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1981 Report on SALT-GILA RIVER CLEARING GILLESPIE DAM ANALYSIS

Prepared For The

FLOOD CONTROL DISTRICT
OF MARICOPA COUNTY, ARIZONA

CONTRACT FCD 80-6

Registered Professional Engineer (Mechanical)
CERTIFICATE NO. 2501
DONALD R. FREISLER
Date Signed 5/21/81
ARIZONA, U.S.A.

JOHN CAROLLO ENGINEERS

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May 21, 1981
P02400.A0

Flood Control District
of Maricopa County
3335 West Durango Street
Phoenix, Arizona 85009

Attention: Mr. Richard Perrault
Project Manager

Gentlemen:

This Report preparation was authorized by contract dated June 2, 1980 and recommends dam modifications to achieve improved flood stage control and maintain diversion capability for irrigation.

We gratefully acknowledge the help of those many agencies and people who cooperated with us during the study period. Please call whenever we can provide help as your program develops.

Very truly yours,

JOHN CAROLLO ENGINEERS

Donald R. Preisler

Donald R. Preisler

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1981 REPORT

ON

SALT-GILA RIVER CLEARING
GILLESPIE DAM ANALYSIS

PREPARED FOR THE

FLOOD CONTROL DISTRICT OF MARICOPA COUNTY,
ARIZONA

Contract FED 80-6

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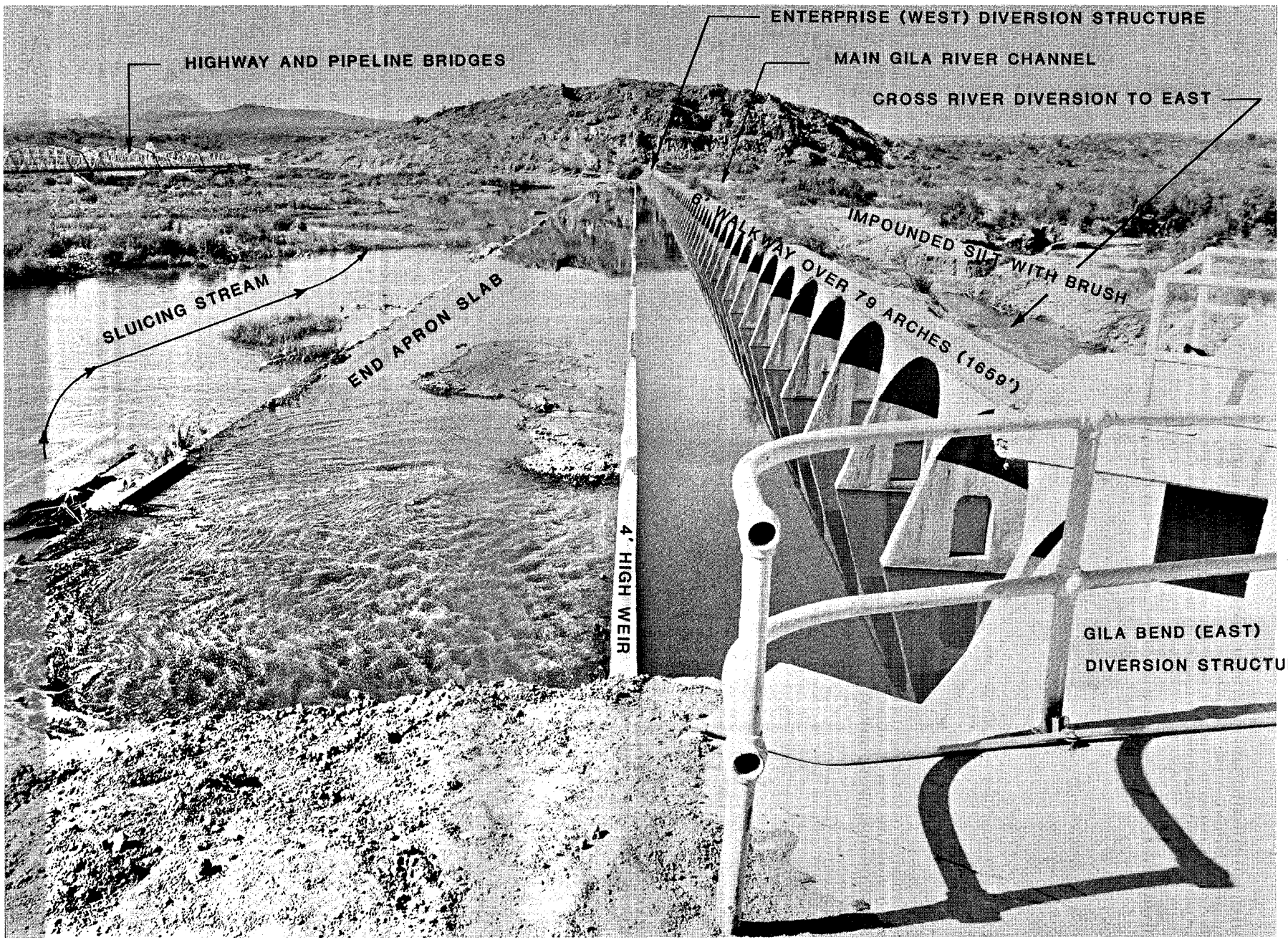


GILA RIVER GILLESPIE DAM
(photographed Nov.1,1980)

SECTION 1

SUMMARY AND RECOMMENDATIONS

FORMAT

This summary is presented as a summary of each Section of the Report and is followed by recommendations for subsequent actions.

There are six Report Sections supported by seven Appendices.

SECTION 1 (This Summary and Recommendations)

SECTION 2, INTRODUCTION

This Report has been prepared by John Carollo Engineers for the Flood Control District of Maricopa County, State of Arizona in 1980. It includes consideration of alternate structural modifications to Gillespie Dam for the purpose of maintaining its irrigation water diversion capability while lowering the water surface level during flood stage on the Gila River. Corresponding alternate channel improvement configurations are considered incidentally.

This is a conceptual report with the understanding that the preliminary recommendations are to be refined for possible integration into the larger program of flood control elements on the Salt River-Gila River system. That larger program is coordinated in the Central Arizona Water Control Study.

Gillespie Dam is a privately owned, concrete, multiple arch structure, 20 feet in height by about 1,700 feet in length, constructed in 1921 as a diversion dam for agricultural irrigation supply from surface water of the Gila River. It is located about 40 miles southwesterly from Phoenix, Arizona, adjacent to the old Phoenix-Yuma highway.

Gillespie Dam was constructed without flood release gates and sediment has filled the stream bed to the spillway elevation. The low flow multiple channels

meander through the phreatophytes growing on the broad sandy-silt upstream stream bed. At flood stage the water surface overflows onto an extensive floodplain of developed and undeveloped land.

The purpose of structural modifications to Gillespie Dam is to lower the flood stage water surface profile and thereby reduce the potential for recurring flood-related damages.

SECTION 3, EXISTING CONDITIONS

The Gillespie Dam reach of the Gila River, for purposes of this study, is defined as River Mile 56.50 to R.M. 69.62 or from 7.6 miles below the Dam to 5.5 miles upstream, about 13 miles in length.

The stream bed upstream is composed of sedimentary deposits, predominantly sand and silt, including a sediment wedge extending from the Dam upstream. The water quality, sediment, and sunny climate provide the environment for growth of dense vegetation over the stream bed.

The floodplain for about 8 miles upstream is a general broad plain, with some rocky hills, of 24,800 acres. Existing land use is predominantly of 3 categories:

9,000 acres of cropland
6,800 acres of river channel
8,800 acres of natural vegetation

Recurring floods have inundated buildings, roadways, croplands, and natural vegetation. Adjacent, downstream, to Gillespie Dam are an old highway bridge, a new highway grade crossing, an underground petroleum pipeline, and a pair of natural gas pipeline suspension bridges.

Gillespie Dam is a 79-arch concrete dam on a 2 foot thick concrete slab 125 feet wide supported on sediment with piling in sediment under arches and continuous sheet piling below each end of the slab. The original diversion

structure at the west abutment has been inactivated and a gated outlet in the third arch now diverts irrigation water to the Enterprise (west) Canal through a 30-inch pipeline. The original diversion structure at the east abutment has just been rehabilitated and provides a 7-gate diversion control to the Gila Bend (east) Canal. A twin gate sluiceway facility is located adjacent to the east diversion structure.

SECTION 4, GILA RIVER HYDROLOGY

Gila River flood records have been compiled and studied by the U.S. Army, Corps of Engineers. Their projections of flood frequency-magnitude for the Central Arizona Water Control Study are one basis for evaluation of alternate dam modification concepts. The HEC-2 water surface profile computer program, a mathematical model of streamflow, was run by the Corps of Engineers and the printout is the specific data, on a 65-year return period, 200,000 cubic feet per second project flood, used in this study. The sequence of flood frequencies/ intensities is not predictable in the short-term and are primarily dependent on upstream dams release rates.

U.S. Geological Survey records of irrigation water diversions at Gillespie Dam are reported. Diversions since 1935 indicate that continuous monthly diversions to both canals have provided substantial supply from the Gila River to extensive, dependent, agricultural properties. Paloma Ranch Joint Venture owns Gillespie Dam. The State of Arizona, Division of Water Resources, reported the current status of water rights to Gila River surface water at Gillespie Dam as a sequence of 5 priorities which are included in this Report. Enterprise (west) Canal can be expected to divert 10 to 20 cfs and Gila Bend (east) Canal up to 160 cfs, normally.

SECTION 5, GILLESPIE DAM MODIFICATIONS CONCEPTS

The basic modification considered for Gillespie Dam is to breach the arch structure to the slab elevation to permit the flood stage water surface to be lowered by the maximum practical amount. This concept requires that the upstream stream bed be lowered to a compatible profile. Alternate new channel cross sections, without dikes were evaluated. A 20-foot deep by 500 foot wide section proved to be the most effective alternative for the 200,000 cfs project flood.

Breaching the Dam for flood stage control of high water surface would not permit gravity diversion of streamflow at low flow stage. To restore the diversion capability, alternate facilities were considered for raising the streamflow to the diversion elevations. A low lift, high capacity pump station is one alternative. Flood control gates installed in the breach is the second alternative, with height to impound streamflow to adequate high water surface. Alternate gate types were evaluated and steel radial gates 42 feet long are judged better than other gates or a pumping station. Cost estimates are provided for the gated breach and the breach-and-pump alternatives. Cost estimates are expressed as present worth, annualized cost, and a five-year annual disbursements schedule. Estimated present worth of the gated breach project on a 50-year, 3 percent interest basis is $2,837,000. The average annual cost estimate is based upon a 3 percent annuity rate, compounded annually, and amounts to $110,300. The 5-year estimated cash disbursements schedule is:

Year 1	$132,000	Design
2	$770,000	Construction
3	$688,000	Construction
4	$ 40,000	Operations
5	$ 40,000	Operations

SECTION 6, BENEFIT/COST DATA

Although the scope of work for this study does not include channel design, it does include an estimate of channel costs for compatible Dam modifications in the recommended project. Therefore, a preliminary plan was prepared for a 50 foot wide pilot channel with a 20-foot crest dike extending 2-1/2 miles upstream along the west bank as a first stage of channel development.

The recommended project is the combination of a 504-foot gated breach Dam modification with the 2.5-mile pilot channel and dike; 1/2 mile dikes each side of a planned channel downstream for existing structures protection; and a 1 mile dike 3 miles upstream to divert streamflow toward the pilot channel. At 1980 cost index, the estimated project cost is $6,990,000.

It is this recommended project for which the Benefit/Cost Data is to be developed.

The 10-step Benefit Evaluation Procedure is discussed and each consideration is related to the recommended project. However, the most significant determination is that the larger project is required to achieve substantial benefits as reduction of potential flood-related damages. It is concluded that benefit evaluation, by this assigned procedure, is not applicable to this conceptual study of structural modifications to Gillespie Dam and nominal consideration of channelization, remaining to be defined in related but subsequent studies.

RECOMMENDATIONS

Although structural modifications to Gillespie Dam can be completed independently of the related upstream and downstream channel improvements, the function of the modified Dam should not be considered to be independent of channelization.

The recommended structural modification to Gillespie Dam is to breach the Dam, to sill level, by removing 24 arches plus parts of 2 arches; construct supporting concrete structures to the 2 remaining part-arches; construct concrete supporting piers and install twelve 42-foot automatically opening steel radial gates. This recommendation is based upon a 200,000 cfs design flood to be confirmed by selection of upstream improvement projects.

The recommended interim channel improvements are 2.5 miles of 50-foot wide pilot channel located from the Dam, upstream, along the west side of a 1,200 foot wide right of way (to be acquired); twin 0.5 mile dikes to establish a 1,000-foot wide channel downstream; and a 1 mile long training dike upstream located to direct braided channels into the constructed pilot channel.

The recommended project elements are considered to be compatible with alternate upstream channel improvements remaining under consideration, including the dike along the west side of the channel. The pilot channel is to be located along the permanent dike alignment, rather than the center of the right-of-way, to limit subsequent project costs while establishing the pilot channel function.

SECTION 2

INTRODUCTION

REPORT AUTHORIZATION

By Contract dated June 2, 1980, the Flood Control District of Maricopa County, Arizona authorized John Carollo Engineers to study and report to them the current flood control problems in the vicinity of Gillespie Dam, on the Gila River, and to recommend a feasible dam modification to alleviate flooding.

This Report has been prepared under terms of that Contract.

STATUS OF RELATED STUDIES

The Central Arizona Water Control Study has analyzed the hydraulic effects of channel clearing and channelization for various widths and various flood flow rates. (See Appendix F, this topic.)

The Flood Control District of Maricopa County, in conjunction with the Arlington Improvement Association, has completed a channel clearing project 300 feet in width upstream from Gillespie Dam. This clearing of phreatophytes is the first stage of a proposed project to clear the channel to 1,000 feet in width from Gillespie Dam to 91st Avenue. The purpose of channel clearing is to provide a more hydraulically effective channel resulting in lower flood stages for given flow rates; reduction of progressive siltation; and control of potential flooding inundation of property outside the cleared channel.

GILLESPIE DAM DESCRIPTION

Gillespie Dam was not constructed as a flood control dam. It was constructed for the purpose of intercepting streamflow for diversion, at controlled rates, to farmland irrigation.

