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Water Resources Commission

of New South Wales

Lake Mejum Storage Proposals

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WATER RESOURCES COMMISSION OF NEW SOUTH WALES

LAKE MEJUM STORAGE PROPOSALS

DECEMBER, 1980.

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FOREWORD

The information contained in this report represents the present stage of development of the Lake Mejum Storage Scheme. Indications to date are that an attractive project to increase the regulated water supplies available in the Murrumbidgee Valley can be implemented at Lake Mejum. The method by which this can best be achieved depends upon the relative importance given to the objectives of economic efficiency, environmental quality and social wellbeing. In the main, the economic benefits stem from irrigation and from the recreational use of the storage.

So that the Commission may properly evaluate the project, this report is being distributed to public authorities, water user associations, conservation groups, aquatic sporting bodies and interested individuals for comment. All comments are sought before the 30th April, 1981 and should be addressed to:

The Secretary,
Water Resources Commission,
Post Office Box 952,
NORTH SYDNEY.
N.S.W. 2060.

LAKE MEJUM STORAGE PROPOSALS

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1. INTRODUCTION

The stage has now been reached in the investigations of the Lake Mejum Storage Project where estimates of the costs and benefits of the most favourable arrangements have been prepared and assessments of their economic and environmental merit have been undertaken. The results of these studies and discussion of their implications are presented in this report.

In June, 1978 the Minister for Water Resources announced that the Water Resources Commission would concentrate further investigations for the project on a Scheme based on pumping water from Bundidgerry Creek. This decision was taken in view of the high cost and questionable viability of the original proposal for gravitating water to Lake Mejum.

In proceeding with these additional studies, the Commission undertook to make available information on the scope and feasibility of both the gravity and pumping schemes. This report is being distributed to public authorities, water user organisations, conservation groups, aquatic sporting bodies and individuals with an interest in the Scheme for consideration and comment.

This report makes it possible for the community generally to be involved in this decision process. The Commission welcomes the expression of views and interests and it will ensure that they receive due consideration in the more detailed development of the scheme and the preparation of an environmental impact statement which is to follow.

2. DESCRIPTION OF PROPOSALS

The Mejum Lakes comprise a series of natural depressions at the southern end of the Narrandera Range, a short distance north of the town of Narrandera. The location of the Lakes within the Murrumbidgee River Valley is shown on Figure 1.

The Lakes comprise four basins separated by low ridges. The basins are: Lake Coolah, Mejum Swamp, Thompsons Lagoon and an unnamed very large and shallow depression north-east of Mejum Swamp designated Lake Mejum. The location of these basins are shown on Figure 2. Various storage combinations are possible utilising these depressions.

The concept of the Lake Mejum Scheme is based on the utilisation of water derived by diversion to the lakes of surplus Murrumbidgee River flows arising from spills from other storages, contributions from downstream tributaries, over-supply and irrigation cut-backs. Additionally the presence of a large body of water in close proximity to the centre of demand will further increase the efficiency of utilisation of the present resources of the Murrumbidgee River.

3. STATEMENT OF OBJECTIVES

Because of the complexity and variety of technical, social and environmental issues raised by the Lake Mejum Storage Proposal a multi-objective approach has been adopted in the planning of the project. The objectives of economic efficiency, environmental quality and social welfare are an integral part of the analysis.

The main purpose of the Lake Mejum Storage Proposal is to provide an improvement in the regulation of the flow of the Murrumbidgee River in order to augment the volume of water available for irrigation purposes.

In close proximity to Narrandera the storage will be a tourist attraction and a recreational focal point for water sports such as motor boating, swimming, and more passive pursuits. This development is in line with Commission policy of promoting the most effective use of facilities at its water storages throughout the State.

4. REQUIREMENT FOR AUGMENTATION OF IRRIGATION SUPPLY

Commitment of the regulated flow now available in the Murrumbidgee River system has reached the stage at which plans need to be prepared for the development of the next major storage on the system, if appreciable further irrigation is to be possible.

Significant increases have been evident in the volume of water used in the Murrumbidgee Areas and Districts, resulting in part from progressive adaption to shifts in costs and prices within the rural sector but most particularly from the response to most favourable rice marketing trends. Further substantial increases in the demand for water could be expected if the rate of growth of private licensed irrigation experienced in recent years were to continue. However, to ensure an equitable distribution of currently available resources, the Commission has had to place an embargo on the issue of additional irrigation licenses. A volumetric allocation system for irrigators in the Murrumbidgee Valley is being developed to more effectively use the present limited water resources.

The completion of the Tombullen Storage and the Hay Weir project will improve the situation and will permit the necessary lead time for planning and development of the next major storage in the Murrumbidgee Valley. The analysis presented in this report assumes that the Lake Mejum project will be implemented at a time such that the further irrigation development which it will allow will follow closely upon the completion of the works.

5. ALTERNATIVES CONSIDERED TO PROVIDE AUGMENTATION

The decision to intensify investigations of the Lake Mejum Storage was made after examination of a number of other alternatives available to supplement the supply available in the Murrumbidgee System.

Earlier work included consideration of alternative head-water storages. The introduction of the concept of pumping water to Lake Mejum invited consideration of pumping from the groundwater reservoir as an option when comparing proposals for supplementing irrigation supplies.

Additional Headwater Storages

Preliminary investigations of some fourteen dam sites, additional to the proposed Lake Mejum Scheme show that all alternatives would be considerably more costly than the Lake Mejum Scheme. The most favourable of these dams on economic grounds are at the Oura and Mingaye sites, (see Figure 1) upstream of Wagga and Gundagai on the Murrumbidgee River. Water supplied by either dam would however be several times the cost of Lake Mejum water.

