

GILA RIVER BASIN
NEW RIVER AND PHOENIX CITY STREAMS
ARIZONA

ALTERNATIVE PLANS
FOR
FLOOD CONTROL
AND
RECREATIONAL DEVELOPMENT

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U S ARMY ENGINEER DISTRICT
LOS ANGELES
CORPS OF ENGINEERS



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APRIL 1974



DEPARTMENT OF THE ARMY
LOS ANGELES DISTRICT, CORPS OF ENGINEERS
P. O. BOX 2711
LOS ANGELES, CALIFORNIA 90053

SPLED-DC

ANNOUNCEMENT OF PUBLIC MEETING

A public meeting will be held at 7:00 p.m., on April 25, 1974, in the Maricopa County Administration Building Board of Supervisors' Auditorium, 111 South Third Avenue, Phoenix, Arizona (see location map on reverse side of this notice). The purpose of the meeting is to present, for public evaluation, alternative plans for flood control and associated needs in the Phoenix area.

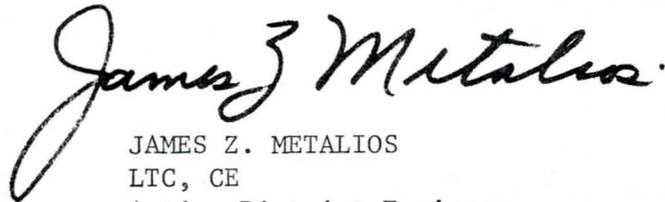
The plans are the result of an investigation of flood and related problems in the Phoenix vicinity, as authorized by the Flood Control Act of 1965, Public Law 89-298, 89th Congress, 1st Session.

The non-structural alternative of "No further action" has been considered along with structural alternatives that would provide flood protection to large portions of Phoenix and several communities to the north and west of Phoenix. As this is a multipurpose project, recreation was also considered for each alternative. Recreation facilities could include lakes and associated development above the dams and a trail system along the channels. Landscaping has been considered where appropriate.

All interested parties are invited and encouraged to be present or represented at the public meeting. You will be afforded full opportunity to express your views concerning the various alternatives and/or to propose others. Final selection of a plan will occur only after full consideration is given to the views of responsible agencies, groups, and citizens.

Please bring this announcement and brochure to the attention of anyone you know who may be interested in this matter.

1 Incl
Brochure

A handwritten signature in black ink that reads "James Z. Metalios". The signature is written in a cursive style with a large, looping initial "J".

JAMES Z. METALIOS
LTC, CE
Acting District Engineer

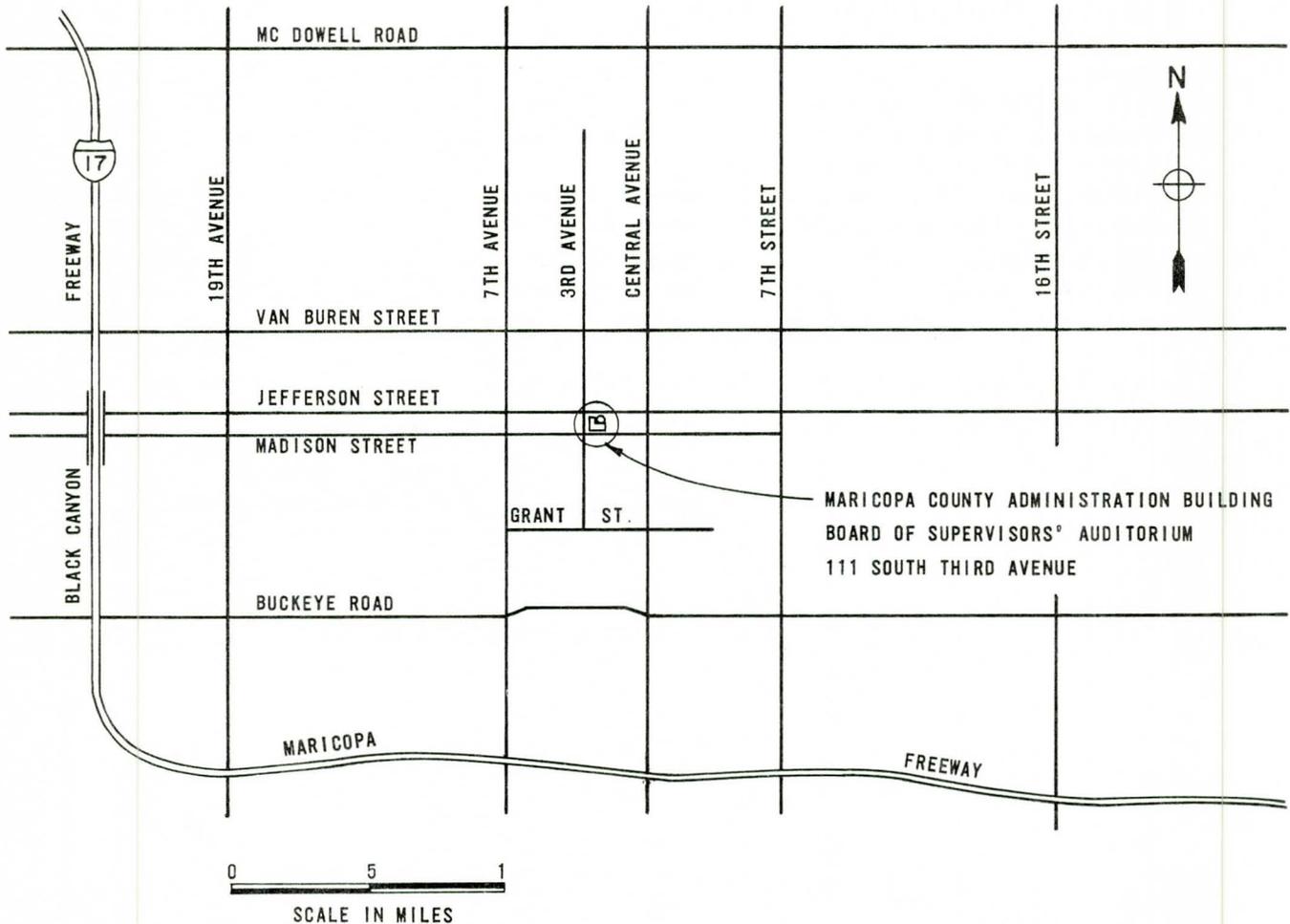
PUBLIC MEETING

FLOOD CONTROL AND RECREATIONAL DEVELOPMENT
NEW RIVER AND PHOENIX CITY STREAMS
ARIZONA

DATE: THURSDAY, APRIL 25, 1974

TIME: 7:00 P.M.

LOCATION: MARICOPA COUNTY ADMINISTRATION BUILDING
BOARD OF SUPERVISORS' AUDITORIUM
111 SOUTH THIRD AVENUE
PHOENIX, ARIZONA 85003



GILA RIVER BASIN
NEW RIVER AND PHOENIX CITY STREAMS, ARIZONA
ALTERNATIVE PLANS
FOR
FLOOD CONTROL AND RECREATIONAL DEVELOPMENT

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PURPOSE OF BROCHURE

This brochure presents the feasible alternatives studied to date for providing flood control and associated needs in the Phoenix area. It describes each alternative plan so that you may assess its effectiveness in reducing flood hazard and its environmental effects. You are encouraged to study this brochure and to freely, fully, and publicly express your views of the alternatives at the forthcoming public meeting or by letter to the District Engineer, Los Angeles District, U.S. Army Corps of Engineers, 300 North Los Angeles Street, Los Angeles, California 90053.

DESCRIPTION OF DRAINAGE AREA

The drainage area tributary to the New River and Phoenix City Streams study area forms a roughly oval shaped area of approximately 2,610 square miles. The basin is located in Maricopa and Yavapai Counties in the south central part of Arizona. About 70 percent of the area is mountainous. The mountain areas above 3,000 feet are rugged and steep. The lower areas consist of fairly flat valley land with regular alluvial slopes. Elevations in the study area range from about 7,000 feet above mean sea level in the headwaters to about 900 feet at the Gila River.

The Agua Fria River rises in the Hieroglyphic Mountains and flows for about 130 miles to the Gila River near Avondale. The major tributary of the Agua Fria River, New River, originates in the New River Mountains and flows generally southward for about 40 miles to its confluence with the Agua Fria River, about 15 miles west of Phoenix. It drains an area of approximately 340 square miles. Skunk Creek, the major tributary of New River, rises in the New River mountains and flows generally southwestward for about 30 miles to its confluence with New River about 15 miles northwest of Phoenix. It drains approximately 110 square miles. Cave Creek has its source in the New River Mountains also, from where it descends to the alluvial fan near the town of Cave Creek and flows south for about 13 miles before encountering Cave Creek Dam, which controls 175 square miles of drainage area. Cave Creek then flows through an alluvial fan which is undergoing urbanization between Cave Creek Dam and the Arizona Canal. Floodflows exceeding the capacity of the canal flow directly through metropolitan Phoenix to the Salt River. Cave Creek drains approximately 311 square miles. Dreamy Draw Wash, a tributary of Cave Creek, rises in the Phoenix Mountains and flows generally southwestward for about 5 miles to its confluence with Cave Creek in Phoenix. The wash has a 2 square mile drainage area.

HISTORY AND AUTHORITY FOR STUDY

The Flood Control Act of 1938 authorized an investigation for flood control in the entire drainage area of the Gila River and tributaries, Arizona and New Mexico. On the basis of the authorization in that act, the Chief of Engineers, on October 16, 1959, authorized an interim investigation of Phoenix and vicinity (including New River). At a public meeting held in Phoenix, Arizona on December 9, 1959, the Flood Control Advisory Committee (the predecessor of the Flood Control District of Maricopa County) presented an outline of a comprehensive plan of improvement for the Phoenix metropolitan area. Subsequently, a comprehensive five-phase flood control plan for the Phoenix metropolitan area was developed by the Corps of Engineers in cooperation with the Flood Control District to serve as a framework for all flood control work in the area. This plan is shown on the opposite map.

The Phase B portion of the comprehensive plan, as described in House Document 216, 89th Congress, 1st Session, was authorized by the Flood Control Act of 1965. Phase B provides for (a) Dreamy Draw (already constructed), Cave Buttes, Adobe, and New River Dams; (b) the Union Hills and Arizona Canal diversion channels; and (c) the Cave Creek, Dreamy Draw, Skunk Creek, New River, and Agua Fria River channel improvements. The plan provides for controlling floodflows in each respective drainage area; for diverting residual flows in Cave Creek and several small washes to Skunk Creek, and for channelizing Skunk Creek, New River, and the Agua Fria River to carry the diverted flows to the Gila River.

