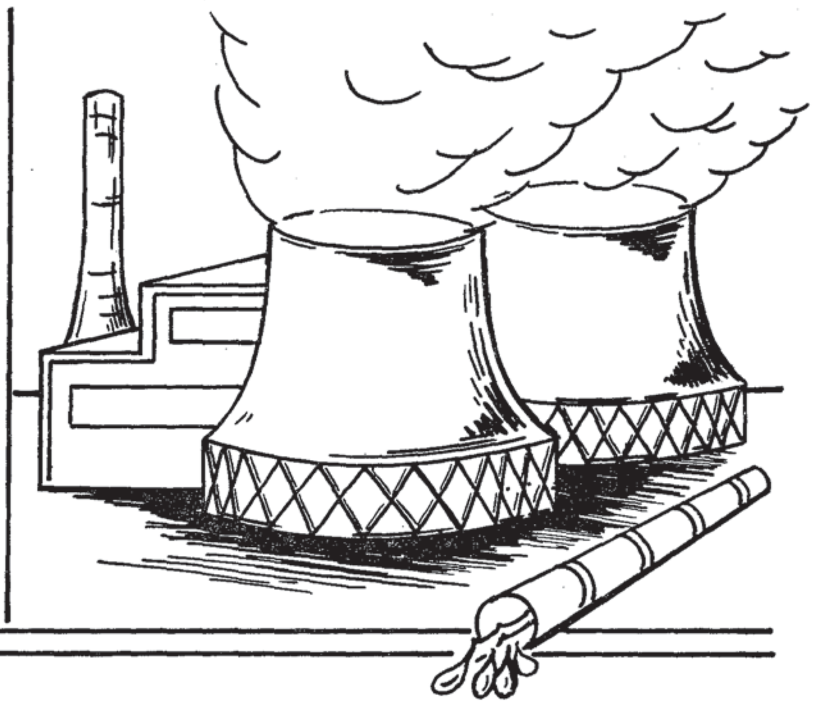
COLORADO RIVER WATER QUALITY IMPROVEMENT PROGRAM

SALINE WATER USE and DISPOSAL OPPORTUNITIES

SPECIAL REPORT
SEPTEMBER-1981



UNITED STATES DEPARTMENT OF THE INTERIOR

Bureau of Reclamation

[redacted]

SPECIAL REPORT

SALINE WATER USE AND DISPOSAL OPPORTUNITIES

Colorado River Water Quality Improvement Program

September 1981

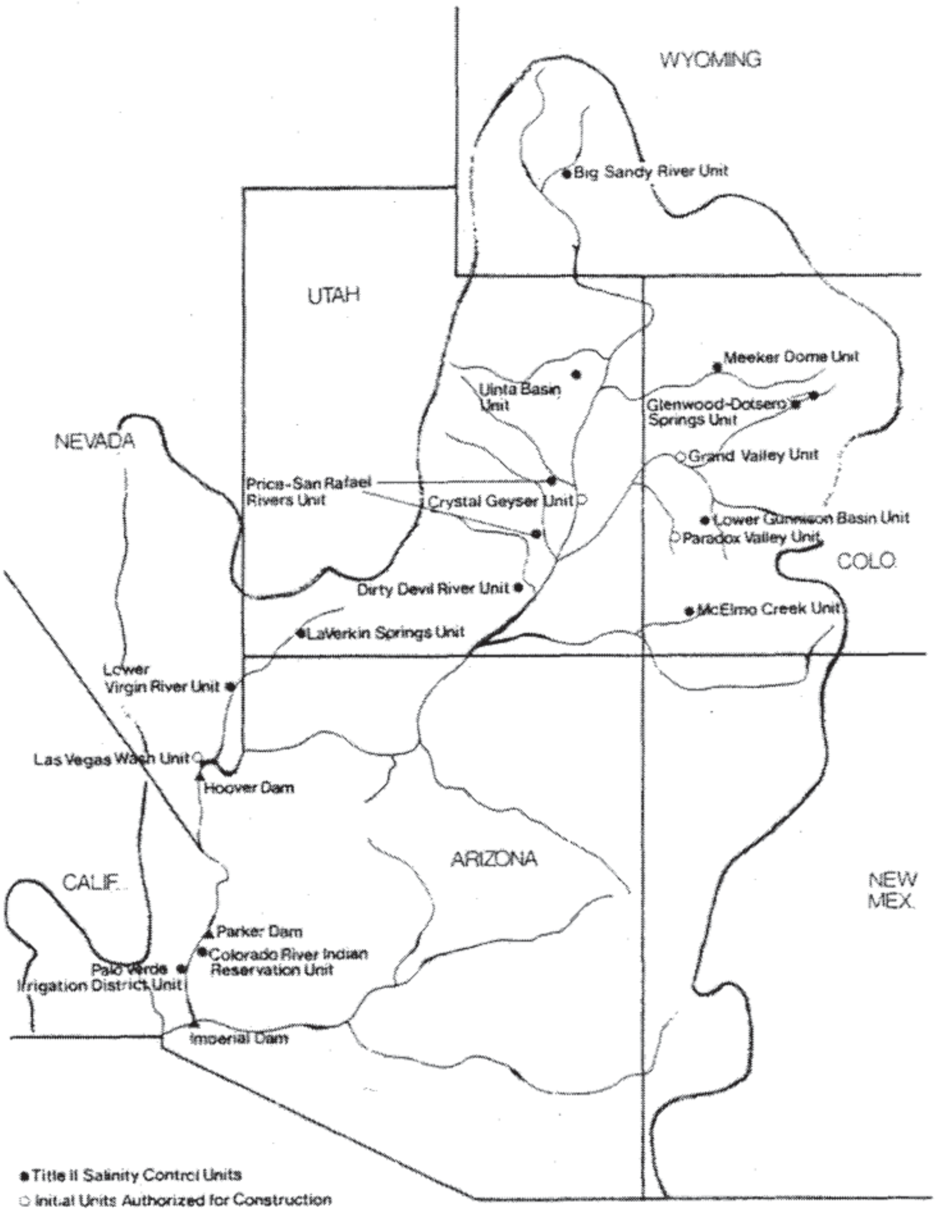
United States Department of the Interior

