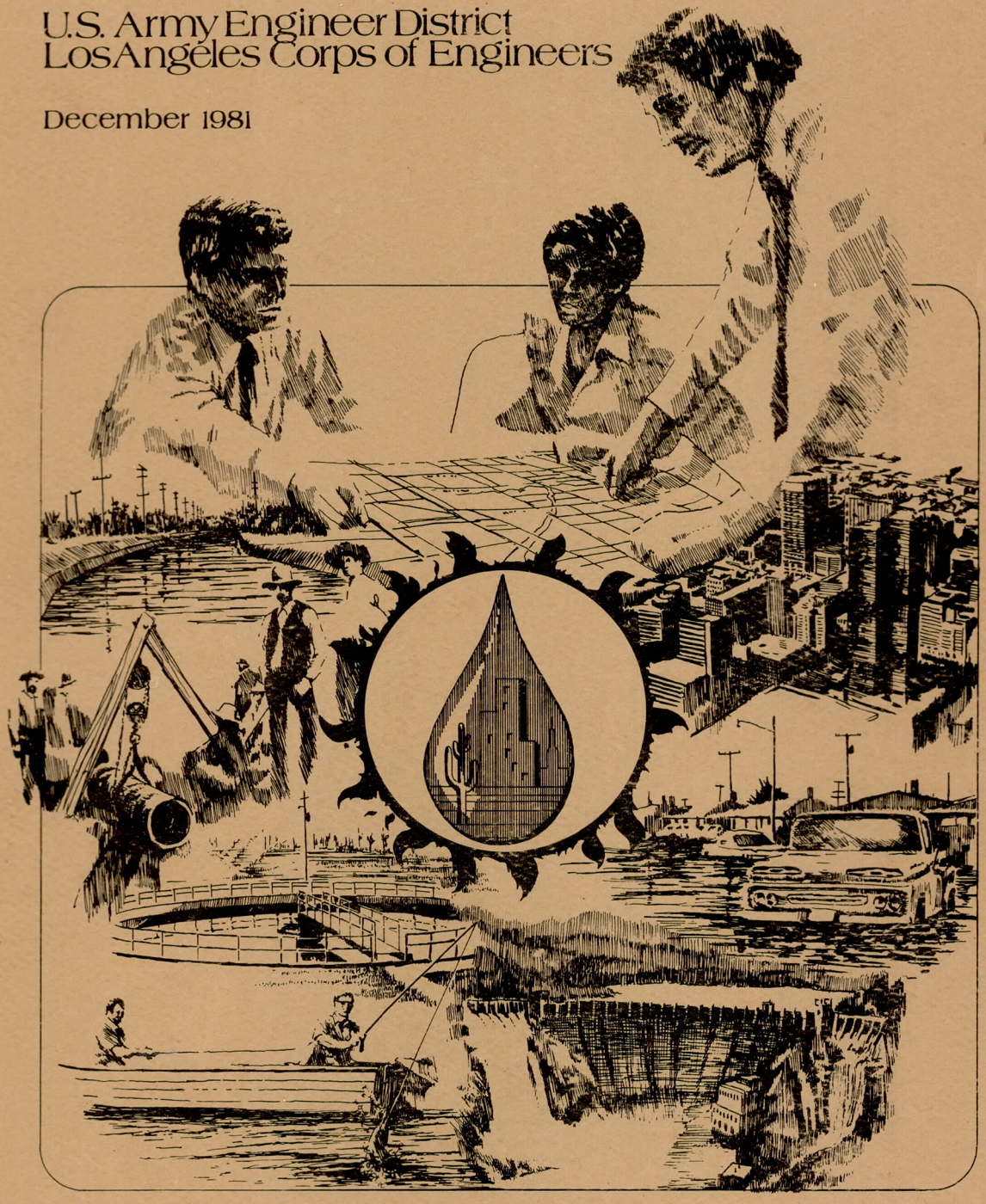
SUMMARY REPORT

Phoenix Urban Study Final Report

U.S. Army Engineer District
Los Angeles Corps of Engineers

December 1981



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FINAL REPORT

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SYLLABUS

The Phoenix Urban Study investigated water and related land resources issues in the Phoenix metropolitan area. The Urban Study began in 1973, and this report marks its conclusion. The project examined the following issues:

1. Water Quality
2. Flood Control
3. Water Conservation
4. Fish and Wildlife Enhancement

Water Quality. A key facet of the Phoenix Urban Study involved an examination in cooperation with the Environmental Protection Agency (EPA) and the Maricopa Association of Governments (MAG) of water quality management problems in the metro area. This included both point and nonpoint sources of pollution. The Urban Study developed an areawide water quality management plan in accordance with Section 208 of Public Law 92-500, the Federal Water Pollution Control Act Amendments of 1972.

Flood Control. The Phoenix Urban Study examined flooding problems in the metro area. Flood control projects proposed by local agencies were investigated for economic and engineering feasibility. None of these projects, with the exception of flood control along the Salt and Gila Rivers through the study area, was found to warrant federal interest. Preliminary alternatives for Salt-Gila flood control were developed by the Urban Study.

Water Conservation. Water conservation was examined from both the standpoints of conserving existing supplies through reducing consumption, and augmenting the study area's water supply by conserving flood flows. The Urban Study participated in the development of a "Watch Our Wastewater" program for MAG. Although this program was designed primarily to reduce flows to already overtaxed wastewater treatment plants in the study area, it also resulted in substantial water conservation. In addition, artifical groundwater recharge was examined as a means of conserving flood flows, as was a scheme to divert all or part of the flow of the New River into Lake Pleasant in the northwest portion of the study area. Artificial groundwater recharge as a water conservation measure is currently being investigated under a separate authority. The New River diversion measure did not warrant further federal interest.

Recreation and fish and wildlife enhancement were examined insofar as they related to specific plans developed by the Urban Study. Recreational aspects of Rio Salado, a land use concept for the Salt River through Phoenix, however, did receive special attention of the study.

PREFACE

Water has been the single most important factor contributing to the phenomenal growth of the Phoenix metropolitan area. The prehistoric Hohokam Indians fashioned a sophisticated culture in the Salt River Valley based on irrigated agriculture. A century ago irrigators laid the groundwork for development of the limited water resources of the area, thereby insuring an adequate supply of the precious liquid. In so doing they provided the single most feasible location for development of a large population center in the entire lower Colorado River Basin. The development which has resulted from the efforts of these pioneers in water resource planning, however, has placed an even greater demand on limited available water supplies. In some instances improvements to the land are subject to flood hazards which were not recognized at the time. In recognition of the need to extend and refine water resource planning, the U.S. Army Corps of Engineers was requested to undertake the Phoenix Urban Study in cooperation with local authorities. This Summary Report marks the conclusion of that study.

The Phoenix Urban Study began at a time when the Phoenix metropolitan area was facing some crucial decisions relating to water resource planning. The rapid growth of the Salt River Valley over the past thirty years had strained existing facilities and resources. Planners were looking not only at the quantity of available water supplies, but also the quality of water in the study area. The importance of flood control was being realized as urbanization spread into undeveloped areas, obliterating natural stream channels and encroaching on floodplains. Just as too much rainfall reminded planners of the need for flood control, dry years emphasized the need for individuals, businesses, and governments in the study area to conserve water wherever possible. Reuse of wastewater seemed promising, but its possibilities had not been fully explored.

Water oriented recreation had long been popular in the Salt River Valley. Rapid increases in population and leisure time, however, resulted in a growing demand for more nearby aquatic recreational facilities. The growth of the urban study area also caused concerns to be voiced over the precarious status of fish and wildlife in the region.

The Phoenix Urban Study was undertaken with the overall objective of assisting local, state, and federal agencies to meet these problems and needs through long range water and water-related land resource planning. The success of the Corps in meeting this challenge through the Phoenix Urban Study can best be seen through an examination of the program's accomplishments.

In a general sense, the major accomplishment of the Phoenix Urban Study has been to heighten the awareness of local planners, government officials, and citizens as to the importance of water resources to urban problems and plans. Through a vigorous planning process and public participation program, the Urban Study has brought about a greater understanding of the close and complex interrelationships among the various aspects of water resource planning; water quality, flood

control, conservation, recreation, and enhancement of fish and wildlife. New programs for reaching long-range solutions to water resource problems originated as a part of the Urban Study. Plans for implementation of some of these programs have already been drawn up, while others require further study.

It is too early to predict what the long-term effects of the Phoenix Urban Study will be. Many unforeseen factors could alter the projected development of the study area. From an examination of this Summary Report and the supporting appendices, however, it is clear that much has been accomplished toward meeting the goal of providing responsible agencies with implementable plans to meet immediate needs and a more complete framework for the planning of water and water related land resources. ■

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 and 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.

Urban Studies incorporate 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

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." This report is in full response to the resolution.

A large portion of the Phoenix Urban Study effort involved an investigation of water quality problems in the study area. This was done in accordance with the Federal Water Pollution Control Act Amendments of 1972 (Public Law 92-500).

In the Federal Water Pollution Act Amendments, Congress included a special section, Section 208, which set up requirements for areawide planning. The "208 planning process" as defined in the Act, in its subsequent regulations, guidelines, and in its 1977 amendments, provides an opportunity for a designated area to identify its specific areawide waste treatment and water quality management problems and set forth a management program to alleviate those problems. Maricopa County in 1975 was designated by the Governor of Arizona and the Environmental Protection Agency (EPA) as a 208 planning area, and the Maricopa Association of Governments (MAG) was designated the 208 planning agency for the area.

The MAG 208 program is countywide, but for ease of execution, it was divided into the Phoenix metropolitan area and the nonmetropolitan area of the county. The U.S. Army Corps of Engineers was requested by MAG to assist in the metro area planning as part of the Phoenix Urban Study.

The flood control portion of the Phoenix Urban Study involved the investigation of a number of flood hazard areas. The Phoenix Urban Study also recognized other authorized Corps projects in the study area, as well as Federal Insurance Administration requirements. Much of the study effort for flood control was associated with flooding along the Salt River through metropolitan Phoenix. At the outset of the Urban Study, it was assumed that the Central Arizona Project (CAP, a project of the Bureau of Reclamation to bring water from the Colorado River to central and southern Arizona) would be constructed as planned, and that Orme Dam and Reservoir (a feature of the CAP to be located at the confluence of the Salt and Verde Rivers) would reduce substantially flooding along the Salt River through Phoenix. The Urban Study staff, therefore, planned to examine flood problems along the Salt residual to Orme Dam.

Substantial public opposition to Orme Dam, as authorized, and its subsequent recommended elimination from the CAP in 1977, caused the Urban Study staff to reorient its approach to Salt River flood control. It participated with the Bureau of Reclamation in studies of alternatives to Orme Dam. The Bureau, with the assistance of the Corps of Engineers, currently is conducting the Central Arizona Water Control Study to examine alternatives for CAP regulation and control of flooding along the Salt and Gila Rivers. This Summary Report is the final action by the Urban Study in the study of Salt River flood control. Material in this report is being used by the Bureau and the Corps in the Central Arizona Water Control Study.

Because drought, more often than flooding, is the prevalent condition in central Arizona, the Phoenix Urban Study undertook an investigation of possible water conservation measures. Two general aspects of water conservation were explored. First, municipal water conservation as means of reducing flows into water treatment plants came under analysis. In line with this, the Maricopa Association of Governments has initiated a program to conserve water.

Secondly, investigations were made into the feasibility of achieving water conservation through the storage of floodwaters for future beneficial use. The potential of artificial groundwater recharge, and diversion of the New River into Lake Pleasant are discussed in this Summary Report. Methods of conserving both floodwaters and CAP waters in underground aquifiers will continue to be examined in the Central Arizona Water Control Study being conducted by the Bureau of Reclamation with the assistance of the Corps of Engineers.

Findings of the Phoenix Urban Study regarding recreation and enhancement of fish and wildlife are not being accorded separate sections in the Summary Report. This is because recreation and fish and wildlife enhancement were not studied separately, but rather in conjunction with specific projects examined. The findings are incorporated into portions of the report dealing with water quality, flood control, and water conservation as they relate to these topics.

The Phoenix Urban Study staff also undertook planning for Rio Salado, a multipurpose greenbelt concept utilizing the Salt River bed through metropolitan Phoenix. Rio Salado is an imaginative concept embracing many aspects of water resource management, including water quality, flood control, water conservation, recreation, and fish and wildlife enhancement. These components of Rio Salado are identical to the objectives of the Phoenix Urban Study. Because of this relationship, special attention is given to Urban Study participation in Rio Salado planning.

FINAL REPORT ORGANIZATION

The Final Report of the Phoenix Urban Study is presented in nine volumes, as shown in Figure I-1. 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; gives a summary of impacts; and presents the final recommendations.

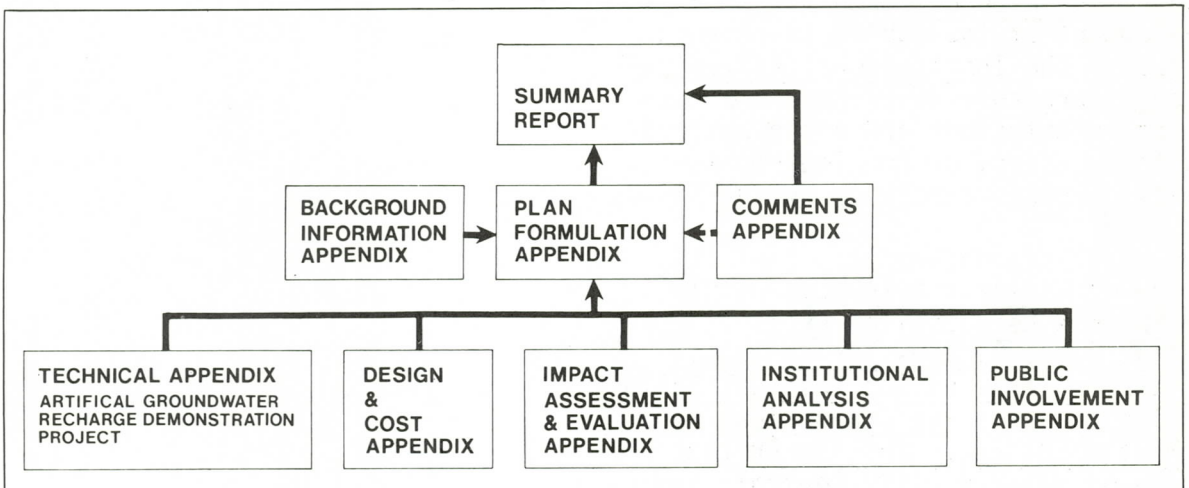


Figure I-1
STUDY REPORT ORGANIZATION AND CONTENT

Three main appendices form the basis for the Final Report. The Background Information Appendix presents a profile of the region today as well as discussions 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 Summary Report.

The remaining five detailed appendices develop analyses supporting the conclusions of the Plan Formulation Appendix. The Design and Cost Appendix contains technical detail for the engineering of component systems. A Technical Appendix presents the Plan of Study for a Demonstration Recharge Project in the Salt River Valley developed during the course of the Urban Study. 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 involvement program. The Institutional Analysis Appendix presents descriptions of existing institutions and organizations and their effect on the implementability of plans developed by the Study.

Five ancillary documents: 1) Initial Survey of Historic Resources Within the Phoenix Metropolitan Area; 2) Potential Reuse Options for Municipal Wastewater Effluent and Residual Solids; 3) Fish and Wildlife Enhancement Report; 4) Management Study for the Arizona Bureau of Water Quality Control; and 5) Groundwater Quality in the Major Basins of Maricopa County, are included as part of the Final Report. These ancillary documents were prepared as part of the Phoenix Urban Study, and had been circulated previously under separate covers.

Study Participants and Coordination

From its inception, the Phoenix Urban Study coordinated with other Government agencies at the federal, state, regional, and local levels, as well as with interest groups and concerned citizens. The Corps coordinated environmental work performed by the Urban Study with the Environmental Protection Agency, Arizona Department of Health Services, Arizona Water Commission, Maricopa County, and Maricopa Association of Governments. ■

CHAPTER II
STUDY AREA DESCRIPTION

LOCATION, PHYSICAL AND BIOLOGICAL CHARACTERISTICS

The boundary of the study area was selected so as to include those cities and communities that are presently within, or are expected in the next 50 years to be within, the contiguous metropolitan area, and whose water resource problems are interrelated. The metropolitan area is located in the south central part of Arizona and in the center of the Salt River Valley. (See figures II-1 and II-2). The study area covers approximately 2300 sq. mi. and includes the cities of Phoenix, Scottsdale, Tempe, Mesa, Chandler, Carefree, Glendale, Peoria, Sun City, Goodyear, Avondale, Tolleson and Buckeye.

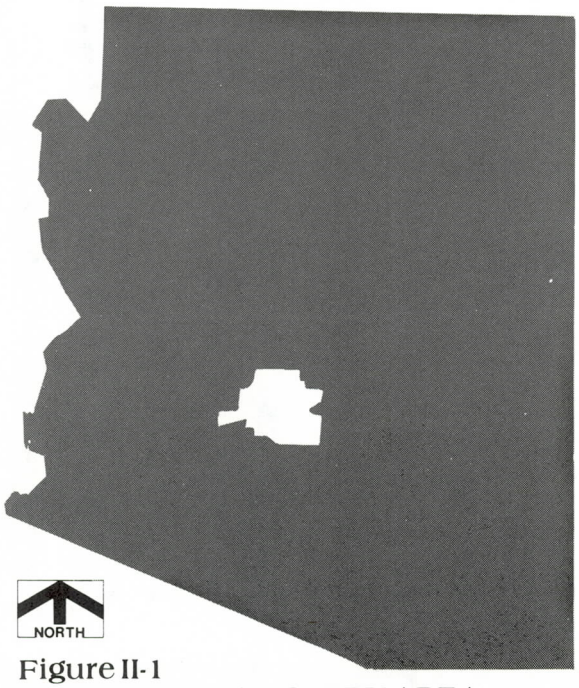


Figure II-1
PHOENIX URBAN STUDY AREA LOCATION

Elevations in metro Phoenix range from 890 feet at Buckeye to 1380 feet above sea level east of Mesa, with mountains in or near the urban area reaching 4000 feet above sea level. Slopes in the study area are, by and large, gentle, although steep gradients (10 percent or greater) occur in the mountainous areas.

The climate of the study area is arid and marked by extreme heat and low rainfall. Precipitation ranges from less than 6 inches per year in the deserts to in excess of 20 inches in the surrounding watershed. Elevations above 3000 feet experience occasional snowfall. Snow accumulates in substantial amounts in the watersheds above 5000 feet, and is a major factor in the hydrology of the rivers in the study area. Snow rarely occurs in the desert.

Precipitation in the study area is divided into two seasons. Winter rains occur from November through March. They are usually the result of cyclonic disturbances originating over the Pacific Ocean. These storms bring widespread, though often light, precipitation. The arrival over Arizona of moist tropical air from the Gulf of Mexico in midsummer signals the start of the summer rainy season. It extends from July to October and is marked by scattered, though often heavy convective showers, thunderstorms and cloudbursts. These storms can result in periods of high winds, severe blowing dust, and flashflooding.

Vegetation in the study area correlates directly with elevation, available moisture, and temperature. The desert plains in the western portion of the study area support only the hardiest plant life, such as creosote bushes, sagebush and catclaw. Stands of mesquite, palo verde, and ironwood are found along

intermittent creeks, washes, and rivers. Denser reparian vegetation occurs along flowing streams.

In historic times, non-native crops supported by intense irrigation have been introduced into the Salt and Gila River Valleys. Leading agricultural products include seed crops (cotton, milo, barley, sorghum, and alfalfa), vegetables, fruit (citrus and grape), and nut crops.

Wildlife in the study area is typical of that found in the desert and foothill regions of the Southwest. Common wildlife species in the study area include the gray fox, desert cottontail rabbit, sidewinder rattlesnake, mourning dove, pocket mouse, whiptail lizard, desert horned toad, roadrunner, gambel's quail, and coyote. In addition the Yuma clapper rail and the bald eagle, both on the U.S. Fish and Wildlife endangered species list, inhabit the wetland and riparian habitat in the study area.

SOCIO-ECONOMIC CHARACTERISTICS

The Phoenix Urban Study area is one of the fastest growing regions in the United States, and one of the few metropolitan areas of the nation that has continued to grow in recent years.

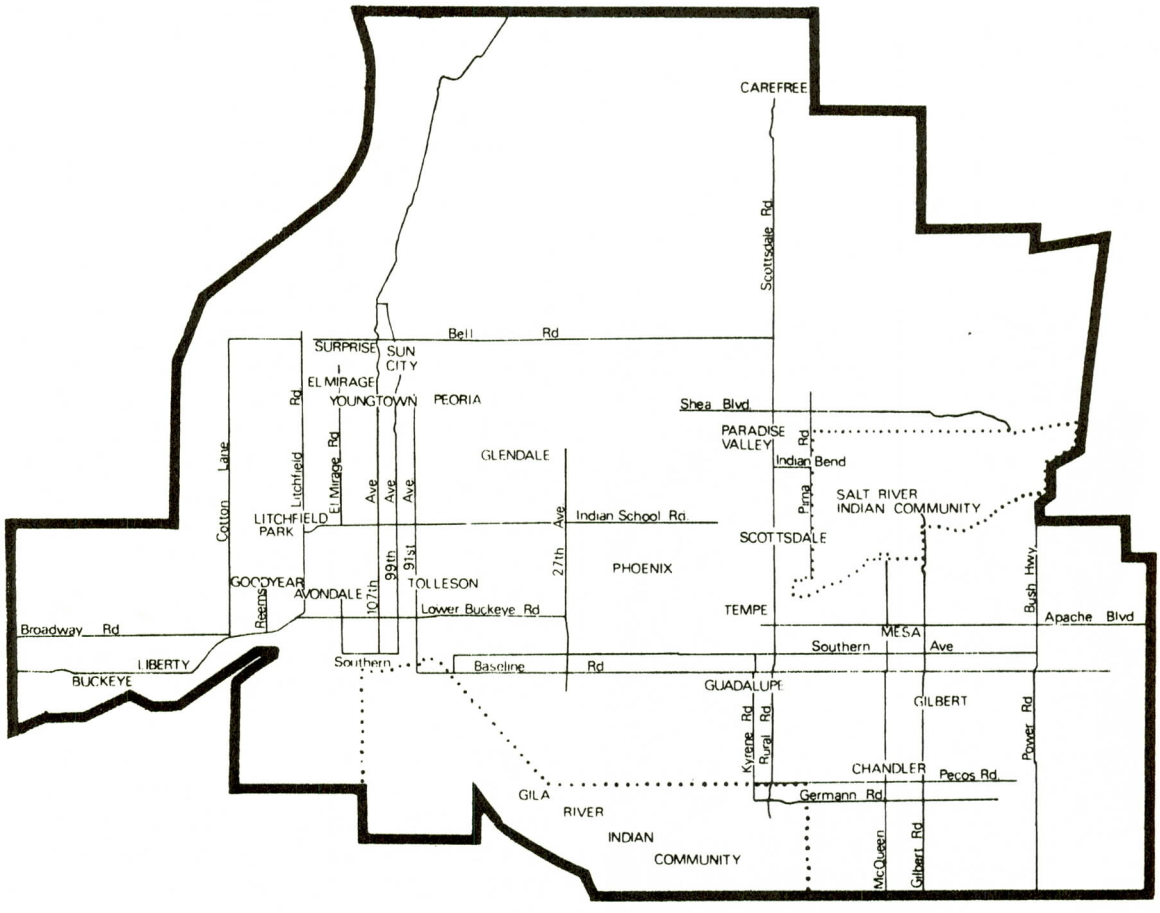


Figure II-2
PHOENIX URBAN STUDY AREA

The population of Maricopa County, of which about 93 percent is presently in the Phoenix metropolitan area, increased from 187,000 in 1940 to 1,173,000 people in 1974, a 630 percent increase. This represents an annual growth rate of 5.6 percent since 1940. Historical population trends are shown in Table II-1.

