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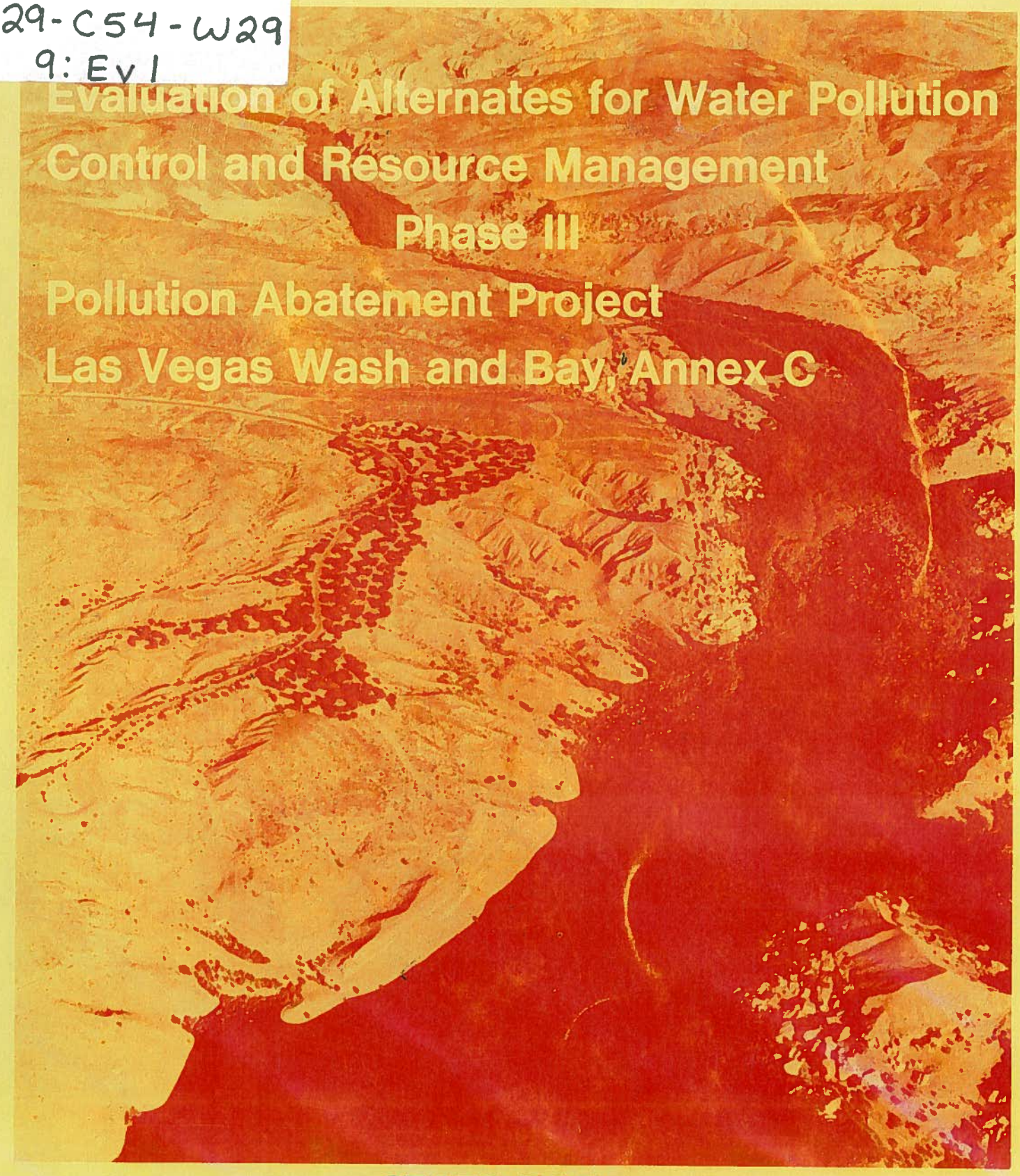
Evaluation of Alternates for Water Pollution Control and Resource Management

Phase III

Pollution Abatement Project

Las Vegas Wash and Bay, Annex C



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The Las Vegas Valley Water District

March 1972 (issued November 1972)

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LAS VEGAS NEVADA 89102

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EVALUATION OF ALTERNATES FOR WATER POLLUTION CONTROL AND RESOURCE MANAGEMENT

POLLUTION ABATEMENT PROJECT
LAS VEGAS WASH AND BAY, ANNEX C

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Prepared For

GAS VALLEY WATER DISTRICT

PHASE III

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SUMMARY AND RECOMMENDATIONS

SUMMARY AND RECOMMENDATIONS

INTRODUCTION

This report describes and analyzes various previously investigated options to the solution of the two interrelated problems of water pollution control and potential future water supply shortage in the Las Vegas Valley area.

The report is not intended to be a complete examination of all of the problems associated with a conventional river basin study. Rather, its scope is limited essentially to a reevaluation of previous work and an economic comparison of various alternate solutions.

The reader is cautioned that an understanding of previous studies conducted in the area is a requisite to full grasp of this volume's contents. Much of this previous work is summarized in the Boyle-CH2M Phase I and II studies completed in 1968-69. We commend these studies and the bibliographies appended thereto to the serious reader of this work.

EDITORIAL NOTE:

Draft copies of this report were prepared and circulated in March 1972. These draft copies were in substantial use as a basis for program discussion and development from that time until November, 1972, the issue date of this report. The March, 1972 draft has been revised to incorporate comment, suggestions, and criticism generated in the intervening time period. The effective date of this report should still be considered to be March 1972, and when read with the total reference material available for the project development, this time frame should be recognized.

March–November 1972 has been a period of intense activity in the development of the Las Vegas Wash Pollution Abatement Project and a number of significant studies have been conducted:

1. The Desert Research Institute has continued its study on the "Effect of Water Management on Quality of Ground and Surface Recharge in the Las Vegas Valley" with particular emphasis on the shallow groundwater system in the Lower Las Vegas Valley.

2. The University of Nevada, Las Vegas has been responsible for conducting two studies:

   a. A biota study of Las Vegas Bay, attempting to determine the inter-relationships among chemical, physical, and biologic factors in the water of the Las Vegas Bay.

b. A study of the eco-system of Las Vegas Wash with emphasis on evaluation of the effects of changing quantity and quality of the water flowing in the Wash.

3. The consulting firms, VTN of Nevada – Jones and Stokes of California, have prepared an environmental assessment of the impact of a number of alternative plans proposed for the solution of the Las Vegas Wash pollution problem.

4. Nevada Environmental Consultants have prepared a Project Report together with Design Appendix recommending a specific course of action in the solution of the abatement project.

5. Throughout the March–November 1972 period the Las Vegas Valley Water District has initiated and monitored the activities outlined above. In addition, the District has conducted a program of public information, and invited comment from the public in relation to proposed solutions to the pollution problem.

Obviously since the draft submittal of this Phase III Report in March 1972, a large amount of additional information has become available. Some of this additional knowledge would have influenced the drafting of this report had it been available in the July 1971–March 1972 period. However, in order to preserve this report in its proper time frame, no attempt has been made to update the report to incorporate this new information.

The purpose of this report is to analyze and evaluate, on a comparable basis, a number of alternative solutions to the pollution problem. The new information developed, although indicating changes in detail of design and program formulation, does not necessitate changing the basic parameters used in evaluating relationships of the various alternates.

SUMMARY

The magnitude of problems associated with wastewater disposal and water resouce development in the Las Vegas Valley area will largely depend on the population. Two population growth rates have been investigated herein. One, the "high population forecast" envisions a permanent resident population of 1,000,000 persons by the year 2000. The second of "low population forecast" foresees only 800,000 permanent residents by the year 2000. These two forecasts provide for an envelope or likely range of growth and conform to the forecasts of the State Engineer.

Presently no justification exists for the reclamation of wastewater for use in augmenting the potable water supply of the Las Vegas area. In fact, a surplus of water from groundwater and the Colorado River will exist even under the high growth rate until about 1990. Therefore, until at least 1990 wastewater is in excess and its use or disposal is a water pollution abatement problem rather than a water supply requirement. Subsequent to the time when the capacity of existing potable quality water supplies is exceeded by demand, the emphasis on wastewater shifts and becomes a water supply requirement.

This shift could occur as early as 1990 (see Figure 21.3) if the high population forecast actually occurs, or as late as 1999 (see Figure 21.2) if the low growth rate is followed. Otherwise, additional sources must be developed as early as 1990 or as late as 1999 for the high and low population forecasts respectively.

The alternate solutions investigated include:

Groundwater Recharge
Complete Treatment
Colorado River Return
Export to Dry Lake
Export to Eldorado Valley
Export to Jean Lake

All of the alternate solutions have been studied for both the high and low population growth ranges. All contain some similar elements such as an in-valley irrigation system. All can be adapted to provide major amounts of water (at least in the near term) for possible supplemental uses. The groundwater recharge, complete treatment and Colorado River return alternates were developed originally in the Phase II studies and are merely reevaluated on the basis of different population and water budgets as used herein. As described in sections 22.60, 22.70, 22.80, and 22.90, all export systems actually are a combination of similar facilities which provide for export of wastewater in early years; utilize in-valley uses to the maximum practicable extent; and desalt wastewater to augment the potable supply when the groundwater and Colorado River resources are at capacity.

These export systems all require the transmission of large volumes of water to the respective export areas immediately after commencement of operations. Because of this immediate problem, interim solutions are not generally practical since the sizing of facilities to meet the near future need is very nearly of the same magnitude as the ultimate development. This apparent anomaly is the result of the need to reuse, in the future, large volumes of reclaimed wastewater to augment the existing potable water resource.

Cost analyses for alternate plans presented have been made on the basis of both the high and low population projections assuming utilizations of wastewaters for power plant cooling at a location outside Las Vegas Valley and assuming no use for that purpose. Cost analyses include estimates of both initial and staged construction costs, maintenance and operation costs, unit costs and appropriate costs summaries. All costs are given in 1972 dollars with future expenditures discounted to that year to give present value estimates.

Analyses of all alternates presented, both on the basis of initial and unit costs, together with consideration of technical feasibility, indicate that one of the export alternates is most desirable. Both the Dry Lake Export Alternate and the Eldorado Export Alternate are of approximately equal cost.

The utilization of treated wastewater for agricultural development does not appear to be a dependable, continuous method of wastewater disposal. All of the export plans are, however, flexible enough to permit the substitution of this usage for disposal by evaporation should agriculture prove feasible. In all probability, a combination of evaporation ponds coupled with agricultural usage would prove most practical. It does not appear that substantial revenues can be generated from the sale of effluent to agricultural enterprise.

To effectively reuse wastewater, the District should consider nonpotable water use to generate revenue and reduce the quantity of water that must be evaporated.

Any one of the alternatives evaluated in this report will produce short-term adverse environmental impact during the construction of the project. Good construction management techniques and methods will minimize these adverse elements.

In the future, plants and reservoirs required can be environmental assets and good neighbors if they are properly designed, operated, and maintained. Certain elements of the export systems, such as the evaporation pond areas, can be designed, constructed, and managed in a manner to considerably enhance the environment for natural plant and animal life, and to provide man with new recreational and commercial opportunity.

The environment of Las Vegas Wash can (within the framework of economic reality) be maintained in any condition desired. At the same time, the export alternates can provide some of the mechanics necessary to capture and dispose of the highly saline groundwaters now surfacing in Las Vegas Wash.

The following table summarizes various parameters and compares the six alternates on the basis of these selected parameters.

COMPARISON OF ALTERNATES

ELEMENT	GROUND WATER RECHARGE	COMPLETE TREATMENT	COLORADO RIVER RETURN	DRY LAKE EXPORT	ELDORADO VALLEY EXPORT	JEAN LAKE EXPORT
TECHNICALLY FEASIBLE IN 1974	NO	QUESTIONABLE		YES	YES	YES
MEETS FEDERAL & STATE STANDARDS	QUESTIONABLE	YES		NONE SET	NONE SET	NONE SET
PROVIDES POLLUTION ABATEMENT	YES	YES		YES	YES	YES
PROTECTS WATER RESOURCE	QUESTIONABLE	YES		YES	YES	YES
AUGMENTS WATER RESOURCE	YES	YES		NO	NO	NO
ENHANCES WATER QUALITY	NO	YES		NO	NO	NO
POTENTIAL FOR AGRICULTURE OUTSIDE LAS VEGAS VALLEY	NO	NO		YES	YES	YES
ENVIRONMENTAL INTERFERENCE	NO	NO		YES	YES	YES
ENVIRONMENTAL ENHANCEMENT	YES	YES		YES	YES	YES
INTERFERENCE WITH PLANNED DEVELOPMENT	NO	NO		NO	YES	NO
INITIAL COSTS		MEDIUM		MEDIUM	MEDIUM	HIGH
STAGED COSTS		HIGH		LOW	LOW	MEDIUM
OPERATING COSTS		HIGH		MEDIUM	MEDIUM	MEDIUM
UNIT COSTS		HIGH		LOW	LOW	MEDIUM
ABILITY TO ACCOMMODATE NON-POTABLE BENEFICIAL USES		FAIR		GOOD	GOOD	GOOD
POTENTIAL FOR POWER COOLING WATER	POOR	POOR		HIGH	FAIR*	POOR
SUGGESTED ORDER OF PREFERENCE FOR IMMEDIATE ACTION TO SOLVE ABATEMENT PROBLEM	REQUIRES FURTHER INVESTIGATION	4		1	2	3

Unknown

Not Viable in Light of Current Attitudes on Discharge Standards

*In the event power generation could be located in Eldorado Valley.

The alternates selected as most favorable—export to Dry Lake and export to Eldorado Valley—are judged to be most suitable of the plans considered for an interim (20–30 year) solution to the pollution abatement problem.

In the longer range beyond the 20–30 year period, exportation for evaporation is less suitable. Sometime between 1990 and 2000, the water supply requirement will probably force curtailment of export and require the reclamation of water for potable use.

In the meantime, however, the export alternates are the most dependable from the standpoint of technological feasibility of construction and operation for relieving nutrient pollution of Lake Mead. These systems also provide major flexibility and opportunity for the development of a groundwater recharge program, for effluent use in irrigated agriculture, for industrial reuse, and for complete treatment at a later date.

The construction and operation of the export systems outlined are judged to be reasonably compatible with the environment of the Las Vegas area. Any new facility necessarily results in environmental changes. The environmental enhancement which can occur from the establishment of a water supported area in an otherwise dry valley may outweigh detrimental effects even though exportation of all waters may diminish the current vegetation and wildlife in Las Vegas Wash.

The consideration of all factors outlined above indicates that the Dry Lake export alternate is the most favorable alternate evaluated.

RECOMMENDATIONS

It is recommended:

1. That the Dry Lake Export Alternate, including its provisions for recovery of wastewater to supplement future potable needs herein outlined, be adopted as the preferred course of action;

2. That requisite preliminary engineering work including geologic and soils investigation, mapping, environmental impact assessment, and engineering design be undertaken as soon as possible; and

3. That a long-range groundwater basin investigation and testing program be developed and implemented.

CHAPTER 20
INTRODUCTION TO PHASE III

CHAPTER 20
INTRODUCTION TO PHASE III

20.00 GENERAL BACKGROUND

This report covers Phase III of a study effort to develop a water pollution control and resource management program for the Las Vegas Valley. The report presents and analyzes various alternate plans for the accomplishment of pollution abatement and the alleviation of potential water resource shortages in the Las Vegas Basin.

Phase I of the study was authorized by the Clark County Board of Commissioners in September 1968, and was completed in February 1969 under the guidance of the Inter-Agency Water Pollution Control Task Force. Phase I includes the work, supporting data, and the conclusions necessary to isolate and define the overall water resource problem within the basin.

Phase II of the study was authorized by the Clark County Board of Commissioners in May 1969, and was completed in December 1969, again under the guidance of the Inter-Agency Water Pollution Control Task Force. Phase II is concerned with the detailed development of a water quality control program, the presentation and analyses of alternative plans of action to achieve the short- and long-range objectives of water resource management. The Phase I and II reports should be considered as necessary background information for the interpretation and understanding of the material presented in this report.

This work was authorized by the Board of Directors of the Las Vegas Valley Water District, which District was placed in charge of the program by the 1971 Legislature of the State of Nevada. The authorization for this report was given in two parts:

1. In July and August of 1971, a review of population projections and water use criteria was accomplished and a series of updated water supply and wastewater disposal budgets were adopted after consultation with the Nevada State Engineer and members of advisory committees to the LVVWD. The results of these studies are reported in Chapter 21.

2. In November 1971, additional studies were authorized by the LVVWD Board of Directors. The purpose of these studies, reported herein, was to investigate more fully the use of irrigation in the Las Vegas Valley and wastewater export from the Valley to provide interim solutions to the pollution problem. Alternatives advanced in previous studies were updated and compared to the new alternatives developed.

20.10 PHASE I REPORT SUMMARY

The Las Vegas Valley area is unique in a number of respects, including geology, hydrology, climate, commerce, government, growth rate, and political factors. The significance of tourism and recreation to the economic base is unusual. The historical growth of the area since 1950 has averaged approximately 10 percent per year compounded. As the population of the area approaches saturation levels, it is anticipated that this growth rate will decline substantially. A general "envelope" of growth probability has been developed, resulting in a maximum anticipated population in the year 2000 of approximately 1,500,000 with a minimum prediction of 610,000. The median population, thought most probable and used in subsequent planning, is 1,000,000 persons in the year 2000.

Because of the uncertainties of predicting future populations, it is essential that the water quality control program be flexible enough to allow for errors in predictions of total water requirements and wastewater loads.

The land use plan adopted by the County is based on an ultimate assumed saturation population of 1,000,000 in approximately the year 2000. This land use plan has been recognized in all future elements of this study.

The water resources for the Valley consist of groundwater, allocations from Lake Mead, and reclaimed wastewater from domestic and industrial uses. The groundwater resource constitutes the principal source of water used in the Valley at the present time. The mean annual recharge to the groundwater basin is estimated at 30,000 acre-feet. Actual withdrawals in 1968 were approximately 88,000 acre-feet. Previous reports have indicated that this overdraft of underground water could be maintained for a period of up to 40 years. These reports also indicate that some overdraft may be desirable to lessen the movement of artesian water from the lower strata into poor quality, near-surface water. Planned overdrafting of this basin may be both prudent and economical. However, close observation and evaluation should be continued in cooperation with the Nevada State Engineer.

In general, the quality of subsurface water derived from all producing wells in the Las Vegas Valley deteriorates from north to south. Near the southern end of the basin, the water is very highly mineralized and not generally used. Most water from major wells meets the Federal and State water quality criteria for drinking water.

Recharge of the groundwater basin may prove desirable; however, not enough is known at the present time to allow prediction of the effects of recharge on the total basin. A pilot program may be necessary to evaluate the unknowns associated with groundwater recharge.

Lake Mead is the single most important body of water in the Las Vegas Valley. Only the portion of the total volume of Lake Mead allocated to the State of Nevada (300,000 acre-feet per year) is presently available to the Las Vegas Valley. This 300,000 net acre-feet

of water is inclusive of all other water diverted from the Colorado River system which may be used within the State. Credit is given for all water returning to the lake through the Las Vegas Wash. Phase I of the Southern Nevada Water Project is now under construction; initial capability will be 176,000 acre-feet per year. Diversions from Lake Mead in 1968 amounted to about 30,000 acre-feet.

Lake Mead water meets or exceeds Federal and State drinking water "permissible" standards, excepting for sulfates; total dissolved solids; coliform; and occasional turbidity, color, and odor. Overall water quality within Lake Mead exhibits a slowly deteriorating trend with respect to total dissolved solids and nutrients.

Increasing attention will be directed to elimination of potential nutrient enrichment of Lake Mead and interrelated factors which promote or encourage eutrophication. Such considerations will almost surely lead to requirements for treatment of wastewaters "to the maximum degree practical" by tertiary treatment before return to Lake Mead.

The Las Vegas Wash is the only surface drainage course for the Las Vegas Valley. The origin of the majority of the flow in the Wash is effluent from sewage treatment plants, cooling tower blowdown from power generation, and shallow groundwater seepage. The Wash carries an average present flow of approximately 21,000 acre-feet per year and terminates in Las Vegas Bay of Lake Mead. The quality of water directly affects, in particular, Las Vegas Bay and less significantly the entire Boulder Basin area of Lake Mead. The present quality of water in the Wash exceeds recommended drinking water standards for chloride, nitrate, sulfate, total dissolved solids, taste, odor, and coliform. It is extremely hard and unsuitable for irrigation purposes. Water quality in the Wash near Lake Mead is significantly worse in nearly all respects that the quality of the sewage effluent discharges.

Investigations by the Federal Water Pollution Control Administration have successfully correlated eutrophication of Las Vegas Bay (as measured by algal densities) with the phosphorous content of treated effluent discharged to the Las Vegas Wash. Based on this correlation, the FWPCA has recommended a tentative limit of 1.2mg/1 of phosphorus from existing effluent. This is equivalent to approximately 90 percent removal of phosphorus. Limitations on nitrogen in effluent should be subject to further review.

Correlation of water quality and quantity in the Las Vegas Wash with known surface discharges to the Wash is difficult. Analysis of data from previous studies and additional information obtained by Boyle-CH2M indicates that the character of flow in the Wash changes substantially along its course to Las Vegas Bay. Changes include a significant decrease in phosphorus entering the Lake from that measured in plant effluents. Nitrogen, as measured by known plant effluent discharges, decreases significantly through the upper Wash and then increases substantially over that measured in the effluent. Flows and dissolved solids increase substantially in various portions of the Wash; the most significant increase occurs in the lower reaches.

Analysis of available data leaves no reasonable doubt that groundwater infiltrates into the Las Vegas Wash above and below the USGS Station at Mile 6.0. The quality of infiltrating water is poor from the parameters of dissolved solids and nitrates. The origin of inflow cannot be definitely stated. The most likely sources appear to be an elevated water table caused by irrigation and leakage from ponds used for waste treatment by the City of Henderson and the Basic Management, Inc. industrial complex.

If water quality in the Las Vegas Wash is to be regulated to protect Lake Mead, all sources of inflow to the Wash must be determined, controlled, and monitored. Since the quality of water in the Wash is presently degraded significantly by inflows from unidentified sources, regulation of domestic effluent alone may not produce water quality adequate to meet standards considered necessary for the protection of Lake Mead. Effective control of Wash water quality will require more reliable identification of pollution sources so the proper credit or responsibility can be assigned to contributors.

Additional information is needed concerning the in-plant water uses at the Basic Management, Inc. complex before conclusions can be reached on in-plant reuse, waste flow separations, individual waste streams quality, and other factors.

Six major water distributors in the study area—Las Vegas Valley Water District, City of North Las Vegas, City of Henderson, City of Boulder City, Basic Management, Inc., and Nellis Air Force Base—distributed approximately 95,600 acre-feet of water in 1968 to an equivalent population of about 304,000 persons. Private wells and small suppliers produced about 25,000 acre-feet. Total groundwater withdrawal equalled about 88,000 acre-feet. Total gross withdrawal and use of water by all sources in the Basin was approximately 128,286 acre-feet.

The Cities of Henderson, Boulder City, North Las Vegas and Las Vegas; the Clark County Sanitation District; Nellis Air Force Base; and Basic Management, Inc. operate sewage collection systems in the study area. All but North Las Vegas operate sewage treatment facilities. Domestic treatment facilities generally meet the existing effluent requirements of the State of Nevada.

The primary sources of reclaimed water in the Valley are the City of Las Vegas and Clark County Sanitation District plants. Approximately 34,000 acre-feet per year of effluent were discharged by these two plants in 1968. Of this amount, 7,300 acre-feet per year was reused for irrigation and cooling water and 26,700 acre-feet was discharged to the Las Vegas Wash.

Based on median growth projections, total annual water use for the year 2000 in the Las Vegas Valley is estimated to be about 500,000 acre-feet. Present 1968 gross water use, exclusive of reclaimed water, was 121,000 acre-feet. Approximately 120,000 acre-feet of wastewater is estimated to be available in the year 2000 for industrial cooling process and uses, irrigation, recharge, and return to Lake Mead.

The availability of water from Lake Mead after construction of a Southern Nevada Project is completed will relieve, to a large extent, the continued increase in the rate of groundwater withdrawal. A total firm water supply of approximately 380,000 acre-feet a year appears to be available at least until the year 2000. This includes the net allotment of 300,000 acre-feet from the Southern Nevada Water Project and a firm supply of 80,000 to 90,000 acre-feet per year from the groundwater resources. Optimum reuse or return of reclaimed wastewaters will be required in subsequent years if the projected 500,000 acre-feet annual demand is to be met from known supplies.

The potential water shortage within 30 to 40 years, coupled with the certainty for more stringent waste effluent quality standards to prevent further deterioration of Lake Mead, are the principal factors indicating an urgent need for development of a water resource management program.

The immediate problems involve water quality control in the Las Vegas Wash and prevention of Lake Mead pollution. The long-range problem is supplementation of the available water supply through the most beneficial uses.

Formation of a water resource management program must consider all available alternatives and be flexible enough to meet changing conditions as they occur. Alternative solutions must consider a phased or step program, integrated with the development of the area from the standpoint of planning and zoning, industrial and commercial expansion, and the social and economic changes which are sure to occur. Evaluation of alternatives must be based on economic comparisons, cost-benefit relationships, aesthetics, adaptability to changing needs, and other factors. Economic factors must be combined into an annual cost-revenue schedule with sufficient detail to indicate yearly expenditure requirements, total annual costs, revenue requirement and sources, and other financial requirements of the total program.

It is essential that an agency of government be selected in the near future with the responsibility of managing an overall water resource program. Early selection will expedite necessary realignment of existing local government responsibilities and will enable effective liaison with the Consulting Engineers during Phase II of the program development. Proper management of the program requires an agency having basin-wide authority over the operation of water supply and wastewater treatment facilities. This agency should have the responsibility for planning, managing, operating, and financing those facilities essential to the program. These functions should be accomplished at the local level with care to coordinate and cooperate with other local, State, and Federal agencies having an interest.

20.20 PHASE II REPORT SUMMARY

The need to legislate and adopt water quality standards pertaining to the final disposition of effluents is basic to the design and implementation of a water quality control

program. Standards for disposition of wastewater into the Las Vegas Wash were adopted on August 26, 1969. These standards (Chapter 12) require advanced or tertiary waste treatment processes in addition to the conventional secondary treatment now provided no later than July 1, 1973. As yet, standards which would apply to treated wastewater discharges to the Colorado River have not been adopted by the State of Nevada. Such action is required, and a proposed standard (Chapter 12) is presented. The Las Vegas Valley wastewater collection and treatment system alternate plan, described in Chapter 16, is predicated upon meeting this proposed standard.

Major water resources which are available to meet future project water demands are the Las Vegas Valley groundwater basin, Colorado River water, and reclaimed wastewater. The groundwater basin, independent of any artificial recharge program, should produce a firm yield of about 50,000 acre-feet per year. Colorado River water will be available from Nevada's allotment in the amount of 265,000 acre-feet per year of net withdrawal. Initial water supply from this allotment is to be furnished from the Southern Nevada Water Project (SNWP), now under construction, and through a system operated by Basic Management, Inc. (BMI). The initial average annual capacity of the Southern Nevada Water Project is 138,000 acre-feet, with provisions for subsequent expansion as requirements dictate. The Basic Management, Inc. system has an approximate annual capacity of 43,000 acre-feet with no planned expansion potential.

The timing of expansions to the Southern Nevada Water Project facilities will be dependent upon two primary factors; industrial and population growth rates, and the effect of water reclamation or reuse on potable water demands.

The basic parameters for reasonable forecasting of water demand and wastewater flows include: past and present conditions, planned land uses, industrial and population growth trends, and a considerable amount of experience and judgment. A median population of 1,000,000 persons in the Las Vegas Valley and Boulder City is foreseen by the year 2000. Projections for both water demand and net wastewater flow to the year 2000 indicate a "gross water demand" of 487,000 acre-feet per year and a "net wastewater flow" of 137,000 acre-feet per year. This "gross water demand" of 487,000 acre-feet per year corresponds to the figures reported in Phase I, Table 5.18 after deduction of 8,700 acre-feet per year for Boulder City. Boulder City currently has reservations for approximately 18,000 acre-feet per year of Colorado River water. The "net wastewater flow" of 137,000 acre-feet per year correponds closely with Table 9.1 (Phase I) after the addition of 17,000 acre-feet per year of industrial wastewater as forecast by Table 14.7. The projected "gross water demand" in the year 2000 can be met, assuming the groundwater basin provides 50,000 acre-feet per year, a Colorado River water allotment of 265,000 acre-feet per year is utilized, and the remaining demand is made up of reused treated wastewaters or obtained from the Colorado River by virtue of allowable increase in the allotment due to return flows of acceptable quality.

A number of possible combinations of treatment and/or disposal techniques to meet the needs of the Las Vegas Valley area have been studied. These include: in-valley irrigation; exportation to five different hydrogeologically isolated areas; combined irrigation and exportation; groundwater recharge; and area-wide collection, treatment and disposal system terminating at the Colorado River below Hoover Dam; and complete treatment to meet effluent standards for Lake Mead disposal. Similarly, a variety of treatment processes were investigated to meet the needs of the various overall alternates. These processes range from no additional treatment through simple filtration to sophisticated desalinization processes. In-depth comparisons were made on four basic alternate plans as follows:

1. Groundwater basin recharge,

2. Exportation to Eldorado and Dry Lake Valleys,

3. Las Vegas Valley wastewater collection and treatment system, and

4. Complete treatment.

Various options within alternate plans were also investigated, including variations in the point of discharge of highly purified effluents and the provision of possible hydroelectric power generation. All plans were designed to properly dispose of solid and gaseous waste by-products generated.

The four alternate plans, including variations, were compared on the basis of capital and total operating costs. Effects on potable water production costs were also evaluated and vary with the four plans. All of these effects have been analyzed and their variable influence on total costs is summarized in Table 16.19. Detailed descriptions of the various alternates, including economic analyses, technological feasibility and plan limitations are provided in Chapters 16 and 17.

The Las Vegas Valley wastewater collection and treatment system is shown to provide the most economical solution to the overall problems of wastewater treatment and disposal of any of the alternates studied. This plan envisions collection of secondary effluent and industrial wastewaters, tertiary treatment of this combined waste, conveyance of the treated effluents around Lake Mead, and final discharge in the Colorado River below Hoover Dam. Initial construction costs for this alternate are shown in Table 16.19 to be approximately $18,616,000 without the hydro-power option or $21,309,000 with. This alternate, with provision for hydroelectric power generation, is estimated to have an average net cost over the time period to year 2000 of $184 per million gallons of wastewater treated. Without provision for hydro power, this figure is estimated to average $187 per million gallons of wastewater treated. The plan should be considered on its own merits, exclusive of hydro power capabilities. Since the hydro power facilities are not required for pollution abatement for water resource development, they need not be an integral part of the plan. They may be added initially or, if desired, at any future date.

The groundwater recharge alternate also appears economically favorable. The analyses performed cannot, however, be verified unless a data collection and testing program is undertaken to check the validity of the assumptions which were made in these analyses.

Economic comparisons are not the only basis on which an overall program for water quality control should be judged. Other factors, mostly intangible in nature, play an equally important role. These intangible factors cannot be rigorously defined or compared on a numerical basis, yet they must be considered and compared in any logical selection methodology. The four basic alternate plans have been analyzed by a method which attempts to recognize both tangible and intangible factors. This analysis (Chapter 17) results in the ranking of possible alternates according to preference. Table 17.2 summarizes the ranking procedures used. The Las Vegas Valley wastewater collection and treatment alternate is shown to have the most favorable ranking of the plans studied by all methods of comparison.

The importance of initiating a groundwater basin investigation and testing program is stressed. Suggestions for the undertaking of such a program are contained in Chapter 18. The groundwater recharge alternate, in addition to appearing attractive economically, also provides a very logical backup program which may be used to supplement or expand any of the other possible alternates. This is another important reason for undertaking the recommended groundwater basin investigation and testing program as soon as possible.

As was indicated in the Phase I study, the selection of a management agency to be in responsible charge of the Las Vegas Valley water quality program is of critical importance. Failure to proceed rapidly in this selection will delay the overall initiation of a program.

Additional costs to an "average" householder in the Las Vegas Valley could be expected to increase over the present charge by an amount ranging from $2.50 to $9.50 per month, depending on the alternate plan chosen for implementation and the amount of Federal grant participation. For the purposes of this calculation, the "average" household is defined as having an annual wastewater contribution of 160,000 gallons. By way of comparison, this would closely correspond to a home having 3.5 occupants, each using about 135 gallons of water per day. Actual household sewage flows are less than this 135 gallons per capita. The 135 gallon per capita figure provides allowance for infiltration, unused system capacity, and other factors. Such an increase would appear to be within the economic capability of the area.

The increased monthly costs to the "average" household for the recommended Las Vegas Valley wastewater collection and treatment alternate averages approximately $2.50 to the year 2000. Maximum Federal grants would reduce this to approximately $2.25.

Required capital outlay, regardless of the alternate plan finally selected, is anticipated to come from the sale of bonds. Because of the present limitation on the property tax rate, the most logical source of bond amortization revenues would appear to be an increase in sewer user charges. The required increase in revenues should be obtained by an equitable sharing of costs between domestic, commercial and industrial contributors on the basis of prorated costs.

20.30 REPORT ORGANIZATION

This report uses essentially the same format as the previous Phase I and II reports. Tables which appear in the Appendices and figures are numbered consecutively, the number (or letter/number) preceding the decimal indicating chapter (or appendix/chapter reference) and the number following the decimal indicating the order of occurrence within the chapter (appendix). Figures appear at the ends of chapters. Short, summary type tables which are not numbered are found in the text closely following reference to their contents. Longer, complicated tables are referenced within chapters but are found in one of the appendices (principally Appendix A).

20.40 ACKNOWLEDGMENTS

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State of Nevada	– Bureau of Environmental Health
	– State Engineer
	– University of Nevada
	– Desert Research Institute
	– Colorado River Commission

Inter-Agency Water Pollution Control Task Force
Clark County
Clark County School District
City of Las Vegas
City of Henderson
City of Boulder City
Las Vegas Valley Water District
Clark County Sanitation District

CHAPTER 21

WATER SUPPLY AND WASTEWATER BUDGETS

CHAPTER 21
WATER SUPPLY AND WASTEWATER BUDGETS

21.00 GENERAL

Subsequent to the completion of the report, "A Comprehensive Water Quality Control Program for the Las Vegas Drainage Basin," by Boyle-CH2M in December 1969, numerous significant events have occurred. Two of these events have been:

1. The 1971 State of Nevada legislature designated the Las Vegas Valley Water District as the agency responsible for planning and developing a program to abate pollution problems in the Las Vegas Wash and Las Vegas Bay.

2. The 1970 census was taken and results made available. Census figures indicate that population growth in the latter years of the 1960 decade did not occur at as high a rate as was assumed in most studies made during the 1960's. The above noted report (which was based on data developed in 1967) projected a 1970 permanent resident population in the Las Vegas Valley of 350,000 persons. Actual 1970 census figures indicate only 266,000 persons, a substantial percentage-wise reduction.

The Board of Directors of Las Vegas Valley Water District realized that the next step in developing a program for pollution control in the Las Vegas Valley (as well as the closely related necessity for insuring an adequate long-range water supply program) was the review of population projections and water use criteria which had previously been considered. The Board employed the Boyle-CH2M organization to update population projections, review water use criteria, develop possible water supply budgets and wastewater disposal budgets and outline plans not previously detailed as possible alternatives to the four plans already presented in the 1969 report. This work was completed in August 1971 and was subsequently presented to the Board for its review. The August 1971 information was based on rates of water use and wastewater generation as they existed in the calendar year 1960. Using actual 1960 census figures and known rates of water use and wastewater generation as they existed in 1970, projections looking towards several future populations were prepared.

Subsequent to the August 1971 report, new population forecasts were prepared by the State of Nevada, Division of Water Resources. These projections indicated a "high forecast" of 1,000,000 people residing in Clark County by the year 2000 and a "low forecast" of 816,000 persons residing in Clark County in the year 2000.

The water supply and wastewater disposal budgets as used herein have been prepared so as to be in conformance with the growth patterns, water utilization and water availability forecasts used by the Nevada State Division of Water Resources in its planning for the State

of Nevada. The methodology employed herein is similar to that used in the August 1971 report previously mentioned. Two specific population growth rates are analyzed. One of these growth rates results in a population within the Las Vegas Valley area of 1,000,000 persons by the year 2000, the other results in a population of 800,000 persons residing in the Las Vegas Valley by the year 2000. In addition to basing future projections on slightly different population forecasts, the work herein differs slightly from the August 1971 report in that the water supply and wastewater disposal budgets have been adjusted to show the effects of a per capita increase in municipal sewage flows and potable water use for residential-transient and light industrial-commercial categories. This per capita increase is at the rate of 2-1/2 percent for each decade.

21.10 POPULATION PROJECTIONS

21.11 BASIS FOR PROJECTION—As previously discussed, the basis for population projections as used herein is the work of the State of Nevada Division of Water Resources. Two population growth rates are evaluated. The higher of these two population forecasts (year 2000 population of 1,000,000) results in the year 2020 population of 1,300,000 permanent residents in the Las Vegas Valley. This population growth rate is hereinafter referred to as the high population forecast. The second, lower population forecast (year 2000 population of 800,000 persons) results in the year 2020 population of 960,000 permanent residents in the Las Vegas Valley area. This population growth rate is hereinafter referred to as the low population forecast. Figure 21.1 graphically presents both the high and low population forecasts as used in the study.

21.20 WATER USE FACTORS

21.21 GENERAL—Records for 1970 water consumption and wastewater generation were compared with the 1970 census figures to obtain current water use criteria. The results of this comparison indicated that the assumptions made for per capita water use and wastewater generation used in the 1969 report were sufficiently accurate for the comparisons in which they were used. For the purposes of this study a new set of per capita factors were developed for various categories of water usage based upon actual flow and census information. Per capita water use and wastewater generation factors were then escalated by a 2-1/2 percent per decade for the residential and transient categories and light industry and commercial categories.

Specific categories used are as follows:

1. Residential and transient
2. Parks and public facilities
3. Golf courses
4. Agriculture

5. Industrial
6. Light industry and commercial
7. Power
8. Military

Each of these individual water use categories is described in more detail below.

21.22 RESIDENTIAL AND TRANSIENT—This category includes all water for domestic uses for permanent and transient persons plus all water used for home and commercial landscaping. Note that water for the irrigation of golf courses, parks and similar uses is not included. The basis for the projections herein is 0.303 acre-feet per year per permanent resident in 1970. This factor is then increased by an amount equivalent to 2-1/2 percent per decade for the years beyond 1970. The factor is, of course, based on the assumption that the ratio of permanent population to transient will remain substantially as it existed in 1970.

21.23 PARKS AND PUBLIC FACILITIES—This category includes water used for the purposes of maintaining irrigated areas such as parks, schools, public facilities, cemeteries and hospitals. Irrigation water for golf courses is not included in this category. Assuming that the growth of water usage for parks and public facilities will parallel population growth, the factor used herein is equivalent to 0.021 acre-feet per year per permanent resident.

21.24 GOLF COURSES—This category includes water for the irrigation of all golf courses. It is assumed that the ratio of golf courses to permanent population will remain as it was in 1970. Based on this assumption the factor is 0.026 acre-feet per year per permanent resident. It is of interest to note that this assumption would indicate a need for approximately forty 18-hole golf courses by the year 2000 if the high population forecast is met.

21.25 AGRICULTURE—This category includes water used for private agricultural enterprises within the Las Vegas Valley. The assumption is made that no significant increase in water demand for agricultural purposes is expected to occur within the Las Vegas Valley. Present usage in this category is approximately 8,800 acre-feet per year with about 3,800 acre-feet from the groundwater supply and the remaining 4,920 acre-feet from utilization of treated wastewater. It is assumed that in-valley agricultural use will increase to 9,000 acre-feet by 1980 and then remain constant at that amount. The major basis for this assumption is that at present a tremendous surplus of wastewater (which has been proven to be usable for irrigation purposes) exists and that there is no present demand for this surplus water. Apparently if agriculture is not feasible now with a large wastewater surplus available at low cost, it certainly will not be feasible in the more distant future when water will be in shorter supply and certainly more costly.

21.26 INDUSTRIAL—This category includes water for all heavy industrial uses of input demand. At present the principal use in this category occurs at the BMI complex. It is assumed that industrial use will approximately double by the year 2000 from a present 16,900 acre-feet per year to 30,000 acre-feet per year. Note that this usage would represent about 70 percent of the existing BMI water delivery system capability by the year 2000. We have further assumed that large "wet" industry would not be sought but that a substantial increase in the present types of industrial use could be accommodated. A further assumption is that industrial use would be the same for both the high and low population forecasts.

21.27 LIGHT INDUSTRY AND COMMERCIAL—This category includes water for light industry and commercial uses. Note that hotel, motel, transient usage has been included in the residential and transient category. Assuming that use in this category will grow at the same rate as the population, the factor is 0.022 acre-feet per year per permanent resident. This factor will be increased 2-1/2 percent every decade.

21.28 POWER—This category includes water required for the generation of power. The assumption is made that in-valley water will be required for the generation of power for use in the valley by out-of-the-valley plants. Power needs are those forecast by Nevada Power Company and are based on 0.5 to 0.8 gallon per KWH. The 1971 forecast of generating capacity needs of Nevada power are 862 megawatts. Their forecast need is 6950 megawatts by year 2000. (See Appendix H.) The further assumption is made that surplus power could be exported if shown to be feasible from a water budgeting standpoint. Existing power plants within the valley are assumed to be utilized until the 1990's, at which time they would be phased out as obsolete. No new power plant construction within Las Vegas Valley is anticipated.

Future Las Vegas Valley power requirements are forecast to be met with generating capacity at proposed Reid Gardner, Moapa, Ft. Mohave Generating Plant, Navajo generating plant and Arrow Canyon north of Las Vegas.

21.29 MILITARY—This category includes water required for use at military bases in the area, primarily Nellis Air Force Base. It is assumed that military uses will increase at a much slower rate than the other water uses described herein and that the maximum use would not exceed 4,000 acre-feet per year (as provided for in the Southern Nevada Water Project Agreements) plus about 500 additional acre-feet per year of reclaimed wastewater for assumed use in the irrigation of military golf courses.

21.30 WATER SUPPLIES

Water supplies are available to the Las Vegas Valley area from the following three major sources plus one as yet unevaluated source:

1. Groundwater basin
2. Colorado River water
3. Reclaimed water
4. Groundwater flows to Las Vegas Wash (unevaluated).

The availability of water from these sources is discussed in more detail in subsequent paragraphs.

21.31 GROUNDWATER BASIN–The State Engineer's water inventory for 1970 and 1971 indicated that groundwater extractions for use in the Las Vegas Valley totaled about 85,500 acre-feet for each year. The allowable rate for groundwater extraction has been set by the State Engineer at approximately 50,000 acre-feet per year. This extraction rate represents the amount of groundwater for which there are valid permanent water rights certificates in conformance with the State of Nevada water rights appropriations statutes. Unless and until other available sources of water supply are fully utilized, the State Engineer has indicated that he will not approve extractions amounting to greater than 50,000 acre-feet per year from the artesian basin.

21.32 COLORADO RIVER WATER–The State of Nevada is entitled to an annual allotment of 300,000 acre-feet per year from the Colorado River. The assumption is made herein that this allotment will be utilized (see Nevada State Engineer's report, "Water Supply for the Future in Southern Nevada", Jan. 1971) to the fullest extent possible for beneficial uses in the Las Vegas Valley. The entire 300,000 acre-feet per year allotment is not available to the Las Vegas Valley area since several commitments, including those for Boulder City and the Fort Mohave Power Plant, must be deducted from the total allotment. Reproduced below is Table II-5 from the above-referenced report.

YEAR	WATER AVAILABLE AcFt/Yr*	EDISON CO. STEAMPLANT AcFt/Yr	FORT MOHAVE LAND DEVELOP. AcFt/Yr	FEDERAL AcFt/Yr	WATER AVAIL. FOR USE IN METRO L.V. SUBAREA** AcFt/Yr
1970	300,000	Nil	Nil	1,000	299,000
1980	300,000	30,000	8,000	2,000	260,000
1990	300,000	25,000	13,000	4,000	258,000
2000	300,000	15,000	13,000	6,000	266,000
2010	300,000	Nil	13,000	6,000	281,000
2020	300,000	Nil	13,000	6,000	281,000

* Does not include credit for return flow.

** Includes water delivered through facilities of Southern Nevada Water Project, Boulder City and BMI.

21.33 RECLAIMED WATER–It is assumed that in the near future reclaimed wastewater will be utilized for as many purposes other than potable water supply as is economically practicable. Reclaimed wastewater is assumed to replace groundwater or Colorado River water for uses such as irrigation of parks, golf courses and agriculture. Water quality and practical financing may delay these assumed uses to sometime in the future. Tables A21.1 and A21.2 of the Appendix indicate the demands assumed for this study. As the demand for potable water meets and exceeds the available sources of supply from groundwater and Colorado River sources, a portion of the reclaimed wastewater is assumed to be treated and used.

21.34 GROUNDWATER FLOWS TO LAS VEGAS WASH–The discharge of water from the underground near-surface aquifer into Las Vegas Wash (generally downstream of sewage treatment plant discharges) represents a potential additional source of water for the area. These flows represent a pollution hazard to Lake Mead and the Colorado river system in that they are high in total dissolved solids (2,000-8,000 mg/1) and may carry toxic substances in sufficient quantities to upset biologic balance in Las Vegas Bay.

It is probable that as additional water is used in the valley (3 to 4 times present usage), the magnitude of these flows will substantially increase. In addition to the waters which surface, it is probable that substantial volumes of subsurface saline waters also exist in the lower part of Las Vegas Valley. These waters (both surface and underground) appear to be in the salinity range which could be economically treated by the membrane method (reverse osmosis, etc.) for salt removal and used in the potable supply. Since these waters have been filtered through the ground, they can probably be treated at a lower cost than can reclaimed wastewaters.

The practicability of the above approach is, at the present time, a matter of conjecture, and for that reason, this potential source has not been considered in the water budgets presented. Present programs of investigation into the characteristics of this water resource are set forth in a manuscript report dated April 20, 1972 by the Desert Research Institute which should give valuable insight into both the water resource and pollution hazard aspects of this problem.

21.40 WATER BUDGETS

To present a perspective of water supply versus demand for the Las Vegas Valley and Boulder City areas, water budgets have been prepared on a ten-year incremental basis from 1970 through 2020 for both of the high and low population forecasts. The water budgets as detailed herein assume that groundwater extractions which have reached 85,500 acre-feet annually will be reduced to 50,000 acre-feet per year. They further assume that the amount of water from the Colorado River, which will be available to the Las Vegas Valley and Boulder City, will vary from year to year from a minimum of about 258,000 acre-feet per year at the peak of the Fort Mohave Power Plant allocation to a maximum of 281,000 acre-feet per year annually after the Fort Mohave Plant requirement diminishes.

All of the wastewater budgets indicate the need for beneficial use of wastewater. The volume of wastewater is dependent upon population increase and varies from about 56,200 acre-feet in 1970 to about 189,000 acre-feet per year in 2020 for the low population forecast, and to about 247,000 acre-feet in the year 2020 for the high population forecast.

Water budgets for both of the low and high population forecasts through the year 2020 are shown in Appendix A as Tables A21.1 and A21.2 respectively. Figures 21.2 and 21.3 show graphically the demand for water during the study period, including the portion of water required to provide cooling water for power needs as presented by Nevada Power Company. Figure 21.2 presents the water demands for the low population forecast and Figure 21.3 presents similar data for the high population forecast.

For the low population forecast, a shortage of water supply is projected to occur prior to the year 2020. For the high population forecast, the projected shortage of supply occurs prior to the year 2000. Figures 21.2 and 21.3 both indicate the need for a reclamation process to provide potable water by about the year 1999 for the low population forecast and by about the year 1990 for the high population forecast. Additional sources of water supply are shown to be necessary to meet the forecast demands. For the low population growth rate, additional sources would be needed about the year 2019 and for the high population growth rate, additional sources would become necessary at about the year 1995.

Figure 21.4 graphically presents water supply and demand if the assumption is made that power could be generated without the use of water from the Las Vegas Valley area for the high population forecast period. Under this set of assumptions, additional sources of water supply could be delayed until about the year 2010.

21.50 WASTEWATER GENERATION FACTOR

21.51 GENERAL–In a manner similar to the assignment of categories and uses for water, categories and volume projections for the generation of wastewater have been made. The categories used herein are as follows:

1. Residential and transient
2. Industrial
3. Military
4. In-Valley Power

Each of these four categories is described in more detail in subsequent paragraphs.

21.52 RESIDENTIAL AND TRANSIENT–This category includes household, hotel and motel (transient) plus light industrial and commercial sewage discharges. Light industrial and commercial flows have been included in this category because no data presently exists which would make it possible to separate them from other sewage flows. Assuming that flow will increase at the same rate as population, the factor is 0.15 acre-feet per year per permanent resident. This basis of generation of flow agrees closely with the 1970 population and wastewater flows as measured during 1970. Wastewater flows of some of these sources have been increased by 2-1/2 percent per decade so as to be commensurate with the increase in water demand forecasted for these users.

21.53 INDUSTRIAL–This category includes wastewater generation from all types of industry and is predominately anticipated to result from cooling systems. We have assumed that wastewater generation in this category will amount to 80 percent of the industrial input water demand. The use of this 80 percent factor assumes that industry will progressively recycle internally more and more of its process waters so as to reduce the total amount of new or make-up water which they use. This recycled water has been assumed as input to the industrial requirements in Table A-21.1 and A-21.2. The use of the term input demand herein is intended to be equivalent to the sum of new make-up water and reused water that is recycled to a greater extent than was the practice in 1970 industry. The assumption as reported herein is that approximately 80 percent of input demand would report as wastewater of which greater recycling would occur with time. The amount that will result as net to a waste system will depend on the extent of recycling which in 1970 was 80 percent of the input*; by year 2000 it is assumed to be 80 percent of input less 2/3 of 80 percent used in recycle or approximately 26 percent of the input to the waste system. At the present time (1970) waste flows from the BMI complex and gravel washing operations are approximately 13,500 acre-feet per year and water input is 16,900 acre-feet per year which is the 80 percent used above. See Appendix tables A-21.2 and A-21.3.

21.54 MILITARY–This category includes wastewater generation from all military operations. It is estimated to be equivalent to 50 percent of the military water demand.

21.55 IN-VALLEY POWER–This category includes cooling system blow-down wastewater from both the Sunrise and Clark Station power plants. It is estimated to be equivalent to 20 percent of the water supplied for cooling purposes to these in-valley power installations.

21.60 PRIORITY OF WATER USE

For the purposes of this report, priorities have been designated to the use of wastewaters as follows:

* Of the 80 percent recycled, approximately 2/3 is recycled internally (within a plant). Although this is considered a part of the input for industrial requirements, it is shown separately only in Table A-21.6 (Heavy Industry, 16.30 re-used).

Priority 1—Those uses necessary to the health and well-being of the population.

Priority 2—Those uses which contribute to the maintenance and growth of the area's economy.

Priority 3—Those uses which contribute to the esthetic development of the community over and above those required for the health and well-being and which do not demonstrate an economic return.

Priority 4—The disposition of wastewater in a way which provides only for pollution abatement with little or no economic or esthetic return.

Accordingly, the wastewater use categories previously described have been assigned priorities as follows:

	Priorities
Public Facilities	
Greenbelts	3
Schools and Parks and Cemeteries	1
Golf Courses	2
Heavy Industry	2
Power Generation	
For power demand of Nevada Power Company customers in the Las Vegas and Boulder City areas	1
For export power	2
Residential and Transient, & Light Industry Industry Potable Uses	1
Agriculture	2
Military Golf Course Use	2
Export for Disposal	4

21.70 WASTEWATER DISPOSAL BUDGETS

As is evident from review of the water budgets previously described, all the wastewater produced will ultimately be needed as an element of the total water supply for the Las Vegas Valley if the forecast populations occur. Unfortunately, such future needs do not solve the present and near future pollution resulting from the present discharge of wastewater into the Las Vegas Wash and Lake Mead.

To present a perspective of the problems associated with wastewater generation and its use, wastewater budgets were prepared in a manner similar to the water budgets on a ten-year incremental basis from the years 1970 through 2000 for both the high and low population forecasts. These wastewater budgets are shown in tabular form in Appendix A as

Tables A21.3 through A21.13. The assumption is made that the maximum practical utilization within economic justification would be made of secondary effluent in order to obviate the necessity for expensive treatment systems. Toxic industrial wastes and highly saline water could not be used for irrigation purposes. Accordingly, such unsuitable wastewaters are expected to be evaporated in sealed ponds at the producer's expense rather than incorporated into a regional disposal system.

The wastewater disposal budgets assume that most of the parks, golf courses, agricultural needs and irrigated vegetation which presently use groundwater or potable water will be converted to irrigation using reclaimed wastewater at the earliest practicable time. This time would, of course, be contingent upon the availability of a distribution system which would permit economic access to reclaimed wastewater for these users. The Tables A21.1 and A21.2 wastewater use for parks and golf courses assume a trend to utilization of more Colorado River water while potable supplies are in excess of potable needs; and gradual increase of use of reclaimed wastewater as the in-valley irrigation system is expanded to 1990 and 2000; then only slight increase of reclaimed wastewater because of the need for potable uses. Deficits for parks have been assumed to be made up from auxiliary sources after 2000 which, for the purpose of the table, is considered groundwater.

The wastewater disposal budgets as delineated in Tables A21.3 through A21.13 reveal that even should major quantities of treated wastewater be used for cooling water for power generation, the disposal of remaining wastewater will represent a considerable problem until the time is reached when reclamation for augmentation of the potable water supply is required. The magnitude of the problem is illustrated in the following tabulation:

EFFLUENT NOT REQUIRED
FOR PRIORITY 1, 2 & 3 USES
(with power)
(from Tables A21.3–A21.13)

POPULATION PROJECTION	ANNUAL VOLUME IN THOUSANDS OF ACRE-FEET					
	1970	1980	1990	2000	2010	2020
"high"	46.51	40.75	59.31	15.24*	21.03*	25.81*
"low"	46.51	35.67	40.72	40.14	25.66	14.22

* Brine from desalting plant. Surplus of unused wastewater (for high population) disappears in 1991 when desalting operations start. As quantity of water being desalted increases, the brine blowdown also increases.

If use of wastewater for cooling water in conjunction with power generation does not develop as a means of disposing of wastewaters, the following tabulation shows the increase in the amount of effluent which will require disposal by means other than uses listed in Priorities 1, 2, and 3:

EFFLUENT NOT REQUIRED
FOR PRIORITY 1, 2 & 3 USES
(without power)
(from Tables A21.3–A21.13)

POPULATION PROJECTION	ANNUAL VOLUME IN THOUSANDS OF ACRE-FEET					
	1970	1980	1990	2000	2010	2020
"high"	46.51	67.95	103.61	85.24	91.03	95.81
"low"	46.51	62.87	85.02	110.14	95.66	84.22

The use of reclaimed wastewater will not be needed to augment potable water supply until about 1999 for the low population forecast. For the high population forecast, reclamation for augmenting the potable water supply would begin in the year 1991. Tables A21.3 through A21.13 show that the maximum discharge of effluent not required for Priority 1, 2 and 3 uses occurs at about the year 1990. Disposal of the excess of wastewater during the period prior to the time when reclamation for augmentation of the potable supply becomes necessary is a problem of tremendous expense and magnitude. As additional potable water is required, the amount of excess wastewater would, of course, diminish as the amount of wastewater reclaimed increases. Since reclamation for augmentation of the potable water supply most probably will not occur until at least beyond 1990, the disposal of excess wastewater prior to that time poses a problem of serious proportions.

21.80 SUMMARY

The magnitude of problems associated with wastewater disposal and water resource development in the Las Vegas Valley area will largely depend on the population of the area. Two population growth rates have been investigated herein. One, the "high population forecast" envisions a permanent resident population of 1,000,000 persons by the year 2000. The second of "low population forecast" foresees only 800,000 permanent residents by the year 2000. These two forecasts provide for an envelope or likely range of growth and conform to the forecasts of the State Engineer.

Presently no justification exists for the reclamation of wastewater for use in augmenting the potable water supply. In fact, a surplus of water from groundwater and the Colorado River will exist even under the high growth rate until about 1990. Therefore, until at least 1990 wastewater is in excess and its use or disposal is a water pollution abatement problem rather than a water supply requirement. Subsequent to the time when the capacity of existing potable quality water supplies is exceeded by demand, the emphasis on wastewater shifts and becomes a water supply requirement.

This could occur as early as 1990 if the high population forecast actually occurs, or as late as 1999 if the low growth rate is followed. Both of these times are based on the

assumption that water sources from within the Las Vegas Valley are utilized to meet projected power demands within the same area. If power could somehow be made available without the necessity to utilize in-valley water, the requirement for additional sources of supply could be delayed until about the year 2010. Otherwise, additional sources must be developed as early as 1995 or as late as 1999 for the high and low population forecasts respectively.