Bureau of Reclamation

Lower Colorado Region, Boulder City, Nevada
Upper Colorado Region, Salt Lake City, Utah
Colorado River Water Quality Office, Denver, Colorado

As the Nation's principal conservation agency, the Department of the Interior has responsibility for most of our nationally owned public lands and natural resources. This includes fostering the wisest use of our land and water resources, protecting our fish and wildlife, preserving the environmental and cultural values of our national parks and historical places, and providing for the enjoyment of life through outdoor recreation. The Department assesses our energy and mineral resources and works to assure that their development is in the best interest of all our people. The Department also has a major responsibility for American Indian reservation communities and for people who live in Island Territories under U.S. administration.

Nothing in this study is intended to interpret the provisions of the Colorado River Compact (45 Stat. 1057), the Upper Colorado River Basin Compact (63 Stat. 31), the Water Treaty of 1944 with the United Mexican States (Treaty Series 994, 59 Stat. 1219), the decree entered by the Supreme Court of the United States in Arizona vs. California, et al. (376 U.S. 340), the Boulder Canyon Project Act (45 Stat. 1057), the Boulder Canyon Project Adjustment Act (54 Stat. 774; 43 U.S.C. 618a), the Colorado River Storage Project Act (70 Stat. 105; 43 U.S.C. 620), the Colorado River Basin Project Act (82 Stat. 885; 43 U.S.C 1501), or the Colorado River Basin Salinity Control Act (88 Stat. 266).



UNITS OF THE COLORADO RIVER
WATER QUALITY IMPROVEMENT PROGRAM

Foreword

This Special Report presents innovative alternative plans for collecting, treating, and transporting saline water for energy development use or disposal in the Colorado River Basin. The concepts developed are considered alternatives to conventional structural salinity control methods which involve lined evaporation ponds and desalination plants. Heavy emphasis is placed on beneficial use of saline water to mitigate the depletion impact of its removal from the river system by structural control. Preliminary costs are developed for selected alternatives showing favorable cost-effectiveness comparisons with current structural control measures. The report addresses the potential cost savings for the most promising alternatives of local saline water use by powerplants and by coal slurry pipeline.

EXECUTIVE SUMMARY

Background

Salinity concentrations (total dissolved solids or mineral salts) in the Colorado River are increasing and will continue to increase as the Basin States develop their lands and available water resources. Salinity comes from salt loading (the addition of mineral salts from natural and manmade sources) and salt concentration (the rise through streamflow depletions). Without a program of salinity control, continued development will result in increased damages to agricultural, municipal, and industrial users in the Lower Basin, possibly reaching $237 million per year by the year 2000. An effective Basin-wide salinity control program also has international implications in view of potential water quality impacts on the Republic of Mexico.

This Special Report assesses the potential technical and economic feasibility to collect saline water in the Colorado River Basin, to transport it for practical use in energy production, and to export and dispose of wastewater in a cost-effective manner. This preliminary study uses previously gathered data and appraisal grade designs and estimates to evaluate the practicability and acceptability of these saline water use proposals from Federal, State, and private sector viewpoints.

The Saline Water Use and Disposal Opportunities investigation is part of the ongoing CRWQIP (Colorado River Water Quality Improvement Program) to determine the most cost-effective means of maintaining the salinity concentrations of the Colorado River at the 1972 historical level while the Basin States continue to develop their apportioned waters.

Legislative History and Authority for Investigation

In 1972, an amendment to the Federal Water Pollution Control Act, Public Law 92-500, set forth a public policy embracing nondegradation of water quality, pollution effluent discharge limitation, and eventual zero pollution discharge by 1985. The Act was interpreted by the EPA (Environmental Protection Agency) to require numerical salinity standards on the Colorado River. Standards were subsequently established at three stations by the Forum (Colorado River Basin Salinity Control Forum), adopted by each of the Basin States, and approved by EPA. The standards, set in terms of milligrams per liter (mg/L) of total dissolved solids (TDS), are:

Station	Annual flow-weighted average TDS
Below Hoover Dam	723 mg/L
Below Parker Dam	747 mg/L
At Imperial Dam	879 mg/L

In response to this policy and related Federal and State program enforcement guidelines, the CRWQIP was selected as part of the implementation plan to prevent salinity concentrations in the Colorado River from exceeding the standards while the Basin States continue to develop their compact-apportioned water supplies.

This investigation of new salinity control alternatives captures the spirit and program direction established in the 1972 Conference Proceedings with the Basin States, In the Matter of Pollution of the Interstate Water of the Colorado River and Its Tributaries * * *.

> "We (the states) want to emphasize that the Bureau of Reclamation's program as submitted in its report 'Colorado River Water Quality Improvement Program,' dated February 1972, and on which the conference recommendation No. III is based, should be considered as an open-ended and flexible program. If alternatives not yet identified prove to be more feasible, they should be included as part of the program, and if elements now included prove to be infeasible, they should be dropped. In addition, it should be recognized that there may be other programs which reduce the river's salinity."

In June 1974, Congress enacted the Colorado River Basin Salinity Control Act, Public Law 93-320, which, among other things, directed the Secretary of the Interior under Title I of the Act to implement specific measures to protect the quality of water delivered to Mexico. Under Title II, the Secretary was to expedite the completion of planning reports on 12 salinity control units in the CRWQIP and to proceed with construction of the Paradox Valley, Grand Valley, Crystal Geyser, and Las Vegas Wash Units.

In October 1980, Public Law 96-375 authorized feasibility studies for 10 of the saline sources identified in earlier studies.

The investigation of Saline Water Use and Disposal Opportunities is being conducted under authority of the Federal Water Pollution Control Act as amended, the 1902 Reclamation Act as amended and supplemented, and specific approval by Reclamation's Assistant Commissioner for Planning and Operations on May 19, 1980. Any followup feasibility study will require congressional authorization.

