear.

It must be emphasised that the type of utilization envisaged would be much different from the largely inefficient irrigation methods used at present; and the economic comparisons are based on the adoption of an enlightened attitude to irrigation for production.

2. DESCRIPTION:

2.1 Geographic, Topographic

The Manuherikia catchment is a true Central Otago catchment of some 3,110 km^2. The Manuherikia Valley and its neighbours form part of the block and basin system which reaches across the central part of the province. The catchment is conveniently divided into two of these depressions, the Ida Valley and the Manuherikia Valley, and these are linked, rather uniquely, part way up their length by the Poolburn Gorge which cleaves the dividing block of the Raggedy Range.

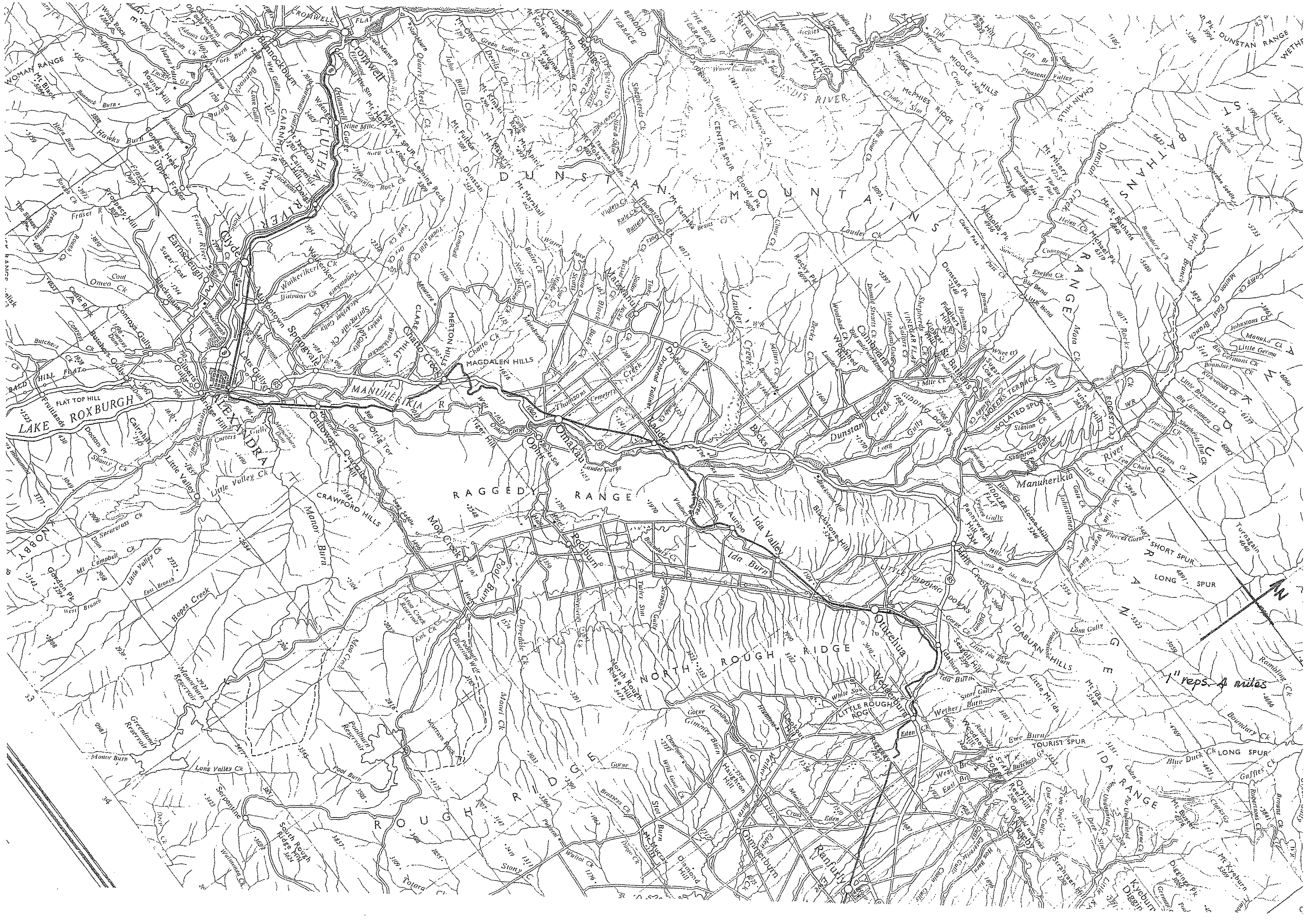
It is convenient to consider these two valleys as separate units in all senses; the Ida Valley being much the drier and less extensive of the two suffers an annual shortage of water for anything other than marginal irrigation. While the Ida Valley is not considered in detail, its relationship to the other (major) part of the catchment is kept in mind.

The Manuherikia Valley itself is aligned N.E.-S.W. and is bounded on the S.W. by the deeply incised Clutha River and the Carrick and Old Man Ranges, on the N.W. by the Dunstan Mountains rising to 5,000', in the N.E. by the Omarama Saddle and St Bathans Range rising to 6,000', and on the S.E. by the Blackstone and Raggedy Ranges of 2,000-3,000'.

A range of hills referred to variously as the Magdelene and Merton Hills and known collectively as Tiger Hills divides the valley into two below the Poolburn confluence and provide a barrier for communications which is also, as will become evident, a key topographic feature when considering distribution of water by race-lines. The Manuherikia has cut a tortuous gorge through this obstacle in its path.

Settlement has closely followed the river with Alexandra (population 3,500) situated at the junction of rivers and lines of communication serving the smaller agricultural service settlements of Omakau/Ophir and Lauder. Mining settlements which existed higher on the terraces were St Bathans and Matakanui : these two being almost non-existent at the present.

To the north and east of St Bathans the transition from the schist of the block and basin formations to the greywacke of the upper catchments is accompanied by a change of elevation and in land use to the upland and run country.


DUNSTAN MOUNTAINS
DUNSTAN RANGE
RAGGED RANGE
NORTH ROUGH RIDGE
ROUGH RIDGE
LITTLE ROUGH RDG
IDA RANGE
IDABURN HILLS
CRAWFORD HILLS
MAGDALEN HILLS
LAKE ROXBURGH
FLAT TOP HILL
ALEXANDRA
Clyde
Cromwell
Bannockburn
Earnscleugh
Omakau
Ophir
Lauder
Becks
St Bathans
Poolburn
Moa Creek
Ida Valley
Oturehua
Wedderburn
Ranfurly
Manuherikia R
CLUTHA RIVER
1" reps. 4 miles

2.2 Climate and Soils

Warm summers and cold winters with an even temporal distribution of precipitation characterise the Central Otago valleys and in particular the Manuherikia.

The valley floor can be classified as semi-arid with annual rainfalls of 350 to 500 mm. However, precipitation on the ranges to the west and north, both of which receive the full benefit of south westerly systems, rises to over 1,100 mm. It is these ranges and hence the upper catchments which can provide for the basin floor (map 2).

Temperatures have high diurnal ranges indicative of the "continental" climate regime.

Highly localised thermal storms occur occasionally.

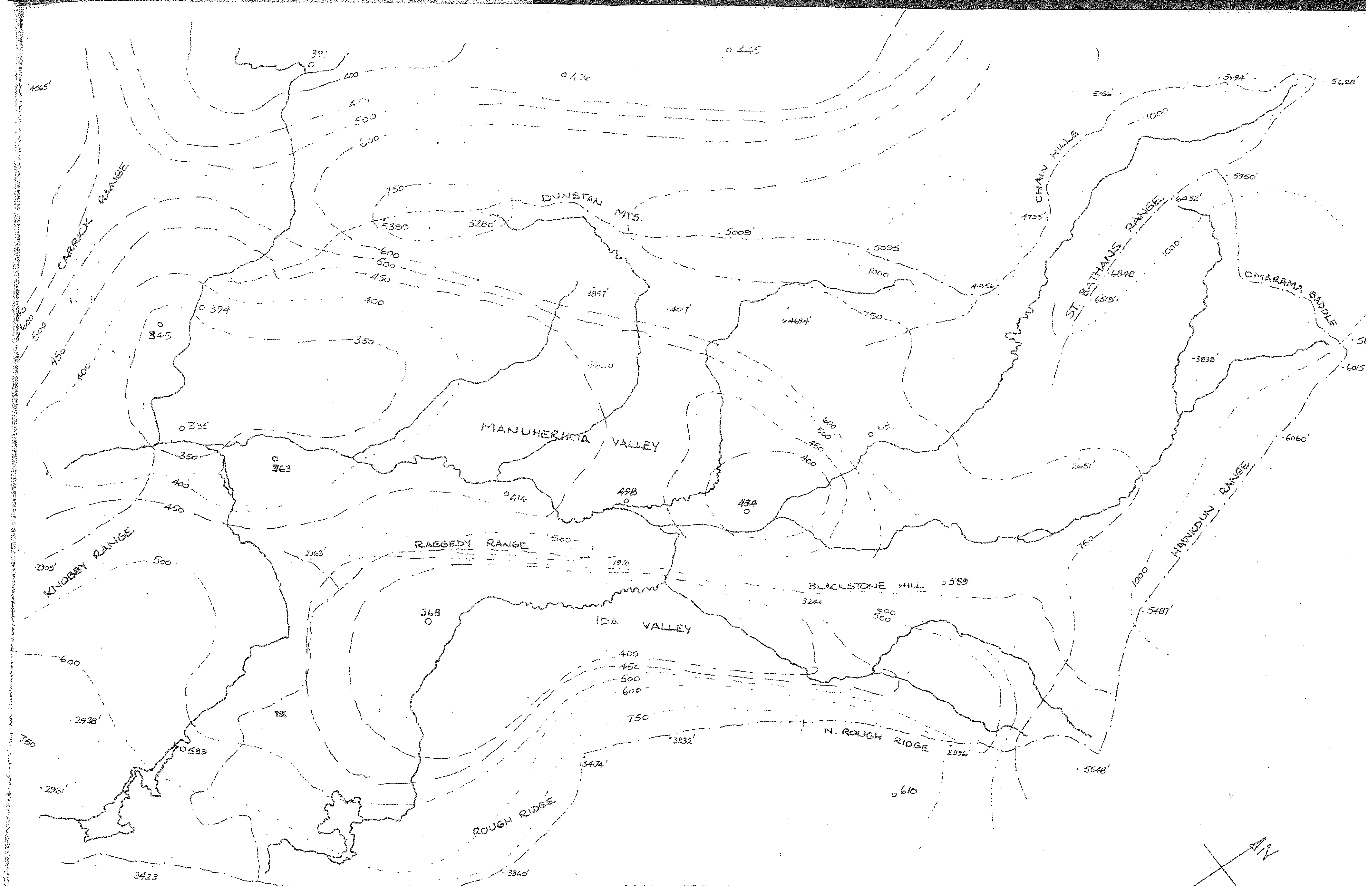
The older soils of the Manuherikia Valley [1, 2, 3] reflect the influence of the climate and consist briefly of a central-southern zone of brown-grey earths, a yellow-grey earth series along the foot of the Dunstans and across the middle part of the valley, and yellow-brown earths in the upper valley. Salinity is not a real problem.

Loess is in evidence at most locations, and more recent soils are the result of mining operations.

Most soils of the terraces and fans suffer from droughtiness and would show various responses to irrigation. However, many of the soils of the downlands and of the flood plains also suffer from impeded drainage and water-logging.

It becomes apparent that the limiting factor on irrigation development in the valley is not the irrigable area but rather the water resource. Optimisation will therefore come from careful choice of the best areas and improved management.

Soils of all classes of response to irrigation are well distributed about the middle and lower valley.



MANUHERIKIA IRRIGATION

NORMAL ANNUAL ISOHYETAL LINES

2.3 River Systems

The Manuherikia flows from its two branches commencing in the N.E. corner of the catchment straight down the fault-angle depression and is joined by the Dunstan Creek emerging from the other side of the St Bathans range. It is in places deeply incised in gorges and in other places flows in a still clearly defined channel through low terraces, with small flood plains.

Tributaries of the west bank rise in high catchments from the dissected fault scarp of the Dunstan Range and flow steadily across the terraces of the western basins. The most notable of these are Lauder, Thomsons and Chatto Creeks. Smaller tributaries between these rising from the foothills of the Dunstans are largely ephemeral.

Tributaries from the left bank of the upper catchment run directly off the Hawkdun Range, but in the lower catchment there is little contribution from the backslope of the Blackstone-Raggedy block formation with the exception of the Poolburn which dissects this range and is the outlet for the very dry Ida Valley. On the same bank the Manorburn system, with its source in the upland plateau bounded by the Knobbies, discharges through the Galloway area, not far above the confluence of the whole with the Clutha on the backwater from Lake Roxburgh.

