# PLAN FORMULATION APPENDIX

## Phoenix Urban Study Final Report

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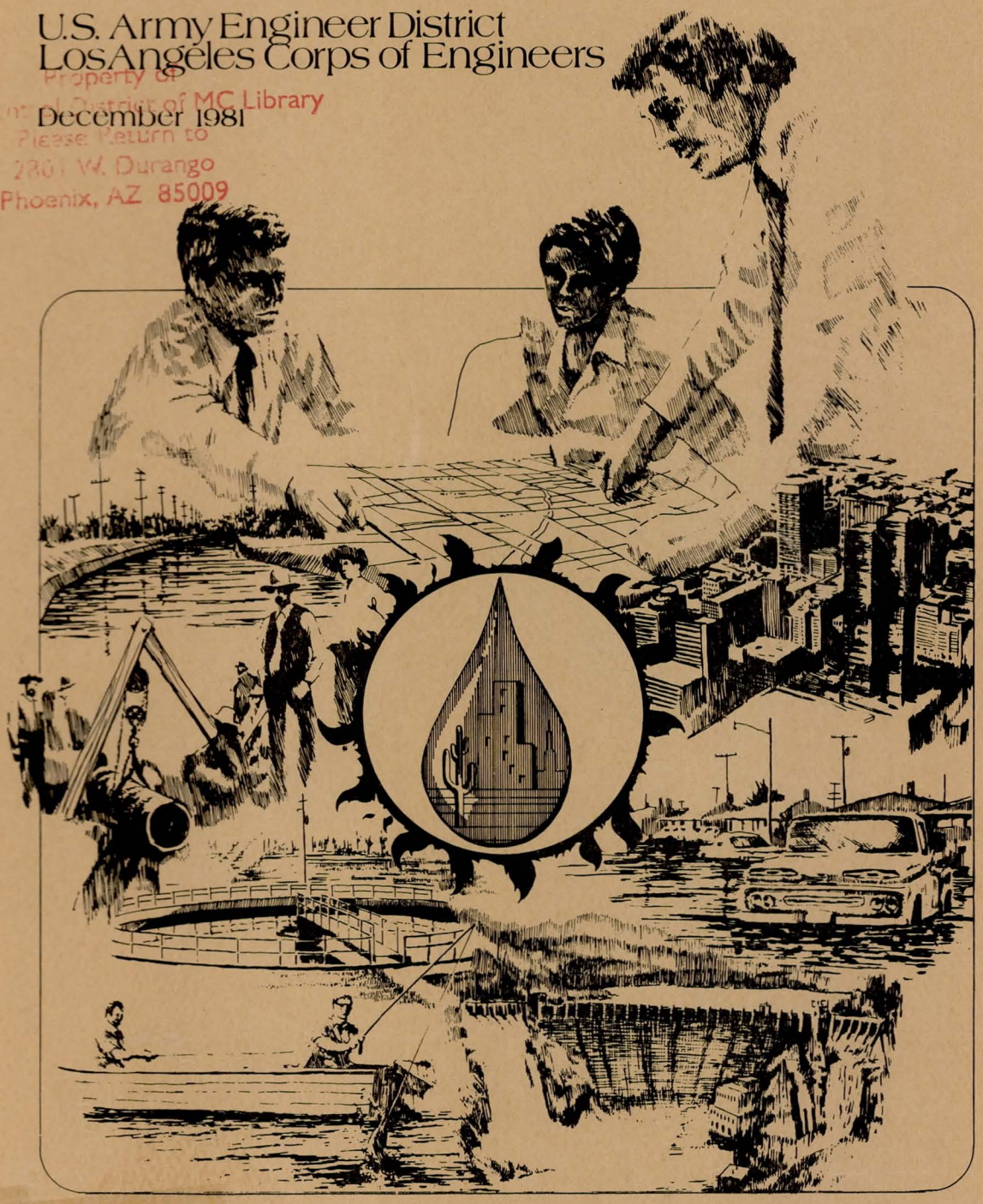

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# PLAN FORMULATION APPENDIX

# PHOENIX URBAN STUDY

# FINAL REPORT

U.S. ARMY ENGINEER DISTRICT
LOS ANGELES
CORPS OF ENGINEERS
DECEMBER 1981

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# CHAPTER I

# INTRODUCTION

The Urban Studies Program is a comprehensive planning program designed to help solve water and land-related problems in urban areas. The U. S. Army Corps of Engineers has been authorized by Congress to direct these study programs.

The roots of the Urban Studies Program reach back to the early 1970's when the Corps of Engineers was authorized by Congress to conduct a series of pilot wastewater management studies in several major metropolitan areas of the United States. Backed by the experience gained from these early studies, the Corps was authorized in 1972 under the Federal Water Pollution Control Act Amendments to provide the same kind of planning and engineering assistance to states and regional urban bodies upon request.

The Urban Studies Program avoids duplication of other federal, state or local government agency's planning effort. The program is being developed in cooperation with other federal agencies in accordance with local community needs and goals.

The end product of Urban Studies is intended to be flexible plans for the future -- realistic, workable plans by which urbanized communities can coordinate, manage, and develop water resources in the best interests of their growing numbers of citizens.

The program incorporates an interdisciplinary approach to planning which relies heavily on public involvement and local and state participation.

The Phoenix Urban Study investigated the following aspects of urban water resources:

- Water Quality
- Urban Flood Control
- Water Conservation
- Recreation
- Fish and Wildlife Enhancement

## PHOENIX URBAN STUDY PROGRAM

Seeking to provide comprehensive water resources planning the Maricopa County Board of Supervisors in 1972 requested through their Congressional

delegation that the U. S. Army Corps of Engineers conduct a water resources study of the Phoenix metropolitan area.

The Phoenix Urban Study was authorized by a resolution adopted July 31, 1973, by the Committee on Public Works of the United States Senate which states: "That the Board of Engineers, created under the provisions of Section 3 of the River and Harbor Act approved June 13, 1902, be, and is hereby required to review with the Chief of Engineers pertinent reports pertaining to Maricopa County, Arizona, with a view to determining whether any modifications of the recommendations contained therein are advisable at the present time, with particular reference to providing a plan for the control, development, utilization, and conservation of water and related land resources of the Phoenix Metropolitan region, with due consideration for metropolitan planning activities in the area. Such study to include appropriate consideration of the needs for protection against floods, storm drainage improvement, wise use of flood plain lands, general recreation facilities, regional water supply, waste water management facilities, enhancement and conservation of fish and wildlife, and other allied measures for environmental enhancement and economic and human resource development to be harmonious components of comprehensive development plans for the metropolitan Phoenix region."

## REPORT ORGANIZATION

The Final Report of the Phoenix Urban Study is presented in nine volumes, as shown in Figure I-2. The Summary Report provides an overview of the conduct and findings of the entire study. It describes the study area, highlighting problems, issues, and concerns; explains the final alternatives; gives a summary of impacts; and presents the final recommendations.

Three main appendices form the basis for the Final Report. The Background Information Appendix presents a profile of the region today as well as discussion of historical trends and future conditions. The Plan Formulation Appendix presents the rationale for conclusions reached during the study and summarizes all appendices. It emphasizes the planning process, component systems, impacts, and public involvement at a greater level of detail than the Summary Report. The Comments Appendix compiles the views of interested parties based upon their review of the draft Final Report.

The remaining four detailed appendices develop analysis supporting the conclusions of the Plan Formulation Appendix. The Design and Cost Appendix contains technical detail for the engineering of component systems. The Impact Assessment and Evaluation Appendix explains how and why alternatives were accepted, rejected, or reformulated. The Public Involvement Appendix documents the development of the public information program. The Institutional Analysis Appendix presents descriptions of existing institutions and organizations and their effect on the implementability of plans developed by the study. The final volume, the Technical Appendix contains the Plan of Study for a Demonstration Recharge Project in the Salt River Valley developed during the course of the Urban Study.

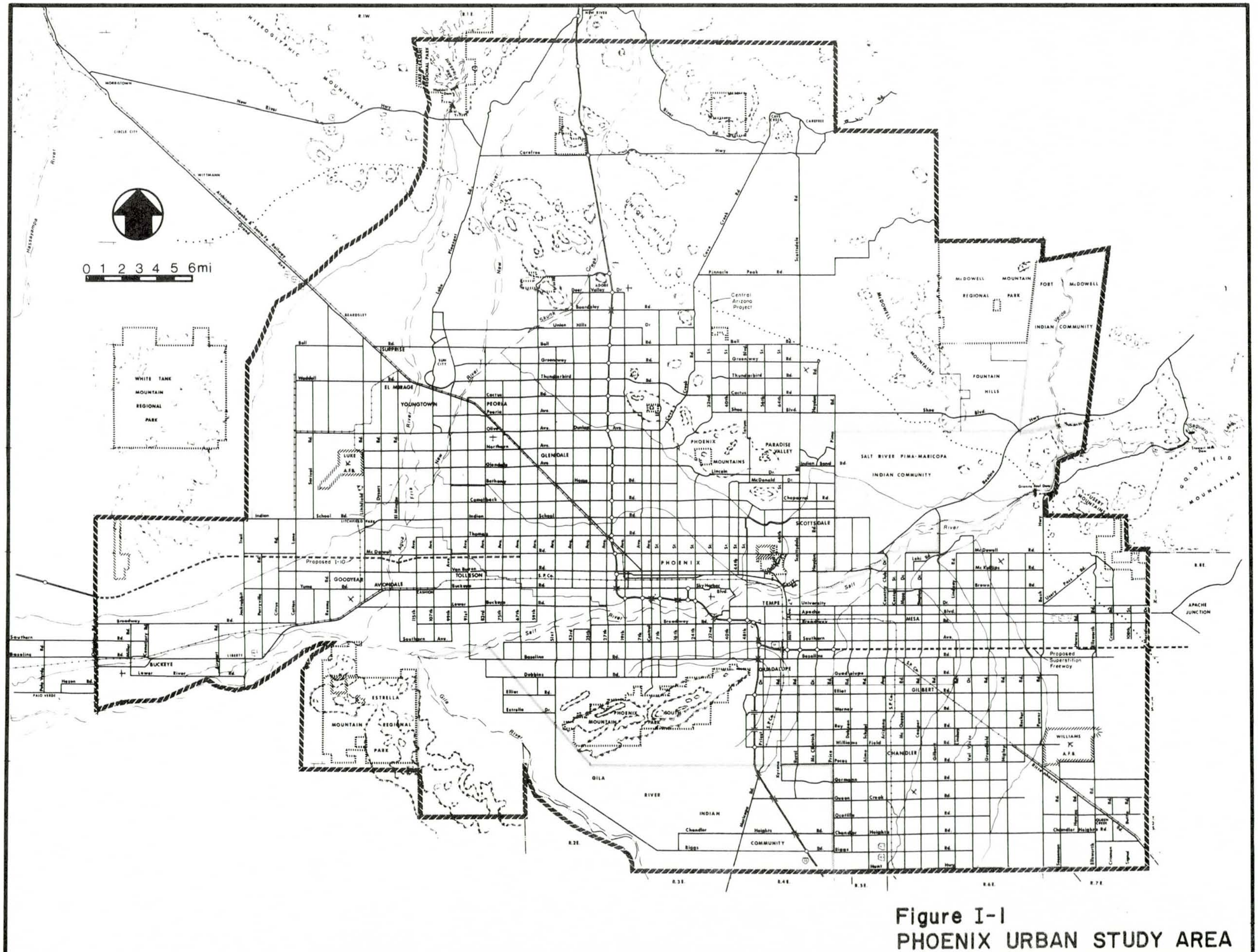



Figure I-1
PHOENIX URBAN STUDY AREA

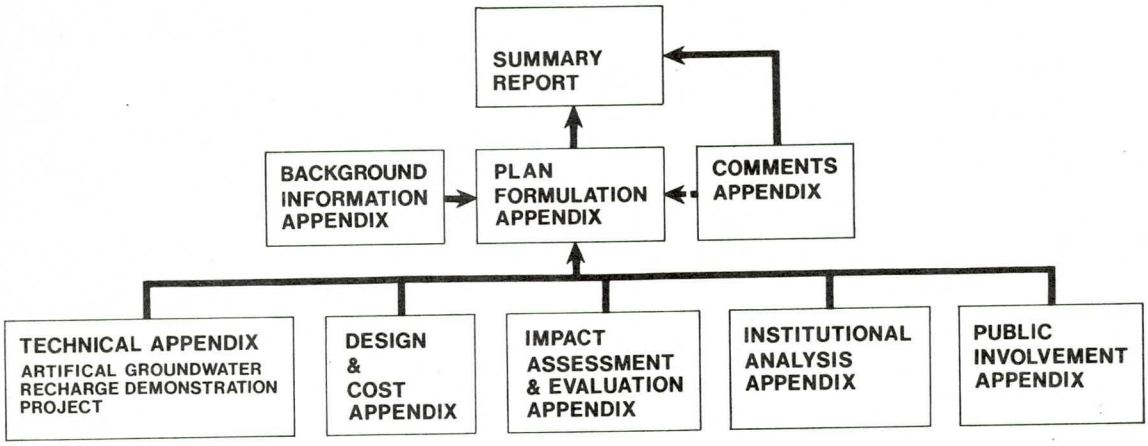



Figure I-2

**Study Report Organization & Content**

# CHAPTER II

# PROBLEMS, NEEDS, AND RESULTS

## PROBLEMS AND NEEDS

Early in the Phoenix Urban Study, a number of problems and needs relating to water resources were identified in the study area. Identification of these issues allowed planners to clarify the objectives of the study and formed the bases for the remaining investigations.

### Water Quality

Water quality, quantity, and use are important aspects of the water supply picture in the study area. More stringent water quality standards and higher levels of treatment are being introduced to counter the problems of deteriorating water quality and increasing demands for usable water. These measures, however, are costly and induce certain environmental impacts of their own. Any actions that can increase the supply of good quality water, decrease wastage, and minimize natural or man-made contaminations will tend to reduce both water quantity and quality problems. The Urban Study, therefore, had the responsibilities of identifying the current situation relative to water quality and quantity and proposing actions to help alleviate the problems.

Study Concerns. In the initial stages of the Phoenix Urban Study, the following concerns relating to water quality were identified:

- The existing wastewater system was operating at capacity, and most facilities needed upgrading to handle flows and improve water quality. Future growth was expected to place additional stress on the system.
- The rapid growth of the Phoenix area over the next 20 years would require a significantly enlarged wastewater treatment system to handle the increased flows.
- Water resources were being depleted in the study area, and reuse of wastewater was seen as a method of conserving these resources.
- There was a lack of knowledge of the quality and quantity of the region's groundwater and of the reasons for areas of poor groundwater quality.
- There was no knowledge of the location or impact of nonpoint sources of pollution in the study area.
- There was a lack of coordinated planning and management for issues pertaining to wastewater, and a general lack of local concern for water quality problems.

Groundwater Quality. Groundwater quality varies widely throughout the study area, both geographically and vertically. At present, the major groundwater quality problems are increasing salinity and high contents of chromium, arsenic, nitrate, and fluorides, apparently because of natural factors. High salinity adversely affects the usefulness of water for agricultural, municipal, and industrial uses. Other factors affect health and may require expensive treatment, blending with higher quality water, or abandonment of the source for drinking purposes.

High contents of chromium and arsenic are found in Paradise Valley. Salinity is increasing near Gilbert, because of irrigation return flow, and near Chandler, because of an altered flow pattern. In addition, high nitrate contents are found in Glendale and west and northwest of Phoenix. There are high fluoride contents west of the Agua Fria River and salinity is increasing in the Goodyear-Liberty area. The increased salinity is the result of altered groundwater flow. Figure II-1 shows the general locations in which nitrate, fluoride, chromium, sulfate, and chloride exceed the primary or secondary standards for drinking water.

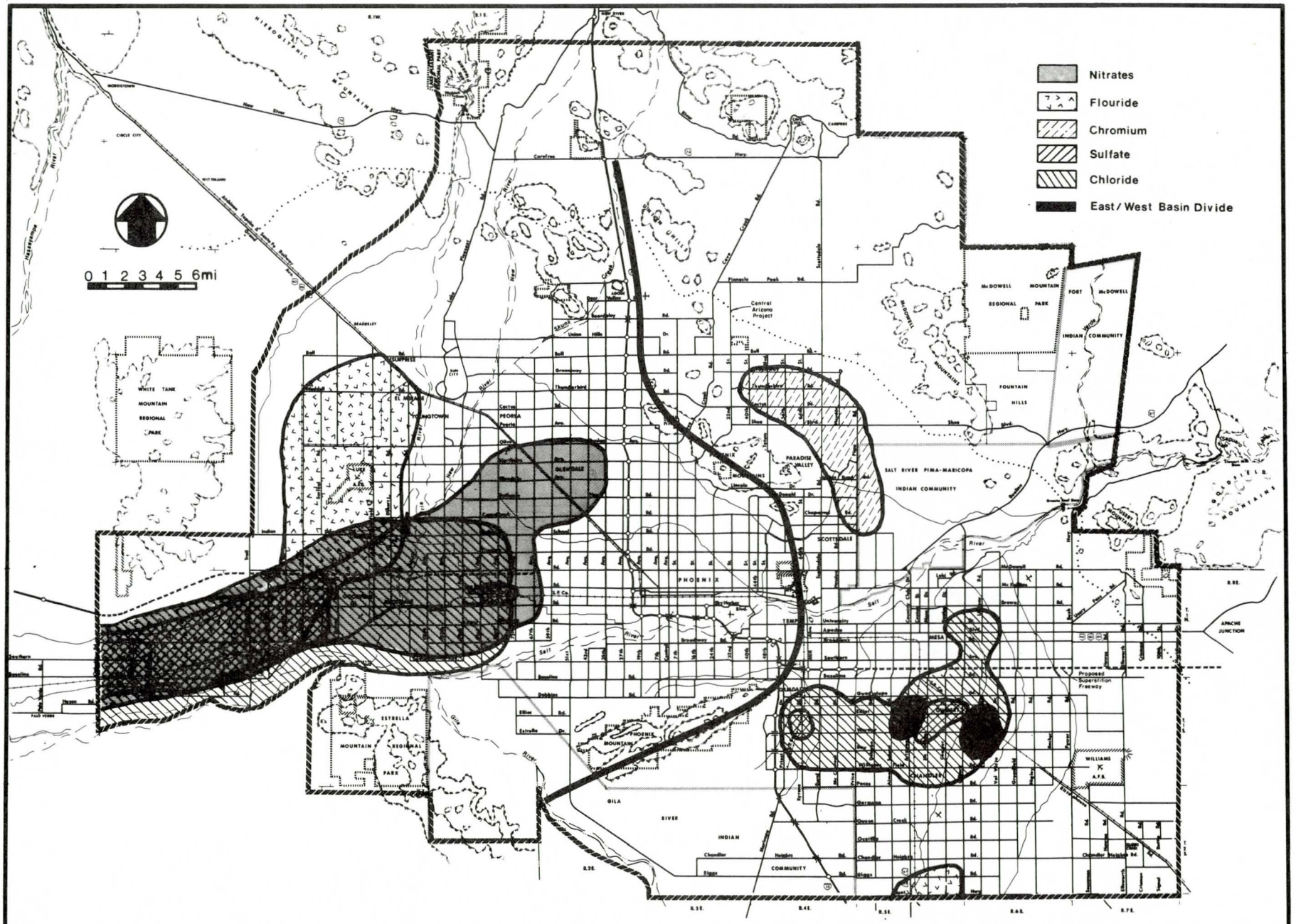
Surface Water Quality. Surface water in the study area is generally of high quality. Water from the Verde River has the highest quality, with a concentration of total dissolved solids (TDS) lower than those of the Salt River. Gila River water is of the lowest quality, exceeding EPA standards for concentration of flouride, nitrate, arsenic, cadmium, lead, mercury, and selenium, as well as secondary standards for sulfate, chlorine and TDS.

## Flood Control

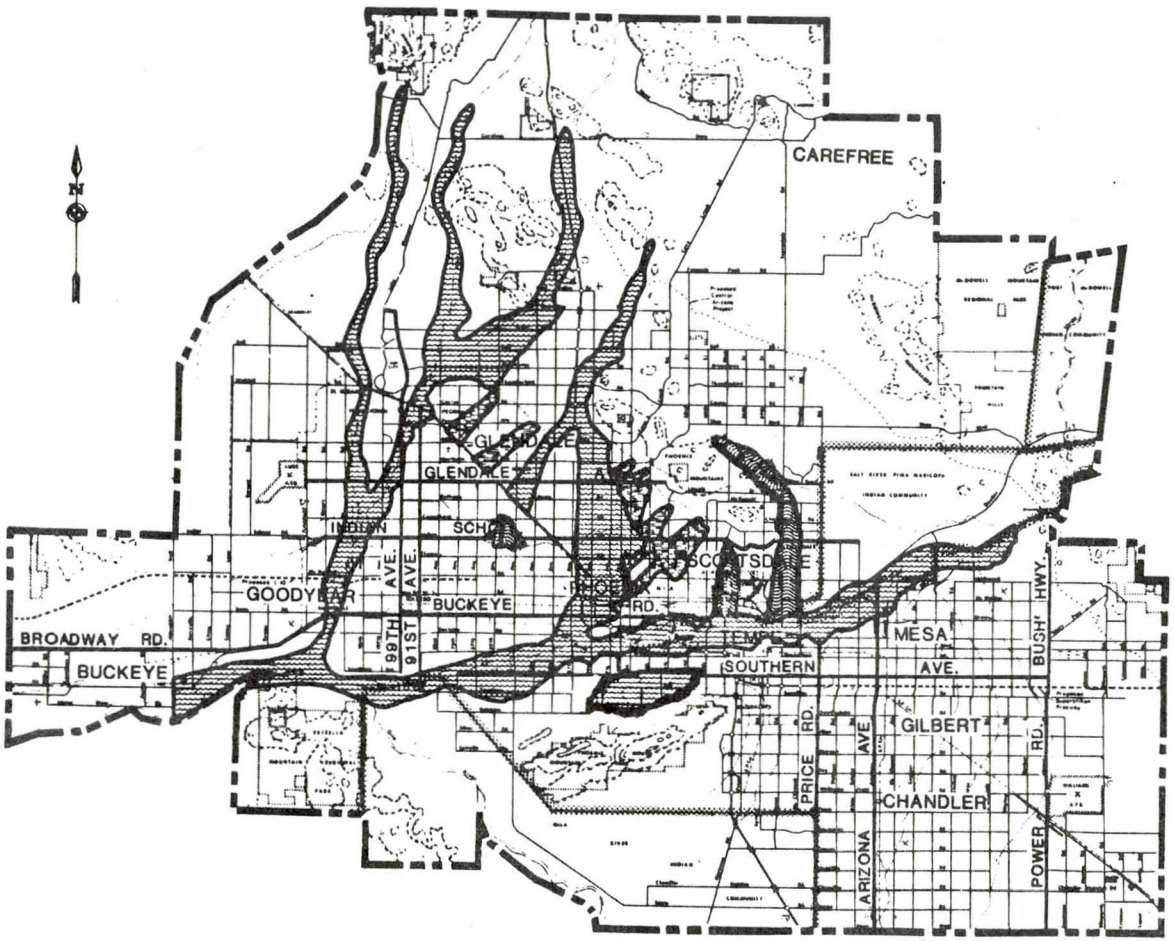
Flood damages and drainage problems vary along water courses throughout the study area. The following flood hazard areas fall within the parameters of the Phoenix Urban Study:

Glendale-Maryvale. No defined channels exist in this area. Flooding results from sheet flow and ponding behind obstructions. The Santa Fe railroad, which passes through Glendale, creates an impediment to the flow of surface waters. The two openings at the trestles and a few drains in the railroad embankment are not of sufficient size to prevent flood waters from ponding against the railroad tracks and flooding adjacent streets and business properties. South of the tracks, runoff flows southwestward toward the Grand Canal where ponding occurs, flooding adjacent homes. In the past, sufficient flood flows have entered the Grand Canal to cause overtopping at the upstream sides of weirs and bridges and at low places in the bank fill. This results in flooding along the south side of the canal.

Glendale has a long history of flooding. The 1963 flood was apparently the most damaging flood of record, and caused ponding along the north side of the railroad tracks to a depth of 2 to 3 feet. Almost all businesses along the 6 mile reach were flooded. In Maryvale, water ponded along the Grand Canal resulting in flooding to a depth up to 3 feet in a concentrated residential area. Damages from this flood amounted to $2,900,000 in the Glendale-Maryvale area.




GROUNDWATER PROBLEMS IN THE STUDY AREA
FIGURE II-1




LEGEND

STANDARD PROJECT FLOOD

FLOOD PRONE AREA

OVERFLOW AREA

FLOOD PRONE AREAS

FIGURE II-2

Cave Creek Downstream from the Arizona Canal. The plan formulated for the authorized New River and Phoenix City Streams Project has resulted in the start of construction of Cave Buttes Dam on Cave Creek and authorization of the Arizona Canal Diversion Channel. These two projects will prevent a substantial portion of the flood damages along Cave Creek. Runoff originating below the diversion channel, however, still would result in flooding of the business and governmental center of downtown Phoenix, as well as large residential and commercial areas.

Upper Indian Bend Wash. Flood problems exist along Indian Bend Wash upstream from the Arizona Canal. The lower reach of Indian Bend Wash from the Arizona Canal to a point near its confluence with the Salt River has been authorized for a flood control project currently under construction

The flood of June, 1972, with a peak discharge of 14,500 cfs at the Camelback Country Club in Paradise Valley, caused damages amounting to nearly $500,000 along the upper reach of Indian Bend Wash. The Bureau of Reclamation has completed the Granite Reef Aqueduct as part of its Central Arizona Project. The aqueduct runs in a northwest-southeast direction, and crosses the Indian Bend Wash drainage area about 7 miles north of the inlet for the lower reach near Indian Bend Road. In conjunction with this aqueduct, the Bureau has constructed a detention dike which provides control for much of the drainage area. Residual flow downstream of the dike and from the Phoenix Mountains, however, still occurs. Upper Indian Bend Wash is being developed by local agencies and private interests as a greenbelt floodway.

South Phoenix. A number of small washes originating in the South Mountains cause flooding problems in the South Phoenix area. The washes are well defined in the upstream reaches, but have been obliterated by development below. No estimates are available on flood frequencies in this area, but damages from past floods have been relatively slight. The potential for severe flooding, however, is present, particularly because of the rapid urban expansion of South Phoenix.

Gila Floodway Area. Portions of the area bounded by the cities of Tempe and Mesa on the north, Interstate 10 on the west, Queen Creek on the east, and the Gila River on the south are poorly drained and subject to flooding. The floodway, however, is not readly visible because of extensive land leveling. The problem, which includes sheet as well as channel flow, will become more severe as large portions of agricultural land become urbanized.

Old Cross Cut Canal. Flooding occurs along the Old Cross Canal between the Arizona Canal and the Grand Canal, and in the Arcadia neighborhood of Phoenix. The area is highly urbanized and in most places drainage is poor. In response to a request from Maricopa County, flood problems along the Old Cross Cut Canal were investigated by the Urban Study.

Scatter Wash. Flooding occurs along Scatter Wash, a tributary of Skunk Creek, and endangers an area developed as mobile home parks, schools, and residential neighborhoods. Closing of dip crossings in the channel during even minor flood events also creates inconveniences for motorists.

Salt River: Flooding along the Salt River through the study area has been recorded since the 1830's. The most serious of the early floods occurred in February 1891. A peak flow of approximately 300,000 cfs overtopped the Arizona Dam, which at that time diverted water into the Arizona Canal, and washed out other downstream diversion dams and irrigation works. Floodwaters inundated much of downtown Phoenix, reaching the intersection of Central Avenue and Jefferson Street.

Since 1891 significant flooding has occurred along the Salt River in 1905-1906, 1916, 1920, 1938, 1965-1966, and 1973. In March 1978, warm rains falling on an extensive snowpack in the watershed produced a flood with a peak flow of 130,000 cfs through the Phoenix area. All but three river crossings were washed out, and 2500 feet of runway at Sky Harbor, the main airport in the study area, were inundated. Although sand and gravel operations and some farmland also were flooded, the only residential areas to suffer severe damages were the Holly Acres and Allenville neighborhoods southwest of Phoenix. Damages from this flood totaled over $33,000,000. In December 1978, warm moist air from the Pacific Ocean and associated precipitation caused another snowpack on the watershed to melt. The resultant peak flows on the Salt River were nearly equal to those of the March flood. A third flood on the Salt River occurred in February 1980. Flows peaked at 180,000 cfs and caused over $60,000,000 in damages. These events illustrate the need to formulate and implement a plan for Salt River flood control.

## Water Conservation

Under normalized conditions for 1970, water consumptions in the Salt River Valley amounted to 1,563,000 acre-feet (AF). The annual dependable supply from surface water and natural recharge totaled just 931,000 AF, thereby producing a total annual overdraft of 632,000 AF. As part of the Central Arizona Project (CAP), currently under construction by the Bureau of Reclamation, water from the Colorado river will be imported into the Salt River Valley to lessen the impact of severe overdrafting. Allocations of this water, however, have not as yet been completed. Even with CAP, overdrafting will remain a serious problem which can be alleviated only through water conservation and reuse measures, including the capture of floodwaters, which currently escape the region, for beneficial use.

Using 1970 normalized conditions, agriculture accounted for 87 percent of water consumption in the Salt River Valley. Urban (municipal and industrial) consumption amounted to 12 percent, and consumption by other interests came to about 1 percent. Although urban needs have increased since 1970, agriculture is still the largest water user in the Salt River Valley. The potential exists for irrigation system improvements and improved agricultural water management practices. Urban water conservation measures will continue to be important as more and more cropland in the Salt River Valley is converted to municipal and industrial uses. Reuse of wastewater also shows promise in helping to meet both urban and agricultural requirements.

The floods of 1978 caused extensive property damages. Another unfortunate aspect of such flooding is the loss of valuable water resources through flow

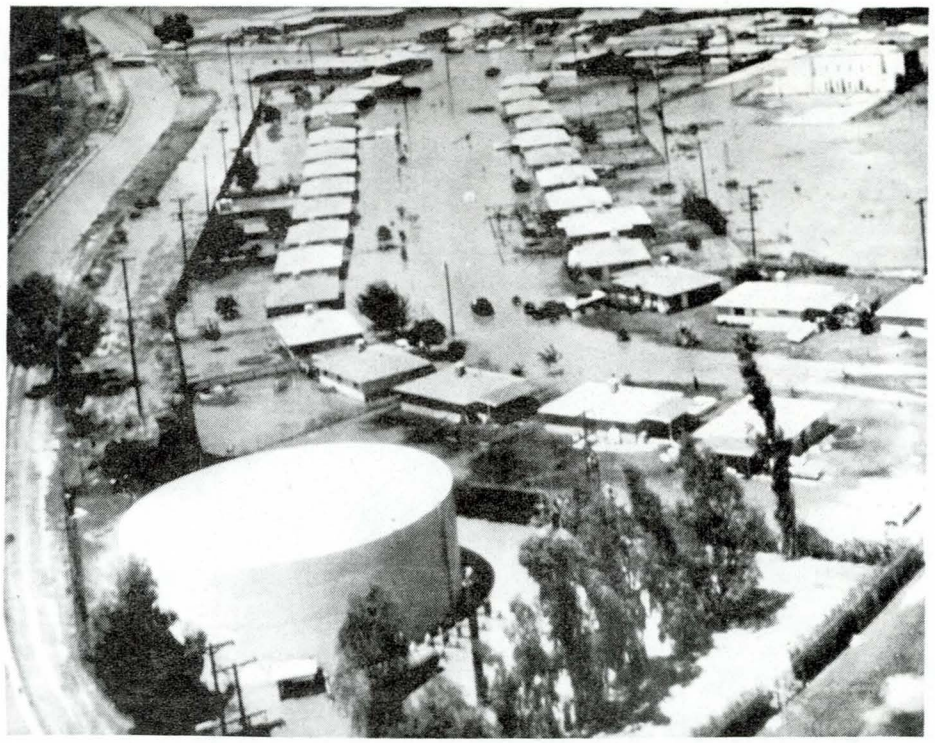


FIGURE II-3. Flooding in Maryvale, 1971. The Grand Canal is at the left.

FIGURE II-4. Ponding along the A.T. & S.F. Railroad tracks, Glendale/ Maryvale, 1971.

FIGURE II-5. Dense development of the Cave Creek floodplain below the Arizona Canal. The Arizona capitol complex is in the center and the I-17 freeway is in the foreground.

FIGURE II-6. Upper Indian Bend Wash is being developed by local interests as a greenbelt floodway with features such as this golf course.

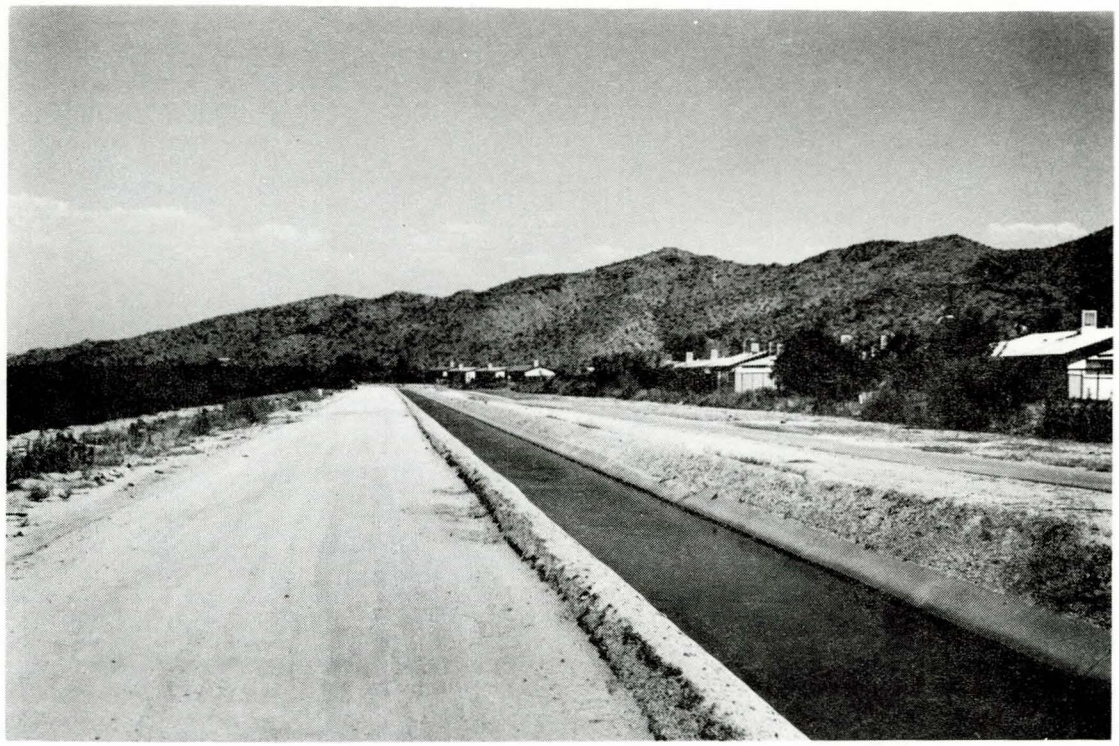


FIGURE II-7. Natural channels coming out of the South Mountains are obiliterated by suburban development, irrigation canals, and agriculture in South Phoenix.

FIGURE II-8. Suburban development is displacing agriculture in much of the Gila Floodway area.

FIGURE II-9. Old Cross Cut Canal, Phoenix.

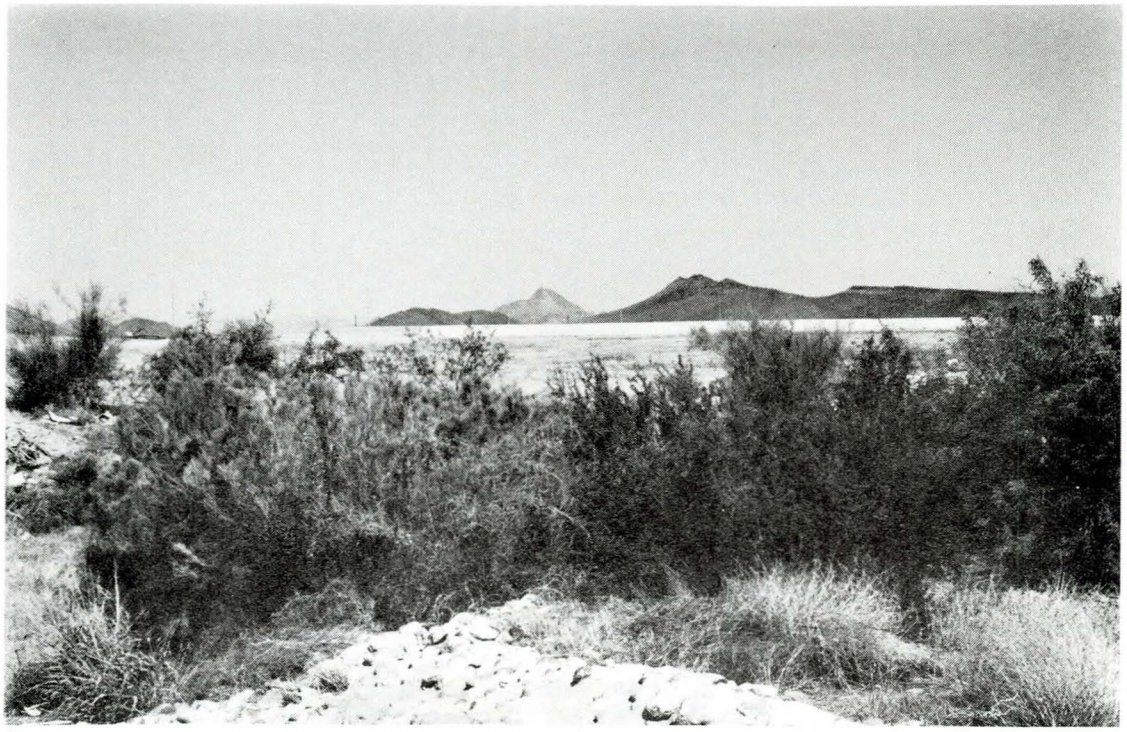


FIGURE II-10. Underbrush chokes much of the channel of Scatter Wash. Adobe Dam, under construction by the Corps of Engineers on Skunk Creek, is in the background.

FIGURE II-11. Flooding at a sand and gravel operation in the Salt River floodplain, 1978.

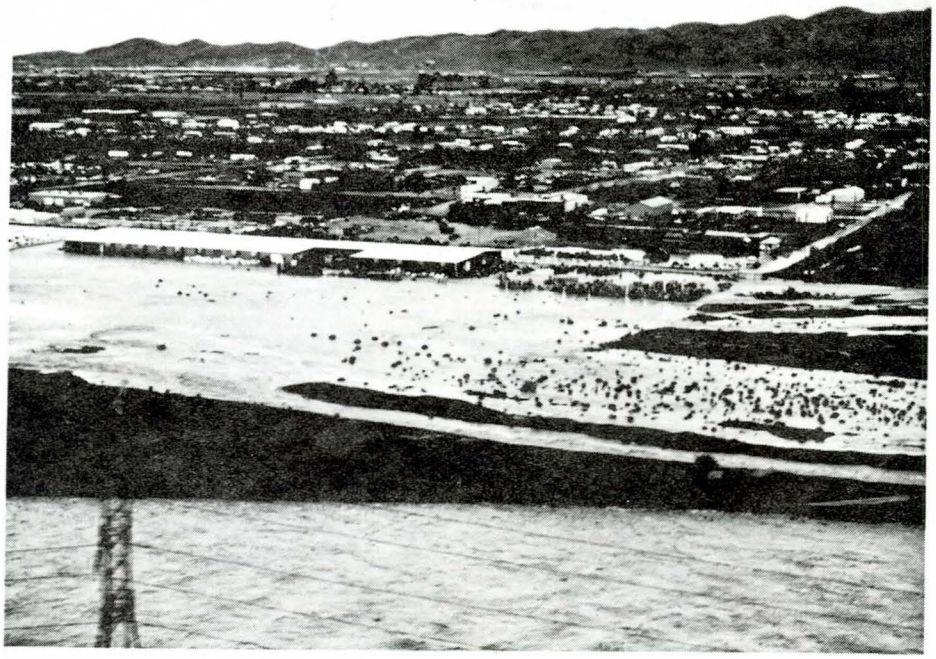


FIGURE II-12. Flooding of businesses along the Salt River, 1978.

