USDA SALINITY CONTROL

AND

ENVIRONMENTAL ASSESSMENT

Moapa Valley Subevaluation Unit, Nevada
Of The Virgin River Unit
Colorado River Basin Salinity Control Program

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United States Department of Agriculture

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FOREWORD

Moapa Valley Subevaluation Unit, a portion of Virgin River Unit, is a drainage to Colorado River. See the inside of the report cover. Moapa Valley Subevaluation Unit was identified as a problem area where irrigation and erosion are diffuse sources of salinity. During the study, alternative solutions were identified and estimates were made of effects of the plans to reduce salt loading to Colorado River.

An interdisciplinary team prepared the report. The "USDA Study Plan for the Virgin River Unit", revised August 1978, and the Soil Conservation Service (SCS) publication "Guide for Environmental Assessment", March 1977 along with SCS environmental policy and 7 CFR-650 were references. Information pertaining to assessments for compliance with the National Environmental Policy Act of 1969 is in the appendices.

Assistance from other Federal and State of Nevada agencies is acknowledged. Nevada Department of Wildlife information was used for biological assessment; the United States Department of Interior (USDI), Bureau of Land Management (BLM) color aerial photography facilitated identification of wetland areas; published reports, stream gage data and other information of the United States Department of Interior, Water and Power Resources Service (WPRS) and the USDI Geological Survey were used. Other input included Clark County Conservation District onfarm irrigation inventories; and reports prepared for Clark County, Nevada, for areawide water management planning which were used extensively.

The USDA, Science and Education Administration-Agricultural Research (SEA-AR) Salinity Laboratory, Riverside, California outlined study needs, provided consultative assistance and analyzed water quality samples. Their assistance in interpreting laboratory test results and reviewing results of the study was very helpful.

SUMMARY

Moapa Valley Subevaluation Unit, Nevada, is the first part of a study of Virgin River Unit in Arizona, Nevada and Utah. See Figure 1, The study identifies alternative solutions for reducing salt loading of Colorado River from irrigation and other diffuse salt sources.

Muddy River flows through Moapa Valley into Lake Mead. Moapa Valley is divided by the "Narrows" downstream of Glendale. Upstream of the Narrows the area is commonly known as "Upper Moapa Valley", and downstream the valley is known as "Lower Moapa Valley." The amount of land irrigated varies from year to year. The irrigated acreage is 4,982 with 2,060 acres in Upper Valley and 2,922 acres in Lower Valley.

The existing condition was evaluated and three levels of salt reduction were analyzed: Future Without Program, Alternative 1, and Alternative 2. The benefits and costs associated with these proposals are summarized in Table 2, page vi.

Muddy River is estimated to contribute an average of 73,400 tons of salt and 385,000 tons of sediment to Lake Mead each year. A future reduction of 19,500 tons of salt could be accomplished by: (1) improving the irrigation delivery system to reduce canal seepage (1,835 tons), (2) improving water management by increasing onfarm irrigation efficiency from 45 to 61 percent (17,390 tons), and (3) reducing erosion by shaping and seeding channel banks with protective measures at road crossings (270 tons) and irrigation management with return flow structures (5 tons). Installation of the erosion control measures is estimated to reduce the annual sediment yield by 5,000 tons. These components are explained in Alternative 2, the recommended plan.

Implementation of the recommended plan, Alternative 2 would requie semi-automated onfarm irrigation systems with a cost of $2,064,600. The present annual operation and maintenance cost would increase from $5,000 to $22,000 because of operation and additional maintenance (and replacement) cost needed for the automated systems. These increased costs would be offset by increased efficiency of crop production.

The existing canal and lateral systems in Upper Moapa Valley need improvement. The improvement of distribution systems in Upper Moapa Valley is needed to obtain onfarm improvements. A pipeline distribution system in Lower Moapa Valley is recommended for the automated onfarm irrigation systems. The cost of the off-farm distribution system is estimated to be $3,596,400. Presently, about $12,000 is spent annually for operation and maintenance. This cost does not include replacement commensurate with needs of the existing distribution system. Operation, maintenance and replacement cost of the recommended off-farm distribution system would be $30,300 annually.

Erosion control improvements are estimated to cost $112,100. Operation and maintenance cost is estimated to be $3,000 annually.

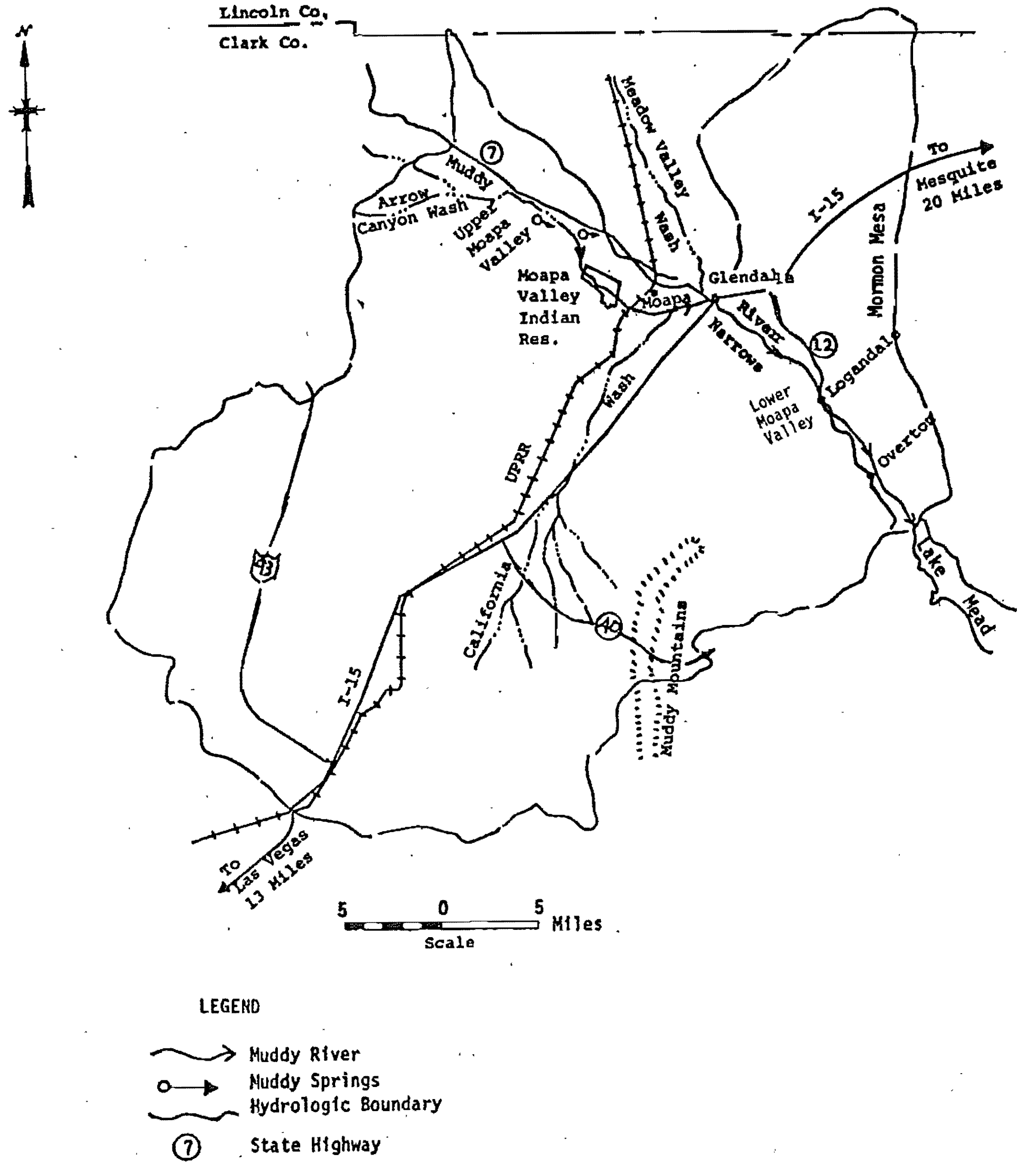


Figure 1

LOCATION MAP

Moapa Valley Subevaluation Unit, Nevada

of the Virgin River Unit

Colorado River Basin Salinity Control Program

Total cost for Alternative 2 including $506,800 for technical assistance is $6,279,900. Total program cost with operation, maintenance and replacement added in is $883,500 annually.

Downstream and onfarm annual benefits increase during installation and total $1,563,400 following installation. Downstream annual benefits are $1,032,400 based on a reduction of 2.0 milligrams per liter in salt concentration in the Colorado River at Imperial Dam near Yuma, Arizona. Water diverted for irrigation would be reduced 5,000 acre-feet increasing instream flow in Muddy River. An estimated 86 percent of this water could be applied to other uses. These other uses would have an annual value of $198,000 based on the value of water used for agriculture in the valley. Annual onfarm benefits accruing from implementing Alternative 2 are $333,000. This includes annual labor savings of $72,000. Total program benefits are $2,327,700 annually ($1,563,400 for a 25-year period and $764,300 during the installation period).

Implementation of Alternative 2 could require a 75 percent or greater federal cost-share assistance to assure farmer participation. Land users would furnish the remaining 25 percent or less, plus annual operation, maintenance, and replacement costs. See Table 1. High local indebtedness may require substantial cost-share assistance or total federal financing for the irrigation delivery system in Lower Valley. Proper irrigation water management of the improved systems will be essential to achieve the salinity control objectives.

TABLE 1. ANNUAL LEVEL OF FUNDING FOR 10-YEAR INSTALLATION PERIOD, ALTERNATIVE 2, MOAPA VALLEY SUBEVALUATION UNIT, NEVADA

Annual Federal Funding			Annual Other Funding			Annual
Construction 1/	Technical Assistance	Total	Construction	OM&R 2/	Total	Total
$433,000	$50,700	$483,700	$144,300	$5,300	$149,600	$633,300

1/ July 1980 Prices - Based on 75 percent federal cost-sharing assistance.
2/ OM&R: Operation, Maintenance and Replacement.

Table 2 is a summary of costs, benefits and physical effects and Table 3 is a summary of composite environmental ratings for alternative resource uses. Environmental evaluation inventory worksheets are in Appendix A. The results in Table 3 show no adverse composite effects to pertinent resource uses studied which result from proposed salinity control measures. Overall improvement in some resource conditions will occur with implementation of the recommended plan. Irrigation water delivered to the Overton Wildlife Refuge near Lake Mead will be of better quality. The improved low flow water quality and the vegetation to be established to control erosion will enhance wildlife habitat.

Physical land treatment of rangeland in Moapa Valley can not be justified and is not considered in this plan. There is no forest land. Unique cultural, historical, archeological, or natural resources will not be disturbed by the installation of proposed measures. About 32 acres of riparian wetland habitat will be converted to upland wildlife habitat which represents about 0.5 percent of the total wetland area in the Subevaluation Unit.

Monitoring of irrigation water management and related resources affected by the improvements will be inititated and expanded to assess impacts of proposed salinity control measures.

TABLE 2: SUMMARY OF SIGNIFICANT EFFECTS OF ALTERNATIVE PLANS MOAPA VALLEY SUBEVALUATION UNIT, NEVADA

ITEM	UNIT	FUTURE WITHOUT	ALTERNATIVES 1 1/	ALTERNATIVES 2 2/
COST (ONE-TIME):				
Onfarm Construction	$1,000	288.0	1,807.1	2,064.6
Delivery System Construction	$1,000	288.0	2,031.3	3,596.4
Erosion Control Construction	$1,000	24.0	112.1	112.1
Total Construction	$1,000	600.0	3,950.0	5,773.1
Technical Assistance (10 years)	$1,000	175.0	446.1	506.8
Total Installation	$1,000	775.0	4,396.6	6,279.9
ANNUAL COST 3/				
Installation 4/	$1,000	68.8	390.1	557.2
Operation, Maintenance and Replacement (OM&R)	$1,000	18.0	60.1	55.3
Interest During Construction 5/		48.8	187.9	253.5
Followup Technical Assistance (25 years)	$1,000	17.5	17.5	17.5
Total	$1,000	153.1	655.6	883.5
ANNUAL BENEFITS: -/				
Salinity Reduction (Downstream) 6/	$1,000	7.4	623.6	1,032.4
Increased Efficiency of Crop Production	$1,000	-0-	208.0	333.0
Other Water Uses	$1,000	12.5	90.8	198.0
Subtotal	$1,000	19.9	922.4	1,563.4
Benefits During Installation (10 Years)	$1,000	9.7	451.0	764.3
Total	$1,000	29.6	1,373.4	2,327.7
ANNUAL NET BENEFITS:	$1,000	-123.5	717.8	1,444.2
PHYSICAL EFFECTS				
Salt Load Reduction	tons/year	-200	11,800	19,500
Salt Concentration Reduction 6/	mg/l	0.01	1.2	2.0
Net Annual Increase of Water in River System	acre-feet	400	2,900	5,000
Wetland Habitat Lost	acre-value	8	21	21
Upland Habitat Gained	acre-value	-0-	114	114
Onfarm Increase in Fossil Fuel Requirement (Average Annual)	gallons/year	—	670	1,000

1/ Alternative 1 - Use existing canal and lateral systems with major repairs, improve onfarm irrigation systems and install erosion control measures.

2/ Alternative 2 - Improve canal, pipeline and lateral system onfarm irrigation systems and install erosion control measures. Minimum deep percolation and high irrigation efficiency.

3/ Compound interest at seven and three-eighths percent on expenditures (equal amounts) during the ten year installation period.

4/ July 1980 price base, 25-year life and interest at seven and three-eighths percent.

5/ Includes O&M, interest on O&M, and interest on the construction cost incurred during the installation period.

6/ Colorado River at Imperial Dam, near Yuma, Arizona.

TABLE 3. SUMMARY RATINGS

ENVIRONMENTAL EVALUATION

MOAPA VALLEY SUBEVALUATION UNIT, NEVADA

Resource Use	Present Conditions 1/	Future Conditions 1/ Planning Alternatives		
		Future Without	1	2
Cropland Production	3	3	3	3
Fish Habitat	3	3	3	3
Industrial Water Supply	4	4	4	4
Irrigation Water	3	3	3	3
Low Flow	2	2	3	3
Municipal Water Supply	3	3	3	3
Pastureland Production	3	3	3	3
Rangeland Production (not applicable)	-	-	-	-
Recreation	3	3	3	3
Wildlife Habitat	3	3	4	4
Economic	3	3	4	4
Visual Quality of Landscape	2.5	2.5	2.5	2.5
Social	2	2	2	2
Unique, Cultural, Historical, and Natural	3	3	3	3
Composite Rating	3	3	3	3

1/ The rating scale is from 1 to 5: 1, unsuited; 2, poor; 3, fair or neutral; 4, good; and 5, excellent.

INTRODUCTION

Authority for Investigation

The Colorado River Basin Salinity Control Act (Public Law 93-320) is the authority for USDA to participate in salinity control investigations along with the U. S. Department of Interior (USDI) and the Environmental Protection Agency (EPA) in the States of Arizona, California, Colorado, Nevada, New Mexico, Utah, and Wyoming. Title II (Section 203) of the act directs the Secretary of the Interior to cooperate with the Secretary of Agriculture in carrying out research and demonstration projects, and in implementing on-the-farm improvements and management practices and programs which will further the objectives of the salinity control program upstream from Imperial Dam on the Colorado River.

Section 203, under Title II defines USDA responsibilities on nine specified irrigation and diffuse source control units and such other areas which contribute significantly to the salinity problem in the Colorado River. Consequently the USDA identified seven other areas that may warrant study, including the Virgin River Basin.

In this report, USDA presents alternative plans for improvement of onfarm irrigation efficiency, expected effects these improvements will have on salinity and a plan for implementing the improvements.

The Memorandum of Understanding between the USDI and the USDA, effective November 27, 1974 (as extended October 26, 1979) was entered into under the authority of the Interdepartmental Work Service Act of March 4, 1915, (38 Stat. 1084), as amended: the Economy Act of June 30, 1932, (31 U.S.C. Sec. 686); and the Colorado River Basin Salinity Control Act of June 24, 1974, (88 Stat. 266). Also Memorandum of Agreement, effective March 27, 1975 as supplemented, was entered into between the Water and Power Resources Service (WPRS) (formerly the Bureau of Reclamation (USBR)) and the Soil Conservation Service (SCS) to implement the specific cooperative activities called for under Title II of the Colorado River Basin Salinity Control Act. Under this Memorandum of Agreement the Water and Power Resource Service agrees to:

1. Establish and develop cooperative Irrigation Management Services (IMS) programs.

2. Provide information relating to the development of designs for improvement of irrigation distribution systems to ensure that onfarm systems designed by the SCS can be successfully integrated into the distribution system.

3. Sponsor appropriate research, extension, and education programs.

4. Participate in the activities of local salinity control coordinating entities.

5. Coordinate investigations in diffuse source areas with appropriate agencies to formulate and implement salinity control plans.

Soil Conservation Service planning activities are authorized under PL-83-566 with added authority under PL-93-320, Section 203 (a) (1) and (b) (1). Under the Title II Memorandum of Agreement between WPRS and SCS, the Soil Conservation Service agrees to:

1. Support the IMS program by providing (a) technical assistance and (b) soil survey data on water management measures. This will be accomplished with ongoing programs with conservation districts.

2. Investigate and develop plans for feasible alternatives to implement onfarm programs to reduce deep percolation by improving irrigation efficiency. Alternative plans will be supplied to WPRS for inclusion in their plans for the area.

3. Arrange for Science and Education Administration - Agricultural Research (SEA-AR) or other appropriate USDA agencies to establish and conduct research and demonstration projects to advance the technology available for designing onfarm systems to increase irrigation efficiencies and control salinity from diffuse sources.

4. Participate in the activities of local salinity control coordinating entities and arrange for educational programs through the Cooperative Extension Service.

5. Appraise the salinity accretion emanating from within the diffuse source areas located on private lands and participate in the development of coordinated programs for these lands and the adjoining or included National Resource lands in cooperation with appropriate agencies of the USDI.

6. In cooperation with research and operational entities concerned with water quality conditions, undertake a comprehensive evaluation of agricultural water use and erosion as they relate to salinity control within the Colorado River Basin and report thereon.

7. The Memorandum of Agreement was ammended August 23, 1979 to include SCS study and installation of lateral improvements under ongoing USDA prograr

Objective and Scope

The objectives of the USDA's participation in the salinity control studies in the Virgin River Unit of the Lower Colorado River Basin are:

1. To determine the contribution of salt and sediment loading from irrigated land and related upland watershed areas.

2. To determine the opportunity for reducing salt loading (1) by reducing seepage and deep percolation losses through improving off-farm conveyance systems and onfarm irrigation efficiencies and (2) by controlling erosion and reducing sediment delivery from irrigated and non-irrigated croplands and contributing private watershed areas.

This study corresponds to the primary objective of salinity control as set forth in the Colorado River Basin Salinity Control Act (Public Law 93-320) and is coordinated with studies of other federal, state and local agencies in the area.

Salinity control contributes to the water quality improvement aspects of the Environmental Quality (EQ) objective as described in the Principles and Standards for Planning Water Resources, published by the U.S. Water Resources Council. The Act also recognizes the contribution that will be made to the Economic Development (ED) objective. By reducing salt loading the value of the Nation's output of goods and services will be increased. Components of the EQ and ED objectives in this study are:

Environmental Quality (EQ) - Improve water quality by reducing the sediment and salt load to the Colorado River and enhance fish and wildlife resources.

Economic Development (ED) - Increase the efficiency of agricultural production by improved irrigation efficiency and reduced downstream salinity damages.

The significant effects of the alternative plans are displayed in three accounts. These include Economic Development, Environmental Quality, and Social Well-Being. See the Alternative Plans section of this report.

The objective of the planning efforts is an implementation plan of action to accomplish the program objectives. The primary focus of the plan is to reduce salt discharges to the Colorado River by controlling salinity and erosion from irrigated and other private lands.

This study is coordinated with WPRS planning on LaVerkin Springs and the Lower Virgin River Units through the Interagency Salinity Control Advisory Committee.

Public Involvement Process

The Local Interagency Salinity Control Committee provides a forum for discussion of study findings and proposals, coordinates study activities and directs the public information program. This committee was organized on July 10, 1979 in Las Vegas. Prior to organization of the committee, public meetings were held to obtain local input. A meeting was held with WPRS's Interagency Planning Team for their Lower Virgin River Unit Salinity Study.

Following is a list of agencies participating on the Local Interagency Salinity Control Committee:

U. S. Department of Agriculture

- Agricultural Stabilization and Conservation Service
- Forest Service
- Science and Education Administration Agricultural Research
- Soil Conservation Service

U. S. Environmental Protection Agency

U. S. Department of Interior

- Bureau of Land Management
- Fish and Wildlife Service
- Geological Survey
- Water and Power Resources Service

State of Nevada

- Department of Wildlife
- Division of Colorado River Resource
- Division of Water Resources
- Cooperative Extension Service
- Desert Research Institute
- Division of Environmental Protectio

Clark County, Nevada

- Comprehensive Planning
- Conservation District
- Public Works Department

Town Boards - Clark County, Nevada

- Glendale
- Overton

Muddy Valley Irrigation Company

An interagency team was organized to conduct an environmental evaluation of the study area. Meetings of the environmental evaluation team members were limited to participants having direct data contributions to specific study tasks; for example, the biological assesment task. Participant include representatives of agencies listed on the Local Salinity Control Committee.

An Interim Salinity Report and Environmental Assessment, Moapa Valley, Nev was prepared in September 1979 and distributed for review by study participants. The final draft of the USDA Salinity Control and Environmental Assessment, Moap Valley Subevaluation Unit was prepared in June 1980 and distributed for review by the Interagency Salinity Advisory Committee, the Local Interagency Control Committee, and others who might be interested. Ninety copies of the draft repo were distributed. Below is a list of reviewers who transmitted written comment and the date of their letters.

REVIEWER	TRANSMITTAL DATE
Clark County, Nevada, Dept. of Comprehensive Planning, Las Vegas, Nevada	September 18, 1980
Clark County, Nevada Dept. of Public Works Las Vegas, Nevada	September 2, 1980

REVIEWER	TRANSMITTAL DATE
State of Nevada, Cooperative Extension Service, Logandale, Nevada	October 8, 1980
State of Nevada, Dept. of Conservation and Natural Resources, Div. of Environmental Protection, Carson City, Nevada	september 18, 1980
State of Nevada, Div. of Preservation and Archeology, Carson City, Nevada	Septmber 2, 1980
State of Nevada, Div. of State Parks Carson City, Nevada	September 17, 1980
State of California, Colorado River Board of California, Los Angeles, California	October 30, 1980
USDA, Science and Education Administration, Agricultural Research, Western Region Riverside, California	September 5, 1980
USDI, Bureau of Indian Affairs, Western Nevada Agency, Stewart, Nevada	August 12, 1980
USDI, Bureau of Land Management Las Vegas, Nevada	August 28, 1980
USDI, National Park Service, Lake Mead Recreation Area, Boulder City, Nevada	August 20, 1980
USDI, Water and Power Resource Service Boulder City, Nevada	September 24, 1980
USDI, Water and Power Resource Service Denver, Colorado	November 7, 1980

Additional verbal comments were provided by members of the Nevada State Coordinating Committee for the Rural Clean Water Program at their meeting on September 10, 1980, in the Nevada State ASCS Office, Reno, Nevada.