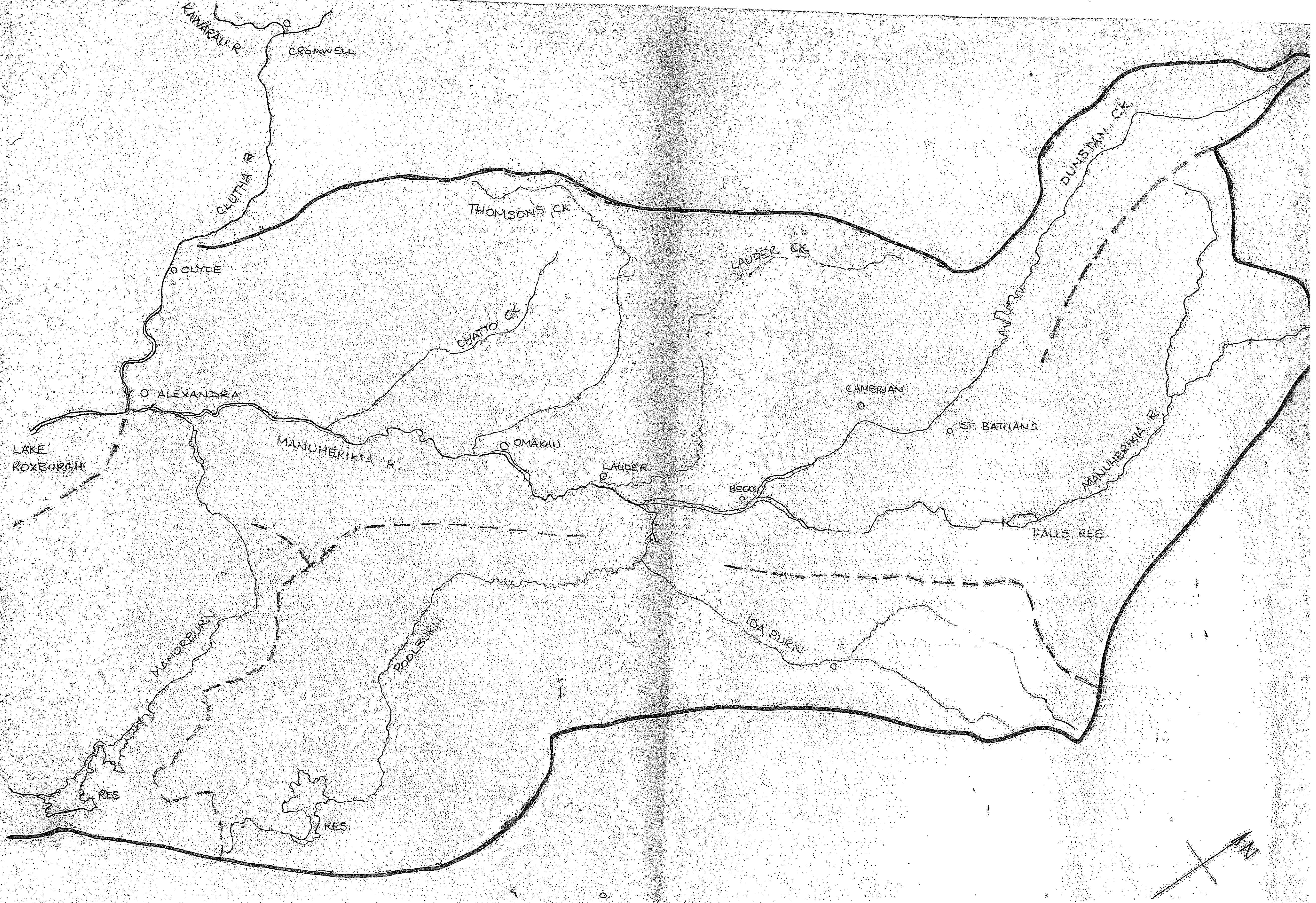
2.4 Existing Irrigation Systems and Restraints

The rivers system as described in 2.3 is modified under present irrigation operations as follows:

2.4.1 Hawkdun Race

This race draws off the major portion of the run-off from the western face of the Hawkdun Range and conveys, during the irrigation season, approximately 15 cusecs across the divide to the head of the Ida Valley and thence to the Eweburn area and beyond, over 100 km in length. While this race has problems of maintenance it must be considered "essential" as part of the partial irrigation scheme it serves and must, for the purposes of this report, be considered a fixture. This effectively makes this raceline the catchment boundary during the irrigation season, but permits the Hawkduns to contribute to storage at, say, Falls during the winter.

BINDING MARGIN



SCALE: 1 inch reps. 4 miles

2.4.2 Falls Dam [5, 7, 8, 9]

Constructed in 1935, a rock-fill structure of 34 m height providing 11,000 Ml storage, has its upstream face cut-off designed to allow for raising to 51 m storing 47,000 Ml. Discharge is controlled by a needle valve and a "morning glory" type spillway operates almost continuously outside the season, as the present storage is only 7% of the mean annual yield.

The site has possibilities for much greater storage. Under present operations the reservoir is seldom called on before December. The crest was raised 2'-0" in 1955.

2.4.3 Blackstone Race

Draws from the Manuherikia River below Falls and traverses the slope of the Blackstone hills serving at present some 530 ha over a total length of 14 km.

While administered for water sales as part of the Omakau scheme, this system is largely farmer-maintained.

2.4.4 Downs Race [10]

Serving the Downs settlement block and administered by Lands and Survey Department, this race has its intake in Dunstan Creek and serves 600 ha over 9 km.

2.4.5 Omakau Scheme [12]

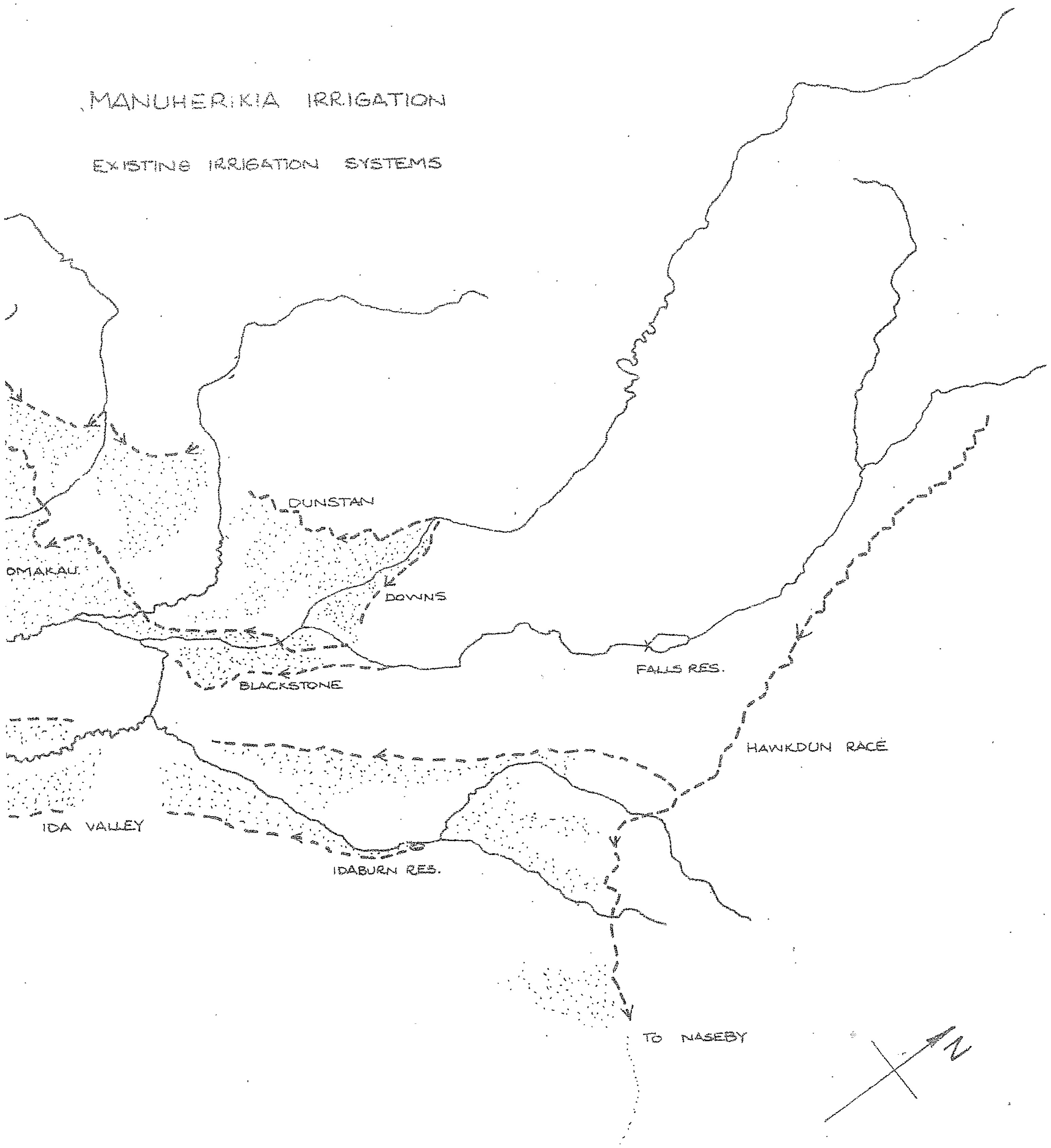
Serving the Omakau basin, takes supply from the Manuherikia River above the Dunstan confluence and, crossing the river lower down, extends to the Tiger Hills with a small pumped extension to the far side.

The Dunstan race serves a higher area from Dunstan Creek as do other smaller races taking their source from Thomsons, Lauder and Devonshire Creeks [10].

The total area served at present is 8 300 ha although only 6 800 ha are under agreement.

2.4.6 Manuherikia Scheme [11, 13]

Serves the lower areas below the Tiger Hills and takes its source from the Manuherikia Gorge. Problems of maintenance of both intake and distribution system are great for reasons made evident in Appendix F. A main race length of 30 km serves 2 100 ha although only 1 900 ha are under agreement.


MANUHERIKIA IRRIGATION
EXISTING IRRIGATION SYSTEMS
DUNSTAN
OMAKAU
DOWNS
FALLS RES.
BLACKSTONE
HAWKDUN RACE
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2.4.7 Galloway Scheme

1,200 ha is supplied, in its upper portion with Manorburn water, and in its lower portion by what is largely return flow from other schemes pumped ex the Manuherikia River.

2.4.8 Ida Valley Scheme

Utilizes many old mining races with storage added at Manorburn and Poolburn. This scheme is very limited in its catchments which are in the long-term overextended, but the scheme is operated on an annually-set quota basis. Some relief could be provided by supplying Galloway exclusively from the Manuherikia area.

The total storage available is 75,000 Ml and from this the maximum area served is 5 600 ha plus a further 600 ha in upper Galloway.

The upper end of the Ida Valley is served partly by the Hawkdun race and partly by a small reservoir in the Idaburn, and is sparsely irrigated.

2.4.9 Private Irrigation

Some 2 000 ha are irrigated privately and only partially by private operators. These small right-holders are in general above Government races, and use a variety of races, some of which are old mining facilities.

2.4.10 Summary and Discussion

For the purposes of this report the Ida Valley is isolated as a separate unit and not considered in detail. While there are inputs from the Manuherikia proper in the form of Hawkdun Race Water and outputs in the form of Manorburn Water to Galloway, it is not considered that the order of magnitude of such transfers could be economically altered to any great extent. This means that the Ida Valley must go its own way, although the possibility of a further pumped transfer from a raised Falls reservoir for stockwater needs in the Idaburn area could be considered.

In the Manuherikia Valley proper the limiting factor to present operation is storage. The seasonal run of all tributaries and of the Manuherikia itself are almost fully utilized. Attempts to squeeze marginally greater areas by tightening efficiency in ageing systems or by marginal increases in storage are possible but perhaps not worthwhile. A comprehensive re-appraisal is considered necessary, and forms the substance of this report.

2.5 Agricultural Practice

In general agricultural usage varies from intense orchard production close to Alexandra and Clyde, through semi-extensive farming, generally in the partially irrigated properties, to very extensive run units where winter feed production under irrigation is important.

A detailed survey of agricultural parameters under the existing Omakau and Manuherikia schemes was carried out in 1971-72[4] and part of this report is included hereafter. This also includes information on water usage under the present schemes.