Very detailed engineering, economic and environmental studies would be needed before a firm proposal on any of these dam sites could be put to the Government for consideration.

Groundwater Potential

In the Murrumbidgee Valley there are large quantities of good quality groundwater in unconsolidated alluvial formations, mostly in deep zones of waterbearing sands and gravels. The Commission has undertaken exploratory drilling and now has a reasonably good knowledge of the extent of the good quality water.

Investigation of a scheme for the conceptual development of a groundwater pumping field instead of the Lake Mejum project but with the same water output as Lake Mejum indicates that such a scheme would offer no cost advantages, but rather would present a number of technical difficulties which could not be resolved in the short term. One of the less desirable aspects of the scheme is the variability of pumping operations. Annual electrical energy charges for groundwater pumping could range up to 6 times that of the average annual energy charges for Lake Mejum.

Utilisation of the groundwater resources of the Murrumbidgee Valley is seen as a progressive post-Mejum development rather than a viable short-term alternative.

6. COMPARISON OF BASIC GRAVITY AND PUMPING SCHEMES

The decision taken in 1978 to concentrate investigations on a less costly pumping scheme was taken following comparison of basic pumping and gravity schemes.

The layout of the works for each basic scheme and their relationship to existing features are shown in Figure 2. Table A-1 in Appendix A allows a ready comparison of essential features of the alternative proposals.

(a) The Gravity Scheme

The gravity scheme is designed to utilise the full storage potential of the Mejum Lakes. Through construction of a diversion weir on the Murrumbidgee River near Mundowy, flows would be directed into the storage through an intake canal entering in the vicinity of Thompsons Lagoon. Discharge of water from the storage would be by a delivery canal, commencing at the western end of Lake Coolah and leading into the Murrumbidgee Irrigation Area Main Canal. Roach's Escape would permit discharge of water from Lake Mejum Storage to the Murrumbidgee River as required.

Based on 1978 costs of $60 million and a yield of 250 000 megalitres per annum, the capital cost per megalitre of water yield is $240. In 1980 money values, the cost would be $75 million or $295 per megalitre of yield.

Quite apart from the high capital costs of development, a number of problems are associated with the long intake canal route. These include permeable soils, rock excavation, high embankments, major-cross drainage structures and the severance of the village of Currawarna and many properties.

(b) The Basic Pumping Scheme

Following the large rise in estimated costs for the gravity scheme, a feasibility study of a low cost pumping scheme was begun by the Commission in early 1978. Preliminary designs and costs were developed for a number of pumping schemes having a range of pumping, storage and outlet canal capacities for which the most effective basic pumping scheme was selected.

In general terms, all elements of the gravity scheme, modified where appropriate for capacity changes, were retained in the basic pumping scheme, with the exception of the intake canal. To utilise the potential storage area, advantage would be taken of a pool in Bundidgerry Creek (M.I.A. Main Canal) formed by the Bundidgerry Regulator, just upstream of Narrandera. From this pool, water would be directed into the storage by an intake canal. The canal would follow a generally northern route, and enter the storage at the south-eastern corner of Lake Coolah, via an intermediate pumping station.

Based on 1978 costs of $20 million and a yield of 200 000 ML/annum, the capital cost per megalitre of yield was assessed at $100. Adjusted for an average annual electrical energy change of $450 000 the equivalent capital cost per megalitre of yield increases to $120.

7. THE RECOMMENDED LAKE MEJUM PUMPING SCHEME OPTIONS

In view of the foregoing preliminary results, more detailed investigations were undertaken into possible pumping schemes. Variations to the basic scheme referred to in Section 6(b) were investigated in respect of their relative environmental impacts and economic cost for benefits generated. Particular significance was attached to the possible displacement of landholders, environmental consequences of drowning Mejum Swamp, water quality and circulation patterns and the creation of permanent recreation areas within the storage.

During the final analysis some thirteen different project layouts ranging in cost from $22.9 to $30.7 million (in December, 1980 values) were assessed, of which three schemes were considered suitable for examination in greater detail. These schemes were selected to best meet the following specific objectives:-

(a) least cost,
(b) recreational value,
(c) environmental quality.

Physical details of the schemes are set out in this Section and illustrated in Figures 3, 4 and 5 and designated Options 'A', 'B' and 'C'. Yield, economic, recreational and environmental considerations for each of the three schemes are described later in this Report. Each of the proposed schemes includes a recreational storage component, but the recreational amenity is maximised in Option 'B'.

It should be stressed that these three options illustrate the range of alternatives available for the proposed Lake Mejum en-route storage. A final decision by the Commission on the most favourable project suitable for submission to the Government will be taken after full consideration and assessment of the public comments and submissions received. At this stage however, the Commission favours the least cost option on the basis of maximising the cost-effectiveness of the limited funds available for water resources projects.

Option 'A': Least-Cost

The least-cost objective was satisfied by determining the arrangement having the least cost per unit of yield generated. Considerable cost savings were achieved by utilising a combined inlet/outlet canal to service the storage.

The main components of this scheme are a 450 000 megalitre storage within the four large depressions serviced by a combined inlet/outlet canal, 9 kilometres in length and capable of carrying water at a rate of 2800 megalitres per day from Bundidgerry Creek via an intermediate pumping station to Lake Coolah. Water released from the storage would gravitate along the same route bypassing the pumping units. Aquatic recreation has been catered for by reserving a minimum volume of 50 000 megalitres in the bed of Lake Coolah some 7 metres below top water level.

