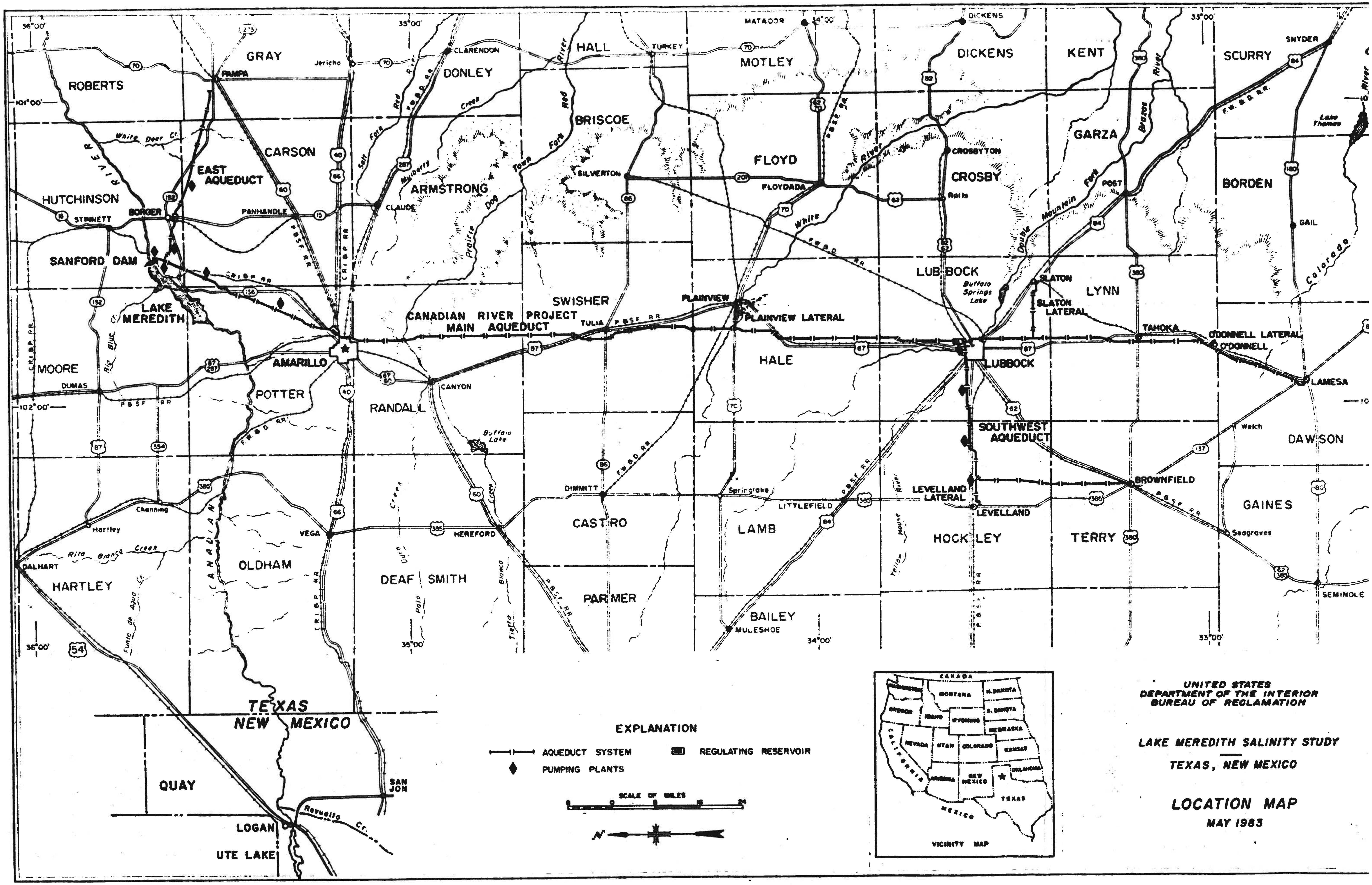
PRELIMINARY FINDINGS REPORT

LAKE MEREDITH SALINITY CONTROL PROJECT, TEXAS - NEW MEXICO

APRIL 1984

U.S. DEPARTMENT OF THE INTERIOR
BUREAU OF RECLAMATION
SOUTHWEST REGION



UNITED STATES
DEPARTMENT OF THE INTERIOR
BUREAU OF RECLAMATION

LAKE MEREDITH SALINITY STUDY

TEXAS, NEW MEXICO

LOCATION MAP

MAY 1983

TABLE OF CONTENTS

TABLES

FIGURE

SUMMARY - FINDINGS AND RECOMMENDATION

Findings

1. A recent contract (Hydro Geo Chem, Inc. [HGC]) study and analysis of regional and site geology (New Mexico and Texas) relating to subsurface salt dissolution states that about 70 percent of the salt entering Lake Meredith comes from the New Mexico side of the Canadian River and that most of this salt originates from brine inflow to the river channel near Logan, New Mexico. The report also states that an additional 10 to 15 percent enters the river channel between the Tascosa and Amarillo gages.

2. As part of the HGC investigation, salt and water balances extended 40 years into the future resulted in the finding that if no actions are taken to reduce the brine inflow to the Canadian River, long-term Lake Meredith chloride concentrations may approach 400 milligrams per liter (mg/L) or even higher during sustained low-flow periods.

3. Results of a HGC simulation model show the effect, after 10 years of 100-percent reduction in brine inflow, is about 24-percent reduction in milligrams per liter of total dissolved solids (TDS) in the river near Lake Meredith. Within the river upstream, TDS was reduced 41 percent after 10 years. When the brine inflow was reduced by 50 percent, the time for the system to respond is nearly the same; but the amount of salinity reduction is about half of that from the model simulation of 100-percent reduction in brine inflow.