TABLE II-1

HISTORIC FLOODS ON THE SALT RIVER*

| Date | Flood Peak (cfs) | Damages |
|---|---|---|
| February 1891 | 300,000 | N/A |
| April 1905 | 115,000 | N/A |
| November 1905 | 200,000 | N/A |
| January 19-20 1916 | 120,000 | N/A |
| January 29-30 1916 | 105,000 | N/A |
| February 1920 | 130,000 | N/A |
| March 1938 | 95,000 | N/A |
| March 1941 | 40,000 | N/A |
| December 1965-January 1966 | 67,000 | $6,000,000 |
| February 21-May 23 1973 | 22,000 | N/A |
| March 2 1978 | 122,000 | $33,000,000 |
| December 19 1978 | 140,000 | $51,000,000 |
| January 19 1979 | 88,000 | N/E |
| March 29 1979 | 67,800 | N/E |
| February 1980 | 180,000 | $60,000,000 |

*Data for early floods obtained from the Interim Report on Survey for Flood Control, Gila and Salt Rivers, Gillespie Dam to McDowell Dam Site, Arizona, U.S. Army Corps of Engineers, Los Agneles District, 1957.

Data for recent floods obtained from the U.S. Geological Survey, measured at 48th Street and the Salt River in Phoenix.

N/A=not available

N/E=not estimated

out of the region or seepage into areas of poor groundwater quality. An need exists to provide increased water conservation through the capture and storage of floodwaters for beneficial use within the study area.

## Recreation

The desert climate which permits year-round enjoyment of outdoor activities together with increased income levels and liesure time has produced an unprecedented demand for recreation of all types in the Phoenix Urban Study area. The steadily rising price of gasoline has, at the same time, caused residents to orient their activities toward easily accessible facilities. The supply of recreational programs and facilities, both public and private, is unable to keep pace with demand. Existing facilities receive heavy, often excessive, use from residents and visitors to the area.

Recreational use of the few watercourses in the study area provides an example of this demand/supply problem. During the hot summer months, the flowing streams and man-made lakes on the Salt, Verde, and Agua Fria Rivers are used for such water-based recreation as fishing, boating, swimming, water skiing, and tubing, while the lakeshores and riverbanks serve as sites for picknicking, hiking, and other non-water related activities. The use of these resources has caused so much damage that management policies have been adopted which restrict the number of visitors to some reservoirs and certain reaches of the rivers. Estimates are that the lakes and rivers in and near the study area will be able to supply only a fraction of the demand for water-related recreation in the future. A larger and more diversified stock of both water and land-based recreational facilities needs to be developed for the use of Phoenix area residents and visitors.

## Fish and Wildlife Enhancement

The Corps of Engineers, through both the Principles and Standards for Planning Water and Land Resources and the National Environmental Policy Act of 1969, has the responsibility and mission of enhancing the nation's natural environmental resources. The Water Pollution Control Act (PL 92-500) also has designated "the protection and propagation of fish, shellfish, and wildlife", as one of several goals to achieve in maintaining the biological integrity of the nation's waters.

The rapid growth of the Phoenix Urban Study area already has reduced the amounts of land and water available for wildlife habitat. Of particular interest to the Urban Study are the regions of riparian vegetation found along the lower Verde River, the Salt River immediately below Granite Reef Diversion Dam, the Salt-Gila Rivers from the 23rd Ave. treatment plant in Phoenix to Gillespie Dam to the southwest of the study area. While relatively few animals would die outright as the result of construction in these regions, the disruption of their habitat could lead to declines in population and possible local extinction of certain species. The U.S. Fish and Wildlife Service has determined that three endangered species occur in the Urban Study area: bald eagle, Yuma clapper rail, and peregrine falcon.

Water based or riparian habitat is naturally scarce in the desert areas of central Arizona. At present, it comprises a small portion of land use in the study area. It also is becoming a diminishing resource because of man-related activities. Development is intense along rivers and streams. Groundwater over-draft and such features as dams, channels, levees, treatment plants, gravel operations and landfill tend to destroy riparian habitat. It is possible, however, for water resource projects to enhance the habitat and associated fish and wildlife.

Aesthetic values are supported by enhancement of biological resources. In what is becoming an increasingly urbanized area, with the attendant technological and labor saving devices, people require reminders of their connection with nature. Natural areas within or peripheral to metropolitan areas can be of therapeutic value in an urban society. These areas can be aesthetically rewarding, physically stimulating, and educationally illuminating. The need exists, therefore, to promote the enhancement of fish and wildlife in the study area through appropriate water resource projects.

## RESULTS

### Water Quality

Major strides toward improving water quality in metropolitan Phoenix were made during the course of the Urban Study. The Maricopa Association of Governments, the designated planning agency for Section 208 of the Federal Water Pollution Act Amendments of 1972, named the Corps of Engineers through the Phoenix Urban Study to undertake planning for the metropolitan portion of Maricopa County. In carrying out this mission, the Phoenix Urban Study accomplished the following:

- Working with local and regional agencies and organizations, an implementable areawide plan for wastewater management was developed and adopted by the Maricopa Association of Governments.

- Local agency staffing requirements were identified and met so as to facilitate implementation of the plan and make annual updates.

- A management arrangement for construction and operation of facilities and to avoid creation of any new governmental agencies was formulated and adopted.

- The needed changes in the Arizona Department of Health Services were identified and implemented so as to enhance the ability of that agency to handle 208 and 201 programs at the state level in the future.

- Options for reuse of wastewater were examined in depth for the first time in the study area, and the relationships between location of facilities, methods of treatment, and feasible reuses were developed.

- Land treatment of wastewater was explored and included in the point source planning effort, although no land treatment was implemented.

- A program for reducing flows to study area wastewater treatment plants was initiated.

- Groundwater quality was studied in detail. Pollutants were identified, and the historical changes in these pollutants were studied. Causes of pollution were discussed where possible, and a monitoring plan to gain a better understanding of them was developed.

- The study greatly increased the awareness of local officials as to the importance of surface and ground-water quality and wastewater management in general.

Flood Control

Reviews were made at the survey level of the feasibility of eight proposed flood control projects in the study area. Although all but one of these (Salt River through Phoenix) did not warrant further federal action, the flood control portion of the Phoenix Urban Study accomplished the following:

- Local agencies were provided with valuable information on controlling floods and overcoming difficulties in floodplain management.

- The negative reports on the seven flood control projects allowed efforts to be focused on the development of alternatives for control of floods on the Salt River through metropolitan Phoenix.

- Under the auspices of the Phoenix Urban Study, Corps personnel provided assistance to the Bureau of Reclamation in Stage I of it's Central Arizona Water Control study.

- Surveys of flood damages were conducted.

- The need for local agencies to implement and enforce retention and detention ordinances was clarified.

Water Conservation

Efforts by the Phoenix Urban Study in the conservation of floodwaters began by looking at floodwater conservation and evolved into an examination of achieving conservation through artificial groundwater recharge. Two major reports resulted from this effort. Each of these documents, in turn, produced their own significant results in the area of water conservation:

- Feasibility Report (1977) - This document represented the first serious effort at examination and quantification of artifical groundwater recharge as a conservation measure. It expanded and documented the need for further research. It initiated a change in attitudes toward artifical groundwater recharge among federal, state, and local agencies.

- A Plan of Study for a Demonstration Recharge Project in the Salt River Valley (1978) - This document increased awareness regarding the possiblities of artificial groundwater recharge and described and quan-

tified the next two phases of a water conservation effort in the study area; a demonstration project, and a full-scale groundwater recharge program.

Much work remains to be done to fund and implement the demonstration and full-scale recharge projects. It was determined that these next phases will both influence and be influenced by other current water resource projects, principally the Central Arizona Water Control Study now being conducted by the Bureau of Reclamation with the assistance of the Corps of Engineers.

Water conservation also was examined from the standpoint of conserving existing supplies through reduced consumption. Demand reduction was accomplished by means of a "Watch Our Wastewater" program as a part of the Section 208 Water Quality planning effort. Although this program was designed primarily to cut down flows to already overtaxed treatment plants in the study area, it resulted in substantial water savings as well.

Rio Salado

Rio Salado is a concept which envisions the usually dry Salt River bed through Phoenix converted into a multi-purpose greenbelt floodway. Included in the concept are proposals for recreation facilities, commercial development, and transportation links.

During the course of the Urban Study, Maricopa County had the responsibility for coordinating Rio Salado planning. At present, this responsibility rests with the Rio Salado Development District, established by the State Legislature in 1980. In addition, the City of Tempe has taken a prominent role in Rio Salado planning and has developed designs for its own Rio Salado facilities.

Although development of the Rio Salado concept is primarily the responsibility of local and regional agencies, Phoenix Urban Study planning for Rio Salado produced the following results:

- Some preliminary engineering work was done resulting in the development of tentative channel configurations.
- Information was generated regarding potential water sources.
- Methods for utilization of treated wastewater for Rio Salado were examined as were the social and environmental impacts of wastewater reuse.
- An institutional analysis developed methods for planning and managing Rio Salado.

# CHAPTER III

# PLANNING PROCESS

## OBJECTIVES

The Phoenix Urban Study sought to develop acceptable solutions to water and related land problems in the metropolitan area. The study conformed to the Principles and Standards for Planning Water and Land Resources, the national objectives established by the Water Resources Council. These objectives require that federal, and federally-assisted planning, develop plans which emphasize national economic development and environmental quality as co-equal national goals. In addition, regional development and social well-being must be taken into account.

The National Economic Development Plan increases the value of the nation's output of goods and services and improves national economic efficiency. This is realized by a maximum net economic return from projects, the determination that a project accomplishes a stated purpose in a more economical manner than any other means of accomplishing that purpose, and realization that a definite need exists for the specific project or component.

The Environmental Quality Plan preserves, restores, or improves the environment. This is accomplished through management, protection, preservation, enhancement or creation of areas of natural beauty, enjoyment, or archaeological, historical, ecological, or geological importance. In all cases, the national objectives and accounts of the Principles and Standards should be in accord with the concepts contained in the National Environmental Policy Act of 1969.

Regional development presents a comparison of the non-federal costs of each plan. It is reached by establishing a project's effects on a region's income, employment, population, economic base, environment, and social development. The social well-being account is determined by a proposal's effect on the real income, security of life, health, and safety, educational, cultural and recreational opportunities, and emergency preparedness of a region.

In general, therefore, the National Economic Development objective seeks the most cost-effective solution from a national viewpoint, while Environmental Quality maximizes the environmental benefits or minimizes adverse impacts, primarily in terms of non-monetary values. The Regional Development account addresses mostly issues of local concern.

A basic problem facing planners concerns the formulation of plans which address mixes of National Economic Development and Environmental Quality and the extent to which economic benefits can be traded-off to avoid adverse impacts on the environment or provide environmental quality benefits. This problem is made more difficult because environmental values are subjective and cannot be measured in strict economic terms. When trade-offs are made,

however, it is implied that the environmental benefits gained are worth the dollars spent to obtain them.

PLANNING STAGES

Corps of Engineers planning for water resource development follows a well-defined three-stage process. In general, this planning process consists of the refinement of a large number of alternatives down to a few detailed plans and eventually to a recommended plan. During the planning process, the number of plans decreases while the level of detail at which they are examined increases.

Additionally, four tasks are accomplished within each planning stage. These four tasks are:

- Problem Identification;
- Formulation of Alternative Solutions;
- Impact Assessment;
- Evaluation.

Although all of these tasks are carried out in the three planning stages, the emphasis placed on them varies at each stage. (See Figure III-1)

The three basic planning stages and associated tasks are:

- Stage I, Delineation of Strategies. Efforts during Stage I center on the identification of problems and needs in the study area, establishment of broad planning objectives, definition of public concerns, and formulation of a management program for conduct of the study.
- Stage II, Formulation of Alternatives. The planners and engineers do the bulk of their work in Stage II. Included in this stage are the detailed investigations of such factors as geology, hydrology, hydraulics, costs, structural designs, and institutional analyses. Detailed environmental assessments and socio-economic studies also are made. Stage II work eliminates non-viable plans, and formulates a limited number of alternatives for more detailed study in Stage III.
- Stage III, Refinement of Plans. Stage III includes the necessary modification of plans and designs based on economic, engineering, environmental, and social concerns during the review at the conclusion of Stage II. Emphasis is placed on a more thorough evaluation of these plans and the necessary arrangements for implementation.

This planning process was followed during the course of the Phoenix Urban Study. In order to address the problems and needs discussed in Chapter II, it was decided following the completion of Stage I that the Urban Study efforts should be divided among the three principal areas of concern.

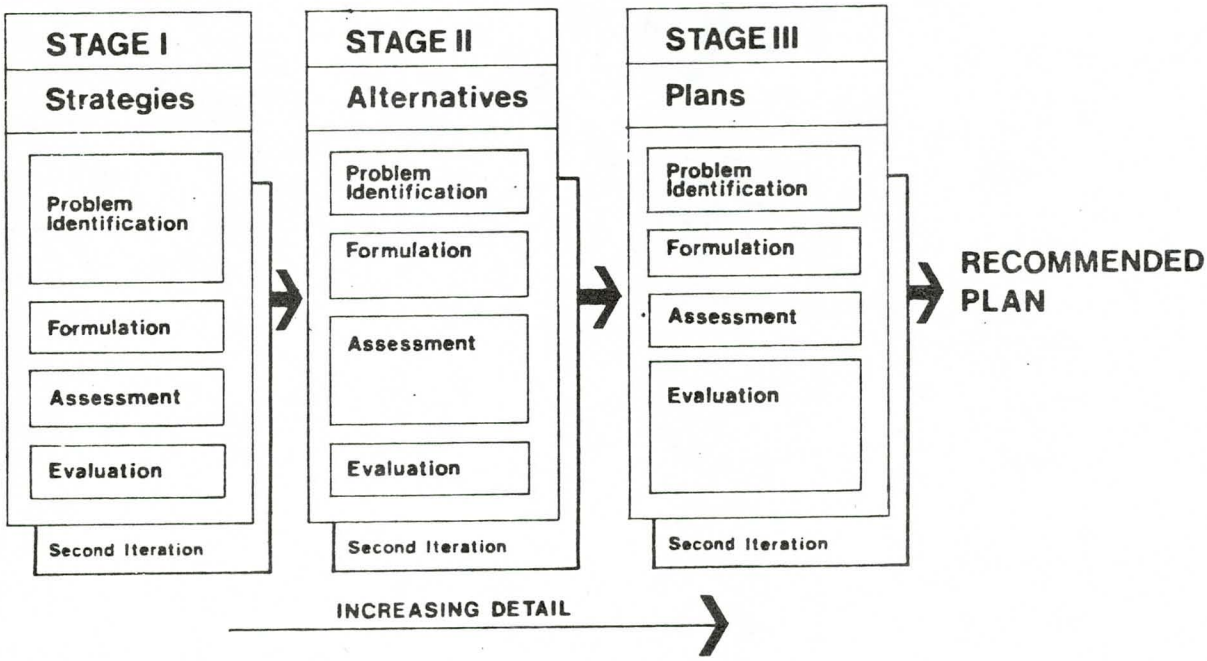



Figure III-1
CORPS OF ENGINEERS PLANNING STAGES AND TASKS

The water quality program involved close coordination with the Maricopa Association of Governments (MAG), as well as with several other federal, state, and local agencies. Planning was carried out through all three stages during the water quality portion of the Phoenix Urban Study.

Flood control investigations progressed through Stage II, at which time the alternatives either were recommended for further study under another authority or dropped from consideration.

Of the two principal components of the water conservation section of the Urban Study, the proposal for a groundwater recharge demonstration project progressed through Stage I with the preparation of a plan of study, while the other, a scheme to divert water from the New River to augment supplies in Lake Pleasant, advanced into Stage II, but was then dropped from consideration, primarily because of strong opposition from local residents.

# CHAPTER IV

# PUBLIC INVOLVEMENT

The role of public involvement in the Corps of Engineers planning process is to provide timely information so that the Corps' water resource plans will respond to public needs and preferences. The Corps also has the responsibility of providing the public information in order to acquaint persons desiring to participate in the study effort with the issues and opportunities associated with a particular project or program. The Corps, together with elected and appointed officials, on the other hand, still retains the major decision making authority. It must balance the needs and preferences of many groups with each other as well as with the technical and political elements which may influence the selection of a plan. Public involvement, therefore, is basically a two-way communication process in which the public relates to the Corps as to the particular problems, needs and concerns of a study area and the Corps, in turn, informs the public about the various technical, environmental, political, and economic issues involved in planning for water resources.

For the purpose of the Phoenix Urban Study, the term "public" describes any entity other than the Corps and MAG staffs directly involved in the study. The public can be identified as several groups to illustrate the broad sense of this definition.

- Governmental Sector. This group includes elected officials and agency representatives at the federal, state and local levels. It also includes public utility companies, irrigation districts, special purpose governments such as flood control districts, and Indian Tribal governments.

- Special Interest Groups. Included in this group are special interest organizations (such as environmental organizations, recreation clubs and home owners' associations), general interest groups (such as Lions, Rotary, Kiwanis), professional associations (such as American Institute of Architects), education institutions, industrial and business organizations, Chambers of Commerce and labor unions.

- General Public. This includes everyone affected by the study. Of particular interest, however, are property owners that would be affected directly by courses of action contemplated by the study, and sensitive ethnic or economic groups.

## OBJECTIVES

The objective of the public involvement program was to provide the opportunity a continuous, two-way communication process which:

- Promoted full understanding of the manner and means by which water resource problems and needs are investigated and solutions are proposed;

- Kept the public fully informed regarding the status and progress of the study and the results and implications of planning activities;

- Actively solicited from the public opinions and perceptions of problems, issues, concerns, and needs, as well as preferences regarding resource use and alternative development, managerial strategies, and other information and assistance relative to the planning program.

Using the public involvement program as a vehicle for discussion of community desires and purposes allowed the opportunity to obtain information concerning the acceptability of alternative plans. In this manner, the possibilities and difficulties of implementing alternative plans could be explored effectively with the public acting as a sounding board.

PROGRAM OVERVIEW

To meet the objectives of the public involvement program, various activities were conducted appropriate to the three Urban Study plan development stages. Rather than being a fixed program, public involvement was flexible and monitored for effectiveness as the study progressed. Considerable effort was devoted to the type and timing of the interaction so as to achieve optimum citizen involvement.

The Stage I public involvement effort was designed to:

- Obtain commitments to participate from the relevant public

- Identify major issues and concerns

- Obtain public input

- Develop a strategy for on-going public involvement

- Approve work plans

The Stage II public involvement was designed to:

- Further identify and define study area problems and needs

- Obtain pertinent reports, data, and other information necessary for the conduct of the study

- Identify other on-going activities and their relevance to the study

- Develop evaluation methodology and criteria

- Assist in plan formulation

- Screen and select alternatives for final analysis

The Stage III public involvement effort was designed to:

- Assist in plan formulation
- Refine the evaluation criteria
- Evaluate the impacts of the alternatives
- Select the final plans

208 PUBLIC INVOLVEMENT

One of the major requirements of the Water Pollution Control Act Amendments is that the public play a key decision-making role in all water pollution control activities at federal, state and local levels. The 208 planning program included a comprehensive public involvement effort, fully integrated with the planning process throughout. The fundamental purpose of the 208 program was to develop solutions to water resource problems which conform to the desires and best interests of the general public. It was not the intent of the public participation program to "sell" the public on programs that were contrary to their desires, but rather to determine what their desires were and develop solutions that met them. Such an approach created a plan sensitive to local needs and values and build support throughout the planning process for implementation of the final 208 plan.

To meet the objectives of the public participation program, various types of activities were conducted and public involvement techniques were utilized throughout the program, namely:

- Establishment of an advisory group structure
- Establishment of a 208 review process
- Public meetings
- Public workshops
- Brochures
- Newsletters
- Speakers
- Media coverage
- Field trips

Advisory Group Structure

As an initial step in developing the 208 public participation program, an advisory group structure was established to assist the 208 staff in plan development. These advisory groups reviewed and commented on program out-

puts in the areas of point sources, nonpoint sources and management, and made recommendations on elements of alternative plans. Specialized groups were created, representing a broad spectrum of public interests. The groups are described below:

Technical Advisory Group: The Technical Advisory Group (TAG) comprised representatives, primarily of various local, state and federal governmental agencies, selected by MAG and the Corps staff to provide adequate technical expertise in the areas of concern. The TAG not only provided insight into past, present and future facility planning, but also assisted in development of reuse options, point and nonpoint source alternatives, and implementation plans.

Agricultural Advisory Group: The Agricultural Advisory Group (AAG) consisted of representatives from irrigation districts, government and agricultural associations. Membership was selected with the assistance of the Soil Conservation Service.

The AAG evaluated technical issues related to the agricultural community and provided insight into the goals of the agricultural community. The AAG also provided background information and acted as liaison between the 208 planning program and the agricultural community.

Citizens Advisory Group: The Citizens Advisory Group (CAG) was formed to provide a forum for interested individuals to voice opinions on subjects addressed in the 208 program. The CAG was responsible for reviewing the planning process, evaluating the needs of the public and the acceptability of the 208 plan by the public, and assisting with efforts for the implementation of the plan. A cross-section of interested organizations was invited to designate representatives for the Citizen Advisory Group.

Management Subcommittee: This is a subcommittee of the existing MAG Management Committee composed of local city and town managers. The subcommittee was established to assist in the development of the proposed management alternatives and provide guidance on water quality issues of special interest to local governments.

208 Executive Committee: The 208 Executive Committee is a policy advisory body with direct access to the MAG Regional Council. The Executive Committee provides a mechanism for presentation of views on water quality management planning that represents a regional rather than a local or special technical viewpoint.

208 Review Process

An important step in development of the public involvement program was to identify the critical points in development of the final elements of the 208 plan and establish the necessary review process to make the critical decisions.

In the 208 program, review occurred at local, state and federal levels. At the local level, the review process consisted of three inter-related

components: advisory group review, public review, and jurisdictional review.

Formal public review of the 208 plan elements was facilitated by five public meetings held at the major decision points in the 208 planning process. Other less formal methods employed to elicit public review of plan elements were brochures, flyers, questionnaires, exhibits, and newsletters. Staff presentations before community groups and on radio and television were designed to solicit public interest and comment.

Regarding jurisdictional review, at key points in the program, presentations were made to the 19 city and town councils, the County Board of Supervisors, Indian communities, Air Force bases, sanitary districts, and unincorporated communities such as Sun City and Litchfield Park. Each jurisdiction had an opportunity to directly participate in plan development and to review and indicate their preferences regarding plan elements prior to decisions by the MAG Regional Council.

Following local review and adoption, the 208 plan has been reviewed and approved by the State and EPA. The Office of Economic Planning and Development (OEPAD), as the State's 208 planning agency, will review the planning process and outputs to assure overall coordination of the regional plans with the state plan. Ensuring mutual cooperation between agencies in the 208 program is also part of the OEPAD function. Also at the state level, the Water Quality Control Council (a legislatively established body) reviews the 208 plans for approval and recommends endorsement of the plans to EPA by the Governor.

On the federal level, EPA and the Corps of Engineers were involved in extensive review of the planning elements to insure technical adequacy and compliance with Corps and EPA planning guidance. EPA makes the final review of the plan elements and approves the final 208 plan.

Work Plans: Over and above meeting technical requirements, the final plan had to be acceptable to the local communities, implementable, and serve as a basis for future planning. These requirements are demanding and in order to meet them, a well thought out program had to be developed. The first efforts, therefore, in the 208 program were to develop work plans for conducting the various elements of the overall program.

Even prior to formal initiation of the 208 program, the first effort in this area was preparation of the Plan of Study for the Corps' Phoenix Urban Study. Extensive agency coordination and public involvement activities were an integral part of this process. As early as 1973, meetings were held with state and federal agencies, cities, and Indian communities to discuss and identify problems and needs relative to water resources, interface between elements of the Urban Study and other on-going planning efforts, and provide data for development of the Plan of Study.

Following initiation of the 208 program in late 1976, detailed work plans were developed for the Metro study (Corps), Nonmetro study (County), and an overall work plan for the 208 program (MAG). In developing the work plan

for the Metro program, initial efforts took the form of numerous area meetings held to discuss the project, local problems and programs and information requirements and procedures. Meetings were held with:

- Office of Economic Planning and Development
- Arizona Department of Health Services
- Arizona Water Commission
- Maricopa County Health Department
- Maricopa Association of Governments
- MAG Transportation and Planning Office
- Cities and towns in the study area
- Air Force bases
- Indian communities

The information obtained was used to develop a draft work plan which was presented to local agencies, the Technical Advisory Group and the Agricultural Advisory Group (CAG had not as yet been formed) for review and comment. In conjunction with this effort, a workshop was held in early August 1976 with contractors, and city, state and county officials for review and comment on the various work plans for the Corps' portion of the 208 program. Results were incorporated into the final work plans which were presented for review and approved by the 208 Executive Committee in September 1976.

Population Projections and Distributions: On August 3, 1977, the governor designated the Department of Economic Security (DES) as the official population projecting and estimating agency for the State of Arizona. For each county, a control total was developed and within each county this was broken down between cities, towns, and unincorporatead areas. In Maricopa County, the Maricopa Association of Governments with the cooperation of the cities and towns assigned population totals to the various planning areas in the county.

A questionnaire was sent to each city and town manager to elicit the local perception of where growth is likely to occur. Each manager responded and the MAG staff totaled the population figures. The total exceeded the 2.3 million control total set by DES. The managers decided to meet and work out the differences in the totals. On August 17, 1977, the Management Committee discussed the population projections for each planning area and came to a consensus on how the population would be distributed. On November 7, 1977 the Management Committee adopted the population projections.

Flow Reduction: The projected sewage flows to the wastewater treatment plants are based on population projections and anticipated changes in water

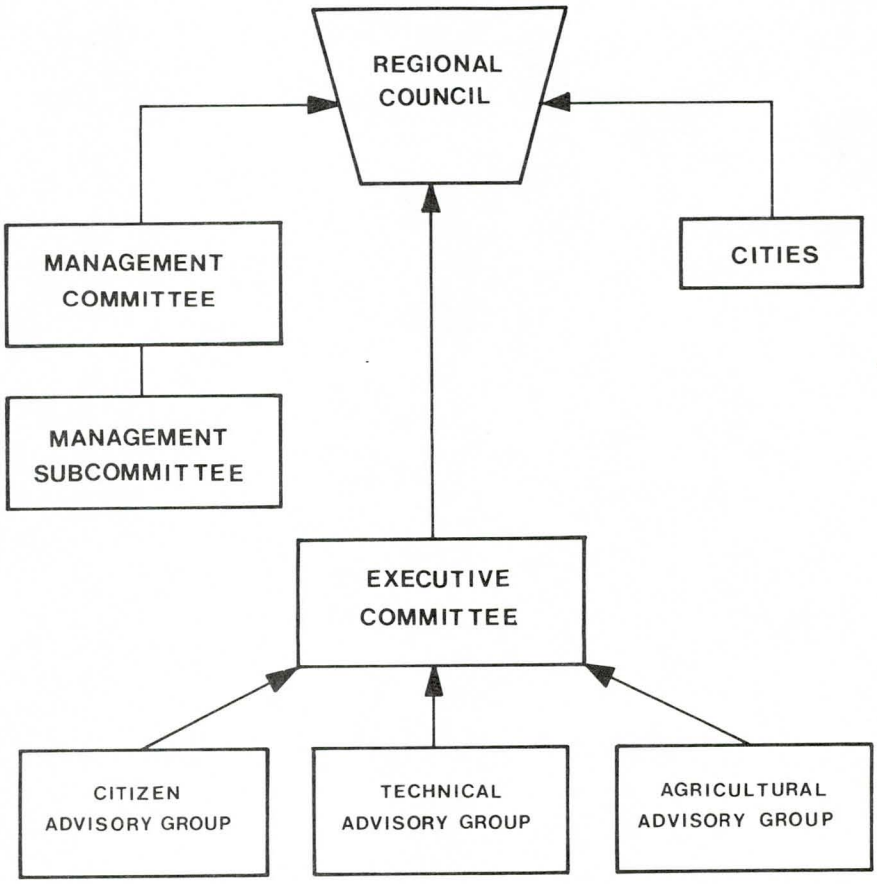



**Figure IV-1**
**208 REVIEW PROCESS**

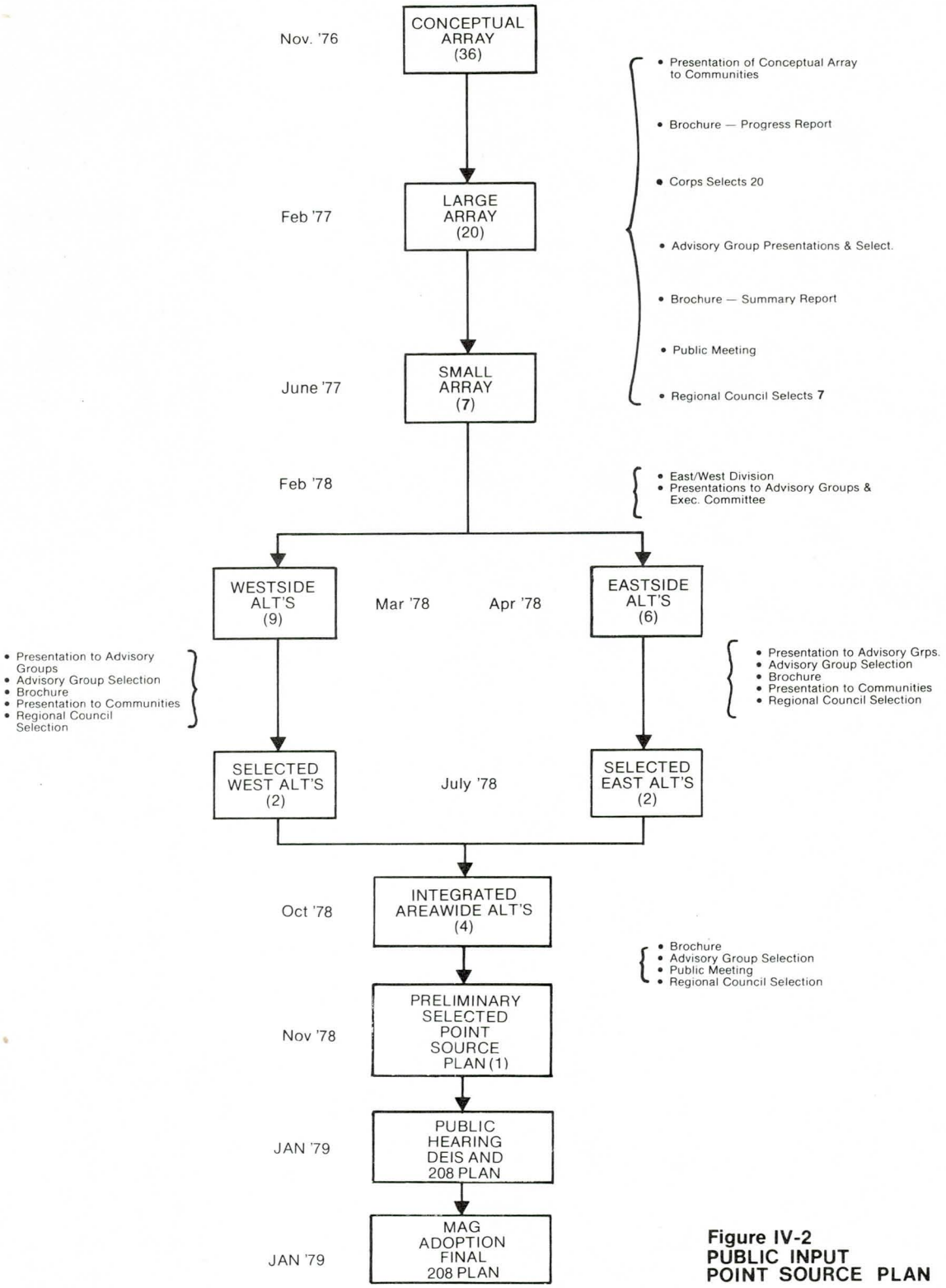



**Figure IV-2**
**PUBLIC INPUT**
**POINT SOURCE PLAN**

consumption. As part of the 208 program, a study was conducted to identify methods of reducing waste flows and determine their applicability to the MAG 208 planning area. The initial effort of this study was preparation of a "Compendium of Nonstructural Flow and Wasteload Reduction Measures" (December 1976) which was presented to the advisory groups. All agreed flow reduction was feasible.

Other efforts in this study included:

- o April 1977 — Brochure issued - water and energy-saving tips; published in conjunction with the City of Scottsdale.
- o May 7, 1977 — Newspaper article, Scottsdale Daily Progress, discussing brochure and program efforts in the area of flow reduction and water conservation.
- o June 1977 — Workshop on water conservation held by City of Scottsdale for the general public.

About this time, Presidential statements on water conservation goals were released and EPA encouraged reducing flows to treatment plants by 15 percent. Efforts of the 208 program were directed toward determining the percentage reduction for the 208 planning area. Working with the Central Arizona Home Builders Association, public works directors, and city managers, a flow reduction of 4 percent for existing homes and 15 percent for new homes was agreed upon and included in all future flows figures.

To implement the reduction in sewage flows a program was initiated by MAG to make the public aware of reducing wastewater. A publicity campaign began on November 1, 1978 with a press conference. Each mayor issued a statement of support for the program, "Watch Our Wastewater" (WOW). News releases, radio and television spots as well as brochures and billboards and bill stuffers publicized the WOW campaign.

Meetings were held with the intergovernmental coordinators from each community and the managers to develop the goals for the program.

Evaluation Methodology and Criteria: Another area where public participation was solicited through the advisory group structure was evaluation methodology and criteria. During the course of developing the final 208 plan, numerous evaluations and selections were made by the advisory groups, committees and City and Town Councils. A key step in this process was development and approval of an acceptable method of evaluating alternatives and establishing criteria to be used in the evaluations.

The area meetings with local agency personnel, cities, Air Force bases and Indian communities provided valuable input for developing the set of evaluation criteria used in the initial alternative screenings. Presentations were made to the advisory groups for review and comment. The results of these advisory group meetings were used to modify and revise the criteria.

These criteria were used to reduce the large array of 20 alternatives to a small array of six, as described later in this chapter.

Input was again obtained in the form of advisory groups review at the subregional evaluation level. When the metro area was split into the east and west sides for detailed analysis, different items were examined and different criteria developed. This process and criteria were developed by the consultants and presented to the advisory groups in February 1978. Based on their review and comments, the evaluation methodology and criteria were revised and presented again to the advisory groups and to the Management Subcommittee and the 208 Executive Committee.

Screening and Selection of Point Source Alternatives: One area of intensive public input and review was the screening and selection of alter natives for the point source alternatives of the 208 program. Formal review and approval of alternatives occurred at the advisory group, jurisdictional and general public levels. This effort was coordinated with public presentations, brochures, workshops and public hearings and meetings.

The first alternatives developed (36) by the Corps were conceptual in nature. The selection of a more manageable number of alternatives was made by the Corps based strictly on technical feasibility, cost and reuse potential. While no formal advisory group selection was made, presentations were made to the study area cities and towns and agencies involved to obtain input and assure that, in selecting the alternatives, no viable options would be eliminated from further consideration.

The next major decision point came after the merging of the 208 activities in the metro area and subsequent division of the metro area into the eastside and westside. Although most of the decisions involved were made internally, the process, background information and other data pertinent to the division were documented in presentations to the advisory groups.

Following development and detailed analysis of "subregional" alternatives for the westside by the City of Phoenix, and the eastside by the Corps of Engineers they were presented to the advisory groups in March 1978 for review and comment. Advisory group selections of preferred alternatives were made in June and forwarded to the Regional Council for final selection in early July.

One major decision now remained: selection of the final point source plan. The selected east and west alternatives were integrated again into areawide alternatives. This integration was the result of another round of discussions with the various communities to better define needs and identify specific problem. Four integrated final point source alternatives were presented for review and selection of one final plan.

Identification and evaluation of options for reusing effluent was carried out throughout the development of the final wastewater collection and treatment alternative for the metro area. Numerous discussions with cities and towns, Indian communities and others involved in potential reuse options were held. Results of these meetings were incorporated into evaluation of the options.

Management System Development: Initial efforts to involve the public in development of a management system to implement the point source plan took the form of extensive interviews, discussions and meetings with local officials, state and federal agencies, private sewer companies and interested general public to discuss management of the present wastewater system and other management issues and to assess the existing system.

Nonpoint Source Assessment

The agricultural community was targeted to be the most affected by the nonpoint source plan and therefore was the focus of the public involvement effort.

Meetings were held with various nonpoint source agency staffs to discuss some of the problems with nonpoint sources. Workshops were held with the advisory groups to explain the existing groundwater quality in the county. Individual members of the agricultural community as well as individuals representing landfills, feedlots and dairies were asked to review all technical reports on groundwater quality and nonpoint sources of pollution. Revisions of the reports were made as necessary.

Public Information/Communications Techniques

Throughout the 208 program, a continuous effort was made to both stimulate public awareness and inform the public. The efforts were for the most part coordinated with final plan development and others were strictly for public education and information purposes.

Information depositories were located in over 50 public libraries and other appropriate public locations, including:

Hayden Library
Arizona State University

State Capitol
Phoenix, Arizona

MAG 208 Program Office
Phoenix, Arizona

Phoenix Urban Study Office
Phoenix, Arizona

Local Libraries

Information available at these locations included:

Technical Reports

Brochures

Newsletters

A mailing list was also compiled and periodically updated. The list comprised over 2000 names from agencies, government, and the general public.

An important element of the public information program was the creation of a newsletter, "Clean Water". Five newsletters were published during the 208 planning process and sent to the entire mailing list. This newsletter kept the public informed of activities and discussed issues pertinent to wastewater planning in the area.

Other informational techniques used included special meeting announcements and new bulletins, flyers, brochures, presentations to community groups and organizations, and newspaper, television and radio coverage.

Television coverage involved public service announcements (PSA) of public meetings and workshops, TV coverage of public meetings, and news interviews.

Public service announcements of meetings were carried on radio stations as well, including two Spanish language stations.

Public workshops were held at critical phases in the 208 program. A major effort in the area was a series of public meetings and hearings and production of informational materials as part of 208 program assistance in the State review of Arizona Water Quality Standards.

Results of this public involvement program in water quality standards are being integrated into the State standards review and revision process which will be complete in 1979.

Other public workshops were held on groundwater quality, point source alternatives, land treatment processes, and management alternatives as previously described in this chapter.

In addition to public workshops, several field trips were sponsored by MAG and the Corps for elected officials, City and Town Managers, and advisory groups to visit existing wastewater treatment plants, reuse sites, land treatement systems, and proposed wastewater treatment plant locations. These were coordinated with presentations to elected officials and community groups.

Flood Control Public Involvement

Public involvement for flood control began with two workshops held in Glendale and Maryvale in May, 1976. Initial public involvement for the flood control portion of the Phoenix Urban Study also involved presentations to

the Citizen's Advisory Board of the Flood Control District of Maricopa County. Although this group's activities were limited, the Citizen's Advisory Board did provide the Urban Study with valuable expertise and public input regarding flood control solutions. As potential projects demonstrated a lack of justification, the need for a formal public involvement program diminished greatly.

Public participation flood control efforts intensified toward the completion of the Urban Study. This occurred as a result of the assistance rendered by Urban Study personnel in Stage I planning for the Bureau Of Reclamation's Central Arizona Water Control Study, presently being conducted by the Corps of Engineers and Bureau of Reclamation.

Stage I public involvement of the Central Arizona Water Control Study had the following objectives:

- to provide an understanding of public perceptions, preferences, concerns and ideas regarding flood control and CAP storage
- to identify other planning efforts and evaluate their relevance to the study
- to identify problems and needs related to flood control in the study area
- to assemble a variety of viable alternatives for further consideration

Interagency Task Force on Orme Dam Alternatives

Based on the responses to the Orme Dam Draft Environmental Statement, published in 1976, the Bureau reassessed alternatives to Orme Dam. The Interagency Task Force on Orme Dam Alternatives was formed in April 1977 to identify and evaluate single-purpose alternatives for CAP regulation and flood control. The Task Force consisted of individuals with varying viewpoints and backgrounds. Urban Study personnel were active in the Interagency Task Force. A Technical Work Group was organized, which in turn was divided into Flood Control, Regulatory, and Environmental/Socioeconomic Subcommittees. On May 5, 1978, the Task Force submitted a final report which stated that a consensus recommendation could not be made because of the complexity of the issues involved, a shortage of time and resources, and the divergent opinions of the Task Force members.

The Community Advisory Board

In 1978, Governor Babbitt organized the Community Advisory Board, Salt-Gila Flood Control and CAP Regulatory Storage Study, to review and advise on the identification and selection of a viable alternative for flood control and CAP regulatory storage. Composed of community leaders representing a wide range of constituencies and interests, the Board meets monthly to receive information regarding the Study (later the Central Arizona Water Control Study)

## Public Meetings

A brochure entitled "You and Central Arizona's Water Future" was published by the Bureau of Reclamation in January 1979 to announce a series of public meetings in the study area. The brochure summarized the alternatives under study and the issues involved and described the study process. A map of the study area showing the alternative sites was included. Three thousand brochures were distributed widely to the public and placed in depositories for reference. A self-addressed postage paid response card was sent with the brochure to give the public an opportunity to comment if they were unable to attend the public meetings. Names of respondents were added to the study mailing list to receive future material.