The three leading industries in the study area are manufacturing, tourism and agriculture. The period from 1960 into the 70's was one of rapid growth for all economic indicators of the study area and even more rapid change in the composition of economic activity. Manufacturing, retail trade, finance, insurance and real estate services, and

Table II-1
POPULATION GROWTH-
ARIZONA AND MARICOPA COUNTY

Year		Arizona*	Maricopa County*
1960	(census)	1,302,160	663,510
1965		1,584,000	852,000
1970	(census)	1,755,400	971,230
1975		2,212,000	1,209,800
1976		2,270,000	1,260,500
1977		2,364,000	1,292,000
1981		2,768,300	1,521,800
2000	(projected)	3,939,000	2,181,000

*Census year data from the Bureau of the Census. Others from the Arizona Department of Economic Security.

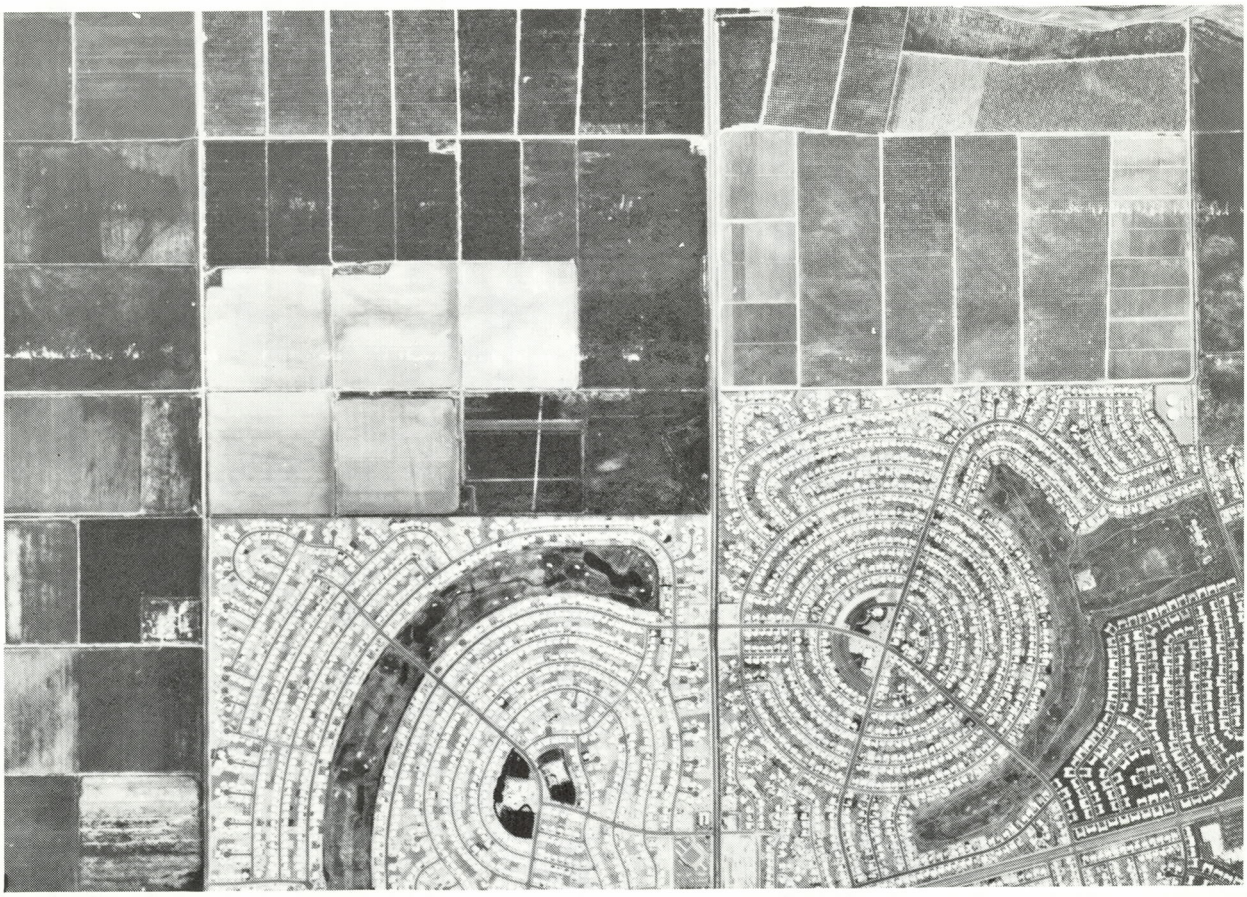


Figure II-3
Increasing Urbanization Of The Study Area Has Led To A Decline In Agricultural Lands.
Sun City Area

government industries grew while agriculture, mining, and transportation declined. The social, economic, political and climatic conditions which recently have made the area one of the leading growth areas in the nation will continue. Agriculture, however, is expected to decline further if the current trend in which municipal and industrial demands for land and water outbid the agricultural demand continues.

Continual outward expansion of the Phoenix metropolitan area during the last 20 years has formed a contiguous urban area. This growth resulted in the rapid development of Scottsdale and Paradise Valley to the north and east, Tempe and Mesa to the southeast, the Maryvale-Glendale area to the west, and the Sun City retirement community to the northwest of downtown Phoenix.

The metro area contains a considerable amount of Arizona State Trust Lands to the north and west of Phoenix that may be fully developed for urban use in the future according to the Arizona Land Department. In contrast, three Indian reservations on the eastern and southern perimeters of the study area act, to some extent, as buffers to urban development.

The Phoenix area was a major population center during portions of the prehistoric past and contains abundant archaeological remains. The Hohokam tradition, which appeared about 350 B.C. is the principal cultural complex represented in the study area. Known Hohokam sites in the Salt River Valley are located along the major and tributary river systems and on irrigable lands adjacent to rivers. In addition, at least seven major prehistoric irrigation canal systems are known to have existed in the study area.

An initial survey of historic sites in metropolitan Phoenix prepared for the Urban Study identified more than 550 existing historic sites, seven of which had been entered on the National Register of Historic Places. An additional 176 sites were considered to be potentially eligible for nomination to either the State or the National Registers.

WATER RESOURCES

In the study area, water is an extremely valuable resource, and both surface water and groundwater are being used extensively.

Surface Water

The major streams in the study area are the Salt, Verde, Agua Fria, and Gila Rivers. Their tributaries in the study area include the New River, Skunk Creek, Cave Creek, Indian Bend Wash, as well as several smaller arroyos and washes. With the exception of the Salt and Verde Rivers above Granite Reef Dam, these streams have intermittent surface flows. The relatively light winter rainfall usually is insufficient to produce surface flows along the smaller washes in the study area, although heavy winter precipitation and spring runoff can cause larger streams and their tributaries to flow. For location of major watercourses in the study area, see figure VI-21. Intense summer thunderstorms occasionally result in flooding along the tributary streams, but not along the major water courses.

The Salt and Verde Rivers supply 93 percent of the surface water available in the study area. They are controlled by four dams on the Salt (Stewart Mountain, Mormon Flat, Horse Mesa, and Roosevelt) and two dams (Bartlett and Horseshoe) on the Verde. These structures impound reservoirs which provide irrigation and domestic water for metropolitan Phoenix and are not intended for flood control. At Granite Reef Diversion Dam, waters from the Salt and Verde are channeled into canals which serve the Phoenix area. The Agua Fria River is impounded by Waddell Dam, forming Lake Pleasant.

Figure II-4
Roosevelt Dam, Completed In 1911, Impounds The Largest Of Six Reservoirs On The Salt And Verde Rivers Which Supply Much Of The Study Area With Water For Both Agricultural And Domestic Uses.
(Courtesy Arizona Historical Foundation)

This reservoir supplies water to Maricopa County Municipal Water Conservation District No. 1, although the amount of surface water available is less reliable than that from the Salt-Verde system.

Groundwater

Groundwater provides a major portion of the water supply to the study area. It has done so since the 1930's, when water demands outstripped surface water supplies. Data of various types were collected during this period, but they were of a form that made determination of the impacts of irrigation practices, effluent reuse, groundwater recharge, and other activities of man which affected both the quality and quantity of groundwater impossible.

At the time Anglo settlers came to the study area, the water table near the Salt River was very close to the surface and no more than 100 feet deep in the central portion of the area. Since 1900, it is estimated that over 70 million acre-feet of water have been pumped out of the Valley. The water table is currently

declining at an average rate of about 1.8 feet per year. The direction of groundwater flow in some areas has changed during this time period with water now heading toward major groundwater table depressions in the Luke and Chandler/Queen Creek areas. For the location and direction of groundwater flows see figure II-5.

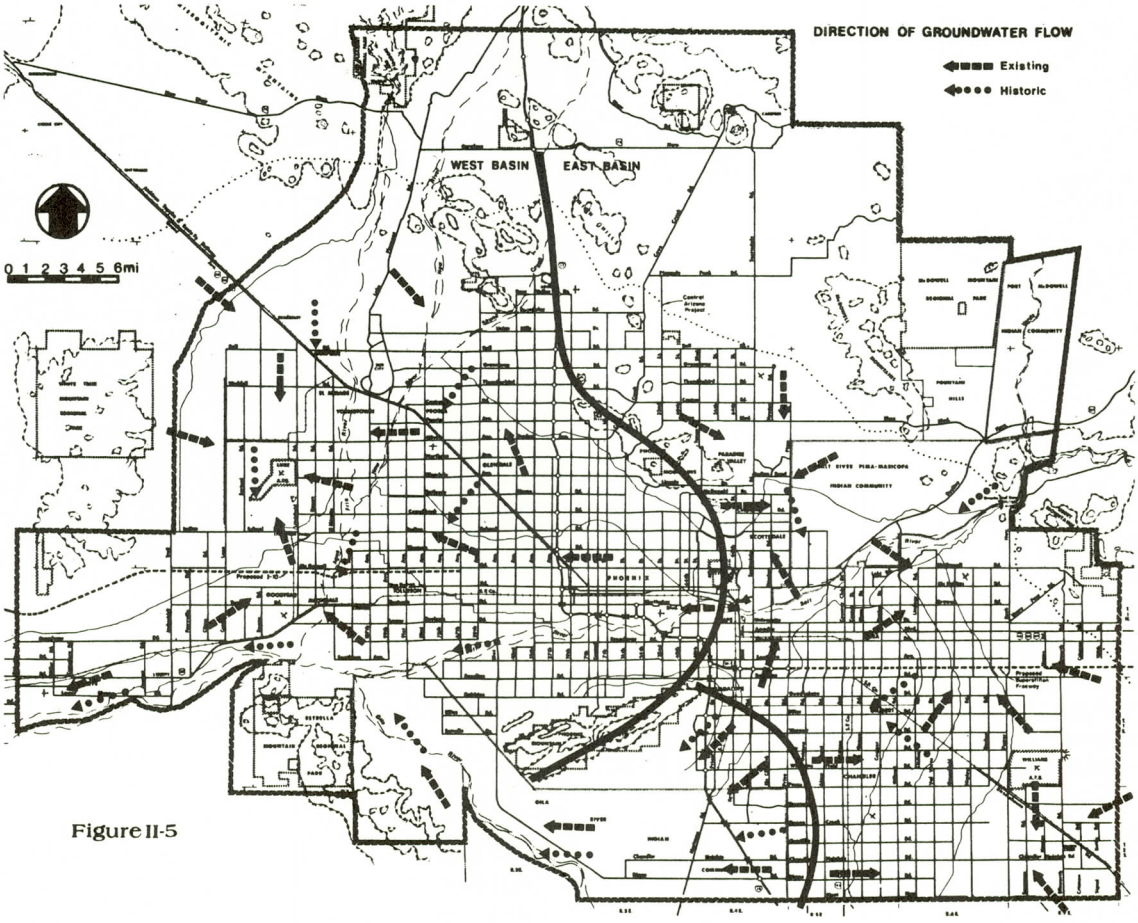


Figure II-5

CHAPTER III

PLANNING PROCESS OBJECTIVES AND RESULTS

PLANNING PROCESS

Corps of Engineers' planning for the Phoenix Urban Study followed a well-defined three-stage process. In general, this planning process consisted 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 decreased while the level of detail at which they are examined increased. Additionally, four tasks were accomplished within each planning stage. These four tasks were:

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

Although all of these tasks were carried out in the three planning stages, the emphasis placed on them varied at each stage (see Fig. III-1).

The three basic planning stages and associated tasks were:

- Stage I, Delineation of Strategies.

Efforts during Stage I centered 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.

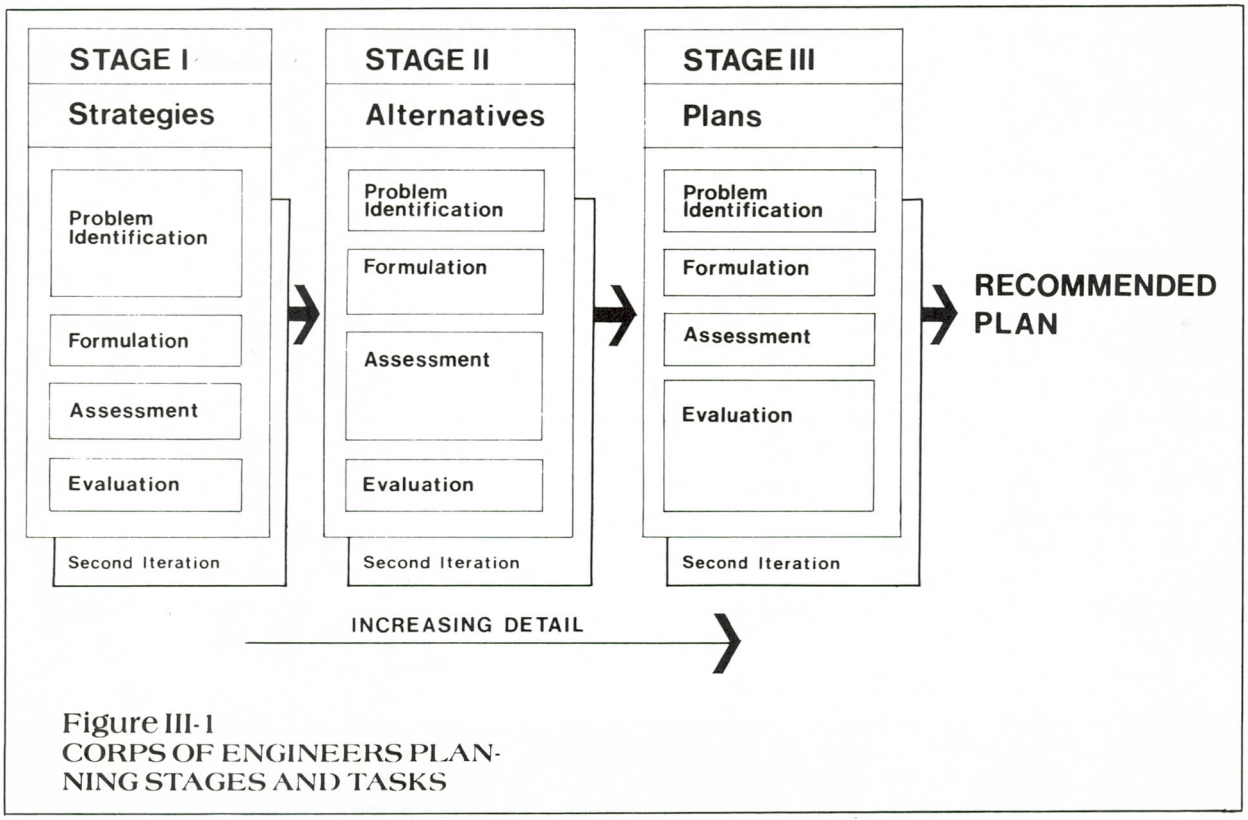


Figure III-1
CORPS OF ENGINEERS PLANNING STAGES AND TASKS

· Stage II, Formulation of Alternatives.

The planners and engineers performed the bulk of their work in Stage II. Included in this stage were the detailed investigations of such factors as geology, hydrology, hydraulics, costs, structural designs, and institutional analyses. Detailed environmental assessments and socio-economic studies also were made.

Stage II work produced a limited number of alternatives for more detailed study in Stage III.

· Stage III, Refinement of Plans.

Stage III included the necessary modification of plans and designs based on economic, engineering, environmental, and social concerns voiced during the review at the conclusion of Stage II. Emphasis was 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 of the study area, it was decided following the completion of Stage I that the Urban Study efforts should be divided among three principal areas of concern.

The Water Quality portion of the Phoenix Urban Study involved close coordination with the Maricopa Association of Governments, as well as with several other federal, state, and local agencies. Planning for water quality was carried through all three stages during the Urban Study. Flood control investigations were carried out during Stage II of the Urban Study. The alternatives either were recommended for further study under another authority or dropped from consideration for lack of adequate benefit/cost ratios or proper authority to continue.

Of the two principal components of the water conservation section of the urban study, the proposal for a groundwater recharge demonstration project, progressed into Stage II with the preparation of a detailed plan for further study under a separate authority, while the proposal to divert water from the New River into Lake Pleasant, also advanced into Stage II, but was then dropped from consideration primarily because of strong opposition from local residents.

OBJECTIVES

In general, the Phoenix Urban Study sought to bring the federal, state, regional, and local planning efforts together in order to develop realistic long-range solutions to water resource problems within the study area. In order to accomplish this task, the following objectives were formulated:

· Development of an areawide water quality management program in compliance with Section 208 of the Water Pollution Control Act Amendments of 1972 (Public Law 92-500). This would involve investigations of historic groundwater quality and quantity, identification of non-point sources of pollution, development of a point source plan, and coordination of state and local planning efforts.

· Investigation of proposed flood control alternatives at Glendale-Maryvale, South Phoenix, Upper-Indian Bend Wash, Cave Creek below the Arizona Canal, Old Crosscut Canal, Gila Floodway and Salt River through Phoenix.

· Development of water conservation measures through demand reduction, encouraging more efficient use of existing supplies, and improved land management practices, and capture and storage of floodwaters.

· Analysis of methods for fish and wildlife enhancement and recrea-

tional development as related to water quality, flood control, and water conservation alternative plans.

These objectives were carried out in accordance with the Principles and Standards for Planning Water and Related Land Resources (1973) (Revised 1979).

RESULTS

Water Quality

Major strides toward improving water qualtiy 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 coordination with the Environmental Protection Agency. The Environmental Protection Agency has approved and will partially fund implementation of the areawide water quality management plan. 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 was formulated and adopted, avoiding creation of any new governmental agencies.
- 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 planning effort.
- A program for reducing flows to study area wastewater treatment plants was initiated.
- Groundwater quality was studied extensively. 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. This monitoring plan has been implemented.
- The study greatly increased the awareness of local officials as to the importance of surface and groundwater quality and wastewater management in general.

Flood Control

Reviews were made 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 to control of floods on the Salt River through metropolitan Phoenix.

- Under the auspices of the Phoenix Urban Study, the Corps rendered assistance to the Bureau of Reclamation in its Central Arizona Water Control Study. Hydrologic studies of the Salt River also were carried out.

- Surveys of damages resulting from the floods of March and December, 1978 were conducted.

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

- Interim flood control measures on the Salt and Gila Rivers were evaluated. One measure, the relocation of the community of Allenville, was determined to warrant further investigation under the authority of Section 205 of the 1948 Flood Control Act (P.L. 80-858).

- Ideas regarding flood warning systems for the Urban Study area were developed and shared with appropriate local agencies.

Water Conservation

Efforts by the Phoenix Urban Study in the field of water conservation 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 its own significant results in the area of water conservation:

- Feasibility Report (1977) - This document represented the first serious effort at examination and quantification of artificial groundwater recharge, and amplified the need for further research. It initiated a change in attitudes toward artificial groundwater recharge among federal, state, and local agencies. The Arizona Groundwater Study Commission (1977-1979), and the Groundwater Recharge Symposium held by the Salt River Project in Phoenix in November, 1978 are manifestations of the increased interest in groundwater management.

- A Plan of Study for a Demonstration Recharge Project in the Salt River Valley (1979) - This document relates the potential and the limitations of artificial groundwater recharge and describes a demonstration project that would enhance greatly our ability to employ artificial groundwater recharge as an integral part of future water resource projects.

  Artificial groundwater recharge is being examined by the Central Arizona Water Control Study as a water conservation measure.

Rio Salado

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:

- 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.

- A preliminary institutional analysis was developed to show methods for planning and managing Rio Salado. ■

CHAPTER IV
PUBLIC INVOLVEMENT PROGRAM

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 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 homeowner's associations), general interest groups (such as Lions, Rotary, Kiwanis), professional associations (such as American Institute of Architects), educational 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 for 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 alter-

native 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.

SPECIFIC ACTIVITIES

208 Public Involvement

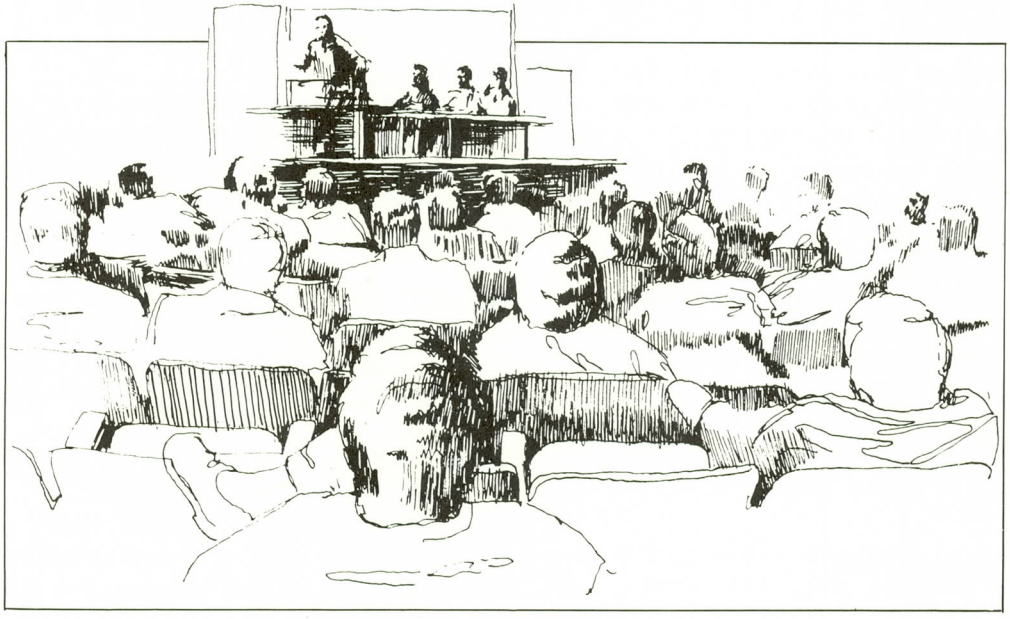
The participation of the Phoenix Urban Study in the MAG 208 program following Stage I required that a separate and more elaborate public involvement program be initiated.

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. Throughout the 208 program a comprehensive public participation program was conducted. This program was aimed at soliciting public input, aiding public education, creating a plan sensitive to local needs and values, and building support for implementation of the final 208 plan.

As an initial step in developing the 208 public participation program, the advisory group structure and 208 review process was established. The advisory groups, representing a broad spectrum of public interests, were:

- Technical Advisory Group
- Agricultural Advisory Group
- Citizens Advisory Group
- Management Subcommittee
- 208 Executive Committee.

These groups assisted the staff in plan development, reviewed and commented on program outputs, and made recommendations on elements of the final plan. Critical milestones in development of the final plans were identified and each of the advisory groups was responsible to review the work of consultants and staff and make recommendations.



At this local level of review, formal public response also was facilitated by public workshops and meetings. Additionally, each city and town council had several opportunities to participate directly in the planning process by reviewing and indicating their preferences at special presentations during council and work-study sessions. Review also occurred at the state and federal levels. All recommendations were then forwarded to the MAG Regional Council, the policy making body of MAG, for its decisions.

Key issues and critical decision points in the development of the final 208 plan elements involving extensive public participation included:

- Approval of work plans;
- Population projections and distribution;
- Wastewater flow reduction;
- Evaluation methodology and criteria;
- Screening and selection of point source alternatives;
- Management system development;
- Nonpoint source assessment.