Gillespie Dam is a multiple arch concrete structure completed in 1921 on the Gila River south of Arlington, Arizona near the U.S. Highway 80 Gila River crossing. It is now owned and operated by the Paloma Ranch Joint Venture, Davis, California. See location map, Plate 2-1.

The reservoir area has accumulated silt in depth to near spillway crest level and supports a dense phreatophyte growth except in the recently cleared channel. Its effectiveness as a diversion dam has been impaired by loss of reservoir storage volume and loss of diversion flow rate capacity.

STUDY SCOPE

The negotiated study scope was developed to provide information for use by the Flood Control District of Maricopa County as input to the County flood control programs and by the Gillespie Dam owners as input to planning for long-term use of the dam in a large farmland irrigation project.

The elements of the contracted scope of work are as follows:

1. Perform limited field reconnaisance to identify physical elements of existing site conditions.

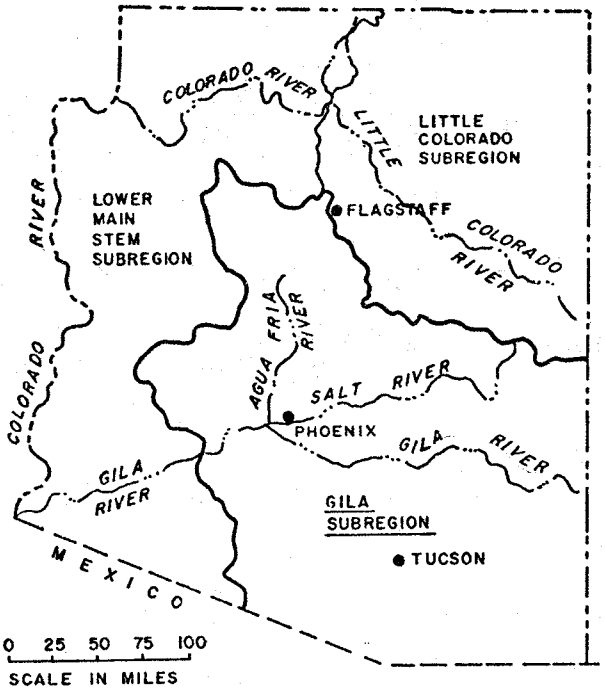
2. Do literature research to identify solutions developed previously for comparable problems.

3. Conduct field interviews to document the concerns and suggestions of the principle interested parties.

4. Document the Gillespie Dam owners' and operators' claims to established water rights as a basis for designing diversion capacities.

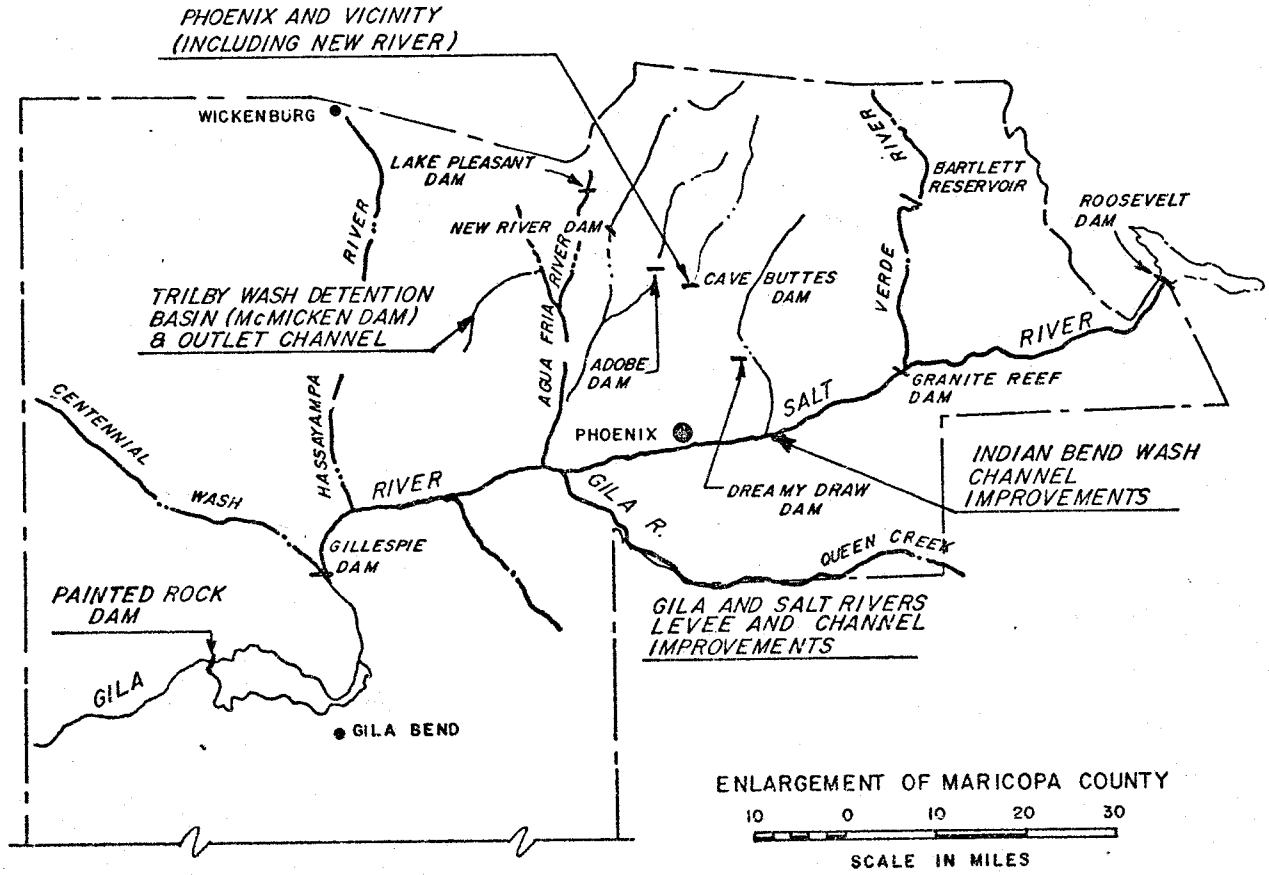
5. Analyze hydraulic data developed by the Corps of Engineers as a basis for planning alternate projects. Determine the effect of the proposed modifications on the structural integrity of the existing dam. Describe existing diversion capacity.

GILA SUBREGION



Gila Subregion Area:
57,606 square miles

Gillespie Dam Tributaries:
- Continental Wash
- Hassayampa River
- Waterman Wash
- Agua Fria River
- Gila River
- Salt River
- Indian Bend Wash
- Verde River



GILLESPIE DAM TRIBUTARY AREAS AND STREAMS

Source: (Pamphlet) Water Resources Development, Arizona - 1977, U.S. Army Corps of Engineers.

Plate 2-1

6. Develop 3 preliminary design concepts for structural modifications to Gillespie Dam.

7. Include input from appropriate Federal, State, and local agencies in their respective areas of expertise.

8. Discuss the criteria used in preliminary design concepts and include in cost estimates the related channel clearing and channeling cost estimate.

9. Recommend a dam structural modification for a corresponding channel clearing and channeling width. As logic for the recommendations discuss:

Advantages and disadvantages of the project;

Impacts on water conservation and irrigation;

Effects of backwater and inundation of agricultural land upstream;

Impacts on phreatophyte growth in and adjacent to the channel;

Impacts on aggradation and degradation of the channel;

Impacts of sediment transport and siltation on downstream farmlands, the Painted Rock Reservoir, and its water release program;

Impacts on downstream structures (the highway bridge and the EPNG Co. pipeline); and

Development of benefit/cost data for the recommended project.

10. Prepare a Draft Report and a Final Report. Participate in two progress meetings and one final project meeting. Provide 10 bound copies of the Report and a set of reproducible Report sheets.

STUDY TIME PERIOD

The time schedule for preparation of this Report extends 4-1/2 months with progress meetings at the end of 30 days and 15 days thereafter. A 30-day FCD review period is included.

FLOOD STAGE CHANGES INDUCED BY FLOW OBSTRUCTIONS

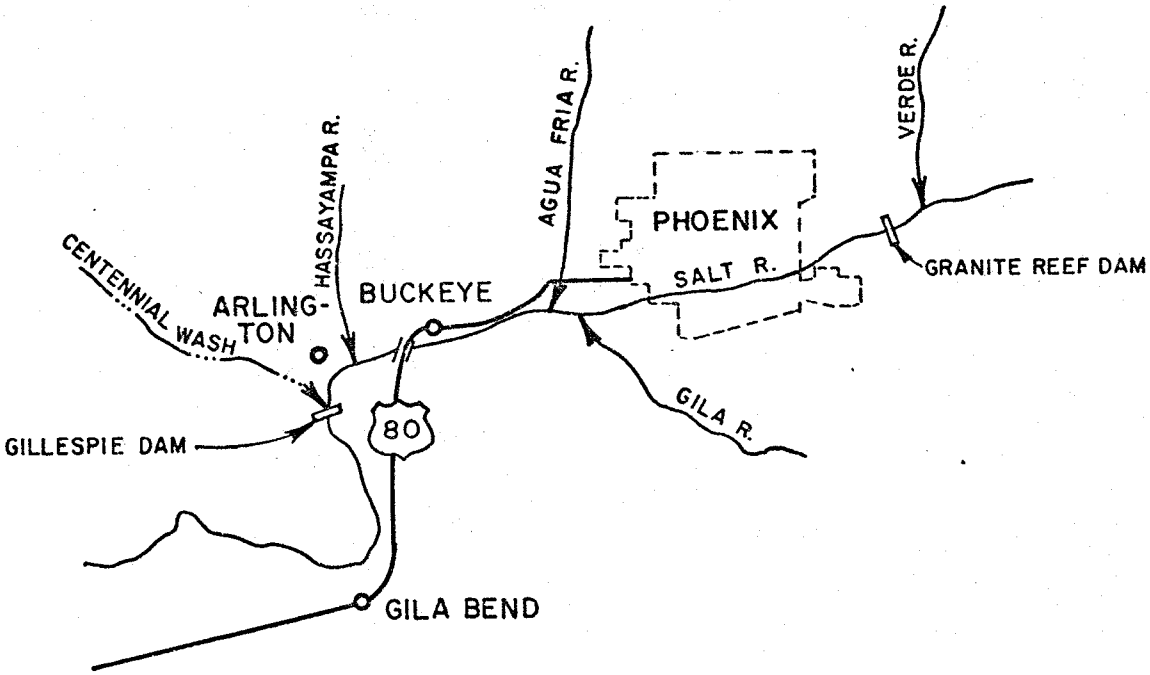
The following generalized deductions refer to the probable sequence of stream bed and stream flow changes induced by construction of Gillespie Dam as an irrigation water diversion structure. It is intended to aid in understanding the probable effects of alternate structural modifications to the dam.

Please refer to Plate 2-2. On Plate 2-2 there is indicated, in plan view and in profile, a schematic diagram of the Salt and Gila River major features upstream from Gillespie Dam. On Plate 2-3, a larger scale schematic profile of Gillespie Dam and the upstream channel indicates the deduced stream bed changes which probably occurred as a result, in part, of the stream flow obstruction created by Gillespie Dam.

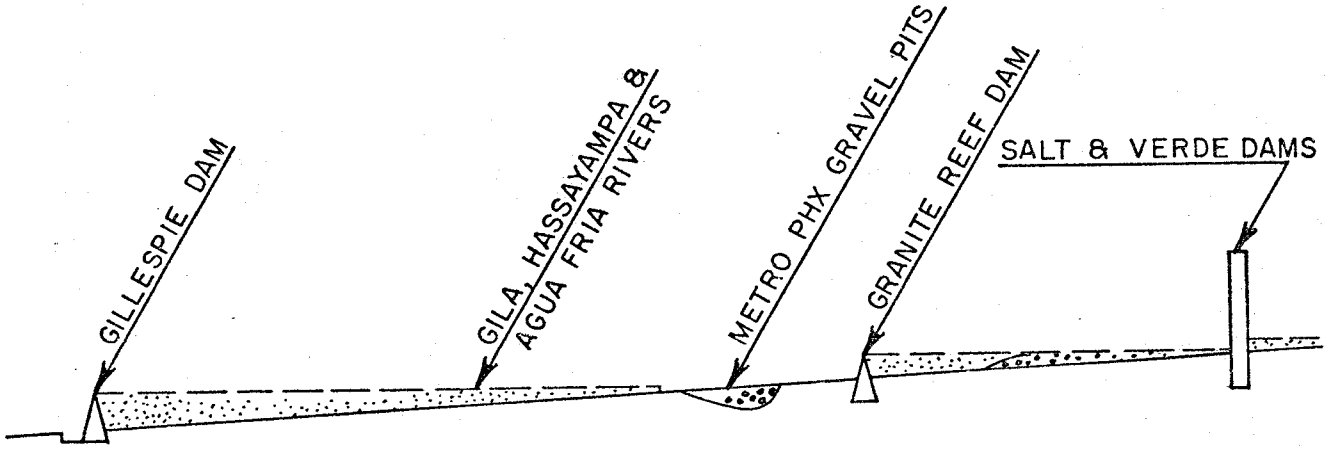
On Plate 2-2, principal tributary streams are indicated in plan view in general relation to Buckeye, Arlington, Gila Bend, and Gillespie Dam. The braided course of the Gila River in that area is typical of desert streams traversing sediment beds during intermittent and variable flow rate.

Sediment is transported downstream or is deposited in pools above dams or in excavated pits as indicated in the small scale profile. Mining of gravel and sand in certain stream bed locations during dry stream bed periods creates a relatively small scale pool during stream flow. Both types of pools accumulate sediment and in gravel pits the new sediment is a replenished source of building materials.