News releases were sent to the media along with 20-second public service announcements for radio and television to inform the public of the series of meetings. All meetings were well covered by the media and KCMR radio recorded the meetings in full for later rebroadcast. The proceedings of each meeting were transcribed and made available on request.

Three public meetings on the Study of Alternatives For Salt-Gila Flood Control and Regulation of Central Arizona Project Waters were held at: the Buckeye High School Auditorium, January 30, 1979, 7:00 p.m., with 188 persons filling out attendance cards; the Maricopa County Supervisor's Auditorium, Phoenix, January 31, 1979, 10:00 a.m., with 57 persons filling out attendance cards; and the Centennial Building, Mesa, January 31, 1979, 7:00 p.m., with 52 persons filling out attendance cards. The first meeting was chaired by the Mayor of Buckeye, the Field Solicitor for the Department of the Interior in Phoenix, chaired the second meeting, and the Mayor of Mesa, moderated at the third meeting. Representatives of the Bureau and Corps also were present at all three meetings.

Each of these meetings began with slide presentations describing the issues of Salt-Gila flood control and regulation of CAP waters and briefly summarized the alternatives under study by the Bureau with the assistance of the Corps. The Study process and schedule which the Bureau and Corps will follow also were discussed. A public information brochure was distributed. The meetings were then open to public question and statements. The representatives of the Bureau and Corps made responses to these questions and comments whenever appropriate.

## Public Review and Comment

Numerous comments and suggestions were received by the Bureau and Corps in addition to the statements made at the public meetings. Several letters and telephone calls were received in response to the brochure, "You and Central Arizona's Water Future". A number of comments were included on the mailback postcards. Letters containing suggestions and points of view were received as a result of newspaper articles and television coverage of the flood events. Letters written to the newspaper editors often contained information relevant to this Study. Many specific public comments on the Bureau Of Reclamation's PLAN OF STUDY were provided by members of the Technical Agency Group and the Community Advisory Board. These groups were furnished

early drafts of this report so that their ideas and comments could be incorporated into the final report.

Water Conservation Public Involvement

Public involvement for the water conservation portion of the Phoenix Urban Study had the following objectives:

- o definition of problems and needs related to water conservation
- o identification of studies completed or currently in progress that relate to water conservation
- o obtaining public and institutional input

Public involvement for the Water Conservation portion of the study began with the formation in Stage I of a Water Conservation Subcommittee. Activities of this group, however, were minimal, and once the Water Conservation portion of the Urban Study became project oriented the public involvement shifted to the individual projects.

Because of the highly technical nature of the subject and lack of available information during the investigation of the possibility of accomplishing water conservation through artificial groundwater recharge, public involvement was limited to meetings, discussions, and interviews with representatives of concerned federal, state, and local agencies, Indian communites, water users groups, and civic organizations. Much of this activity was of an informal nature and designed to assess existing technical information, identify data deficiencies, and determine general attitudes and interests.

Public involvement in the New River diversion measure consisted of contacts with federal, state and local flood control agencies and water conservation districts to explain the project and receive technical input. Meetings were held with residents of the project area which also presented explanations of the project and solicited public comments.

CONCLUSION

In April 1981, the Draft Summary Report and Technical Appendix of the Phoenix Urban Study were circulated to appropriate Federal agencies and through the A-95 Clearinghouse process to state, county and local agencies for review. Few of these agencies chose to respond. Those comments received and appropriate responses have been included in the Comments Appendix to the Final Report.

# CHAPTER V

# WATER QUALITY PROGRAM

## 208 POINT SOURCE PLAN

The objective of the point source planning was to identify the preferred wastewater collection and treatment system for the study area. The planning effort involved looking at many factors and alternatives, all of which had an impact on selection of the final plan:

- Existing System
- Wastewater Flows
- Wastewater Reuse
- Land Treatment
- Sludge Management
- Alternative Plan Development and Evaluation

This chapter summarizes the work effort in the 208 point source planning portion of the Phoenix Urban Study.

### INVENTORY OF EXISTING SYSTEM

An initial inventory of existing systems was completed as part of the Urban Study Work Plan. Following is a brief description of the situation in the existing system at the start of the Phoenix Urban Study: (See Figure V-1)

Avondale: The existing plant uses an aerated lagoon process and has a rated capacity of 1.0 mgd. Discharge is to the Agua Fria River. Projected growth for the Avondale/Goodyear area indicates that additional treatment and interceptor capacity will be required by the early 1980's.

At present, the plant which is to a large extent obsolete, cannot meet National Pollution Discharge Elimination System (NPDES) permit requirements for discharge to the Agua Fria River. The plant is subject to flooding and in the 1978 floods it was badly damaged by flood waters. Interim holding/percolation ponds have been built, but these are considered only a temporary solution.

Buckeye: The community of Buckeye, located in the extreme southwest portion of the metro area, operates and maintains its own water and sewer systems. The existing sewage treatment system in Buckeye consists of two oxidation ponds, which operate in series and discharge to the Arlington Canal. Effluent is taken up from the canal for agricultural irrigation. The capacity of the Buckeye system is 0.6 mgd, and population projections indicate that capacity of an additional 0.1 mgd will be required by the year 2000.

The plant generally meets NPDES permit requirements of 30 mg/l Biochemical Oxygen Demand (BOD) and 90mg/l suspended solids (SS). A chlorination system was under construction at the time of December 1978 floods and was badly damaged by floodwaters. When this system is completed, coliform requirements of the permit will also be met.

Carefree/Cave Creek: At present, two small privately-owned treatment plants with a combined capacity of 0.14 mgd serve the communities of Carefree and Cave Creek. The plants operate as extended aeration units with oxidation ponds that discharge to golf course irrigation ponds. One plant has a capacity of 0.12 mgd and serves the downtown Carefree and Boulders areas.

The other small plant has a capacity of 0.015 mgd and serves a residential development. By the year 2000, Carefree is projected to have a population of 5,400, requiring a treatment capacity of 0.5 mgd; Cave Creek is projected to have a population of 3,600 and flows of 0.3 mgd. To meet population growth, waste water treatment service will have to be expanded in the Carefree/Cave Creek area and an acceptable disposal/reuse option selected.

Chandler: The present Chandler plant uses an aerated lagoon system and has an NPDES capacity of 3.5 mgd. The treatment plant is operating well, but population growth will exceed plant capacity in the early 1980's. By the year 2000, the population in the Chandler area is projected to be 92,700, requiring treatment plant capacity of 8.2 mgd.

The plant is located on Gila River Indian Community lands. Effluent from the plant belongs to the Indian Community under an agreement between the Indians and the City of Chandler. Historically, the effluent has been discharged to the Gila Drain and taken up by a local farmer for use as irrigation water. In 1978, the farmer ceased using the effluent. Presently, the discharge enters the Drain and flows until it infiltrates and percolates into the stream bed. The agreement with the Gila Community does not include the right to discharge to the Gila Drain, and the Indian Community does not favor the continued use of Indian lands for Chandler's wastewater treatment plant. The quality of the effluent does not meet NPDES permit requirements for BOD and suspended solids of 30 mg/l. Existing interceptors will also be overloaded in the future.

Fountain Hills: The Fountain Hills Sanitary District operates a recently built (1974) modified activated sludge secondary treatment facility. The capacity of the facility is 0.5 mgd. Population for Fountain Hills is expected to reach 22,500 by the year 2000, requiring treatment capacity of 2.0 mgd. The plant has no discharge permit; effluent is reused for golf course irrigation.

Gilbert: The town of Gilbert operates a stabilization lagoon system with discharge to a local farming operation for restricted agricultural irrigation. The plant has a design capacity of about 0.5 mgd and is presently operating at or above capacity although no recent flow measurements are available.

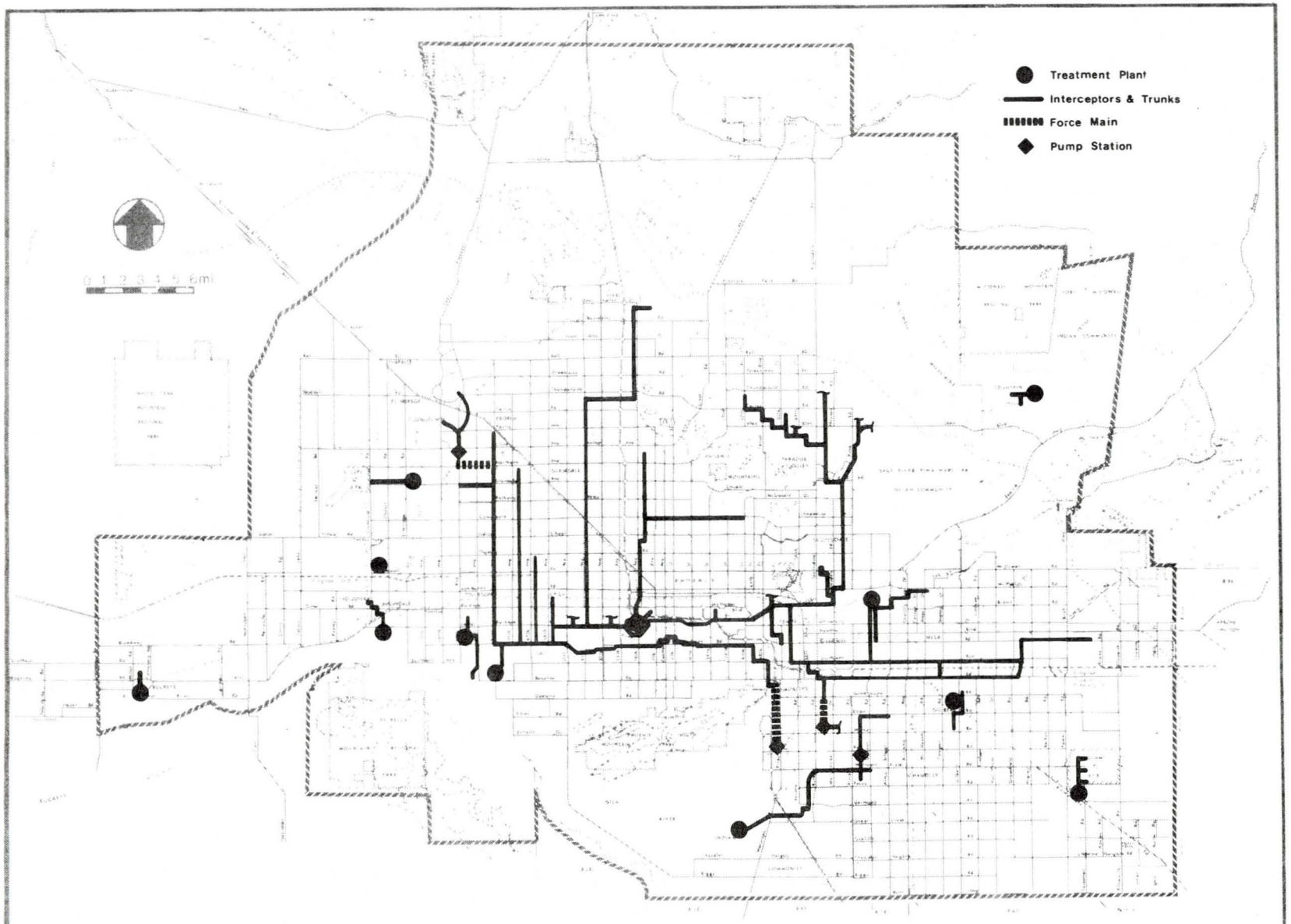



FIGURE V-1

EXISTING SEWER SYSTEM

The local farming operation will cease using effluent for irrigation in the future. Population growth in the area will require increased capacity. By the year 2000, population in the Gilbert area is expected to reach 45,500, requiring treatment of flows of 4.0 mgd.

Litchfield Park: Litchfield Park presently operates an aerated lagoon system with discharge to a land site. The plant is now at capacity (0.4 mgd) and the Litchfield Park Service Company plans to install a package plant for interim treatment of wastewaters.

Luke Air Force Base: The present trickling filter plant, built in 1942, cannot meet the NPDES permit requirements for discharge to the Agua Fria River. In addition, the Base has indicated a desire to phase out use of the plant if other treatment options are available.

Mesa: The present trickling filter plant, with a design capacity of 5.0 mgd, operates at 3.3 mgd in order to maintain effluent quality. Urban development has encroached upon the plant in recent years. The plant is scheduled to be closed down as soon as additional capacity is available at the 91st Avenue treatment plant.

Phoenix 91st Avenue Plant: The 91st Avenue plant is an activated sludge secondary treatment facility owned and operated by the City of Phoenix with a design capacity of 90 mgd. In addition, a 5 mgd trickling filter unit is on site, but is not in use. The plant's rated capacity is 84 mgd, and in 1978 the plant's average daily flow was 85.5 mgd. Plant facilities are in need of retrofitting and upgrading to meet current demands for treatment and to comply with NPDES permit requirements.

An NPDES permit inspection on April 18, 1978, indicated that plant equipment is obsolete and that major deficiencies are occuring because of equipment failure, poor equipment maintenance, and overloads due to rapid population growth and an increased service area. Effluent discharged to the Salt River exceeds permit requirements of average values of 30 mg/l BOD and 30 mg/l suspended solids. Average values for 91st Avenue effluent were 29 mg/l BOD and 49 mg/l suspended solids. Complaints also have been registered at the plant because of odors and the proliferation of insects.

In order to bring the 91st Avenue plant into better operating condition and to accommodate the current growth in the service area, immediate upgrading and retrofitting are required. Plans for the plant call for these actions to take place by 1981, with the plant capacity increased to 90 mgd by that time. The plant will also require disinfection facilities.

Future growth in the area will necessitate expanding the plant in the near future. Building moratoriums are being considered in Glendale, Tempe, Sun City and Peoria.

Phoenix 23rd Avenue Plant: The 23rd Avenue plant is an activated sludge secondary treatment facility owned and operated by the City of Phoenix with a design capacity of 40 mgd and a rated capacity of 31 mgd. In 1978, the average daily flow rate was 27.2 mgd. This plant, like the 91st Avenue plant, is operating with outdated equipment.

Effluent from the 23rd Avenue plant meets BOD and suspended solids NPDES permit requirements, according to data from the April 1, 1978, NPDES inspection report. Average values for 23rd Avenue effluent through 1978 were 18 mg/l BOD and 27 mg/l suspended solids. The NPDES permit for the 23rd Avenue plant requires that effluent contain average fecal coliform counts equal to or less than 200 per 100 ml. This will necessitate the addition of disinfection facilities by 1980.

Tolleson: The Tolleson plant is a trickling filter system that provides secondary treatment for flows up to 4.1 mgd. The plant is in excellent operating condition and effluent quality is well within NPDES requirements. The plant's permit allows discharge of up to 4.1 mgd of effluent to a channel that leads to the Salt River. Effluent, however, is currently being used as needed for commercial sod growing near the plant site. Flows from Peoria and increased flows from Tolleson would require expansion of the plant to reach a capacity of 7.2 mgd by the year 2000. Population serviced in the year 2000 would be approximately 80,000 for the two communities.

Williams Air Force Base: Williams AFB presently operates a trickling filter secondary treatment system with a capacity of 1.0 mgd. Effluent is presently reused for golf course irrigation on the base during most of the year. Excess effluent which can not be utilized on the golf course overflows to an adjacent private farm where it is reused for restricted agricultural irrigation. If all effluent produced can not be utilized on the golf course or the farm it discharges to an irrigation canal used by the Roosevelt Water District. Until August, 1978, NPDES permit requirements of 30 mg/l BOD and 30 mg/l suspended solids were met by the treatment facility. However, EPA changed the requirements to 10 mg/l BOD and 10 mg/l suspended solids because waters in the irrigation canal are used at a downstream location for unrestricted agriculture. Future flows at the base will not require expansion of the facility, but a solution to the problem of not meeting NPDES requirements will need to be developed. Williams AFB is presently considering expansion of the golf course which will utilize all effluent which is produced.

Multi-City Collection System: Some existing interceptors will be overloaded in the near future and some areas of the city need additional sewer capacity to get to the 91st Avenue Plant. Interceptors are needed in the northwest area for Glendale, Sun City and Surprise, South Phoenix, Tempe, Mesa and Scottsdale.

## WASTEWATER FLOWS

### Flow Reduction

One of the earliest tasks in developing a point source plan was to look at ways to reduce the volume of flow to area wastewater treatment plants. Upon examination, it was found that theoretically flows in new homes could be reduced by 50 percent and in old homes by 15 percent through the use of low flow showerheads, low flush toilets, and more efficient appliances.

Table V-1

NONSTRUCTURAL FLOW AND WASTELOAD REDUCTION MEASURES

| Category | Control Measure | Estimated % Reduction in Waste Flow (1) | Incremental Unit Cost Benefits (2) | Incremental Unit Benefits (2) | Major Advantages | Major Disadvantages |
|---|---|---|---|---|---|---|
| Reduction of Storm water inflow | Reduces ponding over manhole covers | Varies with precipitation | $50-$100/ manhole | None | Reduces hydraulic load to STP | Poor ventilation in sewers |
| | Prohibit new drainage connections | Varies with amout of new construction | $1.80 (4) | None | Reduces hydraulic load to STP | May cause drainage problems |
| | Remove existing drainage connections | Varies w/amount of existing connections | Varies | None | Reduces hydraulic load to STP | Difficult to enforce |
| Water-Conserving facilities | Water Saving toilet | 9% | $10/toilet | $0.90/mo. | Easy to purchase | Expensive to replace existing toilet |
| | Dual-flush toilets | 21% | Negligible | $2.10/mo. | Reduces flush volume | Not readily available |
| | Vacum Toilet | 27% | $100/toilet | $2.70/mo. | Major reduction | Expensive in water use |
| | Reduced-flush | 12% | $0 to $14 | $1.20/mo. | Easy to install | Inconsistent effectiveness |
| | Flow-limiting showerheads | 12% | $5 | $4.00/mo. | Easy to install | No obvious disadvantages |
| | Flow-limiting faucets (Kitchen/bath) | 2% | $5 | $0.55/mo. | Minimizes water use | Requires skilled installation |
| | Faucet aerators | 2% | $2 | $0.32/mo. | Easy to install | No obvious dissadvantage |

Table V-1 (Cont.)

NONSTRUCTURAL FLOW AND WASTELOAD REDUCTION MEASURES

| Category | Control Measure | Estimated % Reduction in Waste Flow (1) | Incremental Unit Cost Benefits (2) | Incremental Unit Benefits (2) | Major Advantages | Major Disadvantages |
|---|---|---|---|---|---|---|
| | Pressure reducing valves | 5% | $25 | $1.70/mo. | Reduces excessive household pressure | Should not be used in older homes |
| | Insulation of hot water pipes | 4% | $1.00/ lineal ft. | $1.40/mo. | Water & energy savings | Primarily for new homes |
| | Water-saving clothes washer | 6% | $25 | $2.00/mo. | Water & energy savings | Expensive to replace existing machine |
| | Water-saving dishwasher | 4% | Varies | $1.20/mo. | Water & energy savings | Expensive to replace existing machine |
| | Premixed water systems | 8% | $100 | $2.70/mo. | Water & energy savings | Expensive |
| | Repair of faucet and toilet leaks | Varies | Varies | Up to $5/mo. | Water savings can be substantial | Expensive if plumber required |
| | Washwater recyle systems | 30% | $640 for prototype | $3.00/mo. | Major reduction in wastewater flow | System needs refinement |
| Incentives for water conservation | Installation of water meters | 25% | Meters cost $400/tap | $4.00/mo. | Encourages water conservation | High cost of meters |
| | Pricing systems | 10% for 50% increase in water rates | Varies | $2.60/mo (6) | Incentive for water conservation | Consumer objection |

Table V-1 (Cont.)

NONSTRUCTURAL FLOW AND WASTELOAD REDUCTION MEASURES

| Category | Control Measure | Estimated % Reduction in Waste Flow (1) | Incremental Unit Cost Benefits (2) | Incremental Unit Benefits (2) | Major Advantages | Major Disadvantages |
|---|---|---|---|---|---|---|
| | Industrial sewer meters | (3) | $4,000/tap typical | Varies with industry | Encourages wastewater reuse | High cost of meters |
| | Public education for water conser- | Varies with method chosen | $1.14/mo. | | Encourages voluntary water conservation | Requires coordinated efforts |
| Waste load reduction measures | Restrictions on home garbage disposals | 21% reduction in suspended solids | $3.00/mo. | $0.40/mo. | Reduces pollutant load to STP | Increases solid waste |
| | Prohibiting use of phospate detergents | 50% reduction in phosphorus | None | None | Reduces required chemicals for STP | No obvious disadvantages |
| | Restricting biotoxic products | 15-20% reduction in biotoxic wastes | $1.20(4) | None | Improves conditions for aquatic life | Adequate substitutes not always available |

(1) Estimated percent reduction in household wastewater flows resulting from implementation of the control measure.
(2) The estimated additional cost per unit associated with implementing the control measure.
(3) The actual waste flow reduction would vary depending on the industry.
(4) Prorated administrative cost per household.
(5) Computed as the estimated monthly savings per household in water and energy costs that would occur if the control measue were to be implemented.
(6) Does not reflect a rate increase which would probablly have to occur in order to encourage water conservation.

Table V-2

PROJECTED FLOWS

| Service Area | Projected Average Flows (mgd) 1980 | 1985 | 1990 | 1995 | 2000 |
|---|---|---|---|---|---|
| Avondale | 0.7 | 0.9 | 1.5 | 2.1 | 2.8 |
| Buckeye | 0.3 | 0.4 | 0.5 | 0.6 | 0.7 |
| Carefree-Cave Creek | 0.3 | 0.4 | 0.5 | 0.7 | 0.8 |
| Chandler | 3.0 | 4.0 | 5.4 | 6.8 | 8.2 |
| El Mirage | 0.4 | 0.5 | 0.5 | 0.5 | 0.6 |
| Fountain Hills | 0.5 | 0.7 | 0.9 | 1.3 | 2.0 |
| Gilbert | 1.0 | 1.3 | 2.2 | 3.1 | 4.0 |
| Glendale | 8.6 | 10.0 | 11.5 | 12.9 | 14.5 |
| Goodyear | 0.3 | 0.4 | 0.7 | 1.1 | 1.4 |
| Guadalupe | 0.5 | 0.5 | 0.6 | 0.6 | 0.7 |
| Litchfield Park | 0.3 | 0.3 | 0.7 | 0.9 | 1.3 |
| Luke AFB | 1.5 | 1.5 | 1.5 | 1.5 | 1.4 |
| Mesa | 13.9 | 15.7 | 17.2 | 18.9 | 20.7 |
| Paradise Valley | 1.4 | 1.5 | 1.5 | 1.5 | 1.7 |
| Peoria | 1.8 | 2.0 | 3.1 | 4.2 | 5.4 |
| Phoenix | 75.9 | 80.4 | 86.0 | 91.7 | 98.7 |
| Scottsdale | 8.9 | 9.5 | 9.8 | 10.0 | 10.5 |
| Sun City | 2.8 | 3.2 | 3.2 | 3.2 | 3.2 |
| Sun City West | 0.4 | 0.9 | 1.5 | 2.0 | 2.6 |
| Sun Lakes | 0.2 | 0.3 | 0.4 | 0.5 | 0.7 |
| Surprise | 0.4 | 0.4 | 0.5 | 0.5 | 0.6 |
| Tempe | 12.7 | 15.9 | 17.5 | 19.2 | 21.1 |
| Tolleson | 0.5 | 0.5 | 0.9 | 1.4 | 1.8 |
| Williams AFB | 1.0 | 1.0 | 1.0 | 1.0 | 1.0 |
| Youngtown | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 |
| TOTAL | 137.4 | 152.3 | 169.2 | 186.3 | 206.5 |

Based on these findings, a recommendation was made for a 25 percent reduction in new homes and 4 percent in existing homes. The various advisory groups studied this question quite extensively and eventually agreed upon a 15 percent reduction in flows from new homes and a 4 percent reduction in flows from existing homes. To ensure that the reductions are implemented, MAG has initiated a wastewater flow reduction program (Watch Our Wastewater) for the area.

The flow reduction program is estimated to reduce the year 2000 flows by about 10 percent. This means interceptors and treatment plants will be smaller and therefore will result in an overall reduction in capital costs. Operation and maintenance costs would also be slightly reduced, but to a lesser degree since many of these costs are fixed. Some savings also could be experienced in the water supply systems.

Future Flows

Based upon agreed upon populations and the flow reductions, the projected flows for the communities in the study area are shown in Table V-2.

LAND TREATMENT

Land treatment is a method of treating wastewater by using soil and crops as a filtering and cleansing mechanism. The Urban Study examined land treatment as an alternative to conventional treatment processes and as a means of providing higher quality of effluent before disposal or reuse. A number of separate sites and three different land treatment techniques, overland flow, inflitration/percolation, and irrigation, were investigated. Review by advisory groups determined that for environmental, socioeconomic, and groundwater reasons, most of the land treatment options should be abandoned. At the time the final areawide plans were being evaluated, only seven land treatment alternatives were still viable: Chandler, Gilbert, Williams AFB, 23rd Ave., 91st Ave., Northeast Scottsdale, and Reems Road. During the final selection process, however, MAG planners and the advisory groups preferred conventional treatment alternatives. This decision was based on capital and annual costs for:

- Treatment facilities
- Transmission systems
- Site clearing
- Distribution systems
- Recovery systems
- Service roads
- Fencing

The effect of land treatment on groundwater quality, particularly at the Northeast Scottsdale site, was viewed as a potential problem. This influenced the decision to eliminate the Northeast Scottsdale site with its land treatment option. It was also determined that adoption of land treatment would require pilot projects, thereby adding considerable cost and time to the implementation of the final 208 Areawide Water Quality Plan.

Results of recent studies by the Corps of Engineers, however, have shown land treatment to be a cost effective wasetwater renovation process which poses no greater health or environmental hazard than any conventional treatment method. Land treatment will receive further examination as part of 201 facilities planning for the Phoenix metropolitan area.

SLUDGE MANAGEMENT

Treatment of wastewater in an activated sludge process produces large volumes of waste sludge which must be treated and disposed of in some accep-

table way. The City of Phoenix presently has a contract to sell its sludge from the 91st and 23rd Avenue plants. Unfortunately, no sludge is being removed; it is being stored at the plants. A task, therefore, in the study was to look at alternative sludge treatment and disposal options.

Centralized and local sludge treatment were investigated and it was determined to be economical for sludge to be handled locally, unless there were some overriding local conditions which would prohibit local treatment. The study also looked at alternative disposal options including incineration, land spreading and sanitary landfill. Incineration was ruled out because of its impact on air quality. Land spreading was deemed practical for the area, but serious questions remain as to the impact of heavy metals, such as nickel and cadmium, on the soils and groundwater. A high nitrogen content in digested sludge from the 91st Avenue plant may also be a limiting factor.

Industrial pretreatment requirements may reduce the concentration of the metals in the sludge, but until that takes place, disposal in landfills was selected as the disposal alternative for cost estimating purposes.

Proposed plants in the area will be aerated lagoon systems which do not produce sludge in large quantities, and the Tolleson plant which presently uses its sludge for soil conditioning. The City of Phoenix, as part of its ongoing 201 study, is looking at sludge handling and disposal at the 91st and 23rd Avenue treatment plants. Pilot studies may be required to determine the exact impact of metals on land spreading. The final decision regarding the sludge handling and disposal system for the plants has not as yet been made by the City of Phoenix.

REUSE OPTIONS

In water-short areas, wastewater reuse is an ideal way to supplement water supplies. The following reuses were investigated in the study:

- Agricultural irrigation;
- Recreational use, such as the proposed Rio Salado and existing Indian Bend Wash;
- Groundwater recharge;
- Municipal uses, such as golf courses and parks;
- Industrial cooling water at the Palo Verde Nuclear Power Plant.

All of the reuses were analyzed relative to quality required, sources, costs and benefits. Based on the analysis, agricultural, golf course, and cooling water reuse were deemed most viable. The other reuses were eliminated because of possible health hazards and the high cost of providing the necessary treatment levels.

Specific agricultural reuses were identified for the Chandler plant on the Gila Indian farms, for Gilbert on land adjacent to the proposed sites, for

the Northeast plant on the Salt River Indian farms, and for the Reems Road plant on farm land immediately to the west. The 91st and 23rd Avenue plants would supply cooling water to the Palo Verde Nuclear Generating Station and irrigation water to the Buckeye and Roosevelt irrigation districts. The Tolleson plant would continue to use its effluent on the adjacent sod farm. Williams AFB would continue to use their effluent on their golf courses.

ALTERNATIVE DEVELOPMENT AND EVALUATION

By far, the greatest effort in the development of the point source plan for the metro area was in the development, evaluation and selection of the various collection and treatment alternatives (see Figure V-2). The process required an intenseive two-year planning period. Initially, there were 36 feasible areawide alternatives, ranging from one plant serving the entire area to five plants serving the area. These alternatives were reduced to 20, which were then analyzed in more detail. Careful review by the advisory groups reduced the number of areawide collection and treatment alternatives to seven.

At this point, the metropolitan study area was divided into the east and west areas. Specific subregional alternatives, based on the seven areawide alternatives, were then developed and analyzed for each subarea. During this step, findings from the flow reduction, sludge management, reuse and land treatment were integrated into the alternative development and analysis. These subregional alternatives were presented to the advisory groups and city councils, and two were selected for the eastside and two for the westside.

In the course of integrating the subregional alternatives into areawide plans again, Gilbert and Chandler decided to go with their own plants, and other communities in the outlying areas, such as Buckeye, Fountain Hills and Williams AFB, found it more economical to continue to operate their own plants. Also, Tolleson and Peoria elected to go together and utilize the capacity in the Tolleson plant. The resulting four areawide alternatives for the metro area are described below and shown in Figures V-3 through V-4.

However, a negative consideration regarding the Northeast plant involved the timing of the decision for a Northeast plant and the planning of the Southern Avenue Interceptor (SAI). If a plan was selected which includes the Northeast plant, then the size of the SAI would necessarily be reduced. Conversely, should an option without the Northeast plant be selected, then by necessity the Southern Avenue Interceptor and the 91st Avenue treatment plant would be sized to accommodate the flows from the northeast communities. It was apparent that if a Northeast plant was to be built, all commitments and agreements must be certain and final prior to constructing the SAI.

If a plan was selected at this point without the Northeast plant, this would allow the SAI to be sized to serve the northeast communities. This would retain the option that, should at a future date, more flows be generated than were projected, the northeast facility could still be built.

In summary, with respect to flexibility, Alternative 4 which allowed for the construction of both the Reems Road and Northeast plant, was rated the highest. Alternative 1, which provided for neither the Reems Road nor the Northeast facility was rated the lowest, while Alternatives 2 and 3 were each rated as moderate.

These ratings were viewed with caution, however, as the discussion of the timing of the Northeast plant and the SAI has indicated.

Costs: Each of the four areawide alternatives involves a combination of the following component parts:

- o collection systems
- o treatment facilities
- o reuse/disposal systems

Additionally the component parts were analyzed to determine when during the planning period they would be needed. Once this timing was determined a present worth analysis was performed to determine the most cost effective timing for each component. For treatement plants it was found that staging was generally the best way to go. Interceptors, however, should be built when required because of reasons other than economics.

In order to evaluate the total wastewater systems on an areawide basis, costs were developed for each of the component parts and combined as required for each areawide alternative. Capital and annual operation and maintenance costs were developed; and because all facilities are not scheduled to be constructed at the same time, present worth and equivalent annual costs were developed in order to form an equal basis for comparison between the various alternatives.

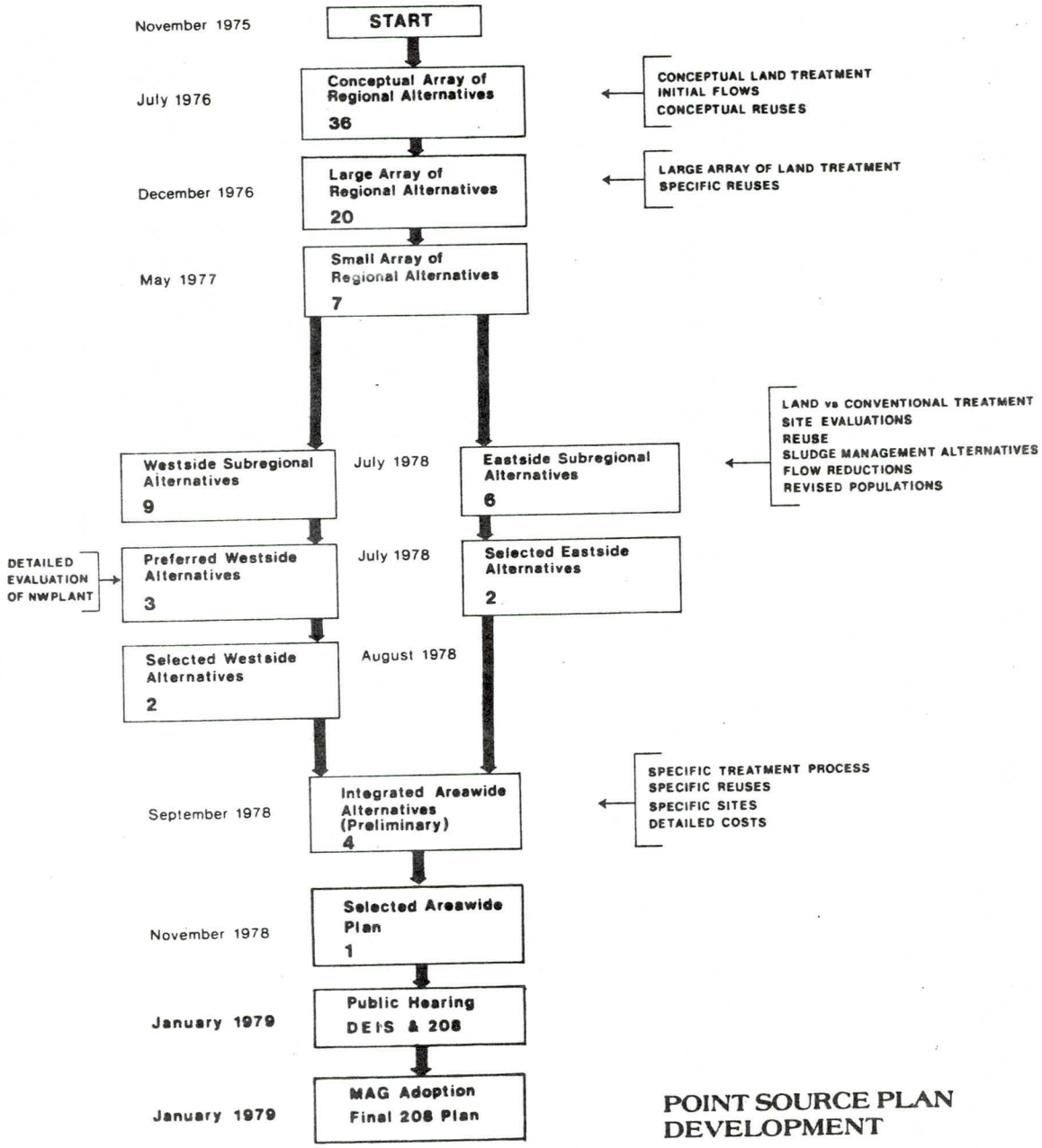
Table V-4 summarizes the various costs for each of the four alternatives.

As can be seen from the table, Alternative 1 is the least costly, followed by Alternative 2, then Alternative 3, with Alternative 4 being the most costly.

Common to all plans are plants at Tolleson (7.2 mgd); Chandler (8.2 mgd); Gilbert, which will have two small plants (2.7 and 0.9 mgd); and the 23rd Avenue plant (37.2 mgd). The 91st Avenue plant is also common to all alternatives, but the flow varies under each alternative. Flows to the plants under the four alternatives are shown in Table V-3.

Alternative 1: The 91st Avenue plant would have a year 2000 flow of 142.5 mgd and would serve all areas except Tolleson/Peoria, portions of Gilbert, and Chandler.

Alternative 2: 91st Avenue would treat a flow of 137.0 mgd. A new plant will also be located at Reems Road (5.4 mgd) to treat flows from Avondale, Goodyear and Litchfield Park.




**POINT SOURCE PLAN DEVELOPMENT**

FIGURE V-2

Alternative 3: The 91st Avenue plant would treat a flow of 133.4 mgd. A new plant (9.1 mgd) will be located on the Salt River Indian Community lands to treat the Northeast flows from Scottsdale, Phoenix and Paradise Valley.

Alternative 4: Has both the Reems Road and Northeast plants. With these two plants in the alternative, the 91st Avenue plant will be sized for 127.9 mgd.

Technical Evaluation of Point Source Alternatives

Flexibility: In evaluating the flexiblitiy of each of the four alternatives the primary concern was to identfy the alternative offering the most options to the region as a whole for wastewater collection and treatment.

On the westside, the construction of the Reems Road plant offered considerably more flexiblility to the westside communities. Without this plant, the westside communities must develop a pumpback system to the 91st Avenue plant. This type system, by its nature, is less readily expanded than would be a system including collection by gravity and treatment on the westside (Reems Road). Therefore, those alternatives containing the Reems Road plant (2 and 4) were viewed as more flexible than those without it.

Similarily, if the Northeast plant were constructed (alternative 3 and 4) the participating communities would have greater flexibility for the treatment of their wastewater. A small local plant can generally be expanded more readily than a large regional plant, and as such is better able to accommodate future population changes.

Environmental Assessment of Point Source Alternatives

Environmental considerations entered into the decision-making process of the point source study at three major points: 1) when the large array of regional alternatives was narrowed to the small array, 2) throughout the subregional (eastside/westside) screening process, and 3) in the evaluation of the four integrated areawide alternatives.

At the large array/small array stage, environmental evaluation of alternatives was generalized. Specific sites had not yet been selected, and environmental evaluation was therefore limited to broad-based considerations. Environmental issues at this point concerned sensitive archaeological, historical, subsidence, flood hazard, and recreation areas, biological features, and public acceptability.

During the subregional screening specific sites for wastewater treatment plants were identified. Unacceptable sites were eliminated on the basis of engineering, institutional, and environmental criteria. Environmental categories evaluated at the subregional level included: biological resources, soils, geology, vectors, flooding, surface water supply, existing recreation, groundwater, land use, population, recreation, public facilities and services, economy, and public acceptability. Considerations of special importance during the subregional screening were water quality constraints, acquisition of land for sites, effects on land use surrounding proposed

treatment plants, and public acceptability. As the alternatives became more focused and specific sites were studied in greater depth, environmental evaluations became commensurately site-specific.

In the last phase of decision-making -- that of evaluating the four proposed integrated areawide alternatives -- environmental impacts and issues were considered at both site-specific and areawide levels with the emphasis on assessment of areawide impacts. Impacts were assessed within 13 environmental categories: air quality, geology/soils, surface water, groundwater, biological resources, cultural resources, aesthetics, public health, land use, population public facilities and services, economic activity, and public and institutional acceptability. A detailed assessment of the alternatives, using these environmental categories, may be found in the Impact Assesment and Evaluation Appendix of the Final Report.

The four integrated areawide alternatives developed in the 208 Point Source Metro Phoenix Study have been described. Important hydrological, natural habitat, socio-cultural, and land use changes would occur under all of these project alternatives, including the selected plan, Alternative 2. Since all of the project alternatives included the 91st Avenue, 23rd Avenue, Tolleson, Chandler, and Gilbert facilities (only the Northeast and Reems Road facilities are variable), environmental consequences of the four plans were similar, since neither the Northeast nor Reems Road plants were expected to produce serious impacts.

Environmental consequences of implementing any of the four alternatives were evaluated by comparing these alternatives to a No Action Alternative. This alternative represents present and projected conditions in the study area under the assumption that there would be no new construction or expansion of municipally-owned wastewater treatment facilities.

In general, the No Action Alternative meant the expansion of low density urbanization in an area 65 to 70 percent greater than that projected by MAG in the Guide for Regional Development, Transportation, and Housing. By the year 2000, 45 percent of the population would rely on septic tanks or private package plants for wastewater treatment under this alternative. A proliferation of single-family dwellings on relatively large homesites (to accommodate septic tank use) would occur.

Areawide impacts of the four project alternatives assessed within the 13 environmental categories are summarized in the following:

Air Quality: Air quality impacts are defined in terms of the consistency or inconsistency between data in the air quality plan and the 208 plan. No major discrepancies are apparent between the NAAP and the project alternatives on this account. Minor inconsistencies have been found to be associated with the Northeast, Reems Road, and 91st Avenue facilities. However, these represent shifts in population and not increases, and are so small their impacts are negligible.