Lake Coolah has been selected as the recreational lake over Mejum Swamp which was suggested in earlier approaches to the Commission. The selection of Lake Coolah was made mainly on cost and environmental considerations. To use Mejum Swamp for recreation would require extensive clearing from the lake of trees which are seen as a fish and bird habitat.

The layout of the proposed works and their relationship to existing features are shown in Figure 3, whilst Table A-2 of Appendix A provides relevant statistics of the scheme.

The capital cost of this proposal is estimated at $22.9 million. A schedule of comparative costs is provided in Table A-3 of Appendix A.

From an environmental viewpoint, the combined inlet/outlet canal would create least disturbance to the environment. However environmental loss would be occasioned by the drowning of Mejum Swamp with consequent loss of this wildlife habitat.

Option 'B': Recreational Considerations

To achieve a most suitable year-long recreation lake, it is desirable to maintain water at a permanent level. This objective was satisfied by selecting a recreation storage site, independent of the main Lake Mejum Storage, south of Lake Coolah in the depression at Clifton Station. A recreation storage of up to 50 000 megalitres capacity and surface area 660 hectares would be created with a permanent water level equivalent to the top water level of the main storage.

Other principal features include a 450 000 megalitre storage within the four large depressions and separate inlet and outlet canals, each of capacity 2800 megalitres per day to deliver water to and from the main storage. Additionally, a control structure of capacity 2800 megalitres per day would regulate the flow of water between the recreation storage and the main Lake Mejum storage.

The different components and relevent statistics of the proposal are illustrated on Figure 4 and in Table A-2 of Appendix A.

The capital cost of this scheme is estimated at $27.9 million, including some $3 million for the recreation storage. A schedule of comparative costs is included in Table A-3 of Appendix A.

From an environmental viewpoint the location of the inlet and outlet canals allows a measure of water circulation through the recreation storage and the storage in Lake Coolah. However construction of two canals would cause greater disturbance to existing holdings and Mejum Swamp again would be inundated.

With the creation of an independent recreation storage, the recreational objective is satisfied leaving the main Lake Mejum storage to accomplish its operational role in servicing the M.I.A. and other water users in the Murrumbidgee River system.

Option 'C': Enviornmental Quality

Recent fauna surveys have recognised that Mejum Swamp is a valuable waterbird habitat in the Riverina Region. Any decision to flood the Swamp would destroy this habitat causing existing wildlife to vacate the area. However a suitable option can be developed to overcome this adverse enviornmental impact - namely containing total storage in Lake Coolah alone. Such a scheme is illustrated on Figure 5.

The necessary embankment between Lake Coolah and Mejum Swamp provides the only real opportunity to reduce the number of landholders directly affected by inundation. Under Options 'A' and 'B' up to 20 properties would have to be acquired for the storage basin. In Option 'C' this would be reduced to 10 thereby preserving the social environment to a greater degree.

The main component of this scheme is a 450 000 megalitres storage with a top water level 5.5 metres higher than in Options 'A' and 'B'. This storage is serviced by a combined inlet/outlet canal, 9 kilometres in length and capable of carrying water at a rate of 2800 megalitres per day from Bundidgerry Creeek via an intermediate pumping station to Lake Coolah as in Option'A'. Aquatic recreation has been catered for by reserving a minimum volume of 50 000 megalitres in the bed of Lake Coolah some 13 metres below top water level. Table A2 in Appendix A details further statistics of this proposal.

The estimated capital cost of this scheme, including provision for recreation facilities is $26.6 million. A schedule of comparative costs is included in Table A-3 of Appendix A.

Implementation of this scheme would ensure an environmentally sound project, highlighted by greater conservation of the social and natural environment. Mejum Swamp would remain essentially in its natural state and disturbance would be minimised through provision of a combined inlet/outlet canal and inundation of only Lake Coolah. Relative to Option'A', this scheme would be less satisfactory in servicing the demand for aquatic based recreation and tourism, which carries a significant portion of the project benefits. This is mainly because of the greater fluctuation in the water level, (see Table A-2 of Appendix A).

Other Alternative Schemes

In all, thirteen different project configurations were assessed before the three options presented in this report were selected. Among these consideration was given to a layout involving the construction of an embankment to prevent inundation of properties in the most northerly lake (Lake Mejum). However the cost of this embankment was estimated at several orders of magnitude greater than the value of the properties saved from flooding.

Similarly a scheme representing a combination of Options 'B' and'C' a recreational lake located south of a "Lake Coolah Only" storage was also investigated and found to be not as beneficial as the configurations presented in this report.

8. WATER YIELD STUDIES

Computer based simulation studies utilising monthly data over the period 1890 to 1979, were undertaken for each storage configuration, particular attention being paid to operational losses resulting from rain rejection and over ordering. The original gravity scheme was also re-assessed for comparison purposes.

The performance of each configuration was assessed by determining the increase in average annual supply relative to the present (no Mejum) situation. The study results provide for the development of additional yield without deterioration in the reliability of supply.

The yield results are set out in the Table below. These yields allow for a 50 000 megalitres recreation storage to be topped up from regulated flow. The yields were used in the economic evaluation of the project in Section 9. It is possible that the assessed yield could increase following the adoption of a volumetric allocation scheme for the Murrumbidgee River system.

YIELD RESULTS

Scheme	Storage Configuration	Storage Size (megalitres)	Increase in Average Annual Supply (megalitres)
Pumping Options			
Option A (Least cost)	4 Lakes	450 000	206 000
Option B (Recreation)	4 Lakes	450 000*	211 000
Option C (Environment)	Lake Coolah only	450 000	208 000
Gravity Scheme	4 Lakes	615 000	250 000

* Add independent 50 000 megalitre recreation storage.