A number of formal and informal meetings have been held with local government and concerned individuals and groups to provide continual information on the progress of the study and to solicit ideas and alternative plans which should be considered in formulating solutions to the flood control and associated problems.

FLOOD HISTORY AND PROBLEMS

Until relatively recent times, floods along Dreamy Draw and Cave Creek rarely caused large damages, mainly because of the predominance of agricultural development in the overflow area. However, since 1940, the population in the Phoenix metropolitan area has increased almost nine-fold and the flood damage potential has increased tremendously. Recent development trends in the Phoenix area may be shown by considering the period of 1960-1970 when the population increased from about 552,000 to 867,000. This increase of 315,000 people required the urbanization of about 73,000 additional acres of land.

Increasing urbanization aggravates flood problems by increasing the rainfall runoff and thus increasing the flow in streams. The natural channels of Dreamy Draw, Cave Creek and other washes virtually disappear at the Arizona Canal (except during floods) with no trace of a watercourse being evident downstream. The area below the Arizona Canal has been subdivided and intensively developed for urban use. Many people who occupy this urban area are not aware of the potential flood danger. Since projections foresee continued population growth and urbanization of the Phoenix area, flood problems can be expected to worsen in the future.



DEC 23, 1965 - Van Buren St. at the Agua Fria River.
Almost submerged car.



DEC 23, 1965 - Peoria Ave. at the New River. Extensive
damage to dip crossing.



DEC 24, 1966 - Olive Ave. at the New River. Dip crossing disappears into river.



DEC 20, 1967 - Broadway Dept. store in Chris-Town.



SEPT 3-7, 1970 - Disabled auto being towed away at intersection of 16th St. and Camelback Road.



SEPT 3-7 1970 - Mirror-like reflections at intersection of 14th Ave. and Glendale Ave.



JUNE 22, 1972 - Young girl experiences difficulty crossing the intersection of 32nd St. and Campbell Ave.



JUNE 22, 1972 - Residents wade in and out of home at intersection of 13th St. and Orangewood Ave.



JUNE 22, 1972 - Floodwaters and debris gush over the top of the southern bank of the Arizona Canal east of 16th St.



JUNE 22, 1972 - Motorists endure stalled autos and traffic delays on Central Ave. near Indian School Road.



JUNE 22, 1972 - Postman makes his appointed rounds with his shoes tucked in mailbag on 3rd Ave. south of Roosevelt St.

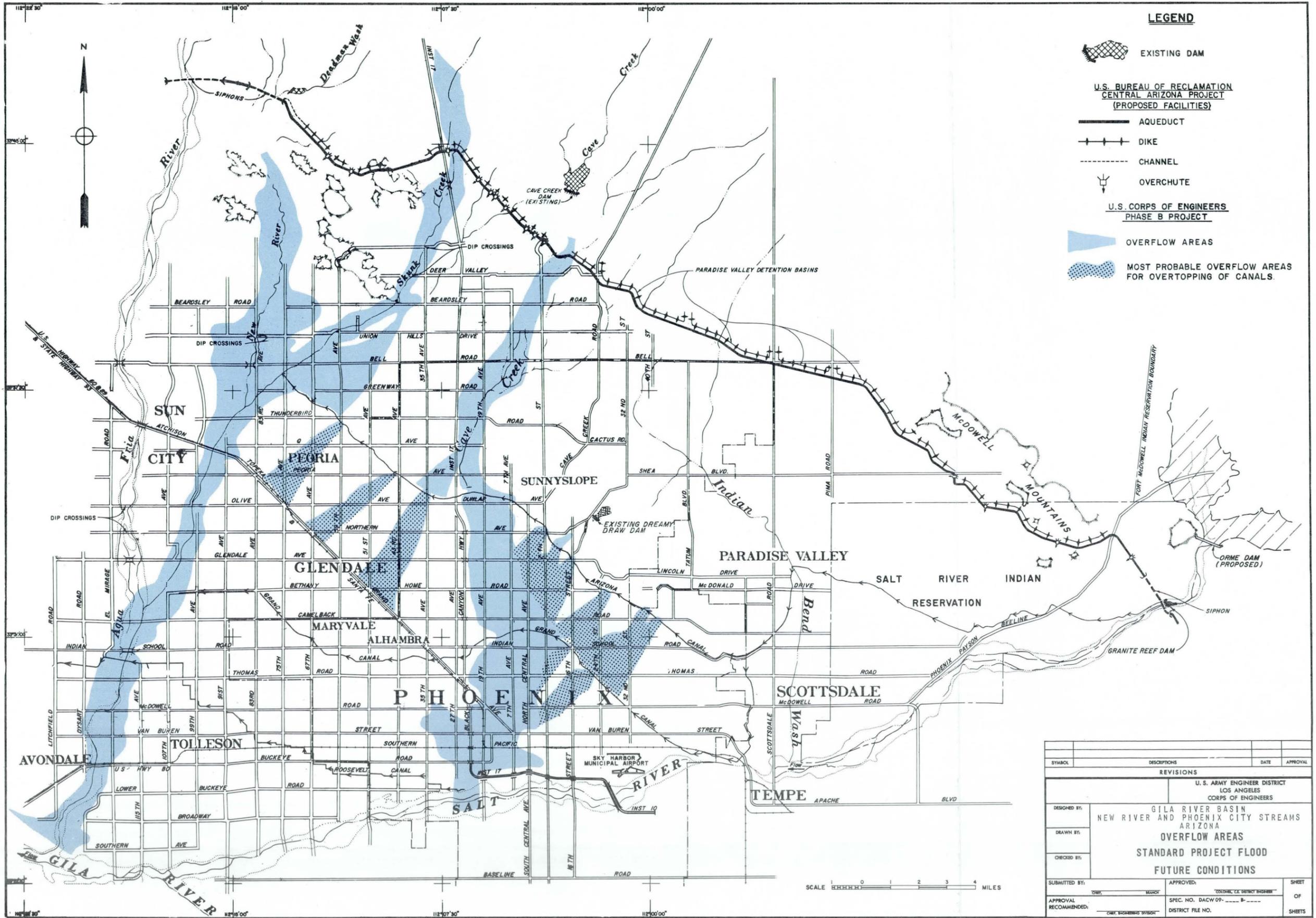


JUNE 22, 1972 - Young girls braving knee deep water at intersection of 3rd Ave. and Roosevelt St.

STANDARD PROJECT FLOOD

Standard Project Flood (SPF) is the name given to the flood which would be caused by the occurrence of the most severe storm of record in an area. It would be exceeded only on rare occasions. Such a flood could occur in the Phoenix area if a storm equivalent in magnitude to the largest storm on record in the general region were to center over the drainage area when ground conditions were conducive to a high rate of runoff. The estimated flood from such a storm represents a reasonable upper limit of the flood producing potential of that part of the basin.

Two types of standard project flood are considered in large comprehensive flood control projects such as this, i.e., local and general. Meteorological studies show that the thunderstorm of August 1954 that occurred over Queen Creek, about 50 miles southeast of Phoenix, could occur in the Phoenix area, and therefore, that storm was used as the basis for determining the local type of SPF. The general summer storm of 3-7 September 1970, which brought very heavy precipitation to all of central and northeastern Arizona, as well as parts of other states, was the storm used in determining the general type of SPF.



LEGEND

-  EXISTING DAM
- U.S. BUREAU OF RECLAMATION
CENTRAL ARIZONA PROJECT
(PROPOSED FACILITIES)**
-  AQUEDUCT
-  DIKE
-  CHANNEL
-  OVERCHUTE
- U.S. CORPS OF ENGINEERS
PHASE B PROJECT**
-  OVERFLOW AREAS
-  MOST PROBABLE OVERFLOW AREAS FOR OVERTOPPING OF CANALS.

SYMBOL	DESCRIPTIONS	DATE	APPROVAL
REVISIONS			
U. S. ARMY ENGINEER DISTRICT LOS ANGELES CORPS OF ENGINEERS			
DESIGNED BY:	GILA RIVER BASIN NEW RIVER AND PHOENIX CITY STREAMS ARIZONA OVERFLOW AREAS STANDARD PROJECT FLOOD FUTURE CONDITIONS		
DRAWN BY:			
CHECKED BY:			
SUBMITTED BY:	APPROVED:	SHEET	
APPROVAL RECOMMENDED:	SPEC. NO. DACW 09- DISTRICT FILE NO.	OF SHEETS	

SCALE 1 0 1 2 3 4 MILES

EXISTING IMPROVEMENTS

The system of irrigation canals, around which the various communities have grown, have been operated as emergency flood control channels in the past. However, these canals are obviously limited in their ability to carry large quantities of water because they are generally full of irrigation water at the time storms hit. Even if they were dry at the time the storm occurred they are not designed to carry flood flows. The canals' maximum capacity is upstream rather than downstream; exactly the reverse of what is required for flood control purposes. The Arizona and Grand Canals frequently overflow their banks during floods. During the flood of June 1972, the banks of both these canals were either breached or overtopped at several locations, resulting in costly damages downstream.

As a result of a large flood along Cave Creek in 1921, when the State Capitol was flooded, the City of Phoenix, Maricopa County, and the State of Arizona, in cooperation with various private interests, constructed Cave Creek Dam about 12 miles north of the Arizona Canal in 1923. It is, however, inadequate to control even the 50-year frequency flood and would be removed if Cave Buttes Dam is constructed.

Lake Pleasant Reservoir (Waddell Dam) was constructed in 1927 on the Agua Fria River about 25 miles upstream from the confluence with New River. The 157,000 acre-foot reservoir, constructed by the Maricopa County Municipal Water Conservation District No. 1, is used for water conservation but provides incidental flood control.

Dreamy Draw Dam, which was completed in August 1973, is a small part of the Phase B flood control project. It reduces flows along Dreamy Draw Wash.

PROPOSED CENTRAL ARIZONA PROJECT

The Central Arizona Project (CAP) is an authorized project under the jurisdiction of the U.S. Bureau of Reclamation which would provide Colorado River water to the southeastern portion of Arizona. The proposed CAP facility in the Phase B project area, the Granite Reef Aqueduct, will be protected by an upstream dike several feet high with cross drainage structures (culverts and overchutes) designed to pass a 50-year flood. Since the amount of storage behind the aqueduct dike would be small, the influence of the dike was not considered in the computation of standard project floods. However, to the east, in the Paradise Valley reach of the CAP, the Bureau is planning to construct a dike system capable of storing all floodwaters emanating from upstream. Construction of this CAP facility would obviate the need for the Union Hills Diversion Channel, a unit of the authorized flood control project.