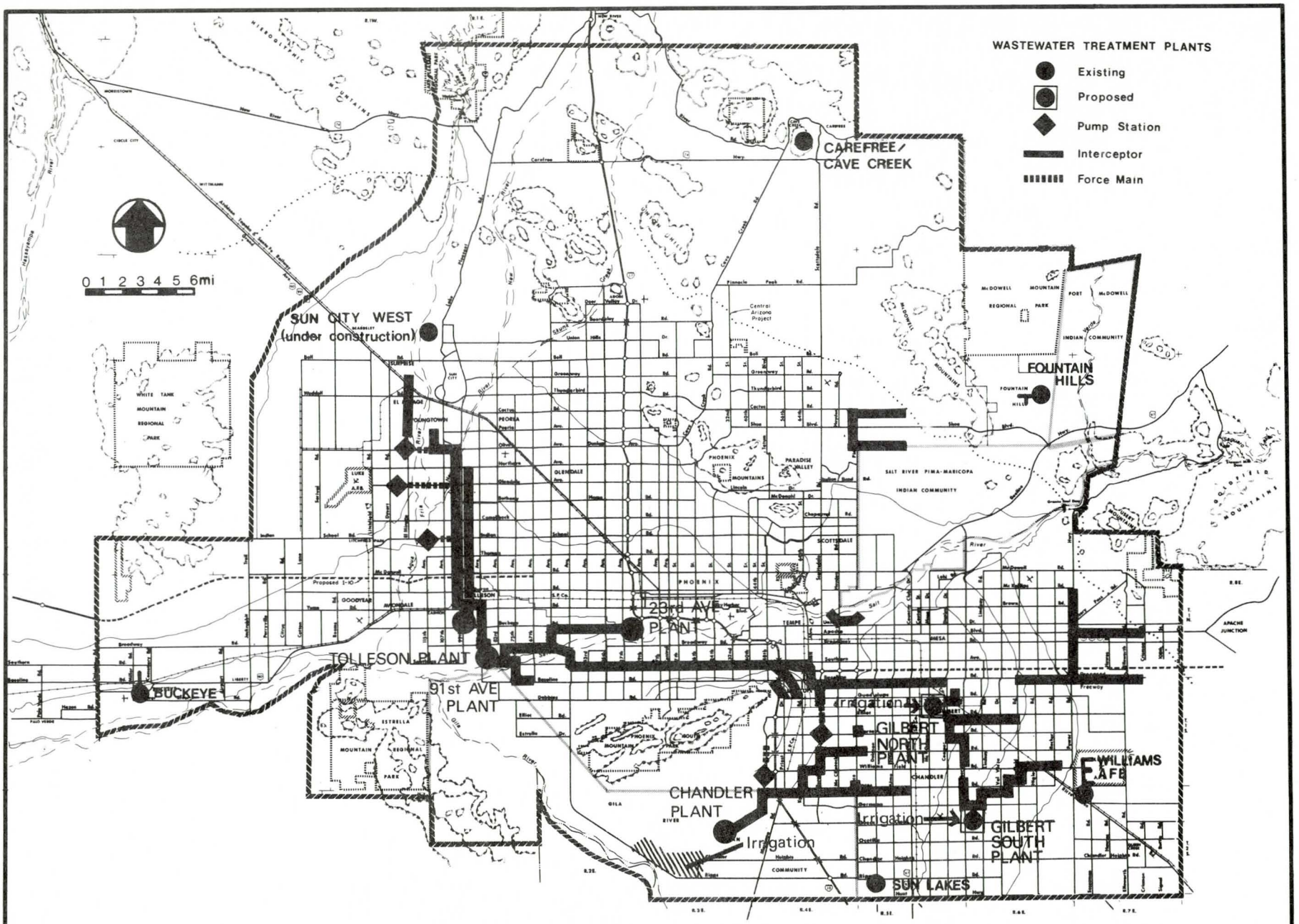



FIGURE V-3

ALTERNATIVE 1

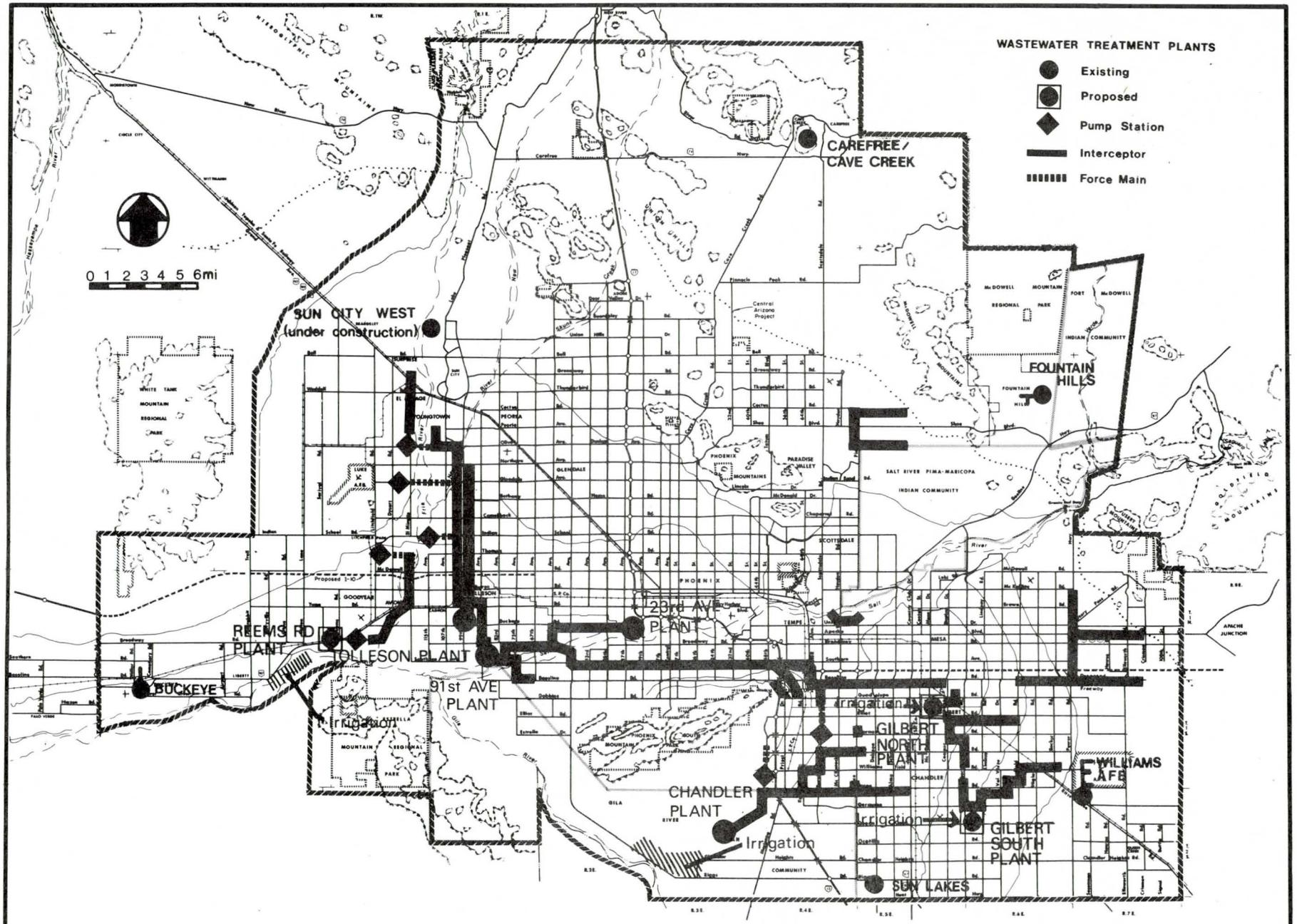



FIGURE V-4

ALTERNATIVE 2

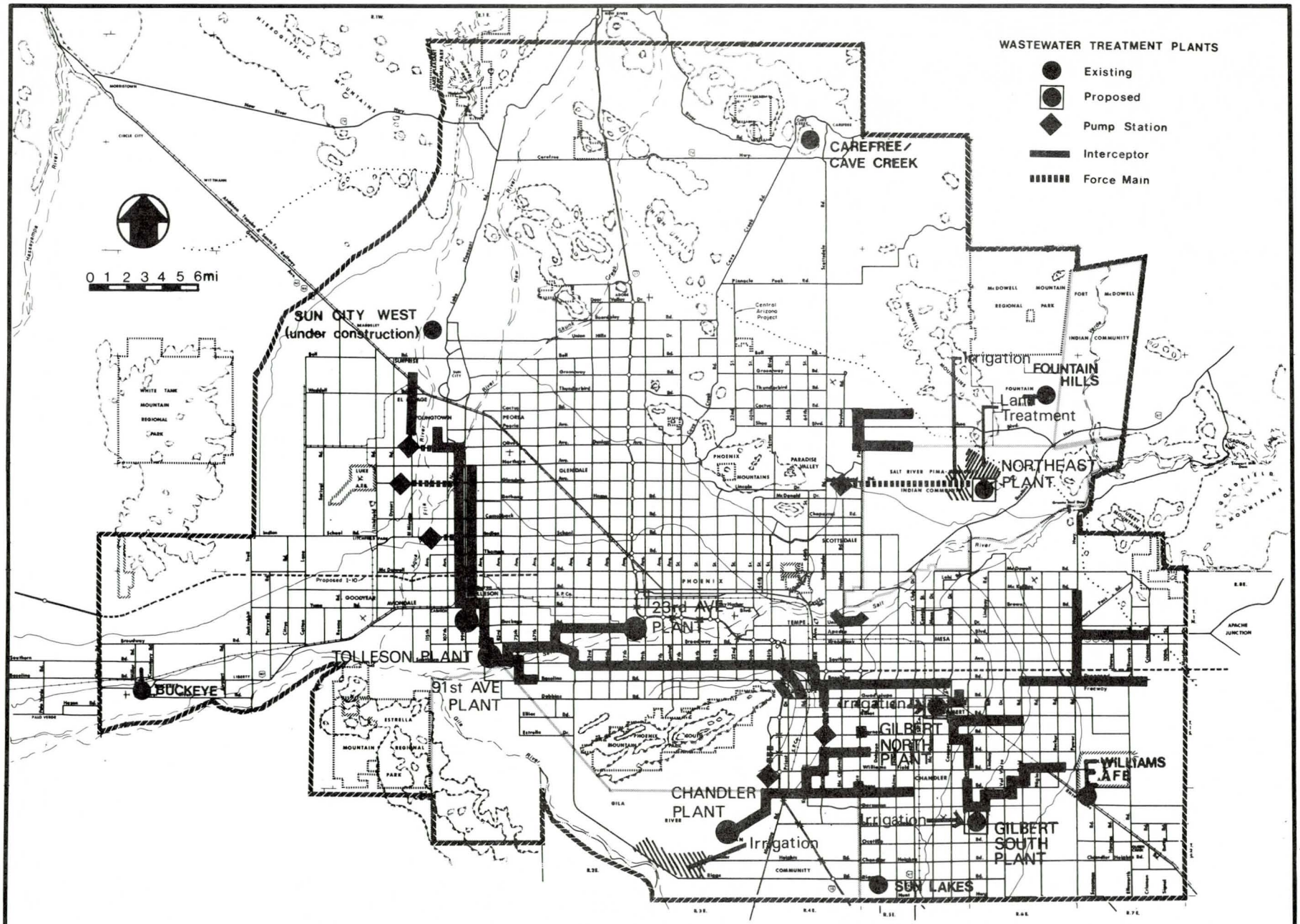



FIGURE V-5

ALTERNATIVE 3

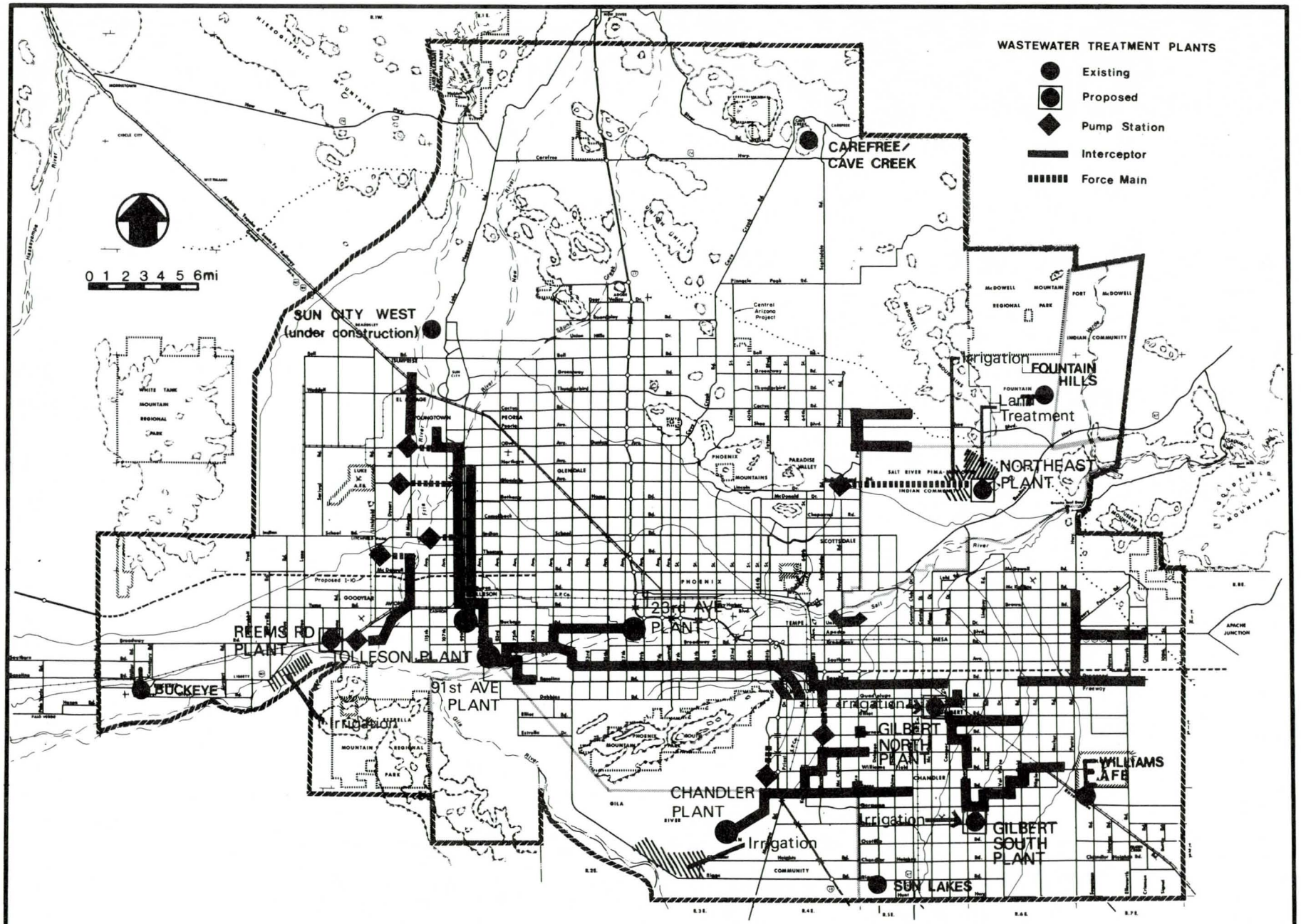



FIGURE V-6

ALTERNATIVE 4

Table V-3

AREAWIDE ALTERNATIVE

YEAR 2000 FLOWS

| Plants | | Alternatives 1 mgd | 2 mgd | 3 mgd | 4 mgd |
|---|---|---|---|---|---|
| Northeast | | - | - | 9.1 | 9.1 |
| Gilbert | North | 2.7 | 2.7 | 2.7 | 2.7 |
| | South | 0.9 | 0.9 | 0.9 | 0.9 |
| Chandler | | 8.2 | 8.2 | 8.2 | 8.2 |
| Reems Road | | - | 5.4 | - | 5.4 |
| Tolleson | | 7.2 | 7.2 | 7.2 | 7.2 |
| 91st Avenue | | 142.5 | 137.0 | 133.4 | 127.9 |
| 23rd Avenue | | 37.2 | 37.2 | 37.2 | 37.2 |
| Total Flow | | 198.7 | 198.7 | 198.7 | 198.7 |

Table V-4

SUMMARY OF REGIONAL ALTERNATIVE COSTS

| Alternative | Capital Cost | Annual O&M | Total Annual |
|---|---|---|---|
| | (Millions of Dollars) | | |
| 1. 91st Avenue | $ 114.91 | $ 1.87 | $ 14.06 |
| Tolleson | 6.83 | 0.29 | 0.89 |
| Gilbert | 9.85 | 0.26 | 0.66 |
| Chandler | 10.43 | 0.46 | 1.10 |
| TOTAL | 142.02 | 2.88 | 16.71 |
| 2. 91st Avenue | 107.39 | 1.64 | 13.54 |
| Tolleson | 6.83 | 0.29 | 0.89 |
| Gilbert | 9.85 | 0.26 | 0.66 |
| Chandler | 10.43 | 0.46 | 1.10 |
| Reems Road | 11.92 | 0.22 | 1.29 |
| TOTAL | 146.42 | 2.87 | 17.48 |
| 3. 91st Avenue | 105.59 | 1.64 | 12.97 |
| Tolleson | 6.83 | 0.29 | 0.89 |
| Gilbert | 9.85 | 0.26 | 0.66 |
| Chandler | 10.43 | 0.46 | 1.10 |
| Northeast | 15.54 | 0.51 | 1.82 |
| TOTAL | 148.24 | 3.16 | 17.44 |
| 4. 91st Avenue | 97.26 | 1.42 | 12.59 |
| Tolleson | 6.83 | 0.29 | 0.89 |
| Gilbert | 9.85 | 0.26 | 0.66 |
| Chandler | 10.43 | 0.46 | 1.10 |
| Reems Road | 11.92 | 0.22 | 1.29 |
| Northeast | 15.54 | 0.51 | 1.82 |
| TOTAL | $ 151.83 | $ 3.16 | $ 18.35 |

Geology/Soils: Geological impacts focus on the exclusion of sand and gravel or other valuable geological materials from extraction due to location of facilities in mineable areas. Major impacts in this category are not apparent.

Surface Waters: All alternatives would result in more beneficial effects to surface water supplies than would the No Action Alternative. Surface water supplies would be increased and redistributed throughout the study area in the form of treated wastewater.

Groundwater: Effects on groundwater center around potential changes in quality and quantity that can occur depending on the location of wastewater discharge in the area.

While aquifer replenishment is only possible in the West Basin of the Salt River Valley under the No Action Alternative, opportunities for local groundwater replenishment are possible in the East and West Basins under all alternatives.

The potential beneficial effects of local groundwater replenishment are based on use of suitable irrigation methods and proper reuse siting. A potential adverse impact to groundwater quality in the Gilbert area exists in all the project alternatives because of the proximity of the reuse site of the north Gilbert plant to public supply water wells.

Biological Resources: Biological resources would be improved by all project alternatives, in comparison to the No Action Alternative. Improvement of resources consists primarily of creation of wetland habitat, which is of high value in the area, through the addition of surface water in the form of aerated lagoons, stabilization ponds, and impoundments for storing treated wastewater for irrigation.

Some loss of terrestrial habitat would occur under all alternatives but they are outweighed by biological advantages of surface water augmentation.

Cultural Resources: Adverse impacts to archaeological resources would occur with all project alternatives due to urbanization. Losses of artifacts would be less extensive than with the No Action Alternative because the area of urbanization assumed for the project alternatives is not as great as for the No Action Alternative. Additional archaeological impacts could occur during construction of sewage treatment systems.

No historically sensitive sites are known to be located in areas of proposed facility expansion or construction.

Public Health and Aesthetics: The incidence of mosquitoes around surface water areas, the likelihood of intentional or inadvertent contact with waste-water, and the likelihood of odors are important environmental consequences of operation of treatment plants. Mitigative measures can reduce or eliminate these impacts. Particular mitigative measures include pesticide control applications, odor suppression techniques, and proper designation of wastewater areas by posting of signs and fencing of enclosures to deter public access.

Land Use: Effects on land use were evaluated in three areas.

- Agricultural Land Use: The consequences of the project alternatives on agricultural land use fall into two main categories: 1) the loss of farmland for treatment facility sites, and 2) the continued support of farming due to availability of effluent for irrigation. The more significant impacts are associated with the latter category, and are considered positive.

  Compared to the total amount of prime farmland in the study area and the loss of farmland due to expected urbanization in the area, losses due to facility siting are slight. Effluent used for irrigation will generally replace the use of existing groundwater or other surface water irrigation supplies, thus making this water available for other uses or reducing current overdrafting.

- Urban Land Use: All alternatives support the adopted MAG regional development guide which anticipates extensive, though more dense, additional urbanization of the Phoenix area. Temporary land use impacts (interrupted access, noise, etc.) will result from facility construction.

- Recreation and Open Space: Wetlands associated with the treatment and storage of effluent for irrigation not only provide an important natural resource but also provide opportunities for recreational land uses such as hunting, picnicking, and bird watching. Under the No Action Alternative, no creation of significant wetland is anticipated, whereas all alternatives contribute to wetland formation.

Population: Effects upon population were considered in terms of compatibility with population projections adopted by MAG. Alternatives 1 through 4 all support the projected population growth patterns developed by MAG. These projections call for extensive additional population in the area, distributed in a denser pattern than in the No Action Alternative. From a regional perspective, there are no significant differences among the project alternatives.

Public Facilities and Services: Impacts concern the extent to which the proposed project action would affect existing or proposed public facilities or the operation of service delivery systems. Consideration is also given to secondary impacts in which project actions may alter future revenues to public agencies without a compensating change in the cost or level of services they must provide. The project alternatives support planning based upon the MAG regional development guide.

Economic Activity: All alternatives would be accompanied by changes in the economy which include reduction in scale of agricultural activity, but not as rapidly as under the No Action Alternative. Most sectors of the economy would increase, but the public service sector would not grow as large as under the No Action Alternative.

Public and Institutional Acceptability: All of the project alternatives will meet the demand for areawide wastewater treatment, so public accept-

tability issues focus on the choice of sites for treatment and potential reuses of effluent. Significant local objection is probable in the areas around sites for the north Gilbert plant (common to all alternatives) and the Northeast conventional plant (Alternatives 3 and 4) due to new urbanization of these areas. Reaction to expansion of the 91st Avenue plant by the Gila River Indian Community will depend upon the extent to which the proposed upgrading of the existing facility reduces existing odor and insect problems.

Alternatives that reduce flows to 91st Avenue and 23rd Avenue plants are opposed by the Arizona Nucleare Power Project because the ability of the cities to meet the contractual agreement for supply of effluent to ANPP would be impaired.

SELECTED POINT SOURCE PLAN

The four areawide alternatives were presented to the advisory groups for review and selection of the preferred plan. The Citizens Advisory Group selected Alternative 4, seeing an alternative with both the Reems Road and Northeast plants as providing the greatest flexibility to the area. The Agricultural Advisory Group selected Alternative 2 for its ease of implementation, but wanted future consideration of the Northeast plant. The Technical Advisory Group also selected Alternative 2, but their reasoning was on the basis of providing larger interceptors for the eastside. For reasons similar to those of the AAG and TAG, both the Management and Executive Committees selected Alternative 2. Final selection of Alternative 2 as the preferred point source plan for the metro area was made by the Regional Council.

It should be noted that cost did not play a major role in the final decision-making process, since the cost difference between the least costly alternative (Alternative 1 -- $142 million) and the most expensive (Alternative 4 -- $152 million) was only about 7 percent. Nor were environmental impacts a determining factor as the alternatives differed only in their impact on surface water.

The selected point source plan for Maricopa County (Figure V-7) calls for 13 plants to serve the metropolitan area. Other plants could in the future also be located at 48th Street and the Salt River and in the Northeast area. A description of the selected plan follows.

91st Avenue System: The 91st Avenue plant will be expanded to 137.0 mgd by the year 2000 with an initial 30 mgd expansion to be on line by 1981. Depending upon population growth, the additional expansion would come on line sometime between 1985 and 1990. Effluent from the plant would be used for irrigation and cooling water. Methods to accomplish the expansion and sludge handling are being analyzed in an existing Phoenix 201 facility plan.

To bring flows from the northwest communities of El Mirage, Glendale, Luke AFB, Sun City East, Surprise, Youngtown and Phoenix to the 91st Avenue plant, a major interceptor will be required along 99th Avenue (1982), as well as pump stations at El Mirage, Luke AFB and Indian School Road.

Flows from the northernmost portion of Gilbert, Guadalupe, Mesa, Paradise Valley, Phoenix, Scottsdale and Tempe will require a new interceptor along Southern Avenue and Baseline (1983). Interceptors will also be required in Scottsdale (1982) and East Mesa, with pump stations in south Tempe and south Phoenix. A parallel to the existing Salt River Outfall (SRO) will also be required (1985-1990), as well as an interceptor to bypass the Mesa treatment plant once it is closed (1981-1983).

Facility plans will be required for the major components of the system.

23rd Avenue Plant: The 23rd Avenue wastewater treatment plant will be upgraded to handle 40 mgd by 1981. Ultimate flow to the plant is projected to be 37.2 mgd. Effluent from the plant will be used for irrigation or cooling water. Sludge disposal problems at the plant are being studied under Multi-City 201 facility planning.

Reems Road System: A new 5.4 mgd facility will be built at Reems Road and the Gila River. It will handle flows from Avondale, Goodyear, and Litchfield Park and should be constructed by 1982.

A new interceptor will be required from Thomas Road to the plant and pump stations will be required at Litchfield Park and the treatment plant. It is proposed that effluent will be used to augment irrigation to the west.

A 201 facility plan will be required.

Buckeye System: The existing Buckeye plant should be expanded and upgraded to 0.6 mgd by 1983. This expansion should be sufficient through 1990, after which further expansion would be required. Effluent will be discharged to the Arlington Canal. A 201 facility plan will be required for the Buckeye system.

Chandler System: The proposed system for Chandler is an expansion of its existing plant in 1981 to 5.6 mgd. A second expansion in 1990 would increase the plant capacity to 8.2 mgd. Effluent reuse would be restricted agriculture on the Gila Indian Community farm at Lone Butte Ranch. New interceptors will be required along Pecos and Ray Roads.

A facility plan is just getting underway and is due for completion in 1979.

Fountain Hills System: Fountain Hills Sanitary District operates a 0.5 mgd plant with reuse on the golf course. Population growth requires a 1985 expansion of the plant to handle the year 2000 flow of 2.0 mgd. Effluent would be used for greenbelt and golf course irrigation.

A 201 facility plan will be required.

Gilbert System: The plan for Gilbert calls for closing its existing plant and splitting the Gilbert flow three ways. The northernmost portion of the Gilbert planning area (0.4 mgd) would go to the 91st Avenue plant. The northern portion of the remaining area would go to a new plant. Staging for this plant would be 1.0 mgd by 1980, in 1981 it would be expanded to 1.8

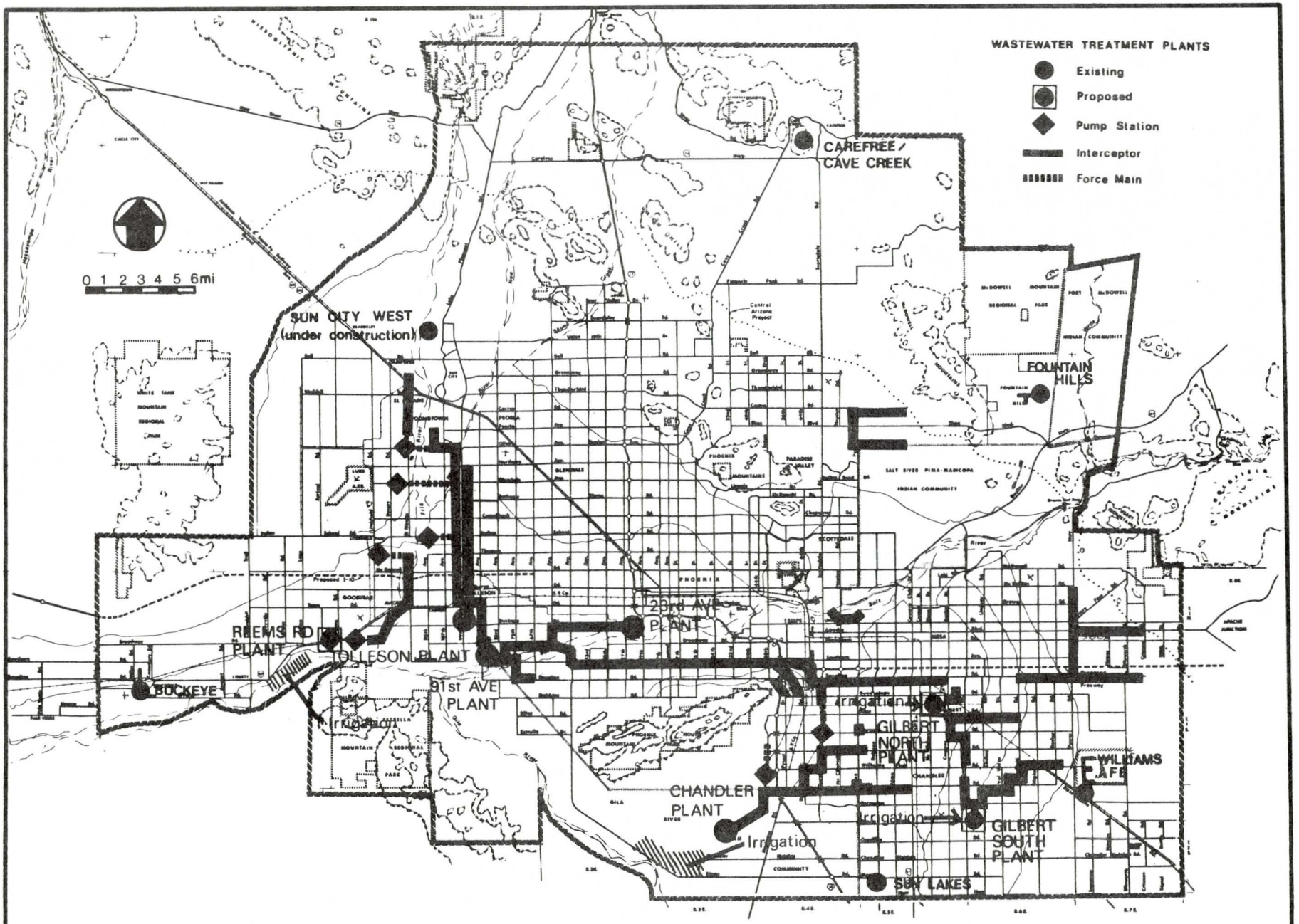



FIGURE V-7

SELECTED AREAWIDE WATER QUALITY PLAN

mgd, and in 1990 to 2.7 mgd. In the southern portion, a plant would be constructed in 1990 to handle a flow of 0.9 mgd. Effluent would be reused in agricultural areas adjacent to the plants. Interceptor systems would be required for both plants.

Gilbert has initiated a 201 plan to define exactly its needs.

Tolleson System: The existing Tolleson plant will be expanded in 1980 to handle a flow of 8.0 mgd. Of this flow, 7.2 mgd is domestic flow from Tolleson and Peoria and the balance is industrial wastes. Effluent from the plant will be used for sod farming with any excess being discharged to the Salt River or sold to ANPP. A new interceptor will be required from Peoria to Tolleson down 99th Avenue.

The expanded Tolleson plant may be able to alleviate some of the wastewater problems of the northwest area by allowing Glendale and Sun City use of the facilities until the 91st Avenue facilities are ready.

Tolleson and Peoria have started a 201 facility plan for the plant and interceptor.

Williams AFB: Williams AFB recently upgraded and expanded its plant to 1.0 mgd. It does not anticipate any future increase in flows. The base is now looking at additional on-base reuses to stop any further discharges.

Sun City West: The new development at Sun City West will have its own privately owned and operated treatment plant. Its ultimate capacity is expected to be 2.6 mgd and the effluent will be reused for golf course irrigation.

Cave Creek/Carefree: The communities of Cave Creek and Carefree are presently unincorporated and are served by two small privately owned facilities. Population growth indicates some form of wastewater system be implemented very soon before problems are created. Analysis shows it is not economical for the area to be connected to the regional system. Therefore a 201 study should be implemented for the area to look at the planning area, treatment plants or individual systems, effluent reuse, combined or separate plants, management structure, costs, sizing and staging.

Sun Lakes: Sun Lakes is a private development and operates its own treatment plant. However, the plant must be expanded in the future to cope with the anticipated growth. Plant effluent should continue to be used as golf course irrigation.

Table V-5 lists the proposed projects for the metro 208 planning area.

Impacts of the Selected Point Source Plan

The major impacts of the selected plan are discussed in the following categories:

- Water resources impacts

- Air quality impacts
- Biological resources impacts
- Socioeconomic impacts
- Cultural impacts

Water Resources Impacts: Implementation of the selected 208 point source plan for the Phoenix area will result in improving the quality of discharges from wastewater treatment plants to meet requirements established by EPA. This also will lead to better surface water quality which meets standards established by the State of Arizona in stream segments affected by the discharges. The plan's effluent reuse schemes will increase the amount of effluent reused and will help improve effluent distribution for agricultural irrigation, energy production, and biological enhancement. Effluent reuse, however, could affect adversely groundwater quality in two locations.

Since there are no other reuse sites available in the area, the irrigation site for the north Gilbert plant is relatively near existing public supply wells. Irrigation at the site is likely to change the groundwater quality in these public supply wells as the result of migration of salts, nitrogen, and dissolved organic carbon to the water table. Monitoring of soil and groundwater has been recommended.

Treated effluent from the Chandler plant, which is used to irrigate crops on the Gila Indian Reservation, could possibly encourage the northeasterly movement of poor quality groundwater. Evidence indicates that this migration already is occurring. This increased northeasterly movement results from an increase in the hydraulic gradient of the groundwater system, which in turn results from recharge and decreased groundwater pumping in the area. A mitigative measure is to use the effluent downgradient of the area underlain by poor quality groundwater, thereby decreasing this movement.

Benefits to groundwater also are expected from the selected plan. Irrigation from the south Gilbert plant could decrease overdrafts in the area and discourage the easterly movement of poor quality groundwater from southwest of Chandler. As agricultural land is taken out of production and converted to low density urban development, there is a net decrease in water use per acre which also will tend to decrease overdrafts and discourage the easterly movement of the poor quality groundwater to the existing pumping cone of depression. If effluent from the Chadler plant is used downgradient of the area that is underlain by poor quality groundwater, it would help discourage the northeasterly movement of the poor quality water, help to keep water in the East Basin, and improve the overall quality of water in the Basin.

Table V-5

POINT SOURCE PLAN

| Project | Size | Estimated Cost (Millions of Dollars) (Jan 1978) | Completion Date | Participating Communities |
|---|---|---|---|---|
| MULTI-CITY SYSTEM | | | | |
| Treatment Plants | | | | |
| 91st Avenue Treatment Plant Expansion and Upgrading | | | | |
| 1st Stage | 30 mgd | $32.58 | 1982 | Phoenix |
| 2nd Stage | 15 mgd | 18.80 | 1990-95 | Tempe<br>Mesa<br>Gilbert<br>Guadalupe<br>Scottsdale<br>Paradise Valley<br>Surprise<br>El Mirage<br>Sun City<br>Glendale<br>Luke Air Force Base |
| 23rd Avenue Treatment Plant Upgrading | 37.2 mgd | 6.00 | 1983 | Phoenix<br>Paradise Valley |
| Collection System | | | | |
| Southern Avenue Interceptor | 21" @ Stapley Dr.<br>42" @ Rural Rd.<br>48" @ 27th Ave.<br>66" @ 59th Ave.<br>78" @ 91st Ave. | 28.68 | 1983 | Phoenix<br>Tempe<br>Mesa<br>Paradise Valley<br>Gilbert<br>Guadalupe |

Table V-5 (Cont.)

POINT SOURCE PLAN

| Project | Size | Estimated Cost (Millions of Dollars) (Jan 1978) | Completion Date | Participating Communities |
|---|---|---|---|---|
| Salt River Outfall Parallel Interceptor (23rd Ave. to 59th Ave.) | 36" @ 23rd Ave.<br>48" @ 59th Ave. | $ 5.83 | 1985-90 | Phoenix<br>Tempe<br>Mesa<br>Scottsdale |
| East Mesa Interceptors | Apache Int. 10"<br>Baseline Int. 12" to 21"<br>Bush Int. 10" to 18" | 2.69 | 1985 | Mesa |
| Mesa STP Bypass Interceptors | 27" | 0.99 | 1983 | Mesa |
| North Scottsdale Interceptors | Cactus Int. 12" to 15"<br>Pima Rd. Int. 15"<br>Reser. Bnd. Int. 10" to 15" | 2.37 | 1983 | Scottsdale |
| South Tempe Interceptors and Pumping System | Rural Int. 36"<br>Kyrene/Priest Int. 15" to 18"<br>P.S. 0.18 mgd | 1.95 | 1984 | Tempe |
| Guadalupe Interceptor | 10" | 0.16 | 1984 | Guadalupe |
| South Ahwatukee Pumping System | 0.7 mgd | 0.42 | 1985-90 | Phoenix |
| Greenway Road to Olive Avenue Interceptor | 18" to 21" | 1.63 | 1985 | El Mirage<br>Surprise |

Table V-5 (Cont.)

POINT SOURCE PLAN

| Project | Size | Estimated Cost (Millions of Dollars) (Jan 1978) | Completion Date | Participating Communities |
|---|---|---|---|---|
| Olive Avenue Pumping System | 1.2 mgd | $ 0.22 | 1985 | El Mirage<br>Surprise |
| Youngtown Interceptor | 8" | 0.13 | 1985 | Youngtown |
| Luke AFB Pumping System | 1.5 mgd | 0.51 | 1983 | Luke AFB |
| Indian School Road Pumping System | 0.9 mgd | 0.27 | 1985-90 | Phoenix |
| 99th Avenue Interceptor from 111th Avenue to Indian School Road | 27" @ Dunlap<br>33" @ Camelback<br>51" @ Indian School | 3.44 | 1983 | El Mirage<br>Glendale<br>Luke AFB<br>Sun City<br>Surprise<br>Youngtown |
| 99th Avenue Interceptor from Indian School Road to 91st Avenue WWIP | 54" @ Thomas<br>51" @ Van Buren<br>66" @ 91st Ave. WWIP | 8.10 | 1983 | El Mirage<br>Glendale<br>Luke AFB<br>Phoenix<br>Sun City<br>Surprise<br>Youngtown |
| AVONDALE/GOODYEAR SYSTEM | | | | |
| Reems Road Plant | 5.5 mgd | 7.75 | 1983 | Goodyear<br>Avondale |
| Interceptors | | | | |
| El Mirage Int. | 21" @ McDowell<br>27" @ Buckeye | - | 1983 | Litchfield Park |

Table V-5 (Cont.)

POINT SOURCE PLAN

| Project | Size | Estimated Cost (Millions of Dollars) (Jan 1978) | Completion Date | Participating Communities |
|---|---|---|---|---|
| Agua Fria Int. | 27" @ Lower Buckeye | - | 1983 | |
| | 33" @ WWTP | - | | |
| Litchfield Park P.S. | 1.3 mgd | - | 1983 | |
| | | $ 4.17 | | |
| BUCKEYE SYSTEM | | | | |
| Plant Upgrade | 0.6 mgd | 0.83 | 1983 | Buckeye |
| Interceptor | 0.1 mgd | 0.04 | 1990-95 | |
| CAVE CREEK/CAREFREE SYSTEM | | | | |
| Plant | 0.8 mgd | 0.81 | 1980-85 | Cave Creek |
| Interceptor | 10" to 15" | | | |
| CHANDLER SYSTEM | | | | |
| Plant Expansion | | | | |
| 1st Stage | 5.6 mgd | 1.42 | 1982 | Chandler |
| 2nd Stage | 2.6 mgd | 1.46 | 1990-95 | |
| Interceptors | | | | |
| Ray Rd. Int. | 18" @ Price Rd. | - | 1982 | |
| Ray Rd. Int. | 27" @ Rural Rd. | - | 1982 | |
| Williams Field Rd. Int. | 27" @ Kyrene | - | 1982 | |
| Gila River Int. | 48" @ WWTP | - | 1982 | |
| | | $ 7.45 | | |
| Price Int. | 15" @ Warner | 0.09 | 1990-95 | |

Table V-5 (Cont.)