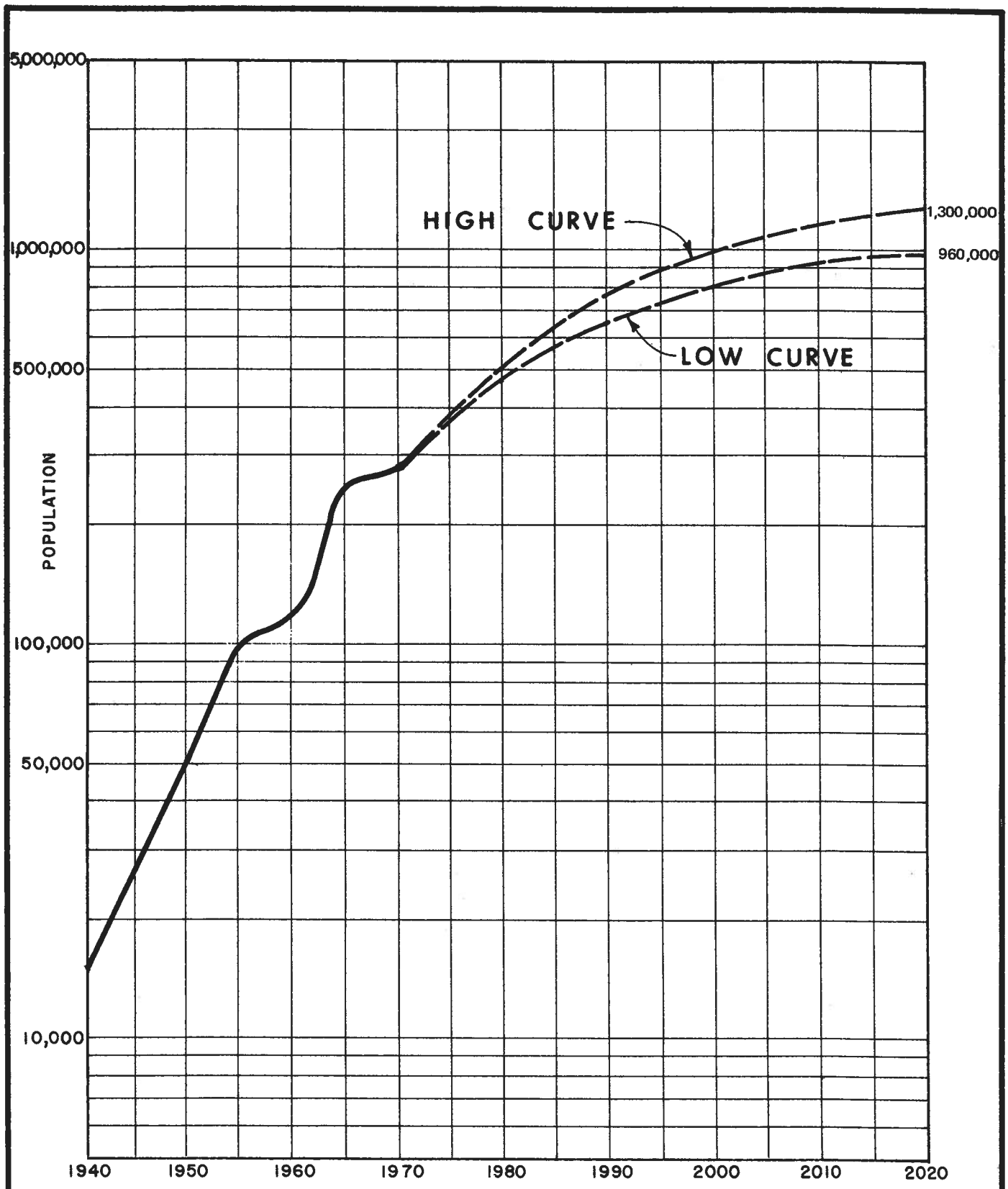


FIGURE 21.1

LAS VEGAS VALLEY AND BOULDER CITY

POPULATION PROJECTION

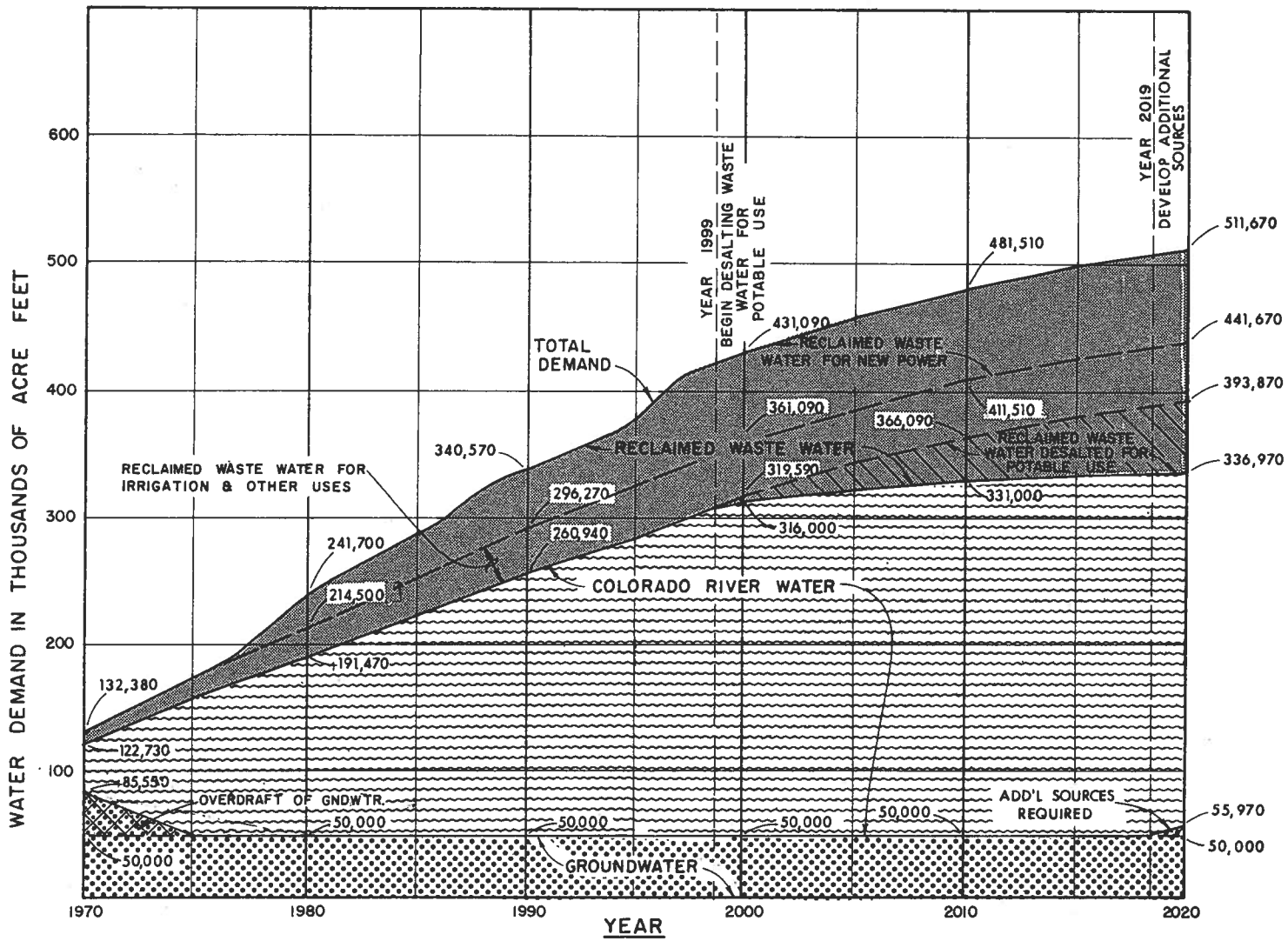


FIGURE 21.2

WATER DEMAND
WITH POWER

800,000 POPULATION AT YEAR 2000

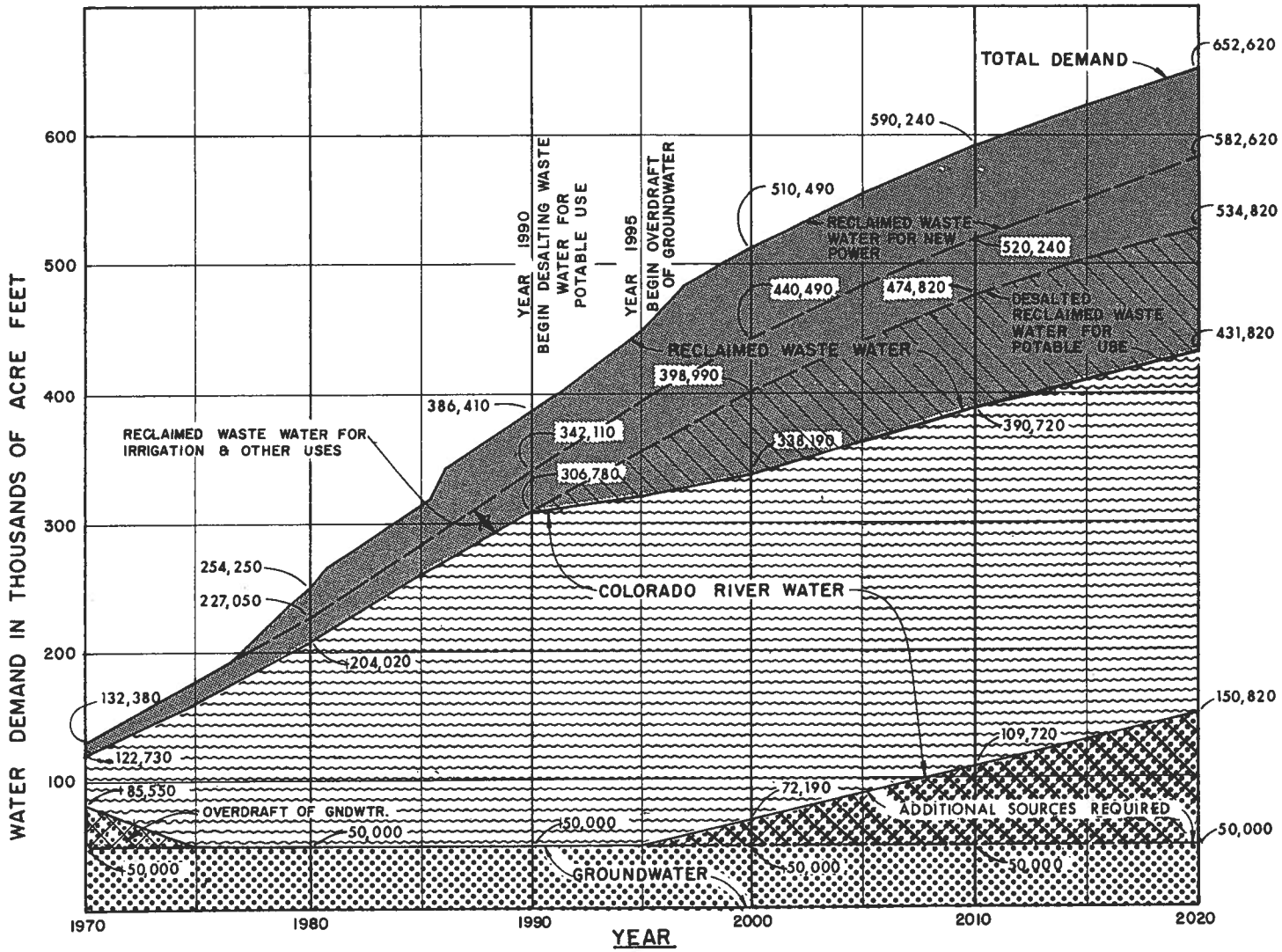


FIGURE 21.3

WATER DEMAND
WITH POWER

1,000,000 POPULATION AT YEAR 2000

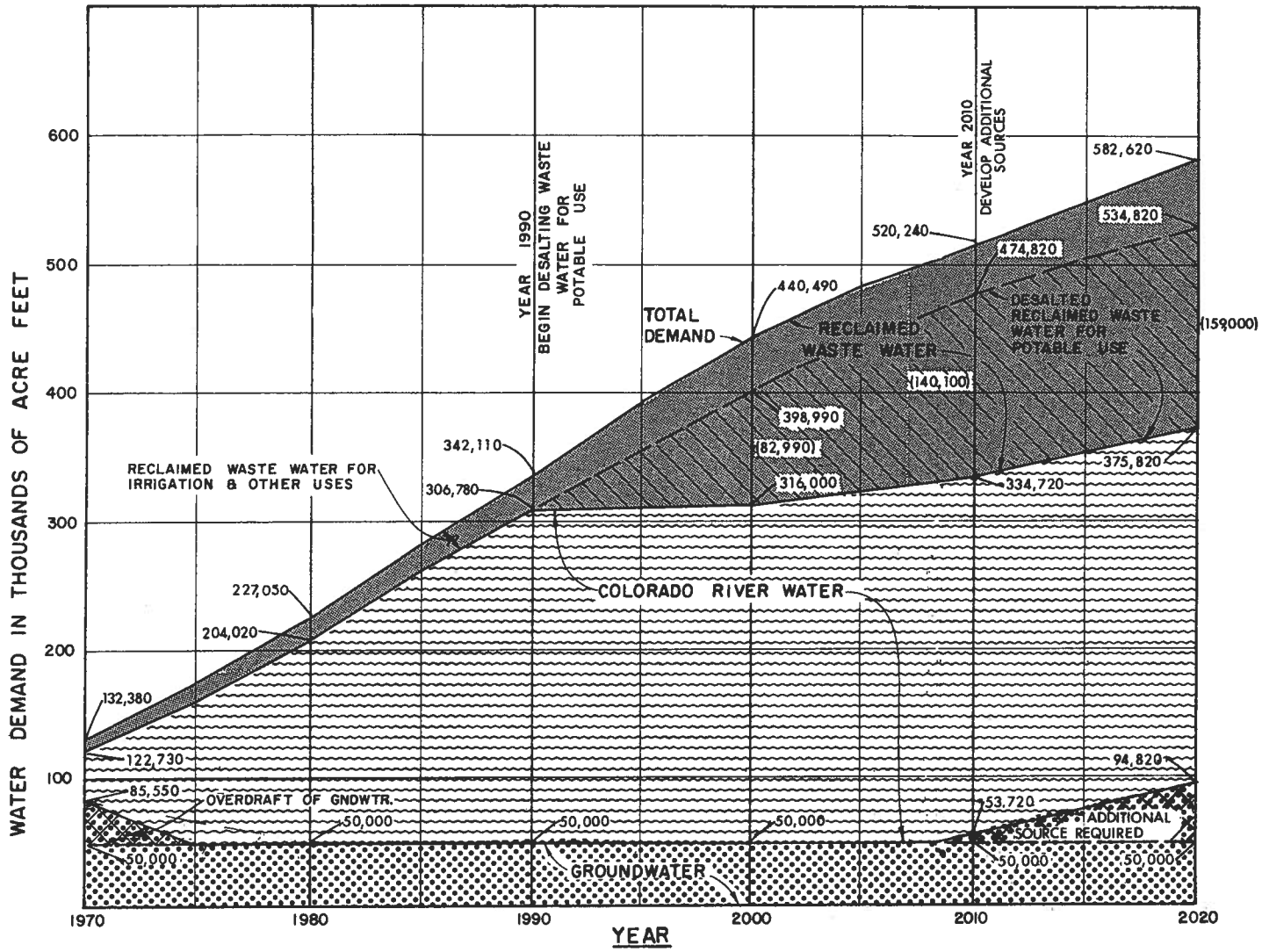


FIGURE 21.4

WATER DEMAND
WITHOUT POWER

1,000,000 POPULATION AT YEAR 2000

CHAPTER 22
DEFINITION OF ALTERNATE PLANS

CHAPTER 22
DEFINITION OF ALTERNATE PLANS

22.00 GENERAL

The Phase II report considered various arrangements of facilities, methods and processes to accomplish pollution abatement and to alleviate potential water resource shortages. These possible methods were divided into the following main categories as noted in paragraph 16.20 of the Phase II report:

1. Groundwater basin recharge.

2. Use of secondary effluents for in-valley irrigation, or for irrigated agriculture in conjunction with exportation from the Las Vegas Valley to nearby valleys.

3. Exportation of wastewaters to prevent their reintroduction into the Colorado River System.

4. Treatment of secondary effluents to the degree then thought necessary to permit introduction of treated wastewater into the Colorado River below Hoover Dam.

5. Treatment to the degree necessary to permit introduction of the treated wastewater into Lake Mead.

All of the plans presented in both the Phase II report and in this report are based on the assumption that municipal wastewater will have been given the equivalent of secondary treatment before being received into the pollution abatement system. It is further assumed that industrial wastes from BMI and others will be pre-treated if necessary to prevent the delivery of deleterious substances to the regional system. It is anticipated that after a project has been selected, the managing agency will set quality requirements for all classes of wastewaters to be accepted by the system.

Although no new methods have been advanced since submittal of the Phase II report, certain developments have occurred which make a reanalysis based on evaluating these new developments desirable.

The developments which have been significant in the reevaluation are primarily the following:

1. The results of the 1970 census indicated that rates of growth previously assumed valid for the Las Vegas area were probably too high. Therefore, the

following analyses are based on year 2000 population figures of 800,000 as well as 1,000,000 persons. In addition, the 1970 base population figures have been revised downward to agree with 1970 census findings.

2. Actions by the Nevada State authorities and by the Federal authorities on environmental problems indicate that very rigid standards on wastewater treatment will probably be promulgated and may be enforced vigorously. The degree of treatment required for waters to be readmitted to the Colorado River System appears to make this alternate economically impractical at the present time.

The following paragraphs define alternative plans which incorporate all of the methods covered in the Phase II report, modified as indicated in light of the new developments noted above.

22.10 BOULDER CITY WASTEWATERS

By virtue of its location outside the Las Vegas Valley and distance from the principal collection points for wastewater generated within the Las Vegas Valley, Boulder City cannot logically be considered as a participant (as regards wastewater disposal) in the regional systems hereinafter discussed. Boulder City's wastewaters presently are not discharged to Lake Mead or the Colorado River System. Instead they are treated by waste stabilization ponds, which drains to the Eldorado Valley. In a recent study by Kirker Chapman Associates (1967), a recommendation was made that wastewater disposal for Boulder City continue in the future by those means. We concur in this recommendation. While probably not a logical participant in the regional wastewater disposal alternate discussed hereinafter, Boulder City's water needs must, of course, be included in any analyses of total area-wide water budgets. Accordingly, the water budgets previously discussed include Boulder City's needs. Since the population bases used herein are gross projections inclusive of Boulder City, no specific deduction from anticipated gross wastewater production has been made. In this respect then, the wastewater budgets (which include wastewater generated at Boulder City) may actually indicate slightly more wastewater for disposal in the regional systems hereinafter discussed than will actually occur. This discrepancy is, however, very slight since:

1. Actual measured per capita wastewater generation at Boulder City is significantly less than for either the City of Las Vegas or the Clark County Sanitation District; and

2. Even if the assumptions are made that Boulder City grows at the same rate as the Las Vegas Valley area, and per capita wastewater generation is the same, Boulder City's year 2000 wastewater generation on the "high" population curve would amount to only 1.73 percent of total wastewater production as shown in Table A21.11.

For these reasons, we conclude that Boulder City's impact on any regional system is slight, and that its present system will likely be continued in use with expansion in kind as may be required. Therefore, the alternative systems discussed hereinafter for regional wastewater systems do not make provision for collection of, or utilization of, Boulder City's wastewaters.

22.20 IN-VALLEY IRRIGATION AND EVAPORATION

The utilization of secondary effluents for irrigation of agricultural lands, landscaping of parks and public facilities, golf courses and greenbelts within the Las Vegas Valley offers an immediate opportunity for the beneficial use and disposal of treated wastewaters. This method of disposal, however, is not without accompanying costs as well as benefits, and cannot be considered a total solution to the problem because of the volume of wastewaters currently being produced.

Study of the Clark County land use plan for 1,000,000 population indicates that approximately 10,000 acres of land would be utilized in the categories noted above. Assuming an annual demand of 5 acre-feet per acre per year, the maximum effluent use could be no more than 50,000 acre-feet per year when the 1,000,000 population is reached. It is also evident that much of the 10,000 acres involved will be in relatively small parcels at remote locations and at high elevations.

100 per (1) 5 acs per ye

In order to evaluate the economic feasibility of serving all of these lands, a preliminary layout of a reclaimed water system which could deliver 50,000 acre-feet per year was made and costed. It was found that the cost of such a system would be in excess of $20,000,000. Based on this capital expenditure and adding the costs of maintenance and operation, a delivery cost of $60 to $70 per acre-foot was estimated. Because of the high delivery costs (defined as the total cost of capital amortization plus operation and maintenance costs to provide water at a pipeline discharge), a reduced system was evolved which covered lands nearer the source of supply and at lower elevations. This plan is presented as a recommended in-valley irrigation system, serving about 5,000 acres and is one of the elements offered in all of the alternates presented later in this report.

The in-valley irrigation system detailed hereinafter is capable of delivering 25,000 acre-feet per year of secondary effluent. The system is scheduled to be constructed in phases with the first phase estimated to involve a capital outlay of about $6,000,000 in 1975 and the remainder of the system to be installed in 1985. The unit costs of delivery from this smaller system are estimated to be in the range of $35 to $45 per acre-foot. The in-valley irrigation system proposed is essentially the same for all of the plans presented. Minor changes are necessary because of shifts in location of major elements of each alternate. These minor changes of the in-valley irrigation system are reflected in the cost estimates presented with each plan and are shown in Figures 22.1, 22.2, 22.4, 22.5 and 22.6.

The operation of an in-valley irrigation system using secondary treated sewage effluent is not without certain hazards. These include: (1) the possibility of health hazards due to increased public exposure to treated wastes, (2) the common problems associated with a dual water system (such as cross-connection and mistaken use of nonpotable water for potable uses), (3) the possibility of odor production, (4) problems associated with operation (such as pipeline corrosion, slime growths, and hydrogen sulfide production), (5) increased salinity in the near-surface aquifer and in Las Vegas Wash after a period of time, (6) salt buildup in the soil, and (7) surface crustations. All of these potential problems exist today (though on a smaller scale) with presently operated systems in the Valley including the Winterwood and Paradise Valley Golf Course irrigation systems. Judicious operation has been shown to minimize the problems; accordingly, we believe the in-valley irrigation system (admitting the potential problems) can function both safely and effectively to the enhancement of the Las Vegas area.

In conjunction with the evaluation of an in-valley irrigation system, the merits of constructing evaporation ponds within the Las Vegas Valley was also considered. The required area of ponds is approximately 13,000 acres. Consideration of use of in-valley evaporation ponds was dropped for the following reasons:

1. Unless expensive measures for sealing ponds are utilized, infiltration into the shallow aquifer is likely to occur. This water, which will be of poor quality due to salt concentration through evaporation, will degrade natural waters in this aquifer. The long-term result will be an increase in volume and salt load carried in the shallow aquifer. The water may ultimately percolate to lower aquifers or may surface in Las Vegas Wash.

2. Land to accommodate such a large area of ponds must be located far from present and projected urban development. Even so, land acquisition costs could be prohibitive. As the land becomes more remote, both in location and elevation, costs of the transmission pipeline and pumping system increase.

22.30 GROUNDWATER RECHARGE

The Phase II report outlined in some detail the possibilities of utilizing the Las Vegas Groundwater Basin for the disposal of treated wastewaters thus augmenting the supply available from that source. Furthermore, this method, if practical, can be used as a means of storing excess waters now available for use in years of short supply which is anticipated near the year 2000. The groundwater recharge alternate shows definite promise, but it can be proven only through the activation of a long-range investigation and testing program. For this reason, the Groundwater Recharge Alternate, although it should not be abandoned, cannot be considered a viable alternate for immediate action. The reader is referred to the Phase II report for a more complete discussion of this subject.

The groundwater recharge alternate as discussed in the Phase II report did not include systems for desalting water for recharge uses. Because of increasing TDS content of the area's wastewaters, the need to lower TDS content of water for recharge is a distinct possibility. In all probability, should desalting of recharge water be necessary, the most logical approach would be to desalt a portion of the recharge flow and blend the desalted water with the remaining portion before injection into the underground. Determination of the fraction of recharge water, which when desalted and blended with nondesalted treated effluent, would result in essentially no change in existing groundwater quality is beyond the scope of this study. Clearly, however, should desalting prior to recharge be necessary, costs associated with this alternate will rise in proportion to the amount of water desalted. Also, the basic features of the plan would necessarily change to incorporate desalting facilities plus brine disposal facilities. Desalting facilities would undoubtedly be located adjacent to the filtration system. Brine disposal would likely be by means of evaporation ponds (lined if required) located either within the Las Vegas Valley or outside the valley depending on the amount of basin production.

22.40 COMPLETE TREATMENT ALTERNATE

As described in the Phase II study report, the complete treatment alternate has been formulated to allow discharge of the effluent to Lake Mead to meet the recently adopted (August 1969) water quality standards of the State of Nevada for the effluent discharge to the Las Vegas Wash. Because the treatment systems proposed in this alternate would produce an effluent of far better quality than the waters of Lake Mead, consideration has again been given to upgrading the potable water supply by blending the treated effluent with Lake Mead water just ahead of the treatment plant of the Southern Nevada Water Project. This option is therefore considered as a part of the complete treatment alternate. Without special provisions for maintaining the Wash, it can be expected that vegetation and wildlife will diminish in the Wash.

Figure 22.1 shows the basic features of this alternate plan which includes an in-valley irrigation system (as do all of the plans). It envisions initial construction of a tertiary treatment plant utilizing phosphorous removal by chemical coagulation, coagulant recovery by recalcination, mixed media filtration, and carbon adsorption with carbon regeneration facilities. An export system designed to dispose of brine from the desalinization process to Dry Lake Valley would also be constructed initially. The export system would be used to its full capacity to export secondary effluent without further treatment initially and until the year 1980. Tertiary effluent meeting the 1973 standards would be discharged to the Las Vegas Wash. To meet the effluent quality standards of 1980, a desalinization process would be added at that time. Then the Dry Lake Valley export pipeline would be used to convey brine from the desalinization process to disposal with the balance of the pipeline capacity used for disposal of secondary effluent. (Evaporation ponds in the Valley for brine quantity of 20 percent of the input would be approximately 17,000 AF by 1985 requiring 3,000 to 4,000 acres of lined ponds at a cost of approximately $200,000,000.) When desalinization

operations are started, the high quality of effluent produced may tend to preclude discharge into the Las Vegas Wash. The benefits of TDS removal (by virtue of desalting) could be largely lost by admixture with relatively high TDS solids water which may be present in the Wash. Should experience show (by 1980 when desalinization becomes necessary) that flows in the Las Vegas Wash are minimal and that accretion of TDS content from the Wash bed do not occur, then the necessity for a lined channel would be obviated. In any event, disposal of desalted effluent to Lake Mead via whatever means would result in an exchange of high quality water for water of lesser quality. Therefore, an alternate disposal via lined channel and pipeline to the Southern Nevada Water Project is included and costed as a part of this alternate.

If the discharge to Lake Mead is selected and a lined channel is required, to prevent contamination from residual salt concentrations in the Wash, an open concrete channel approximately 41,000 feet in length would be provided to convey treated effluent to Lake Mead.

If the discharge to the SNWP treatment plant is selected, a combination of lined, open channel, and 60-inch diameter pipeline approximately 72,000 feet in length would be provided to convey treated effluent to the Southern Nevada Water Project treatment plant at sufficient hydraulic gradient to allow gravity flow through that treatment plant. The desalted effluent would be of superior quality to water withdrawn from Lake Mead by intake pumps and, after blending with Lake Mead water and treatment at the water treatment plant, would enhance rather than degrade the final delivered potable water.

22.41 CONSTRUCTION REQUIRED FOR THE "HIGH" POPULATION FORECAST–Initial construction during 1973-74 would include:

1. A wastewater collection system sized for the projected year 2000 flows.

2. A tertiary treatment plant sized for an average annual 1980 flow of 60 mgd (67,000 AF/yr) including units for lime feed, flash mix, flocculation, clarification, filtration, carbon adsorption, chlorination, coagulant recovery and carbon regeneration.

3. An export system to Dry Lake sized for a brine disposal flow of 40,000 AF/yr (20 percent of year 2020 desalinization plant capacity) including two pump stations and 36-inch and 42-inch diameter pipeline.

4. The initial portion of an in-valley irrigation system having a capacity of about 12,000 AF/yr as detailed on Table A23.12.

(NOTE: One feature may require additional explanation. The initial construction of the 60 mgd (67,000 AF/yr) tertiary plant includes activated carbon systems. This was included to insure compliance with the 1973 MBAS standard (0.5 mg/l)*. By 1980 when desalting systems are used, additional carbon systems would not be required since MBAS removal would be accomplished by the desalt system. The original carbon would still be used albeit at a lessened contact time for final polishing of the desalt product water.)

This initial system would be capable of meeting the 1973 standards but not the 1980 standards. It would also provide sufficient peaking capacity so as to delay need for flow regulation until 1980. By 1980 desalting would be required.

The initial phase construction program to be undertaken during 1978-79 would include:

1. A 54 acre-feet regulating reservoir.

2. A 60 mgd desalting plant (67,000 AF/yr).

3. The selected alternative discharge system for desalted effluent either to Lake Mead or the SNWP water treatment plant.

Subsequent phased construction in the year 1984 would double the capacity of the initial in-valley irrigation system to a capacity of 25,000 AF/yr. The final phase of construction during 1986-87 would add the following:

1. A 60 mgd (67,000 AF/yr) addition to the tertiary treatment plant excepting for the carbon adsorption and regeneration facilities which would not be expanded.

2. A 60 mgd (67,000 AF/yr) addition to the desalt plant.

Cost estimates for initial and phased construction for this alternate as well as more detailed information concerning unit sizes is shown in Table A23.12.

22.42 CONSTRUCTION REQUIRED FOR THE "LOW" POPULATION FORECAST–Initial construction during 1973-74 would be the same as indicated for the "high" population forecast excepting that the export system to Dry Lake would have a 30,000 AF/yr (20 percent of year 2020 desalinization plant capacity). Line sizes would be 30-inch and 36-inch diameter.

* Typical test results at South Tahoe have indicated mean MBAS content after secondary treatment plus lime coagulation, clarification and filtration to be about 0.85 mg/l. After carbon adsorption, this value falls to about 0.13 mg/l.

Initial phased construction during 1978-85 would be the same as indicated for the "high" population forecast.

The final phase of construction during 1988-89 would add the following:

1. A 35 mgd (39,000 AF/yr) addition to the tertiary treatment plant excepting the carbon adsorption and regeneration facilities which would not be expanded.

2. A 35 mgd (39,000 AF/yr) addition to the desalt plant.

Cost estimates for initial and phased construction for this alternate as well as more detailed information concerning this alternate as well as more detailed information concerning unit sizes is shown in Table A23.12. The reader is also referred to the Phase II study for additional background information concerning this complete treatment alternate.

22.43 OPERATION OF THE COMPLETE TREATMENT ALTERNATE– Understanding the operation of this alternate is complicated by the fact that not all of the wastewater receives the same degree of treatment in the overall system. For example, while the "high" population, year 2000 wastewater production is estimated to be 187,540 acre-feet, only 170,740 would report to the system because of the "internal" recycle of 16,800 acre-feet of wastewater at industrial plants and military installations. Of the 170,740 acre-feet, 24,700 are scheduled for irrigation uses within the valley. The remaining 146,040 acre-feet would be divided as follows:

Flow to and from plant headworks	146,000 AF/yr
Secondary effluent bypassed to brine system	13,440 AF/yr
Flow to tertiary treatment and desalt system	132,600 AF/yr
Brine from desalt system	26,560 AF/yr

Thus, while a total of 146,040 AF/yr (130.41 mgd) of secondary effluent arrive at the system headworks, only 132,600 AF/yr (118.4 mgd) actually must be passed through the tertiary and desalt systems. This explains the apparent "undersizing" of the system. The overall system economics, which are discussed in succeeding chapters, are based on such a method of operation; that is, any capacity provided in the export system not required for brine disposal is fully utilized by bypass of secondary effluent through the export system, thus using this element of the system in the most efficient manner.

Feasibility of the initial tertiary stage of the complete treatment alternate is demonstrated by several similar treatment systems now in operation including those at South Lake Tahoe and Pomona, California. Although these tertiary treatment systems are more sophisticated than any now in existence in the Las Vegas area, it is not beyond the area's capability to finance or operate such a system. The complete treatment alternate

would provide adequate treatment to meet the pre-1980 effluent quality standards for Lake Mead. An added advantage of this alternate is that the wastewater is, in effect, returned to the Colorado River, conserving a natural resource and insuring additional water supplies for the Colorado River area.

The most serious limitation of this alternate would arise in 1980 when the need to add desalinization processes to the system occurs in order to meet the more stringent standards. These processes have not been utilized on any scale even approaching the Las Vegas Valley's 1980 requirements; therefore, the validity of cost estimates based on desalinization processes is at least subject to some degree of conjecture. Based on today's present knowledge, several serious limitations can be isolated. The cost of desalinization would be very high; large amounts of electrical energy would be consumed; maintenance requirements would be considerable; and finally, a considerable amount of brine would require disposal by evaporation. For example, a reverse osmosis desalt system (as used herein for illustrative purposes) consumes about 7,200 kWh of power per million gallons of throughput. Thus, for a 60 mgd (67,000 AF/yr) system, electrical demand for the desalting portion of the system alone would be on the order of 18,000 kW and energy consumed would be about 432,000 kWh per day.

In all probability better and more economical desalinization processes will be available by the year 1980, or perhaps other means to selectively remove such pollutants as nitrogen and phosphorus. Therefore, the limitations of this plan may well be less important in the future than they now appear. At present, however, current costs and technological restraints would make operation of a desalinization system of this magnitude an expensive, complicated and uncertain undertaking.

22.50 COLORADO RIVER RETURN ALTERNATE

As described in the Phase II study report, the alternate of Colorado River return has been formulated to collect all wastewater prior to its entering the Las Vegas Wash, treating it, and discharging it to the river below Hoover Dam. By discharging all treated wastewater below the dam, maximum pollution abatement in Lake Mead can be achieved.

Figure 22.2 shows the basic features of this alternate plan. In common with the other alternates, excess secondary sewage discharged by the sewage treatment plants in the Valley, including acceptable industrial waste from the Henderson-BMI complex, will be collected and conducted to a tertiary treatment plant. As 75% of this flow is industrial from BMI (which is independent of population) the same size collection system is used for "high" or "low" population projections. The in-valley irrigation system, common to all plans, will be used to dispose of some of the secondary sewage. A tertiary treatment plant will be provided to improve the quality of the wastewater by removing large quantities of phosphorus and nitrogen, utilizing chemical coagulation, coagulant recovery by recalcination, and breakpoint chlorination. The resulting well treated effluent would essentially

meet the 1973 standards adopted for discharge to the Las Vegas Wash excepting for the MBAS standard. Table 12.9, page 17 of the Phase II report indicated the anticipated effluent quality for this alternate.

This reclaimed water would be conducted by a system of canals and pipelines above the Las Vegas Wash, around Lake Mead, and through a tunnel to a pipeline and penstock system for delivering the water to the Colorado River. Energy dissipating valves at the outlet structure would remove any excess residual hydraulic pressure. The hydroelectric power plant option included in the Phase II study report is not included herein because the effluent flows as reported herein, after deduction of flows disposed of for in-valley irrigation, would be so much smaller than those on which the Phase II hydroelectric option were based as to largely negate any positive economic return.

22.51 CONSTRUCTION REQUIRED FOR THE "HIGH" POPULATION PROJECTION–Initial construction during 1973-74 would include:

1. A wastewater collection system sized for the projected year 2000 flows.

2. An outfall system consisting of 72-inch diameter pipeline and tunnel with a penstock and energy control system.

3. A tertiary treatment plant sized for and average annual flow of 90 mgd (101,000 AF/yr as a standard increment for the quantity to be treated to 1989-90 of 99,940 Ac.Ft./yr, Table A22.1-1/2) including units for lime feed, flash mix, flocculation clarification, and coagulant recovery.

4. The initial portion of an in-valley irrigation system having a capacity of about 12,000 AF/yr.

This initial system would be capable of essentially meeting the 1973 standards as previously discussed. It would also provide sufficient peaking capacity so as to postpone the need for flow regulation until about 1980.

Initial phased construction to be undertaken in 1978-79 would include addition of a 54 acre-feet regulating reservoir.

Subsequent phased construction to be undertaken in 1985 would double the capacity of the in-valley irrigation system to a capacity of 25,000 AF/yr.

The final phase of construction during 1988-89 would provide an additional 45 mgd (50,000 AF/yr a total of 135 mgd (151,000 AF/yr) as a standard increment for the quantity to be treated to the year 2000 of 146,040 AF/yr, Table A22.1-1/2) of tertiary treatment similar to the initial construction.

Cost estimates for the initial and phased construction for this alternate as well as more detailed information concerning unit sizes are shown in Table A23.13.

22.52 CONSTRUCTION REQUIRED FOR THE "LOW" POPULATION PROJECTION–Initial construction during 1973-74 would include:

1. The same wastewater collection system, outfall system and in-valley irrigation system described in section 22.51.

2. A tertiary treatment plant sized for an average annual flow of 75 mgd (84,000 AF/yr as a standard increment for the quantity to be treated to the year 1989-90 of 85,020 AF/yr, Table A22.1-2/2) similar to but smaller than that described in section 22.51.

Initial phased construction would occur in 1978-79 and would add a 44 acre-feet regulating reservoir to the system for peaking capacity.

Subsequent phased construction during 1985 would double the in-valley irrigation system to a capacity of 25,000 acre-feet per year.

The final phased construction during 1988-89 would provide an additional 30 mgd (34,000 AF/yr a total of 105 mgd (118,000 AF/yr) as a standard increment for the quantity to be treated to the year 2000 of 113,730 AF/yr, Table A22.1-2/2) of tertiary treatment similar to the initial construction.

Costs estimates for initial and phased construction for this alternate as well as more detailed information concerning unit sizes is shown in Table A23.13.

The reader is also referred to the Phase II study for additional background information concerning the Colorado River Return Alternate.

From the standpoint of construction and operation, this alternative is very feasible. Local geography is suitable for a gravity type disposal system bypassing Lake Mead entirely. The gravity system is much simpler, more troublefree, and more economical to maintain than any system relying on pumping. The tertiary treatment operations of phosphorous and nitrogen removal have been proven by various prototype plants, as mentioned in section 22.40. This alternative also has the advantage that it returns valuable water to the river for subsequent use. Acceptable quality reclaimed water returned to the Colorado River can be credited to the State of Nevada's annual allotment of river water.

The most serious limitation of this alternate is in the quality of effluent discharged to the river. Although the water quality standards recommended in the Phase II report (Table 12.90, page 17) for discharge into the Colorado River provide for a high degree of treatment, these standards do not meet the requirements set by the Nevada State Board of

Health for effluents discharged to the Las Vegas Wash. At this time, the standards for effluents to Las Vegas Wash (and thus to Lake Mead) have not been formally adopted by the State or by EPA to apply to the Colorado River. However, if they are, this alternate would have to be revised to include desalinization, brine disposal and refrigeration resulting in costs similar to the Complete Treatment alternate.

In view of the posture of State Authorities on these standards, and in view of current and proposed federal regulations relating to returning treated wastewaters to natural streams, it does not appear that treatment short of desalinization (and possibly including effluent refrigeration) will meet discharge requirements. Unless these standards are relaxed, the Colorado River Return Alternate cannot be considered acceptable.

22.60 EXPORT SYSTEM ALTERNATES

22.61 GENERAL–The export systems described hereinafter have been formulated to meet the needs indicated by the two population projections presented in this report.

The essential elements of all export systems presented may be outlined as follows:

1. Wastewater Collection Facilities: Wastewater generated by the City of Las Vegas, Clark County Sanitation District, City of Henderson, BMI and others will be collected at a central point with a system of pipelines and open channels. These conduits will terminate in the collection reservoir which will be sized to contain daily flow variations. It is possible to compartmentalize this reservoir in such a way that wastewaters of differing quality can be stored separately, and pumped through the export line in slug flows for separate disposal at the export line discharge.

2. Export Pipeline Facilities: The export pipeline system consisting of transmission pipeline, pumping stations, forebay regulation, surge control and appurtenances conveys the wastewater from the collection reservoir to the disposal area in a closed valley adjacent to the Las Vegas Basin. This export system is sized to convey the required amounts of wastewater based on year 2000 populations of 800,000 and 1,000,000. The low population maximum wastewater excess of 111,000 AF/yr is forecast to occur in the year 1999; the high population maximum excess is very nearly that amount (104,000 AF/yr) in 1990. After 1990 the high population requires reclamation of waste water for potable use.

3. Disposal System Facilities: The disposal system facilities in the adjacent dry valleys include the transmission by canal from the export line discharge to the ponding area, the construction of a series of ponds as illustrated in Figure 22.3 for the purpose of supplying evaporative surface, the construction of a flood relief

drainage channel into the playa at the bottom of each dry valley, and the diking of the playa to provide an evaporation pond for the most saline waters. The diking of the playa will also permit storage and later evaporation of infrequent surface runoff.

Evaporation pond design is predicted on construction of unlined basins. This assumption is based on the investigations reported in Appendix B which indicate the relative impermeability of the soils in both the fans and playas of the various dry valley areas. The investigations made cover only the Dry Lake area but we believe the assumption of unlined basins is warranted for all of the various dry valleys studied.

4. Controls and Corrosion Protection: The system as outlined will be fitted with automatic controls to the maximum extent practicable, including monitoring of operating pressures and water quality at appropriate points in the system. System corrosion from both electrolytic action and hydrogen sulfide action will be provided by judicious selection of construction materials, possible cathodic protection systems, and control systems which prevent the formation of hydrogen sulfide concentrations. Careful control of hydrogen sulfide formation should minimize odor problems.

5. In-Valley Irrigation Systems: Each of the Export plans includes an in-valley irrigation system sized to deliver 25,000 acre-feet per year of secondary effluent to irrigate in-valley lands.

22.70 EXPORT TO DRY LAKE

22.71 GENERAL DESCRIPTION–The Dry Lake System as shown on Figure 22.4 will collect wastewaters from secondary treatment plants and acceptable industrial discharges within the valley, export surplus flows to Dry Lake, provide for in-valley irrigation use, and desalting facilities if ultimately found necessary. Elements are as follows: (1) Construction of collection facilities to convey wastewater from secondary treatment plants and wastewater discharges to a primary regulating reservoir. (2) Construction of a primary regulating reservoir and an export pipeline with pumping stations including pumping facilities, forebays, and surge protection to convey the waste flows to a disposal area in Dry Lake Valley. (3) Construction of an effluent distribution system in-valley with supply lines, pumping stations, and regulating reservoirs to convey wastewater to parks, schools, golf courses, and other maintained vegetation now irrigated with potable water. (4) Construction of disposal facilities in Dry Lake Valley consisting of evaporation ponds and utilization of the main playa of Dry Lake to evaporate the wastewater not suitable for other purposes. (5) Construction of desalting facilities to treat secondary effluent for the purpose of augmentation of the potable water supply when the demand exceeds the available existing potable water resource.

22.72 CONSTRUCTION REQUIRED FOR THE "HIGH" POPULATION PROJECTION—Initial construction during 1973-76 would include:

1. A 30-inch and 36-inch diameter collection system to serve BMI and Henderson including a small (150 hp) pump station for Henderson's wastes. (Sized for 20,000 AF/yr, year 2000, population 50,000 people—Henderson, 5 MGD, Industrial Waste 15 MGD.)

2. A lined canal to convey wastewater from the Las Vegas and CCSD plants to the regulating reservoir. (Purpose to conserve head at the regulating reservoir and economic construction.)

3. A 42 acre-feet regulating reservoir. (For regulation of maximum day flow (15 percent of average day.)

4. A 55,000 AF/yr pump station at the reservoir designed for an ultimate TDH of 564 feet. (50 percent of 103,600 AF/yr capacity.)

5. A 66-inch diameter pipeline (110,000 AF/yr capacity.)

6. A second 49,000 AF/yr pump station, designed for an ultimate TDH of 510 feet, midway along the pipeline route including a 21 acre-feet forebay reservoir. (See 4.)

7. A reservoir at the high point in the pipeline of 10.5 acre-feet capacity. (To control fluctuation of flow.)

8. A 4,200 acre lake in the Dry Lake Playa (for 50% of 103,600 AF max. rqmt).

9. 2,675 acres of evaporation ponds above the Dry Lake Playa with diversion canals. (For 50 percent of the 103,600 acre-foot maximum requirement.)

10. The initial portion of the in-valley irrigation system previously described.

Phased construction would be added in stages to increase capacity to an ultimate of 103,600 acre-feet per year by the year 1990 and to expand the in-valley irrigation system to a 25,000 acre-feet per year capacity by 1985. Specific incremental addition would be as shown in Tables A23.1, A23.2, and A23.3. By the year 1991, a desalting system would be required to provide potable water. Therefore, phased construction in 1989-90 would provide a 95 mgd (106,000 AF/yr being standard increment for the year 2000 of 103,800 AF/yr requirement indicated for desalted reclaimed wake for potable use: 82,900 Ac/Ft plus 20% of input for brine = 103,800 AF) desalting system for this alternate similar to that

described in Section 22.40 excepting that no carbon system would be provided. Brine from the desalt system would be disposed of through the Dry Lake export line which would have ample capacity by virtue of decreased export requirements after desalting commences. Also included would be one of the alternate desalt effluent discharge systems similar to those described in Section 22.40 for the complete treatment alternate.

22.73 CONSTRUCTION REQUIRED FOR THE "LOW" POPULATION PROJECTION—Low population requires more capacity in export system, (see Table A22.1). Hence, flows and head losses are greater.

Initial construction during 1973-77 would include:

1. A 30-inch and 36-inch diameter collection system to serve BMI and Henderson including a small (150 hp) pump station for Henderson's wastes. (Sized for 20,000 AF/yr, year 2000, population 50,000 people—Henderson, 5 MGD; Industrial Waste, 15 MGD.)

2. A lined canal to convey wastewater from the Las Vegas and CCSD plants to the regulating reservoir. (Purpose to conserve head at the regulating reservoir and economic construction.)

3. A 46 acre-feet regulating reservoir. (For regulation of maximum day flow (15% of average day).)

4. A 55,000 acre-feet per year pump station at the reservoir designed for an ultimate TDH of 577 feet. (50% of 111,300 AF/yr capacity.)

5. A 66-inch diameter pipeline (111,300 AF/yr capacity).

6. A second 55,000 acre-feet per year pump station designed for an ultimate TDH of 515 feet midway along the pipeline route including a 23 acre-feet forebay reservoir. (See 4.)

7. A reservoir at the high point in the pipeline of 11.5 acre-feet capacity. (To control fluctuation of flow.)

8. A 4,200 acre lake in the Dry Lake Playa. (For 50% of 11,300 acre-feet maximum requirement.)

9. 2,675 acres of evaporation ponds above the Dry Lake Playa with diversion canals. (For 50% of 111,300 AF maximum requirements.)

10. The initial portion of the in-valley irrigation system previously described.

Phased construction would be added in stages to increase capacity to an ultimate of 111,300 acre-feet per year by the year 1999 (Table A22.1 year 1999 Power and Disposal) and to expand the in-valley irrigation system to a 25,000 acre-feet per capacity by 1985. Specific incremental addition would be as shown in Tables A23.1, A23.2, and A23.3. Desalting systems would not be required until the year 2000. For this reason no provisions for desalting is made insofar as cost information is concerned in the chapters which follow inasmuch as primary scope of project is for the period to the year 2000. The proposed system would, however, allow inclusion of desalting facilities when required.

22.80 EXPORT TO ELDORADO VALLEY

22.81 GENERAL DESCRIPTION–The Eldorado Valley system, shown on Figure 22.5, will collect wastewaters from secondary treatment plants and acceptable industrial discharges within the valley, provide for in-valley irrigation use, export surplus flows to Eldorado Valley, and provide for desalting facilities if ultimately found necessary. Elements are as follows: (1) Construction of collection facilities to convey wastewater from secondary treatment plants and wastewater discharges to a primary regulating reservoir. (2) Construction of a primary regulating reservoir and an export pipeline with pumping facilities, including pumping plants, forebays, and surge protection to convey the waste flows to a disposal area in Eldorado Valley. (3) Construction of an effluent distribution system in-valley with supply lines, pumping stations and regulating reservoirs to convey wastewater to parks, schools, golf courses, and other maintained vegetation now irrigated with potable water. (4) Construction of beneficial irrigation facilities and disposal facilities in Eldorado Valley to provide, in conjunction with irrigation of agricultural lands, for evaporation in evaporation ponds and in the main body of Eldorado Lake playa. The construction of protection dikes to protect power facilities and the elevating of the Searchlight highway will also be included. (5) Construction of desalting facilities to treat secondary effluent for the purpose of augmentation of the potable water supply when the demand exceeds the existing potable water resource. (Refer to Appendix C page C-6 for planned development in Eldorado Valley.)

22.82 CONSTRUCTION REQUIRED FOR THE "HIGH" POPULATION PROJECTION (See Sect. 22.72 for general design factors)–Initial construction during 1973-74 would include:

1. A 27-inch and 36-inch diameter collection system to serve BMI and Henderson.

2. A lined canal and 66-inch pipe system to convey wastewater from the Las Vegas and CCSD plants to the regulating reservoir.

3. A 42 acre-feet regulating reservoir.

4. A 52,000 acre-feet per year pump station designed for an ultimate TDH of 885 feet at the reservoir.

5. A 66-inch diameter pipeline.

6. A 42 acre-feet terminal reservoir.

7. A 2,900-acre lake in the Eldorado playa.

8. 6,360 acres of agricultural enterprise.

9. The initial portion of the in-valley irrigation system having a capacity of about 12,000 acre-feet per year.

Phased construction would be added in stages to increase capacity to an ultimate capacity of 103,600 acre-feet per year by the year 1990. Specific incremental additions would be as scheduled in Tables A23.4 and A23.5 and consist of additional pump capacity, agricultural enterprise in the Eldorado Valley and evaporation ponds. The in-valley irrigation system would be expanded in 1984 to double its capacity to 25,000 acre-feet per year. Specific information is shown in Table A23.6.

By the year 1991 a desalting system would be required to provide potable water. Therefore, phased construction in 1989-90 would provide a 95 mgd (106,000 AF/yr) desalting system for this alternate similar to that described in Section 22.4 excepting that no carbon system would be provided. Brine from the desalt system would be disposed of through the Eldorado Export line, which would have ample capacity by virtue of decreased export requirements after desalting commences. Also included would be one of the alternate desalt effluent discharge systems similar to those described in Section 22.40 for the complete treatment alternate.

22.83 CONSTRUCTION REQUIRED FOR THE "LOW" POPULATION PROJECTION (See Sect. 22.72 for general design factors)—Initial construction during 1973-74 would include:

1. A 27-inch and 36-inch diameter collection system to serve BMI and Henderson.

2. A lined canal and 66-inch pipe system to convey wastewater from the Las Vegas and CCSD plants to the regulating reservoir.

3. A 46 acre-foot regulating reservoir.

4. A 55,000 acre-foot per year pump station designed for an ultimate TDH of 899 feet at the reservoir.

5. A 66-inch diameter pipeline.

6. A 46 acre-foot terminal reservoir.

7. A 2,900-acre lake in the Eldorado playa.

8. 6,360 acres of agricultural enterprise.

9. The initial portion of the in-valley irrigation system having a capacity of about 12,000 acre-feet per year.

Phased construction would be added in stages to increase capacity to an ultimate of 111,300 acre-feet per year by the year 1999. Specific incremental additions would be as scheduled in Tables A-23.4 and A-23.5 and consist of additional pump capacity, agricultural enterprise in the Eldorado Valley and evaporation ponds. The in-valley irrigation system would be expanded in 1985 to double its capacity to 25,000 acre-feet per year. Specific information is shown in Table A-23.6. Desalting systems would not be required until the year 2000. Accordingly, no provision for these would be made insofar as cost information is concerned in the chapters which follow. The proposed system would, however, allow inclusion of desalting facilities when required.

22.90 EXPORT TO JEAN LAKE

22.91 GENERAL DESCRIPTION—The Jean Lake system, shown on Figure 22.6, will collect wastewaters from secondary treatment plants and acceptable industrial discharges within the valley, export surplus flows to Jean Lake, provide for in-valley irrigation use, and desalting facilities if ultimately found necessary. Elements are as follows: (1) Construction of collection facilities to convey wastewater from secondary treatment plants and wastewater discharges to a primary regulating reservoir. (2) Construction of a primary regulating reservoir and an export pipeline with pumping facilities, including plants, forebays, and surge protection, to convey the waste flows to a disposal area in the Jean Lake area. (3) Construction of an effluent distribution system in-valley with supply lines pumping stations and regulating reservoirs to convey wastewater to parks, schools, golf courses, and other maintained vegetation now irrigated with potable water. (4) Construction of disposal facilities in the Jean Lake Valley to provide for evaporation of the wastewater in the Jean Lake playa. (5) Construction of desalting facilities to treat secondary effluent for the purpose of augmentation of the potable water supply when the demand exceeds the existing potable water resource.

22.92 CONSTRUCTION REQUIRED FOR THE "HIGH" POPULATION PROJECTION (See Sect. 22.72 for general design factors)—Initial construction during 1973-74 would include:

1. A 30-inch and 36-inch diameter collection system to serve BMI and Henderson including a small (150 hp) pump station to serve Henderson.

2. A lined canal to convey wastewater from the Las Vegas and CCSD plants to the regulating reservoir.

3. A 42 acre-foot regulating reservoir.

4. A 52,000 acre-feet per year pump station designed for an ultimate TDH of 590 feet at the reservoir.

5. A 66-inch diameter pipeline.

6. A 2,350-acre lake in the Jean Lake playa.

7. 4,525 acres of evaporation ponds.

8. The initial portion of the in-valley irrigation system having a capacity of about 12,000 AF/yr.

Phased construction would be added in stages to increase capacity to an ultimate of 103,600 acre-feet per year by the year 1990. Specific incremental additions would be as scheduled in Table A-23.7 and A-23.8 and consist of additional pump capacity (two additional 55,000 acre-feet per year pump stations designed for ultimate TDH's of 595 and 542 feet respectively, one with a 21 acre-feet forebay reservoir, and the second with a 10.5 acre-feet forebay reservoir) and evaporation ponds. The in-valley irrigation system would be expanded in 1985 to double its capacity of 25,000 acre-feet per year. Specific information is shown in Table A-23.9.

By the year 1991, a desalting system would be required to provide potable water. Therefore, phased construction in 1989-90 would provide a 95 mgd (106,000 acre-feet per year) desalting system for this alternate similar to that discussed in Section 22.4 excepting that no carbon system would be provided. Brine from the desalt system would be disposed of through the Jean Lake export line which would have ample capacity by virtue of decreased export requirements after desalting commences. Also included would be one of the alternate desalt effluent discharge systems similar to those described in Section 22.4.

22.93 CONSTRUCTION REQUIRED FOR THE "LOW" POPULATION PROJECTION (See Sect. 22.72 for general design factors)—Initial construction during 1973-74 would include:

1. A 30-inch and 36-inch diameter collection system to serve BMI and Henderson including a small (150 hp) pump station to serve Henderson.

2. A lined canal to convey wastewater from the Las Vegas and CCSD plants to the regulating reservoir.

3. A 46 acre-foot regulating reservoir.

4. A 55,000 acre-feet per year pump station designed for an ultimate TDH of 600 feet at the reservoir.

5. A 66-inch diameter pipeline.

6. A 2,350-acre lake in the Jean Lake playa.

7. 4,525 acres of evaporation ponds.

8. The initial portion of the in-valley irrigation system having a capacity of about 12,000 acre-feet per year.

Phased construction would be added in stages to increase capacity to an ultimate capacity of 11,300 acre-feet per year by the year 1999. Specific incremental additions would be as scheduled in Tables A-23.7 and A-23.8 and consist of additional pump capacity (two additional 55,000 acre-feet per year pump stations designed for ultimate TDH's of 605 and 549 feet respectively, one with a 23 acre-foot forebay reservoir, and the second with a 11.5 acre-foot reservoir) and evaporation ponds. The in-valley irrigation system would be expanded in 1985 to double its capacity to 25,000 acre-feet per year. Specific information is shown in Table A-23.9.

Desalting systems would not be required until the year 2000. Accordingly, no provision for these would be made insofar as cost information is concerned in the chapters which follow. The proposed system would, however, allow inclusion of desalting facilities when required.

22.100 CHAPTER SUMMARY

The alternate solutions investigated include:

Groundwater Recharge
Complete Treatment
Colorado River Return
Export to Dry Lake
Export to Eldorado Valley
Export to Jean Lake

All of the alternate solutions are studied for both the high and low population growth rates of 1,000,000 and 800,000 persons respectively in the year 2000. All contain some similar elements such as an in-valley irrigation system. All can be adapted to provide major amounts of water (at least in the near term) for possible use as a cooling water supply. The groundwater recharge, complete treatment and Colorado River return alternates were developed originally in the Phase II studies and are merely reevaluated on the basis of different population and water budgets as used herein.

As described in Sections 22.60, 22.70, and 22.80, all export systems actually are a combination of similar facilities which provide for export of wastewater in early years; utilize in-valley uses to the maximum practicable extent; and desalt wastewater to augment the potable supply when the groundwater and Colorado River resources are being used to capacity.

As shown in Appendix A, these export systems all require the transmission of large volumes of water to the respective export areas immediately after commencement of operations. Because of this immediate problem, interim solutions are not generally practical since the sizing of facilities to meet the near future need is very nearly of the same magnitude as the ultimate development. This apparent anomaly is the result of the need to reuse, in the future, large volumes of reclaimed wastewater to augment the existing potable water resource.