An application for Rural Clean Water Program funds by the Clark County Conservation District for the Muddy River Water Quality Improvement Program was reviewed at the meeting. The application contains portions of this report.

Improvements adopted at the meeting were incorporated into this report.

The application for funds and this report have been updated to current prices and rates of interest used for water resource planning.

SETTING

Location

Moapa Valley Subevaluation Unit is in Clark County near the southeastern corner of Nevada (see Figure 1). This unit is about 40 miles long in a north-south direction and has an area of 874 square miles. Interstate Highway 15 crosses the study area in a northeast direction. Other highways include State Highway 40 and U.S. Highway 93. In addition, the Union Pacific Railroad traverses the unit. Most services are available within a two hour drive in the Las Vegas metropolitan area.

During planning the Moapa Valley was determined to be a contributing area of salts to the Colorado River and was selected by USDA for study. Areas not studied are Upper Muddy River, White River and Meadow Valley Wash areas, which are essentially noncontributing areas on which a treatment program would not significantly reduce salinity. See inside of cover.

Figure 2 shows land ownership within the Moapa Valley Subevaluation Unit in Nevada. Study objectives are for improvements on privately owned and Indian owned lands. Figure 3 shows the Moapa Valley area of privately owned and Indian owned lands on which program implementation would occur. Environmental impacts other than those related to downstream water quality and quantity will occur within this vicinity. Such impacts include improvemen of low flow water quality, disturbance of wildlife habitat due to additional agricultural activity, etc.

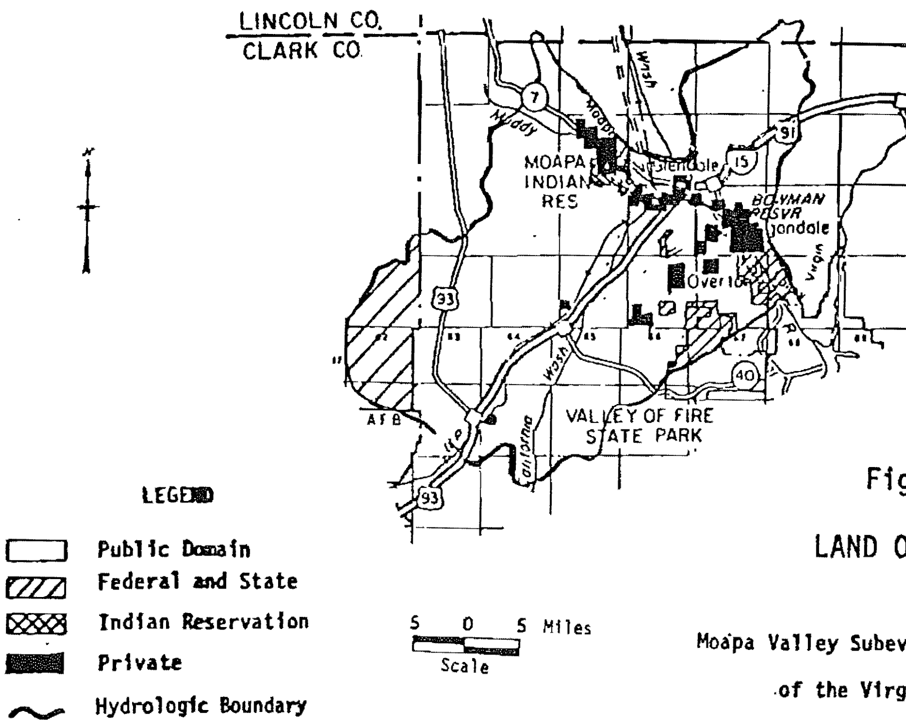


Figure 2

LAND OWNERSHIP

Moapa Valley Subevaluation Unit, Nevada
of the Virgin River Unit
Colorado River Basin Salinity Control Prog

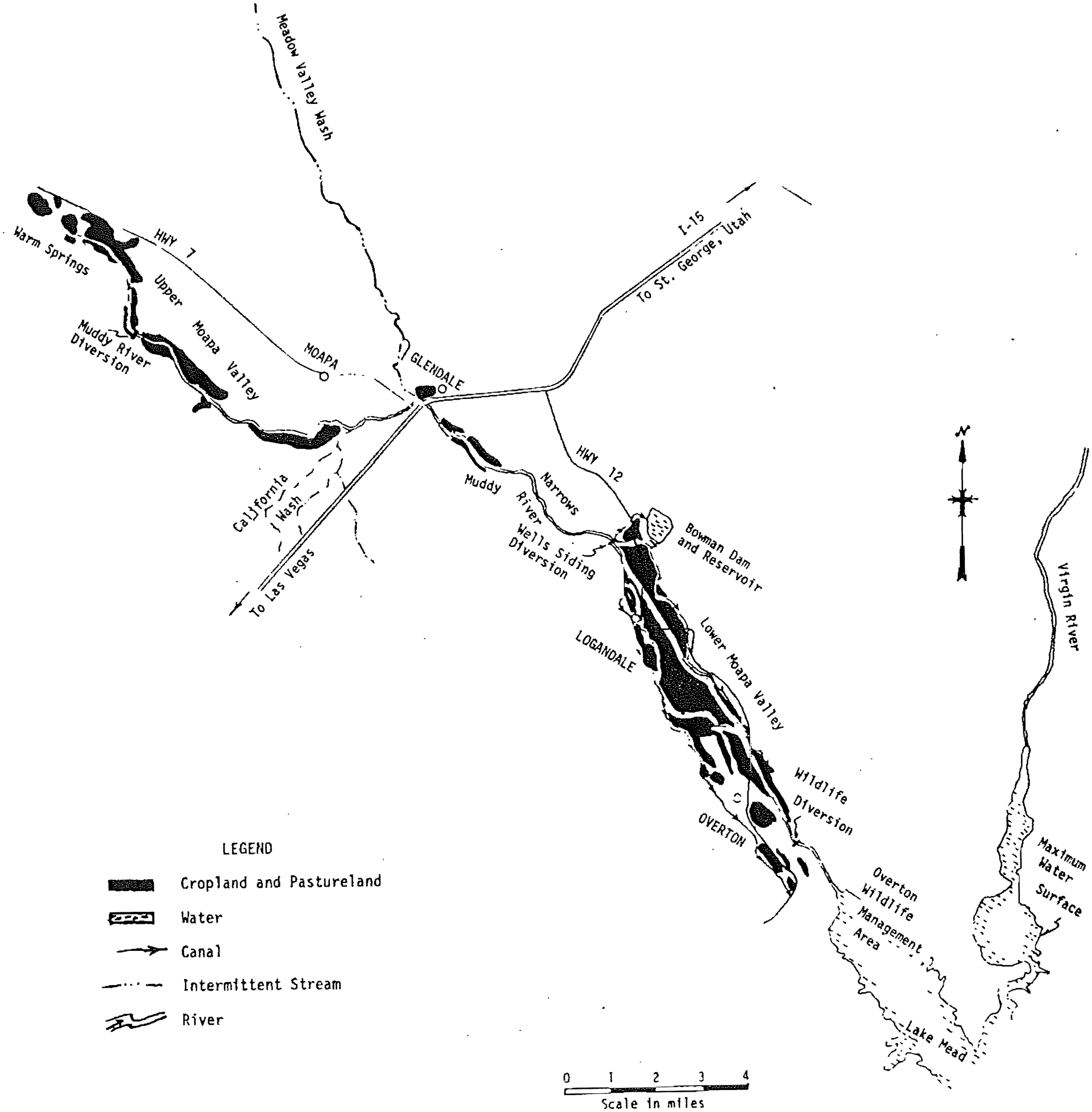


Figure 3

PROGRAM AREA MAP

Moapa Valley Subevaluation Unit, Nevada
of the Virgin River Unit
Colorado River Basin Salinity Control Program

Natural Environmental Characteristics

Physiography and Geology

The Moapa Valley Subevaluation Unit is in the Basin and Range Province and elevations vary from about 3,000 feet at the highest point to about 1,200 feet at Lake Mead. The relief and topography is characterized by mountain ranges and ridges and intermontane valleys such as Moapa Valley, Meadow Valley Wash and California Wash.

The four geomorphic units recognized in the area are the folded and faulted mountains, the intermediate slopes below the mountains and slightly above the valley floor, the valley floor, and low lying flood plains of the drainage systems.

Thrust faulting and folding formed the mountainious terrain. As this structural activity occurred, adjoining basins were subsequently filled with deep alluvial and lacustrine sediments.

Rocks in the area are sedimentary and consist of limestone, dolomite, shale, sandstone, conglomerate, and gypsum and salt (see Figures 4-A and 4-B). These rocks indicate the topographic and climatic conditions that existed in the area during their time of deposition.

During much of geologic time the study area had an environment conducive to the formation of calcium and magnesium carbonate rock (limestone and dolomite), calcium sulfate (gypsum) and sodium chloride (salt). These rock types have an effect on the salinity of water (surface and subsurface) and soils.

The following rock units mapped (see Geologic Maps Figure 4-A and 5) in the study area and interpretations as to environments of deposition are from Longwell (1928).

Muddy Creek Formation: During time of sedimentation the region was arid, with basin and range topography. Basins alternately held playas and shallow lakes. Lake waters were strongly saline and when complete evaporation occurred bodies of rock salt and gypsum were formed.

Horse Spring Formation: During time of sedimentation the area was arid with low ridges and shallow basins in which playa deposits were formed. The area had widespread discontinuous water bodies in which calicum and magnesium carbonate, gypsum and associated saline materials plus sand and silt were deposited.

Overton Fanglomerate: Characteristic of a deposit in an arid country of high relief. Considered as a formation built on a relatively steep grade adjacent to high scarps by swift intermittent desert streams.

Jurassic Cross Bedded Sandstone: Probably continental.

Chinle Formation: Characteristic of arid climate deposition in water with basin or lagoon conditions indicated by gypsum layers.

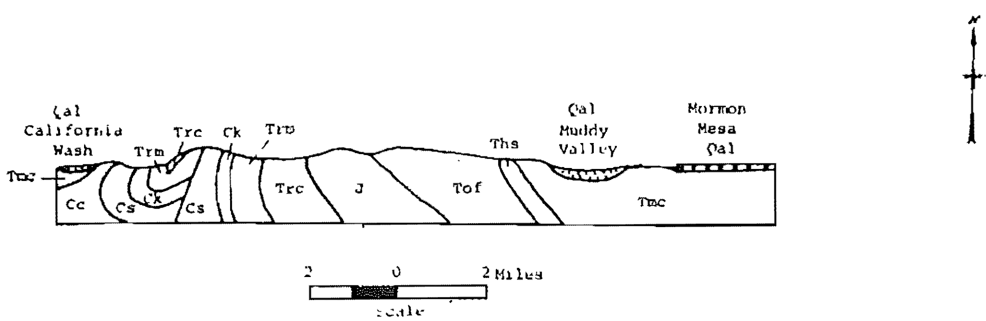
Shinarump Conglomerate: May represent deposition by slope wash and temporary streams in areas with moderate relief and arid or semiarid climate.

Moenkapi Formation: Lower part of formation deposited in shallow marine waters. Gypsum near the top indicates partial or complete isolation from the open sea, perhaps in a hot, dry climate. The top of the formation has ripple marked sandstone, gypsum and indications of lagoon and deltaic conditions in a dry climate along the margin of a slowly withdrawing sea.

Kaibab Limestone: Formed in a shallow sea in a generally arid climate as indicated by gypsum layers.

Supai Formation: Continental and probably nearshore conditions with effective dry seasons as evidenced by the red sandstone and gypsiferous shale. These are massive beds of gypsum up to 15 feet in thickness southwest of Overton.

Callville Limestone, Bluepoint Limestone, Rogers Spring Limestone, and Muddy Peak Limestone: Probably all shallow inland sea formations.



LEGEND

Qal	Alluvial deposits
Trc	Muddy Creek formation
Ths	Horse Spring formation
Tof	Overton famglomerate
J	Red and gray sandstone
Trc	Chinle formation
Trm	Moenkopi formation
Ck	Kaibab limestone
Cs	Supai formation
Cc	Callville limestone

Reference: Longwell, C. R., 1928

Figure 4-A

GEOLOGIC CROSS SECTION

Moapa Valley Subevaluation Unit, Nevada

of the Virgin River Unit

Colorado River Basin Salinity Control Program

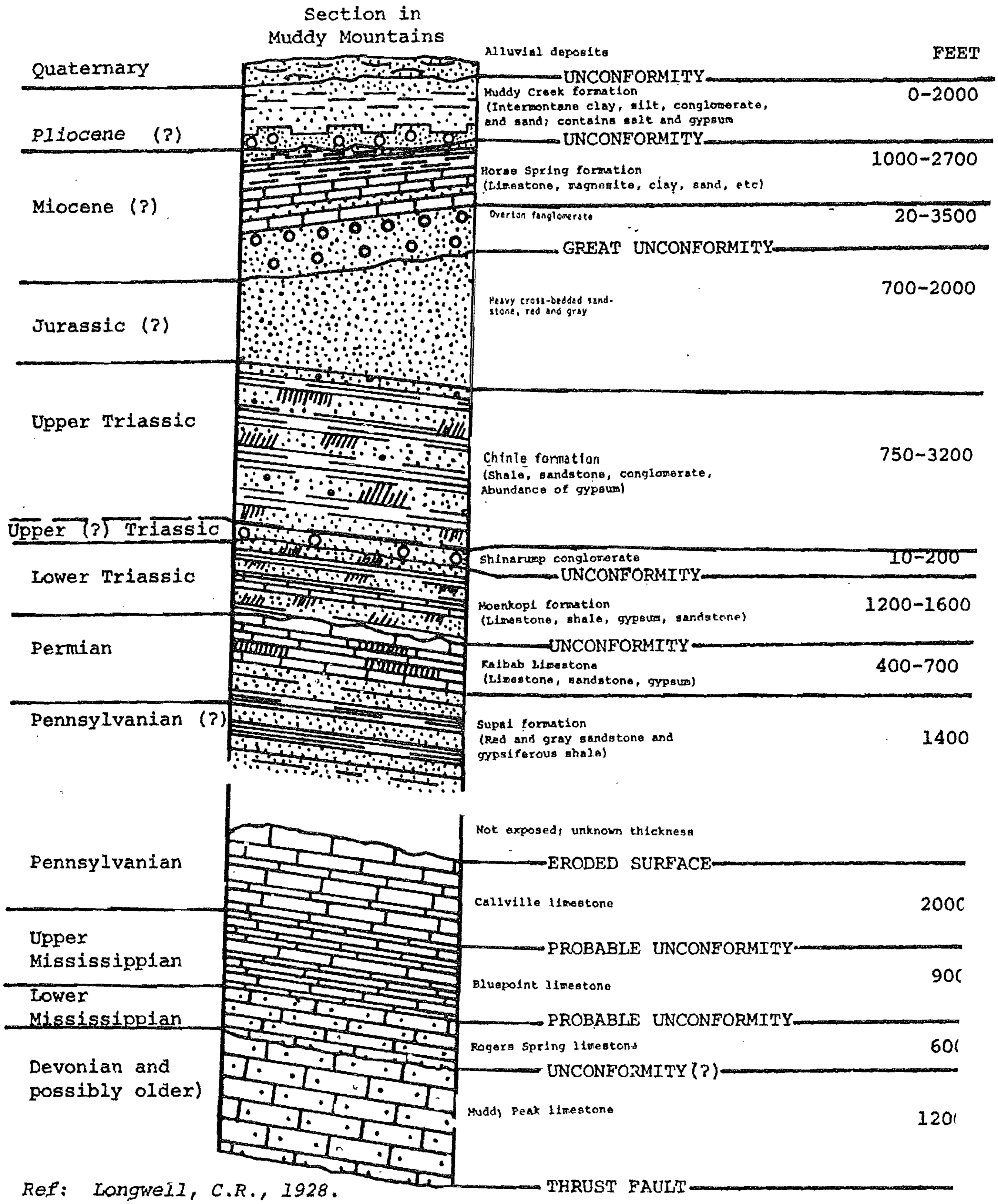
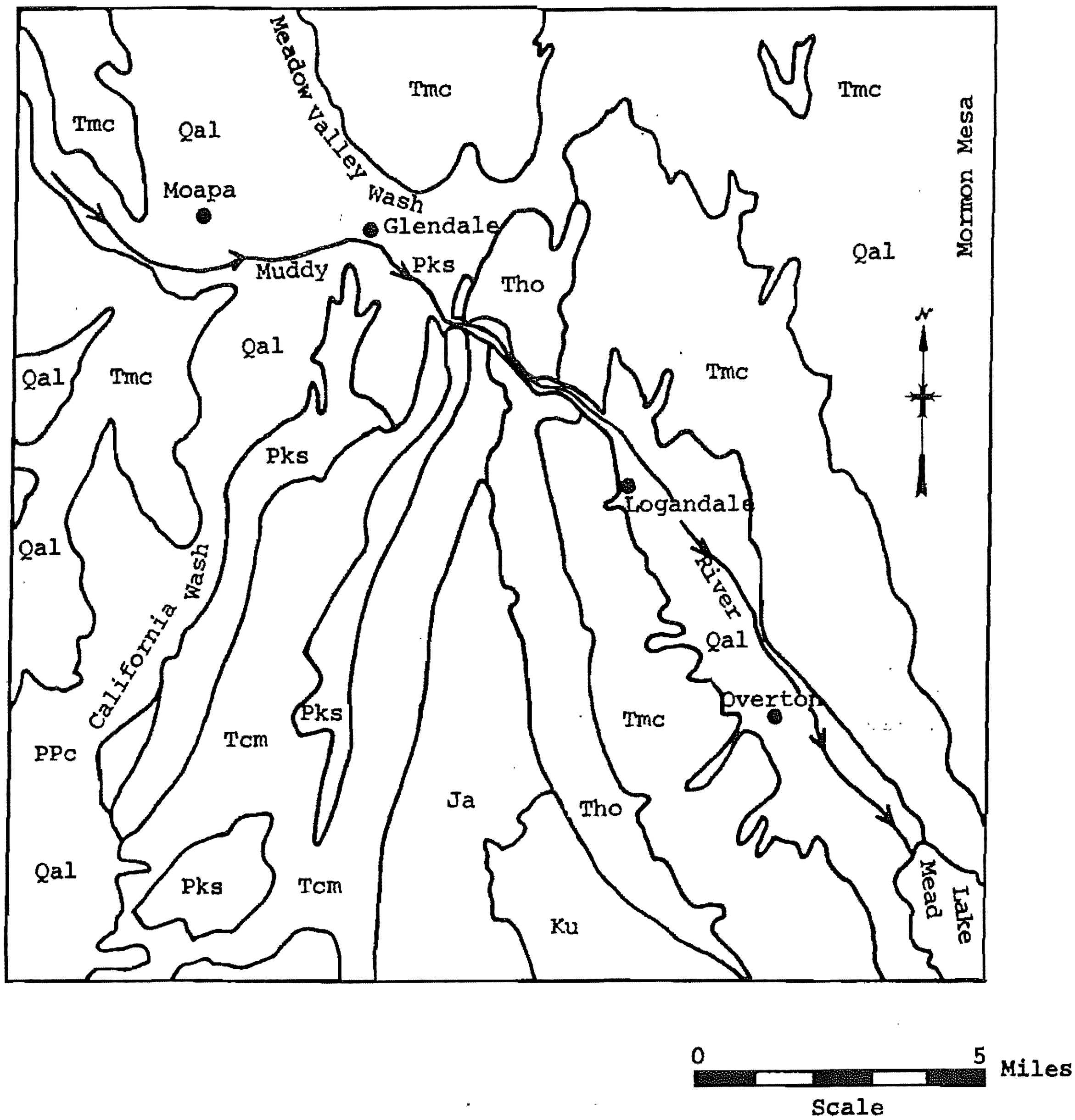


Figure 4-B

GEOLOGIC SECTION

Moapa Valley Subevaluation Unit, Nevada
of the Virgin River Unit
Colorado River Basin Salinity Control Prog



LEGEND

Qal	Alluvium
Tmc	Muddy Creek formation
Tho	Horse Spring formation and Overton famglomerate
Ku	Cretaceous rocks, undifferentiated
Ja	Aztec sandstone
Tcm	Chinle formation including Shinarump member at base, and and Moenkopi formation
Pks	Kaibab limestone and Supai (?) formation
PPc	Callville limestone

Ref: Modified from Bowyer, Pampeyan and Longwell, 1958 Geologic Map of Clark County, Nevada, Mineral Investigations Field Studies Map MF 138.

Figure 5

GEOLOGIC MAP

Moapa Valley Subevaluation Unit, Nevada

of the Virgin River Unit

Colorado River Basin Salinity Control Program

Climate

The Moapa Valley Subevaluation Unit is in an arid climatic regime. The frost-free season (in the irrigated area) averages about 240 days. Based on observations at Lake Mead since 1936, the average annual evaporation from a free water surface is 80 inches. Evaporation rates are highest during July, August and September when 10 to 12 percent of the total evaporation occurs each month. At Overton, the December mean temperature is 45° F. while the July mean is 85° F. The precipitation in the irrigated area varies from three inches during an average year to about six inches in a wet year and comes in the form of rain primarily in the winter months. A few summer convective storms are likely to occur and can cause serious problems such as flooding, crop damage, and erosion.

Water Resource

Muddy River water has been used for irrigation in Moapa Valley since the latter 1850's. The mineral content of the water makes it undesirable for domestic use.

Surface Water - The surface water supply originates from Muddy River Springs in Upper Moapa Valley and flows about 25 miles to the southeast where it empties into Overton Arm of Lake Mead, just south of Overton, Nevada The mean annual discharge measured below Muddy River Springs at Moapa USGS Gaging Station in 1977 was 32,670 acre-feet with 39 years of record. The gaging station at Glendale which measures the streamflow to Lower Moapa Valley had an average annual discharge in 1977 of 32,750 acre-feet with 27 years of record. Tributary areas contribute little water. Less than five percent of the average annual flow is produced by surface runoff from summer storms. Runoff from Meadow Valley Wash and California Wash only occur during infrequent large convective storms.