Greater velocity of flow rate during flood stage provides the energy to erode larger aggregate from the stream bed and tributaries. As the flow rate (velocity) decreases, the progressive settlement of coarser to finer particles



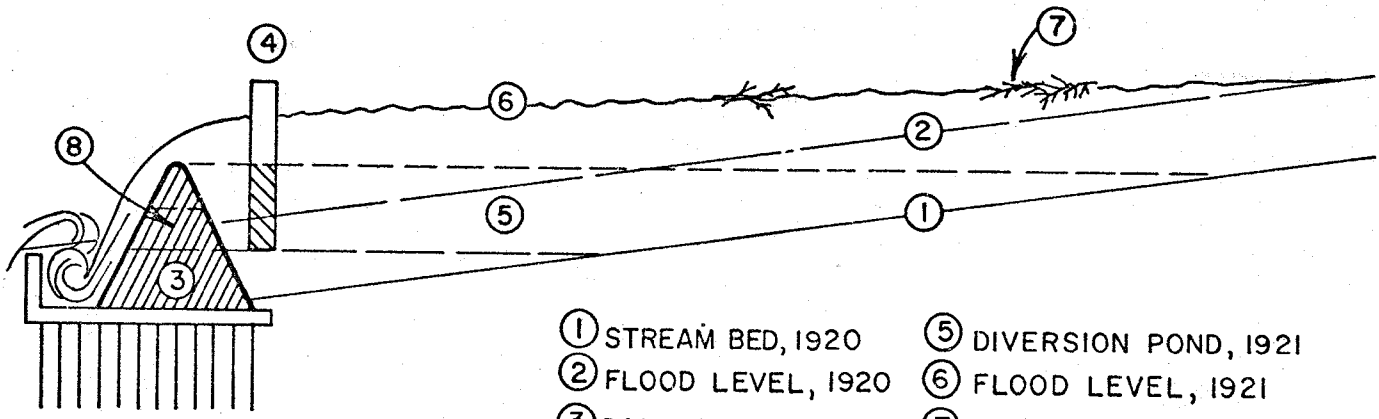
GILA - SALT RIVER SYSTEM - PLAN VIEW



GILA - SALT RIVER SYSTEM - PROFILE

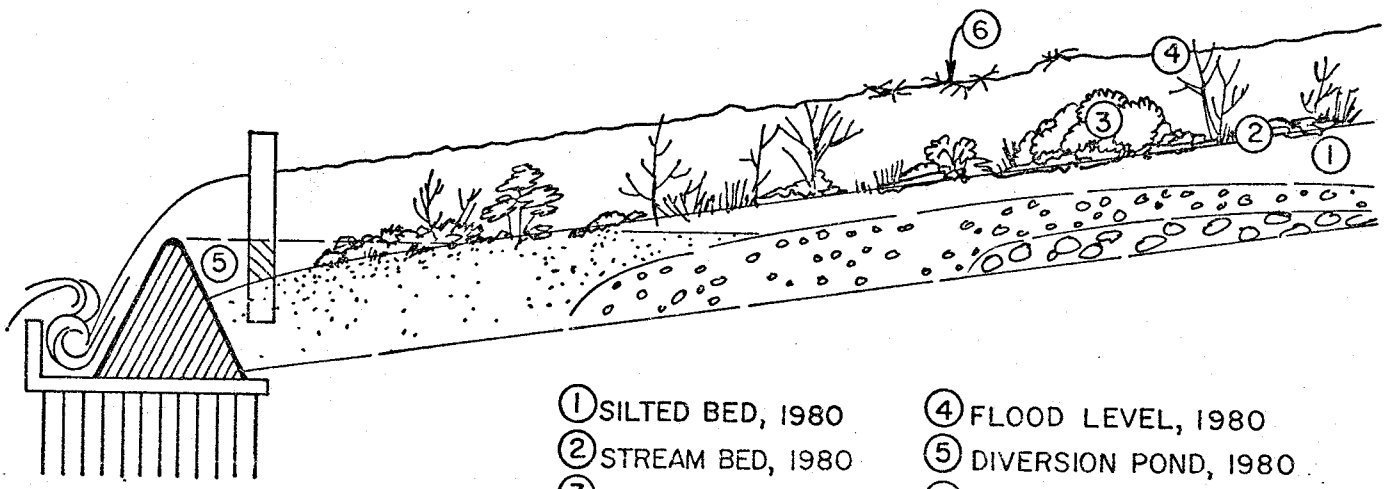
SCHEMATIC PLAN & PROFILE GILA-SALT RIVER SYSTEM

GILLESPIE DAM TO GRANITE REEF DAM



1920-21

1 STREAM BED, 1920
2 FLOOD LEVEL, 1920
3 DAM, 1921
4 DIVERSION, 1921
5 DIVERSION POND, 1921
6 FLOOD LEVEL, 1921
7 FLOATING DEBRIS, 1921
8 PROPOSED FLOOD GATE, POST-1920



1980

1 SILTED BED, 1980
2 STREAM BED, 1980
3 PHREATOPHYTES AND TRAPPED DEBRIS, 1980
4 FLOOD LEVEL, 1980
5 DIVERSION POND, 1980
6 FLOATING DEBRIS, 1980

DEDUCED SCHEMATIC GILA RIVER STREAM BED CHANGES

GILLESPIE DAM, 1920-1980

Note: Channel clearing projects were begun 1980.

occurs in natural relation to the available energy. Coarser sediment is dropped in the upper end of pools and finer sediment is carried closer to the lower end of the pool. Strata deposit vertically with successive runoff periods of variable flow rates and alternate tributaries and thereby create variable bedding characteristics. Successive low flow rates have less energy and erode and transport only the finer sediment but greater, and therefore less frequent, flow rates are needed to provide the energy to erode and transport the coarser sediment.

The flow rates, flow durations, and sediment loads to be expected at the Gillespie Dam are dependent, in part, upon the upstream natural and man-made stream conditions.

The larger scale profile of the Gila River upstream from Gillespie Dam indicates, by successive profiles numbered in the sequence of deduced occurrence, the progressive siltation of the original ponding capacity and the resulting progressive increase in water surface at high flood stage. When the water surface in the channel exceeds the riverbank elevation, the water spills over the banks and seeks its own elevation on adjacent land, inundating a corresponding area.

PURPOSE OF GILLESPIE DAM STRUCTURAL MODIFICATIONS

Alternate structural modifications to Gillespie Dam would be made with the intent to lower the maximum water surface to prevent damaging inundation; to provide adequate seasonal irrigation water for diversion by controlling siltation in the pool; and to control erosion of upstream sediment which could be damaging downstream if not controlled. There will be only minor flood control potential at Gillespie Dam because of the relatively small pool volume and the primary purpose of the dam, to provide capability for controlled stream diversion. Flood control will be by channelization.

SECTION 3

EXISTING CONDITIONS

GILA RIVER - GILLESPIE DAM REACH

The general location of the Gila River reach, which would be significantly affected by structural modifications to Gillespie Dam, is indicated in the introduction on Plate 2-1, being the reach from the Salt/Gila confluence to Painted Rock Dam. The 8 principal potential tributaries which could contribute to flood stage at Gillespie Dam are listed on Plate 2-1. In its natural state, the Gila River had a significantly greater flood stage potential at Gillespie Dam than the Salt River at Phoenix or Granite Reef Dam. Progressive development of dams and control channels will reduce flood magnitudes and intensities at Gillespie Dam but a greater flood potential, as compared to Phoenix and Granite Reef, will remain.

During periods of increasingly significant stream flow, Painted Rock Dam will impound a lake of increasing area reaching upstream past Gila Bend toward Gillespie Dam. Sediment carried at high velocity to the lake will be deposited on the lake bottom as the water velocity decreases.

Current study programs include attempts to evaluate alternate channel dimensions for a channel to be excavated from the Salt/Gila confluence through a modified Gillespie Dam to the upper end of Painted Rock Lake. The HEC-2 computer program, developed by the Corps of Engineers, has been applied by them to projection of water surface profiles and corresponding water surface areas. This study utilizes two of those projections, one for 200,000 cfs intensity and one for 320,000 cfs intensity. The HEC-2 program outputs report calculations for the Gila River reach from river mile (RM) 56.50 upstream to Gillespie Dam, RM 64.11, and continuing upstream to RM 69.62. That is 7.61 miles below Gillespie Dam to 5.51 miles above, a total reach of 13.12 miles.

It is this 13-mile reach that can be significantly altered, directly, by channelization and structural modification of Gillespie Dam.

CHANNEL CHARACTERISTICS

The Gila River streambed varies, in time, in response to its physical characteristics' reactions to extremely variable streamflow intensities (flow rates). Those characteristics include vegetation, sediment gradation, and slope. The streambed consists of sedimentary deposits containing large proportions of sand and silt and is therefore susceptible to selective erosion and transport of sediment. A sediment wedge extends upstream from Gillespie Dam.

The water quality, sediment, and sunlight provide a natural environment for growth of vegetation on the Gila River bed. One or more small channels normally meander through this vegetated plain. Common vegetation types include grass and vine ground cover, low and dense bush types, and deeply rooted trees. The predominant trees are tamarisks (salt cedars) which commonly develop into dense clusters and, when mature, remain relatively intact through all but the largest floods. Emergent tamarisks near Gillespie Dam cover most of the sand bars which were left barren after the 1980 spring floods subsided. They average about 3 to 4 feet in height at only about 7 months of age.

FLOOD PLAIN CHARACTERISTICS

The flood plain, upstream from Gillespie Dam, extends over both developed and undeveloped land as indicated on a land use map included in Section 6, Plate 6-2. Developed areas are predominantly agricultural and include both croplands and pasture lands. Undeveloped areas are mostly rough desert terrain of poorer soil classes not economically feasible for land leveling and flood irrigation, the normal practice for agriculture in this region.

Floods have inundated some roads and residences in the flood plain and significant damage has resulted. Interruption of normal transportation routes has been another recurring problem during and after Gila River floods. Low flow channels have meandered over the flood plain which extends up to 3 miles wide.

BRIDGE CROSSINGS DOWNSTREAM

Structural modifications to Gillespie Dam would, by intent, alter the flood stage conditions at Gillespie Dam. Three bridges and a buried pipeline crossing are located within one-half mile downstream from the dam. The probable effects, of altered streamflow, on these structures is a part of the evaluation of dam modifications.

The first bridge downstream, the old U. S. Highway 80 (Phoenix-Yuma) bridge, is a 9-span steel girder, 2-lane structure supported by piers founded on bedrock. It has withstood floods to date. Review of the bridge plans and a field inspection lead to the judgment that this bridge is not imperiled by flooding. The bridge is closed to traffic and paralleled by a grade crossing adjacent downstream. The grade crossing utilizes culvert pipes to pass lower flow rates. Flood flow overtopping this grade crossing could result in a washout and interruption of traffic, with or without dam modifications.

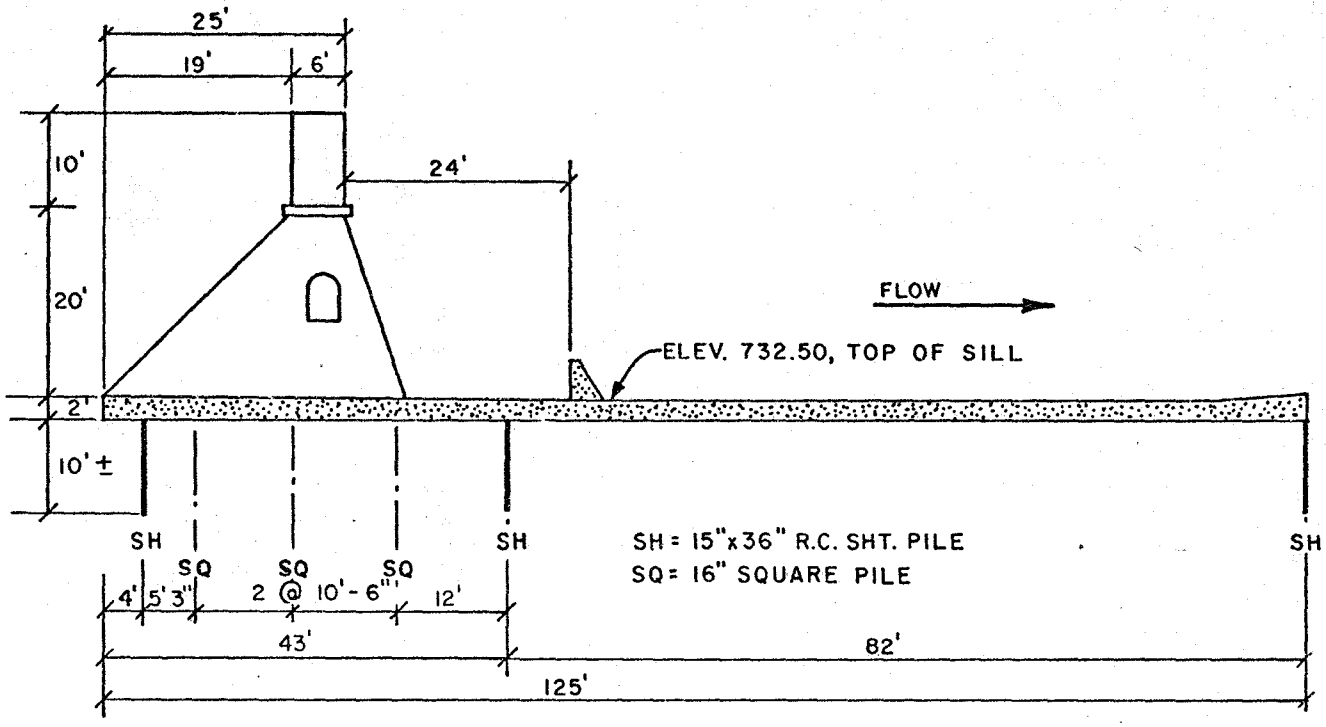
Next downstream are twin suspension cable bridges supporting El Paso Natural Gas Company pipelines. The towers appear to be founded on piling to bedrock and anchored by end structures on high ground above flood stage. These structures appear to be in sound condition and well maintained. The buried pipeline must be protected from the effects of channel excavation. See Appendix B.