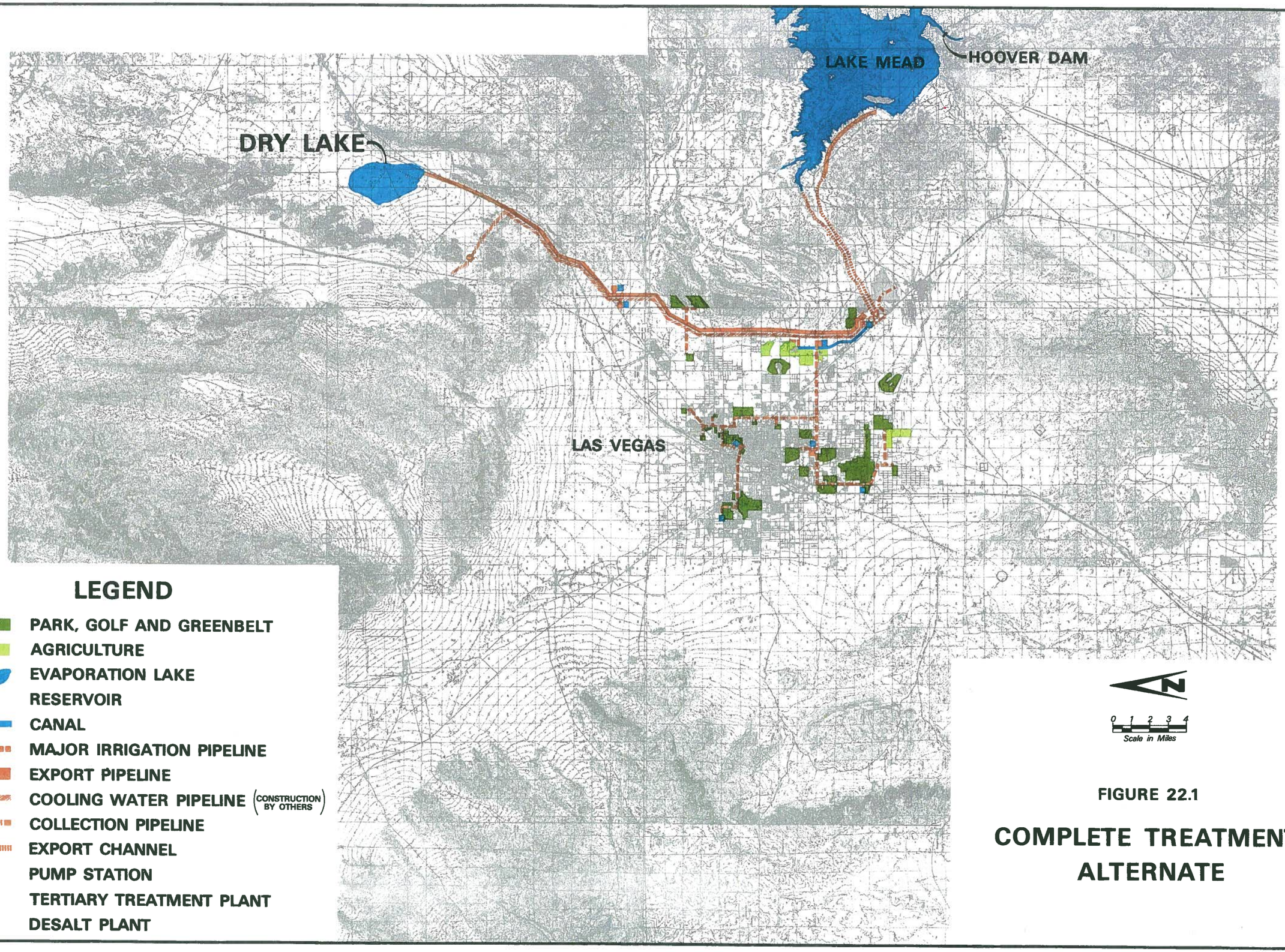


FIGURE 22.1

COMPLETE TREATMENT ALTERNATE

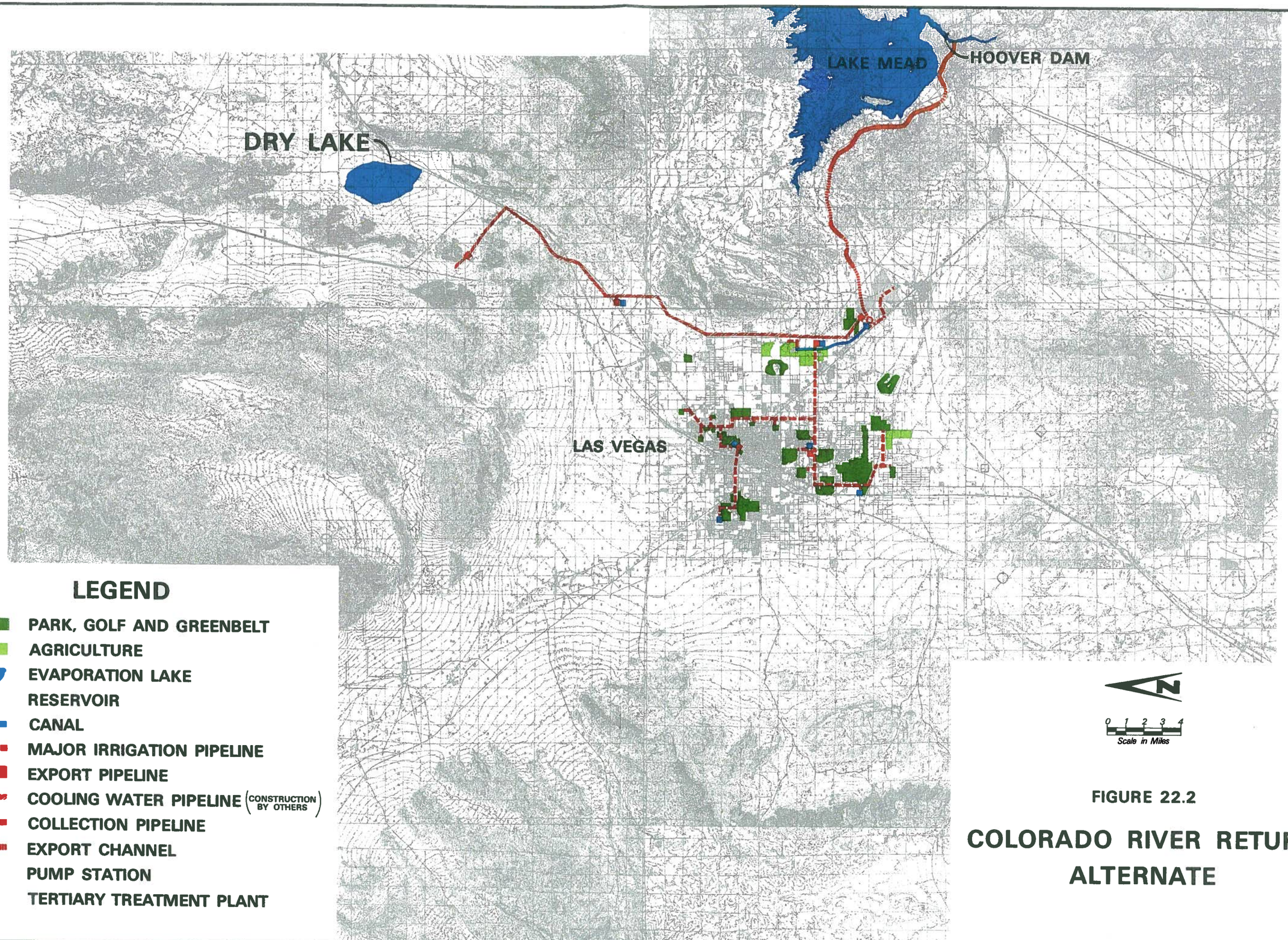
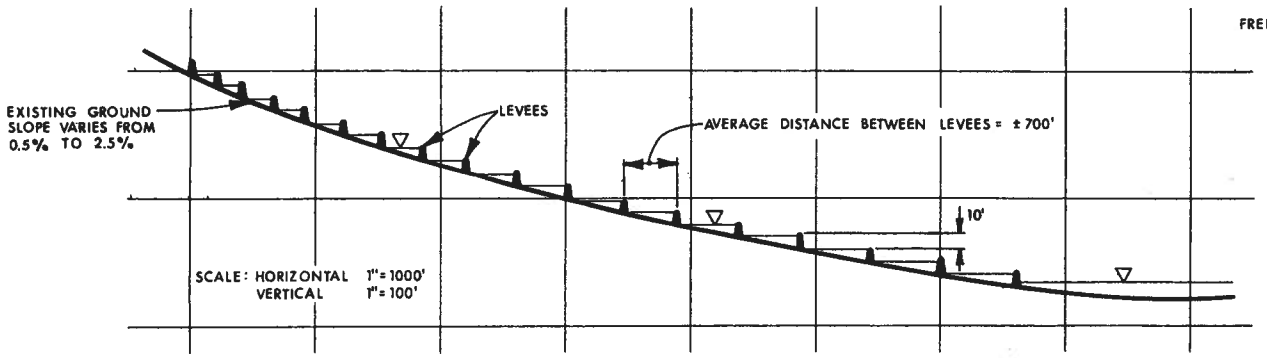
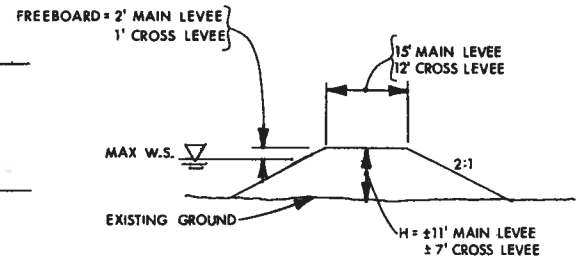


FIGURE 22.2

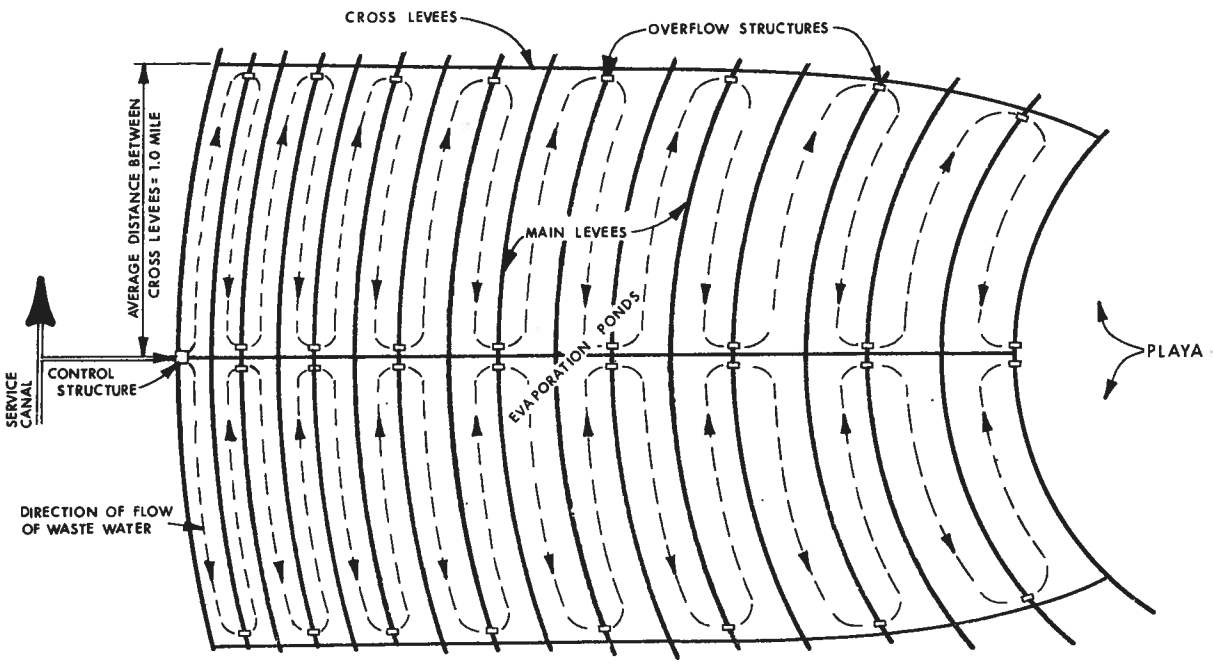
COLORADO RIVER RETURN ALTERNATE



PROFILE



TYPICAL SECTION OF LEVEE



PLAN
SCALE 1" = 1000'

FIGURE 22.3

TYPICAL DISPOSAL AREA EVAPORATION PONDS

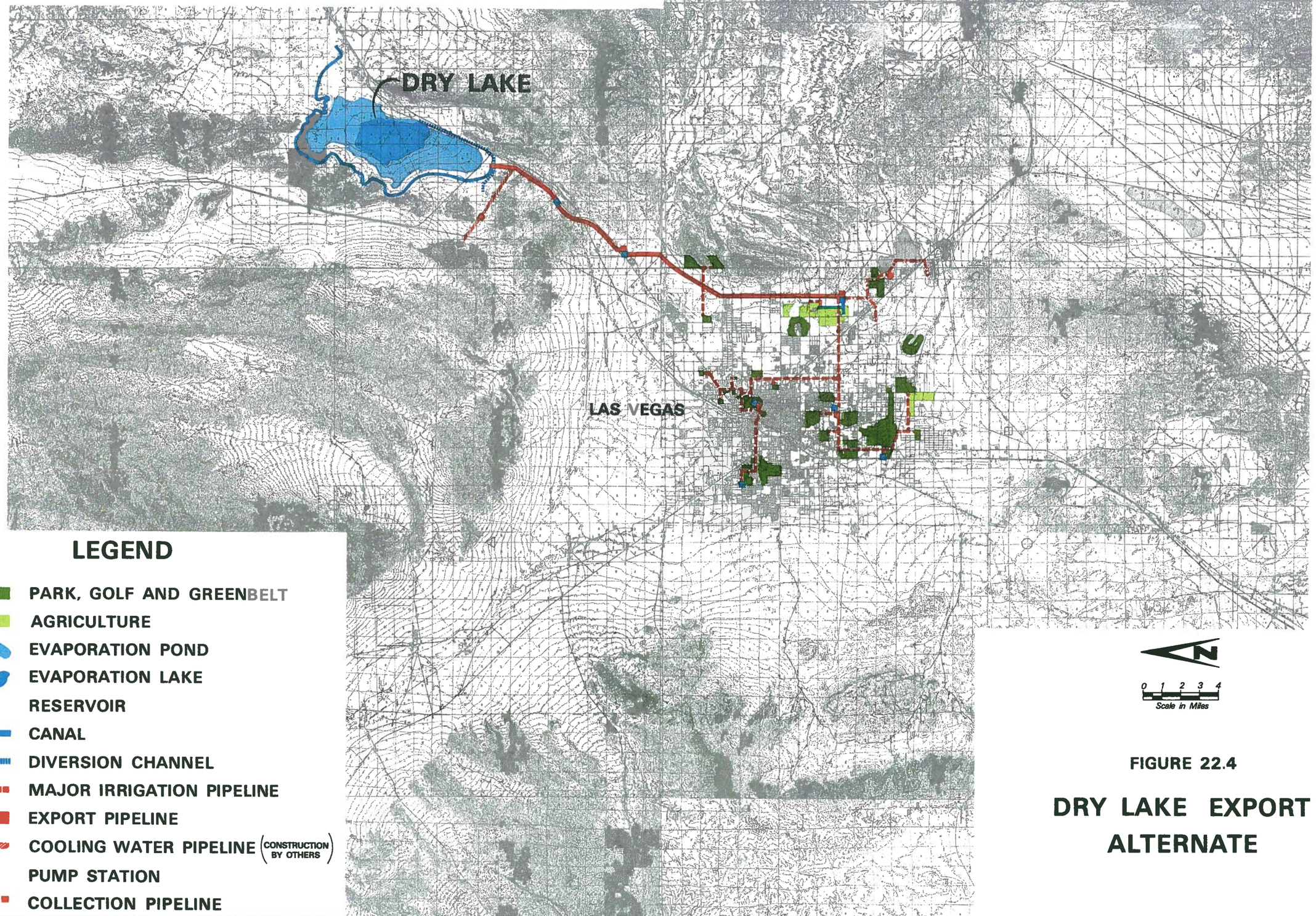


FIGURE 22.4

DRY LAKE EXPORT ALTERNATE

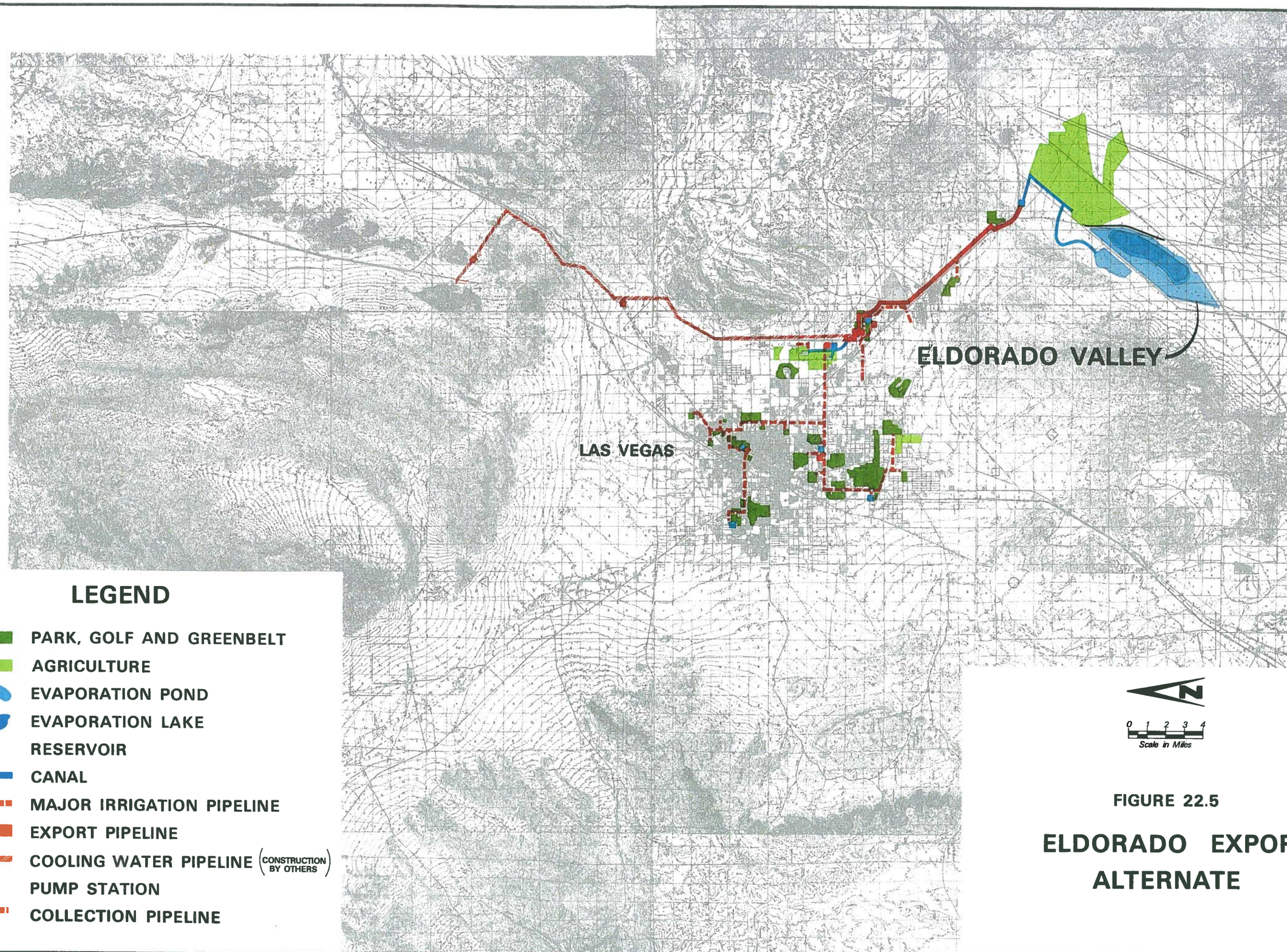


FIGURE 22.5

ELDORADO EXPORT ALTERNATE

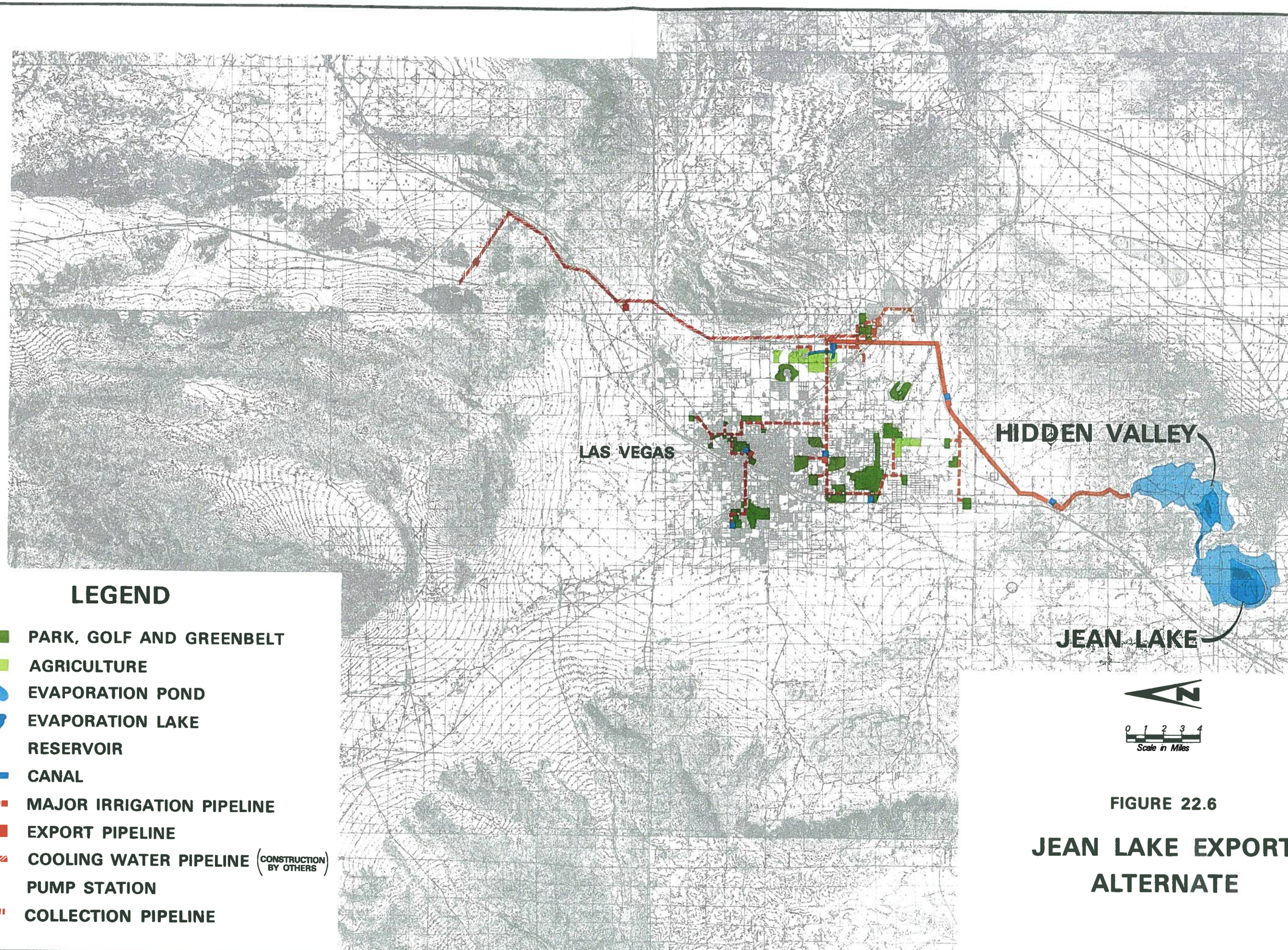
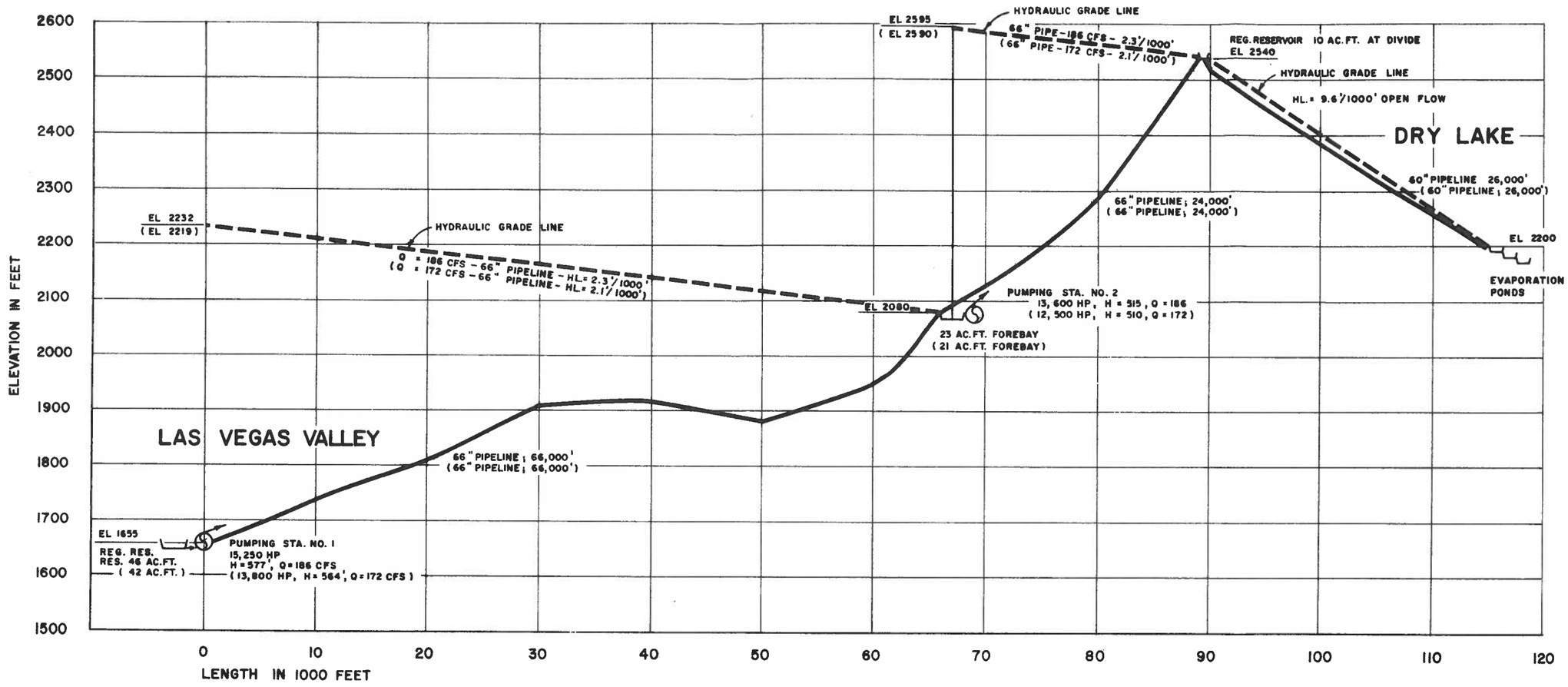


FIGURE 22.6

JEAN LAKE EXPORT ALTERNATE

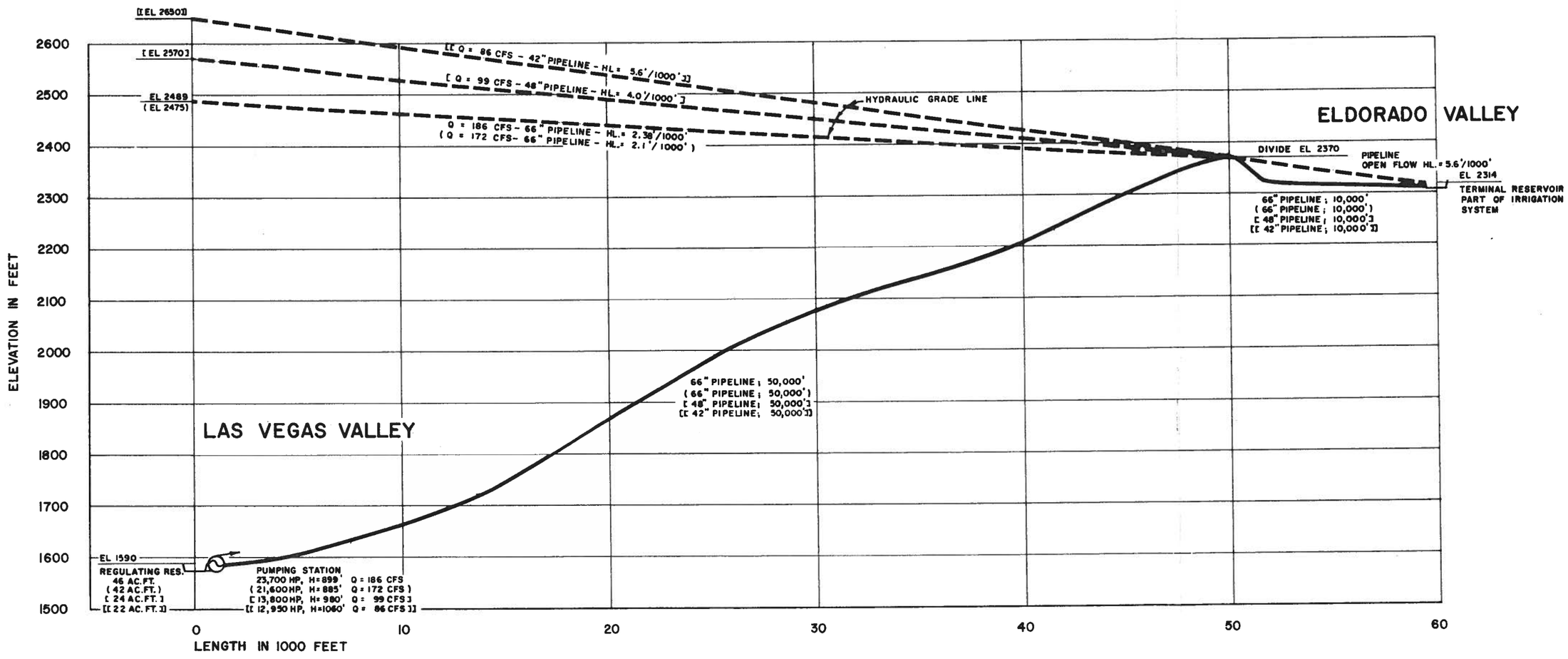


PROFILE OF

DRY LAKE EXPORT SYSTEM

800,000 POPULATION WITH & WITHOUT POWER
(1,000,000 POPULATION WITH & WITHOUT POWER)
800,000 - DESIGN YEAR 1999 - EXPORT QUANTITY 111,310 AC.FT., AVG. FLOW 154 CFS, DESIGN FLOW 186 CFS
(1,000,000 - DESIGN YEAR 1990 - EXPORT QUANTITY 103,610 AC.FT., AVG. FLOW 143 CFS, DESIGN FLOW 172 CFS)

FIGURE 22.7



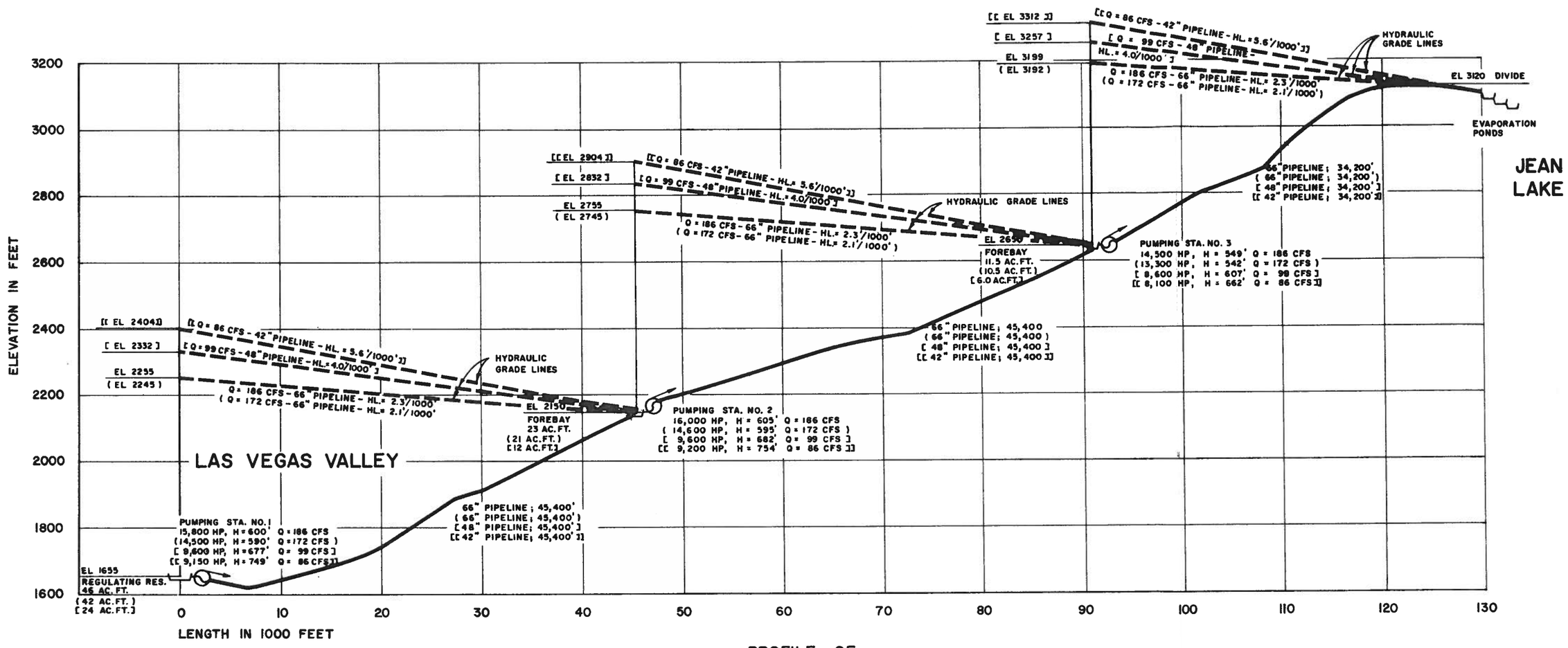
PROFILE OF

ELDORADO VALLEY-EXPORT SYSTEM

800,000 POPULATION WITHOUT POWER
[[800,000 POPULATION WITH POWER IN DOUBLE BRACKETS]]
(1,000,000 POPULATION WITHOUT POWER IN PARENTHESIS)
[1,000,000 POPULATION WITH POWER IN BRACKETS]

800,000 - DESIGN YEAR 1999 - EXPORT QUANTITY 111,310 AC. FT. - AVG. FLOW 154 CFS - DESIGN FLOW 186 CFS)
[[800,000 - DESIGN YEAR 1976 - EXPORT QUANTITY 51,700 AC. FT. - AVG. FLOW 72 CFS - DESIGN FLOW 86 CFS]]
(1,000,000 - DESIGN YEAR 1990 - EXPORT QUANTITY 103,610 AC. FT. - AVG. FLOW 143 CFS - DESIGN FLOW 172 CFS)
[1,000,000 - DESIGN YEAR 1990 - EXPORT QUANTITY 59,310 AC. FT. - AVG. FLOW 82 CFS - DESIGN FLOW 99 CFS]

FIGURE 22.8



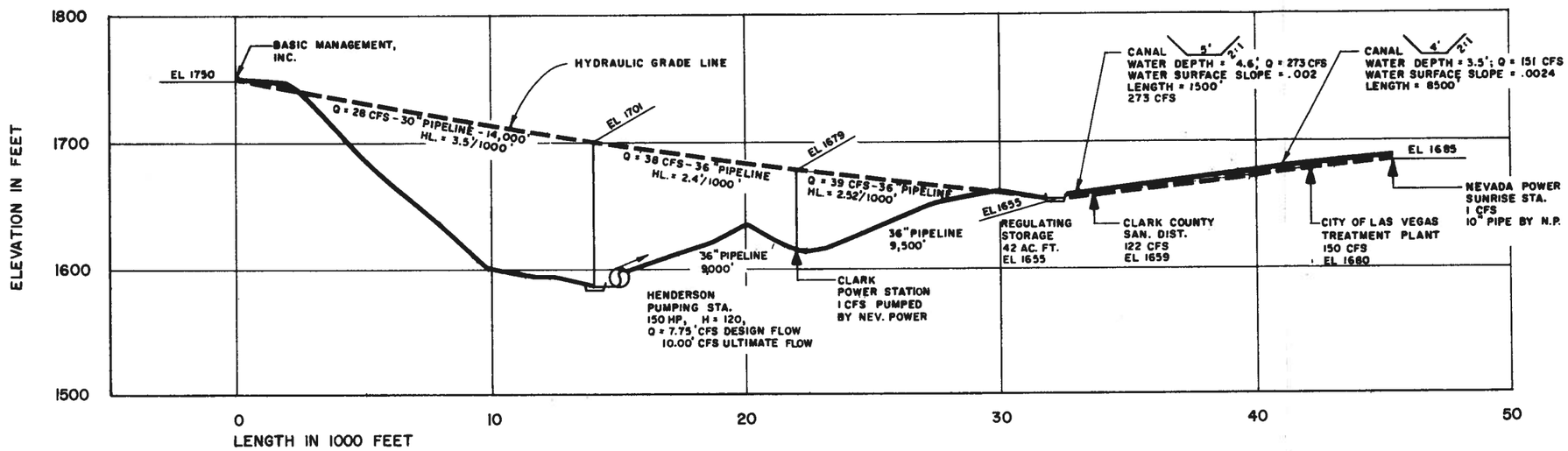
PROFILE OF

JEAN LAKE EXPORT SYSTEM

800,000 POPULATION WITHOUT POWER
[[800,000 POPULATION WITH POWER IN DOUBLE BRACKETS]]
(1,000,000 POPULATION WITHOUT POWER IN PARENTHESIS)
[1,000,000 POPULATION WITH POWER IN BRACKETS]

800,000 - DESIGN YEAR 1999 - EXPORT QUANTITY 111,310 AC. FT. - AVG. FLOW 154 CFS - DESIGN FLOW 186 CFS
[[800,000 - DESIGN YEAR 1976 - EXPORT QUANTITY 51,700 AC. FT. - AVG. FLOW 72 CFS - DESIGN FLOW 86 CFS]]
(1,000,000 - DESIGN YEAR 1990 - EXPORT QUANTITY 103,610 AC. FT. - AVG. FLOW 143 CFS - DESIGN FLOW 172 CFS)
[1,000,000 - DESIGN YEAR 1990 - EXPORT QUANTITY 59,310 AC. FT. - AVG. FLOW 82 CFS - DESIGN FLOW 99 CFS]

FIGURE 22.9



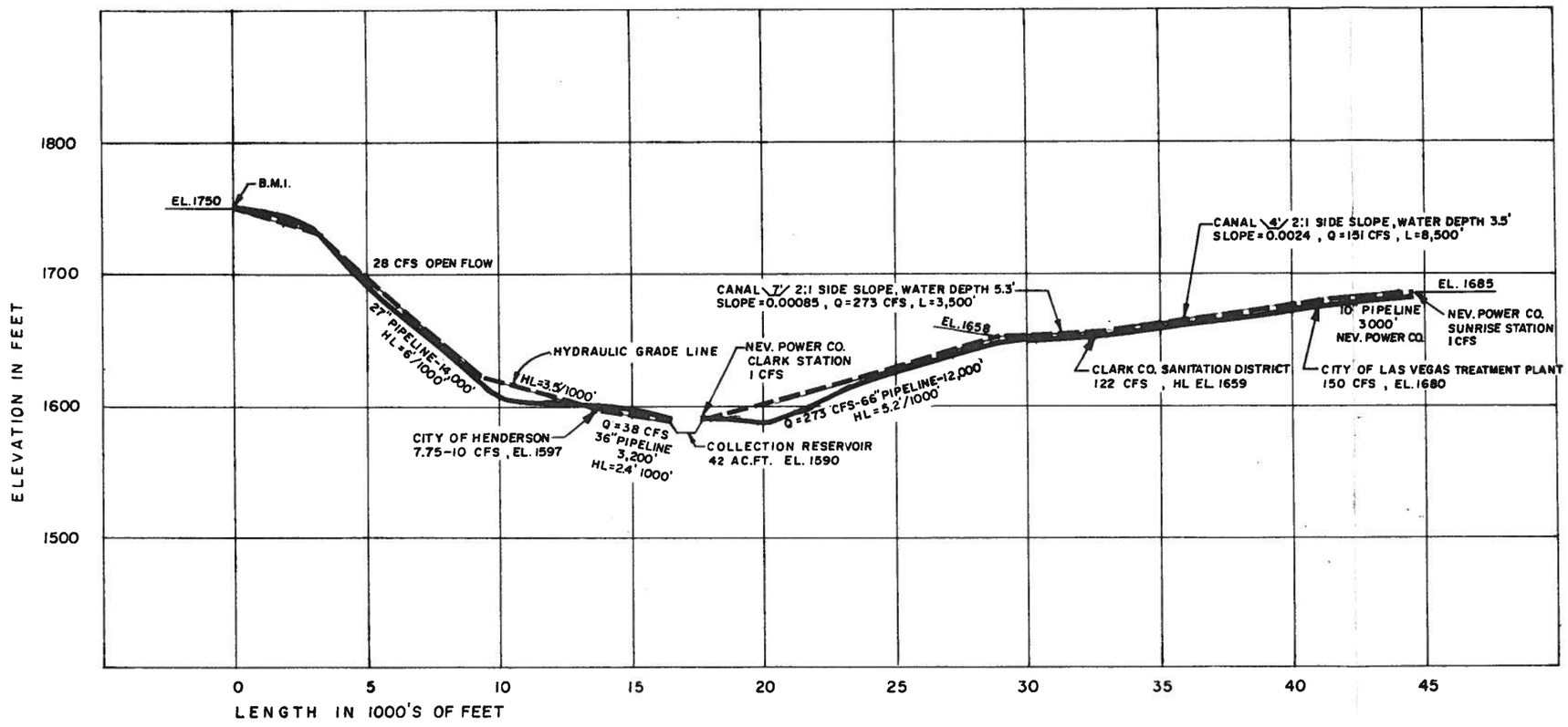
PROFILE OF

COLLECTION SYSTEM FOR DRY LAKE & JEAN LAKE EXPORT SYSTEMS

1,000,000 POPULATION - DESIGN YEAR 2000

	AVG. FLOW	DESIGN FLOW
CITY OF LAS VEGAS	124.50 CFS	150.00 CFS
CLARK COUNTY SAN. DIST.	101.90 CFS	122.00 CFS
BASIC MGMT., INC. - 15 MGD	23.25 CFS	28.00 CFS
HENDERSON - 5 MGD	7.75 CFS	7.75 CFS (PUMP)
"	" "	10.00 CFS (PIPE)
CLARK POWER STATION	0.80 CFS	1.00 CFS
SUNRISE POWER STATION	0.80 CFS	1.00 CFS
TOTAL QUANTITY = 187,540 AC.FT.	259.00 CFS	312 CFS

FIGURE 22.10



PROFILE OF
COLLECTION SYSTEM FOR ELDORADO EXPORT SYSTEM
TYPICAL

FIGURE 22.11

CHAPTER 23
COSTS OF ALTERNATE PLANS

CHAPTER 23
COSTS OF ALTERNATE PLANS

23.00 GENERAL

The purpose of this chapter is to present and discuss cost information on each of the selected plans for treating and disposing of wastewater. Before considering the results, the approach is outlined and some terms are defined.

23.01 METHODOLOGY—In the approach used for comparing the costs of the plans, an attempt was made to treat each on a comparable basis. The costs for each plan are complete for treating or disposing of the wastewater without any consideration of possible cost-sharing between the District and other parties. As in previous studies, costs of conventional primary-secondary treatment, private treatment and general administrative costs common to all plans were excluded. Possible financing arrangements and revenues from sale of wastewater are considered in Chapter 26. The approach uses constant prices throughout. To some degree one could assume inflation to parallel the discount rate of future cash. Thus, costs of construction, operation, maintenance, and repair are based on estimates for January 1972, regardless of the year in which the cost is incurred. The rate of inflation in the economy, beyond a few years in the future, is highly uncertain, and it was not considered necessary for plan selection to estimate inflation of costs of the various plans. The evaluation period was 1973 to 2000, although the reader is cautioned against placing too much faith in future values beyond 10-15 years because of changes in technology and institutions that may take place. In every case, the best cost information currently available was used.

Although the evaluation period 1973-2000 is less than the life of bonds issued to finance the facilities, and although some facilities may have useful lives of more than 30 years and some less than 30 years, unit cost analysis has not been carried beyond year 2000. In general, unit costs shown beyond that point should decrease since total flows will be increasing, and bond amortization costs will decrease as initial issues are retired.

Costs were discounted to obtain an estimate of present value of the costs of each plan. This procedure adjusts costs for differences in their time incidence, recognizing that, because capital represents scarce resources, there are benefits from other uses of the funds or savings in delaying expenditures. (Although this savings may be offset by inflation, it is seldom wise to purchase something not needed now in the anticipation of inflation, because inflation is not dependable.) A rate of 7 percent was used for discounting and the conventional means was used.

Present Value of Cost = Sum ($Cost_i\ (1+r)^{-i}$), where i is year of occurrence or number of years from present and r is the rate of discount.

The annual unit cost of wastewater treatment or disposal was estimated by the following:

$$\text{Annual cost per MG} = \frac{\text{Annual Debt Service + Annual OM\&R*}}{\text{Annual Wastewater Requiring Treatment and Disposal in MG**}}$$

To estimate cost per million gallons, level debt service on the cumulative construction capital for a given year was used for an assumed 7 percent interest on a 30-year loan of funds.

A 30-year bond amortization period is usual for financing this type of development, although shorter or longer terms are used in some cases. The thirty-year period is approximately consistent with the evaluation period of 1973-2000. The major facilities to be constructed initially (including the export and disposal facilities) are all estimated to have some element of useful life through and beyond a 30-year period.

The cost of land and right-of-way acquisition has not been included in any of the alternates. It has been assumed that when large parcels of land are necessary for disposal by evaporation in connection with the export plans, the use of such lands can be obtained from the Federal Government at nominal cost. It has been further assumed that the cost of land and right-of-way acquisition from private owners will be essentially common to all alternates.

23.02 ORGANIZATION OF COST DATA—Costs have been estimated for each condition of the alternate plans: for year 2000 population of 1,000,000 or 800,000. These costs are presented and analyzed on the basis of initial capital costs, staged capital costs, costs of maintenance and operation, present value, and unit costs. All of the above anlayses include tabular presentations. These tabulations are presented in Appendix A of this report.

23.10 COST SUMMARIES

Summary information from the cost analyses are shown in the following tabulation on the next page. It may be noted that complete treatment and Colorado River return have lower initial costs than the export alternates. A commitment of complete treatment, however, results in additional construction costs at an earlier date and higher annual O.M.&R. costs than other plans. As a result, the discounted value of all costs of complete treatment for the 1972-2000 period is considerably greater than costs of other plans.

---

* Operation, maintenance and repair, including power for pumping and treatment, equipment repair and replacement, labor for operation, maintenance of evaportation ponds (vegetation, insect and erosion control), chemicals and other supplies, building maintenance, etc.

** Annual wastewater requiring disposal is shown in Tables A-21.3, A-21.4 and A-22.1. Includes wastewater for which no economic or continued aesthetic in-valley use can be created.

COST SUMMARIES
WASTEWATER TREATMENT & DISPOSAL PLANS[1/]
1973-2000
(WITHOUT POWER)

CONSTRUCTION COST

ALTERNATIVE	1973-74 (Mil. $)	PHASED (Mil. $)	TOTAL (Mil. $)	ANNUAL O.M. & R. RANGE (Mil. $)	DISCOUNTED VALUE[2/] (Mil. $)	25 YR. RAI COST PE MG/YR FL
GROUNDWATER RECHARGE	3/	3/	3/	3/	3/	
COMPLETE TREATMENT[4/]						
1 MIL. POP.	36.4	76.4	112.8	2.1–11.7	130.3	$231–$4
0.8 MIL. POP.	34.2	62.9	97.1	2.1– 9.6	116.7	$226–$4
COLORADO RIVER RETURN[5/]						
1 MIL. POP.	28.6	10.1	38.7	2.4– 5.6	65.2	$157–$2
0.8 MIL. POP.	27.3	8.3	35.6	2.2– 4.5	58.6	$167–$2
DRY LAKE EXPORT						
1 MIL. POP.	37.6	82.8	120.4	1.2– 9.3	92.0	$185–$3
0.8 MIL. POP.	38.2	19.8	58.0	1.2– 2.7	61.2	$161–$2
ELDORADO VALLEY EXPORT						
1 MIL. POP.	37.1	83.9	121.0	1.2– 9.2	92.0	$187–$3
0.8 MIL. POP.	37.	20.9	58.4	1.2– 2.5	61.2	$160–$2
JEAN LAKE EXPORT						
1 MIL. POP.	45.8	83.6	129.4	1.8–10.2	108.4	$235–$3
0.8 MIL. POP.	46.7	20.7	67.4	1.8– 3.9	77.5	$206–$2

1/ ASSUMES NO USE OF WASTEWATER FOR POWER PLANT COOLING FOR ANY ALTERNATIVE.
2/ ALL COSTS DISCOUNTED AT 7 PERCENT TO 1972.
3/ SEE PHASE II REPORT AND TEXT DISCUSSION.
4/ DISCHARGE TO SNWP.
5/ DISCHARGE WILL NOT MEET ANTICIPATED 1980 WATER QUALITY STANDARDS

Colorado River return, although attractive from a cost standpoint, is not expected to meet water quality standards for discharge to streams except possibly for the very near future. Among the export plans, export to Dry Lake or Eldorado are nearly equal and lower in cost than export to Jean Lake.

23.20 UNIT COSTS

23.21 GROUNDWATER RECHARGE–The groundwater recharge alternate as studied in Phase II resulted in an estimated unit cost range of from $224 to $338 per million gallons for treatment and disposition of wastewater (1970 dollars). Because the methods of reporting costs in the Phase II study included a 4.5 percent per year inflation factor for capital costs and some of the annual costs, the high end of this cost range would not be a fair comparison with other costs developed in this Phase II study. On the cost basis used herein (no inflation factor), a reasonable estimate of cost for wastewater disposal by groundwater recharge would be $225 to $250 per million gallons, not inclusive of costs associated with the possible need for desalting prior to recharge. For more detailed information on capital and annual costs for groundwater recharge, the reader is referred to Tables 16.3 and 16.4 of the Phase II report.

Should it become necessary to consider desalting a portion of the water used for recharge in order to protect the quality of the groundwater basin, unit costs for the alternate will be increased. Removal of 25 percent of the salts in the recharge water would increase costs by $75 to $100 per million gallons. Removal of 50 percent of the salts would increase costs approximately $150 to $200 per million gallons. The advisability of such a course of action cannot be evaluated until more facts have been developed relating to the capacity, flow patterns and mixing characteristics of the groundwater basin.

23.22 COMPLETE TREATMENT–Unit costs for construction and operation of the Complete Treatment Alternate, as described in Chapter 22, are based upon the use of present day technology. It is probable that with construction of a large capacity plant, and with the postponement of much of this construction in future years, these unit costs would be reduced. However, it is not considered prudent to count upon these projected savings at this time. The costs of this alternate appear to be excessively high as compared to others; however, substantial benefits to water users receiving a higher quality of water have not been evaluated. The range of unit costs for this alternate as shown in Appendix A is $231 to $434 (see Table A-23.16) per million gallons (1972 prices).

23.23 COLORADO RIVER RETURN– The cost estimates for this alternate (which is described in Chapter 22) are based upon the treatment of effluent to standards proposed in the Phase II Study, and on that basis costs appear to be quite favorable. The current posture of State and Federal authorities, together with objectives of fishing and recreational groups, make this alternate much less viable. If the return of treated wastewaters to the Colorado River System is ever permitted, the cost of such treatment and disposal will likely

be somewhere between the range of $157 to $217 per million gallons (as outlined in Table A23.16) and a range of $373 to $434 per million gallons stated for the complete treatment alternate. Current policies and attitudes indicate that complete treatment will most probably prevail. To be more specific, the low range estimates are based on treatment intended to essentially meet the standards set for 1973 discharges to Las Vegas Wash. If the 1980 standards set for Las Vegas Wash discharges are extended to apply to discharge to the Colorado River below Hoover Dam, treatment by means of a desalting process will be required.

23.24 EXPORT ALTERNATES–Estimating the costs of the export alternates is complicated by the many variable factors which can be introduced.

1. The export systems act strictly as a pollution abatement vehicle except for possible power generation used at Arrow Canyon under the Dry Lake Alternate until it becomes necessary to begin complete treatment of effluent in order to meet needs for potable water supply. Complete treatment is expected to be required in the 1990-2000 decade with exact timing being dependent on population growth. Additional capital and operating costs have been phased into the analyses at the indicated dates. Data from the cost analyses are presented in the appropriate tables of Appendix A.A summary of unit costs as presented below.

2. The systems have been designed (a) considering no use of industrial power plant cooling water outside Las Vegas Valley, and (b) assuming that allocated water is taken for cooling purposes, primarily for electric power generation outside Las Vegas Valley.

3. The without-power alternates visualize a single system which disposes of all wastewaters necessary at a single site.

4. The with-power alternate visualizes a reduced system which disposes of all wastewaters except cooling water at the designated site. The Dry Lake export line is designed to also accommodate cooling water with a spur line (by other) running to the Arrow Canyon plant site. In the case of the Eldorado and Jean Lake systems, a separate export system (by others) is added to convey cooling water from the central wastewater collection reservoir to the Arrow Canyon site. In case cooling water is used, it has been assumed that special facilities required will be financed, constructed, and operated by someone other than the District.

23.25 UNIT COST SUMMARY–The approximate ranges in unit costs listed below are given in 1972 dollars. For the complete treatment alternate, complete treatment including desalting does not commence until year 1980. However, costs shown in the table include desalting. For the Colorado River return alternate, the assumption was made in the Phase II report that desalting of the wastewater was not required. However, in light of current posture at State and Federal levels, costs in the table include desalting. If desalting is

required, the cost for this alternate would be about the same as for the complete treatment alternate. For the export alternate, for population projection of 1,000,000 at year 2000, desalting of wastewater to supplement the potable supply is required in about 1990. For population projection of 800,000 at year 2000, desalting would not be necessary until about year 1999. In the table, unit costs for export plans include desalting.

UNIT COSTS AND BRIEF COMMENTS ON ALTERNATE WASTEWATER TREATMENT AND DISPOSAL PLANS

(1,000,000 POPULATION WITHOUT POWER)

ALTERNATE	COST PER MILLION GALLONS 1980	1990	2000	REMARKS
GROUNDWATER RECHARGE	$240 ±	240 ±	240 ±	NEEDS FURTHER EVALUATION TO PROVE FEASIBILITY
GROUNDWATER RECHARGE WITH 50 PERCENT DESALTING	415 ±	415 ±	415 ±	
GROUNDWATER RECHARGE WITH 100 PERCENT DESALTING	590	680	610	
COMPLETE TREATMENT	378	434	373	COSTS BEFORE 1980 WOULD BE LOWER BECAUSE OF LOWER DISCHARGE STANDARDS
COLORADO RIVER RETURN	190*-378**	180*-434**	157-373**	COSTS BEFORE 1980 WOULD BE LOWER BECAUSE OF LOWER DISCHARGE STANDARDS
DRY LAKE EXPORT	194	285	335	NOTE: COSTS BEFORE 1990 WOULD BE LOWER IF DESALTING IS NOT NECESSARY
ELDORADO VALLEY EXPORT	198	285	336	NOTE: COSTS BEFORE 1990 WOULD BE LOWER IF DESALTING IS NOT NECESSARY
JEAN LAKEEXPORT	246	330	366	NOTE: COSTS BEFORE 1990 WOULD BE LOWER IF DESALTING IS NOT NECESSARY

* Present Requirements
** With Complete Treatment

23.30 SUMMARY

Cost analyses for alternate plans (shown in Appendix A) have been made on the basis of both the high and low population projections. Cost analyses include estimates of both initial and staged construction costs, maintenance and operation costs, present value, unit costs and appropriate cost summaries. All costs are given in 1972 dollars with future expenditures discounted to that year to show present value estimates.

Analyses of all alternates presented, both on the basis of initial and unit costs, together with consideration of technical feasibility, indicates that one of the export alternative is most desirable. Evidence indicates that both the Dry Lake Export System and the Eldorado Export System are of approximately equal cost.

CHAPTER 24
SUPPLEMENTAL BENEFICIAL USES

CHAPTER 24
SUPPLEMENTAL BENEFICIAL USE

24.00 GENERAL

The design and cost analysis of the alternate systems presented in this report have been prepared assuming that no supplemental beneficial uses of water for agriculture, except for Eldorado Valley, outside Las Vegas Valley or power production will exist. The Eldorado Valley agricultural enterprise has been assumed to return no payment for the Eldorado system. This approach was considered necessary for the following reasons:

1. The use of treated water for agriculture outside the Valley depends upon the development of new enterprise which is not under the control of the District. As such, it is dependent on some third party not yet in evidence.

2. Contracts for use of agricultural water, even though entered into in good faith by then reliable persons, are by their nature dependent on the year-to-year profitability of the enterprise. The history of agriculture in Las Vegas Valley is one of marginal profitability, thus reducing the probability of obtaining firm long-term use contracts.

3. The use of agricultural water is seasonal in nature. This requires the construction of substantial and expensive holding reservoirs or the provision of alternate means of wastewater disposal during times of off-peak agricultural use.

4. The use of treated wastewater as a cooling water for power plant use is in control of a third party, and not at the present time controlled by the District. Until such time as a firm contract, legally enforceable, with a power producer is entered into, provision must be made to dispose of excess wastewaters by other means. However, the possibility of using the export pipeline of the Dry Lake Export Alternate for the conveyance of cooling water to the proposed Arrow Canyon Power Plant is a valid factor to be considered in the selection of this alternate. (This statement does not imply that the use of sewage effluents for power plant cooling water is not a useful and productive application of such water and in the interest of the citizens of the Las Vegas area.)

All of the alternates presented are capable of disposing of wastewater generated without relying on out-of-valley agriculture or the power producer. The following sections of this chapter present pertinent information and analysis relating to these uses.

24.10 AGRICULTURE

The assessment presented in Appendix C of this report investigates the potential for use of secondary treated effluent in the development of new agricultural lands in areas adjoining Las Vegas Valley. Because of climate and soil conditions in the area, it appears that only relatively low value crops can be raised successfully. The economic analysis presented in Appendix C indicates that agriculture in these adjoining valleys would be a marginal economic undertaking. This conclusion is substantiated by the history of Las Vegas Valley where only minor amounts of treated wastewater (which has been available at essentially no cost) have been put to use in irrigated agriculture. Potential use of water for agriculture for each of the export plans is discussed below.

24.11 ELDORADO VALLEY–Eldorado Valley offers the most favorable soil conditions for agricultural development. For this reason, and also on the assumption that agriculture would be preferred to evaporation ponds in the area adjacent to Boulder City, the plan presented shows a combination of agriculture and evaporation for the disposal of excess wastewaters. The evaporation areas provided should be sufficient to absorb the seasonal fluctuations in water demand, and to also receive and dispose of the sizeable irrigation return flows. These return flows are estimated to be on the order of 20-30 percent of the irrigation water applied.

In the event that an agricultural operation as visualized does not prove successful, the facilities could be utilized to dispose of water by waste irrigation methods. Another possibility would be to convert areas delineated for agriculture to evaporation pond use.