FORMULATION OF ALTERNATIVE PLANS

The current formulation study includes a review of the authorized plan and development of alternative plans to finally arrive at a plan that will meet all (or most) of the prerequisites necessary to a major flood control project. The major considerations in such a plan formulation study, in addition to providing flood protection, are (a) the environmental and social impacts, (b) the impacts of the new State of Arizona law, passed May 3, 1973, which requires flood plain management along watercourses and the Flood Disaster Protection Act of 1973, (c) current and projected urbanization trends, (d) the potential for recreational development to be incorporated into the flood control project, and (e) economic justification.

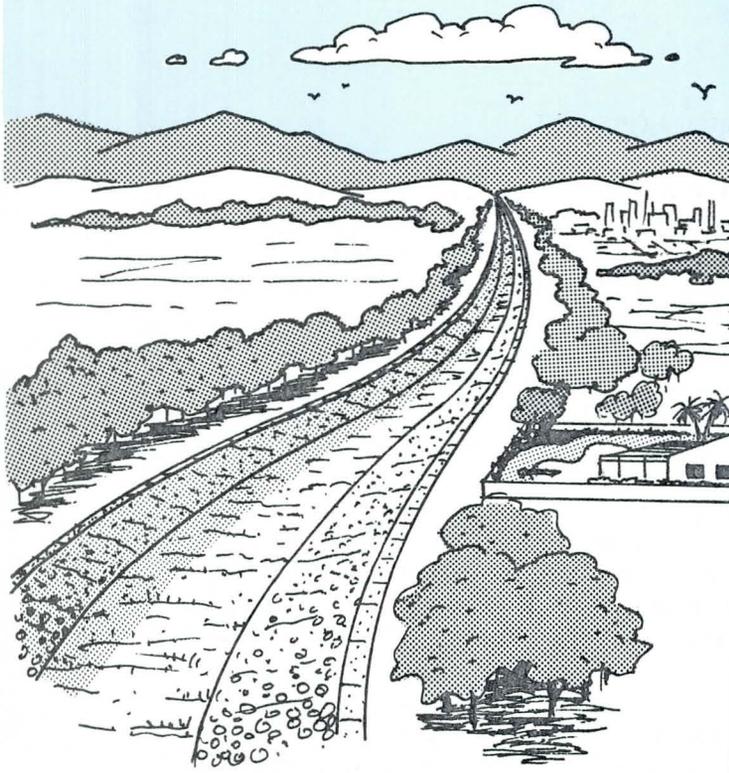
The formulation of alternative plans was accomplished in two stages. First, alternative damsites were analysed to determine the best site; then alternative plans for providing flood protection to the Phoenix area were developed. Five alternatives that were considered to be the most feasible are briefly described on the following pages. They are (1) No further action; (2) Combination of dams and channels; (3) Dams only; (4) Channels only; and (5) A combination of structural and nonstructural measures.

During plan formulation, studies were made of flowage easements and channelization of the various streams in the project area and channelization of the Arizona Canal diversion channel. The primary types of channels studied were concrete-rectangular, concrete-trapezoidal, and earth-bottom-trapezoidal with rock side slopes. A table indicating the rights-of-way requirements and costs and a sketch of each type of channel appears on the following pages. The type of channel selected for each reach was based on cost, environmental and social impacts, and recreation potential. The impacts and recreation potential are outlined in the discussion of alternatives.

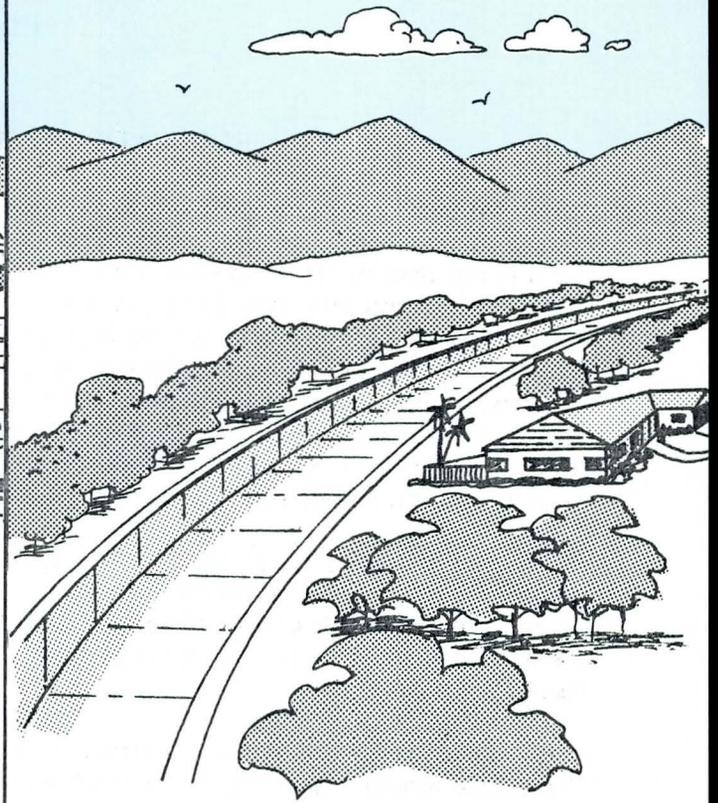
TABLE 1

Cost Data for Types of Channels by Reach

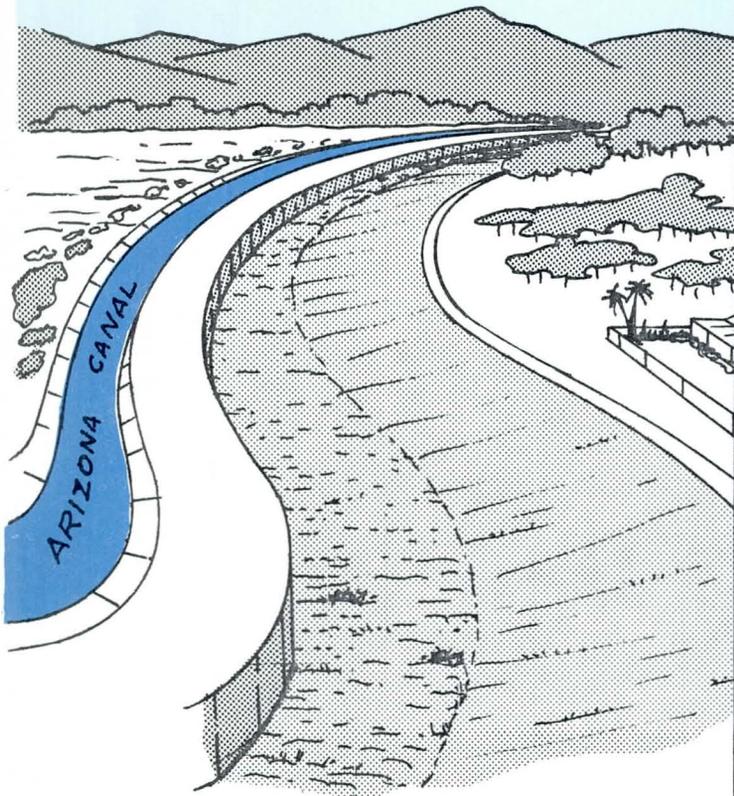
Channel	Type of Channel	Rights-of-way width (feet)	Total Cost (\$1,000)	
			Federal	Non-Federal
Cave Creek Diversion	Concrete trapezoidal	90 to 100	3,300	2,600
	Earth bottom trapezoidal with revetted side slopes	120 to 160	1,800	6,100
Skunk Creek	Concrete trapezoidal	100 to 160	6,000	2,700
	Earth bottom trapezoidal with revetted side slopes	130 to 600	3,900	5,200
	Flowage easement	400 to 3,500	0	1,200
New River	Earth bottom trapezoidal with revetted side slopes	600	9,600	24,700
	Flowage easement	250 to 4,500	0	1,170
Agua Fria River	Earth bottom trapezoidal with revetted side slopes	500	10,800	10,500
	Flowage easement	3,500 to 8,500	0	1,260
Arizona Canal Diversion: 40th St. to Dreamy Draw	Concrete rectangular	55 to 65	14,200	6,100
	Concrete trapezoidal	105 to 115	5,900	12,700
	Earth bottom trapezoidal with revetted side slopes	140 to 160	5,700	18,300
Dreamy Draw to 51st Ave.	Concrete rectangular	70 to 140	33,000	25,000
	Concrete trapezoidal	120 to 195	15,600	39,700
	Earth bottom trapezoidal with revetted side slopes	175 to 320	17,000	66,600
	Concrete wall and swale	240 to 600	7,900	142,000
51st Ave. to Skunk Crk.	Concrete rectangular	130	19,800	7,800
	Concrete trapezoidal	200	10,100	11,500
	Earth bottom trapezoidal with revetted side slopes	340	12,000	21,300