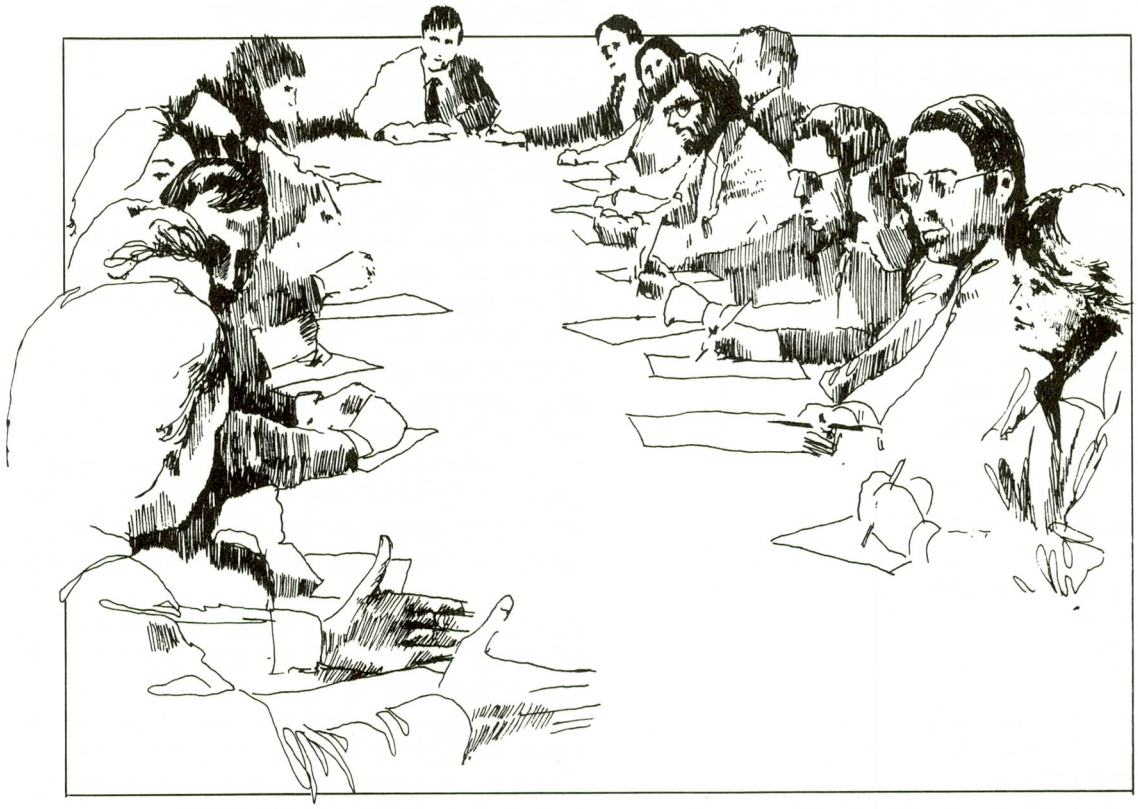
Throughout the program, a continuous effort was made both to stimulate public awareness of and inform the public about the 208 program. Public information and communication techniques utilized in the public participation program included: publication of a newsletter, Clean Water, which kept the public informed of activities and major decisions of the 208-Urban Study program and discussed issues pertinent to wastewater planning in the area; publication of brochures and flyers; presentations to community groups; newspaper, television and radio coverage; public workshops; mail-in surveys; and field trips.

Flood Control Public Involvement

Initial public involvement for the flood control portion of the Phoenix Urban Study involved public meetings, public workshops, and presentations to the Citizen's Advisory Board of the Flood Control District of Maricopa County. Although the Citizen's Advisory Board's activities were limited, the group did provide the Urban Study with valuable expertise and public input. As potential projects demonstrated a lack of justification, however, the need for more extensive public involvement in flood control diminished greatly.

Public participation in flood control efforts increased toward the end of the Urban Study as a result of its assistance to the Bureau of Reclamation in Stage I planning for its Central Arizona Water Control Study. Stage I public involvement was designed to:

- provide an understanding of public perceptions, concerns, ideas, and preferences;
- identify other planning efforts and evaluate their relevance to the current study;
- identify problems and needs related to flood control in the study area;
- assemble a variety of viable alternatives for consideration in Stage II;
- involve Urban Study personnel in the Community Advisory Board organized by Governor Babbitt to advise him on alternatives for flood control and CAP storage;
- encourage formation of a Technical Agency Group to review Stage I activities of the Study of Alternatives.



The public involvement program for this portion of the Phoenix Urban Study consisted of:

- presentations to special interest and professional groups;
- informal discussions with local governments and influential citizens;
- participation in an Interagency Task Force formed by the Bureau of Reclamation to study Orme Dam alternatives.

Water Conservation Public Involvement

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

- definition of problems and needs related to water conservation;
- identification of studies completed or currently in progress that relate to water conservation;
- 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 the lack of available information overall, public involvement during the investigation of the possibility of accomplishing water conservation through artificial groundwater recharge was limited to meetings, discussions, and interviews with

representatives of concerned federal, state, and local agencies, Indian communities, water users groups, and civic organizations. Much of this activity was of an informal nature and designed to assess existing 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. ■

CHAPTER V

WATER QUALITY PROGRAM

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 demand 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 had the responsibilities of identifying the current situation relative to water quality and quantity and proposing actions to help alleviate the problems.

In 1975, Maricopa County was formally designated by the Governor of Arizona and the Environmental Protection Agency as an area experiencing substantial water quality control problems, and the Maricopa Association of Governments was designated as the 208 planning agency for that area. The Corps of Engineers in cooperation with MAG developed a water quality plan which met all requirements of section 208 of Public Law 92-500. MAG also requested that the Maricopa County Planning Department be responsible for the technical analysis in the nonmetro portion of the County and integrating the metro and nonmetro portions into a final areawide plan.

The Corps divided its program into three elements:

- Point Source Plan
- Nonpoint Source Plan
- Environmental Assessment.

The environmental assessment centered on assessment of the impacts of the point source alternatives for the Phoenix metro area.

Material contained in this report represents 208 planning efforts as of September 1979.

PROBLEMS AND NEEDS RELATED TO WATER QUALITY

An initial survey of existing conditions in the study area identified potentially significant water quality problems. Two problem areas determined to have the greatest potential impact on water quality were:

- Inadequate wastewater collection and treatment facilities.

At the time the 208 program began, the existing wastewater collection and treatment system was already strained. The system was operating at capacity and most facilities were in need of upgrading to handle the flows. Discharges from many plants did not meet National Pollution Discharge Elimination System (NPDES) permit requirements and as a result were a direct cause of water quality problems in some areas. The rapid growth expected in the Phoenix area over the next 20 years would only place additional stress on the system.

- Surface activities such as septic systems, irrigated agriculture, and landfills, and their impact on groundwater quality.

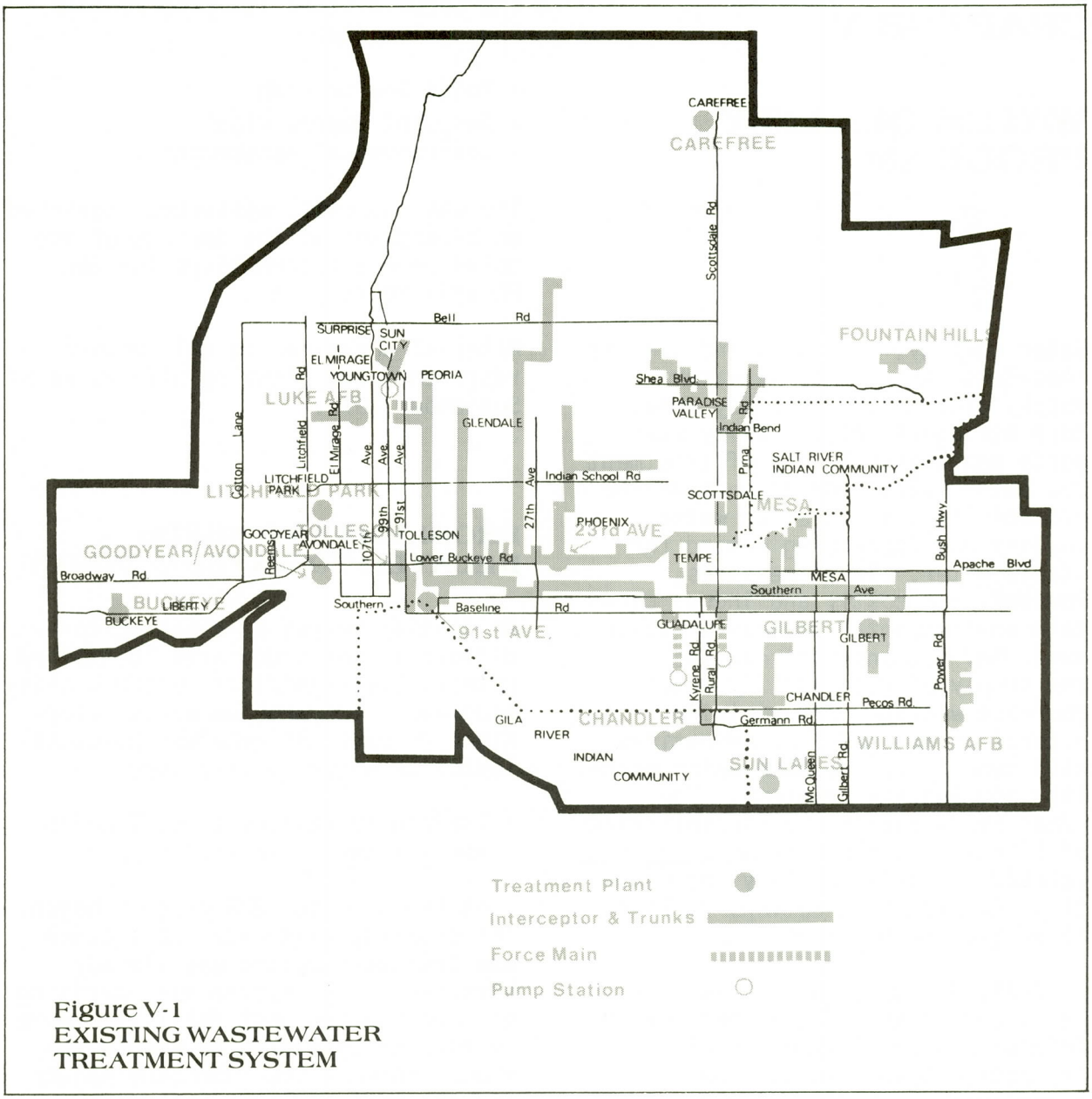


Figure V-1
EXISTING WASTEWATER
TREATMENT SYSTEM

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 flouride 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.

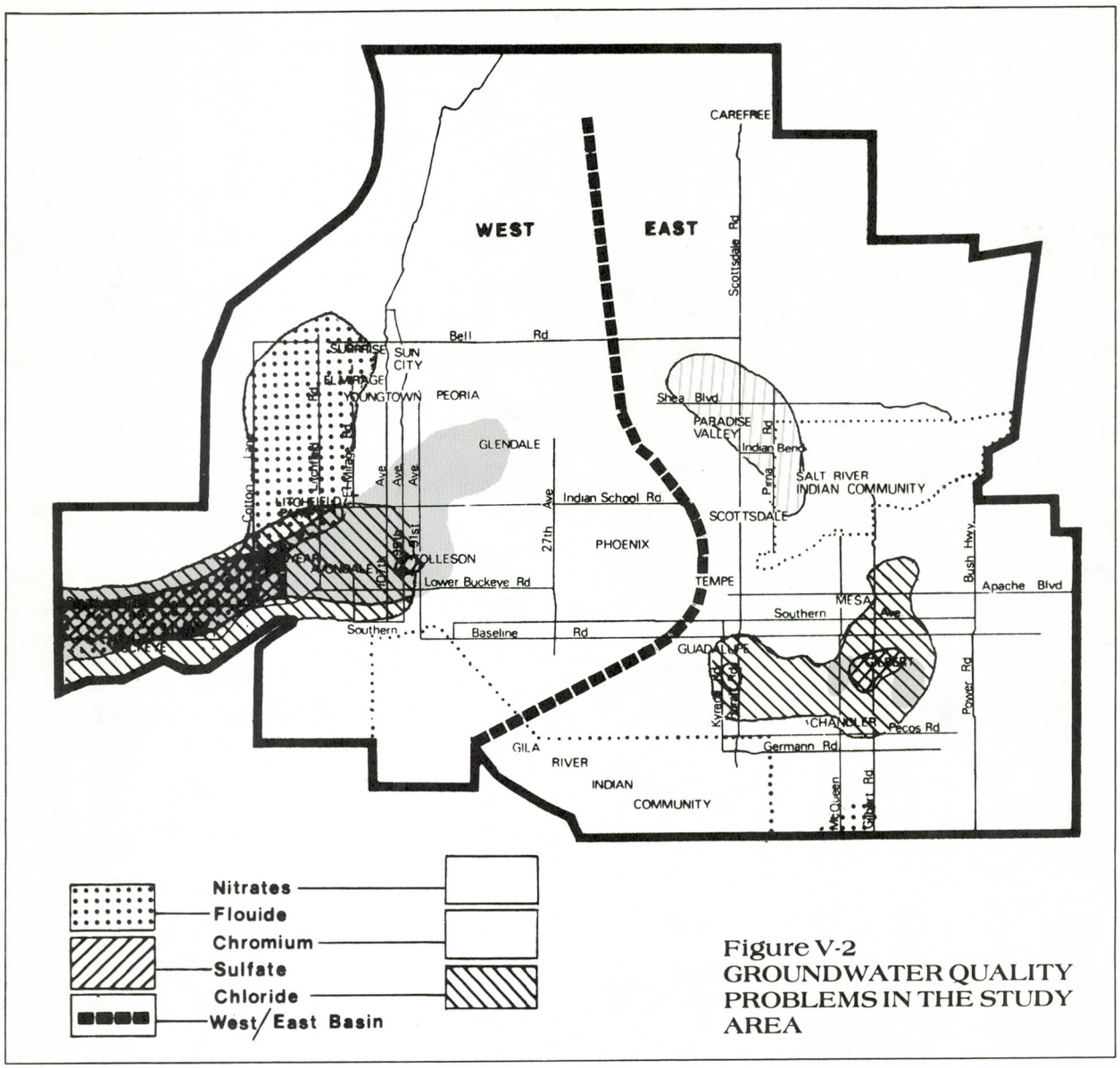


Figure V-2
GROUNDWATER QUALITY PROBLEMS IN THE STUDY AREA

Identification of these and other issues allowed planners to clarify the objectives of the study and formed the basis for remaining investigations (see Figure V-2).

POINT SOURCE PLAN

The point source or wastewater collection and treatment plan was the major single effort undertaken in the 208 program. This effort was primarily directed toward finding the preferred wastewater collection and treatment system for the Phoenix metropolitan area. Wastewater system components evaluated during the development and selection of the point source plan were:

- Regional versus subregional wastewater treatment facilities
- Land versus conventional wastewater treatment
- Wastewater treatment plant and interceptor sizing and location
- Wastewater reuse
- Sludge management.

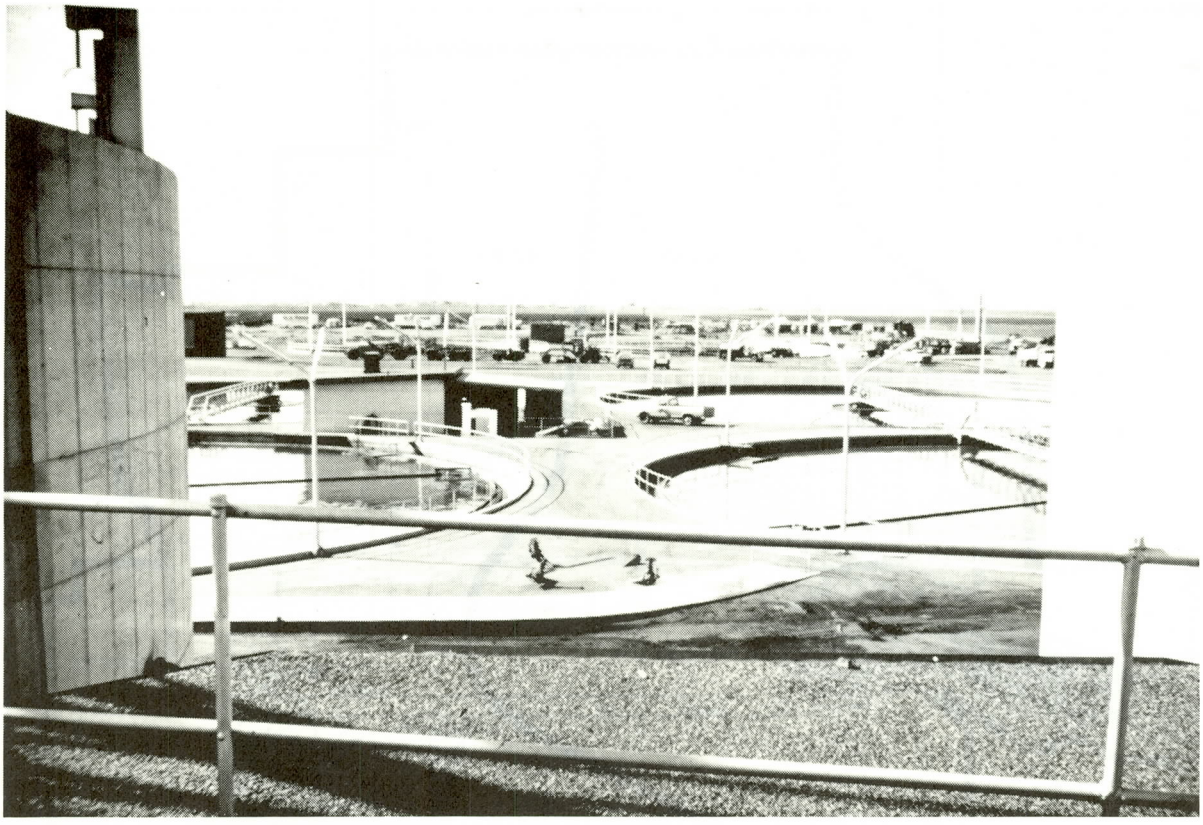


Figure V-3
91st Avenue Wastewater Treatment Plant, Phoenix

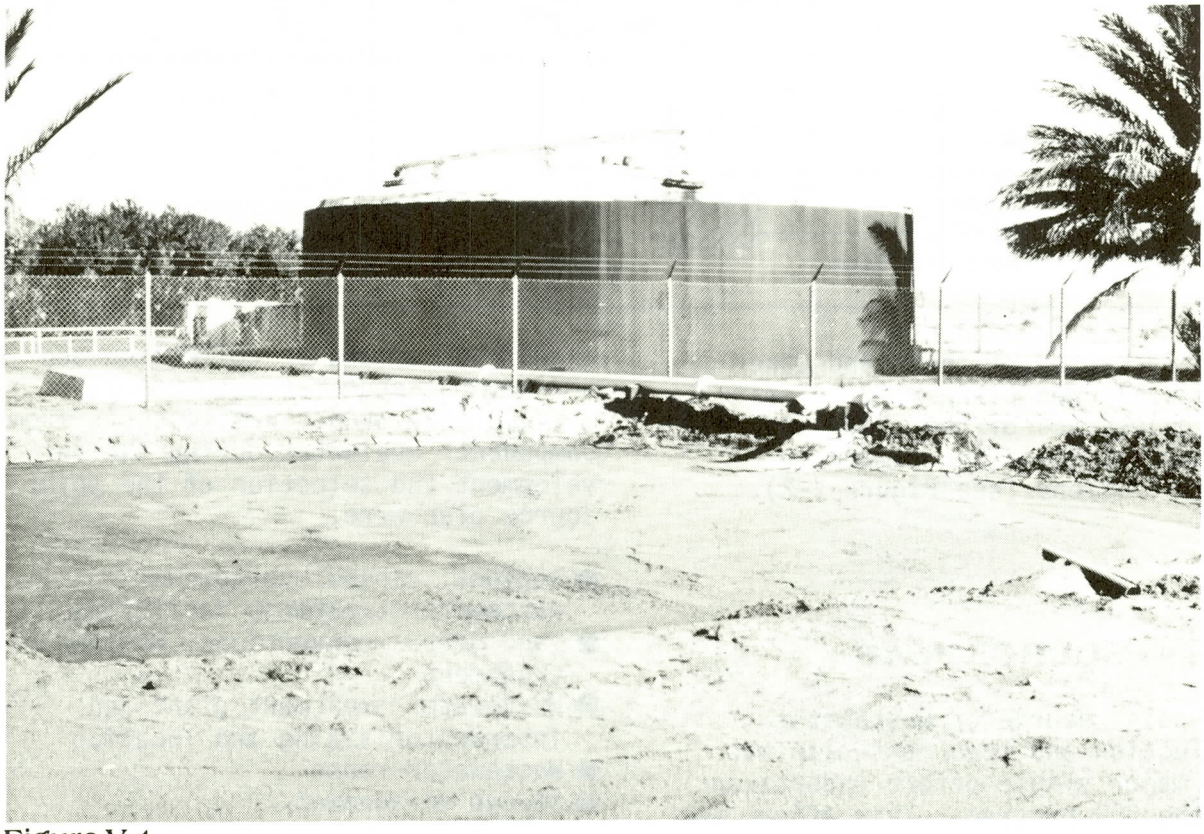


Figure V-4
Sludge Drying Bed At Avondale

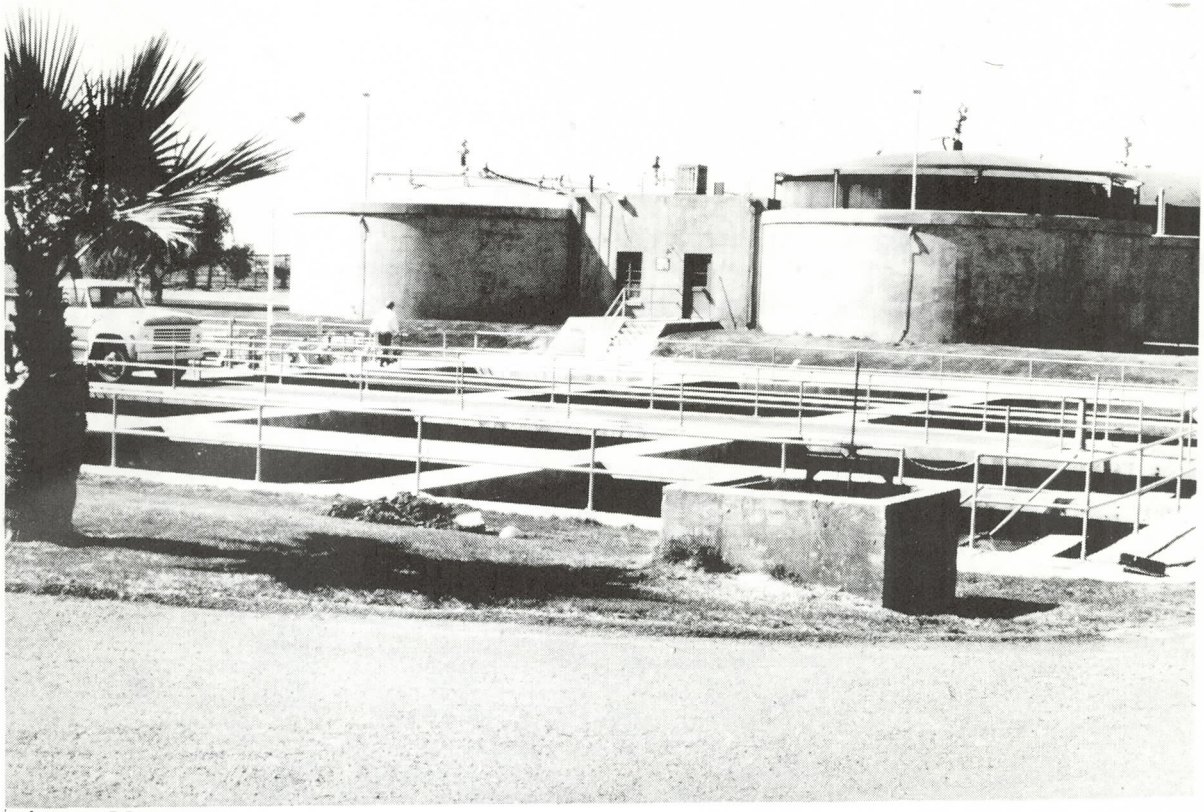


Figure V-5
Mesa Wastewater Treatment Plant

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 means of providing a higher quality of effluent before disposal or reuse. A number of separate sites and three different land treatment techniques, overland flow, infiltration/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 six land treatment alternatives were still viable. These were located at Chandler, Gilbert, 23rd Avenue, 91st Avenue, Northeast Scottsdale, and the proposed Reems Road Site. During the final selection process, however, MAG planners and advisory groups preferred conventional treatment alternatives. This decision was based on capital and annual costs for:

- Treatment Facility
- Transmission System
- Site Clearing
- Distribution System
- Recovery System
- 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 alternatives would

require pilot projects thereby adding considerable time and expense to the implementation of the final 208 plan.