24.12 JEAN LAKE–Jean Lake-Hidden Valley area has good soil conditions and an area of sufficient extent to permit favorable farming operations. Although the plan presented for this alternate incorporates evaporation ponds only, these ponds are scheduled for staged construction. If, either at the program's inception or later, an agricultural operator could be found, lands designated for pond development could be converted to farming.

24.13 DRY LAKE–Potential for agricultural development in Dry Lake Valley is limited by poor soil conditions. Marginal soils are estimated to exist in an area of some 2,500 acres. For this reason, only evaporation ponding was considered as a means of wastewater disposal. As in the case of the Jean Lake alternate, agricultural use in Dry Lake Valley is not precluded if it can be proven to be feasible. One additional feature of the Dry Lake plan is the incorporation of a by-pass canal which can, by gravity, divert water around the valley and make delivery to the Moapa area if desired.

24.20 POWER

24.21 GENERAL–Economic reuse of wastewater quantities developed in the Las Vegas Valley depends upon the markets available. After fulfilling all feasible irrigation needs within the valley, enough valuable water remains to demand careful consideration.

In general, large amounts of water required for industrial use should be of better quality than water which will be available. Because generally better qualities of water are available in locations nearer marketing areas, it is not anticipated that industries requiring large volumes of water for processes will locate in the Las Vegas area. A notable exception to this statement appears to be the use of this water as a cooling water for power generation. Further, the predicted population growth in the area will occur only if required electric power needs can be met. Should the Arrow Canyon site be confirmed to be environmentally acceptable, the market for any power generated there already exists. Also, the transmission line corridor for export power is nearby.

24.22 IN-VALLEY POWER PLANTS—The Nevada Power Company (NPC) presently uses sewage effluent water for cooling purposes as do several other users in similar arid regions. The Clark Station, built in 1957, generates 194 megawatts (MW) and uses approximately 3 million gallons per day (mgd); the Sunrise Station, built in 1964, generates 85 MW and uses approximately 1 mgd.

For establishment of water budgets described in Chapter 21, the useful life of these plants would terminate between year 1990 and 2000.

24.23 ARROW CANYON PLANT

24.231 *Power and Water Needs.* To meet present loads, NPC has, in addition to its 100 MW commitment from Hoover Dam, several purchase agreements with other agencies to augment its 544-MW generating capacity. In a report dated July 21, 1971, NPC projects that if new construction of generating plants follows the schedule outlined, the proposed Arrow Canyon 2,000 MW plant output would be fully used within the Las Vegas Valley by 1994. Variations in such a plan can be expected and would accelerate or delay such full usage accordingly.

It follows that during periods until 1994, some export of power, with provisions for recapture, would take place to achieve greatest plant benefits. Cooling water requirements for 2,000 MW are about 32,200 acre-feet (AF) per year (28.8 mgd) with an 85 percent load factor.

Prior to the year 1985, the trends of population growth would have to be confirmed and technological developments in power generation examined to determine if additional generation can be effectively supported and cooled with wastewater. NPC has indicated that a second 2,000 MW generating facility may be undertaken at that time. Between construction and 1994, power generated by such a plant would be exported to users outside the Valley. For water budget purposes outlined in Chapter 21, this second 2,000 MW plant has been included to demonstrate its effect on total water availability if all other assumptions prove to be as projected. Total water allocated for power generation outside Las Vegas Valley by 1994 is 70,000 AF/yr.

24.232 *Adaptation of Dry Lake System.* In the alternates described in Chapter 22, excepting the Dry Lake Alternate, an independent system of transport water from the central collection reservoir to the Arrow Canyon site must be provided. It is assumed in this report that such construction will be by others than the District. In the case of the Dry Lake Alternate, however, the NPC has indicated an interest in sharing the cost of a joint facility, and a draft of a tentative contract has been prepared which could serve as a guideline in developing an agreement that would more nearly reflect the project envisioned, since water budgets and more detailed project costs have now been prepared.

The export system to Dry Lake must be constructed without regard to power since the system for disposal of wastewater must be in operation before the power plant can be built, and further, the export system must still dispose of water should the power plant be inoperative for an extended time. The size of the export line to the Dry Lake site will be the same with or without power, but a short transmission line with a pumping station will be required at the export line in the vicinity of Arrow Canyon to accommodate 70,000 AF/yr cooling water flow. Table A-23.11 shows the construction cost of this increment at $5.4 million to be added to the incremental cost assigned to power from the Dry Lake export scheme.

24.233 *Adaption of Other Export Systems.* Other export systems would require essentially independent construction of a system to serve cooling water for power generation, except:

1. Northerly in-valley irrigation uses could be served from a line built principally to serve power, whereas it would not be feasible to construct a line to serve irrigation of those sites alone.

2. Groundwater recharge systems may be located where joint line use would be a benefit.

These exceptions are not presently being considered further. Table A-23.10 shows the construction cost for an independent system to serve only power generation at Arrow Canyon to be about $20 million.

24.234 *Cost of Delivery.* Table A-23.17 has been prepared to indicate what the total annual cost would be to provide cooling water to a power plant built in Arrow Canyon, independent of any export schemes. This cost would average $1,750,000 per year or approximately $160 per MG. Should power and the Dry Lake export scheme be combined, the saving to the District could be significant.

24.30 SUMMARY

The utilization of treated wastewater for agricultural development does not appear to be a dependable, continuous method of wastewater disposal. All of the export plans are, however, flexible enough to permit the substitution of this usage for disposal by evaporation should agriculture prove feasible. In all probability a combination of evaporation ponds coupled with agricultural usage would prove most practical. It does not appear that substantial revenues can be generated from the sale of effluent to agricultural enterprise although there would be an economic benefit to the community.

To effectively reuse wastewater, the District should consider large non-potable water-using industries to generate revenue and reduce the quantity of water that must be evaporated. A possible user is an electrical power generation industry since additional power needs will grow with population and with consumer demands.

Two in-valley power plants owned by NPC presently use wastewater for cooling, and the trend for others to use wastewater for this purpose is growing. By 1994, NPC forecasts in-valley demands, including its nominal outlying Henderson customers, will fully utilize the output of an additional 2,000 MW plant.

Should the Dry Lake export alternate be chosen and the Arrow Canyon plant become feasible, economy to the District will come through jointly using the same facilities to export water and to provide water for power plant cooling. Economy for other alternates will not be as significant since facilities may have to be built for the entire wastewater flow, with or without power. However, with some water being diverted to power, the operating cost to dispose of the remainder will be somewhat reduced.

CHAPTER 25
ENVIRONMENTAL CONSIDERATIONS

CHAPTER 25
ENVIRONMENTAL CONSIDERATIONS

25.00 GENERAL

Underlying any discussion of environmental factors relating to sewage effluent disposition is the fact that water is a valuable resource. Resource conservation is an important concept which applies to all water resources including wastewater. Multiple use or reuse of wastewater as a principle of natural resource conservation is, in the long run, a most desirable course of action from the standpoint of environmental quality as well as community economics.

The most desirable alternate from both long-term economic and conservation perspectives would be to provide advanced treatment with the injection of wastewater into underground aquifers for reuse as potable water. This alternate cannot be recommended, however, until the necessary pilot project studies have been carried out in order to insure technical feasibility with complete safety to public health and as regards continued viability of the groundwater basin.

Multiple use of wastewater is a highly desirable environmental goal which provides economic and ecological advantages. The return of nutrients to the soil is an important ecological benefit of utilizing wastewater for irrigation purposes. Such use also means a substantial community economic benefit because the cost of advanced treatment of wastewater is not required and the amount of fresh water purchases for irrigation can be substantially reduced. There are (to some degree) offsetting impacts of salt buildup in the soil and underlying groundwater.

Important to the total effort in the formulation of plans for pollution abatement and water resource conservation is the protection of the desirable features of both the natural and man-made environment. This involves minimizing interferences (when necessary) and maximizing opportunities to enhance the environment. The following sections of this chapter deal with environmental considerations for elements of the various alternates proposed.

25.10 PIPELINES AND OPEN CONDUITS

The construction of pipelines and canals must of necessity create some disturbance of the landscape and of the normal activities of persons living or working nearby. The normal construction hazards of noise, dust, traffic interruption, safety of the public, etc., cannot be avoided, but they can be minimized by insisting on top grade construction management. In any working pipeline and pumping system there exists some hazard of rupture. The probability of such a failure can be reduced by care in design, prevention and operation.

Long pipeline carrying secondary treated effluent can have the potential of generating hydrogen sulfide from these waters. Provisions for its control by air injection and scrubbing of vented air can reduce odor to acceptable limits in residential areas.

The long-range effect of such construction can be minimized by restoring the landscape to its original contours, replanting (and irrigating when necessary) suitable ground cover to protect against erosion, establishing suitable protective barriers to safeguard the casual or curious visitor, and landscaping appurtenances which disrupt the view of the land surface.

25.20 TREATMENT PLANTS, PUMPING PLANTS, REGULATING RESERVOIRS

Assuming that these facilities are constructed in the proximity of developed areas, the same construction annoyances as those cited in the previous paragraph will occur. These annoyances must be minimized by good management of the job. Such facilities can, after construction, create problems relating to noise, odors, other forms of air pollution, visual offense, and health hazard. These are all elements that can and must be controlled through the creation of a design which minimizes or eliminates these elements of objection. A properly designed plant which is architecturally pleasing, well landscaped, properly maintained and operated can be an excellent neighbor. Adopting and enforcing stringent maintenance and operating practices is also essential to make any design, perform the intended function and to prevent it from becoming a nuisance.

25.30 DISPOSAL AREAS

The creation of disposal areas for effluent evaporation, an integral part of each of the export alternates, offers an opportunity to maximize the positive environmental factors in such areas. The proposed areas are all dry desert valleys which can benefit from the introduction of water supply.

With the exception of the Eldorado Valley disposal area, all of the other areas are remote enough that any disruption from construction activity should be minimal. Here again, good construction management should minimize dust, noise, visual offense, and unnecessary destruction of the native vegetation.

The generation of air pollution in the form of noxious odors from the evaporation ponds can be eliminated by the proper design of these ponds. By terracing the natural hillsides as they slope down to the playa, a series of shallow ponds will give a good air-water contact which will speed evaporation and prevent septic conditions. In addition, the cascading of water from one terrace to the next will tend to entrain air, further providing oxygen to the process.

The lower pond, the natural playa, will form the ultimate evaporation area where the accumulated salts will be deposited. These areas have been, during the past few millenniums, natural evaporation ponds where salts have been deposited on the impervious lake beds which prevent infiltration into the underground water basin.

In order to prevent siltation of the upper ponds, diversion channels around the terraced ponds will carry the major surface runoff flows directly into the playa, which is the natural repository for such flood carried sediments.

The construction of disposal area ponds in the Dry Lake, Jean Lake, and Eldorado Valley will obviously disrupt habits and habitats of wildlife in these specific areas. Although these ponds cover a large area, they are not significant when compared to the area of the surrounding desert. It is believed that the presence of a water source for those locations will tend to result in a proliferation rather than dimunition of animals and other forms of wildlife in the vicinity of ponds. Some of the ponds may also provide refuge for migrant waterfowl.

It is anticipated that the ponds with the better quality secondary wastewater could be planted with appropriate species of fish which will assist in preventing the areas from being a breeding spot for insects, especially mosquitos.

All proposed ponding areas lie adjacent to arterial highways leading into the Las Vegas Valley. It is not anticipated that either odors or water vapor from these ponds will create an unpleasant or hazardous condition for the motorist. On the contrary, the appearance of water and vegetation will lend variety to the landscape. If desired, it should be a simple matter to create and maintain clumps of shrubbery and groves of trees to further enhance the view and to screen any appurtenant structures, maintenance yards, or other activities.

25.40 LAS VEGAS WASH

The ecological system in Las Vegas Wash, as it has evolved over the past thirty to forty years, is unique in the Las Vegas area. Any change in current water conditions will have a significant environmental impact. A study of the impact on the ecology of the wash under alternative water quality management actions is currently being made by staff members of the University of Nevada, Las Vegas. This study is scheduled for completion in December 1972.

The mechanics are available to provide a wide range of alternatives in the environment of the Wash downstream from existing treatment plant discharges. It is certainly possible to permit quantities of treated effluent to continue to discharge into the Wash, where it can maintain present growth and ultimately mix with the groundwaters now surfacing in the Wash. This mixed flow can be recaptured at some appropriate point and pumped to the central collection reservoir for the export system. Since this mixed flow will undoubtedly be

of poor quality as regards total dissolved solids, it can be segregated and transmitted by the slug-flow method directly to the playa in the evaporation pond area. This method provides one way of preventing the highly saline groundwater flows from reaching Lake Mead. Utilizing this method (within the bounds of economic reality) it should be possible to maintain any desired environment in Las Vegas Wash.

25.50 SUMMARY

Any one of the alternatives evaluated in this report will produce short-term adverse environmental impact during the construction of the project. Good construction management techniques and methods will minimize these adverse elements.

In the future, the operating plants and reservoirs required can be environmental assets and good neighbors if they are properly designed, operated and maintained. Certain elements of the export systems, such as the evaporation pond areas can be designed, constructed, and managed in a manner to considerably enhance the environment for natural plant and animal life, and to provide man with new recreational and commercial opportunity.

The environment of Las Vegas Wash can (within the framework of economic reality) be maintained in any condition desired. At the same time the export alternates can provide the mechanics necessary to capture and dispose of the highly saline groundwaters now surfacing in Las Vegas Wash.

CHAPTER 26

ANALYSIS OF SELECTED ALTERNATE PLANS

CHAPTER 26
ANALYSIS OF SELECTED ALTERNATIVE PLANS

26.00 GENERAL

In Chapter 23, the number of pollution abatement plans considered was reduced to two: Export to Dry Lake, and Export to Eldorado Valley. For the selected plans, this chapter will consider interim and long-range suitability, technological feasibility, economic relationships, environmental compatibility and local economic impact of four power plants located at Arrow Canyon.

26.10 INTERIM SUITABILITY

Primary consideration was given in Chapter 23 to unit cost comparisons between the plans. The selected alternates had the lowest overall cost, both in discounted value and in the cost per million gallons to treat and dispose of wastewater. Also, some of the capital expenditure and increased O.M.&R. costs appear in these selected plans only after year 1989 (for 1,000,000 population) or after year 2000 (for 800,000 population), at which time it becomes necessary to add a treatment plant giving complete treatment to a portion of the wastewater to supplement the potable water supply. Therefore, on an interim basis, export to Dry Lake or to Eldorado Valley are the lowest cost solutions.

In the Phase II study report, costs were developed for potable water taken from Lake Mead, treated, and pumped to the Las Vegas Valley water supply systems. (See Chapter 16.205 in the Phase II Report.) These costs were on the order of $18 to $45 per million gallons. Since neither of the treatment and disposal systems studied in this chapter provides facilities to obtain potable water or wastewater acceptable as credit to secure rights for additional potable water from the Colorado River, the lowest cost scheme is suggested. Because potable water can be obtained from the Lake Mead supply, the best interim alternate for wastewater disposal is by evaporation in a location least harmful to the environment.

The use of a portion of this sewage effluent for irrigation is a benefit both as an interim operation and as a long-range operation. By using secondary effluent instead of potable water for irrigation, both the problems of wastewater disposal and potable water supply have been lessened.

26.20 LONG-RANGE SUITABILITY

In the long-range view, disposal of wastewater by evaporation is less suitable. Eventually the potable water demand in Las Vegas will exceed the available supplies. As estimated in the water supply and wastewater budgets presented in Chapter 21, the available

potable water supplies for the Las Vegas area will be used by year 1990 for 1,000,000 population and by year 1999 for 800,000 population. Beyond this time, wastewater must be recycled for potable use. Until then, the use of wastewater evaporation for disposal will comply with adopted water quality regulations. Further developments in technology will probably continue and likely make recycling of wastewater much simpler and more economical in the future than at present.

Although the construction of export lines for the immediate solution to the pollution abatement problem is suggested as an "interim" solution, this solution is flexible and incorporates many elements useful to the long-range solution. Some of these elements may be listed as follows:

1. The export solution "buys time" at a relatively low cost against expensive and technologically questionable plans for complete treatment and recycling of wastewater.

2. The export solution permits time for a thorough appraisal of the practicability of the groundwater recharge alternate.

3. Some elements of the export system will be useful in conveying water to proper locations and elevations should a recharge program prove feasible.

4. The export system to Dry Lake could provide delivery at a point convenient to the proposed Arrow Canyon power plant site.

5. The export systems to both Dry Lake and Eldorado Valley can deliver treated wastewater at a point convenient for agricultural development in these areas.

6. The export systems can be adapted to convey (through the slug flow concept) water of differing qualities to the disposal areas. This properly would permit the transmission of higher quality waters for irrigation, cooling water, or other beneficial uses through the same pipeline as waters of much poorer quality such as power plant blow-down, industrial wastes, or the highly mineralized waters now surfacing in Las Vegas Wash.

7. The export system can be adapted to provide a means of maintaining the present ecology of Las Vegas Wash as described in Chapter 25.

8. When the time arrives that it is necessary to completely recycle all available waste discharges, it will be necessary to provide a brine line for wastes, which approximates 20 percent of the total volume treated (unless there is a radical change in technology). An export pipeline can serve this function far into the future.

26.30 TECHNOLOGICAL FEASIBILITY

From a technical point of view there are less unknowns in the export alternates than in the other plans, particularly the complete treatment and groundwater recharge plans. The export alternates depend mainly on pumping stations and pipelines (at least until 1990), and successful performance, capital costs, and operation on prototype systems have been proven many times.

There are, of course, many critical design problems which must be given careful consideration. Some of these include: (1) careful selection of pipeline and pumping station materials to handle the various grades of water to be pumped, (2) surge control in the system, (3) provisions to protect against power interruption, and (4) noise and odor control, as well as other environmental considerations.

Generally, with increased pollutant removal requirement, the processes involved become increasingly sophisticated and more elaborate; therefore, less experience is available. Presently there are no desalinization plants operating of the type and size needed for handling the quantities of wastewater generated by the Las Vegas Valley. Similarly, present day technology is limited in its application to groundwater recharge. To determine the actual effectiveness and feasibility of groundwater recharge, a thorough investigation of the local geology and other controlling parameters will be needed.

From a technological standpoint, then, one of the export plans would provide a satisfactory interim wastewater disposal solution until such time as better systems for complete treatment and groundwater recharge become available. Though this choice encompasses the "state of the art" today, it should be reviewed at intervals of five years or less to determine if better technical solutions to wastewater disposal can be achieved.

26.40 ECONOMIC RELATIONSHIPS

Economic considerations in the choice of a wastewater treatment and disposal plan may be roughly classified into cost and return aspects. It is essential to have reliable estimates of all costs expected to be incurred, and costs to be borne by each party for cases of cost-sharing. On the return side, rational decision-making also calls for information on total benefits and, for joint beneficiaries, the value received by each party.

In the case of a single party and identical expected benefits from each plan, the choice criterion is minimum cost. This is a special case seldom encountered. It is more usual to be faced with different benefits for different plans and multi-parties sharing costs and benefits. In the common case, minimum cost is only one criterion for choosing the final plan. Interest must also be focused on total benefits, the distribution of benefits among beneficiaries, and an equitable sharing of costs for each possible plan. The present study was not of sufficient scope to cover all economic aspects, but some considerations can be discussed.

Gains from wastewater treatment and disposal facilities, with or without power included, could accrue to agricultural irrigators through profits on farming operations; to the local public through satisfaction from irrigation of public and private areas, sewerage service, and protection of environmental values of surface waters; and to downstream water users through environmental values of cleaner water and returns from other uses of water; and to the power company if the plan includes purchase of wastewater for power generation.

It is likely, for the near term, that economic benefits are greater if water is used for power production regardless of the plan chosen. This appears to be the case for the short term because, in the immediate future, the use of wastewater for power does not conflict with use for other beneficial purposes. However, this conclusion may not be warranted for the long run because of lack of knowledge of possible future beneficial uses. Therefore, generally it appears that for either the Dry Lake Export or the Eldorado Valley Export plan, total benefits will be higher with water used for power than if not. A risk in a long-term commitment of water for power uses is the possibility of emergence of a more valuable use before the end of the commitment.

Total costs of Dry Lake Export and Eldorado Valley Export are nearly equal and do not provide a good economic criterion for choosing between the two plans. If the wastewater is to be sold for power generation and this use is to substitute for other treatment and disposal means, total costs are lower for the Dry Lake Export plan than the Eldorado Valley plan.

An equitable distribution of costs depends on the distribution of benefits of the plan. As indicated above, neither the total benefits nor their distribution among affected parties were estimated in this study.

26.50 LOCAL ECONOMIC IMPACT OF POWER PLANT CONSTRUCTION

The District may wish to give weight to the local growth effect if a power plant is constructed in Clark County. The value of economic growth is not easily measurable and, to some persons, is a mixed benefit. While its net effects on society's well-being may be debatable, economic growth is a much sought-after goal by most national, regional and local policy-makers. An analysis of the economic impact is given in Appendix E.

If very much importance is attached to local economic impacts resulting from construction of the power plant, the scale will be weighted in favor of the plan which includes sale of wastewater for power generation. That is, the economic effects of the plant will likely be of substantial benefit.

Tax, employment and income effects were estimated for a 2,000 megawatt plant. If additional power generation facilities are added after 1981, as assumed in the water budgets in Chapter 21, economic impacts would be correspondingly greater at the time of additions. Data were supplied by the Nevada Power Company and obtained from other sources. The effects for Clark County only are estimated as shown below.

1. Tax Effects

   a. Sales Tax

      $4.9 million tax revenue on construction materials (1974-1980)

      $0.4 million tax revenue annually on coal and operating materials (1980 and after)

      Other indirect effects not estimated

   b. Property Tax

      $6.8 to $8.4 million maximum in 1980, $2.6 to $3.4 million in year 2000 (for 2,000 MW only) Other indirect effects not estimated

   c. Increased Government Services Required

      Not estimated

2. Employment Effects

   a. Construction Period

      500 to 1,300 employees per year (1974-1981)

   b. Operating Period

      200 employees per year (1980 and after)

   c. Other Indirect Effects

      Not estimated

3. Income Effects

   a. Construction Period

      $147.8 million payroll total (1974-1981)

      $4.5 to $6.0 million materials (1974-1981)

   b. Operating Period

      $2.3 million annual payroll (1980 and after)

      $0.6 million materials annual

   c. Other, Indirect

      Not estimated

26.60 ENVIRONMENTAL COMPATIBILITY

As outlined in Chapter 25, the environmental impact of both the Dry Lake and Eldorado Valley export alternates can be favorable to the Las Vegas community:

1. Both plans create similar disturbances and inconveniences during construction.

2. Both plans will have essentially the same in-valley operating characteristics.

3. Both plans can be adapted to provide for the maintenance of the existing ecology in Las Vegas Wash.

4. Both plans will provide for good quality secondary treated wastewater ponds which might be adapted to fish culture, water fowl, and support of other wildlife.

5. Both plans provide opportunity for irrigated agriculture to develop. For this purpose the soils of Eldorado Valley are judged to be superior to those of Dry Lake.

6. Both plans can be adapted to supply cooling water to the Arrow Canyon power plant. In this connection the Dry Lake plan is judged superior, both from the standpoint of environmental impact and economic effects.

7. Both plans offer the hazards of mosquito breeding and odor generation as outlined in Chapter 25. Dry Lake appears to be a superior site in this regard because of its remote location fromresidential areas.

8. Both plans impinge upon highway and railway transportation in the area and both offer the opportunity, through landscaping, to improve visually the approaches to the Las Vegas Valley.

In evaluating the items noted above, it appears that the Dry Lake Export plan—all things considered—is likely to have more positive effects and fewer negative effects on the overall environment of the Las Vegas metropolitan area.

26.70 SUMMARY

The alternates selected as most favorable—export to Dry Lake and export to Eldorado Valley—are judged to be most suitable of the plans considered for an interim (20-30 year) solution to the pollution abatement problem.

In the longer range, beyond the 20-30 year period, exportation to evaporation is less suitable. Sometime between 1990 and 2000, the water supply requirement will probably force curtailment of export and the reclamation of water for potable use.

In the meantime, however, the export alternates are the most dependable from the standpoint of technological feasibility of construction and operation. These systems also provide major flexibility and opportunity for the development of a groundwater recharge program, for effluent use in irrigated agriculture, and for complete treatment at a later date.

If the Dry Lake plan with power is utilized, financial return from the use of effluent (for power plant cooling water) can be realized. This return can come both from the sale of cooling water to the power company, and from the economic impact accompanying the construction and operation of a major power generating facility.

The construction and operation of the export systems outlined are judged to be reasonably compatible with the environment of the Las Vegas area. Any new facility necessarily results in environmental changes. The environmental enhancement which can occur from the establishment of a water supported area in an otherwise dry valley must be weighed against detrimental effects.

The consideration of all factors outlined above indicates that the Dry Lake export alternate is the most favorable plan evaluated.

CHAPTER 27
DESIGN CRITERIA

CHAPTER 27
DESIGN CRITERIA

27.00 GENERAL

The basic objective of each of the alternates outlined in this report is to provide an interim or immediate element which solves the pollution abatement problem coupled with other elements to meet the long-range objectives of water resource management.

As such, many of the alternates have elements in common. (Which common elements remain essentially the same regardless of which alternate is selected.)

The purpose of this chapter is to summarize the more pertinent design criteria for the most likely contending alternates as well as to delineate design features of elements common to these most likely contenders.

27.10 COMPLETE TREATMENT ALTERNATE

The following Table 27.1 indicates basic design criteria for the unique elements of the complete treatment alternate.

TABLE 27.1

DESIGN CRITERIA UNIQUE TO THE COMPLETE TREATMENT ALTERNATE

ITEM				DESIGN CRITERIA/PARAMETER 1,000,000 POPULATION with Power	1,000,000 POPULATION without Power	800,000 POPULATION with Power	800,000 POPULATION without Power
TERTIARY TREATMENT PLANT – I							
PHOS. REM.		CAP'Y	MGD	60	60	60	60
FILTRATION		CAP'Y	MGD	60	60	60	60
CARBON ADS.		CAP'Y	MGD	60	60	60	60
CHLORINATION		CAP'Y	MGD	60	60	60	60
TERTIARY TREATMENT PLANT – P							
PHOS. REM.	ADD'N	CAP'Y	MGD	NONE	60	NONE	35
FILTRATION	ADD'N	CAP'Y	MGD	NONE	60	NONE	35
DESALT PLANT – I		CAP'Y	MGD	60	60	60	60
DESALT PLANT – P	ADD'N	CAP'Y	MGD	NONE	60	NONE	35
BRINE EXPORT SYSTEM		CAP'Y	AF/YR	30,000	40,000	20,000	30,000
REGULATING RESERVOIR		CAP'Y	AF	54	54	54	54

NOTES: 1. I = initial construction, P = phased construction
2. See Tables 27.6 and 27.7 for collection system and In-Valley irrigation systems which are common to all alternatives.

27.20 COLORADO RIVER RETURN ALTERNATE

The following Table 27.2 indicates basic design criteria for the unique elements of the Colorado River return alternate.

TABLE 27.2

DESIGN CRITERIA UNIQUE TO THE COLORADO RIVER RETURN ALTERNATE

ITEM				DESIGN CRITERIA/PARAMETER			
				1,000,000 POPULATION		800,000 POPULATION	
				with Power	without Power	with Power	without Power
TERT. TRM'T – I		CAP'Y	MGD	60	90	50	75
TERT. TRM'T – P	ADD'N	CAP'Y	MGD	15	45	NONE	30
REG. RESERVOIR		CAP'Y	AF	35	54	21	44
OUTFALL SYSTEM		CAP'Y	MGD	135	135	135	135

NOTES: 1. I = initial construction, P = phased construction
2. See Tables 27.6 and 27.7 for collection system and In-Valley irrigation systems which are common to all alternates.

27.30 DRY LAKE EXPORT

The following Table 27.3 indicates basic design criteria for the unique elements of the Dry Lake export alternate.

TABLE 27.3

DESIGN CRITERIA UNIQUE TO THE DRY LAKE EXPORT ALTERNATES

ITEM	DESIGN CRITERIA/PARAMETER 1,000,000 POPULATION with Power	1,000,000 POPULATION without Power	800,000 POPULATION with Power	800,000 POPULATION without Power
EXPORT PIPELINE				
DESIGN FLOW MGD	92.5	92.5	100	100
PEAKING FACTOR %	120	120	120	120
PEAK FLOW MGD	111	111	120	120
REG. RESERVOIR NO. 1 CAP'Y AF	42	42	46	46
REG. RESERVOIR NO. 2 CAP'Y AF	21	21	23	23
PUMPING STATION NO. 1				
TOT. DYN. HEAD FT.	564	564	577	577
HORSEPOWER	13,800	13,800	15,250	15,250
PUMPING STATION NO. 2				
TOT. DYN. HEAD	510	510	515	515
HORSEPOWER	12,500	12,500	13,600	13,600
DISPOSAL SYSTEM – I CAP'Y AF/YR	55,000	55,000	51,700	55,000
DISPOSAL SYSTEM – P ADD'N CAP'Y AF/YR	4,200	48,600	NONE	56,300
DESALTING SYSTEM CAP'Y MGD	70	95	NONE	NONE

NOTES: 1. I = initial construction, P = phased construction

2. See Tables 27.6 and 27.7 for collection system and In-Valley irrigation systems which are common to all alternates.

27.40 ELDORADO VALLEY EXPORT

The following Table 27.4 indicates basic design criteria for the unique elements of the Eldorado Valley export alternate.

TABLE 27.4

DESIGN CRITERIA UNIQUE TO THE ELDORADO VALLEY EXPORT ALTERNATE

ITEM	DESIGN CRITERIA/PARAMETER 1,000,000 POPULATION with Power	1,000,000 POPULATION without Power	800,000 POPULATION with Power	800,000 POPULATION without Power
EXPORT PIPELINE				
DESIGN FLOW MGD	53	92.5	46.6	100
PEAKING FACTOR %	120	120	120	120
PEAK FLOW MGD	64	111	56	120
REGULATING RESERVOIR CAP'Y AF	24	42	22	46
TERMINAL RESERVOIR CAP'Y AF	24	42	22	46
PUMPING STATION NO. 1				
TOT. DYN. HEAD FT.	980	885	1060	899
HORSEPOWER	13,800	21,600	12,950	23,700
DISPOSAL SYSTEM – I CAP'Y AF/YR	55,000	55,000	51,700	55,000
DISPOSAL SYSTEM – P – CAP'Y AF/YR	4,300	48,600	NONE	56,300
DESALTING SYSTEM CAP'Y MGD	70	95	NONE	NONE

NOTES: 1. I = initial construction, P = phased construction
2. See Tables 27.6 and 27.7 for collection system and In-Valley irrigation systems which are common to all alternates.

27.50 JEAN LAKE EXPORT

The following Table 27.5 indicates basic design criteria for the unique elements of the Jean Lake export alternate.

TABLE 27.5

DESIGN CRITERIA UNIQUE TO THE JEAN LAKE EXPORT ALTERNATE

ITEM	DESIGN CRITERIA/PARAMETER 1,000,000 POPULATION with Power	1,000,000 POPULATION without Power	800,000 POPULATION with Power	800,000 POPULATION without Power
EXPORT PIPELINE				
DESIGN FLOW MGD	53	92.5	46.6	100
PEAKING FACTOR %	120	120	120	120
PEAK FLOW MGD	64	111	56	120
REGULATORY RESERVOIR CAP'Y AF	24	42	22	46
FOREBAY RESERVOIR @ PS-1 CAP'Y AF	12	21	11	23
FOREBAY RESERVOIR @ PS-2 CAP'Y AF	6	105	5.5	11.5
TOT. DYN. HEAD FT	677	590	749	600
HORSEPOWER	9600	14,500	9150	15,800
PUMPING STATION NO. 2				
TOT. DYN. HEAD FT	682	595	754	605
HORSEPOWER	9600	14,600	9200	16,000
PUMPING STATION NO. 3				
TOT. DYN. HEAD FT	607	542	662	549
HORSEPOWER	8600	13,300	8100	14,500
DISPOSAL SYSTEM – I CAP'Y AF/YR	55,000	55,000	51,700	55,000
DISPOSAL SYSTEM – P CAP'Y AF/YR	4300	58,600	NONE	56,300
DESALTING SYSTEM CAP'Y MGD	70	95	NONE	NONE

NOTES: 1. I = initial construction, P = phased construction

2. See Tables 27.6 and 27.7 for collection systems and In-Valley irrigation systems which are common to all alternates.

27.60 IN-VALLEY IRRIGATION SYSTEM AND COLLECTION SYSTEM.

The following Tables 27.6 and 27.7 indicate basic design criteria for the elements which are common to all alternatives regardless of population or power alternatives.

TABLE 27.6

DESIGN CRITERIA FOR THE IN-VALLEY IRRIGATION SYSTEM

ITEM	DESIGN PARAMETER
ANNUAL WATER DEMAND	5 AF/A/YR
SYSTEM DELIVERY CAPABILITY	
AFTER 1975 CONSTRUCTION	12,500 AF/YR
AFTER 1985 CONSTRUCTION	25,000 AF/YR
AVERAGE PUMPING HEAD	670 FT
AVERAGE POWER COST	$1.42 per AF/100 FT. OF LIFT

TABLE 27.7

DESIGN CRITERIA FOR COLLECTION SYSTEM

ITEM	DESIGN PARAMETER
BMI COLLECTION LINE	15 MGD
BMI–HENDERSON COLLECTION LINE	20 MGD
DESIGN FLOW FROM OTHER STP'S	176 MGD
HENDERSON PUMPING STATION	
FLOW	5 MGD
HEAD	120 FT
HORSEPOWER	150 HP.

APPENDIX A

APPENDIX A

Introduction to Appendix A Cost Tables

TABLE	
A-21.1	Water Budget - 1,000,000 Population @ year 2000
A-21.2	Water Budget - 800,000 Population at year 2000
A-21.3 - A-21.13	Waste Water Budgets
A-22.1 (2 sheets)	Waste Water Disposition
A-23.1 (2 sheets)	Cost Estimate - Export to Dry Lake - Export System
A-23.2 (4 sheets)	Cost Estimate - Export to Dry Lake - Disposal System and Desalting System
A-23.3	Cost Estimate - Export to Dry Lake - In-Valley Irrigation System
A-23.4 (4 sheets)	Cost Estimate - Export to Eldorado Valley - Export System
A-23.5 (4 sheets)	Cost Estimate - Export to Eldorado Valley - Disposal System and Desalting System
A-23.6	Cost Estimate - Export to Eldorado Valley - In-Valley Irrigation System
A-23.7 (4 sheets)	Cost Estimate - Export to Jean Lake - Export System
A-23.8 (4 sheets)	Cost Estimate - Export to Jean Lake - Disposal System and Desalting System
A-23.9	Cost Estimate - Export to Jean Lake - In-Valley Irrigation System
A-23.10	Cost Estimate - Delivery System for Arrow Canyon Power Plant - All Except Dry Lake
A-23.11	Cost Estimate - Delivery System for Arrow Canyon Power Plant - Dry Lake Only
A-23.12	Cost Estimate - Complete Treatment
A-23.13	Cost Estimate - Colorado River Return
A-23.14 (8 sheets)	Cost Schedules for Alternative Plant
A-23.15 (20 sheets)	Detail of Capital Expenditures
A-23.16 (2 sheets)	Unit Costs for Alternative Plans
A-23.17	Estimate of Annual Costs for Power Only

the cost of Stage 2 Disposal System facilities ($4,068,000) needed by 1977 (Table A-23.2, sheet 1 of 4).

3. No construction is contemplated for 1977 and 1978. In 1979, the Stage 3 construction of the Dry Lake Disposal System would be constructed to ready it for operation in 1980. This cost ($3,719,000) comes from Table A-23.2, sheet 1 of 4.

4. No construction is contemplated for the years 1980 through 1982. In 1983, the capital cost of $427,000 is anticipated as half the total cost ($854,000) of adding additional pumping capacity to the Export System by 1985 (Table A-23.1, sheet 1 of 2). In 1984, the other half of this cost ($429,000) would be incurred, together with $2,718,000 for Stage 4 additions to the Disposal System at Dry Lake (Table A-23.2, sheet 1 of 4), and $3,477,000 for the Phase 2 additions to the In-Valley Irrigation System scheduled to go into operation in 1985 (Table A-23.3, sheet 1 of 1).

5. In 1985 through 1988 no construction is contemplated. In 1989, $1,104,000 (Table A-23.2, sheet 1 of 4) would be expended for Stage (Ult.) additions to the Dry Lake Disposal System, and $32,509,000 for half the cost ($65,018,000 to SNWP) of constructing a desalting system (Table A-23.2, sheet 2 of 4) needed to provide additional potable water to the Las Vegas area by 1991. In 1990, the other half of the cost ($32,509,000) of the desalting system would be incurred.

6. The O, M and R (operation, Maintenance, and Repair) costs begin in 1975, when the initial construction has been completed and the facilities go into operation. Generally, operation and maintenance costs are a function of the size and complexity of the facility; the estimated number of personnel required to operate it; and the power (and chemicals) that are needed, power and chemicals being a function of the quantity of wastewater handled. Repair costs, for purposes of cost estimating, are a function of the capital cost of the facility, being annually some percentage of the initial capital cost. Note that the O, M and R costs gradually increase from year 1975 to 1990. This reflects the gradually increasing quantities of wastewater handled during this time period by the In-Valley Irrigation, Export, and Disposal Systems. In 1991, a sudden increase in the total O, M and R costs occurs when the desalting system goes into operation. Beyond 1991, the O, M and R costs gradually increase to year 2000, reflecting again the increasing quantities of wastewater handled by the combined facilities.

Table A-23.15 (20 sheets) shows the details of the Capital Expenditures for each Alternate as described above. Each Capital Expenditure is listed in the year incurred (and indicates the year such construction goes into operation). These are all referenced to the table containing the original calculations. The total of each sheet is the same total (for the same Alternate) of the Capital column in Table A-23.14.

Table A-23.16 then summarizes the estimated cost of alternate plans at five-year intervals. Figures in the column "O, M and R" come directly from Table A-23.14. The "Debt Service" figures were calculated as explained in Chapter 23, based on the capital costs given in Table A-23.14. Flow, given in Table A-23.16 as both million gallons per year as well as acre-feet per year, represents the total flow handled by the combined facilities used for the alternate plan. Under the Dry Lake Export Alternate, 1,000,000 population without power, for instance, in 1980 the total wastewater flow is 27,677,000,000 gallons per year (=75.83 MGD - 84,900 AF/year). This comes from Table A-22.1, sheet 1 of 2, where it can be seen that the combined total 1980 wastewater disposition for In-Valley Irrigation (16,950 AF/year) and Export (67,950 AF/year) is 84,900 AF/year. As another example under the Dry Lake Export Alternate, in 1995, Table A-22.1, sheet 1 of 2 shows that the combined wastewater disposition of In-Valley Irrigation (24,500 AF/year), Desalting (30,000 AF/year), and Export for power and/or disposal (97,090 AF/year) is 151,590 AF/year (=135 MGD = 49,418,000,000 gallons per year, as shown in Table A-23.16.)

It is emphasized that the unit cost figures given in Table A-23.16 in terms of $/AF and $/MG represent the overall cost of disposing of wastewater by the combined facilities of a particular alternate plan, these facilities including In-Valley Irrigation, Export, and Desalting to supplement the potable water supply. The unit cost of disposing of a portion of the total wastewater through only one facility, such as Desalting or In-Valley Irrigation, could be more or less than the overall unit cost of disposing of all of the wastewater through the combined facilities. The large increase in the complete treatment alternate in 1980 is because of the requirement for desalt to meet the 1980 standards.

TABLE A-21.1
LAS VEGAS REGIONAL WATER BUDGET
1,000,000 PEOPLE IN THE YEAR 2000
(Including Boulder City)
1000's Acre-Feet Per Year

R	1970				1980				1990				2000				2010				2020			
JLATION	271,800				500,000				770,000				1,000,000				1,175,000				1,300,000			
ER USE CATEGORY	DEMAND AC. FT.	SUPPLY 1	SUPPLY 2	SUPPLY 3	DEMAND AC. FT.	SUPPLY 1	SUPPLY 2	SUPPLY 3	DEMAND AC. FT.	SUPPLY 1	SUPPLY 2	SUPPLY 3	DEMAND AC. FT.	SUPPLY 1	SUPPLY 2	SUPPLY 3	DEMAND AC. FT.	SUPPLY 1	SUPPLY 2	SUPPLY 3	DEMAND AC. FT.	SUPPLY 1	SUPPLY 2	SUPPLY 3
sidential & Transient	82.35	62.30	20.05	0	155.29	36.80	118.49	0	245.12	38.99	206.13	0	326.30	52.53	212.97	60.80	392.98	69.58	239.30	84.10	445.66	107.91	234.75	103.00
rks & Public Facilities	5.78	5.05	0.73	0	10.50	3.40	4.10	3.00	16.17	2.15	7.52	6.50	21.00	2.60	10.00	8.40	24.68	11.76	3.20	9.72	27.30	12.90	4.00	10.40
lf Courses	6.84	5.21	0.20	1.43	13.00	2.10	5.50	5.40	20.02	1.36	11.66	7.00	26.00	2.37	11.33	12.30	30.55	15.85	0	14.70	33.80	17.40	0	16.40
riculture	8.80	3.88	0	4.92	9.00	2.00	2.75	4.25	9.00	1.50	1.97	5.53	9.00	5.00	0	4.00	9.00	5.00	0	4.00	9.00	5.00	0	4.00
dustrial Incl. BMI	16.90	2.05	14.75	0.10	20.00	2.00	12.60	5.40	25.00	2.50	11.20	11.30	30.00	3.00	10.70	16.30	30.00	3.00	10.50	16.50	30.00	3.00	10.50	16.50
wer*	3.20	0	0	3.20	31.68	0	0	31.68	48.80	0	0	48.80	70.00	0	0	70.00	70.00	0	0	70.00	70.00	0	0	70.00
ght Industrial & Commercial	6.06	4.61	1.45	0	11.28	3.20	8.08	0	17.80	2.50	15.30	0	23.69	5.69	18.00	0	28.53	3.53	25.00	0	32.36	3.61	28.75	0
litary	2.45	2.45	0	0	3.50	0.50	2.50	0.50	4.50	1.00	3.00	0.50	4.50	1.00	3.00	0.50	4.50	1.00	3.00	0.50	4.50	1.00	3.00	0.50
tal Water Use	132.38	85.55	37.18	9.65	254.25	50.00	154.02	50.23	386.41	50.00	256.78	79.63	510.49	72.19	266.00	172.30	590.24	109.72	281.00	199.52	652.62	150.82	281.00	220.80
pply Available	-	50.00	299.00	56.16	-	50.00	260.00	95.28	-	50.00	258.00	144.24	-	50.00	266.00	187.54	-	50.00	281.00	220.55	-	50.00	281.00	246.61
cess (+) or Deficiency (-)	-	- 35.55	+ 261.82	+ 46.51	-	0	+ 105.98	+ 45.05	-	0	+ 1.22	+ 64.61	-	- 22.19	0	+ 15.24	-	- 59.72	0	+ 21.03	-	- 100.82	0	+ 25.81

SUPPLIES

(1) Groundwater
(2) Colorado River Water
(3) Reclaimed Water

(1) Assumes water used at quantities used in 1970 and increased 2 1/2 percent every 10 years.
(2) Assumes wastewater generated at rate of generation in 1970 and increased 2 1/2 percent every 10 years.
(3) Water distributed to wells based on requirement for peaking and availability up to 50,000 AF/yr. When resources of Colorado River and wastewater (except 25% brine from desalt) are reached, additional supply obtained from groundwater drafts in excess of 50,000 AF/yr.
(4) Water demand for power includes needs for existing plants as well as future plants.

TABLE A-21.2

LAS VEGAS REGIONAL WATER BUDGET

800,000 PEOPLE IN THE YEAR 2000

(Including Boulder City)

1000's Acre-Feet per year

YEAR	1970				1980				1990				2000				2010				2020			
POPULATION	271,800				467,000				652,000				800,000				907,000				960,000			
WATER USE CATEGORY	DEMAND AC. FT.	SUPPLY 1	SUPPLY 2	SUPPLY 3	DEMAND AC. FT.	SUPPLY 1	SUPPLY 2	SUPPLY 3	DEMAND AC. FT.	SUPPLY 1	SUPPLY 2	SUPPLY 3	DEMAND AC. FT.	SUPPLY 1	SUPPLY 2	SUPPLY 3	DEMAND AC. FT.	SUPPLY 1	SUPPLY 2	SUPPLY 3	DEMAND AC. FT.	SUPPLY 1	SUPPLY 2	SUPPLY 3
Residential & Transient	82.35	62.30	20.05	0	145.04	37.50	107.54	0	207.56	38.50	169.06	0	261.04	38.60	218.85	3.59	303.35	22.08	246.18	35.09	329.10	27.90	244.30	56.90
Parks & Public Facilities	5.78	5.05	0.73	0	9.81	3.40	3.41	3.00	13.69	3.20	3.99	6.50	16.80	3.00	5.40	8.40	19.05	7.28	2.05	9.72	20.18	7.78	2.00	10.40
Golf Courses	6.84	5.21	0.20	1.43	12.14	2.10	4.64	5.40	16.95	1.40	8.55	7.00	20.80	1.40	7.10	12.30	23.58	8.88	0	14.70	24.99	8.59	0	16.40
Agriculture	8.80	3.88	0	4.92	9.00	2.00	2.75	4.25	9.00	1.50	1.97	5.53	9.00	1.00	4.00	4.00	9.00	5.00	0	4.00	9.00	5.00	0	4.00
Industrial incl. BMI	16.90	2.05	14.75	0.10	20.00	2.00	12.60	5.40	25.00	2.20	11.50	11.30	30.00	2.50	11.20	16.30	30.00	3.00	10.50	16.50	30.00	3.00	10.50	16.50
Power*	3.20	0	0	3.20	31.68	0	0	31.68	48.80	0	0	48.80	70.00	0	0	70.00	70.00	0	0	70.00	70.00	0	0	70.00
Light Industrial & Commercial	6.06	4.61	1.45	0	10.53	2.50	8.03	0	15.07	2.20	12.87	0	18.95	2.50	16.45	0	22.03	2.76	19.27	0	23.90	2.70	21.20	0
Military	2.45	2.45	0	0	3.50	0.50	2.50	0.50	4.50	1.00	3.00	0.50	4.50	1.00	3.00	0.50	4.50	1.00	3.00	0.50	4.50	1.00	3.00	0.50
Total Water Use	132.38	85.55	37.18	9.65	241.70	50.00	141.47	50.23	340.57	50.00	210.94	79.63	431.09	50.00	266.00	115.09	481.51	50.00	281.00	150.51	511.67	55.97	281.00	174.70
Supply Available	-	50.00	299.00	56.16	-	50.00	260.00	90.20	-	50.00	258.00	125.65	-	50.00	266.00	155.23	-	50.00	281.00	176.17	-	50.00	281.00	188.92
Excess (+) or Deficiency (-)	-	- 35.55	+ 261.82	+ 46.51	-	0	+ 118.53	+ 39.97	-	0	+ 47.06	+ 46.02	-	0	0	+ 40.14	-	0	0	+ 25.66	-	- 5.97	0	+ 14.22

SUPPLIES

(1) Groundwater
(2) Colorado River Water
(3) Reclaimed Water

(1) Assumes water used at quantities used in 1970 and increased 2 1/2 percent every 10 years.
(2) Assumes wastewater generated at rate of generation in 1970 and increased 2 1/2 percent every 10 years.
(3) Water distributed to wells based on requirement for peaking and availability up to 50,000 AF/yr. When resources of Colorado River and wastewater (except 25% brine from desalt) are reached, additional supply obtained from groundwater drafts in excess of 50,000 AF/yr.
(4) Water demand for power includes needs for existing plants as well as future plants.

Las Vegas Valley Water District

LAS VEGAS VALLEY WASTE WATER BUDGET FOR POPULATION CURVES

TABLE A-21.3

Population Curve: 1,000,000 Persons at year 2000
and 800,000 Persons at year 2000

YEAR	1970					
POPULATION	271,800 Persons					
WASTE WATER USE PER PRODUCTION CATEGORY	TOTAL WASTE WATER PROD.	WASTE WATER USE PRIORITY *** 1000'S ACRE FEET PER YEAR				TOTAL WASTE WATER USE
		1	2	3	4	
RESIDENTIAL & TRANSIENT	40.77	0	0	0	0	0
PUBLIC FACILITIES						
Greenbelts		0	0	0	0	0
Schools and Parks		0	0	0	0	0
GOLF COURSES		0	1.43	0	0	1.43
AGRICULTURE		0	4.92	0	0	4.92
HEAVY INDUSTRY	13.52	0	.10	0	0	.10
POWER GENERATION* In Valley	.64	3.20	0	0	0	3.20
POWER GENERATION* Arrow Cyn		0	0	0	0	0
LIGHT INDUSTRY	**	0	0	0	0	0
MILITARY	1.23	0	0	0	0	0
WASTE IRRIGATION						
In Valley		0	0	0	0	0
Export		0	0	0	0	0
RETURN TO COLORADO						
For Credit		0	0	0	0	0
For Disposal		0	0	0	46.51	46.51
TOTAL		3.20	6.45	0	46.51	
TOTAL	56.16					56.16

* Cooling tower blowdown not included for out of valley power

** Included in Residential and Transient

*** Priority 1 - Uses necessary for health and well-being of the population

Priority 2 - Uses contributing to the maintenance and growth of the area's economy

Priority 3 - Uses contributing to aesthetic development of the community above that required for health and well-being and which do not demonstrate an economic return

Priority 4 - Uses which provide only for pollution abatement, with no economic or aesthetic return

Las Vegas Valley Water District

LAS VEGAS VALLEY WASTE WATER BUDGET FOR POPULATION CURVES

TABLE A-21.4

Population Curve: 1,000,000 Persons

YEAR	1980					
POPULATION	500,000 Persons					
WASTE WATER USE PER PRODUCTION CATEGORY	TOTAL WASTE WATER PROD.	WASTE WATER USE PRIORITY *** 1000'S ACRE FEET PER YEAR				TOTAL WASTE WATER USE
		1	2	3	4	
RESIDENTIAL & TRANSIENT	76.88	0	0	0	0	0
PUBLIC FACILITIES						
Greenbelts		0	0	4.30	0	4.30
Schools and Parks		3.00	0	0	0	3.00
GOLF COURSES		0	5.40	0	0	5.40
AGRICULTURE		0	4.25	0	0	4.25
HEAVY INDUSTRY	16.00	0	5.40	0	0	5.40
POWER GENERATION* In Valley	.90	4.48	0	0	0	4.48
POWER GENERATION* Arrow Cyn		9.32	17.88	0	0	27.20
LIGHT INDUSTRY	**	0	0	0	0	0
MILITARY	1.50	0	0.50	0	0	0.50
WASTE IRRIGATION						
In Valley		0	0	0	0	0
Export		0	0	0	40.75	40.75
RETURN TO COLORADO						
For Credit		0	0	0	0	0
For Disposal		0	0	0	0	0
TOTAL		16.80	33.43	4.30	40.75	
TOTAL	95.28					95.28

* Cooling tower blowdown not included for out of valley power

** Included in Residential and Transient

*** Priority 1 - Uses necessary for health and well-being of the population

Priority 2 - Uses contributing to the maintenance and growth of the area's economy

Priority 3 - Uses contributing to aesthetic development of the community above that required for health and well-being and which do not demonstrate an economic return

Priority 4 - Uses which provide only for pollution abatement, with no economic or aesthetic return

Las Vegas Valley Water District

TABLE A-21.5

LAS VEGAS VALLEY WASTE WATER BUDGET FOR POPULATION CURVES

Population Curve: 1,000,000 Persons

YEAR	1990					
POPULATION	770,000 Persons					
WASTE WATER USE PER PRODUCTION CATEGORY	TOTAL WASTE WATER PROD.	WASTE WATER USE PRIORITY *** 1000'S ACRE FEET PER YEAR				TOTAL WASTE WATER USE
		1	2	3	4	
RESIDENTIAL & TRANSIENT	121.34	0	0	0	0	0
PUBLIC FACILITIES						
Greenbelts		0	0	5.30	0	5.30
Schools and Parks		6.50	0	0	0	6.50
GOLF COURSES		0	7.00	0	0	7.00
AGRICULTURE		0	5.53	0	0	5.53
HEAVY INDUSTRY	20.00	0	11.30	0	0	11.30
POWER GENERATION* In Valley	.90	4.50	0	0	0	4.50
POWER GENERATION* Arrow Cyn		35.40	8.90	0	0	44.30
LIGHT INDUSTRY	**	0	0	0	0	0
MILITARY	2.00	0	0.50	0	0	0.50
WASTE IRRIGATION						
In Valley		0	0	0	0	0
Export		0	0	0	59.31	59.31
RETURN TO COLORADO						
For Credit		0	0	0	0	0
For Disposal		0	0	0	0	0
TOTAL		46.40	33.23	5.30	59.31	
TOTAL	144.24					144.24

* Cooling tower blowdown not included for out of valley power

** Included in Residential and Transient

*** Priority 1 - Uses necessary for health and well-being of the population

Priority 2 - Uses contributing to the maintenance and growth of the area's economy

Priority 3 - Uses contributing to aesthetic development of the community above that required for health and well-being and which do not demonstrate an economic return

Priority 4 - Uses which provide only for pollution abatement, with no economic or aesthetic return

Las Vegas Valley Water District

TABLE A-21.6

LAS VEGAS VALLEY WASTE WATER BUDGET FOR POPULATION CURVES

Population Curve: 1,000,000 Persons

YEAR	2000					
POPULATION	1,000,000 Persons					
WASTE WATER USE PER PRODUCTION CATEGORY	TOTAL WASTE WATER PROD.	WASTE WATER USE PRIORITY *** 1000'S ACRE FEET PER YEAR				TOTAL WASTE WATER USE
		1	2	3	4	
RESIDENTIAL & TRANSIENT	161.54	60.80	0	0	0	60.80
PUBLIC FACILITIES						
Greenbelts		0	0	0	0	0
Schools and Parks		8.40	0	0	0	8.40
GOLF COURSES		0	12.30	0	0	12.30
AGRICULTURE		0	4.00	0	0	4.00
HEAVY INDUSTRY	24.00	0	16.30	0	0	16.30
POWER GENERATION* In Valley	0	0	0	0	0	0
POWER GENERATION* Arrow Cyn		70.00	0	0	0	70.00
LIGHT INDUSTRY	**	0	0	0	0	0
MILITARY	2.00	0	0.50	0	0	0.50
WASTE IRRIGATION						
In Valley		0	0	0	0	0
Export		0	0	0	15.24	15.24
RETURN TO COLORADO						
For Credit		0	0	0	0	0
For Disposal		0	0	0	0	0
TOTAL		139.20	33.10	0	15.24	
TOTAL	187.54					187.54

* Cooling tower blowdown not included for out of valley power

** Included in Residential and Transient

*** Priority 1 - Uses necessary for health and well-being of the population

Priority 2 - Uses contributing to the maintenance and growth of the area's economy

Priority 3 - Uses contributing to aesthetic development of the community above that required for health and well-being and which do not demonstrate an economic return

Priority 4 - Uses which provide only for pollution abatement, with no economic or aesthetic return

Las Vegas Valley Water District

LAS VEGAS VALLEY WASTE WATER BUDGET FOR POPULATION CURVES

TABLE A-21.7

Population Curve: 1,000,000 Persons

YEAR	2010					
POPULATION	1,175,000 Persons					
WASTE WATER USE PER PRODUCTION CATEGORY	TOTAL WASTE WATER PROD.	WASTE WATER USE PRIORITY *** 1000'S ACRE FEET PER YEAR				TOTAL WASTE WATER USE
		1	2	3	4	
RESIDENTIAL & TRANSIENT	194.55	84.10	0	0	0	84.10
PUBLIC FACILITIES						
Greenbelts		0	0	0	0	0
Schools and Parks		9.72	0	0	0	9.72
GOLF COURSES		0	14.70	0	0	14.70
AGRICULTURE		0	4.00	0	0	4.00
HEAVY INDUSTRY	24.00	0	16.50	0	0	16.50
POWER GENERATION* In Valley		0	0	0	0	0
POWER GENERATION* Arrow Cyn		70.00	0	0	0	70.00
LIGHT INDUSTRY	**	0	0	0	0	0
MILITARY	2.00	0	0.50	0	0	0.50
WASTE IRRIGATION						
In Valley		0	0	0	0	0
Export		0	0	0	21.03	21.03
RETURN TO COLORADO						
For Credit		0	0	0	0	0
For Disposal		0	0	0	0	0
TOTAL		163.82	35.70	0	21.03	
TOTAL	220.55					220.55

* Cooling tower blowdown not included for out of valley power

** Included in Residential and Transient

*** Priority 1 - Uses necessary for health and well-being of the population

Priority 2 - Uses contributing to the maintenance and growth of the area's economy

Priority 3 - Uses contributing to aesthetic development of the community above that required for health and well-being and which do not demonstrate an economic return

Priority 4 - Uses which provide only for pollution abatement, with no economic or aesthetic return

Las Vegas Valley Water District

TABLE A-21.8

LAS VEGAS VALLEY WASTE WATER BUDGET FOR POPULATION CURVES

Population Curve: 1,000,000 Persons

YEAR	2020					
POPULATION	1,300,000 Persons					
WASTE WATER USE PER PRODUCTION CATEGORY	TOTAL WASTE WATER PROD.	WASTE WATER USE PRIORITY *** 1000'S ACRE FEET PER YEAR				TOTAL WASTE WATER USE
		1	2	3	4	
RESIDENTIAL & TRANSIENT	220.61	103.00	0	0	0	103.00
PUBLIC FACILITIES						
Greenbelts		0	0	0	0	0
Schools and Parks		10.40	0	0	0	10.40
GOLF COURSES		0	16.40	0	0	16.40
AGRICULTURE		0	4.00	0	0	4.00
HEAVY INDUSTRY	24.00	0	16.50	0	0	16.50
POWER GENERATION* In Valley		0	0	0	0	0
POWER GENERATION* Arrow Cyn		70.00	0	0	0	70.00
LIGHT INDUSTRY	**	0	0	0	0	0
MILITARY	2.00	0	0.50	0	0	0.50
WASTE IRRIGATION						
In Valley		0	0	0	0	0
Export		0	0	0	25.81	25.81
RETURN TO COLORADO						
For Credit		0	0	0	0	0
For Disposal		0	0	0	0	0
TOTAL		183.40	37.40	0	25.81	
TOTAL	246.61					246.61