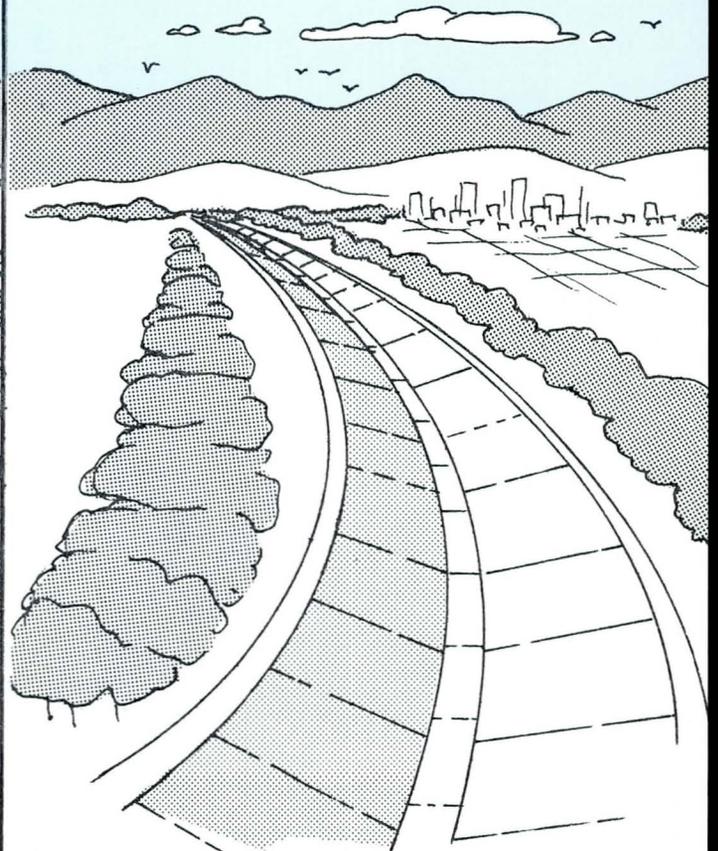
**EARTH BOTTOM
TRAPEZOIDAL CHANNEL**



**CONCRETE RECTANGULAR
CHANNEL**



**CONCRETE WALL,
GRASS SLOPE**



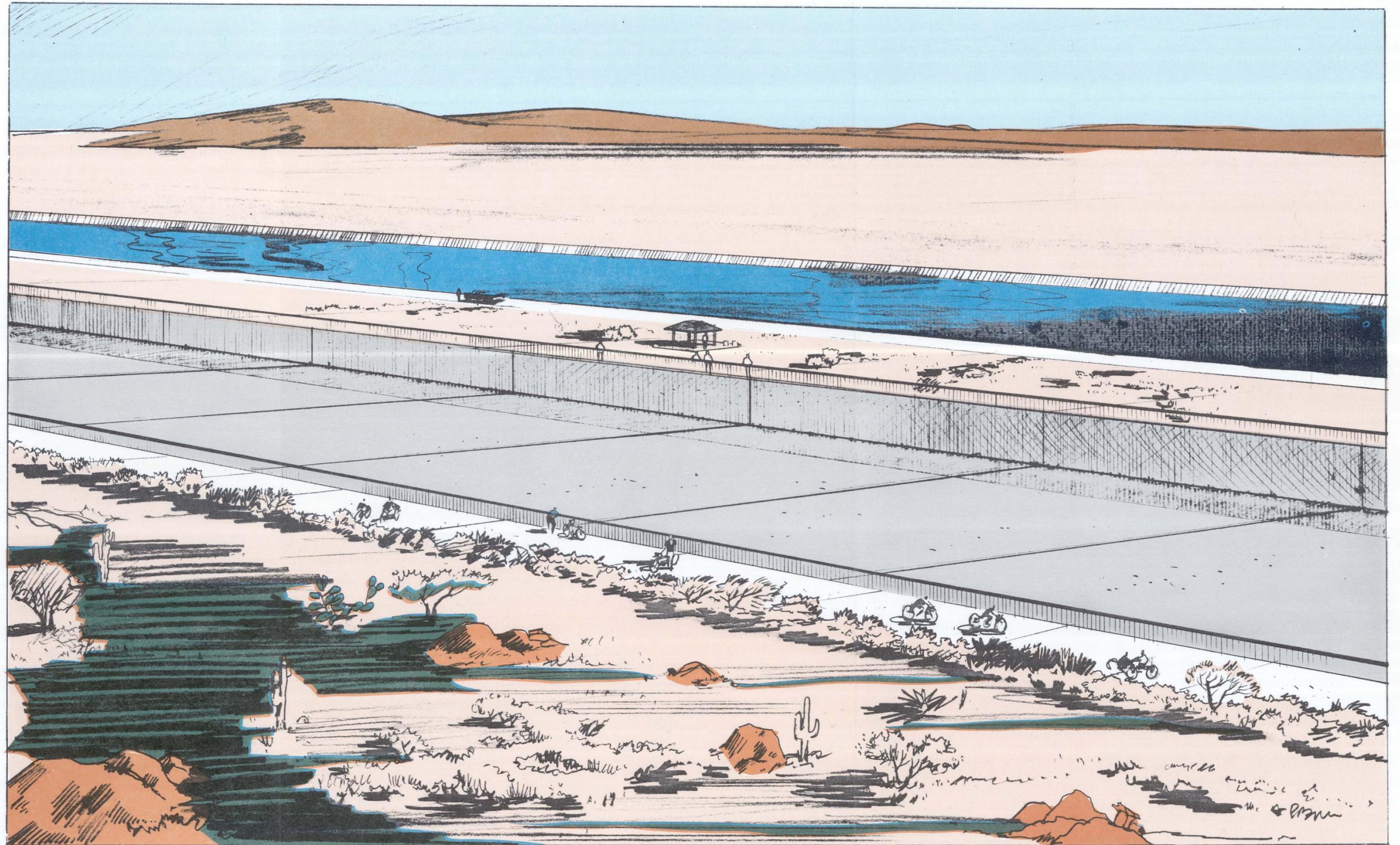
**CONCRETE
TRAPEZOIDAL**

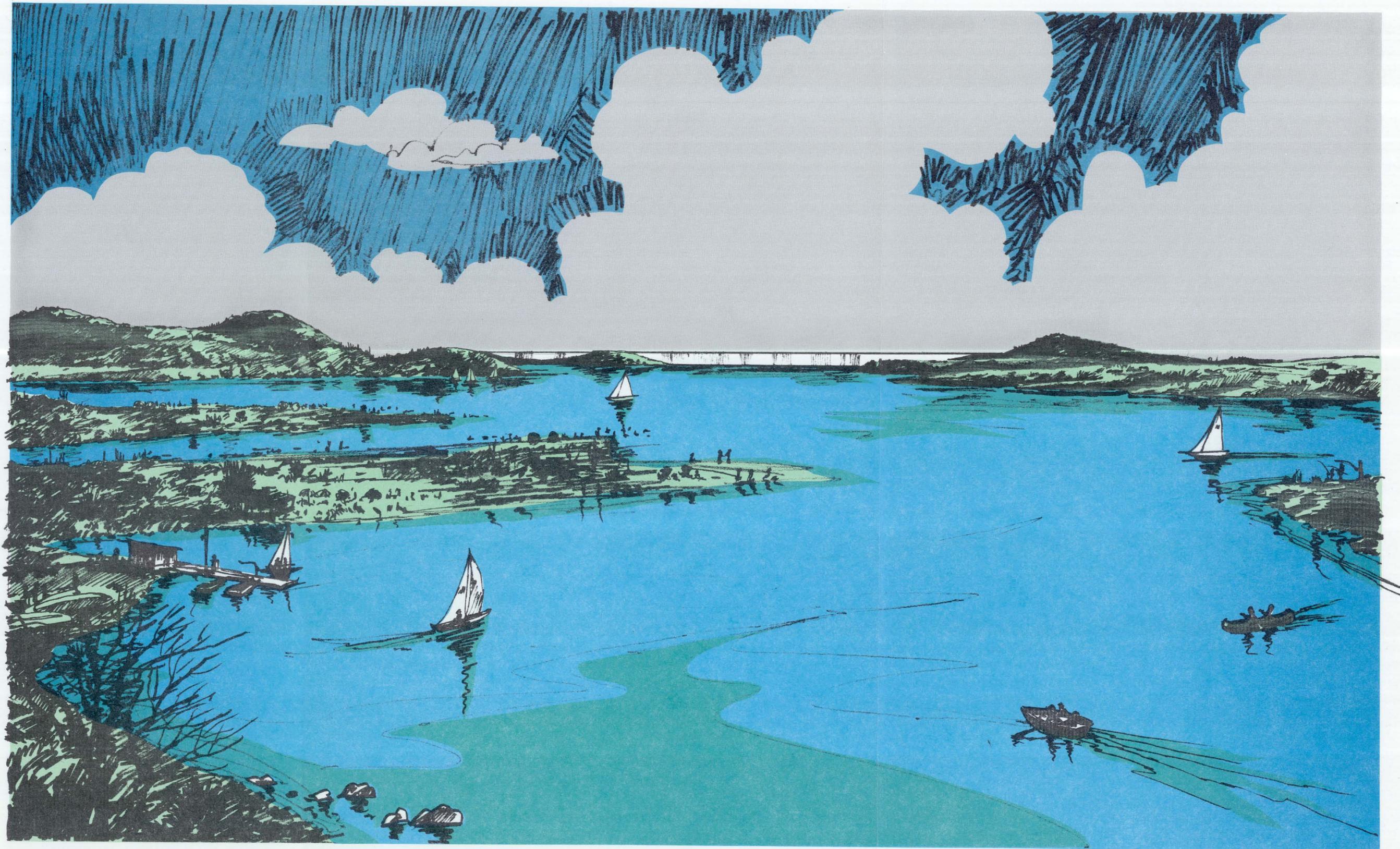
RECREATIONAL DEVELOPMENT

Recreational development is being considered as a feature of the project. A multi-agency recreation task force, formed in September 1973, has been studying alternative plans for recreational development associated with flood control in the Phoenix metropolitan area. State, county and city task force members agreed that water-based recreation should be developed at all three damsites, and hiking and riding trails should be provided along the channels. After studying several lake sizes at each damsite and comparing costs, esthetic qualities, recreation potential and benefits, we are considering lakes of from 300 to 620 surface acre size behind the three dams. The final decision to provide recreational lakes is dependent upon the ultimate plan of protection selected, adequate water supply and a satisfactory solution to water quality problems.

Activities provided for at each of the recreational lakes could include fishing, non-power boating, swimming, picnicking and camping. Trail systems in the reservoir areas would be designed to coordinate with existing and proposed county trails. There is a major archeological site near the Adobe Dam site that could be protected and utilized for educational purposes as part of the recreation plan.

Hiking, jogging, bicycle and equestrian trails could be developed along the channel reaches. These trails would augment and enhance the existing Sun Circle Trail System. Rest areas with comfort facilities, picnic tables, watering troughs and shade trees would be developed at appropriate intervals.





ENVIRONMENTAL AND SOCIAL CONSIDERATIONS

Studies have included an analysis of the environmental and social considerations and have identified possible measures to minimize or mitigate adverse effects. The Corps has actively participated in a dialogue with responsible Federal, State and local authorities, as well as concerned individuals and conservation groups to identify areas of concern.