Ground Water - In Upper Moapa Valley 3,920 acre-feet of ground water is pumped for irrigation and cooling at Nevada Power electrical generating plant. Little pumping in Lower Valley occurs because the quality of the water is poor. Ground water samples from wells in Moapa Valley reflect the presence of geologic formations containing soluble and moderately soluble minerals, such as halite (sodium chloride) and gypsum (calcium sulfate). Sodium and calcium are the principal positive ions found in the ground water while sulfate and bicarbonate are the predominant negative ions.

Water Use - The major use of water is by irrigated agriculture in Moapa Valley. Large volumes of water are also consumed by phreatophytes and by evaporation. The reuse of water in onfarm systems is minor. The effect of water reuse on irrigation efficiency is small. The principal reuse of water consists of irrigation runoff, return flows, and power plant return flow in the Upper Valley being delivered to the Lower Valley for irrigation. Some 7,035 acres of wetland supporting phreatophytes (of which 1,559 acres are riverine) use an estimated 3,200 acre-feet of water annually. Salt cedar and arrowweed provide a limited amount of nesting for song birds.

Water Budget - The average annual outflow of Muddy River to Lake Mead is estimated to be 16,400 acre-feet. Surface outflow is 5,250 acre-feet and sub-surface outflow is 11,150 acre-feet. A summary of water supply and depletions for Muddy River is given in Table 4, Water and Salt Budgets.

Water Quality - The water of Muddy River at Muddy Springs has an average dissolved mineral or salt concentration of 683 milligrams per liter (mg/l). The average concentration increases to 941 mg/l at the stream gage near Glendale. At Wells Siding Diversion and Bowman Reservoir in the Lower Valley, the average surface water quality is 1,111 mg/l. Drain water concentrations in Lower Moapa Valley range from 4,494 to 5,825 mg/l. The average salt concentration of ground water in wells is 1,971 mg/l. The surface water flowing into Lake Mead has an average annual salt concentration of 2,397 mg/l. The ground water entering Lake Mead has an estimated salt concentration of 3,722 mg/l (weighted value of drains and wells). A map illustrating the change in salinity concentration of the surface water of Muddy River is shown in Figure 6-A.

Muddy River has moderately mineralized water which has a high proportion of calcium, magnesium, and sulfate in relation to sodium and chloride. The concentration of dissolved solids and the relative abundance of sulfate in Muddy River increase downstream. Increases result from the addition of more saline ground water, irrigation return flows during the growing season, and other factors such as evaporation. Table 5 shows typical concentrations of constituents in the surface waters of Muddy River. Tables 6 and 7 give typical compositions of drain and ground water in Moapa Valley.

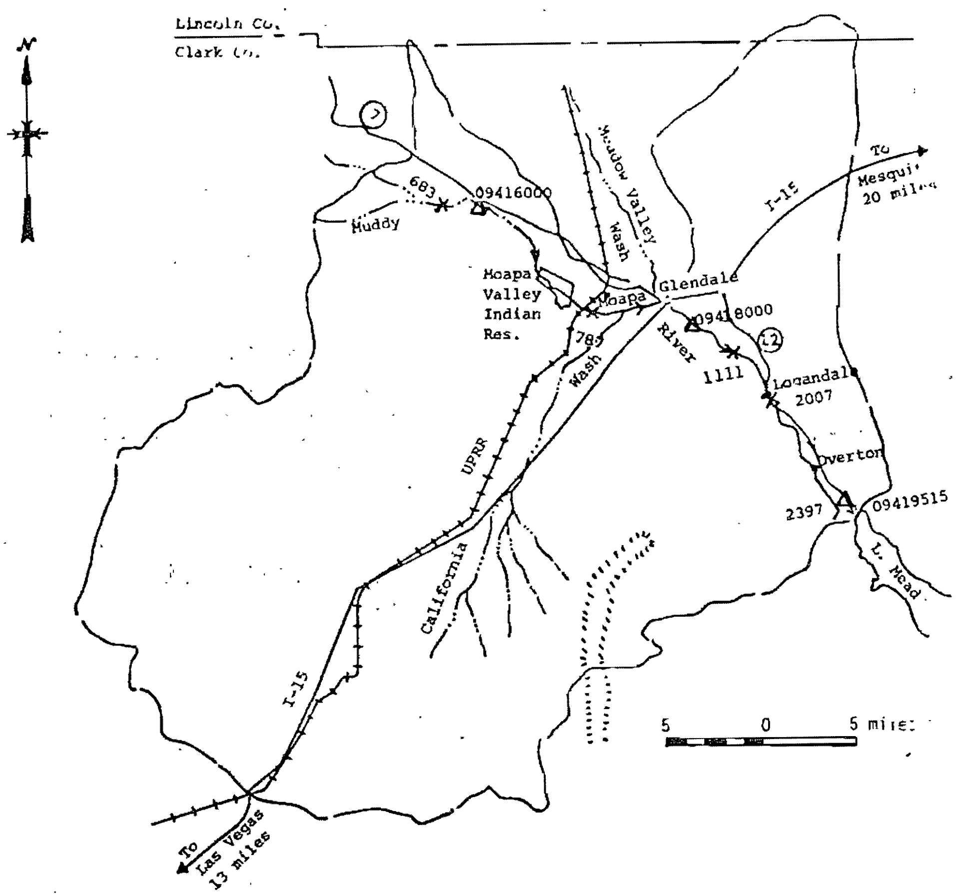
Salt Budget - Approximately 38,900 tons of salt flow annually from Muddy River Springs in Upper Moapa Valley. Downstream, additional salts are contributed from ground and surface waters of Meadow Valley Wash, California Wash, and from irrigation return flows. The salt loading at Glendale gage, near the mouth of Upper Moapa Valley increases to about 41,900 tons.

The average annual salt load at Wells Siding Diversion Dam near the head of Lower Moapa Valley is 49,500 tons. The increase in salt load in the Narrows between Glendale gage and Wells Siding Diversion Dam is from subsurface flow (through saline aquifers) and erosion. Agricultural irrigation is estimated to add 21,300 tons of salt to the outflow of Lower Moapa Valley. Erosion processes in Lower Valley are estimated to add 2,700 tons of salt to the total outflow. Total salt contribution each year from Muddy River Drainage is estimated to be 73,400 tons.

The salt budget is given in Table 4. Figure 6-B illustrates the magnitude of component salt loads. Figure 6-C shows the cumulative addition of component loads.

TABLE 4. WATER AND SALT BUDGETS PRESENT CONDITIONS (1978)
MOAPA VALLEY SUBEVALUATION UNIT, NEVADA

	Water Acre-feet/year	Salt tons/year
Upper Moapa Valley		
<u>Water Supply</u>		
Springs above Moapa Gage (#09416000)	39,900	38,900
California, Meadow Valley, Weiser Washes	2,200	
Subtotal	42,100	
<u>Depletions</u>		
Power and Evaporation	600	
Crop Use (Irrigation)	7,850	
Phreatophytes	1,000	
Subtotal	9,450	
Water at Glendale Gage (#09418000)	32,750	41,900
Lower Moapa Valley		
<u>Water Supply</u>		
Water at Wells Siding Diversion Dam	32,750	49,500
Side Wash Inflow	500	
Subtotal	33,250	
<u>Depletions</u>		
Evaporation	2,900	
Crop Use (Irrigation)	11,750	
Phreatophytes	2,200	
Subtotal	16,850	
Lake Mead		
Surface Flow from Moapa Valley	5,300	17,100
Groundwater Flow from Moapa Valley	11,100	56,300
Total Outflow from Moapa Valley	16,400	73,400



LEGEND

Hydrologic Boundary

Δ Stream Gage Station

2397 Total Dissolved Solids in mg/l

(7) State Highway

Figure 6-A

SALINITY CONCENTRATION OF TOTAL DISSOLVED SOLIDS

SURFACE WATER

Moapa Valley Subevaluation Unit, Nevada

of the Virgin River Unit

Colorado River Basin Salinity Control Program

TABLE 5. CHEMICAL COMPOSITION, MUDDY RIVER SURFACE WATERS MOAPA VALLEY SUBEVALUATION UNIT, NEVADA

Location	Na^+	K^+	Ca^{++}	Mg^{++}	Cl^-	HCO_3^-	SO_4^{-2}	NO_3^{-2}	TDS	SAR
	(Concentration in mg/l or ppm)									
Muddy River Springs 1/	108	11	68	30	65	288	192	12	774	2.8
Glendale Stream Gage 2/	-	-	-	-	108	293	-	3	980	-
Wells Siding Diversion 3/	213	19	104	46	104	288	383	10	1167	3.1
Logandale Dip 4/	261	23	226	106	201	482	872	25	2196	3.6
Airport Road 5/	329	27	228	127	256	494	998	31	2490	4.3
Fish and Game Diversion 6/	376	35	197	129	267	421	1048	1	2474	5.1

1/ Average of 2 samples dated 3/9/62 and 4/15/63 from USGS Report No. 50 and 1 sample dated 7/12/77 analyzed by USDA Salinity Laboratory, Riverside, CA.
2/ Average of 30 samples from 7/28/68 to 6/29/76 analyzed by USGS.
3/ Average of 5 samples dated 5/77, 7/12/77, 8/17/78, 11/29/78 and 2/8/79 analyzed by USDA Salinity Laboratory, Riverside, CA.
4/ Average of 2 samples dated 7/12/77 and 10/4/77 analyzed by USDA Salinity Laboratory, Riverside, CA.
5/ Sample dated 10/4/77 analyzed by USDA Salinity Laboratory, Riverside, CA.
6/ Average of 8 samples from 7/14/76 to 4/14/77 analyzed by Nevada Division of Health.

TABLE 6. CHEMICAL COMPOSITION DRAIN WATER, LOWER MOAPA VALLEY 1/ MOAPA VALLEY SUBEVALUATION UNIT, NEVADA

Drains - Lower Moapa Valley	Na^+	K^+	Ca^{++}	Mg^{++}	Cl^-	HCO_3^-	SO_4^{-2}	NO_3^{-2}	TDS	SAR
	(Concentration in mg/l or ppm)									
Cottonwood	951	59	368	257	771	641	2399	21	5467	9.3
Capallapa	1067	73	366	292	559	663	3035	19	6074	10.1
Catherine	777	56	286	225	601	577	1976	18	4516	8.3

1/ Average of 5 samples dated 5/77, 7/12/77, 8/17,78, 11/29/78,2/8/79 analyzed by USDA Salinity Laboratory, Riverside, CA.

TABLE 7. CHEMICAL COMPOSITION, GROUND WATER 1/ MOAPA VALLEY SUBEVALUATION UNIT, NEVADA

Location	$Na^+ + K^+$	Ca^{++}	Mg^{++}	Cl^-	HCO_3^-	SO_4^{-2}	NO_3^{-2}	TDS	SAR
	(Concentration in mg/l or ppm)								
					UPPER VALLEY				
Wells of California Wash Area	261	55	18	125	371	285	-	1115	7.8
	153	474	164	156	183	1750	-	2880	1.6
					LOWER VALLEY				
Wells of Various Valley Locations in the Agricultural Area	-	184	80	174	355	771	-	-	3.8
	177	106	54	92	371	421	-	1221	3.8
	188	85	73	133	309	462	-	1250	3.6
	231	161	88	168	554	552	-	1754	3.6
	408	148	103	205	260	998	-	2122	6.3
	478	187	132	316	496	1150	-	2759	6.5
	336	422	133	256	281	1670	-	3098	3.7

1/ From USDI, Geological Survey, Nevada, Water Resources - Report No. 50, page 44, December 1968..

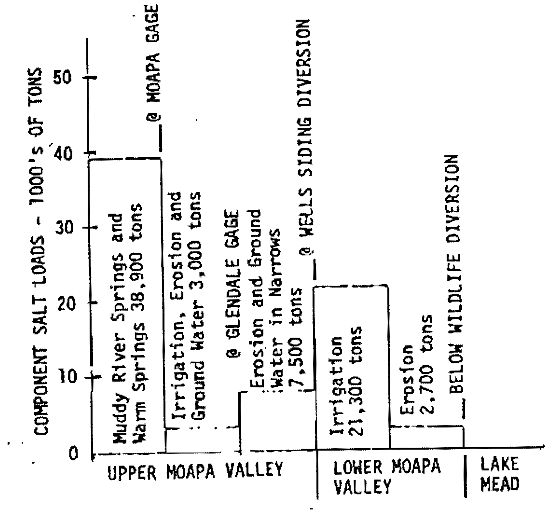


Figure 6-B

COMPONENT SALT LOADS

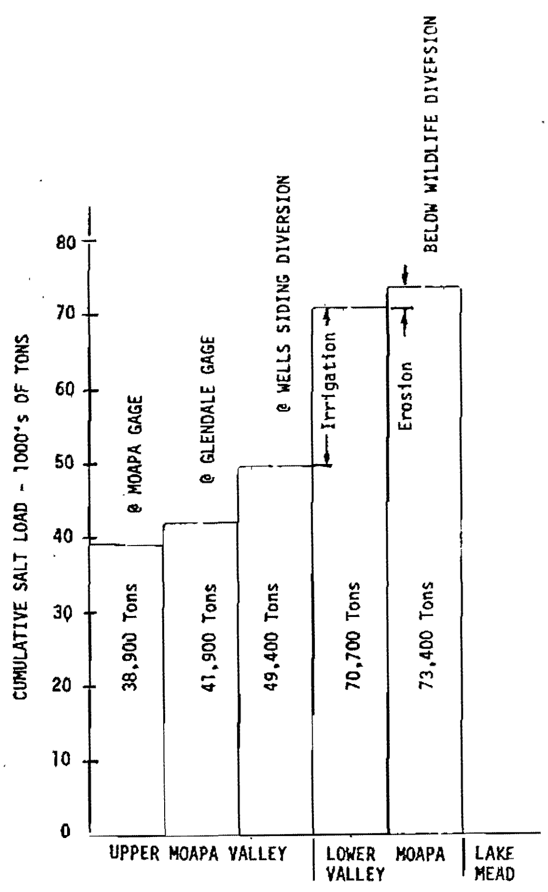


Figure 6-C

CUMULATIVE SALT LOAD

SALT LOADS

MUDDY RIVER

Moapa Valley Subevaluation Unit, Nevada

of the Virgin River Unit

Colorado River Basin Salinity Control Program

Agricultural Systems and Practices

There are five separate irrigation diversions and delivery systems supplying irrigation water to the 2,060 irrigated acres in Upper Moapa Valley. The delivery systems consist of about 20 miles of open ditches. The condition of the systems is fair. There are no reservoirs for storage in the Upper Valley.

Water is diverted during the winter months at Wells Siding Diversion structure in Lower Moapa Valley to Bowman Reservoir. About 4,000 acre-feet of stored water is delivered to Lower Valley in the summer months along with available stream flow. The water is distributed by Muddy Valley Irrigation Company's ditch system. Their system is approximately 306,000 feet (58 miles) in length, with an average ditch size of 18 inches bottom width and 30 inches depth. There are 242 stockholders in the irrigation company servicing 2,922 acres. The ditch delivery system is in poor condition. The concrete lined portions have deteriorated from sulfate reactions. Presently, the irrigation company operates a rotational system, providing water every seven days.

Nevada Department of Wildlife has a diversion located immediately above Lake Mead which irrigates the 510 acres of the Overton Wildlife Management Area. The present system of graded borders and lined ditches is being replaced with level basins and plastic pipeline.

Irrigation methods in Moapa Valley are random flooding, graded and level borders, corrugation and furrow. The predominant method used is graded borders.

The present irrigation efficiency, based on an analysis of a sample of 28 percent of the irrigated acreage in the Moapa Valley, averages 45 percent.

Conservation measures presently applied on irrigated and adjacent lands include:

- Brush Management
- Clearing and Snagging
- Conservation Cropping Systems
- Crop Residue Management
- Irrigation Ditch and Canal Lining
- Irrigation Field Ditch
- Irrigation Water Management
- Irrigation Land Leveling
- Land Smoothing
- Structures for Water Control
- Wildlife Wetland Management
- Wildlife Upland Management

Land Resource

Soil Survey - Variations in climate, biological forces, relief, parent materials and age of land surfaces within the study area have resulted in a complex pattern of soils and miscellaneous land areas. Soil orders represented include Aridisols, Entisols and Inceptisols which are considered to be potential sources of salts and sediments to the resources.

The following descriptions indicate the general character of the soil associations in the study area. The Soils Map (Figure 7) shows their distribution.

Glendale-Gila-Toquop Association: Deep, well drained and excessively drained, nearly level to moderately sloping soils; on flood plains, low stream terraces and alluvial fans. Surface soil is loam or fine sand or fine sandy loam.

Toquop-Calico-Overton Association: Deep, excessively drained, somewhat poorly drained, and very poorly drained, nearly level to moderately sloping soils; on flood plains, broad terraces and alluvial fans. Surface soil is fine sand or fine sandy loam or silty clay.

Toquop-Virgin River-Land Association: Deep, excessively drained, somewhat poorly drained and very poorly drained, nearly level to moderately sloping soils; on flood plains, broad terraces and alluvial fans. Surface soil is fine sand, or fine sandy loam or silty clay. This soil unit is considered to have a high salt content.

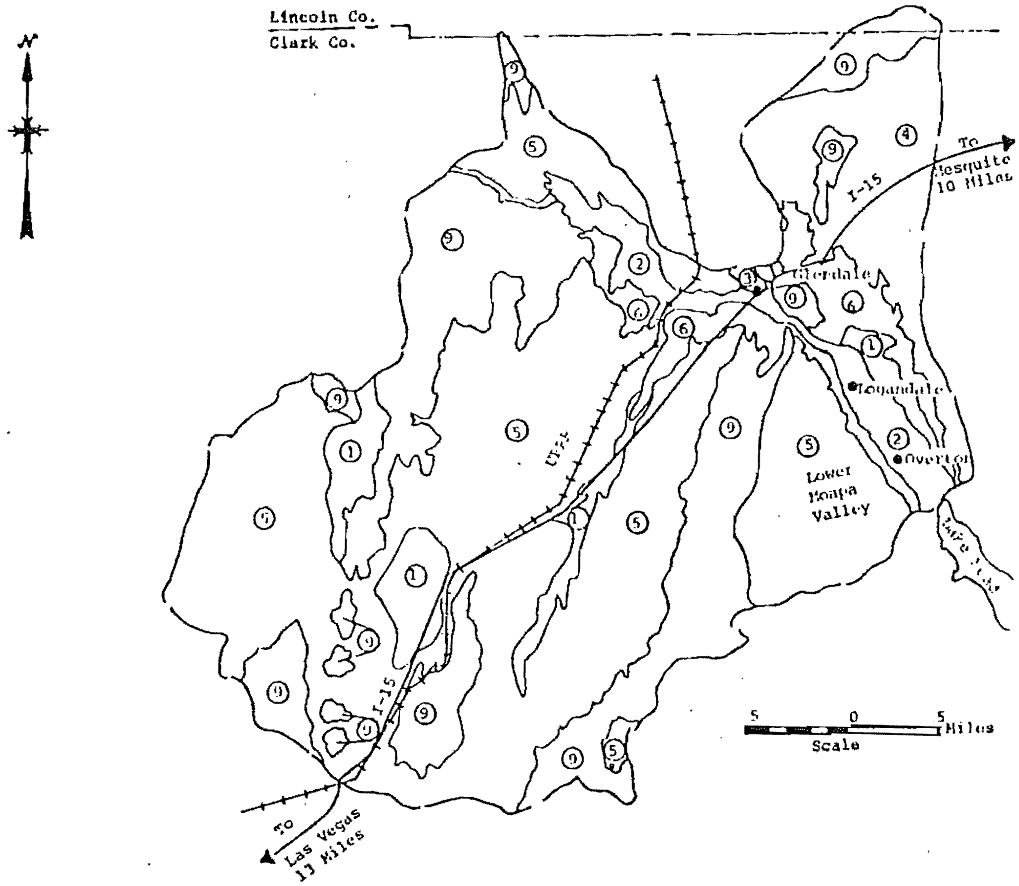
Mormon Mesa-Arada-Flattop Association: Shallow to deep, well drained and somewhat excessively drained, nearly level to moderately sloping soils; on Mormon Mesa and on terraces and alluvial fans. In the study area the surface soil is fine sandy loam or fine sand.

Bard-Colorock-Tonopah Association: Moderately deep and deep, well drained and escessively drained, nearly level to strongly sloping soils; on broad alluvial fans and old terraces. Surface soil is gravelly sandy loam or gravelly fine sandy loam.

Badland-Bard-Tonopah Association: Badland, and moderately deep and deep, well drained and excessively drained, nearly level to strongly sloping soils; on old terraces and alluvial fans. Badland consists of severely eroded and gullied areas. It is highly stratified deposits of silt and clay that contain a large amount of gypsum and calcium carbonate. The other units have surface soil of gravelly sand and fine sandy loam.

Rockland-St. Thomas-Moapa Association: Shallow and moderately deep, well drained, moderately steep to very steep soils; on mountains and colluvial foothills. The St. Thomas surface soil is a cobbly loam, while the Moapa surface soil is fine sand.

Figure 7 is a soils map for the Subevaluation Unit.



LEGEND

Hydrologic Boundary

SOILS OF THE FLOODPLAINS, LOW ALLUVIAL FANS AND LOW TERRACES

1. Glendale-Gila-Toquop Association
2. Toquop-Calico-Overton Association
3. Toquop-Virgin River-Land Association

SOILS OF THE ALLUVIAL FANS, LOW HILLS AND MESA TOPS

4. Mormon Mesa-Arada-Flattop Association
5. Bard-Colorock-Tonopah Association
6. Badland-Bard-Tonopah Association

SOILS OF THE UPLANDS AND MOUNTAIN SLOPES

9. Rockland-St. Thomas-Moapa Association

Figure 7

SOIL MAP

Moapa Valley Subevaluation Unit, Nev.

of the Virgin River Unit

Colorado River Basin Salinity Control P

Erosion and Sediment - Field observations indicate that the average annual erosion rate on 30 percent of the study area is in excess of five tons-per-acre-per-year. Streambank erosion in excess of 1,000 tons per mile occurs on about ten percent of the stream channels.

The badlands within the area are rapidly eroding and are major contributors of both salts and sediments to irrigated land and water resources. Much of the badlands have developed in the Muddy Creek Formation which is made up of clay, silt and sand and also contains much salt and gypsum. As shown in the geologic section (Figure 4-B) there is and abundance of limestone, gypsum and salt in other strata exposed to the forces of geologic erosion which also contribute to the salinity of Muddy River. Geologic erosion of these formations is not economically feasible to control. This erosion will continue with or without implementation of the program plan.