A sensitivity analysis to test assumptions adopted in the studies indicates that:

(i) the difference in yields between the various options is mainly attributible to evaporation and seepage losses;

(ii) the effect of reserving a 50 000 megalitre recreation storage in Lake Coolah, topped up from regulated flow, is to

- reduce irrigation yields by up to 4% and
- increase pumping costs by 1% approximately.

9. PROJECT EVALUATION

Project Benefits

Irrigation Benefits

The marginal benefit per megalitre of yield of Lake Mejum water was determined - (i.e., the extra output, in dollar terms, obtainable from the addition of one megalitre of water, holding all other inputs constant). This figure of $18.80 per megalitre, which was applied to the water yield as part of the project evaluation, is after allowing $1.00 per megalitre for system distribution costs. The value was checked against likely representative irrigation crop mixes within and without the Irrigation Areas and no significant difference was found in the value of water.

Recreation Benefits

A recreation-tourist study of the Lake Mejum Storage proposal, involving a questionnaire and interview technique approach was undertaken to quantify the demand for these facilities. The questionnaires, designed to generate source data on the expected benefits of recreation-tourism, were distributed to aquatic clubs, local government authorities and Chambers of Commerce in the towns of Narrandera, Griffith, Leeton and Wagga Wagga.

Analysis of data provided by responses to the questionnaires enabled an aggregated recreational benefit, in monetary terms, to be derived.

The recreational benefits provided by these large inland lakes include sailing, power-boating, water skiing, canoeing, fishing, swimming as well as passive recreational pursuits such as camping, picnicking and bird-watching. In all some 200 000 visitors per annum are expected at the lakes.

Benefits would accrue not only to residents of Narrandera and regional sporting bodies but also to tourists who would seek to utilise the recreation and accommodation facilities which will follow once the tourist potential of the scheme is recognised.

Industrial Benefits

At the present time large scale industrial developments, using significant volumes of water, are not a major feature in towns in the Murrumbidgeee system. Nevertheless, several additional industrial water users were identified. Industrial benefits were allowed conservatively at the current value of water to irrigators and are therefore included in the summation of agricultural benefits.

Flood Mitigation Benefits

Based on an examination of behaviour analyses for Lake Mejum storage under a variety of conditions, the project will have no significant effects on medium and major floods. The possibility of providing flood mitigation "air-space" in Burrinjuck Dam was also examined . However the cost of loss of system yield far exceeds the value of any flood mitigation benefits derived. Consequently, flood mitigation benefits have not been quantified in the assessment of benefits.

Project Costs

Capital Costs

Capital costs vary depending on the type of scheme, either gravity or pumping and the combination of storage, inlet and outlet canals provided. Details are set out in Table A-3 of Appendix A.

Electrical Energy Costs

Based on advice from the Murrumbidgee County Council, annual electrical energy costs for pumping were estimated using standard tariffs of the Electricity Commission of N.S.W. plus a small margin to cover Council's requirements.

These costs ranged from $480 000 (Option A), $550 000 (Option B) to $620 000 (Option C) and represent an average cost per megalitre of water diverted to the Lake Mejum Storage of $1.85, $2.15 and $2.40 for the options A, B and C, or $2.30, $2.60 and $3.00 respectively per megalitre of increased system yield. The average electrical energy costs correspond to about 20 cents per megalitre of water available to irrigators when spread over the Murrumbidgee System.

As may be implied from the Storage Behaviour Diagram (See Figure 6), pumping costs are very variable from year to year, actual annual energy costs could vary from near zero to nearly twice these average costs.

Pumping costs increase from Option 'A', through Option'B' to Option 'C' principally because of the increasing head against which water must be pumped.

Other Operational and Maintenance Costs

In addition to electrical energy costs, operation and maintenance costs (including a component for amortization of pump and motor costs) amount to approximately $1.00 per megalitre of increased system yield.

Energy costs and other operation and maintenance costs are summarised in Table A-3 of Appendix A. Additionally this table shows total equivalent annual costs per megalitre of water yield.

Project Assessment Criteria

Five project evaluation criteria have been introduced into this analysis. These criteria are benefit-cost comparisons, revenue generation potential, operational procedures, regional multiplier impact and environmental and social quality. These criteria measure the degree to which the main objectives are satisfied. The aim is to promote that storage which has the most consistent support on all five criteria.

Benefit-Cost Comparisons

Results of analyses for internal rate of return and benefit-cost are set out hereunder.

INTERNAL RATE OF RETURN AND BENEFIT COST RATIOS

Scheme	Internal Rate of Return	Benefit Cost Ratios at Discount Rates of:- 10%	11%	12%
Gravity	5.7%	0.60	0.55	0.50
Pumping Options				
A (Least Cost)	14.5%	1.50	1.35	1.20
B (Recreation)	12.6%	1.25	1.15	1.05
C (Environment)	12.0%	1.20	1.10	1.00

The internal rate of return (IRR) is a discount rate which makes the present value of benefits equal to the present value of costs. For a commercial operation this would be equivalent to return on capital. The gravity scheme generated an IRR of 5.7 percent which is extremely low given the present financial market conditions. By comparison, pumping option 'A' had the highest IRR of 14.5 percent with options 'B' and 'C' having IRR's of 12.6 and 12.0 respectively. All these IRR's are acceptable in economic efficiency terms.

With the exception of the gravity scheme, all schemes have benefit-cost ratios equal to or greater than one for discount rates of 10, 11 and 12 percent. Option 'A' has the highest ratio of 1.50 at 10 percent. The benefit-cost ratio for the gravity scheme is only 0.6 at 10 percent.