The potential environmental and social impacts resulting from project construction are summarized below:

a. Open space, esthetics, viewsapes and natural landscapes would be destroyed or altered by project features. Landscaping, preservation of recreational open space and structural modifications to make project features less conspicuous are being considered as mitigation.

b. Riparian vegetation and wildlife dependent upon this habitat would be destroyed or impaired by project construction. Mitigation by acquisition of lands for wildlife purposes is being considered.

c. Some archeological sites would be destroyed by construction as well as subjected to periodic inundation; however, the most significant sites would not be affected. The archeological sites that would be destroyed would be studied by the National Park Service before project construction.

d. Both dams and channels would alter the patterns of ground water percolation and ground water is a significant resource in this arid region. Surface drainage patterns and sediment transport systems would also be affected. Water spreading facilities as well as "earth bottom" channels could be provided to mitigate impacts on ground water.

e. The construction of dams and channels, especially the Arizona Canal diversion channel, would require relocation of homes, businesses and utilities, and would disrupt community cohesion.

f. Local transportation systems, including bridges and streets, would require relocation.

g. A flood control project would reduce the fear of flooding, would reduce canal overtopping and flooding, would interrupt traffic flow during construction at street crossings, thereby disrupting the social and economic patterns of the area for a time, would reduce the hazards to health, and would improve community morale.



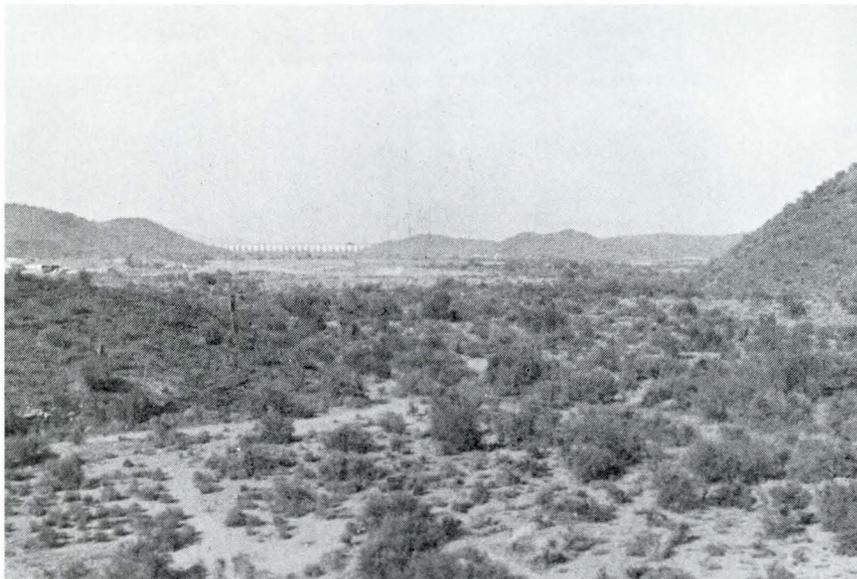
City park along the Arizona Canal, west of Central Avenue, which would be removed by the Arizona Canal diversion channel.



Skunk Creek near Greenway Road and 83rd Avenue. This reach would be affected by the project.



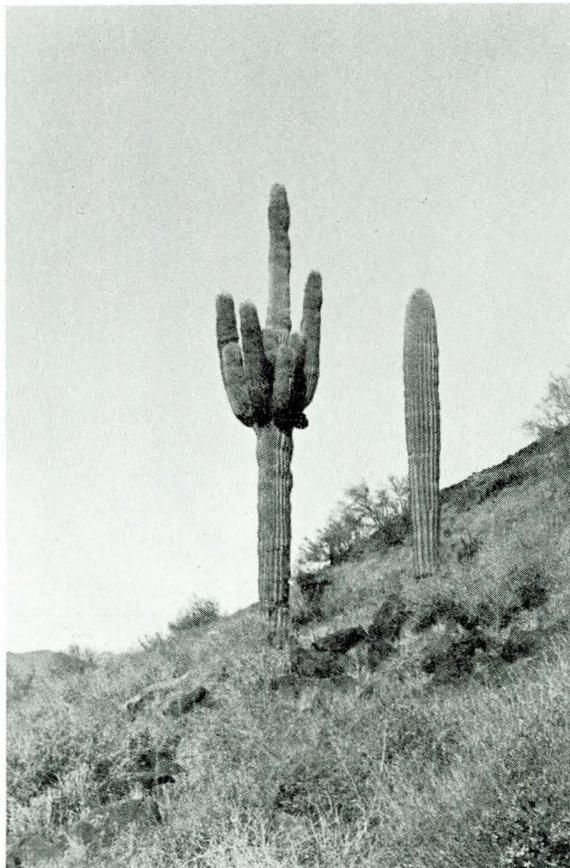
Remains of prehistoric rock wall built by Indians atop hill overlooking Cave Creek. This site could be preserved as an archeological education park.



View of riparian vegetation along Cave Creek, below the Cave Creek Dam, which would be affected by the project.



Example of Inidan petroglyphs in the vicinity of Adobe Dam which would be affected by the project.



Saguaro, Little Leaf Palo Verde, Brittle Bush Bursage and annual and other perennial grasses on the east abutment of Adobe Dam.

ALTERNATIVE 1

NO FURTHER ACTION

ALTERNATIVE 1
NO FURTHER ACTION

Dreamy Draw Dam, a feature of this project, was completed in August 1973. No additional features would be constructed with Federal funds under the authority of the Flood Control Act of 1965. Management of the flood plains would be accomplished by local governments through implementation of the new State flood plain management law and other pertinent laws and regulations. Development within the flood plains would be restricted within the estimated 100-year flood line; however, existing development within these flood plains would still be subject to flooding. Floods larger than the 100-year flood would continue to cause damage. Some of the personal loss from flood damages might be lessened through a flood insurance program. However, this is aid only after damages have occurred. The other problems associated with floods, i.e., disruption of communications, transportation and utilities, loss of income, and threat to life and health, would continue.

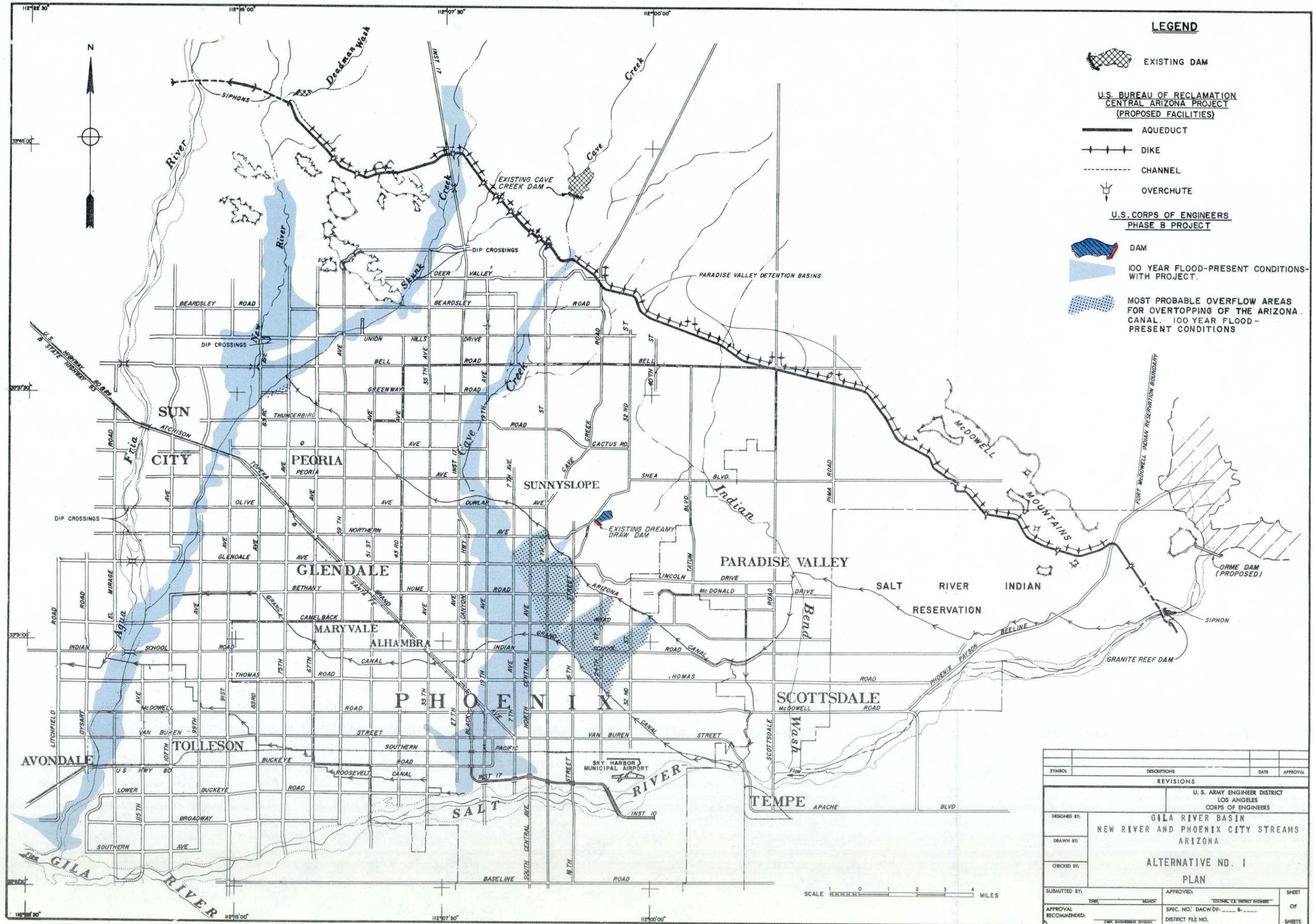
This alternative could be valuable in promoting the maintenance of the existing environment. However, it cannot guarantee that the status quo will remain, as it does not preclude local interests from constructing flood control improvements or performing work which would satisfy local requirements for protection of development within the flood plains.

Potential environmental and social impacts include: (a) continued flood threat; (b) no project associated recreational development; (c) no esthetic impairment of the landscape; (d) no destruction of vegetation and wildlife habitat; (e) no alteration of ground water recharge; (f) no family relocations; (g) no destruction of archeological sites; and (h) no disruption of mineral extraction operations.

ECONOMIC SUMMARY*
(3-1/4 percent — 100 Years)

	Federal	First Costs Non-Federal	Total
Flood Control	\$600	\$62	\$662
Recreation	0	0	0
Total Project Cost	\$600	\$62	\$662
Equivalent Annual Benefits (Flood Control)			\$120
Equivalent Annual Nonprevented Damages			\$41,800
Benefit-Cost Ratio (Flood Control)			4.6

* in thousands of dollars



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U. S. ARMY ENGINEER DISTRICT LOS ANGELES CORPS OF ENGINEERS			
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ALTERNATIVE 2

DAMS AND CHANNELS

ALTERNATIVE 2
DAMS AND CHANNELS

This alternative is a modification of the authorized plan and differs from it as follows: (a) the recommendation for construction of the Union Hills diversion channel east of Cave Creek is withdrawn; (b) Cave Creek channel and Union Hills diversion channel west of Cave Creek were realigned to become Cave Creek diversion channel; (c) the Arizona Canal diversion channel is extended to 40th Street; (d) the recommended site of Adobe Dam is approximately 4 miles south of the authorized site; (e) the recommended site of Cave Buttes Dam is approximately 1-1/2 miles north of the authorized site; (f) the downstream end of the Agua Fria River was realigned and extended into the Gila River floodplain; and (g) recreation development was included as a project purpose.