GILLESPIE DAM

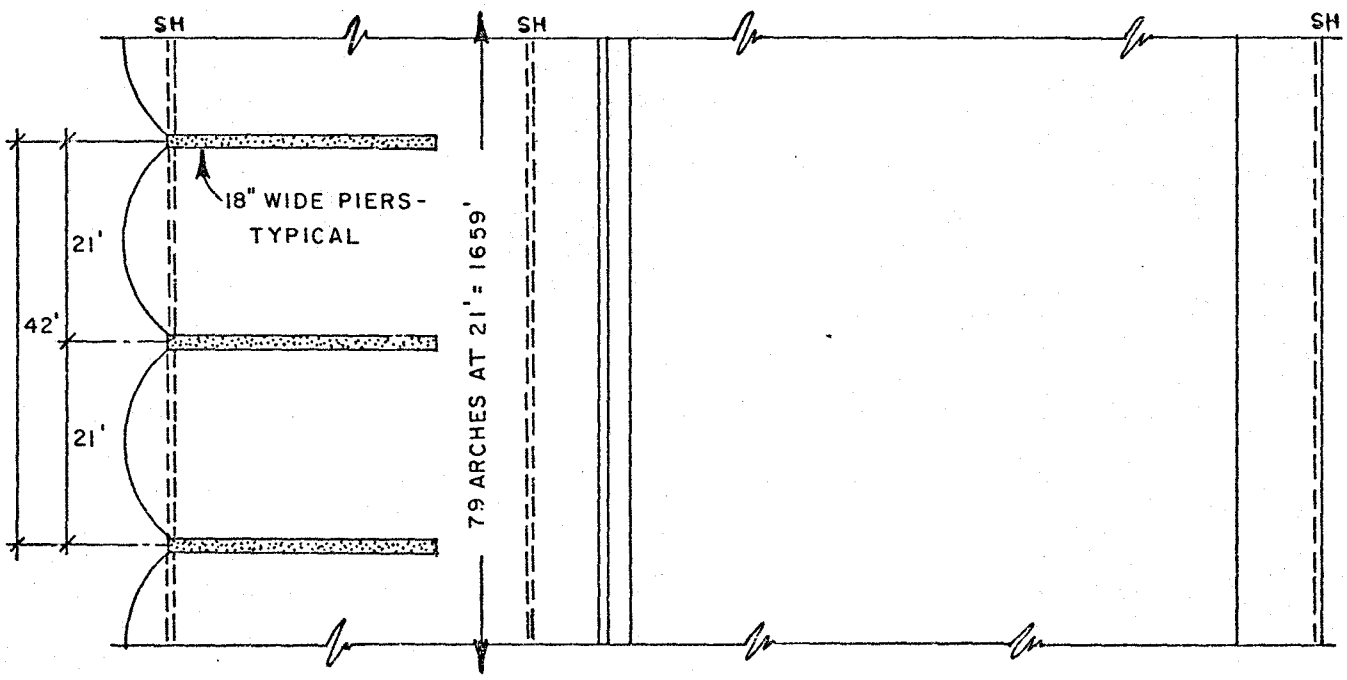
Gillespie Dam is a privately owned irrigation water diversion dam constructed in 1921 and appears to be maintained in sound condition with minor areas of spalled concrete noticed along the spillway crest. It is a multiple arch concrete dam founded on a 2-foot thick concrete slab with piling below pier walls and with concrete sheet piling as cut off walls near the upstream and downstream edges of the slab. Diversion structures at the east and west ends of the dam were constructed and included sluice gates. The west diversion structure has been inactivated and its function replaced by a gated opening in the third arch from the west end which releases impounded streamflow to the 4-foot deep water cushion impounded by a concrete weir. A 30-inch diameter corrugated metal pipe has been installed, with inlet submerged below the water cushion, to divert irrigation water to the Enterprise (west) Canal. The transition length of the Gila Bend (east) Canal has been rehabilitated from the diversion gates to the newly lined canal.

Plate 3-1 indicates the principal structural features of the dam in plan view and in elevation. Form, dimensions, and materials of this structure have been derived from field inspections and blueprints on file with the Arizona Water Commission. There are 79 arches spanning 21 feet, each, making the length 1,659 feet, between diversion structures. The slab extends 125-feet in the direction of streamflow.

Dam height is 20-feet above the slab with a 6-foot wide walkway serving as the continuous, ungated spillway crest. The slab is apparently constructed at the natural streambed elevation. Sediment has accumulated over the arches to the spillway crest elevation, about 20-feet in depth. Because the new east sluice gates have been opened to lower the water surface during recent work on the diversion canal there is a channel maintained adjacent to the upstream



SECTION OF DAM



PART - PLAN OF DAM

PRINCIPAL STRUCTURAL FEATURES

GILLESPIE MULTIPLE ARCH DIVERSION DAM

Source: Blueprints on file at Arizona Water Commission

Plate 3-1

face of the dam with streamflow from the west side to the east side of the river. About 6,000 cfs appeared to be flowing through the sluice gates on November 1, 1980. There were 3 separate channels in the riverbed but the only significant flow was along the west side, crossing to the sluice gates, and flowing to the area ponded by the grade crossing between the old highway bridge and the twin suspension cable bridges.

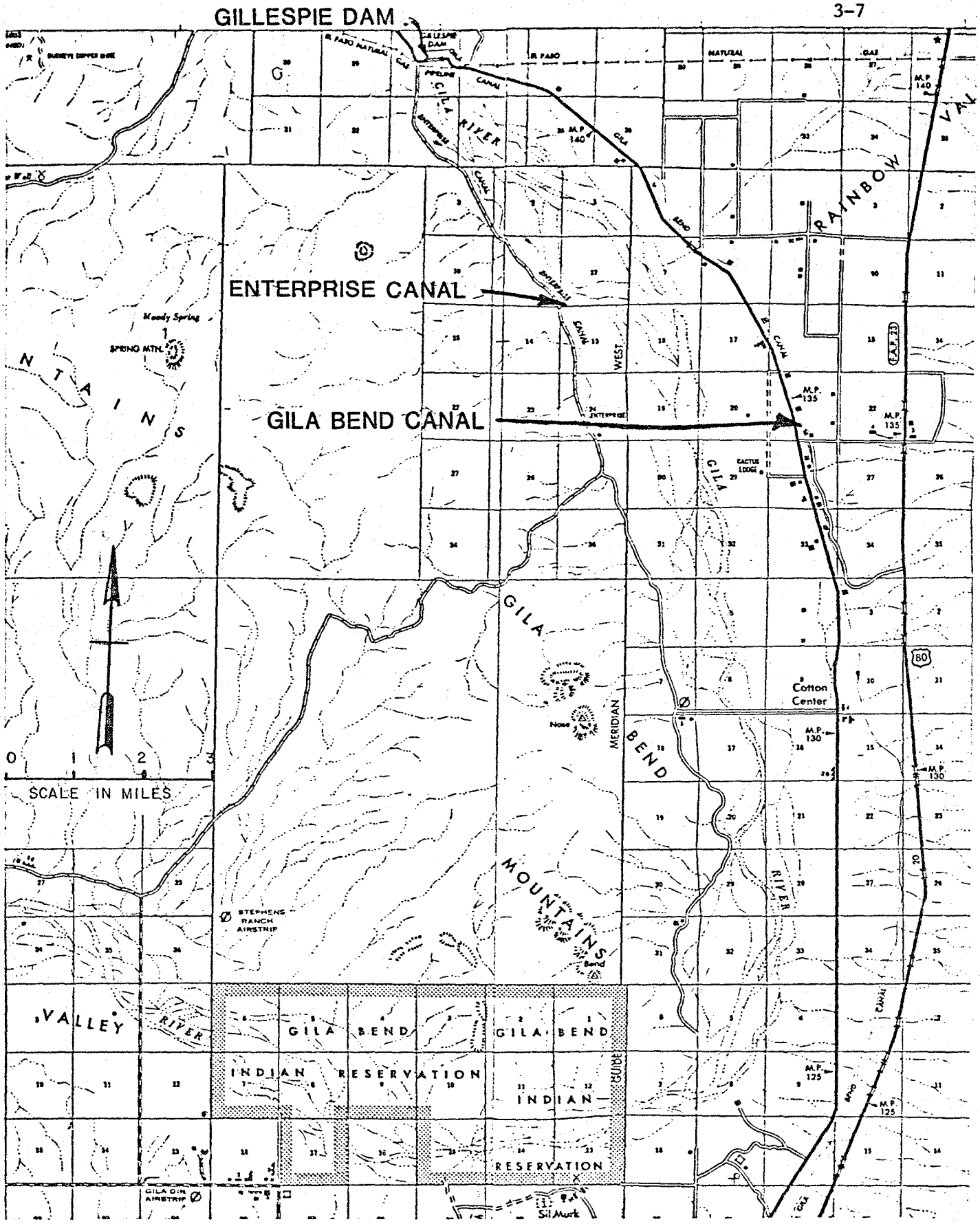
GILLESPIE DAM DIVERSION DATA

Gila River surface water has been diverted, for agricultural irrigation, at Gillespie Dam since its construction in 1921. Two principal canals have transported the diverted water for many miles and provided a basis for development of large acreages of cropland and pasture. These canal routes have permitted development of many wells located adjacent to the canals to supplement surface water supply by pumping groundwater. The general magnitude of this integrated development is indicated on Plate 3-2.

Table 3-1 lists the annual diversion records for Enterprise (west) Canal and Gila Bend (east) Canal since 1935. It is evident that these significant diversions have contributed a substantial part to the related agricultural production of crops and stock for many years. Therefore, structural modifications to Gillespie Dam must account for maintenance of adequate diversion capability for the foreseeable future.

SURFACE WATER DIVERSION RIGHTS

A letter from Paloma Ranch to the Flood Control District of Maricopa County authorizes John Carollo Engineers to enter upon their private property at the Gillespie Dam site to investigate existing conditions. In that letter Paloma Ranch Joint Venture is named as the owner of Gillespie Dam and CRANCO as the lessee. (See Appendix B.)



SERVICE AREAS OF ENTERPRISE AND GILA BEND CANALS

GILLESPIE DAM ANALYSIS

Plate 3-2

TABLE 3-1

IRRIGATION WATER ANNUAL DIVERSION RECORDS

GILLESPIE DAM ON GILA RIVER

Station / Year	Diversions, Ac-Ft. 09518500 East Gila Bend	Diversions, Ac-Ft. 09519000 West Enterprise
1935	15,640*	3,115*
36	69,030	M 9,900
37	M 84,020	8,260
38	75,320	7,520
39	64,330	m 6,750**
40	m 60,050	6,870
1941	M 95,960	7,640
42	78,010	7,390
43	64,650	m 6,760
44	72,520	8,370
45	74,650	7,340
46	73,360	m 7,250
47	73,140	9,940
48	45,880	8,510
49	38,530	8,300
50	m 30,840	M 8,910
1951	28,030	9,910
52	M 40,300	7,920
53	21,030	8,320
54	16,490	9,100
55	10,580	9,970
56	12,190	8,730
57	m 3,980	9,240
58	4,980	M 11,180
59	4,870	7,410
60	11,540	m 7,220
1961	2,890	5,980
62	3,140	m 5,380
63	3,840	5,820
64	10,130	5,580
65	5,850	7,110
1966	15,140	5,880
67	m 1,530	6,370
68	M 11,030	M 9,340
69	7,070	8,470
70	5,180	5,230
1971	6,310	9,090
72	Not Published	
73	Not Published	
74	0	5,018
75	0	15,630
76	111	17,256
77	12,592	13,525
78	26,708	12,465
79	Not Available	

1935-1950		
Annual Max.	247 cfs	34 cfs
	14,800 AcFt/Mo.	2,020 AcFt/Mo.
Max. Mo.	11,170 Ac.Ft.	1,160 Ac.Ft.
Min. Mo.	1,070 Ac.Ft.	442 Ac.Ft.
1951-1960 (Monthly Records, Only)		
Max. Mo.	5,980 Ac.Ft.	1,260 Ac.Ft.
Min. Mo.	0 Ac.Ft.	355 Ac.Ft.
1961-1979 (Monthly, Discontinuous)		
Max. Mo.	-	1,860 Ac.Ft.
Min. Mo.		572 Ac.Ft.

*Incomplete record, total is larger.
M = Maximum annual diversion in decade or part decade.
m = Minimum annual diversion in decade or part decade.
**Water Stage recorder installed November 29, 1939.
Source: USGS Water Supply Papers.

Mr. Douglas Nelson, Attorney for Paloma Ranch, reported to John Carollo Engineers in a telephone conversation on September 17, 1980 that the Paloma Ranch water rights to surface water diversion at Gillespie Dam include all the Gila River flow that they can divert. They divide this flow at the rate of 10 cubic feet per second (cfs) to the Enterprise (west) Canal and the remainder to the Gila Bend (east) Canal.

The State of Arizona, Division of Water Resources responded to our request, on November 12, 1980, for their opinion of surface water diversion rights at Gillespie Dam. The essence of their opinion is summarized in Table 3-2. Enterprise Ranch has the first and fifth priority rights. Gila River Ranch has the second and fourth priority rights. Pierpont Ranch has the third priority right and it relies on downstream diversion from Gila River water which passes below, through, and over Gillespie Dam.

Enterprise Ranch has the right to divert, continually, at the rate of 10 cfs whenever streamflow will supply that rate.

Gila River Ranch has the right to divert 9,450 AF, annually, as second priority. At their canal capacity, 160 cfs, they could complete that diversion right at 317 AF per day in 30 days, concurrently with 10 cfs to Enterprise Canal, whenever streamflow will supply 170 cfs.

Pierpont Ranch has the only stated right to water which seeps under the Dam. Fourth and fifth diversion rights are subject to prior release of at least 8 cfs as the source for the third priority diversion by Pierpont Ranch.

The second plus fourth priority diversion rights' average annual rate is equivalent to the Gila Bend (east) Canal capacity. Inadequate streamflow or canal maintenance requirements will probably prevent diversion of the total annual right. Inadequate streamflow could be mitigated by ponding

TABLE 3-2

IRRIGATION WATER DIVERSION RIGHTS AT GILLESPIE DAM

GILLESPIE DAM MODIFICATION ANALYSIS

	Enterprise Canal		Gila Bend Canal		Downstream		Cumulative	
	cfs	AFY *	cfs	AFY *	cfs	AFY *	cfs	AFY *
DIVERSION PRIORITY								
1 Enterprise Ranch	10	7,227					10	7,227
2 Gila River Ranch			(13.1)	9,450			(23.1)	16,677
3 Pierpont Ranch					(8.0)	5,768	(31.1)	22,445
4 Gila River Ranch			(149.8)	108,418			(180.9)	130,863
5 Enterprise Ranch**	10	7,227					(190.9)	138,090
Total		14,454		117,868		5,768		138,090
[Total in cfs]				[162.8]				
[Nominal Capacity]				[160]				

* Up to this cumulative annual limit.
() Calculated constant rate equivalent to annual limit.
** Estimating Enterprise Canal capacity is 20 cfs.

Source: State of Arizona, Division of Water Resources

Note: See Appendix B-3

behind gates in a wide channel. That would improve seepage to satisfy the Pierpont water right and retain some streamflow during canal downtime. The Gila Bend (east) Canal capacity may actually exceed the 160 cfs nominal capacity, or be improved to do so. In that case annual diversion could more nearly approach the annual diversion right.