* Cooling tower blowdown not included for out of valley power

** Included in Residential and Transient

*** Priority 1 - Uses necessary for health and well-being of the population

Priority 2 - Uses contributing to the maintenance and growth of the area's economy

Priority 3 - Uses contributing to aesthetic development of the community above that required for health and well-being and which do not demonstrate an economic return

Priority 4 - Uses which provide only for pollution abatement, with no economic or aesthetic return

Las Vegas Valley Water District

TABLE A-21.9

LAS VEGAS VALLEY WASTE WATER BUDGET FOR POPULATION CURVES

Population Curve: 800,000 Persons

YEAR	1980					
POPULATION	467,000 Persons					
WASTE WATER USE PER PRODUCTION CATEGORY	TOTAL WASTE WATER PROD.	WASTE WATER USE PRIORITY *** 1000'S ACRE FEET PER YEAR				TOTAL WASTE WATER USE
		1	2	3	4	
RESIDENTIAL & TRANSIENT	71.80	0	0	0	0	0
PUBLIC FACILITIES						
Greenbelts		0	0	4.30	0	4.30
Schools and Parks		3.00	0	0	0	3.00
GOLF COURSES		0	5.40	0	0	5.40
AGRICULTURE		0	4.25	0	0	4.25
HEAVY INDUSTRY	16.00	0	5.40	0	0	5.40
POWER GENERATION* In Valley	.90	4.48	0	0	0	4.48
POWER GENERATION* Arrow Cyn		8.02	19.18	0	0	27.20
LIGHT INDUSTRY	**	0	0	0	0	0
MILITARY	1.50	0	0.50	0	0	0.50
WASTE IRRIGATION						
In Valley		0	0	0	0	0
Export		0	0	0	35.67	35.67
RETURN TO COLORADO						
For Credit		0	0	0	0	0
For Disposal		0	0	0	0	0
TOTAL		15.50	34.73	4.30	35.67	
TOTAL	90.20					90.20

* Cooling tower blowdown not included for out of valley power

** Included in Residential and Transient

*** Priority 1 - Uses necessary for health and well-being of the population

Priority 2 - Uses contributing to the maintenance and growth of the area's economy

Priority 3 - Uses contributing to aesthetic development of the community above that required for health and well-being and which do not demonstrate an economic return

Priority 4 - Uses which provide only for pollution abatement, with no economic or aesthetic return

Las Vegas Valley Water District

TABLE A-21.10

LAS VEGAS VALLEY WASTE WATER BUDGET FOR POPULATION CURVES

Population Curve: 800,000 Persons

YEAR	1990					
POPULATION	652,000 Persons					
WASTE WATER USE PER PRODUCTION CATEGORY	TOTAL WASTE WATER PROD.	WASTE WATER USE PRIORITY *** 1000'S ACRE FEET PER YEAR				TOTAL WASTE WATER USE
		1	2	3	4	
RESIDENTIAL & TRANSIENT	102.75	0	0	0	0	0
PUBLIC FACILITIES						
Greenbelts		0	0	5.30	0	5.30
Schools and Parks		6.50	0	0	0	6.50
GOLF COURSES		0	7.00	0	0	7.00
AGRICULTURE		0	5.53	0	0	5.53
HEAVY INDUSTRY	20.00	0	11.30	0	0	11.30
POWER GENERATION* In Valley	.90	4.50	0	0	0	4.50
POWER GENERATION* Arrow Cyn		28.30	16.00	0	0	44.30
LIGHT INDUSTRY	**	0	0	0	0	0
MILITARY	2.00	0	0.50	0	0	0.50
WASTE IRRIGATION						
In Valley		0	0	0	0	0
Export		0	0	0	40.72	40.72
RETURN TO COLORADO						
For Credit		0	0	0	0	0
For Disposal		0	0	0	0	0
TOTAL		39.30	40.33	5.30	40.72	
TOTAL	125.65					125.65

* Cooling tower blowdown not included for out of valley power

** Included in Residential and Transient

*** Priority 1 - Uses necessary for health and well-being of the population

Priority 2 - Uses contributing to the maintenance and growth of the area's economy

Priority 3 - Uses contributing to aesthetic development of the community above that required for health and well-being and which do not demonstrate an economic return

Priority 4 - Uses which provide only for pollution abatement, with no economic or aesthetic return

Las Vegas Valley Water District

TABLE A-21.11

LAS VEGAS VALLEY WASTE WATER BUDGET FOR POPULATION CURVES

Population Curve: 800,000 Persons

YEAR	2000					
POPULATION	800,000 Persons					
WASTE WATER USE PER PRODUCTION CATEGORY	TOTAL WASTE WATER PROD.	WASTE WATER USE PRIORITY *** 1000'S ACRE FEET PER YEAR				TOTAL WASTE WATER USE
		1	2	3	4	
RESIDENTIAL & TRANSIENT	129.23	3.59	0	0	0	3.59
PUBLIC FACILITIES						
Greenbelts		0	0	0	0	0
Schools and Parks		8.40	0	0	0	8.40
GOLF COURSES		0	12.30	0	0	12.30
AGRICULTURE		0	4.00	0	0	4.00
HEAVY INDUSTRY	24.00	0	16.30	0	0	16.30
POWER GENERATION* In Valley		0	0	0	0	0
POWER GENERATION* Arrow Cyn		58.20	11.80	0	0	70.00
LIGHT INDUSTRY	**	0	0	0	0	0
MILITARY	2.00	0	0.50	0	0	0.50
WASTE IRRIGATION						
In Valley		0	0	0	0	0
Export		0	0	0	40.14	40.14
RETURN TO COLORADO						
For Credit		0	0	0	0	0
For Disposal		0	0	0	0	0
TOTAL		70.19	44.90	0	40.14	
TOTAL	155.23					155.23

* Cooling tower blowdown not included for out of valley power

** Included in Residential and Transient

*** Priority 1 - Uses necessary for health and well-being of the population

Priority 2 - Uses contributing to the maintenance and growth of the area's economy

Priority 3 - Uses contributing to aesthetic development of the community above that required for health and well-being and which do not demonstrate an economic return

Priority 4 - Uses which provide only for pollution abatement, with no economic or aesthetic return

Las Vegas Valley Water District

TABLE A-21.12

LAS VEGAS VALLEY WASTE WATER BUDGET FOR POPULATION CURVES

Population Curve: 800,000 Persons

YEAR	2010					
POPULATION	907,000 Persons					
WASTE WATER USE PER PRODUCTION CATEGORY	TOTAL WASTE WATER PROD.	WASTE WATER USE PRIORITY *** 1000'S ACRE FEET PER YEAR				TOTAL WASTE WATER USE
		1	2	3	4	
RESIDENTIAL & TRANSIENT	150.17	35.09	0	0	0	35.09
PUBLIC FACILITIES						
Greenbelts		0	0	0	0	0
Schools and Parks		9.72	0	0	0	9.72
GOLF COURSES		0	14.70	0	0	14.70
AGRICULTURE		0	4.00	0	0	4.00
HEAVY INDUSTRY	24.00	0	16.50	0	0	16.50
POWER GENERATION* In Valley		0	0	0	0	0
POWER GENERATION* Arrow Cyn		70.00	0	0	0	70.00
LIGHT INDUSTRY	**	0	0	0	0	0
MILITARY	2.00	0	0.50	0	0	0.50
WASTE IRRIGATION						
In Valley		0	0	0	0	0
Export		0	0	0	25.66	25.66
RETURN TO COLORADO						
For Credit		0	0	0	0	0
For Disposal		0	0	0	0	0
TOTAL		114.81	35.70	0	25.66	
TOTAL	176.17					176.17

* Cooling tower blowdown not included for out of valley power

** Included in Residential and Transient

*** Priority 1 - Uses necessary for health and well-being of the population

Priority 2 - Uses contributing to the maintenance and growth of the area's economy

Priority 3 - Uses contributing to aesthetic development of the community above that required for health and well-being and which do not demonstrate an economic return

Priority 4 - Uses which provide only for pollution abatement, with no economic or aesthetic return

Las Vegas Valley Water District

LAS VEGAS VALLEY WASTE WATER BUDGET FOR POPULATION CURVES

TABLE A-21.13

Population Curve: 800,000 Persons

YEAR	2020					
POPULATION	960,000 Persons					
WASTE WATER USE PER PRODUCTION CATEGORY	TOTAL WASTE WATER PROD.	WASTE WATER USE PRIORITY *** 1000'S ACRE FEET PER YEAR				TOTAL WASTE WATER USE
		1	2	3	4	
RESIDENTIAL & TRANSIENT	162.92	56.90	0	0	0	56.90
PUBLIC FACILITIES						
Greenbelts		0	0	0	0	0
Schools and Parks		10.40	0	0	0	10.40
GOLF COURSES		0	16.40	0	0	16.40
AGRICULTURE		0	4.00	0	0	4.00
HEAVY INDUSTRY	24.00	0	16.50	0	0	16.50
POWER GENERATION* In Valley		0	0	0	0	0
POWER GENERATION* Arrow Cyn	*	70.00	0	0	0	70.00
LIGHT INDUSTRY	**	0	0	0	0	0
MILITARY	2.00	0	0.50	0	0	0.50
WASTE IRRIGATION						
In Valley		0	0	0	0	0
Export		0	0	0	14.22	14.22
RETURN TO COLORADO						
For Credit		0	0	0	0	0
For Disposal		0	0	0	0	0
TOTAL		137.30	37.40	0	14.22	
TOTAL	188.92					188.92

* Cooling tower blowdown not included for out of valley power

** Included in Residential and Transient

*** Priority 1 - Uses necessary for health and well-being of the population

Priority 2 - Uses contributing to the maintenance and growth of the area's economy

Priority 3 - Uses contributing to aesthetic development of the community above that required for health and well-being and which do not demonstrate an economic return

Priority 4 - Uses which provide only for pollution abatement, with no economic or aesthetic return

WASTE WATER DISPOSITION

1,000,000 Population @ Year 2000

TABLE A-22.1

Sheet 1 of 2

Year	Wastewater Produced 1000's AF/Yr.	EXPORT SYSTEMS ONLY (1000's AF/YR)							Complete Treatment (Max. to be Treated)	
		IN VALLEY USES				EXPORT				
		Irrigation	Industrial & Military	Power	Treated (Desalted)	Power Only	Disposal Only	Power & Disposal	1000's AF/Yr.	MG/Yr.
1970	56.16	6.35	0.10	3.20	0	0	46.51	46.51	46.51	15,160
71	60.07	6.35	0.10	3.84	0	0	49.78	49.78	49.78	16,230
72	63.98	6.35	0.10	4.00	0	0	53.53	53.53	53.53	17,450
73	67.89	6.35	0.10	4.20	0	0	57.24	57.24	57.24	18,660
74	71.80	6.35	0.10	4.48	0	0	60.87	60.87	60.87	19,840
75	75.72	14.80	4.90	4.48	0	0	51.54	51.54	51.54	16,800
76	79.63	15.30	5.10	4.48	0	0	54.75	54.75	54.75	17,850
77	83.54	15.80	5.30	4.48	0	3.24	54.72	57.96	57.96	18,895
78	87.45	16.20	5.50	4.48	0	10.60	50.67	61.27	61.27	19,975
79	91.36	16.60	5.70	4.48	0	18.90	45.68	64.58	64.58	21,050
1980	95.28	16.95	5.90	4.48	0	27.20	40.75	67.95	67.95	22,150
81	100.17	17.79	6.50	4.50	0	32.20	39.18	71.38	71.38	23,270
82	105.06	18.63	7.08	4.50	0	32.20	42.65	74.85	74.85	24,400
83	109.96	19.47	7.67	4.50	0	32.20	46.12	78.32	78.32	25,530
84	114.86	20.31	8.26	4.50	0	32.20	49.59	81.79	81.79	26,660
85	119.76	21.15	8.85	4.50	0	32.20	53.06	85.26	85.26	27,795
86	124.65	21.78	9.44	4.50	0	36.20	52.73	88.93	88.93	28,990
87	129.54	22.41	10.03	4.50	0	40.20	52.40	92.60	92.60	30,190
88	134.44	23.05	10.62	4.50	0	44.30	51.97	96.27	96.27	31,385
89	139.34	23.69	11.21	4.50	0	44.30	55.64	99.94	99.94	32,580
1990	144.24	24.33	11.80	4.50	0 1/	44.30	59.31 4/	103.61 5/	103.61	33,780
91	148.57	24.36	12.30	4.50	6.00	44.30	57.11	101.41	107.41	35,015
92	152.90	24.40	12.80	4.50	12.00	44.30	54.90	99.20	111.20	36,250
93	157.22	24.43	13.30	4.50	18.00	44.30	52.69	96.99	114.99	37,490
94	161.56	24.46	13.80	4.50	24.00	44.30	50.50	94.80	118.80	38,730
95	165.89	24.50	14.30	0	30.00 2/	50.70	46.39	97.09	127.09	41,430
96	170.22	24.54	14.80	0	36.00	57.20	37.68	94.88	130.88	42,670
97	174.55	24.58	15.30	0	42.00	63.60	29.07	92.67	134.67	43,900
98	178.88	24.62	15.80	0	48.00	70.00	20.46	90.46	138.46	45,140
99	183.21	24.66	16.30	0	54.00	70.00	18.25	88.25	142.25	46,375
2000	187.54	24.70	16.80	0	60.80	70.00	15.24	85.24	146.04	47,610
2010	220.55	28.42	17.00	0	84.10 3/	70.00	21.03	91.03	175.13	57,090
2020	246.61	30.80	17.00	0	103.00	70.00	25.81	95.81	198.81	64,810

1/ Begin desalting waste water for potable use in year 1990.
2/ Begin overdrafting of groundwater in year 1995 when power option is considered.
3/ Begin overdrafting of groundwater in year 2008 when power option is not considered.
4/ Maximum average annual flow occurs in year 1990 when power option is considered.
5/ Maximum average annual flow occurs in year 1990 when power option is not considered.

WASTE WATER DISPOSITION

800,000 Population @ Year 2000

TABLE A-22.1

Sheet 2 of 2

		EXPORT SYSTEMS ONLY (1000's AF/YR)							Complete Treatment (Max. to be Treated)	
		IN VALLEY USES				EXPORT				
Year	Wastewater Produced 1000's AF/Yr.	Irrigation	Industrial & Military	Power	Treated (Desalted)	Power Only	Disposal Only	Power & Disposal	1000's AF/Yr.	MG/Yr.
1970	56.16	6.35	0.10	3.20	0	0	46.51	46.51	46.51	15,160
71	59.56	6.35	0.10	3.84	0	0	49.27	49.27	49.27	16,060
72	62.96	6.35	0.10	4.00	0	0	52.51	52.51	52.51	17,120
73	66.36	6.35	0.10	4.20	0	0	55.71	55.71	55.71	18,160
74	69.77	6.35	0.10	4.48	0	0	58.84	58.84	58.84	19,180
75	73.18	14.80	4.90	4.48	0	0	49.00	49.00	49.00	15,975
76	76.58	15.30	5.10	4.48	0	0	51.70 3/	51.70	51.70	16,855
77	79.98	15.80	5.30	4.48	0	3.24	51.16	54.40	54.40	17,735
78	83.38	16.20	5.50	4.48	0	10.60	46.60	57.20	57.20	18,650
79	86.79	16.60	5.70	4.48	0	18.90	41.11	60.01	60.01	19,560
1980	90.20	16.95	5.90	4.48	0	27.20	35.67	62.87	62.87	20,495
81	93.74	17.79	6.50	4.50	0	32.20	32.75	64.95	64.95	21,170
82	97.28	18.63	7.08	4.50	0	32.20	34.87	67.07	67.07	21,865
83	100.82	19.47	7.67	4.50	0	32.20	36.98	69.18	69.18	22,550
84	104.37	20.31	8.26	4.50	0	32.20	39.10	71.30	71.30	23,240
85	107.92	21.15	8.85	4.50	0	32.20	41.22	73.42	73.42	23,935
86	111.46	21.78	9.44	4.50	0	36.20	39.54	75.74	75.74	24,690
87	115.00	22.41	10.03	4.50	0	40.20	37.86	78.06	78.06	25,450
88	118.54	23.05	10.62	4.50	0	44.30	36.07	80.37	80.37	26,200
89	122.09	23.69	11.21	4.50	0	44.30	38.39	82.69	82.69	26,960
1990	125.65	24.33	11.80	4.50	0	44.30	40.72	85.02	85.02	27,715
91	128.60	24.36	12.30	4.50	0	44.30	43.14	87.44	87.44	28,505
92	131.56	24.40	12.80	4.50	0	44.30	45.56	89.86	89.86	29,295
93	134.52	24.43	13.30	4.50	0	44.30	47.99	92.29	92.29	30,090
94	137.48	24.46	13.80	4.50	0	44.30	50.42	94.72	94.72	30,880
95	140.44	24.50	14.30	0	0	50.70	50.94	101.64	101.64	33,135
96	143.39	24.54	14.80	0	0	57.20	46.85	104.05	104.05	33,920
97	146.35	24.58	15.30	0	0	63.60	42.87	106.47	106.47	34,710
98	149.31	24.62	15.80	0	0	70.00	38.89	108.89	108.89	35,500
99	152.27	24.66	16.30	0	0 1/	70.00	41.31	111.31 4/	111.31	36,290
2000	155.23	24.70	16.80	0	3.59	70.00	40.14	110.14	113.73	37,075
2010	176.17	28.42	17.00	0	35.09	70.00	25.66	95.66	130.75	42,625
2020	188.92	30.80	17.00	0	56.90 2/	70.00	14.22	84.22	141.12	46,005

1/ Begin desalting waste water for potable use in year 1999.
2/ Begin overdrafting of groundwater in year 2019 when power option is considered.
3/ Maximum average annual flow occurs in year 1976 when power option is considered.
4/ Maximum average annual flow occurs in year 1999 when power option is not considered.

EXPORT SYSTEM

DRY LAKE - WITHOUT POWER & WITH POWER

COST ESTIMATE

1,000,000 Population @ Year 2000

TABLE A-23.1
Sheet No. 1 of 2

ITEM		CLASS*	UNIT	SIZE	QUANTITY	UNIT PRICE	AMOUNT
BMI Collection Line, 15 MGD	Pipe	A	LF	30"	13,800	$ 38	$ 524,000
	Pipe	D	LF	30"	3,000	48	144,000
Highway Crossing	Pipe	A	LF	30"	200	90	18,000
BMI + Henderson 15+5 = 20 MGD	Pipe	D	LF	36"	9,000	61	549,000
	Pipe	A	LF	36"	9,500	49	466,000
Henderson P.S. $\frac{7.75 \text{ cfs} \times 120}{8.8 \times 70\%}$ = 150 HP; H = 1720 - 1600 = 120		-	HP	-	150	300	45,000
City & County SD's to Pump Sta. #1	Canal	A	LF	Lined	10,500	40	420,000
Regulating Reservoir @ P.S. #1		-	AF	-	42	6,800	286,000
P.S. #1 to P.S. #2	RC Pipe Class 200 (avg)	A-E	LF	66"	66,000	111	7,326,000
P.S. #1 $\frac{172 \times 564}{8.8 \times .8}$ = 13,800	WS @ PS #2 = 2080 WS @ PS #1 = 1655 425	D	HP	-	13,800	205	2,829,000
Hf = 66,000 x 2.10 = 139'; H = 139 + 425 = 564							
Forebay @ P.S. #2 = 1/2 Size of Reg. Res.		-	AF	-	21	9,100	191,000
Surge Protection @ PS #1 L = 66,000 = 12.5 miles	172 x 646 = 111,000 12.5 x 1000 = 13,000 124,000	-	-	-	-	LS	124,000
P.S. #2 to divide	RC Pipe Class 200 (avg) RC Pipe Class 200 (avg)	A-E E	LF LF	66" 66"	14,000 10,000	111 100	1,554,000 1,000,000
P.S. #2 $\frac{172 \times 510}{8.8 \times .8}$ = HP = 12,500	WS @ Divide = 2540 WS @ PS #2 = 2080 460	A	HP	-	12,500	205	2,563,000
Hf = 24,000 x 2.1'/1000 = 50; H = 50 + 460 = 510							
Forebay @ Divide = 1/4 Size of Reg. Res.		-	AF	-	10.5	10,100	106,000
Surge Protection @ P.S. #2 L = 24,000 = 4.5 Miles	172 x 646 = 111,000 4.5 x 1000 = 5,000 116,000	-	-	-	-	LS	116,000
Divide to Evap. Ponds	RC Pipe Class 100 (avg)	A	LF	60"	26,000	102	2,652,000
Freeway Crossing		E	LF	66"	200	125	25,000
Railway Crossing		E	LF	66"	50	LS	12,000
Pavement Replacement		-	LF	-	390,000	0.33	129,000
Terminal Structure		-	SF	-	-	LS	30,000
Nevada Power Collection & Highway Crossing		-	-	-	-	LS	121,000

REMARKS

Avg. Ann. Flow max. = 103,600 AF/Yr.

XI.2 = max. day flow
= 124,000 AF/Yr.
= 172 cfs
= 111 MGD
= 340 AF/Day

Stage Const.

1975 - 55,000 AF - Pumps
- 103,600 AF - Pipeline
1977 - 85,000 AF - Pumps
1985 - 103,600 AF - Pumps

Reg. Reservoir @ P.S. #1
= 12.5% of max. day
= 12.5% x 340 = 42 AF

Surge Protection
= $1000/MGD + $1000/Mile
$646/cfs

Pump HP = $\frac{Q\ H}{8.8 \times .8}$

eff = .8 large pumps
= .70 Henderson Pump

General Notes for all Cost Estimates

1. Unit prices are based upon Jan. 1972 prices and with no escalation.
2. Cost for land acquisition is not included.

CONSTRUCTION COST (ULTIMATE)	$21,230,000 + 30% =	$27,599,000 (1985) operation
HP 26,450 - 19,880 = 6,570 @ 100	657,000	854,000 (see note 3)
CONSTRUCTION COST (3/4 Pumping Cap.)	$20,573,000 + 30% =	$26,745,000 (1977) operation
HP 19,880 - 13,310 = 6,570 @ 100	657,000	854,000 (see note 2)
CONSTRUCTION COST (1/2 Pumping Cap.)	$19,916,000 + 30% =	$25,891,000 (1975) operation (see note 1)
	TOTAL COST	

* Class indicates ease of construction for pipe lines & P.S.

A = average (P.S. #1 - Wash)
D = difficult (P.S. #2 - Hwy 91)
E = easy

Note 1 - Construct ½ in 1973 and ½ in 1974
Note 2 - Construct ½ in 1975 and ½ in 1976
Note 3 - Construct ½ in 1983 and ½ in 1984

EXPORT SYSTEM

DRY LAKE - WITHOUT POWER & WITH POWER

COST ESTIMATE

800,000 Population @ Year 2000

TABLE A-23.1
Sheet No. 2 of 2

ITEM		CLASS*	UNIT	SIZE	QUANTITY	UNIT PRICE	AMOUNT	REMARKS
BMI Collection Line, 15 MGD	Class 150 (avg) Pipe	A	LF	30"	13,800	$ 38	$ 524,000	Stage Const.
	Class 150 (avg) Pipe	D	LF	30"	3,000	48	144,000	1975 - 55,000 AF Cap.- Pumps
Highway Crossing	Pipe	A	LF	30"	200	90	18,000	111,300 AF Cap.- Pipeline
BMI + Henderson	Class 150 (avg) Pipe	D	LF	36"	9,000	61	549,000	1978 - 85,000 AF Cap.- Pumps
15 + 5 = 20 MGD	Class 150 (avg) Pipe	A	LF	36"	9,500	49	466,000	1985 -111,300 AF Cap.- Pumps
Henderson P.S. $\frac{7.75 \text{ cfs} \times 120}{8.8 \times 70\%}$ = 150 HP	H = 1720 - 1600 = 120	-	HP	-	150	300	45,000	Reg. Res. @ Pump Sta. #1 = 12.5% of Max. Day = 12.5% x 366 = 46 AF
City & County S.D.'s to Pump Sta. #1	Canal	A	LF	Lined	10,500	40	420,000	Surge Protection
Regulating Reservoir @ P.S. #1		-	AF	-	46	6,400	294,000	= $1000/MGD + $1000/mi
P.S. #1 to P.S. #2	RC Pipe Class 200 (avg)	A	LF	66"	66,000	111	7,326,000	= $646/cfs
P.S. #1 = $\frac{136 \times 577'}{8.8 \times .8}$ = 15,250 HP Hf = 66,000 x 2.3' = 152'; H = 152 + 425' = 577'	WS @ PS #2 = 2080 WS @ PS #1 = 1655 425'	D	HP	-	15,250	205	3,126,000	Average Annual Flow Max. = 111,300 AF/Yr.
Forebay @ PS #2 = 1/2 Size of Reg. Res.		-	AF	-	23	8,800	202,000	XI.2 = Max. day flow = 133,600 AF/Yr.
Surge Protection @ PS #1 L = 66,000 = 12.5 miles	186 x 646 = 120,000 12.5 x 1000 = 13,000 133,000	-	-	-	-	LS	133,000	= 186 cfs = 120 MGD = 366 AF/Day
PS #2 to Divide	RC Pipe Class 200 (avg)	A E	LF LF	66" 66"	14,000 10,000	111 100	1,554,000 1,000,000	
PS #2 $\frac{186 \times 515}{8.8 \times .8}$ = 13,600 Hf = 24,000 x 2.3'/1000 = 55; H = 55 + 460 = 515'	WS @ divide = 2540 WS @ PS #2 = 2080 460'	A	HP	-	13,600	205	2,788,000	Pump HP = $\frac{Q \times H}{8.8 \times \text{eff.}}$ eff. = .80 large pumps = .70 Henderson pump
Forebay @ divide = 1/4 Size of Reg. Res.		-	AF	-	11.5	10,000	115,000	
Surge Protection @ PS #2 L = 24,000' = 4.5 miles	186 x 646 = 120,000 4.5 x 1000 = 5,000 125,000	-	-	-	-	LS	125,000	
Divide to evaporation ponds	Class 150 (avg) Pipe	A	LF	60"	26,000	102	2,652,000	
Freeway Crossing		E	LF	66"	200	125	25,000	
Railway Crossing		E	LF	66"	50	LS	12,000	
Pavement Replacement		-	-	-	390,000	0.33	129,000	
Terminal Structure		-	-	-	-	LS	30,000	
Nevada Power Collection & Hwy Crossing*		-	-	-	-	LS	121,000	TOTAL COST

CONSTRUCTION COST (ULTIMATE)	$21,798,000 + 30% =	$28,337,000 (1985) operation
HP 29,000 - 21,800 = 7,200 @ 100	720,000	936,000 (see note 3)
CONSTRUCTION COST (3/4 Pumping Cap.)	$21,078,000 + 30% =	$27,401,000 (1978) operation
HP 21,800 - 14,600 = 7,200 @ 100	720,000	936,000 (see note 2)
CONSTRUCTION COST (1/2 Pumping Cap.)	$20,358,000 + 30%	$26,465,000 (1975) operation (see note 1)

* Class indicates ease of construction for pipe lines & P.S.

A = average (P.S. #1 - Wash)
D = difficult (P.S. #2 - Hwy 91)
E = easy

Note 1 - Construct ½ in 1973 and ½ in 1974
Note 2 - Construct ½ in 1976 and ½ in 1977
Note 3 - Construct ½ in 1983 and ½ in 1984

DISPOSAL SYSTEM

DRY LAKE - WITHOUT POWER

COST ESTIMATE

800,000 Population @ Year 2000

TABLE A-23.2

Sheet No.3 of 4

ITEM		CLASS	UNIT	SIZE	QUANTITY	UNIT PRICE	AMOUNT	REMARKS
Stage 1 (Initial)	Capacity							Max. 111,300 AF in 1999
Main Lake	33,600 AF	-	AC	-	4,200	None	-	
South Evaporation Ponds	21,400 AF	-	AC	-	2,675	$ 1,500	$ 4,013,000	
Diversion Channel	55,000 AF	-	-	-	-	LS	250,000	
Canal 2.0 miles		-	Mile	-	2.0	31,700	63,000	TOTAL COST
							4,326,000	+ 30% $5,624,000(1975)*
Stage 2								
Main Lake	33,600	-	AC	-	4,200	None		
South Evaporation Ponds	26,400	-	AC	-	3,300	1,500	4,950,000	
North Evaporation Ponds	10,000	-	AC	-	1,250	1,500	1,875,000	
Diversion Channel	70,000 AF	-	-	-	-	LS	250,000	
Canal 12 miles		-	Mile	-	12.0	31,700	380,000	Add $4,068,000**
						-	7,455,000	+ 30% $9,692,000(1978)*
Stage 3								
Main Lake	33,600	-	AC	-	4,200	None	-	
South Evaporation Ponds	26,400	-	AC	-	3,300	1,500	4,950,000	
North Evaporation Ponds	25,000	-	AC	-	3,125	1,500	4,688,000	
Diversion Channel	85,000 AF	-	-	-	-	LS	250,000	
Canal 13.5 miles		-	Mile	-	13.5	31,700	428,000	Add $ 3,719,00**
							10,316,000	+ 30% $13,411,000(1985)*
Stage 4								
Main Lake	33,600	-	AC	-	4,200	None	-	
South & West Evaporation Ponds	41,200	-	AC	-	5,150	1,500	7,725,000	
North Evaporation Ponds	25,200	-	AC	-	3,150	1,500	4,725,000	
Diversion Channel	100,000 AF	-	-	-	-	LS	250,000	
Canal 15 miles		-	Mile	-	15	31,700	467,000	Add $ 3,718,000**
							13,176,000	+ 30% $17,129,000(1990) *
Stage (ult.)								
Main Lake	33,600	-	AC	-	4,200	None	-	
Evaporation Ponds	77,700	-	AC	-	9,712	1,500	14,568,000	
Diversion Channel	111,300 AF	-	-	-	-	LS	250,000	
Canal 20.5 miles		-	Mile	-	20.5	31,700	650,000	Add $ 2,979,000**
							$15,468,000	+ 30% $20,108,000 (1995)*

*For operation in year indicated

**For construction in preceding year

DISPOSAL SYSTEM

DRY LAKE - WITH POWER

COST ESTIMATE

800,000 Population @ Year 2000

TABLE A-23.2

Sheet 4 of 4

ITEM		CLASS	UNIT	SIZE	QUANTITY	UNIT PRICE	AMOUNT		REMARKS
Stage 1 (Initial & Ultimate)	Capacity								Max. 51,700 AF in 1976
Main Lake	33,600	-	AC	-	4,200	$ -	$ -		
South Evaporation Ponds	18,100	-	AC	-	2,265	1500	3,394,000		
Diversion Channel	51,700 AF	-	-	-	-	LS	250,000		TOTAL COST
Canal 2.0 miles		-	Mile	-	2.0	-	63,000		
							$3,707,000	+ 30%	$4,819,000 (1975)* (construct in 1974)

*Year of operation

IN VALLEY IRRIGATION SYSTEM

DRY LAKE - WITH AND WITHOUT POWER

COST ESTIMATE

TABLE A-23.3
Sheet No. 1 of 1

ITEM		CLASS*	UNIT	SIZE	QUANTITY	UNIT PRICE	AMOUNT	REMARKS
South System - Phase 1 - 1975								
Pump Sta."a" @ Wash #1 PS		A	HP	-	3,010	$ 150 1/	$ 452,000 2/	
Pump Sta."b" @ El. 2000		A	HP	-	1,850	205	379,000	
Surge Protection @ PS "a", 32,000 + 11,000		-	-	-	-	LS	43,000	1/ Cost per HP reduced to $150 since PS is located with main export P.S.
Surge Protection @ PS "b", 32,000 + 5,000		-	-	-	-	LS	37,000	
Pipe Lines, Flamingo Road	Class 200 (avg)	A-E	LF	42"	24,000	56	1,344,000	
Freeway Crossing		E	LF	42"	250	125	31,000	
Flamingo Road	Class 200 (avg)	A	LF	36"	8,000	50	400,000	
Flamingo Rd. & Strip	Class 200 (avg)	A	LF	30"	26,000	39	1,014,000	
Railway to Maryland	Class 150 (avg)	A	LF	24"	19,000	27	513,000	2/ $377,000 in 1975
Feeder	Class 150 (avg)	A	LF	18"	5,300	20	106,000	$75,000 in 1985
	Class 150 (avg)	A	LF	12"	11,000	12	132,000	
	Class 150 (avg)	A	LF	8"	2,000	8	16,000	
Storage		-	AF	-	18	9,500	171,000	
Pavement Replacement		-	SF	-	330,000	0.33	109,000	TOTAL COST
			Sub Total				$4,672,000 + 30% = $6,074,000 for 1975 operation (1974 construction)	
North System - Phase 2 - 1985								
Pipe Lines, Mohave Rd. etc.	Class 150 (avg)	A	LF	24"	39,500	$ 27	$1,067,000	
Highway Crossings (2)	Class 150 (avg)	A	LF	24"	500	75	38,000	
Service Lines	Class 150 (avg)	A	LF	12"	3,000	12	36,000	
	Class 150 (avg)	A	LF	10"	3,000	10	30,000	
	Class 150 (avg)	A	LF	8"	24,000	8	192,000	
Reservoir		-	MG	-	1.3	.10	130,000	
Pavement Replacement (4' wide avg)		-	SF	-	290,000	0.33	96,000	
West of Freeway								
Pump Station		-	HP	-	320	208	67,000	
Surge Protection		-	-	-	--	LS	10,000	* Class indicates ease of construction for pipe lines
Reservoir		-	MG	-	1.1	.11	120,000	
Railway & Freeway Crossings		-	LF	18"	400	70	28,000	
Pipe Lines - Feeder	Class 150 (avg)	A	LF	18"	27,000	20	540,000	A = average
Pavement Replacement (4' wide avg)		-	SF	-	110,000	0.33	33,000	D = difficult
Northeast Area								E = easy
Service Lines	Class 150 (avg)	A	LF	16"	4,000	17	68,000	add $3,477,000**
	(9,500' Nellis AF)	A	LF	10"	14,500	10	145,000	
						Total Cost =	$7,347,000 + 30% = $9,551,000 for 1985 operation	

**1984 construction

EXPORT SYSTEM

ELDORADO VALLEY - WITHOUT POWER

COST ESTIMATE

1,000,000 Population @ Yr. 2000

TABLE A-23.4
Sheet No. 1 of 4

ITEM		CLASS 1/	UNIT	SIZE	QUANTITY	UNIT PRICE	AMOUNT	REMARKS
BMI Collection Line, 15 MGD	Pipe	A	LF	27"	2,000	$ 31	$ 62,000	
	Pipe	E	LF	27"	8,000	24	192,000	
	Pipe	D	LF	27"	3,800	41	156,000	Refer to Dry Lake - Without Power 1,000,000 Population @ year 2000 for remarks.
Highway Crossing	Pipe	A	LF	27"	200	80	16,000	
BMI + Henderson, 15+5 = 20 MGD	Pipe	A	LF	36"	3,200	49	157,000	
City & County SD's to PS #1	Canal	A	LF	Lined	12,000	40	480,000	
.176 MGD	RC Pipe	D	LF	66"	12,000	120	1,440,000	
Regulating Reservoir @ PS #1	12.5% x Max. Day		AF	-	42	6,800	286,000	
P.S. #1 to Divide	RC Pipe Class 500	D	LF	66"	6,000	164	984,000	
	Class 300(avg)	E	LF	66"	18,000	106	1,908,000	
	Class 150(avg)	A	LF	66"	26,000	119.50	3,107,000	
Divide to Terminal Res.	RC Pipe Class 100	A	LF	66"	10,000	117.50	1,175,000	
PS #1 $\frac{172 \times 885}{8.8 \times .8}$ = 21,600 HP	WS @ Divide = 2370 WS @ PS #1 = 1590	D	HP	-	21,600	205	4,428,000	
Hf = 50,000 @ 2.1'/1000 = 105, H=105+780=885' 780								
Surge Protection @ PS #1	172 x 646 = 111,000							
L = 50,000 = 9.5 miles	9.5 x 1000 10,000 121,000	-	-	-	-	LS	121,000	
Terminal Reservoir - Same as Reg. Res.		-	AF	-	42	6,800	286,000	
Freeway Crossing		A	-	66"	-	LS	65,000	
Railway Crossing		A	-	66"	-	LS	15,000	
Pavement Replacement		-	SF	-	100,000	0.33	33,000	
Terminal Structure		-	-	-	-	LS	20,000	
Nevada Power Collection & Hwy. Crossing		-	-	-	-	LS	203,000	

		TOTAL COST
CONSTRUCTION COST (ULT)	$15,134,000 + 30% =	$19,674,000 in 1985
HP 21,600=16,200 = 5,400 @ 100	540,000	702,000***
CONSTRUCTION COST (3/4 Pump. Cap.)	$14,594,000 + 30% =	$18,972,000 in 1977
HP 16,200-10,800 = 5,400 @ 100	540,000	702,000**
INITIAL CONSTRUCTION COST (1/2 Pump. Cap.)	$14,054,000 + 30% =	$18,270,000*

1/ Class indicates ease of construction for pipe lines.

A = average
D = difficult
E = easy

*Construct ½ in 1973, ½ in 1974 for 1975 operation
**Construct ½ in 1975, ½ in 1976 for 1977 operation
***Construct ½ in 1983, ½ in 1984 for 1985 operation

EXPORT SYSTEM

ELDORADO VALLEY - WITH POWER

COST ESTIMATE

1,000,000 Population @ Year 2000

TABLE A-23.4
Sheet No. 2 of 4

ITEM		CLASS 1/	UNIT	SIZE	QUANTITY	UNIT PRICE	AMOUNT	REMARKS
BMI Collection Line, 15 MGD	Pipe	A	LF	27"	2,000	$ 31	$ 62,000	Avg.Ann.Flow - Max
	Pipe	E	LF	27"	8,000	24	192,000	= 59,300 in 1990
	Pipe	D	LF	27"	3,800	41	156,000	X1.2 = 71,100 AF/Yr
Highway Crossing	Pipe	A	LF	27"	200	80	16,000	= 99 cfs
BMI + Henderson, 15+5 = 20 MGD	Pipe	A	LF	36"	3,200	49	157,000	= 64 MGD
City & County SD's to PS #1	Canal	A	LF	Lined	12,000	40	480,000	= 195 AF/day
176 MGD	RC Pipe	D	LF	66"	12,000	120	1,440,000	
Regulating Reservoir @ PS #1	12.5% x Max. Day	-	AF	-	24	8,700	209,000	$V_{48"} = \frac{99}{12.57} = 7.87'$ per sec.
P.S. #1 to Divide	RC Pipe Class 500	D	LF	48"	6,000	106	636,000	
	Class 300(avg)	E	LF	48"	18,000	64	1,152,000	
	Class 150(avg)	A	LF	48"	26,000	75.5	1,963,000	
Divide to Terminal Res.	RC Pipe Class 100	A	LF	48"	10,000	74	740,000	Stage Construction
PS #1 $\frac{99 \times 980}{8.8 \times .8}$ = 13,800 HP	WS @ Divide = 2370							
	WS @ PS #1 = 1590	D	HP	-	13,800	205	2,829,000	1975 = 55,000 AF pumps
Hf = 50,000 @ 4.0'/1000 = 200+780=980'	780							= 59,300 AF pipeline
Surge Protection @ PS #1	99 x 646 = 64,000	-	-	-	-	LS	74,000	
L = 50,000 = 9.5 miles	9.5 x 1000 = 10,000							1990 = 59,300 AF pumps
	74,000							
Terminal Reservoir - Same as Reg. Res.		-	AF	-	24	8,700	209,000	
Freeway Crossing		A	-	48"	-	LS	55,000	
Railway Crossing		A	-	48"	-	LS	13,000	
Pavement Replacement		-	SF	-	80,000	0.33	26,000	
Terminal Structure		-	-	-	-	LS	16,000	
Nevada Power Collection & Hwy. Crossing		-	-	-	-	LS	203,000	TOTAL COST

CONSTRUCTION COST (ULT.) $10,628,000 + 30% = $13,816,000 in 1990

HP 13,800-12,700 = 1,100 @ 100 = 110,000 143,000 *

INITIAL CONSTRUCTION COST (92% Pump. Cap.) $10,518,000 + 30% = $13,673,000 for 1975 operation (Construct ½ in 1973, ½ in 1974)

1/ Class indicates ease of construction for pipe lines.

A = average
D = difficult
E = easy

*For operation in 1990 (construct in 1989)

EXPORT SYSTEM

ELDORADO VALLEY - WITHOUT POWER

COST ESTIMATE

800,000 Population @ Year 2000

TABLE A-23.4
Sheet No. 3 of 4

ITEM		CLASS[1/]	UNIT	SIZE	QUANTITY	UNIT PRICE	AMOUNT	REMARKS
BMI Collection Line, 15 MGD	Pipe	A	LF	27"	2,000	$ 31	$ 62,000	
	Pipe	E	LF	27"	8,000	24	192,000	
	Pipe	D	LF	27"	3,800	41	156,000	
Highway Crossing	Pipe	A	LF	27"	200	80	16,000	
BMI + Henderson, 15+5 = 20 MGD	Pipe	A	LF	36"	3,200	49	157,000	Refer to Dry Lake
City & County SD's to PS #1	Canal	A	LF	Lined	12,000	40	480,000	Without Power
176 MGD	RC Pipe	D	LF	66"	12,000	120	1,440,000	
Regulating Reservoir @ PS #1 12.5% x Max. Day		-	AF	-	46	6,400	294,000	800,000 pop. @
P.S. #1 to Divide	RC Pipe Class 500	D	LF	66"	6,000	164	984,000	Year 2000 for
	Class 300(avg)	E	LF	66"	18,000	106	1,908,000	remarks.
	Class 150(avg)	A	LF	66"	26,000	119.50	3,107,000	
Divide to Terminal Res.	RC Pipe Class 100	A	LF	66"	10,000	117.50	1,175,000	
PS #1 $\frac{186 \times 899}{8.8 \times .8}$ = 23,700 HP	WS @ Divide = 2370							
	WS @ PS #1 = 1590	D	HP	-	23,700(ult)	205	4,859,000	
Hf = 50,000 @ 2.38'/1000 = 119+780=899'	780							
Surge Protection @ PS #1	186 x 646 120,000							
L = 50,000 = 9.5 miles	9.5 x 1000 = 10,000	-	-	-	-	-	130,000	
	130,000							
Terminal Reservoir - Same as Reg. Res.		-	AF	-	46	6,400	294,000	
Freeway Crossing		A	-	66"	-	LS	65,000	
Railway Crossing		A	-	66"	-	LS	15,000	
Pavement Replacement		-	SF	-	100,000	0.33	33,000	
Terminal Structure		-	-	-	-	LS	20,000	
Nevada Power Collection & Hwy. Crossing		-	-	-	-	LS	203,000	TOTAL COST

CONSTRUCTION COST (ULT.)	$15,590,000 + 30% =	$20,267,000
HP = 23,700-17,800 = 5,900 @ 100 =	590,000	767,000***
CONSTRUCTION COST (3/4 Pump. Cap.)	$15,000,000	$19,500,000
HP = 17,800-11,900 = 5,900 @ 100 =	590,000	767,000**
CONSTRUCTION COST (1/2 Pump. Cap.)	$14,410,000	$18,733,000*

1/ Class indicates ease of construction for pipe lines.

A = average
D = difficult
E = easy

*Construct ½ in 1973, ½ in 1974 for 1975 operation
**Construct ½ in 1976, ½ in 1977 for 1978 operation
***Construct ½ in 1983, ½ in 1984 for 1985 operation

EXPORT SYSTEM

ELDORADO VALLEY - WITH POWER

COST ESTIMATE

800,000 Population @ Year 2000

TABLE A-23.4
Sheet No. 4 of 4

ITEM		CLASS[1/]	UNIT	SIZE	QUANTITY	UNIT PRICE	AMOUNT	REMARKS
BMI Collection Line, 15 MGD	Pipe	A	LF	27"	2,000	$ 31	$ 62,000	Stage Construction
	Pipe	E	LF	27"	8,000	24	192,000	1975 - 51,700 AF
	Pipe	D	LF	27"	3,800	41	156,000	- 51,700 AF -
Highway Crossing	Pipe	A	LF	27"	200	80	16,000	High in 1976
BMI + Henderson, 15+5 = 20 MGD	Pipe	A	LF	36"	3,200	49	157,000	for all Export
City & County SD's to PS #1	Canal	A	LF	Lined	12,000	40	480,000	facilities.
176 MGD	RC Pipe	D	LF	66"	12,000	120	1,440,000	
Regulating Reservoir @ PS #1	12.5% x Max. Day		AF		22	8,900	196,000	Design for Avg.Ann.
P.S. #1 to Divide	RC Pipe Class 500	D	LF	42"	6,000	91	546,000	flow = 51,700 AF
	Class 300(avg)	E	LF	42"	18,000	53	954,000	X1.2 = max.day flow
	Class 150(avg)	A	LF	42"	26,000	61.50	1,599,000	= 62,000 AF/Yr
Divide to Terminal Res.	RC Pipe Class 100	A	LF	42"	10,000	60.50	605,000	= 86 cfs
PS #1 $\frac{86 \times 1060}{8.8 \times .8}$ = 12,950 HP	WS @ Divide = 2370							= 56 MGD
	WS @ PS #1 = 1590	D	HP	-	12,950 (ult)	205	2,655,000	= 171 AF/day
Hf = 50,000 @ 5.6'/1000 = 280+780 = 1060	780							$V_{42"} = \frac{86}{9.62} = 8.92'$ per sec.
Surge Protection @ PS #1	86 x 646 = 56,000	-	-	-	-	LS	66,000	Surge Prot. =
L = 50,000 = 9.5 miles	9.5 x 1000 = 10,000							$1000/mile + $646
	66,000							per cfs
Terminal Reservoir - Same as Reg. Res.		-	AF	-	22	8,900	196,000	
Freeway Crossing		A	-	42"	-	LS	50,000	Res.Cap. = 10% x
Railway Crossing		A	-	42"	-	LS	12,000	max.day
Pavement Replacement		-	SF	-	75,000	0.33	25,000	= 171 x 10% =
Terminal Structure		-	-	-	-	LS	15,000	17.1 AF
Nevada Power Collection & Hwy. Crossing		-	-	-	-	LS	203,000	

CONSTRUCTION COST (INITIAL & ULT.) = $9,625,000 + 30% = $12,513,000*

1/ Class indicates ease of construction for pipe lines.

A = average
D = difficult
E = easy

*Construct ½ in 1973, ½ in 1974 for 1975 operation

DISPOSAL SYSTEM

ELDORADO VALLEY - WITHOUT POWER

COST ESTIMATE

1,000,000 Population @ Year 2000

TABLE A-23.5

Sheet 1 of 4

ITEM		Capactiy	CLASS	UNIT	SIZE	QUANTITY	UNIT PRICE	AMOUNT	REMARKS
Stage 1 (Initial)									
Main Lake		23,200	-	Ac	-	2900	$ -	$ -	Max. 103,600 AF in 1990
Agriculture		31,800	-	Ac	-	6360	1,500	9,540,000	
Road Relocation	4.0 Mi.	55,000 AF	-	Mi	-	4.0	50,000	200,000	
Canal	1.3 Mi.		-	Mi	-	1.3	31,700	41,000	TOTAL COST
								9,781,000	+ 30% $12,715,000 (1975)*
Stage 2									
Main Lake		23,200	-	Ac	-	2900	-	-	
Agriculture		46,500	-	Ac	-	9300	1,500	13,950,000	
South Evaporation Ponds		300	-	Ac	-	37.5	1,500	56,000	
Canal		70,000 AF	-	Mi	-	2.8	31,700	89,000	
Road Relocation			-	Mi	-	4.0	50,000	200,000	Add $ 5,869,000**
								14,295,000	+ 30% $18,584,000 (1977)*
Stage 3									
Main Lake		23,200	-	Ac	-	2900	-	-	
Agriculture		46,500	-	Ac	-	9300	1,500	13,950,000	
South Evaporation Ponds		15,300	-	Ac	-	1910	1,500	2,865,000	
Canal	2.8 Mi.	85,000 AF	-	Mi	-	2.8	31,700	89,000	
Road Relocation	4.0 Mi.		-	Mi	-	4.0	50,000	200,000	Add $ 3,701,000**
								17,104,000	+ 30% $22,285,000 (1980)*
Stage 4									
Main Lake		23,200	-	Ac	-	2900	-	-	
Agriculture		46,500	-	Ac	-	9300	1,500	13,950,000	
Evaporation Ponds		30,300	-	Ac	-	3788	1,500	5,681,000	
Canal		100,000 AF	-	Mi	-	5.8	31,700	184,000	
Road Relocation			-	Mi	-	4.0	50,000	200,000	
Highway Crossings			-	-	-	-	LS	20,000	Add $ 3,760,000**
								20,035,000	+ 30% $26,045,000 (1985)*
Stage (Ult.)									
Main Lake		23,200	-	Ac	-	2900	-	-	
Agriculture		46,500	-	Ac	-	9300	1,500	13,950,000	
Evaporation Ponds		33,900	-	Ac	-	4237.5	1,500	6,356,000	
Canal		103,600	-	Mi	-	5.8	31,700	184,000	
Road Relocation			-	Mi	-	4.0	50,000	200,000	
Highway Crossings			-	-	-	-	LS	20,000	Add $ 878,000**
								$20,710,000	+ 30% $26,923,000 (1990)*

*For operation in year indicated
**For construction in preceding year

DISPOSAL SYSTEM AND DESALTING SYSTEM

COST ESTIMATE

1,000,000 Population @ Year 2000

ELDORADO VALLEY - WITH POWER

ITEM		CLASS	UNIT	SIZE	QUANTITY	UNIT PRICE	AMOUNT	REMARKS
Stage 1 (Initial)	Capacity							
Main Lake	23,200	-	AC	-	2900	$ -	$ -	Max. 59,300 AF in 1990
Agriculture	31,800	-	AC	-	6360	1,500	9,540,000	
Canal 1.3	55,000 AF	-	Mi	-	1.3	31,700	41,000	TOTAL COST
Road Relocation 4.0		-	Mi	-	4.0	50,000	200,000	
							$9,781,000 + 30% =	$12,715,000 (1975)* (1974 construction)
Stage 2 (Ult.)								
Main Lake	23,200	-	AC	-	2900	-	-	
Agriculture	36,100	-	AC	-	7220	1,500	$10,830,000	
Canal 1.3	59,300	-	AC	-	1.3	31,700	41,000	
Road Relocation 4.0		-	Mi	-	4.0	50,000	200,000	Add $ 1,677,000**
							$11,071,000 + 30% =	14,392,000 (1990)*

DESALTING SYSTEM

Eldorado Valley - Without Power

Phosphorus Removal	MGD	95	1	LS	$ 7,800,000	
Mixed Media Filtration	MGD	95	1	LS	4,350,000	
Desalt Plant	MGD	95	1	LS	35,500,000	
Alternate Desalt Effluent Discharge (to Lake Mead)	LF	Channel	41,000		1,085,000	
					$48,735,000 + 30% =	$63,356,000 (1991)* (for construction in 1989 and 1990)
Alternate Desalt Effluent Discharge (to SNWP)	LF	60" pipe & channel	72,000		2,441,000	
					$50,091,000 + 30% =	$65,018,000 (1991)* (for construction in 1989 and 1990)

DESALTING SYSTEM

Eldorado Valley - With Power

Phosphorus Removal	MGD	70	1	LS	$ 6,000,000	
Mixed Media Filtration	MGD	70	1	LS	3,400,000	
Desalt Plant	MGD	70	1	LS	26,000,000	
Alternate Desalt Effluent Discharge (to Lake Mead)	LF	Channel	41,000		1,085,000	
					$36,485,000 + 30% =	$47,431,000 (1991)* (for construction in 1989 and 1990)
Alternate Desalt Effluent Discharge (to SNWP)	LF	60" pipe & channel	72,000		2,441,000	
					$37,841,000 + 30% =	$49,193,000 (1991)* (for construction in 1989 and 1990)

*For operation in year indicated
**For construction in 1989

DISPOSAL SYSTEM

ELDORADO VALLEY - WITHOUT POWER

COST ESTIMATE

800,000 Population @ Year 2000

TABLE A-23.5
Sheet 3 of 4

ITEM		CLASS	UNIT	SIZE	QUANTITY	UNIT PRICE	AMOUNT	REMARKS
Stage 1 (Initial)	Capactiy							
Main Lake	23,200	-	Ac	-	2900	$ -	$ -	Max. 111,300 AF in 1999
Agriculture	31,800	-	Ac	-	6360	1,500	9,540,000	
Road Relocation 4.0 Mi.	55,000 AF	-	Mi	-	4.0	50,000	200,000	
Canal 1.3 Mi.		-	Mi	-	1.3	31,700	41,000	TOTAL COST
							9,781,000	+ 30% $12,715,000 (1975)* (construct in 1974)
Stage 2								
Main Lake	23,200	-	Ac	-	2900	-	-	
Agriculture	46,500	-	Ac	-	9300	1,500	13,950,000	
South Evaporation Ponds	300	-	Ac	-	37.5	1,500	56,000	
Canal	70,000 AF	-	Mi	-	2.8	31,700	89,000	
Road Relocation		-	Mi	-	4.0	50,000	200,000	Add $ 5,869,000**
							14,295,000	+ 30% $18,584,000 (1978)*
Stage 3								
Main Lake	23,200	-	Ac	-	2900	-	-	
Agriculture	46,500	-	Ac	-	9300	1,500	13,950,000	
South Evaporation Ponds	15,300	-	Ac	-	1910	1,500	2,865,000	
Canal 2.8 Mi.	85,000 AF	-	Mi	-	2.8	31,700	89,000	
Road Relocation 4.0 Mi.		-	Mi	-	4.0	50,000	200,000	Add $ 3,701,000**
							17,104,000	+ 30% $22,285,000 (1985)*
Stage 4								
Main Lake	23,200	-	Ac	-	2900	-	-	
Agriculture	46,500	-	Ac	-	9300	1,500	13,950,000	
Evaporation Ponds	30,300	-	Ac	-	3788	1,500	5,681,000	
Canal 5.8 mi.	100,000 AF	-	Mi	-	5.8	31,700	184,000	
Road Relocation 4.0 mi.		-	Mi	-	4.0	50,000	200,000	
Highway Crossings		-	-	-	-	LS	20,000	Add $ 3,760,000**
							20,035,000	+ 30% $26,045,000 (1990)*
Stage 5 (Ult.)								
Main Lake	23,200	-	Ac	-	2900	-	-	
Agriculture	46,500	-	Ac	-	9300	1,500	13,950,000	
Evaporation Ponds	41,600	-	Ac	-	5200	1,500	7,800,000	
Canal 5.8 Mi.	111,300 AF	-	Mi	-	5.8	31,700	184,000	
Road Relocation 4.0 Mi.		-	Mi	-	4.0	50,000	200,000	
Highway Crossings		-	-	-	-	LS	20,000	Add $ 2,755,000**
							$22,154,000	+ 30% $28,800,000 (1995)*

*For operation in year indicated
**For construction in preceding year

DISPOSAL SYSTEM

ELDORADO VALLEY - WITH POWER

COST ESTIMATE

800,000 Population @ Year 2000

TABLE A-23.5

Sheet 4 of 4

ITEM		CLASS	UNIT	SIZE	QUANTITY	UNIT PRICE	AMOUNT	REMARKS
Stage 1 (Initial & Ultimate)	Capacity							Max. 51,700 AF in 1976
Main Lake	23,200	-	Ac	-	2900	$ -	$ -	
Agriculture	28,500	-	Ac	-	5700	1,500	8,550,000	
Road Relocation 4 Mi.	51,700 AF	-	Mi	-	4.0	50,000	200,000	TOTAL COST
Canal 1.3 Mi.		-	Mi	-	1.3	31,700	41,000	
							$ 8,791,000	+ 30% $11,428,000 (1975)* (construct in 1974)

*For operation in 1975

IN VALLEY IRRIGATION SYSTEM

ELDORADO VALLEY - WITH AND WITHOUT POWER

COST ESTIMATE

TABLE A-23.6
Sheet No. 1 of 1

ITEM		CLASS*	UNIT	SIZE	QUANTITY	UNIT PRICE	AMOUNT	REMARKS
South System - Phase 1 - 1975								
Pump Sta."a" @ Wash #1 PS		A	HP	-	3,010	$ 150 1/	$ 452,000 2/	
Pump Sta."b" @ El. 2000		A	HP	-	1,850	205	379,000	1/ Cost per HP reduced to $150 since PS is located with Main Export PS.
Surge Protection @ PS "a", 32,000 + 11,000		-	-	-	-	LS	43,000	
Surge Protection @ PS "b", 32,000 + 5,000		-	-	-	-	LS	37,000	
Pipe Lines, Flamingo Road	Class 200 (avg)	A	LF	42"	24,000	56	1,344,000	
Freeway Crossing		E	LF	42"	250	125	31,000	
Flamingo Road	Class 200 (avg)	A	LF	36"	8,000	50	400,000	2/$377,000 in 1975 $75,000 in 1985
Flamingo Rd. & Strip	Class 200 (avg)	A-D	LF	30"	26,000	39	1,014,000	
Railway to Maryland	Class 150 (avg)	A	LF	24"	19,000	27	513,000	
Feeder	Class 150 (avg)	A	LF	18"	5,300	20	106,000	
	Class 150 (avg)	A	LF	12"	11,000	12	132,000	
	Class 150 (avg)	A	LF	8"	2,000	8	16,000	
Storage		-	AF	-	18	9,500	171,000	
Pavement Replacement		-	SF	-	330,000	0.33	109,000	
				Sub Total			$4,672,000 + 30% = $6,074,000 1975* (construct in 1974)	
North System - Phase 2 - 1985								
Pipe Lines, Mohave Rd. etc.	Class 150 (avg)	A	LF	24"	39,500	27	1,067,000	
Highway Crossings (2)	Class 150 (avg)	A	LF	24"	500	75	38,000	
Service Lines	Class 150 (avg)	A	LF	12"	3,000	12	36,000	
	Class 150 (avg)	A	LF	10"	3,000	10	30,000	
	Class 150 (avg)	A	LF	8"	24,000	8	192,000	
Reservoir		-	MG	-	1.3	.10	130,000	
Pavement Replacement (4' wide avg)			SF		290,000	0.33	96,000	*Class indicates ease of construction for Pipe Lines A = average D = difficult E = easy
West of Freeway								
Pump Station		-	HP	-	320	208	67,000	
Surge Protection		-	-	-	-	LS	10,000	
Reservoir		-	MG	-	1.1	.11	120,000	
Railway & Freeway Crossings	Class 150 (avg)	-	LF	18"	400	70	28,000	
Pipe Lines - Feeder	Class 150 (avg)	A	LF	18"	27,000	20	540,000	
Pavement Replacement (4' wide avg)		-	SF	-		0.33	33,000	
Henderson - Black Mtn.								
Service Line	Class 150 (avg)	A	LF	10"	6,000	10	60,000	
Highway Crossing (2)		A	LF	10"	250	LS	10,000	
Outlet		-	-	-	-	LS	2,000	Add $3,294,000**
				CONSTRUCTION COST (Ult)			$7,206,000 + 30% = $9,368,000*	