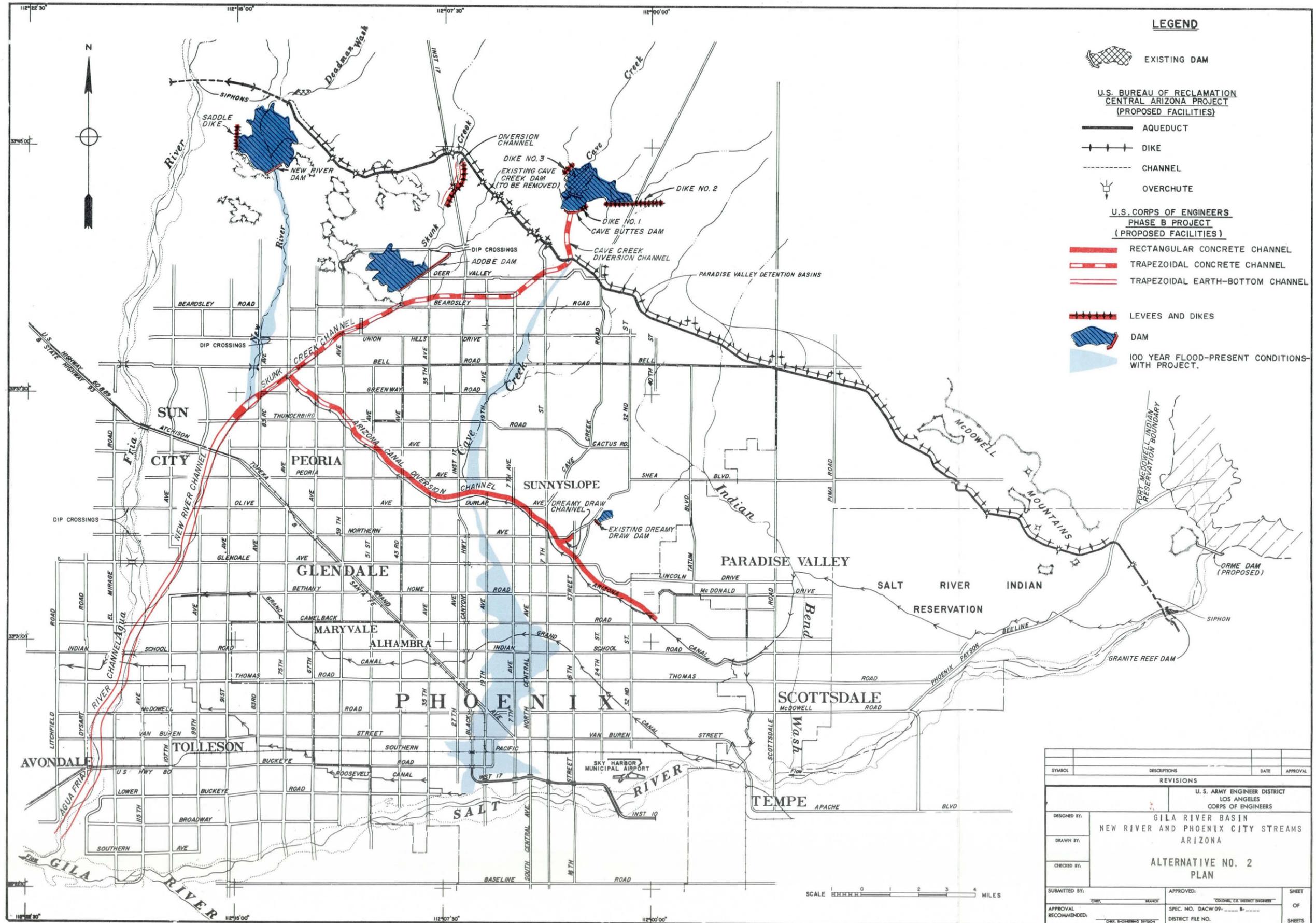
Alternative 2 provides flood protection using structural measures. It would insure that present and future development of the flood plains would be provided with a high degree of flood protection; however, it would have major impacts on some important aspects of the existing environment – especially the wildlife habitat along the New and Agua Fria Rivers and the Arizona Canal, and water percolation along the natural water courses.

Potential environmental and social impacts include: (a) esthetic impairment of the landscape; (b) destruction of vegetation and wildlife habitat; (c) increased duration of flooding at dip crossings because of dams; (d) increased traffic density near regional recreational facilities; (e) relocation of families and businesses; (f) destruction of some archeological sites after recovery studies are completed, while preserving other sites as archeological education sites; (g) elimination of some mineral extraction operations; (h) barrier to movement of wildlife; (i) flood protection; (j) introduction of aquatic habitat; (k) recreational development; (l) preservation of open space in dam and channel areas; (m) increased ground water recharge resulting from increased duration of flows because of the dams; and (n) reduced fear of flooding and improved community morale.

ECONOMIC SUMMARY*
(3-1/4 percent -- 100 Years)

	Federal	First Costs Non-Federal	Total
Flood Control	\$115,000	\$101,000	\$216,000
Recreation	9,700	9,700	19,400
Total Project Cost	\$124,700	\$110,700	\$235,400
Equivalent Annual Benefits (Flood Control)			\$35,900
Equivalent Annual Nonprevented Damages			\$6,200
Benefit-Cost Ratio (Flood Control)			4.3

* in thousands of dollars



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APPROVAL RECOMMENDED:	SPEC. NO. DACW 09-	DISTRICT FILE NO.	OF SHEETS

ALTERNATIVE 3

DAMS ONLY

ALTERNATIVE 3
DAMS ONLY

Under this alternative, only Cave Buttes Dam would be constructed in addition to the already existing Dreamy Draw Dam. The dam would have a gated outlet and the outflow would follow the natural Cave Creek channel to the Arizona Canal. Management of the flood plains would be accomplished in the same manner as in Alternative 1, since there would be no structural channelization of any watercourse. Under this alternative, Adobe and New River Dams would not be constructed because they would not be economically justified. Although this alternative would reduce flood flows below Cave Buttes Dam, nonprevented damages would be great because of large residual floodflows.

Potential environmental and social impacts include: (a) esthetic impairment of the landscape at Cave Buttes Dam; (b) destruction of vegetation and wildlife habitat at the damsite; (c) alteration of ground water recharge; (d) increased traffic density near regional recreational facilities; (e) destruction of some archeological sites after recovery studies are completed, while preserving other sites as archeological education sites; (f) elimination of some mineral extraction operations; (g) flood protection from storms centered above Cave Buttes Dam; (h) preservation of riparian vegetation; (i) introduction of aquatic habitat; (j) recreational development; (k) preservation of open space at dam areas; (l) no relocation of families and businesses; (m) increased ground water recharge resulting from increased duration of flows because of the dams; and (n) reduced fear of flooding and improved community morale.

ECONOMIC SUMMARY*
(3-1/4 percent -- 100 Years)

	Federal	First Costs Non-Federal	Total
Flood Control	\$12,600	\$4,800	\$17,400
Recreation	1,600	1,600	3,200
Total Project Cost	\$14,200	\$6,400	\$20,600
Equivalent Annual Benefits (Flood Control)			\$10,400
Equivalent Annual Nonprevented Damages			\$31,700
Benefit-Cost Ratio (Flood Control)			14.1

* in thousands of dollars

ALTERNATIVE 4

CHANNELS ONLY

ALTERNATIVE 4
CHANNELS ONLY

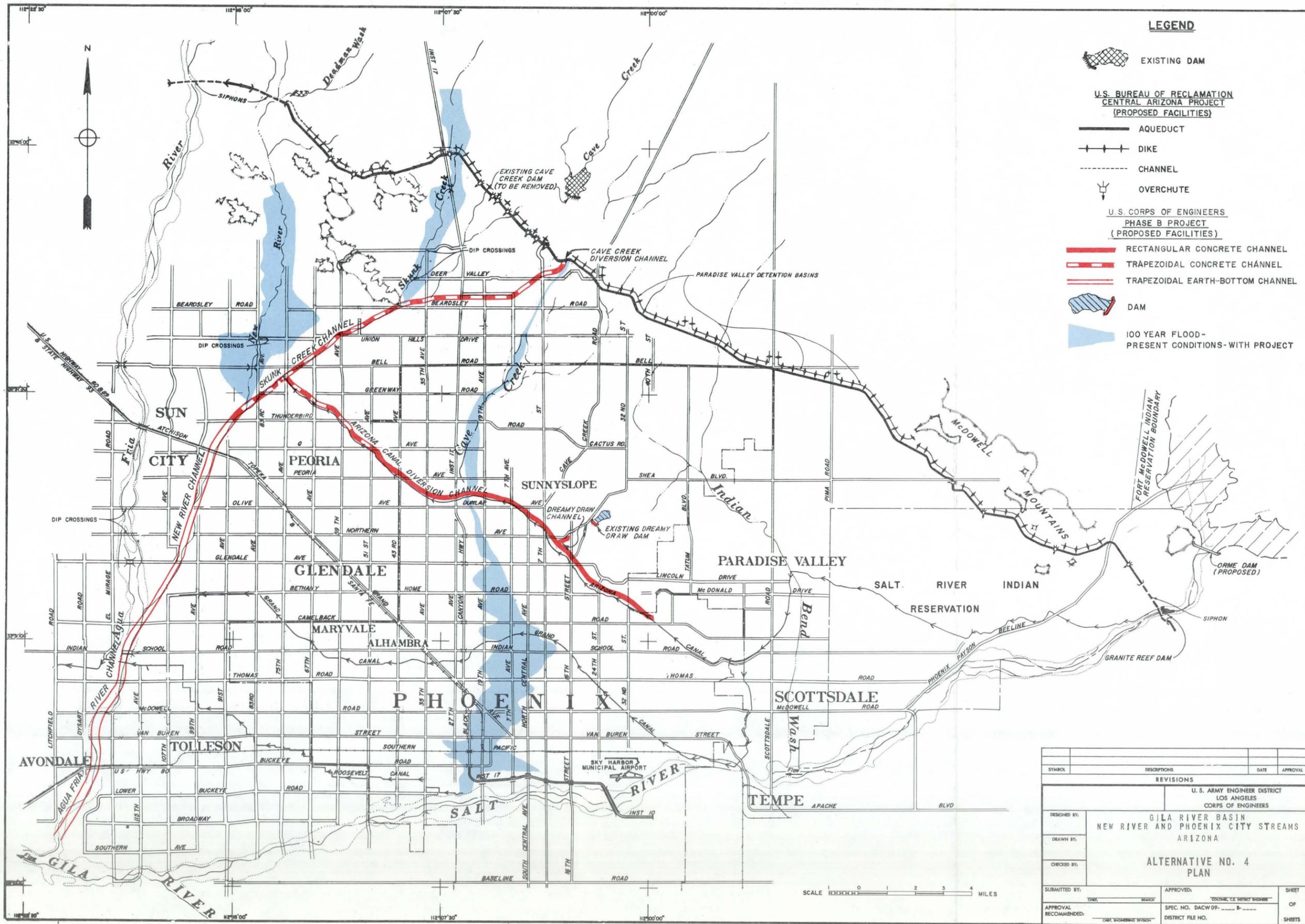
This alternative would consist of the same channels described under Alternative 2. They would, however, be larger to convey greater peak discharges because of no dams. Nearly the same degree of flood protection as the authorized plan would be provided and all of the adverse environmental impacts from the construction of dams would be eliminated. However, since the Cave Creek, Skunk Creek, New River, and Agua Fria River channels would be considerably larger, they would make this plan much more costly than the combination dams and channels plan and would require the relocation of many more homes and businesses.