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

Point Source Alternative Development

By far the greatest effort in the development of the point source plan was the development, evaluation, and selection of collection and treatment alternatives. Through a process of evaluation and selection, and varying levels of analysis, the alternatives for collection, treatment, and reuse of wastewater were reduced in number until the preferred alternative was selected (see Figure V-6).

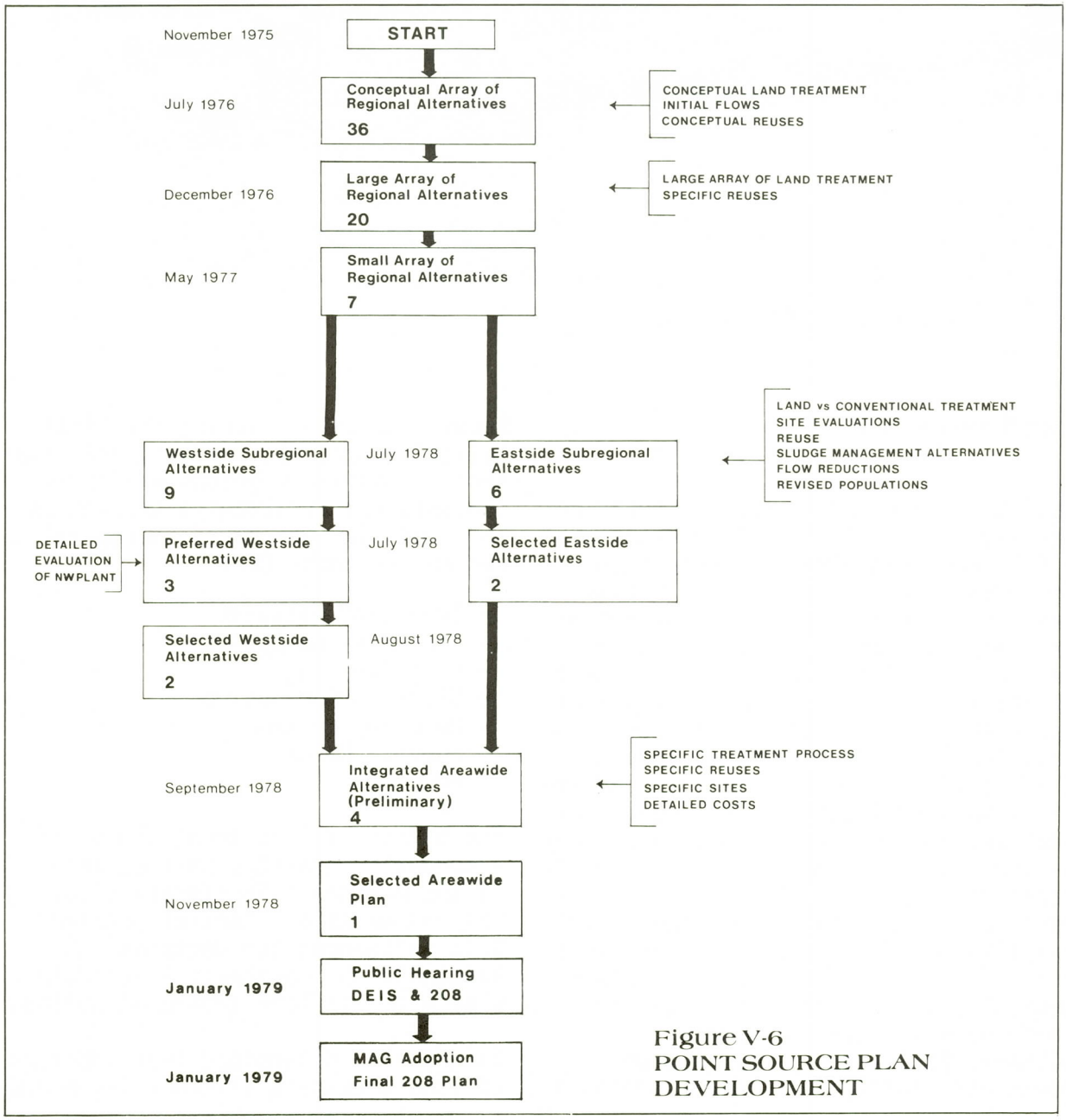


Figure V-6
POINT SOURCE PLAN DEVELOPMENT

Selected Point Source Plan

The selected point source plan calls for 13 wastewater treatment plants to serve the metro area (see Figure V-7). They are:

- o 91st Avenue
- o 23rd Avenue
- o Buckeye
- o Cave Creek/Carefree
- o Fountain Hills
- o Gilbert-North
- o Gilbert-South
- o Reems Road
- o Sun City West
- o Sun Lakes
- o Tolleson
- o Williams Air Force Base

The selected plan does not preclude other plans from being considered at a later date. Other plans could in the future also be located at 48th Street near the Salt River and in the Northeast area when a decision has to be made as to further expansion of the system.

Following is a brief description of the major components of the point source plan.

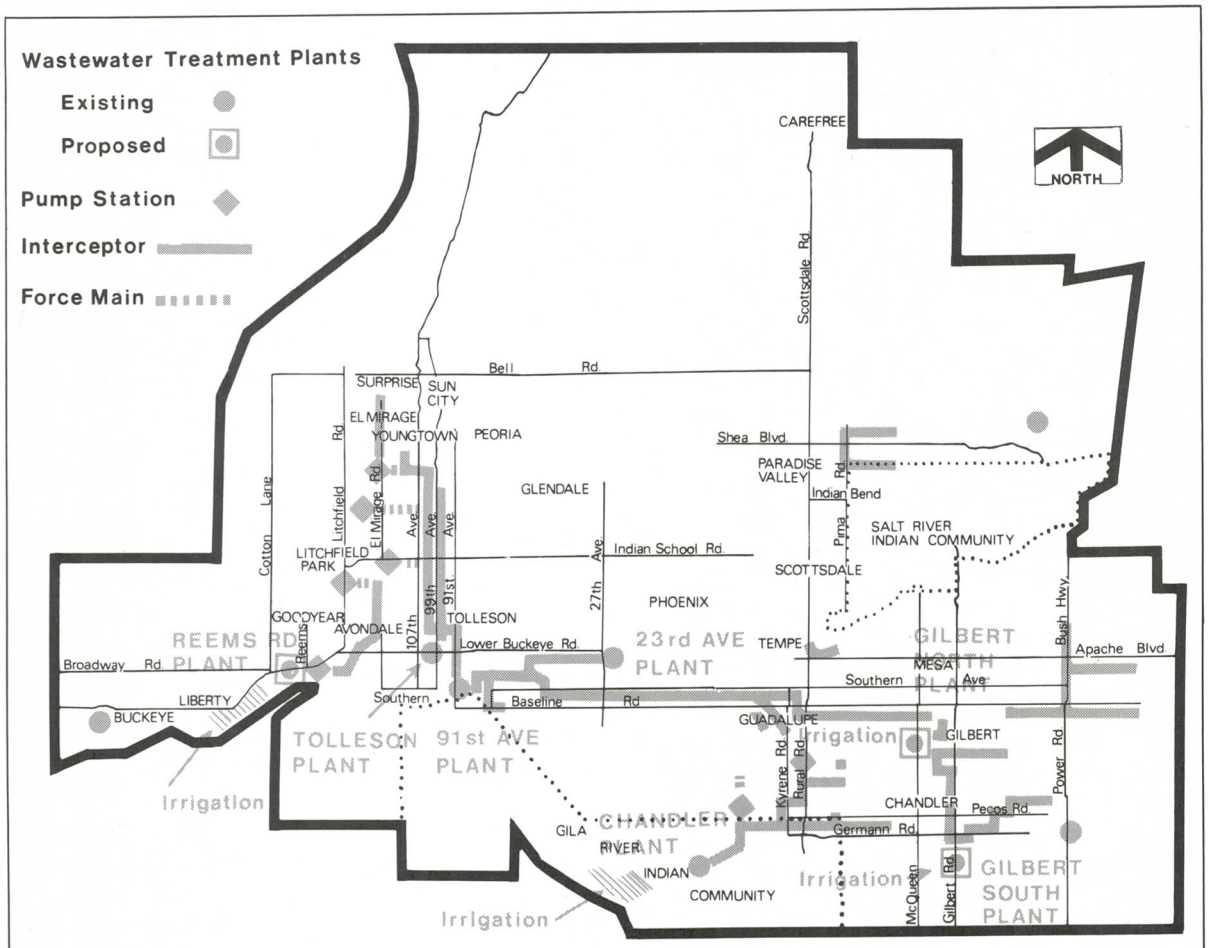


Figure V-7
SELECTED POINT SOURCE PLAN

91st Avenue System: The 91st Avenue plant will be expanded from its current 90 million gallons daily (mgd) 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 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 existing Multi-City 201 facility planning (Phoenix, Glendale, Mesa, Scottsdale, Tempe, Gilbert, and Youngtown with Phoenix as lead agency).

Flows from the western portion of the service area from the communities of El Mirage, Glendale, Luke Air Force Base, Sun City East, Surprise, Youngtown and Phoenix to the 91st Avenue plant will require a major interceptor line along 99th Avenue by 1982. Pump stations at El Mirage, Luke Air Force Base and Indian School Road also will be needed.

Flows from the eastern portion of the service area from the communities of Gudalupe, Mesa, Paradise Valley, Phoenix Scottsdale, Tempe and the northernmost portion of Gilbert to the 91st Avenue plant will require a new interceptor along Southern Avenue and Baseline by 1983. Interceptors also will 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).

Separate facility plans will be required for the major components of this system.

23rd Avenue System: The 23rd Avenue wastewater treatment plant will receive flows from portions of Phoenix and Paradise Valley and will be upgraded to handle 40 mgd by 1981. Effluent from the plant will be used for irrigation or cooling water. Plant upgrading and sludge disposal problems at the plant are being addressed in the Multi-City facility plan.

Buckeye System: The existing Buckeye plant should be expanded and upgraded to 0.6 mgd by 1983. This expansion should provide adequate capacity through 1990. Effluent will be discharged to the Arlington Canal. A 201 facility plan will be required for the Buckeye system.

Cave Creek/Carefree: These communities are presently served by two small, privately owned facilities and population growth indicates some form of wastewater system be implemented soon. Analysis shows it is not economical for the area to be connected to the regional system. A 201 facility plan will therefore be required to specifically identify the necessary treatment system.

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

A 201 facility plan is underway.

Fountain Hills System: Fountain Hills Sanitary District operates a 0.5 mgd plant with effluent 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 reused 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 be to the 91st Avenue plant. The northern portion of the remaining area would go to a new plant in the area. Staging for this plant would be 1.0 mgd by 1980; in 1981 it would be expanded to 1.8 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 facility plan to define its needs.

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 on El Mirage Road 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 needs to the west. A 201 facility plan will be required.

Sun City West: A privately owned and operated treatment facility is currently under construction to serve the needs of this northwest area development. It is planned that effluent will be reused for golf course irrigation.

Sun Lakes: Sun Lakes is to construct, operate, and maintain a local collection and treatment system at Sun Lakes. The existing 35,000 gallons per day (gpd) package secondary treatment plant, although reported to be operating well, is over 10 years old and does not have sufficient capacity to accommodate the projected year 2000 flows of 700,000 gpd. The new facility will continue to reuse all of its treated effluent on the development's golf courses.

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 reused for sod farming with any excess being discharged to the Salt River or sold to the Arizona Nuclear Power Project. 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 capacity problems of the northwst area by allowing Glendale and Sun City use of the facilities until the 91st Avenue plant expansion has been completed.

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

Williams Air Force Base: Williams AFB recently upgraded and expanded its plant to 1.0 mgd. They do not anticipate any future increase in flows. The base is now looking at additional on-base reuses to stop any further discharges to the Roosevelt Water Conservation District Canal. Discharge to the canal would require advanced waste treatment at the plant.

The capital cost by community for the selected plan is shown in Table V-1.

Table V-1
SELECTED PLAN COMMUNITY
COSTS

Community	Year 2000 Flow (mgd)	Project Cost ($ Millions)
91st Avenue System		
El Mirage	0.6	2.4
Gilbert	0.4	1.0
Glendale	14.5	10.5
Guadalupe	0.7	1.4
Luke AFB	1.4	2.9
Mesa	20.7	29.2
Paradise Valley	0.9	1.6
Phoenix	62.3	19.6
Scottsdale	10.5	5.3
Sun City	3.2	6.2
Surprise	0.6	2.3
Tempe	21.1	25.9
Youngtown	0.1	0.3
Subtotal	137.0	108.6
23rd Avenue		
Phoenix	36.4	6.0
Paradise Valley	0.8	0.0
Subtotal	37.2	6.0
Reems Road Plant		
Avondale	2.8	6.1
Goodyear	1.3	2.3
Litchfield Park	1.3	3.5
Subtotal	5.4	11.9
Buckeye System	0.6	0.9
Cave Creek/Carefree	0.8	1.8
Chandler System	8.2	10.4
Fountain Hills	2.0	3.2

TABLE V-1 (cont)

Community	Year 2000 Flow (mgd)	Project Cost ($ Millions)
Gilbert System		
North Plant	2.7	6.0
South Plant	0.9	3.8
Subtotal	3.6	9.8
Tolleson/Peoria System		
Tolleson	1.8	0.0
Peoria	5.4	6.8
Subtotal	7.2	6.8
Sun City West	2.6	N/A
Sun Lakes	0.7	1.8
Williams AFB	1.0	0.2

Impacts of the Selected Point Source Plan

The major impacts of the selected plan identified during the course of the Phoenix Urban Study are discussed in the following categories:

- Water resources impacts
- Air quality impacts
- Biological resources impacts
- Socioeconomic impacts
- Archaeological 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, leading to better surface water quality in stream segments affected by the discharges. In addition, the plan's effluent reuse schemes will increase the amount of effluent reused and help improve effluent distribution for agricultural irrigation, energy production, and biological enhancement. In general, elements of the plan will have little or no effect on regional ground water.

Air Quality Impacts: Minor local, short-term air quality changes are expected to 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 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 creosote bush-bursage communities. These communities, along with the paloverde-saguaro and riparian communities, also will undergo change as the result of plant operations and associated habitat management schemes. Terrestrial habitat losses of 700 acres will be partially offset by creation of 390 acres of similar or improved habitat depending on the biological habitat development scheme selected for each wastewater treatment plant.

Socioeconomic Impacts: The principal consequences of the selected plan are as follows:

- 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, so 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 or 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 from five to twelve years. To ensure their availability when required, these sites will have to be acquired or optioned well before they can be utilized and land acquisition costs will be substantial.

- Impacts 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 Arizona Nuclear Power Project's 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 also will help offset costs of treatment.

Wastewater effluent provides a desirable source of water for agricultural irrigation and power production and both interests 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 will not be adequate, however, to meet both

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.

Cultural Resources Impacts: The selected plan has the potential for disturbing prehistoric sites, mainly through direct removal or destruction of artifacts during construction of interceptor lines. Detailed archaeological work will be done as part of 201 facilities planning. No existing historic sites are located in areas affected by expansion or new construction or wastewater facilities.

NONPOINT SOURCE PLAN

Water quality problems caused by sources of pollution other than municipal and industrial discharges of wastewater are termed "nonpoint sources" and also were studied in the Urban Study/208 planning process.

In the 208 program, the approach used to identify the nonpoint problem in Maricopa County was a combination of identifying possible sources of pollution from land surface activities and natural factors and relating them to existing historical groundwater quality data.

Sources of pollution looked at in the 208 program included:

- Urban (sewage collection, treatment and disposal, septic tanks, storm runoff, lawn, garden, and park irrigation, landfills)
- Industrial
- Agricultural (irrigation, feedlots and dairies, pesticide wastes)
- Hydrologic modifications (well construction, altered groundwater flow direction, imported water)
- Natural factors (recharge, evapotranspiration, soil characteristics).

Basin Assessment

The Salt River Valley contains the greatest concentration of potential nonpoint sources of pollution in the county. These include agricultural and lawn irrigation, industrial wastes, storm runoff, sewage effluent, landfills, hydrologic modifications, animal wastes, and septic tanks. Also, assuming that the presently projected deliveries of Central Arizona Project water are made, about 500,000 tons of salt will be imported into the Valley each year.

In the East Basin of the Valley, there are several areas where man's activities appear to have affected groundwater. Salinity is increasing in the groundwater in the Gilbert area because of irrigation return flow and near Chandler because of changes in the direction of groundwater flow. Discharge from the Mesa wastewater treatment plant has caused a localized high nitrate concentration.

Natural factors have caused high arsenic, chromium and fluoride concentrations in the Scottsdale and Paradise Valley areas.

In several parts of the West Basin, man's activities have affected groundwater quality, Salinity and chloride content, in particular, are noticeably higher beneath lands irrigated with Salt River water compared to adjacent areas (also true in the East Basin). In the Glendale and west Phoenix area, nitrate content and salinity have decreased considerably since the 1930's as a

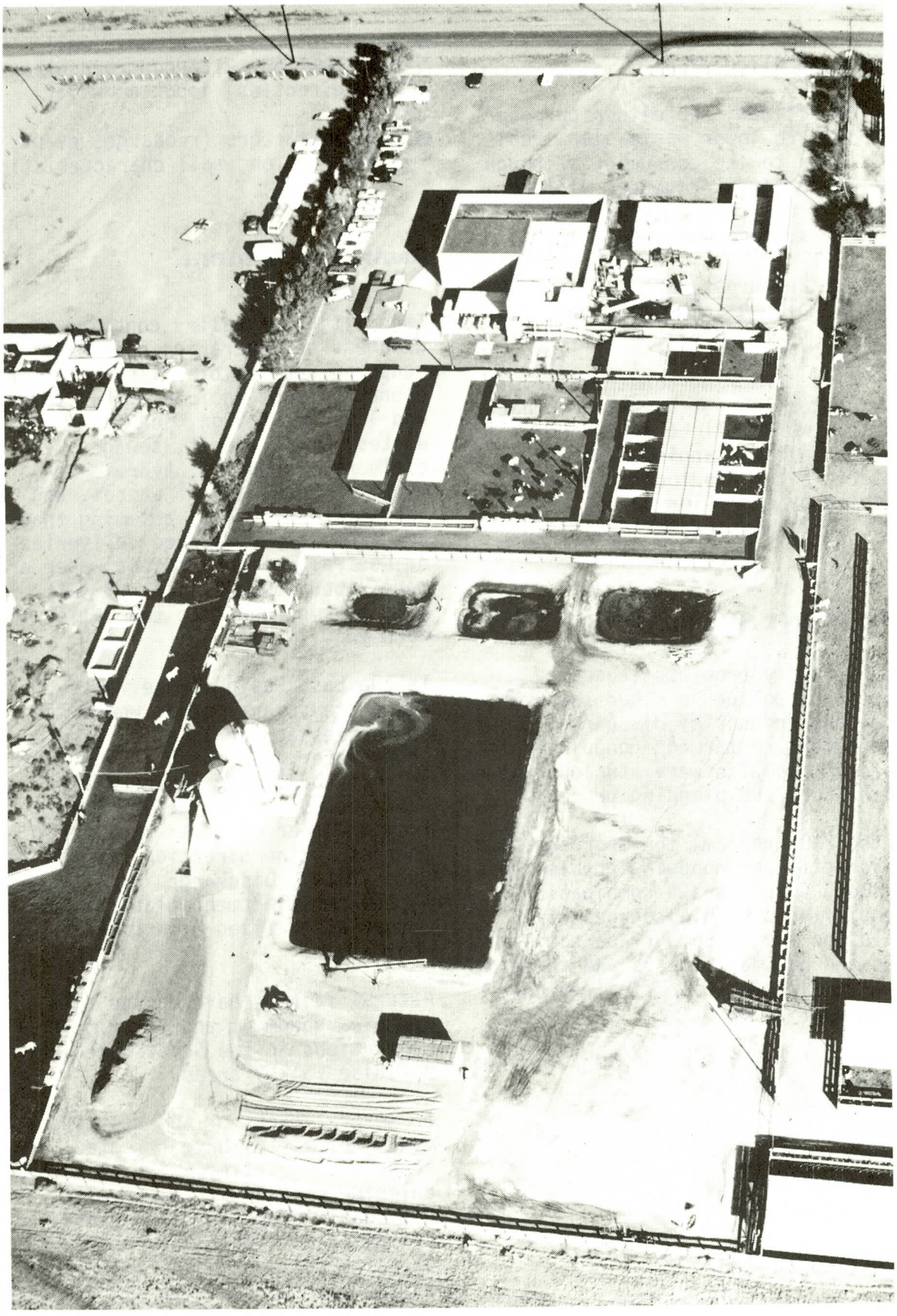


Figure V-8
Waste Ponds Such As At This Dairy Are Potential Sources Of Nonpoint Pollution

result of pumpage and recharge. Use of sewage effluent from crop irrigation in the Buckeye Irrigation District has decreased the salinity of well water and increased nitrate content.

High salinity groundwater in the Buckeye area is partly the result of natural factors, and man's influence. Wastewater from various sources has been utilized as part of the water supply for decades and shallow groundwater levels have increased the concentration of salts because of evapotranspiration. Salinity is increasing in the Goodyear-Liberty area because of changes in the direction of groundwater flow. Also, higher salinity groundwater from near the Gila River and Buckeye area is now moving northward toward Luke AFB.

In the Salt River Valley, there has been no reported monitoring specifically oriented toward the effect of irrigation, disposal of storm runoff, disposal of sewage effluent (other than the Flushing Meadows reclamation project), landfills, septic tanks, feedlots and dairies, or industrial wastes on groundwater quality.

Monitoring Needs

The evaluation of existing groundwater quality data indicated a lack of precise data to assess accurately nonpoint sources of pollution in the study area. Generally, three types of data must be available: hydrogeologic, regional groundwater quality, and site specific groundwater quality.

Figure V-9
Other Potential Contributors To Non Point Pollution Are Landfills Such As This One In The Salt River Bed.

The hydrogeologic data should include subsurface geology, groundwater flow patterns, characteristics of the vadose zone immediately above the water table, accurate water level maps, and aquifer characteristics.

Information on regional groundwater quality is needed to evaluate site-specific conditions. In the Salt River Valley, large amounts of regional data exist on the inorganic chemical constituency, but they have been collected in terms of irrigation or domestic supply needs. Little information exists for organic chemical or radiological parameters.

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 Palo Verde Nuclear Generating Station site.

These types of information are mandatory before the problem can be clearly defined and technically sound control measures for nonpoint sources can be recommended for implementation.

Proposed Monitoring Program

Based upon the need to identify better the nonpoint sources and their potential impact on groundwater quality, a monitoring program for the study area was proposed. Work was divided into hydrogeologic, regional groundwater quality, and site specific monitoring.

Work in the hydrogeologic area includes cooperation with the U.S. Geological Survey (USGS) to complete its subsurface studies for the Valley, preparing up-to-date water-level evaluation maps, measuring canal seepage, and developing procedures to collect data on the vadose zone during well drilling.

Regional groundwater quality monitoring includes intensive sampling of about 1,200 large capacity wells every five years, developing procedures to collect well construction data, sampling during pump testing of about 20 large capacity wells, and developing a program to collect and organize groundwater quality data.

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

Proposed Control Measures

While a clearer definition of problems is needed, existing data indicates that several potential sources of pollution could be addressed through implementation of control measures. They include landfills, industrial wastes, and certain types of hydrologic modifications.