2.5.1 Irrigable Area

A total of 43,489 acres (17 613 hectare) are commanded by Government races on the Omakau and Manuherikia Schemes out of a total farm area of 199,488 acres (80 793 ha). Of this area 21,626 acres (8 759 ha) are covered by irrigation agreement along with some areas supplied on a cusec-day basis (if and when water available) and some small holdings on pipe supply.

The results of the farm survey undertaken indicate that 26,861 acres (10 879 ha) are at present irrigated from the Government controlled races, and that it would be possible to irrigate 37,214 acres (15 071 ha) from these races if races were enlarged and storage capacity increased. Private irrigation accounts for a total of 5,406 acres (2 189 ha) much of it above Government races although several private water rights are used to supplement the irrigation water received from these races and are not accounted for in the area figure.

A breakdown of these figures was made in the survey and is tabulated in Table 1. The breakdown for the irrigated land into border-dyked, efficient contour (where water is utilised well, being picked up and re-used etc.), partial irrigation (where water is wasted or the land only receives one or two irrigations per season), spray and trickle is based mainly on the farmer's own knowledge of his property and not field measurement.

Table I

		Omakau Scheme		Manuherikia Scheme	
Total Number of Properties		80		103**	
Total area of Properties	(ac.)	173,362	100%	26,126	100%
	(ha.)	70,000		10,560	
Area below races	(ac.)	34,729	20%	8,760	33.5%
	(ha.)	14,050		3,540	
Agreed Area/Below races	(ac.)	16,865	48.5%	4,761**	52.4%
	(ha.)	6,820		1,930	
Present Irrigated/Area Below	(ac.)	21,573*	62.0%	5,288	60.3%
1. Border dyked/Total Present		963	4.5	1,339	25.3
2. Efficient Contour/T.Present		16,983	78.8	3,427	65.0
3. Partial Irrigation/T.P.		3,331	15.4	495	9.4
4. Spray Irrigation/T.P.		296	1.3	19	0.2
5. Trickle Irrigation/T.P.		-	-	8	0.1
Possible Irrigable/Area Below	(ac.)	30,413	87.7%	6,801	77.7%
1. Border dyked/Total Poss.		12,652	41.6	3,150	46.3
2. Efficient Contour/T. Poss.		15,550	51.1	3,477	51.1
3. Partial Irrigation/T.Poss.		1,841	6.1	147	2.2
4. Spray Irrigation/T. Poss.		370	1.2	19	.3
5. Trickle Irrigation/T.Poss.		-	-	8	.1
Private Irrigation	(ac.)	5,229	100.0%	177	100.0%
1. Border dyked/Total Private		42	0.8	-	-
2. Efficient Contour		2,134	40.8	16	9.1
3. Partial Irrigation		2,903	55.5	155	87.6
4. Spray Irrigation		150	2.9	6	3.3

* Includes Blackstone Hill Race

** Excludes some cusec-day and pipe irrigators

The properties unvisited on the Manuherikia Scheme were all small (about 10 acres) with the owners employed elsewhere in the district. A rough estimate was made from knowledge of adjoining properties etc. of the various areas to enable Table I to be prepared.

Roughly 50% of the area below the races is under agreement in both schemes with the area actually irrigated being about 60% of the area below the races or about 12% greater than under agreement. Indications are that given a greater supply of water, it would be feasible to irrigate about 88% and 78% of the areas below the races on the Omakau and Manuherikia Schemes respectively.

2.5.2 Land Utilisation

Also undertaken with the survey was a land utilisation study which classified land use into five groups for the areas above and below the races. The groups were Lucerne, Grass, Crop (includes cereal, winter feed etc.), Native or Undeveloped, and Orchard. The results of this survey are tabulated in Table III. There are some stands of farm forest and considerable areas in shelter belts that are not included separately. Several lucerne stands below the races were on river flats and not irrigated. Where these were identified this has been noted.

Table II

LAND UTILISATION : MANUHERIKIA VALLEY

	Omakau Scheme	Manuherikia Scheme
Below Government Races	34,729	8,760
Lucerne	2,473*	705
Grass	27,945	5,120
Crop	1,921	183
Native	2,392	2,410
Orchard	-	342
Above Government Races	138,631	17,366
Lucerne	1,102*	112
Grass	35,857	5,250
Crop	587	109
Native	101,085	11,873
Orchard	-	12

* 124 acres unirrigated.

As can be seen from the above Table II and Table III, which follows, the area is grazing oriented, basically toward sheep, but following the current trend and venturing into cattle. Only the area immediately around Alexandra and Clyde is concerned with horticulture to any extent.

2.5.3 Stocking Rates

The stock numbers wintered in 1971 were requested from all farmers and converted to ewe equivalents. The average stocking rate in ewe equivalents (e.e.) per hectare over the whole area covered by the survey was 2.7 e.e./ha. The results are summarised in Table III.

Table III

MANUHERIKIA VALLEY IRRIGATION : STOCK NUMBERS

	Nos. in ewe equivalents	
	Omakau Scheme	Manuherikia Scheme
Sheep	166,503	24,072
Cattle	31,320	3,300
Other	36	106
	197,859	27,478

The area irrigated only represents about 11% of the total farm areas, compared with 59% which is still in native tussock-browntop vegetation. Stocking rates of 5-6 ewe equivalents to the acre are not uncommon under irrigation on both schemes (12-15 e.e./ha).

2.5.4 Water Usage

Analysis of water usage over the twelve seasons 1955/56 to 1966/67 has been completed. The mean water diverted from the Manuherikia River was 52,000 Ml with a maximum in the 1966/67 season of 70,800 Ml. These figures exclude the Blackstone Hill Race which in a normal season with no rationing would withdraw about 4,200 Ml, but include the Galloway Scheme pumps. These figures compare with J.D. Watt's[5] stated peak usage of 52,000 Ml in 1944/45 from the Manuherikia River.

It can be concluded from this and other indications that more water is being drawn from the river as farmers become more aware of the "productive" rather than "insurance" use of irrigation. Farmers now irrigate a larger area and more frequently. The variability of usage is much greater on the Omakau Scheme than on the Manuherikia or Galloway Schemes. The slightly higher rainfall and altitude, and the larger properties, are offered as the explanation although the more constant demand of the Manuherikia Scheme is associated with the numerous small holdings with domestic and stockwater requirements.

2.5.5 Water Sold

On the Manuherikia Scheme the mean season's water sold (22,350 Ml) is equivalent to 1040 mm over the 2 140 ha at present irrigated. The maximum season's water sold (28,400 Ml) represents 1375 mm over the same area.

The mean season's water sold on the Omakau Scheme (22,500 Ml) corresponds to 285 mm over the present irrigated area of 7 900 ha (the Blackstone Hill Race irrigates 815 ha, but is not covered by the water sold figures). The maximum season's water sold (38,400 Ml) represents 486 mm over the same area.

Peak usage has coincided with the driest seasons indicating that although the existing storage has not satisfied the full demand at the latter end of the season the storage can cope with about a 1 in 10 year "drought". This is the accepted design requirement on newer irrigation schemes.

Race losses appear to be about 20%. The usable return flow to the Manuherikia River from the Omakau Races and overwatering has been assessed as 15% of the total water diverted.

The monthly demand for water in an average season (taken from Water Sold figures) as a percentage of the total season demand is as follows:

Table IV

	Galloway Pump %	Manuherikia Scheme %	Omakau Main R. %	Dunstan Race %	
September	8	3	4	2	4
October	15	15	13	10	13
November	16	17	16	15	16
December	17	17	20	20	19
January	17	17	18	20	18
February	16	15	15	18	16
March	8	10	9	10	
April	3	6	5	5	

Table IV summarises the water usage for the seasons 1955/56 to 1966/67.

Table V

MANUHERIKIA VALLEY IRRIGATION

WATER USAGE OVER 12 SEASONS (1955/56 TO 1966/67)

FIGURES IN ACRE-FT

1 AC-FT = 1.233 ML

	Mean.	Standard Deviation (S)	Coeff. of Variation CV	Max. Season Usage (Season)	Min. Usage (Season)
1. GALLOWAY SCHEME:					
Water pumped ex Manuherikia R.	2904	362	0.125	3492 (66/67)	1980 (57/58)
2. MANUHERIKIA SCHEME					
Water diverted ex Manuherikia R.	22888	3238	0.142	29304 (66/67)	18280 (57/58)
Water diverted ex Chatto and Younghill Cks	2344	350	0.149	2944 (60/61)	1358 (55/56)
Total Water Sold	18098	2828	0.156	23026 (66/67)	13520 (56/57)
Pipe Users	886	90	0.102	1130 (55/56)	770 (65/66)
Stock and Domestic	488	152	0.312	838 (64/65)	330 (64/65)
3. OMAKAU SCHEME					
Water ex Manuherikia R:	16310	5250	0.322	24572 (66/67)	5402 (57/58)
Water ex Cks (Launder, Dunstan Thorn, Devon, etc.)	9706	3722	0.384	16252 (66/67)	1984 (57/58)
Total Water Sold	18232	6492	0.356	31072 (66/67)	5480 (57/58)
Water liberated unsold	1860			4214 (60/61)	- (57/58)

2.5.6 Water Quota and Charges

Omakau Scheme

There is a standard water quota of 12" per acre per season for the Omakau Scheme at a standard charge of $0.625 per acre, and extra water costs $0.60 per acre-ft. The Blackstone Hill irrigators pay an annual charge equivalent to $83.60 for each cusec continuous supply, but organise their own maintenance and distribution.

Note: 12"/ac = 123 mm/ha.

Manuherikia Scheme

The water quota varies between 24" and 36", with the majority being 30", 33" or 36" per acre, and the annual charge per acre from $1.025 to $1.625. Extra water charge is $0.2625 per acre-foot. It is recommended that on renewal of agreements that a standard water quota and charge be struck over the irrigable area.

2.5.7 Water Usage

The number of irrigations per season on the Manuherikia Scheme is considerably higher than the Omakau Scheme as evidenced by the water usage figures. Ten irrigations are not uncommon compared with four to six irrigations on the Omakau Scheme (Efficient Contour classification).

The majority of farmers visited would prefer a greater rate of flow for a shorter time, rather than a continuous supply. Many of them just wanted a greater flow. The orchardists in general have a satisfactory supply and with moves towards trickle irrigation lower rates of continuous supply are probably more desirable. An attempt should be made to supply new orchard areas in preference to new areas for meat and wool production because of the much more intensive use, and ability to carry water charges. Provision should also be made for sprinkler frost-fighting in August-September.

2.5.8 Discussion of Practices

Extrapolation of these figures to other areas must be tempered with judgement. There are many large run properties extending from the ranges to the terraces and fans particularly in the Moutere area which would further lower the proportion of irrigated to unimproved land.

D.J. Hamilton's report (2.5.1 to 2.5.7) shows that usage of water is excessively on the high side, and this is clearly due to the poor application methods employed. Wild flooding (and this includes so-called "contour ditch" operations, but with too few contour ditches) on lands suitable for bordering lead to very inefficient use of the water resource. Further to this, insufficient attention to drainage in certain locations (and drainage must be considered an integral part of irrigation) has resulted in waterlogging, though saline problems are not so extensive as in other valleys.

There are properties where irrigation is being carried out efficiently, but the inefficient users would on the whole be encouraged to join the former group under a rational charging system, and with direct encouragement to develop the land for the appropriate system of application.

Irrigation for production could then be achieved.

3. WATER RESOURCE ASSESSMENT:

3.1 Available Data

3.1.1 Flow records for the period October 1919 to December 1930 in terms of smoothed daily means at Ophir are available from figures extracted from Alexandra file P.W. 32/5 by Power Design. This station is adopted as the base for the flow model constructed.

3.1.2 Daily staff gauge readings taken adjacent to the Manuherikia Irrigation intake (February 1928 to April 1952) in the Manuherikia Gorge, while covering a longer period, are not of much value as no reliable rating(s) can be applied at this poor site. Lack of rating information also applies to records for the Scandinavian race intake site (November 1909 to March 1912) on the Manuherikia West Branch.

3.1.3 Comparative gaugings for various tributaries are on record over the period 1922-1928 and a current series of similar gaugings (with an emphasis in low flow conditions) commenced in February 1971.

3.1.4 Stage records for Dunstan Creek and for Chatto Creek mentioned in the files have not been located nor have a possible series on the Poolburn.

3.1.5 A full set of operating records for all irrigation facilities and in particular for reservoirs, intakes and bywashes is available.

3.1.6 Rainfall data as published by the Meteorological Service includes some stations originated by the P.W.D. in the early days of irrigation development.