Biotic Resources

The study area has a highly diversified environment consisting of a variety of biotic communities. Vegetation zones forming a basis for recognition of biotic communities are:

- Creosote Brush
- Blackbrush
- Saltbrush
- Desert Riparian
- Riparian and Cliff
- Desert Springs and Marsh
- Streamside and Riparian

Distribution of biota in terms of the numbers of species of vascular plants, fish, amphibians, reptiles, birds and mammels is given in Appendix C.

Numerous species of macroinvertibrates exist but investigations have not been conducted to identify them and the effects of varying flows and salinity.

Fisheries - Species endemic to the Muddy River belong to two families *Cyprinidae* (minnows and carp) and *Cyprinodontidae* (killifishes). Four endemic and eight exogenous species of fish have been identified in the study area. Nevada Wildlife Commission has listed two of the endemic species, the White River Spring Fish and the Moapa Dace, as "rare", as of February 1, 1979. However, only the Moapa Dace is listed as a threatened species by U. S. Fish and Wildlife Service. Species are listed in Appendix C.

Wildlife - A total of 169 species of birds have been identified in Moapa Valley Subevaluation Unit. This includes species classified as breeding in the area, transients or winter residents as well as those shown as accidental sightings. Data on birds is from a list of Clark County avifauna presented by Austin and Bradley (1971) and modified by information provided by Johnson (1973), Lawson (1972), Ryser (1970) and records on file with the Nevada Department of Wildlife.

A list of ninety-three species of mammals (12 nonconfirmed and 2 feral) found in the study unit was compiled from information presented by Deming (1963), Hall (1946), Ryser (N.D.), and records of the Nevada Department of Wildlife.

Vegetation - Vegetation on irrigated agricultural land consists primarily of legumes, grasses and small grains. The estimated impact area is within the confines of the valley bottom. Range conditions improve slowly in this arid climate. Future conditions of the rangeland resources would be unaffected by any of the proposed alternatives, and were not studied.

Vegetation on wildlife land that has been classified as wetland according to Wetlands of the U.S. Circular 39 are: saltcedar *(Tamarix pentandra)*, big saltbush *(Atriplex lentiformis)*, creosotebush *(Larrea divaricata)*, mesquite *(Prosopis juliflora)*, fourwing saltbush *(Atriplex canescens)*, arrowweed pluchea *(Pluchea sericea)*, black greasewood *Sarcobatus vermiculatus)*, iodinebush *Allenrolfea occidentalis)*, alkali sacaton *(Sporobolus airoides)*, inland saltgrass *(Distichlis stricta)*, and other annual and perennial forbs and grasses. Lacustrine land, 406 acres, includes types I, IV, V and XI wetlands; palustrine land, 5,070 acres, includes types II and IX wetlands; and riverine land, 1,559 acres consists of type X wetland. Habitat system definition is 1979, U. S. Fish and Wildlife Service.

Recreation Resources

Recreation opportunities vary from hunting, fishing, photography, camping, hiking, and bird watching to the personal enjoyment of the aesthetics and natural beauty of the desert environment. Alternatives or levels of management under consideration for salinity control will not have any long lasting adverse effects on the recreational aspects of the area. Overall improvement will be realized within a few years.

<u>Social and Economic Characteristics</u>

Population - The population (1970 census) of the subevaluation unit was about 2,525 and was projected to reach about 6,000 within ten years. Centers of population growth and expansion in the valley are the communities of Overton, Logandale, Glendale and Moapa.

Cultural, Social and Economic Factors - The age distribution for the area is approximately as follows:

Under 5 years	10 percent
5 - 19 years	27 percent
20 - 44 years	31 percent
45 - 64 years	21 percent
65 years and over	11 percent

The median school completion is 12.3 years. The adult schooling is:

No schooling	0.4 percent
8 years	9.1 percent
4 years of high school	25.8 percent
4 years of college	18.6 percent

The annual (1970 census) family income is:

$10,000 or more	53 percent
$5,000 - $10,000	33 percent
Less than $5,000	14 percent
$4,000 and less	7 percent

The value of agricultural land and buildings is about $3,000 per acre with a range from $1,000 to $5,000. The market value of agricultural products produced on irrigated land in 1974 was estimated at $716,000 in Clark County or $90 per acre. About one-half of the irrigated land in the county is in the study area. The major crops in descending order of abundance, if not importance, are alfalfa, barley, pasture, and sudan cut for forage.

Employment - Employment in the area is diverse and most of the employed labor works within the area. About two percent commute to jobs outside the area (primarily Las Vegas).

The labor force of the area comprises approximately 67 percent of the population over 16 years of age. About 94 percent is civilian labor and about 95 percent of the labor force is employed. Farming is not a major source of employment in the area. The majority of the labor force is in the service, craftsman, managerial and professional categories.

Changes in population density, social and economic conditions will occur whether or not the salinity control measures are implemented.

Historic and Archeologic - No properties presently listed on or pending nomination to the National Register of Historic Places are located in the Moapa Valley study area. The Muddy River, California Wash, and Mormon Mesa areas are however, known to be some of the richest archeological regions in the state. The area was settled very early and several remnants of that history remains. The historic trails crossing the study area are the Yount-Pattie (1826) and Joseph Walker (1833). The Archeological Research Center, University of Nevada, Las Vegas, and the Southern Nevada Historical Society maintain information on what is presently known of the area.

PROBLEMS AND NEEDS

Problems and Needs Associated With Salt Loading

Agricultural, municipal and industrial problems result from excessive salts contained in the waters of the Colorado River System. Water of 500 milligrams per liter (mg/l) total dissolved solids (TDS), or greater concentration can cause problems. Water in Lake Mead has an average concentration of 680 mg/l. The salt concentration increases downstream in the Colorado River. At Imperial Dam near Yuma, Arizona the average concentration of salts in 1977 was 820 mg/l. Overall, annual economic damages attributed to salinity are estimated at $499,000 for each mg/l at Imperial Dam, based on 1980 prices. Additional agricultural and other damages occur in the Republic of Mexico below Imperial Dam.

Irrigation in the Colorado River Basin increases the rate at which soluble salts are removed from soil and underlying aquifer by surface and ground water flows.

Salinity affects irrigated agriculture by (1) limiting the types of crops grown and (2) reducing crop yields. Salinity affects municipalities and industries by (1) requiring the use of water softeners and reducing the effective life of water pipes, fixtures and water-using appliances and (2) causing corrosion and scale formations in boilers and cooling systems from calcium and magnesium.

Agricultural production in Moapa Valley that has either been eliminated or significantly reduced by excessive accumulation of salts is estimated to exceed five percent of the total irrigated cropland. Salts have built up in soils over the years because of inadequate drainage, composition of parent material and insitu weathering.

Sources and Kinds of Salts

Sources of salt are natural and man-induced. The man-induced salinity in the Colorado River system is estimated at 53 percent of the total, distributed as follows:

37%	Irrigation
12%	Reservoir evaporation
3%	Exports
1%	Municipal and industrial
53%	Total man-induced salinity

About 33 percent of the salt load of Muddy River is man-induced. This is distributed as follows:

31%	Irrigation and evaporation from reservoirs and distribution systems
2%	Man accelerated erosion
33%	Total man-induced salt load

About two-thirds of the average annual salt load flowing from Moapa Valley is due to natural causes. Other factors which increase salinity are evaporation from stream surfaces, erosion, consumptive use by plants, and movement of water through strata containing soluable salts: saline soils (Figures 8, 9A-C) and underlying geologic formations (Figures 4A, 4B, 5) with high salt content. Salts are only added to the river system by irrigation drainage waters when more saline waters or readily soluble salts are present in the flow path.

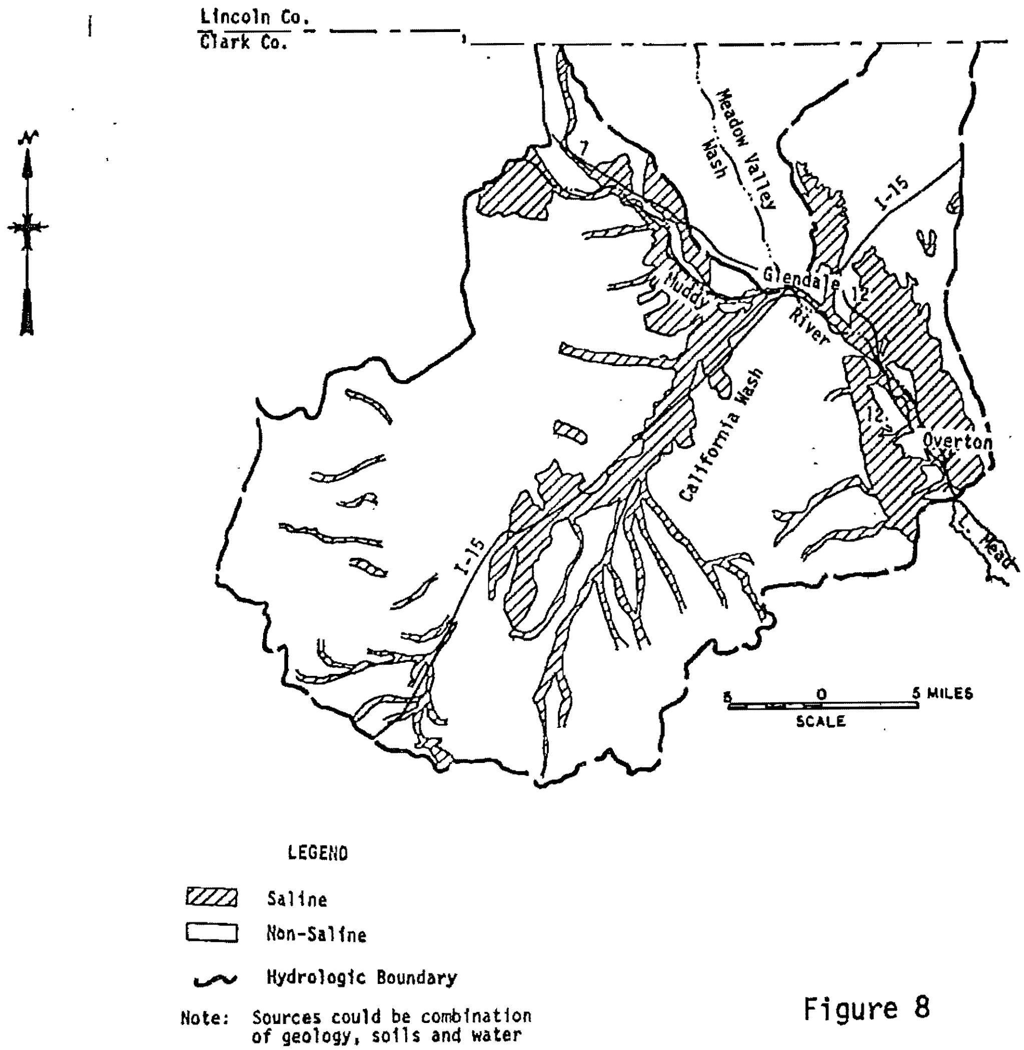


Figure 8

SALINE SOILS

Moapa Valley Subevaluation Unit, Nevada

of the Virgin River Unit

Colorado River Basin Salinity Control Program

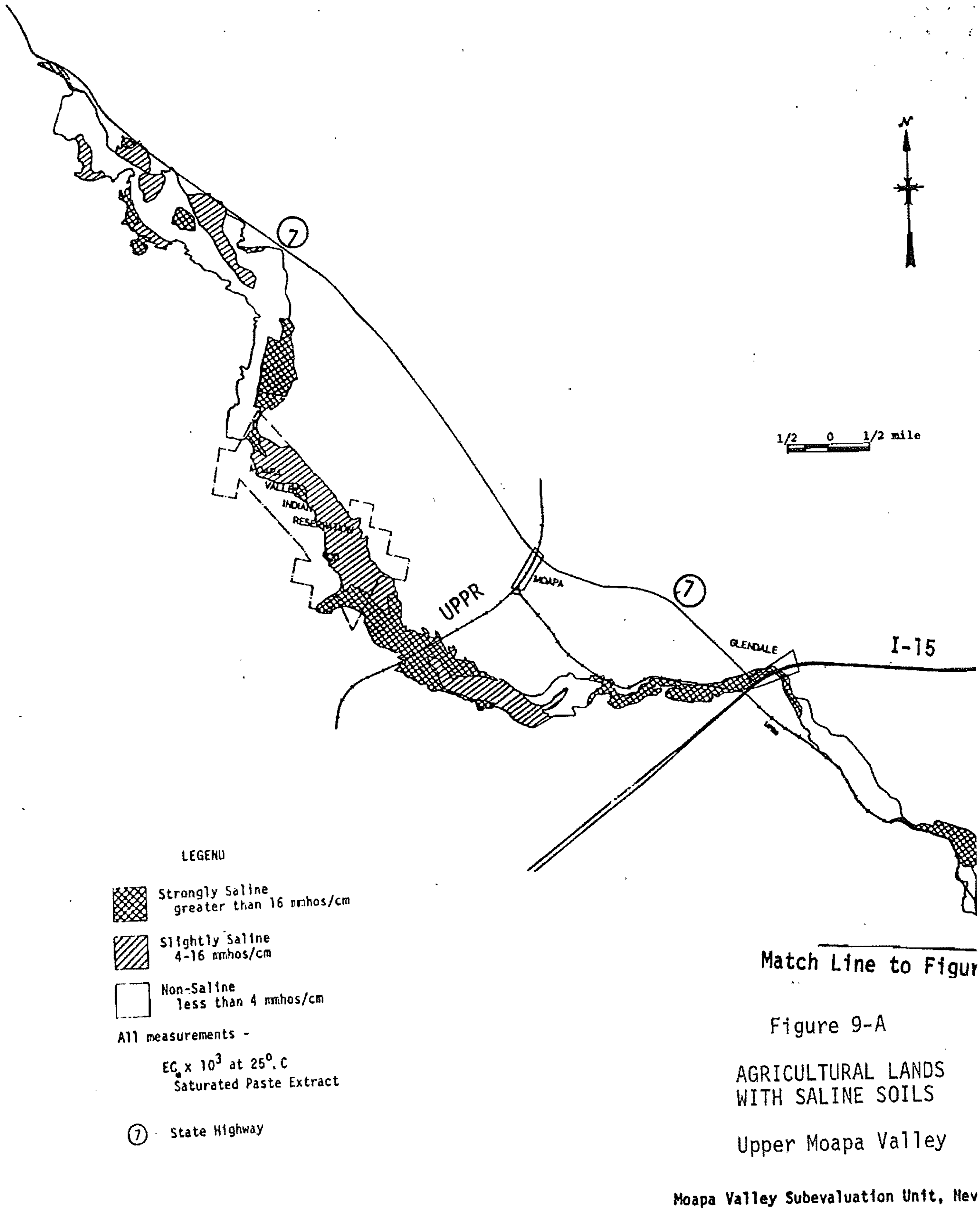
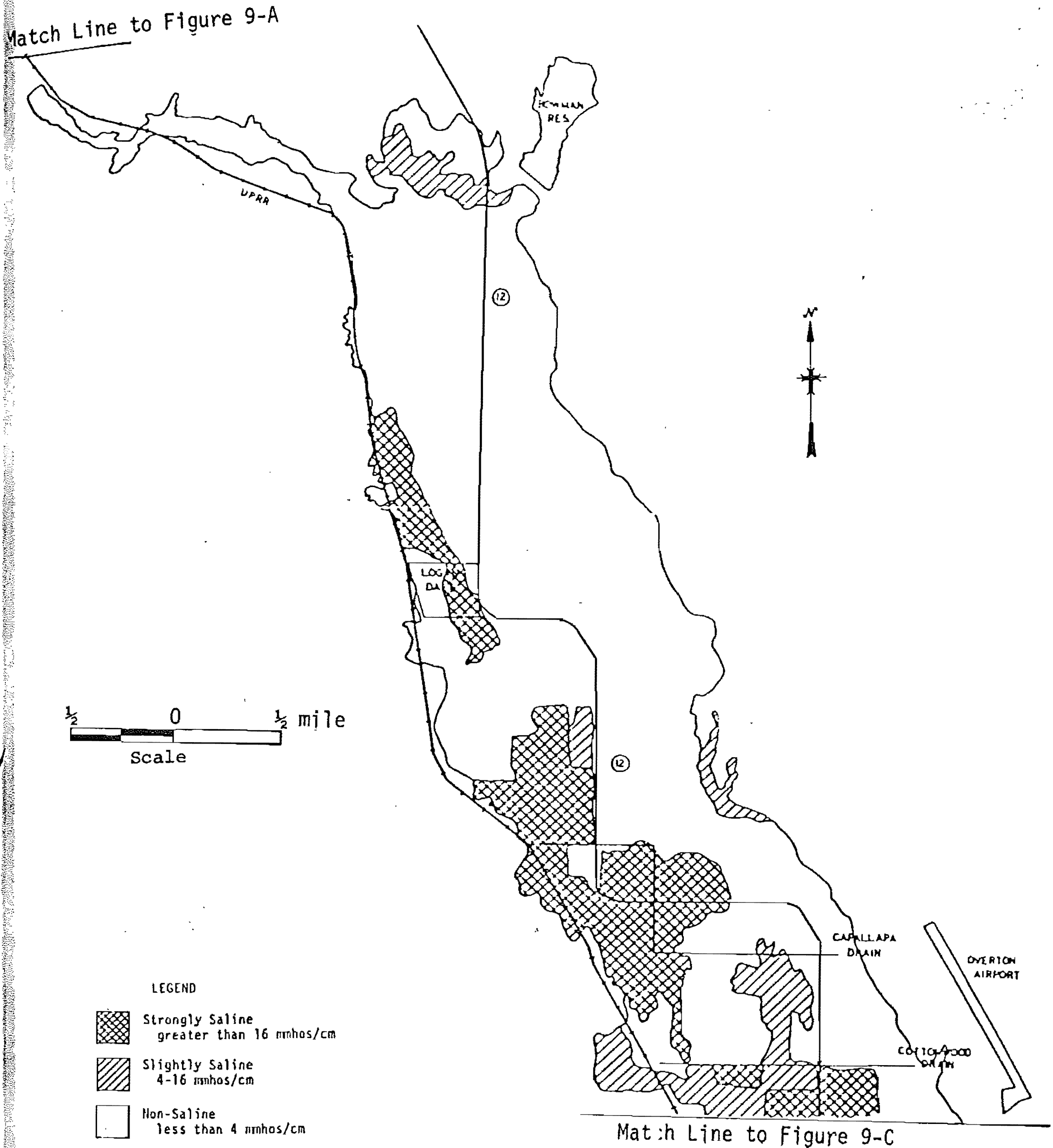


Figure 9-A

AGRICULTURAL LANDS
WITH SALINE SOILS

Upper Moapa Valley

Moapa Valley Subevaluation Unit, Nev
of the Virgin River Unit
Colorado River Basin Salinity Control P



LEGEND

Strongly Saline greater than 16 mmhos/cm

Slightly Saline 4-16 mmhos/cm

Non-Saline less than 4 mmhos/cm

All measurements - $EC_e \times 10^3$ at 25° C Saturated Paste Extract

(12) State Highway

Figure 9-B

AGRICULTURAL LANDS WITH SALINE SOILS

Lower Moapa Valley

Moapa Valley Subevaluation Unit, Nevada

of the Virgin River Unit

Colorado River Basin Salinity Control Program

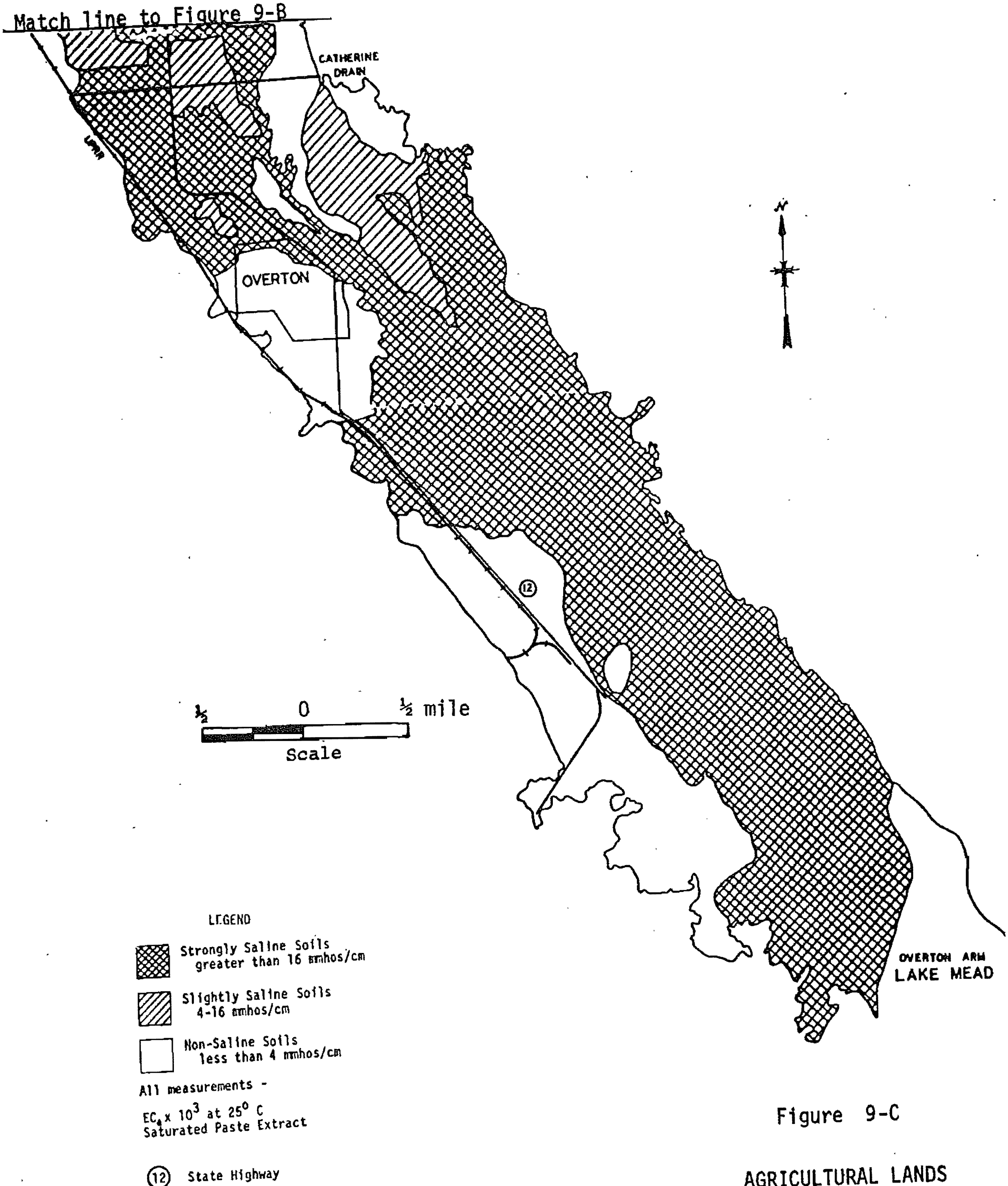


Figure 9-C

AGRICULTURAL LANDS WITH SALINE SOILS
Lower Moapa Valley

Moapa Valley Subevaluation Unit, Nevad
of the Virgin River Unit
Colorado River Basin Salinity Control Pro

Amount of Salts

Fifty three percent of the annual salt load of 74,300 tons from Moapa Valley comes from the springs in Upper Moapa Valley. An increase of 3,000 tons of salt in the Upper Valley results from irrigation, addition of saline ground water and erosion. Salt loading increases in the Narrows from natural sources.