Revenue Generation Potential

The criteria of revenue generation potential in no way implies any Commission policy on pricing. Real costs are explicitly identified and distributed according to proportional benefits generated. A different set of assumptions on distribution of costs would produce a different set of outcomes.

One of the implications arising from a project of this kind is the potential ability of beneficiaries to pay for part of the costs which are incurred. Multi-purpose schemes have the potential to distribute the cost over a greater number of beneficiaries than does a single purpose scheme. The following table shows for each of the three recommended pumping options, details of the costs allocated to irrigation and recreation-tourism respectively, when distributed in proportion to benefits.

REAL COST ALLOCATION AMONG BENEFICIARIES
(Calculated for an interest rate of 11% per annum and a repayment period of 50 years)

ITEM	SCHEME A	SCHEME B	SCHEME C
Agriculture ($/ML)*			
Capital Cost Component	0.93	1.12	1.13
Annual Cost Component	0.22	0.25	0.29
Total	1.15	1.37	1.42
Agriculture ($/ML)**			
Capital Cost Component	10.76	12.64	12.96
Annual Cost Component	2.58	2.84	3.30
Total	13.34	15.48	16.26
Recreation-Tourism ($/ML)**			
Capital Cost Component	1.45 ($2.00/visitor)	1.82 ($1.67/visitor)	1.16 ($2.42/visitor
Annual Cost Component	0.43 ($0.59/visitor)	0.43 ($0.40/visitor)	0.28 ($0.59/visitor)
Total	1.88 ($2.59/visitor)	2.25 ($2.07/visitor)	1.44 ($3.01/visitor)

* $/ML of total available water in Murrumbidgee Valley.
** $/ML of annual yield from Lake Mejum Scheme.

It may be seen from this table that Scheme 'A' is the most attractive from the point of view of agriculture. Scheme 'B' is the most effective from a recreational viewpoint.

Regional Impact

Investment in a region will have an impact on the regional economy by creating increased secondary spending, production and employment. This impact is called the multiplier effect. Beneficial economic impact on the Riverina Region has been estimated, at the 11 percent discount rate, to be $680 000, $720 000 and $630 000 per annum respectively for Options 'A', 'B' and 'C'. These figures represent $3.30, $3.40 and $3.00 per megalitre of annual water yield from the Lake Mejum Scheme.

Operational Procedures

Guidelines for storage operation need to recognise the multi-purpose function of the storage.

It is expected that there will be a significant demand for aquatic based recreation and recreation-tourism benefits have been assessed at up to 25 percent of total benefits.

To serve irrigation needs, the storage will be drawn down during the main growing season in summer This may be in conflict with recreation-tourism objectives for which a relatively stable water level is preferred. Water levels may fluctuate by up to 13 metres for Option 'C' and by 7 metres for Option 'A'. The relatively constant water level in the recreational lake of Option 'B' best satisfies recreation-tourism needs.

Depending on the pumping option adopted, the Lake Mejum storage could have a comparatively large surface area to volume ratio (up to 9700 hectare surface area for 450 000 megalitres volume at the projected top water level of R.L. 160.48 metres). In these circumstances evaporation losses will be high if the storage is maintained in a full condition. Therefore to minimise these evaporation and possible seepage losses, the water contained in the storage will be released for use downstream as early in each irrigation season as practicable, depending upon demand.

There may be rare occasions when the 50 000 megalitre recreation storage of Schemes 'A' and 'C' would in part be called upon to meet demand for water. In those cases, regulated flow would be used to top up the recreation storage as quickly as possible. The recreation storage of option 'B' is less able to respond rapidly to shortfalls in supply.

A typical behaviour diagram, Figure 6, shows the behaviour of the Lake Mejum pumping scheme based on records of flow in the Murrumbidgee River from 1890 to 1979 inclusive.

Environmental and Social Quality

The first Environmental Study Report on the Lake Mejum gravity scheme was released in January 1978 and it is expected that a revised report in the form of an Environmental Impact Statement incorporating details of the preferred pumping option should be available in late 1981.

Although the initial studies based on the gravity scheme encompassed a much broader area, the majority of identified environmental impacts are seen to be common to the current pumping proposals.

In terms of the natural environment, the major impact is the flooding of Mejum Swamp if Options 'A' or 'B' were to be adopted. A study undertaken by a consultant biologist for the Commission has shown that Mejum Swamp provides an important regional habitat for waterbirds in respect of both feeding and breeding.

It is also possible that changes to the Murrumbidgee flow regime will affect wildlife habitat in billabongs downstream of Darlington Point. The Commission is investigating the feasibility and likely benefits of artificially prolonging flooding of the billabong system to create a flooding pattern more similar to the natural system, which would have prevailed prior to regulation of flows in the Murrumbidgee River system.

With regard to fish life, the New South Wales State Fisheries has expressed interest in stocking a water storage in the vicinity of its Research Station at Narrandera. It is currently undertaking studies of Mejum Swamp to evaluate its suitability for this purpose.

Terrestrial fauna will generally be unaffected by the project. No unique or endangered species have been recorded in the area and opportunist species including amphibians, reptiles and the smaller marsupials will be afforded a more extensive feeding habitat by the storage foreshores.

Remnant natural vegetation associations prevail along stock routes, road reserves, watercourses and swamps and on hilltops. The majority of these associations will not be affected by Option 'C'. If Options 'A' or 'B' were adopted, the Mejum Swamp river red gum forest would be killed. However, some regeneration could occur around the margins of this depression. Thompsons Lagoon would be similarly affected.

In adopting any of the three pumping options the Commission would carry out suitable plantings along the margins of the lake to inhibit bank erosion.