In support of this study, the Forum has adopted an official policy encouraging and promoting the use of saline water wherever feasible. A copy of the September 1980 policy statement is appended to the main report.

Study Objective

In order to meet the overall salinity control objective for the Basin, approximately 2.8 million tons of salt per year will have to be removed from the river system around the turn of the century. All irrigation improvement measures and other cost-effective controls as presently envisioned will remove only about 1.2 million tons per year. Hence, the annual capture and removal of an additional 1.6 million tons, using structural controls or conceptual plans outlined in this report, will be necessary to meet the basic program objectives.

Problems and Needs

Sixteen saline water sources, as identified in table 1, were evaluated in the study in various collection configurations for local use or export. The source sites are located on the frontispiece map. The total water volume considered as potential sources for use or disposal is 610,000 acre-feet of saline water averaging about 3,200 milligrams per liter (mg/L) of TDS (total dissolved solids) and carries 2.6 million tons of salt per year.

Table 1. - Saline water sources

Units	Annual average discharge		
	acre-ft/yr	TDS mg/L	Salt 1,000 tons
1. Big Sandy River	19,900	5,015	110
2. Meeker Dome	1,090	19,300	29
3. Glenwood-Dotsero Springs	25,000	14,200	500
4. Grand Valley 1/	43,500	3,300	195
5. Lower Gunnison 1/	17,200	2,900	68
6. Paradox Valley	568	265,000	205
7. McElmo Creek	32,500	2,700	119
8. Uinta Basin 1/	13,600	4,500	83
9. Price River 2/	24,900	4,000	136
10. San Rafael River 2/	22,200	3,600	109
11. Crystal Geyser	150	14,000	3
12. Dirty Devil River	68,800	1,703	159
13. La Verkin Springs	8,300	10,000	109
14. Lower Virgin	7,200	2,800	27
15. Las Vegas Wash	72,000	2,000	196
16. Palo Verde Irrigation District	253,000	1,700	585
Totals	609,908	3/ 3,173	2,633

1/ Remaining flow after implementation of irrigation systems and onfarm improvements.
2/ Price and San Rafael Rivers in this study are considered separate sources. Public Law 96-375 authorizes feasibility studies for the Price-San Rafael Rivers Unit. Consequently, other report references to the "unit" will be the combined Price-San Rafael Rivers Unit.
3/ Weighted average.

After identification and quantification of saline sources, efforts were directed to highlighting opportunities of using saline water in powerplant cooling and industrial processing as well as coal slurry pipelines. The WSCC (Western System Coordinating Council) estimates that about 15,500 megawatts of new coal-fired generating capacity will be installed in or near the Colorado River Basin in the 1981-1990 period. These projections reflect the influence of recent energy conservation measures. An additional 17,000 megawatts of coal-fired generating capacity is anticipated in the Basin by the 1990's.

About 42 potential powerplant and synfuel facility sites located in the Basin were screened for saline water use. Those 42 sites are active as well as dormant in terms of near term potential development. Water supplies for most have already been identified and some have been obtained. Saline water use generally has not been considered because of the additional cost. However, if technical and financial barriers can be overcome, saline water use on a large scale could be achieved. The needs for cooling water in the 1980's for 15,500 megawatts of installed capacity would be about 185,000 acre-feet per year. A similar volume could be used in the 1990's. In view of the 610,000 acre-feet per year saline water supply available, a sizable portion of the projected future water requirement for energy development in and near the Basin could be met using saline water.

The study summarizes projected powerplant additions for the Western States and the Colorado River Basin to further delineate the need for cooling water. A significant shift in the electrical plant generation mix was seen over the next 25 years to coal-fired facilities. For purposes of this study, a coal market scenario was developed which projects the need for about 50 to 100 million tons of coal to be transported to possible future market centers near the West Coast. This is based on a conservative view of the combination of possible coal uses illustrated in the following table:

Table 2. - Estimated coal requirements

Coal use	Area	Total tonnage 1981-1990 (10^6 tons/yr)	Total tonnage 1990-2000 (10^6 tons/yr)
Coal-fired powerplants	Southern California	10	20
Coal gasification	Southern California	1	10
Coal export	Southern California	5	50
Subtotal		16	80
Coal-fired powerplants	Colorado River Basin States (approx.)	34	60
Total		50	140

WSCC is not now projecting any replacement of petroleum-fired powerplants in the southern California coastal plain. If such a policy were adopted, additional coal demands of 50 million tons could occur.

Public Involvement

A primary function of the public involvement process was to identify water-related problems and needs. These were verified by a planning team, and plans were formulated to meet those needs to the extent possible.

A plan of study was released in May 1980 for comment by the seven Basin States, Federal agencies, the environmental community, and energy development companies. Overall, the responses and comments were generally supportive and positive.

Four formal public participation group meetings were conducted, as well as several separate meetings with representatives of the environmental community, utilities, coal interests, and railroads as the study concepts evolved. As a result of the public participation meetings, the concepts suggested have been incorporated into the study effort and are reflected in the final report.

The public participation groups shown in table 3 provided review and consultation as the study progressed. The Forum adopted a policy statement indicating that to implement the concept of using saline waters the Basin States support Reclamation's special study of saline water collection, pretreatment, and potential industrial use. Energy interests supported the concept of saline water use for powerplant cooling and coal slurry pipelines but added that technology must be proven and that financial incentives were needed. The environmental community suggested that further consideration be given to pipeline systems to transport coal out of the Basin; some interest was indicated in disposing of saline water in dry lakes for possible use in solar salt gradient ponds for power generation and desalting.