POINT SOURCE PLAN

| Project | Size | Estimated Cost (Millions of Dollars) (Jan 1978) | Completion Date | Participating Communities |
|---|---|---|---|---|
| FOUNTAIN HILLS SYSTEM | | | | |
| Plant Expansion | 2.0 mgd | $ 3.15 | 1984 | Fountain Hills |
| GILBERT SYSTEM | | | | |
| North Plant | | | | |
| 1st Stage | 1.8 mgd | 1.91 | 1981 | Gilbert |
| 2nd Stage | 0.9 mgd | 1.11 | 1990-95 | |
| Interceptors | | | | |
| Elliot Rd. Int. | 18" @ Lindsay | - | 1983 | |
| McQueen Rd. Int. | 12" | - | 1983 | |
| Gilbert Rd. Int. | 12" to 15" | - | 1983 | |
| | | 2.75 | | |
| Elliot Rd. Int. | 10" @ Greenfield | 0.27 | 1985 | |
| South Plant | | | | |
| Plant | 0.9 mgd | 1.43 | 1990-95 | Gilbert |
| Interceptors | | | | |
| Williams Field Rd. Int. | 8" to 12" | - | | |
| Pecos Rd. Int. | 15" | - | | |
| Germann Rd. Int. | 15" | - | | |
| | | 2.38 | | |

Table V-5 (Cont.)

POINT SOURCE PLAN

| Project | Size | Estimated Cost (Millions of Dollars) (Jan 1978) | Completion Date | Participating Communities |
|---|---|---|---|---|
| SUN CITY WEST SYSTEM | 2.6 mgd | $ - | 1979 | Sun City West |
| SUN LAKES SYSTEM | 0.70 mgd | 1.80 | 1985 | Sun Lakes |
| TOLLESON/PEORIA SYSTEM | | | | |
| Plant Expansion | 7.2 mgd | 1.30 | 1981 | Tolleson |
| 99th Ave. Interceptor | 36" @ Northern<br>36" @ WWTP | 5.53 | 1981 | Peoria |
| WILLIAMS AIR FORCE BASE | 1.0 mgd | 0.16 | 1979 | Williams AFB |

Air Quality Impacts: Minor local, short-term air quality changes will occur during construction phases of the wastewater management plan. These changes will consist principally of increases in fugitive dust. Increases in dust will occur most often during excavation and laying of interceptor lines in the more highly developed northwest, northeast, and eastern portions of the metropolitan area. Dust associated with construction is subject to state and local fugitive-dust-control regulations, which will be complied with during facility construction.

Biological Resources Impacts: Construction of treatment facilities in the selected plan will result in removal of portions of cropland, saltbush, and creosotebush-bursage communities. The saltbush and creosotebush-bursage communities that will be removed were found to be of poor quality, primarily as a result of intensive human encroachment in the study area. These communities, along with the paloverde-saguaro and riparian communities, will also undergo change due to plant operations and associated habitat management schemes. Terrestrial habitat losses of 700 acres will be offset somewhat by creation of 390 acres of similar or improved habitat, depending on the biological habitat development scheme selected for each wastewater treatment plant. Despite these habitat losses, net biological changes throughout the area are expected to be beneficial as a result of implementation of the plan.

Socioeconomic Impacts: The principal socioeconomic consequences of the selected plan are discussed in three categories:

- Impacts of Proposed Facilities - Construction of proposed facilities will primarily affect agricultural areas by conversion of agricultural land for use for treatment facilities. About 43 percent of this agricultural land is expected to be urbanized by the year 2000 even if not used for treatment facilities. The actual amount of agricultural land removed from production that can be attributed solely to the project is about 146 acres.

  Two aspects of the proposed treatment plants may result in conflicts over land uses. First, the presence of a wastewater treatment plant may, for aesthetic reasons, discourage the development of adjacent properties in residential and commercial uses. Second, reuse of effluent for agricultural irrigation implies, and may require, a commitment to maintain the area to be irrigated in production of nonedible crops for an extended period of time.

  Site availability is another important consideration. Several of the plants included in the selected plan will not be needed for five to twelve years. To ensure their availability when required, these sites will have to be acquired or optioned before they can be utilized. Land acquisition costs will be substantial.

- Impacts of Proposed Effluent Reuse - Although construction of facilities will remove farmland from production, use of effluent for irrigation will support agriculture. This support includes 1) provision of additional agricultural water supplies, 2) requirements that include the long-term commitment of land irrigated with effluent to agricultural purposes under reuse agreements, and 3) improvement of groundwater supplies through additional recharge.

  The use of effluent at the Palo Verde Nuclear Generating Station supports energy production in the area and is considered beneficial to the provision of reliable electric power. Revenues from the sale of effluent will also help offset costs of treatment.

Wastewater effluent provides a desirable source of water for both agricultural irrigation and power production. Both have expressed interest in obtaining additional amounts. Flows from the 91st Avenue and 23rd Avenue plants are projected to be adequate to meet most existing commitments for effluent. Flows, however, are not adequate to meet all existing commitments and requests for future allocations.

Sale of effluent for either purpose will tend to lower wastewater treatment costs to the consumer, although some agricultural revenues will be offset by the cost of providing delivery systems for the effluent.

- Impacts of Plan Implementation - Compared to the added costs associated with providing on-site sewage treatment for each development project or individual building, the level of expenditure for the treatment plant system would not, by itself, significantly impact the local economy. The timing of this construction will influence the impact on the regional economy. If major facility construction is initiated during a period of heavy construction activity, it will tend to encourage inflation of materials and labor costs. By contrast, facility construction could have a counter-cyclical effect if initiated during a depressed construction period.

  The future costs per household of wastewater treatment, under the point source metro plan, will vary from community to community but will be higher, overall, than current costs. Part of this variation is due to the fact that some communities incur costs for an entirely new treatment system while others are paying for only an expansion of existing facilities. Other major cost variations are explained by the necessity of some communities to provide interceptor lines to new or expanded treatment facilities. This condition is common for communities at some distance from the treatment plant, such as El Mirage and Surprise.

  Construction and operation costs of the new treatment system components may be financed through user charges. While user charges are an efficient financing mechanism because those who use the system pay for it, the charges tend to impose a heavier burden on low-income households.

  Under the Final Point Source Management Plan, individual communities expecting to discharge flows to the 91st Avenue treatment plant must "buy in" to the system. The cost to each will be determined by its proportion of all flows going into the plant, multiplied by the total amount of the local (non-federal) share of the initial capital costs. This initial "buy-in" amount will probably be financed by bonds in most communities.

  A small community, such as Guadalupe, which does not now have a centralized wastewater treatment system may not have an adequate assessed value to support bonds to pay for both a local collection system and its share of the cost of the expanded treatment plants. The user costs per household may also be excessive, even if the city has adequate bonding capacity to pay for the system.

Cultural Impacts: The selected plan has the potential for disturbing archaeological sites, mainly by direct removal or destruction of artifacts during construction of interceptor lines. No existing historic sites are located in areas affected by expansion or new construction of wastewater facilities.

# CHAPTER VI

## WATER QUALITY PROGRAM

## NONPOINT SOURCE PLAN

Nonpoint sources of pollution are, by definition, those sources which discharge over a wide area rather than those which are discharged from a specific, identifiable point. Because of their nature it is extremely difficult to quantify them or to assess their impacts. In an arid area such as the Salt River Valley, the assessment is even more difficult since the receiving water is the groundwater.

This difficulty in assessing the pollution potential of nonpoint sources was dramatized in an early attempt at defining the pollution from agriculture, urban runoff, feedlots, dairies, sanitary landfills, and gravel operations and salt seeps. The method used in this initial attempt was to review the literature for work done in other areas of the country. Much data existed, but it quickly became apparent that nonpoint sources are very site specific and data from one part of the country cannot be readily used in another. Also much of the previous work dealt with impacts on surface waters and little with impacts on groundwater. After an initial report, this approach was modified to a new method. The new approach reviewed historical groundwater quality data to assess trends. These trends were then related to surface activities or natural influences to determine which potential nonpoint sources have been causing groundwater pollution in this area.

The waste sources analyzed in the 208 program were:

- Urban
- Industrial
- Agricultural
- Hydrological modifications
- Natural

### SALT RIVER VALLEY BASIN ASSESSMENT

The Salt River Valley contains the greatest concentration of nonpoint sources of pollution in Maricopa County. Figure VI-1 shows the general location of these wastes and a brief description of them follows.

In 1978, there were 8,500 acres that contained more than two septic tanks per acre, with an additional 10,300 acres having between one and two septic tanks per acre. Greatest concentration of septic tanks is in the Apache Junction area, east of Mesa. Other significant areas are north Scottsdale, southeast of Gilbert, the communities of Surprise and El Mirage, and south

of the Salt River. About 25 percent of these areas will be sewered within the next five to ten years. Future septic tank areas include northern areas of Glendale, Phoenix and Scottsdale.

Disposal or reuse of wastewater effluent is significant in the Valley. The largest area irrigated with effluent is the Buckeye Irrigation District. Effluent is mixed with other water and applied to the crops in the 18,000-acre district. Presently 70,000 acre-feet of effluent is diverted into the district but this is expected to drop to as little as 30,000 acre-feet in the future when the Palo Verde power plant receives effluent for cooling. Additional irrigation with effluent occurs at the Mesa and Tolleson plants, and the Roosevelt Irrigation District may take about 20,000 acre-feet per year of reclaimed water from the 23rd Avenue treatment plant. Other potential point sources in the Valley include existing and abandoned landfills, many of which are located in the floodplain; industrial discharges; and storm runoff discharges to stream channels and disposal wells.

Lawn irrigation in the valley is extensive. It includes parks, schools, cemeteries and golf courses, as well as residential areas and is a potential source of groundwater pollution.

In 1975, there were about 350,000 acres of irrigated land in the Salt River Valley and about 2.1 million acre-feet of water used for irrigation. This means that about 700,000 acre-feet of water became groundwater recharge through canal seepage and irrigation return flow. This return flow can result in the degradation of groundwater quality.

The salt balance in the Valley is going to be affected by the importation of water from the Central Arizona Project (CAP). It is estimated that about 500,000 acre-feet per year would be available in the year 1990. The salinity of this water will be about 735 mg/l which means that approximately 500,000 tons of salt will be imported into the valley each year. This will be somewhat alleviated by the export of salt in the sewage effluent going to the PVNGS and the fact that some of the CAP salt will be precipitated in the top soil and the vadose zone.

There were about one dozen feedlots and about 120 dairies scattered around the valley in 1978. The feedlots are generally in the rural areas, and the dairies are concentrated in the Chandler, Glendale, Tolleson and Avondale areas. These feedlots and dairies are important source of groundwater pollution.

## PROPOSED CONTROL MEASURES

Control measures can readily be identified for all of the potential nonpoint sources in the study area. However, the knowledge of the impact of these nonpoint sources, as previously discussed, is severely limited due to the lack of sufficient groundwater monitoring. Control measures should not be implemented unless and until sufficient data is available to identify a definite hazard. The thrust of this report is to recommend future monitoring that will provide information upon which meaningful control measures can be formulated to protect groundwater quality.

Present information, however, does indicate that several potential sources in the Salt River Valley could be addressed through implementation of control measures. They include landfills, industrial wastes, and certain types of hydrologic modification.

For landfills, the control measures included limiting their locations in floodplains, limiting the application of liquids, limiting the depth of excavation compared to the groundwater table, and required monitoring of groundwater beneath landfills.

For some industrial wastes, the installation of impervious liners is recommended to stop percolation of the waste into the groundwater.

Two types of hydrologic modifications are suggested for possible control: 1) well construction, and 2) altering groundwater flow patterns.

Poorly constructed or abandoned wells can allow the vertical movement of poor quality groundwater into other zones, thus degrading the quality of water in some strata. Control measures can be implemented through well construction ordinances.

Large scale pumping has caused increasing groundwater salinities in the Chandler and Liberty/Goodyear areas. Possible control measures include decreasing the pumping, recharge of groundwater in downgradient areas or pumping out of the poor quality water.

MONITORING NEEDS

The analysis of the existing groundwater quality data pinpointed the lack of precise data to accurately assess nonpoint sources of pollution. In general, there are three areas in which data must be available: hydrogeologic, regional groundwater quality, and site specific groundwater quality.

The hydrogeologic data should include subsurface geology, groundwater flow patterns, characteristics of the vadose zone, accurate water level maps and aquifer storage and transmissivity factors.

In the Salt River Valley, large quantities of regional data exists but it has been collected from the point of view of irrigation or domestic supply needs. Less information exists for organic or radiological parameters because analyses have shown inorganic chemical constituents to be the greatest problem.

Site specific monitoring involves data from several components: pollution sources, infiltration potential, vadose zone, and aquifer. The only site specific monitoring identified in the 208 program was from the effluent reclamation projects at the 91st and 23rd Avenue treatment plants and at the PVNGS site.

Recommended Monitoring

Based upon the need to identify better the groundwater characteristics of Maricopa County and the nonpoint sources and the lack of data to accomplish

these, the general outline of a groundwater and nonpoint source monitoring program was proposed. The program would divide the east and west basins of the Salt River Valley, with the work in each basin being divided into hydrogeologic, regional groundwater quality and site specific monitoring.

Work in the hydrogeologic area includes requesting the USGS to complete its subsurface studies for the total Valley, preparing up-to-date water level contour maps, measuring canal seepage at 12 sites, developing procedures to collect well data and collecting data on the vadose zone.

Regional groundwater quality monitoring includes intensive sampling of 1200 large capacity wells every five years, developing procedures to collect well construction data, complete 24-hour sampling on 20 large wells and developing a program to transfer data.

The site specific work includes monitoring of the increasing salinity in Chandler and the Goodyear/Liberty area, monitoring irrigation return flow in shallow groundwater areas, monitoring storm runoff, and monitoring landfills and animal and industrial waste sites.

Implementation Considerations

In order to implement the proposed monitoring activities, several items are of paramount importance. First monitoring generally requires access to specific sites. In order to gain access, close cooperation is necessary with local entities and individuals. Through the 208 advisory committee structure, local input can be obtained on suggested monitoring and assistance with potential problems such as access.

In the case of monitoring irrigation return flow or animal wastes, the cooperation of the agricultural community is necessary. This includes Natural Resources Conservation Districts, irrigation districts, and individual farmers. For example, water sampling rounds for pumping wells must be coordinated to insure optimal sampling during heavy pumping periods. Also, sampling of cascading water, in part, requires access to wells when pumps are temporarily pulled for repair.

For monitoring potential sources in the urban area, there should be close cooperation with the various cities. In some cases, cities may have existing monitor wells that could be sampled; for example, near landfills. On-going investigations by the Arizona Department of Health Services, the U.S. Geological Survey, the Arizona Water commission, and others should have a direct influence on the 208 program. If monitoring can be conducted in cooperation with these agencies, there can be substantial economic savings, by avoiding duplication. In terms of solid wastes, industrial wastes, and hazardous wastes, there should be close cooperation with the relevant Arzona Bureau of Sanitation programs. Monitoring in all of the basins should be coordinated with the on-going Southwest Alluvial Basin Study of the U.S. Geological Survey. Monitoring in the Salt River Valley should be coordinated with the on-going Arizona Water Commission investigation. Lastly, monitoring of groundwater quality in Maricopa County should be coordinated

with that done for the Pima County 208 program to avoid duplication; for example, in the case of urban storm runoff.

Implementation of the proposed monitoring program will require further study, detailed plan formulation and close cooperation with on-going related programs will allow consideration of all potential sources. For example, sampling of well water for dissolved organic carbon may indicate sources of groundwater pollution not previously considered. The 208 program should be sufficiently flexible to allow changes each year in priorities. As some potential problems are shown to be minimal, less attention can be given to these and more attention given to others. In this manner, more attention is gradually focused on the most significant problems. Control measures can then be inacted, where necessary.

# CHAPTER VII

## WATER QUALITY PLAN IMPLEMENTATION

A key element of the 208 and Urban Study planning processes is the identification of a management system to implement the plan. Specifically, Section C (1) of Section 208 states that "The Governor of each state in consultation with the planning agency shall designate one or more waste treatment management agencies which may be an existing or newly created local, regional or state agency or political subdivision". According to Section 208, the management agency must have authority:

"(A) to carry out appropriate portions of an areawide waste treatment management plan developed under subsection (b) of this section;

(B) to manage effectively waste treatment works and related facilities serving such area in conformance with any plan required by subsection (b) of this section;

(C) directly or by contract, to design and construct new works, and to operate and maintain new and existing works as required by any plan developed pursuant to subsection (b) of this section;

(D) to accept and utilize grants, or other funds from any source; for waste treatment management purposes;

(E) to raise revenues, including the assessment of waste treatment charges;

(F) to incur short and long-term indebtedness;

(G) to assure in implementation of an areawide waste treatment management plan that each participating community pays its proportionate share of treatment costs;

(H) to refuse to receive any wastes from any municipality or subdivision thereof, which does not comply with any provisions of an approved plan under this section applicable to such areas; and

(I) to accept for treatment industrial wastes."

The Section 208 Management requirements can be met by a single governmental entity or by distributing the duties and responsibilities to a group of governments thus creating a management system. In essence, the management requirements are viewed by EPA to be as important as the plan itself. Congressional intent also places great importance on plan implementation and Water Quality Management.

Corps of Engineers Engineering Regulation 1105-2-92 states that a national objective of Urban Studies is that they "be implementable with respect to financial and institutional capabilities and public acceptance"; and that

Urban Study personnel "are responsible for identifying and analyzing the institutions affected by each plan, developing the necessary plan or institutional modifications, and assisting in the development of implementation strategies".

POINT SOURCE MANAGEMENT PLAN

An initial part in developing the point source management system was to complete an inventory of the existing system and assess it against the EPA requirements. The assessment of 35 agencies and municipalities was completed in March of 1977 and results presented to the communities. After much discussion, it was generally agreed that the existing system was, in some respects, not in compliance with Public Law 92-500 at the planning, operating, financing and management levels.

Alternative Management Systems

In June 1977, a subcommittee of the MAG Management Committee was formed to investigate optional methods for developing institutional mechanisms to meet the requirements of PL 92-500. Based on a review of Section 208 of the law, three alternative management arrangements were proposed:

- Combined planning and operating agency
- Separate planning agency and separate operating agency
- Separate planning and multiple operating agencies.

The alternatives were then evaluated using the following criteria:

- Economic efficiency in the system
- Equity
- Political accountability
- Political acceptability
- Administrative efficiency

After several meetings and considerable discussion, the MAG Management Subcommittee selected the Separate Planning Agency Subregional Operators Alternative, with MAG as the Planning Agency and a series of subregional operating groups as the Operators, each made up of a lead agency and individual communities. This was considered by the Subcommittee to be the most easily implemented management system for Phoenix area local governments because the management system concept, as opposed to the single entity management agency, causes minimum disruption to the present political and governmental system, and many of the system components are already in place.

The MAG/Subregional Operating Group concept was developed in more detail and after considerable discussion and modification was approved by the MAG

Management Subcommittee on September 28, 1977. In December of 1977, the proposed management system concept was reviewed by the 208 Citizen, Agricultural, and Technical Advisory Groups and several changes were incorporated into the draft report based on their comments and recommendations. The MAG Management Committee endorsed it on December 28, 1977, and the MAG Regional Council adopted it on March 15, 1978.

The adopted MAG Point Source Management System, as shown in Figure VII-1, calls for the MAG Regional Council, with the assistance of a Water Quality Policy Advisory Committee and the MAG Management Committee to be responsible for on-going areawide wastewater management planning, plan implementation, and coordination of municipalities and private agencies in meeting the requirements of Public Law 92-500. Subregional operating groups (SROG), composed of local governments and private agencies have been created and have coordination, planning, grants management and operational responsibilities (Figure VII-1). MAG is responsible for regional water quality planning and for monitoring implementation actions to assure conformance with the adopted plan. Each SROG with the approval of the MAG Regional Council has designated a Lead Agency to carry out the day-to-day operation of the system.

The subregional operating group concept has been designed to provide flexibility. Several governmental agencies of an area can participate jointly (multiple member SROG) or an agency can participate as a single entity (single member SROG). A local government may also be a member of more than one SROG.

The governing body of each city and town in each multiple member SROG has adopted a resolution to establish the SROG and agree to be a SROG member and requested designation by MAG. The resolutions also outline the duties and responsibilities assigned to MAG for overall planning and coordination of areawide water quality management in Maricopa County. MAG, in turn, adopted resolutions designating each SROG and Lead Agency.

In addition to resolutions and requests for designation, Intergovernmental Agreements are being prepared by multiple member SROGs to finalize SROG and member agency duties and responsibilities.

Multiple Member SROG: Three multiple member SROGs have been designated by MAG for the metro study area:

| SROG | Lead Agency |
|---|---|
| o Multi-City (Phoenix, Mesa, Gilbert, Tempe, Scottsdale, Youngtown, Glendale) | Phoenix |
| o Tolleson | Avondale |
| o Avondale-Goodyear | Goodyear |

Single Member SROG: The following single member SROGs have been designated for the metro area:

- Buckeye
- Chandler
- Gilbert

A brief description of the duties and responsibilities of each member of the management system follows.

Maricopa Association of Governments

Under the adopted management system, MAG will assume a major new role in the planning and implementation of the wastewater management function.

Regional Council: The MAG Regional Council will now have to assure that the 208 plan is implemented and that each community follows the plan for wastewater management. The Council will also have to ensure that problems within the SROG be resolved before they affect the SROG's ability to carry out its delegated responsibilities.

Water Quality Policy Advisory Committee: This committee will provide assistance to the Regional Council in recommending construction priorities for the region and in updating the 208 plan. The committee, which includes members from the MAG 208 technical, agricultural and citizen interest groups, also serves as the advisory committee for the Multi-City 201 facility plans. The committee will review, evaluate and recommend facility planning alternatives.

MAG Management Committee

The MAG Management Committee will assume new responsibilities for wastewater management. These include ensuring that the region's 208 plan is coordinated with state and federal agencies, monitor compliance of local governments with the 208 plan, and make recommendations to the Regional Council on proposed wastewater treatment projects.

Water Quality Management Staff

This staff will be a continuation of the present 208 staff. Its major duties will be to provide assistance to the Management Committee, Water Quality Policy Advisory Committee and the MAG Regional Council.

Subregional Operating Groups

In the multiple member SROGs, a SROG Board composed of officials appointed by the governing body of member agencies is established with coordination responsibility. The Lead Agency will provide staff to carry out the duties and responsibilties of the SROG. In a single member SROG, the governing body of the individual city or town will serve as the SROG Board and the Lead Agency.

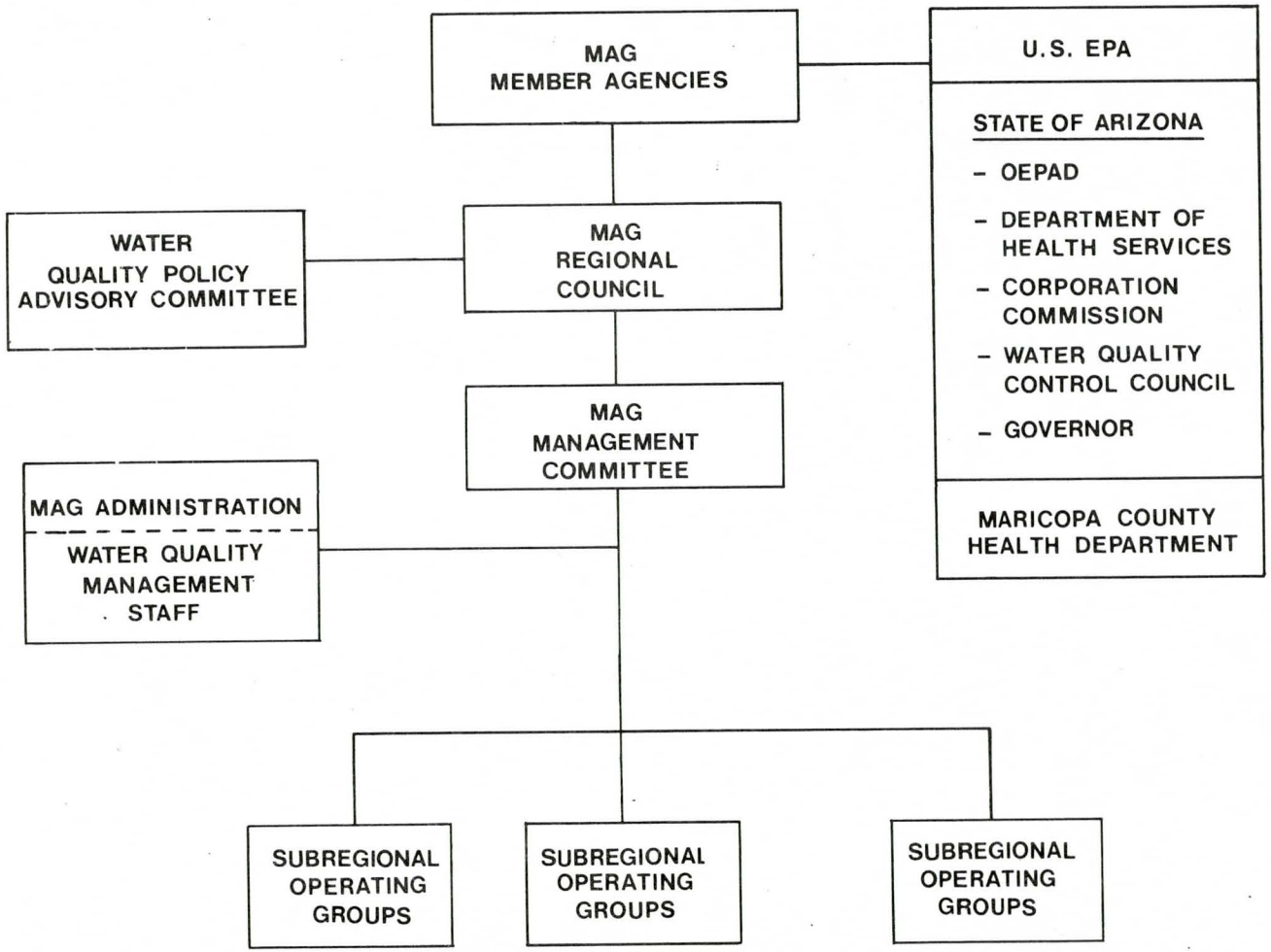



Figure VII-1
SELECTED POINT SOURCE MANAGEMENT PLAN

Management of the wastewater facilities by the SROGs will include the following duties and responsibilities:

- o Wastewater planning for the SROG area and submit annually to MAG projected projects for the area
- o Annual review of the sewer user charge and industrial cost recovery to ensure rates are satisfactory and that the system is in compliance with EPA
- o Apply for federal grants for wastewater projects
- o Supervise construction of projects
- o Operate and maintain the wastewater facilities
- o Conduct monitoring to ensure compliance with EPA, state and local standards and permits.

Management System Implementation

The point source management plan concept is now fairly well understood by all of the local communities and the single and multiple member SROGs. What has to be done in the immediate future is for the specific details of the MAG/community agreements and the intergovernmental agreements to be worked out and the agreements signed.

NONPOINT SOURCE MANAGEMENT PLAN

The 208 work program intended that like the Point Source Plan, some form of management structure would be established to implement the recommendations to reduce nonpoint sources of pollution. Unlike the Point Source Plan there were no specific structural or non-structural control measures recommended and the monitoring program recommended to better define the problem came too late in the program to be able to develop an agency structure. Therefore the major effort to define and develop a nonpoint management plan and identify interested agencies to implement the program still has to be completed in future 208 planning.

Monitoring Program

The Maricopa Association of Governments initiated a groundwater monitoring program in 1879-1980. This program has been completed, although the results have not yet been finalized. Under an agreement between MAG and the City of Phoenix, a routine quarterly sampling of groundwater quality at the Phoenix landfills in the Salt River bed began in August 1980. This program, along with a similar one at the Tri-Cities landfill on the north side of the Salt River on the Salt River Indian Reservation, is continuing. Results of these efforts also have not yet been finalized.

# CHAPTER VIII

# FLOOD CONTROL

The Phoenix Urban Study considered alternatives for reducing flood damages and protecting people, property, and productive lands from flood losses. Flood prone areas examined by the Urban Study included Glendale-Maryvale, South Phoenix, Cave Creek downstream from the Arizona Canal, the Old Cross Cut Canal, Upper Indian Bend Wash, Gila Floodway, Scatter Wash, and the Salt River through the study area. Structural and non-structural measures were considered to control floods and protect property from damage. Information regarding flood hazards and overflow areas developed in the course of Urban Study flood damage assessments was made available to the appropriate local agencies for their use.

## PROGRAM ORGANIZATION

Organization of the flood control portion of the Phoenix Urban Study involved coordination between Urban Study planners and the Flood Control District of Maricopa County and the Bureau of Reclamation.

With the exception of the Gila Floodway project and Scatter Wash, all of the flood prone areas examined by the Phoenix Urban Study fall within the comprehensive five-phase flood control plan for the Phoenix Metropolitan area developed by the Corps of Engineers in cooperation with the Flood Control District of Maricopa County. This plan is intended to serve as a framework for all flood control projects in the study area. Phases of the plan are:

- Phase A - Indian Bend Wash from the Arizona Canal to the Salt River. Plan formulation on this phase has been completed and approved and construction on the Indian Bend Wash greenbelt floodway is underway.

- Phase B - New River and Phoenix City Streams. Plan formulation and general design memorandum proposing flowage easements along Skunk Creek and the New and Agua Fria Rivers and dams on Cave and Skunk Creeks and the New River and a diversion channel along the northbank of the Arizona Canal have been approved. Construction of Cave Buttes Dam on Cave Creek has been completed.

- Phase C - Glendale-Maryvale area and South Phoenix. Preliminary survey of alternatives for flood control in these areas was included in the Phoenix Urban Study.

- Phase D - Salt River from Granite Reef to the Confluence with the Gila River. Preliminary survey of alternatives for Salt River flood control was included in the Phoenix Urban Study.

- Phase E - Indian Bend Wash North of the Arizona Canal. Preliminary survey of alternatives for flood control along upper Indian Bend Wash was included in the Phoenix Urban Study.

The Flood Control District also requested that control of flooding along the Old Cross Cut Canal and in the Arcadia district of east Phoenix be included in the Urban Study.

## FLOOD CONTROL PROJECTS

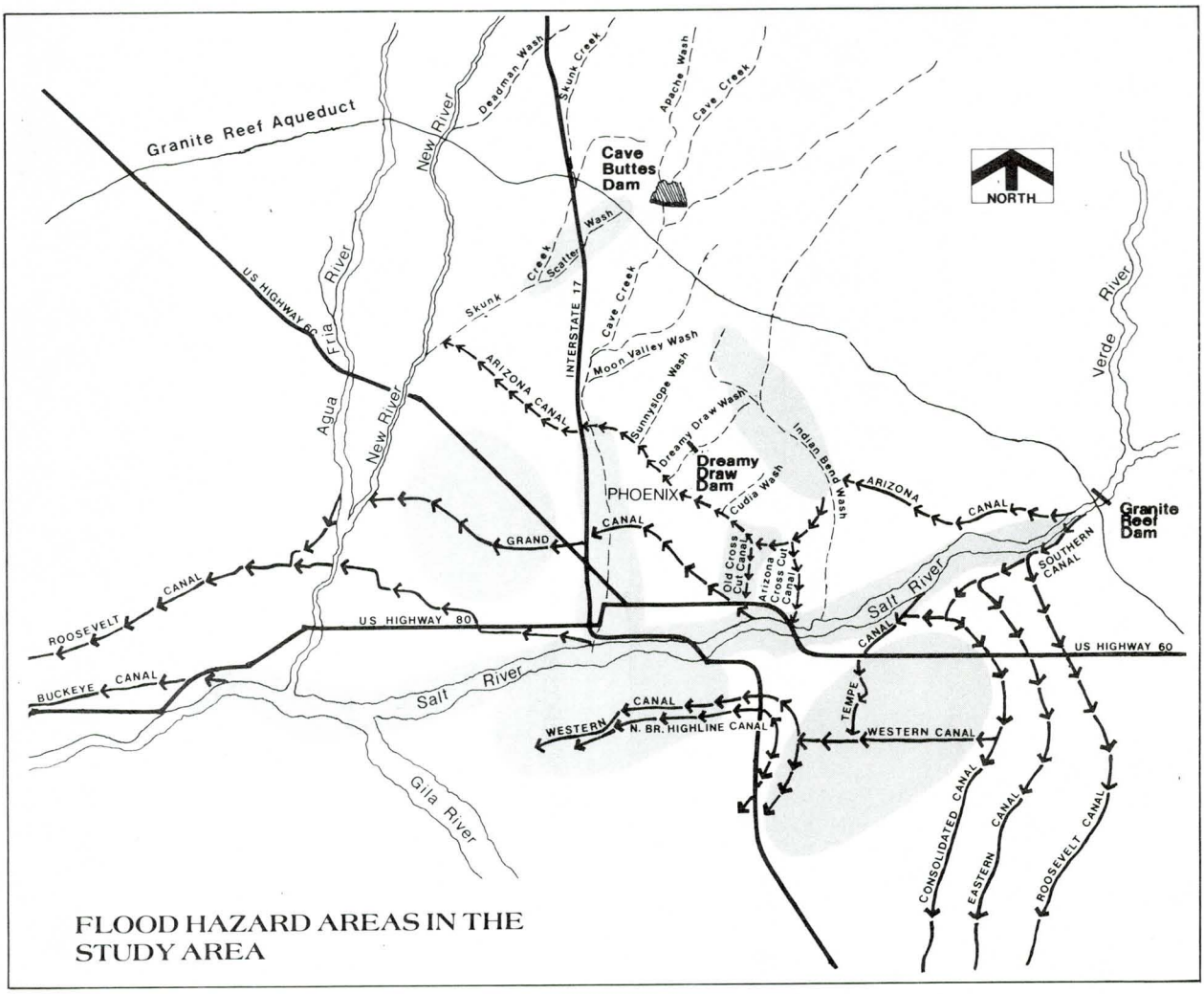
The examination of flood control alternatives in metropolitan Phoenix was conducted to determine if further Federal interest in them was warranted. The economic analysis of these alternatives was carried out to the point that it became obvious that they did not merit additional study by the Corps. The economic data presented in this appendix represent the level of detail needed to make such a decision, and emphasizes benefits derived from inundation reduction. Had additional study by the Corps appeared to be warranted, the level of detail of economic analysis would have increased to include emergency costs and business losses. In addition, since none of the flooding problem areas, with the exception of the Salt River through Phoenix, involved lengthy closure of bridges or roadways, the calculation of transportation delay costs was not considered to be appropriate.

### Glendale-Maryvale

Flooding in the City of Glendale and in the adjacent Maryvale area occurs as a result of intense rainstorms directly over the area. The drainage area considered in this report lies between the Arizona Canal and the Grand Canal as shown in Figure VIII-1. Urbanization and agricultural development have obliterated most original watercourses, and runoff occurs basically as sheet flow spred rather uniformly over the flat valley slopes. The depth of flooding does not become a serious problem until the floodwaters collect behind the man-made obstructions such as the Santa Fe railroad embankment and the Grand Canal levees. It is in these areas where deep ponding of floodwaters occurs that structural solutions to the flood problem have been sought.

Plan formulation for flood control in the City of Glendale was based on the assumption that the recommended flood control channel along the north side of the Arizona Canal, as described under Phase B above, would be in operation and provide 100-year frequency flood protection to the area south of the canal. Floodwaters produced from rainfall over the area below the Arizona Canal still would collect and be conveyed along the city streets, in the irrigation ditches, and overland as sheet flow to the Santa Fe railroad embankment. Floodwaters back up along the north side of the railroad embankment in ponding areas from about 43rd Avenue northwestward. Flows through two small trestles eventually would drain the ponding areas south to the Grand Canal.

The standard project flood with a peak discharge of 7,100 cubic feet per second (cfs) in Glendale and a frequency of 500 years would cause flooding to property situated along Grand Avenue to an average depth of 3 feet. Flooding to an average depth of 2 feet would result from the 100 year flood with a peak discharge of 3,800 cfs. The 25-year flood with a peak discharge of 2,500 cfs would produce average depths of 1.5 feet.




FLOOD HAZARD AREAS IN THE STUDY AREA

FIGURE VIII-1

South of the railroad embankment, water flowing from the two small trestles and a few smaller drainage structures through the embankment combines with rainfall and flows southwestward to the Grand Canal in the Maryvale area. It ponds along the north side of the Canal from about 43rd Avenue to New River, a distance of about 9 miles.

The standard project flood would cause flooding to property to an average ponding depth of 3 feet. The 100-year event would result in an average ponding depth of 2 feet. The 25-year flood would cause flooding to an average ponding depth of 1.5 feet.

The alternative plans to alleviate flooding in Glendale-Maryvale fell into two groups: major channels and retention basins. The major channels described below consist of a North Unit and a South Unit and would convey floodflows away from populated areas of Glendale westward in the North Unit for discharge into the New River and away from the populated areas of Maryvale in the South Unit for discharge in either the New River or the Agua Fria River. The retention basin alternative would provide protection from a single 100-year flood event, but not storage for additional floods occuring in rapid sequence. The basins would have to be emptied in order to provide subsequent protection.

Alternative A (See Figure VIII-2 for Alignment): This alternative consisted of a North Unit and a South Unit. The North Unit, about 8.5 miles long, begins 2,500 feet east of 43rd Avenue and approximately 1,900 feet south of Olive Avenue with a rectangular concrete lined open channel about 5.35 miles long. It becomes a trapezoidal concrete lined channel just downstream of 75th Avenue. This section of channel is about 3.15 miles long and discharges into the New River just west of 99th Avenue. The rectangular channel would have a bottom width ranging from 8 to 30 feet and a depth ranging from 6.5 to 13 feet. The trapezoidal section would have side slopes of two horizontal to one vertical, bottom widths ranging from 30 to 35 feet, and depths ranging from 10.5 to 13.5 feet. The 100-year design capacity of the channel would be from 250 to 8,000 cubic feet per second. To complete the North Unit, a rectangular concrete covered channel about 1.2 miles long located under Grand Avenue begins just northwest of the Santa Fe Depot and flow northwestward to the main channel. Base widths range from 12 to 28 feet and wall heights from 7.5 to 10 feet. The 100-year design capacity would be from 500 to 2,500 cubic feet per second. All open channels would be excavated to a depth at or below the adjacent ground surface so as to intercept surface runoff. Catch basins along Grand Avenue would collect the surface runoff for conveyance in the covered section. One railroad bridge and eighteen street bridges would be required at half-mile intervals for street crossings.

The first costs were estimated to be $24 million (1976 dollars) with average annual charges estimated at $1.53 million based on an amortization rate of 6-3/8 percent over a 100-year period. The average annual benefits from flood damages prevented were estimated at $1.21 million. The benefit to cost ratio would be less than 0.8 for this increment of the project. The above first costs do not include the cost of storm sewer systems to collect

the floodwater runoff along the city streets and in the ponding areas. These would be required of local interests to make the channels fully effective.