SURFACE WATER DIVERSION CAPACITY

The Enterprise (west) Canal 30-inch diameter pipeline has capacity in excess of the 10 cfs planned diversion rate. At a velocity of 4-feet per second the capacity is about 20 cfs.

The Gila Bend (east) Canal has been lined recently and has a capacity of about 160 cfs at a velocity of 4-feet per second. Note that it has not been determined in this study that the canal profile slope is adequate to sustain the 4 fps velocity assumed above.

The State of Arizona, Division of Water Resources reported that the Gila Bend (east) Canal capacity is 160 cfs.

POSSIBLE DAM REPAIR REQUIREMENTS

The exposed concrete surfaces indicate Gillespie Dam is structurally sound and will require only minor repair of concrete surfaces to maintain the structure.

The upstream face of arches and the upstream slab is covered by sediment and water. At the beginning of breaching this surcharge must be removed to prevent collapse of arches planned to remain. At that time the upstream concrete should be inspected and a determination made of required repair. Reserve funding should be available for this contingency.

SECTION 4

GILA RIVER HYDROLOGY

THE U.S. CORPS OF ENGINEERS HEC-2 COMPUTER PROGRAM

Flood water surface profiles have been calculated for the reach of the Gila River in which the Gillespie Dam is located. The computer program used in the calculations was developed in 1964 by the USA COE, Tulsa District and modified in the Hydrologic Engineering Center, COE, Davis, California. The program designation is 723-X6-L202A.

The COE provided computer printout packets, through the Flood Control District of Maricopa County, for floods of 200,000 and 320,000 cubic feet per second for evaluation by John Carollo Engineers in this study.

EVALUATION OF HEC-2 COMPUTER PROGRAM

The HEC-2 computer program calculates and plots the water surface profile for river channels of any cross section for either subcritical or super-critical flow conditions. The basic theory of this program applies Bernoulli's theorem for the total energy at each cross section and Manning's formula for the friction head loss between cross sections.

These are accepted standard engineering applications for calculation of stream flow. In application they require estimates of factors to be used in the calculations to account for site-specific channel conditions. Critical depth in channel flow is the water depth above streambed at which, for a given total head, flow rate is a maximum. At depth more than critical, flow is turbulent. In channels of nonuniform cross section, nonuniform velocity is to be expected. A constructed uniform cross section channel can provide a near uniform mean velocity through successive reaches but, at flood stage above the

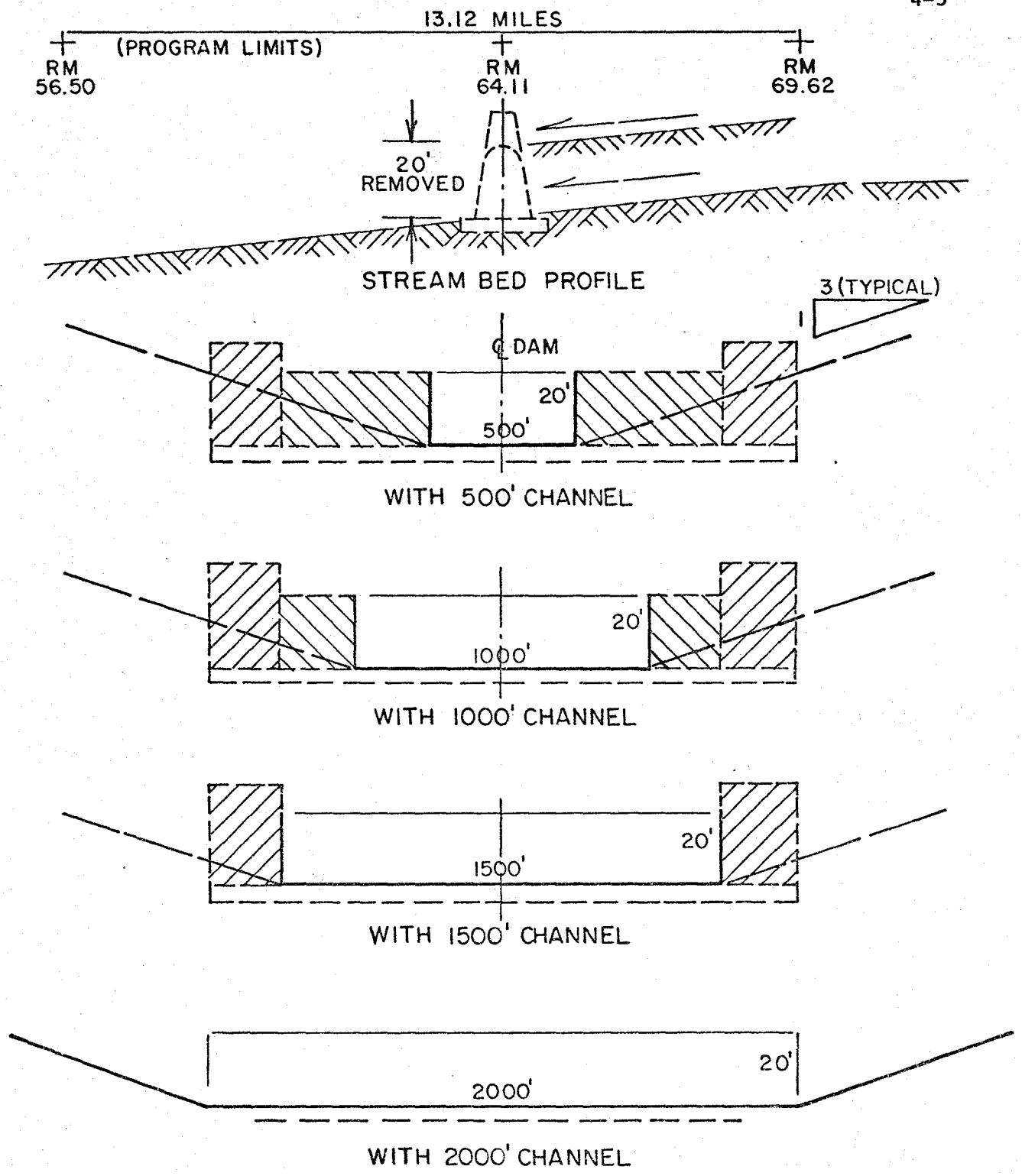
constructed channel, the flood plain section adds nonuniform increments to each cross section and the stream flow is better analyzed in short reaches to better account for variable channel cross sections.

The HEC-2 program recognizes these complexities by using four cross sections per mile from Gillespie Dam, upstream, a distance of 5-1/2 miles in the program reviewed. For the excavated channel cross section "n" values for use in the Manning formula have been selected and, in our opinion, they reflect appropriate judgments of channel roughness with significant impediments to flow. The program has capability to calculate "n" values from gaged flood flow and high water marks at cross sections. Aerial photos provided the base for this program. "NC" entries, selected n values, have been selected for the streambed below Gillespie Dam to 1-1/2 miles above the Dam with excavated channel (on the order of 0.050 - 0.060) and from 1-1/2 miles above the Dam to 5-1/2 miles above the Dam, with an excavated channel (on the order of 0.035 to 0.040).

These "n" values appear to be reasonable for projected streambed at flood stage when maintained in good condition and appear to imply that channelization without significant phreatophyte emergence is the planned maintenance condition.

The standard cross sections for alternate excavated channels are flat bottomed with side slopes of 1 vertical to 3 horizontal. The alternate bottom widths are 500-, 1000-, 1500-, and 2000-foot. Equivalent cross sections are assumed at the Dam by removal of part of the Dam. The 2000-foot channel width would require removal of the Dam and nullify the function of an existing diversion structure at each end. See Plate 4-1.

Channel dikes are not included in the computer printout but the left and right banks are plotted in profile in relation to water surface elevation at 500-foot stations for reference.



SCHEMATIC DIAGRAM

ALTERNATE REMOVALS OF GILLESPIE DAM

(Alternately 500', 1000', 1500', or 2000' lengths)

The HEC-2 program, as applied to this reach of the Gila River and reported, does not define the channel center line. Mapping received from other consultants does not resolve the center line location problem. Water surface elevations could not be correlated with map contour elevations at cross sections. The channel center line for the HEC-2 program has not been determined in this study.

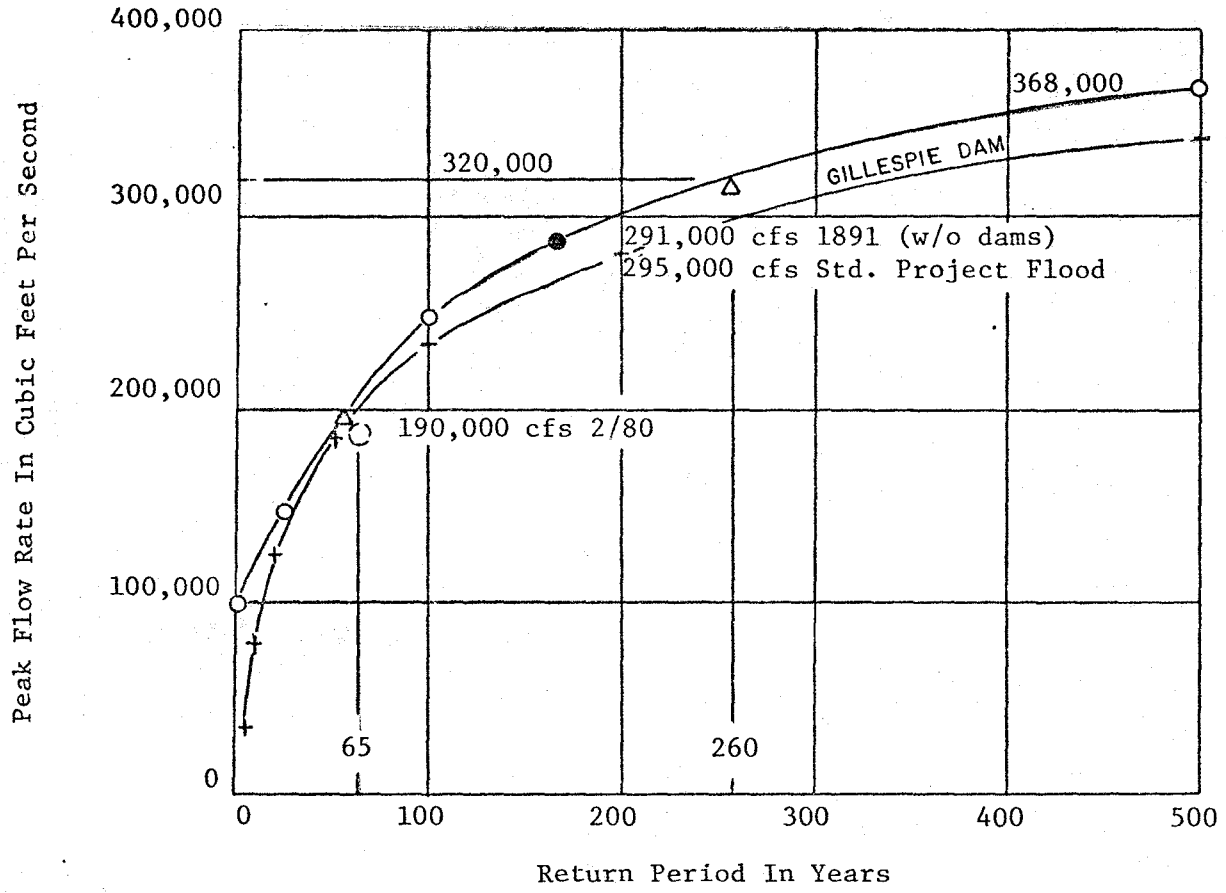
In summary, this HEC-2 program printout is considered applicable to this study in the conceptual stage for water surface profiles but not for water surface area plots. In Section 6 the land use mapping, received from the Natelson Company, Inc., is reproduced as the currently accepted flooding limit definition for purposes of evaluating benefit/cost elements of dam modifications.

PROJECT FLOOD

On Plate 4-2 the flood frequency and magnitude records and projections are plotted for the purpose of placing, in the regimen, the 200,000 cfs and 320,000 cfs floods for which water surface profiles were provided from the HEC-2 program. The 200,000 cfs flood event plots at about a 65-year return period. The 320,000 cfs event plots at about a 260-year return period.

For the purposes of this study the 295,000 cfs Project Flood, at the Salt/Verde confluence, can be considered an upstream event and the 320,000 cfs a corresponding event at Gillespie Dam. The 200,000 cfs event at Gillespie Dam was designated the Project Flood by staff of the Flood Control District of Maricopa County.

The "Gillespie Dam" line is plotted from a preliminary tabulation provided, on December 8, 1980, by U.S. Army Engineer District, Los Angeles, COE. The standard project flood is listed as 311,000 cfs. The 500-year event is listed as 335,000 cfs. The Salt/Verde confluence standard project flood is listed as 295,000 cfs. These tabulated values conform reasonably with the values on which this study has been based.



Legend:

- ○ Corps of Engineers 1980 projections.
- ● Corps of Engineers - Standard Project Flood.
- △ Corps of Engineers - Water Surface Profiles Calculated
- + CAWCS Preliminary Tabulation, 6/25/80, C/E

SALT-GILA RIVER PROJECTED FLOOD FREQUENCY AND MAGNITUDE
(ORME DAM - PUBLIC RELEASE)

Source: COE/USA, Gila River Computer Program, 6/9/80.

Plate 4-2

SECTION 5

GILLESPIE DAM MODIFICATIONS CONCEPTS

GENERAL

Gillespie Dam was constructed for the purpose of intercepting Gila River flow, raising the low flow stage water surface, and thereby providing adequate head for gravity diversion to the Gila Bend (Eastside) Canal. The high flow stage weir crest is 20.0 feet above the natural stream bed.

DAM BREACHING CONCEPTS

The concepts for potential dam breaching modifications are developed to accomplish improved flood control while maintaining diversion capability. Eight goals are listed, below, in approximate order of precedence:

1-1 Maintain adequate surface water diversion capability.

2-1 Maximize project reliability.

2-2 Minimize project implementation time.

2-3 Minimize recurrent flood damages.

2-4 Minimize project costs.

2-5 Minimize project maintenance requirements.

2-6 Maximize project benefit/cost ratio.

2-7 Minimize relocation of flood plain developments.