3.1.7 Various historical anecdotes gleaned from correspondence files give valuable low flow estimates 10, 14.

3.2 Interpretation and Processing.

All the data was reviewed and examined for its worth. Since it was obvious from the start that storage would have to be considered, some long-term record approach was necessary and it was decided that in view of the sparse information available, the Ophir site would be considered as the base station for the catchment as a whole, and that an effort should be made to construct a simple flow model relating all data to the Ophir record 1919-1930, the best available.

The comparative gaugings attempted in the 1922-28 period were recommenced and are continuing in an effort to establish the seasonal pattern of contribution to total flow from the various sub-catchments. This work is continuing but to date a fairly clear picture is already available and is the basis for this report. Further work is necessary to establish within-season subcatchment variability.

Ministry of Works
New Zealand

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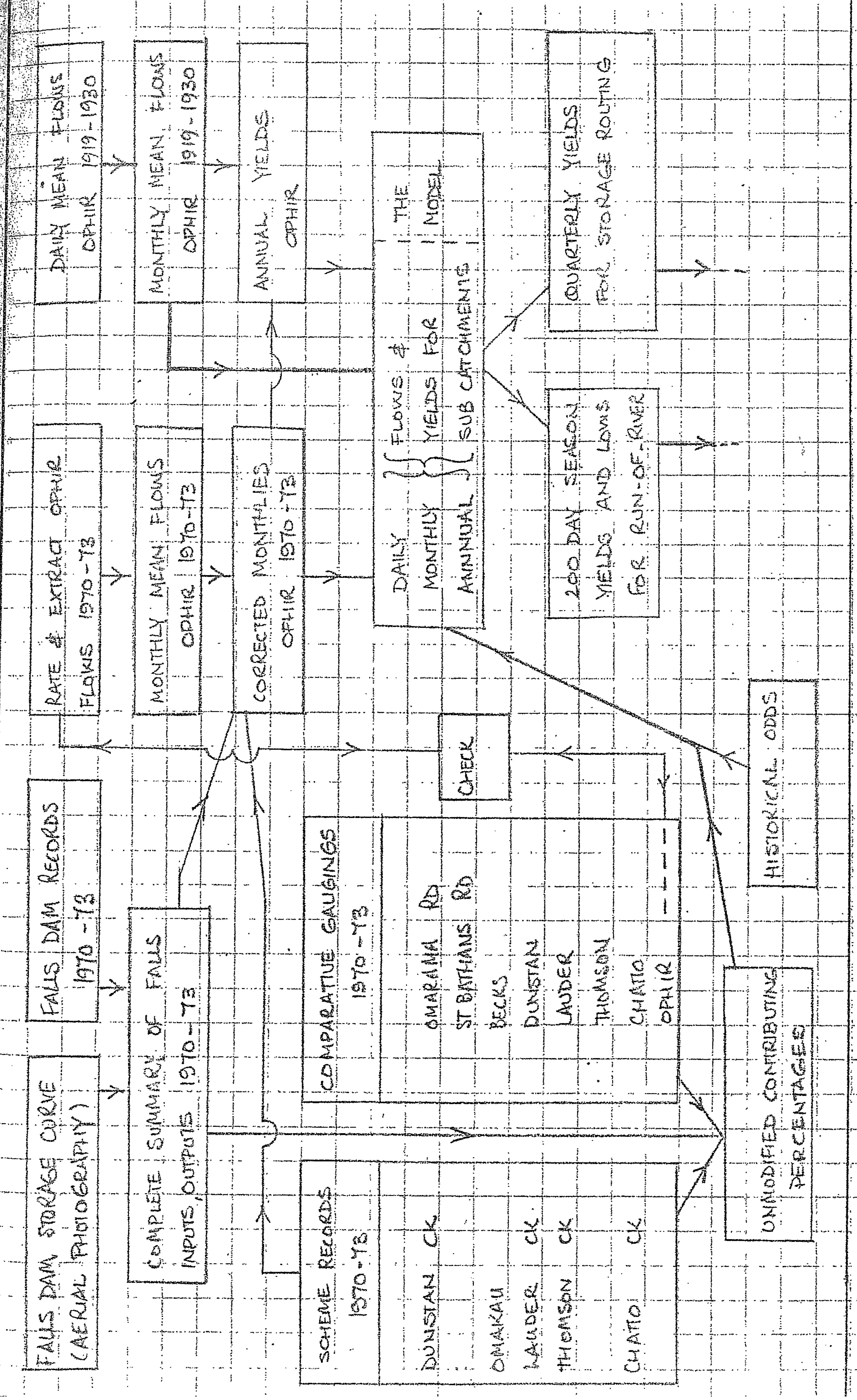
Description

Sheet No. 20

PROJECT MANUHERIKIA WATER RESOURCE



SCHEMATIC APPROACH TO ASSESSMENT OF WATER RESOURCE

Fig I

The recent series of gaugings is, of course, modified by irrigation operations, so recourse was made to the various scheme records to correct, where appropriate, to the unmodified (or natural, pre-irrigation) situation.

This approach is shown schematically on Fig. I, and Map 5 shows the various contributing catchments. Appendix B summarizes the monthly mean flows at Ophir which can be extended back to these sub-catchments with the reservations outlined as the results of the following comments. All figures are for convenience referred to as a percentage of the corresponding Ophir figure.

3.3 Characteristics of Subcatchments

3.3.1 Upper Manuherikia

A typical Otago high country catchment of 21% of the Ophir area, provides an annual yield of 37% or approximately 178.5 x 10^3 Ml for the base period. Together with the Upper Dunstan catchment, this area provides reliably the bulk of the summer run-offs as is evidenced by the increase in contributing percentage over the warmer months, and is clearly the most important of the sub-divisions. The estimated 1 in 10 drought year yield is 122.5 x 10^3 Ml.

3.3.2 Upper Dunstan

Considering the catchment above the Dunstan Gorge, the same comments apply as to the Upper Manuherikia. The area is 18% of Ophir above the storage site increasing to 23% at the exit from the gorge with no appreciable gain, with gaugings at the latter site showing the yield to be 20% of Ophir (conservatively) or an annual mean of 96.5 x 10^3 Ml and a 1 in 10 year drought of 66.2 x 10^3 Ml yield, having a similar variability to the Upper Manuherikia catchment.

It is readily observable that combining these two areas, which can be considered as outside the potential irrigable area, provides almost 60% of the yield with 45% of the plan area. Reference to the isohyetal map makes the reason for this abundantly clear.

3.3.3 Western Tributaries

Lauder, Thomsons and Chatto Creeks and a few others with essentially mountain catchments provide another not unimportant source of supply, as indeed they do at present. It is convenient to consider these streams as they emerge from the foothills, as their behaviour as they cross the valley proper is variable and subsurface losses may be high.

The three named provide 7.5%, 11.5% and 4.5% respectively and together with other major creeks, notably Mata, Browns and others, can be considered to provide a total annual mean contribution of 30% to the Ophir flow (5% of this enters downstream of Ophir). This represents a total annual mean yield of 145 x 10^3 Ml and allowing for slightly increased variability the estimated yield in the design drought year is 99.25 x 10^3 Ml.

Notes from Alexandra P.W.D. files 33/2 and 15/24 [10] show that the all-time recorded low for Thomsons Creek was 7 cusecs with representative low flows of 10½ and 11 cusecs being common both in the period of recent gaugings and in a series taken in 1889 to 1892.

3.3.4 Others

1. The Poolburn, draining the Ida Valley, provides a flow which represents on an annual basis 4.5% of the Ophir flow, though this falls to about 2% in the irrigation season. This water can be neglected in consideration of west bank irrigation although this will be discussed further in detailed consideration of Galloway operations.

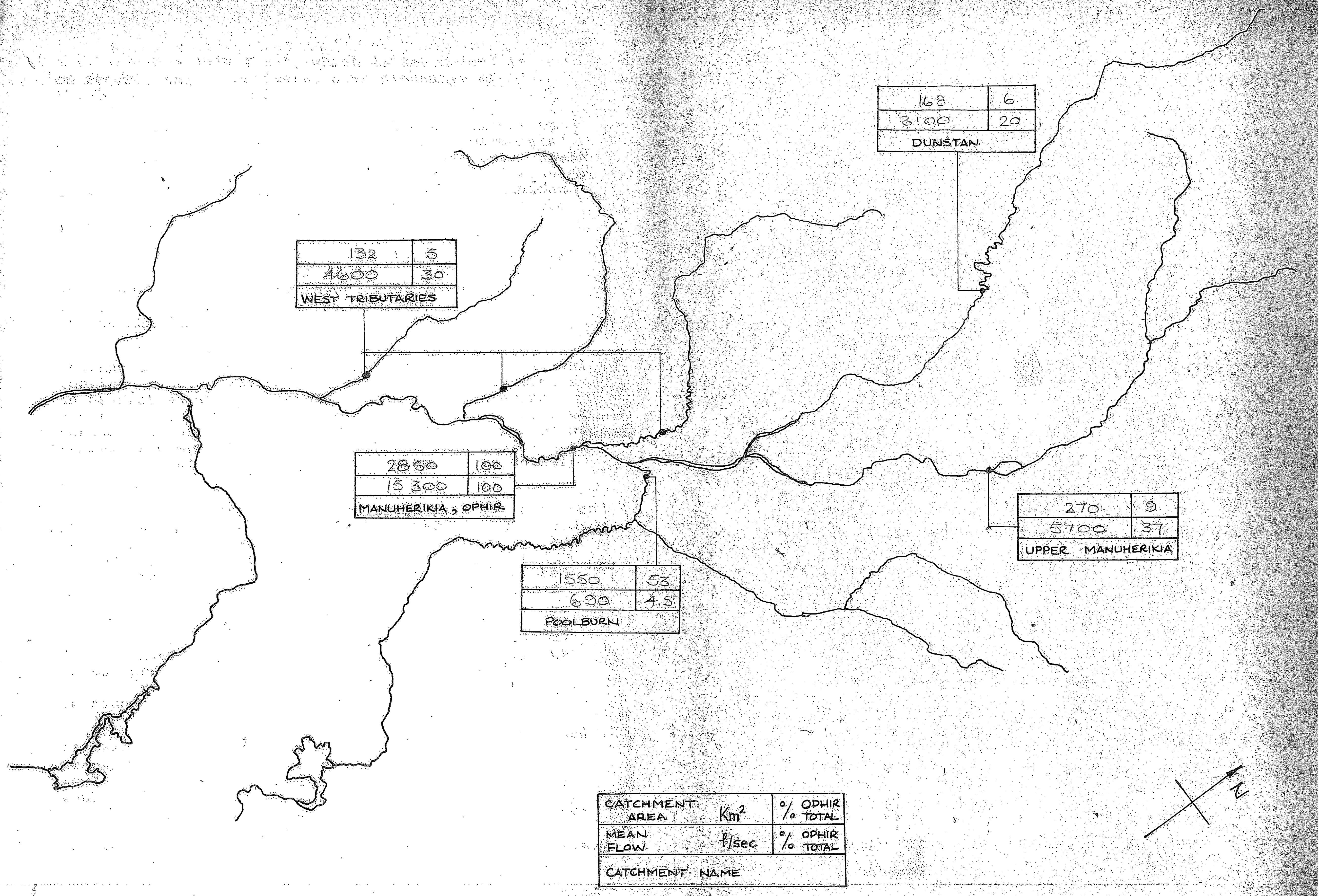
2. Minor tributaries from the western terraces and from the left bank ridges must by reasons of continuity (on the mean) provide the balance of the 105% flow that can be measured below the Chatto Creek confluence. Arithmetic shows this to be 13.5%, an amount which though not insignificant is in fact within-season highly variable and in effect must be neglected as not utilisable in engineering terms. These tributaries have their source as a whole on low altitude and low rainfall catchments, and where some provide some flow all year round, do not necessarily do so throughout their full length.

3.4 Comment on Accuracy

The above-described model has been constructed from a fairly limited series of observations, but is, however, of an accuracy of ± 5%. It is felt that this is quite satisfactory for the purposes of this report where neither demand, engineering costs, benefits and other factors can be estimated to any greater degree of accuracy. A greater refinement of hydrological information would be necessary for definition of precise operating and sizing parameters.

3.5 Floods

The exceptional flood of 1878 is described [6] as raising the Manuherikia 29 feet above normal and "the valley was transformed into a great lake". This has been estimated to have a peak discharge of 24,000 c.f.s. (677,000 l/sec.) at Ophir.



cheaper water. The Falls site must, therefore, be utilised to its maximum, and Dunstan storage becomes

The 1919 flood, which is the second largest on record, had an estimated peak discharge of 17,500 c.f.s. (495,000 l/sec.).