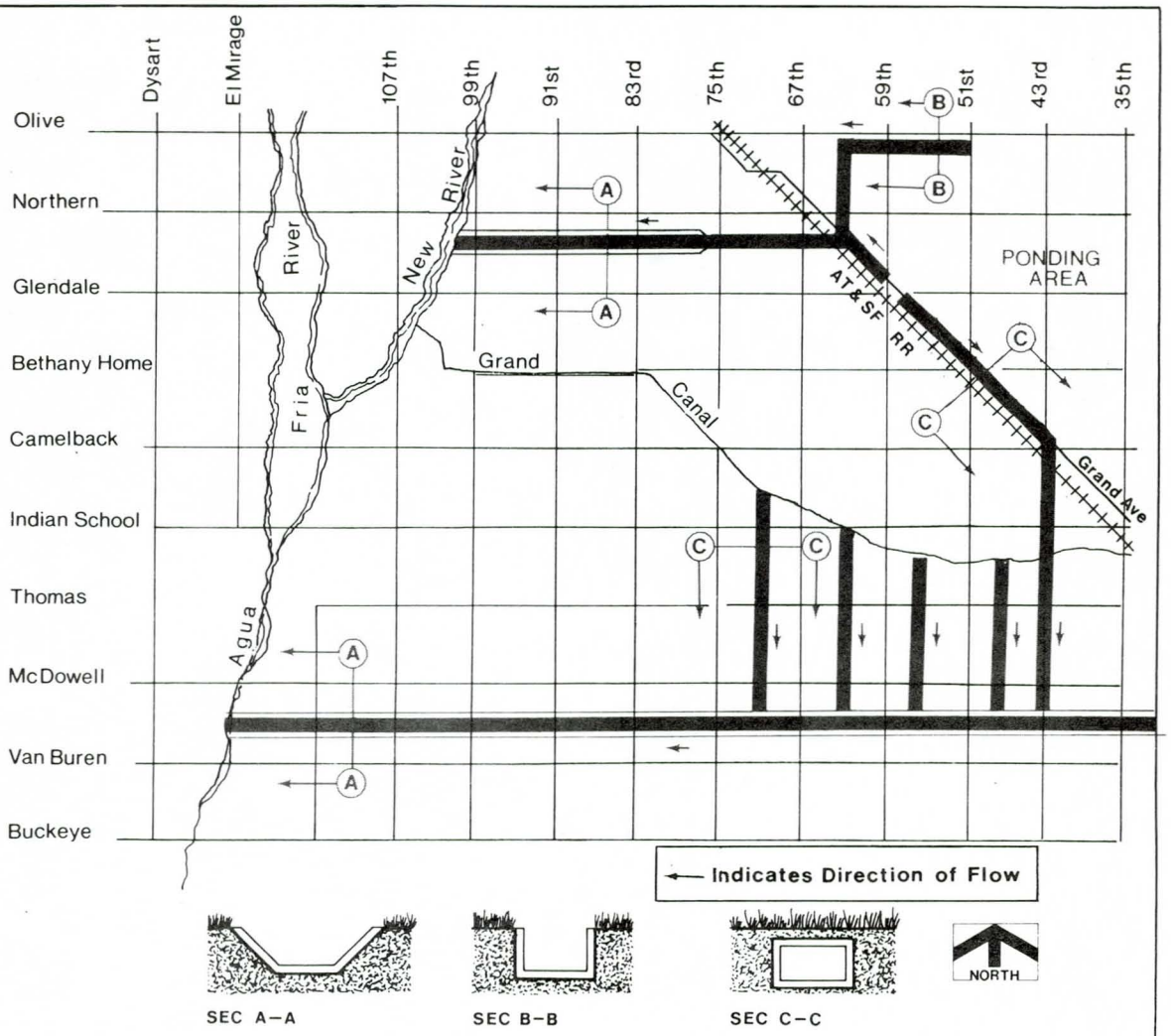
The South Unit, about 15.6 miles long, begins at 58th Avenue in Glendale with a rectangular covered channel section located under Grand Avenue and flows southeasterly to 43rd Avenue. At 43rd Avenue the direction of the covered channel changes and flows to the south under 43rd Avenue to a point about 1,400 feet south of McDowell Road. It discharges floodwaters into a trapezoidal channel located parallel to the north side of the proposed I-10 Interstate Highway. This section of channel would be about 5.3 miles long with base widths ranging from 14 to 30 feet and wall heights ranging from 9 to 12 feet. The 100-year design capacity would be from 730 to 4,100 cubic feet per second.

The concrete-lined trapezoidal channel, about 10.3 miles long, located along the north side of the proposed I-10 Interstate Highway would convey floodwaters westward for discharge into the Agua Fria River. It would have a bottom width ranging from 28 to 35 feet and depths ranging from 11.5 to 15 feet with side slopes of two horizontal to one vertical. The 100-year design capacity ranges from 4,500 to 10,500 cubic feet per second. The channel also would be designed and constructed to collect runoff from the I-10 Highway.

In addition to the channels described above, Alternative A would include four covered rectangular sections under 55th, 63rd, 71st, and 83rd Avenues to collect floodwater along the Grand Canal in Maryvale and convey it southward for discharge into the trapezodial section at the I-10 Highway. These channels would extend under the Grand Canal. Inlet structures of sufficient capacity would be provided adjacent to the Grand Canal along its north bank. The base widths of these channels range from 8 to 14 feet and wall heights range from 7 to 15 feet. The lengths would be from about 2 miles at 55th Avenue to 4.5 miles at 83rd Avenue. The 100-year design capacity would range from 1,100 to 3,600 cubic feet per second.

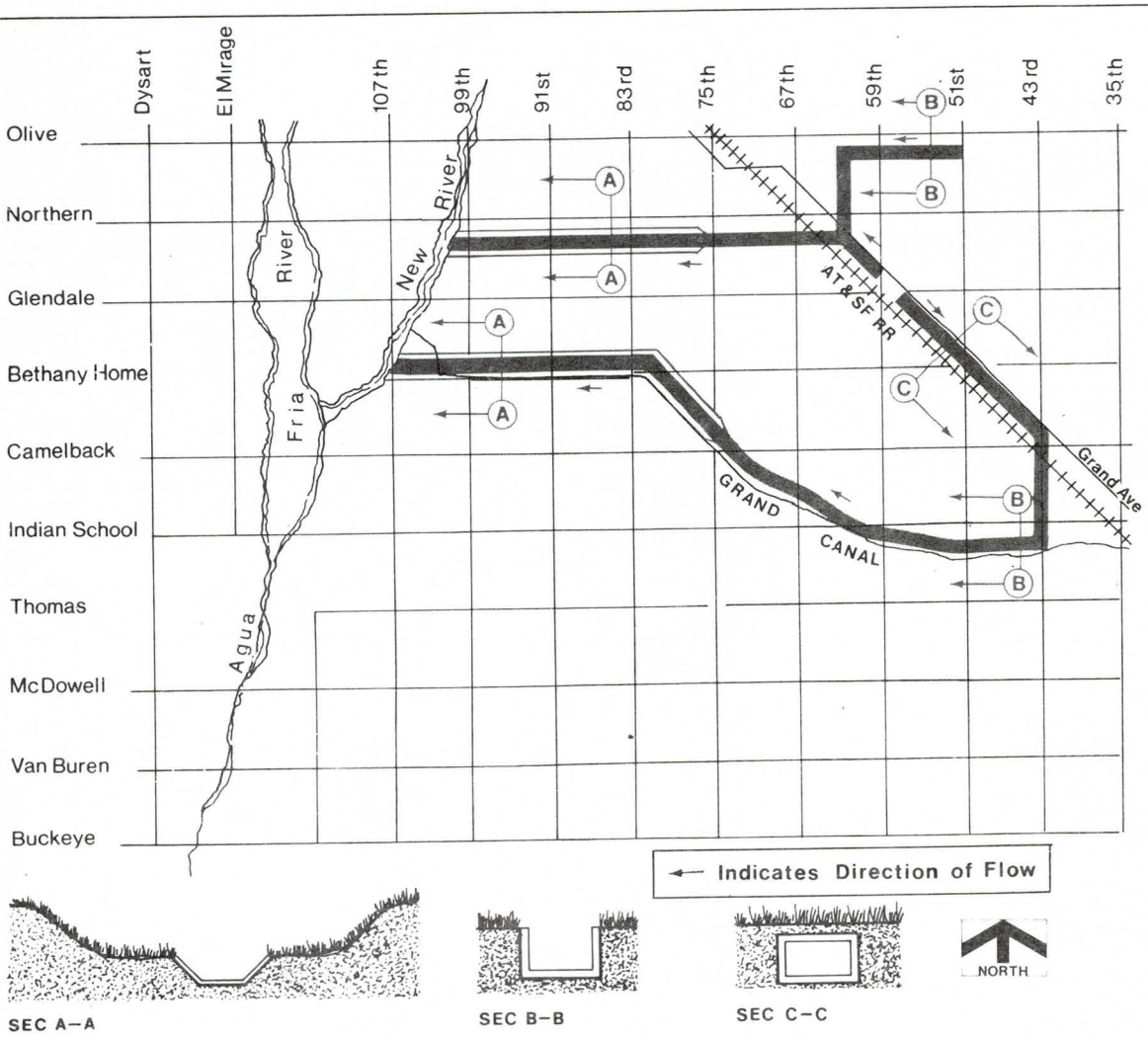
The first costs were estimated at $97.4 million with annual charges estimated at $6.2 million. The average annual benefits from flood damages prevented are estimated at $1.2 million. The benefit to cost ratio would be less than 0.2 for the South Unit of the system. The combined cost of Alternative A would be $121.4 million. The average annual charges were estimated at $7.7 million, with average annual benefits from flood damages prevented by 100-year protection estimated at $2.1 million. The benefit to cost ratio would be less than 0.3. (See Table VIII-1)

Alternative B (See Figure VIII-3 for Alignment): This alternative also consisted of a North Unit and a South Unit. The North Unit of Alternative B is identical to Alternative A with one exception. The trapezodial concrete lined channel from about 75th Avenue to the New River just west of 99th Avenue would be replaced with a greenbelt/low-flow channel section. The greenbelt channel would be trapezoidal with a bottom width




GLENDALE-MARYVALE FLOOD CONTROL ALTERNATIVE A

FIGURE VIII-2






SEC A–A



SEC B–B



SEC C–C

GLENDALE-MARYVALE FLOOD CONTROL ALTERNATIVE B

FIGURE VIII-3

of 600 feet and side slopes of six horizontal to one vertical. The low-flow channel also would be trapezoidal, three feet deep, and unlined, with side slopes of six horizontal to one vertical. The bottom of the greenbelt channel would slope upward from the bank of the low-flow channel at a rate of 50 feet horizontal to one vertical. Two drop structures would control the velocities. The grass-lined channel would be irrigated by a sprinkler system.

The first costs were estimated to be $32.5 million with average annual charges of $2.1 million. Estimated average annual benefits from flood damages prevented were $930,000. The benefit to cost ratio would be less than 0.5 for the North Unit. The South Unit of Alternative B would be identical to Alternative A from its beginning at 58th Avenue in Glendale to a point on 43rd Avenue at the Grand Canal. The channel alignment would then be directed west along the north side of Grand Canal to its confluence with New River near 107th Avenue, a distance of about 9 miles.

Between 43rd Avenue and 75th Avenue, a distance of about 4.5 miles, the flood control channel and the Grand Canal would be designed as a composite rectangular concrete open channel section with a common wall between them. The flood control channel would be excavated to a depth at or below the existing ground surface. The resulting elimination of the existing berm on the north side of the Grand Canal would permit surface runoff to enter the channel and eliminate the ponding problem in the Maryvale area.

The flood control channel would have base width ranging from 50 feet at 43rd Avenue to 90 feet at 75th Avenue and wall heights from 11 feet to 14 feet. The irrigation canal would maintain its present elevation and vary in width to accommodate the maximum irrigation demand. The 100-year design capacity of the flood control channel would range from 5,660 to 12,000 cfs.

At 75th Avenue the rectangular channel becomes a greenbelt channel as described above for the North Unit. This reach would extend for about 4.5 miles to the New River. The 100-year flood design ranges from 12,000 to 14,900 cfs. Two drop structures would be required. The first costs were estimated at $75 million with average annual charges of $4.8 million. The average annual benefits from flood damage reduction are estimated at $1.2 million, producing a benefit/cost ratio for the South Unit of less than 0.3.

The combined cost for Alternative B is estimated at $107.5 million, with average annual costs of $7.0 million. The average annual benefits from flood damages prevented with 100-year protection are estimated at $2.1 million. The benefit/cost ratio for this alternative would be less than 0.3. (See Table VIII-1)

Alternative C (See Figure VIII-4 for Alignment): This alternative consisted of 18 retention basins located in flood prone areas at selected concentration points. The basins would provide for the collection and retention of the total volume of rainfall runoff resulting from the 100-year storm centered over the sub-area for that basin.

Each basin would have a controlled outlet to provide control for the release of the retained floodwaters for disposal as wastewater or for beneficial reuse options. The grass-lined basins would be excavated below adjacent street elevations, thereby removing the necessity for emergency spillways. Beautification measures and general landscaping would be provided. The total volume of the 100-year storm thus retained is estimated at 2,600 acre-feet with total surface area of 360 acres.

The first costs were estimated to be $36.2 million with average annual charges $2.5 million. The average annual benefits from flood damages prevented were estimated at $2.1 million, giving a benefit/cost ratio less than 0.9. (See Table VIII-1)

It was determined through a process of optimization that the benefit/cost ratio could be increased by lowering the level of protection. A 25-year level of protection might have produced a benefit/cost ratio of 1.0. This design, however, clearly indicated that, using the criteria contained in Engineering Regulation 1165-2-21, the project would be a storm drain and not a flood control project. Storm drain projects are the responsibilities of local governments, and for this reason, planning by the Urban Study for Glendale-Maryvale flood control was discontinued.

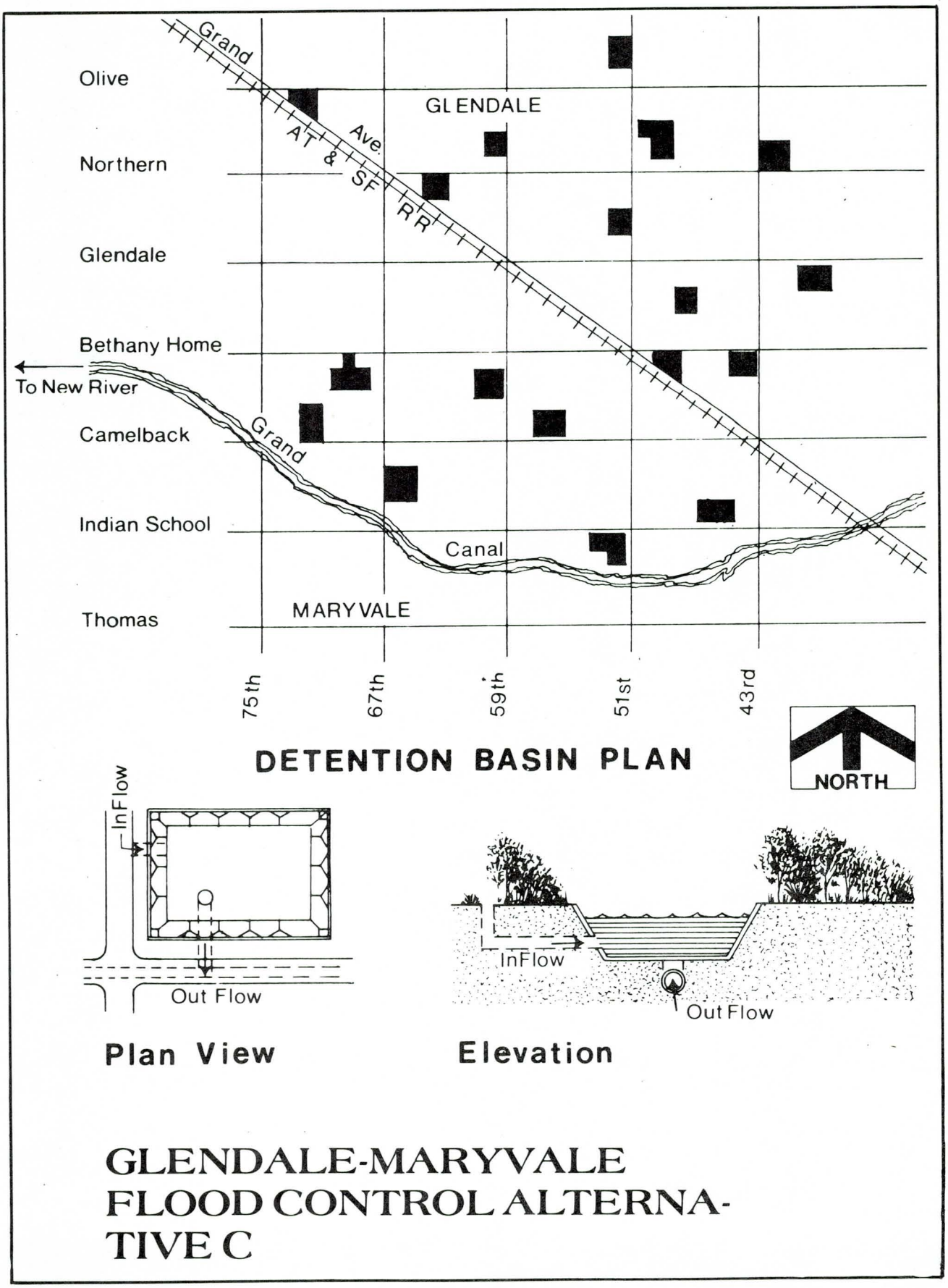
Cave Creek Below the Arizona Canal

The Cave Creek overflow area examined by the Phoenix Urban Study lies between 7th Street on the east and 19th Avenue on the west beginning at the Arizona Canal and flowing southward to the Salt River (see Figure VIII-5).

The plan formulated for the authorized New River and Phoenix City Streams Project (Phase B of the comprehensive flood control plan for the Phoenix metro area) proposed the construction of the Cave Buttes Dam, now complete and the Arizona Canal Diversion Channel, scheduled for construction in the mid-1980's. These structures will reduce significantly the flooding in the study area. The Arizona Canal Diversion Channel will control the 100-year frequency flood. Floods of greater magnitude will overtop the diversion channel and areas above it will contribute to runoff to lower Cave Creek. A drainage area of 36.7 square miles below the Arizona Canal also contributes to flooding in the overflow area.

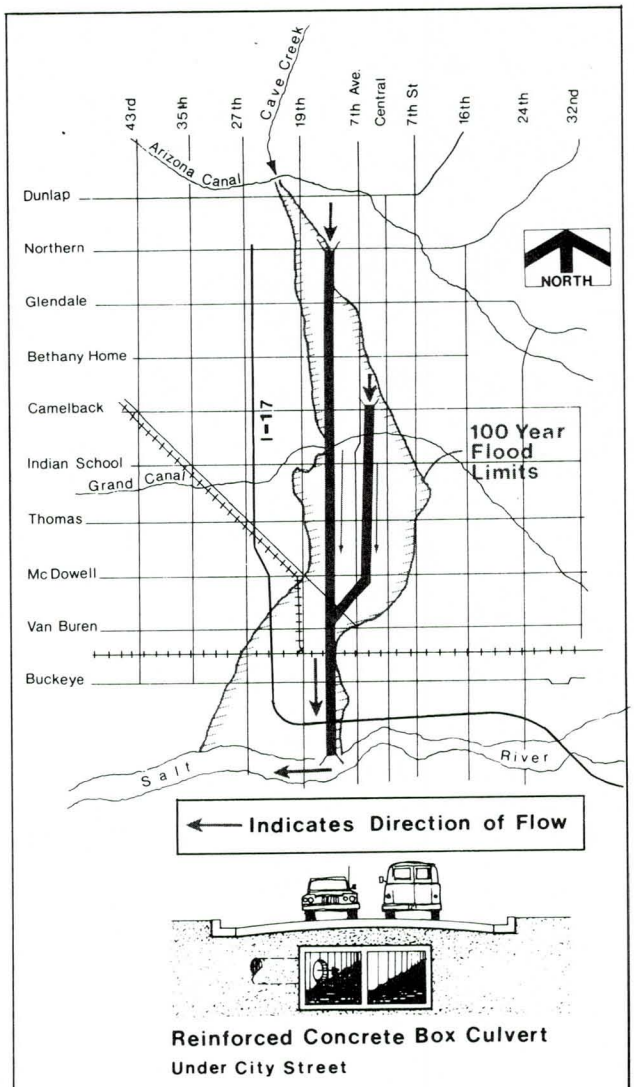
With the upstream projects in operation, a standard project flood of an estimated 18,000 cfs would occur at the Arizona Canal increasing to 21,000 cfs at the Salt River. Average ponding depths of 3.9 feet can be expected from this event in the overflow area, flooding the business and government centers of downtown Phoenix, residential neighborhoods, commercial areas, and shopping centers. The 100-year flood flows would vary from zero at the Arizona Canal to 14,000 cfs at the Salt River with ponding depths to two feet in the lower areas.

The drainage area, and particularly the overflow area below Arizona Canal, is laced with existing storm sewers constructed by the City of Phoenix.




# GLENDALE-MARYVALE FLOOD CONTROL ALTERNATIVE C

FIGURE VIII-4




Reinforced Concrete Box Culvert
Under City Street

FLOOD CONTROL ALTERNATIVES FOR CAVE CREEK BELOW THE ARIZONA CANAL

FIGURE VIII-5

The City of Phoenix capital improvements program projects future major storm sewer trunk lines at approximately one mile intervals along north-south major streets and terminating at the Salt River. Also included is the construction of trunk lines in selected one-half mile collector streets to drain newly improved east-west major streets and improve the interception rate of parallel trunk lines. The completion of this storm sewer system will reduce the depth of sheet flow and ponding that occurs throughout the drainage area. Economic analyses made for the New River and Phoenix City Streams project indicate that average annual flood damages estimated at $1,145,000 would remain after construction of the project. This figure was used to estimate the probable benefits for plan formulation described below.

Alternative A Consisted of a reinforced concrete covered channel 9.5 miles in length constructed beneath the pavement of 15th Avenue beginning just north of Glendale Avenue and extending southward to the Salt River. It would be designed to serve as an outlet channel for a storm sewer system and to intercept overland flows at pricipal concentration points. The 100-year design flood varies from 500 cubic feet per second at the inlet above Glendale Avenue to 16,000 cubic feet per second at the Salt River. The soffit to the covered channel would be set at an elevation of about 5 feet below pavement to accommodate future storm sewer connections of east-west trunk lines. Width of the channel would be from 10 to 48 feet, with walls from 5 to 16 feet in height. First costs for this plan were estimated at $40 million and average annual charges at $2.6 million. The average annual benefits from flood damages prevented were put at $920,000, giving a benefit/cost ratio less than 0.4. (See Table VIII-1)

Because of the exceedingly poor benefit/cost ratios for both alternatives, the Flood Control District requested that the Urban Study cease work, deciding that non-Federal solutions such as flood plain regulation were more appropriate means of reducing flood damages.

Old Cross Cut Canal

The Old Cross Cut Canal was constructed the late 1880s to transfer water between the Arizona Canal and the Grand Canal.

The Old Cross Cut Canal begins near 48th Street in Phoenix, and courses south from a gated outlet in the Arizona Canal to the Grand Canal, a distance of 3.6 miles. The canal is an earth channel, deeply incised, much of which is unimproved. Culverts at the major street corssings vary in size, shape, and combinations and are of limited capacity. The canal is no longer used by the Salt River Project as a water supply transfer system between the Arizona and Grand Canals, but it is used for wasting from the Arizona Canal during rainstorms or floods. The canal also receives local storm drainage from the east through overland flow and from east and west storm sewer conduits. Gates in the Grand Canal with an outlet to the Salt River assist in dumping storm flows in the Old Cross Cut Canal and the Grand Canal.

The drainage area contributing stormwater runoff to the headgate of the Old Cross Cut Canal comprises nearly 4 square miles and lies between Camelback Mountain and the Arizona Canal from 40th Street to 68th Street. Runoff from Camelback Mountain-Arcadia area results in sheet flow and ponds behind the north levee of the Arizona Canal. Runoff from floods exceeding the 25-year event overtops the north levee at various locations and is intercepted by the Arizona Canal. During such events, the Arizona Canal is emptied into the Old Cross Cut Canal. Floodwaters eventually fill the Arizona Canal and overflow its south bank. Floodflows then disperse into sheet flow through developed areas below the canal. Some of the sheet flow will be intercepted by the Old Corss Cut. The remaining flows will pond along the north bank of the Grand Canal.

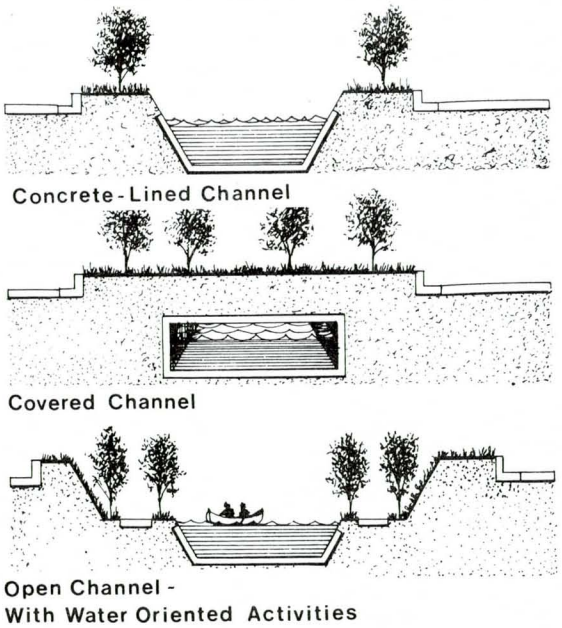
The standard project flood immediately north of the Arizona Canal would result in a ponded area about 300 feet in width. Depths of ponding would vary from 0 to 5 feet. Below Arizona Canal, an estimated 3,000 acres of residential property would be flooded to depths varying from 0.5 feet as sheet flow to depths 3.5 feet in ponded areas adjecent to the Grand Canal.

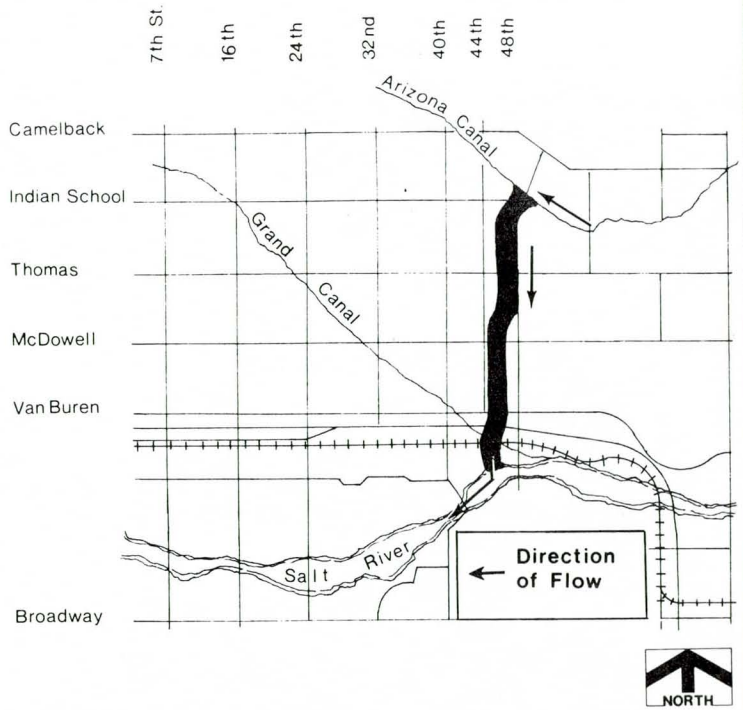
A preliminary estimate of the costs and benefits for a flood control project (see Figure VIII-6) consisting of improved channels indicated a favorable benefit/cost ratio for 25-year protection. The project, however, was withdrawn from further consideration by the Phoenix Urban Study on July 18, 1978. This action resulted from the policies and guidance contained in Engineering Regulation 1165-2-21 which provided criteria for Corps of Engineers participation in flood control projects in urban areas. According to this regulation, the Corps can participate only in flood control projects associated with natural streams or modified natural waterways. It was determined that the Old Cross Cut Canal project did not conform to these criteria.

South Phoenix

The standard project flood overflow area considered in South Phoenix comprised about 22 square miles lying between the base of the South Mountains and the Salt River. It is bounded on the east by 48th Street and on the west by 35th Avenue. The area is crossed in an east-west direction by two principal irrigation canals of the Salt River Project: the Highline and Western Canals. The area slopes to the north and west with elevations ranging from about 1,000 feet at the Salt River to about 2,500 feet in the South Mountains (sometimes referred to as the Salt River Mountains). A number of small washes originate along the north slope of the South Mountains and flow north through well-defined channels until they emerge from the mountains onto the alluvail fan below. At this point, agricultural and urban development have obliterated all trace of stream channels and the stream flow becomes sheet flow as the water spreads out along streets, irrigation ditches, and other man-made obstructions. Possibly this spreading effect of stormwaters has prevented serious flood damages from occurring. Stormwaters reach damaging depths only immediately behind irrigation canals and along the berms of irrigation ditches.

In the South Phoenix study area local interests have constructed major trunk




FLOOD CONTROL ALTERNATIVES FOR THE OLD CROSS CUT CANAL

FIGURE VIII-6

storm sewers along 19th Avenue, 7th Avenue, 7th Street, and 24th Street beginning at Southern Avenue and flowing northward to the Salt River, and under the capital improvements program of the City of Phoenix, are extending these sewers southward to Baseline Road. In addition, major trunk storm sewers are planned along Central Avenue from Baseline Road to the Salt River, 16th Street from Southern Avenue to the Salt River, 32nd Street from Baseline Road to the Salt River, and 40th Street from Baseline Road to the Salt River. Plans also have been developed by the City of Phoenix for the construction of a detention basin at the mouth of a canyon located near the intersection of Central & Mineral Avenues utilizing the gravel pits located there serving as an adjunct to South Mountain Park Recreation Area.

Floodwaters from a standard project storm centered over the South Mountains are concentrated along a 6-mile front between 48th Street and Central Avenue. When the flat area is reached, the runoff is dispersed by city streets, irrigation ditches, and other developments. The floodwaters generally follow the principal north-south thoroughfares until they reach a point of discharge into the Salt River. The magnitude of floodwaters continues to increase as rain falls over the valley area. As an example, the standard project flood would range from about 5,600 cfs at South Mountain Detention Dam to about 7,100 cfs at the Broadway Road and 19th Avenue intersection. Flooding would cover about 14,000 acres to an average depth of 0.5 feet. Damages to future developments caused by the standard project flood are estimated to total $31.7 million to property valued at $443 million. Due to the spreading effect of floodwaters, damages from floods of lesser magnitude decrease rapidly.

The alternate plans considered consisted of detention basins in combination with major channels to collect floodwaters as they emerge from the South Mountains and convey them away from the populated areas to the Salt River.

Alternative A: This plan consisted of a diversion system and a detention basin described below (see Figure VIII-7):

The diversion system is composed of an upstream reach of about 6 miles of earth levee and channel, and a downstream reach of about 6 miles of entrenched concrete-lined channel with access ramps provided at appropriate locations for operation and maintenance.

A levee would extend along the south side of Highline Irrigation Canal from about 48th Street to 7th Avenue. Fill material could be obtained from an excavated earth channel on the south side of the levee. Levee heights would vary from 4 to 12 feet above the existing ground.

A concrete lined channel, located about 1/4 mile north of Dobbins Road, would extend westward from 7th Avenue to a point about 1/4 mile east of 35th Avenue and then north to the Salt River. The channel would be trapezoidal in section with a base width from 30 to 40 feet and height from 9 to 24 feet. Paved berms would be provided where sheet flow enters the channel.

The system would be designed to divert flows up to the magnitude of a standard project flood. The design discharges range from 900 cfs at the upstream end to 22,500 cfs at the confluence with Salt River.

Numerous small washes and tributary areas would enter the leveed, unlined channel at an angle of about 90 degrees. Flows from these small washes have a high potential for moving sediment because of the steep gradients. In those washes which can be expected to deposit sediment in large volumes, excavated basins capable of storing the expected debris also would be provided. The minimum freeboard would be 5 feet, without debris deposition, for the earth levee and 2.5 feet for the concrete-lined channel. Velocities parallel to the levee are subcritical and vary from 2 to 6 feet per second. Velocities in the concrete-lined channel, however, would be supercritical and vary from 26 to 32 feet per second.

A detention basin was considered for construction at the mouth of a canyon located near the intersection of Central and Mineral Avenues. The details of this proposed basin will not be described in this report as the City of Phoenix has responsibility for the design and construction of a similar structure in the immediate vicinity.

First costs for this plan were estimated to be $27.2 million with average annual charges put at $1.89 million. The average annual benefits from flood damages prevented are estimated at $845,000. The plan is designed to prevent about 56 percent of the possible future flood damage, but would have a benefit/cost ratio less than 0.5. (See Table VIII-1)

Alternative B: This plan consisted of detention basins located at the base of the South Mountains with outlet pipes running north to points of discharge at the Salt River (see Figure VIII-8).

The detention basins would be designed to control a standard project flood discharge. The estimated first costs for this plan are $24.6 million with average annual charges estimated at $1.7 million. Average annual benefits from flood damages prevented are projected at $580,000. This plan would prevent about 36 percent of the future flood damages and have a benefit/cost ratio less than 0.4. (See Table VIII-1)

Alternative C: This plan consisted of detention basins with a diversion channel and levee system (see Figure VIII-9). The improvement would be similar to Alternative A west of 7th Street with the diversion levee and channel and a detention basin at the entrance to South Mountain Park. A second detention basin constructed between 7th and 16th Streets, just downstream of Dobbins Road, would discharge into the diversion channel. From 20th Street to 40th Street a detention basin and diversion channel would be constructed along the base of the South Mountains with outlet conduits running north to the Salt River. Estimated first costs for this plan are $33.3 million with average annual charges estimated at $2.2 million. The average annual benefits from flood damages prevented would be about $772,000. This plan would prevent about 50 percent of the possible future average annual flood damages. The benefit/cost ratio is less than 0.4. (See Table VIII-1)

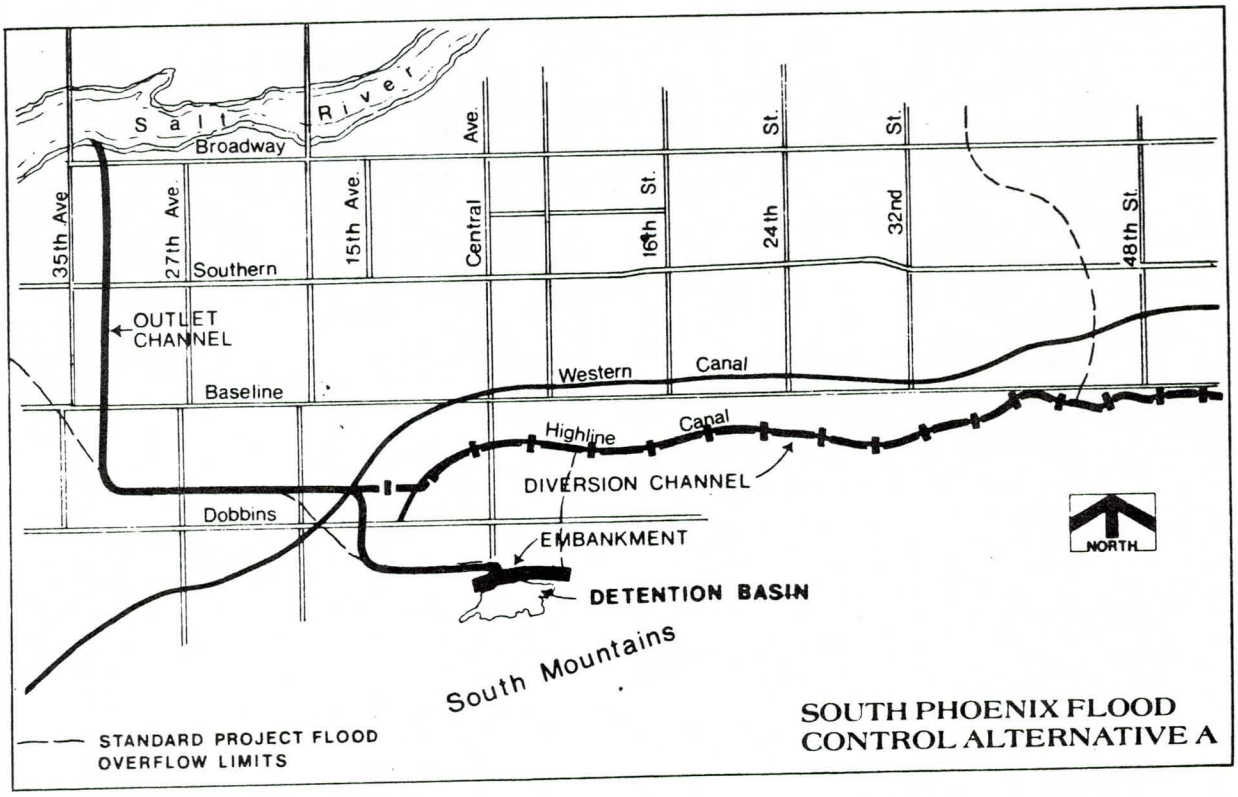



FIGURE VIII-7

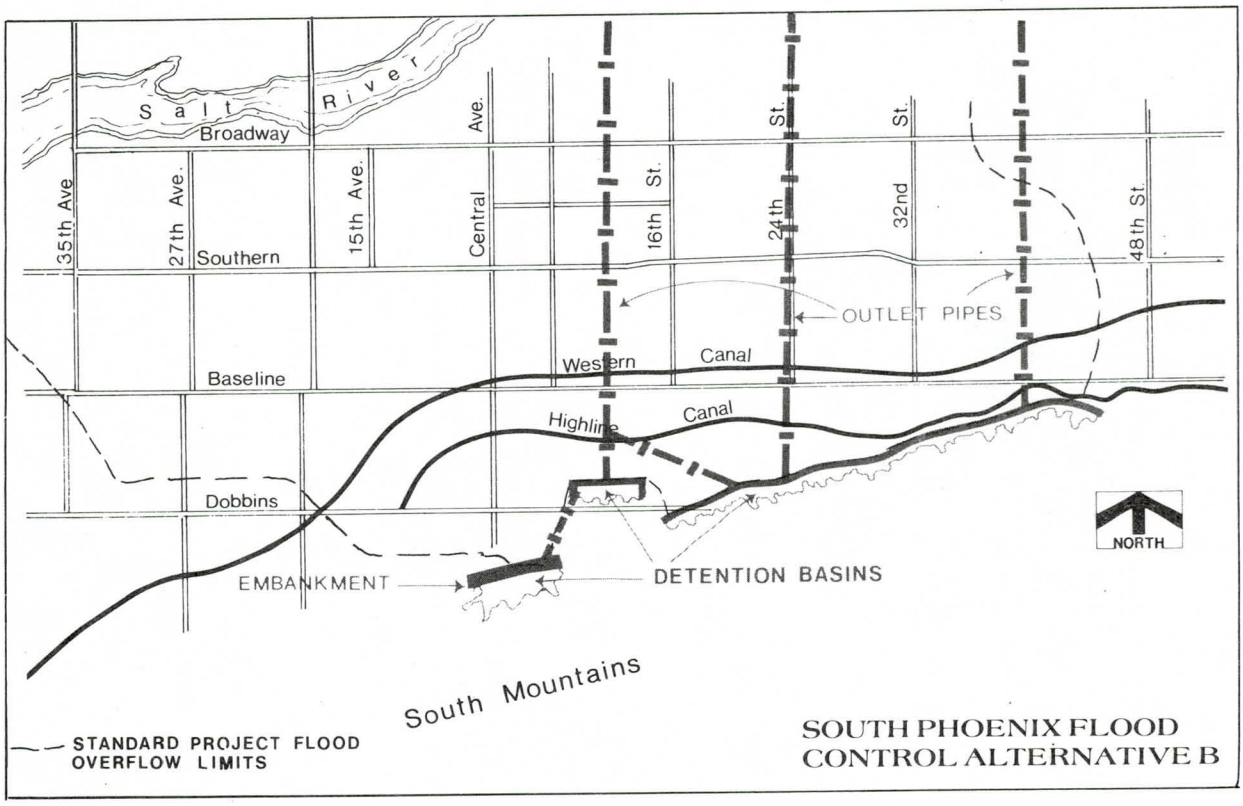



FIGURE VIII-8

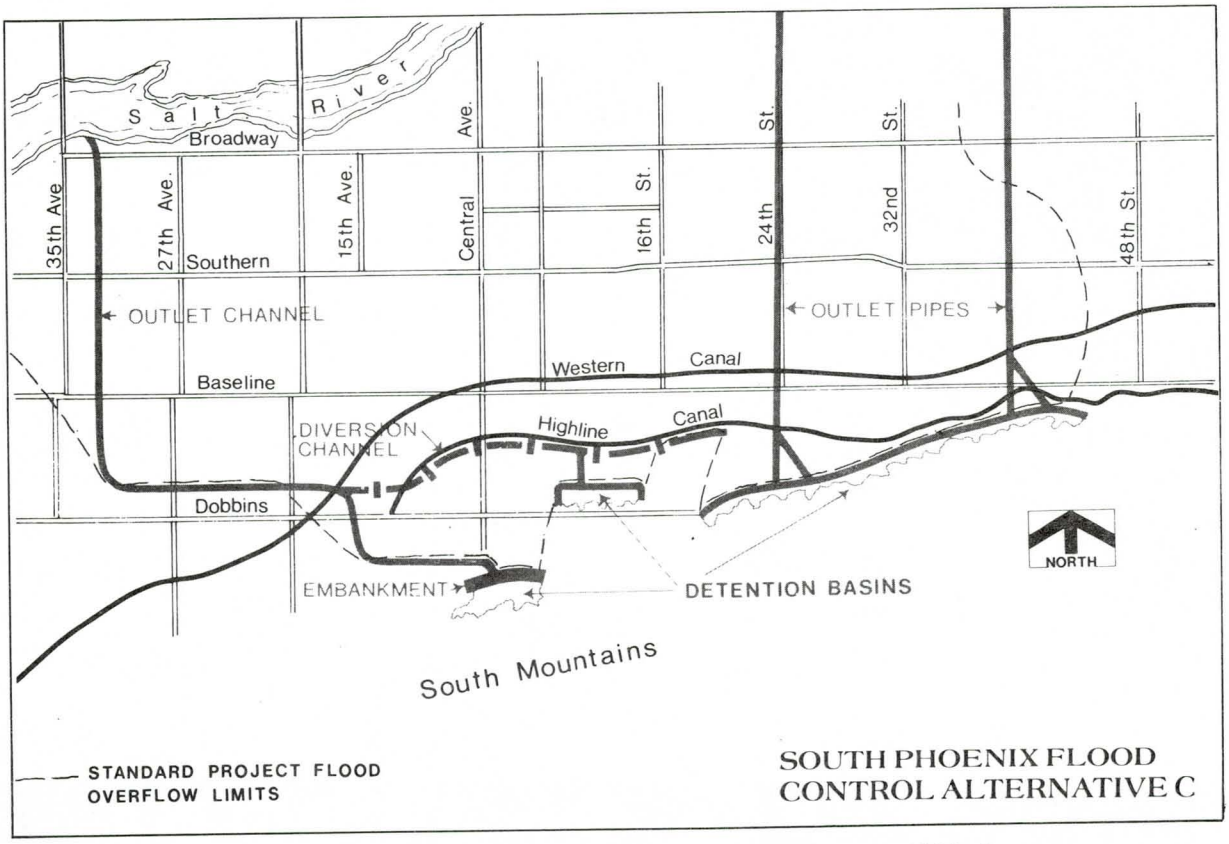



FIGURE VIII-9

Unfavorable initial benefit/cost ratios for South Mountain flood control projects caused them to be removed consideration by the Urban Study.