Alternate concepts for achieving these goals by dam modifications include the NO PROJECT concept to be evaluated and the related channelization concepts. To maintain diversion capability to the Gila Bend (Eastside) Canal, the water surface can be maintained at adequate elevation in the stream for gravity diversion or the stream flow can be diverted to a wet well and pumped at low pressure to discharge into the canal. These two concepts are:

1-1 Maintain gravity diversion by breached and gated dam.

1-2 Without gates in a breached dam, pump stream flow to the diversion canal(s).

There are two concepts for minimizing the flood plain area:

2-1 Lower the flood stage water surface by excavating a channel and breaching the dam without gates.

2-2 Confine flood stage stream flow to the controlling channel through open gates by:

2-2-1 Alternate channel widths

2-2-2 Alternate channel depths (excavated, dikes, or both)

For a considered flood plain area and frequency of flooding, the concept of minimizing flood damage can be by:

3-1 Relocate the more vulnerable improvements out of the flood plains.

CONCEPT 2-1: Lower the flood stage water surface by excavating a channel and breaching the dam without gates. In related studies, alternate excavated channel widths are considered for a common channel depth of 20 feet with side slopes 1-vertical to 3-horizontal. Twenty-foot deep channels correspond to the 20-foot height of Gillespie Dam.

Alternate channel widths considered are 500, 1,000, 1,500, and 2,000 feet. The dam could be breached to the sill to provide continuity with the 20-foot deep excavated channel. The length of dam breached could be multiples of 21 feet, the typical arch span, which accumulate to about 500, 1,000, or 1,500 feet for 3 of the 4 alternate channel widths.

The total of multiple arch spans existing is 1,659 feet. The 2,000-foot wide channel would require removal of the entire dam, including existing diversion structures.

The principal effects of breaching the dam to stream bed elevation are:

1-1 Loss of gravity diversion capability.

2-2 Minimizing project implementation time.

2-3 Minimizing recurrent flood damages.

2-4 Minimizing capital costs.

2-7 Minimizing relocation of flood plain developments.

The consequent considerations are:

1. Need for diversion pumping facilities plus their operation and maintenance costs.
2. Uncontrolled release of sediment now deposited upstream from the dam.
3. Release of the low flow stage irrigation water potentially impoundable above an unbreached or breached-and-gated dam.

CONCEPT 2-2-1: Confine flood stage stream flow to the controlling channel by 2-2-1, alternate channel widths with open gates. As in Concept 2-1, three alternate widths are considered as 500, 1,000, and 1,500 feet. The 2,000-foot channel could not be matched by a 2,000-foot long gated opening through the existing 1,659-foot long dam. The principal effects of operating with gated openings would be to provide capability to divert, by gravity, low stage stream flow; to minimize recurrent flood damages; and to minimize relocation of flood plain developments. Gate construction would involve substantially more capital cost and implementation time.

Gated openings would obviate the need for pumping from stream flow for irrigation; would provide means for control of sediment release; and would provide capability for limited impoundment of low stage stream flow.

The 3 alternate gated openings could be provided in 3 stages of construction if funding limitations excluded prompt implementation of the one-stage project.

In either case, there would be opportunity to stage-construct channel widths and provide an element of controlled upstream scour, sediment transport, and downstream deposition.

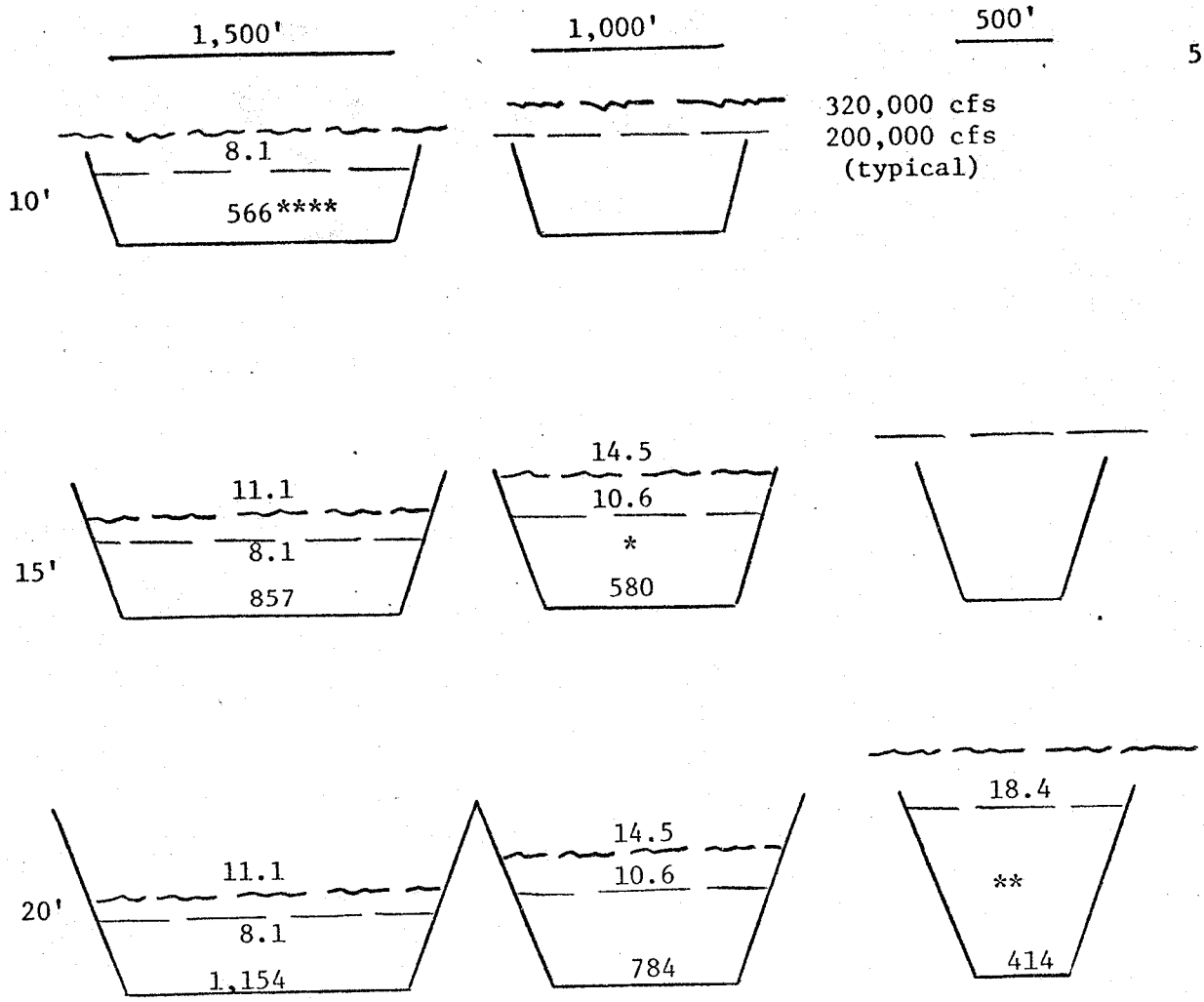
CONCEPT 2-2-2: Confine flood stage stream flow to the controlling channel by 2-2-2, alternate channel depths with open gates. This concept is considered in the interest of minimizing channel excavation, excavated spoil disposal, and channelization costs. It would provide an initial water surface elevation reduction at flood stage, but less than with a 20-foot deep channel. Subsequent erosion and transport of sediment would be expected to occur in the channel approach to the 20-foot deep breach in the dam.

Plate 5-1 presents a schematic diagram of alternate channel widths and depths with calculated excavation quantities and flood stage water depths. The 1,500-foot wide channel would be more than 10 feet deep to control the 320,000 cfs flood stage. The 500-foot wide channel by 20 feet deep could control the 200,000 cfs flood stage with 1.6 feet of freeboard. The 1,000-foot wide by 15-foot deep channel would control the 200,000 cfs flood stage with 4.4 feet of freeboard. It would also provide 0.5 feet of freeboard for the 320,000 cfs flood stage. These water depths are from the HEC-2 printout.

For the 200,000 cfs flood stage, the tabulated calculations indicate that the 500 x 20-foot channel ratio of capacity to excavation is best, at 0.48 cfs/cy, of all the alternate cross sections considered. At the 200,000 cfs flood stage, the 500 x 20-foot cross section would produce an average velocity of about 20 feet per second.

RELATION OF ALTERNATE CHANNEL SECTIONS TO DAM MODIFICATIONS

The published new bridge designs for the Phoenix Metropolitan Area in 1980 indicate 200,000 cfs is the common project design flood intensity. The channel



Depth Feet	Width Feet	Excv. cy/lf	Flow 1,000 cfs	Ratio cfs/cy	Velocity, fps*** 200	320
10	1,500	566	200	0.35		
15	1,500	857	320	0.37	18.3	21.2
15	1,000	580	320	0.55*	18.3	21.2
15	1,000	580	200	0.34		
20	1,500	1,154	320	0.28	16.2	18.8
20	1,000	784	320	0.41		
20	500	414	200	0.48**	22.2	

*Most effective at 320,000 cfs.
**Most effective at 200,000 cfs.
***Velocities from HEC-2 program printout.
****Channel excavation in cubic yards per linear foot of channel, typical.

ALTERNATE WIDTHS AND DEPTHS OF CHANNELS

DEPTHS OF FLOW AT 200,000 CFS AND 320,000 CFS

design project flood has been on the order of 300,000 cfs until recent incomplete reviews of data has led to published preliminary calculations indicating an intensity substantially more than 300,000 cfs may be selected as channel design criteria. In the interim, this study has available the water surface elevation printouts for 200,000 cfs and 320,000 cfs.

The Flood Control District of Maricopa County has designated the Project Flood for purposes of this study to be at a maximum flow rate of 200,000 cfs. The dam breach is to pass the Project Flood without overtopping the remaining dam spillway. A flood intensity which exceeds the gated opening capacity is foreseen to rise to higher stages and spillway discharge would pass the excess.

ANALYSIS OF BREACHING THE DAM

The existing dam is composed of a large concrete apron, or sill, 2 feet thick by 125 feet wide by about 1,700 feet long supported on sediment with driven piling supporting concrete piers between multiple arches. The slab, piers, arches, and walkway are constructed as mutually dependent elements transferring the imposed forces by compression of concrete to the piling and resisting slab uplift by weight of the concrete structure.

The walkway forms the continuous spillway crest at 20.0 feet above the top of sill.

To breach this dam means to remove enough arches, to sill level, to permit a design intensity stream flow through the breach. The gravity type arches transfer the force of the impounded water depth to the piers which receive balancing forces from adjacent piers. If at least one but less than all of the arches were to be removed, the balanced forces at adjacent remaining piers would be brought into imbalance at flood stage and successive piers would

collapse. Therefore, the breaching plan must include the addition of adequate structural support for the two piers at the ends of the breached opening.

If a series of arches is removed, the intermediate piers will necessarily be lowered by removal of the upper 6 feet, and the back arch and walkway will be removed for lack of support. The remaining pier stub wall would then be useless and a channel obstruction to be removed also. Therefore, the extent of breaching should be nearly complete to within 2 feet of the top of sill for a length to provide stream flow capacity equal to the excavated channel. A channel 500 feet in width by 20 feet deep was calculated to be the most effective of alternate cross sections considered for a flood of 200,000 cfs. The existing arches are at 21-foot centers and 24 arches would be removed to provide the breach equivalent to a 500-foot wide channel. The broken concrete would be disposed by burial on-site in channel sides or below stream bed.

There would be two principle effects of breaching without installation of spillway gates. One effect would be lowering of the water surface below the required elevation for gravity diversion to the Gila Bend (East) Canal and reliable diversion to the Enterprise (West) Canal. A subsequent part of this report section provides an evaluation of the pumping station which could replace the lost diversion capability.

The second principle effect of breaching the dam would be alteration of the stream's sediment scour, transport, and deposition regimen. The effects would be radically different for a natural stream bed or a channeled stream bed. The existing wedge of sediment deposited upstream from the Dam is about 18 feet above the sill at the arch face. The braided channel(s) and broad spreading stream result in lower velocities and minor scour and transport of sediment in an unpredictable pattern of degradation and aggradation.

Breaching the 20-foot dam and providing constructed channels of adequate capacity would contain the streamflow but at much greater velocity. The increased velocity would provide more available energy for scour and transport within the channel limits. Therefore, coarser exposed sediment would be expected to be eroded and transported along the channel to be deposited in the pool above Painted Rock Dam. This process would be expected to recur with successive floods of varying intensities until a new stream regimen was established and a more uniform stream bed was created. The sequence of flood frequency/intensity events is not predictable in the short-term and is primarily dependent on upstream dams' release rates. Release rates cannot be planned for control of flood intensity solely in the reach of the Gila River near Gillespie Dam. Therefore, breaching and channeling, without addition of spillway gates, must be considered to result in uncontrolled transition to the more uniform stream bed.

Construction of a pilot channel of substantial width and depth but less than 500 feet by 20 feet, for example, could be provided with the intention of creating scour of the channel bottom and erosion of the sides; sediment transport; and deposition in Painted Rock Reservoir.

The probable significant benefits of this alternative are early implementation, minimal project costs, and minimal volume of excavated sediment to dispose. With pumped irrigation water diversion, the related benefits would be retained.

The probable significant costs of this alternative are demolition and construction costs plus O&M costs for pumping. Possible significant additional costs are related to occurrence of a major flood before successive minor floods had completed a harmless transition of sediment transport to Painted Rock Reservoir. A major flood occurring in a channel with inadequate capacity could not only result in damage by flooding upstream but, also, flooding and uncontrolled

sediment deposition downstream between Gillespie and Painted Rock Dams. With excessive sediment transport, there would be a related problem at Painted Rock Dam of controlling sediment transport downstream.

Flood control by this ungated breaching alternative is to be considered less reliable than by gated breaching. The benefit/cost ratio estimate would be less reliable than for a gated breach project because of the indeterminate sequence of minor and major floods and the dependent consequences.

PUMPED DIVERSION FACILITIES

An ungated breached Gillespie Dam would effect a lowered water surface that would preclude gravity diversion to the Gila Bend (East) Canal and reduce the diversion potential to the Enterprise (West) Canal. To restore the diversion capability would require pumping from the lowered water level to diversion canals. The operation and maintenance of pumping facilities would be at added long-term costs and demand efficient operation. The capacity to be provided would be the maximum flow rates required for the diversion requirements.