Surface flow from Lower Moapa Valley carries 17,100 tons of salt annually and ground water carries 56,300 tons.

Control Potential

Control of salts is limited to those entering the river system from irrigation and accelerated erosion due to man's activities. Control of naturally caused salt loading does not appear to be economically feasible.

Onfarm - Improved water management can minimize deep percolation of irrigation water which is not beneficial to crop production. Optimum crop production using saline water requires some deep percolation to leach salts below the root zone.

The present application of water to irrigated lands in Lower Moapa Valley results in 6,300 acre-feet of water percolating below the crop root zone. This water mixes with the ground water and carries 21,300 tons of salt downstream. Average irrigation efficiency is 45 percent. More efficient application of irrigation water can reduce deep percolation and surface runoff. Flexible scheduling and uniform applications of smaller amounts of water are needed to attain higher irrigation efficiencies. Inefficient water application has resulted from a lack of available technical information and the high cost associated with increased labor requirements for more efficient irrigation. Through the use of semiautomated irrigation systems improved water application would be feasible.

Techniques for irrigation automation include clock controlled water control gates and valves, and water measuring devices. Such methods reduce labor requirements. Moisture and salinity monitoring devices also enhance management of an irrigation system.

Increased crop yields and labor savings do not provide sufficient economic returns to motivate installation by the land owners. Variations in market prices for low value crops and inflating production costs discourage the substantial investments required for automating irrigation. Cost-sharing assistance for onfarm improvement of irrigation systems is needed to accomplish reduction of downstream salinity damages.

Off-Farm - Improvements of the irrigation delivery system further enhances benefits attainable with improved onfarm irrigation systems. In Upper Moapa Valley, some modifications of the five delivery systems are needed to enhance irrigation automation capability. The Moapa Indians have requested assistance from Clark County Conservation District to redesign the system serving their fields (about 600 acres). The present conservation district program will require acceleration to meet technical assistance demands. Accelerated cost-share assistance is needed to accomplish downstream annual salt load reduction from off-farm improvements.

In Lower Moapa Valley replacement of the open canal delivery system with pipelines would facilitate automation and allow application of water to more accurately meet actual crop needs. Cost-share assistance is recommended to accomplish installation due to insufficient onfarm benefits and a current high level of indebtedness by the irrigation company. Such financial assistance is justified by downstream salinity reduction benefits.

Needed repairs to the Muddy Valley Irrigation Company's distribution system include: 1,420 feet of lining of earth ditch, repair of 16,020 feet of concrete ditch, 1 diversion box, 100 feet of 24 inch corrugated metal pipe, and 100 feet of corrugated matal pipe for a flume. If the existing system was replaced with a pipeline system about 25 percent of the system would be relocated.

Erosion control would provide downstream salinity benefits. Onfarm water management would also reduce erosion. Acceleration of present SCS programs and cost-share assistance would be needed. There is a need for reducing erosion on 10 bank miles of channel (7-1/2 in Lower Valley) and for erosion control at road crossings and waste water inlets in both valleys.

Problems and Needs Associated With Erosion and Sedimentation

Erosion, sediment and consequent salt loading, both from natural and man-induced sources cause land and water quality problems. Sediment and salt loading problems occur on cropland, rangeland, pastureland and in urbanized areas.

Average annual sheet, rill and gully erosion varies from less than one to greater than ten tons-per-acre-per-year. (See Figure 10 - Erosion Areas). Ten percent of the stream channel has erosion in excess of 1,000 tons per mile. Sheet and rill erosion account for 20-30 percent of the sediment yield. Erosion of gullies, washes, streambanks and channel bottoms account for the other 70 to 80 percent of sediment yield. Estimated sediment yield from Muddy River averages 385,000 tons annually. The estimated salt loading resulting from erosion averages 10,000 tons annually.

Most of the sediment load is derived from rangeland areas. However, a land treatment program in rangeland areas is not economically feasible. Improved irrigation water management would reduce erosion on crop and pasture lands and provide a minor sediment yield reduction. Treatment of channel banks would significantly reduce average annual sediment yield.

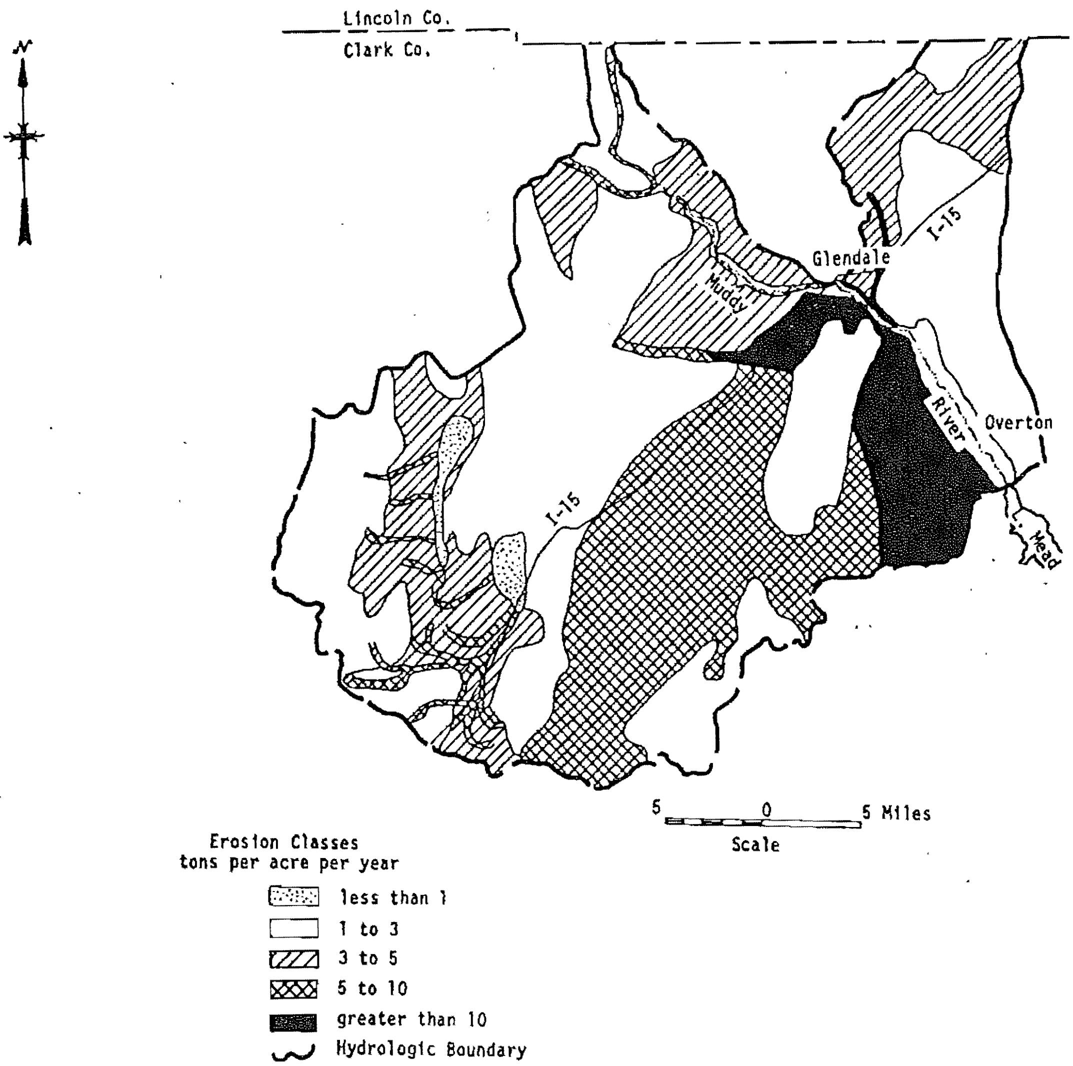


Figure 10

EROSION AREAS

Moapa Valley Subevaluation Unit, Nevada

of the Virgin River Unit

Colorado River Basin Salinity Control Program

Treatment Opportunities for Erosion Problems

Treatment of eroding streambanks on Muddy River would consist principally of sloping and vegetating steep banks and structural protection at bridges, culverts and drain outlets.

A reduction of 5,000 tons or about one percent reduction in annual sediment yield is possible if the treatment opportunities outlined are installed or implemented. An associated reduction of 275 tons of salt can be achieved.

Improved irrigation water management and installation of return flow structures can reduce erosion on the irrigated lands and provide an averag annual sediment reduction of 400 tons with five tons of salt reduction. Treatment of eroding channel banks can reduce annual sediment yeild 4,600 tons and salt loading 270 tons.

A number of ongoing Federal programs have been used to reduce soil erosion and sedimentation problms for several years. USDA agencies (SCS, ASCS, SEA, FmHA) provide technical assistance, cost-sharing and credit assistance through their ongoing programs in the area. These programs are being carried out cooperatively with state and local organizations such as conservation districts and through the efforts of the landowners and operators. The Bureau of Indian Affairs provide similar assistance for tribal lands of the Moapa Indians.

The entire subunit is within Clark County Conservation District. This local unit of state government has carried out active water and related land resource improvement programs for many years.

Problems and Needs Associated with Water Resource

Analysis of present irrigation application indicates that crops may require additional water in Upper Moapa Valley. Field measurements shoul be made to determine soil moisture conditions in the root zone. Irrigati water should be applied to meet crop needs.

Analysis of irrigation management in Lower Valley shows that water application could be reduced. A higher level of management could be attained using a demand distribution system rather than the rotational method. Allotted water is usually applied in anticipation that the wate will be required by the crop in the intervening period prior to the next delivery date.

A potential source of additional water for Moapa Valley is from Lak Mead. This source was studied by the Bureau of Reclamation in connectic with the Moapa Valley Pumping Project (May 1971). This plan was found t be economically unfeasible. Other than Lake Mead, there is very limitec potential for augmentation. However, there is good potential for impro\ use of existing water supply. The present irrigation efficiency of 45 percent can be improved through either Alternative 1 or 2 as described in the Alternative Plans section. Through more efficient irrigation methods, the water saved could be used for other purposes to enhance development and environmental resources.

Principal water-supported recreational opportunities in the area are those provided by the State of Nevada, Department of Wildlife, Overton Wildlife Management Area located near the mouth of Muddy River. Development of additional wildlife habitat would expand the present recreational resources of the area.

Other water supply problems exist. There is no local source of municipal water for Lower Moapa Valley. Both ground and surface water quality are too poor for municipal use. Water was brought in by train in the past. Presently, approximately one cubic-foot-per-second is piped from Muddy River Springs to Overton. Economic growth in the valley has been limited by the potable water supply.

Flooding is a problem. Much of the urban and agricultural land is in the floodplain. The area has had erosion, sedimentation and crop damage many times in the past. Muddy River channel in Lower Valley is being maintained to retain channel capacity. The U.S. Army Corps of Engineers, Flood Plain Information, Muddy River Vicinity of Overton, Clark County, Nevada, report was prepared June 1974. SCS completed a Flood Insurance Study for Clark County, Unincorporated Areas, Nevada, April 1979 for the Federal Emergency Management Agency. The flood hazard information in these studies will help to minimize future flood damage.

ALTERNATIVE PLANS

Most of the irrigated land needs improved systems and management. One-half of the water withdrawn for irrigation goes to deep percolation. This percolating water dissolves salts from the underlying strata, resulting in increased salt loading of subsurface flows. Major irrigation system improvements would increase efficiency and reduce deep percolation.

Formulation of irrigation alternatives considered: (1) water control and measuring devices; (2) using the irrigation system and method best adapted to the soils, crops and level of management desired; and (3) applying the proper amount of water at the proper time to meet consumptive use plus cultural practice (leaching, sluicing, prewetting, etc.) requirements. Drainage is inadequate in some areas and aggravated by inefficient water scheduling that results in over irrigation. Improved irrigation efficiency would alleviate some drainage problems. Land leveling and planing on a regular basis are important conservation practices for better distribution of water on the field. Land planing will continue as a part of the ongoing program regardless of which alternative is implemented.

The SCS computer program for Irrigation Methods Analysis (IRMA) was used to estimate irrigation efficiencies for the alternative water management plans (see Table 8). Water and salt budgets (Table 9) were prepared for alternative plans using IRMA output information for crop consumptive use, and deep percolation to ground water. The predominant irrigation methods are graded border and level border systems. The alternatives minimize changes in these irrigation methods. Only minor changes in crops and field size are suggested. Changes in irrigation methods, crops, field size and land use are dictated by physical geography and institutional constraints of road location, land ownership and water rights. The sample of fields processed in the computer analysis is representative of crop, soil type and location in the valley. Twenty eight percent or 1,388 acres of the total irrigated land in the valley was used in the computer analysis.

Gully and channel erosion of saline soils contributes both salt and sediment to Muddy River. Water erosion results in salts being removed through solution and the sediment detached and moved by surface waters. Erosion control alternatives are limited by climate. Vegetative measures are difficult to establish because of low rainfall. Structural treatment which traps sediment is not recommended because of the high expense relative to salinity benefits. Control of erosion is limited to channel bank shaping and seeding and protecting drain outlets and road crossings. These erosion measures have the highest salinity benefit relative to cost and would be limited to areas where implementation is practical.

Change in land use was considered for the program area. Only a small portion of the Subevaluation Unit is in private or Indian ownership. Purchase of agricultural lands by the government for conversion to nonirrigated land was considered. Opposition to government land ownership is high in the study area, and future State and local acceptance of such an alternative is unlikely.

TABLE 8. ONFARM IRRIGATION WATER MANAGEMENT ANALYSIS (IRMA) MOAPA VALLEY SUBEVALUATION UNIT, NEVADA

Factor	Future Without Salinity Program 1/	Alternative 1	Alternative 2
Efficiency Percent	45	55	61
Seasonal Gross Application			
Acre-feet	44,415 2/	37,349	33,477
Acre-feet/acre	9.07	7.63	6.84
Seasonal Net Application			
Acre-feet	19,295	19,670	19,876
Acre-feet/acre	3.94	4.02	4.06
Seasonal Net Runoff			
Acre-feet	16,410	12,796	11,928
Acre-feet/acre	3.35	2.61	2.44
Seasonal Deep Percolation			
Acre-feet	8,701	4,882	1,673
Acre-feet/acre	1.78	1.00	0.34

1/ The ongoing conservation program is assumed to continue.
2/ Based on projected area of 4,897 acres.

TABLE 9. WATER AND SALT BUDGET - ALTERNATIVE PLANS, MOAPA VALLEY SUBEVALUATION UNIT, NEVADA

	FUTURE WITHOUT SALINITY PROGRAM 1/		ALTERNATIVE 1		ALTERNATIVE 2	
	Water Acre-feet/year	Salt Tons/year	Water Acre-feet/year	Salt Tons/year	Water Acre-feet/year	Salt Tons/year
UPPER MOAPA VALLEY						
Water Supply						
Springs above Moapa Gage	39,000	38,900	39,900	38,900	39,900	38,900
California, Meadow Valley, Weiser Washes	2,300		2,300		2,300	
Subtotal	42,150		42,200		42,200	
Depletions						
Power and Evaporation	600		600		600	
Crop Use (Irrigation)	7,700		8,600		8,600	
Phreatophytes	1,000		900		900	
Subtotal	9,300		10,100		10,100	
Total Water at Glendale Gage (Surface and Groundwater)	32,900	41,900	32,100	41,900	32,100	41,900
LOWER MOAPA VALLEY						
Water Supply						
Water at Wells Siding Diversion Dam	32,900	49,500	32,100	49,500	32,100	49,500
Side Wash Inflow	500		500		500	
Subtotal	33,400		32,600		32,600	
Depletions						
Evaporation	2,900		2,900		2,800	
Crop Use (Irrigation)	11,600		11,100		11,300	
Phreatophytes	2,200		2,100		2,100	
Subtotal	16,700		16,100		16,200	
LAKE MEAD						
Surface Flow from Moapa Valley	5,700	17,800	8,600	21,000	10,700	24,300
Groundwater Flow from Moapa Valley	11,000	55,800	7,900	40,800	5,700	29,800
TOTAL OUTFLOW FROM MOAPA VALLEY	16,700	73,600	16,500	61,800	16,400	54,100

1/ The ongoing conservation is assumed to continue.

Two alternative plans were identified. The first plan, Alternative 1, minimizes structural works. The second plan, Alternative 2, maximizes irrigation efficiency and salt load reduction. This latter plan is designated the "Environmental Quality Plan" and provides the greatest reduction in salt loading. Net economic benefits are largely derived from reduced salinity. This results in the "Environmental Quality Plan" yielding the highest net benefits; therefore, Alternative 2 is also identified as the "Economic Development Plan." All alternatives are evaluated for a 25-year project life at seven and three-eighths percent interest after a ten-year installation period. The ongoing conservation program is assumed to continue for all alternative conditions. Followup technical assistance is necessary to maintain present irrigation efficiency with future conditions.

The major practice in both alternative plans is onfarm irrigation water management. The off-farm conveyance system improvement alternatives were identified by the SCS and the Clark Conservation District in August 1978 and are used in this study.

The alternatives consider fish and wildlife resources. Assessment of fish, wildlife and recreation, etc. are located in the Environmental Evaluation Appendices. The impact on the visual resource and its quality was considered. The proposed alternatives will not adversly impact these resources.

Other nonreturn flow and concentrated return flow uses of water from irrigated lands were examined. Water not used for irrigation may be allocated for industrial use or power generation purposes. Saline waters from return flows could be used to develop additional wildlife habitat. Return flow ditches presently provide some wildlife habitat. Flow in these ditches will be reduced and result in minimal habitat disturbance.

The proposed onfarm measures would not result in land modification below plow depth and therefore, will not effect cultural resources beyond present agricultural activity.

Future Without Salinity Program

The future without program for salinity control condition is based on projected changes without implementation of a salinity control program. Projected land use change from agricultural to urban is 425 acres. Some 85 acres are estimated for building lots and the remainder for use as small pastures, lawns and gardens.

Irrigated land considered for this alternative is 4,897 acres distributed as follows:

48% alfalfa	20% barley
25% pasture	7% sudan grass

No change in production levels are considered. Changes in onfarm irrigation systems would result from ongoing conservation programs.

The trend for drainage of agricultural lands is assumed to continue. Drainage of irrigated land serves several purposes: (1) lowers the water table, (2) intercepts water going to deep percolation, (3) facilitates leaching, and (4) increases crop yields. Minimal channel stabilization is anticipated for this alternative, however, the ongoing program of brush clearing is expected to continue. Maintenance of the existing irrigation water distribution system is assumed.

This alternative would not have a measurable effect on fish and wildlife habitat. Muddy River is considered a fishery only due to documented occurrence of the Moapa dace which has been chartered by the State of Nevada and the USFWS as an endangered species. The habitat of the Moapa dace would not be affected by less saline water in the last few miles of Muddy River because their habitat is limited to the upstream Warm Springs area (Reference: USFW, Threatened Wildlife of the U.S. Resource Publication No. 114, p. 33). Other species of fish would have a slightly enhanced habitat.

Clark County Conservation District will continue assistance with management of wildlife on wetland and upland areas. The quantity of recreation land and water, camping supply and demand, and picnicking supply and demand will remain at present levels.

Water quantity in the river would be similar to the present quantity. Effective reduction in salt loading would not be attained through projected urbanization and land use change.

Total new construction cost of the ongoing program (with minor salinity benefit) is estimated to be $600,000. For the comparable installation period of a proposed salinity control program (see Table 2, page ix) technical assistance in this period is projected to be $175,000. Much of this assistance cost reflects assistance other than that provided for new construction, such as for maintenance, replacement of existing irrigation systems, and for onfarm wildlife habitat management.

Alternative 1

Alternative 1 would use existing canal and lateral systems with major repairs and improve the onfarm irrigation systems and erosion control. This is the alternative having a minimum of structural works.

This alternative would improve irrigation efficiency and reduce salt loading by improved water scheduling and control of water applied to irrigated fields. Changes to the onfarm irrigation systems would be minimal. Seasonal gross application would be smaller, thus reducing runoff and deep percolation. See Table 8.

The replacement of sections of the deteriorated water delivery system in Lower Moapa Valley and repair of deteriorated sections in the Upper Valley are proposed. This work would reduce canal seepage. The condition of other components of the irrigation system is satisfactory. Its design and construction are credits to those irrigation pioneers responsible for its development.

Bowman Reservoir provides supplemental water. Periodic dredging and other routine maintenance are necessary. The Bureau of Reclamation reported in 1971 the structure condition as adequate. The safety of the structure was confirmed by U.S. Army Corps of Engineers under the National Dam Inspection Act. The structure was enlarged in 1967-1968 by the Muddy Valley Irrigation Company under professional engineering supervision. Limited seepage occurs below the structure.

Improved water scheduling will require equipment to measure soil moisture, salinity of irrigation water, and quantities of water delivered. In addition, water delivery schedules on a more flexible basis than the present rotation system should be developed. Programmable calculating equipment is recommended for this alternative. A telemetry system is recommended to support the water delivery scheduling. Water scheduling is complicated by limited storage for supplemental water.

Automation (or semiautomation) of onfarm systems is needed to control short irrigation set times (length of time water is applied to fields). Many of the irrigators work at nonfarm jobs. Additional labor costs would be incurred to manually operate with shorter set times. Onfarm automation reduces labor about 18,000 hours or $72,000 on an average annual basis. Telemetry associated with data input would include monitoring of automated (and/or semiautomated) onfarm irrigation systems. Monitoring would alert managers of automation failure so that repairs could be made as soon as possible.

Irrigators are assumed to obtain the same level of water management, but onfarm irrigation efficiencies would vary depending on soil type, length of run, irrigation head, slope, etc. Irrigation efficiency is expected to average 55 percent. Water management data are summarized in Table 8.

Increased production from this alternative is based on improved water management. The land use on the 4,897 irrigated acres is projected to be:

53% alfalfa	18% barley
22% pasture	7% sudan grass.

Channel stabilization of Muddy River to control streambank erosion and associated salt loading is recommended on two and one-half miles in Upper Valley and seven and one-half miles in Lower Valley. The cost of channel treatment is estimated at $112,100. Onfarm irrigation management described by this alternative would result in additional erosion control.