*For operation in year indicated
**For construction in preceding year

EXPORT SYSTEM

JEAN LAKE - WITHOUT POWER

1,000,000 Population @ Year 2000

TABLE A-23.7

Sheet No. 1 of 4

ITEM		CLASS 1/	UNIT	SIZE	QUANTITY	UNIT PRICE	AMOUNT	REMARKS
BMI Collection Line, 15 MGD	Pipe	A	LF	30"	13,800	$ 38	$ 524,000	
	Pipe	D	Lf	30"	3,000	48	144,000	
Highway Crossing	Pipe	A	LF	30"	200	90	18,000	
BMI + Henderson 15+5 = 20 MGD	Pipe	D	LF	36"	9,000	61	549,000	Refer to DRY LAKE without
	Pipe	A	LF	36"	9,500	49	466,000	power
Henderson P.S. $\frac{7.75 \text{ cfs} \times 120}{8.8 \times .70}$ = 150 HP; H = 1720 - 1600 =	120	-	HP	-	150	300	45,000	1,000,000 pop. @ year 2000
City and County SD's to Pump Sta. #1	Canal	A	LF	Lined	12,800	40	512,000	for remarks
Regulating Reservoir @ PS #1 = 12.5% of max. day		-	AF	-	42	6,800	286,000	
PS #1 to Divide	RC Pipe Class 200 (avg.)	A	LF	66"	34,000	122	4,148,000	
	RC Pipe Class 200 (avg.)	E	LF	66"	80,000	100	8,000,000	
	RC Pipe Class 150 (avg.)	D	LF	66"	11,000	136.50	1,502,000	
PS #1 $\frac{172 \times 590}{8.8 \times .8}$ = HP = 14,500; Hf = 45,400 x 2.1'/1000 = 95; H = 95 + 495 = 590; WS @ PS #2 = 2150, WS @ PS #1 = 1655, 495		-	HP	-	14,500	205	2,973,00	
PS #2 $\frac{172 \times 595}{8.8 \times .8}$ = 14,600 HP; Hf = 45,400 x 2.1'/1000 = 95; H = 95 + 500 = 595; WS @ PS #3 = 2650, WS @ PS #2 = 2150, 500		-	HP	-	14,600	205	2,993,000	
PS #3 $\frac{172 \times 542}{8.8 \times .8}$ = 13,300 HP; Hf = 34,200 @ 2.1'/1000 = 72'; H = 72 + 470 = 542; WS @ Divide = 3120, WS @ PS #3 = 2650, 470		-	HP	-	13,300	205	2,727,000	
Forebay @ PS #2 = ½ Size of Reg. Res.		-	AF	-	21	9,100	191,000	
Forebay @ PS #3 - ¼ Size of Reg. Res.		-	AF	-	10.5	10,100	106,000	
Surge Protection @ PS #1; L = miles = 8.6	172 x 646 = 111,000; 8.6 x 1000 9,000; 120,000	-	-	-	-	LS	120,000	
Surge Protection; L = 8.6 miles	same	-	-	-	-	LS	120,000	
Surge Protection; L = 6.5 miles	172 x 646 = 111,000; 6.5 x 1000 7,000	-	-	-	-	LS	118,000	
Freeway Crossing		-	-	-	-	LS	25,000	
Highway Crossing (Henderson Cutoff)		-	-	-	-	LS	20,000	
Railway Crossing		-	-	-	-	LS	15,000	
Pavement Replacement		-	SF	-	505,000	0.33	167,000	
Terminal Structure		-	-	-	-	LS	30,000	
Nevada Power Collection & Highway Crossing		-	-	-	-	LS	121,000	TOTAL COST

CONSTRUCTION COST (ULTIMATE)	$25,920,000 + 30%	$33,696,000	(1985)*
HP 42,550 - 32,000 = 10,550 @ 100	1,055,00	1,372,000 ***	
CONSTRUCTION COST (3/4 Pumping Cap.)	24,865,000 + 30%	32,324,000	(1977)*
HP 32,000 - 21,400 = 10,600 @ 100	1,060,000	1,378,000 **	
CONSTRUCTION COST (1/2 Pumping Cap.)	$23,805,000 + 30%	$30,946,000	(1975)*
		(construct ½ in 1973, ½ in 1974)	

1/Class Indicates ease of construction for pipelines
- A - average PS#1 (Wash)
- D - difficult PS#2 (Henderson Co.)
- E - easy PS#3 (Sloan)

*For operation in year indicated

**Construct ½ in 1975, ½ in 1976

***Construct ½ in 1983, ½ in 1984

EXPORT SYSTEM

JEAN LAKE - WITH POWER

1,000,000 Population @ Year 2000

TABLE A-23.7

Sheet No. 2 of 4

ITEM		CLASS 1/	UNIT	SIZE	QUANTITY	UNIT PRICE	AMOUNT	REMARKS
BMI Collection Line, 15 MGD	Pipe	A	LF	30"	13,800	$ 38	$ 524,000	
	Pipe	D	LF	30"	3,000	48	144,000	
Highway Crossing	Pipe	A	LF	30"	200	90	18,000	Refer to Eldorado Valley
BMI + Henderson 15+5 = 20 MGD	Pipe	D	LF	36"	9,000	61	549,000	With Power.
	Pipe	A	LF	36"	9,500	49	466,000	1,000,000 pop. @ year
Henderson P.S. $\frac{7.75 \text{ cfs} \times 120}{8.8 \times .70}$ = 150 HP; H = 1720 - 1600 = 120		-	HP	-	150	300	45,000	2000 for remarks.
City and County SD's to Pump Sta. #1	Canal	A	LF	Lined	12,800	40	512,000	
Regulating Reservoir @ PS #1 12.5% of max. day		-	AF	-	24	8600	206,000	
PS #1 to Divide RC Pipe	Class 200 (avg.)	A	LF	48"	34,000	77	2,618,000	
	Class 200 (avg.)	E	LF	48"	80,000	61	4,880,000	
	Class 150 (avg.)	D	LF	48"	11,000	89.50	985,000	
PS #1 $\frac{99 \times 677}{8.8 \times .8}$ = HP = 9,600 Hf = 45,400 @ 4.0'/1000 = 182 H = 182 + 495 = 677	WS @ PS #2 = 2150 WS @ PS #1 = 1655 495	-	HP	-	9,600	205	1,968,000	
PS #2 $\frac{99 \times 682}{8.8 \times .8}$ = 9,600 Hf = 45,400 @ 4'/1000 = 182 H = 182 + 500 = 682	WS @ PS #3 = 2650 WS @ PS #2 = 2150 500	-	HP	-	9,600	205	1,968,000	
PS #3 $\frac{99 \times 607}{8.8 \times .8}$ = HP = 8,600 Hf = 34,200 @ 4'/1000 = 137 H = 137 + 470 = 607	WS @ divide = 3120 WS @ PS #3 = 2650 470	-	HP	-	8,600	205	1,763,000	
Forebay @ PS #2 = ½ size of Reg. Res.		-	AF	-	12	10,300	124,000	
Forebay @ PS #3 = ¼ size of Reg. Res.		-	AF	-	6	12,000	72,000	
Surge Protection @ PS #1 L = 3.6 miles	99 x 646 = 64,000 8.6 x 1000 = 9,000	-	-	-	-	LS	73,000	
Surge Protection @ PS #2 L = 8.6 miles	same	-	-	-	-	LS	73,000	
Surge Protection @ PS #3 L = 6.5 miles	99 x 646 = 64,000 6.5 x 1000 = 7,000	-	-	-	-	LS	71,000	
Freeway Crossing		-	-	-	-	LS	25,000	
Highway Crossing (Henderson Cutoff)		-	-	-	-	LS	20,000	
Railway Crossing		-	-	-	-	LS	15,000	
Pavement Replacement		-	SF	-	400,000	0.33	132,000	
Terminal Structure		-	-	-	-	LS	30,000	
Nevada Power Collection & Highway Crossing		-	-	-	-	LS	121,000	TOTAL COST

CONSTRUCTION COST (ULTIMATE)	$17,402,000 + 30%	$22,623,000	(1990)*
HP 27,950 - 25,650 = 2300 @ $100 =	230,000	299,000 **	
CONSTRUCTION COST (92% Pumping Cap.) (Initial)	$17,172,000 + 30%	$22,324,000	(1975)*
		(construct ½ in 1973, ½ in 1974)	

1/Class indicates ease of construction for pipelines
A - average PS #1 (Wash)
D - difficult PS #2 (Henderson)
E - easy PS #3 (Sloan)
*For operation in year indicated
**For construction in 1989

EXPORT SYSTEM

JEAN LAKE - WITHOUT POWER

800,000 Population @ Year 2000

ITEM		CLASS[1/]	UNIT	SIZE	QUANTITY	UNIT PRICE	AMOUNT	REMARKS
BMI Collection Line, 15 MGD	Pipe	A	LF	30"	13,800	$ 38	$ 524,000	
	Pipe	D	LF	30"	3,000	48	144,000	
Highway Crossing	Pipe	A	LF	30"	200	90	18,000	Refer to Dry Lake without power
BMI + Henderson 15+5 = 20 MGD	Pipe	D	LF	36"	9,000	61	549,000	
	Pipe	A	LF	36"	9,500	49	466,000	800,000 pop. @ year 2000
Henderson P.S. $\frac{7.75 \text{ cfs} \times 120}{8.8 \times .70}$ = 150 HP; H = 1720 - 1600 = 120		-	HP	-	150	300	45,000	for remarks
City and County SD's to Pump Sta. #1	Canal	A	LF	Lined	12,800	40	512,000	
Regulating Reservoir @ PS #1 12.5% of max. day	-	-	AF	-	46	6400	294,000	
PS #1 to Divide RC Pipe	Class 200 (avg)	A	LF	66"	34,000	122	4,148,000	
	Class 200 (avg)	E	LF	66"	80,000	100	8,000,000	
	Class 150 (avg)	D	LF	66"	11,000	136.50	1,502,000	
PS #1 $\frac{186 \times 600}{8.8 \times .8}$ = 15,800 HP; 45,400 x 2.3'/1000 = 105; H = 105 + 495 = 600	WS @ PS #2 = 2150; WS @ PS #1 = 1655; 495	-	HP	-	15,800	205	3,239,000	
PS #2 $\frac{186 \times 605}{8.8 \times .8}$ = 16,000 HP; 45,400 x 2.3'/1000 = 105; H = 105 + 500 = 605	WS @ PS #3 = 2650; WS @ PS #2 = 2150; 500	-	HP	-	16,000	205	3,280,000	
PS #3 $\frac{186 \times 549}{8.8 \times .8}$ = 14,500 HP; 34,200 x 2.3'/1000 = 79; H = 79 + 470 = 549	WS @ divide= 3120; WS @ PS #3 = 2650; 470	-	HP	-	14,500	205	2,973,000	
Forebays @ PS #2 = ½ size of Reg. Res.		-	AF	-	23	8800	202,000	
Forebays @ PS #3 = ¼ size of Reg. Res.		-	AF	-	11.5	10,400	120,000	
Surge Protection @ PS #1	186 x 646 = 120,000; 8.6 x 1000 9,000	-	-	-	-	LS	129,000	
L = 8.6 miles								
Surge Protection @ PS #2	same	-	-	-	-	LS	129,000	
L = 8.6 miles								
Surge Protection @ PS #3	186 x 646 = 120,000; 6.5 x 100 7,000	-	-	-	-	LS	127,000	
L = 6.5 miles								
Freeway Crossing		-	66"	-	-	LS	25,000	
Highway Crossing		-	-	-	-	LS	20,000	
Railway Crossing		-	-	-	-	LS	15,000	
Pavement Replacement		-	SF	-	505,000	0.33	167,000	
Terminal Structure		-	-	-	-	LS	30,000	
Nevada Power Collection & Highway Crossing		-	-	-	-	LS	121,000	

1/Class indicates ease of construction for pieplines
- A - average
- D - difficult
- E - easy

PS #1 (Wash)
PS #2 (Henderson)
PS #3 (Sloan)

*For operation in year indicated
**Construct ½ in 1976, ½ in 1977
***Construct ½ in 1983, ½ in 1984

CONSTRUCTION COST (ULTIMATE)	$26,779,000	+ 30% =	$34,813,000	(1985)*
HP = 46,450 - 34,900 = 11,550 @ 100 =	1,155,000		1,502,000	***
CONSTRUCTION COST (3/4 Pumping Cap.)	25,624,000	+ 30% =	33,311,000	(1978)*
HP = 34,900 - 23,300 = 11,600 @ 100 =	1,160,000		1,508,000	**
CONSTRUCTION COST (1/2 Pumping Cap.)	$24,464,000	+ 30% =	$31,803,000	(1975)* (construct ½ in 1973, ½ in 1974)

TOTAL COST

EXPORT SYSTEM

JEAN LAKE - WITH POWER

800,000 Population @ Year 2000

TABLE A-23.7

Sheet 4 of 4

ITEM		CLASS[1/]	UNIT	SIZE	QUANTITY	UNIT PRICE	AMOUNT	REMARKS
BMI Collection Line, 15 MGD	Pipe	A	LF	30"	13,800	$ 38	$ 524,000	
	Pipe	D	LF	30"	3,000	48	144,000	
Highway Crossing	Pipe	A	LF	30"	200	90	18,000	Refer to Eldorado Valley
BMI + Henderson 15 + 5 = 20 MGD	Pipe	D	LF	36"	9,000	61	549,000	with power
	Pipe	A	LF	36"	9,500	49	466,000	800,000 population
Henderson P.S. $\frac{7.75 \text{ cfs} \times 120}{8.8 \times .70}$ = 150 HP; H = 1720 - 1600 = 120		-	HP	-	150	300	45,000	@ year 2000 for remarks
City and County SD's to Pump Sta. #1	Canal	A	LF	Lined	12,800	40	512,000	
Regulating Reservoir @ PS #1 12.5% of max. day		-	AF	-	22	8900	196,000	
PS #1 to Divide RC Pipe	Class 200 (avg.)	A	LF	42"	34,000	63	2,142,000	
	Class 200 (avg.)	E	LF	42"	80,000	50	4,000,000	
	Class 150 (avg.)	D	LF	42"	11,000	74.50	820,000	
PS #1 $\frac{86 \times 749'}{8.8 \times .8}$ = 9,150 Hf = 45,400 @ 5.6'/1000 = 254' H = 254 + 495 = 749	WS @ PS #2 = 2150 WS @ PS #1 = 1655 495	D	HP	-	9,150	205	1,876,000	
PS #2 $\frac{86 \times 754}{8.8 \times .8}$ = 9200 Hf = 45,400 @ 5.6'/1000 = 254 H = 254 + 500 = 754	WS @ PS #3 = 2650 WS @ PS #2 = 2150 500	A	HP	-	9,200	205	1,886,000	
PS #3 $\frac{86 \times 662}{8.8 \times .8}$ = 8100 Hf = 34,200 x 5.6'/1000 = 192 H = 192 + 470 = 662	WS @ Divide= 3120 WS @ PS #3 = 2650 470	A	HP	-	8,100	205	1,661,000	
Forebay @ PS #2 = ½ size of Reg. Res.		-	AF	-	11	10,500	116,000	
Forebay @ PS #3 = ¼ size of Reg. Res.		-	AF	-	5.5	12,400	68,000	
Surge Protection @ PS #1 L = 8.6 miles	86 x 646 = 56,000 8.6 x 1000 =9,000	-	-	-	-	-	65,000	
Surge Protection @ PS #2 L = 8.6 miles	same	-	-	-	-	-	65,000	
Surge Protection @ PS #3 L = 6.5 miles	86 x 646 = 56,000 6.5 x 1000 = 7,000	-	-	-	-	-	63,000	
Freeway Crossing		-	-	-	-	LS	20,000	
Highway Crossing (Henderson Cutoff)		-	-	-	-	LS	15,000	
Railway Crossing		-	-	-	-	LS	12,000	
Pavement Replacement		-	SF	-	375,000	0.33	124,000	
Terminal Structure		-	-	-	-	LS	25,000	
Nevada Power Collection & Highway Crossing		-	-	-	-	LS	121,000	TOTAL COST
		CONSTRUCTION COST (Initial & Ultimate)					$15,533,000 + 30%	$20,193,000 (1975)*

1/Class indicates ease of construction for pipelines
- A - average
- D - difficult
- E - easy

PS #1 (Wash)
PS #2 (Henderson)
PS #3 (Sloan)

*Construct ½ in 1973, ½ in 1974 for 1975 operation

A-1

IN VALLEY IRRIGATION SYSTEM

JEAN LAKE - WITH AND WITHOUT POWER

COST ESTIMATE

TABLE A-23.9
Sheet No. 1 of 1

ITEM		CLASS*	UNIT	SIZE	QUANTITY	UNIT PRICE	AMOUNT	REMARKS
South System - Phase 1 - 1975								
Pump Sta."a" @ Wash #1 PS		A	HP	-	3,010	$ 150 1/	$ 452,000 2/	
Pump Sta."b" @ El. 2000		A	HP	-	1,850	205	379,000	1/ Cost per HP reduced to $150 since PS is located with main export P.S.
Surge Protection @ PS "a", 32,000 + 11,000		-	-	-	-	LS	43,000	
Surge Protection @ PS "b", 32,000 + 5,000		-	-	-	-	LS	37,000	
Pipe Lines, Flamingo Road	Class 200 (avg)	A-E	LF	42"	24,000	56	1,344,000	
Freeway Crossing		E	LF	42"	250	125	31,000	
Flamingo Road	Class 200 (avg)	A	LF	36"	8,000	50	400,000	
Flamingo Rd. & Strip	Class 200 (avg)	A	LF	30"	26,000	39	1,014,000	
Railway to Maryland	Class 150 (avg)	A	LF	24"	19,000	27	513,000	2/ $377,000 in 1975 $75,000 in 1985
Feeder	Class 150 (avg)	A	LF	18"	5,300	20	106,000	
	Class 150 (avg)	A	LF	12"	11,000	12	132,000	
	Class 150 (avg)	A	LF	8"	2,000	8	16,000	
Storage		-	AF	-	18	9,500	171,000	
Pavement Replacement		-	SF	-	330,000	0.33	109,000	
			Sub Total				$4,672,000 + 30% = $6,074,000 (1974 construction - for 1975 operation)	
North System - Phase 2 - 1985								
Pipe Lines, Mohave Rd. etc.	Class 150 (avg)	A	LF	24"	39,500	$ 27	$1,067,000	
Highway Crossings (2)	Class 150 (avg)	A	LF	24"	500	75	38,000	
Service Lines	Class 150 (avg)	A	LF	12"	3,000	12	36,000	
	Class 150 (avg)	A	LF	10"	3,000	10	30,000	
	Class 150 (avg)	A	LF	8"	24,000	8	192,000	
Reservoir		-	MG	-	1.3	.10	130,000	
Pavement Replacement (4' wide avg)		-	SF	-	290,000	0.33	96,000	
West of Freeway								
Pump Station		-	HP	-	320	208	67,000	
Surge Protection		-	-	-	--	LS	10,000	* Class indicates ease of construction for pipe lines
Reservoir		-	MG	-	1.1	.11	120,000	A = average
Railway & Freeway Crossings		-	LF	18"	400	70	28,000	D = difficult
Pipe Lines - Feeder	Class 150 (avg)	A	LF	18"	27,000	20	540,000	E = easy
Pavement Replacement (4' wide avg)		-	SF	-	110,000	0.33	33,000	
Henderson Cut-off System								
Service Lines		A	LF	14"	4,000	15	60,000	
		A	LF	12"	8,000	12	96,000	
		A	LF	10"	10,000	10	104,000	
Highway Crossing		A	LF	14"	100	50	5,000	Add $3,545,000
			Total Cost				$7,399,000 + 30% = $9,619,000 (1984 construction for 1985 operation)	

DELIVERY SYSTEM FOR
ARROW CANYON POWER PLANT

COST ESTIMATE

FOR ALL PLANS EXCEPT DRY LAKE

TABLE A-23.10
Sheet No. 1 of 1

ITEM	CLASS*	UNIT	SIZE	QUANTITY	UNIT PRICE	AMOUNT	REMARKS
Regulating Reservoir @ PS #1	-	AF	-	23	8,800	$ 202,000	Avg.Ann.Flow (max) = 70,000 AF
Pipe Line - PS #1 to PS #2 RC Class 200 (avg)	A-E	LF	54"	66,000	82.50	5,445,000	
PS #2 to Divide RC Class 200 (avg)	A-E	LF	54"	14,000	82.50	1,155,000	
RC Class 200 (avg)	E	LF	54"	10,000	74	740,000	X1.2 = Max.day flow = 84,000 AF/Yr. = 116 cfs = 75 MGD = 230 AF/day
Divide to Term.Res. RC Class 100	A	LF	54"	40,000	87.50	3,500,000	
PS #1 @ Reg. Res. HP = $\frac{116 \times 610}{8.8 \times .8}$ = 10,050; WS @ PS #2 = 2080; WS @ Reg.Res. = 1655; 425'; Hf = 66,000 x 2.8 = 185; H = 185+425= 610'	-	HP	-	10,050	205	2,060,000	Storage Reg. Res. @ PS #1 = 10% of max day = 23 AF.
PS # 2 HP = $\frac{116 \times 527}{8.8 \times .8}$ = 8,700; WS @ Divide = 2540; WS @ PS #2 2080; 460'; Hf - 24,000 x 2.8 = 67'; H=67+460=527	-	HP	-	8,700	205	1,784,000	Forebay @ PS #2 = 5% of max.day = 11.5 AF.
Forebay @ PS #2	-	AF	-	11.5	10,400	120,000	Forebay @ Divide = 2.5% of max.day= 5.8 AF.
Forebay @ Divide	-	AF	-	5.8	12,200	71,000	
Terminal Res @ Arrow Cyn.	-	AF	-	38	7,200	274,000	Term.Res. @ Arrow Cyn = Max.day-Avg.day = 230 AF-192 AF = 38 AF
Surge Protection @ PS #1 - 116 x 646 = 75,000; L = 66,000 - 12.5 miles 12.5 x 1000 = 13,000	-	-	-	-	LS	88,000	Surge Protection = $646/cfs + $1000/mile
Surge Protection @ PS #2 - 116 x 646 = 75,000; L = 24,000 - 4.5 miles 4.5 x 1000 = 5,000	-	-	-	-	LS	80,000	
PS @ Term. Res. HP = $\frac{116 \times 64}{8.8 \times .8}$ = 1,055; WS @ Supply = 2480; WS @ Term.Res. = 2430; 50; Hf = 5000 x 2.8 = 14'; H = 64'	-	HP	-	1,055	205	216,000	Pump Horse Power = $\frac{QH}{8.8 \times .8}$
Pipe Line - Term. Res. to Power Plant RC Class 150	A	LF	54"	5,000	87.50	438,000	Stage Construction
Freeway Crossing	E	LF	54"	200	100	20,000	1975= 35,000 AF - pumps; 70,000 AF - pipelines
Railway Crossing	E	LF	54"	50	LS	10,000	
Pavement Replacement	-	SF	-	320,000	0.33	106,000	
Terminal Structure	-	-	-	-	LS	25,000	1985= 70,000 AF - pumps
CONSTRUCTION COST						$16,334,000	
+30%							
1985 TOTAL COST (Ult.)						$21,234,000	
HP 19,805 x 1/2 = 9,900 @ 100 = 990,000 x 1.3 =						-1,287,000	
1975 TOTAL COST						$19,947,000	

* Class indicates ease of construction for pipelines

A = average (P.S. #1 = wash)
D = difficult (P.S. #2 = Hwy 91)
E = easy

DELIVERY SYSTEM FOR

ARROW CANYON POWER PLANT

COST ESTIMATE

FOR DRY LAKE PLAN ONLY

TABLE A-23.11
Sheet No. 1 of 1

ITEM	CLASS	UNIT	SIZE	QUANTITY	UNIT PRICE	AMOUNT	REMARKS
Increase in dual use line pipe size from Divide to point on dual use line to evaporation ponds. 60" RCP Class 100 avg. to 66" RCP	A	LF	6"diff.	16,000	$ 15	$ 240,000	Avg. Ann. Flow (max) = 70,000 AF X1.2 Factor = max. day flow = 84,000 AF/Yr. = 116 cfs = 75 MGD = 230 AF/day
Pipe Line - Dual Use Line to Term. Res. RC Class 100	A	LF	54"	34,000	87.50	2,975,000	
Terminal Reservoir @ Arrow Cyn	-	AF	-	38	7,200	274,000	
Pump Station @ Term. Res. $HP \doteq 1{,}055 = \frac{116 \times 64}{8.8 \times .8}$ Static Head = 50'	-	HP	-	1,055	205	216,000	
Hf = 5000 x 2.8 = 14'; H = 14 + 50 = 64							
Pipe Line from Term. Res. to Power Plant	A	LF	54"	5,000	87.50	438,000	
Terminal Structure	-	-	-	-	LS	25,000	
			CONSTRUCTION COST			$4,168,000	
				+30%		1,250,000	
		1975 TOTAL COST				$5,418,000	

COST ESTIMATE

(See Sheet 3 of 3 for Summary)

Complete Treatment

Table A-23.12
Sheet 1 of 3

ITEM	UNIT	SIZE	QUANTITY	UNIT PRICE	AMOUNT	REMARKS
Collection System*						
Concrete Channel	LF		22,500	$ 21.85	$ 492,500	
Siphon	LF		1,500	89.00	134,000	
Pipeline	LF		10,500	36.00	378,000	
				Subtotal	$1,004,500	+ 30% = $ 1,306,000
Tertiary Treatment Plant*						
Phosphorus Removal System	MGD	60	1	LS	$5,340,000	
Mixed Media Filtration System	MGD	60	1	LS	3,080,000	
Carbon Adsorption System	MGD	60	1	LS	4,960,000	
Chlorination System	MGD	60	1	LS	553,000	
				Subtotal	$13,933,000	+ 30% = $18,113,000
Brine Export System*						
Forebays			3		$ 179,000	
Pipelines	LF	36" & 42"	116,000		6,268,000	
Pump Stations			2		1,750,000	
Surge Protection				LS	88,000	
Freeway & Railroad Crossings				LS	25,000	
Pavement Replacement	SF		270,000	0.33	89,000	
Terminal Structure				LS	15,000	
				Subtotal	$ 8,414,000	+ 30% = $10,938,000 (for 1,000,000 population at year 2000 without pow
Brine Export System Alternative*						
Forebays			3		$ 150,000	
Pipelines	LF	30" & 36"	116,000		4,912,000	
Pump Stations			2		1,408,000	
Surge Protection				LS	72,000	
Freeway & Railroad Crossings				LS	22,000	
Pavement Replacement	SF		250,000	0.33	83,000	
Terminal Structure				LS	13,000	
				Subtotal	$ 6,660,000	+ 30% = $ 8,658,000 (for 1,000,000 population at year 2000 with power)
Brine Export System Alternative*						
Forebays			3		$ 150,000	
Pipelines	LF	30" & 36"	116,000		4,912,000	
Pump Stations			2		1,408,000	
Surge Protection				LS	72,000	
Freeway & Railroad Crossings				LS	22,000	
Pavement Replacement	SF		250,000	0.33	83,000	
Terminal Structure				LS	13,000	
				Subtotal	$ 6,660,000	+ 30% = $ 8,658,000 (for 800,000 population at year 2000 without pow
Brine Export System Alternative*						
Forebays			3		$ 85,000	
Pipelines	LF	24" & 30"	116,000		3,736,000	
Pump Stations			2		650,000	
Surge Protection				LS	44,000	
Freeway & Railroad Crossings				LS	20,000	
Pavement Replacement	SF		230,000	0.33	76,000	
Terminal Structure				LS	12,000	
				Subtotal	$ 4,623,000	+ 30% = $ 6,010,000 (for 800,000 population a year 2000 with power)

COST ESTIMATE

COMPLETE TREATMENT (See Sheet 3 of 3 for Summary)

Table A-23.12
Sheet 2 of 3

ITEM	UNIT	SIZE	QUANTITY	UNIT PRICE	AMOUNT	REMARKS
In-Valley Irrigation System-Phase 1 1975 operation (construct in 1974)						Same as for export to Dry Lake, see Table A-23.3
(See Table A-23.3)				Subtotal	$ 4,672,000	+ 30% = $6,074,000
Regulating Reservoir Construct in 1978 and 1979 for 1980 operation	AF	54	1	$7,250	391,000	+ 30% = $508,000
Desalt Plant Construct in 1978 and 1979 for 1980 operation	MGD	60	1	LS	22,400,000	+ 30% = $29,120,000
Alternate Desalt Plant Effluent Discharge (to Lake Mead) Construct in 1978 and 1979 for 1980 operation	LF	Channel	41,000		1,085,000	+ 30% = $1,411,000
Alternate Desalt Plant Effluent Discharge (to SNWP) Construct in 1978 and 1979 for 1980 operation	LF	60" pipe & channel	72,000		2,441,000	+ 30% = $3,173,000
In-Valley Irrigation System-Phase 2 Construct in 1984 for 1985 operation						Same as for export to Dry Lake, see Table A-23.3
(See Table A-23.3)				Subtotal	$ 2,675,000	+ 30% = $3,477,000
Tertiary Treatment Plant Additions Construct in 1986 and 1987 for 1988 operation						For 1,000,000 population at year 2000 without power only
Phosphorus Removal System	MGD	60	1	LS	5,340,000	
Mixed Media Filtration System	MGD	60	1	LS	3,080,000	
				Subtotal	$ 8,420,000	+ 30% = $10,946,000
Desalt Plant Additions Construct in 1986 and 1987 for 1988 operation	MGD	60	1	LS	22,400,000	For 1,000,000 population at year 2000 without power only
				Subtotal	$22,400,000	+ 30% = $29,120,000
						For 1,000,000 population at year 2000 with power only. No Tertiary Plant or Desalt Plant Additions required.
Tertiary Treatment Plant Additions Construct in 1988 and 1989 for 1990 operation						
Phosphorus Removal System	MGD	35	1	LS	3,500,000	For 800,000 population at year 2000 without power only
Mixed Media System	MGD	35	1	LS	2,040,000	
				Subtotal	$ 5,540,000	+ 30% = $7,202,000
Desalt Plant Additions Construct in 1988 and 1989 for 1990 operation	MGD	35	1	LS	15,000,000	For 800,000 population at year 2000 without power only
				Subtotal	$15,000,000	+ 30% = $19,500,000
						For 800,000 population at year 2000 with power only. No Tertiary Plant or Desalt Plant Additions required.

COST OF COMPLETE TREATMENT ALTERNATIVES IN YEAR 2000

ITEM	1,000,000 pop. without power	1,000,000 pop. with power	800,000 pop. without power	800,000 pop. with power
Collection System	$ 1,306,000	$ 1,306,000	$ 1,306,000	$ 1,306,000
Tertiary Treatment Plant	18,112,000	18,112,000	18,112,000	18,112,000
Tertiary Treatment Additions	10,946,000	-	7,202,000	-
Brine Export Systems	10,938,000	8,658,000	8,658,000	6,010,000
In-Valley Irrigation Systems	9,551,000	9,551,000	9,551,000	9,551,000
Regulating Reservoir	508,000	508,000	508,000	508,000
Desalt Plant	29,120,000	29,120,000	29,120,000	29,120,000
Desalt Plant Additions	29,120,000	-	19,500,000	-
Desalt Effluent Discharge (to SNWP)	3,172,000*	3,172,000*	3,172,000*	3,172,000*
Total (SNWP)	$112,773,000	$70,427,000	$97,129,000	$67,779,000
Desalt Effluent Discharge (Lake Mead)	1,411,000*	1,411,000*	1,411,000*	1,411,000*
Total (Lake Mead)	$111,012,000	$ 68,666,000	$ 95,368,000	$66,018,000

*Alternate discharge points

COST ESTIMATE

COLORADO RIVER RETURN (See Sheet 2 of 2 for Summary)

Table A-23.13
Sheet 1 of 2

(Quality at 1973 standards for Las Vegas Wash)

ITEM	UNIT	SIZE	QUANTITY	UNIT PRICE	AMOUNT	REMARKS
Collection and Outfall System (construct in 1973 and 1974 for 1975 operation)						
Concrete Channel	LF		71,500		$2,343,000	
Siphon	LF	75"	1,500	97.00	146,000	
Pipeline	LF	42"	11,200	36.00	405,000	
Pipeline	LF	72"	55,000	93.00	5,115,000	
Tunnel	LF	72"	3,100	164.00	508,000	
Penstock and Energy Control			1	LS	717,000	
				Subtotal	$9,234,000	+ 30% = $12,004,000 + Land Cost = 8,000 $12,012,000
Tertiary Treatment Plant Alternative (construct in 1973 and 1974 for 1975 operation)						
Phosphorus Removal System	MGD	90		LS	$7,310,000	For 1,000,000 population at year 2000, without power only, + 30% = $10,490,000
Chlorination System	MGD	90		LS	760,000	
				Subtotal	$8,070,000	
Tertiary Treatment Plant Alternative (construct in 1973 and 1974 for 1975 operation)						
Phosphorus Removal System	MGD	60		LS	$5,340,000	For 1,000,000 population at year 2000, with power only, + 30% = $7,661,000
Chlorination System	MGD	60		LS	553,000	
				Subtotal	$5,893,000	
Tertiary Treatment Plant Alternative (construct in 1973 and 1974 for 1975 operation)						
Phosphorus Removal System	MGD	75		LS	$6,400,000	For 800,000 population at year 2000, without power only, + 30% = $9,186,000
Chlorination System	MGD	75		LS	666,000	
				Subtotal	$7,066,000	
Tertiary Treatment Plant Alternative (construct in 1973 and 1974 for 1975 operation)						
Phosphorus Removal System	MGD	50		LS	$4,650,000	For 800,000 population at year 2000, with power only, + 30% = $6,675,000
Chlorination System	MGD	50		LS	485,000	
				Subtotal	$5,135,000	
In-Valley Irrigation System-Phase 1 (construct in 1974 for 1975 operation) (see Table A-23.3)				Subtotal	$4,672,000	Same as for export to Dry Lake, see Table A-23.3, + 30% = $6,074,000
Regulating Reservoir (construct in 1978 and 1979 for 1980 operation)			1	LS	$ 391,000	+ 30% = $508,000 for 1,000,000 population at year 2000 without power only
Regulating Reservoir (construct in 1978 and 1979 for 1980 operation)			1	LS	$ 254,000	+ 30% = $330,000 for 1,000,000 population at year 2000 with power only
Regulating Reservoir (construct in 1978 and 1979 for 1980 operation)			1	LS	$ 317,000	+ 30% = $412,000 for 800,000 population at year 2000 without power only
Regulating Reservoir (construct in 1978 and 1979 for 1980 operation)			1	LS	$ 150,000	+ 30% = $195,000 for 800,000 population at year 2000 with power only
In-Valley Irrigation System-Phase 2 (construct in 1984 for 1985 operation) (see Table A23.3)				Subtotal	$2,675,000	Same as for export to Dry Lake, see Table A-23.3 + 30% = $3,477,000

COST ESTIMATE

COLORADO RIVER RETURN (See below for Summary)

Table A-23.13
Sheet 2 of 2

(Quality at 1973 standards for Las Vegas Wash)

ITEM	UNIT	SIZE	QUANTITY	UNIT PRICE	AMOUNT	REMARKS
Tertiary Treatment Plant Additions (construct in 1988 and 1989 for 1990 operation)						For 1,000,000 population at year 2000, without power only, + 30% = $6,170,000
Phosphorus Removal System	MGD	45			$4,300,000	
Chlorination System	MGD	45			446,000	
				Subtotal	$4,746,000	
Tertiary Treatment Plant Additions (construct in 1991 and 1992 for 1993 operation)						For 1,000,000 population at year 2000, with power only, + 30% = $2,554,000
Phosphorus Removal System	MGD	15			$1,780,000	
Chlorination System	MGD	15			185,000	
				Subtotal	$1,965,000	
Tertiary Treatment Plant Additions (construct in 1988 and 1989 for 1990 operation)						For 800,000 population at year 2000, without power only, + 30% = $4,451,000
Phosphorus Removal System	MGD	30			$3,100,000	
Chlorination System	MGD	30			324,000	
				Subtotal	$3,424,000	
						For 800,000 population at year 2000, with power only, no addition to tertiary treatment plant required

SUMMARY OF COST OF COLORADO RIVER RETURN ALTERNATIVES IN YEAR 2000

ITEM	1,000,000 pop. without power	1,000,000 pop. with power	800,000 pop. without power	800,000 pop. with power
Collection and Outfall System	$12,012,000	$12,012,000	$12,012,000	$12,012,000
Tertiary Treatment Plant	10,490,000	7,661,000	9,186,000	6,675,000
Tertiary Treatment Plant Additions	6,170,000	2,554,000	4,451,000	-
In-Valley Irrigation System	9,551,000	9,551,000	9,551,000	9,551,000
Regulating Reservoir	508,000	330,000	412,000	195,000
Total	$38,731,000	$32,108,000	$35,612,000	$28,433,000

TABLE A23.14

COST SCHEDULES FOR ALTERNATIVE WASTEWATER TREATMENT AND DISPOSAL PLANS, LAS VEGAS VALLEY

1 Mil. Pop., W/O Power

Year	COMPLETE TREATMENT Capital ($1,000)	O,M&R ($1,000)	Total ($1,000)	COLORADO RIVER RETURN Capital ($1,000)	O,M&R ($1,000)	Total ($1,000)
1973	15178	0	15178	11251	0	11251
1974	21252	0	21252	17325	0	17325
1975	0	2056	2056	0	2398	2398
1976	0	2235	2235	0	2499	2499
1977	0	2351	2351	0	2600	2600
1978	16400	2540	18940	254	2700	2954
1979	16400	2692	19092	254	2807	3061
1980	0	4871	4871	0	2914	2914
1981	0	5167	5167	0	3026	3026
1982	0	5408	5408	0	3140	3140
1983	0	5803	5803	0	3258	3258
1984	3477	6122	9599	3477	3370	6847
1985	0	6410	6410	0	3485	3485
1986	20033	6753	26786	0	3601	3601
1987	20033	6989	27022	0	3719	3719
1988	0	8588	8588	3085	3831	6916
1989	0	8816	8816	3085	3943	7028
1990	0	8993	8993	0	4380	4380
1991	0	9209	9209	0	4496	4496
1992	0	9376	9376	0	4609	4609
1993	0	9654	9654	0	4722	4722
1994	0	9821	9821	0	4829	4829
1995	0	10504	10504	0	5077	5077
1996	0	10764	10764	0	5193	5193
1997	0	10987	10987	0	5304	5304
1998	0	11209	11209	0	5419	5419
1999	0	11432	11432	0	5526	5526
2000	0	11676	11676	0	5639	5639
Total	112773	190426	303199	38731	102485	141216
P.V. (1972)	70462	59877	130339	29540	35687	65227

TABLE A23.14

COST SCHEDULES FOR ALTERNATIVE WASTEWATER TREATMENT AND DISPOSAL PLANS, LAS VEGAS VALLEY

1 Mil. Pop., W/O Power

Year	DRY LAKE EXPORT			ELDORADO VALLEY EXPORT			JEAN LAKE EXPORT		
	Capital ($1,000)	O,M&R ($1,000)	Total ($1,000)	Capital ($1,000)	O,M&R ($1,000)	Total ($1,000)	Capital ($1,000)	O,M&R ($1,000)	Total ($1,000)
1973	12945	0	12945	9135	0	9135	15473	0	15473
1974	24644	0	24644	27924	0	27924	30371	0	30371
1975	427	1202	1629	351	1214	1565	689	1764	2453
1976	4495	1271	5766	6220	1273	7493	4552	1873	6425
1977	0	1416	1416	0	1453	1453	0	2058	2058
1978	0	1470	1470	0	1499	1499	0	2143	2143
1979	3719	1524	5243	3701	1545	5246	3657	2228	5885
1980	0	1653	1653	0	1663	1663	0	2386	2386
1981	0	1730	1730	0	1727	1727	0	2501	2501
1982	0	1807	1807	0	1791	1791	0	2616	2616
1983	427	1884	2311	351	1855	2206	686	2731	3417
1984	7622	1961	9583	7405	1919	9324	8089	2846	10935
1985	0	2113	2113	0	2061	2061	0	3037	3037
1986	0	2184	2184	0	2119	2119	0	3146	3146
1987	0	2255	2255	0	2177	2177	0	3255	3255
1988	0	2326	2326	0	2235	2235	0	3364	3364
1989	33613	2397	36010	33387	2293	35680	33403	3473	36876
1990	32509	2487	34996	32509	2366	34875	32509	3600	36109
1991	0	4899	4899	0	4785	4785	0	5993	5993
1992	0	5366	5366	0	5259	5259	0	6441	6441
1993	0	5827	5827	0	5727	5727	0	6883	6883
1994	0	6294	6294	0	6201	6201	0	7331	7331
1995	0	6783	6783	0	6697	6697	0	7801	7801
1996	0	7273	7273	0	7194	7194	0	8272	8272
1997	0	7783	7783	0	7711	7711	0	8763	8763
1998	0	8261	8261	0	8196	8196	0	9222	9222
1999	0	8767	8767	0	8709	8709	0	9709	9709
2000	0	9251	9251	0	9200	9200	0	10175	10175
Total	120401	100184	220585	120983	98869	219852	129429	123611	253040
.V. (1972)	63563	28393	91956	63906	28072	91978	71411	36966	108377

TABLE A23.14

COST SCHEDULES FOR ALTERNATIVE WASTEWATER

TREATMENT AND DISPOSAL PLANS, LAS VEGAS VALLEY

1 Mil. Pop., W/ Power

	COMPLETE TREATMENT			COLORADO RIVER RETURN		
Year	Capital ($1,000)	O,M&R ($1,000)	Total ($1,000)	Capital ($1,000)	O,M&R ($1,000)	Total ($1,000)
1973	14038	0	14038	9836	0	9836
1974	20112	0	20112	15911	0	15911
1975	0	2213	2213	0	2184	2184
1976	0	2247	2247	0	2285	2285
1977	0	2326	2326	0	2290	2290
1978	16400	2182	18582	0	2175	2175
1979	16400	2038	18438	0	2033	2033
1980	0	3220	3220	0	1897	1897
1981	0	3309	3309	0	1852	1852
1982	0	3551	3551	0	1967	1967
1983	0	3793	3793	0	2078	2078
1984	3477	4034	7511	3477	2196	5673
1985	0	4331	4331	0	2315	2315
1986	0	4436	4436	0	2308	2308
1987	0	4442	4442	0	2304	2304
1988	0	4372	4372	165	2297	2462
1989	0	4454	4454	165	2409	2574
1990	0	4811	4811	0	2532	2532
1991	0	5148	5148	1277	2645	3922
1992	0	5609	5609	1277	2755	4032
1993	0	5915	5915	0	2975	2975
1994	0	6146	6146	0	3088	3088
1995	0	6360	6360	0	3145	3145
1996	0	6222	6222	0	3065	3065
1997	0	6070	6070	0	2990	2990
1998	0	5841	5841	0	2911	2911
1999	0	6071	6071	0	3024	3024
2000	0	6339	6339	0	3137	3137
Total	70427	115480	185907	32108	64857	96965
P.V. (1972)	53371	38728	92099	25425	24065	49490

TABLE A23.14

COST SCHEDULES FOR ALTERNATIVE WASTEWATER TREATMENT AND DISPOSAL PLANS, LAS VEGAS VALLEY

1 Mil. Pop., W/ Power

Year	DRY LAKE EXPORT			ELDORADO VALLEY EXPORT			JEAN LAKE EXPORT		
	Capital ($1,000)	O,M&R ($1,000)	Total ($1,000)	Capital ($1,000)	O,M&R ($1,000)	Total ($1,000)	Capital ($1,000)	O,M&R ($1,000)	Total ($1,000)
1973	12945	0	12945	6836	0	6836	11162	0	11162
1974	24644	0	24644	25626	0	25626	26060	0	26060
1975	427	1202	1629	0	1302	1302	0	1929	1929
1976	427	1271	1698	0	1335	1335	0	1992	1992
1977	0	1341	1341	0	1367	1367	0	2054	2054
1978	0	1395	1395	0	1297	1297	0	1907	1907
1979	0	1449	1449	0	1227	1227	0	1760	1760
1980	0	1503	1503	0	1157	1157	0	1611	1611
1981	0	1580	1580	0	1207	1207	0	1702	1702
1982	0	1657	1657	0	1257	1257	0	1793	1793
1983	427	1734	2161	0	1307	1307	0	1884	1884
1984	3904	1811	5715	3294	1357	4651	3545	1975	5520
1985	0	1888	1888	0	1410	1410	0	2066	2066
1986	0	1959	1959	0	1439	1439	0	2121	2121
1987	0	2030	2030	0	1468	1468	0	2176	2176
1988	0	2101	2101	0	1497	1497	0	2231	2231
1989	25619	2172	27791	26416	1526	27942	25943	2286	28229
1990	24597	2265	26862	24597	1561	26158	24597	2362	26959
1991	0	4062	4062	0	3328	3328	0	4065	4065
1992	0	4402	4402	0	3638	3638	0	4311	4311
1993	0	4741	4741	0	3947	3947	0	4556	4556
1994	0	5080	5080	0	4256	4256	0	4801	4801
1995	0	5419	5419	0	4565	4565	0	5046	5046
1996	0	5785	5785	0	4874	4874	0	5291	5291
1997	0	6098	6098	0	5184	5184	0	5537	5537
1998	0	6436	6436	0	5492	5492	0	5781	5781
1999	0	6776	6776	0	5802	5802	0	6027	6027
2000	0	7171	7171	0	6164	6164	0	6330	6330
Total	92990	83301	176291	86769	68964	155733	91307	83594	174901
V. (1972)	51621	24523	76144	45874	20464	66338	50258	26586	76844

TABLE A23.14

COST SCHEDULES FOR ALTERNATIVE WASTEWATER

TREATMENT AND DISPOSAL PLANS, LAS VEGAS VALLEY

.8 Mil. Pop., W/ Power

	COMPLETE TREATMENT			COLORADO RIVER RETURN		
Year	Capital ($1,000)	O,M&R ($1,000)	Total ($1,000)	Capital ($1,000)	O,M&R ($1,000)	Total ($1,000)
1973	12714	0	12714	9440	0	9440
1974	18788	0	18788	15516	0	15516
1975	0	2330	2330	0	2043	2043
1976	0	2394	2394	0	2124	2124
1977	0	2399	2399	0	2116	2116
1978	16400	2292	18692	0	1984	1984
1979	16400	2185	18585	0	1826	1826
1980	0	3773	3773	0	1670	1670
1981	0	3854	3854	0	1596	1596
1982	0	3943	3943	0	1671	1671
1983	0	4108	4108	0	1746	1746
1984	3477	4197	7674	3477	1817	5294
1985	0	4309	4309	0	1893	1893
1986	0	4369	4369	0	1850	1850
1987	0	4375	4375	0	1809	1809
1988	0	4151	4151	0	1759	1759
1989	0	4157	4157	0	1835	1835
1990	0	4300	4300	0	1909	1909
1991	0	4468	4468	0	1979	1979
1992	0	4699	4699	0	2056	2056
1993	0	4929	4929	0	2125	2125
1994	0	5083	5083	0	2196	2196
1995	0	5167	5167	0	2209	2209
1996	0	5083	5083	0	2090	2090
1997	0	4778	4778	0	1975	1975
1998	0	4242	4242	0	1856	1856
1999	0	4396	4396	0	1930	1930
2000	0	4557	4557	0	1893	1893
Total	67779	104538	172317	28433	49957	78390
P.V. (1972)	50977	37384	88361	23918	19726	43644

TABLE A23.14

COST SCHEDULES FOR ALTERNATIVE WASTEWATER TREATMENT AND DISPOSAL PLANS, LAS VEGAS VALLEY

.8 Mil. Pop., W/ Power

Year	DRY LAKE EXPORT			ELDORADO VALLEY EXPORT			JEAN LAKE EXPORT		
	Capital ($1,000)	O,M&R ($1,000)	Total ($1,000)	Capital ($1,000)	O,M&R ($1,000)	Total ($1,000)	Capital ($1,000)	O,M&R ($1,000)	Total ($1,000)
1973	13232	0	13232	6256	0	6256	10096	0	10096
1974	24126	0	24126	23759	0	23759	24189	0	24189
1975	0	1158	1158	0	1277	1277	0	2014	2014
1976	468	1216	1684	0	1266	1266	0	1985	1985
1977	468	1274	1742	0	1255	1255	0	1956	1956
1978	0	1330	1330	0	1244	1244	0	1926	1926
1979	0	1375	1375	0	1233	1233	0	1899	1899
1980	0	1419	1419	0	1221	1221	0	1871	1871
1981	0	1472	1472	0	1218	1218	0	1852	1852
1982	0	1525	1525	0	1215	1215	0	1833	1833
1983	468	1578	2046	0	1212	1212	0	1814	1814
1984	3945	1631	5576	3294	1209	4503	3545	1795	5340
1985	0	1688	1688	0	1209	1209	0	1777	1777
1986	0	1733	1733	0	1213	1213	0	1779	1779
1987	0	1778	1778	0	1217	1217	0	1781	1781
1988	0	1823	1823	0	1221	1221	0	1783	1783
1989	0	1868	1868	0	1225	1225	0	1785	1785
1990	0	1912	1912	0	1229	1229	0	1785	1785
1991	0	1971	1971	0	1269	1269	0	1871	1871
1992	0	2031	2031	0	1310	1310	0	1958	1958
1993	0	2090	2090	0	1350	1350	0	2044	2044
1994	0	2150	2150	0	1391	1391	0	2131	2131
1995	0	2210	2210	0	1432	1432	0	2218	2218
1996	0	2244	2244	0	1390	1390	0	2127	2127
1997	0	2279	2279	0	1349	1349	0	2037	2037
1998	0	2313	2313	0	1307	1307	0	1946	1946
1999	0	2348	2348	0	1266	1266	0	1856	1856
2000	0	2381	2381	0	1222	1222	0	1766	1766
Total	42707	46797	89504	33309	32950	66259	37830	49589	87419
V. (1972)	36104	16714	52818	28061	12948	41009	32137	19636	51773

DETAILS OF CAPITAL EXPENDITURES

Complete Treatment, 1,000,000 Population, without Power

Year	Amount ($1,000)	
1973	653	½ Collection System (Table A23.12, sheet 1/3) for 1975 operation
	9,056	½ Tertiary Treatment Plant (Table A23.12, sheet 1/3) for 1975 oper.
	5,469	½ Brine Export System(36" & 42" Pipes) " "
1973	15,178	Total for 1973
1974	653	½ Collection System (Table A23.12, sheet 1/3) for 1975 operation
	9,056	½ Tertiary Treatment Plant " "
	5,469	½ Brine Export System " "
	6,074	In-Valley Irrig. System Phase I (Table A23.3) for 1975 operation
1974	21,252	Total for 1974
1975	0	
1976	0	
1977	0	
1978	254	½ Regulating Reservoir (Table A23.12, sheet 2/3) for 1980 operation
	14,560	½ Desalt Plant " "
	15,586	½ Desalt Pl. Eff. Disch. (SNWP) " "
1978	16,400	Total for 1978
1979	254	½ Reg. Res. (Table A23.12, sheet 2/3) for 1980 operation
	14,560	½ Desalt Plant " "
	1,586	½ Desalt Pl. Eff. Disch (SNWP) " "
1979	16,400	Total for 1979
1980	0	
1981	0	
1982	0	
1983	0	
1984	3,477	In-Valley Irrig. System-Phase II (Table A23.12, sheet 2/3) 1985 oper.
1985	0	
1986	5,473	½ Tertiary Treatment Plant Add. (60 MGD) " " 1988 oper.
	14,560	½ Desalt Plant Addition (60 MGD) " " "
1986	20,033	Total for 1986
1987	5,473	½ Tertiary Plant Addition " " "
	14,560	½ Desalt Plant Addition " " "
1987	20,033	Total for 1987
1988	0	
1989	0	
1990	0	
1991	0	
1992	0	
1993	0	
1994	0	
1995	0	
1996	0	
1997	0	
1998	0	
1999	0	
2000	0	
TOTAL	112,773	

DETAILS OF CAPITAL EXPENDITURES

Complete Treatment, 1,000,000 Population, with Power

Year	Amount ($1,000)	
1973	653	½ Collection System (Table A23.12, sheet 1/3) for 1975 operation
	9,056	½ Tertiary Treatment Plant " "
	4,329	½ Brine Export System (30" & 36" Pipes) " "
1973	14,038	Total for 1973
1974	653	½ Collection System (Table A23.12, sheet 1/3) for 1975 operation
	9,056	½ Tertiary Treatment Plant " "
	4,329	½ Brine Export System " ""
	6,074	In-Valley Irrig. System-Phase I (Table A23.3) "
1974	20,112	Total for 1974
1975	0	
1976	0	
1977	0	
1978	254	½ Regulating Reservoir (Table A23.12, sheet 2/3) for 1980 operatio
	14,560	½ Desalt Plant " "
	1,586	½ Desalt Pl. Eff. Disch. (SNWP) " "
1978	16,400	Total for 1978
1979	254	½ Regulating Reservoir (Table A23.12, sheet 2/3) for 1980 operatio
	14,560	½ Desalt Plant " "
	1,586	½ Desalt Pl. Eff. Disch. (SNWP) " "
1979	16,400	Total for 1979
1980	0	
1981	0	
1982	0	
1983	0	
1984	3,477	In-Valley Irrig. System-Phase II (Table A23.12, sheet 2/3) 1985 ope
1985	0	
1986	0	
1987	0	
1988	0	
1989	0	
1990	0	
1991	0	
1992	0	
1993	0	
1994	0	
1995	0	
1996	0	
1997	0	
1998	0	
1999	0	
2000	0	
TOTAL	70,427	

DETAILS OF CAPITAL EXPENDITURES

Complete Treatment, 800,000 Population, without Power

Year	Amount ($1,000)	
1973	653	½ Collection System (Table A23.12, sheet 1/3) for 1975 operation
	9,056	½ Tertiary Treatment Plant " "
	4.329	½ Brine Export System (30' & 36" Pipes) "
1973	14,038	Total for 1973
1974	653	½ Collection System (Table A23.12, sheet 1/3) for 1975 operation
	9,056	½ Tertiary Treatment Plant " "
	4,329	½ Brine Export System " "
	6.074	In-Valley Irrig. System-Phase I (Table A23.3) "
1974	20,112	Total for 1974
1975	0	
1976	0	
1977	0	
1978	254	½ Regulating Reservoir (Table A23.12, sheet 2/3) for 1980 operation
	14,560	½ Desalt Plant " "
	1,586	½ Desalt Pl. Eff. Disch. (SNWP) " "
1978	16,400	Total for 1978
1979	254	½ Regulating Reservoir (Table A23.12, sheet 2/3) for 1980 operation
	14,560	½ Desalt Plant " "
	1,586	½ Desalt Pl. Eff. Disch. (SNWP) " "
1979	16,400	Total for 1979
1980	0	
1981	0	
1982	0	
1983	0	
1984	3,477	In-Valley Irrig. System-Phase II (Table A23.12, sheet 2/3) 1985 oper.
1985	0	
1986	0	
1987	0	
1988	3,601	½ Tertiary Treatment Plant Add. (35 MGD)(A23.12, sheet 2/3) 1990 oper.
	9,750	½ Desalt Plant Add. (35 MGD) " "
1988	13,351	Total for 1988
1989	3,601	½ Tertiary Treatment Plant Add. (35 MGD) (A23.12, sheet 2/3) 1990 oper.
	9,750	½ Desalt Plant Add. (35 MGD) " "
1989	13,351	Total for 1989
1990	0	
1991	0	
1992	0	
1993	0	
1994	0	
1995	0	
1996	0	
1997	0	
1998	0	
1999	0	
2000	0	
TOTAL	97,129	

DETAILS OF CAPITAL EXPENDITURES

Complete Treatment, 800,000 Population, with Power

Year	Amount ($1,000)	
1973	653	½ Collection System (Table A23.12, sheet 1/3) for 1975 operation
	9,056	½ Tertiary Treatment Plant " "
	3,005	½ Brine Export System (24-30" Pipe) " "
1973	12,714	Total for 1973
1974	653	½ Coll. System (Table A23.12, sheet 1/3) for 1975 operation
	9,056	½ Tertiary Treatment Plant " "
	3,005	½ Brine Export System (24-30" Pipes) "
	6,074	In-Valley Irrig. System-Phase I (Table A23.3) "
1974	18,788	Total for 1974
1975	0	
1976	0	
1977	0	
1978	254	½ Regulating Reservoir (Table A23.12, sheet 2/3) for 1980 oper.
	14,560	½ Desalt Plant " "
	1,586	½ Desalt Pl. Effluent Discharge (SNWP) "
1978	16,400	Total for 1978
1979	254	½ Regulating Reservoir (Table A23.12, sheet 2/3) for 1980 oper.
	14,560	½ Desalt Plant " "
	1,586	½ Desalt Pl. Effluent Discharge (SNWP) "
1979	16,400	Total for 1979
1980	0	
1981	0	
1982	0	
1983	0	
1984	3,477	In-Valley Irrig. System-Phase II (Table A23..2, sheet 2/3) 1985 op.
1985	0	
1986	0	
1987	0	
1988	0	
1989	0	
1990	0	
1991	0	
1992	0	
1993	0	
1994	0	
1995	0	
1996	0	
1997	0	
1998	0	
1999	0	
2000	0	
TOTAL	67,779	