Major floods of this nature are likely to occur with rapid snowmelt coinciding with warm rain and find their source in the upper catchments. However, their effect on the lower velley in respect of erosion of pastoral land &damage to assets is fairly limited in extent on the whole due to the incised nature of the Lower Manuherikia.

Highly localised thunderstorms of very high intensity can occur at any location[10], and while of very short duration, can cause local damage.

3.6 Storage Considerations

The above data was applied to unlimited storage units at the Falls, Dunstan and a hypothetical combined site, enabling capacity vs safe yield curves to be plotted with no consideration of engineering restraints. These curves were constructed by routing through the appropriate figures for the base period at various storage levels and estimating safe yields. Other small storage locations are examined in detail in Appendix C.

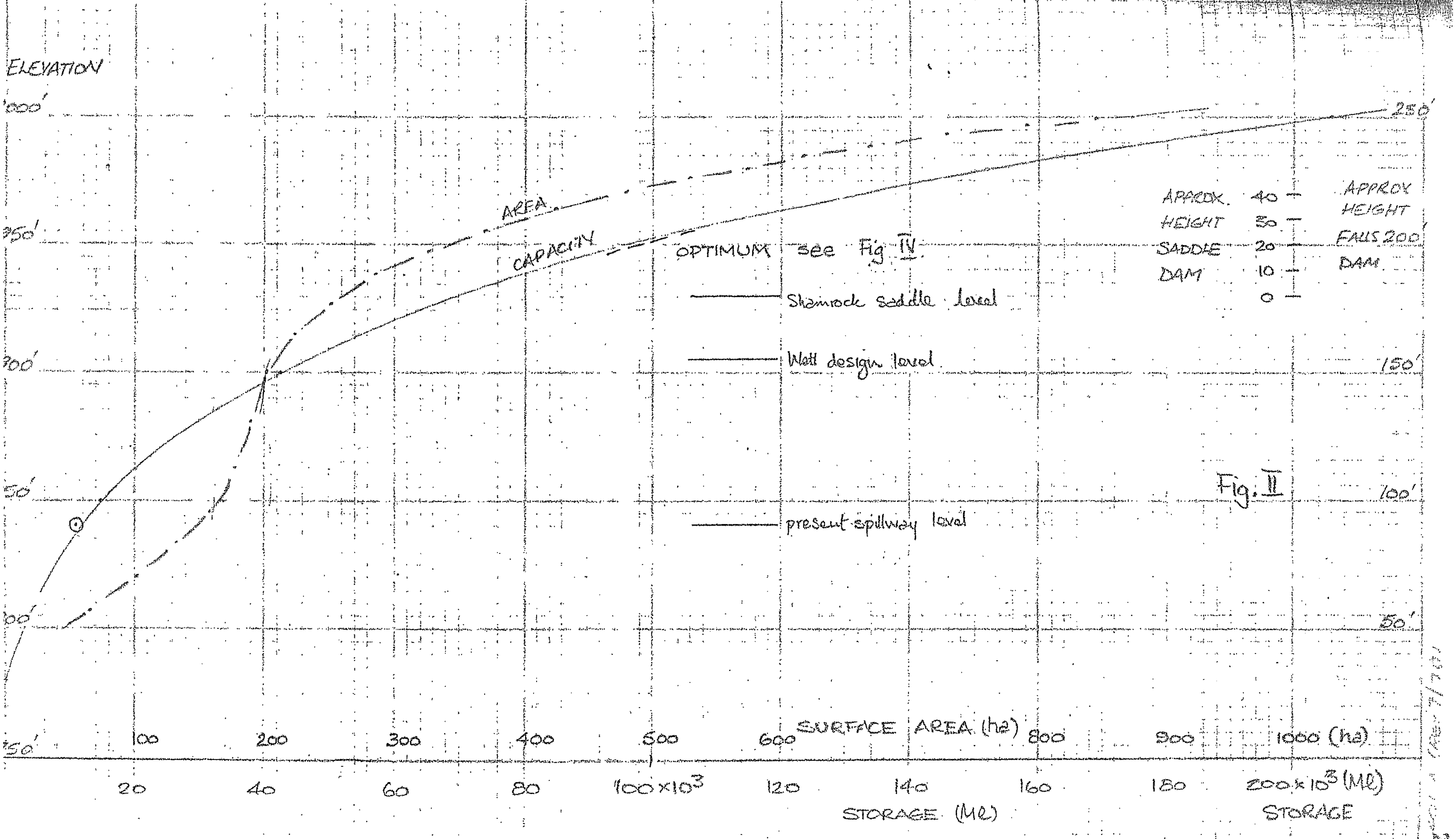
Examination of the rainfall data for stations in the catchment show that the base period (1919-1930) is a fairly representative period with regard to the (longer) period of precipitation observations, and thus no adjustment is considered necessary to either the long term or annual yields within this period for routing purposes.

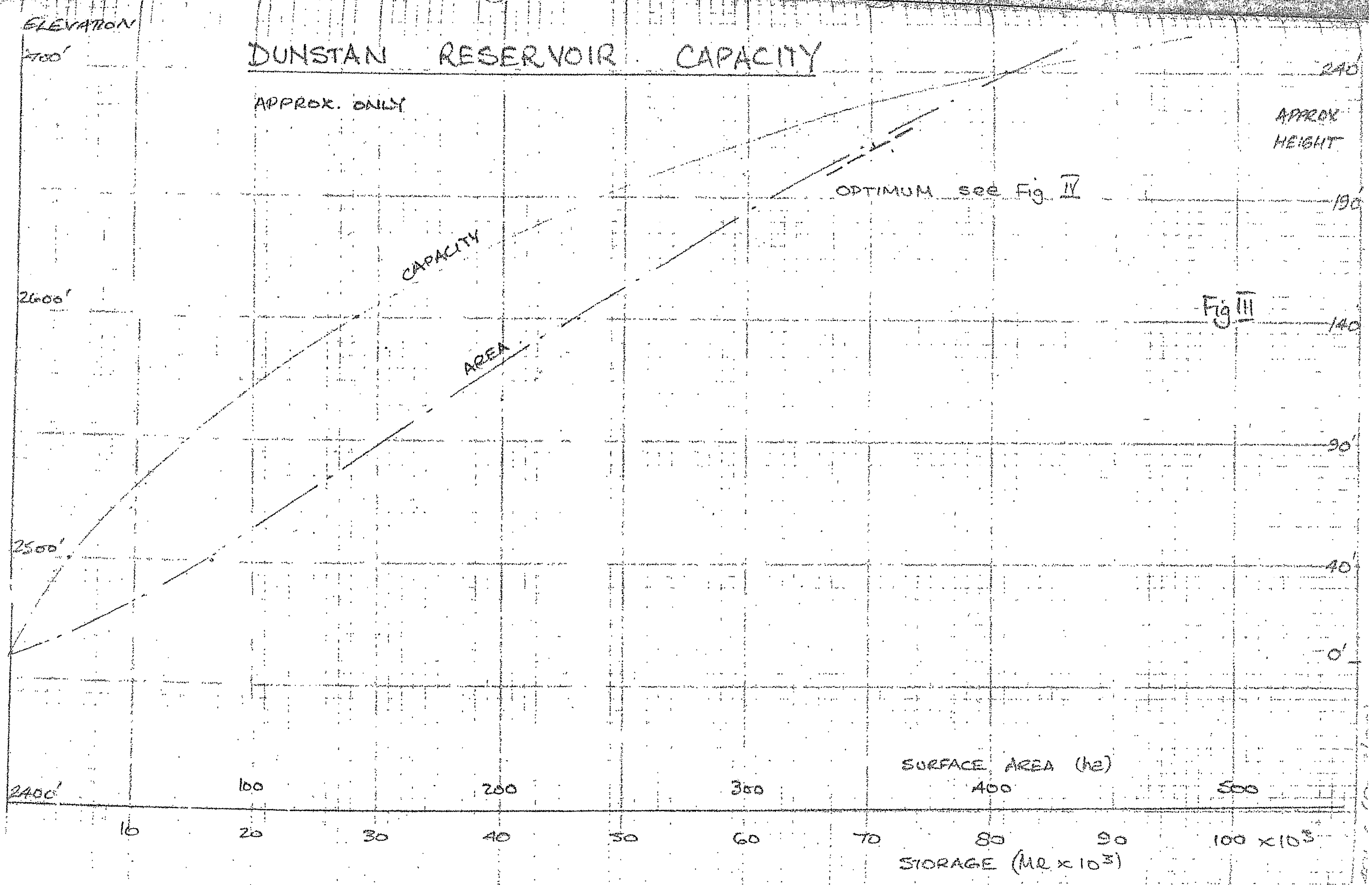
The safe yields established are considered "safe" indeed for the 11 and 22 year cycles apparent in the precipitation records for Otago and take account of evaportation losses assuming an average in round terms of 900 mm per year.

It can readily be seen from the Figs. II and III that a 200' structure at Falls would have a storage capacity of 100 x 10^3 Ml giving a safe yield of 130 x 10^3 Ml while a 230' structure on the Dunstan would store 70 x 10^3 Ml but have a safe yield of only 74 x 10^3 Ml. These heights and storage levels quoted are, from inspection of the shape of the graphs, fairly close to optimum, and of course the safe yields quoted are for each unit considered in isolation.

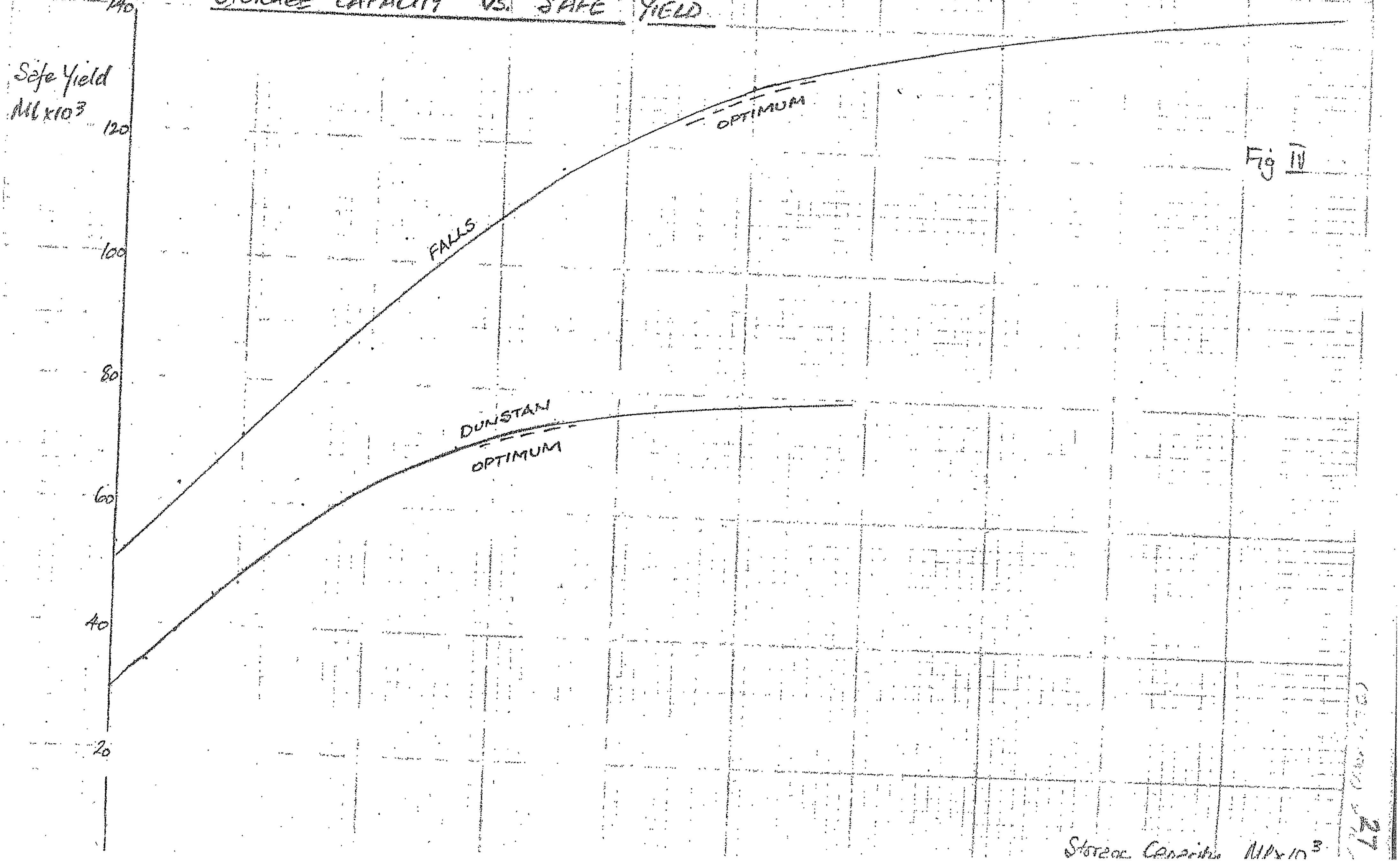
From the above considerations alone, assuming both structures to be of a similar type (probably earthfill), the Falls site is the one to provide the cheaper water. The Falls site must, therefore, be utilised to its maximum, and Dunstan storage becomes one expensive secondary consideration.