Potential environmental and social impacts for this alternative include: (a) esthetic impairment of the landscape; (b) destruction of vegetation and wildlife habitat; (c) alteration of ground water recharge; (d) relocation of families and businesses; (e) no preservation of open space; (f) barrier to movement of wildlife; (g) flood protection; (h) recreational development; (i) no archeological sites destroyed; (j) increased flow in the Gila River downstream of the Agua Fria River confluence; and (k) reduced fear of flooding and improved community morale.

ECONOMIC SUMMARY*
(3-1/4 percent — 100 Years)

	Federal	First Costs Non-Federal	Total
Flood Control	\$121,000	\$132,000	\$253,000
Recreation	800	800	1,600
Total Project Cost	\$121,800	\$132,800	\$254,600
Equivalent Annual Benefits (Flood Control)			\$35,800
Equivalent Annual Nonprevented Damages			\$6,300
Benefit-Cost Ratio (Flood Control)			4.0

* in thousands of dollars



SYMBOL	DESCRIPTIONS	DATE	APPROVAL
REVISIONS			
U. S. ARMY ENGINEER DISTRICT LOS ANGELES CORPS OF ENGINEERS			
DESIGNED BY:	GILA RIVER BASIN NEW RIVER AND PHOENIX CITY STREAMS ARIZONA		
DRAWN BY:	ALTERNATIVE NO. 4 PLAN		
CHECKED BY:			
SUBMITTED BY:	APPROVED:		
APPROVAL RECOMMENDED:	SPEC. NO. DACW 09-		
	DISTRICT FILE NO.		

ALTERNATIVE 5A

STRUCTURAL AND NONSTRUCTURAL MEASURES

ALTERNATIVE 5a
STRUCTURAL AND NONSTRUCTURAL MEASURES

This alternative combines structural and nonstructural measures to provide flood protection to the urbanized areas of Phoenix along Cave Creek and south of the Arizona Canal while maintaining the natural floodway along Skunk Creek, New River, and Agua Fria River. Under this plan, local interests would acquire flowage easements and provide assurances that the floodways would be maintained through flood plain zoning.

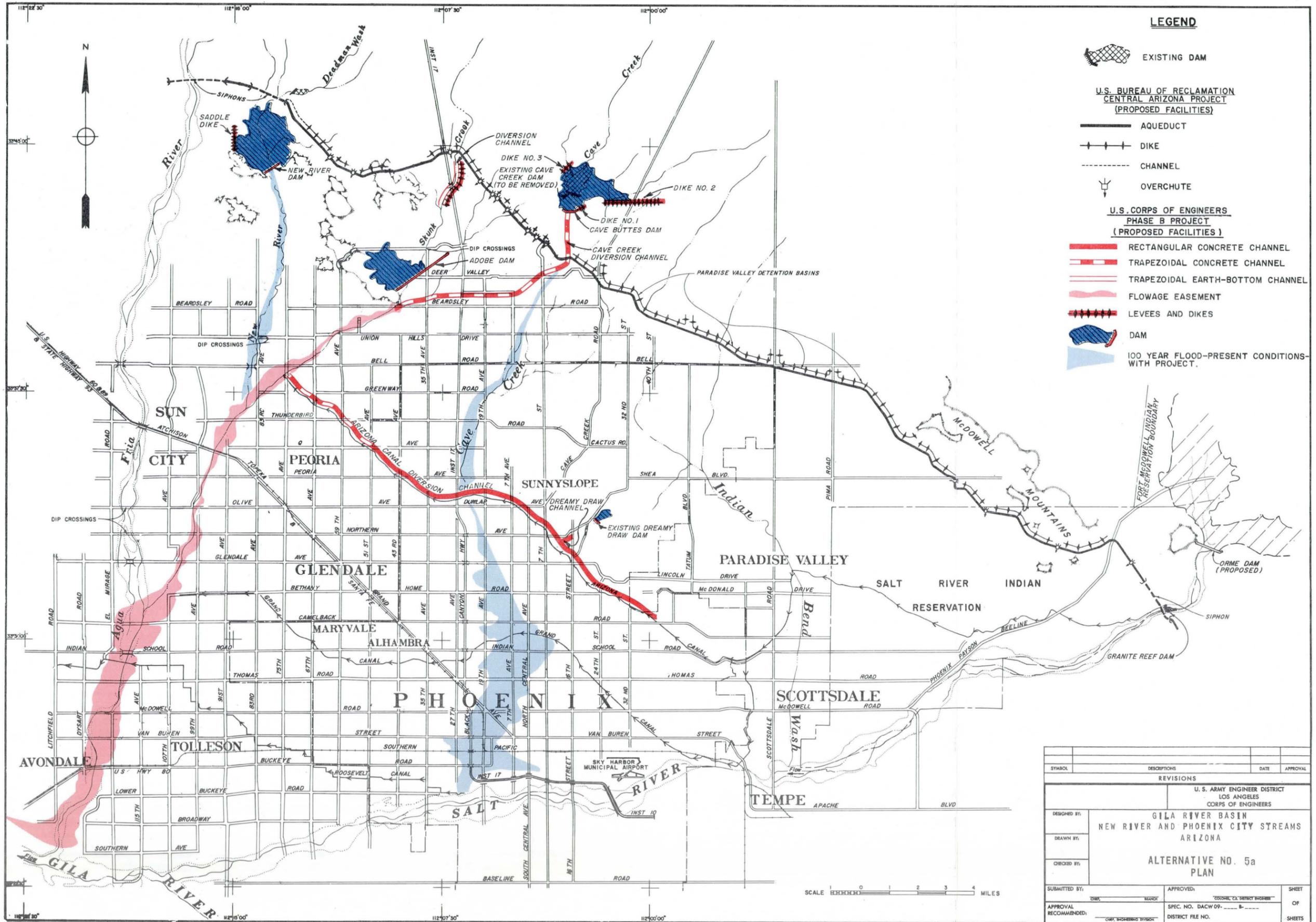
Alternative 5 is divided into two plans: 5a and 5b. Under Alternative 5a, Cave Buttes, Adobe, and New River Dams would be built as well as the Arizona Canal and Cave Creek diversion channels. The other streams - Skunk Creek, New River and Agua Fria River - would remain natural. The presence of Adobe and New River Dams would reduce the floodway width downstream. Flowage easements would be required for Skunk Creek and the New and Agua Fria Rivers.

Potential environmental impacts include: (a) esthetic impairment of the landscape; (b) destruction of vegetation and wildlife habitat; (c) alteration of ground water recharge; (d) increased traffic density near regional recreational developments; (e) relocation of families and businesses; (f) destruction of some archeological sites after recovery studies are completed, while preserving other sites as archeological education sites; (g) elimination of mineral extraction operations; (h) barrier to movement of wildlife; (i) increased duration of flooding at dip crossings because of dams; (j) flood control; (k) introduction of aquatic habitat; (l) recreational development; (m) preservation of open space in dam and channel areas; (n) preservation of riparian vegetation; (o) increased ground water recharge resulting from increased duration of flows because of the dams; and (p) reduced fear of flooding and improved community morale.

ECONOMIC SUMMARY*
(3-1/4 percent - 100 Years)

	Federal	First Costs Non-Federal	Total
Flood Control	\$88,000	\$66,000	\$154,000
Recreation	9,500	9,500	19,000
Total Project Cost	\$97,500	\$75,500	\$173,000
Equivalent Annual Benefits (Flood Control)			\$35,900
Equivalent Annual Nonprevented Damages			\$6,200
Benefit-Cost Ratio (Flood Control)			5.9

* in thousands of dollars



LEGEND

- EXISTING DAM
- U.S. BUREAU OF RECLAMATION
CENTRAL ARIZONA PROJECT
(PROPOSED FACILITIES)**
- AQUEDUCT
- DIKE
- CHANNEL
- OVERCHUTE
- U.S. CORPS OF ENGINEERS
PHASE B PROJECT
(PROPOSED FACILITIES)**
- RECTANGULAR CONCRETE CHANNEL
- TRAPEZOIDAL CONCRETE CHANNEL
- TRAPEZOIDAL EARTH-BOTTOM CHANNEL
- FLOWAGE EASEMENT
- LEVEES AND DIKES
- DAM
- 100 YEAR FLOOD-PRESENT CONDITIONS WITH PROJECT.