In the following development of a preliminary plan, the pump station is considered to utilize large capacity pumps mounted over a large wet well with electric equipment mounted above flood stage. The pump station is sited on the existing dam's concrete apron near the existing Gila Bend (East) Canal diversion gates. The existing 4-foot high concrete stilling weir is assumed to remain in place to provide a minimum water level to the wet well inlet weirs.

The preliminary design criteria used are:

1. The design flood stage is 200,000 cfs.
2. The Enterprise (West) Canal design diversion rate is 20 cfs.
3. The Gila Bend (East) Canal design diversion rate is 160 cfs.

4. The pump station design diversion rate is 160 cfs assuming the 10 cfs existing Enterprise (West) Canal gravity diversion rate will be available concurrently with maximum pumped diversion rate (East) and coincident maximum demand rates (East and West) will not be required.

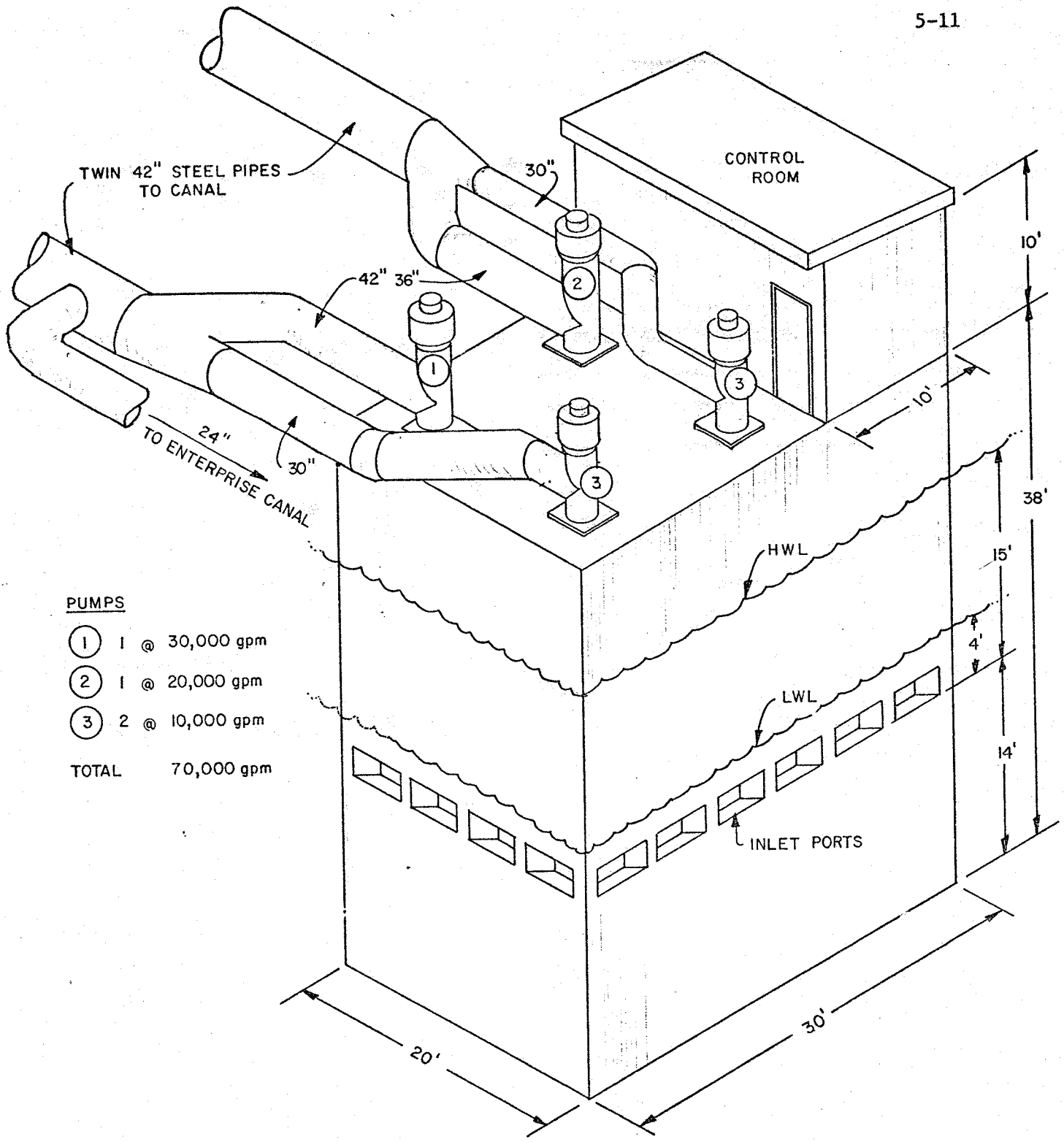
On Plate 5-2, a preliminary sketch of the pump station includes principle dimensions of the structure, its inlet features, its arrangement of 4 pumps and piping, and the electrical controls building. Inlet ports are at the apron elevation. The sump is 20 x 30 x 14 feet providing storage, below inlet weir level, of about 63,000 gallons.

Four pumps in 3 capacities are planned as:

1 @ 30,000 gpm	(300 hp)	=	30,000 gpm
1 @ 20,000 gpm	(200 hp)	=	20,000 gpm
2 @ 10,000 gpm	(150 hp)	=	20,000 gpm
Totals	(800 hp)		70,000 gpm (156 cfs)

The average pumping head is planned to be about 25 feet. Twin 42-inch diameter steel discharge pipelines are planned for the short distance to the Gila Bend (East) Canal and one 24-inch diameter steel discharge pipeline, about 1,500 feet long, to the Enterprise (West) Canal. Complete electrical equipment is included in the plan to provide individual or combined operations of all 4 pumps to provide pumping rates in increments of 10,000 gpm (22 cfs) from 10,000 gpm (smallest pump) to 70,000 gpm (all pumps). At 10,000 gpm the 63,000 gallon wet well low water capacity represents a pumping time of only 6 minutes. Low water level pump shutoff would be controlled at water depth in ports.

The principal advantage of this alternate diversion facility is to restore the diversion capability lost by breaching the dam. The two principal disadvantages are costs and energy consumption. Costs are the one time construction



PRELIMINARY SKETCH - IRRIGATION PUMPING STATION

GILLESPIE DAM MODIFICATIONS

Plate 5-2

cost and the cumulative operation and maintenance costs. Energy consumption at 25 feet TDH and 60 percent system efficiency is about 43 kilowatt-hours per acre-foot.

SPILLWAY GATE TYPES CONSIDERED

By installing spillway gates in the proposed breach through the dam, the flood flow can be passed by opening gates and, during lower flow stages, the closed gates can impound stream flow in the upstream channel for gravity diversion. The preliminary selections from proven gate types is based upon operating features and customary applications to the projected characteristics of channeled stream flow at the Gillespie Dam site.

Floating objects at flood stage should be expected to include brush, urban trash, and larger objects such as power poles, trees, and wooden structures. Gated openings should be about 30 feet wide, say, to provide adequate clearance and prevent bridging by large floating objects. The gates should be at least 20 feet high when closed to maintain existing diversion capability.

Alternate types of gates considered are:

1. Radial, most common to this type service.
2. Roller, applicable, less common, more expensive.
3. Ring, top entry to shaft and tunnel not applicable.
4. Drum, recessed, existing spillway height inadequate.
5. Vertical Leaf, inapplicable for long, clear opening.

For the purpose of this study, the radial type gate is the selected type for the reasons that the ring, drum, and vertical leaf types are not applicable for the existing conditions and the roller gate type is more complex and expensive than the radial gate to attain the simple functional positions, full-open and closed, for this application.

PRELIMINARY PLAN - RADIAL GATES

Radial gates consist of circular segments, fabricated from steel plates and standard steel shapes, supported by fabricated steel space frames which transmit the forces of hydraulic pressure and structural weight to stub shafts and trunnion bearings mounted in concrete buttress walls. For application to Gillespie Dam and a design flood of 200,000 cfs, the breached and gated opening is to be correlated with a 500-foot wide channel and a water depth of 20 feet.

Preliminary design calculations indicate the individual gate lengths should be 42 feet supported by buttress walls at 30 feet on centers. Plate 5-3 presents the general conformation and dimensions in the plan view and a sectional view. The structural support is indicated, typically, as required at each end of the breach to stabilize the remaining existing arches.

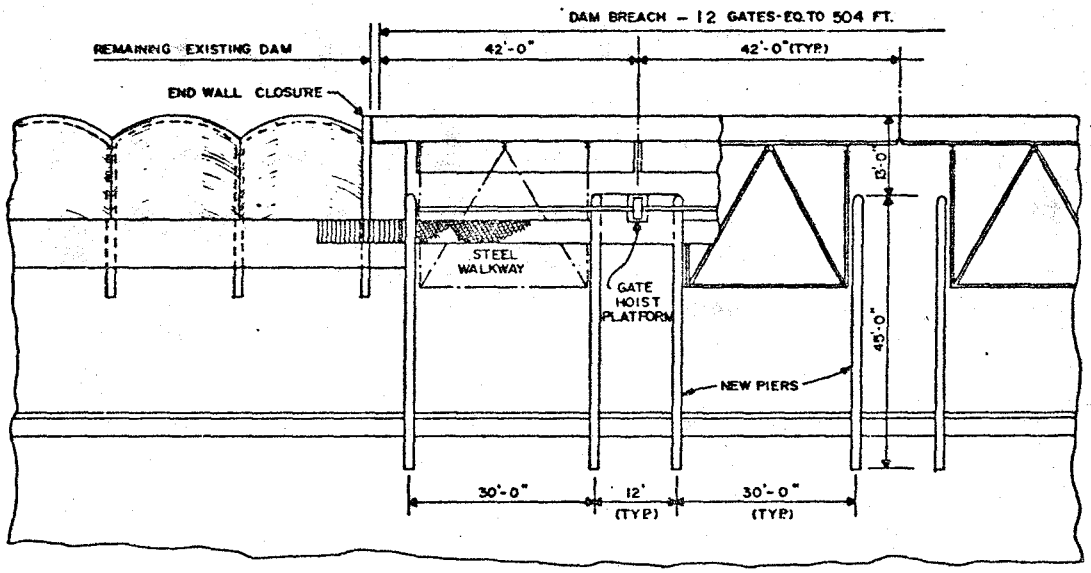
A motor powered gate hoist and cable is indicated to be located on a concrete operating deck which spans the space between buttress walls, about 10 feet. The angled steel plate forming the top of the gate would receive a lifting force, adequate to open each gate automatically, when rising water level reaches the height where uplift exceeds the buoyed weight of the gate assembly.

A steel walkway with railings is indicated to span the breach with steel stairways to the remaining existing concrete walkway.

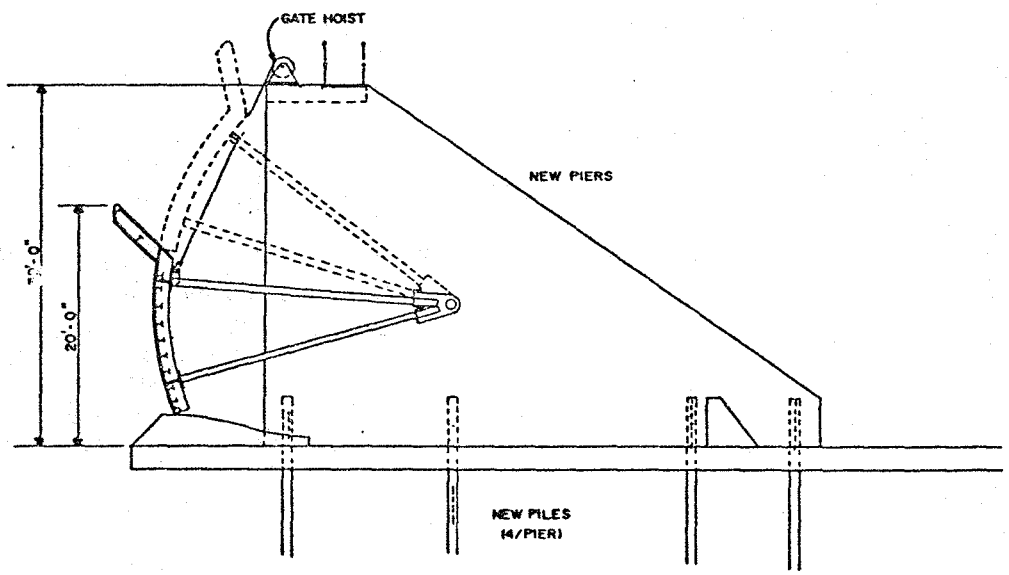
This preliminary plan includes piling driven to bedrock under each new wall to provide stable support for the gates in all operating positions.

SUMMARY OF DAM MODIFICATION CONCEPTS

Eight goals to be attained by structural modifications to Gillespie Dam are listed in this Section 5. Alternate concepts for attaining those goals are discussed. Two alternate projects have been chosen for estimated cost comparisons. Recommendation is to be made of a single project.



PLAN VIEW



ELEVATION VIEW

PRELIMINARY PLAN FOR PROVIDING SPILLWAY GATES

GILLESPIE DAM

In Table 5-1 there is entered a preliminary evaluation of goals attainment for alternate projects. This evaluation matrix serves the purpose of comparing the relative potential of each alternative to attain each of the goals. Two evaluation symbols are used in Table 5-1 to indicate either attainment or non-attainment of each goal. Attainment is indicated by a "+". Nonattainment is indicated by a "0". Three footnotes define the implications of symbols with regard to specific goals. In addition to the No Project alternative there are five alternatives based upon breaching Gillespie Dam and constructing approach and release channels. The breached dam would lower the flowing water surface at all flow stages but, therefore, would require pumping to divert irrigation water. Gates installed in the breach would permit full channel capacity release at all flow stages and permit gravity diversion at noncritical flow stages. Entries in two columns, in Table 5-1, indicate goals attainment evaluations for the ungated breach; and three columns, for alternate gated breach widths with alternate channel widths and depths.

The No Project alternative fails to attain 3 of the goals, all related to lowering the water surface elevation at flood stage.

Without pumps the ungated breach fails to meet 3 goals, all related to loss of diversion capability.

With pumps, the ungated breach fails to meet 3 goals, all related to the costs of installing, operating, and maintaining the pumping facilities.

With a 1,500-foot breach, gated, 3 goals are not met. Gravity diversion is restored by gating the breach without imposing significant O&M requirements. However, implementation time and costs would be greater than without gates, with pumps.