4. At this level of study, the concept of using hydrostatic control ponds on the Canadian River is found to have less acceptability than other alternatives due to cost, effectiveness in obtaining desired results, and Canadian River Compact limitations.

5. The Canadian River Municipal Water Authority (CRMWA) is restricted to the delivery of Lake Meredith waters, with acquisition or use of ground water being specifically prohibited. Therefore, the reduction of salinity by a process of blending ground water with Lake Meredith water cannot be considered by the CRMWA as a viable alternative at this time. Secondly, not all member cities have locally available ground water of good quality for use as a blending supply.

6. The cost of the desalination process exceeds the ability and willingness to pay criteria.

7. Appraisal-level economic evaluations were conducted on (a) brine-well pumping with surface brine disposal and (b) brine-well pumping with deep-well injection brine disposal. Both methods appear to be viable at this level of study with surface disposal method having a benefit/cost (B/C) ratio of 2:1 and deep-well injection method having a 4:1 B/C ratio based on annual costs of $1,230,500 and $657,600, respectively. However, the costs for developing surface evaporation ponds exceed the CRMWA's indicated willingness to pay criteria and make the concept unacceptable.

8. Information on deep formations in the Logan, New Mexico, area is insufficient to judge whether a suitable disposal horizon exists for deep-well injection.

9. It is the expressed desire and interest of the CRMWA member cities that further study of the salinity problem be confined to a plan that would eliminate the problem at the source (Canadian River near Logan, New Mexico).

Recommendation

Based on the above findings, it is recommended that the study of Lake Meredith salinity problems continue and that the Bureau of Reclamation (Reclamation) focus its investigation on the following tasks:

- Conduct seismic work needed to identify the best probable location for a deep-well brine injection disposal system.

- Develop a firm-cost estimate for a brine production and deep-well disposal system to include costs for operation, maintenance, replacement, and energy.

- Determine the need for and, if necessary, conduct an environmental assessment of the preferred plan.

- Continue to evaluate alternative energy-producing methods for pumping and disposing of the brine water.

- Continue water quality analysis.

- Prepare a "Project Report" with supporting data by December 1984. The report would be used by the CRMWA and Reclamation to determine a course of action.

PROBLEMS AND NEEDS

Study Area Description

The study area includes the boundaries of the Canadian River Project (CRP) located on the High Plains of Texas; Lake Meredith, the storage facility for the project; and a 150-mile reach of the Canadian River from Lake Meredith upstream to Ute Lake located in New Mexico.

The CRP is a municipal and industrial (M&I) water supply project serving 11 member cities; Amarillo and Lubbock being the two largest. The project is designed to deliver up to the estimated firm annual yield of 103,000 acre-feet.

Lake Meredith, located on the Canadian River northeast of Amarillo, Texas, has a conservation capacity of about 840,000 acre-feet. In 1973, the reservoir achieved its largest volume of about 523,000 acre-feet. Since 1973, the reservoir has experienced a gradual decline in volume, reaching a low point of about 108,000 acre-feet in 1981. Inflow to the reservoir since 1981, however, has improved with the volume in storage measuring about 460,000 acre-feet in April 1983.

Problem

Lake Meredith has experienced a gradual decline in water quality since impoundment began in 1965. The decline is attributed to an increase in concentration levels for sodium (Na), chlorides (Cl), sulfates (SO_4), and TDS. The extent of increase is such that concentration levels often exceed the recommended secondary standards for domestic water supplies. For example, the maximum level of concentration measured for Cl is 600 mg/L and for TDS is 1,880 mg/L. These values are excessively high when compared to the recommended level of 250 mg/L for Cl and 500 mg/L for TDS.

Table 1 provides a summary of water quality data recorded at Lake Meredith.

The effects of poor water quality on the water user are varied. When Cl concentrations exceed 250 mg/L, water begins to taste salty and the corrosion of steel and aluminum begins to increase. Sulfates may cause problems for some industrial users when concentrations exceed 100 mg/L; and when over 250 mg/L, the water will begin to taste bitter.

Available data suggest that the quality of water in Lake Meredith will continue to decline, especially during periods of low inflow and low volume accompanied by high evaporation. The mean value of concentration for Na, Cl, and SO_4 can be expected to remain in excess of the recommended secondary standards for drinking water supplies.

Need

The CRMWA and its water users are concerned about the degrading water quality of Lake Meredith. Inasmuch as Lake Meredith is the principal source of water for the 11 member cities, its value, both in quantity and quality, is extremely