The Lake Mejum scheme will have several diverse social impacts. Up to 20 separate properties would be acquired for the storage area for Options 'A' and 'B'. Proposal 'C' would require acquisition of 10 properties.

The Commission will either acquire landholdings, on which viability has been lost or provide access to severed holdings, which remain viable. Consideration is also being given to landholders' requests for access to the inlet/outlet canals for water supplies.

Inundated arterial roads will be relocated. In the case of some landholders this will cause increased travelling distances and transportation costs and may disrupt existing social contacts. Consideration will also be given to relocation of travelling stockroutes, where existing Reserves are severed by the storage.

The Commission will engage an archaeologist to undertake a survey for aboriginal artifacts in the area and will report any findings to the National Parks and Wildlife Service for a decision on the appropriate course of action to safeguard such relics.

The important environmental aspect of water quality is currently being investigated by the Commission. Water quality data already gathered indicates that unles properly managed, the waters of the proposed storage could be potentially eutrophic and might result in undesirable environmental effects, including algal blooms and fish kills. The Commission will undertake a water management programme aimed at minimising the likelihood of eutrophication.

The relatively shallow storage which would be created by options 'A' and 'B' may exacerbate any problems associated with the effects of eutrophication. Additionally areas of shallow stagnant water and swampy ground, which provide potential breeding areas for arbo-viral disease carriers such as mosquitos, would be increased.

At this stage it appears that the major environmental objectives of conservation of the natural environment, maintenance of the best quality water and minimisation of health hazards will best be met by Option 'C' - the "Lake Coolah only" storage. Additionally land acquisition for such a storage would be less than half that required for utilisation of the four lakes thereby causing less social disruption.

The environmental advantages of Option 'C' ("Lake Coolah only") must be weighed against the additional cost (over $3 million) compared to the least cost scheme. In addition, Option 'C' is the most costly in terms of average annual electrical energy consumption because of its higher average pumping lift. Least disturbance of the natural and social environment is the main advantage of Option 'C'.

No attempt has been made to quantify the environmental aspects in monetary terms.

10. CONCLUSIONS

1. The Mejum Lakes group could be developed to provide an off-river storage of capacity ranging from the 450 000 ML pumped storage proposals to the maximum 615 000 ML storage associated with the gravity scheme. In terms of cost-effectiveness the proposals for development of the pumping scheme are the only ones which can be seriously considered.

2. The three pumping options advanced illustrate the range of alternatives available for the project.

   These options are all attractive economic propositions with internal rates of return ranging from 14.5% (option A) to 12% (option C).

3. The merit of each of the three schemes has been compared on the basis of five criteria. The results of the comparison are as follows:

SUMMARY OF CRITERIA BY RANKING OF SCHEMES

CRITERION	SCHEME		
	A	B	C
Internal Rate of Return (Benefit-Cost Ratio)	1	2	3
Revenue Generation Potential			
. Agriculture	1	2	3
. Recreation	2	1	3
Regional Multiplier Impact	2	1	3
Operational Procedures	2	1	3
Environmental and Social Quality	2	3	1

4. Further work is necessary to develop a firm pumping proposal. Analysis of community preference concerning the Option 'A', 'B' and 'C' described in this report will be part of this further work.

The Commission anticipates a significant response from other public authorities, water user organisations, conservation groups, aquatic sporting bodies and individuals on the merits of the proposed schemes.

A final decision by the Commission on the most favourable project suitable for submission to the Government will only be taken after full consideration and assessment of the public comments received.

APPENDIX 'A'

PHYSICAL DETAILS AND COSTS OF THE LAKE MEJUM PROPOSALS

TABLE A-1

PHYSICAL DETAILS OF THE BASIC LAKE MEJUM SCHEMES

Feature	Gravity Scheme Proposal	Original Pumping Scheme Proposal
Capital Cost (1978 money)	$60 Million	$20 Million
Construction Time	4 years	3 years
Top Water Level (A.H.D.)	162.2 m	160.48 m
Storage Capacity Provided (includes Thompsons Lagoon, Lake Mejum, Mejum Swamp, Lake Coolah)	615 000 ML	450 000 ML
Surface Area	12 000 ha	9 700 ha
Diversion Point	Proposed Mundowy Weir	Bundidgerry Regulator
Inflow enters storage at:	Thompsons Lagoon	Southern Lake Coolah
Intake Canal - Capacity Length	5000 ML/day 74 km	2810 ML/day 12 km
Outlet Canal - Capacity Length	5000 ML/day 14 km	2100 ML/day 14 km
(Both schemes use the same outlet canal route from Lake Coolah S.W. Embankment to the M.I.A. Main Canal)		
Addition to Average Annual Supply (Yield)	250 000 ML	200 000 ML
Annual Cost of Electrical Energy Consumption (1978 Money)	-	$450,000

ML = megalitres = 1 000 000 litres = 0.8 acre feet (approx.)