Wildlife wetland and wildlife upland management assistance would be augmented by proposed cost-sharing. Riparian wetland habitat would be enchanced by the increased flow in the river. Upland wildlife habitat improved would have a 114 acre-value. This alternative would have no impact on Muddy River Springs or Warm Springs, the habitat of the Moapa dace.

Land modification would not result from repair of the irrigation delivery system so that cultural resources will not be disturbed. Erosion control work may require land modification. Design for such works would warrant more site specific investigation of cultural resources.

Monitoring of program effectiveness is included in the technical assistance and automation costs. Installation of shallow wells to observe and measure groundwater for quality and quantity is a part of onfarm automation. The annual value of downstream economic benefits from a 275 ton reduction in salt load due to erosion control efforts is estimated to be $14,300. Other benefits include protection of irrigated land and annual reduction of 5,000 tons sediment deposition in Lake Mead.

Alternative 2

Alternative 2 would improve canal, pipeline and lateral systems, onfarm irrigation systems and erosion control. This is the alternative with minimum deep percolation and high irrigation efficiency.

This alternative includes water management improvements of Alternative 1 plus changing the set width. Maximum efficiency and minimum deep percolation are attained within many of the contraints of the present onfarm irrigation systems including: field dimensions (length and width), direction of flow, slope, irrigation head delivered to the farm, and crops grown.

Changing field set widths would optimize unit stream flow for fields irrigated by the border method. About one-third of the existing borders would need reconstruction. Reorganization and land leveling of fields would be compatible with recommended modification and realignment of the delivery system. These water management measures will reduce seasonal gross application, runoff and deep percolation below those of Alternative 1 and will be more effective in salt load reduction. The irrigation efficiencies will vary, but are expected to average 61 percent. Data for Alternative 2 is summarized in Table 8.

Study results for Upper Moapa Valley indicated that with Alternative 2 a three-inch average leaching would be needed annually for optimum crop production with respect to salinity (a zero percent yield decrement due to salinity of irrigation water). An average leaching of four inches is required for optimum production in Lower Valley and is satisfied by deep percolation during irrigation. Minimum deep percolation will take place and a significant reduction in salinity will occur.

A demand pipeline delivery system is recommended in Lower Moapa Valley to attain the irrigation efficiencies associated with this alternative. Muddy Valley Irrigation Company study shows a preference for a pipeline system as opposed to a canal system. The advantages of this system include lower maintainance cost because of its high resistance to sulfate and other soil chemicals. Control of siltation and debris will be incorporated into the system. The estimated cost of the pipeline system is 3.59 million dollars. Land modification may result from off-farm delivery system improvements. Design for such works would warrant more site specific investigation of cultural resources.

The channel stabilization and erosion control program proposed in Alternative 1 is applicable to Alternative 2. Accelerated assistance for wildlife wetland and wildlife upland management proposed for Alternative 1 is also applicable to Alternative 2. Riparian habitat enhanced by an increase in surface flow in Lower Moapa Valley would exceed that of Alternative 1.

Comparative Analysis for Plans

Irrigation efficiencies for the alternatives are listed in Table 8. Water and salt budgets are given in Table 9. Comparative analyses of economic development, environmental quality, social well-being effects for future without, and Alternative 2 plans are shown in Tables 10, 11 and 12. The Recommended Plan and Implementation Program section provides further information on Alternative 2 which is the recommended plan.

Alternative 1 would impact the same economic, environmental and social well-being factors identified for Alternative 2. The qualitative effects are thus given by tables 10, 11 and 12. Quantative results are provided in Table 2 and Appendix A.

TABLE 10. ECONOMIC DEVELOPMENT ACCOUNT, ALTERNATIVE 2, MOAPA VALLEY SUBEVALUATION UNIT, NEVADA

Components	Measure of Effects Dollars (Average Annual)1/
Benefits:	
A. The value to users of increased output of goods and services	
1. Increased efficiency of agricultural production	333,000
2. Salinity reduction	1,032,400
3. Industrial and power production	198,000
Total Benefits Following Installation	1,563,400
Total Benefits During Installation	764,300
Total Benefits for Program Period	2,327,700
Costs:	
A. The value of resources required by the plan	
1. Installation and technical assistance	557,200
2. Operation, maintenance and replacement	308,800
3. Followup technical assistance	17,500
Total Cost	883,500
Net Beneficial Effects	1,444,200

1/ Twenty five years at seven and three-eighths percent interest. July 1980 price base. Program consists of: 10-year installation period with benefits increasing proportional to program costs; and 25-year period following installation with constant benefits.

TABLE 11. ENVIRONMENTAL QUALITY ACCOUNT, ALTERNATIVE 2,
MOAPA VALLEY SUBEVALUATION UNIT, NEVADA

Components	Measure of Effects
Beneficial and adverse effects:	
A. Areas of natural beauty	1. More efficient use of existing water supply for irrigation, providing a green color contrast over a longer period of time in an arid area.
	2. Eliminate some onfarm earthen ditc and associated vegetation.
	3. Increase average streamflow by 6.9 cubic feet per second in Lower Moapa Valley from increased irrigation efficiency.
	4. Reduce loss of natural soil resour by waterlogging with accompanying salt buildup.
B. Quality considerations of water, land, and air resources.	1. Decrease 5,000 acre-feet of water percolating to and being contaminated by saline aquifers.
	2. Annual reduction of 19,500 tons of salt in the river system.
	3. Less diversions during spring allo ing higher flows tc move down rive
	4. Dust, smoke, and noise will be cre during construction.

TABLE 11. ENVIRONMENTAL QUALITY ACCOUNT, ALTERNATIVE 2, MOAPA VALLEY SUBEVALUATION UNIT, NEVADA (Continued)

Components	Measure of Effects
C. Biologic resources and selected ecosystems	1. 168 acres of upland wildlife habitat with an acre-value of 84 acres will be disturbed temporary during construction.
	2. 24 acres of wetland habitat with an acre-value of 24 acres will be disturbed temporarily during construction.
	3. 32 acres of riparian wetland habitat with an acre-value of 16 acres will be replaced with upland habitat with an acre value of 64 acres.
	4. 20 acres of greasewood-salt cedar wetland with an acre-value of five acres will be replaced with upland habitat with an acre value of 50 acres.
D. Unique cultural historical, archeological, architectural and natural resources	1. No effects - No additional land would be converted to irrigated cropland. Existing cropland would not be disturbed below existing plow depth.
E. Irreversible or Irretrievable	1. Annual increased consumption of 1,000 gallon of fossil fuel.
	2. Fuel and materials used during construction.

TABLE 12. SOCIAL WELL-BEING ACCOUNT ALTERNATIVE 2, MOAPA VALLEY SUBEVALUATION UNIT, NEVADA

Components	Measures of Effects
Beneficial and adverse effects:	
A. Life, health and safety	1. Reduce salt content in drinking water of down-stream residents in CA, AZ, NV and Republic of Mexico.
B. Civil rights	2. No effect.

RECOMMENDED PLAN AND IMPLEMENTATION PROGRAM

Alternative 2 is the recommended plan for implementation. This plan is briefly described in the ALTERNATIVE PLANS of this report.

Public Recommendations

The study area is contained within the Clark County Conservation District. The District has taken an active role in conservation planning. Close liaison with private landusers and local government entities has been maintained to recognize local needs and desires. SCS investigations on Moapa Indian lands are under a cooperative agreement between the Conservation District and the local Tribal Council. The SCS field office at Las Vegas, Nevada has disseminated information to increase public awareness about the study objectives and goals. Suggested concepts were reviewed with board members of the Muddy Valley Irrigation Company and found to be acceptable. Site specific details will be clarified in the operations or detailed design phase of implementation.

Basis for Selection of Recommended Plan

Onfarm irrigation system and management improvement is influenced by what is physically possible, economically feasible, and acceptable to the farmer. Alternative plan elements and effects were jointly determined and evaluated in both physical and economic terms by the irrigation specialist, design engineer, biologist, geologist, economist, range conservationist, soil scientist, resource conservationist and district conservationist.

The Physical analysis involved an inventory and evaluation of improvement opportunities for irrigation systems and irrigation water management. Improvements in irrigation systems and management were analyzed to determine the physical effects on both water conservation and salt load reduction. It also involved an inventory and analysis of improvement opportunities for agronomic and cultural practices for each crop which influenced irrigation efficiency and water requirements. An environmental assessment was made to identify significant wildlife and other biotic resources.

The Economic analysis was directly linked to studies by other disciplines and is sensitive to the varying levels of resource development in both alternatives. Each practice or group of practices was analyzed to determine its contribution in both physical and economic terms. An analysis was made of the social impacts of alternatives.

Additional Research and Demonstration Needs

Research on consumptive use of crops and phreatophytes in the valley would be beneficial. Field research on consumptive use could refine the irrigation analyses, and the salt and water budgets. Studies are being conducted by the University of Nevada, Cooperative Extension Service on the consumptive use of alfalfa.

Effects of Recommended Plan

Effects of the recommended plan are analyzed as if no further agricultural water development were to take place. Downstream the salinity benefits are the result of the 2.0 milligrams per liter reduction in salt concentration in the Colorado River at Imperial Dam. These benefits are based on $499,000 for each milligram per liter salt reduction. Benefits are derived from the effects that reduced salinity has on public water supplies, agricultural, and industrial uses.

Other economic benefits accrue: $333,000 annually from increased crop production, as a result of improved water management, and $198,000 annually from availibility of water for other uses.

Long-term adverse effects on the wildlife and waterfowl habitat within the area will be minimal. It is anticipated that within a few years after project implementation there will be a noticeable improvement in the quantity and quality of wildlife habitat systems.

Vegetative treatment of 10 bank miles of channel and clearing of drainage ditches will allow an increase in the amount and values of wildlife habitat. This improvement will be due to the control and possible elimination of undesirable phreatophytes such as arrowweed and saltcedar. Natural and artificial revegetation by more valuable species such as 4-wing saltbush, quailbush and saltgrass is planned.

The measures of effects are summarized in the following three accounts, Economic Development, Environmental Quality and Social Well-Being. The environmental quality account includes impacts to wildlife habitat. The improvements in water quality and quantity will not have a measurable effect on the fisheries in Lake Mead and downstream.

Implementation Program

USDA recommends that ongoing USDA conservation programs be used to accelerate needed improvements. Implementation plans can be prepared as a Long-Term Agreement (LTA), as part of a conservation plan of operations for each farm.

An LTA provides direct dealing with the landowner. The local conservation district will play a key role in establishing priorities for assistance. The district will coordinate onfarm and conveyance system improvements and encourage the landowners to operate and maintain their systems properly.

Each farm may be planned under one LTA. Irrigation improvements may be installed on lands identified in the conservation plan. A close correlation between planned improvements and installed improvements should result.

During development of the LTA, with an individual farmer, local site specific wildlife impacts will be identified and a determination made of the techniques or practices required to improve wildlife habitat. USDA encourages establishment or improvement of wildlife habitat during planning with individual landowners; however, the participation in any cost-sharing practice to improve wildlife habitat is voluntary. An LTA with the landowner can extend for a maximum period of ten years. The minimum period will be determined by the required management practices. A landowner may accelerate his rate of installation shown in the agreement.

The USDA will administer the technical assistance program through the field office in Las Vegas over a ten-year installation period. USDA could accept signups under this program until onfarm irrigation systems, delivery system and erosion control measures are planned and approved. Signups for improving the onfarm irrigation systems and the associated management practices will be limited to 4,897 acres. The estimated total cost, $5,773,100 (July 1980 price base), for the recommended plan includes the surface components of the systems as well as the buried components.

A high cost-share rate is needed to accelerate the installation to allow full implementation in a reasonable period of time. This was determined by considering net onfarm benefits, capital expenditures required, present local indebtedness, downstream salinity benefits versus onfarm benefits, and acceptance by local people.

Noncostshared management practices would be required as a condition for cost-share assistance of structural practices, where such management practices are necessary to achieve program objectives. Noncost-shared management practices may be implemented concurrently with cost-shared practices.

The federal cost-share applies to the pipeline and canal and lateral systems, the onfarm application and distribution systems, and necessary wildlife enhancement facilities. Technical assistance for the program amounts to $506,800.

Any non-cost shared or landowner costs plus annual operation, maintenance and replacement costs, will be furnished by the landowners. This money may be available to the eligible landowner in the form of low interest loans through the Farmers Home Administration (FmHA). If FmHA assistance is anticipated, that agency should be alerted to target funds for management plans. Such assistance allows the landowner to accelerate his application of practices.

Onfarm and off-farm conservation practices and associated costs are shown in Table 13.

TABLE 13. IMPLEMENTATION PROGRAM AND COST, RECOMMENDED PLAN MOAPA VALLEY SUBEVALUATION UNIT, NEVADA

CONSERVATION PRACTICES		TOTAL APPLICATION	
Name	Unit	Amount	Construction Cost $
ONFARM CONSTRUCTION			
IRRIGATION SYSTEM SURFACE	Acre	4,897	--- 1/
IRRIGATION WATER CONVEYANCE			
Ditch Lining	Feet	11,000	44,400
Appurtenant items for:			
Irrigation Automation and Water Measuring	Acre	3,170	334,900
Salinity Monitoring	Job	1	72,200
Pipelines			
15 - 18 inch diameter	Feet	64,500	601,300
Appurtenant items for:			
Irrigation Automation	Acre	1,727	561,100
Water Measuring 2/	Job	1	174,300
Salinity Monitoring	Job	1	38,900
IRRIGATION WATER MANAGEMENT	Acre	4,897	27,800
PASTURE AND HAYLAND ENHANCEMENT	Acre	847	3,300
WILDLIFE HABITAT ENHANCEMENT	Acre	2,700	155,400
OTHER CONSERVATION PRACTICES	Job	1	51,000
SUBTOTAL			2,064,600
DELIVERY SYSTEM CONSTRUCTION			
IRRIGATION WATER CONVEYANCE			
Lateral and Canal Lining	Feet	1,400	31,100
Pipelines			
42 inch, A/C T-30	Feet	1,6000	161,000
36 inch, A/C T-30	Feet	20,200	1,554,000
30 inch, A/C T-30	Feet	13,800	827,000
24 inch, A/C T-30	Feet	18,150	788,100
20 inch, 100 ft. PVC	Feet	4,500	61,000
15 inch, 100 ft. PVC	Feet	5,300	44,400
12 inch, 100 ft. PVC	Feet	15,890	94,300
Gate, values and stands	Job	1	35,500
SUBTOTAL			3,596,400
EROSION CONTROL CONSTRUCTION			
STEAMBANK PROTECTION	Feet	52,800	112,100
WILDLIFE HABITAT ENCHANCEMENT	Acre	114	--- 3/
TOTAL CONSTRUCTION			5,773,100
TECHNICAL ASSISTANCE			506,800
TOTAL			6,279,900

1/ Component conservation practices included in cost which subtotals $2,064,600
2/ Includes flow meters, flumes, reducers, etc.
3/ Costs included in streambank protection work.

BIBLIOGRAPHY

Ayers, R. S. and Westcot, D. W., United Nations, Food and Agriculture Organization, "Water Quality for Agriculture", Irrigation and Drainage Paper 29, Rome, Italy, 1976.

Clark County Conservation District, "Evaluation of Agriculturally Related Diffuse Sources", Clark County 208 Water Quality Management Plan, pp. 50-67, January 1978.

__________, "Environmental Report No. 2, Land Development Suitability Analysis", Clark County 208, October 1977.

__________, "Water Quality Management Plan," Clark County 208, May 9, 1978.

__________, "Muddy River Project Plan, unpublished, 1975.

__________, "Resource Data-Moapa Valley, Clark County, Nevada", In cooperation with U.S. Department of Agricultural, Soil Conservation Service, June 1976.

Nevada, State Department of Conservation and Natural Resources, "Ground Water Appraisal of Coyote Spring and Kayne Spring Valleys and Muddy River Springs Area, Lincoln and Clark Counties, Nevada, "Reconnaissance Series Report 25, U.S. Department of Interior, Geological Survey, Carson City, Nevada, February 1964.

__________, State Department of Conservation and Natural Resources, "Ground-Water Appraisals of the Meadow Valley Area, Lincoln and Clark Counties, Nevada", Reconnaissance Series Report 27, U.S. Department of Interior, Geological Survey, Carson City, Nevada, July 1964.

__________, State Department of Conservation and Natural Resources, "Water Resources Appraisal of the Lower Moapa-Lake Mead Area, Clark County, Nevada", Reconnaissance Series Report 50, U.S. Department of Interior, Geological Survey, Carson City, Nevada, December 1968.

__________, State Department of Conservation and Natural Resources, "Recreation in Nevada, Part Two", February 1967.

__________, State Department of Conservation and Natural Resources, "Alternative Plans for Water Resource Use", Colorado River Basin Area V, Detail Report, April 1974.

Shamberger, Hugh A., "Present and Potential Use of the Waters of the Colorado River and Tributaries within Nevada Together With Related Matters", A report to the Colorado River Commission of Nevada, Carson City, Nevada, May 1954.

Turner, J. H. and Anderson, C. L., American Association for Vocational Instructional Materials, "Planning for An Irrigation System", USDA, Soil Conservation Service, June 1971.

U.S. Department of Agriculture, Agricultural Research Service, Soil and Water Conservation Research Branch, U.S. Salinity Laboratory Staff," "Diagnosis and Improvement of Saline and Alkali Soils", Agricultural Handbook No. 60, February 1954.

U.S. Department of Agriculture, Soil Conservation Service, "Earth Dams and Reservoirs", Technical Release No. 60, June 1976.

_________, Soil Conservation Service, Special Projects Division, Golden, Colorado, "Erosion, Sediment and Related Salt Problems and Treatment Opportunities", December 1975.

_________, Soil Conservation Service, "Guide for Environmental Assessment" March 1977.

_________, Soil Conservation Service, "Flood Control Channel, Ground Water Drainage, and Supplementary Phases of Land Utilization, Lower Moapa Valley, Clark County, Nevada", Preliminary Report, Unpublished, October 1939.

_________, Soil Conservation Service, "Irrigation", SCS National Engineering Handbook, Section 15, Border Irrigation, Chapter 4, August 1974, U.S. Government Printing Office.

_________, Soil Conservation Service, "Irrigation Method Analyses Program IRMA", Users Guide, Colorado River Basin Salinity Control Studies and Irrigation Planning, July 1979.

_________, Soil Conservation Service, "Nevada Irrigation Guide", Draft, Reno, Nevada, unpublished, January 1979.

_________, Soil Conservation Service, "Lower Gunnison River Basin Wetland Inventory and Evaluation", Denver, Colorado, February 1979.

_________, Soil Conservation Service, "Procedures to Establish Priorities in Landscape Architecture", Technical Release No. 65, October 1978.

_________, Soil Conservation Service, "Sedimentation", SCS, National Engineering Handbook, Section 3, Sediment Sources, Yields and Delivery Ratios Chapter 6, unpublished, April 1971.

_________, Soil Conservation Service, "Soil Survey Laboratory Data and Descriptions for Some Soils of Nevada", Soil Survey Investigations Report No. 23, Nevada Agricultural Experiment Station, May 1970.

_________, Soil Conservation Service, "USDA Procedures for Planning Water and Related Land Resources in Programs administered by the Soil Conservation Service", Economic Research Service, Forest Service, Federal Register, Volume 38, Number 174, Part III, September 10, 1973.

__________, Soil Conservation Service, "USDA, Study Plan for the Virgin River Unit, Colorado River Salinity Control Program, Plan of Study", SCS Planning Staff, Reno, Nevada, August 1978.

__________, Soil Conservation Service, "Water and Related Land Resources, Virgin River Unit, Nevada, Arizona, Utah", Summary Report Part I, Bibliography Part II, October 1977, SCS, Reno, Nevada.

U.S. Department of Army, Corps of Engineers, Los Angeles District, "Interim Report on Survey, Flood Control Meadow Valley Wash and Lower Muddy River, Nevada", S-F 11, unpublished, November 15, 1978.

__________, Corps of Engineers, Los Angeles District, "Floodplain Information Muddy River, Vicinity of Overton, Clark County, Nevada", June 1974.

__________, Corps of Engineers, Sacramento District, "National Program for Inspection of Dams, Phase 1 Inspection Report for Bowman Dam, Clark County, Nevada," October 1980.

U.S. Department of the Interior, Bureau of Land Management, Denver Service Center, "The Effects of Surface Disturbance on the Salinity of Public Land in the Upper Colorado River Basin", 1977, Status Report, February 1978.

__________, Bureau of Reclamation, "Moapa Valley Pumping Project, Nevada", Concluding Report, May 1971.

__________, Bureau of Reclamation, "Moapa Valley Pumping Project, Nevada" Reconnaissance Report, August 1962.

__________, Bureau of Reclamation, Branch of Project Planning, Region 3, Boulder City, Nevada, "Water Conditions in the Muddy River Basin, Nevada", April 1950.

__________, Bureau of Reclamation, and U.S. Department of Agriculture, Soil Conservation Service, "Final Environmental Statement, Colorado River Water Quality Improvement Program", Volume I and II, May 19, 1977.

__________, Bureau of Sport Fisheries and Wildlife, Fish and Wildlife Service, "Threatened Wildlife of the United States", Resource Publication 114, March 1973.

__________, Geological Survey, "Water Resources Data for Nevada", Water Data Report NV-78-1, 1978.

__________, Geological Survey, "Hydrologic Unit Map - 1974, State of Nevada", 1975.

U.S. Environmental Protection Agency, Regions VIII and IX, "The Mineral Quality Problem in the Colorado River Basin", Appendix A, 1971.

APPENDICES

APPENDIX A

ENVIRONMENTAL EVALUATION INVENTORY WORKSHEETS

Environmental evaluation worksheets on the following pages were prepared to quantify or rate present and probable future environmental conditions with and without proposed program alternatives. The objective of environmental assessment is to provide adequate information to decision makers not to provide all-inclusive data bases on complex environments.

Evaluation was divided into an accounting of resources and their uses. The summary rating prepared relates the proposed resource use to the program alternative (see Table 3 in the Summary section). The Environmental Relationship Summary tabulation lists the technical discipline assigned leadership for evaluation of a specific resource use. The tabulation, developed in the initial phase of assessment after field examination, documents the broad areas of environmental concern.

Data collected and recorded on inventory worksheets may in some instances vary slightly from following more detailed study which is documented by the text of this report.