Table 1

WATER QUALITY
LAKE MEREDITH NEAR SANFORD, TX 07227900
GENERAL CONSTITUENTS, USGS DATA

CONSTITUENTS	NUMBER OF SAMPLES	MEAN LEVEL	MEDIAN LEVEL	MAXIMUM LEVEL	MINIMUM LEVEL	STANDARDS OR CRITERIA: DOMESTIC WATER SUPPLY	FRESH WATER AQUATIC	IRRIGATION SUPPLY	PERCENT * EXCEEDING STANDARD
TEMP WATER CENTIGRADE	36	14.8	15.0	28.0	4.5	--	--	--	0.00
TRANSPARENCY SECCHI (METERS)	3	2.9	2.8	3.7	2.1	--	--	--	0.00
COLOR (PT CO UNITS)	2	0	0	0	0	75.0	--	--	0.00
SP. CONDUCTANCE (UMHOS/CM)	40	1740	1680	3010	1090	--	--	--	0.00
DISSOLVED OXYGEN (MG/L)	5	9.7	9.9	11.6	7.3	**	**	**	0.00
DISSOLVED OXYGEN (SAT)	5	92	92	97	85	--	--	--	0.00
PH (UNITS)	33	7.9	7.8	8.7	7.2	**	**	**	3.03
ALK (MG/L CACO3)	39	170	170	200	140	**	**	**	0.00
HARDNESS TOT (MG/L CACO3)	39	250	260	.340	190	--	--	--	0.00
HARDNESS NONCARB (MG/L CACO3)	39	280	83	8000	33	--	--	--	0.00
CALCIUM DISS (MG/L CA)	39	58	59	70	44	--	--	--	0.00
MAGNESIUM DISS (MG/L MG)	39	26	26	42	17	--	--	--	0.00
SODIUM DISSOLVED (MG/L NA)	34	270	260	550	150	--	--	--	0.00
SODIUM ADSORPTION RATIO	40	7.4	7.4	13	4.8	--	--	--	0.00
SODIUM,PERCENT	34	66	69	78	60	--	--	--	0.00
POTASSIUM DISSOLVED (MG/L K)	32	6.8	6.6	8.8	4.3	--	--	--	0.00
CHLORIDE DISSOLVED (MG/L CL)	41	300	280	600	160	250	--	--	80.49
SULFATE DISSOLVED (MG/L SO4)	39	260	260	520	150	250	--	--	56.41
FLUORIDE DISSOLVED (MG/L F)	36	.80	.80	1.0	.50	**	**	**	0.00
SILICA DISS (MG/L SIO2)	39	3.8	2.9	18	.40	--	--	--	0.00
DISSOLVED SOLIDS (180C, MG/L)	4	748	764	842	621	--	--	--	0.00
SUM OF CONSTITUENTS (MG/L)	36	1050	1030	1890	821	--	--	--	0.00
DISSOLVED SOLIDS (TONS/ACREFT)	40	1.4	1.4	2.6	.84	--	--	--	0.00

** STANDARD OR CRITERIA VARIABLE, BUT CALCULATED
-- STANDARD OR CRITERIA VARIABLE OR NOT ESTABLISHED
* ONLY MOST STRINGENT STANDARD CONSIDERED

important to its users. They believe that corrective action should be taken to maintain the concentration of salts in Lake Meredith water within desirable limits, preferably those limits recommended for secondary levels.

Resources and Constraints

The principal resource affected by the study is the source of water supply (Lake Meredith) for the CRP. Water quality data collected over the life of the reservoir indicate that an increase in salinity levels, above recommended levels, is occurring. Any action taken that would reduce the salinity level in the reservoir would be perceived as a positive impact to that resource.

All the construction alternatives being considered would require the purchase of some private or State land to accommodate project structures and other related facilities. The amount of land needed for a given plan is relatively small and is considered not to be a constraint to plan development.

Several schemes for controlling salts entering the Canadian River from a leaky saline artesian aquifer near Logan, New Mexico, are being considered. One plan would require the State of Texas to obtain a water right from New Mexico to permit pumping of the brine aquifer to lower the artesian head. It is not known if the New Mexico State Engineer could grant such a permit under existing State water laws. At this time, the State of New Mexico has indicated that it would be necessary for Reclamation to apply to the State Engineer for well and disposal permits before such a determination can be made. The application would require additional information specifically related to well location, production and disposal zones, pumpage rates, etc. This information is not available and would require additional fieldwork. A second plan proposes construction of a dike or small dam to provide a hydrostatic control pool over the brine seep areas located near Logan. It is assumed, based on existing data, that about 10 feet of head would be sufficient to suppress the seepage.

Approximately 11,000 acre-feet of water would be stored behind the dam. Constructing additional storage capacity on the Canadian River would present a legal problem for New Mexico. The Canadian River Compact states that 200,000 acre-feet of conservation storage can be stored in New Mexico between Conchas Dam and the State line. New Mexico has allotted 195,000 acre-feet to Ute Reservoir and 5,000 acre-feet for stock ponds and other miscellaneous storage. Therefore, it is doubtful that the State of New Mexico would agree to reallot its storage to provide 11,000 acre-feet of capacity.

Other plans, that consider blending ground water with lake water to achieve a favorable water quality, may necessitate the purchase and retirement of irrigation water rights. The availability of ground water varies as to locality. For instance, the city of Lubbock is located in a water-short area where development of suitable ground water could be expensive. Secondly, blending would probably have to occur on an individual city basis as the CRMWA does not have the legal authority to purchase and deliver ground water to any or all of its member cities.

A final constraint, and perhaps the most critical, is the willingness of member cities to accept any water quality plan that would require a major expenditure to construct and operate. While the cities are concerned about the quality of water they provide to its citizens, at the present time there is no mandate (law) requiring a municipality to meet recommended secondary standards for Na, Cl, SO_4, and TDS.

ALTERNATIVES CONSIDERED

Various alternative plans that would reduce the salinity level of Lake Meredith water, either in the reservoir or at the point of use, have been evaluated and were found to have merit to the extent that they should be comparatively analyzed. The primary objective of each alternative is to achieve a salinity level of about 800-900 mg/L for TDS, assuming that the level of concentration for TDS in Lake Meredith water would be about 1,200 mg/L.*/

Brine Aquifer Control Plans

Well pumping and brine disposal

This plan would reduce brine seepage into the river by lowering the piezometric surface of the aquifer through pumping and brine disposal. If the effects of the brine aquifer are eliminated, the average concentration of Na, Cl, and SO_4 flowing into Lake Meredith is expected to be reduced resulting in an average TDS concentration in the reservoir of about 800-900 mg/L.