Upper Indian Bend Wash

Indian Bend Wash is a wide shallow swale which begins in the vicinity of 32nd Street and Acoma Drive in the City of Phoenix. It flows southeasterly through northeast Phoenix, the Town of Paradise Valley and the City of Scottsdale to its confluence with the Salt River about one mile east of Scottsdale Road Bridge in the City of Tempe. The Urban Study examined the uppermost reach which is about 8.5 miles in length upstream of the Arizona Canal. At this point, Upper Indian Bend Wash drains an area of 60 square miles lying between the Phoenix Mountains on the south and the Granite Reef Aqueduct of the Central Arizona Project on the north.

The drainage divide on the south is roughly parallel to Indian Bend Wash and about two and one-half miles away. The slopes from this side are steep and tributary drainage areas are well-defined deeply entrenched channel. Tributaries entering from the north are more numerous with small, relatively indistinct channels. The slopes to the north are also much flatter than those to the south. This situation has a pronounced effect on the pattern of runoff from the two sites. Flows arriving from the north tend to be slow moving sheet flows that flood wide areas to shallow depths. The land to the south is not subject to flooding because the water runs off more rapidly in steep well-defined channels.

The natural floodway of Indian Bend Wash includes the wash and the adjacent relatively flat land which has been or could be covered by floodwaters. A large flood can cause depths to 6 feet of flow in areas of the floodplain and result in a floodway width of up to 4,000 feet. The City of Phoenix, the Town of Paradise Valley, and the City of Scottsdale have designated Upper Indian Bend Wash to be developed as a greenbelt. The reach of floodway between Indian Bend Road and Scottsdale Road has already been developed into a greenbelt with golf courses and recreation lakes. The reach from Scottsdale Road through the Camelback Country Club Golf Course is also located in the floodway. The Town of Paradise Valley from the Camelback Country Club golf course to the town limits near Shea Boulevard is requiring developers to conform to the greenbelt concept and maintain the integrity of the 100-year floodway through channel excavation and the proper placement of structures within the floodway fringe areas of the floodplain. The City of Phoenix has sections of the floodway completed from Shea Boulevard to the headwaters near 32nd Street. A new bridge at Shea Boulevard has been built across the wash and a bridge at Tatum Boulevard has also been completed. The City of Phoenix also requires that the 100-year floodway be maintained by developers. They are expected to develop the floodplain into parks, trails, lakes, golf courses and related recreation uses compatible with flood control measures. Even with these developments, floodwaters from a standard project flood, with a frequency of 500 years and a discharge of between 5,500 cfs near the headwaters and 39,000 cfs at the Arizona Canal, would inundate about 3,000 acres to an average depth of 2.5 feet. Damages to residential and recreational property valued at $160 million are estimated at $32 million. Average annual flood damages are estimated at $786,000.

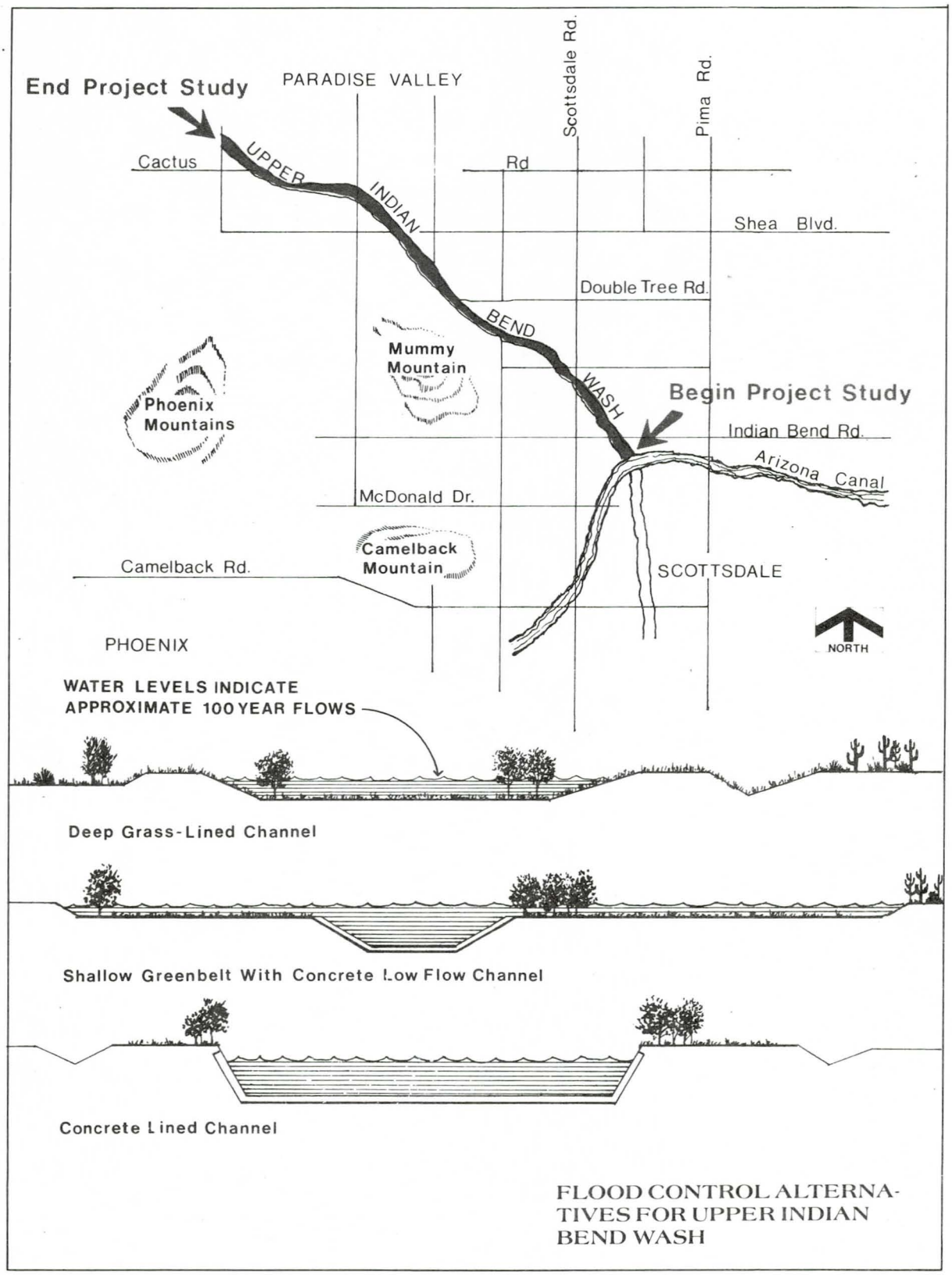
At the request of the Flood Control District of Maricopa County the Phoenix Urban Study re-examined four channelization schemes for the handling of 100-year flows in the main channel of Upper Indian Bend Wash developed by Yost-Gardner Engineers for the City of Phoenix in 1975. The plans were reviewed for hydraulic efficiency, channel construction costs updated, and the concepts extended to include the reach of channel through the Town of Paradise Valley. Flood control channels would begin at an existing drop structure on the Camelback Club Golf Course about one mile northwest of Scottsdale Road and extend upstream 2.45 miles through the Town of Paradise Valley and 4.4 miles through the City of Phoenix. The following paragraphs describe the four channel plans:

Alternative A: Concrete-lined trapezoidal channel. A typical cross section for the concrete-lined channel would have an average depth to flowline of 9 feet. The width of the bottom would vary from 100 feet to 170 feet with channel sides sloping at a rate of two horizontal to one vertical. This plan would provide 100-year protection to residential property along Indian Bend Wash. First costs were estimated to be $16.9 million with average annual costs of $1.17 million. Average annual benefits from flood damages prevented were estimated to be $786,000. The benefit to cost ratio for Alternative A would be less than 0.7. (See Table VIII-1)

Alternative B: Deep grass-lined channel. A typical cross section of a deep grass-lined channel would have water depths to 14 feet. The bottom width would vary from 70 feet at the upper end to 220 feet downstream, with sides sloping at a rate of six feet horizontal to one vertical. Drop structures with drops of four feet are required at intervals of about 1,800 feet to prevent excessive erosion. First costs were estimated at $13.6 million and average annual charges at $1.06 million. The average annual benefits from flood damages prevented would be about $786,000, resulting in a benefit/cost ratio less than 0.8. (See Table VIII-1)

Alternative C: Shallow grass-lined greenbelt with a concrete-lined low flow channel. The typical section for this channel would have water depths to 5 feet with levee or top of bank heights of 7.5 feet. Bottom widths would vary from 350 feet to 600 feet for the main channel, and from 8 to 12 feet for the low flow channel. The low flow channel would vary from 4 to 6 feet deep with sides sloping at the rate of two feet horizontal to one vertical. Ten drop structures with drops of 5 feet are required to prevent excessive eroision of the grass lining. First costs were estimated at $18.6 million and average annual charges at $1.6 million. The average annual benefits from flood damages prevented were estimated to be $786,000. The benefit/cost ratio for this alternative would be less than 0.5. (See Table VIII-1)

Alternative D: Shallow grass-lined greenbelt with 50:1 bottom slopes. The bottom width of this channel would vary from 350 feet to 600 feet with a low flow grass-lined channel 8 feet wide. The sides of the low flow channel and the sides of the main channel would slope at the rate of six feet horizontal to one vertical. The main channel bottom would slope at the rate of fifty feet horizontal to one vertical between the top of the low flow channel and




FLOOD CONTROL ALTERNATIVES FOR UPPER INDIAN BEND WASH

FIGURE VIII-10

the top of the bank of the main channel. First costs were estimated at $15 million and the average annual charges at $1.3 million. Estimated average annual benefits from flood damages prevented were $786,000. The benefit/cost ratio would be less than 0.7. (See Table VIII-1)

Following presentation of this information to the Flood Control District, that agency indicated that it would prefer to address flooding problems on Upper Indian Bend Wash itself. It was expected that local municipalities and private interests in cooperation with the Flood Control District would develop Upper Indian Bend Wash as a greenbelt floodway. No further action by the Corps of Engineers was warranted.

Gila Floodway

The study for flood control along the Gila Floodway was authorized under Section 6 of the Flood Control Act of 1938 which authorized a study for flood control and allied purposes for the entire Gila River Basin. In October 1973, Congress funded an interim Corps of Engineers study for the Gila drain. An unpublished report titled, "Summary Report for Flood Control, Gila Floodway, Maricopa and Pinal Counties, Arizona", dated September 1977, prepared by the Los Angeles District and approved by the South Pacific Division, reached the following conclusions:

- A flood problem exists in the Gila Floodway study area and damages will result from inundation, erosion, and siltation;
- Future floods will endanger life and well-being of the people in the study area;
- Federal participation in structural solution to the flood problem is not economically justified;
- To reduce and ameliorate future damages and hazards from floods, local interest should continue to implement flood plain management techniques and insurance programs to the maximum extent possible.

Preliminary costs and benefits for Gila Floodway projects are contained in Table VIII-2. These findings of economic infeasibility reinforced the conclusions of the 1977 report. Following presentation of this information to the Flood Control District, it determined that no additional studies of the Gila Floodway by the Urban Study were necessary.

Scatter Wash

Scatter Wash, a tributary of Skunk Creek in the immediate vicinity of the authorized Adobe Dam project, was included in the Phoenix Urban Study to be analyzed as a separate flood control project. Structural solutions considered would include channel improvements along 3.2 miles of Scatter Wash beginning at the Black Canyon Highway and extending to the confluence with Skunk Creek (see Figure VIII-11).

Scatter Wash overflow areas considered in this report begin just east of the Black Canyon Highway and extend downstream to a point near the confluence of Scatter Wash with Skunk Creek near 43rd Avenue, a distance of about 3.2 miles. The capacity of the existing channel is about 300 cfs. The channel is in a natural state with trees and brush growing in the channel bottom and along its banks. With the exception of a culvert of limited capacity under Deer Valley Road, all streets have dip crossings and are closed to traffic when relatively minor flows occur. During floods greater than about 300 cfs, damages occur to mobile homes located near the channel banks. The velocity of flows for the standard project flood range from 5 feet per second to over 9 feet per second in the channel area and from 3 feet per second to over 6 feet per second on the overbank flows. The depth of flooding would range from 8 feet to 11 feet in the channel, and to depths of 5 feet for some distance out onto the overbanks. With depths and velocities of such a magnitude, extensive damage to mobile homes would occur. Many would be totally destroyed or swept away to clog the channel, thereby creating an even worse flood condition.

In the area east of and along the Black Canyon Highway between Scatter Wash and Deer Valley Road there is an estimated 10 acres of commercial development, 6 acres of trailer parks, and 10 acres of scattered residential property within the flood limits of the SPF floodplain. Flooding depths range up to 3 feet. There are 36 acres of vacant land in this overflow area.

West of the Black Canyon Highway, 774 acres are subject to SPF overflow. This area consists of 24 acres commercial development, 53 acres in trailer parks, 54 acres residential (predominantly mobile homes) and 643 acres of vacant land. Two new schools also have been constructed in the floodplain. The Deer Valley High School is particularly vulnerable to flooding from divided flows coming out of the Deer Valley Interchange. All developed property in the floodplain is subject to flooding ranging from relatively shallow sheet flow to average depths of 4 feet. Units located near the existing unimproved channels could experience total destruction. Dollar value of all damageable property in the SPF floodplain has been estimated at $16,000,000. This amount would include streets and utilities.

Structural solutions considered included channdel improvements along 3.2 miles of Scatter Wash beginning at the Black Canyon Highway and extending to the confluence with Skunk Creek. All plans required the construction of new bridges at the Black Canyon Highway to replace the existing box culverts. Two freeway thru-lane bridges and two frontage road bridges with attendant temporary detour construction would be necessary. Table VIII-3 lists pertinent design and cost data for three channel schemes to control the 100-year flood.

In addition to plans for channel imporvements along the main stem of Scatter Wash as described above, consideration was given to a plan to collect and divert all the floodflows arrving on the east side of the Black Canyon

Table VIII-2

GILA FLOODWAY ALTERNATIVES
COSTS AND BENEFITS

| Description | First Costs | Average Annual Charges | Average Annual Benefits From Flood Protection | Benefit/Cost Ratio |
|---|---|---|---|---|
| Alternative A Major Channel to Gila River SPF* Protection | $27,000,000 | $1,790,000 | $299,000 | 0.2 |
| Alternative B Major Channel to Gila River 100-yr. Protection | $ 8,750,000 | $ 580,000 | $ 94,000 | 0.2 |
| Alternative C Major Channel to Salt River SPF* Protection | $18,400,000 | $1,220,000 | $241,000 | 0.2 |
| Alternative D Major Channel to Salt River SPF Protection for Mesa and Tempe | $ 5,000,000 | $ 335,000 | $ 88,000 | 0.3 |
| Alternative E Retention Basins 100-yr. Protection | | | | |
| Gilbert | $ 970,000 | $ 65,000 | $ 8,000 | 0.1 |
| Chandler | $ 820,000 | $ 54,000 | $ 22,000 | 0.4 |

*Standard Project Flood

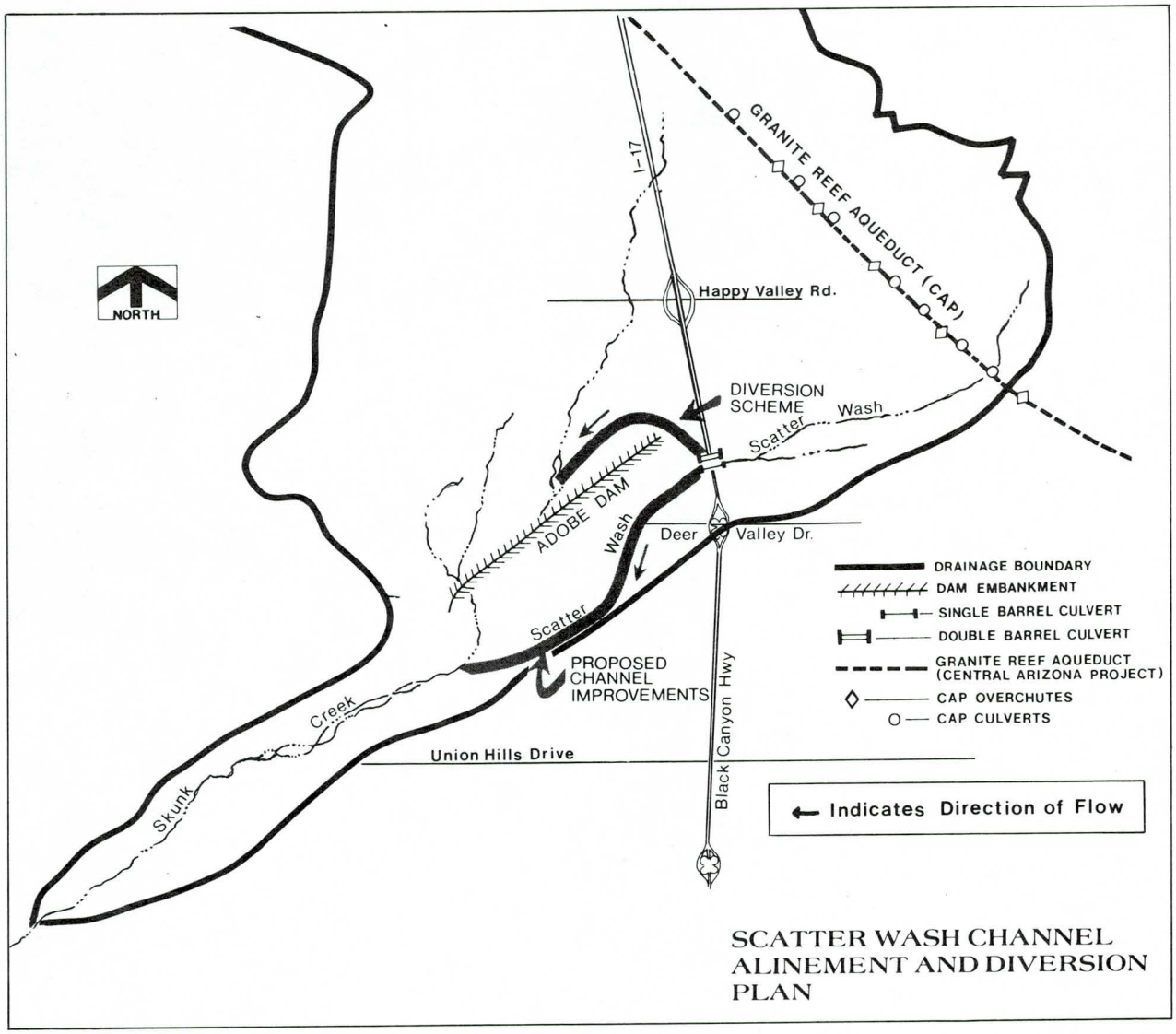



FIGURE VIII-11

Table VIII-3

SCATTER WASH CHANNEL SCHEMES

| Type | Capacity | Cost | | |
|---|---|---|---|---|
| | | Federal | Non-Federal | Total |
| Soft Bottom revetted side slopes/drop structures | 10,200 cfs* | $5,700,000 | $4,200,000 | $ 9,900,000 |
| Rectangular concrete | 10,200 cfs | 9,600,000 | 1,600,000 | 11,200,000 |
| Trapezoidal concrete-lined | 10,200 cfs | 5,200,000 | 2,100,000 | 7,300,000 |

*100-year flood event

Highway at Scatter Wash to the north of Adobe Mountain and confluence with Skunk Creek, in the vicinity of the intersection of 35th Avenue and Pinnacle Peak Road. This diversion plan could be implemented with or without Adobe Dam. The channel was sized to control the SPF, assuming overflow from Skunk Creek to Scatter Wash had been eliminated at the Skunk Creek crossing. Without the Adobe Dam and upstream works, a slighly larger channel would be required. The respective SPF discharges to be diverted to the Adobe Dam conditions at Scatter Wash would be 20,000 and 27,000 cfs.

The cost for the above described diversion channel plan has been estimated at $6,100,000; $4,800,000 federal cost and $1,300,000 non-federal cost. Tangible benefits would accrue from the construction of channels or diversions through the reduction in flood damages and saving in cost of fill (as opposed to filling in of the fringe area between the 100-year flood limit line and the floodway as designated by the Maricopa County Flood Control District). Incidental recreational opportunities could be derived through the utilization of maintenance roadways along the channel right-of-way for equestrian trails and bikeways connecting other facilities in the Adobe recreational area. A summary of the economic analyses is given in Table VIII-4.

The ratios between benefits and costs for flood control projects along Scatter Wash were determined to be too poor to warrant further consideration by the Urban Study. No action by the Crops of Engineers was recommended.

Salt River

The Urban Study's initial examination of flood control along the Salt River through metropolitan Phoenix assumed that an upstream structure at or near the confluence of the Salt and Verde Rivers, such as Orme Dam, would be constructed as a feature fo the Central Arizona Project and would reduce the standard project flood discharge from 295,000 cfs to 50,000 cfs. Operating on this assumption, Urban Study planners formulated two preliminary alternative channels to control flooding along the Salt. The alternatives were as follows:

Alternative A considered of a concrete-lined trapezoidal channel with a hydraulic capacity that varied from 50,000 to 80,000 second feet. The channel would have begun at a flood control structure at or near the confluence site and extend 35 miles downstream to 91st Avenue. The average depth of channel would have been about 23 feet, with base width varying form 62 to 115 feet. Side slopes would have been two feet horizontal to one vertical.

The first costs for this plan were estimated at $115 million and average annual charges at $8.2 million. Average annual benefits from flood damages prevented were estimated at about $6 million.

Alternative B would have served the same purpose and produced the same result as Alternative A. It would have been a soft bottom trapezoidal channel with revetted side slopes and drop structures. The average depth was to have been 11 feet. The bottom width would have varied from 600 to 100 feet, and side slopes would have been 2.25 feet horizontal to one

vertical.

The first costs for this plan were estimated at $150 million and average annual charges at $10.9 million. Estimated average annual benefits from flood damages prevented were $6 million.

The recommended elimination of Orme Dam, an authorized feature of the CAP to be constructed at the Salt/Verde confluence, as a result of President Carter's 1977 Water Projects Review caused the Urban Study to reorient its approach to Salt River flood control. Local interests requested that the Corps of Engineers explore alternative means of reducing flooding along the Salt River through Phoenix. Urban Study personnel joined with staff from the Bureau of Reclamation, other federal, state and local agnecies, civic organizations and interest groups and concerned citizens in the Interagency Task Force on Orme Dam alternatives. Organized by the Bureau of Reclamation in response to the 1977 Water Projects Review, the Task Force failed to reach a concensus alternative to Orme. It did, however, develop a number of plans for further study. The Interagency Task Force was followed by the initiation of the Study of Alternatives for Salt/Gila Flood Control and Regulation of Central Arizona Project waters, now known as the Central Arizona Water Control Study to examine in detail plans already suggested and possibly devise new ones.

Although the Bureau of Reclamation is the lead agency for the new study, the Corps of Engineers has taken a prominent support role. Through its Phoenix Urban Study authority, the Corps has participated in CAWCS Stage I planning. The following section lists alternatives examined by the Urban Study for inclusion in Stage II of the CAWCS and their relation to flood control and other Urban Study objectives.

Structrual Alternatives - Dams: A number of damsites were identified and investigated for both CAP regulatory storage and flood control.

The following discussion of the alternative sites reflects that studies for Stage I have focused on single-purpose functions. Several of the sites were believed to have multipurpose functions served, which would enhance their economic viability.

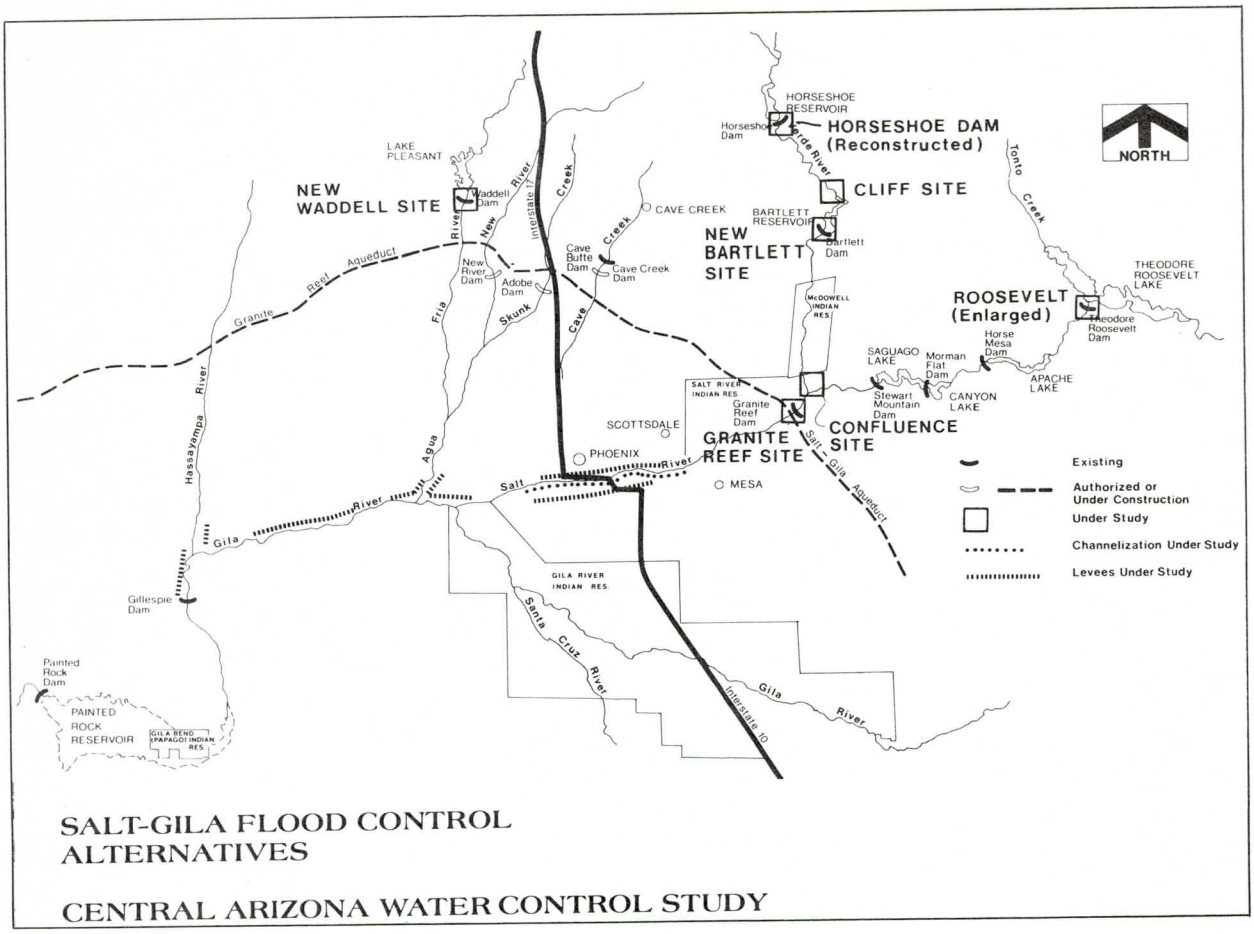
Upstream Alternatives

Confluence and Granite Reef Sites: Orme Dam and Reservoir, as authorized, would be constructed at the confluence of the Salt and Verde Rivers about 20 miles northeast of Phoenix. This earthen dam would be about 195 feet high and 5,700 feet long. Storage capacity at the spillway crest would be 1,360,000 acre-feet. The site does not present any serious geologic difficulties; however, it is expected to produce serious environmental impacts on bald eagle and riparian habitat, as well as on flowing stream recreation. Archaeological and historical sites also would be impacted. Additionally, a significant portion of the Fort McDowell Indian Reservation and some of the Salt River Indian Reservation would be inundated if the dam were constructed.

Table VIII-4

SUMMARY OF ECONOMIC ANALYSES FOR PROJECT JUSTIFICATION

| | Alternatives | | | |
|---|---|---|---|---|
| Item Design | Soft Bottom 100-Yr. | Rectangular 100-Yr. | Trapezoidal 100-Yr. | Diversion SPF |
| Flood Control: | | | | |
| Federal | 5,700,000 | 9,600,000 | 5,200,000 | 4,800,000 |
| Non-federal | 4,200,000 | 1,600,000 | 2,100,000 | 1,300,000 |
| Annual Costs: | | | | |
| I&A | $ 633,000 | $ 716,000 | $ 455,000 | $ 390,000 |
| O&M | $ 50,000 | $ 30,000 | $ 40,000 | $ 20,000 |
| Total Annual Cost | $ 683,000 | $ 746,000 | $ 495,000 | $ 410,000 |
| Benefits: | | | | |
| Avg. Annual Damage Prevented | $ 270,000 | $ 270,000 | $ 270,000 | $ 280,000 |
| Flood Proofing Cost | $ 62,000 | $ 62,000 | $ 62,000 | $ 62,000 |
| Total Average Annual Benefit | $ 332,000 | $ 332,000 | $ 332,000 | $ 342,000 |
| Benefit/Cost Ratio | 0.49 | 0.45 | 0.67 | 0.83 |




SALT-GILA FLOOD CONTROL ALTERNATIVES

CENTRAL ARIZONA WATER CONTROL STUDY

FIGURE VIII-12

Orme Dam and Reservoir has, in addition to its regulatory storage and flood control functions, the potential for development of hydroelectric power generation and recreation, and the enhancement of habitat for some species of fish and wildlife. Orme Dam would reduce a standard project flood inflow of 290,000 cubic feet per second to a release of 50,000 cubic feet per second. At the time of the investigation, multipurpose Orme Dam was estimated to cost $243,000,000. The benefit/cost ratio for Orme Dam and Reservoir, as authorized, was 1.8.

Two smaller structures at the Salt-Verde confluence were studied. Some adverse impacts were reduced with the smaller structures, but at a considerable loss in flood control capacity. Specific advantages of smaller structures included the reduction of riparian habitat inundation, the elimination of water backed up against Stewart Mountain Dam, a more stable water surface elevation for recreational use, and reduced impact on the Fort McDowell Indian Reservation.

Structures of various sizes at the Granite Reef site located a short distance downstream were investigated. The estimated cost of a dam at the Granite Reef site to provide a regulatory storage reservoir with a capacity of 767,000 acre-feet was $243,000,000.

Both the confluence and Granite Reef sites were recommended for further study.

Coon Bluff: The Coon Bluff Site is located on the Salt River immediately upstream from its confluence with the Verde River and downstream from Stewart Mountain Dam. It would be an earthen dam, 128 feet in height, 5,000 feet long with a total capacity of 258,000 acre-feet. The Coon Bluff site impacts about half of the archeological and historical sites affected by a dam at the confluence. Adverse environmental impacts, including effects on eagle habitat, riparian habitat, and flowing stream recreation would result from a dam at Coon Bluff. Serious geologic problems were found to be present at this site.

Abutment and foundation drilling began in September 1976, and indicated the foundation is comprised of weakly to noncemented sandy and silty gravel grading to gravelly silt and sand toward the right abutment. This formation extends to depths of at least 356 feet. Materials of these types are considered permeable. The increased hydraulic pressures caused by a reservoir, coupled with the easily erodable foundation material, proved to be causes for serious concern. Blanketing of the foundation area to reduce seepage volume and velocity was not practical because of local topography.

The Coon Bluff alternative had the potential for hydroelectric power generation, recreation, and enhancement of some species of fish and wildlife, but little additional downstream flood control would be provided.

This alternative did not warrant further study because of the significant geologic problems associated with the site.

Tangle Creek: This alternative site is located on the Verde River near its

confluence with Tangle Creek, 7 miles upstream from the present Horseshoe Reservoir. The dam considered for this site would impound a reservoir with a flood control capacity of 393,000 acre-feet. A dam and reservoir at Tangle Creek would impact eagle and riparian habitats. It could also affect a sheep bridge which is on the National Register of Historic Places.

As a single-purpose flood control structure, Tangle Creek would have provided limited control over Verde River floodflows. Greater flood control could have been obtained in combinations with other schemes. The discovery of hot springs under the site indicated unsuitable geologic conditions, and caused this alternative to be dropped from further study.

Cliff Site: This alternative is located on the Verde River, immediately upstream from Bartlett Reservoir. It would serve much the same function as Tangle Creek. Further geologic study was needed to determine feasibility.

The Cliff alternative would impact riparian and eagle habitats. Archeological, social, or historical impacts were not assessed by the Urban Study. This alternative warranted further study.

New Bartlett Site: This alternative called for construction of a new dam near the site of the existing Bartlett Dam. The enlarged reservoir which would result could impact riparian habitat. This alternative warranted further study.

Modified Horseshoe Dam: This alternative would modify the existing Horseshoe Dam for flood control and water conservation. Water exchanges between the CAP and the Salt River Project might also allow this structure to be used in a CAP regulatory role. Geologic investigations of the site had not been completed. A modified Horseshoe Dam would impact eagle habitat and archeological sites.

In addition to its flood control or regulatory storage functions, a modified Horseshoe alternative could possibly be developed for hydroelectric generation.

Further study of this alternative was warranted.

Modified Roosevelt Dam: This alternative called for the enlargement of Roosevelt Dam for flood control or regulatory storage of CAP waters. The site has no identified geologic problems. Some archeological sites would be impacted, and Roosevelt Dam itself is on the National Register of Historic Places.

Besides flood control or regulatory storage functions, enlargement of Roosevelt Dam could result in increased hydroelectric generation.

This alternative warranted further study.

Carrizo Creek: The Carrizo Creek alternative called for the construction of a new dam on the Salt River below the confluence of the Black and White

Rivers and near Alkali Canyon. The purposes of this dam and reservoir would be to improve the quality of Salt River water and allow for the diversion of water to the Gila River to augment the natural inflow to San Carlos Reservoir. This proposal, however, failed to meet the needs of CAP regulatory storage and would offer very limited flood control for the Phoenix area.

Because of these factors, the Carrizo Creek site was not an acceptable alternative and no further study was warranted.

Klondike Buttes: This alternative site was located on the Salt River above Roosevelt Lake. The dam and reservoir at Klondike Buttes would impact riparian vegetation and would encroach upon a proposed Wild and Scenic Rivers area. Geology of the site required additional investigation. Klondike Buttes would not control Tonto Creek, a major tributary to Roosevelt Lake, leaving a large uncontrolled area downstream.

Klondike Buttes was an unacceptable alternative for flood control or CAP storage and no further study was warranted.

Downstream Alternatives

Levees: Levees are embankments along a river that contain flows. They generally provide a wider floodway than channels and are constructed of earthen materials.

A continuous system of flood control levees which would create a floodway has been analyzed. This alternative would not provide CAP water storage. Controlled water releases from upstream reservoirs may require some easements on lands which would be flooded. Levees should be considered in combination with reservoirs to reduce easement requirements.

Levees can be constructed with or without a supplementary concrete or soft-bottom low-flow channel. They are constructed to accommodate either the Standard Project Flood or a 100,000 cfs flow.

Levees along the Salt-Gila Rivers did not appear to be economically justified as a total solution to the flood problem. Specifically, the sections between Granite Reef Diversion Dam and Country Club Drive and 35th Avenue to the Salt-Gila River confluence did not incur enough flood damage to justify the annual costs associated with construction of levees. Further study of levees between Country Club Drive and 35th Avenue and between the Salt-Gila confluence and Gillespie Dam (located outside the Phoenix Urban Study area), however, was warranted.

Channels: Channelization of portions of the Salt and Gila Rivers was proposed to reduce flooding. Flows would be confined in relatively deep, narrow channels constructed in the riverbed. Several channel configurations were analyzed for flood control purposes. They included rectangular concrete, trapezoidal concrete, and soft-bottom with revetted side-slopes. Of the three, the soft-bottom type appeared to be the most cost effective for flood control.

Initial analysis indicated that a continuous system of channels from Granite Reef Dam to Gillespie Dam was not justifiable economically. Further examination, however, showed that channelization between Country Club Road and 35th Avenue did warrant additional investigation by the Central Arizona Water Control Study.

It should be noted that different design criteria are used for determining channel capacity than were used for levees. Levees are normally designed to pass the standard project flood safely, whereas channels may be designed to a much smaller capacity. The rationale for this practice is explained in the analysis of the consequences of overtopping. In the case of a levee system, overtopping would probably result in failure with catastrophic results. In the case of a channel, overtopping would not impair the operation of the channel, and it would be expected to reduce flood damages even though the actual flow exceeded its capacity.

Channel Clearing: The overgrowth of salt-cedar and other such desert shrubs has obstructed the Gila River channel in many areas. Clearing a swath through this growth has been suggested as a means of providing flood flows a path to follow there by reducing damages. Several methods, including chaining and controlled burning, could be used to accomplish the clearing. The Maricopa County Flood Control District is presently conducting a program to provide a 1,000-foot wide clearing on the Gila River from 91st Avenue to Powers Butte at the southwestern edge of the Urban Study area, and a 300-foot wide clearing from Powers Butte to Gillespie Dam.

In addition to these flood control elements, the Central Arizona Water Control Study examined other sites in the Urban Study area for achieving regulatory storage of Central Arizona Project Waters. These alternatives included construction of low dams in the Salt River bed, utilizing existing Lake Pleasant facilities, construction of a New Waddell Dam on the Agua Fria River, construction of Agua Fria Dam at a point where the Granite Reef Aqueduct crosses the Agua Fria River, construction of Calderwood Butte Dam on the Agua Fria River, and regulatory use of North Phoenix flood control dams. These alternatives involved purposes other than those of the Urban Study and they are not examined in detail in this report. They were of interest to the Urban Study only in so far as they affected drainage areas or existing or authorized Corps of Engineers projects in metro Phoenix.

Nonstructural Alternatives:

Water Exchanges. The concept of water exchanges envisions storing imported CAP water in existing reservoirs for regulatory purposes. The Salt River Project and Maricopa County Water Conservation District No. 1 have been determined to be the only water supply agencies in central Arizona with the CAP. Exchanges with the San Carlos Project were not considered in this context because they are already assumed in the operation of the proposed Buttes Dam and Reservoir and will be addressed in planning studies. Proposed exchanges could be related to an enlargement of Roosevelt, Horseshoe, and/or Waddell Dams, or carried out using existing facilities. No geologic problems have been associated with this alternative; however, an evaluation of

the existing Waddell Dam will be required to determine if the structure meets federal standards. Increases in reservoir sizes related to water exchanges could impact eagle nesting areas, riparian habitat, and archeological sites and could cause an alteration in downstream seasonal flows. Flood control problems might be increased. A major constraint also would be the institutional conflicts which would arise from implementation of water exchanges.

Salt River Flexible Operational Criteria (SRFOC): This is a concept of operating the existing reservoir system on the Salt River so as to optimize water conservation and flood damage reduction. It involves flexible operating criteria and may include any or all of the following:

- Sophisticated runoff forecasting capability;
- Improved monitoring of watershed conditions;
- Designation of flood control space which varies according to season and watershed conditions;
- Modification of the water outlets of the existing system.

Use of the SRFOC would decrease downstream releases of water from the system, lessen flood damages and increase utilization of the Salt River floodplain. Impacts on flood control, water conservation, hydropower generation, recreation, and fish and wildlife habitat must be considered. Serious institutional conflicts also could result from implementation of such a program. This alternative warranted further study.