For landfills, the control measures could include limiting the location of the landfills in floodplains, limiting the liquids applied to landfills, limiting the depth of excavation compared to the groundwater table, and requiring 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 -- well construction and

altered groundwater flow patterns -- are suggested for possible controls.

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 salinity in the Chandler and Liberty-Goodyear areas. Possible control measures include decreasing the pumping, recharge of groundwater in downgradient areas or pumping out the poor quality water.

WATER QUALITY PLAN IMPLEMENTATION

Identification of a management system is key to implementation of the 208 plan. EPA requires that a management system be established to ensure that the plans developed will be properly managed, financed and updated. In the 208 program, a management system was developed only for the point source plan. No management plan was developed for nonpoint sources because of the undefined nature of the nonpoint source problem.

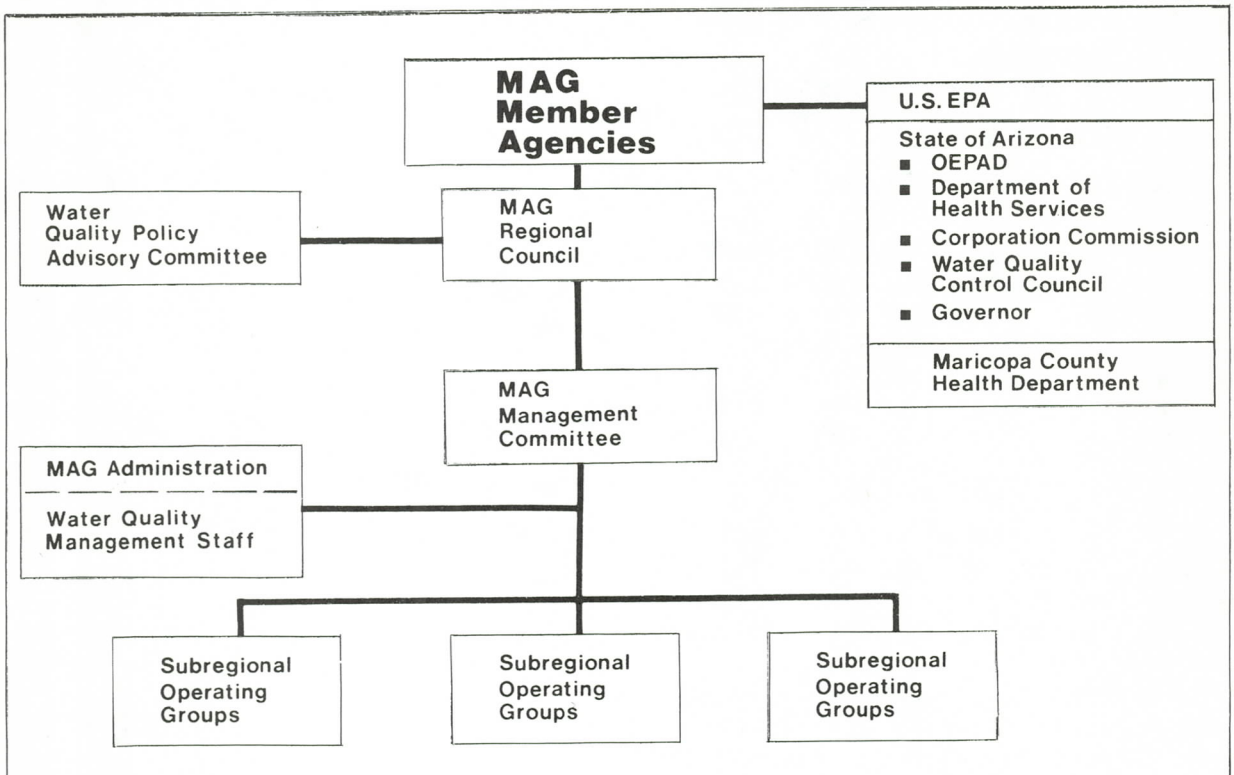


Figure V-10
SELECTED POINT SOURCE MANAGEMENT PLAN

Point Source Plan Implementation

The initial task in developing the point source management system was to complete an inventory of the existing system and assess it against EPA requirements. In general, this effort identified a lack of coordinated planning and management for wastewater facilities. When completed in March 1977, results were presented to the communities, and 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.

Subsequently, various management system alternatives were developed to correct the identified deficiencies. After considerable discussion and refinement of the alternatives by the 208 advisory groups, a preferred management system alternative was selected (see Figure V-10). Under this system, the duties and responsibilities necessary to meet EPA requirements were assigned to the agencies and municipalities determined to be most capable of carrying them out. Areawide wastewater facility planning would be the responsibility of MAG, similar to MAG's current role in the 208 process. The operation of the wastewater facilities would be the responsibility of the selected cities and towns in which the facilities were located.

This management system calls for the MAG Regional Council, with the assistance of a Water Quality Policy Advisory Committee to be responsible for ongoing 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 served by a facility have been created and have coordination, detailed planning, grants management and operation responsibilities. 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 governing body of each participating city and town has adopted a resolution establishing the SROG and agreeing to be a SROG member and requested MAG designation of the SROG and Lead Agency. MAG, in turn, has designated by resolution each SROG and Lead Agency.

The SROGs designated for the study area are:

SROG	Lead Agency
● Multi-City (Phoenix, Gilbert, Tempe, Scottsdale, Youngtown, Glendale)	Phoenix
● Avondale/Goodyear	Goodyear
● Tolleson/Peoria	Tolleson

Single Member:

- Buckeye
- Chandler
- Gilbert

Future SROGs could be Fountain Hills Sanitary District, Desert Foothills Sanitary District, El Mirage and Surprise. Guadalupe and Paradise Valley may in the future become Multi-City SROG members. Other communities which were

included in 208 planning but do not wish to participate at this time have the opportunity to do so in the future.

The MAG/SROG management system is based upon developing a spirit of cooperation among all government and appropriate private wastewater treatment management agencies in the Phoenix area. It takes advantage of the experience gained through intergovernmental cooperation by the local governments of Phoenix, Youngtown, Scottsdale, Mesa, Tempe, and Glendale. For the past decade they have participated in a cooperative endeavor to provide wastewater treatment management services through the Multi-City Agreement. The MAG/SROG management concept proposes to establish a system that is close to the citizenry and existing local governments, and avoids creating a new level of government for wastewater management.

Implementation of the point source management system is nearly complete. For the multiple member SROGs, intergovernmental agreements are being prepared to finalize SROG and member agency duties and responsibilities. These agreements are required by EPA before 208 plan approval to ensure that a management agency exists and that the plan will be implemented.

Nonpoint Source Plan Implementation

Much planning was accomplished during the Urban Study for the proposed groundwater monitoring program. The MAG 208 program, as a part of its own continuing planning process, took the responsibility for managing and implementing the monitoring program. Results of the program have not yet been released. ■

TABLE V-2

The schedule for completion of the elements of the areawide water quality management plan appears below:*

91st Ave. WWTP Modifications & Expansion	-	1980-1990
23rd Ave. WWTP Upgrade	-	1983
Southern Ave. Interceptor Line	-	1983
Salt River Outfall Parallel Interceptor	-	1988
Mesa Eastern Area Interceptor	-	1985
Mesa Sewage Treatment Plant Bypass Interceptor	-	1983
North Scottsdale Interceptor	-	1983
South Tempe Interceptor Pump Station and Forcemain	-	1984
Guadalupe Interceptor	-	1984
South Ahwatukee Pump Station	-	1985-1990
Greenway Road Interceptor & Olive Ave. Pump Station	-	1985
Youngtown Interceptor	-	1985
Luke AFB Pump Station	-	1983
Indian School Road Pump Station	-	1985-1990
99th Ave. Interceptor	-	1982
Avondale/Goodyear New Interceptor & Treatment System At Reems Road	-	1983
Buckeye WWTP Upgrade and Expansion	-	1990-1995
Chandler Collection and Treatment System Expansion	-	1990-1995
Fountain Hills Treatment Plant Expansion	-	1984
Gilbert Collection and Treatment System (2 Plants)	-	1990-1995
Tolleson Treatment Plant Expansion	-	1981
Williams AFB System Expansion and Upgrade	-	1979

*Source: Maricopa Association of Governments, 208 Water Quality Management Program, Final Plan, July 1979.

CHAPTER VI
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 (see Figure VI-1). Structural and nonstructural 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.

GLENDALE-MARYVALE

Problems Related to Flood Control

No defined channels exist in this area. Flooding results from sheet

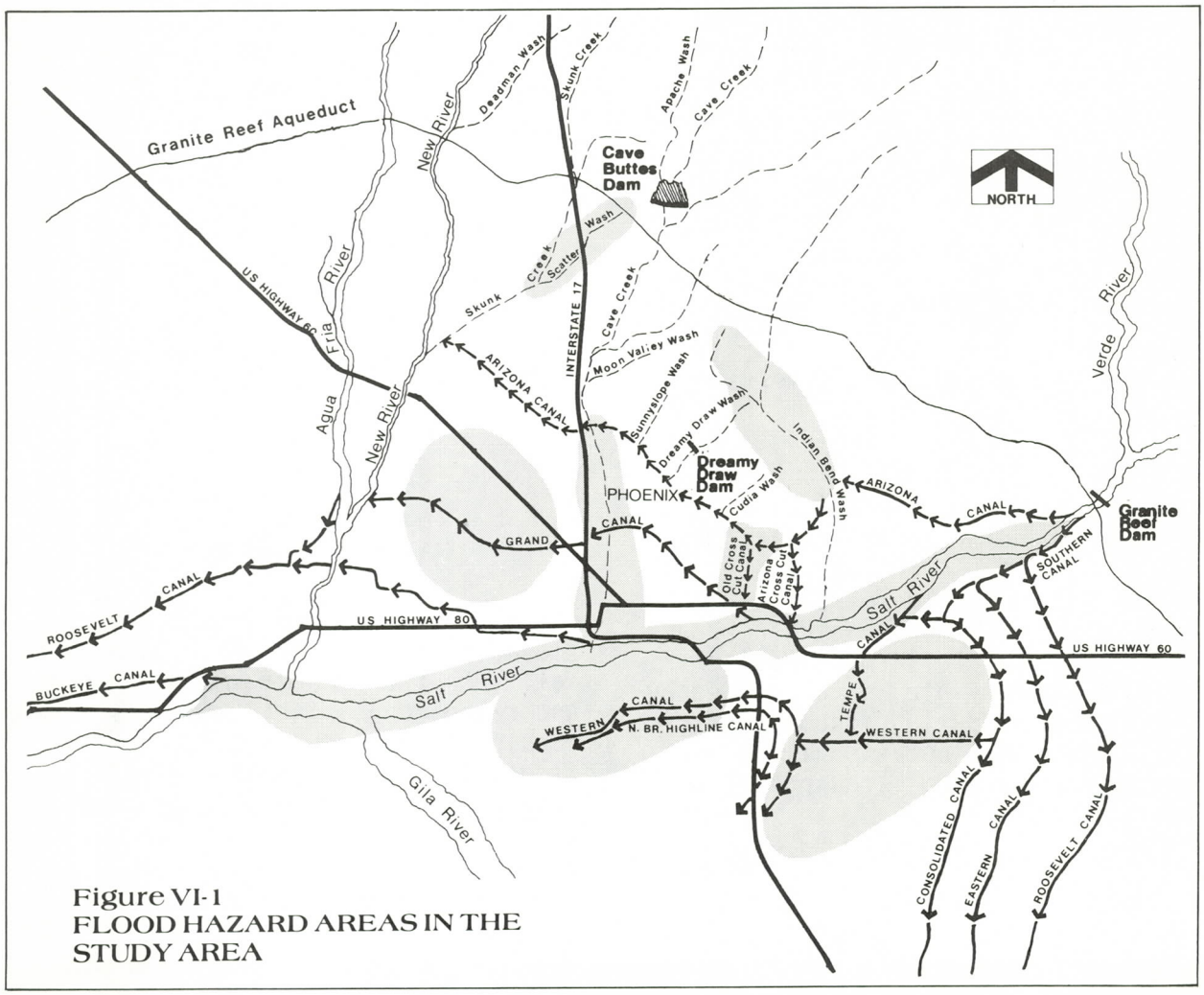


Figure VI-1
FLOOD HAZARD AREAS IN THE STUDY AREA

Figure VI-2
Flooding On A Suburban Street In Maryvale 1963

flow and ponding behind obstructions. The two principal obstructions are the Santa Fe railroad embankment in Glendale and the Grand Canal in Maryvale. The flooding problem in Maryvale is compounded by the fact that during flood events, the Grand Canal occasionally is overtopped causing flooding below the structure.

Alternatives Examined

Alternative plans for controlling floods in the Glendale-Maryvale area fall into two groups: major channels and retention basins. Channels would consist of a North Unit to convey floodflows away from Glendale for discharge into the New River, and a

Figure VI-3
Floodwaters Breach The Grand Canal And Flow Into A Maryvale Neighborhood, 1963

South Unit to convey floodwaters away from the Maryvale area to either the New River or the Agua Fria River. Retention basins would provide protection from a single flood event but not from additional floods occurring in rapid sequence. The basins would have to be emptied to provide subsequent protection. (For Glendale-Maryvale flood control alternatives see Figures VI-4-6).

It was determined, however, that the benefit/cost ratios for all Glendale-Maryvale alternatives would be unfavorable for floods exceeding a 25-year event. The lack of benefits for protection from larger floods reduced the economically justified alternatives to virtual storm drain projects, which are local responsibilities. For these reasons planning for Glendale-Maryvale flood control was discontinued (see Table VI-1).

Table VI-1
PHOENIX URBAN STUDY AREA
FLOOD CONTROL ALTERNATIVES, COSTS AND BENEFITS

Description	First Costs	Average Annual Charges	**	Benefit/Cost Ratio
Glendale/Maryvale				
Alternative A 100-Yr. Protection	$121,400,000	$7,700,000	$2,100,000	Less than 0.3
Alternative B 100-Yr. Protection	$107,500,000	$7,000,000	$2,100,000	Less than 0.3
Alternative C 100-Yr. Protection	$ 36,200,000	$2,500,000	$2,100,000	Less than 0.9
South Phoenix				
Alternative A SPF* Protection	$ 27,200,000	$1,890,000	$ 845,000	Less than 0.5
Alternative B SPF* Protection	$ 24,600,000	$1,700,000	$ 580,000	Less than 0.4
Alternative C SPF* Protection	$ 33,300,000	$2,200,000	$ 772,000	Less than 0.4
Cave Creek Below the Arizona Canal				
Alternative A 100-Yr. Protection	$ 76,000,000	$4,800,000	$ 920,000	Less than 0.2
Alternative B 100-Yr. Protection	$ 40,000,000	$2,600,000	$ 920,000	Less than 0.4

TABLE VI-1 (Cont.)

Description	First Costs	Average Annual Charges	**	Benefit/Cost Ratio
Upper Indian Bend Wash				
Alternative A 100-Yr. Protection	$ 16,900,000	$1,170,000	$ 786,000	Less than 0.7
Alternative B 100-Yr. Protection	$ 13,600,000	$1,060,000	$ 786,000	Less than 0.8
Alternative C 100-Yr. Protection	$ 18,600,000	$1,600,000	$ 786,000	Less than 0.5
Alternative D	$ 15,000,000	$1,300,000	$ 786,000	Less than 0.7
Scatter Wash				
Soft Bottom Channel 100-Yr. Protection	$ 9,900,000	$ 683,000	$ 332,000	0.49
Rectangular Channel 100-Yr. Protection	$ 11,200,000	$ 746,000	$ 332,000	0.45
Trapezoidal Channel 100-Yr. Protection	$ 7,300,000	$ 495,000	$ 332,000	0.67
Diversion SPF* Protection	$ 6,100,000	$ 410,000	$ 332,000	0.83

*Standard Project Flood.

**Average annual benefits resulting from flood protection.

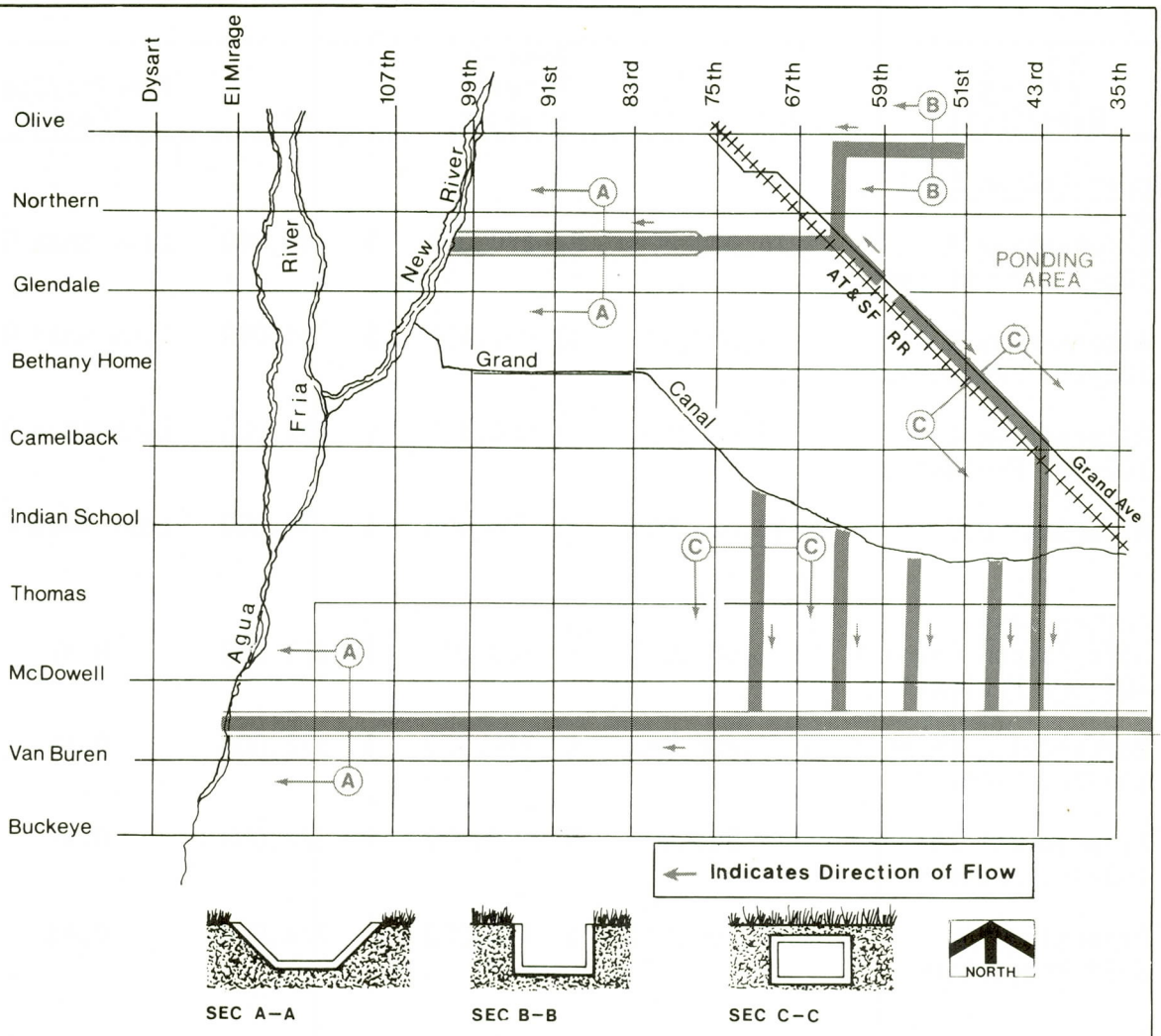


Figure VI-4
GLENDALE-MARYVALE
FLOOD CONTROL ALTERNA-
TIVE A

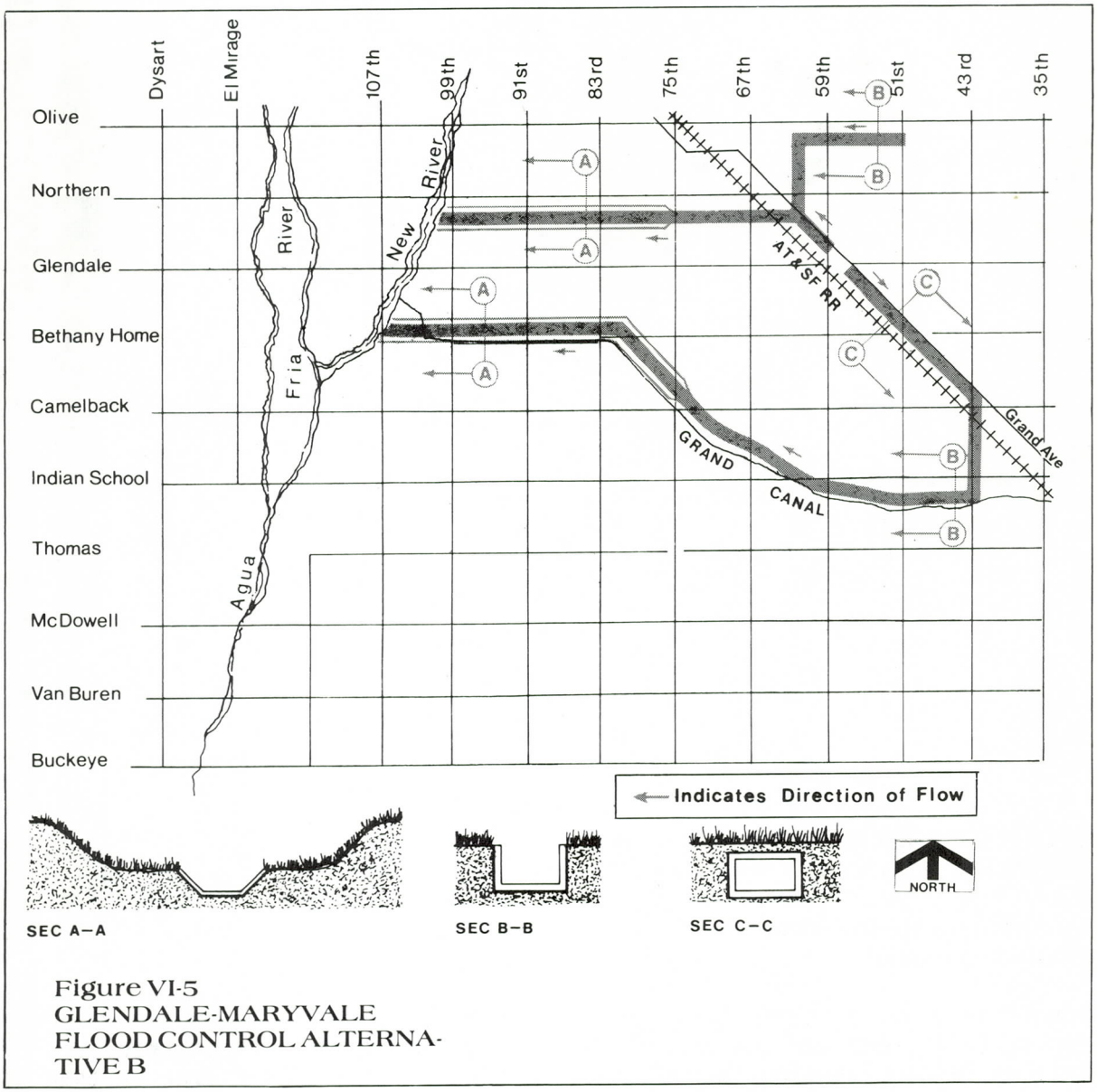


Figure VI-5
GLENDALE-MARYVALE
FLOOD CONTROL ALTERNA-
TIVE B

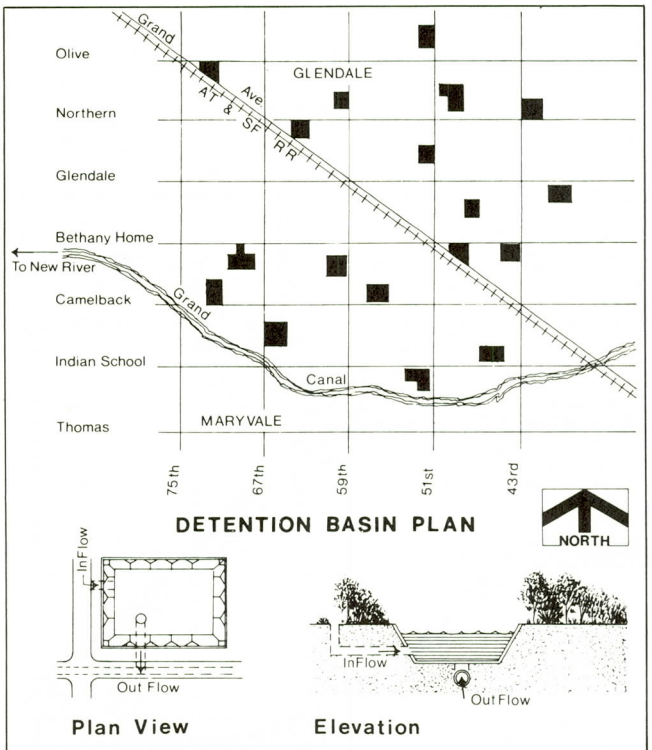


Figure VI-6
GLENDALE-MARYVALE
FLOOD CONTROL ALTERNATIVE C

CAVE CREEK BELOW THE ARIZONA CANAL

Problems Related to Flood Control

Runoff originating below Cave Buttes Dam on Cave Creek and the authorized Arizona Canal Diversion Channel would result in urban flooding in Phoenix. Areas subject to inundation from flooding along Cave Creek include the business and governmental center of downtown Phoenix, as well as large residential and commercial districts. Flows on Cave Creek greater than the 100-year event also would overtop the Arizona Canal and cause damages to these areas. Flooding also could result from runoff originating below the canal.