Based on hydraulic data obtained from the appraisal study pump test, a production well with a pumping capacity of about 1 cubic foot per second (ft^3/s) could lower the artesian head of the aquifer sufficiently to prevent the upward seepage of brine into the river channel. The discharge from the well could be transported by pipeline to a nearby playa for storage and evaporation or to a deep well for injection.

*/ Concentration level recorded in January 1978. Level used for analysis purposes in appraisal study completed 1979.

Production well(s) would be located downstream of Ute Dam in Quay County, New Mexico, south of the Canadian River. The well(s) would be sited so as to accomplish the lowering of the artesian head of the saline aquifer. Siting, depth, and completion of the well(s) will depend on analysis of physical characteristics of the saline aquifer.

A potential brine storage and evaporation site selected for this study is within a playa located southeast of the production well site. The site is located on low-productive land and has a minimal drainage area of about 12.5 square miles. Protective measures including monitoring devices would be required to minimize brine seepage from occurring at the site. Two hundred and thirty acres, lined with a 20-mil polyvinyl-chloride membrane liner and enclosed with a dike, are used for estimating purposes. A system of drainpipes with risers under the liner material and eight observation wells around the perimeter are provided to monitor any seepage. Rights-of-way required for the disposal site are estimated at 350 acres and would be purchased in fee title. Some 2.7 miles of fencing would also be required to enclose the area. A net average annual evaporation rate of 3.5 feet was used. Operation studies and geologic information on the playa are not yet available.

The annual amount of salts that would accumulate through evaporation is estimated to be about 34,500 tons. It is estimated that the storage site has the capacity to contain 100 years of salt and sediment deposits in addition to the brine water.

Delivery of the brine from the production well to the surface disposal site would be accomplished by a pipeline and two pumping plants. The pipeline would have a diameter of 12 inches and a length of about 36,750 feet (7 miles). The pipeline route from the production well would be easterly across open rangeland to State Highway 39, southeast along Highway 39, and then south to the playa. Approximately 42 acres of easement right-of-way would be required using a width of 50 feet. The pumping plant at the well would have a total dynamic head of 178 feet, and the second pumping plant would have a total dynamic head of 182 feet.

The first pumping plant would be located at the production well; the second plant would be about at the midpoint or mile station 3.4 on the pipeline. Each plant would have electrically operated pumps rated at a capacity of 400 gal/min.

There is some concern regarding the effects of pumping the saline aquifer on water wells in the local area since there may be hydraulic connections between potable water aquifers and the saline aquifer.

The New Mexico Department of Game and Fish lists three species, the "Canadian" speckled chub, the Arkansas River Shiner, and the smooth softshell turtle, as State-endangered species which are restricted to the Canadian River in New Mexico. The paper-shell mussel is proposed for State listing and also occurs in the area.

During low-flow conditions in the river, these species are maintained by seeps in the channel. The relationship between these seeps and the brine aquifer is not known. There is concern that pumping of the aquifer could dewater the river and jeopardize the endangered species. Dewatering could also impact the terrestrial habitat and animals along the river course.

Other environmental impacts of this plan are those related to construction of project features and the conversion of 350 acres of playa habitat to a brine evaporation pond. It is assumed that the disposal pond would have a life of 100 years.

Based on January 1984 price levels, the construction and annual operation, maintenance, and energy (OM&E) costs for a surface discharge-surface evaporation plan are:

Construction	
Production well	$ 260,000
Observation wells (6)	130,000
Pumping plants (2)	190,000
Pipeline	1,720,000
Brine disposal area	7,120,000
Powerline	320,000
Seepage monitor system	280,000
Field cost	$10,020,000
Other costs (35%) 1/	3,480,000
Construction cost	$13,500,000

Operation, Maintenance, and Energy		
Operation and maintenance		$10,800
Pumping plants	($1,500)	
Pipeline	($4,500)	
Observation wells and disposal area	($4,800)	
Energy (368,000 kWh)		20,200
Total annual OM&E cost (1/84)		$31,000

1/ Includes 10 percent preconstruction planning.

Disposal of the brine by deep-well injection would be studied further if the geologic analysis contract shows that this is a feasible alternative. Rough preliminary costs ($5,600,000; see table 3 on page 22) indicate that disposal by this method may be less than one-half the cost for surface disposal. If deep-well injection proves to be feasible, the cost advantage of this disposal method would be significant. Environmentally, deep-well injection would be the preferred method of disposal.

Hydrostatic control pool

It is assumed that this plan would achieve the same reduction of TDS in Lake Meredith as the well pumping plan. A diversion dam-type structure below the confluence of the Revuelto Creek would be constructed to provide a hydrostatic control pool over the brine seepage areas. It is assumed that 10 feet of head in the vicinity of test well (TW-1)*/ would suppress the seepage areas, that seepage would not recur downstream from the structure, and that the brine seepage area is confined upstream from the confluence of the Canadian River and Revuelto Creek.

To produce a hydrostatic head of 10 feet at TW-1, the crest of the uncontrolled structure would be at elevation 3,685. The river bed at the proposed structure site was assumed to be at elevation 3,655. Bedrock is probably 50 feet below the riverbed.

*/ Test well No. 1 was drilled during previous appraisal investigations; its location is just downstream from the intersection of the Canadian River and U.S. Highway 54 near Logan, New Mexico.

A pool with a normal water-surface elevation of 3,685 will require about 10,800 acre-feet of water with a surface area of 660 acres. The annual net evaporation rate at Ute Reservoir is 4.33 feet; therefore, 2,860 acre-feet annually of makeup water would be required. The Canadian River Compact states that 200,000 acre-feet can be used for conservation storage in New Mexico between Conchas Dam and the State line. New Mexico has allotted 195,000 acre-feet to Ute Reservoir and 5,000 acre-feet for stock ponds and other miscellaneous storage. Therefore, it may not be legal to store 10,800 acre-feet in this pond; and the question remains as to whom would be charged with the makeup water.