SYMBOL	DESCRIPTIONS	DATE	APPROVAL
REVISIONS			
U. S. ARMY ENGINEER DISTRICT LOS ANGELES CORPS OF ENGINEERS			
DESIGNED BY:	GILA RIVER BASIN NEW RIVER AND PHOENIX CITY STREAMS ARIZONA		
DRAWN BY:	ALTERNATIVE No. 5a PLAN		
CHECKED BY:			
SUBMITTED BY:	APPROVED:	SHEET	
APPROVAL RECOMMENDED:	SPEC. NO. DACW 09-	OF	
	DISTRICT FILE NO.	SHEETS	



ALTERNATIVE 5B

STRUCTURAL AND NONSTRUCTURAL MEASURES

ALTERNATIVE 5b
STRUCTURAL AND NONSTRUCTURAL MEASURES

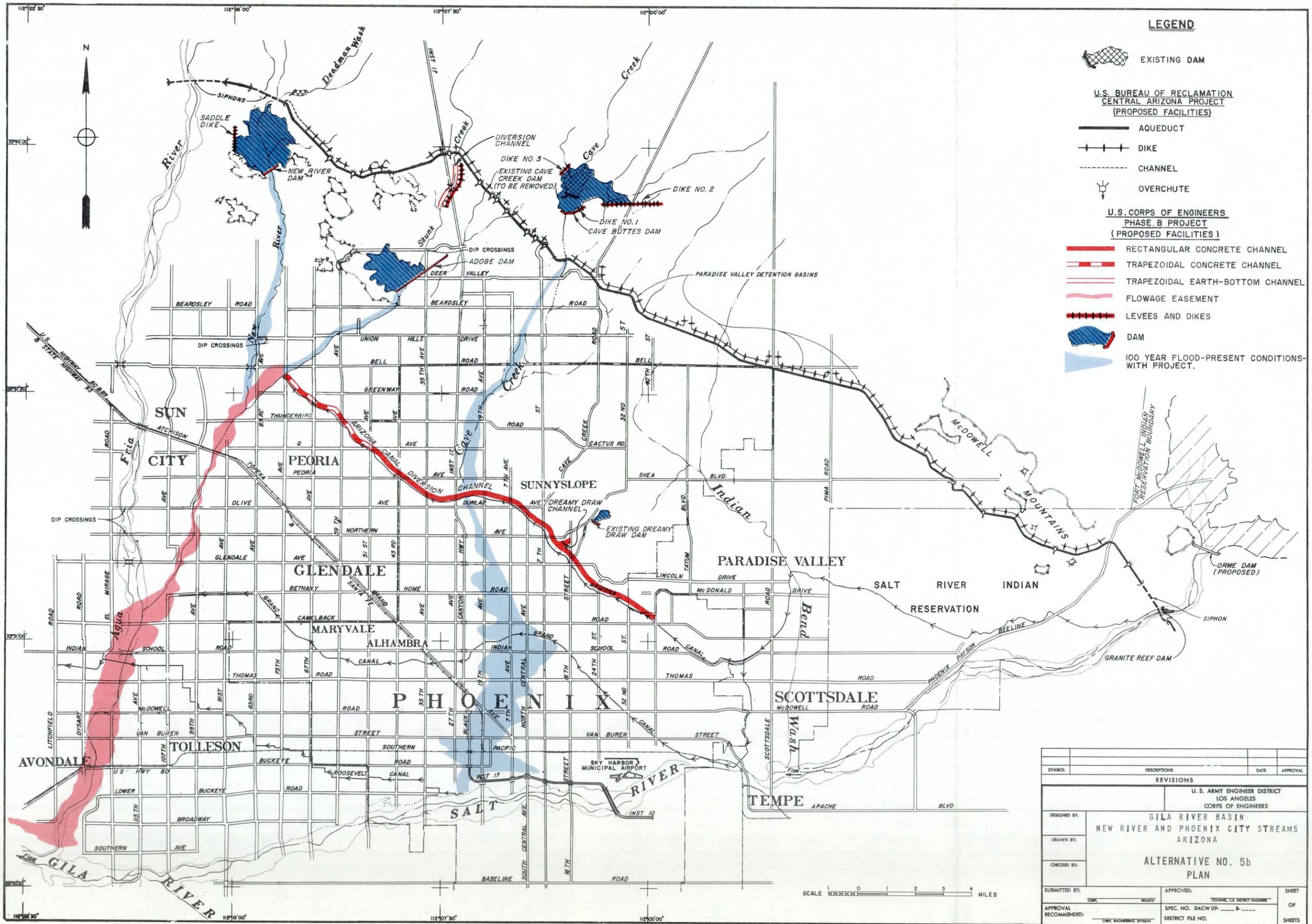
Alternative 5b is basically the same as 5a except that the Cave Creek diversion channel would be eliminated, thus removing the need for flowage easements along Skunk Creek. The outflow from Cave Buttes Dam would follow the natural Cave Creek to the Arizona Canal diversion channel. As in Alternative 5a, Skunk Creek, New River and Agua Fria River would remain natural.

Potential environmental and social impacts include: (a) esthetic impairment of the landscape; (b) destruction of vegetation and wildlife habitat; (c) alteration of ground water recharge; (d) increased traffic density at regional recreation facilities; (e) relocation of families and businesses; (f) destruction of some archeological sites after recovery studies are completed, while preserving other sites as archeological education sites; (g) elimination of mineral extraction operations; (h) barrier to movement of wildlife; (i) increased duration of flooding at dip crossings because of dams; (j) flood control; (k) introduction of aquatic habitat; (l) recreational development; (m) preservation of open space in dam and channel areas; (n) preservation of riparian vegetation; (o) increased ground water recharge resulting from increased duration of flows because of the dams; and (p) reduced fear of flooding and improved community morale.

ECONOMIC SUMMARY*
(3-1/4 percent – 100 Years)

	Federal	First Costs Non-Federal	Total
Flood Control	\$83,000	\$63,000	\$146,000
Recreation	9,400	9,400	18,800
Total Project Cost	\$92,400	\$72,400	\$164,800
Equivalent Annual Benefits (Flood Control)			\$35,900
Equivalent Annual Nonprevented Damages			\$6,200
Benefit-Cost Ratio (Flood Control)			6.3

* in thousands of dollars



LEGEND

- EXISTING DAM
- U.S. BUREAU OF RECLAMATION
CENTRAL ARIZONA PROJECT
(PROPOSED FACILITIES)**
- AQUEDUCT
- DIKE
- CHANNEL
- OVERCHUTE
- U.S. CORPS OF ENGINEERS
PHASE B PROJECT
(PROPOSED FACILITIES)**
- RECTANGULAR CONCRETE CHANNEL
- TRAPEZOIDAL CONCRETE CHANNEL
- TRAPEZOIDAL EARTH-BOTTOM CHANNEL
- FLOWAGE EASEMENT
- LEVEES AND DIKES
- DAM
- 100 YEAR FLOOD-PRESENT CONDITIONS WITH PROJECT.

SYMBOL	DESCRIPTIONS	DATE	APPROVAL
REVISIONS			
U. S. ARMY ENGINEER DISTRICT LOS ANGELES CORPS OF ENGINEERS			
DESIGNED BY:	GILA RIVER BASIN NEW RIVER AND PHOENIX CITY STREAMS ARIZONA		
DRAWN BY:	ALTERNATIVE NO. 5b PLAN		
CHECKED BY:			
SUBMITTED BY:	APPROVED:	SHEET	
APPROVAL RECOMMENDED:	SPEC. NO. DACW 09- _____ B- _____	OF	
	DISTRICT FILE NO. _____	SHEETS	

LOCAL COOPERATION
REQUIREMENTS
AND
CONCLUSIONS

LOCAL COOPERATION REQUIREMENTS

Some of the specific requirements of local cooperation for flood control projects are that they: (a) provide all lands, easements, and rights-of-way necessary for the construction of the project; (b) perform without cost to the United States all relocation of highways, bridges, and utilities; (c) hold and save the United States free from damages due to the construction works; (d) maintain and operate the project after completion; (e) prevent encroachment upon the existing or improved channels or within the detention basin areas that would reduce their flood-conveying or storage capacities; and (f) hold and save the United States free from all damages arising from water-rights claims resulting from construction, maintenance, and operation of the project. One-half of the separable costs allocated to the recreation function of the project must be borne by local interests. In addition, in the Phoenix area, local interests must contribute 2.3 percent of the cost of construction allocable to flood control because of land appreciation benefits.

CONCLUSIONS

As can readily be seen in Table 2 (Page 57), all of the alternative plans enjoy favorable benefit-to-cost (B/C) ratios, meaning each alternative is economically justified. However, many factors must be considered in the selection of a plan for implementation. Economic justification is one of the more important factors, but only one. The relatively low initial costs of plans 1 and 3 are attractive except that flood damages that may be incurred even with these alternatives (nonprevented damages) are very high in both instances. Alternatives 2, 4, 5a, and 5b all offer relatively low nonprevented damages, but the higher costs of both 2 and 4 when compared to 5a and 5b do not yield a proportionate increase in benefits. Alternatives 5a and 5b do not provide flood protection along Skunk Creek, New River, and the Agua Fria River but do lessen the adverse environmental impacts of channelization along these rivers.

Based on economic considerations and environmental impacts, 5b appears to be the most attractive alternative. Studies are underway to determine the degree to which adverse environmental and social effects of this alternative can be mitigated. Measures being investigated include wildlife conservation areas, warm water fisheries, recovery of archeological resources, development of archeological educational sites, contouring of dam embankments to lessen esthetic impact of the structures and use of native plants.

TABLE 2

Summary of Economic Data for Alternative Plans

Alternative No.		First Cost			Flood Control		Benefit/Cost (B/C) Ratio
		Flood Control	Recreation	Total Project	Equivalent Annual Benefits*	Equivalent Annual Nonprevented Damages*	
1	Federal	600	0	600			
	Non-Federal	62	0	62			
	Total	\$662	\$0	\$662	\$120	\$41,800	4.6
2	Federal	115,000	9,700	124,700			
	Non-Federal	101,000	9,700	110,700			
	Total	\$216,000	\$19,400	\$235,400	\$35,900	\$6,200	4.3
3	Federal	12,600	1,600	14,200			
	Non-Federal	4,800	1,600	6,400			
	Total	\$17,400	\$3,200	\$20,600	\$10,400	\$31,700	14.1
4	Federal	121,000	800	121,800			
	Non-Federal	132,000	800	132,800			
	Total	\$253,000	\$1,600	\$254,600	\$35,800	\$6,300	4.0
5a	Federal	88,000	9,500	97,500			
	Non-Federal	66,000	9,500	75,500			
	Total	\$154,000	\$19,000	\$173,000	\$35,900	\$6,200	5.9
5b	Federal	83,000	9,400	92,400			
	Non-Federal	63,000	9,400	72,400			
	Total	\$146,000	\$18,800	\$164,800	\$35,900	\$6,200	6.3

*in thousands of dollars