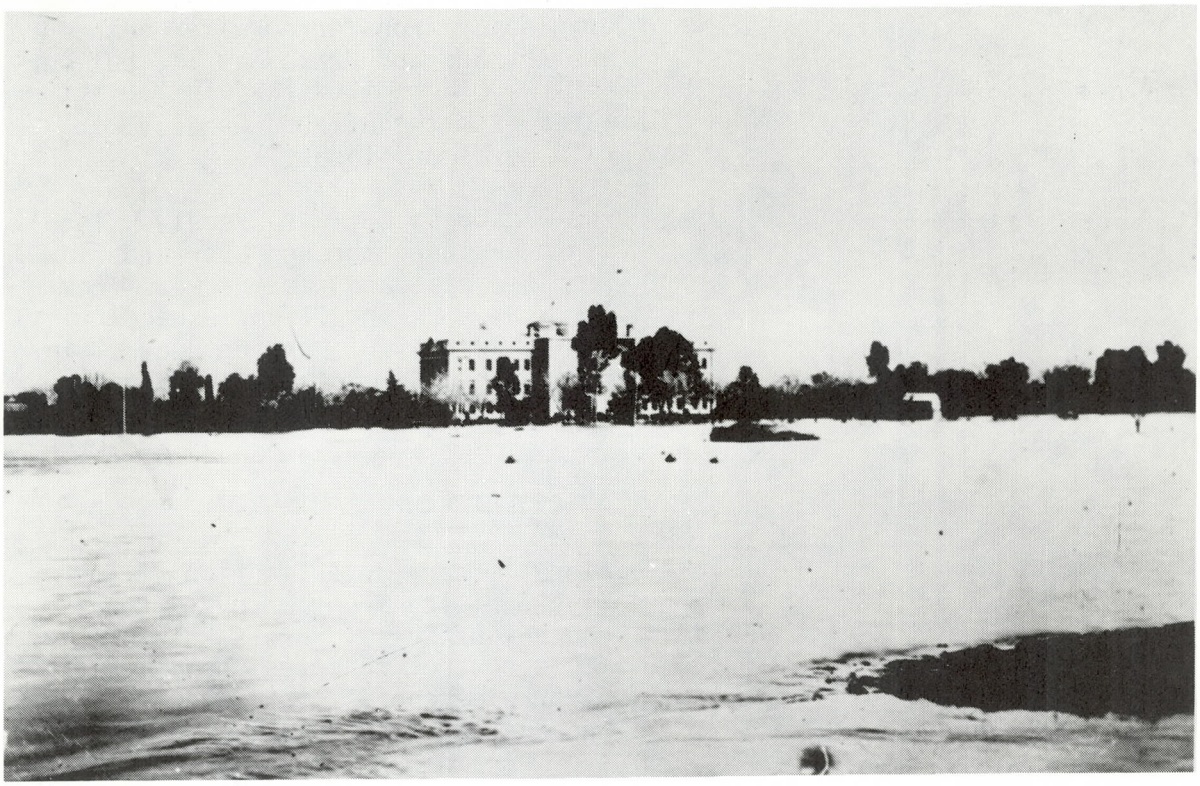


Figure VI-7
In 1905 And 1921 Floodwaters From Cave Creek Isolated The Arizona Capitol Building
(Courtesy Arizona Historical Foundation)

Alternatives Examined

Alternatives considered would collect floodwaters from below the Arizona Canal for conveyance to a point of discharge at the Salt River. The plans consist of a rectangular concrete covered channel located beneath the city streets or retention basins located throughout the overflow area with sufficient capacities to contain the volume of the 100-year flood event (Figure VI-8).

The benefit/cost ratios for these two alternatives would be low. Further consideration by the Phoenix Urban Study was not warranted (see Table VI-1).

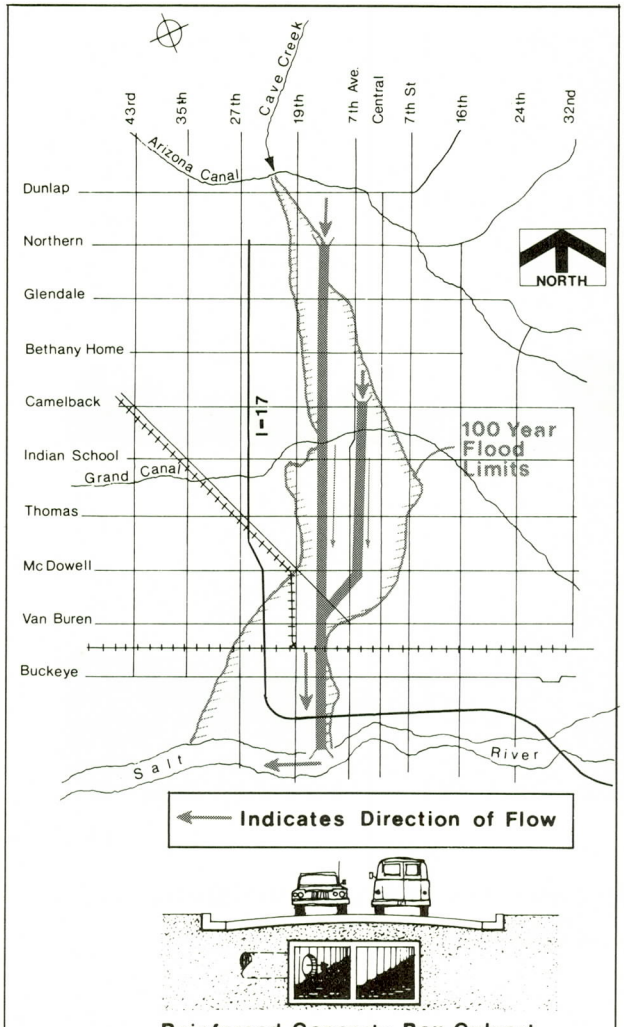


Figure VI-8
FLOOD CONTROL ALTERNATIVES FOR CAVE CREEK BELOW THE ARIZONA CANAL

southward to the Grand Canal. It originally transferred water between the Arizona and Grand Canals, but current use is limited largely to wasting water from the Arizona Canal during rainstorms or floods.

The Old Cross Cut also receives local storm drainage through overland flow from the east and storm sewers from the west. During floods exceeding the 25-year event ponding occurs along the north bank of the Grand Canal.

Alternatives Examined

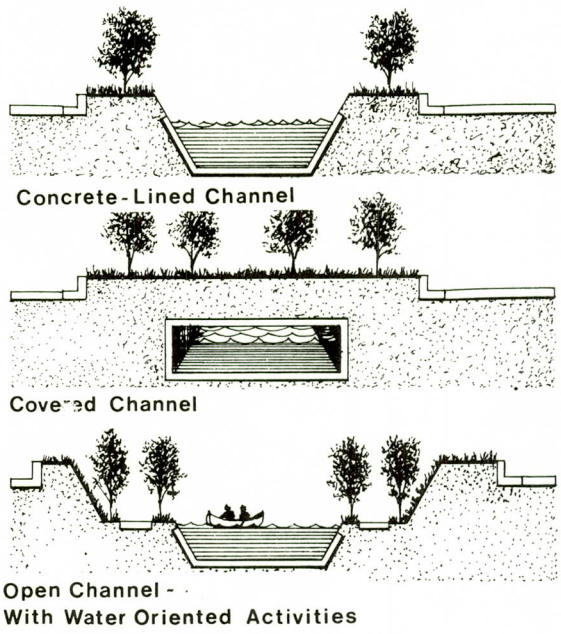
A preliminary investigation of benefits achieved from improving the channel of the Old Cross Cut for flood control purposes indicated a favorable benefit/cost ratio just for the 25-year event, making a virtual storm drain project for which the Corps of Engineers has no responsibility. (For a description of preliminary flood control alternatives for the Old Cross Cut Canal, see Figure VI-10). The project was withdrawn from consideration, however, following the issuance on 8 May 1978 of ER1165-2-21. This regulation stated that the Corps of Engineers can participate only in flood control projects associated with natural streams or modified natural waterways. The Old Cross Cut Canal did not meet this criteria.

OLD CROSS CUT CANAL

Problems Related to Flood Control

The canal is located near 48th Street in Phoenix and runs from a gated outlet in the Arizona Canal

Figure VI-9
Headgates Of The Old Cross Cut Canal At The Arizona Canal



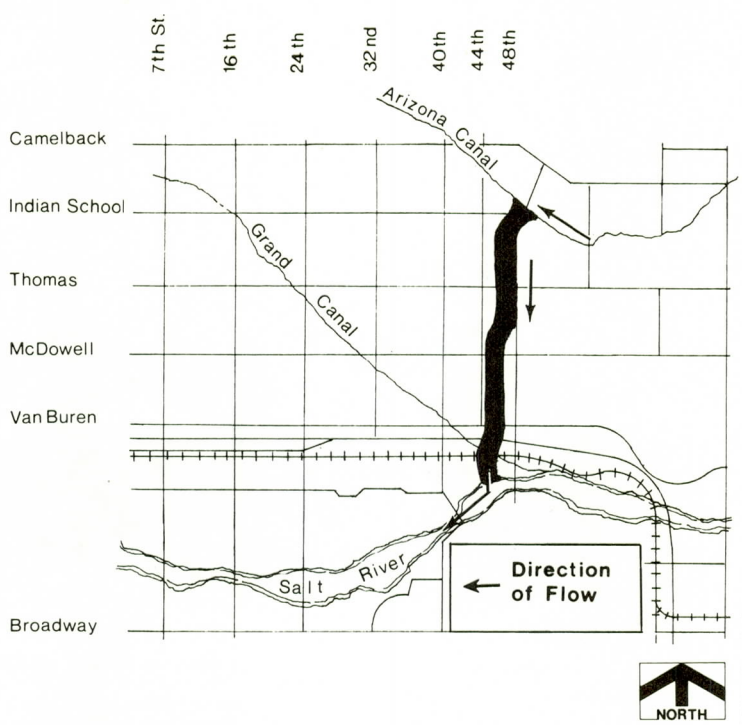


Figure VI-10
FLOOD CONTROL ALTERNATIVES FOR THE OLD CROSS CUT CANAL

SOUTH PHOENIX

Problems Related to Flood Control

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. The potential for severe flooding exists particularly as a result of the rapid urban expansion of South Phoenix.

Alternatives Examined

Local interests in the study area have constructed major storm sewers to convey stormwater from Southern Avenue to the Salt River. In addition, under a capital improvements program, the City of Phoenix plans to extend these sewers south to Baseline and construct new sewers in South Phoenix. A detention basin at the mouth of a canyon near the intersection of Central and Mineral Avenues also is projected.

The alternative plans considered by the Phoenix Urban Study consisted of levees, and detention basins in combination with channels to collect floodwaters emerging from the South Mountains and convey them away from populated areas to the Salt River. Unfavorable benefit/cost ratios for these projects, however, caused them to be removed from further consideration (see Table VI-1 and Figures VI-12-14).

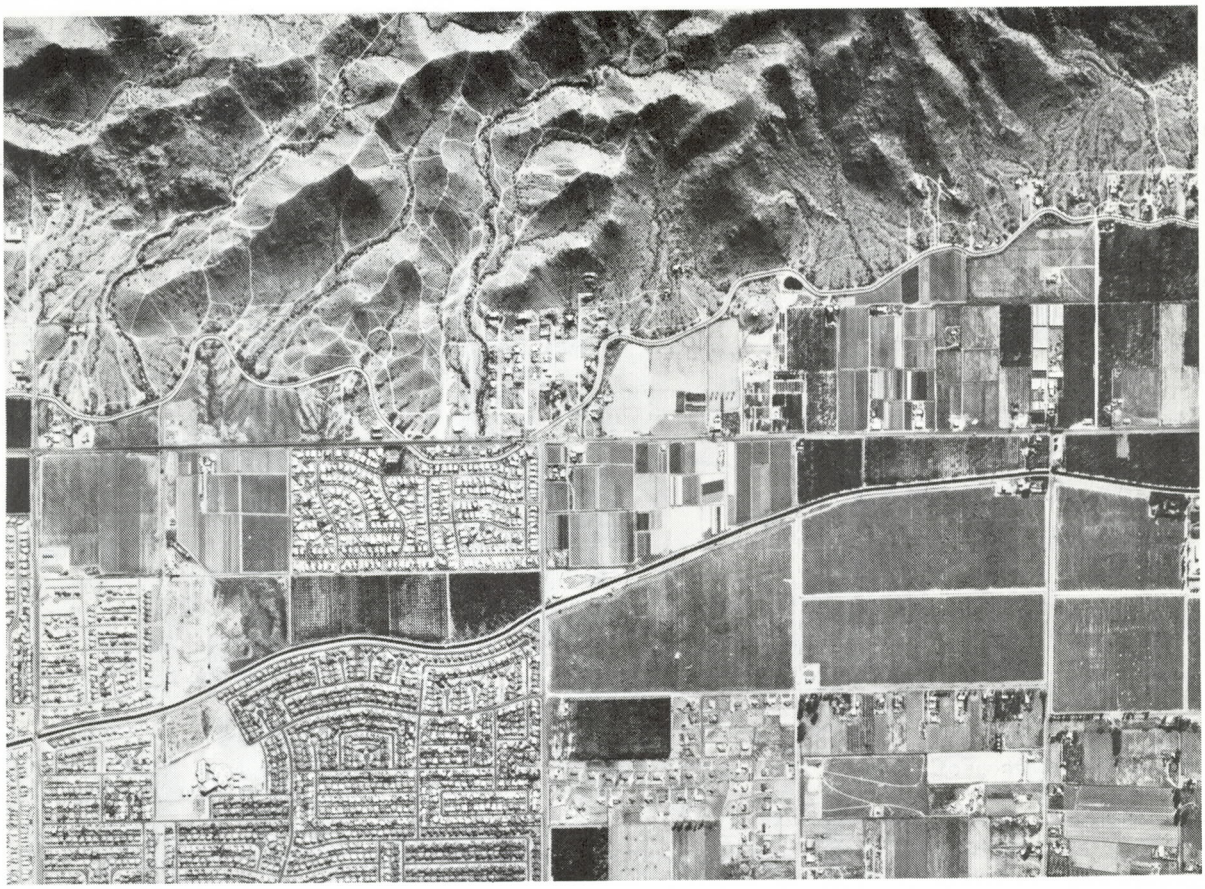


Figure VI-11
Portion Of South Phoenix Showing Obliteration Of Natural Channels By Agricultural And Suburban Development.

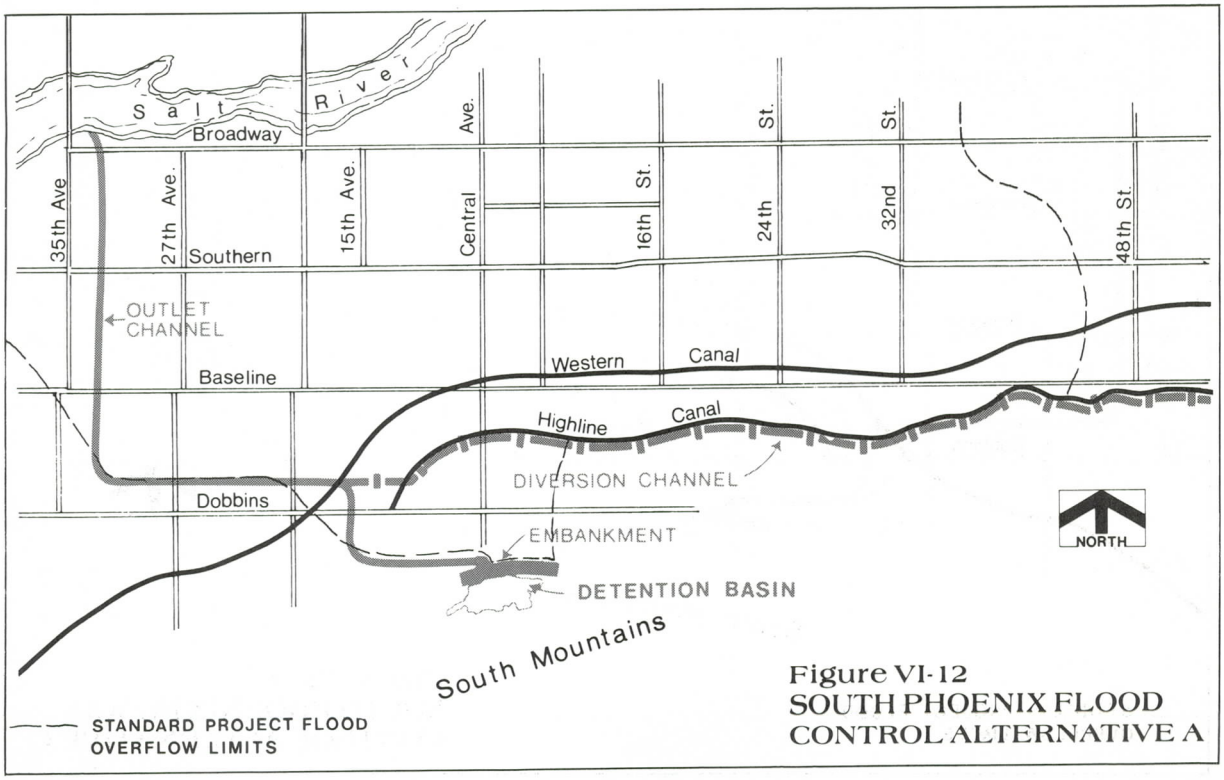


Figure VI-12
SOUTH PHOENIX FLOOD CONTROL ALTERNATIVE A

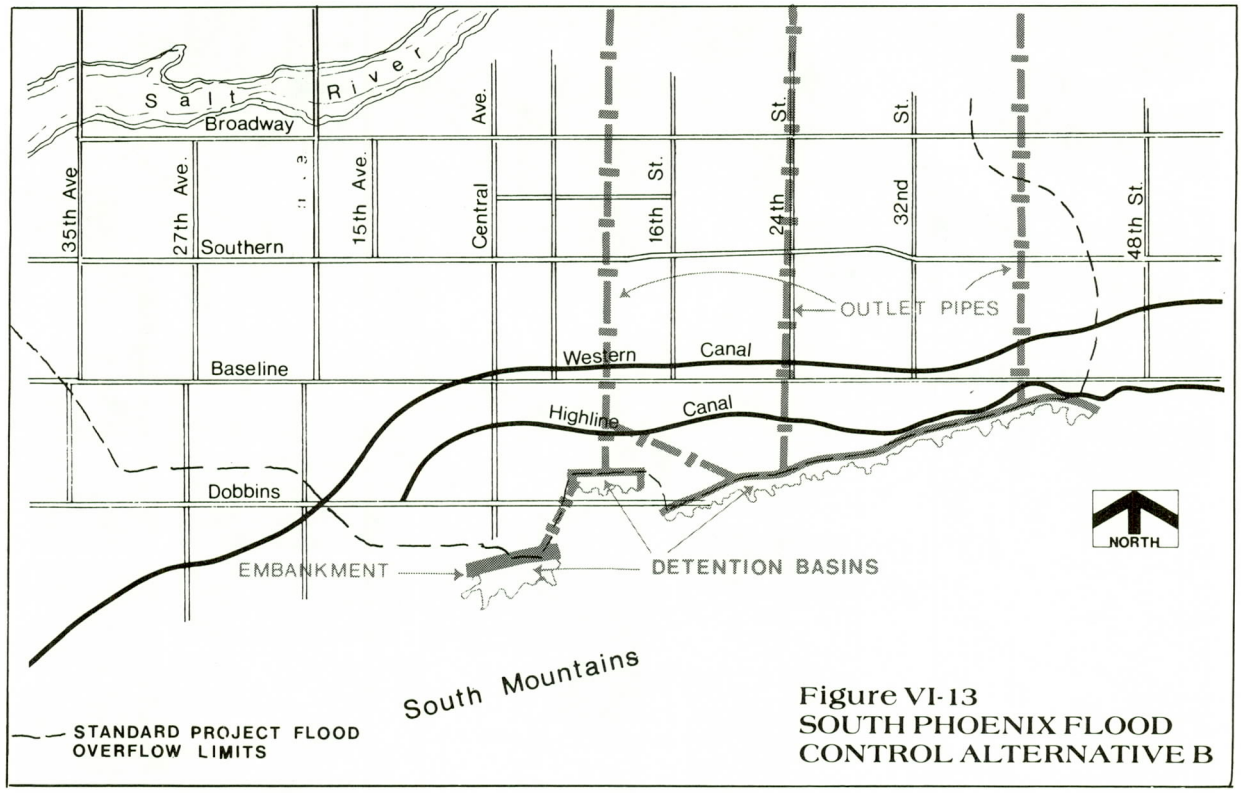


Figure VI-13
SOUTH PHOENIX FLOOD
CONTROL ALTERNATIVE B

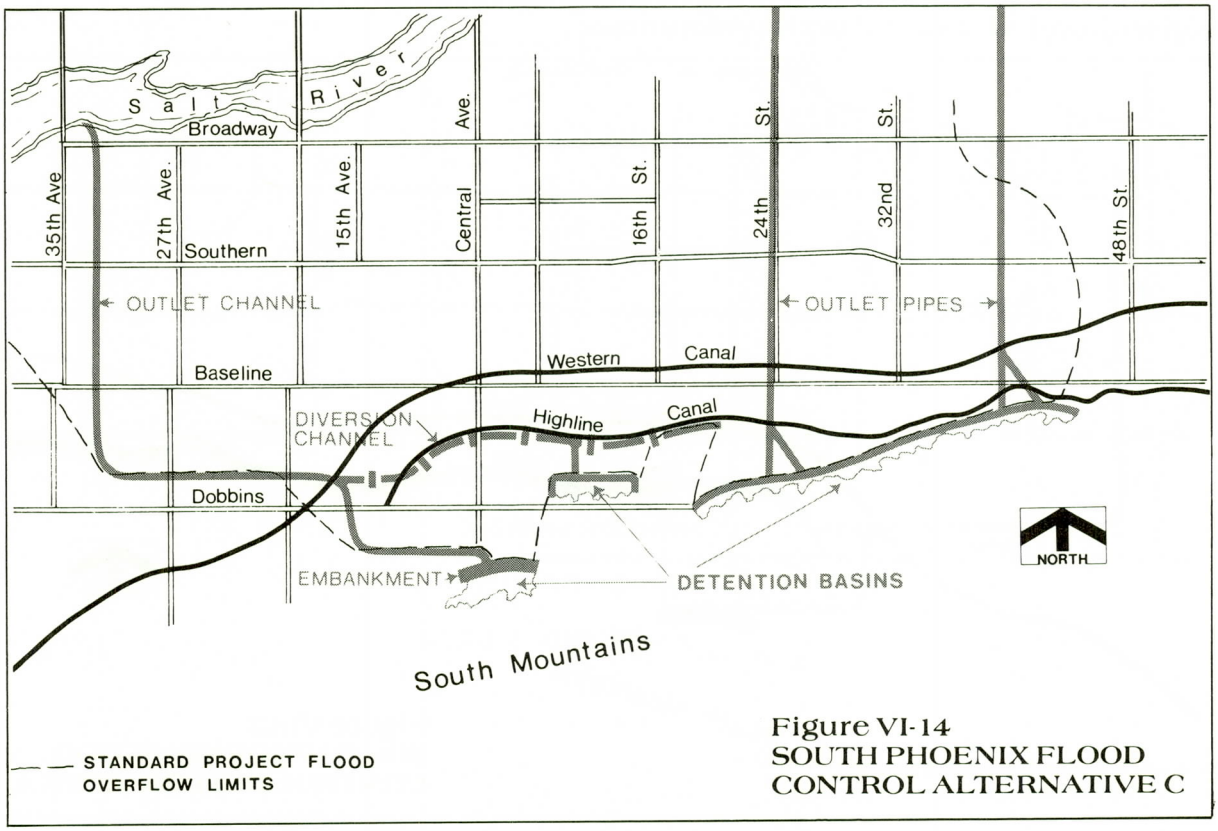


Figure VI-14
SOUTH PHOENIX FLOOD
CONTROL ALTERNATIVE C

UPPER INDIAN BEND WASH

Problems Related to Flood Control

Flood problems exist along Indian Bend Wash upstream from the Arizona Canal. The lower reach of the 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 by the Corps of Engineers.