Floodplain Management Measures: These non-structural alternatives to flood control and mitigation of flood damages involve:

- Floodprofing - alteration of existing and future development by such means as floodwalls, small levees, temporary closures on openings, raising structures, and removal of structures and/or their contents.
- Floodplain acquistion - use of regulations to lessen flood damage.
- Floodplain regulation - use of regulations to lessen flood damage.
- Bridge construction - construction of bridges of sufficient capacity to pass flood flows would reduce traffic delay costs experienced during floods.

These measures do not completely solve flood problems, but might be justified in combination with other alternatives or by themselves. For this reason, further study was warranted.

Artificial Groundwater Recharge: This concept incorporates structural measures and operating criteria to increase the amount of surface water that reaches groundwater reservoirs. Preliminary consideration of the spreading basin method of artificial groundwater recharge completed during

the Urban Study indicates that further study is warranted. Employment of this technique would allow floodwaters or CAP waters to be introduced into groundwater reservoirs.

Physical characteristics of the study area would limit the recharge rate. The art of groundwater recharge is not highly developed and would require additional study. Artificial groundwater recharge is not in and of itself a solution to either the flood control problem or the regulatory storage problem. However, it may be incorporated with other measures to arrive at the best solution. This alternative merited further consideration. Additional information on groundwater recharge is contained in Chapter IX of this Plan Formulation Appendix, and in the Technical Appendix.

No Action Alternative: A "No Action Alternative" also was developed to assess future conditions in the study area if no action is taken to provide flood control. The importance of an accurate assessment of these conditons, based on carefully weighed assumptions, cannot be overemphasized. It is against this scenario, not against present conditons, that all alternatives will be compared and evaluated.

Since the No Action Alternative assumes no additional federal flood protection for metropolitan Phoenix, the area would be subject to flood damages, loss of life, and disruption of vital services. Future development of the Salt River floodplain also would be limited under the No Action Alternative in accordance with Federal Insurance Administration regulations.

## FLOOD WARNING

An important portion of the Phoenix Urban Study is flood control investigation involved an examination of potential flood warning systems for the metropolitan area. A number of different types of detection devices and equipment were examined as were existing systems operated by the National Weather Service, Salt River Project, Corps of Engineers, and other agencies. Rain and stream gages and automatic reporting systems received particular attention. Attention also was given to the problems of flooding along major water courses such as the Salt-Gila and Agua Fria Rivers, as well as along smaller urban and suburban washes. Flood events on these latter streams, along with flooding caused by sheetflow, posed particular problems because of the short warning times.

Refinements to the existing flood warning systems on the large river drainages in the study area would increase warning times somewhat. There remains a danger from flooding of smaller urban and suburban washes, since available warning times would be so short that evacuation of residents from these areas would be impossible in most cases. For most of the flood problems on medium washes and tributary streams in the study area, however, some sort of automatic warning system appears to be feasible and should be considered for implementation by local agencies. The initial system should be installed so that it can later be combined into a system of greater complexity, perhaps eventually into an areawide flood warning network. Each community within the study area should consider its flood problems and determine what types of flood warning systems it would like to see installed

within its jurisdiction. Frequent consultations among federal, state, county and local agencies should take place, and planning for flood warning systems periodically updated.

The Phoenix Urban Study served as a catalyst for the formation of the Central Arizona Hydrometeorological Data Management Association (CAHDMA), an organization of federal, state, and local agencies currently which is developing an improved early flood threat recognition system for central Arizona, including the Phoenix Urban Study area.

The data generated by the Urban Study's examination of flood warning are preliminary and no conclusions or recommendations are presented in this report. Information regarding warning systems developed during the Urban Study, however, has been made available to local agencies. The subject is undergoing further investigation by the Central Arizona Water Control Study.

## ALLENVILLE COMMUNITY DEVELOPMENT

Near the conclusion of the Phoenix Urban Study, the Urban Studies Section joined with the Arizona State Division of Emergency Services in a study of flood damage reduction for the community of Allenville. Located in the Gila River in the southwest corner of the study area, Allenville had been practically destroyed by the floods of 1978, and it appeared that permanent relocation of the residents out of the flood plain was the only economically justified solution. It was decided, however, that because of the unique social cohesion which had developed in this largely black settlement, a new community could be developed for the residents outside the flood plain. Planning for this new community continued after completion of the Phoenix Urban Study and resulted in the authorization of the Allevnille Community Development under Section 205 of the Flood Control Act of 1948. The project was completed in November 1981.

# CHAPTER IX

## WATER CONSERVATION

The importance of water conservation in the Western States was highlighted by the widespread drought in 1977. Insufficient winter precipitation and subsequent reduced runoff and storage necessitated water rationing in several western cities. In Arizona, dry years are the rule and not the exception. Early in their history, Arizonans adopted a conservation ethic as a matter of survival. Coupled with the hardships presented by drought in the state, is the unfortunate paradox that when water becomes available it often occurs in the form of large, often unmanageable, floods.

In 1973 extensive water releases by the Salt River Project down the normally dry Salt River channel through the study area graphically illustrated the need for water conservation measures. Although the releases were controlled and relatively little damage resulted, close to 600,000 acre-feet of high quality water were lost to beneficial use. Because of the magnitude of the waste, the Phoenix Urban Study chose to investigate the possibilities of floodwater conservation throughout the study area. These initial investigations made two key assumptions:

1) An adequate source of floodwaters was available in the study area.

2) The floodwaters could be controlled.

The second requirement necessitated dams on the area's major drainages. The four drainages and their control structures were: 1) New River and the Corps' authorized New River Dam; 2) Skunk Creek and the Corps' authorized Adobe Dam; 3) Cave Creek and the Corps' authorized Cave Buttes Dam; and 4) Salt River and Orme Dam, a feature of the CAP. Hydrologic studies, however, revealed that the New River, Skunk Creek, and Cave Creek drainages did not generate sufficient average annual volumes to warrant further study for water conservation. Only the Salt River drainage seemed suitable. It was determined, therefore, that the Urban Study would concentrate on examining water conservation through recharge of floodwaters along the Salt. Following the recommended deletion of Orme Dam from the CAP, however, the artificial groundwater recharge study expanded in scope to include water from additional sources, including imported Colorado River water, treated wastewater effluent, and water from the Salt and Verde Rivers, supplied either by floods or controlled Salt River Project releases. In addition to these investigations, the Urban Study examined one additional method of water conservation. This involved a measure to divert floodflows of the New River into Lake Pleasant. Results of the study are included in this Plan Formulation Appendix.

### ARTIFICIAL GROUNDWATER RECHARGE

Artificial groundwater recharge is a concept of incorporating structural measures and operating criteria so as to increase the amount of surface water that reaches the groundwater reservoirs. Such a project could relieve problems groundwater table depressions in the Luke and Chandler/QueenCreek districts of the study area which have resulted from groundwater withdrawl.

## Planning a Recharge Program

A few small-scale artificial recharge projects of an investigative nature have been conducted in the state, such as those reported by Bouwer, Rice and Escarcega (1974), Maddox and Resnick (1961), and Wilson (1972). These projects were primarily concerned with technical, engineering, and environmental considerations, and to a less extent with legal, institutional and economic factors. Unplanned recharge occurs by flood flows in nartural channels, irrigation return flow and by canal seepage. At this time there is a pressing need for a demonstration recharge project followed by a full-scale project, in an appropriate basin such as the Salt River Valley.

The evolution of a groundwater recharge project in a given basin generally comprises the following four phases:

Phase I: Identification of subregions of the basin most suitable for infiltration, storage and recovery of recharge water; and identification of the quantity and quality of available water sources.

Phase II: Preparation of a detailed plan of study for a demonstration recharge project, including: 1) defining information availability and needs in five constraint areas (technical, environmental, legal, institutional and economic); 2) developing engineering plans for alternative recharge techniques; 3) identifying alternative recharge sites and water sources; and 4) preparing an estimate of budgetary requirements and time frame for activities in Phase III.

Phase III: Implementation of a demonstration project involving the following items: 1) a second iteration through elements of the five constraint areas, particularly to quantify unknowns identified in the first iteration; 2) physically constructing, operating, managing, and monitoring a demonstration recharge operation; and 3) using collected information to plan and design a full-scale recharge project. A closely related purpose is to demonstrate the feasibility of incorporating an artificial recharge function into the design of future water resource projects.

Phase IV: Construction, operation and management, and monitoring of a full-scale, long-term recharge project, based on the limitations imposed by the five constraint areas. The full-scale project would be evaluated in terms of the economic benefit and long-term utility of recharge technology to achieve conjunctive management of surface and groundwater supplies.

It should be stressed that the progression of a project from Phase I through Phase IV requires that problems arising during each stage are not insurmountable. Thus, a "go" or "stop" decision must be logically reached at the end of each phase.

## Review of Phase I Activities, Phoenix Urban Study

Essentially, the Phase I activities for a recharge project in the Salt River Valley were completed and are reported upon as the Technical Appendix of the

Phoenix Urban Study Final Report. The feasibility of conserving floodwaters and other sources in the Phoenix area via artificial recharge techniques was examined. The focus of the study was on two watersheds: the Salt River watershed and the collective group of watersheds comprising the "New River and Phoenix City Streams".

The study was cursory and based upon somewhat tenuous assumptions. Nevertheless, it has been concluded tentatively that artificial recharge via basins would conserve only small amounts of floodwater on the "New River and Phoenix City Streams" flood control project of the Corps of Engineers. In contrast, artificial recharge appeared to be a viable approach for conserving floodwaters along the Salt River.

The reach between Granite Reef Diversion Dam and the Tempe Buttes appears to be particularly suitable for artificial recharge for the following reasons: 1) the channel is normally dry because the upstream structures preclude surface flows in the rivers except for controlled releases; 2) the groundwater table has been markedly lowered in the region because of large pumping drafts; and 3) the river bed is comprised mainly of coarse, boulder-sized deposits ideally suited for infiltration basins. The reach downstream of the Tempe Buttes was not considered to be suitable for artificial recharge because of shallow water tables. Alternate designs for recharge basin systems were included in the study.

The major potential water source for recharge examined in Phase I was water released from the then proposed Orme Dam, at the confluence of the Salt and Verde Rivers. Based on 86 years of flow data a computer program, HEC-5C, was used to estimate the amount of water available both for recharge and "additional water". "Additional water" is released by SRP into their canals to users with established rights whenever large flows exceed the storage capacity of SRP reservoirs. The total amount of "additional water" plus normal deliveries is limited by the total canal capacity. In the analysis it was stipulated that releases from Orme Dam for recharge and "additional water" would be available only when the reservoir pool at the proposed Orme Dam exceeded 410,010 acre-feet. Two scenarios were examined: 1) giving recharge a priority, 355 cfs (260,000 acre-feet per year) would be used for infiltration, and 79 cfs (68,000 acre-feet per year) for "additional water"; and 2) giving "additional water" priority, 350 cfs (250,000 acre-feet per year) would be available for "additional water" and 93 cfs (68,000 acre-feet per year) for recharge. Although the results of Phase I activities were positive, in view of the number of assumptions it was recommended that a demonstration recharge project should be conducted along the Salt River.

The Arizona Water Commission (AWC) in 1978 also speculated upon the amount of water potentially available for artificial recharge in the Salt River. As indicated above, the AWC estimates that between 50,000 and 70,000 acre-feet per year of flood water might be available, on the average, for recharge.

Phase II, The Plan of Study

The general goals of activities during this phase were to evaluate the feasibility of a demonstration recharge project and to present a plan of

study to facilitate planning, constructing, and monitoring such a project. Specific objectives were as follows:

1. Determine available information and define data gaps in each of the five constraint areas;

2. Identify specific work tasks to overcome informational gaps in each constraint area and propose alternatives for obtaining information needed to plan a demonstration project;

3. Recommend a sequence of work tasks within the constraint areas for implementing a demonstration project;

4. Estimate a range of costs for accomplishing recommended work tasks to plan and implement a demonstration project;

5. Select and evaluate several alternative demonstration sites within the study area; and

6. Assess the general implications of a full-scale, long-term groundwater recharge program.

Specific study objectives were delineated and are reviewed in detail in the Technical Appendix of the Final Report which presents the Plan of Study.

General Study Procedures: Evaluating the potential of groundwater recharge requires an interdisciplinary approach. Therefore, an interdisciplinary study team was assembled to provide a comprehensive first iteration through the five respective constraint areas, also referred to as study elements. Each of the study elements was under the direction of respective work-unit leaders. In order to integrate the recommendations and conclusions of all study elements, periodic review meetings were held to insure the necessary coordination and interaction among respective study team members and work-unit leaders.

An extensive search of available literature in the five study elements relative to artificial recharge was conducted utilizing the Remote Console (RECON) capabilities offered through the University of Arizona's Office of Arid Lands Studies. Throughout the study process additional literature and informational sources were incorporated into the original list of references. The review of existing literature was used to develop a background of information on previous artificial recharge efforts and to identify informational and data gaps which must be satisfied prior to planning and implementing artificial recharge operations within the study area.

Utilization of existing literature precluded unnecessary duplication of effort. It also permitted concentration on the assessment of available information relative to specific study objectives and the identification of apparent informational deficiencies. Such deficiencies were translated into specific work tasks.

## NEW RIVER DIVERSION MEASURE

As part of its water conservation efforts, the Phoenix Urban Study also examined the feasibility of diverting surface runoff from the upper reaches of the New River drainage basin to the Agua Fria River basin for storage in the existing Lake Pleasant Reservoir. The purpose of this diversion would be to provide additional water supplies and to provide additional water for recreation and for the enhancement of wildlife habitat associated with Lake Pleasant.

Hydrologic investigations estimate average annual surface runoff from a 72 square mile drainage area (shown as upper basin "A" in Figure IX-1) to be in the neighborhood of 5,300 acre feet. All or part of this runoff should be available for diversion to Lake Pleasant where it could be put to beneficial use. The amount of base flow to satisfy downstream water users and to recharge the aquifers has not been determined to date.

The point of diversion selected for study is located on the New River about 3.5 miles above the community of New River. A natural saddle in the terrain separates the two drainage basins. A diversion structure outlet channel constructed here would be about 4,000 feet in length and discharge into a natural waterway which is tributary to the Agua Fria River at the "Little Grand Canyon Rancho". The natural waterway slopes at the rate of 120 feet per mile and is about 4 miles in length from the proposed diversion outlet channel to its confluence with the Agua Fria River. From this point a distance of about 6 river miles remains on the Agua Fria River to a point of discharge into the upper reach of Lake Pleasant.

### Alternative Plans

Two schemes for diverting the surface flows have been explored to date (see Figure IX-2). Scheme A would divert the entire surface flows to Agua Fria basin with only the underground flows permitted past the structure to the lower basin of New River watershed. Scheme B would divert only those flows remaining after downstream water demands are satisfied. The conceptual design of these schemes follows:

Alternative A: A low dam or levee would be constructed across the streambed of New River and would "seal off" any downstream surface runoff. The entire New River flows would be routed to the Agua Fria watershed by means of an excavated channel sized to accommodate a flood of 50,000 cfs. The channel, as well as the low dam or levee, would be constructed with sufficient freeboard so as to divert the maximum probable flood of 113,000 cfs.

Alternative B: A dam across the streambed of the New River would be constructed with a controlled outlet structure to permit flows up to a pre-determined rate to pass through the structure for downstream water users. The outlet channel as described in Alternative A above would be modified to include a spillway structure, doubling as a diversion structure and an emergency spillway to control the maximum probable flood. The cost for this alternative, because of the added design requirements

of the higher dam, spillway, and outlet works, to overturn the cost of Alternative A. In both alternatives, an excavated diversion channel is required to connect the two drainage basins. New bridges crossing the channel at Table Mesa Road and at the I-17 Highway also would be necessary. Variations of the above or similar alternatives would have to be studied in detail to produce the most cost-effective structure.

Impacts of the Proposed Diversion Measure

It is anticipated that the diversion of water from the New River into Lake Pleasant could create significant problems to the operation of that reservoir. The existing spillway structure might not be able to pass floods from both the Agua Fria and New River drainage areas.

The diverting of flood flows away from the community of New River would provide flood protection for residences, schools, and business establishments. For example, the flood of March 1978 with a flow of 10,400 cfs washed away a mobile home, threatened the school, cut access roads to residences, and inundated the New River stores near Carefree Road bridge. All of these damages would have been prevented by the diversion structure.

The diversion could affect the final design of the authorized New River Flood Control Dam. The dam presently is designed to control flooding from a 164 square mile drainage area. The diversion of water from the upper drainage basin would leave only 92 square miles to be controlled by the authorized New River Dam. A new design based on this reduction in drainage area could result in reduced structure, right-of-way, and flowage easement costs.

Lake Pleasant Regional Park area would benefit from additional water particularly during periods of extreme drought. It is anticipated that recreational opportunities and fish and wildlife habitat would be enhanced by this action.

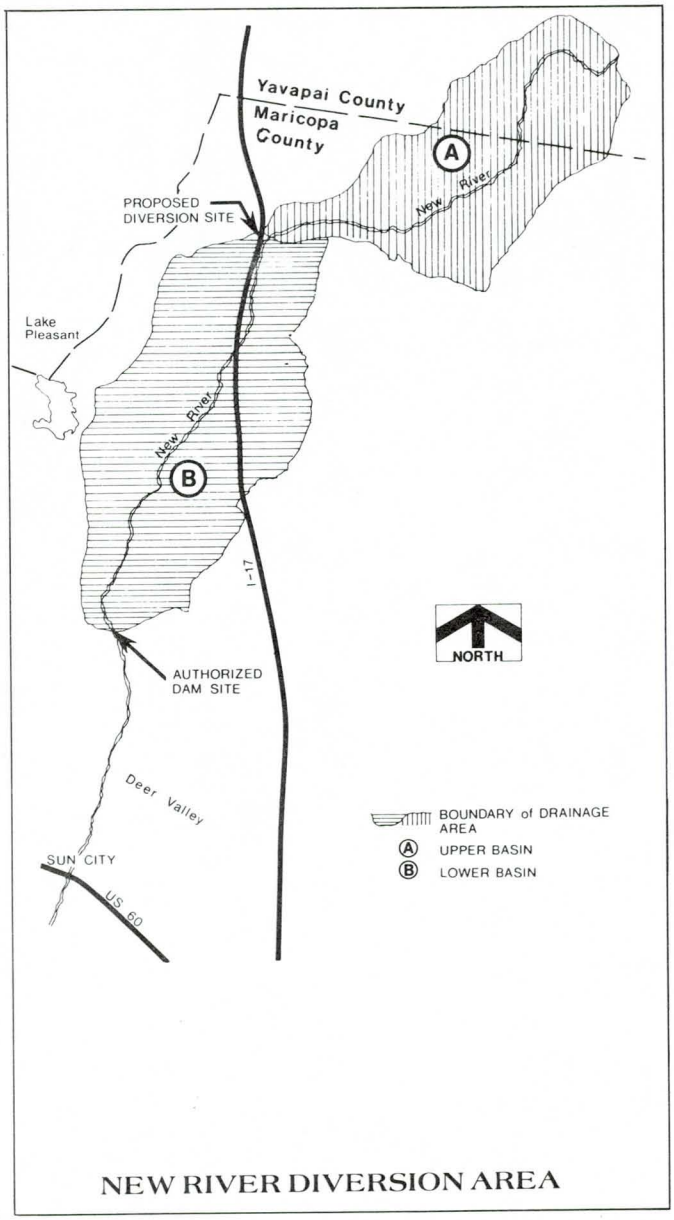
Problems may occur in the Agua Fria River basin when a floodway is developed along the Little Grand Canyon Wash. Considerable erosion with subsequent sediment transport could be expected particularly in the early stages when new channels are being formed. This may impact somewhat on the capacity of Lake Pleasant reservoir.

Planning has been suspended for the following reasons:

- Residents of the community of New River expressed serious concern that regarding a depletion of the aquifer in the region.

- The Bureau of Reclamation is considering the feasiblility of either using existing Lake Pleasant facilities or constructing a new Waddell Dam and reservoir for regulatory storage of CAP waters. Either of these plans probably would pre-empt the diversion because available reservoir space would be required for regularoty storage.

- Legal implications of the diversion would be difficult or impossible to resolve. Specifically, the liability for any damage by diverted waters and damage caused by reduction in natural groundwater recharge were were sources of concern.




NEW RIVER DIVERSION AREA

FIGURE IX-1

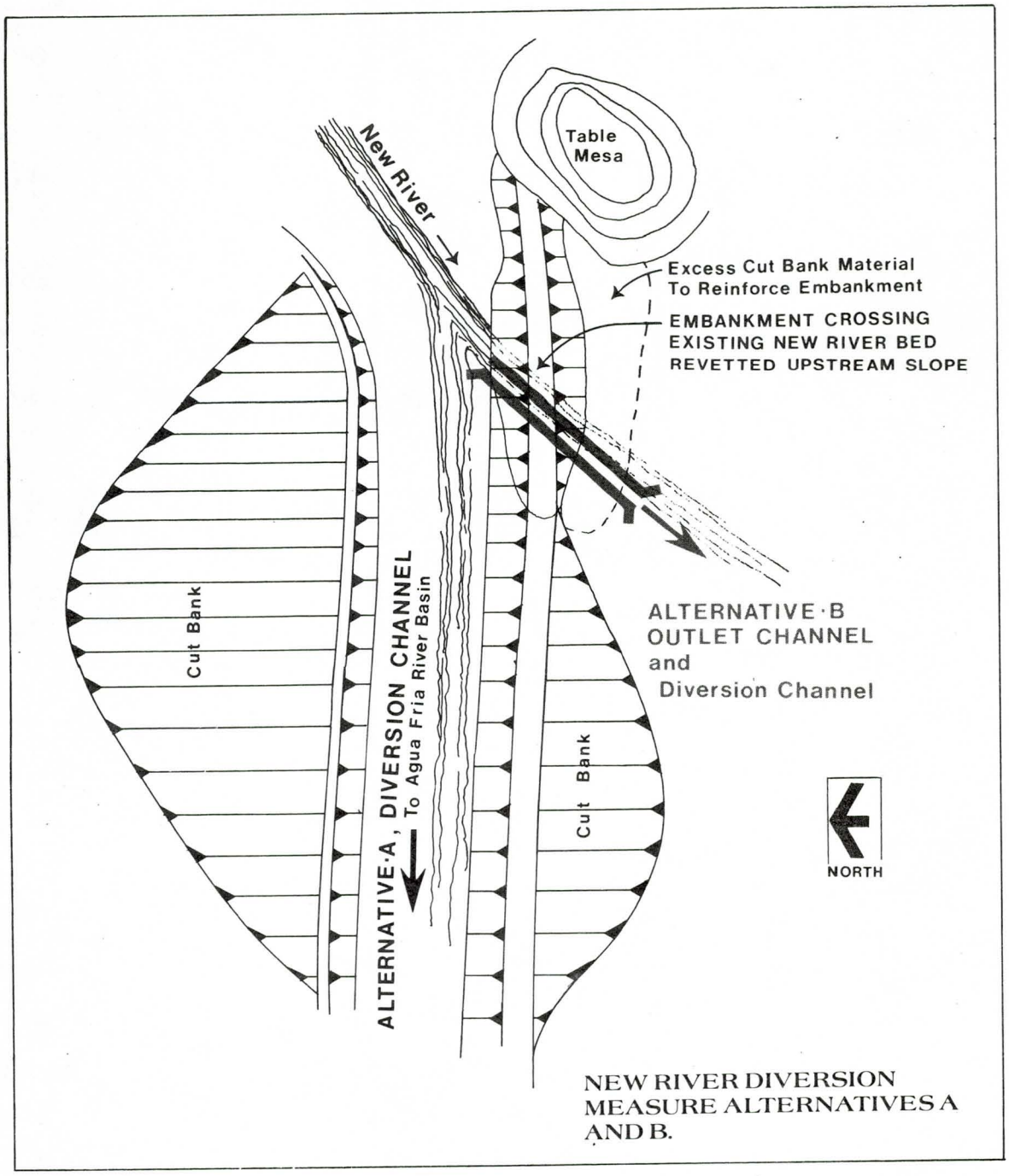

New River
Table Mesa
Excess Cut Bank Material To Reinforce Embankment
EMBANKMENT CROSSING EXISTING NEW RIVER BED REVETTED UPSTREAM SLOPE
ALTERNATIVE·B OUTLET CHANNEL and Diversion Channel
Cut Bank
ALTERNATIVE·A, DIVERSION CHANNEL
To Agua Fria River Basin
Cut Bank
NORTH
NEW RIVER DIVERSION MEASURE ALTERNATIVES A AND B.

FIGURE IX-2

# CHAPTER X

# RIO SALADO

The Rio Salado is an intriguing proposal that envisions transformation of the normally dry Salt River bed as it passes through metropolitan Phoenix into a multipurpose greenbelt floodway (see Figure X-1).

The Rio Salado Concept Study, undertaken as an element of the Phoenix Urban Study, seeks to enlarge the basis for evaluation of Rio Salado's potential contribution in the five areas of Urban Study concern, water quality, flood control, water conservation, recreation, and enhancement of fish and wildlife. Impacts of the project on the environment also are taken into consideration. The study area extends along the Salt River from its confluence with the Gila River to Granite Reef Dam but focuses especially on the 16 mile reach between 27th Avenue in Phoenix and Country Club Drive in Mesa.

## BACKGROUND

The Rio Salado concept was initiated in the College of Architecture at Arizona State University in the fall of 1966. The idea of restoring life to the river by maintaining water bodies along its course was advanced in three separate student projects. At the conclusion of each stage, the proposals were presented to some 80 public officials and business and civic leaders of the communities along the river. The last of these presentations was a day-long conference and work session from which issued the request that the Valley Forward Association (VFA), an organization of community leaders, "assume immediately the responsibility for the coordination and prosecution of the Rio Salado Project, making maximum use of all public and private entities concerned and involved".

Since that conference in the fall of 1969, Valley Forward has carried the Project forward with the close collaboration of the Maricopa Association of Governments (MAG) as official contracting agency.

Under VFA and MAG leadership, two phases of planning were commissioned to the Los Angeles firm of Daniel, Mann, Johnson & Mendenhall with local consultants including Earl V. Miller Engineers, Group Civitas and Western Management Consultants, Inc. Phase 1 was a "plan for planning" and Phase 2 provided a proposal for the entire project length with added detail for demonstration projects in Phoenix and Tempe.

### Recent Developments

A demonstration of the ultimate potential of Rio Salado must await resolution of the flood control question along the Salt River. A number of recent developments, however, may move the Project toward ultimate realization:

- In the area of the Tempe pilot project, the Scottsdale Road bridge has been completed with its deck having a height sufficient to accommodate the passage beneath of both boats and riders on horseback. Considerable

channel excavation has been accomplished and a mile of Rio Salado Parkway has been built to connect Mill Avenue with Scottsdale Road and provide access to Sun Devil Stadium. While none of these works were undertaken as "Rio Salado Projects", they well exemplify the steps necessary to make it a reality.

- The 1974 Arizona Legislature appropriated $100,000 t be matched by any jurisidiction along the river for the acquisition of land for Rio Salado. The City of Tempe used these funds to assist in the acquisition of a parcel just east of Mill Avenue that connects the river's north bank with Papago Park, thus providing a continuous flow of open space.

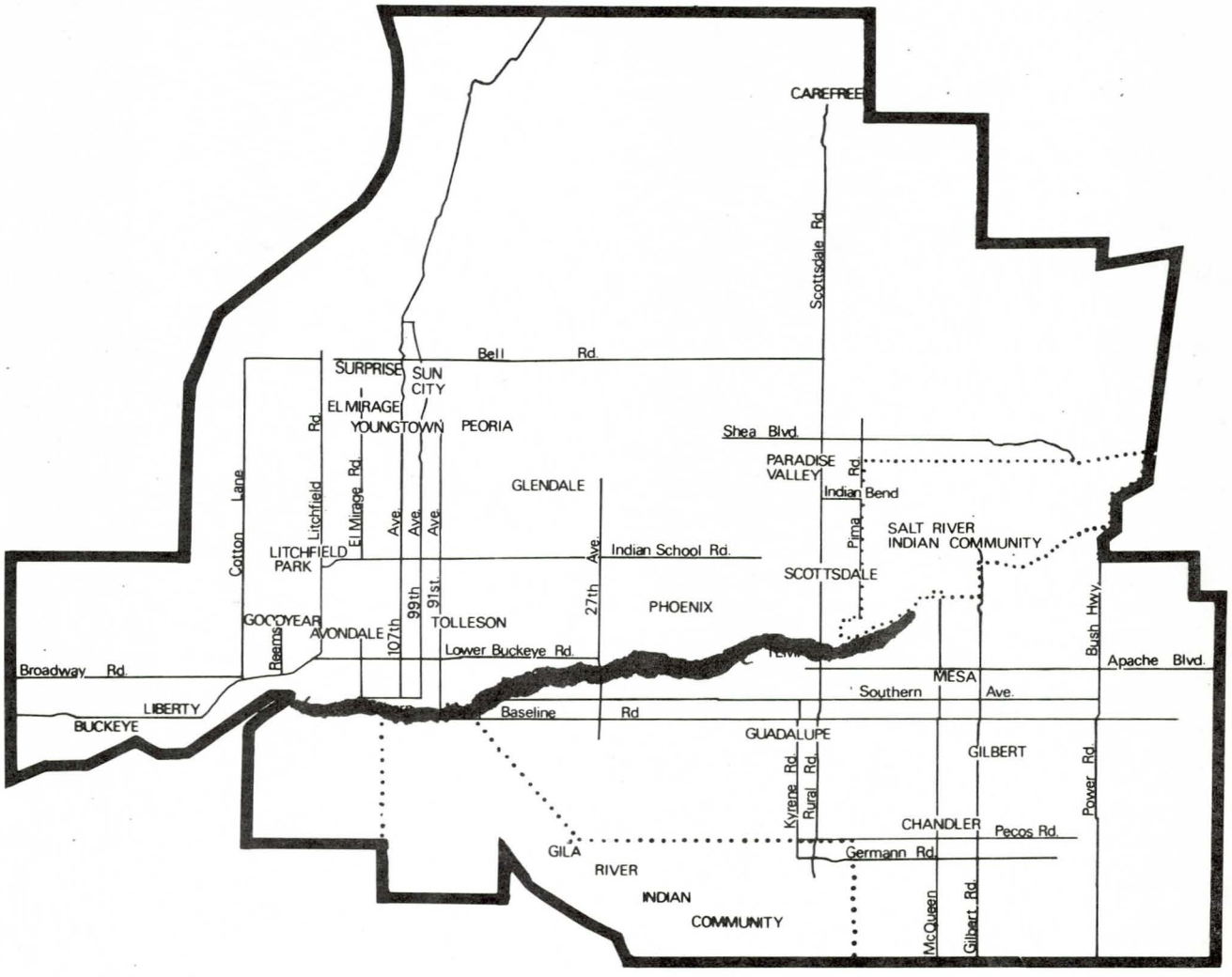
- In 1975, the Arizona Legislature designated Maricopa County, through its Board of Supervisors, to be fiscal agent for the administration of State funds appropriated for Rio Salado. In this same action, the County was charged with initiating intergovernmental agreements and forming a committee to advise contracting agencies and review and comment on all Project matters. These actions are in progress.

The Rio Salado possibilities that ultimately become reality will be determined through the evolutionary processes of detailed planning and actual construction. Because there are so few "knowns" that might help "precipitate out" an ideal course of action, further consideration of the Rio Salado concept must rely on empirical methods.

Project Area Definition: The Rio Salado District consists of all land required for flood control and the other stated functions of Rio Salado. It includes area needed along the shoreline for hotels, motels, shops, restaurants, marinas and similar facilities to be franchised for private development and also those required for trails, public parks, open spaces, parking and general public access. For the most part, the land would be acquired and owned by the responsible authority although, in some instances, use of land not so owned might be regulated through special district planning and zoning to achieve adopted goals. Included within the District are certain areas already in public ownership and committed to compatible uses. The perimeter is drawn to follow perceivable features, existing or propsed, mainly streets.

Land Use: In general terms, land uses within the Rio Salado District would be limited to these:

- floodway
- park and recreation space
- greenbelt
- water and water-related activities
- hotel, motel, restaurants, shops
- cultural establishments




# LOCATION OF RIO SALADO CONCEPT

FIGURE X-1

- o places of entertainment
- o access to all these

Land Value Enhancement: The value of land in and adjacent to the District would be increased because of the newly feasible land uses. The extent of this remains to be determined through further studies.

DETERMINANTS

The course of action for managing both the problems and the assets of the Rio Salado flood plain will be determined by many interacting forces. Some are absolute, such as the necessity for flood control and the availability of water. Others are less directly demanding but ultimately as essential to the success of the whole venture. They are identified below.

Flood Control

The problem of floods emanating from the watersheds of the Salt and Verde Rivers is a major constraint to Rio Salado development. Orme Dam would have provided needed the flood control. Because of objections that have been raised concerning Orme Dam and its impact, however, the futures of it and other structures at or near the confluence are in doubt. Alternatives for flood control are being examined by the Corps of Engineers as a part of its assistanct to the Bureau of Reclamation's Central Arizona Water Control Study.

Water Availability

The idea of maintaining lakes and flowing streams along the otherwise normally dry river bed makes the availability of water a vital consideration in evaluating the Rio Salado concept. Earlier studies have identified the following as potential sources of water:

- o Salt River Project (SRP) water for specific parcels having established water rights
- o SRP water for the Grand Canal delivered at its origin west of Mill Avenue by flowing in the river bed
- o exchanges of water with SRP and other irrigation districts
- o Central Arizona Project water -- purchase or exchange
- o renovated effluent from sewage treatment plants such as the three now operating (in Mesa and at 23rd and 91st Avenues in Phoenix) and plants in Scottsdale and near the Salt River which may be constructed in the future
- o storm and flood waters
- o municipal drainage systems

- municipal water supply sources

- drilled wells

The source or combination of sources to be used will be influenced by economic and other factors.

Environmental Effects

Until the completion of Roosevelt Dam in 1911, water flowed continuously in the Salt River. The effect of the Rio Salado Project would be to restore life to the river. Viewed from the perspective of today, however, Rio Salado would introduce a number of environmental changes. As identified below, these considerations must be taken into account in the further development of the project.

- Except for its westerly end, there is little of "natural" environment in the project area. As now modified by human activity, the flood plain has lost its riparian character and more closely resembles the nearby desert. The habitats it now provides are of that nature. However, there is an evident potential for the reintroduction of a variety of fish, wildlife, and plant species.

- The effect of the newly created water bodies on humidity in the Valley can be expected to be negligible. Although research has not developed a basis for predicting any change with confidence, it is known that a lake will evaporate about the same amount of water as an equal area of cropland under irrigation. A very slight increase in humidity might be experienced downwind from the lakes, this being the western part of the Valley in the morning and the eastern during the afternoon. A noticeable cooling effect would be experienced along the lakes on a summer evening.

- Maintenance of water quality at the appropriate levels for Rio Salado activities will require not only treatment of waste water sources but also:

  - protection from pollution by industrial wastes and the numerous solid waste disposal sites, including landfills now in existence.
  - prevention of undesirable concentrations resulting from evaporation.
  - protection from pollution by storm drainage and nutrient run-off from fertilizer used on grassed areas.

- Archeological and historic sites abound. They must be identified and actions taken to preserve and/or inventory them.

- Noise and safety standards, particularly relating to Sky Harbor International Airport, will be important factors in the determination of appropriate land uses and Rio Salado activities.

## RECREATIONAL POSSIBILITIES

Although it is multipurpose in nature, Rio Salado is usually and quite naturally perceived as a recreational project. It is likened to developments in other cities where the "edge" between land and water creates heightened interest, activity and opportunity. Along with other possibilities, a most important contribution of Rio Salado is, indeed, recreation -- "in town" recreation. It could go far toward alleviating the kind of overcrowding of available facilities that has caused authorities, on occasion, to limit the number of visitors to Saguaro Lake, the nearest of the Salt River lakes to the metropolitan area.

### Boating

Craft that would use the waterways include pedalboats, canoes, rowboats, motorboats and sailboats. Management procedures would be instituted to deal with any competition for space. As more and more lakes and streams become available, this regulation would work with increasing smoothness and effect.

Ideally, it would be possible for boats to pass from one lake to another and along connecting streams as they occur. Because the valley falls 10 to 15 feet per mile from east to west, this ideal can be supported only through special measures. It is estimated that a 20-foot wide channel to accommodate craft with a 5-foot draft would require a flow of about 300 cfs in order to be free of locks. A 10-foot wide channel, 3-feet deep, would require approximately 100 cfs. With more modest flows, including the minimum required to maintain water quality, locks would be required. Such locks, with a suggested width of 10 feet and length of 30 feet, can be operated manually by those on the boats passing through them and, as is the case on British canals, very little is required in the way of supervision or maintenance relating to their operation. Locks may be provided in streams or in canals designed especially for inter-lake traffic. At some places, portages, less costly than locks, may provide a wider choice of routes for craft that can be manhandled.

### Swimming

It can be expected that health and safety standards will limit the use of the lakes and streams for full body contact, whatever the source of water. However, it would be possible for lagoons with beaches of considerable size to be provided as arms of the larger system. These can be isolated by dams allowing proper supply and treatment of water while otherwise retaining functional and visual continuity with the lakes they adjoin. Several possible sites for this are suggested in the proposal including one on the north bank east of Central Avenue near where Riverside Park once offered recreational opportunities including swimming.

### Hiking & Riding

Extending the length of the Project would be the primary Rio Salado Trail for strolling, jogging, hiking, bicycling and horseback riding. Its design would separate these uses from one another as necessary. By passing under

all the bridges that cross the lakes and streams it follows, it would be completely separated from vehicular traffic. It would connect with the major Valley "Sun Circle Trail" and other systems such as those in Indian Bend Wash, in Papago Park and along SRP canals. At key locations, private entrepreneurs could develop centers to serve the needs and pleasure of trail users. Perhaps called "Trailports", each might contain any or all of such facilities as an equipment shop, a food and general store, a restaurant/ snack shop and a motel, hostel and/or campsite.

Other Recreation

A variety of recreational opportunities can be accommodated in and/or along the channel in addition to those water-related and trail-oriented activities discussed in the preceding paragraphs. Included are picnicking sites, campgrounds, group activity areas, hobby facilities, equestrian arenas, motor and other racing courses, playing fields for games and team sports and spectator enjoyment of all of this. To insure the safety of the many people engaged in these numerous activities, a flood warning system would be established.

FISH & WILDLIFE ENHANCEMENT

Lakes with depths of 4 to 15 feet would be managed to control algae and provide habitat for tilapia and other species of fish that thrive in such waters. Extensive opportunities for fishing could be provided. Birds and small animals would be attracted to the newly created environments. Further study of this aspect of Rio Salado is necessary.

IMPLEMENTATION

Rio Salado is of such magnitude and complexity that the several studies and numerous discussions of it have agreed that some measure of centralized direction will be required. There are two extremes among the possibilities for the exercise of such control. They differ markedly with respect to mandate, power and procedures:

- A coordinating council: Such an entity, with representation from all affected agencies, would determine overall concept and standards. Through review and comment, it would then seek coordination of the work of the several responsible jurisdictions in completing Rio Salado projects as part of their regular programs, financed largely from general funds budgeted over many years.

- A development authority: A duly constituted agency, with representation from all affected jurisdictions and exercising the powers expressly given it, would carry on an agressive program to make Rio Salado happen. Effectively, it would conduct a business in the public interest, making Rio Salado pay for itself.

The possibilities for Rio Salado development are to be examined further in the Central Arizona Water Control Study currently being conducted by the Bureau of Reclamation with the assistance of the Corps of Engineers.

## Rio Salado Development District

The Rio Salado Development District was established by the Arizona State Senate and approved by Governor Bruce Babbitt in April 1980.

The legislation provides the District with jurisdiction over the natural bed of the Salt and Gila Rivers from Granite Reef Dam to the confluence of the Gila and Agua Fria Rivers as well as the adjoining lands included within the 100-year floodplain of the Salt River.

The purpose of the District is to assist in the solution of flood control problems in the Salt River bed, to encouage the optimum development of prime lands along the river course within the jurisdiction of the District, to promote the development of outdoor recreational facilities, and to combine flood control with environmental design in a manner that will achieve the greatest social and economic benefits for the region and its population.

The Board of Directors of the District consists of nine appointed members: three from the City of Phoenix, two from Tempe, one from Mesa, and three from the State.

A technical advisory council provides representation from a cross-section of agencies, including the Corps of Engineers, Brueau of Reclamation, Arizona Game and Fish Department, Salt River Project, Flood Control District of Maricopa County, and the Arizona Office of Economic Planning and Development.