The dam structure cost was estimated using a sheet piling cutoff protected with riprap and an outlet works. The sheet piling and upstream-downstream embankment buttresses would extend 30 feet above the streambed and down about 50 feet to bedrock. A concrete cap 4 feet by 4 feet would protect the crest of the sheet piling. An outlet works would be provided to drain the reservoir.

Environmental considerations for this plan would be similar to those discussed under the well pumping plan except that there would not be a surface disposal problem. Approximately 5 miles of the river and 660 acres of riverbed would be inundated by the hydrostatic control pool. Impacts related to construction of the dike are thought to be minimal.

Approximately 990 acres of rights-of-way would need to be purchased. The only known improvements are railroad and highway bridges; it was assumed that relocation would not be required. The January 1983 construction cost was estimated to be $7,260,000. This includes 15 percent for unlisted items, 30 percent for contingencies, and 25 percent for indirect costs. Annual costs for operation and maintenance would be minimal; costs were not computed for this plan.

Channel infiltration gallery

The plan for an infiltration gallery system consists of an excavated infiltration trench with perforated pipe installed as the collection element, a water collection sump, and a sump pumping plant. The perforated pipe would be laid in the river alluvium to intercept the brine as it enters the channel alluvium. The brine would flow into the sump by gravity and be pumped to an evaporation pond or injected in a deep well.

The main disadvantage of this concept is that some "freshwater" in the alluvium could be lost through the collection and disposal process.

This plan was included for consideration at a late date; therefore, details of the features and related construction costs have not been completed. Additional plan analysis is needed to determine viability.

Blending Ground Water with Lake Meredith Water

This plan considers blending available ground water supplies with Lake Meredith water to achieve the desired quality. The availability of ground water for M&I purposes varies considerably in the study area. The TDS concentration in ground water varies from 300 mg/L north of Amarillo to about 500 mg/L at the southern end of the study area. Some CRP user cities are already blending to improve quality and to meet peaking requirements.

To fully evaluate the blending concept, it is necessary to examine the long-term water demands of the member cities and how these demands will be met. Local projections for growth in the CRP area indicate that M&I water needs will increase from 107,600 acre-feet per year (acre-ft/yr) in 1980 to about 213,700 acre-ft/yr by the year 2040. The estimated yield of Lake Meredith, as predicted in the Definite Plan Report (1960), is 103,000 acre-ft/yr. However, for the period 1977-1981, deliveries averaged only 72,100 acre-ft/yr. Based on the 103,000 acre-foot yield, a deficit supply occurs in 1980 and increases to a deficit of about 110,000 acre-feet by the year 2040. Since surface water supplies are extremely limited, ground water appears to be the most likely alternative source for some CRP member cities; i.e., Amarillo. However, the city of Lubbock has indicated that they do not have ground water locally available for blending. Importation of water from outside the study area is also a possibility.

Table 2 (columns 1, 2, and 3) provides a summary of the water demands versus supply capabilities for the CRP area.

To estimate the quantities of ground water needed for blending to achieve better quality, it is assumed that well water of 300 mg/L TDS would be available to blend with 1,200 mg/L of Meredith water. Therefore, to achieve blended water of about 800 mg/L TDS, four parts (44 percent) of well water must be mixed with five parts (56 percent) of Lake Meredith water. More ground water, however, would be required to achieve an average level of 350 mg/L for Na, Cl, and SO_4.

Table 2

Canadian River Project Long-Range Water Needs and Ground Water Blending with Lake Meredith Water

(acre-feet/year)

Year	Total Demand 11 Cities 1/	Lake Meredith Supply 2/	Ground Water Needed to Meet Demand 3/	Ground Water Needed for Blending 4/	Net Ground Water Needed for Blending 5/
1980	107,600	103,000	4,600	47,800	43,200
1990	120,400	103,000	17,400	53,800	36,400
2000	135,300	103,000	32,300	60,100	27,800
2010	156,300	103,000	53,300	69,500	16,200
2020	180,600	103,000	77,600	80,300	2,700
2030	197,300	103,000	94,300	87,700	-6,600
2040	213,700	103,000	110,700	95,000	-15,700

1/ Based on actual projections by five major cities plus 8 percent for other cities.
2/ Firm yield of Lake Meredith - DPR.
3/ Column 1 minus column 2.
4/ Based on a ratio of four parts well water to five parts lake water to achieve 800 mg/L TDS.
5/ Column 4 minus column 3.

Based on a total water use by the 11 member cities in 1980 of 107,600 acre-feet, 59,800 acre-feet of Lake Meredith water would be needed for mixing with 47,800 acre-feet of ground water to achieve a quality of about 800 mg/L TDS.

The 47,800 acre-feet of ground water used for blending in 1980 would be the maximum amount needed since demand requirements are beginning to become the dominant purpose. By the year 2020, 77,600 acre-feet of additional ground water would be needed to meet demand while only 2,700 acre-feet is needed for blending. At a point in time, somewhere between the years 2020 and 2030, the need to use ground water for meeting demand overcomes the need to blend for a quality purpose only.

Table 2 (columns 3, 4, and 5) shows the relationship between demand and blending needs for supplemental ground water.

The following criteria were used to estimate the cost of a plan to supply ground water for blending purposes:

1. New wells and appurtenances, collection systems, and transmission lines would have a base cost of $460,000 per million gallons per day (Mgal/d) (January 1983). This cost is based on a plan for Amarillo obtaining water from Carson County and does not take into account any existing capability to supply ground water.