ENVIRONMENTAL RELATIONSHIP

SUMMARY

Description of Area: Moapa Valley Subevaluation Unit, Nevada

Basic Resources	Disciplines With Evaluation Leadership	Present Conditions	Future Conditions		
			Future Without	Planning Alternatives	
				1	2
Land Quantity	Dist. Consvst.	M	M	M	M
Land Quality	Dist. Consvst.	M	M	M	M
Water Quantity	Engineer	M	M	M	M
Water Quality	Plng. Staff Ldr.	I	I	I	I
RESOURCE USE					
Cropland Production	Dist. Consvst.	S	S	S	S
Fish Habitat	Biologist	S	S	S	S
Industrial Water Supply	Engineer	S	S	S	S
Irrigation Water	Engineer	I	I	I	I
Low Flow	Engineer	I	I	I	I
Municipal Water Supply	Engineer	S	S	S	S
Pastureland Production	Dist. Consvst.	S	S	S	S
Recreation	Biologist	S	S	S	S
Wildlife Habitat	Biologist	S	S	S	S
Economic	Economist	S	M	M	M
Visual Quality of Landscape	All	S	S	S	S
Social	Economist	S	M	M	M
Unique, Cultural, Historical and Natural	Dist. Consvst.	S	S	S	M

Relationship - S-Slight, Moderate, I-Important

ASSESSMENT SHEET

LAND QUANTITY LEVELS

Description of Area: Moapa Valley Subevaluation Unit, Nevada

Parameters	Unit	Present Conditions	Future Conditions: Future Without	Future Conditions: Planning Alternatives 1	Future Conditions: Planning Alternatives 2
Land Use					
Cropland	acres	4,094	3,568	3,663	3,710
Pastureland	acres	1,088	1,189	1,094	1,047
Rangeland (none considered within impact area)	acres	-	-	-	-
Forestland	acres	-0-	-0-	-0-	-0-
Wildlife land	acres	7,035	7,035	7,035	7,035
Urban land or built-up land	acres	175	600	600	600
Recreation land	acres	44,800	44,800	44,800	44,800
Water (ponds)	acres	372	372	372	372
Cover Type					
Urban or built-up land	acres	175	600	600	600
Agricultural land 1/	acres	5,182	4,757	,757	4,757
Rangeland (none considered within impact area)	acres	-	-	-	-
Forestland	acres	-0-	-0-	-0-	-0-
Water (ponds)	acres	372	372	372	372
Wetland 2/ Riverine 1,559; Lacustrine 406; Palustrine 5,070; Total 7,035	acres	7,035	7,035	7,035	77,035

1/ Agricultural lands total 5,182 acres, not including wasteland or wildlife lands; 4,982 acres of the agricultural lands are irrigated.

2/ See page C-5 for definitions.

ASSESSMENT SHEET

LAND QUALITY LEVELS

Description of Area: Moapa Valley Subevaluation Unit, Nevada

Parameters	Unit	Present Conditions	Future Conditions: Future Without	Planning Alternatives: 1	Planning Alternatives: 2
Gross Erosion[1/]	acres				
A. 1 ton or less/ac/yr		7,000	7,000	7,160	7,160
B. 1 to 3t/ac/yr		264,000	264,000	264,000	264,000
C. 3 to 5 t/ac/yr		119,000	119,000	119,000	119,000
D. 5 to 10t/ac/yr		156,000	156,000	156,000	156,000
E. 10 t/ac/yr or more		13,000	13,000	12,840	12,840
Flood hazard total flood plain (100-year flood)		7,500	7,500	7,500	7,500
A. Previously flood proofed		-0-	-0-	-0-	-0-
B. Subject to flooding		7,500	7,500	7,500	7,500
C. No. of inhabitable properties	acres	114	165	165	165
D. No. of commercial and industrial properties		7	10	10	10
Farmland (important to the State of Nevada)	acres	4,982	4,557	4,557	4,557
Saline lands (includes all land ownerships)[2/]	sq. mi.	183	183	183	183

1/ See Figure 10, EROSION AREAS

2/ See Figure 8, SALINE SOILS

ASSESSMENT SHEET

LAND QUALITY LEVELS (Con.)

Description of Area: Moapa Valley Subevaluation Unit, Nevada

Parameters	Unit	Present Conditions	Future Conditions: Future Without	Planning Alternatives: 1	Planning Alternatives: 2
Considerations for specific uses					
Cropland					
Soil management systems	Percent	25	30	40	70
A. Adequate[1/]		25	30	40	70
B. Not adequate		75	70	60	30
Production Potential	Percent				
A. More than 90% of potential		25	30	40	50
B. 70 to 90% of potential		60	60	50	40
C. Less than 70% of potential		15	10	10	10
Water management systems acres					
A. Drainage, total[2/]					
1. Adequate	acres	2,594	2,268	3,321	3,368
2. Not adequate	acres	1,500	1,300	342	342
B. Irrigation[3/]					
1. Adequate	acres	800	1,100	2,700	3,000
2. Not adequate	acres	3,294	2,468	963	710

1/ For 1979.

2/ Total acres of cropland that could benefit from drainage practices (not proposed for recommended program).

3/ Includes conveyance and onfarm systems.

ASSESSMENT SHEET

LAND QUALITY LEVELS (Con.)

Description of Area: Moapa Valley Subevaluation Unit, Nevada

Parameters	Unit	Present Conditions	Future Conditions: Future Without	Future Conditions: Planning Alternatives 1	Future Conditions: Planning Alternatives 2
Pastureland					
Production potential	percent				
A. More than 90% of potential		25	30	40	50
B. 70 to 90% of potential		60	60	50	40
C. Less than 70% of potential		15	10	10	10
Soil anagement systems	percent				
A. Adequate		25	30	40	70
B. Not adequate		75	70	60	30
Water management systems	acres				
A. Drainage, total 1/					
1. Adequate		688	589	694	647
2. Not adequate		400	600	400	400
B. Irrigation					
1. Adequate		200	389	494	547
2. Not adequate		888	800	600	500

1/ Acres or pastureland that could benefit from drainage practices (not proposed for recommended program).

ASSESSMENT SHEET

LAND QUALITY LEVELS (Con.)

Description of Area: Moapa Valley Subevaluation Unit, Nevada

Parameters	Unit	Present Conditions	Future Conditions: Future Without	Future Conditions: Planning Alternatives 1	Future Conditions: Planning Alternatives 2
Rangeland - No rangeland considered within estimated impact area					
Wildlife land					
Wildlife habitat management system	acres				
A. Adequate		1,965	1,965	2,079	2,079
Riverine 1,559 Lacustrine 406					
B. Not adequate		5,070	5070	4,956	4,956
Palustrine 5,070					
Urban land (includes specialized land uses)					
Land developed to include designs that overcome the soil and/or site limitations	acres				
A. Adequate		150	500	500	500
B. Not adequate		25	75	75	75
Recreation land					
Land developed to include acres designs that overcome soil and/or site limitations	acres				
A. Adequate		60	60	60	60
B. Not adequate		40	40	40	40

ASSESSMENT SHEET

WATER QUANTITY LEVELS

Description of Area: Moapa Valley Subevaluation Unit, Nevada

Parameters	Unit	Present Conditions	Future Conditions: Future Without	Future Conditions: Planning Alternatives 1	Future Conditions: Planning Alternatives 2
Streams					
Perennial (Muddy River)	miles	28.0	28.0	28.0	28.0
Intermittent	miles	0	0	0	0
Ephemeral	miles	0	0	0	0
Average discharge (Moapa Gage)	cfs	45.1	45.1	45.1	45.1
Average annual yield (Moapa Gage)	ac-ft	32,670	32,670	32,670	32,670
Minimum flow - Upper Muddy	cfs	27	27	27	27
- Lower Muddy		3.2	3.8	7.8	10.7
No flow (Lower Muddy)	days/yr	0	0	0	0
Stream size by reach width 50' to 150' depth 2' to 35'	miles	28.0	28.0	28.0	28.0
Streambank	miles	56	56	56	56
Type of stream channel 1/	upper - natural lower - natural with man-made improvements				
Bowman Reservoir					
Effective storage	ac-ft	4,000	4,000	4,000	4,000
Surface area	acres	186	186	186	186
Shoreline	miles	1.6	1.6	1.6	1.6
Ground water					
Major springs	no.	6	6	6	6
Available storage (to 100 ft. depth on 13,000 ac)	ac-ft	130,000	130,000	No change	
Expected life	years	indef.	indef.	indef.	indef.

1/ Natural or man-made.

ASSESSMENT SHEET

WATER QUALITY LEVELS

Description of Area: Moapa Valley Subevaluation Unit, Nevada

Parameters	Unit	Present Conditions	Future Conditions: Future Without	Future Conditions: Planning Alternatives 1	Future Conditions: Planning Alternatives 2
Physical properties 1/					
Discharge - Average Annual	cfs	7.3	7.9	11.8	14.7
pH	no.	8.2	8.2	8.0	8.0
Suspended solids	mg/l	>2000	>2000	slight reduction	slight reduction
Water temperature	°C	19-22	19-22	19-22	19-22
Air temperature (July Mean)	°C	29	29	29	29
Electrical conductance	mmho/cm @ 25° C	2005	1,941	1,518	1,411
Chemical properties 1/					
Major cations					
Ca^{++} (calcium)	mg/l	190	182	146	135
Mg^{++} (magnesium)	mg/l	124	119	95	88
Na^{+} (sodium)	mg/l	362	347	278	257
SAR (sodium absorption ratio)	no.	5.0	4.9	4.4	4.2
Major anions					
Cl^{-} (chloride)	mg/l	257	246	197	182
$SO_4^{=}$ (sulfate)	mg/l	1,011	969	775	716
HCO_3^{-} (bicarbonate)	mg/l	406	389	311	287
DO (dissolved oxygen)	mg/l	5.0			
Dissolved solids (total)	mg/l	2,373	2,297	1,796	1,670
Nitrogen compounds (nitrate)	mg/l	0.34	0.34	0.34	0.34
(ammonia)	mg/l	0.10	0.10	0.10	0.10
Phosphorus (total)	mg/l	0.18	0.18	0.18	0.18
(ortho)	mg/l	0.15	0.15	0.15	0.15
Coliforms, fecal	MPN/ 100 ml	445	445	445	445
BOD (biological oxygen demand)	mg/l	2.00	2.00	2.00	2.00

1/ Data is for surface water at the State of Nevada, Department of Wildlife Diversion below the town of Overton.

RESOURCE USE

For

FISH HABITAT

Description of Area: Moapa Valley Subevaluation Unit, Nevada

Parameters	Unit	Present Conditions	Future Conditions: Future Without	Future Conditions: Planning Alternatives 1	Future Conditions: Planning Alternatives 2
Lakes or ponds 1/	acres	1,372	1,372	1,372	1,372
Water Quality	rating 2/	3	3	3	3
Biological productivity					
Fish	lb/ac	Unknown - 1,000 acres of Overton Arm of Upper Lake Mead is considered a fishery			
Rare or endangered species	number	0	0	0	0
Streams 3/					
Water quality	rating 2/	2	2	2	2
Rare or endangered species (list) Moapa dace	number	500-1000	500-1000	500-1000	500-1000
Summary rating 2/		3	3	3	3

1/ Includes about 1,000 acres of the Overton Arm of Lake Mead.

2/ The rating scale is from 1 to 5: 1, unsuited; 2, poor; 3, fair or neutral; 4, good; and 5, excellent.

3/ Muddy River is considered a fishery due to occurrance of the Moapa dace whose habitat is limited to the upstream Warm Springs area. This area would not be impacted by proposed program alternatives.

RESOURCE USE

For

INDUSTRIAL WATER SUPPLY

Description of Area: Moapa Valley Subevaluation Unit, Nevada

			Future Conditions		
			Planning Alternatives		
Parameters	Unit	Present Conditions	Future Without	1	2
Industrial need	mgd	6.18	>6.18	>6.18	6.18
Quantity available	mgd	6.18	6.6	9.1	11.0
Summary rating 1/		4	4	4	4

1/ The rating scale is from 1 to 5: 1, unsuited; 2, poor; 3, fair or neutral; 4, good; and 5, excellent.

RESOURCE USE

For

IRRIGATION WATER

Description of Area: Moapa Valley Subevaluation Unit, Nevada

Parameters	Unit	Present Conditions	Future Conditions		
			Future Without	Planning Alternatives 1	Planning Alternatives 2
Gross Application	ac-ft/yr	44.177	44,415	37,349	33,477
Seasonal Net Application	ac-ft/yr	19,630	19,295	19,670	19,876
Area served	acres	4,982	4,897	4,897	4,897
Water use efficiency 1/	percent	45	45	55	61
Conveyance efficiency 2/	percent	90	92	95	98
Available Supply (Upper and Lower Valley)					
Direct flow	ac-ft/yr	45,500	45,500	45,500	45,500
Reservoir storage	ac-ft/yr	4,000	4,000	4,000	4,000
Ground-water pumpage	ac-ft/yr	2,330	2,330	2,330	2,330
Reuse	ac-ft/yr	<100	<100	<100	<100
Quality (Upper & Lower Valley)	rating	2	2	2	2
Adequacy to Meet Requirements					
Upper	percent	90	90	100	100
Lower	percent	105	105	100	100
Availability vs. Time of Need	rating 3/	4	4	4	4
Return Waters					
Surface flow (field runoff)	ac-ft/yr	16,694	16,410	12,796	11,928
Ground water recharge (field deep percolation)	ac-ft/yr	8,853	8,701	4,882	1,873
Quality	rating 3/	2	2	2	2
Summary Rating 3/		3	3	3	3

1/ Onfarm.
2/ Off-farm.
3/ The rating scale is from 1 to 5: 1, unsuited; 2, poor; 3, fair or neutral, 4, good; and 5, excellent.

RESOURCE USE

For

LOW FLOW

Description of Area: Moapa Valley Subevaluation Unit, Nevada

Parameters	Unit	Present Conditions	Future Conditions: Planning Alternatives: Future Without	1	2
Minimum flow					
Moapa Gage	cfs	27	27	27	27
Glendale Gage	cfs	7.6	7.6	7.6	7.6
Overton	cfs	3.2	3.8	7.8	10.7
Water quantity needed					
Fish	cfs	2	2	3	3
Wildlife 1/	cfs	2	2	3	3
Esthetic	cfs	2	2	2	2
Recreation	cfs	2	2	3	3
Summary rating 2/		2	2	3	3

1/ The only recreation involved with the stream channel is hunting of upland game, waterfowl, and small game.

2/ The rating scale is from 1 to 5: 1, unsuited; 2, poor; 3, fair or neutral, 4, good; and 5, excellent.

RESOURCE USE

For

MUNICIPAL WATER SUPPLY

Description of Area: Moapa Valley Subevaluation Unit, Nevada

Parameters	Unit	Present Conditions	Future Conditions		
			Planning Alternatives		
			Future Without	1	2
Population	no.	2,525	6,000	6,000	6,000
Total hookups	no.	631	1,481	1,481	1,481
Consumption per capita	gal/day	207	225	225	225
Municipal water needs	mgd	.52	1.35	1.35	1.35
Quantity available	mgd	.6	2.58	2.58	2.58
Quantity vs. need	pct	100	100	100	100
Quality	rating 1/	3	3	3	3
Water reuse					
Quantity	mgd	<1	<1	<1	<1
Quality	rating 1/	3	3	3	3
Summary rating 1/		3	3	3	3

1/ The rating scale is from 1 to 5: 1, unsuited; 2, poor; 3, fair or neutral, 4, good; and 5, excellent.

RESOURCE USE
For
RECREATION

Description of Area: Moapa Valley Subevaluation Unit, Nevada

Parameters	Unit	Present Conditions	Future Conditions: Planning Alternatives: Future Without	1	2
Population in local area of influence (LAI)	no.	30,000	36,000	36,000	36,000
Recreation land					
Quantity in LAI[1/]	acres	44,800	44,800	44,800	44,800
Quantity in 1,000 pop. in LAI	acres	1.5	1.25	1.25	1.25
Proximity	rating[2/]	3	3	3	3
Access	rating	3	3	3	3
Hunting land	acres	2,814	2,500	3,200	3,200
Recreation facilities and development	rating	3	3	3	3
Recreation water					
Quantity in LAI	acres	1,100	1,000	1,000	1,000
Quantity per 1,000 pop. in LAI	acres	1	·1	1	.1
Fishing water, stream	miles	14 miles	Not classed as fishery		
Fishing water, lakes	acres	1,000	1,000	1,000	1,000
Only 1,000 acres of uppermost part of Lake Mead considered.					
Camping	visits per year				
Supply		36,000	36,000	36,000	36,000
Demand		18,000	18,000	18,000	18,000
Picnicking	visits per year				
Supply		42,000	42,000	42,000	42,000
Demand		24,000	24,000	24,000	24,000

1/ LAI, local area of influence, generally a 2-hour drive.

2/ Rating scale: 1, unsuited; 2, poor; 3, neutral or fair; r, good; 5, excellent.

RESOURCE USE

For

RECREATION (Con.)

Description of Area: Moapa Valley Subevaluation Unit, Nevada

Parameters	Unit	Present Conditions	Future Conditions		
			Future Without	Planning Alternatives 1	Planning Alternatives 2
Swimming	visits per year				
Supply		30,000	30,000	30,000	30,000
Demand		12,000	12,000	12,000	12,000
Boating	visits per year				
Supply		144	144	144	144
Demand		200	200	200	200
Fishing	visits per year				
Supply		90	90	90	90
Demand		180	180	180	180
Hunting	visits per year				
Supply		180	180	320	320
Demand		540	540	540	540
Total	visits per year				
Supply		108,414	108,414	108,554	108,554
Demand		54,920	54,920	54,920	54,920
Total Opportunity	visits per year				
Supply		108,414	108,414	108	108,554
Demand		54,920	54,920	54,920	54,920
Opportunity index 3/	percent	197	197	198	198
Summary	rating	3	3	3	3

3/ Opportunity index: Total supply divided by total demand times 100.

RESOURCE USE

For

WILDLIFE HABITAT

Description of Area: Moapa Valley Subevaluation Unit, Nevada

Parameters	Unit	Present Conditions	Future Conditions: Planning Alternatives: Future Without	1	2
Open land					
Palustrine 4,160	ac/ac-	.25	.25	.50	.50
Abandon crop 910		.25	.25	.25	.25
Total acre 5,070		.25	.25	.25	.25
Most important major species	number of species	22	22	22	22
Rare or endangered species - Peregrine Falcon - Bald Eagle	list	Not Affected			
Woodland (by type) - None	ac/ac-value	0	0	0	0
Major species - None	numbers	0	0	0	0
Threatened or endangered species - None		0	0	0	0
Wetland (by type)	ac/ac-value				
Riverine 1,559 ac.		.50	.50	.75	.75
Lacustrine 406 ac.		.75	.50	.75	1.00
Palustrine 5,070 ac.		.25	.25	.50	.50
Native habitat is 6,125 ac.1/					
Riverine - 544 ac. Type X					
Lacustrine - 60 ac. Type I, 13 ac. Type IV 170 ac. Type V, 163 ac. Type XI					
Palustrine - 98 ac. Type II, 5,077 ac. Type IX					
Abandon cropland habitat - 910 ac.					
Total habitat2/	acre	7,035	7,035	7,035	7,035
Favorably impacted by slight decreased elevation of water table (40%)	acre	-0-	-0-	2,814	2,814
Adversely impacted by slight decreased elevation of water table, Type IX and X.	acre	-0-	-0-	89	89

1/ According to USFW, Circular No. 39, 1979.

2/ Impacts favorable and adverse are slight or not significant.

RESOURCE USE

For

WILDLIFE HABITAT (Con.)

Description of Area: Moapa Valley Subevaluation Unit, Nevada

Parameters	Unit	Present Conditions	Future Conditions: Future Without	Future Conditions: Planning Alternatives 1	Future Conditions: Planning Alternatives 2
Major species					
Riverine	number of species present	7	7	7	7
Lacustrine		6	6	6	6
Palustrine		8	8	8	8
Rare or endangered species		0	0	0	0
Summary rating 1/		3	3	4	4

1/ The rating scale is from 1 to 5: 1, unsuited; 2, poor; 3, fair or neutral; 4, good; and 5, excellent.

RESOURCE USE

For

ECONOMIC

Description of Area: Moapa Valley Subevaluation Unit, Nevada

Parameters	Unit	Present Conditions	Future Conditions: Future Without	Future Conditions: Planning Alternatives 1	Future Conditions: Planning Alternatives 2
Salt damages 1/	avg. annual $	3,954,400	3,965,100	3,329,400	2,914,600
Salt damage reduction 2/	avg. annual $	0		635,700	1,050,700
Other benefits 3/	avg. annual $	0		737,700	1,277,000
Costs	avg. annual $	0		655,600	883,500
Net benefits	avg. annual $	0		717,800	1,444,200
Summary rating 4/		3	3	4	4

1/ Average annual salinity damage (or damage reduction)due to loss (or gain of) water is not included here. Values in Table 2 of the text include such effects. Damages and costs are based on 1980 prices.

2/ Damage reduction is measured from future without program condition. Values for future without program condition are in Table 2 of the text and were measured from present condition (1978).

3/ Other benefits include salinity benefit or loss due to additional water, increased crop production, water available for other uses, and benefits during installation. Costs and benefits were amortized over a 25-year evaluation period using an interest rate of 7 3/8 percent.

4/ The rating scale is from 1 to 5: 1. unsuited; 2. poor; 3. fair or neutral; 4. good; and 5. excellent.

RESOURCE USE

For

VISUAL QUALITY OF THE LANDSCAPE

Description of Area: Moapa Valley Subevaluation Unit, Nevada

Parameters	Unit	Present Conditions	Future Conditions: Future Without	Future Conditions: Planning Alternatives 1	Future Conditions: Planning Alternatives 2
Land					
Visual quality of land 1/	rating	3	3	3	3
Geologic surface material	rating	2	2	2	2
Water					
Water-land ratio	rating	2.5	2.5	2.5	2.5
Visual quality of water body or stream	rating	3	3	3	3
Air					
Sound	rating	3	3	3	3
Odor	rating	3	3	3	3
Visibility	rating	2.5	2.5	2.5	2.5
Manmade objects					
Linear structures (dikes, spoils, channels)	rating	2	2	2	2
Dams	rating	2.5	2.5	2.5	2.5
Recreation facilities (shelter houses, restrooms, swimming beaches, boat docks, etc.)	rating	3	3	3	3
Other structures (buildings, pumping plants, sewage treatment plants, etc.)	rating	3	3	3	3
Summary rating 2/		2.5	2.5	2.5	2.5

1/ USDA-SCS TR-65 procedure was used.

2/ The rating scale is from 1 to 5: 1, unsuited; 2, poor; 3, fair or neutral; 4, good; and 5, excellent.