FALLS RESERVOIR CAPACITY APPROX. ONLY




DUNSTAN RESERVOIR CAPACITY
APPROX. ONLY
ELEVATION
2700'
2600'
2500'
2400'
APPROX HEIGHT
240'
190'
140'
90'
40'
0'
CAPACITY
AREA
OPTIMUM see Fig. IV
Fig III
SURFACE AREA (ha)
100
200
300
400
500
10
20
30
40
50
60
70
80
90
100 ×10³
STORAGE (Mℓ ×10³)

STORAGE CAPACITY VS. SAFE YIELD



The maximum constraint on Falls is provided by topography, being the saddle between the storage basin and Shamrock Gully (see Fig. VI) and this conveniently is at an elevation which is close to that giving optimum storage, and at the same time provides an easier site for a spillway than that which would be necessary in the gorge for a lower structure.

This level is much higher than that for which the present dam was designed. The ramifications of this are discussed in Appendix C.

Assuming full development of this, the best, site, additional considerations which can be isolated and dealt with individually are as follows:

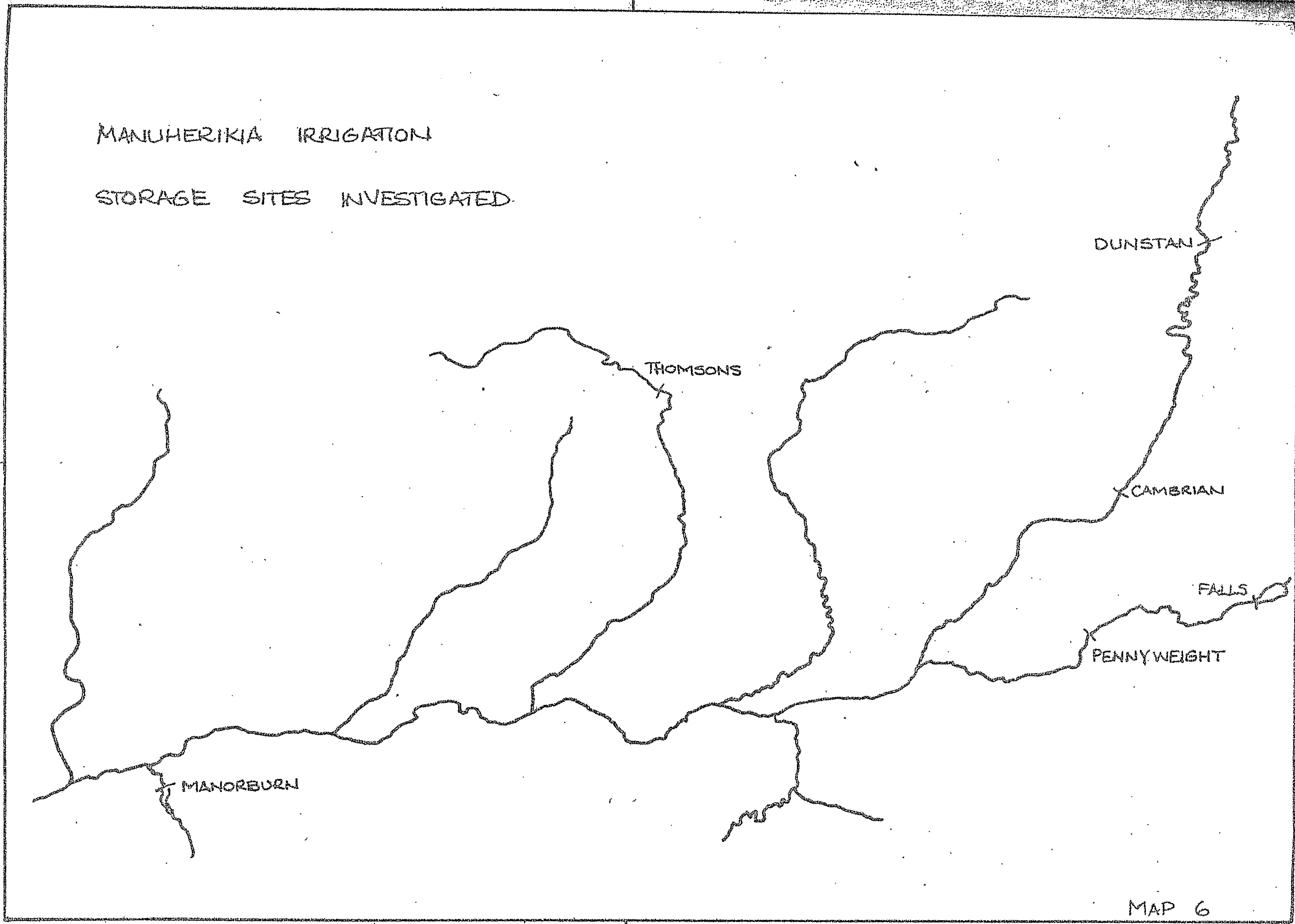
1. Operate on the run of Dunstan Creek and the West Bank tributaries. No extra storage.

2. Provide some storage in Dunstan Creek at either gorge or Cambrian site, or in Thomsons Creek.

3. "Top-up" Falls off-season with Dunstan Creek water thus increasing the total in-season availability.

4. Provide additional low-level storage at Pennyweight site below Falls.

Each of these additional components may be considered and compared in isolation from distribution proposals, for, being well upstream of conceivable intakes, all these above possibilities have little effect on the configuration of distribution systems other than their marginal extent and therefore they may be compared in cost-per-hectare-served terms. This comparison is carried out in section 5.


MANUHERIKIA IRRIGATION
STORAGE SITES INVESTIGATED
DUNSTAN
THOMSONS
CAMBRIAN
FALLS
PENNYWEIGHT
MANORBURN
MAP 6

W. 485

4. IRRIGATION REQUIREMENT:

For scheme studies some broad initial assumptions on the requirement for irrigation are required. The assumptions made must depend on soil types and their moisture deficiencies and on the efficiency of distribution and application.

Bearing in mind the soil information[1] summarised in 2.2, and the distances that could be involved in distribution using both natural and artificial channels, a rounded figure for duty of water has been established as follows:

Assumed season application depth (including for on-paddock losses)	930	mm
Allow 20% on-farm distribution losses	232	mm
	1162	mm
Allow 20% main distribution losses	290	mm
	1452	mm
Adopt	1460	mm
=	14.6	Ml/ha.

This figure is derived on a seasonal basis rather than from a short period demand requirement in view of the fact that storage is involved. However, 930 mm is equivalent to 12 15-day applications of 78 mm each.

Use of 14.6 Ml/ha for the whole area is considered to take account of all losses excepting reservoir evaporation (see 3.6), including river channel, intake operating, main, distributary, and farm head-race losses while allowing for a reasonable level of re-usable return flow to serve such lower areas as may benefit under a two or three-tier distribution system (see 5).

The adopted design figure of 930 mm should be compared with the rates of past usage on the existing schemes (see 2.5.5), being 1040 mm for Manuherikia and 285 mm for Omakau.

It must be emphasised that this duty of water is aligned towards efficient control and towards production and not to intermittent **partial** irrigation.

Where direct run-of-river operation is involved (i.e. with the west-bank tributaries and also with Dunstan Creek) the figure of 14.6 Ml/ha is equivalent to a continuous flow of 0.845 l/sec/ha.

5. SCHEME PROPOSALS

5.1 General Layout

A discussion of the approach to optimisation of storage was broached in 3.6 It is similarly in order to make a broad study of distribution systems with particular reference to areas commanded. At this stage capacity of main races is not so important as extent as costs/unit length do not rise steeply with respect to capacity for the sizes under consideration.

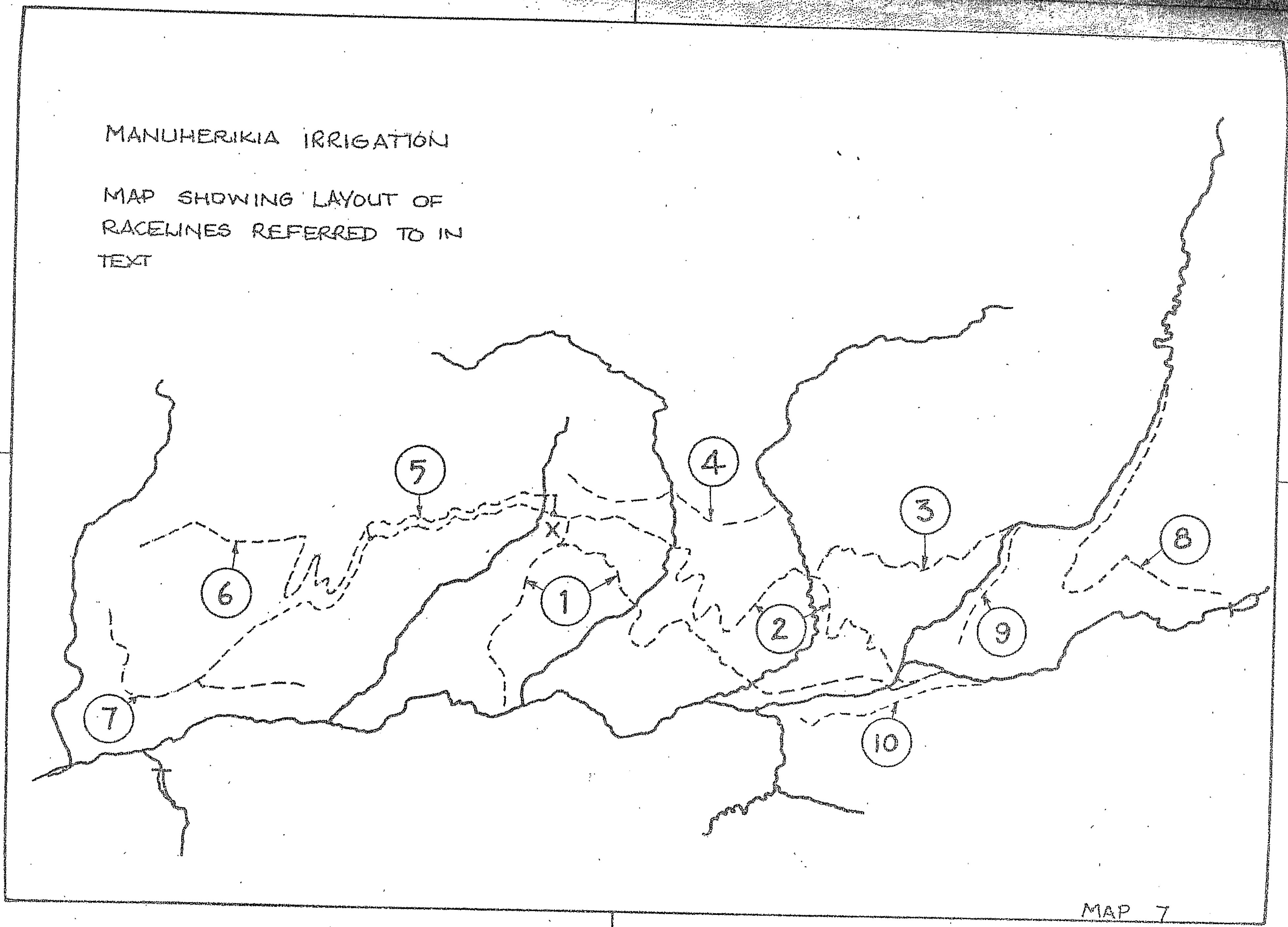
Map 7 shows in diagrammatic form the raceline alternatives which may be briefly commented on as follows:

The line indicated as (1) is the existing Omakau scheme main race and together with (3) Dunstan Race, (4) Matakanui and Lauder Creek systems and (10) Blackstone Hill Race form the present Omakau scheme. The Main Race (1), as previously described, draws supply from the Manuherikia and Falls, swings around the Omakau basin and bywashes just upstream of the Manuherikia Gorge. In passing the point X, which represents the position of the critical saddle over the rear of the Tiger Hills, it does actually command some of the Chatto Creek basin but not at a level high enough to be of use on the Moutere terraces. (3), the existing Dunstan Race, skirts the base of downlands below the Cambrian area and commands the Becks and middle Lauder Creek basins. The Devonshire (trib. Chatto), Lauder, Thomson-fed system shown collectively as (4) follows the base of the range and commands ridges and fans of high elevation.