Table 3. - Public participation groups

Contacts	Expertise
U.S. Fish and Wildlife Service	Identify fish, wildlife, and environmental concerns
Department of Energy	Energy development sites
Colorado River Basin Salinity Control Advisory Council and Forum	Legal and institutional concerns and potential resolution
Western Area Power Administration	Siting of future coal-fired powerplants
Environmental Protection Agency	Water and energy policy and program implementation
Energy Development Interests - Electric Power Research Institute and WEST Associates	Use of water for powerplant cooling and coal slurry pipelines
Office of Water Research and Technology and Utah State University	Research studies on use of saline waters
Environmental Interests - Environmental Defense Fund, Trout Unlimited, and National Wildlife Federation	Environmental impacts

On July 1, 1981, in Las Vegas, the public was given the opportunity to comment on the draft special report. Many comments were received and considered in preparing the final special report. Letters of support and indications of interest in participating were received and are appended to the main report.

Alternative Plans and Evaluation Basis

The alternatives selected for preliminary study exemplify a range of options based on public input and judgment of the Bureau of Reclamation planning team. The alternatives arrayed a range of options covering some of the technical possibilities as well as bracketing system costs and relative cost-effectiveness. The alternatives were grouped into two major categories: local use for energy development and long distance transport for use and/or disposal. No attempt was made to optimize systems or components of plans because of their preliminary status. The alternatives were developed to provide relative cost-effective comparisons with current structural control measures.

Study was made of the local use by linking saline sources with nearby (less than 100-mile delivery) powerplants for cooling water supply. Detailed analysis was made for three specific sites, and another seven sites were studied in less detail to present a more complete range of site sensitivity costs and total local use potential.

The long distance transport alternative addressed pipeline collection systems for the Upper Basin, Lower Basin, and entire Basin with terminus locations assumed at Sevier Dry Lake in Utah (for Upper Basin) and Danby Dry Lake in California (for Lower Basin and entire Basin). The long distance pipeline systems were sized to provide water for local use as well as export in order to provide system cost sensitivities. The systems were then developed with sufficient level of detail to estimate relative cost-effectiveness.

Finally, a base case provides a reference from which to measure the relative cost-effectiveness of the local use or long distance transport alternatives. In this case, the current cost-effectiveness for structural salinity control measures such as evaporation ponding and desalting are presented. The base case assumes that the most cost-effective measures, such as onfarm irrigation improvements and canal and lateral lining, where applicable, will generally have a higher priority of implementation than structural measures and would be implemented before more expensive measures involving desalting treatment and/or disposal of saline waters.

Potential for Cost Savings Beneficial Joint Use of Saline Water

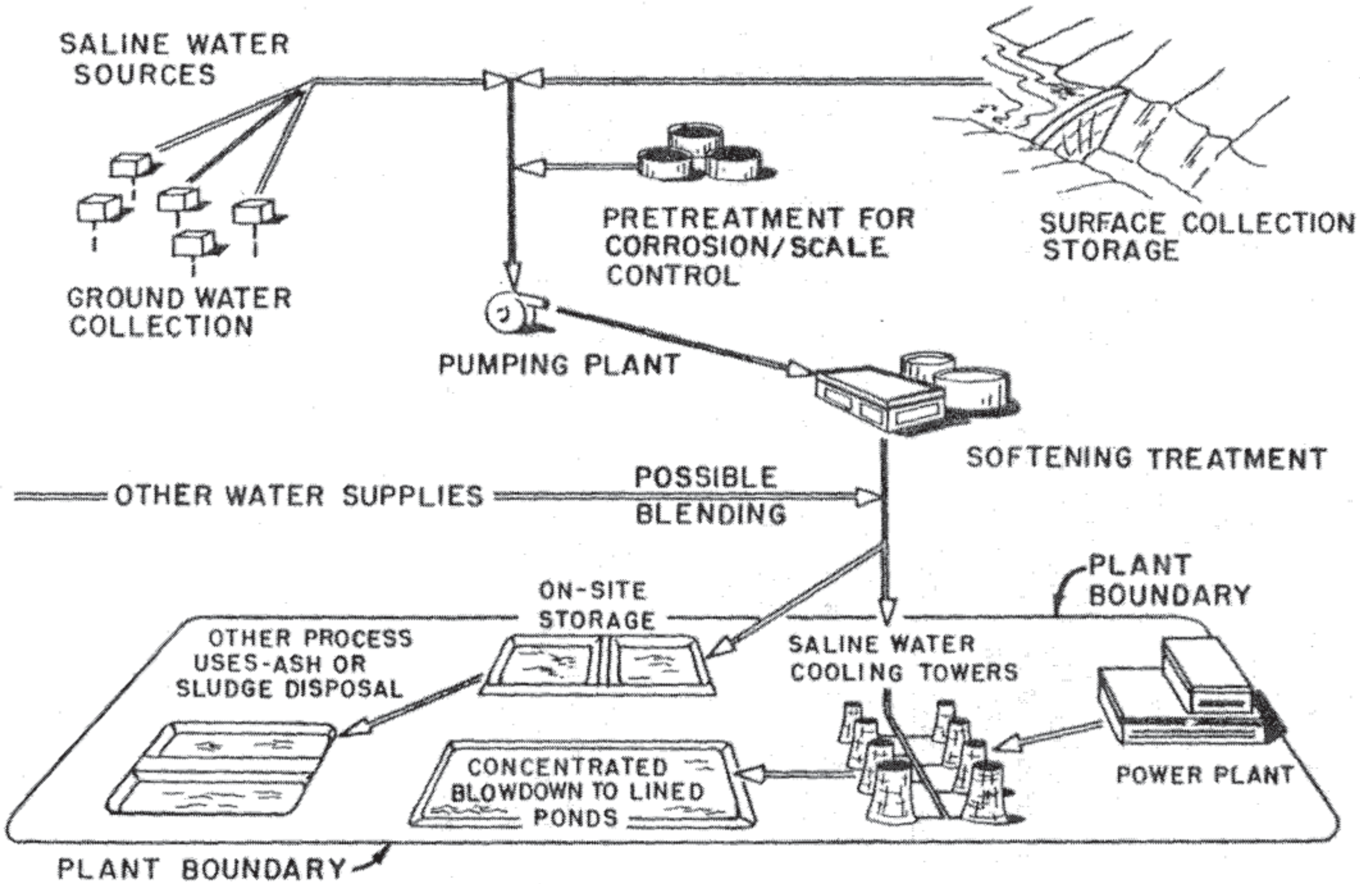
Potential beneficial uses of saline water are found in both the local use and export alternatives. Two beneficial use cases were studied to establish the general level of savings in joint development with private industry. Detailed economic analyses were not attempted in these cases since new technology, variable market conditions, and lack of data limited the depth of the investigation. The most promising beneficial use cases appear to be:

1. Local use of saline water for powerplant cooling (see figures 1 and 2). In this case, the unit costs of water supply presently facing utilities were estimated to derive monetary credits that could occur if saline water were sold to utilities. The incremental costs to the user of saline water for cooling in place of alternate freshwater sources were considered in the estimated credit.

2. A coal slurry pipeline carrying 50 or 100 million tons of coal per year to southern California using saline water as the transport medium (see figures 3 and 4). In this case, the primary cost savings are derived from providing a pipeline collection system and reliable water supply source for coal transport.

Cost-Effectiveness and Performance Summary

Table 4 summarizes the net cost-effectiveness estimates for the most promising alternatives developed in this study. Costs reflect net Federal costs after adjustments for savings or added costs resulting from beneficial use of saline water. In order to show relative cost-effectiveness and total salt removal potential, comparative estimates are also displayed for the base case and long distance pipeline transport alternatives. On this relative cost-effectiveness basis, the local use and coal slurry pipeline alternatives appear very attractive. On the other hand, the long distance



BENEFICIAL USE

Fig. I LOCAL USE OPTION (Delivery less than 100 mi.)

SYSTEM SCHEMATIC

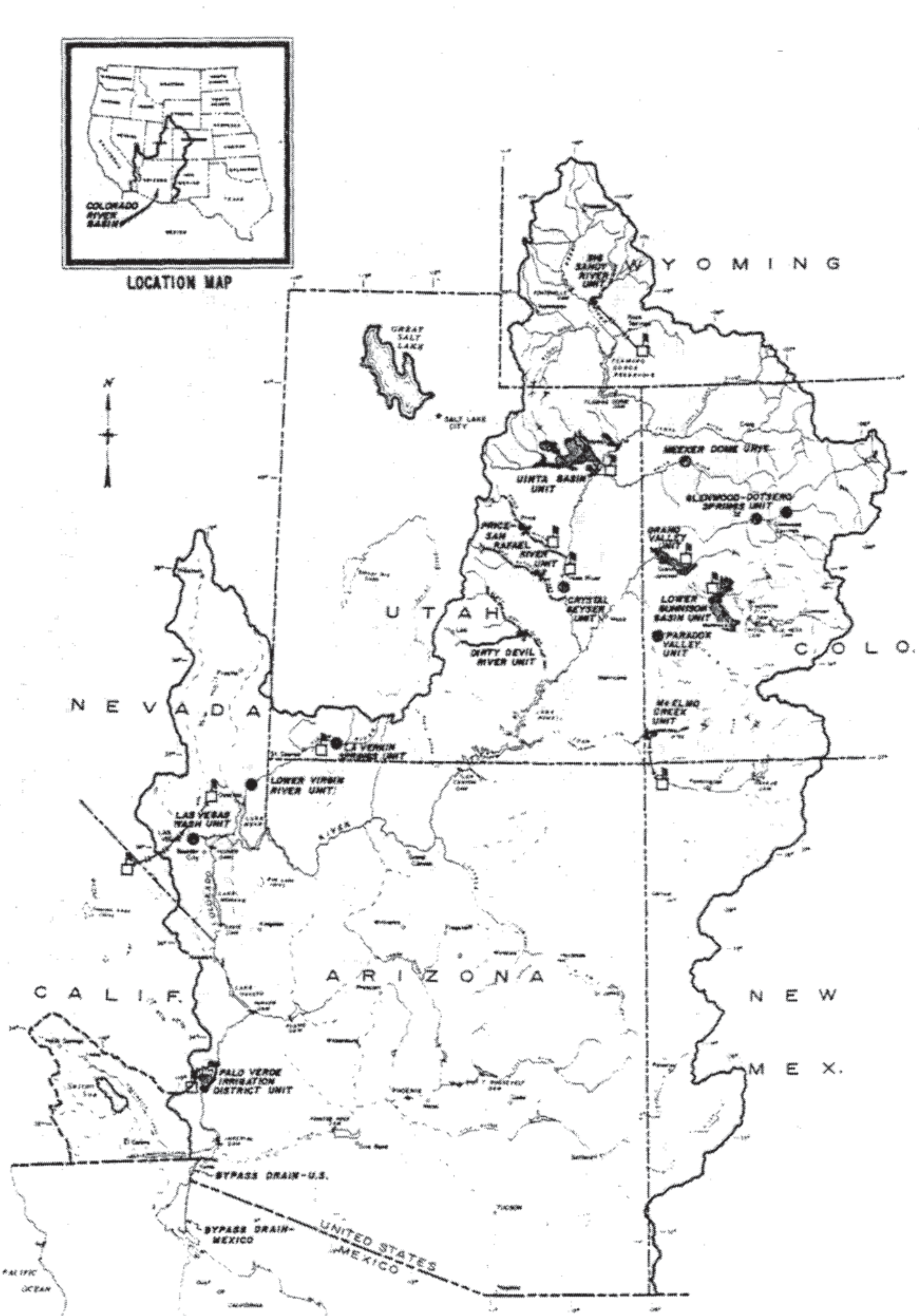


Figure 2

LOCAL USE OPTION

EXPLANATION

- IDENTIFIED SALINITY SOURCES
- PROPOSED DAM SITE
- COLLECTION POINT
- SALINE WATER PIPELINE
- WATER TREATMENT PLANT
- SALT-GRADIENT OR EVAPORATION PONDS
- POTENTIAL POWERPLANT