TABLE A-2

PHYSICAL DETAILS OF THE RECOMMENDED LAKE MEJUM OPTIONS

Feature		Option 'A' (Least Cost)	Option 'B' (Recreational Considerations)	Option 'C' (Environmental Conservation)
Capital Cost (1980 Money)		$22.9 Million	$27.9 Million	$26.6 Million
Construction Time		3 years	3 years	3 years
Top Water Level (A.H.D.)		160.48 m	160.48 m	166 m (appr.)
Storage Capacity	- 4 Depressions	450 000 ML*	450 000 ML**	
	- Lake Coolah only			450 000 ML*
Surface Area (at top water level)		9700 ha	9700 ha	3700 ha
Addition to Average Annual Supply (Yield)		206 000 ML	211 000 ML	208 000 ML
Average Pumping Lift (metres)		13.0	16.1	18.2
Maximum Pumping Lift (metres)		16.3	16.1	21.8
Average Annual Electrical Energy Consumption (kilowatt-hours)		14.0 million	16.2 million	20.4 million
Peak Electrical Power Requirement (megawatts)		6.4	7.4	9.0
Combined Inlet/Outlet Canal	- Capacity	2800 ML/day		2800 ML/day
	- Length	9 km		9 km
Inlet Canal	- Capacity	-	2800 ML/day	-
	- Length		7 km	
Outlet Canal	- Capacity	-	2800 ML/day	-
	- Length		14 km	
<u>Recreation Facility</u>				
Location		Lake Coolah	Clifton Station	Lake Collah
Minimum pool level (A.H.D.)		153.20 m	160.48 m	153.20 m
Maximum pool level (A.H.D.)		160.48 m	160.48 m	166 m (appr.)
Volume***		50 000 ML (min)	50 000 ML	50 000 ML (min)
Surface Area***		1800 ha	660 ha	1800 ha
Maximum depth***		3.1 m	14 m	3.1 m
Average depth***		2.8 m	7.5 m	2.8 m
Water level fluctuation		7.3 m	0	12.8 m

ML = megalitres = 1 000 000 litres = 0.8 ac. ft. (approx.)

* including 50 000 ML recreational storage within Lake Coolah.
** exlcuding 50 000 ML independent recreational lake south of Lake Coolah.
*** at minimum pool level.

TABLE A-3

SCHEDULE OF COSTS

Feature	Gravity Scheme Proposal (1978 Costs) $	Pumping Scheme Proposal (December, 1980 Costs) Option 'A' (Least Cost) $	Option 'B' (Recreation) $	Option 'C' (Environment) $
CAPITAL COSTS				
Storage Basin	8 260 000	8 095 000	8 095 000	12 280 000
Road Deviations	1 240 000	1 680 000	1 680 000	825 000
Canals	38 900 000	6 900 000	9 745 000	6 860 000
Pumping Station	-	5 615 000	5 375 000	6 040 000
Recreational Facilities	-	635 000	3 015 000	635 000
Diversion Weir and Regulator	11 600 000	-	-	-
Total Capital Costs	60 000 000	22 925 000	27 910 000	26 640 000
Expressed as equivalent annual cost per megalitre of annual yield (at 11% discount rate)	($31.30/ML)	($13.70/ML)	($16.30/ML)	($15.80/ML)
ANNUAL COSTS				
Electrical Energy	-	480 000 ($2.30/ML)	550 000 ($2.60/ML)	620 000 ($3.00/ML)
Operation and Maintenance (including pump and motor replacement)	200 000 ($0.80/ML)	210 000 ($1.00/ML)	220 000 ($1.00/ML)	210 000 ($1.00/ML)
Total Annual Costs	200 000	690 000	770 000	830 000
Expressed as equivalent annual cost per megalitre of annual yield	($0.80/ML)	($3.30/ML)	($3.60/ML)	($4.00/ML)
TOTAL EQUIVALENT ANNUAL COST PER MEGALITRE OF ANNUAL YIELD (at 11% discount rate).	($32.10/ML)	($17.00/ML)	($19.90/ML)	($19.80/ML)

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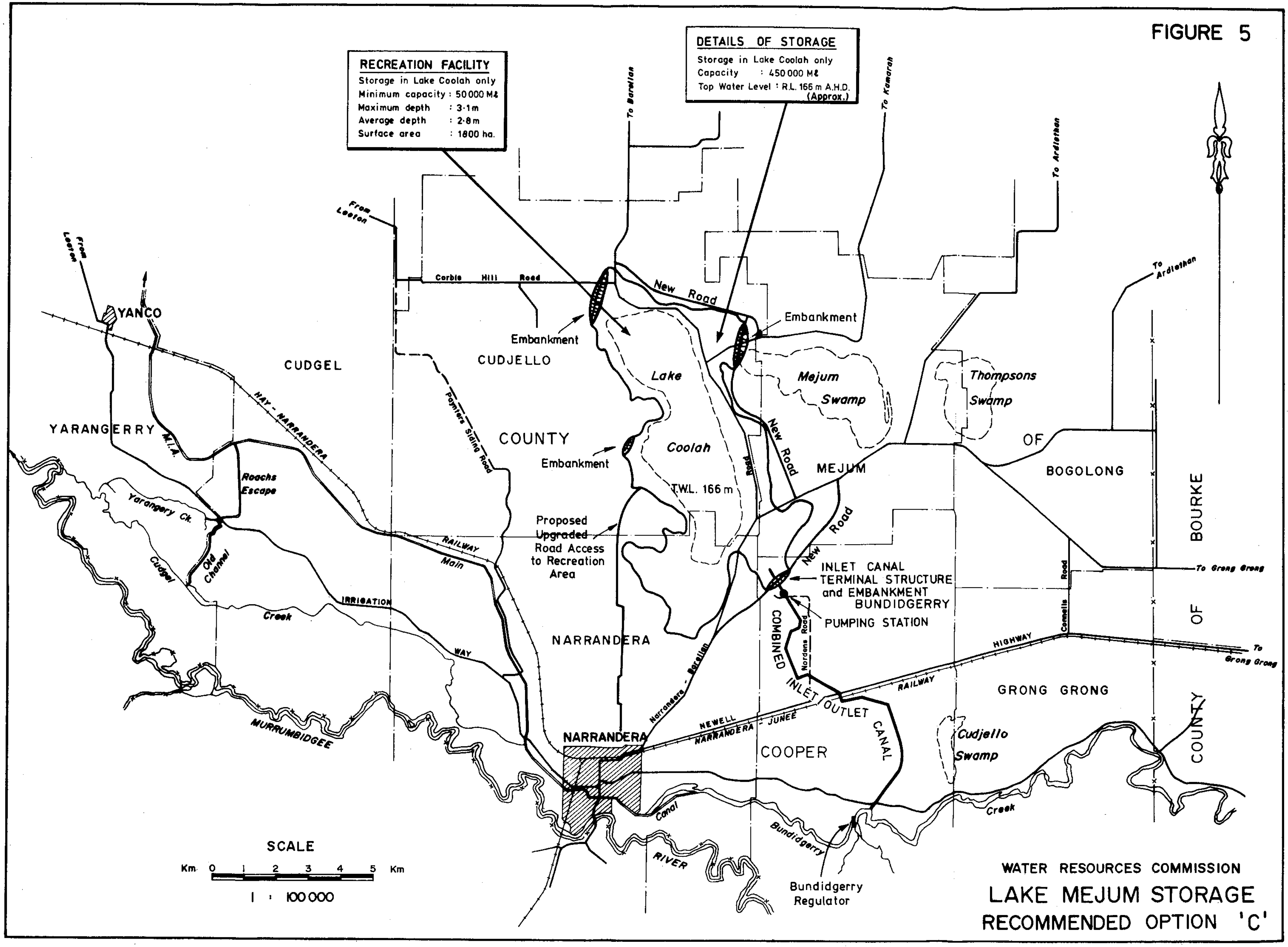