2. Water rights will be leased for $0.20 (January 1983) per thousand gallons: this includes 10 percent for administration.

3. Operation, maintenance, replacements, and energy (OMR&E) is $0.35 per thousand gallons.

4. Unlisted items (10 percent), contingencies (25 percent), and administrative (15 percent) costs were added to the base cost of new wells and appurtenances, collection system, and transmission lines.

Construction Cost	January 1983 Cost	January 1984 Cost
38.5 Mgal/d */ x $460,000/Mgal/d =	$17,737,600	$18,450,000
Unlisted items (10%±)	1,762,400	1,850,000
	$19,500,000	$20,300,000
Contingencies (25%±)	4,880,000	5,000,000
	$24,380,000	$25,300,000
Administrative cost (15%)	3,620,000	3,700,000
Construction cost (January 1983)	$28,000,000	$29,000,000
Annual water rights cost		
14,074,000 (1,000 gal/yr) x $0.20/1,000 gal)	$ 2,815,000	$2,930,000
Annual OMR&E		
14,074,000 (1,000 gal/yr) x $0.35/1,000 gal)	$4,926,000	$5,300,000

*/ Amount of ground water needed to meet 1980 net blending needs, see table 2.

Desalination

This alternative provides for desalting Lake Meredith water along the Main Aqueduct. The most desirable place to do this appears to be at the bifurcation of the Main Aqueduct and the East Aqueduct, near Pumping Plant No. 2. The aqueduct has a capacity to deliver a steady rate of 92 Mgal/d which equals the firm yield of the reservoir.

Environmental impacts of this plan would be those associated with the construction of project features and disposal of the brine effluent. Disposal of the effluent could be accomplished by a surface evaporation pond or deep-well injection. Approximately 6,100 acre-feet of brine effluent would be discharged annually from one Reverse Osmosis (RO) plant.

Approximately 2,240 acres of private land would be needed for the plant and disposal pond.

A cost estimate was prepared for an RO plant using the computer program based on "Desalting Handbook for Planners" by the Office of Saline Water and the Bureau of Reclamation, May 1972. The estimating data limits the capacity of the plant to 50 Mgal/d. The product water from a RO plant ranges from 100 to 500 Mgal/d TDS. Blending product water from one RO plant with 1,200 Mgal/d lake water would result in about 800-900 mg/L TDS.

The following tabulation presents the cost of one 50 Mgal/d RO plant:

Construction costs (January 1984)	
Desalting plant	$84,300,000
Evaporation ponds	40,650,000
Site development	4,930,000
Owner's expenses	9,250,000
Land	1,120,000
Cost--one RO plant	$140,250,000

Annual OMR&E (January 1984)	
Operation and Maintenance	$ 3,317,000
Chemicals	3,203,000
Replacement	2,605,000
Energy (electricity @ $0.045/kWh)	24,631,000
Cost--one RO plant	$33,756,000

Table 3 provides a cost summary for the brine control, blending, and desalination alternatives.

Table 3

Annual Cost Summary (January 1984 Prices)

(Fiscal Year 1985 Plan Formulation Rate 8.375 Percent; Annual Investment Amortized for 50 Years at 8.375 Percent)

Alternatives	Construction Cost	Interest During Construction	Total Investment	Annual Investment	Annual OMR&E	Annual Cost	Cost/K Gallons
Canadian River Brine Aquifer Control							
Logan Pumping Site - Deep-well brine disposal	$ 5,600,000	$ 234,500	$ 5,834,500	$ 497,560	$ 160,000	$ 657,560	$ .13 1/
Logan Pumping Site - Evaporation pond brine disposal	$ 13,500,000	$ 565,312	$ 14,065,312	$ 1,199,474	$ 31,000	$ 1,230,474	$ .24 1/
Blending ground water with Lake Meredith water	$ 29,000,000	$ 1,214,375	$ 30,214,375	$ 2,576,649	$ 8,230,000 2/	$10,806,649	$ .46
Desalination							
One RO Plant	$140,250,000	$18,418,239	$158,668,239	$13,531,053	$33,756,000	$47,287,053	$2.02
Two RO Plants	$280,500,000	$36,836,477	$317,336,477	$27,062,106	$67,512,000	$94,574,106	$4.03

1/ Assuming full effectiveness by 18 years after implementation.
2/ Include $2,930,000 annual lease costs.

Financial Analyses

Preliminary cost estimates for this project result in the following annual cost summary for potential alternative actions to accomplish the objective of the project.

The rate of interest during construction is the plan formulation rate of 8.375 percent for fiscal year 1965, the rate in effect at the time of the proposed final report.

Appraisal-level economic evaluations were conducted on (1) brine-well pumping with surface brine disposal and (2) brine-well pumping with deep-well injection brine disposal. Both methods appear to be viable at this level of study with surface disposal method having a B/C ratio of 2:1 and the deep-well injection method having a 4:1 B/C ratio based on annual costs of $1,230,500 and $657,600, respectively.

The evaluation consists of municipal water supply salinity damage functions based on household damages as determined in the Salinity Management Options for the Colorado River 1/, a study of the Lower Colorado River service area.

A damage reduction factor (household annual cost per milligram per liter of $0.0458) was assigned to each milligram per liter reduction of TDS. The assumed reduction of 400 mg/L TDS (1,200 to 800 mg/L) was computed for 168,071 year-round housing units in the cities now receiving water from Lake Meredith.

1/ Water Resources Planning Series, Report P-78-003, June 1978, Utah Water Research Laboratory, Utah State University, Logan, Utah 84322.