UNITED STATES
DEPARTMENT OF THE INTERIOR
BUREAU OF RECLAMATION

COLORADO RIVER
WATER QUALITY IMPROVEMENT
PROGRAM

ARIZONA-CALIFORNIA-COLORADO
NEVADA-NEW MEXICO-UTAH-WYOMING

SALINE WATER USE AND DISPOSAL OPPORTUNITIES
ALTERNATIVE NO. 1

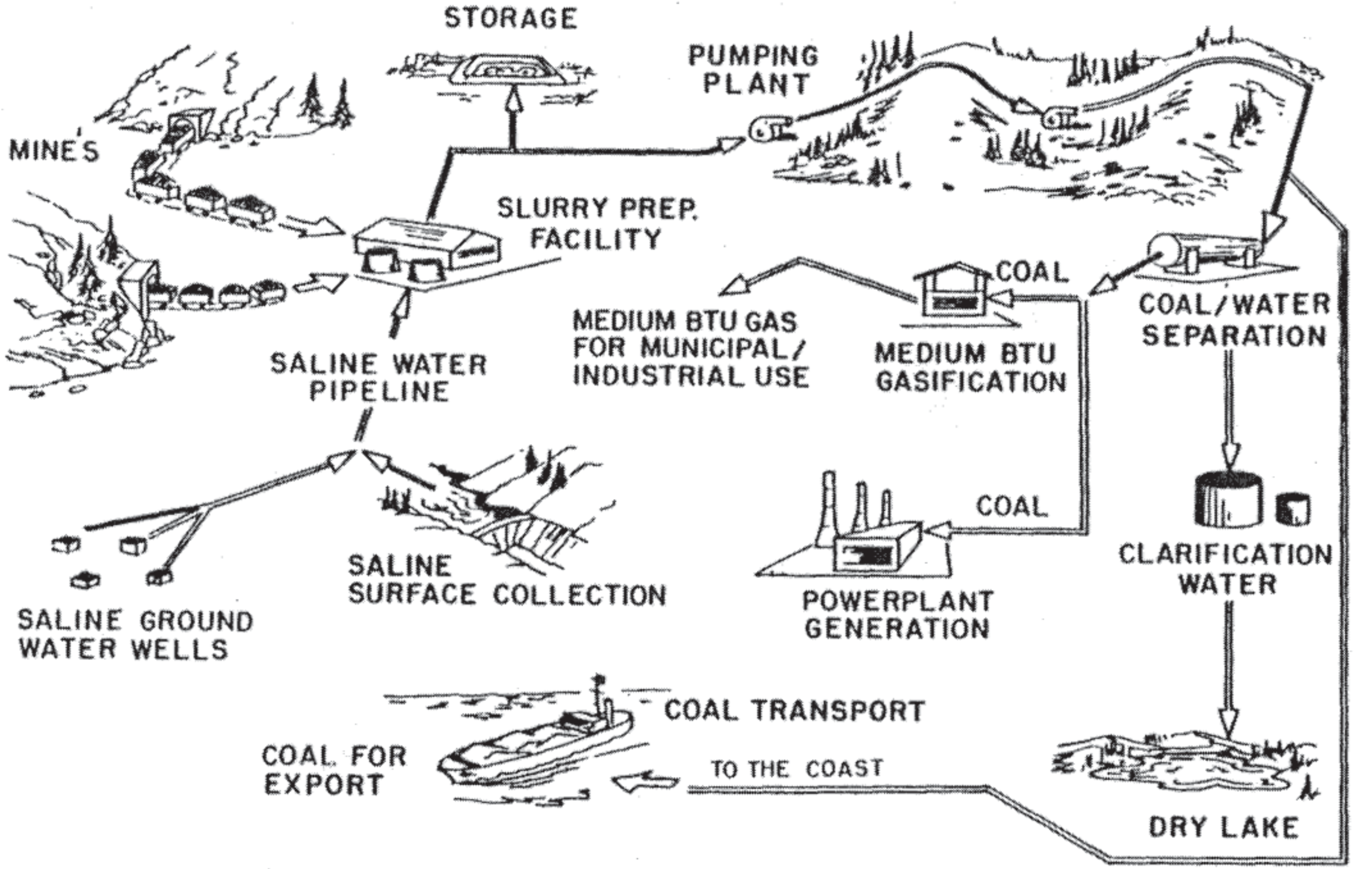


Fig. 3 COAL SLURRY PIPELINE SYSTEM
SYSTEM SCHEMATIC

Figure 4
COAL SLURRY ALTERNATIVE

transport alternative costs stretch beyond the present range of acceptable cost-effectiveness. It is readily acknowledged that not all additional costs and/or benefits of joint use could be identified or quantified at this time. As such, the net Federal cost-effectiveness estimates are very preliminary and subject to changing, site-sensitive cost conditions. However, the ranges of displayed costs, even allowing for considerable error in estimates, do give encouragement for more specific study of the local use and coal slurry transport cases.

Table 4. - Summary comparison of cost-effectiveness estimates for major study alternatives

Alternative	Potential salt removal (1,000 tons)	TDS reduction at Imperial Dam (mg/L)	Net Federal cost-effectiveness in $/mg/L per year
Base Case (desalting and evaporation ponds)	1,600	160	1,400,000 - 2,000,000
Long Distance Transport	768 - 1,975	77 - 198	1,850,000 - 5,130,000
Local Use			
Total potential for 10 sites	878	84	(Representative range as shown below)
LaVerkin Springs	103	8	795,000
McElmo Creek	60	6	880,000
Big Sandy River	98	8	519,000
Coal Slurry Pipeline			
100 million tons of coal	531	50	260,000
50 million tons of coal	183	15	518,000

It is also useful to view cost estimates for promising alternatives from a utility or industry viewpoint. Table 5 summarizes the Federal costs, incremental costs for use that could be reimbursed to industry, and alternative costs (credits) from the sale of saline water supplies for the base case and promising alteratives.