The necessity to convey water to the Moutere area 7 at as high a level as possible and also farther to the Springvale-Alexandra-Clyde area commanded by (7) (and at present served at a lower level by the Manuherikia scheme), would require either a pump lift from the line of (1) or, more attractively, the avoidance of such a lift by the adoption of line (2). The exact level of (2) at X is difficult to determine in the absence of detailed survey, but would be of the order of 50-100' above the present level of (1) in that area.

The use of line (1) with a pump lift to (5) would of course mean the enlargement of the existing race on that line, and to do this to the standard required would involve virtual reconstruction and provide continuity-of-present-supply problems. This is discussed more fully elsewhere.

The precise line of (2) would also have an effect on the duty of (3), source - Dunstan Creek, and (4), source - West Bank tributaries, although study shows that this is not critical until (2) is positioned at a much lower level than shown in Map 7, even with no


MANUHERIKIA IRRIGATION
MAP SHOWING LAYOUT OF RACELINES REFERRED TO IN TEXT
1
2
3
4
5
6
7
8
9
10
X
MAP 7

W. 485

storage on the Dunstan (i.e. (3) operating as at present), and therefore the line of (2) is primarily governed by its required arrival level at X, and this in turn is determined by the requirements of (5), (6) and (7), bywash from (3) and (4) would be collected by (2), and (1) could be utilised, in part, as a distributary of (2).

The section indicated as (5) has been termed "Link" race for obvious reasons; it commands very little irrigable areas that are not commanded by other races and along its full length from "X"; Devonshire Road to the Kilmarnock area passes through fairly dissected country, being the gullies contributing to Chatto Creek.

Two lines have been shown on the diagram under (5) and the choice of these alternatives depends largely on whether (7) is to be supplied by this route at all, and upon further detailed study of the topography.

(6) serves the Moutere terraces and this area would be partly served by a pump lift, while the Clyde area could also be served down the Waikerikeri valley from a lower (6) without pumping.

(7) in effect covers the same area as the Manuherikia Scheme but omits the present headworks of that scheme, and by being supplied over 40 km as part of the larger system could still be a better proposition than endeavouring to upgrade the headworks and Chatto Creek to Springvale sections of race on the existing Manuherikia Scheme.

Reference to Table VI will show rounded estimates or irrigable areas under the races outlined above. (9) and (10) are considered to remain "as is", being isolated in terms of what has been discussed above.

Line (8) is offered as an alternative to expensive storage of Dunstan and would instead transfer Dunstan "out-of-season" water to top up a fully developed Falls site, thus increasing the estimated safe yield by a significant amount (see 3.6).

5.2 Comparison of Alternatives - Formulation of a Scheme

In preparing cost estimates to compare the various possibilities, the main considerations affecting distribution costs (i.e. race costs) are those of topography and standards of access to the completed works which must be capable of being maintained by machine. Structures such as weirs, drops and distributors are included for in general rates as outlined in Appendix E.

AREAS UNDER RACES

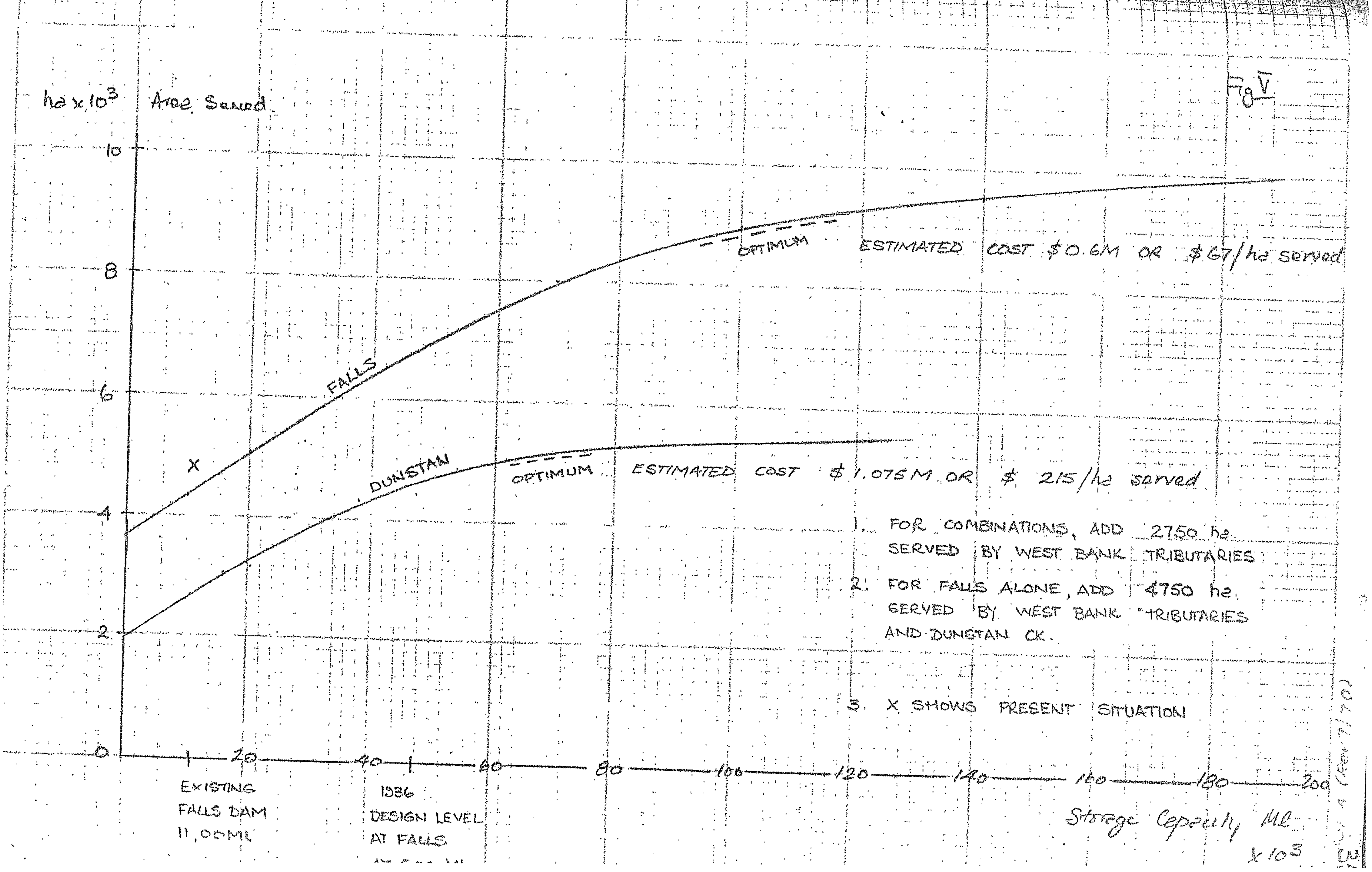
Table VI

Refer to Map 7 for race lines.

Race No.	Description	Total Area Commanded	Estimated Irrigable Area	% of Total	Proposed Area Irrigat
1.	Omakau Main Race (existing)	8000	7000	87	-
2.	Possible Higher Main Race	11000	9000	82	6300
		(includes areas shown under 1)			
3.	Dunstan Race	2800	2400	87	700
4.	Matakanui and Lauder Ck System	1400	800	57	600
5.	Link Race	-	1000	-	300
6.	Moutere-Waikerikeri Race	11200	5600	50	4700
7.	Alexandra Race	3700	2900	78	2800
8.	Falls Link Race (off season only)	N/A	N/A	-	N/A
9.	Downs Settlement Race (existing)	1000	700	70	600
10.	Blackstone Hill Race (existing)	1000	700	70	500
		Totals -	30,100 ha.		16,500 ha.

Note: "Irrigable" estimated on both soils and engineering basis.

STORAGE CAPACITY VS. AREA SERVED



Reference to Fig. V shows the areas served (at 14.6 Ml/ha) by the two main possible sites.

Making optimum use of the Falls site involves adopting a TWL of 1950' (200' height) and the construction of a low dam on the saddle. This provides a safe yield to serve 9 000 ha. A further 2 750 ha can be served by the run of the west bank tributaries, and an additional 2 000 ha from the run of Dunstan Creek.

From:	Falls optimum storage	9 000 ha
	West bank tributaries	2 750 ha
	Run of Dunstan Creek	2 000 ha
		13 750 ha served.

However, were both dam sites utilised to their optimum, then the areas which could be served would be:

			per hectare storage cost ratio
From:	Falls optimum storage (200')	9 000 ha	1
	West bank tributaries	2 750 ha	N/A
	Dunstan optimum storage (215')	5 000 ha	3
		16 750 ha served.	

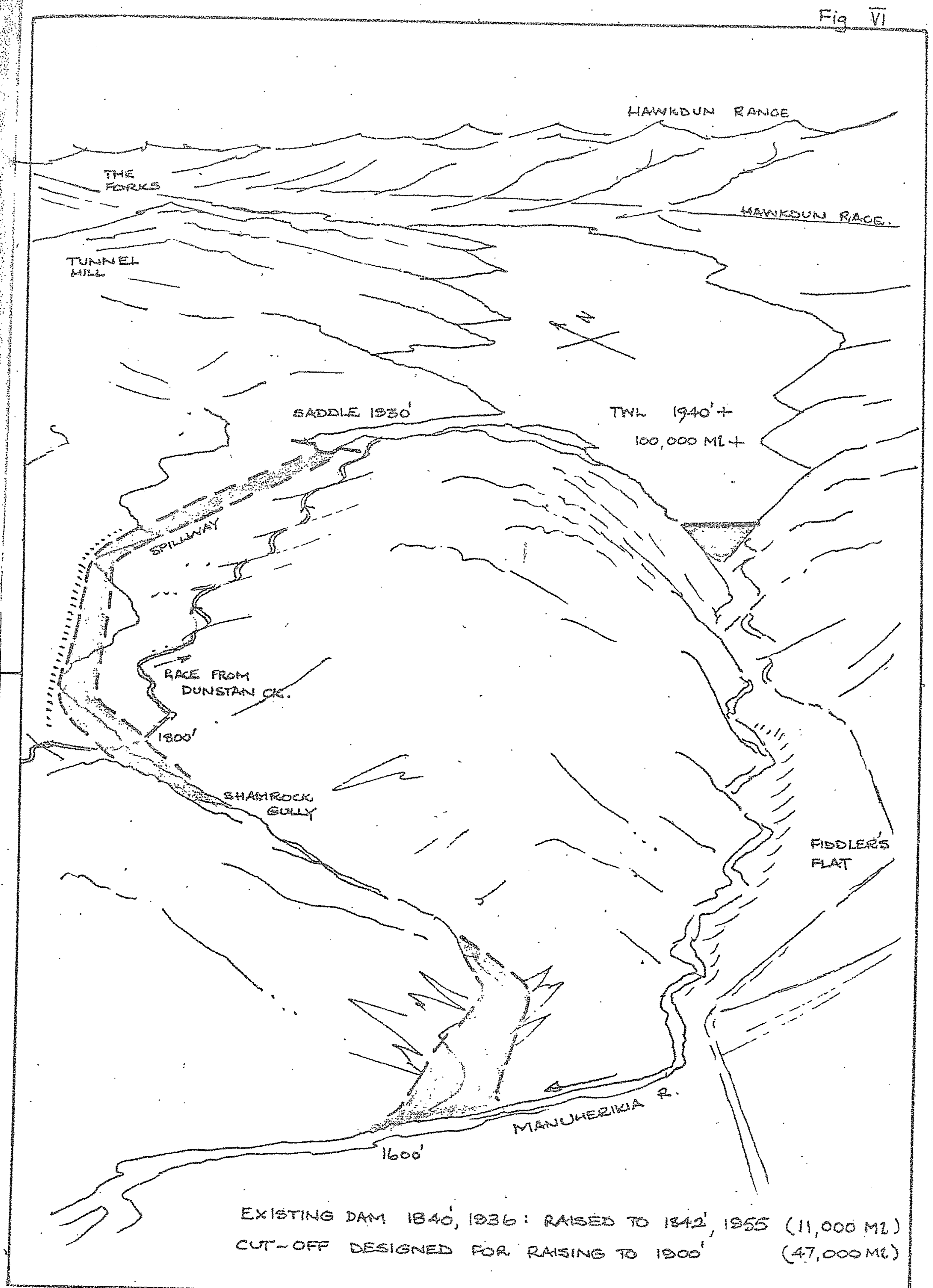
This latter figure of 16 750 ha represents the "ultimate" in irrigation for the valley as a whole (and represents approximately double the area which can be efficiently irraged at present.