Even though there is some risk in applying these damage functions to the Lake Meredith service area, the likely margin of error is small enough to support viability at the preliminary findings level.

At the preliminary survey level of computing household damages to water and wastewater galvanized piping systems, water faucets, water heaters, dishwashing machines, garbage disposals, and toilet flushing mechanisms for households, annual damages would be approximately $3 million.

A critical element of the analysis is the comparability of proportionate constituents of the TDS in the Lower Colorado River and Canadian River waters. The report cited above indicates that hardness is likely the most critical factor in determining the damage functions. Since Lower Colorado River water hardness is twice the level of Lake Meredith hardness, further study could result in reduced B/C ratios. Even though, in this event, the surface disposal option could become marginal, it is reasonable to expect that the deep-well injection method would remain viable.

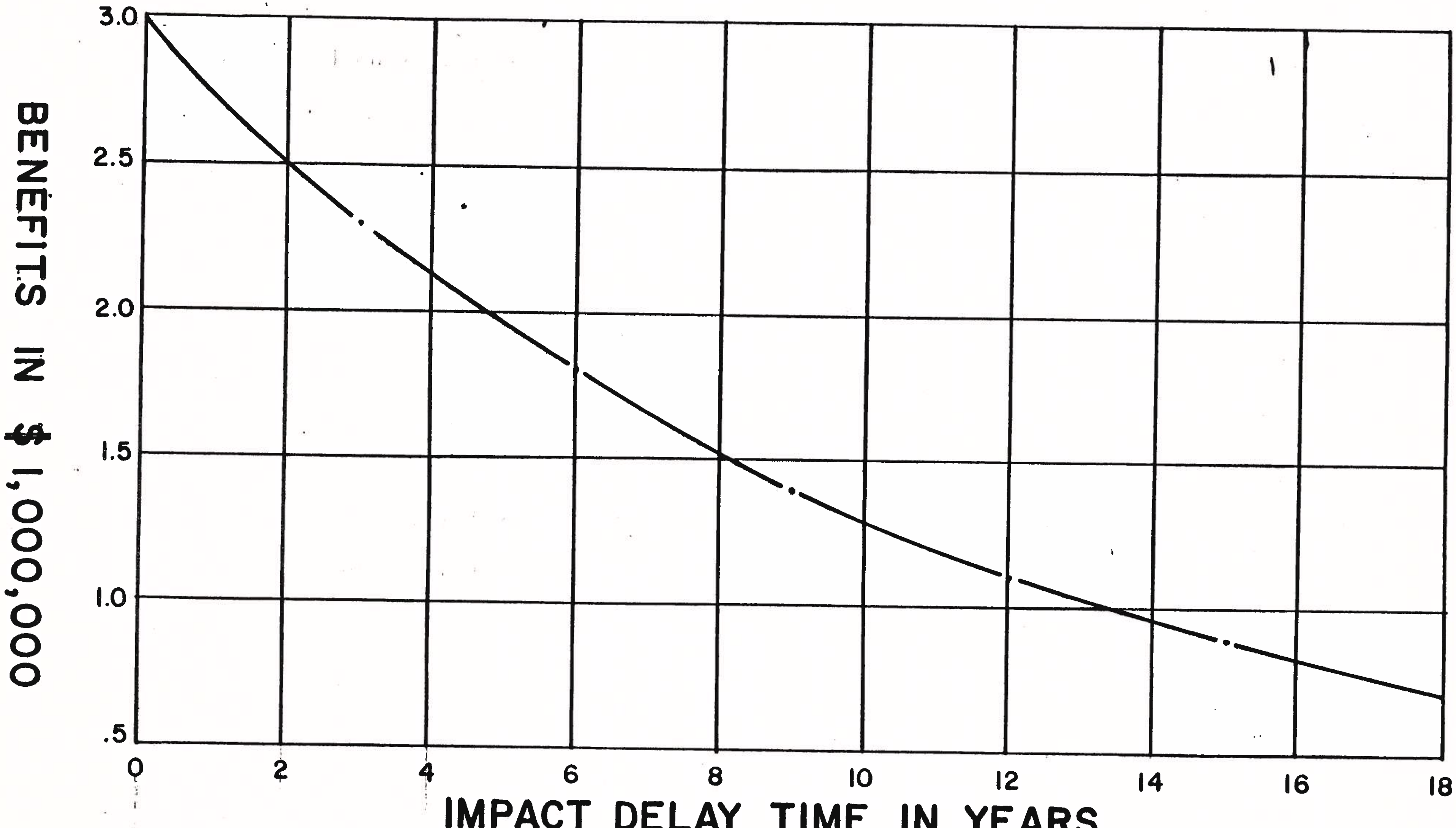
Figure 1 shows benefits discounted to years in which 400 mg/L reduction of TDS may occur.

In the past, local landowners attempted to irrigate about 200 acres of water right land east of Logan, New Mexico, and adjacent to the Canadian River. Due to the high salt concentrations in the river water, these attempts were unsuccessful. This same land is presently dry farmed; however, the irrigation diversion facilities are still in place and would probably be reactivated if good

1 Feb. 84
Fig. 1

LAKE MEREDITH SALINITY CONTROL PROJECT

Benefits discounted to years in which 400mg/l reduction of TDS may occur.



Benefits based on Municipal Damage Functions for Household Appliances and Plumbing Fixtures as Determined in "Salinity Management Options for the Colorado River", Anderson and Kleinman, et al., Utah Water Research Laboratory, 1978.

quality water was made available. Irrigation benefits for these 200 acres were not calculated for the purpose of this preliminary findings report.

Other anticipated benefits along the Canadian River (below Ute) to Lake Meredith would be fish, wildlife, recreation, and water for livestock.