Table 5. - General display of Federal costs, reimbursable costs to industry, and water supply credits (total annual costs shown in parentheses) ($1,000)

Local use options	Federal investment costs for water supply system	Incremental Federal costs for use reimbursed to industry	Credit for providing an alternate water supply to industry	Net Federal cost
LaVerkin Springs	$ 24,304 (3,135)	$ 27,316 (3,226)	$ 0 (0)	$51,620 (6,361)
McElmo Creek	70,112 (6,104)	25,000 (3,183)	--- (4,000)	95,112 (5,287)
Big Sandy River	145,150 (14,550)	25,000 (3,183)	135,760 (13,593)	34,390 (4,149)
Coal slurry pipeline	**Total estimated non-Federal costs for slurry pipeline**	**Federal cost for water supply system**	**Credit from sale of water for slurry 1/**	
50 million tons per year	$1,810,000	$126,000 (15,000)	(7,000)	(8,000)
100 million tons per year	3,350,000	261,000 (27,000)	(14,000)	(13,000)

1/ Based on sale of water at $200 per acre-foot.

The local use options represent examples of the direct Federal costs for completing a saline water supply system (collection, storage, treatment, etc.) as well as net reimbursable costs that would be paid to industry after appropriate credits for providing a firm water supply. For coal slurry pipeline cases, total non-Federal pipeline system capital costs, Federal water supply costs, and credits for the sale of water indicate the general cost sharing potential.

Beneficial Use Cases Which May Warrant Further Study

Other potential beneficial uses include salt gradient solar ponds for desalting and power generation located at Sevier Dry Lake, Danby Dry Lake and locations within the Basin near saline water sources. Recent cost information from studies in Israel and at the Salton Sea in California indicates that power from solar ponds may be developed into an economically competitive source of power. If so, there may be opportunities to improve the apparent unacceptably high costs of long distance transport of saline wastewater through a joint use concept with solar pond development. Saline wastewater could be used to develop solar ponds either at local sites or in dry lakebeds.

Wastewater and blowdown collection and disposal service were also examined for energy development sites located near saline water pipeline collection systems. The costs of final disposal of wastewater or blowdown under zero discharge requirements for utilities in the Basin are significant. The unit costs of wastewater transport/export were compared against alternative costs for the utilities to dispose of wastewater individually by desalting or evaporating. If a long-distance pipeline is developed for other purposes, economies of scale may make wastewater collection and disposal a viable alternative.

Composite Alternative Plans

Additional study is needed to analyze adequately the potential of composite alternative plans. These alternatives could combine and optimize the different components and uses of saline water. Composite plans could include local use, wastewater disposal, coal slurry pipelines, salt gradient ponds, and other energy-related uses. Overall planning would integrate these various components into Basin-wide plans that would include staged development depending on needs of the salinity control program and various energy projects.

Major Issues and Concerns

Several issues and concerns were expressed during the course of the study related to water rights, compact allocations, saline water use technology, environmental impacts, institutional arrangements, and financial implications.

The water rights and allocation issue can be subdivided into three categories:

1. Current procedures for diverting saline water under State Water Law are unclear, particularly since (1) some States do not recognize salinity control as a beneficial use, and (2) only implied authority exists to purchase needed diversion rights from existing water rights holders for salinity control purposes. There is no uniform implementation of the Forum's policy of promoting saline water use in the Basin States.

2. Since a majority of the salinity control opportunities are in Colorado and Utah, potential exists for placing an inordinate depletion burden on those States if substantial volumes of water must be removed from the river system.

3. Studies of saline water use for industrial/energy-related purposes suggest that some of the more attractive options involve intrabasin/interstate transfer of saline water from source to point of use. Although procedures exist among Upper Basin States to allocate Colorado River water use to the State where the use takes place, no such procedures exist for intrabasin exchanges among Lower Basin States, nor from Upper to Lower Basin.

To one degree or another, these water right and allocation issues need to be addressed and resolved if the beneficial use concepts described herein are to come to fruition. On March 20, 1981, at its meeting in Scottsdale, Arizona, the Colorado River Basin Salinity Control Forum (representing the governors of the seven Colorado River Basin States) focused these water right and allocation issues to its work group for consideration.

The technology for saline water use in cooling powerplants, processing and transporting coal, and salt gradient solar ponds for power generation is not fully developed or widely accepted. Energy development interests are reluctant to make large investments in facilities without some evaluation of the reliability of new equipment. An urgent need has been identified for demonstrating the long-term maintainability and reliability of recently developed saline water cooling towers.

The environmental impacts of the alternative plans were considered in a Basin-wide or cumulative context. Significant impact highlights include:

1. Substitution of saline water for fresh water at local use sites would have only minimal incremental environmental impacts associated with collection systems and blowdown disposal requirements.

2. Saline water coal slurry transport pipelines could facilitate potential transfer of a significant part of energy development impacts outside of pristine areas in the Basin from mine mouth to near load centers. However, these impacts would have to be balanced against adverse impacts in the desert areas of California, which, themselves, have value for recreation and public use as relatively undisturbed natural areas.

3. Minor disruptions of land features, including wildlife habitat, may occur in collection areas and along pipeline routes. If existing road rights-of-way are used for pipeline corridors, impacts will be minimized over cross-country routes. All national parks, monuments, and scenic areas can be avoided. Coal transport by buried pipeline could reduce the need for long distance high-voltage transmission lines with attendant reduction in regional environmental impacts.

4. Use of saline water for coal transport to the West Coast could conceivably help in improvements in air quality in the Los Angeles basin. Coal-fired power generation and combined-cycle gas production in the

California desert areas could be used to replace or convert existing petroleum-fueled powerplants in the Los Angeles and San Diego basins.

5. Centralized collection of saline water and wastewater or blowdown for export to evaporation disposal sites presents an opportunity to contain or minimize undesirable environmental effects of final disposal.