A detention dike for the Granite Reef Aqueduct crosses the Indian Bend Wash about 7 miles north of the Arizona Canal, and controls much of the drainage area. Residual flows downstream from the dike and from the Phoenix Mountains are expected to cause flood problems in the future.

Alternatives Examined

In 1964, the Corps of Engineers issued a Flood Plain Information Study for Indian Bend Wash. This report urged the initiation of a program of flood plain regulation and management for Indian Bend. Although these proposed measures were not enforced, the Flood Plain Information Study has discouraged extensive residential and commercial development of the wash. The cities of Phoenix and Scottsdale and the Town of Paradise Valley in recent years have designated upper Indian Bend Wash to be developed as a greenbelt.

At the request of local interests, the Urban Study examined four alternative plans for handling flows from a 100-year flood event in the main channel of Upper Indian Bend. These plans were originally developed by Yost and Gardner Engineers in April, 1975 as part of a master drainage study for Indian Bend Wash within the City of Phoenix. They were reviewed for hydraulic efficiency and costs, and were extended to include a reach of channel through Paradise Valley. The prospects considered consisted of a concrete-lined trapezoidal channel, a deep grass-lined channel, a shallow grass-lined greenbelt with a concrete-lined low flow channel, and a shallow grass-lined greenbelt with 50:1 bottom slopes (see Figure VI-15). Each of these alternatives, however, was found to have unsatisfactory benefit/cost ratios (see Table VI-1) and were removed from further consideration. It is expected that private interests will continue to develop the Upper Indian Bend Wash floodplain into parks, trails, lakes, golf courses, and recreational uses compatible with flood control.

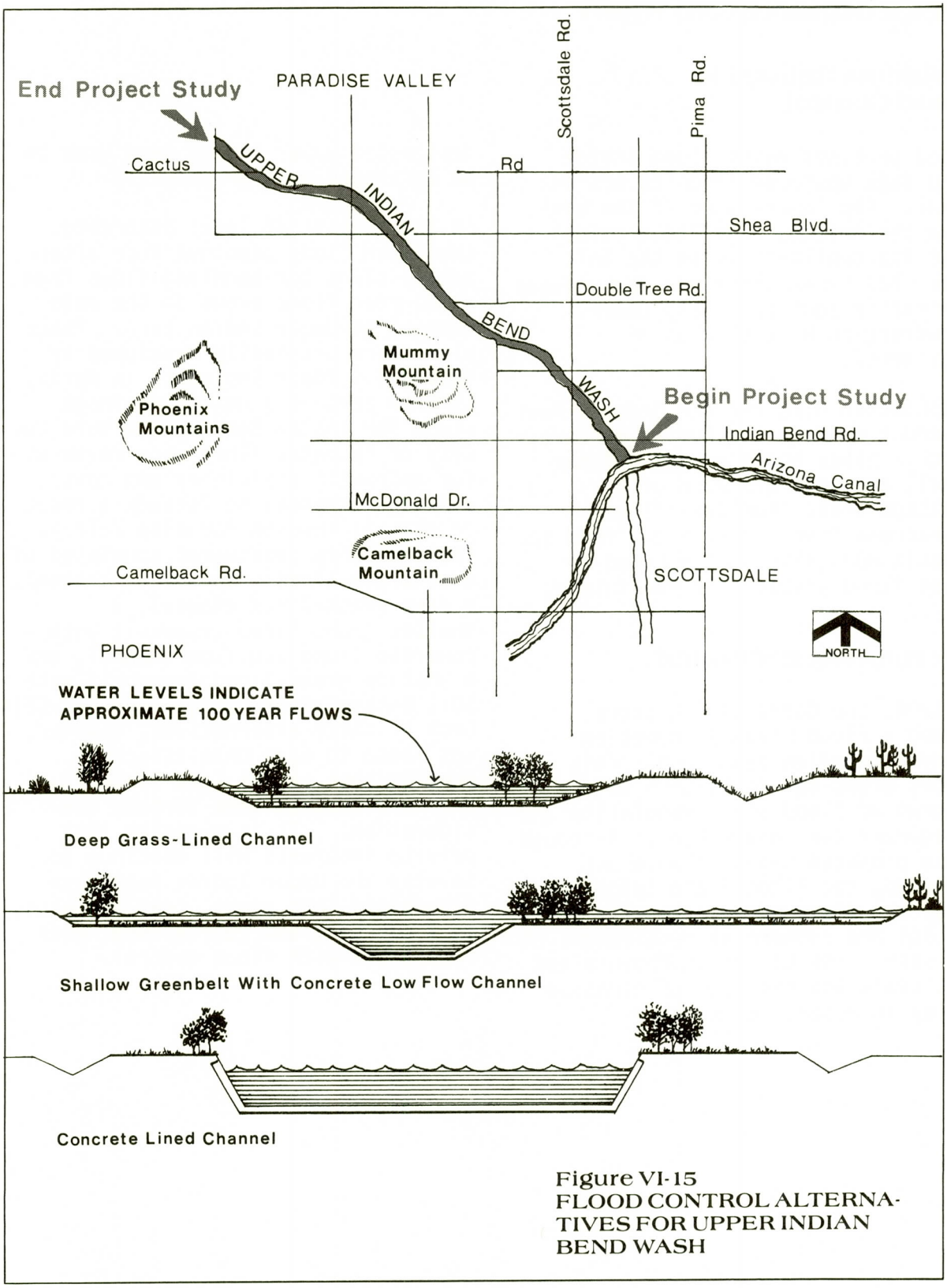


Figure VI-15
FLOOD CONTROL ALTERNATIVES FOR UPPER INDIAN BEND WASH

SCATTER WASH

Problems Related to Flood Control

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

Alternatives Examined

Scatter Wash was included in the Phoenix Urban Study to be analyzed as a separate flood control project. Structural solutions considered included channel improvements along 3.2 miles of Scatter Wash beginning at the Black Canyon Highway and extending to the confluence with Skunk Creek.

In addition to the plans for channel improvements, consideration was

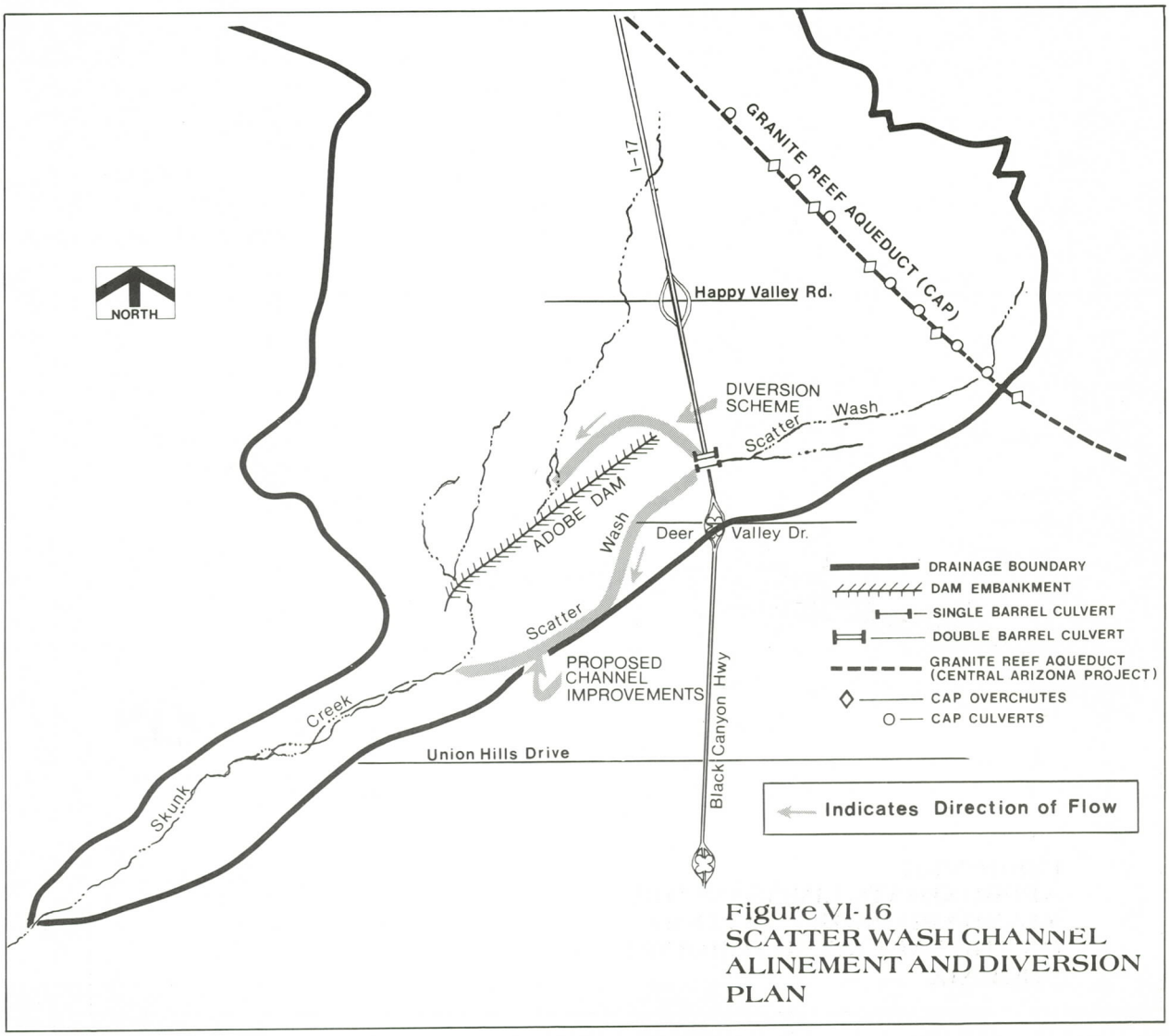


Figure VI-16
SCATTER WASH CHANNEL ALINEMENT AND DIVERSION PLAN

given to a scheme to collect and divert all floodflows along Scatter Wash arriving on the east side of the Black Canyon Highway (I-17), to north of Adobe Mountain and discharge them into Skunk Creek near the intersection of 35th Avenue and Pinnacle Peak Road (see Figure VI-16). Benefits from this measure and from channel improvements would accrue primarily through prevention of flood damages, although some incidental recreational benefits also could exist. Poor benefit/cost ratios, however, caused the projects along Scatter Wash to be removed from further consideration by the Phoenix Urban Study (see Table VI-1).

SALT RIVER THROUGH PHOENIX

Problems Related to Flood Control

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, 1981 with a peak flow of approximately 300,000 cubic feet per second (cfs).

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. In all, damages from this flood amounted to approximately $33,000,000. All but three river crossings were washed out, and 2500 feet of runway at Sky Harbor, the main airport in the study

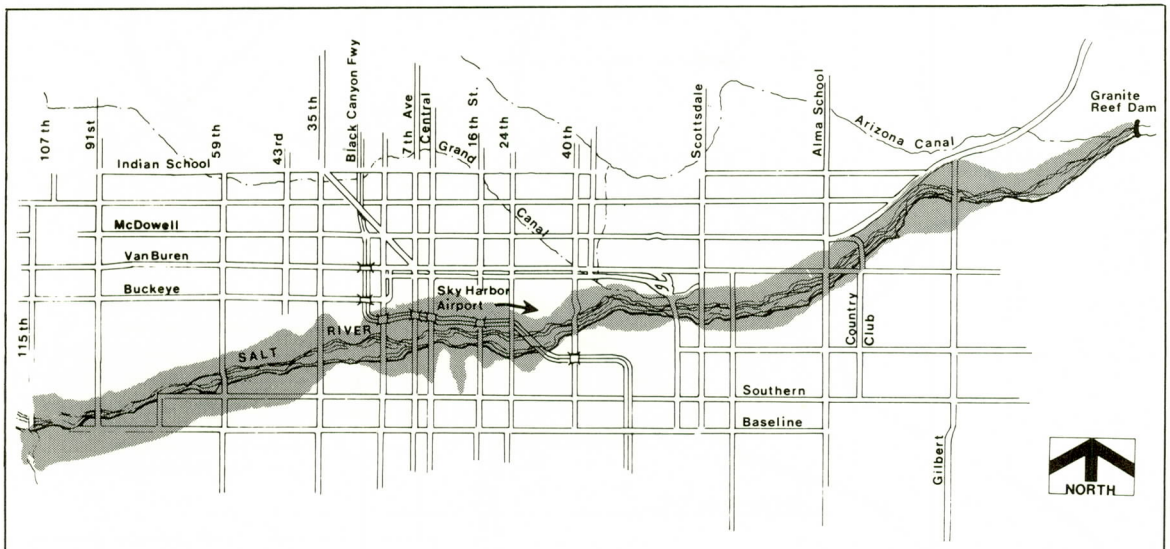


Figure VI-17
APPROXIMATE LIMITS OF THE STANDARD PROJECT FLOOD ON THE SALT RIVER THROUGH PHOENIX.

area, were inundated. Sand and gravel operations and some farmland also were flooded, and the residential areas of Holly Acres and Allenville received severe damages. In December, 1978, warm moist air from the Pacific Ocean caused another snowpack on the watershed to melt. The resultant peak flow was approximately 140,000 cfs. It produced damages of about $40,000,000. Heavy rains resulting from a series of tropical Pacific Ocean storms passing through Central Arizona in February 1980 caused extensive runoff on the Salt and Verde River watersheds. The combined flows peaked at 180,000 cfs on the Salt River at the Old Joint Head Dam near 48th Street in Phoenix. Damages for this event have been put at $63,700,000.

Alternatives Examined

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 reduce the standard project in-flow of 290,000 cfs to a discharge to 50,000 cfs. Operating on this assumption, Urban Study planners formulated two alternative channels to control flooding along the Salt from the proposed confluence site to 91st Avenue. Concrete and soft bottom trapezoidal channels with revetted side slopes were considered. Both would extend 35 miles to 91st Avenue and would be capable of passing 50,000 cfs.

Figure VI-18
In 1891, Flooding On The Salt River Washed Out The Maricopa And Phoenix Railroad Bridge At Tempe.
(Courtesy Arizona Historial Foundation)

Table VI-2
HISTORIC FLOODS ON THE
SALT RIVER *

Date	Flood Peak (cfs)
February 1891	300,000
April 1905	115,000
November 1905	200,000
January 19-20, 1916	120,000
February 1920	130,000
March 1938	95,000
December 1965 - January 1966	67,000
February 21 - May 29, 1973	22,000
March 2, 1978	122,000
December 19, 1978	140,000
January 19, 1979	88,000
March 29, 1979	67,800
February 1980	180,000

*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 Angeles District, 1957.

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

The recommended elimination of Orme Dam, an authorized feature of the CAP at the confluence of the Salt and Verde Rivers, caused a reorientation in the Urban Study's 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 participated in the Interagency Task Force on Orme Dam alternatives organized by the Bureau of Reclamation. Although this group failed to develop a concensus alternative to Orme, it did put forth a number of plans for further study. The Interagency Task Force was followed by the formation by the Bureau of Reclamation of the Central Arizona Water Control Study. Through its Phoenix Urban Study authority, the Corps of Engineers participated in Stage I planning for the new study. As a result of this effort, the following alternatives were determined to be suitable for more detailed investigation in Stage II:

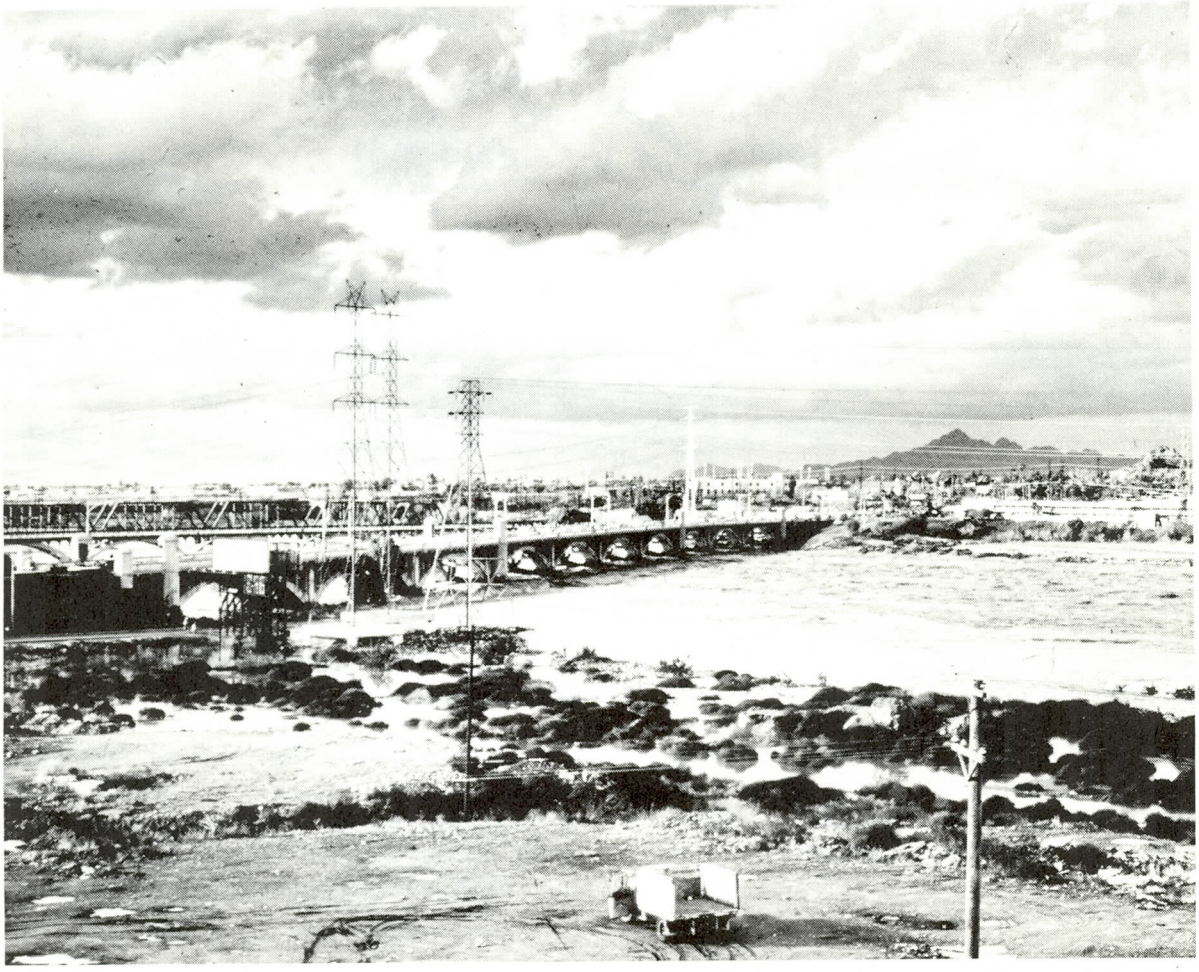


Figure VI-19
Salt River Flood Waters Flow Past Tempe, Destroying The Northbound Highway Dip Crossing And Snarling Traffic, 1978.

forecasting and Salt River Project reservoir operation in order to minimize downstream flood damage.

New Waddell Dam and Lake Pleasant

During Stage I of the Central Arizona Water Control Study, the Bureau of Reclamation examined construction of new structures and modification of the existing Waddell Dam on the Agua Fria River and water exchanges with the Salt River Project to achieve Central Arizona Project regulation. To the extent that such measures affect study area hydrology or flood control, they are of interest to the Corps.

Channels and Levees

In this alternative, floodway channels and/or levees would be constructed in or along selected reaches of the Salt and Gila Rivers between Granite Reef Diversion Dam and Painted Rock Reservoir to prevent flood damages.

Flood Proofing, Zoning or Flood Plain Aquisition

This alternative involves the implementation of non-structural methods of flood control which are compatible with all types of flood control measures and can act to minimize flood damage.

No Action

The No Action alternative is a decision course which provides for no federally sponsored measures to reduce flood damages along the Salt and Gila Rivers through the study area.

GILA FLOODWAY

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 problem will become more severe as large portions of agricultural land become urbanized.

The study for flood control along the Gila Floodway was pursued under Section 6 of the Flood Control Act of 1938 which authorized a study of the entire Gila River Basin. In October 1973, the Congress funded an interim study for the Gila portion of the drainage basin. An unpublished report titled, "Summary Report for Flood Control, Gila Floodway Maricopa and Pinal Counties, Arizona", and dated September, 1977 was prepared by the Los Angeles District of the Corps of Engineers and approved by the South Pacific Division. The conclusions reached in this report were that structural measures for flood control were not economically justified, and that no federal improvements be undertaken in the Gila Floodway study area at this time (see Table VI-3). Findings of the previous report have not changed under current conditions.

Table VI-3
GILA FLOODWAY ALTERNATIVES, COSTS AND BENEFITS

Description	First Costs	Average Annual Charges	**	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.

**Average annual benefits resulting from flood protection.

FLOOD WARNING

An important portion of the Phoenix Urban Study 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. Attention was given to the problems of flooding along major watercourses and smaller urban and suburban washes. 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. ■

CHAPTER VII
WATER CONSERVATION

The importance of water conservation in the western states was highlighted by the widespread drought of 1977. Insufficient winter precipitation and subsequent reduced runoff into storage reservoirs resulted in water rationing in water conservation measures in the several western cities. In central Arizona, dry years are the rule rather than the exception, and Arizonans early adopted a conservation ethic as a matter of survival. Ironically, the hardships presented by droughts in Arizona are made worse by the fact that when water becomes available it is often in the form of large, unmanageable floods.