FIGURE 5

WATER RESOURCES COMMISSION
LAKE MEJUM STORAGE
RECOMMENDED OPTION 'C'

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FIGURE 6

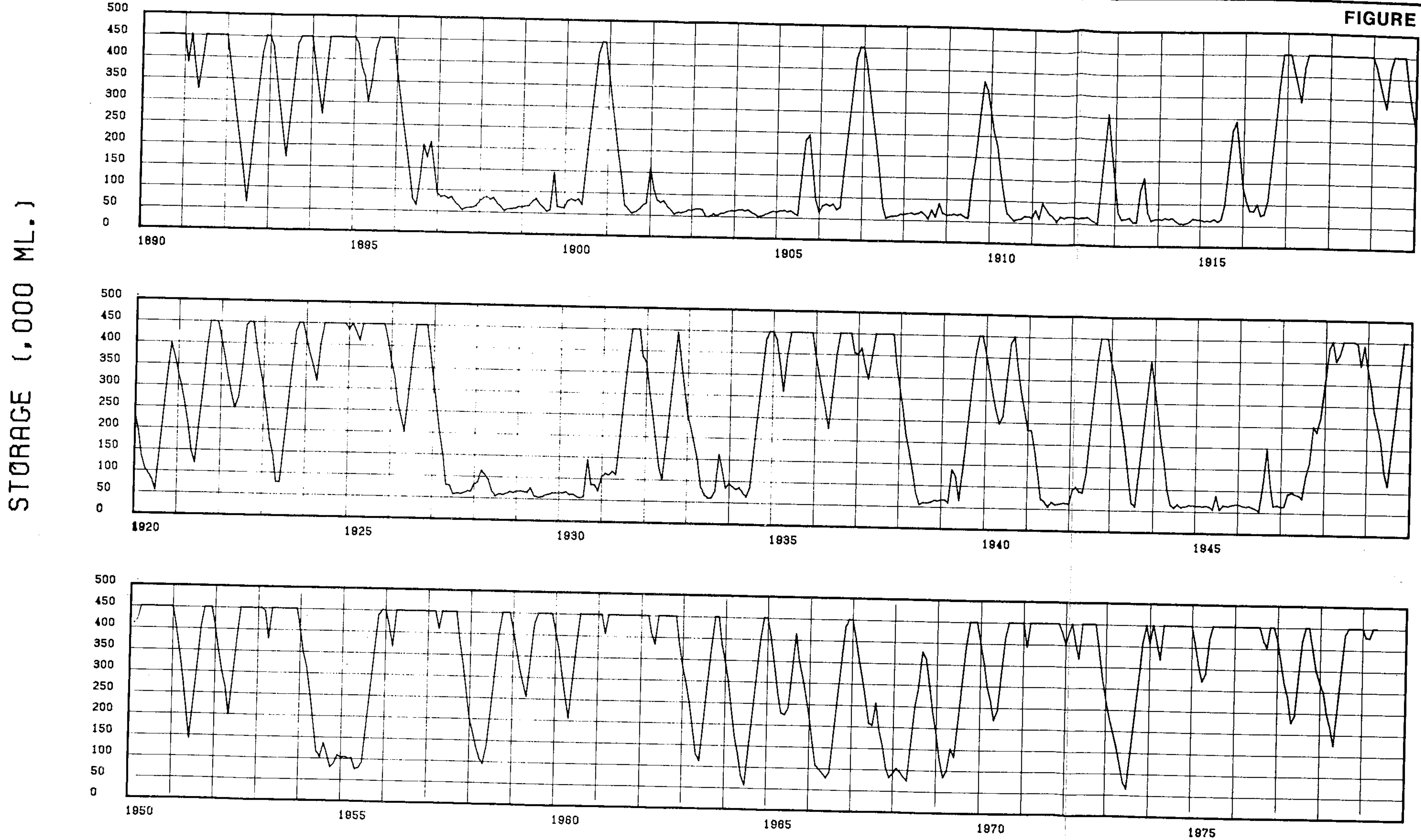

DIAGRAM OF LAKE MEJUM STORAGE BEHAVIOUR

(Pumping Proposal, Option "A")