The institutional arrangements for implementing the options considered in this study do not fit traditional modes, but rather lend themselves to a unique partnership between the Federal Government and industry. The nonsalinity benefits identified by the study would largely fall to non-Governmental entities in the form of decreased costs or increased project potentials. Alternatively, salinity control, environmental enhancement, and energy production potential associated with the options are regional and national in scope. In the coal slurry option, the benefits to industry would appear to suggest that leadership for implementation be in the non-Federal sector. Similarly, the local use options may lend themselves more to a turnkey approach by industry where long lead times for Federal water resources planning process could be avoided. In such partnerships, it may be desirable to have the Federal Government function as facilitator and financial participant as opposed to taking the lead in implementation.

The financial implications to the Government and industry from the concepts considered appear to be very significant. The base case of a sole source, Federal salinity control effort, using desalting plants and lined evaporation ponds for ultimate disposal, would require significant investments in terms of up-front construction costs plus continuing annual operation, maintenance, replacement, and energy costs. Conversely, if the private sector makes the identified investments for coal slurry lines and for local use water supply facilities, those investments would involve a similar financial demand. Thus, if a part of the Government capital, that would otherwise be dedicated to structural control measures, could be focused toward a joint venture with energy-related industries, the lesser combined costs could be shared with decreased investments by both. Detailed cost allocation for joint venture facilities would need to be addressed in future studies.

Conclusions

- Local saline water use (less than 100 miles) for energy production looks promising. However, cost-effectiveness is very sensitive to specific site conditions. Demonstration of the long-term operating characteristics of saline water cooling towers may be a prerequisite to local use.

- Most utilities need regulatory and/or financial incentives to encourage use of saline water as opposed to using fresh water. Financial assistance to offset additional costs of using saline water in combination with State implementation of the Forum's Policy for Use of Brackish and/or Saline Water for Industrial Purposes are necessary if these options are to be implemented.

- Use of saline water for coal slurry transport appears to offer significant potential for joint use savings and reduction in the costs of salinity control.

- Long distance transport of saline water (greater than 100 miles) for single purpose salinity control is generally not cost-effective and should not be further considered.

- Future generation of power or production of freshwater using the demonstrated technology of salt gradient solar ponds may soon become economically attractive. Because long-distance, single-purpose transport of saline wastewater is not cost-effective, the benefits of joint development are difficult to quantify. More study is needed to define costs and comparative economics.

- The economic and cost-sharing potential for the use of saline water pipelines in a wastewater collection system could not be determined and more study is needed.

- Composite plans that combine beneficial uses offer promise and warrant additional study.

Recommendations

- The legal and institutional issues and concerns raised concerning procedures for acquiring diversion rights, allocation of wasted saline water among State and Federal interests, and transfer of saline water across State boundaries need to be addressed by the Basin States acting through the Forum.

- An interagency and industry effort is recommended to demonstrate the reliability of advanced saline water cooling tower technology and other related technologies that are necessary for saline water use.

- The Department of the Interior should expedite feasibility level planning studies for local use of saline water on a site-specific basis where potential users express a willingness to participate in a joint venture. Such studies should be on a "fast track" basis, or alternatively delegated to utilities on a "turnkey" basis, in order to mesh with the planning horizon of utilities.

- A planning study of a coal slurry pipeline should be conducted using saline water for transfer of coal. It would be a cooperative study with private interests and the Forum to examine a broad range of physical, legal, and institutional alternatives prior to selection of a recommended plan.

- Following appropriate feasibility studies, the Secretary of the Interior should be granted authority to enter into contractual arrangements with private energy development interests to share the costs and benefits of saline water use.

- The States, acting within established legal constraints, should actively pursue implementation of the Forum's Policy for Use of Brackish and/or Saline Waters for Industrial Purposes.

- To further the development of a composite plan, continued research, technical studies, and detailed field evaluation should continue in cooperation with other Federal and State agencies for use of saline water in power generation or desalting using salt gradient pond technology.

Future Activities

In general, future studies anticipated after authorization and funding would depend primarily on close cooperation with industry. Cooperative studies and demonstrations will be necessary to pursue the promising alternatives in sufficient detail to resolve remaining questions and issues. The following schedule indicates the types of studies and construction activities that may be considered as well as a representative time requirement.

Fiscal Year 1982 - Develop a cooperative effort with other agencies and utilities to demonstrate saline water cooling tower capabilities and long-term reliability at a site in the Colorado River Basin.

Conduct a system analysis of the various promising alternatives to evaluate and tentatively optimize a composite plan.

Prepare a Plan of Study and Request for Proposal for a formal coal slurry pipeline study. Arrange for contributions and support from other interests.

Pursue local use studies with cooperating utilities on an opportunity basis.

Fiscal Year 1983 - Award contract for the cooperative coal slurry pipeline study.

- Begin demonstration of saline water cooling tower.

Fiscal Year 1984 - Complete contract study of coal slurry pipeline.

Fiscal Year 1984 and continuing - Begin construction of local use systems for saline water.

Fiscal Year 1985 - Arrange for coal slurry cost sharing joint ventures based on expected benefits to potential participants. Financial and construction arrangements to be completed along with legal and institutional clearances and approvals from the Colorado River Basin Salinity Control Forum and the Congress.

Fiscal Years 1986-1990 - Construction of coal slurry pipeline system.

Fiscal Years 1990-1995 - Completion of coal slurry pipeline systems.

The above schedules represent "most optimistic" implementation strategies based upon collaborative partnerships between government (Federal and State) and industry. Bringing these concepts to fruition in the time frames described above will occur only if the various interests commit the resources needed. Included must be timely authority, funding, and administrative action from the Federal Government; effective regulatory, legal, and institutional assistance from the States; and collaborative participation and associated risk-sharing by private industry. With such commitments of resources, saline water in the Colorado River Basin can be beneficially used in a timely and cost-effective fashion, and the salinity control program can proceed toward meeting its goals in a cost-effective and environmentally acceptable manner.