PROBLEMS RELATED TO WATER CONSERVATION

Because of the arid environment of the study area, water conservation

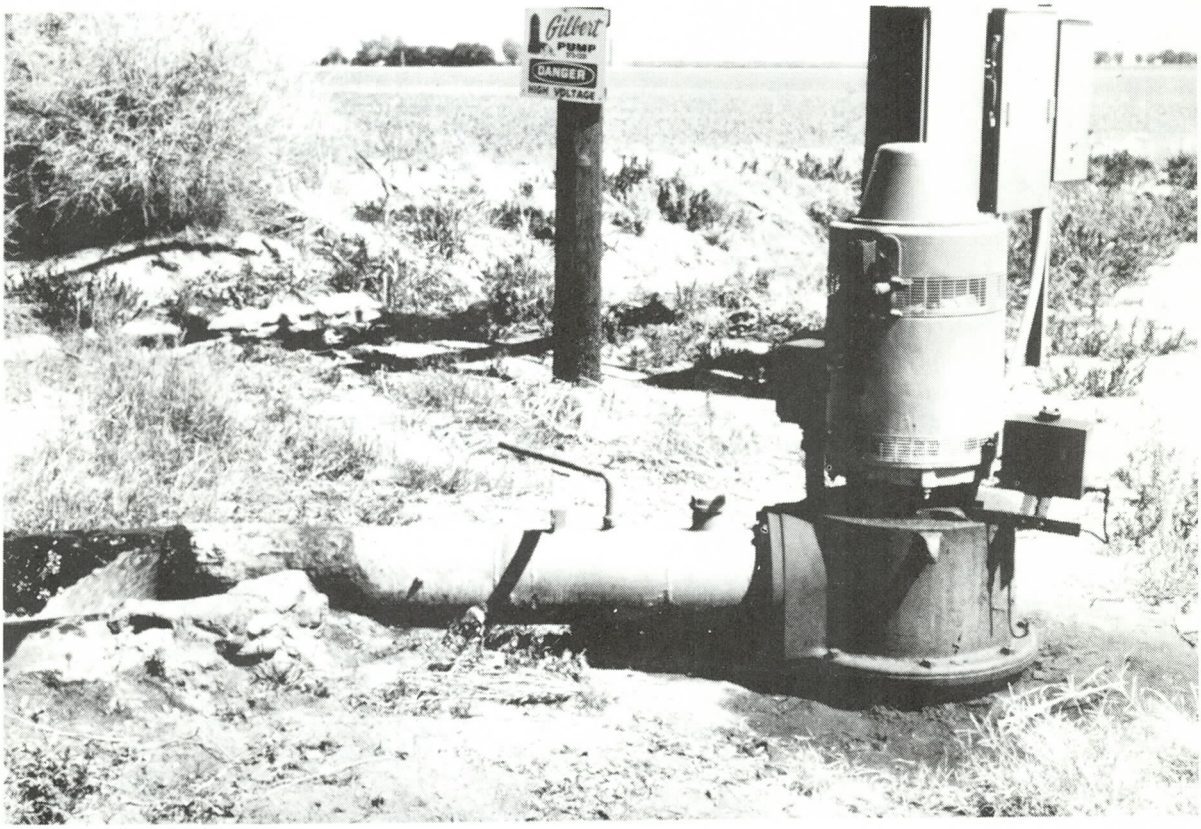


Figure VII-1
Intensive Pumping Of Groundwater Has Made Possible Large Scale Agricultural Production In Much Of The Study Area, But Has Also Lowered The Water Table.

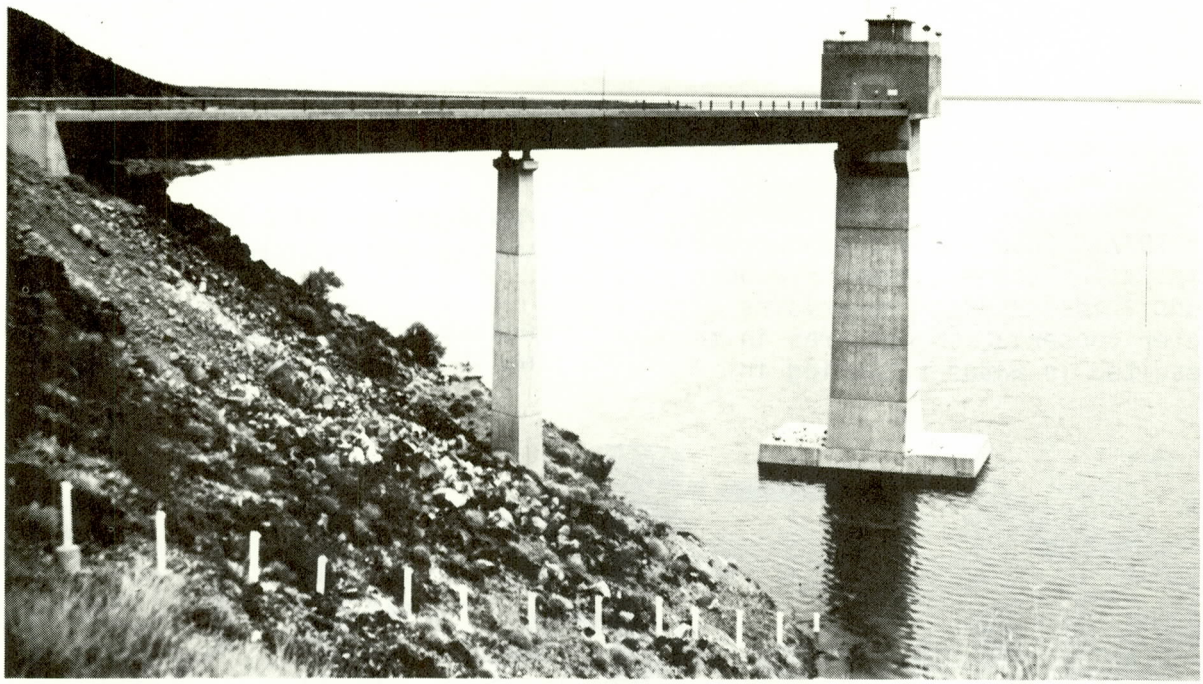


Figure VII-2
Water Behind Painted Rock Dam Following The 1978 Floods. The Phoenix Urban Study Examined Ways Of Conserving This Wasted Resource For Beneficial Use.

takes on increased importance. At present, urban and agricultural interests in metropolitan Phoenix are consuming more water than comes into the area naturally through surface flow and recharge of the groundwater. Even though the Central Arizona Project will import water from the Colorado River to the study area, over-drafting of the region's available water supplies is expected to continue.

ARTIFICIAL GROUNDWATER RECHARGE

Extensive water releases by the Salt River Project in 1973 and 1978-79 graphically illustrated the need for floodwater conservation in the study area. Although the releases were controlled in 1978-79, damages exceeding $60 million resulted, and furthermore over 3 million AF of excellent quality water was lost to beneficial use.

The Urban Study investigated the possibilities of flood-water conservation throughout the Phoenix area. This evolved into a study of recharge of floodwaters along the Salt River and finally into a study of artificial groundwater recharge along the Salt, not only of floodwaters, but also Colorado River water imported by the CAP and treated wastewater effluent.

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. As a result of preliminary consideration of this concept during the Phoenix Urban Study it was concluded that the spreading basin method of artificial groundwater recharge deserves further consideration. Employment of this technique would allow flood waters or CAP waters to be introduced into the groundwater reservoirs.

A preliminary evaluation of general potential sites within the valley also was completed during the Phoenix Urban Study.

Review of Stage I Activities

Essentially, the Stage I activities for a recharge project in the Salt River Valley were completed in 1977 as an adjunct to the Phoenix Urban Study. In that study, 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 for lack of adequate data, was necessarily based upon somewhat tenuous assumptions. Nevertheless, it was concluded tentatively that artifical recharge via basins would conserve only small amounts of floodwater on the Corps of Engineers' "New River and Phoenix City Streams" flood control project. In contrast, artifical recharge appeared to be a viable approach for conserving floodwaters along the Salt River. Detailed information regarding the possibilities and constraints of a demonstration groundwater recharge project can be found in the Technical Appendix, Plan of Study for a Demonstration Recharge Project in the Salt River Valley contained in this Final Report.

NEW RIVER DIVERSION MEASURE

At the request of local residents the Phoenix Urban Study also investigated the feasibility of diverting the New River into Lake Pleasant. The purpose of the measure would be to provide conservation through diversion of additional water into the lake, as well as to provide flood control for the community of New River. Diverted water also would result in improved recreation and enhancement of fish and wildlife at Lake Pleasant.

The alternative plans developed for this measure involved diversion of the New River about 3.5 miles above the community of New River (see Figure VII-3). Water would be discharged into a natural waterway which is tributary to the Agua Fria River at the "Little Grand Canyon Rancho" and would flow down the river into Lake Pleasant. One scheme would seal off completely all downstream surface flows and route them into the Agua Fria. The other plan featured a controlled outlet to permit flows at a pre-determined rate to pass through

the structure. Diversion would be made only after demands of downstream water users are satisfied. Both plans could affect the final design of the authorized New River Dam by reducing substantially the area to be controlled by the structure. New bridges crossing the diversion channel at Table Mesa Road and the I-17 Highway also would be required.

Planning for the New River diversion measure has been suspended for the following reasons:

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

- Legal conflicts resulting from the diversion would be difficult or impossible to resolve. Specifically the liability for any damages caused by diverted waters or through the reduction of natural groundwater recharge were sources of concern.

- The Bureau of Reclamation is studying the feasibility of either using existing Lake Pleasant facilities or constructing a new Waddell Dam and reservoir for regulatory storage of Central Arizona Project Waters. Either of these plans would pre-empt diversion because available reservoir space would be required for regulatory storage. It was decided that further study of the New River diversion should be held in abeyance at least until the Bureau determines whether or not CAP waters will be stored at or near Lake Pleasant. ■

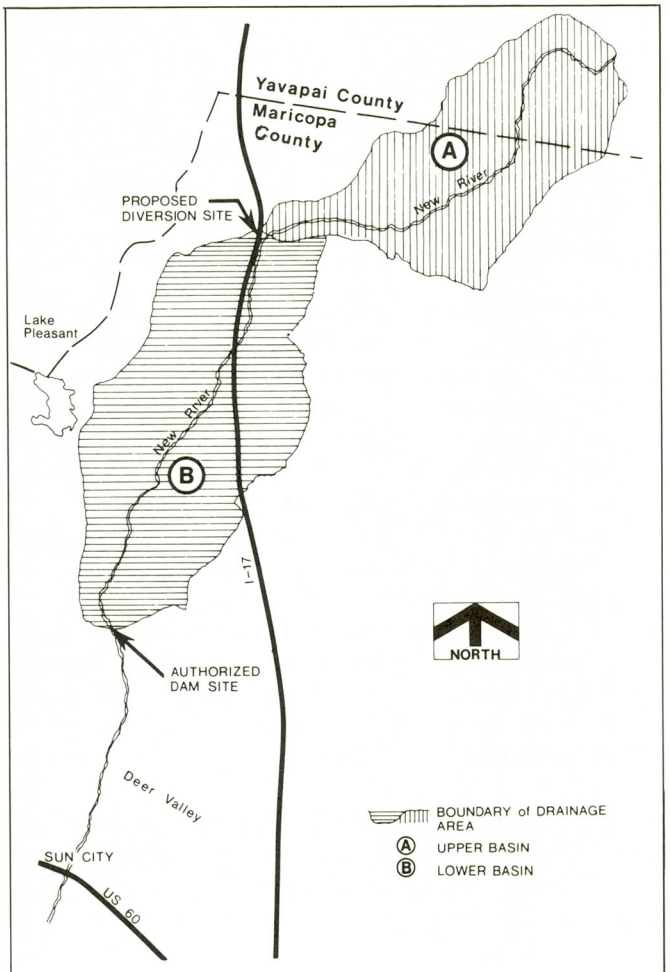


Figure VII-3
NEW RIVER DIVERSION AREA

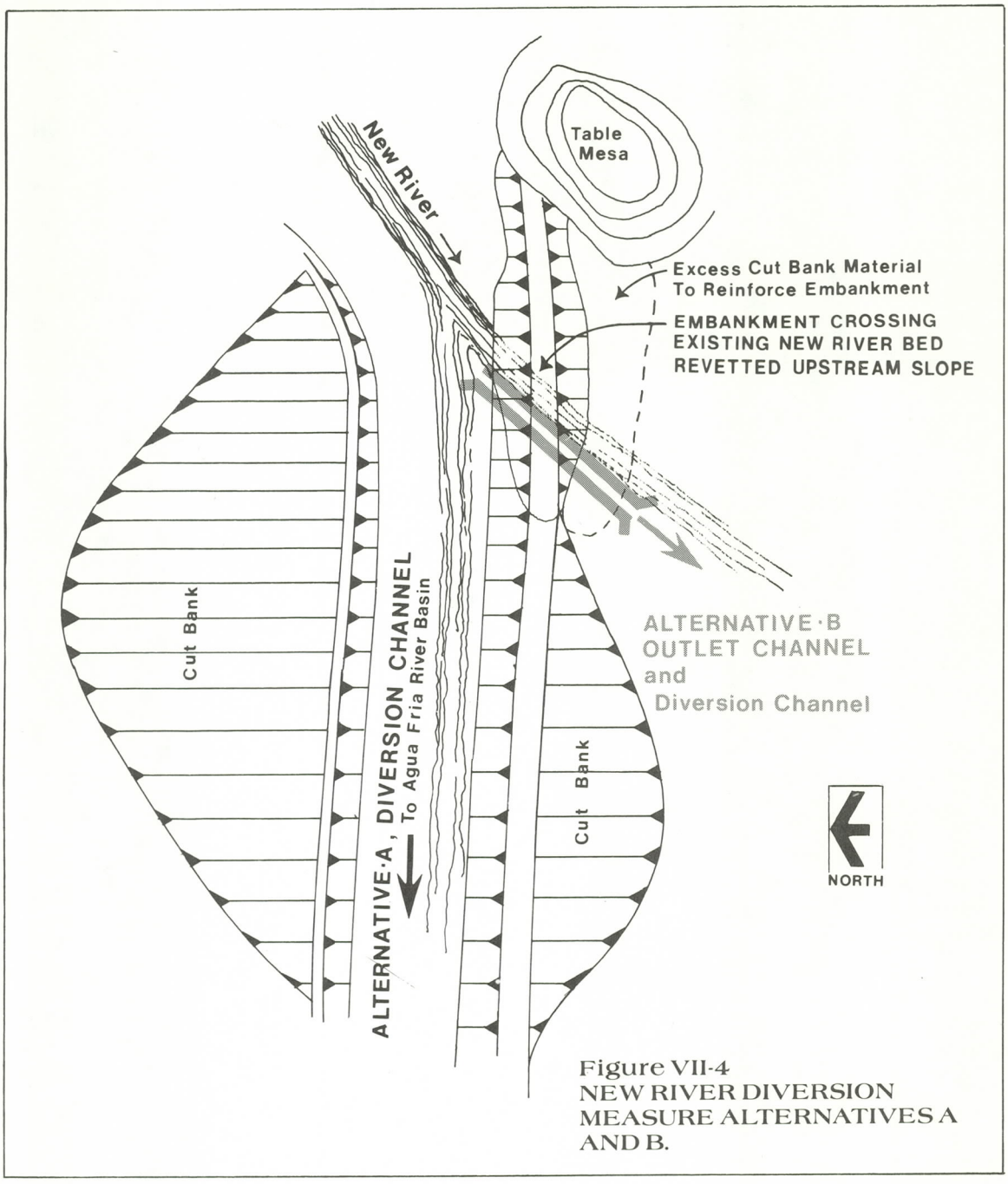


Figure VII-4
NEW RIVER DIVERSION MEASURE ALTERNATIVES A AND B.

CHAPTER VIII
RIO SALADO

Rio Salado is a stimulating concept that envisions transforming the usually dry Salt River bed into a multi-purpose greenbelt floodway as it passes through metropolitan Phoenix. Although a bond issue to undertake construction of a small part of Rio Saldo in Phoenix was rejected by voters in 1976, local planners still feel the concept to be usable.

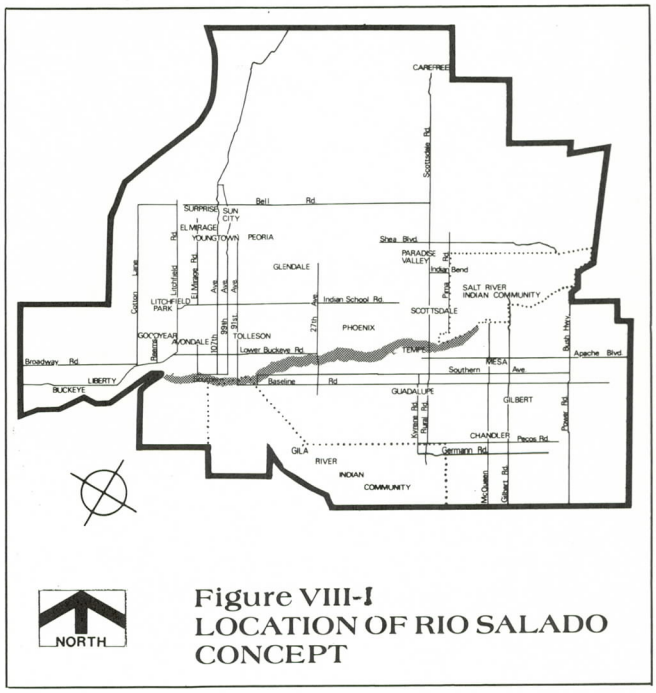


Figure VIII-1
LOCATION OF RIO SALADO CONCEPT

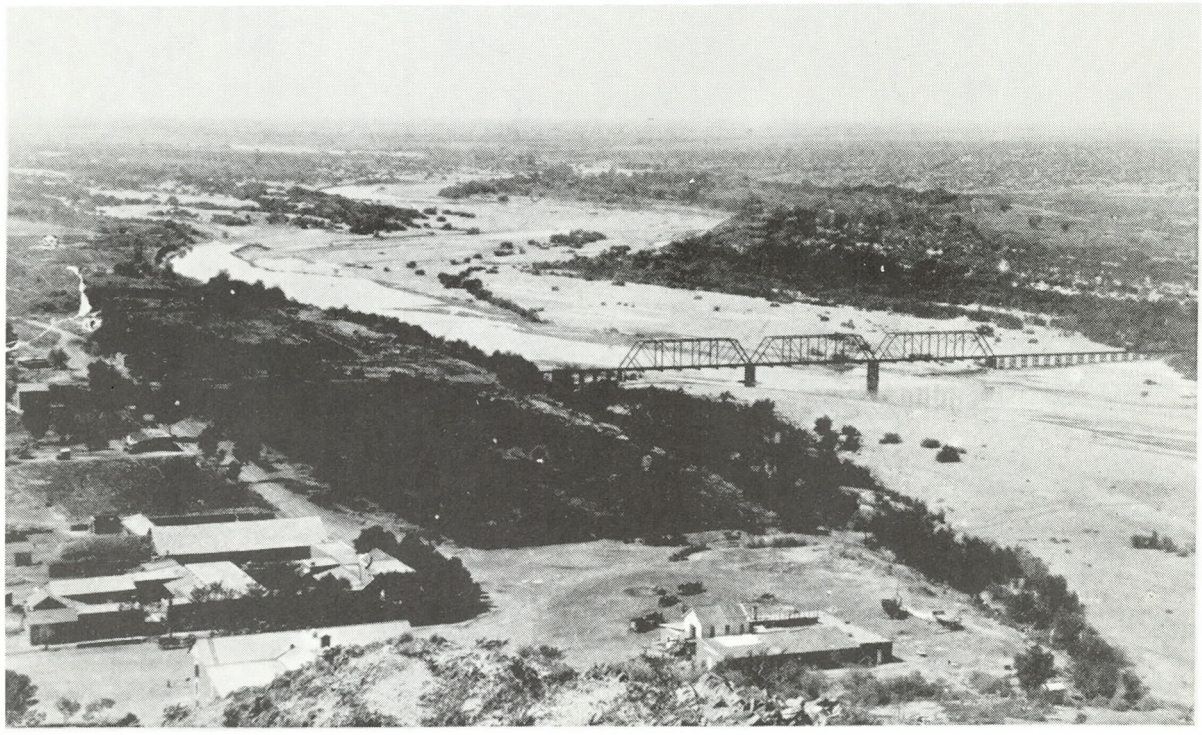


Figure VIII-2
Until The Early Twentieth Century, The Salt River Flowed Through The Study Area, Creating A Rich Riparian Habitat Along Its Banks. The Rio Salado Concept Envisions Returning Water And Life To The Salt. View Looking Toward Phoenix From Tempe Butte, CA. 1888
(Courtesy Arizona Historical Foundation)

The City of Tempe has undertaken its own Rio Salado planning effort in coordination with other state and county agencies. In April 1980, the Rio Salado Development District was established by the Arizona Legislature to assist in the solution of flood control problems in the Salt River and the oversee development of adjacent lands for commercial and recreational purposes.

As an element of its examination of water resources in the Phoenix area, the Phoenix Urban Study looked at the nature and potential of the Rio Salado concept. In so doing it evaluated Rio Salado's role in the five areas of interest to the Urban Study: water quality, flood control, water conservation, recreation, and enhancement of fish and wildlife. As a result of this investigation the Urban Study identified a Phase 3 scenario for future development of Rio Salado. It was an attempt at further project definition which anticipates future in-depth research.

Figure VIII-3 and Figure VIII-4
Indian Bend Wash, A Greenbelt Floodway Being Developed By The Corps Of Engineers In Scottsdale, Arizona Provides An Example Of The Possibilities For Rio Salado.

Figure VIII-3
McDowell Exhibit Plaza

The Phase 3 scenario for Rio Salado outlined the possibilities and limitations of flood control, reuse of wastewater, recharge of groundwater, development of boating, and other recreational facilities, and improvement of fish and wildlife habitat along the river. One important feature of this outline was the development of preliminary cross sections of channels that might pass floods of various magnitudes. These study channels would be used primarily for evaluating the impacts of all channelization alternatives. Reuse of treated wastewater and groundwater recharge, as they related to Rio Salado, were presented as being contingent on other projects and planning efforts. The recreation, fish and wildlife, and other aspects of Rio Salado Phase 3 also were seen in broad and as yet largely undefined terms.

Planning for Rio Salado will continue beyond the termination of the Phoenix Urban Study. The possibilities for Rio Salado 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. ■

Figure VIII-4
McKellips Lake

CHAPTER IX
CONCLUSIONS

The Phoenix Urban Study investigated water and related land resource problems in the Phoenix metropolitan area. From the findings presented in the Final Report the following conclusions can be drawn:

1. The Water Quality Management Plan (208) for the Metro Area is in compliance with PL 92-500. It is being implemented by the Maricopa Association of Governments. The plan includes an acceptable program for reducing waste flows to area treatment plants, thereby achieving significant water conservation.

2. The flood control projects examined for: a) Glendale-Maryville, b) Cave Creek below the Arizona Canal, c) South Phoenix, d) Old Cross Cut Canal, e) Upper Indian Bend Wash, f) Gila Floodway, and g) Scatter Wash do not warrant further study by the Corps of Engineers.

3. A serious flood hazard exists along the Salt River from Granite Reef Dam to the confluence with the Gila River, and on the Gila River from the Salt River confluence to Painted Rock Dam. Further study of this problem is warranted.

4. Artificial groundwater recharge appears to be a feasible method for achieving water conservation. A demonstration project as outlined in the Technical Appendix of the Final Report warrants further consideration.

5. The diversion of the New River into the Agua Fria River and Lake Pleasant for water conservation does not warrant further study by the Corps of Engineers.

CHAPTER X
RECOMMENDATIONS

Based on the findings of the Phoenix Urban Study, the District Engineer recommends:

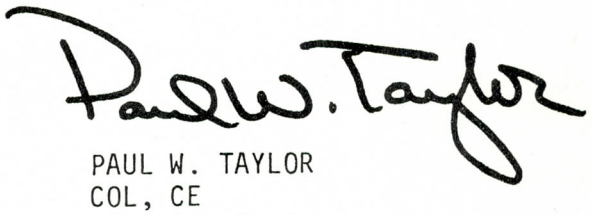
1. That the Water Quality Management Plan (208) for the metro Phoenix area already implemented by local agencies be updated annually in compliance with provisions of PL 92-500, The Federal Water Pollution Control Act Amendments of 1972.

2. That the Watch Our Wastewater program developed by the Urban Study and Maricopa Association of Governments as a wasteflow reduction measure be continued and expanded by local interests to reduce water consumption in the study area.

3. That for lack of economic justification, the Corps of Engineers undertake no further action at this time relative to flood control projects at: a)Glendale-Maryvale, b)Cave Creek Below the Arizona Canal, c) South Phoenix, d)Upper Indian Bend Wash, e)Gila Floodway, and f)Scatter Wash; and that for lack of appropriate jurisdiction, the Corps of Engineers take no further action on the Old Cross Cut Canal.

4. That planning for flood control on the Salt River through Phoenix continue as part of the Central Arizona Water Control Study being conducted by the Bureau of Reclamation with support as necessary by the Corps of Engineers.

5. That in keeping with expressed local wishes, the Corps of Engineers not continue the investigation of diversion of the New River into the Agua Fria River and Lake Pleasant as a water conservation measure.



PAUL W. TAYLOR
COL, CE
District Engineer