DETAILS OF CAPITAL EXPENDITURES

Colorado River Return, 1,000,000 Population, without Power

Year	Amount ($1,000)	
1973	6,006	½ Collection and Outfall System (Table A23.13, sh. 1/2) 1975 oper.
	5,245	½ Tertiary Treatment Plant " "
1973	11,251	Total for 1973
1974	6,006	½ Collection and Outfall System " "
	5,245	½ Tertiary Treatment Plant " "
	6,074	In-Valley Irrig. System-Phase 1 (Table A23.3) "
1974	17,325	Total for 1974
1975	0	
1976	0	
1977	0	
1978	254	½ Regulating Reservoir (Table A23.12, sh. 1/2) for 1980 operation
1979	254	" " "
1980	0	
1981	0	
1982	0	
1983	0	
1984	3,477	In-Valley Irrig. System-Phase 2 " " for 1985 operation
1985	0	
1986	0	
1987	0	
1988	3,085	½ Tert. Tr. Pl. Add. (45 MGD) (Table A23.13, sh. 2/2) 1990 oper.
1989	3,085	" " "
1990	0	
1991	0	
1992	0	
1993	0	
1994	0	
1995	0	
1996	0	
1997	0	
1998	0	
1999	0	
2000	0	
TOTAL	38,731	

DETAILS OF CAPITAL EXPENDITURES

Colorado River Return, 1,000,000 Population, with Power

Year	Amount ($1,000)	
1973	6,006	½ Collection and Outfall System (Table A23.13, sh. 1/2) 1975 oper.
	3,830	½ Tertiary Treatment Plant " "
1973	9,836	Total for 1973
1974	6,006	½ Coll. and Outfall Syst. " "
	3,831	½ Tertiary Tr. Pl. " "
	6,074	In-Valley Irrig. System-Phase 1 (Table A23.3) "
1974	15,911	Total for 1974
1975	0	
1976	0	
1977	0	
1978	0	
1979	0	
1980	0	
1981	0	
1982	0	
1983	0	
1984	3,477	In-Valley Irrig. System-Phase 2 (Table A23.3) for 1985 operation
1985	0	
1986	0	
1987	0	
1988	165	½ Regulating Reservoir (Table A23.13, sh. 1/2) for 1990 operation
1989	165	" " "
1990	0	
1991	1,277	½ Tert. Tr. Pl. Add. (Table A23.13, sh. 2/2) for 1993 operation
1992	1,277	" " "
1993	0	
1994	0	
1995	0	
1996	0	
1997	0	
1998	0	
1999	0	
2000	0	
TOTAL	32,108	

DETAILS OF CAPITAL EXPENDITURES

Colorado River Return, 800,000 Population, without Power

Year	Amount ($1,000)	
1973	6,006	½ Collection & Outfall System (Table A23.13, sh. 1/2) 1975 operation
	4,593	½ Tertiary Treatment Plant " "
1973	10,599	Total for 1973
1974	6,006	½ Coll. & Outfall Syst. " "
	4,593	½ Tert. Tr. Pl. " "
	6,074	In-Valley Irrig. System-Phase 1 (Table A23.3) "
1974	16,673	Total for 1974
1975	0	
1976	0	
1977	0	
1978	206	½ Regulating Reservoir (Table A23.13, sh. 1/2) for 1980 operation
1979	206	" " "
1980	0	
1981	0	
1982	0	
1983	0	
1984	3,477	In-Valley Irrig. Syst.-Phase 2 (Table A23.3) for 1985 operation
1985	0	
1986	0	
1987	0	
1988	2,226	½ Tert. Tr. Pl. Add. (Table A23.13, sh. 2/2) for 1990 operation
1989	2,225	" " "
1990	0	
1991	0	
1992	0	
1993	0	
1994	0	
1995	0	
1996	0	
1997	0	
1998	0	
1999	0	
2000	0	
TOTAL	35,612	

DETAILS OF CAPITAL EXPENDITURES

Colorado River Return, 800,000 Population, with Power

Year	Amount ($1,000)	
1973	6,006	½ Coll. & Outfall System (Table A23.13, sh. 1/2) for 1975 operatic
	3,337	½ Tertiary Treatment Plant " "
	97	½ Regulating Reservoir " "
1973	9,440	Total for 1973
1974	6,006	½ Coll. & Outfall Syst. " "
	3,338	½ Tert. Tr. Pl. " "
	98	½ Reg. Res. " "
	6,074	In-Valley Irrig. System-Phase 1, (Table A23.3) "
1974	15,516	Total for 1974
1975	0	
1976	0	
1977	0	
1978	0	
1979	0	
1980	0	
1981	0	
1982	0	
1983	0	
1984	3,477	In-Valley Irrig. System-Phase 2 (Table A23.3) for 1985 operation
1985	0	
1986	0	
1987	0	
1988	0	
1989	0	
1990	0	
1991	0	
1992	0	
1993	0	
1994	0	
1995	0	
1996	0	
1997	0	
1998	0	
1999	0	
2000	0	
TOTAL	28,433	

DETAILS OF CAPITAL EXPENDITURES

Dry Lake Export, 1,000,000 Population, without Power

Year	Amount ($1,000)	
1973	12,945	= ½ 1975 const. cost Export System (Table A23.1, sheet 1/2)
1974	12,946	= ½ 1975 const. cost Export System (Table A23.1, sheet 1/2)
	5,624	= Initial cost, Disposal System (A23.2, sheet 1/4)
	6,074	= Initial cost, In-Valley Irrig. System (A23.3, sheet 1/1)
1974 total	24,644	Total for 1974
1975	427	= ½ Add. Pump Cap. Export System (A23.1, sheet 1/2) needed by 1977
1976	427	= ½ Add. Pump Cap. Export System (A23.1, sheet 1/2) needed by 1977
	4,068	= Add. Disposal System fac. (A23.2, sheet 1/4) needed by 1977
1976 total	4,495	
1977	0	
1978	0	
1979	3,719	Add. Disposal System fac. (A23.2, sheet 1/4) needed by 1980
1980	0	
1981	0	
1982	0	
1983	427	Add. Pumping Cap. to Export System (A23.1, sheet 1/2) needed by 1985
1984	427	Add. Pumping Cap. to Export System (A23.1, sheet 1/2) needed by 1985
	3,718	Add. Disposal System fac. (A23.2, sheet 1/4) needed by 1985
	3,477	Phase II add. to In-Valley Irrig. Sys. (A23.8, sheet 1/1) needed 1985
1984 total	7,622	Total for 1984
1985	0	
1986	0	
1987	0	
1988	0	
1989	1,104	Add. Disposal System fac. (A23.2, sheet 1/4)
	32,509	½ Desalt System (A23.2, sheet 2/4) needed by 1991
1989 total	33,613	
1990	32,509	Second ½ Desalt System(started 1989) (A23.2, sheet 2/4) needed 1991
1991	0	
1992	0	
1993	0	
1994	0	
1995	0	
1996	0	
1997	0	
1998	0	
1999	0	
2000	0	
TOTAL	120,401	

DETAILS OF CAPITAL EXPENDITURES

Dry Lake Export, 1,000,000 Population, with Power

Year	Amount ($1,000)	
1973	12,945	½ const. cost (Table A23.1, sheet 1/2) Export System, needed by 197
1974	12,946	½ const. cost (Table A23.1, sheet 1/2) Export System, needed by 197
	5,624	Initial cost, Disposal System (A23.2, sheet 2/4) needed by 1975
	6,074	Phase 1, In-Valley Irrig. System (A23.3, sheet 1/1) needed by 1975
1974	24,644	Total for 1974
1975	427	½ added Pump Capacity, Export System (A23.1, sheet 1/2) needed 1977
1976	427	" "
1977	0	" "
1978	0	" "
1979	0	" "
1980	0	" "
1981	0	" "
1982	0	" "
1983	427	½ added Pump Capacity, Export System (A23.1, sheet 1/2) needed 1985
1984	427	" "
	3,477	Phase II, In-Valley Irrig. System (A23.3, sheet 1/1) needed by 1985
1984	3,904	Total for 1984
1985	0	
1986	0	
1987	0	
1988	0	
1989	1,023	Add. Disposal System (A23.2, sheet 2/4) needed by 1990
	24,596	½ Desalt System (SNWP) (A23.2, sheet 2/4) needed by 1991
1989	25,619	Total for 1989
1990	24,597	½ Desalt System (SNWP) (A23.2, sheet 2/4) needed by 1991
1991	0	
1992	0	
1993	0	
1994	0	
1995	0	
1996	0	
1997	0	
1998	0	
1999	0	
2000	0	
TOTAL	92,990	

DETAILS OF CAPITAL EXPENDITURES

Dry Lake Export, 800,000 Population, without Power

Year	Amount ($1,000)	
1973	13,232	½ Dry Lake Export System (Table A23.1, sheet 2/2) for 1975 oper.
1974	13,233	½ " " "
	5,624	Disposal System, Stage 1 (Table A23.2, sheet 3/4) "
	6,074	In-Valley Irrig. System-Phase I(Table A23.3, sheet 1) "
1974	24,931	Total for 1974
1975	0	
1976	468	½ Added Pump Cap., Export System (Table A23.1, sh. 2/2) 1998 oper.
1977	468	½ " " "
	4,068	Stage 2 Disposal System (Table A23.2, sh. 3/4) "
1977	4,536	Total for 1977
1978	0	
1978	0	
1980	0	
1981	0	
1982	0	
1983	468	½ Added Pump Cap., Export System (Table A23.1, sh. 2/2) 1985 oper.
1984	468	" " "
	3,719	Stage 3 Disposal System (Table A23.2, sh. 3/4) "
	3,477	In-Valley Irrig. System-Phase II (Table A23.3) "
1984	7,664	Total for 1984
1985	0	
1986	0	
1987	0	
1988	0	
1989	3,718	Stage 4 Disposal System (Table A23.2, sh. 3/4) for 1990 operation
1990	0	
1991	0	
1992	0	
1993	0	
1994	2,979	Stage 5 Disposal System (Table A23.2, sh. 3/4) for 1995 operation
1995	0	
1996	0	
1997	0	
1998	0	
1999	0	
2000	0	
TOTAL	57,996	

DETAILS OF CAPITAL EXPENDITURES

Dry Lake Export, 800,000 Population, with Power

Year	Amount ($1,000)	
1973	13,232	½ Dry Lake Export System (Table A23.1, sh. 2/2) for 1975 operation
1974	13,233	½ " "
	4,819	Disposal System (Table A23.2, sh. 4/4) "
	6,074	In-Valley Irrig. System-Phase 1 (Table A23.3) "
1974	24,126	Total for 1974
1975	0	
1976	468	½ Added Pump Cap., Export System (Table A23.1, sh.2/2) 1978 oper.
1977	468	½ " "
1978	0	
1979	0	
1980	0	
1981	0	
1982	0	
1983	468	½ Added Pump Cap., Export System (Table A23.1, sh. 2/2) 1985 oper.
1984	468	½ " "
	3,477	In-Valley Irrig. System, Phase 2 (Table A23.3) "
1984	3,945	Total for 1984
1985	0	
1986	0	
1987	0	
1988	0	
1989	0	
1990	0	
1991	0	
1992	0	
1993	0	
1994	0	
1995	0	
1996	0	
1997	0	
1998	0	
1999	0	
2000	0	
TOTAL	42,707	

DETAILS OF CAPITAL EXPENDITURES

Eldorado Valley Export, 1,000,000 Population, without Power

Year	Amount ($1,000)	
1973	9,135	½ Initial Cost, Export System (Table A23.4, sh. 1/4) for 1975 oper.
1974	9,135	" " "
	12,715	Stage 1, Disposal System (Table A23.5, sh. 1/4) "
	6,074	Phase 1, In-Valley Irrig. Syst. (Table A23.6) "
1974	27,924	Total for 1974
1975	351	½ Added Pump Cap., Export Syst. (Tab. A23.4, sh. 1/4) for 1977 oper.
1976	351	" " "
	5,869	Stage 2, Disposal System (Table A23.5, sh. 1/4) "
1976	6,220	Total for 1976
1977	0	
1978	0	
1979	3,701	Stage 3, Disposal System (Table A23.5, sh. 1/4) for 1980 operation
1980	0	
1981	0	
1982	0	
1983	351	½ Added Pump Cap., Export Sys. (Table A23.4, sh. 1/4) 1985 operation
1984	351	" " "
	3,760	Stage 4, Disposal Sys.(Table A23.5, sh. 1/4) "
	3,294	Phase 2, In-Valley Irrig. Syst. (Table A23.6) "
1984	7,405	Total for 1984
1985	0	
1986	0	
1987	0	
1988	0	
1989	878	Stage (Ult.) Disposal Sys. (Table A23.5, sh. 1/4) for 1990 operation
	32,509	½ Desalt System (SNWP) (Table A23.5, sh. 2/4) for 1991 operation
1989	33,387	Total for 1989
1990	32,509	½ Desalt System (SNWP) (Table A23.5, sh. 2/4) for 1991 operation
1991	0	
1992	0	
1993	0	
1994	0	
1995	0	
1996	0	
1997	0	
1998	0	
1999	0	
2000	0	
TOTAL	120,983	

DETAILS OF CAPITAL EXPENDITURES

Eldorado Valley Export, 1,000,000 Population, with Power

Year	Amount ($1,000)	
1973	6,836	½ Initial Cost, Export Sys. (Table A23.4, sh. 2/4) for 1975 oper.
1974	6,837	" " "
	12,715	Stage 1, Disposal System (Table A23.5, sh. 2/4) "
	6,074	Phase 1, In-Valley Irrig. System (Table A23.6) "
1974	25,626	Total for 1974
1975	0	
1976	0	
1977	0	
1978	0	
1979	0	
1980	0	
1981	0	
1982	0	
1983	0	
1984	3,294	Phase 2, In-Valley Irrig. System (Table A23.6) for 1985 operation
1985	0	
1986	0	
1987	0	
1988	0	
1989	1,677	Stage 2 (Ult.) Disposal Syst. (Table A23.5, sh. 2/4) 1990 oper.
	143	½ Desalt System (SNWP) (Table A23.5, sh. 2/4) for 1991 operation
	24,596	Added Pump Cap., Export Syst. (Table A23.4, sh. 2/4) 1990 oper.
1989	26,416	Total for 1989
1990	24,597	½ Desalt System (SNWP) (Table A23.5, sh. 2/4) for 1991 operation
1991	0	
1992	0	
1993	0	
1994	0	
1995	0	
1996	0	
1997	0	
1998	0	
1999	0	
2000	0	
TOTAL	86,769	

DETAILS OF CAPITAL EXPENDITURES

Eldorado Valley Export, 800,000 Population, without Power

Year	Amount ($1,000)	
1973	9,366	½ Export System (Table A23.4, sh. 3/4) for 1975 operation
1974	9,367	" " "
	12,715	Stage 1, Disposal System (Table A23.5, sh. 1/4) for 1975 oper.
	6,074	Phase 1, In-Valley Irrig. Syst. (Table A23.6, sh. 1/4) "
1974	28,156	Total for 1974
1975	0	
1976	383	½ Added Pump Cap., Export System (Table A23.4, sh. 3/4) 1978 oper.
1977	384	" " "
	5,869	Stage 2, Disposal System (Table A23.5, sh. 3/4) "
1977	6,253	Total for 1977
1978	0	
1979	0	
1980	0	
1981	0	
1982	0	
1983	383	½ Added Pump Cap., Export Sys. (Table A23.4, sh. 3/4) 1985 oper.
1984	384	" " "
	3,701	Stage 3, Disposal Sys. (Table A23.5, sh. 3/4) "
	3,294	Phase 2, In-Valley Irrig. Sys. (Table A23.6, sh. 1/1) "
1984	7,379	Total for 1984
1985	0	
1986	0	
1987	0	
1988	0	
1989	3,760	Stage 4, Disposal Sys. (Table A23.5, sh. 3/4) for 1990 operation
1990	0	
1991	0	
1992	0	
1993	0	
1994	2,755	Stage 5, Disposal Sys. (Table A23.5, sh. 3/4) for 1995 operation
1995	0	
1996	0	
1997	0	
1998	0	
1999	0	
2000	0	
TOTAL	58,435	

UNIT COSTS FOR ALTERNATE PLANS

800,000 POPULATION WITHOUT POWER

Alternate	ANNUAL COST OM&R ($1,000)	Debt. Serv. ($1,000)	Total ($1,000)	Flow (MG/yr)	Flow (AF/yr)	Cost ($/AF)	Cost ($/MG)
DRY LAKE EXPORT:							
1975	1,174	3,076	4,250	20,799	63,800	$ 66	$ 204
1980	1,510	3,479	4,989	26,021	79,900	63	192
1985	1,854	4,070	5,924	30,830	94,700	63	192
1990	2,153	4,369	6,522	35,648	109,400	60	183
1995	2,507	4,610	7,117	41,122	126,400	56	173
2000	2,678	4,610	7,288	45,128	138,700	52	161
COMPLETE TREATMENT: (discharge to SNWP)							
1975	2,131	2,572	4,703	20,799	63,800	74	226
1980	5,112	5,396	10,508	26,021	79,900	132	404
1985	6,077	5,676	11,753	30,830	94,700	124	381
1990	7,812	7,829	15,641	35,648	109,400	143	439
1995	8,840	7,829	16,669	41,122	126,400	132	405
2000	9,591	7,829	17,420	45,128	138,700	126	386
JEAN LAKE EXPORT:							
1975	1,717	3,764	5,481	20,799	63,800	86	264
1980	2,201	4,197	6,398	26,021	79,900	80	246
1985	2,669	4,893	7,562	30,830	94,700	80	245
9990	3,083	5,204	8,287	35,648	109,400	76	232
1995	3,605	5,427	9,032	41,122	126,400	72	220
2000	3,869	5,427	9,296	45,128	138,700	67	206
ELDORADO VALLEY EXPORT:							
1975	1,192	2,993	4,185	20,799	63,800	66	201
1980	1,533	3,528	5,061	26,021	79,900	63	194
1985	1,840	4,168	6,008	30,830	94,700	63	195
1990	2,102	4,471	6,573	35,648	109,400	60	184
1995	2,393	4,693	7,086	41,122	126,400	56	172
2000	2,524	4,693	7,217	45,128	138,700	52	160
COLORADO RIVER RETURN: *							
1975	2,218	2,198	4,416	20,797	63,800	69	212
1980	2,653	2,231	4,884	26,021	79,900	61	188
1985	3,026	2,512	5,538	30,830	94,700	59	180
1990	3,617	2,870	6,487	35,648	109,400	59	182
1995	4,105	2,870	6,975	41,122	126,400	55	170
2000	4,459	2,870	7,329	45,128	138,700	53	162

800,000 POPULATION WITH POWER

Alternate	ANNUAL COST OM&R ($1,000)	Debt. Serv. ($1,000)	Total ($1,000)	Flow (MG/yr)	Flow (AF/yr)	Cost ($/AF)	Cost ($/MG)
DRY LAKE EXPORT:							
1975	1,158	3,011	4,169	20,799	63,800	$ 65	$ 200
1980	1,419	3,086	4,505	26,021	79,900	56	173
1985	1,688	3,378	5,066	30,830	94,700	53	164
1990	1,912	3,378	5,290	35,648	109,400	48	148
1995	2,210	3,378	5,588	41,122	126,400	44	136
2000	2,381	3,378	5,759	45,128	138,700	42	128
COMPLETE TREATMENT: (discharge to SNWP)							
1975	2,330	2,539	4,869	20,799	63,800	76	234
1980	3,773	5,183	8,956	26,021	79,900	112	344
1985	4,309	5,463	9,772	30,830	94,700	103	317
1990	4,300	5,463	9,763	35,648	109,400	89	274
1995	5,167	5,463	10,630	41,122	126,400	84	258
2000	4,557	5,463	10,020	45,128	138,700	72	222
JEAN LAKE EXPORT:							
1975	2,014	2,763	4,777	20,799	63,800	75	230
1980	1,871	2,763	4,634	26,021	79,900	58	178
1985	1,777	3,049	4,826	30,830	94,700	51	157
1990	1,785	3,049	4,834	35,648	109,400	44	136
1995	2,218	3,049	5,267	41,122	126,400	42	128
2000	1,766	3,049	4,815	45,128	138,700	35	107
ELDORADO VALLEY EXPORT:							
1975	1,277	2,419	3,696	20,799	63,800	58	178
1980	1,221	2,419	3,640	26,021	79,900	46	140
1985	1,209	2,685	3,894	30,830	94,700	41	126
1990	1,229	2,685	3,914	35,648	109,400	36	110
1995	1,432	2,685	4,117	41,122	126,400	33	100
2000	1,222	2,685	3,907	45,128	138,700	28	87
COLORADO RIVER RETURN: *							
1975	2,043	2,011	4,054	20,799	63,800	64	195
1980	1,670	2,011	3,681	26,021	79,900	46	141
1985	1,893	2,292	4,185	30,830	94,700	44	136
1990	1,909	2,292	4,201	35,648	109,400	38	118
1995	2,209	2,292	4,501	41,122	126,400	36	109
2000	1,893	2,292	4,185	45,128	138,700	30	93

*Does not include desalting costs.

ESTIMATE OF ANNUAL COSTS FOR POWER ONLY

ANNUAL COST SUMMARY FOR COOLING WATER EXPORT SYSTEM
FROM COLLECTION POINT TO ARROW CANYON PLANT SITE

Year	Item	Capital Cost	Annual Debt Service*	Maintenance Costs ($/Year) Pipeline	Reservoir	Pump Sta.	Cooling Water Flow	Pumping Cost	Total Cost	Total Cost
		$	$/Year				MGD	$/Year	$/Year	$/MG
1975	Pipelines, Reservoirs	19,947,000	0	-	-	-	0	-	-	-
1976	and Pump Stations		1,607,000	-	-	-	0	-	1,607,700	-
1977			1,607,700	74,400	20,000	54,500	3	43,000	1,799,600	1,643
1980			1,607,700	74,400	20,000	54,500	25	374,000	2,130,600	233
1985	Additional Pumping	1,287,000	1,607,700	74,400	20,000	108,900	30	448,000	2,259,000	206
1990	Capacity		1,711,500	74,400	20,000	108,900	40	641,000	2,555,800	175
1995			1,711,500	74,400	20,000	108,900	46	765,000	2,679,800	160
2000			1,711,500	74,400	20,000	108,900	63	1,114,900	3,029,700	132

ANNUAL COST SUMMARY FOR COOLING WATER EXPORT SYSTEM
FROM JUNCTION OF DUAL-USE PIPELINE AND ARROW CANYON SPUR

1975	Pipelines, Reservoirs	5,418,000	0	-	-	-	0	-	-	-
1976	and Pump Stations		436,700	-	-	-	0	-	436,700	-
1977			436,700	18,200	8,000	5,800	3	2,300	471,000	430
1980			436,700	18,200	8,000	5,800	25	20,100	488,800	54
1985			436,700	18,200	8,000	5,800	30	24,700	493,400	45
1990			436,700	18,200	8,000	5,800	40	35,900	504,600	35
1995			436,700	18,200	8,000	5,800	46	42,600	511,300	30
2000			436,700	18,200	8,000	5,800	63	63,600	532,300	23

ANNUAL COST SUMMARY FOR COOLING WATER EXPORT SYSTEM
FROM COLLECTION POINT TO ARROW CANYON SPUR

Year	Total Cost $/Year	Total Cost $/MG
1975	-	-
1976	1,171,000	-
1977	1,328,600	1,213
1980	1,641,800	179
1985	1,765,600	161
1990	2,051,200	140
1995	2,168,500	130
2000	2,497,400	109

*Debt Service @ 7% for 30 years

APPENDIX B

APPENDIX B

INFILTRATION POSSIBILITIES OF WATER APPLIED TO DRY LAKE VALLEY FOR EVAPORATION

Shoro Budo, Consulting Geologist
July 1971

SUMMARY

Tests and observations made on the dry lake playas of southern Nevada, which have been flooded by rainstorm or runoff waters, show that penetration of water into the clay and silt sediments of the playa is essentially nil. Drill hole information from a hole in the Dry Lake Valley playa shows the playa is underlain mainly by thick impervious clay layers.

Drill holes located on the apron areas of Dry Lake Valley also indicate relatively impermeable sediments. The drill holes located on the fringe of the valley near the mountain flanks show the sediments are caliche, cemented gravels or clays intermixed with gravel. The drill holes located on the aprons mid-way between the mountain slopes and the playa show the sediments are mainly clay and silt. The cemented gravels and clay intermixed with gravel, like the clay and silts, are relatively impermeable and will obstruct the infiltration of water applied to their surfaces.

The fine clays and silts of the unit have low permeability and do not transmit water readily. The U.S. Geological Survey made water penetration studies of the clay and silts on Yucca Lake playa (Colton 1965) and found that two days after the dry lake was flooded and covered with a layer of water from the rainstorm, the moisture penetration into the clay sediments was only about 1/2 inch.

The clay and silt sediments of the dry lake playas of southern Nevada are probably hydrologically quite similar and are all relatively impermeable.

Younger alluvial deposits in this area consist mainly of coarse erosional debris deposited on the immediate flanks of the ranges. The deposits are composed mostly of carbonate boulders, cobbles and pebbles along with fine to coarse sand. This debris generally grades to finer grained deposits towards the center of the valley. Jenkins (1970) indicates most of these deposits are uncemented, but locally, caliche cements the debris into very tough, resistant beds which are commonly 10 to 15 feet thick and may have a lateral extent of several thousand feet.

DRILL HOLE DATA

The U. S. Geological Survey drilled two test holes in Dry Lake Valley for a geological study in 1966. One hole, 1,500 feet deep, was drilled in the center of the valley floor or playa. The sediments were mainly clay through the entire depth of the hole. The other hole was drilled approximately 1.5 miles to the west on the apron mid-way between the mountain flank (Arrow Canyon Range) and the playa. The sediments encountered in this hole were mainly clay and silts.

The Union Pacific R. R. constructed a water well approximately two miles east of the USGS playa drill hole. This hole is also located almost mid-way between the mountain slope (Dry Lake Range) and the playa. Approximately six feet of gravel was drilled at the surface, but the sediments were mainly clays down to a depth of 500 feet.

A water well for highway construction was drilled at the southeast edge of the valley. The sediments from the surface to a depth of 345 feet were clays intermixed with gravel.

U. S. Lime recently drilled a water well in the extreme southwest end of the valley, but it was abandoned as a dry hole. They are presently drilling a second well approximately 1.5 miles southeast of their first well. Both drill holes are on the apron near the mountain flanks. The

first hole drilled through clay and cemented gravels to a depth of 550 feet. The second hole reportedly encountered approximately 375 feet of similar sediments.

The two USGS holes and the UPPR water well form an east-west line across the central part of the valley. The sediments encountered in these drill holes are clays and silts of the older alluvium unit which are relatively impermeable and will allow very little penetration of water applied to their surface.

The cemented gravel and gravels in clay matrix drilled in the two U. S. Lime drill holes and the construction water well correlate with the young alluvium unit and form a relatively impervious apron area at the south end of the valley.

The large apron area between these two lines of drill holes is probably underlain by impervious sediments similar to that encountered in the existing drill holes, but the subsurface conditions should be verified with two or three shallow (50 ft.) test holes.

If impermeable clay and silt sediments or clay and gravel sediments are encountered in the test holes, most of the intermediate slope area between the mountains and the playa in the southwest portion of the valley should be favorable for flooding or spreading of wastewater.

The additional evaporation should be accomplished without any adverse infiltration problems.

REFERENCES

Colton, R. B., 1965. Fissures in Playas, Nevada Test Site and Vicinity: U. S. Geological Survey Technical Letter NTS - 137.

Jenkins, E. C., 1970. Geologic Studies in Dry Lake Valley and Hidden Valley, Southern Nevada, Part II: (NTS-176) USGS - 475-55.

Rush, F. E., 1968: Water-Resources Appraisal of the Lower Moapa-Lake Mead Area, Clark County, Nevada: Nevada Dept. Conservation and Natural Resources, Water Resources-Reconnaissance Series Report 50.

APPENDIX C

APPENDIX C

POTENTIAL FOR AGRICULTURAL UTILIZATION OF SECONDARY TREATED MUNICIPAL EFFLUENT IN THE LAS VEGAS, NEVADA REGION

The United States Department of Agriculture, Soil Conservation Service and the University of Nevada, Reno, as part of the State Water Plan, initiated the investigation of potential beneficial agriculture sites in the Las Vegas region at the request of the Las Vegas Valley Water District and the State Engineer.

The SCS supplied basic data and location for the analysis of beneficial irrigation uses of secondary treated municipal sewage flows and waste discharges similar to those that now enter the Las Vegas Wash. In addition to the areas considered by the SCS, the Eldorado Valley information, as presented in the Boyle-CH2M Phase II Report, has been reviewed and compared with areas of Hidden Valley South, Jean Lake Valley, the Dry Lake Valley North, Hidden Valley North, the California Wash, and the Moapa-Meadow Valley Wash areas.

CRITERIA AND AVAILABLE SITES

Criteria utilized in the selection of areas for reclaimed wastewater irrigation included:

1. Multiple use: Any application of a seasonally variable supply

of water requires storage. This requires that suitable sites be available for storing volumes to meet peak season needs. Storage reservoirs suggest the possibility of multiple use including recreation as related to hunting, fishing, boating, and other water-based activity. Each of the sites selected and evaluated is adaptable to recreational facilities, although no economic benefit in these comparisons has been designated. At sites where evaporation ponds are considered, these ponds may possibly be utilized and operated to effect storage for agriculture's varying demand. Total agriculture will, however, need to support its own storage.

2. Acreage required: The Soil Conservation Service considered a minimum of 10,000 acres to be necessary for a multiple use complex which could maximize beneficial use of the effluent supply. Because of the application rates required with the treated wastewaters, this acreage may be adjusted downward when considering soil characteristics in combination with water characteristics, and when evaporation ponds are constructed in conjunction with irrigation as a system for utilizing and disposing of excess wastewaters.

3. Drainage of Surface Water: Surface slopes accumulate and conduct excess waters to impounding areas, for evaporation, reuse and wildlife support, the most suitable being dry lake playas. Areas that lie within watersheds that drain to Lake Mead and the Colorado River were considered less suitable.

4. Subsurface drainage: Soils with adequate subsurface drainage capability to prevent water table build-up and excessive soil salinization are necessary since high leaching water application rates can be anticipated.

5. Air Movement: Secondary treated effluents may carry a faint residual of hydrogen sulphide odor. Potential odors from this water may become objectionable in locations where air does not drain readily. Air drainage should be away from areas extensively used by people, such as highways and habitations. Areas with poor air drainage or with drainage to populated areas are less suitable.

6. Soil Characteristics: Soils showing the following characteristics favorable to agriculture production were selected at each location.

   Surface Texture: Gravelly, loamy sands to clay loam

   Subsurface Texture: Gravelly sands to loam

   Depth: Greater than 30 inches

   Salinity: Less than 20 millimhos

   Exchangeable Sodium: Less than 15 percent

   Permeability: Moderate to rapid

   Available Water Capacity: Greater than 4 inches

7. Land Surface Modification: Stone removal, brushing and leveling costs should be minimal.

Listed below are locations examined by the Soil Conservation Service. Summary comments for each area are given.

Meadow Valley Wash - This area was not considered as a feasible site. The acreage is insufficient and the flood plain poses a potential surface drainage problem to downstream water users, Lake Mead, and the Colorado River.

California Wash - This area provides insufficient acreage because of underlying hard pan and poor soil. There is a potential pollution problem to downstream water users and Lake Mead.

Dry Lake Valley - The irrigable soils in this area have flat slopes which surround the playa. This dish-like terrain poses the hazards of a high water table with attendant surface salt build-up. About 40 percent of the soils are subject to occasional storm water overflow. A large portion of the lower valley soils best suited to agriculture may be covered with the saline waters of an evaporative lake which would receive excess leaching waters. If this valley is selected, a major portion of the area occupies alluvial fans with marginal soil having depth restrictions because of hard pan. The SCS believes that these items present a sufficient amount of difficulties to preclude beneficial agriculture. However, because of the potential of a power plant site near the Dry Lake Valley, some 2,500 acres have been evaluated for potential returns after the addition of a drainage system to

intercept groundwater above and below the areas with the most suitable agricultural soils. The Dry Lake Valley has also poor air drainage with respect to the highway, which passes by the lower part of the Dry Lake Basin. The area is favorable for a water fowl sanctuary. Inasmuch as the acreage suitable for beneficial agriculture is insufficient to accept the available effluent flows, it could be considered in combination with Hidden Valley North, but the increased pumping lift to Hidden Valley precludes this combination from economical development if an entire agricultural utilization disposal is required.

Hidden Valley North - The elevation of Hidden Valley North is higher and thus requires a greater lift of water. There are about 3,000 acres of good agricultural soils available which are subject to occassional storm runoff overflow. This could be corrected by diversion of flood waters. The evaluation of this area has not been included in the economic comparison because of its high water lift, small acreage, and surface runoff diversion costs.

Hidden Valley South - This high valley is deemed suitable for multiple purpose use, has favorable soils and air drainage. Its low point could be occupied by a lake with an outlet into the Jean Lake Valley. The soils and slopes are well suited for multiple uses of water, including irrigation, agriculture, horticulture, floraculture, aquatic life production, water fowl refuge and

recreational use. Any excess water reaching Jean Lake would be expected to have reduced odor potential.

Jean Lake Valley - The Jean Lake Valley is the largest area of irrigable soils of any of the sites studied, exclusive of the Eldorado Valley. The low point and its sloping fringe are not suitable as irrigable acreage because of potential ponding and flooding. With irrigation, the lower areas would be expected to impound water and create a high water table in the fringe areas. The area could be adapted to a multiple use with recreational facilities.

TABLE I

EVALUATION OF POTENTIAL EFFLUENT USE SITES
(numbers in order of preference)

Consideration	1 Jean Lake V.	2 Hidden V., South	3 Dry Lake V.	4 Hidden V., North	5 Meadow V., Wash	6 California Wash	7 Eldorado Valley
Multiple Use	Good	Good	Poor	Poor	Poor	Poor	Good
Acreage	10790	5460	5260	2950	3000	500	12200
Drainage							
Surface Water	Good	Good	Poor	Fair	Good	Good	Good
Pollution poten.	Low	Low	Low	Low	High	High	Low
Subsurface water	Good	Good	Poor	Fair	Fair	Poor	Good
Air	Fair	Good	Poor	Fair	Good	Good	Poor
Soils	Good	Good	Fair	Good	Good	Poor	Good
Land modification costs	Low	Low	Low	Low	Moderate	High	Low

The following is a tabulation of the areas investigated by the SCS as set forth in Table I. Table II includes Eldorado Valley for a comparison with respective valleys selected by the SCS.

TABLE II

LOCATION	AREA ADAPTABLE TO AGRICULTURE	REMARKS
Eldorado Valley	9,200 acres of favorable soils; 3,000 acres of marginal soils	Colorado River Commission of the State of Nevada and Boulder City have prepared master planning which anticipates urban and municipal type development within the Valley. The Colorado River Commission Policy for development of the Eldorado Valley adopted Dec. 21, 1971, states "the Eldorado Valley should be developed into an industrial area or community and the nucleus of the development would be an industrial complex with the possibility that a major airport system would be integrated into the complex". Air drainage from the Valley is marginal: the increasingly traveled Highway 95 will be exposed to any inversions as will future development lower in the basin. Prevailing winds will tend to carry residual odors to the populated areas of Boulder City and possibly to a lesser degree the Las Vegas Valley. There is concern in Boulder City over a large-scale agricultural development with effluent water because of potential residual odors and the image connoted by the disposal of Las Vegas Valley secondary treated sewage effluent in the area. Power transmission lines and U.S. Highway 95 through the lower portions of the Valley restrict the size and depth of the evaporation lake for saline brines from agricultural leach water and excess wastewater flows. Evaporative ponds in addition to the playa will be required.

TABLE II
(continued)

LOCATION	AREA ADAPTABLE TO AGRICULTURE	REMARKS
Hidden Valley South	5,460 suitable acres	Hidden Valley is a site for potential beneficial agricultural development and has been evaluated in economic comparison herein.
Jean Lake Valley	10,790 suitable acres	Jean Lake will function more beneficially agricultural-wise in conjunction with the Hidden Valley South. This area has been considered in the following evaluations separate from the Hidden Valley South. It would be expected to provide equal or more favorable economic results when compared in conjunction with the South Hidden Valley.
Las Vegas Valley	600 acres	Even though there are limited acreages of suitable soils within the Valley, these lands have a high potential for urban development. This potential escalates their value too high to consider them for the irrigation system expenditures that would be required to put them under profitable cultivation.
Dry Lake Valley	5,260 acres	Although this valley has shallow hard pan and less favorable, denser soils, and because of the potential of Nevada Power Company locating its planned Arrow Canyon plant in this vicinity, 2,500 acres not subject to storm and lake inundation have been evaluated. The limited area and the cost of providing a drainage system for all irrigable acreage present a marginal agricultural development. Further discounting may be necessary because of less favorable soils.
California Wash Area	Less than 500 acres	The Soil Conservation Service finds less than 500 acres of suitable soils in this favorably appearing area.

TABLE II
(continued)

LOCATION	AREA ADAPTABLE TO AGRICULTURE	REMARKS
Moapa-Meadow Valley Wash	Less than 3,000 acres	Because of its limited area and the distance from the Las Vegas Wash, the Meadow Valley Wash areas have essentially been ruled out on the basis of construction costs of facilities to reach the area, as well as potential return flows to downstream irrigators and Lake Mead. The Moapa Meadow Valley Wash area has been reviewed in a concluding report entitled "Moapa Pumping Project Concluding Report" dated May 1971 and released January 1972 by the Bureau of Reclamation. On page 119, the report concludes the project is not economically justified. The Moapa Valley pumping project considers the exchange of 22,828 AF/yr of water to irrigate the lower Moapa Valley from Lake Mead, and the diversion of 22,140 AF/yr of the Muddy River flows to irrigate some 2,840 acres in the Meadow Valley Wash. The project would include a major drainage system in the lower Moapa Valley to increase the irrigable acreage to 3,825 acres at a cost estimated to be $3,986,000. A canal and pipeline system from the Dry Lake area to the Meadow Valley Wash that will carry 70 cubic feet per second can be constructed for an estimated $8,500,000. The canal would replace the need for the Warm Springs Reservoir, the diversion dam, and the Meadow Valley tunnel, costing $10,867,000. The canal could further alleviate the need for some $6,000,000 worth of evaporative ponds in the Dry Lake area. An economic comparison made with these adjustments using 7 percent interest on capital expenditures in lieu of the 4-7/8 percent considered by the Bureau of Reclamation, only decreases the annual cost of the

TABLE II
(continued)

LOCATION	AREA ADAPTABLE TO AGRICULTURE	REMARKS
		project 10 percent and does not overcome the unjustifiable benefits ratio. The more saline waters of Las Vegas Valley's effluent discharges will increase drainage costs and make the benefits ratio even less favorable.

POTENTIAL CROPS

Potential crops considered for production within the climate-soil-water characteristic limitations are discussed below and either selected or discarded for further economic evaluations.

TABLE III

CROP	REMARKS
Alfalfa	Alfalfa has been selected because of its local demand and its favorable history in the Moapa and Pahrump areas. It is a needed and profitable crop in the Las Vegas area.
Barley	Barley has been selected with sorghum for annual two-crop production. It has local demand for grain and suitability for forage in the dairy industry in the Moapa Valley and for livestock with the Las Vegas Valley. It also has demonstrated itself to have a favorable and reasonably profitable history when compared with other crops.
Bermuda grass pasture	Considered for a pasture operations, but has not been evaluated because of extensive investment required for livestock operations.
Cotton	Considered but not evaluated since approximately 3,000 acres are required for an economic and profitable operation. As long as the Pahrump Valley and Amorgosa Valley hold the dominant acreage allotments, it will not be considered a likely producer.
Fescues	Fescues were considered for pasture and hay but not evaluated because of the large livestock investment required.
Grapes and fruit trees	These and other low salt-tolerant crops requiring excessive leaching with water available are not considered suitable crops.

TABLE III
(continued)

CROP	REMARKS
Fallow	It has been estimated that in any normal agricultural operation, 10 to 12 percent of the improved land would lie idle in any crop rotation cycle even in the best of managed agricultural enterprises.
Wheats	Have been considered where some varieties will fit in rotation with other crops for a two-crop annaul return, but are assumed to have the monetary return equal to barley. Most are not economical on a single-crop basis.
Sorghum	Sorghum has been selected with barley ~~for two-crop~~ annual production because of its local demand and favorable history.
Sugar Beets	Not evaluated since approximately 30,000 acres are required for a profitable venture.
Sugar Beet Seed	Considered but not evaluated because of the number of unknowns involved.
Greenhouses and Floral Production	Considered but not evaluated. Even though potential returns are high, potential investors are few. There also are too many unknowns in extensive developments of greenhouse production that could utilize the quantities of saline effluent water that will be available.

Crops selected for their highest potential and favorable history are alfalfa in a three-year run, replaced with grain and sorghum for one year. The cropping cycle considers a half-year of fallow in a four and one-half year sequence as that being realistic and that which can be anticipated with the least number of unknowns.

WATER REQUIREMENTS

The UNR - Max Fleischmann Agricultural College anticipates the water requirements for agriculturally isolated basins will be substantially in excess of those forecast in the Boyle-CH2M Phase II Report for the following reasons:

1. Applications experienced in the Pahrump-Amorgosa and Upper Moapa valleys applied to the selected crops.

2. The heat and drying effects of air currents from land not under cultivated vegetation to the relatively small irrigated acreages in the confined basins will produce higher evaporation and evapotranspiration.

3. Leaching requirements of 25 to 30 percent of the water application will be required to maintain maximum crop production. Inefficiencies of irrigation in hot dry climates will be on the order of 25 percent.

WATER APPLICATION

Evapotranspiration rates considered to be applicable are shown in Table IV.

"Olivier's" method, by consenses of the UNR staff, is considered to be the most representative for initial cropping and probably Penman's

most representative for sustained agriculture in the Dry Lake basins of the Las Vegas region. Evapotranspiration rates presented in this table is for green vegetation with full ground coverage throughout the year.

TABLE IV

POTENTIAL EVAPOTRANSPIRATION AS ESTIMATED BY PENMAN'S METHOD

January	2.8 inches
February	3.5
March	5.3
April	7.6
May	9.9
June	11.1
July	11.3
August	10.3
September	7.7
October	5.2
November	2.8
December	2.1
	79.6 ± 5.0

The following Tables V through VIII present applicable water use data.

TABLE V

WATER QUALITY ANTICIPATED BASED ON 14-MONTH ANALYSIS FROM CLARK COUNTY SANITATION DISTRICT'S EFFLUENT

EC = 2200 to 2800 Micromhos/cm
SAR = 4.5
pH = 7.6
B = 0.57 ppm
Total P = 52.4 lb $p20_5$/Acre foot
Total N = 42.5 lb N/Acre foot = 15.6 ppm (12.55 ppm NH_4-N)

TABLE VI

ESTIMATED LEACHING REQUIREMENT
FOR VARIOUS CROPS

Crop	Expected Max. EC That Will Not Reduce Yield (Millimhos)	Leaching* Requirement $\left(\frac{EC_{iw}}{EC_{e}\,max.}\right)$ – %
*Alfalfa	4	0.55
	6 (25% reduction)	0.37
Barley	12	0.18
Sugar Beets (possible seed)	10	0.22
Cotton	10	0.22
Wheat or Oats	6	0.37
*Sorghums	6	0.37
Bermuda Grass	12	0.18
Pomegranate) Fig) Olive)	4-6	0.55-0.37
Grape	4	0.55
Fescue	7	0.32

* Subsequent to this table preparation, discussions with the UNR Agriculturalists adjusted these leaching requirements for the cropping sequence of alfalfa, barley and sorghum to 25 to 30 percent with nominal crop reduction.

TABLE VII

APPLICATION OF WATER
IN INCHES OF WATER PER MONTH
FOR SELECTED CROPS

	WATER UTILIZED*	J	F	M	A	M	J	J	A	S	O	N	D	TOTAL		PERCENT OF TOTAL CULTIVATED AREA IN CROP
lfa	CS	1.5	2	5	7	10	11	11	10	7.5	5.0	2.0	1.0	73	47%	
	L	5	5	4	3	3	2	2	3	4	4	4	4	43	28%	67%
	IE	2	2	3	3	4	4	4	4	4	3	2	2	37	25%	
	Total	8.5	9	12	13	17	17	17	17	15.5	12	8	7	153	100%	
hum & ey			(Barley									(Barley)				
	CS Barley	2.8	3.5	5.3	7.6	9.9		(Sorghum)				2.8	2.1	34	22%	
	CS Sorghum				(7.6)	(9.9)	11.1	11.3	10.3	7.7				40.5	26%	22%
	L	3	5	4	3	3	2	2	3	4	5	4	4	42	27%	
	IE	2	2	3	3	4	4	4	4	4	3	2	2	37	25%	
	Total	7.8	10.5	12.3	13.6	16.9	17.1	17.3	17.3	15.7	8	8.8	8.1	154	100%	

Total area in beneficial production utilizing 154 inches 12.8 feet of water per year 89%

ow Area of idle developed land in cropping sequence 11%

TOTAL Cultivated Acreage Developed 100%

Annual application rate based on total cultivated acreage = .89 x 12.8 - 11.4 acre feet per acre per year

· Consumptive Use
· Leaching Water
· Irrigation Inefficiencies

TABLE VIII

EXPECTED WATER RETURN FROM AGRICULTURE*

.TION	% OF LEACH WATER REACHING PLAYA OR EVAPORATIVE LAKE	% OF INEFFICIENCY WATER REACHING PLAYA OR LAKE#		% OF TOTAL AREA UNDER SPRINKLER SYSTEM	COMPOSITE INEFFICIENCY RUN-OFF	***ACRE FOOT PER ACRE OF WATER TO PLAYA OR EVAPORATIVE LAKE		
		SPRINKLER IRRIGATION	FLOOD IRRIGATION METHOD			Leach	I.E.	T
'orado	30%	5%	25%	50%	15%	.94	.43	1.37
. & Hidden	25%	5%	30%	50%	17.5%	.78	.50	1.28
Lake	75%**	10%	50%	100%	10%	2.39	.29	2.68
.rs	30%	7%	30%	50%	18.5%	.94	.53	1.47

*Based on judgments of the writer, of the leach waters that pass through the soil profile, a major portion should percolate to the underground water table.

**Dry Lake has an indicated high return because of the hard pan that is expected to be encountered by the leach water. Also because of the expected need for a soil drainage system for the Dry Lake acreage to maintain crop production.

***Based on the application of 11.4 acre foot per acre applied to the gross acreages.

#The irrigation inefficiency losses are expected to be evaporated from sprinkler irrigation systems and a small amount percolating to the underground water basin. With surface flooding irrigation, a lesser portion is evaporated and a larger portion reaches the underground.

ECONOMICS

*Basic data for the following evaluations are substantially based on those presented by the University of Nevada, Reno, Mac C. Fleischmann College of Agriculture. Dr. Barmettler has been the principal author.

LAND IMPROVEMENT COSTS

Cost of Land - Estimated acquisition and appraisal costs per acre	$ 20.00/Ac.	
Preparing Land - Brush, land plane, plow, etc.	37.00/Ac.	
Farm Equipment - Assumes equipment of equivalent cost will be required for alfalfa-sorghum grain, as for alfalfa	46.50/Ac.	
Subtotal cost of Land Improvement and Equipment		$103.50/Ac.
Irrigation Systems		
Flood Irrigation System: Concrete lined ditches	$185.00/Ac.	
Solid Set Sprinkler System	825.00/Ac.	
Subtotal Cost of Irrigation System 50% solid set, 50% flood irrigation equals 50% x 185 + 50% x 825		$505.00/Ac.

* Cost escalation used herein is based primarily on the Engineering News Record escalations from time of U of N (1968, 1969 and 1971) reports to January, 1972, based on the Index for materials.

Storage Requirement

If leaching water applications are applied in winter, storage requirement is 10.5% of annual applications. If storage provided for normal irrigation, storage requirement is 28% - assume since acreage reduced and playa used for winter flows to permit storage of 3% and any excess flows by-passed to the playa or saline evaporative lakes $513.00/Ac.

Assume storage system required in:
Eldorado Valley
Hidden and Jean Lake Valleys
Assume evaporative ponds will serve as storage in Dry Lake Valley $160.00/Ac.

Drainage System

Assumed required for Dry Lake area only. The Eldorado Valley, Hidden Valley and Jean Lake Valley soils expected to receive 20 to 25 years of irrigation without excessive salt buildup.

Summary of Land Development Costs

Eldorado, Hidden & Jean Lake Valley:		
Land, Land Preparation and Equipment	$103.50/Ac.	
Irrigation System	505.00/Ac.	
Storage Facilities	513.00/Ac.	
		$1121.50/Ac.
Dry Lake Valley:		
Land, Land Preparation and Equipment	$103.50	
Irrigation System	825.00	
Drainage System	160.00	
		$1088.50/Ac.

Annual Cost of Land and Improvements

Based on agricultural development being over ten years with 10 percent salvage and interest at 10 percent during development and 8% thereafter.

Eldorado, Hidden & Jean Lake Valleys:	$ 150.29/Ac.
Dry Lake Valley:	$ 145.86/Ac.

ANNUAL COST OF AGRICULTURAL OPERATIONS

Water Application - Flood Irrigation	$54.40/Ac.
Water Application - Solid Set Sprinkler System	$20.25/Ac.
Water Application - 50/50 System	$37.33/Ac.
Crop Development (except irrigation & fertilizer)	
Alfalfa:	
Before harvest cost	$26.33/Ac.
Harvest cost	$67.76/Ac.
Sorghum:	
Before harvest cost	$16.05/Ac.
Harvest cost	$29.26/Ac.
Grain:	
Before harvest cost	$10.55/Ac.
Harvest cost	$12.26/Ac.

SUMMARY OF COST OF AGRICULTURAL OPERATION

TABLE IX

COST OF FARM OPERATION PER ACRE

Crop	Labor & Equip.	Fertilizer & Materials*	Irrigation Costs	Harvest Cost	TOTAL
Alfalfa	$26.33	$10.00	$37.33**	$67.76	$141.42
Sorghum	16.05	6.00	18.67	29.26	
Grain	10.55	10.00	18.66	12.26	
	$26.60	$16.00	$37.33**	$41.52	$121.45

* Fertilizer and materials expected to be low because of nutrient value of effluent.

** Irrigation costs decrease to $20.25 in the solid set system of Dry Lake to $124.34/Ac and $104.37/Ac for alfalfa and sorghum and grain respectively.

GROSS RETURN AVERAGE

Alfalfa - $36/ton -- 10 ton/acre equals $360/acre

Grain and Sorghum - Grain $190/acre, Sorghum $155/acre equals $345/acre annually.

ACREAGE UNDER CULTIVATION

Based on:

1. The average amount of water available with and without power generation in the Las Vegas region over a 25-year period.

2. The maximum availal le acreage at location for agriculture.

3. Both 800,000 & 1,000,000 populations have maximum of 53,000 AF/yr and 57,000 AF/yr respectively with power and 112,000 AF/yr and 100,000 AF/yr without power. Table D-X assumes the average for 25-year period to be the same for both populations.

TABLE X

	Average Area Developed		Maximum Area Developed	
	With Power	Without Power	With Power	Without Power
	Acres	Acres	(1,000,000 pop)	(800,000 pop)
Valley	42,500 AF/yr	74,200 AF/yr	57,000 AF/yr	112,000 AF/yr
Eldorado	3730	6500	5000	9.200
Hidden	3730	5460	5000	5,460
Jean Lake	3730	6500	5000	10,790
Dry Lake	2500	2500	2500	2,500

TABLE XI

AVERAGE RATE OF RETURN WITH POWER

LOCATION	AREA DEVEL-OPED ACRES	COST OF LAND & EQUIPMENT		ANNUAL COST OF CAPITAL SECTION	CROPPING IRRIGATION & HARVEST EXPENSES		MANAGE-MENT COSTS	TOTAL EXPENSE	GROSS		TOTAL GROSS	NET AVAIL-ABLE FOR WATER, LEASE OR TAXES	IF ALL ALLOCATED TO WATER	
		Unit Cost Per Acre	Total		Alfalfa	Gr&Sorg			Alfalfa	Grain & Sorghum			Water Use	Value Per AF
ElDorado Valley	3730	$1121.50	4,183.195	560,582	353,423	99,662	40,000	1053,667	889,676	283,107	1,182,783	129,116	42,500	$3.04
Hidden Valley	3730	1121.50	5,183,195	560,582	353,423	99,662	40,000	1053,667	899,676	283,107	1,182,783	129,116	42,500	3.04
Jean Lake	3730	1121.50	4,183,195	560,582	353,423	99,662	40,000	1053,667	899,676	283,107	1,182,783	129,116	42,500	3.04
Dry Lake	2500	1088.50	2,721,250	364,650	208,270	57,404	36,680*	667,004	603,000	189,750	792,750	125,746	28,500	4.41

*Includes $1,680/yr for drainage system pumping.

**It is quite possible the finer soils of the Dry Lake Valley will reduce crop production 10 to 15 percent, in which event gross income will drop $79,300, expenses will drop $20,300, a net loss of $59,000 or $667,004 gross, resulting a net return of $66,746.

TABLE XII

AVERAGE RATE OF RETURN WITHOUT POWER

LOCATION	AREA DEVEL-OPED ACRES	COST OF LAND & EQUIPMENT Unit Cost Per Acre	COST OF LAND & EQUIPMENT Total	ANNUAL COST OF CAPITAL SECTION	CROPPING IRRIGATION & HARVEST EXPENSES Alfalfa	CROPPING IRRIGATION & HARVEST EXPENSES Cr&Sorg	MANAGE-MENT COSTS	TOTAL EXPENSE	GROSS Alfalfa	GROSS Grain & Sorghum	TOTAL GROSS	NET-AVAIL-ABLE FOR WATER, LEASE, TAXES OR PROFIT	IF ALL ALLOCATED TO WATER Water Use	IF ALL ALLOCATED TO WATER Value Per AF
ElDorado Valley	6500	$1121.50	7,289,750	976,885	615,884	173,674	50,000	1,816,443	1,567,800	493,350	2,061,150	244,707	74,100	3.30
Hidden Valley	5200**	1121.50	5,831,800	781,508	517,383	145,886	50,000	1,494,777	1,316,952	414,414	1,731,366	236,589	59,280	3.99
Jean Lake	6500	1121.50	7,289,750	976,885	615,834	173,674	50,000	1,816,443	1,567,800	493,350	2,061,150	244,707	74,100	3.30
Dry Lake	2500	$1088.50	2,721,250	364,650	208,270	57,606	36,680*	667,004	603,000	189,758	792,750	125,746**	28,500	4.41

*Includes $1,680/yr for drainage system pumping.

**It is quite possible the finer soils of the Dry Lake Valley will reduce crop production 10 to 15 percent, in which event gross income will drop $79,300, expenses will drop $20,300, a net reduction of $59,000 or $667,004 gross, resulting in a net return of $66,746 or $2.34 per acre foot.

**Assure 260 acres of available land used for storage.

SUMMARY

Sufficient areas of suitable soils exist in Eldorado Valley, Hidden Valley and Jean Lake Valley to support agricultural enterprise. Dry Lake has 2,500 acres of marginal soils.

The allocation of costs for storage to permit the maximum utilization of excess wastewater places a burden on agriculture which it cannot support. Tables XI and XII allocate 25 percent of the storage that is required for full utilization of excess water for which income is projected at the rate of 3 percent of the annual water quantity used for agriculture. The exception is Dry Lake where evaporative ponds provide for excess wastewater disposal and summer wastewater flows are sufficient to meet peak irrigating demands.

Neither Hidden Valley or Jean Lake can provide sufficient agricultural income to offset the added cost of the facilities and operating costs to deliver water to these valleys. ($13 to $17 per acre foot)

Eldorado Valley has the most favorable area for agriculture, but it cannot justify the storage cost requirement to utilize all the excess wastewater. If acreage is reduced by 25 percent to 40 percent to adjust the summer irrigation demands to the summer supply rate of wastewater, additional storage can be eliminated. However, these savings will be offset by the need to provide evaporative ponds and improve and protect the existing power and highway facilities within the Valley.

Eldorado Valley irrigation may be opposed by residents of Boulder City who may object to having the Eldorado Valley used as a waste disposal site for Las Vegas Valley's wastewater flows. Their planning, as well as previous planning by the Colorado River Commission, foresees an industrial area and community that could well provide beneficial returns far in excess of that which could be provided by agriculture.

APPENDIX D

APPENDIX D

STATEMENT

PROBABLE VALUE OF WASTE WATER DELIVERED TO ARROW CANYON POWER PLANT SITE

In attempting to appraise the probable value of water to the Arrow Canyon site we are faced with a very difficult problem of analysis. Without the water, the plant cannot be build at this site or any other site reasonably close to the Las Vegas Valley. Based on the above statement, assessment of the value of this water becomes a hopelessly complex problem relating to complete site evaluation and comparison at a number of different locations, assuming cost factors and water availability factors can be deliniated.

Examination of the current trends in power plant location in the Southwestern United States reveals two predominant factors which seem to dictate location:

(1) availability of a cooling water supply;

(2) location in an area remote from existing development.

All too frequently these two requirements are not compatible. The necessity for remote locations has, in general, certainly increased the cost, if not the value, of cooling water.

In the instance of the Arrow Canyon plant, a case study of other plants in the arid Southwest is of little value. The final settlement, if made in this unique case, will be a matter of agreement between buyer and seller as to a price that is fair to both.