Environmental and Cultural Resources Aspects

In cooperation with the New Mexico Game and Fish Department and the U.S. Fish and Wildlife Service, Reclamation is conducting fishery surveys in the Canadian River below Ute Dam. So far, none of the species identified require a saline environment for their survival. If any species requiring saline water are found, Reclamation will quantify the project's anticipated impact on their populations and develop mitigation measures if possible.

Any of the alternatives (except no Federal action and no action) would require Reclamation to conduct cultural resource surveys. All well locations, pipeline rights-of-way, brine disposal ponds, and associated facilities would be surveyed. With the exception of the brine ponds, most facilities could probably be designed to avoid most site locations. Those sites which could not be avoided would require evaluation and potential testing and mitigation.

PLAN ANALYSIS

Lake Meredith Salinity Control Project

Criteria	Canadian River Brine Aquifer Control	Blending Ground Water	Desalination
Acceptability			
Local Project Sponsor - CRMWA	Yes, this is project sponsor's intent	No, not project sponsor's intent	No, too costly
Member cities	Undetermined	Some cities doing this now	Undetermined Some private companies have installation
General public	Undetermined	May require acquisition of water rights	Undetermined
State of New Mexico	Undetermined	Not affected Ground water source would be in Texas	Not affected
State of Texas	Yes	CRMWA operating charter would need legislation change 3/	Undetermined
Cost sharing	Yes, requires confirmation	No, not project sponsor's objective	No, too costly
Efficiency			
Total construction cost	$ 13,500,000 (January 1984) 1/	$29,000,000 (January 1984) Maximum cost should individual communities develop facilities	$140,250,000 (January 1984) 1-RO Plant
Annual OMR&E	$ 31,000	$ 8,230,000	$ 33,756,000
Water cost/Kgal	$ 0.24	$ 0.46	$ 2.02
Annual M&I economic benefits	Time and effectiveness of salinity reduction undetermined	Not calculated, but would be realized immediately	Not calculated, but would be realized immediately
Annual economic costs	$ 1,230,500	$10,806,600	$ 47,287,000
Irrigation benefits	Yes, 200 acres in New Mexico	None	None
Recreation benefits	None	None	None
Fish and wildlife benefits	Yes, negligible	None	None
Effectiveness			
Water quality improvement to users	Yes	Yes	Yes
Reduction of TDS	From 1,200 to 800 mg/L	From 1,200 to 800 mg/L	From 1,200 to 800 mg/L
Reduction of combined NA, CI, SO_4	Would likely achieve secondary standards	Would likely achieve secondary standards	Would likely achieve secondary standards
Reduction of hardness	Negligible	Depending on ground water quality	Would improve
Land requirements	Approximately 400 acres	Undetermined	2,240 acres
Water rights	Texas entity would need to obtain water right from New Mexico	Will require obtaining water rights in Texas only	No water rights needed.
Brine disposal	Deep well or surface evaporation	None	Deep well or surface evaporation
Institutional/Legal constraints	Obtaining New Mexico water right; compact limitation 2/	CRMWA does not have authority to comingle ground water in pipeline 3/	None
Availablity of ground water for blending	Not applicable	Additional data needed; ground water varies in area	Not applicable
Time and amount salinity reduction	Undetermined	Immediate	Immediate
Preservation of ecosystem	Disposal (surface) may impact wildlife Would improve river/lake quality	May be some vegetation disturbance if additional wells are needed	Disposal site may impact upon wildlife
Preservation of endangered/threatened species	Could impact saline-water dependent species	No impact	No impact
Preservation of cultural/historic resources	Possible impact to cultural resources (medium risk)	Possible impact to cultural resources (medium risk)	Possible impact to cultural resources (low risk)

Alternative Plan Resources

1/ Evaluation applies to Brine Aquifer Pumping and Surface Evaporation Plan. If feasible, deep-well injection would provide a significant cost savings.
2/ If additional storage is required on the Canadian River.
3/ Comment applies to "Project Type" Ground Water Development Plan only. If individual communities develop own ground water system, this would not be a constraint.

PLAN ANALYSIS (Con.)

Lake Meredith Salinity Control Project

Criteria	Canadian River Brine Aquifer Control	Blending Ground Water	Desalination
	Alternative Plan Resources		
Effectiveness (con.)			
Capability for meeting future demands	None	Yes	None
Capability for meeting cyclic demands	Yes, within limits of existing CRMWA facilities	Yes, by adding additional source of supply	Yes, within limits of existing CRMWA facilities
Compatibility with present system	Yes	Limited Existing pipeline capacity is 92 Mgal/d 3/ Additional facilities would be required	Yes
Water added or lost to supply	-750 acre-feet/year minimum	+43,200 acre-feet/year	-6,100 acre-feet/year
Completeness			
Satisfies Project Sponsor's objective	Yes	No	No
All costs of plan identified	No, additional study required	No, additional study required	Yes, for PFR purposes
Sponsor repayment capability	Undetermined	Undetermined	Undetermined
Sponsor repayment intent	Yes, pending future studies	No, not sponsor's objective	No, not sponsor's objective
Technical feasibility	Requires field testing to verify effectiveness on salt reduction	Requires field testing and verification of ground water conditions regarding quantities and quality availability	Due to cost, no further analysis required

1/ Evaluation applies to Brine Aquifer Pumping Plan.
2/ If additional storage is required on the Canadian River.
3/ Comment applies to "Project Type" Ground Water Development Plan only. If individual communities develop own ground water system, this would not be a constraint.
4/ Based on assumption that effect would be realized by eighteenth year.
5/ Construction scheduled so that plant on-line date would be 18 years hence.