RESOURCE USE

For

SOCIAL

Description of Area: Moapa Valley Subevaluation Unit, Nevada

Parameters	Unit	Present Conditions	Future Conditions: Planning Alternatives: Future Without	1	2
Total population	no.	2,525	6,000	6,000	6,000
Population density 1/	no./mi^2	1.45	3.44	3.44	3.44
Age					
0 - 18	pct.	42	42	42	42
18 - 65	pct.	48	48	48	48
Over 65	pct.	10	10	10	10
Health					
Doctors per 1,000 pop.	no.	0	0	0	0
Dentists per 1,000 pop.	no.	0	0	0	0
Hospitals (beds per 1,000 pop.)	no.	0	0	0	0
Residence for aged (beds per 1,000 pop.)	no.	0	0	0	0
Vector control	acres	100	100	25	25
Education					
Median school completed	year	12.3	12.3	12.3	12.3
Outmigration	no./yr.	0	0	0	0
Median family income	$/yr.	9,100	9,100	9,100	9,100
Below poverty level of $4,000 per year	pct.	7	7	7	7
Income distribution					
Less than $5,000	pct.	14	14	14	14
$5,000 to $10,000	pct.	33	33	33	33
Greater than $10,000	pct.	53	53	53	53
Summary rating 2/		2	2	2	2

1/ The population density is based on 1740 square miles which includes the Upper Muddy River drainage. The study area was reduced to 874 square miles after preparation of this worksheet.

2/ The rating scale is from 1 to 5: 1, unsuited; 2, poor; 3, fair or neutral; 4, good; and 5, excellent.

RESOURCE USE

For

UNIQUE, CULTURAL AND HISTORICAL

Description of Area: Moapa Valley Subevaluation Unit, Nevada

Parameters	Unit	Present Conditions	Future Conditions: Future Without	Future Conditions: Planning Alternatives 1	Future Conditions: Planning Alternatives 2
Landmarks					
Historical sites and monuments		Two historical pioneer trails cross the study area.			
Unique natural geologic areas		Man's activities have disturbed areas of proposed improvements.			
Archeological sites		None known to be designated in areas of proposed improvements.			
Architectural sites		None known to be designated in areas of proposed improvements.			
Scientific sites		None known to be designated in areas of proposed improvements.			
Cultural Resources					
Population migration		Negligible			
Ethnic groups	no.	4	4	4	4
Seasonal homes	pct.	2	2	2	2
Summary rating 1/		3	3	3	3

1/ The rating scale is from 1 to 5: 1, unsuited; 2, poor; 3, fair or neutral; 4, good; and 5, excellent.

APPENDIX B

BEST MANAGEMENT PRACTICES

Best Management Practices are conservation measures that should be installed to reduce the adverse affects of irrigated agriculture on water quality. These practices reduce erosion, sediment and salt loading from irrigated crop and pasture lands. Installation of these practices will help restore stream flow to a higher quality.

Selected material was taken from "Agriculturally Related Diffuse Sources", Water Quality Series, Clark County 208 Water Quality Management Plan, Clark County, Nevada, Clark County Conservation District, January 1978. Conservation practices identified in the Clark County Plan are practices which are included in the USDA-SCS, "National Handbook of Conservation Practices." Names of conservation practices used for county planning differ somewhat from names designated as official by the SCS.

A list of recommended practices for Moapa Valley and a discussion of their application follows:

IRRIGATION WATER MANAGEMENT

- Water Measuring Devices
- Improved Methods of Irrigation
  - Level Borders or Basins
  - Graded Borders
  - Sprinkler Irrigation
- Canal and Ditch Lining Systems
- Water Control Structures
- Pipeline Distribution Systems
- Tailwater Recovery Systems

WATER EROSION CONTROL

- Grassed Waterways with
- Crop Rotation
- Cover Crops
- Pasture Management

Irrigation Water Management

Determining and controlling the rate, amount and timing of irrigation water application in an efficient manner is necessary to effectively utilize available water supply. Managing and controlling the moisture environment of crops is needed to promote the desired crop response. Minimizing soil erosion and loss of plant nutrients and controlling undesirable water loss protects water quality. The following practices are recommended to improve irrigation water management and water quality.

Water Measuring Devices

A measuring device is used by an irrigator to determine how much water is used and when to make necessary adjustments for efficient use. The simplest of all measuring devices is a weir, but it requires a considerable drop or loss of head to function accurately. When such a head loss cannot be tolerated, a flow meter or trapozoidal flume may be used. Usually large canal systems have a measuring device built into the headgate. Some pumping installations are equipped with meters on the discharge line.

Improved Methods of Irrigation

Level Borders or Basins - The level border method of irrigation consists of surrounding a nearly level area with a long narrow low dike, which can be filled with the desired amount of water. A temporary pond is created until the water infiltrates the soil. Level basins are similar to level borders except that the basins are generally as wide as they are long, while level borders are several times longer than they are wide. These systems can be adapted to automation easily or can be operated efficiently by inexperienced labor. High application efficiency can be obtained and runoff is eliminated.

Both row crops and close grown crops are adapted to use with level borders or basins as long as the crop is not affected by temporary innundation or is planted on beds so that it will remain above the water level. The area within the border must be carefully leveled. Preferably there should be no cross slope and the total fall within the length of the border should not exceed one-half the normal net water application depth.

As the intake rate of the soil increases, the stream size must be increased or the run lengths shortened in order for water to cover the area within the correct period of time. Large irrigation streams usually require higher border ridges. Level borders are useful when leaching is required to remove salts from the soil profile.

Graded Borders - With graded border method of irrigation, the field is divided into rectangular parallel strips separated by small earth dikes called border ridges. These ridges are broad and low enough so that they can be planted and harvested with the rest of the field. Borders are usually level or nearly level across the border strip, but have slope in the direction of irrigation run.

The graded border method is adapted to close growing crops. A stream of water is introduced into the upper end and it flows across the field in a sheet between the border dikes. By selecting the proper stream size, efficient irrigation application results.

Ideally, graded borders should have a uniform slope in a downfield direction. When this is not possible, the steepest slope should not be greater than twice the flattest and the slope should either steadily increase or decrease in a downstream direction. Undulating slopes are inefficient.

Sprinkler Irrigation - The sprinkler method applies the irrigation water by means of a spray somewhat resembling rainfall. Sprinkler systems must be designed to meet specific conditions. The Nevada SCS Irrigation Guide gives the required information concerning:

1) The soil-slope group adapted to sprinklers.
2) The peak consumptive use rates for various crops.
3) Maximum allowable sprinkler application rate.
4) Available water holding capacities of soils.
5) The estimated application efficiencies.

The time of application depends upon the rate at which the water is applied, and must be computed individually.

Canal and Ditch Lining Systems

A fixed lining of impervious material installed in existing or newly constructed irrigation field ditches, irrigation canals or laterals will prevent water-logging of land, maintain water quality, prevent erosion, and reduce water loss.

The choice of a suitable material for ditch lining, non-reinforced concrete, or a flexible membrane depends on the existing conditions and the results required.

Non-reinforced concrete lining should be installed only in well-drained soils or on sites where subgrade drainage facilities are installed with or below the lining. They should not be installed on sites subject to severe frost heave or on sites where the sulphate salt concentration in the soil causes rapid concrete deterioration.

Flexible membrane linings such as plactic, rubber or asphalt, should be used on side slopes which will be statically stable. They should be protected by an earth and/or gravel covering and the materials itself should meet individual required thickness standards. Quality of the lining is important, and care in installation is necessary to maintain that quality. The membrane must be sufficiently anchored to prevent movement.

Water Control Structures

Water control structures are used to regulate and maintain water levels to control water table, fish and wildlife management, and for flooding land surfaces. The control is accomplished by use of gates or stoplogs that can be fitted into several types of structures. Water control structures can be used to control drainage, flooding, and for water level regulation. Diversions, headgates, etc. are typical water control structures used for irrigation.

Pipeline Distribution Systems

Irrigation pipelines can be used for the same purposes or in place of open channels. Water distribution efficiency is high as they almost eliminate losses from evaporation and seepage. They are particularly adapted to areas where seepage losses from ditches are high. Buried pipelines have many advantage over open ditches. Pipelines require careful planning for the correct location, capacity requirements, selection of materials and construction methods.

Tailwater Recovery Systems

Tailwater recovery systems collect, store and transport irrigation tailwater for re-use in the farm irrigation distribution system. They help conserve farm irrigation water supplies and enhance water quality. Tailwater systems are adapted for use on sloping lands that are served by an irrigation system where recoverable irrigation runoff occurs.

A sump or pit is necessary to store the collected tailwater until it is to be redistributed, and return facilities are needed to convey the tailwater to the point of re-entry into the farm irrigation system. All pipelines, ditches, and pumping plants should be constructed in accordance with appropriate engineering standards.

Water Erosion Control

Water erosion is the major source of sediment. Some factors attributed to water erosion, such as climate, topography and soil types, are generally uncontrollable. However, methods such as crop rotations and cover crops are available to reduce water erosion.

Grassed Waterways with Irrigation

Grassed waterways are natural or constructed outlets, shaped to required dimensions and established with erosion-resistant vegetation. They are used for safe disposal of runoff from fields, diversions, terraces, and other conservation measures. Grassed waterways are a basic conservation practice commonly used by farmers. Stable outlets to transport concentrated runoff are vital to the functioning of most conservation systems.

The most satisfactory location for a waterway is a well-vegetated natural draw. Some shaping or enlarging may be required to handle the increased flow. In this case, the design and construction should provide a stable channel.

A pasture or meadow strip may be used in lieu of a constructed or natural waterway. The strip should be wide enough to carry the volume of flow. The type and density of vegetation should be adequate to withstand expected flow velocities. In arid areas irrigation is needed to establish and maintain grassed waterways.

Crop Rotation

Different crops are grown in a sequential pattern on the same field. In a crop rotation system, combinations of crops provide opportunities for maintaining soil productivity and reducing soil erosion.

Sod-forming grasses and legume crops, used in rotation with row crops, are highly effective in maintaining the soil structure and tilth and in reducing soil and nutrient losses by erosion. In addition, the rotation of crops often allows for the planting of both shallow and deep rooted plants; this pattern improves the physical condition and the internal drainage of both the surface soil and the subsoil.

Cover Crops

Grasses and other close-growing crops gives more soil protection than row crops such as corn and grain sorghum. Crops that leave large quantities of residue after harvest offer more soil protection than crops with small quantities of residue.

Cover crops are grown when there would otherwise be no growing plants and/or residues to protect the soil from erosion. An example is winter rye seeded immediately after a corn crop is harvested for silage. The gowing rye protects the soil during the fall, winter and early spring when the field would otherwise be bare and subject to erosion. Many cover crops are left on the soil to serve as protective mulch, or are plowed under for soil improvement.

Cover crops may be special crops planted to provide soil cover and protection or they may be crops typically found in the rotation but planted in a different season. An example is spring oats, which are seeded in the fall, following a row crop. The growing oats freeze in the winter and the tops protect the soil.

Pasture Management

Land use for grazing is characterized by a diversity fo climate, topography, soils, vegetative type, and vegetative condition. This diversity, coupled with varying intensities of livestock use, creates the potential for varying degrees of water erosion.

Prevention and control of erosion on irrigated pasture land are accomplished through management practices that control the intensity of livestock use, and/or increase the density and productivity of the vegetation. Overgrazing results in soil structural changes because of soil compaction and reduction of soil permeability. It also changes the density, vigor, and species composition of vegetation and reduces the protective soil cover afforded by vegetation.

APPENDIX C

BIOTIC COMMUNITIES AND MAJOR WILDLIFE RESOURCES

Environmental evaluation of biotic communities and major wildlife resources is divided as follows:

BIOTIC COMMUNITIES

MAJOR WILDLIFE RESOURCES

- List of Fish
- List of Birds
- List of Mammals

WILDLIFE RESOURCE INVENTORY

- Riverine Habitat System
- Lacustrine Habitat System
- Palustrine Habitat System

BIOTIC COMMUNITIES

A summary of the Distribution of the Biota in the Zonal Biotic Communities of the study area follows. Communities are grouped as desert and hydric-acquatic communities. Transzonal communities are not considered since they pass through two or more of the zonal communities.

Biota	Desert Communities			Hydric-Aquatic Communitie				
	Cr	Bl	Total	DS	SR	St	La	Total
Vascular Plants	256	185	311	21	36	3	0	50
Fish	0	0	0	20	0	21	17	41
Amphibians	0	0	0	7	7	7	3	9
Reptiles (total)	30	19	30	0	14	1	0	15
Turtles	1	1	1	0	0	1	0	1
Lizards	14	13	14	0	7	0	0	7
Snakes	15	5	15	0	7	0	0	7
Birds (total)	33	26	40	202	159	15	44	245
Permanent residents	8	6	9	22	18	0	2	26
Summer residents	6	8	11	19	20	3	0	28
Winter residents	10	7	10	65	40	7	27	71
Non-residents	9	5	10	107	87	5	16	139
Mammals (total)	44	33	48	26	37	7	2	45
Insectivores	0	0	0	0	0	0	0	1
Bats	14	6	14	6	9	6	0	9
Rodents	16	14	18	10	18	1	1	19
Lagomorphs	2	2	2	2	2	0	0	2
Carnivores	9	6	9	4	6	0	1	9
Ungulates	3	5	5	4	2	0	0	5
Totals	363	263	429	276	253	54	70	405

Code letters for the biotic communities are: Cr = creosote bush, Bl = blackbrush, DS = desert spring and marsh, SR = stream riparian, St = stream, La = lake (Bradley and Deacon, 1967).

Source: Clark County 208 Environmental Report No. 2, Land Development Suitability Analysis, Table 16, page 56.

MAJOR WILDLIFE RESOURCES

List of Fish

Species endemic to Muddy River include: (Bradley and Deacon, 1967)

Roundtail chub *Gila robusta seminuda*
Moapa dace *Moapa coriacea*
Speckled dace *Rhinichthys osculus*
White River spring fish *Crenichthys bailiey*

Species exogenous to Muddy River include: (Bradley and Deacon, 1967)

Common carp *Cyprinus carpio*
Red shiner *Notropis lutrensis*
Fathead minnow *Pimephales promelas*
Channel catfish *Ictalurus punctatus*
Mosquitofish *Gambusia affinis*
Mexican molly *Poecilia mexicana*
Largemouth bass *Micropterus salmoides*
Green sunfish *Lepomis cyanellus*

List of Birds

This list of birds was divided into classifications used by the Nevada Department of Wildlife. The various classifications and most important species are as follows:

Upland Game Birds

Gambell's quail *Lophortyx gambelii*
Ring-necked Pheasant *Phasianus colchicus*
White-winged Dove *Zenaida asiatica*
Mourning Dove *Zenaicura macroura*

Migratory Game Birds

*Canada Goose *Branta canadensis*,
*Mallard *Anas platyrhynchos*,
*Pintail *Anas acuta*,
*Green-winged Teal *Anas carolinensis*,
*Cinnamon Teal *Anas cyanoptera*,
*Shoveler *Spatual clypeata*,
*Redhead *Aythya americana*,
Lesser Scaup *Aythya affinis*
*Bufflehead *Bucephala albeola*,
*Ruddy Duck *Oxyura jamaicensis*,
Common Merganser *Mergus merganser*,
Red-breasted Merganser *Mergus serrator*,
Common Gallinule *Gallinula chloropus*,
Common Coot *Fulica americana*,
**Mourning Dove *Zenaidura macroura*.

** Species of importance to man due to their value for sport hunting and relative abundance in this portion of the study area.

** Dual classification as Upland Game Birds.

Nongame Birds

Nongame birds include all wild birds not classified as upland game or migratory game birds (150 species).

Nongame birds that are not protected by Federal or State Laws that are found within the Nevada drainage area of the Colorado River include, but are not limited to the House Sparrow *Passer domesticus* and the Starling *Sturnus vulgaris*.

List of Mammals

This list of mammals was divided into classifications used by the Nevada Department of Wildlife. The various classifications and major species are as follows:

Game Animals

Big Game: None

Small Game:

Audubon cottontail *Sylvilagus auduboni*
Nuttall cottontail *Sylvilagus nuttallii*
pygmy rabbit *Sylvilagus idahoensis*

Furbearing Animals

Muskrat *Ondatra zibethica*
Beaver *Castor canadensis*
River Otter *Lutra canadensis*
Kit fox *Vulpes macrotis*
Bobcat *Lynx rufus*

Nongame Animals

Nongame animals include all wild animals not classified as furbearing or game animals (84 species).

Nongame animals that are not protected by either Federal or State laws that are found within the study area are the following:

Coyote *Canis latrans*
black-tailed jackrabbit *Lepus californicus*
Spotted skunk *Spilogale gracilis*
Striped skunk *Mephitis mephitis*
Long-tailed Weasel *Mustela frenata*
Short-tailed Weasel *Mustela erminea*

WILDLIFE RESOURCE INVENTORY

Riverine Habitat System

The Riverine System includes all wetlands and deep-water habitats contained within a channel except wetlands dominated by trees, shrubs, persistent emergents, nonaquatic mosses or lichens. A channel is, "an open conduit either naturally or artificially created which periodically or continuously contains moving water, or which forms a connecting link between two bodies of standing water" (Langbein and Iseri 1960:5).

Species used in habitat evaluation procedures for the wildlife resource inventory of the riverine habitat system are:

American Coot *Fulica americana*
Raccoon *Procyon lotor*
Muskrat *Ondatra zibethica*
Killdeer *Characrius vociferus*
Red-tailed Hawk *Buteo jamaicensis*
Red-winged Blackbird *Agelaius phoeniceus*
Common Gallinule *Gallimula chloropus*

Lacustrine Habitat System

The Lacustrine System includes wetlands and deep-water habitats with all of the following characteristics: 1) situated in a topographic depression or a dammed river channel; 2) lacking trees, shrubs, persistent emergents, nonaquatic mosses or lichens with greater than 30 percent areal coverage; and 3) greater than 8 hectares (20 acres in size). Similar wetlands and deep-water habitats smaller than 8 hectares are also included in the Lacustrine System if an active waye-formed or bedrock shoreline feature forms all or part of the boundary, or if the water depth in the deepest part of the basin is greater than 2 meters at low water.

Species used in habitat evaluation procedures for the wildlife resources inventory of the lacustrine habitat system are:

Ruddy Duck *Oxyura jamaicensis*
Pied-billed Grebe *Podilymbus podiceps*
Muskrat *Ondatra zibethica*
Red-tailed hawk *Buteo jamaicensis*
Black-crowned Night Heron *Nycticorax nycticorax*
Double-crested Cormorant *Phalacrocorax auritus*

Palustrine Habitat System

The Palustrine System includes all wetlands dominated by trees, shrubs, persistent emergents, nonaquatic mosses or lichens. It also includes wetlands lacking such vegetation, but with all the following characteristics: 1) size less than 8 hectares; 2) absence of an active-wave-formed or bedrock shoreline feature; and 3) water depth in the deepest part of basin less than 2 meters at low water.

Species used in habitat evaluation procedures for the palustrine habitat system are:

Red-tailed Hawk *Buteo jamaicensis*
Golden Eagle *Aquila chrysaetos*
Mourning Dove *Zenaidura macroura*
Black-tailed jackrabbit *Lepus californicus*
Nuttall cottontail *Sylvilagus nuttallii*
Common Raven *Corvus corax*
Gambel's Quail *Lophortyx gamelii*
Roadrunner *Geococcyx californianus*

The following reference material was utilized as background information in the resource inventory.

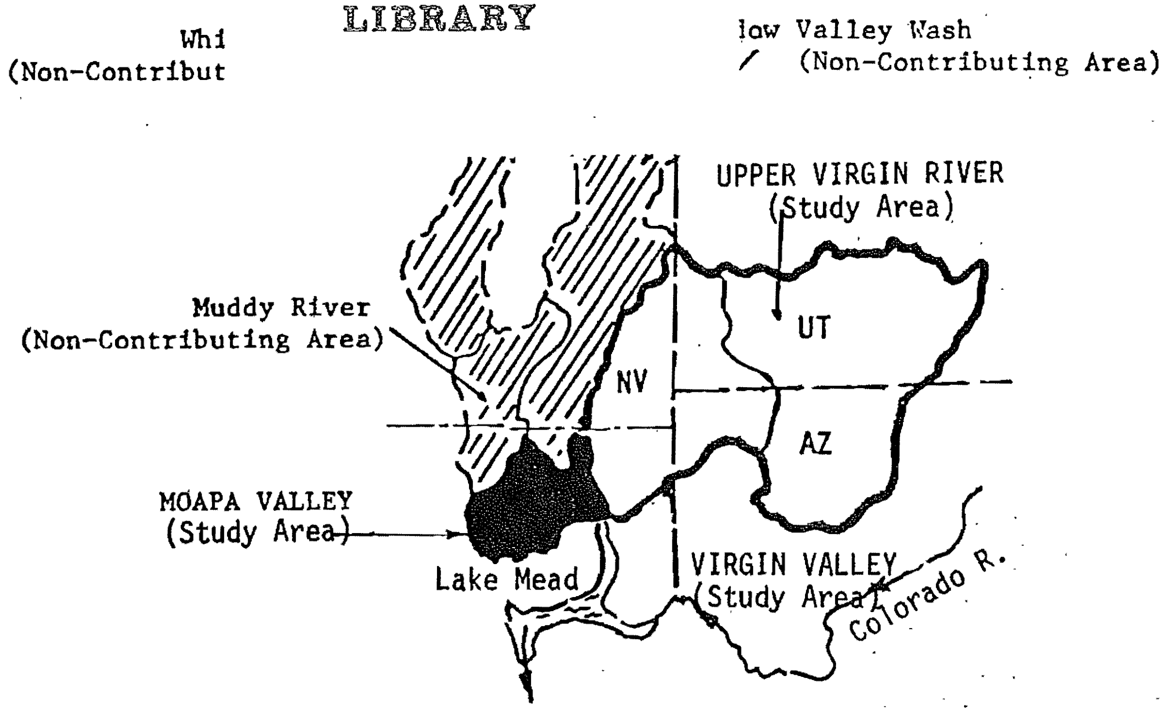
1. "Species List of Birds and Mammals Occurring in the Colorado River Drainage of Nevada," February 1975. by Robert J. Oakleaf under contract to the Nevada Department of Fish and Game as a Special Report in the Nongame Program.

2. "Birds Sighted on Overton Wildlife Management Area", September 26, 1974 information fact sheet, unpublished, 3 pp.

3. "National Listing of Threatened and Endangered Wildlife" and Appendix I and II, Revised February 1, 1979, Federal Register.

4. "A Field Guide to Western Birds", Peterson, R. T., 2nd Edition.

5. "Working Draft - Water Quality Standards Review - Virgin and Muddy Rivers", Clark County 208 Water Quality Management Program, 208 project Staff, May 17, 1978.



MOAPA VALLEY SUBEVALUATION UNIT, NEVADA

Colorado River Basin Salinity Control Program