The small storage sites possible at Pennyweight, at Cambrian and at Thomsons, all show capital costs many times in excess of the per-hectare-served cost of a high Falls dam and are clearly dismissable as uneconomic (refer to Appendix E).

The areas quoted as being served by the run of Dunstan Creek and of the West bank tributaries have been calculated from the 200-day season yield of these components, but do not represent the areas that can safely be irrigated by systems (3) and (4) above the main race (2). The areas commanded by (3) and (4) but above (2) which can safely be irrigated by Dunstan, Lauder and Thomson Creeks will be determined both by the low flow characteristics of those streams and by the requirements of the Downs area (9), and will therefore in practice not be a great deal in excess of the areas at present irrigated by (3) and (4) but above (1), the existing Omakau main race.

It is, however, quite valid to allow much greater total "areas served" (200-day yield) by (3) and (4) provided that the balance is commanded by races which are also supplied from storage (Falls), i.e. (2), (5), (7) etc., and which would

Fig VI



FALLS RESERVOIR
AS PROPOSED N.T.S.

1113.

This in effect means that (3) and (4) would be providing a great deal of bywash into (2) at all times except for periods of low flow.

To irrigate 13,750 ha. throughout the length of the valley with Falls - only storage would incur an estimated capital cost (off farm).

Falls Storage 1950'	$0.6M	
Distribution (approx.)	$4.0M	
(a)	$4.6M	or $335/ha.

To irrigate 16,750 ha. throughout the length of the valley with Falls and Dunstan storage:-

Falls storage	(200')	$0.600M	
Dunstan storage	(215')	$1.075M	
Distribution		$4,630M	
(b)		$6.305M	or $377/ha.

It is, however, possible to irrigate 16,500 ha. by dispensing with Storage in Dunstan Creek and constructing a race from the Dunstan to Falls to allow "topping-up" during the off-season (Map 7, Race No. 8) Capital cost is thus:-

Falls Storage (200')	$0.600M	
Race No. 8	$0.700M	
Distribution	$4.630M	
(c)	$5.903M	or 360/ha.

Race No. 8 would be in part through difficult scree country and of the three alternative routes investigated, the longest (around Gidding Downs) would appear to be the cheapest, however the possibility of a drive in the vicinity of St. Bathans need not be discounted. Further investigations of a detailed nature could well reduce the generous estimate figure. Some 45 000 Ml could be conveyed to Falls in the off-season.

Of the three basic alternative schemes, (c) is considered to be the most economical basis for development of the full resource, serving only 750 ha. less than the "ultimate" at a cost of $17/ha. less than the two-reservoir alternative (b).

To irrigate an area intermediate between 13,750 and 16,500 ha. would involve an off-farm per hectare cost in excess of $370, and while schemes of lesser extent than 13,750 ha. could be devised to give a per hectare cost of less than $300, a great deal of the total resource would be wasted.

It is therefore recommended that a more detailed investigation of a (c) type proposal be authorised. This scheme would consist of all the basic systems numbered 2-10 on Map 7 and would utilise the full resource as far as is reasonably economic.

Table VI (page 34) shows the areas which would be irrigated under such a scheme.

5.3 Brief Economics

It is considered that a scheme showing an off-farm capital cost of $300/ha. would most probably be an economic proposal for this area; and to this extent it appears that the $360/ha. estimated cost for the 16,500 ha. proposal is much too high.

However, it is increasingly apparent that both the Omakau and Manuherikia schemes as they are operated at present would require a substantial injection of capital to keep them both operational, in particular the latter has serious headworks problems, which are fully outlined in the 1967 report by Mr Bolt,[13] which forms Appendix F of this report.

An estimated expenditure of $1,000,000 is considered necessary to put these two schemes "on their feet" to modern standards. It is suggested that this sum, or at very least, a sizeable proportion of it is therefore "creditable" to any new proposals.

For example accrediting $0.8M would reduce off-farm capital costs of the large proposal to $5.13M or $310/ha. The proposal, of course, involves the abandonment of the Manuherikia scheme headworks and a large proportion of the main race, using some of the remnants as the basis for the distribution system (7).

6. DISCUSSION:

6.1 Other Uses

No conflict of usage is conceivable at this stage as the only possible uses in the valley apart from irrigation are for public supply, stock-water and for the proposed Omakau Freezing Works. The Manuherikia River will not be affected by any of the Clutha Power Development proposals at present being investigated.

6.1.1 Galloway Scheme

No reference to the Galloway Scheme, as existing, has been made in any of the previous discussions or tables of areas served, etc. It is considered that should the Galloway Scheme continue to function as at present, with pumping from the Manuherikia serving part of the area only, then needs can be met by return flow and bywash from any scheme of the scale proposed in 5.2 together with Poolburn flows (which were not included in the calculations), although return-flows under more efficient application would probably be less than the present 15% reported by Hamilton.

However, in order to relieve pressure on the Manorburn-Poolburn-Ida Valley System, an extension to make the whole Galloway System pumped (from the Manuherikia) could prove economic and would do away with the need for any water to be transferred from the Ida Valley system. This would of course, increase the demand on the lower Manuherikia and could require the west-bank area to be reduced slightly. This suggestion would require careful study, and would involve the Galloway area becoming part of the "greater Manuherikia" scheme for both operational and administration purposes.

Recreational use of the Lower Manorburn Weir, for winter sports would not be affected.

6.1.2 Hawkdun Scheme Diversions

The Hawkdun race (ref. map 4), as operated at present, provides an essential service outside this catchment and by doing such cannot be scrapped. The water removed would represent an additional 250 ha. irrigation within the Manuherikia Valley.

A possible additional transfer could be the provision of a piped rural water supply scheme (stock water only) to the upper Ida Valley and beyond. This would involve a pump lift of some 475' from Falls, but the withdrawal involved would only marginally affect irrigation in the Manuherikia.

6.1.3 Proposed Omakau Freezing Works

A feasability study is at present being conducted by a private company as to the establishment of a freezing facility at Omakau. This establishment would interact with irrigation development through water requirement, effluent disposal problems and increase in production.

The fresh water requirement of this type of works would be of the order of 60 l/sec, which during the irrigation season would represent an equivalent area irrigated amounting to only 70 ha. and which could be withdrawn from the Manuherikia without requiring any discharge from Falls Dam (i.e. with no effect).

However, the effluent disposal problem of such a works would be a serious competitor if treatment and dilution with river water were required It is understood that alternative disposal by spraying is being investigated.

6.1.4 Domestic and Stockwater Supply

The Borough of Alexandra is supplied by bores in the township, but numerous irrigators throughout the valley use race-water to supplement domestic rain-water systems.

The stockwater requirements of most irrigated properties are provided largely by irrigation facilities, but some property-owners, and particularly those not served by the present schemes, operate stockwater facilities on private water rights, and in some areas competition for water between various properties is intense.

The demand which could be imposed by public supply in the townships and for possible rural water supply schemes in the future is fairly insignificant when measured against the quantities required for irrigation, but must nevertheless be considered a usage of higher priority. With the tendency towards beef raising, a closer look may have to be taken at stock water distribution systems, in certain areas, as a parallel to automatic irrigation systems.

6.1.5 Water Rights

Should a large irrigation development take place, it would be both convenient and advisable for certain privately held rights to be surrendered and transferred to the Crown. This applies in particular on the west bank tributaries where operation at low flows would be critical. Inclusion of such rights within the scheme would lead to the most efficient use of the resource.

6.1.6 Electrical Power Generation

The incorporation of a small generation facility with the main storage unit would be almost ruled out due to the variability of head if the reservoir were to be operated primarily for irrigation purposes. There are no other major sites.

6.2 Environmental Considerations

Modification of river flow patterns due to storage and diversions as proposed would lead to changes both in reduction of the effect of flood peaks and in re-distributing annual variations in the Manuherikia itself. The west bank tributaries and Dunstan Creek would be more fully utilised and to this extent under low flow conditions would be very low between intakes and their confluences with the Manuherikia. "Minimum" flows, as stipulated in the Act, would have to be set for all the major water-courses, but it is envisaged that the proposals outlined would be compatible with any minima provisions enforced.

The effects of raising Falls reservoir would be of a greater magnitude than the original raising but of no greater impact. Loss of production due to flooded areas would be marginal when compared with downstream benefits and would not result in the serious disruption of any units. The type of country involved is rough pasture and tussock and while of gentle slope towards the north end of the reservoir would be steep enough on some terraces closer to the retaining structure for some scars and slips to appear. There is every possibility of an improved water-bird habitat.

Other major impacts would be the increased stocking and productivity which would have secondary effects on farm service industries, increased transport system usage as well as direct effects on farm management as a whole.

The valley would be appreciably greener.

7. SUMMARY AND RECOMMENDATIONS

At present some 13 000 ha are under irrigation on the banks of the Manuherikia, excluding the Galloway scheme. However, a large portion of this is irrigated on a "partial" basis only. This is achieved by a number of small and medium-sized schemes operating on a run-of-the river basis with additional small storage at Falls reservoir (11,000 Ml). Further development is limited by lack of storage.

It is possible to irrigate 16 500 ha for production with the resource available and this would require the construction of a 100,000 Ml-plus storage unit at the Falls site. A 200' high structure could be erected just downstream of the existing small dam, and winter flows in Dunstan Ck could be diverted and conveyed to this new reservoir. The valley would be served by the construction of an extensive distribution system a levels higher than, and involving partial abandonment of, existing systems, and would irrigate the best soils through the length of the valley from Cambrians to Clyde, including Moutere.

The proposal is likely to be economic only if the large amount of capital expenditure which is considered necessary to keep the existing Manuherikia and Omakau schemes running is credited to future development.

This sum is at least $1,000,000 and would largely be incurred on the delapidated Manuherikia Scheme headworks, which would be abondoned.

Storage in the Dunstan Ck Catchment, where the only other major site exists, would cost about three times (per hectare served) the proposed Falls Unit and has not been considered further, but the Dunstan to Falls diversion race would achieve almost the same effect at a much lesser cost and is clearly the best proposal to utilise the resource provided by the two main supply sub-catchments to anything like the full extent.

The off-farm capital cost of such a scheme is estimated to total $5.9 million or $360 per hectare served. This total may be reduced by $1 million, as mentioned previously and thus brings the proposal into a more economically favourable light.

Other demands for water in the valley are light, but may be of higher priority. The proposed Omakau freezing works could be supplied with marginal effect on irrigation, provided treatment and dilution of waste effluent is not required.

It is therefore recommended that a more detailed engineering and economic investigation of the following courses of action be proceeded with:-

1. The proposal to construct a scheme to irrigate 16,500 ha in the Manuherikia, involving large storage at the Falls site, transfer of off-season run-offs from Dunstan Ck to this reservoir, and an extensive distribution system abandoning certain assets of the existing smaller schemes.

2. Amendment to the Galloway Scheme to provide for a greater proportion of supply to be drawn from the Manuherikia, thus permitting the Ida Valley to be more fully supplied from Manorburn and Poolburn reservoirs.

3. Construction of a piped rural water supply scheme supplied by pump lift from the Upper Manuherikia.

Detailed investigation would involve the extension of the present programme of hydrological observations, aerial and ground survey to establish racelines at critical locations, and additional design to arrive at firm engineering estimates, including for on-farm development.

The following points will require clarification:-

(a) Definition of "minimum flows" under the Water and Soil Conservation Act.

(b) The future of piped rural water supplies both within and without the area of irrigation interest.

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DUNEDIN.

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18.1.74

APPENDICES

APPENDIX A-REFERENCESAND ACKNOWLEDGEMENT

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9. – Manuherikia Irrigation Investigations of further modifications to Falls Dam. P.W. 15/43 (25.11.64) (M.R. Bolt)

10. P.W.D. Files 33/2, 15/24 various correspondence and reports relating to Matakanui and Omakau Schemes. Also contain some hydrological data, 1920 onwards. Summaries prepared in each file.

11. – Engineering Reassessment, Manuherikia Scheme. M.O.W. Alexandra (M.E. Hely) October 1971.

12. – Engineering Reassessment, Omakau Scheme. M.O.W. Alexandra (M.E. Hely) June 1971

13. - Manuherikia Irrigation Scheme. Main Intake and Gorge Section. M.O.W., Dunedin. P.W. 15/3/2 (M.R. Bolt) (Attached as Appendix F).

14. P.W.D. Files 15/16 interesting hydrological data. 1920 onwards.

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I.M.B.