In order to give some general guidance it may be well to quote costs paid by industrial and commercial users in Southern California for water. Note that these figures reflect cost (including water rate charges as well as taxes paid for development and delivery of water) and not value. It should be safe to assume that the value of water exceeds the cost in some degree. The report "Water Pricing Policy Study", prepared for the Metropolitan Water District of Southern California in June 1969, reports on such water costs to the user. These costs are presumably for water of Colorado River quality delivered through the meter at the user's property line, and may be generally summarized as follows:

Customer	Lowest Cost Reported $/ac. ft.	Highest Cost Reported $/ac. ft.	Estimated Average Cost $/ac.ft.	Estimated Average Cost $/MG
Heavy Commercial User	55	627	180	540
Heavy Industrial User	62	428	140	420

Additional information relating to the cost of delivery (not the value) of water at the Arrow Canyon Plant site is contained in the following tabulations which show the cost of delivery to the plant site on the basis of the following analysis: (Refer to table A 23-17)

Transportation Element 63MGD (70,000 ac.ft./yr.)	Lowest Cost $/MG	Highest Cost $/MG	Estimated Average Cost $/MG
Pipeline from Collection to Junction	109	1213	140
Pipeline from Junction to Site	23	430	35
Total Transportation	132	1643	175

The above figures include capital, maintenance and operation costs for transmission facilities only. No charge for the value of water as a commodity is included. It should be noted that the water supplied is of considerably lesser quality than the water supplied to Southern California users under conditions noted in the previous paragraph. Therefore, it would be logical to discount the Southern California cost to allow for necessary pre-treatment of wastewater. The following table shows annual revenues from the sale of water for power use which may encompass the actual value to the Nevada Power Company. This table may permit certain conclusions to be drawn which may be useful for comparison with proposed cost-sharing agreements or proposed water rate structures.

Year	Cooling Water Required	Possible Water Charge			
		$100/MG	$150/MG	$200/MG	$300/MG
	Million Gallon	$1,000			
1977	1,060	106	159	212	318
1978	3,450	345	518	690	1036
1979	6,150	615	923	1230	1846
1980	8,850	885	1328	1770	2656
1981-85	10,490	1049	1574	2098	3148
1986	11,800	1180	1770	2360	3540
1987	13,110	1311	1967	2622	3934
1988-94	14,440	1444	2166	2888	4332
1995	16,530	1653	2480	3306	4960
1996	18,650	1865	2798	3730	5596
1997	20,730	2073	3110	4146	6220
1998-2000	22,820	2282	3423	4564	6846
TOTAL		32,323	48,354	64,464	96,708
PRESENT VALUE, 7%		12,665	19,001	25,330	38,002

If it is assumed that the present worth of projected capital investment in the Arrow Canyon Generating Complex varies between 500 million and 1,000 million dollars; and if it is assumed that present value of cumulative charges as tabulated above is interpreted as the capital cost of water supply at the plant site, the following percentages can be derived.

Unit Cost Cooling Water $/MG	Present Value for water to year 2000	% Total Capital Chargeable To Water at Various Plant Investments		
		$500 mil.	$750 mil.	$1,000 mil.
- - -Million Dollars - - - -		(%)	(%)	(%)
100	12.6	2.50	1.88	1.25
200	25.3	5.06	4.80	2.53
300	38.0	7.60	5.70	3.80

If we assume that the volumes of water will support generating facilities in excess of 4000 mega-watts, the present value of such facilities should be in excess of $750,000,000, indicating that even at the higher water rates an investment of 4 to 5 percent of the total investment contemplated would provide this facility with a 30 year right to delivery of necessary water at plant site.

As stated earlier, it is not possible to define the value of water to the proposed Arrow Canyon Power Complex. The ideas presented herein are given for the purpose of trying to put some scale on the problem, and to suggest some approaches or guidelines in subsequent discussions.

TABLE VII

APPLICATION OF WATER
IN INCHES OF WATER PER MONTH
FOR SELECTED CROPS

CROP	WATER UTILIZED*	J	F	M	A	M	J	J	A	S	O	N	D	TOTAL		PERCENT OF TOTAL CULTIVATED AREA IN CROP
Alfalfa	CS	1.5	2	5	7	10	11	11	10	7.5	5.0	2.0	1.0	73	47%	
	L	5	5	4	3	3	2	2	3	4	4	4	4	43	28%	67%
	IE	2	2	3	3	4	4	4	4	4	3	2	2	37	25%	
	Total	8.5	9	12	13	17	17	17	17	15.5	12	8	7	153	100%	
Sorghum & Barley			(Barley									(Barley)				
	CS Barley	2.8	3.5	5.3	7.6	9.9		(Sorghum)				2.8	2.1	34	22%	
	CS Sorghum				(7.6)	(9.9)	11.1	11.3	10.3	7.7				40.5	26%	22%
	L	3	5	4	3	3	2	2	3	4	5	4	4	42	27%	
	IE	2	2	3	3	4	4	4	4	4	3	2	2	37	25%	
	Total	7.8	10.5	12.3	13.6	16.9	17.1	17.3	17.3	15.7	8	8.8	8.1	154	100%	
	Total area in beneficial production utilizing 154 inches 12.8 feet of water per year															89%
Fallow	Area of idle developed land in cropping sequence															11%
	TOTAL Cultivated Acreage Developed															100%

Annual application rate based on total cultivated acreage = .89 x 12.8 - 11.4 acre feet per acre per year

*CS - Consumptive Use
L - Leaching Water
IE - Irrigation Inefficiencies

APPENDIX E

APPENDIX E

ECONOMIC IMPACT OF PROPOSED
ARROW CANYON POWER PLANT

The Nevada Power Company has proposed construction of a thermal power plant at a site in Arrow Canyon northwest of Las Vegas. The quantities of wastewater that would be purchased for condenser cooling and the effect on other facilities in the treatment and disposal systems are covered in the Boyle-CH2M/Hill Phase III Report of April 1972. The purpose of this statement is to discuss results of an evaluation of the local economic impact of construction and operation of the power plant.

Economic impact is defined here as the effects on employment, payrolls, taxes, and income, were the power plant to be placed in operation in Clark County. Constant, present-day prices and costs were assumed in this evaluation. The time period considered is 1972 to 2000. Data for the evaluation were obtained from the Nevada Power Company and other sources. Independent estimates were made by CH2M/Hill and Boyle Engineering.

The proposed Arrow Canyon electric generating plant consists of four 500-MW units. Design is scheduled to begin in the second half of 1972 and construction in the second half of 1974.[1/] Completion of the four units will be staged--one unit due for operation in the second half of each of the years 1977-1980. The estimates here cover only the 2000-MW plant although there are preliminary plans for additional generation indicated

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1/ Design of the plant will be done in either Los Angeles or Denver and, thus, will have little impact on Clark County's economy.

in the water budgets of the Phase III Report. Economic impacts for larger or smaller developments would be roughly proportional to their size in relation to the 2000-MW plant assumed for this study.

DIRECT IMPACTS

EMPLOYMENT

The construction work force was estimated by Nevada Power Company but was revised slightly for this study.[1/] The estimated average of 960 construction workers would earn $18.5 million annually between 1974-1981; peak employment and payrolls would exceed 1,300 and $25 million in some of those years. Total construction employment and payrolls over eight years thus would approximate 7,700 man-years and $147.8 million, respectively.

The construction employment and payrolls cannot be evaluated in number of jobs and income alone, however. If the majority of jobs were filled by local residents, the economic benefits which would accrue to Clark County could be considerably greater than if the majority of jobs were filled by migrating construction workers. Nonresident construction workers would demand additional public and private services--for example, police and fire protection, educational facilities, possibly more highways, retail facilities, etc. Once this large construction crew left the area,

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1/ The construction manpower schedule provided by NPC was as follows:

1974 - 500 jobs	1977 - 1,300 jobs	1980 - 1,300 jobs
1975 - 1,000 "	1978 - 1,300 "	1981 - 800 "
1976 - 1,300 "	1979 - 1,300 "	

there would likely be redundant public and private capacity in the local economy which could represent sizable investments. On the other hand, if the construction crew consisted primarily of local residents who were either unemployed or underemployed, the benefits would include not only the jobs and payrolls, but also: (1) a higher per capita income for the county, (2) reduced unemployment, and (3) a higher local spending rate than in the case of nonresident construction workers. Also, there would not be as great a need for increased public and private services.

Upon completion of the first generating unit in July 1977, approximately 80 persons would be needed to operate and maintain the plant. Each additional unit would require another 40 employees, bringing total permanent employment at the plant to 200 in 1980. Annual payrolls at the plant at full operation could be expected to approximate $2,300,000.[1/]

In addition to employment at the plant, a number of local jobs would result from the direct purchases by NPC of materials for the power plant, the ensuing interindustry purchases, and the induced income effects of households. These effects are discussed in the section entitled "Indirect Impact."

TAXES

If the proposed plant is constructed, Nevada Power Company will pay a sales tax of 3.5 percent on all purchases of equipment, construction

material, fuel, and annual supplies. One percent of this tax is returned to the county's school districts, 2 percent goes to the state, and 0.5 percent goes to the incorporated cities in Clark County. In addition, the $500 million investment in the proposed plant would add to the property value of Clark County. The benefits of property taxes on the power plant could be passed on to the community in terms of: (1) increased public services; (2) lower taxes; or (3) a combination of (1) and (2).[1/]

In addition to the 1.5 percent portion of the sales tax that is received by the county, part of the benefits of the remaining 2 percent of the sales tax could be expected to be received by Clark County. The exact benefit is unknown, but might be assumed to be equivalent to 56 percent of the collection because Clark County's population was 56 percent of state population in 1970.

Sales tax would be levied on an estimated 65 percent[2/] of the total construction materials investment, or $325 million. Sales tax revenue from construction of the plant would total $11.4 million, of which $4.9 million[3/] would accrue to Clark County (Table 1).

Property tax liability of the new plant would be between 3.8 percent and 5 percent of assessed value,[4/] assessed value being equivalent to 35

1/ The effects on the county tax base will be discussed in greater detail in a subsequent section.

2/ NPC estimated sales tax on 70 percent of investment. Construction payrolls, however, consist of 30 percent of the plant investment, and do not include the cost of design.

3/ This does not account for benefits to the county from the state's portion of the sales tax.

4/ The Nevada Tax Commission advised us that county tax rates were in this range.

percent of market value. Straightline depreciation, over a 35 year period, was assumed here because it is used by most of the utilities in the State of Nevada and depreciated value is generally a close measure of market value.[1/] Based on these assumptions, property tax revenue schedules were calculated as shown on Table 3.

1/ Nevada State Tax Commission, private communication.

TABLE 1

ESTIMATED SALES TAX REVENUE FROM

PURCHASE OF MATERIALS FOR CONSTRUCTION OF

ARROW CANYON PLANT BY NEVADA POWER COMPANY

1974-1980

	Total Sales Tax Payments	Clark County's Receipts 1/
	Million Dollars	
1974	$ .18	$ .08
1975	2.38	1.02
1976	2.66	1.14
1977	2.80	1.20
1978	2.80	1.20
1979	.42	.18
1980	.14	.06
TOTAL	$11.38	$ 4.88

Coal purchases and other supplies likewise would be taxed.2/ The revenues from sales tax on these purchases is summarized in Table 2.

TABLE 2

SALES TAX REVENUE RESULTING FROM NPC PURCHASES

OF OPERATING SUPPLIES FOR ARROW CANYON PLANT

ANNUAL SALES TAX

	Coal	Other Supplies	Total	Clark County's Receipts
	$1,000			
1977	$ 94	$ 5	$ 99	$ 42
1978	306	15	321	138
1979	545	26	571	245
1980	764	37	821	352
1981-2000	929	44	973	417

1/ This does not account for benefits to the county from the state portion of the sales tax.

2/ Purchases of wastewater for cooling are excluded in the estimates of sales tax on purchases by NPC.

TABLE 3

ESTIMATED TAXABLE VALUE AND PROPERTY TAX REVENUE LIABILITY OF NEVADA POWER COMPANY FOR PROPOSED ARROW CANYON PLANT, 1974-2000

Year	Taxable Value of Plant 1/	Tax Revenue: .038 rate (.35 x .038 x Taxable Value)	Tax Revenue: .05 rate (.35 x .05 x Taxable Value)
	Millions of Dollars		
1974	$ 11	$ .15	$ .19
1975	83	1.10	1.45
1976	184	2.45	3.22
1977	311	4.14	5.44
1978	422	5.63	7.40
1979	467	6.21	8.17
1980	478	6.36	8.37
1981	464	6.17	8.12
1982	450	5.99	7.88
1983	435	5.79	7.61
1984	421	5.60	7.37
1985	407	5.41	7.12
1986	393	5.23	6.88
1987	378	5.03	6.62
1988	364	4.84	6.37
1989	350	4.66	6.13
1990	335	4.46	5.86
1991	321	4.27	5.62
1992	307	4.08	5.37
1993	293	3.90	5.13
1994	278	3.70	4.87
1995	264	3.51	4.62
1996	250	3.33	4.38
1997	235	3.13	4.11
1998	221	2.94	3.87
1999	207	2.75	3.62
2000	193	2.57	3.38

1/ Assumes plant life of 35 years.

OTHER INCOME

In addition to effects of payments for payrolls and taxes, the local economy would also be stimulated by local purchases of equipment, supplies, and materials. Industries in Clark County whose output would be affected most by the proposed plant include wholesale trades, transportation, utilities, and finance.[1/] Direct local purchases during construction would approximate $15 to 20 million and add $4.5 and $6.0 million gross income to Clark County[2/] (Table 4).

TABLE 4

PURCHASES AND GROSS INCOME DERIVED FROM CONSTRUCTION MATERIALS FOR POWER PLANT, CLARK COUNTY, NEVADA, 1974-1980

	Purchases		Income	
	Low	High	Low	High
	$1,000			
1974	$ 230	$ 310	$ 69	$ 93
1975	3,140	4,180	942	1,254
1976	3,510	4,650	1,053	1,404
1977	3,690	4,920	1,107	1,476
1978	3,690	4,920	1,107	1,476
1979	560	740	168	222
1980	180	250	54	75
	$15,000	$20,000	$4,500	$6,600

1/ Other industries would be affected in lesser degrees.
2/ Income is defined as including not only payrolls, but also proprietors' income, profits, dividends, contributions to social insurance, unemployment compensation, etc.

Major equipment would be manufactured and purchased outside the county either through a local wholesale distributor or directly by Nevada Power Company. Apart from tax revenues, these purchases would not add much income to the community.

Purchases during operation include coal, chemicals, lubricating oils, parts, water, and miscellaneous supplies. Coal would be purchased outside Clark County and is not being considered here.[1/] The magnitude of purchases of operating materials would likely correspond closely to the cooling water demand schedule. Based on that assumption and an income/output ratio of .30, purchases and gross income were derived as shown in Table 5.

TABLE 5

GROSS INCOME FROM PURCHASES
OF LOCAL OPERATING MATERIALS

Year	Purchases	Income
	---------- $1,000 ----------	
1977	$ 195	$ 58.5
1978	627	199.1
1979	1,109	332.7
1980	1,591	477.3
1981-2000	1,878	563.4

1/ Transportation of coal to the Arrow Canyon Plant would likely generate indirect income to Clark County.

INDIRECT IMPACT

An indirect impact would be triggered by the payrolls, sales and property taxes, and purchases of supplies and materials by Nevada Power Comapny. Although quantitative measurement of these indirect or secondary activities goes beyond the scope of this report, it is nevertheless possible to indicate the sectors in the Clark County economy that would benefit most from the additional rounds of spending.

The major sources of income to Clark County as a direct result of the Arrow Canyon plant would likely be payrolls to construction and plant personnel, and additional taxes collected. Purchasers in these two sectors--consumers and government--in turn buy most of their goods and services from wholesale and retail trades and, also, personnel and business services sectors. A major portion of the wholesale and retail goods would be imported into Clark County, rather than being produced locally. Purchases from other industries would have less impact.

EFFECT ON PROPERTY TAX BASE AND AD VALOREM RATE

It was estimated (Table 3) that the proposed power plant would have a maximum taxable value of $478 million in 1980 when the last 500-MW unit was completed. This value might be taxed at $6.4 - $8.4 million, depending upon the tax rate applied.

The impact of the plant value on the county tax base cannot be predicted with certainty. Some assumptions were made to approximate the effect. First, 1971-72 prices were assumed to prevail throughout

the evaluation period. Next, assessed values in the county were increased at an annual rate of 8 percent between 1971-72 and 1980-81. The county's assessed value in 1980-81 without the plant would be about $2,091 million and with the plant, $2,258 million (assessed value of plant $167 million). The greatest proportional effect of the plant's value on the county tax base would occur in the 1979-80 tax year when assessed value of the plant would be about 7.7 percent of the county's assessed value. By 1990-91, the plant's assessed value would have declined to about 3.2 percent of the total county assessed value. It was assumed that the tax rate on the plant was equal to the average county tax rate in the estimates of tax collections. Table 6 illustrates possible future assessed values and tax collections.

TABLE 6

PROJECTED ASSESSED VALUES AND AD VALOREM
TAX COLLECTIONS WITH AND WITHOUT PROPOSED ARROW
CANYON PLANT, CLARK COUNTY, NEVADA

Tax Year	Assessed Value[1]		Tax Collections @5%		Tax Collections @4.5%	
	w/o Plant	w/Plant[2]	w/o Plant	w/Plant	w/o Plant	w/Plant
	Millions of Dollars					
1971-72	1,045.8[3]	1,045.8	52.3	52.3	47.1	47.1
1980-81	2,090.6	2,257.9	104.5	112.9	94.1	101.6
1985-86	2,797.2	2,939.6	139.9	147.0	125.9	132.3
1990-91	3,569.2	3,686.4	178.5	184.3	160.6	165.9

1/ Assessed value without plant assumed to increase at an annual rate of 8 percent, 1971-72 to 1980-81, 6 percent 1980-81 to 1985-86, and 5 percent 1985-86 to 1990-91.
2/ Assessed value of plant assumed to equal 35 percent of taxable value, Table 3.
3/ From Clark County Administrator's Office.
4/ See Table 6.

SUMMARY

An estimated $343 to $380 million direct gross income would be derived within Clark County over the period 1974-2000, of which $199 million would be wages paid, $14 million sales tax revenues, between $113-$149 million property tax revenues, and between $17-$18 million derived from local purchases. In addition to the direct impact, an indirect impact would be triggered by consumer, government, and industry spending resulting from the direct activities.

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APPENDIX F

COMPARISON OF COOLING WATER REQUIREMENTS FOR NUCLEAR AND FOSSIL-FUELED POWER GENERATION

INTRODUCTION

This discussion compares cooling water requirements for nuclear and fossil-fueled power generation. By far the greatest quantity of water used in a power generating plant of the steam-electric type (regardless of fuel types) is for cooling purposes. Small quantities of water are used for drinking, sanitary, and miscellaneous purposes, and for boiler water make-up, but these quantities are insignificant in comparison to cooling water requirements.

GENERAL DESCRIPTION OF STEAM-ELECTRIC POWER PLANTS

The basic principle of electric power generation is the same in both fossil-fueled (coal, natural gas, or oil) and nuclear power generating plants. The fuel provides heat needed to produce steam in a boiler. Steam drives a turbine-generator which produces electricity. After the steam has passed through the turbine, it is cooled in a condenser prior to returning to the boiler to be reheated. The boiler water circuit is separated from the cooling water circuit. Figure B.1 shows a schematic of a typical cooling water circuit and part of the boiler water circuit. The cooling water circuit is essentially the same in both fossil-fueled and nuclear power plants. The particular cooling water circuit shown in Figure B-1 utilizes a cooling tower; other methods of cooling the condenser cooling water are discussed hereinafter.

DIFFERENCES IN COOLING REQUIREMENTS OF FOSSIL-FUELED AND NUCLEAR POWER PLANTS

The amount of waste heat discharged to the condenser is related to the heat input as well as the type of plant (fossil-fueled or nuclear). Improvements in the design of both types of plants have resulted in a gradual reduction in the required heat input--or heat rate per kWh--over the past years, and this improvement is expected to continue in the future. Newer plants therefore will need less cooling water per kWh of power generated.

In a fossil-fueled plant, approximately 15 percent of the heat input is lost in the boiler, the stack, the turbines and generators, and for station use. Approximately 45 to 50 percent is lost in the condensing process by rejection of heat to the cooling water. The balance (35 to 40 percent) is changed from energy in the form of heat to electric energy.

Thus, for the average fossil-fueled plant in use today having a heat rate of 10,300 Btu per kilowatt-hour of power produced, the heat loss in the condenser is about 5,300 Btu per kWh; for very modern and efficient plants with a heat rate of 8,600 Btu, the heat loss in the condenser is approximately 3,900 Btu per kWh; and for future fossil-fueled plants with heat rates of 8,000 Btu, the heat loss in the condenser would be about 3,400 Btu per kWh generated.

In a nuclear-fueled plant, heat losses through the stack are not involved and the in-plant losses amount to 5 percent or less of the thermal input. Because of limitations on temperatures and pressures in the reactors, current nuclear-fueled steam-electric plants using light water reactors have heat rates of 10,000 Btu per kWh or higher. In these plants, approximately 65 percent of the heat input is rejected to the cooling water. It is expected that plants using breeder reactors, now being developed, and advanced converters such as high temperature gas reactors, will have heat rates which approach those of the most efficient fossil-fueled plants. These plants are expected to come into operation some time in the 1980's.

In a light water reactor with a heat rate of 10,500 Btu, the loss to the condenser would be about 6,700 Btu per kWh generated. For a future breeder reactor with a heat rate of 8,200 Btu, the heat discharge to the condenser and cooling water is expected to be about 4,500 Btu per kWh generated.

From the above it is apparent that nuclear-fueled plants reject to the cooling system about 25 to 50 percent more heat per kWh of power generated, with the average being about 40 percent. This results in a correspondingly greater use of cooling water in nuclear-fueled plants.

METHODS OF WASTE HEAT DISPOSAL

There are five general methods of supplying cooling water to a power plant condenser in use today. These five methods are listed in

their order of preference from an operating and experience point of view (which is not necessarily the best environmental point of view):

1. Once-Through Fresh Water Cooling. Fresh water from a stream or lake is circulated through the condenser once and returned to the source, where the heat is rejected. This is generally the most economical method.

2. Cooling Ponds or Reservoirs. Fresh water is circulated through the condenser, returned to the pond or reservoir for rejection of its heat to the atmosphere, and then recirculated to the condenser. This is also an economical method.

3. Once-Through Sea Water Cooling. Sea water is circulated through the condenser once and returned to the sea to reject the heat. This method has a higher cost than fresh water cooling.

4. Evaporative Cooling Towers. Where ample supplies of cooling water are not available, this method is often used. The rejected heat is dissipated to the atmosphere by evaporation of a portion of the condenser cooling water, and the cooling water is recirculated several times. The use of evaporative cooling towers is generally more expensive than the first three methods.

5. Non-Evaporative Dry Type Cooling Towers. Dry type towers may be used where cooling water is in very short supply. In this method, the cooling water is not allowed to evaporate; instead, the rejected heat is transferred to the air through a tubed radiator

type of cooling tower. Generally this method is the most expensive type of cooling.

Evaporative cooling towers have been used in the southwestern states for years. This method has received increased attention throughout the United States in recent years as demands on water supplies have increased. Evaporative cooling towers are now used by the Nevada Power Company in their Clark and Sunrise power generating plants, and are the method proposed for cooling the Arrow Canyon plant. The use of evaporative cooling towers rather than once-through systems can increase the cost of generating power by as much as five percent.

COOLING WATER QUANTITIES

Since evaporative cooling systems are the most likely types to be used in the Las Vegas area, only these types are discussed herein. In steam-electric power plants, the total flow of condenser water pumped through the cooling system generally ranges from 30 to 55 gallons per kWh of power generated. 30 gallons per kWh represents the anticipated flow rates for the newest fossil-fueled plants now being designed; 55 gallons per kWh represents the flow rates for the larger nuclear plants now in operation. Actual consumption of cooling water is referred to as "make-up water". In comparison, systems using cooling ponds or reservoirs require make-up water in quantities of about 5 to 8 gpm per MW of power generated (0.6 to 1.1 gallons per kWh, averaging 0.75 gallons per kWh for fossil-fueled plants). Nonevaporative cooling towers require about one gpm per MW.

In cooling systems using evaporative cooling towers, make-up water must be added to compensate for water lost by evaporation, windage, and blowdown. The loss of water from evaporation can account for up to 90 percent of the total water requirement. As Figure B.1 shows, the water is sprayed or otherwise broken up into small drops so that large water-air contact surface areas result, allowing evaporation to take place. The evaporation accounts for most of the heat transfer to the air from the cooling water as it passes through the cooling tower. The amount of evaporation which takes place depends on a combination of temperature and humidity; during warm, dry days the rate of evaporation will be greater than on cool, wet days.

The loss of water by windage is caused by droplets of the cooling water being caught up in the air movement and carried out of the cooling tower in suspension. Blowdown is the periodic or continuous discharge to waste of a portion of the circulating water to prevent the buildup of solids in the cooling towers. These solids are suspended or dissolved in the source water and, as evaporation occurs, they become more concentrated in the water that is not evaporated.

The total make-up water required to replace evaporative losses and windage and to provide for blowdown generally amounts to about 2 percent of the total cooling water circulated, although it may be higher if the atmospheric conditions are conducive to high evaporation rates and if the source water is high in dissolved solids.

The use of very hard waters and sewage effluents for cooling purposes requires pretreatment because of the phosphates and other chemicals in the water. By pretreating the water, it may be recycled through the cooling system more times before the concentration of solids builds up and requires blowdown.

COMPARISON OF ACTUAL COOLING WATER REQUIREMENTS FOR SOME CURRENTLY OPERATING PLANTS

Shown in Table B.1 is a comparison of cooling water requirements for some typical power generating plants which use fossil or nuclear fuel. The first five plants in the table are in the eastern United States, fueled with coal, and cooled with river water. The sixth and seventh plants are in California, one gas or oil-fired and one nuclear-fueled, and both cooled with sea water. The last four plants listed in the table are in the southwestern states, fueled with gas, and cooled with sewage treatment plant effluent.

Of the first six plants listed in Table B.1, two plants use once-through cooling. The other four, located where there is not an adequate supply of fresh water for once-through cooling, use fresh water for cooling in evaporation towers and have an average make-up water requirement of 0.013 mgd per 1,000 kW of power generated. The last four plants listed in the table, all of which use sewage treatment plant effluent for cooling, have an average make-up water requirement of 0.0133 mgd per 1,000 kW of power generated. Other plants using sewage effluent for

cooling might vary somewhat from these quantities, depending on the quality of the sewage effluent.

Although the cooling water for the nuclear-fueled plant at San Onofre is used on a once-through basis, a rough idea of this plant's cooling water requirements are illustrated by comparing its condenser cooling water pumping rate with the average of the first six plants listed. The average condenser cooling water pumping rate of the first six plants is 0.594 mgd per 1,000 kW, while the nuclear plant pumps 1.120 mgd per 1,000 kW, or about 89 percent more cooling water for an equivalent amount of generating capacity. This is considerably higher than the general average for fossil-fueled plants, and the one example does not form an accurate comparison. The estimate given earlier of 25 to 50 percent more cooling water used by nuclear plants was based on more examples, and is therefore more representative.

Table B.1 shows average make-up water requirements of 0.013 mgd per 1,000 kW of plant generating capacity. This figure is influenced by at least two factors which would tend to make a safe estimating figure of make-up water requirements somewhat higher. First, some of the power plants being located in the eastern states would not experience average evaporation rates as high as in the southwest. Secondly, quantities of make-up water required are reported in terms of kW of plant capacity, not actual plant output. Since plant output will always be less than plant capacity, the figure of 0.013 mgd per 1,000 kW would increase if water requirements were reported in terms of plant output.

These two factors might increase the average cooling water requirements to about 0.018 mgd per 1,000 kW of power generated (0.018 mgd per 1,000 kW equals 0.75 gallons per kWh).

CONCLUSIONS

The following general conclusions may be drawn.

1. The cooling systems in typical fossil-fueled and nuclear-powered steam-electric plants are similar in operation.

2. Nuclear-powered plants are less efficient than fossil-fueled plants in the amount of heat input they require to generate a like amount of power. They also reject a greater percentage of heat input to the cooling system. Nuclear plants reject about 25 to 50 percent more heat to the cooling system per kWh of power generated than do fossil-fueled plants.

3. The most likely cooling system for use in power plants in the southwestern states utilizes evaporative cooling towers to dissipate the heat generated to the atmosphere. These cooling towers require make-up water of about two percent of the total cooling water circulated through the cooling system.

4. The average quantity of make-up water required for fossil-fueled plants with evaporative cooling towers is about 0.75 gallons per kWh of power produced. This fugure varies somewhat, depending on evaporation rates influenced by atmospheric condi-

tions and on the quality of the cooling water used. In general, make-up water requirements for fossil-fueled plants range from 0.6 to 0.9 gallons per kWh of power produced.

5. Make-up water quantities required for nuclear-powered plants are about 25 to 50 percent higher than for fossil-fueled plants. It is expected that future developments in design will reduce this figure so that nuclear plants require only about 25 percent more cooling water than fossil-fueled plants.

TABLE B.1

COOLING WATER REQUIREMENTS FOR VARIOUS FOSSIL AND NUCLEAR FUEL POWER GENERATION PLANTS

	POWER PLANT AND LOCATION	COOLING WATER	FUEL	TOTAL PLANT GENERATING CAPACITY MW	NUMBER OF UNITS	GENERATING CAPACITY PER UNIT 1000 KW/UNIT	CONDENSOR COOLING WATER PUMPING RATE MGD/1000 KW	MAKE-UP WATER REQUIRED MGD/1000 KW
(1)	Keystone Station near Shelocta, Pa.	River Water	Coal	1800	2	900	0.447	0.0068-0.0124
(2)	Mt. Storm Station Mt. Storm, W.Va.	River Water	Coal	1080	2	540	0.666	0.666*
(3)	Ft. Martin Station Pt. Marion, Pa.	River Water	Coal	1080	2	540	0.533-0.719	0.0133
(4)	Clinch River Plant Carbo, Va.	River Water	Coal	700	3	233	0.680	0.0154
(5)	Big Sandy Plant near Louisa, Ky.	River Water	Coal	265 800	1 1	265 800	0.652 0.446	0.0271 0.009
(6)	Alamitos Steam Station near Long Beach, Calif.	Sea Water	Nat. Gas or Oil	1950	6	325	0.651	0.651*
(7)	San Onofre Station near San Clemente, Calif.	Sea Water	Nuclear	450	1	450	1.120	1.120*
(8)	Sunrise Station near Las Vegas, Nev.	Sewage Effluent	Gas	85	1	85		0.0118

TABLE B.1 (continued)

') Clark Station near Las Vegas, Nev.	Sewage Effluent	Gas	194	3	65	0.0129-0.0154
') Nicholls Plant near Amarillo, Texas	Sewage Effluent	Gas	471	3	112 112 247	0.0137-0.0147
) Jones Plant near Lubbock, Texas	Sewage Effluent	Gas	250 250	1 1	250 250	0.0132 0.0132

* Cooling water at these plants is used on a once-through basis, so make-up water requirements equal condenser cooling water pumping rates.

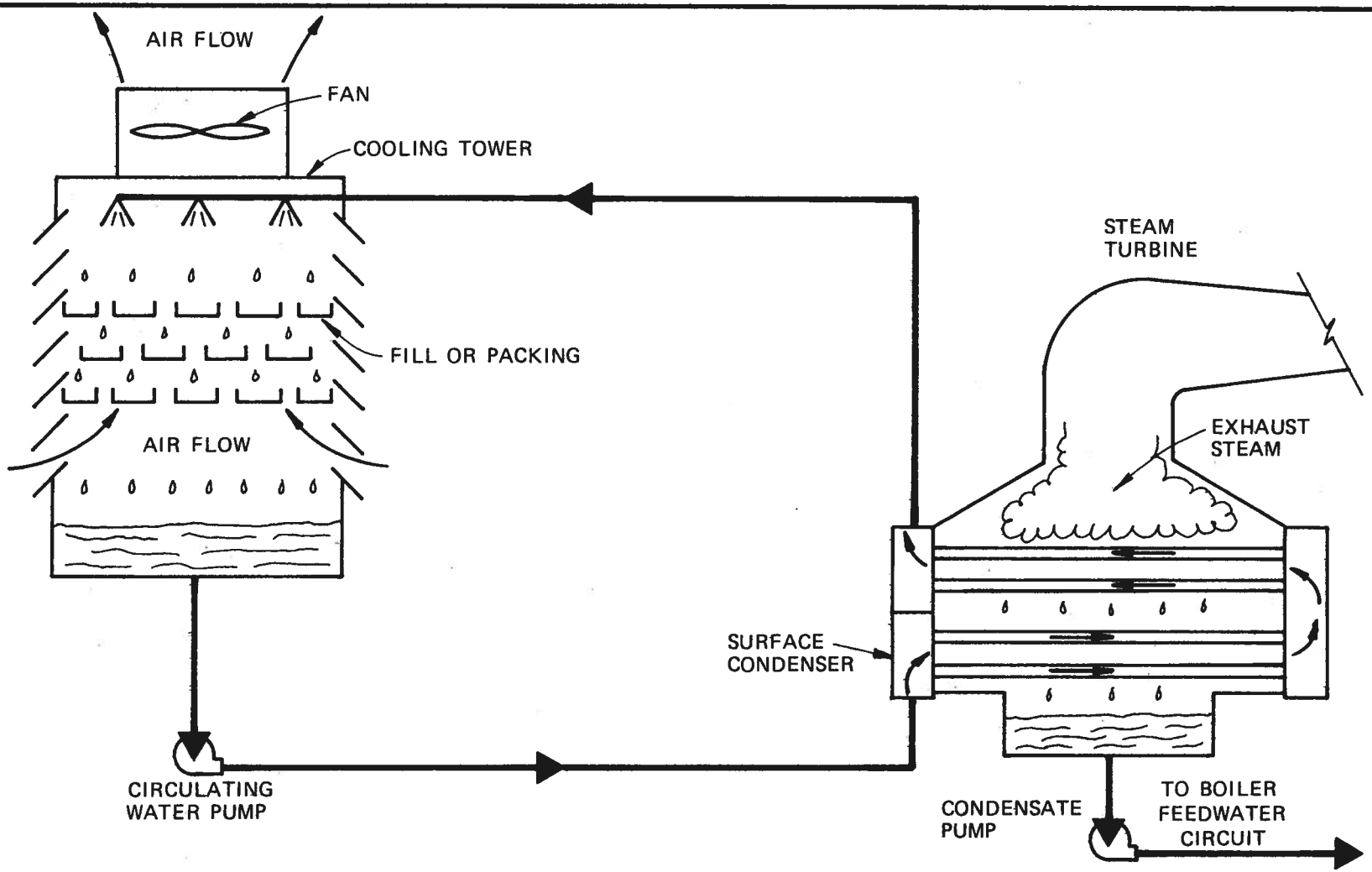

FIGURE B–1

EVAPORATIVE COOLING TOWER CONDENSING SYSTEM

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APPENDIX G

APPENDIX G

THE EFFECT OF TOTAL DISSOLVED SOLIDS ON COOLING WATER USES AND THE IRRIGABILITY OF SEWAGE EFFLUENT

COOLING WATER USES

GENERAL

Sewage effluents generally exhibit substantially higher total dissolved solids (TDS) content than the potable water supply for a given situation. The use of water prior to its return to a sewerage system is responsible for a variable increase in TDS (depending on many factors) of from 200 to 500 mg/l. Usually this increase (after sewage treatment) principally in the form of Ca^{2+}, Cl^{1-}, NH_3, Alkalinity (mostly HCO_3-), SO_4 2+ and Na^{1+}. Lesser increase of PO_4^{3-}, NO_3^{2-} (depending on the type of sewage treatment) and trace elements occur. Purely as an example, the following table illustrates the results of extensive testing of a large metropolitan area's sewage effluent (Denver, Colorado) in comparison with its water supply to characterize the increases in specific TDS content due to passage through the water and sewerage system.

INCREMENTAL INCREASES IN TDS CONTENT OF TREATED SEWAGE OVER CONTENT OF POTABLE WATER[1/]

Substance	Denver**	Average of five cities	Average of 22 cities
Toxic Chemicals			
Barium	.150		
Chromium	.044		
Fluoride	.4		
Lead	.310		
Boron	trace		
Inorganic Chemicals			
Aluminum	.05		
Alkalinity	172.	122	81
Amonia - N *	17.5	16.1	15
Bromine	.152		
Calcium	29.5	23	18
Chloride	90	56	74
Copper	.045		
Hardness	99		79
Iron	2.90		
Magnesium	1.8	7	6
Manganese	.068		
Molybdenum	(.070)		
Nickel	.110		
Nitrate - N	(-)	3.5	10
Phosphate	8.5	24.3	24
Rubidium	.050		
Silver	.007		
Strontium	.200		
Sulfate	118	33	28
Total dissolved solids	330		
Total inorganic solids	360	222	320
Uranium	.029		
Organic Parameters			
CCE	2.419		
CAE	1.094		
MBAS *	.116	7.4	6.4
COD *	62	143	87
Kjeldahl Nitrogen *	28.2	18.3	

* Quantity in water taken as Zero.
** Based on South Platte source.

1/ Data courtesey of Denver Water Board, Metropolitan Denver Sewage Disposal District No. 1 and CH2M.

Of principal interest to the user of sewage effluent for cooling water are the nitrogen, phosphorus, calcium, magnesium, silica, and chloride contents of the wastewater, less specifically, the TDS concentration is important since it limits the permissible number of concentrations in any cooling system. Phosphorus can be removed by lime coagulation in a process similar to cold lime softening. In general, however, sufficient phosphorus will remain to inhibit calcium removal by sequestering the calcium carbonate. Nitrogen, which stimulates slime formation, is not usually removed, but heavy chlorine doses will control the sliming tendency. Chlorides are not usually removed or controlled and are of importance, since they affect the corrosion rate of iron and admiralty brass surfaces. Magnesium is removed by the lime coagulation (as is much of the silica, if present). The major problems attendant to an increase in TDS of a given sewage effluent then are the possibility of calcium phosphate scale formation or calcium carbonate scale formation. In general, if a water possesses concentrations of either calcium or carbonate, or phosphate to an extent where the solubility product for calcium phosphate salts or calcium carbonate is exceeded, heat exchanger surfaces will scale. The problem is aggravated by the increase in concentrations of any specific ion by virtue of loss of water (but not dissolved solids) due to evaporation from the cooling towers. Figure C-1 is a graphical representation of the effect of TDS concentration in make-up water for cooling use. It is necessarily general (since presence of a specific ion in abnormal concentration could limit a system long before the indicated allowable TDS was reached), but presents a

reasonable set of TDS limits if sewage effluent is lime-treated and pH adjusted. As shown on Figure C-1, an increase of from 1,300 to 2,600 TDS (mg/l) in sewage effluents would change the allowable number of concentrations in a cooling system from about 3.1 to about 2.4 times. This corresponds to an increased cooling water make-up requirement of about 30 percent.

IRRIGABILITY OF SEWAGE EFFLUENT

This subject has been covered in Appendix A of the Phase II study report by P. F. Pratt and S. J. Richards. Portions of that Appendix A are recapped here; for a broader discussion the reader is referred to the Phase II report. Sewage effluents, having dissolved solids contents within the normal range for such effluents, have been used successfully for irrigation of crops, lawns, and ornamental plantings in a wide variety of cases.

Of particular interest to the user of sewage effluents for beneficial irrigation are the nitrogen, phosphorus, potasium, calcium, magnesium, sodium, sulphate, chloride and boron contents of the wastewater. The total dissolved solids concentration is important for two reasons: first, it has a positive value as essential plant nutrients; and, second, it has a negative value in that some of the dissolved solids, the salts, contribute to degradation of the soil. Of course, the water itself in the sewage effluent is essential to maintain plant growth, particularly in arid regions receiving little rainfall.

On the positive side, the fertilizer value of sewage effluent from the Las Vegas Valley was estimated in the Phase II report to be $10 to $12 per acre-foot. This is based on the average concentration of nitrogen, phosphorus and potassium. If four to eight acre-feet of sewage effluent is used per acre per year, no additional fertilizers would be needed (except perhaps some trace elements) for the types of crops expected to be grown in the area.

On the negative side, increased total dissolved solids in the effluent means an increase in the amount of dissolved salts which accumulate in the soil by evapotranspirating of the wastewater, thus making the soil less suitable for growing crops. The buildup of salts must be overcome by leaching or applying more water to the irrigated land than required for proper plant growth. The excess water percolates through the soil and carries away with it the salts (calcium, magnesium, sodium, sulphates and chlorides). A large percentage of the salts added to the soil from the effluent will go out in the drainage water; only a small amount of the salts are removed by the crops.

The amount of leaching required depends on the concentration of dissolved solids in the effluent, the type of salt tolerant crops to be grown, and the type and condition of the irrigated soil. Given the type of soils in the Las Vegas area, which by themselves are saline to begin with and which produce salts by the weathering of minerals, considerable leaching will be necessary. The amount of leaching required would best be determined by routine soil analysis as part of the soil management

program where the effluent is used. The Phase II report stated that an average leaching requirement of 17 percent for medium tolerance crops and eight percent for high tolerance crops could be used for present and future effluent waters from the Las Vegas Valley. The following table summarizes the opinions of Drs. Pratt and Richards, University of California, Davis, California regarding leaching requirements for various classes of crops when irrigated with sewage effluents and grown on the better soils occuring in the Las Vegas area.

Leaching requirements for low, medium and high salt tolerances of crops and SAR values for various concentration factors

Water	Leaching Requirement*			SAR**		
	Low Tolerance	Medium Tolerance	High Tolerance	Original Water	C=5***	C=10***
	%	%	%	$(mmoles/l)^{1/2}$		
Sewage effluent:						
Las Vegas	25	12	5.5	5.2	24	34
Clark County	55	23	10	4.8	25	35
Average	37	17	7.9	4.9	25	35
Colorado River Water	16	9.0	4.4	2.1	9.2	13

* Leaching requirements as percent of irrigation water added.

** Sodium absorption ratios = $\frac{\text{Na mmoles/l}}{(\text{Ca} = \text{Mg}) \text{ mmoles/l}}$

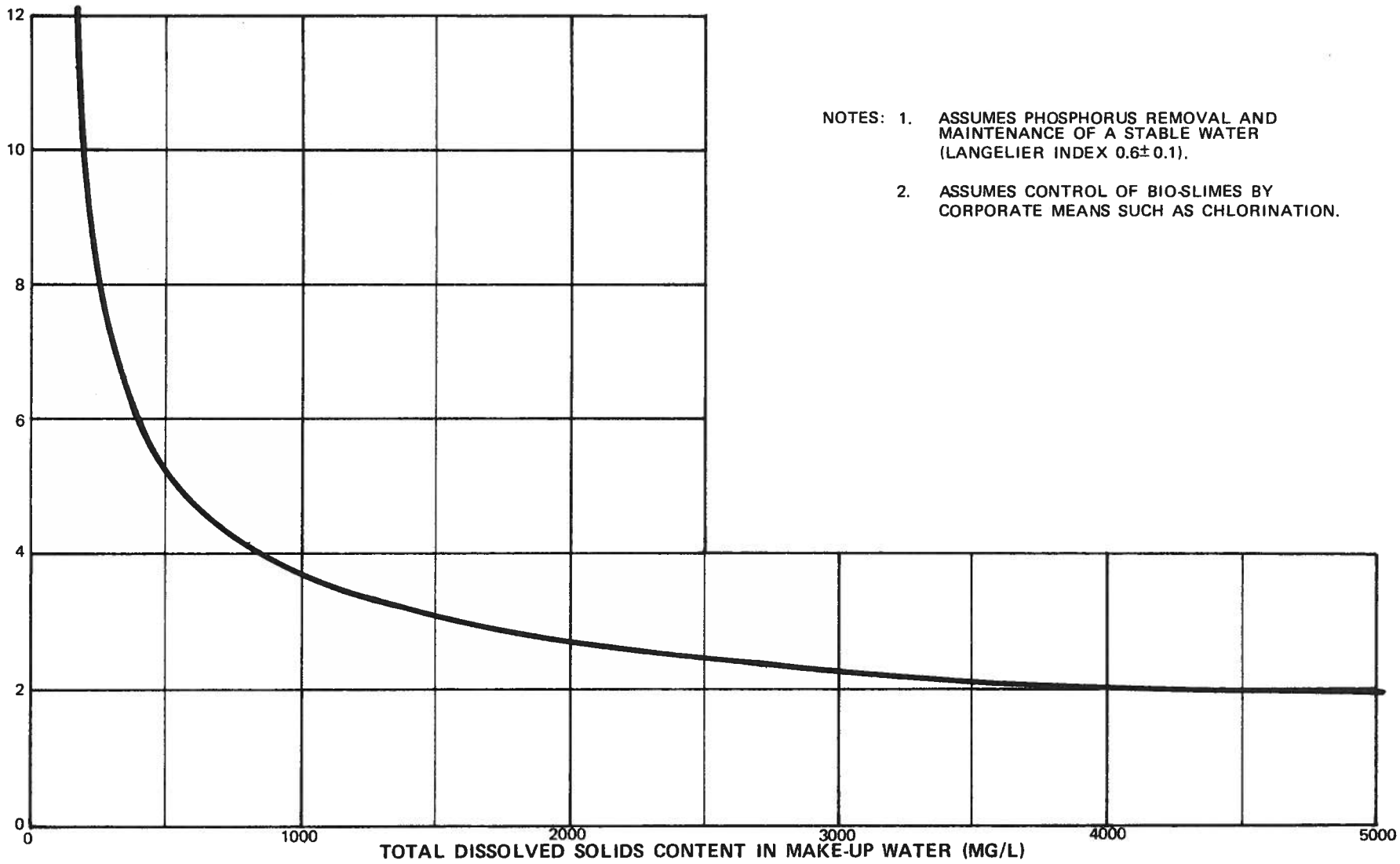
*** C represents the concentration factor as the water becomes the soil solution at the bottom of the rootzone of crops. A value of 5 represents a leaching requirement of 20 percent and a value of 10 represents a leaching requirement of 10 percent.

The University of Nevada Soil Sciences Department opinion varies with that expressed by Drs. Pratt and Richards. In general, they (University of Nevada) indicate 20 to 30 percent leaching requirements for medium tolerance crops grown in the Las Vegas area and irrigated with sewage effluent.

Obviously certain wastewaters which may occur in the area may contain toxic compounds and/or such high concentration of TDS as to be totally unfit for irrigation usage. For example, the total dissolved solids concentration in the brine from a desalting plant of the type contemplated in this report for the "complete treatment" alternative would be five times as great as that for secondary effluent. With these concentrations no amount of leaching would be adequate to prevent a buildup of dissolved solids in the soil, and use of this effluent for irrigation would quickly render the soil unsuitable. Other disposal facilities for complete treatment wastes will need to be provided - the most tangible being evaporation.

In summary, we anticipate that present levels of TDS or moderate increases would not materially change the irrigability of sewage effluent use on the types of soils and crops likely to be found in the area.

Should large increases occur (such as have been occurring during the past three years in the TDS content of CCSD effluent) the suitability and profitability of use of sewage effluent for agronomy will most certainly be limited.



NOTES: 1. ASSUMES PHOSPHORUS REMOVAL AND MAINTENANCE OF A STABLE WATER (LANGELIER INDEX 0.6± 0.1).

2. ASSUMES CONTROL OF BIO-SLIMES BY CORPORATE MEANS SUCH AS CHLORINATION.

FIGURE C–1

EFFECT OF TOTAL DISSOLVED SOLIDS CONTENT OF MAKE-UP WATER FOR COOLING TOWER USE*

* FROM INDUSTRIAL AND ENGINEERING CHEMISTRY, S.T. POWELL, 46, 3, 112A (1954)

APPENDIX H

APPENDIX H

TABLE H-21.28.1

NEVADA POWER COMPANY

1971-2000 ESTIMATED LOAD & RESOURCES

(all figures in megawatts)

January 1972

Year	Load	20% Reserve	Capacity Required	Total Committed Purchases	Annual Capacity Additions	Added Purchases Required	Firm Power Flow to NPC (F)
1971	718	144	862	73(B)	111 Mohave	34	318
72	779	156	935	141(C)	- -	39	391
73	845	169	1014	40(D)	111 Mohave	108	470
74	917	183	1100	0	87 Navajo	147	556
75	995	199	1194	0	87 Navajo	154	650
76	1080	216	1296	0	101 Navajo (E)	155	764
77	1172	234	1406	0	150 Arrow	115	362
78	1272	254	1526	0	150 Arrow	85	(18)
79	1380	276	1656	0	150 Arrow	65	(488)
80	1497	299	1796	0	150 Arrow	55	(748)
81	1609	322	1931	0	- -	169	(634)
82	1730	346	2076	0	- -	335	(468)
83	1860	392	2252	0	200 Arrow (G)	311	(292)
84	2000	400	2400	0	200 Arrow (G)	259	(144)
85	2150	430	2580	0	- -	439	36
86	2311	462	2773	0	250 Plant X	382	(21)
87	2484	497	2981	0	250 Plant X	340	(63)
88	2670	534	3204	0	250 Plant X	313	(90)
89	2870	574	3444	0	400 GT	153	(250)
90	3085	617	3702	0	200 Arrow (G)	211	8
91	3286	657	3943	0	200 Arrow (G)	252	249
92	3500	700	4200	0	200 Arrow (G)	309	506
93	3728	746	4474	0	200 Arrow (G)	383	780
94	3970	794	4764	0	200 Arrow (G)	473	1070
95	4228	846	5074	0	400 GT	383	980
96	4503	901	5404	0	400 Plant Y	313	910
97	4796	959	5755	0	400 Plant Y	264	861
98	5108	1022	6130	0	400 Plant Y	239	836
99	5440	1088	6528	0	400 Plant Y	119	716
2000	5794	1159	6953	0	300 GT	362	959

Notes:

(A) Growth rate 8½% to 1980; 7½% to 1990, 6½% to 2000.
(B) 38 MW of CRSP and 35 MW of SCE.
(C) 106 MW of CRSP and 35 MW of SCE.
(D) 5 MW of CRSP and 35 MW of SCE.
(E) Includes 14 MW of USBR CAP Returned in 1981.
(F) Includes 100 MW of Hoover Power.
(G) Arrow Canyon Recapture Power
1970 Capacity as follows:

Reid Gardner	234 MW
Clark	195
Sunrise	85
Diesels	30
Hydro	100
Total	644 MW

JCG/af

TABLE H-21.28.2

FORECAST WATER NEEDS FOR NEVADA POWER COMPANY
FOR LAS VEGAS AREA POWER
in 1000's of AF/YR

YEAR	SUNRISE CLARK STATION	ARROW CANYON PLANT	PLANT (1) "X"	PLANT (1) "Y"	TOTAL
1970	3.20				3.20
1971	3.84				3.84
1972	4.00				4.00
1973	4.20				4.20
1974	4.48				4.48
1975	4.48				4.48
1976	4.48				4.48
1977	4.48	3.24			7.72
1978	4.48	10.60			15.08
1979	4.48	18.90			23.38
1980	4.50	27.20			31.70
1981	4.50	32.2			36.70
1982	4.50	32.2			36.70
1983	4.50	32.2			36.70
1984	4.50	32.2			36.70
1985	4.50	32.2			36.70
1986	4.50	32.2	4.0 (2)		40.70
1987	4.50	32.2	8.0		44.70
1988	4.50	32.2	12.1		48.80
1989	4.50	32.2	12.1		48.80
1990	4.50	32.2	12.1		48.80
1991	4.50	32.2	12.1		48.80
1992	4.50	32.2	12.1		48.80
1993	4.50	32.2	12.1		48.80
1994	4.50 (2)	32.2	12.1		48.80
1995		32.2	12.1	6.4	50.7
1996		32.2	12.1	12.9	57.2
1997		32.2	12.1	19.3	63.6
1998		32.2	12.1	25.7	70.00
1999		32.2	12.1	25.7	70.00
2000		32.2	12.1	25.7	70.00

(1) Forecast power plants "X" and "Y" required for energy to meet the Las Vegas area power needs (Including NPC service area) from Las Vegas area water resources. Plant "X" and "Y" usage estimated to be in proportion to that required for Arrow Canyon (32,200 AF/YR for 2000 MW power plant).

(2) Expect Sunrise and Clark Station to be obsolete by 1994.

APPENDIX I

APPENDIX I

USES AND PROBABLE VALUE OF TREATED WASTEWATER FOR IRRIGATION PURPOSES IN THE LAS VEGAS VALLEY

The beneficial use of treated wastewaters from municipal sewage treatment plants for irrigation in the Las Vegas Valley is a matter of concern in the current effort to abate pollution in Las Vegas Wash. For the purposes of this discussion, it will be assumed that the water discussed is essentially equal to the secondary effluents currently being produced by the City of Las Vegas and Clark County Sanitation District sewage treatment plants.

The uses projected for these wastewaters within the Las Vegas Valley may be categorized as follows:

A. Irrigation replacing potable water

(1) Parks and other recreational areas

(2) Landscaping

(3) Golf Courses

B. Irrigation for economic return

(1) Agriculture

C. Irrigation for Environmental Enhancement

(1) Green belts

(2) Maintenance of Las Vegas Wash ecology

(3) Wildlife support

All of the above potential uses for wastewaters have been considered and evaluated, based on present conditions and present knowledge. It is obvious that changes in economic incentives,

administrative rulings, or legal provisions could radically influence this evaluation. For example, administrative action by the State Engineer could either substantially reduce planned groundwater use, or could make this use more desirable. Action by the State and Federal agencies relating to required treatment standards could markedly change present evaluations of the above items.

For the purposes of present discussion, only those actions which can be taken, and only those incentives which can be offered through the local Clark County Agencies are considered.

The estimated costs of different classes of water delivered to the consumer at appropriate operating pressures currently used in the Las Vegas Valley for irrigation purposes is listed as follows:

(1)	Irrigation water served through the Las Vegas Valley Water District system	$75/AF
(2)	Irrigation water developed through wells owned and operated by the irrigator (pumping, well and equipment costs)	$25 – $50/AF
(3)	Treated wastewaters delivered by Clark County Sanitation District to nearby golf courses (estimate includes all pumping costs and system costs)	$40/AF
*(4)	Treated wastewaters delivered by City of Las Vegas to nearby farming operation (estimate for power, pumping and monitors)	$ 2/AF

In comparison to the above costs to the consumer, the cost of transmitting secondary treated wastewaters through the In-Valley Irrigation System outlined in this report when this system is operating at its maximum capacity of 25,000 acre feet per year is estimated as follows:

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*Wastewaters delivered to farming operation at essentially ground level (zero pressure).

Debt interest and amortization	$30/AF
Power cost	$11/AF
System Maintenance and Operation	$ 4/AF
Total cost of transmission and delivery	$45/AF

The above costs are estimated on the basis of delivery of water to the consumer's on-site system at appropriate operating pressures.

The value of a water delivered to irrigators has two bases for determination:

(1) The cost of developing or purchasing water from a different source;

(2) The ability of the water to produce revenue for a profit-making enterprise.

The first category would include such uses as irrigation of parks, recreational areas, landscaping, green belts, and maintenance of Las Vegas Wash ecology. For these uses, it appears the secondary treated waters would present an economic alternate choice of water. This judgment must be tempered, however, by consideration of the water quality. The salt content of the treated wastewater will require higher total annual application volumes in order to keep plant root zones free of growth hindering salt buildup. If the present trends toward increased salt content of wastewaters continues, it may be necessary to remove a portion of the salts carried in order to produce a satisfactory irrigation water.

Golf courses, considered as profit-making enterprises, must consider the price of water as one of the maintenance and operation expense items which will have significant effect on the profitability of the enterprise. Since all of the regulation golf courses in the Valley are served either by well water or treated wastewaters, it appears that these are the most advantageous from an economic standpoint. Based on unit costs outlined above, under prevailing conditions treated wastewater

even if delivered to the golf course system under adequate pressure, could not compete with well water of good quality.

The use of secondary treated wastewater in irrigated agriculture does not appear feasible on a large scale. Current farming operations near the City of Las Vegas Wastewater Treatment Plant are feasible only because of the extremely low cost of water. The analysis of irrigated agriculture in adjacent dry valleys presented in Appendix C to this report indicates that such operations could not pay any appreciable cost for water.

The cost of providing water of either a potable grade or secondary treated wastewater to irrigators in other parts of the United States varies widely. These costs are dependent upon the cost of developing and delivering these supplies, as well as the pricing policies of the water purveyor. As an example of the delivered cost of a potable water to the agricultural consumer in Southern California, records developed by the Metropolitan Water District of Southern California show a range of $22 to $143 per acre foot. The average of these figures are judged to be on the order of $40 to $50 per acre foot. The cost of providing treated wastewaters is a function of location of the point of use, both distance and elevation, from the treatment plant. Thus, no general frame of reference can be given. The practice of delivering treated wastewaters to irrigators is, in general, a highly subsidized operation, utilized more for the purpose of effluent disposal than for the sale of irrigation water. It is a rare case where delivery costs of these waters are totally recovered from the consumer.

Administrative incentives for the use of treated wastewaters would appear to be primarily in the pricing structure for the sale of these waters. Unit costs quoted above indicate that these waters can be delivered at costs somewhat above local well water production and substantially below potable water costs. One element not considered in costs quoted above is the trade-off of incremental costs incurred by disposing of this water by means other than irrigation. These incre-

mental costs may be substantial (on the order of $30 - $35 per acre foot) and this differential could be used to either reduce the selling price or to produce a better quality of treated wastewater for sale.

Other administrative and legal measures to encourage the use of reclaimed wastewaters will revolve around the management of the groundwater basin, and will impinge upon water rights determinations made at the State level, as well as distribution of costs for maintaining such rights and taxation policies affecting such rights.

UNIT COSTS AND BRIEF COMMENTS
ON ALTERNATE WASTEWATER TREATMENT
AND DISPOSAL PLANS
(1,000,000 Population without Power)

ALTERNATE	COST PER MILLION GALLONS 1980	1990	2000	REMARKS
Groundwater Recharge	$240±	240±	240±	Needs further evaluation to prove feasibility
Groundwater Recharge with 50 percent desalting	415±	415±	415±	
Groundwater Recharge with 100 percent desalting	590	680	610	
Complete Treatment	378	434	373	Costs before 1980 would be lower because of lower discharge standards
Colorado River Return	190*-378**	180*-434**	157*-373*	Costs before 1980 would be lower because of lower discharge standards
Dry Lake Export	194	285	335	Note: Costs before 1990 would be lower if desalting is not necessary
Eldorado Valley Export	198	285	336	Note: Costs before 1990 would be lower if desalting is not necessary
Jean Lake Export	246	330	366	Note: Costs before 1990 would be lower if desalting is not necessary

* Present Requirements
** With Complete Treatment