TABLE 5-1

GOALS VERSUS ALTERNATIVES COMPARISONS

GILLESPIE DAM MODIFICATION REPORT

+ = Attainment
0 = Nonattainment

Goals	Alternate Dam Modifications					
		Breach Dam & Develop Channel				
				Add Gates, Depths x Widths		
	No Project	W/O Gates W/O Pumps	W/O Gates With Pumps	10' x 1500'	15' x 1000'	20' x 500'
1-1 Maintain Diversion Capability	+	0	+	+	+	+
2-1 Maximize Project Reliability (1)	+	0	+	+	+	+
2-2 Minimize Implementation Time (2)	+	+	+	0	0	0
2-3 Minimize Flood Damages (2)	0	+	+	+	+	+
2-4 Minimize Project Costs (3)	+	+	0	0	0	+
2-5 Minimize O&M Requirements (3)	+	+	0	+	+	+
2-6 Maximize Benefit/Cost Ratio (2)	0	0	0	0	0	+
2-7 Minimize Flood Plain Relocations	0	+	+	+	+	+

(1) Reliable diversion, flood control, and channel maintenance.

(2) Each compared to "W/O Gates, with Pumps".

(3) Each compared to 20 x 500 foot channel, cfs/cy = 0.48

The 500-foot breach, gated, can release flood stages with a channel 20 x 500 feet. Only one goal is not met: minimize implementation time. The channel excavation ratio, capacity per cubic yard, is the best of the 7 cross sections evaluated on Plate 5-1 for the 200 cfs project flood.

The 1,000-foot breach, gated, with a 15 x 1,000 foot channel fails to meet 3 goals. This alternative does retain the 320,000 cfs flood stage within the channel.

In summary, Table 5-1 entries indicate that the gated breach, without pumps, with a 20 x 500 foot channel attains the set goals better than the compared alternatives except for the inevitable implementation time required to construct the large channel. Therefore, the recommended project includes breaching the Dam; installing about 504-feet of gates; constructing an approach channel and dike equivalent to a 20 x 500 foot channel; and constructing a release channel adequate to protect the downstream pipeline facilities owned by EPNGCO, a reach of about 1,500-feet in length.

COST ESTIMATES

From the evaluations entered in Table 5-1, there appear to be two alternate projects to be priced for evaluation of estimated project costs, and estimated operation and maintenance costs but not including channeling costs:

I. Breach 504 feet of dam and add a pump station for diversion of irrigation water.

II. Breach 504 feet of dam and add radial gates to maintain gravity diversion capability for irrigation water.

These alternate projects' cost estimates are prepared to account for all considered construction at 1980 cost index with 20 percent added for incidental costs. Incidental costs include legal, engineering, and administrative costs.

Operation and maintenance costs are estimated at 1980 cost index for a 50-year period and expressed as present worth for addition to project costs for comparison of the estimated alternate projects' costs.

Breaching of 504 feet of Gillespie Dam, 24 of the existing 79 arches, was considered to be accomplished by air powered tools, by crane-slung ball, or by explosives. The resulting broken concrete debris was considered to be buried below stream bed or incorporated into adjacent channel side slopes. The two new structural walls required to stabilize the two remaining adjacent arches are required after breaching, with or without gates.

The estimated present worth values for each of the two alternate programs are calculated using a useful life of 50 years and a discount rate of 3 percent per annum.

I. Breached dam with pump station: $11,509,000

II. Breached dam with radial gates: $2,837,000

Alternative II is significantly more energy efficient than is Alternative I.

Alternative I does not provide the stream flow control of flood rates.

Table 5-2 summarizes the calculations of estimated present worth and annualized costs for Alternative I.

Table 5-3 summarizes the calculations of estimated present worth and annualized costs for Alternative II.

Estimated operation and maintenance costs in Alternative I for pumping service are based on an estimated average pumping rate of 10 cfs to the Enterprise (West) Canal and 147 cfs (11 of 12 months at 157 cfs) to the Gila Bend (East) Canal. The pumping total dynamic head of about 25 feet, an estimated system efficiency of 60 percent, and an estimated power cost of 6¢/kw-hr are the other factors applied in calculating the estimated average annual power cost.

TABLE 5-2

PRESENT WORTH AND ANNUALIZED COST ESTIMATE
BREACHED DAM WITH PUMP STATION

GILLESPIE DAM MODIFICATION ANALYSIS
(Expressed in Thousands of Dollars)

	Project Cost	Present Worth of Replacement @ 20 Years	Present Worth of Replacement @ 40 Years	Total Present Worth	Annualized Cost Over 50 Years
BREACH DAM					
Demolition & Disposal	31			31	
New Structures	38			38	
20% Incidental	14			14	
Subtotal	83			83	3.2
CONSTRUCT PUMP STATION					
Structural	300			300	
Pumps & Motors	250	138	77	465	
Electrical Equip.	230	127	71	428	
Elec. Transmission	100			100	
Piping & Valves	250		77	327	
20% Incidental	226	53	45	324	
Subtotal	1,356	318	270	1,944	75.6
ANNUAL MAINTENANCE COSTS					
Structural @ 1%					3.0
Pumps & Motors @ 4%					10.0
Electrical Equip. @ 4%					9.2
Elec. Transmission @ 1%					14.3
Piping & Valves @ 2%					5.0
Subtotal				1,068	41.5
ANNUAL OPERATING COSTS					
Power @ 6¢/kw-hr					267
Labor 3000 Mhr @ $20					60
Subtotal				8,414	327
Total	1,439			11,509	447.3

NOTE: Calculations of present worth and annualized cost of capital items are based on a discount rate of 3% per annum.

TABLE 5-3

PRESENT WORTH COST ESTIMATE
BREACHED AND GATED DAM PROGRAM

GILLESPIE DAM MODIFICATION ANALYSIS
(Expressed in Thousands of Dollars)

	Initial Construction Cost	Present Worth of Replacement @ 20 Years	Present Worth of Replacement @ 40 Years	Total Present Worth	Annualized Cost Over 50 Years
BREACH DAM					
Demolition & Disposal	31			31	
New Structures	38			38	
20% Incidental	14			14	
Subtotal	83			83	3.2
INSTALL GATES					
Structural	713			713	
Mechanical	522		160	682	
Electrical	20	11	6	37	
20% Incidental	251	2	33	286	
Subtotal	1,506	13	199	1,718	66.8
ANNUAL MAINTENANCE COSTS					
Structural @ 1%					7.1
Mechanical @ 2%					10.4
Electrical @ 4%					0.8
Subtotal				470	18.3
ANNUAL OPERATING COSTS					
Power @ $2,000 min. rate					2.0
Labor 1,000 man-hour @ $20					20.0
Subtotal				566	22.0
Total	1,589			2,837	110.3

NOTE: Calculations of present worth and annualized cost of capital items are based on a discount rate of 3% per annum.

Avg. flow = 157 (11/12) = 144 cfs, or 93 mgd

kw-hrs/mg = TDH(ft) x 3.15/dec. effic.

= 25 x 3.15/0.60 = 131.3

131.3 kw-hrs/mg x 93 mgd = 12,200 kw-hrs/day

12,200 kw-hrs/day x 365 days = 4,453,000 kw-hrs/yr

4,453,000 kw-hrs/yr x 50 yrs = 222,650,000 kw-hrs

222,650,000 kw-hrs x $0.06/kw-hr = $13,359,000 (50-yr)

4,453,000 kw-hrs/yr x $0.06/kw-hr = $267,000/yr

Annual maintenance costs are estimated as a percentage of construction costs at:

Structures:	1%
Gates, Piping and Valves:	2%
Pumps and Motors:	4%
Electrical Equipment:	4%
Electrical Transmission Line	1%

Cost escalation with time has not been included in these estimates. The functional life of the dam modifications considered are estimated to be:

Concrete structures	50-year
Pumps, motors, & electric equipment	20-year
Electrical transmission lines	50-year
Piping and valves	40-year
Gates and mechanisms	40-year

FIRST FIVE-YEAR ANNUAL CASH DISBURSEMENTS SCHEDULE

The following cash disbursements schedule, Table 5-4, is based upon an allowance of one year for preparation of contract documents and 3 years to construct modifications to Gillespie Dam. The schedule does not include related

TABLE 5-4

5-YEAR ANNUAL CASH DISBURSEMENTS SCHEDULE

GILLESPIE DAM MODIFICATIONS REPORT
(At 1980 Cost Index)

	W/O Gates, With Pumps			With Gates, W/O Pumps		
Year	Design Phase	Constr. Phase	Cumul. Totals	Design Phase	Constr. Phase	Cumul. Totals
1 *	$120,000			$132,000		
2		$ 700,000			$ 700,000	
*		70,000			70,000	
		$ 770,000	$ 770,000		$ 770,000	$ 770,000
3		500,000			625,000	
*		50,000			63,000	
		$ 550,000	$1,320,000		$ 688,000	$1,458,000
Subt.	$120,000	$1,320,000		$132,000	$1,458,000	
Total	$1,440,000			$1,590,000		
			Operating Phase			Operating Phase
4			$ 369,000			$ 40,000
5			$ 369,000			$ 40,000

Note: Totals from Tables 5-2 and 5-3

* Typical 10% incidental cost increment

channel excavation or dike construction. The fifth year is the first year of operating the new facilities. The operating phase cost estimates are typical for successive years. All cost estimates are at 1980 cost index without any projected cost escalation. Incidental costs, 20 percent of construction costs, are proportioned 10 percent to the design phase and 10 percent to the construction phase.

SECTION 6

BENEFIT/COST DATA

RECOMMENDED PROJECT

SCOPE OF BENEFIT/COST ANALYSIS

The scope of work for this study and Report limits the development of Benefit/Cost Data to the recommended project and does not include anything for alternate projects. The scope of work does not include preliminary design of upstream and downstream channels to complement structural modifications to Gillespie Dam. However, the scope of work does include the consideration of channelization costs.

The Flood Control District of Maricopa County provided a range of channel cost estimates which had been prepared in related studies and they are:

Channel Width (Feet)	Cost Estimate Range (Million Dollars)
2,000	7-11
1,500	5-8
1,000	3-6
500	2-3

The Arizona Republic (January 3, 1980) reported that the Flood Control District of Maricopa County had contracted for clearing the Gila River bed from Gillespie Dam upstream for 7 miles, to a width of 300 feet, at a low bid of $178,500. That amount represents an average clearing construction cost of $8,500 per mile per 100 feet wide.

At this time the upstream flood control program has not been completed. Without a recommended project upstream it is not possible to develop a coordinated program for the Gila River reach which includes Gillespie Dam. However, certain elements of the upstream program are common to all remaining alternatives and that does permit recommending dam modifications and initial channel improvements.

RECOMMENDED PROJECT

Preliminary planning for a pilot channel upstream from Gillespie Dam is indicated by a typical cross section entered on Plate 6-1. The design would develop a balanced cut/fill section to produce a 50 foot wide pilot channel and adjacent dike to provide for a stream flow 16 feet deep with 4 feet of freeboard to top of dike at the westerly bank. Floodwater could spill over the easterly bank and that risk is to be considered.

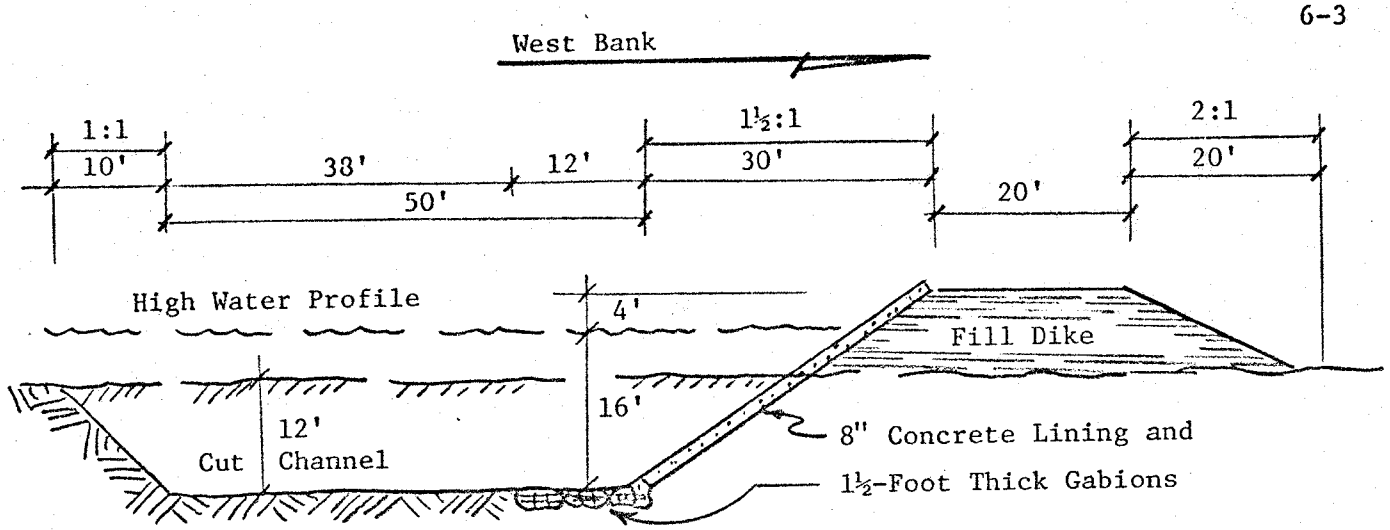
The estimated construction quantities and cost estimate are entered below the typical cross section. Almost 20 percent of the estimated cost is for right of way, 1,200 feet in width for future channel improvement. The estimated project cost is $2,167,000 per mile.

Plate 6-2 is a location plan for the recommended project elements. The base map and land use designations are from mapping by the Natelson Company provided through the Flood Control District of Maricopa County.

Elements of the recommended project are located within the reach from 1/2 mile downstream to 2-1/2 miles upstream from Gillespie Dam. The elements are:

1. 1,200 foot wide right of way.
2. Dike both sides of 1,000 foot wide channel downstream for 1/2 mile.
3. Breach and gate 504 feet of Gillespie Dam.
4. Construct a 50 foot wide pilot channel and 20 foot crest dike along the westerly bank for 2.5 miles upstream from Gillespie Dam.
5. Construct a one mile long diversion dike along the easterly side of the proposed 500 foot wide channel to protect the natural vegetation and cropland areas.

The estimated project costs of the elements comprising the recommended projects are:



TYPICAL CROSS SECTION

50-Foot x 20-Foot Pilot Channel with 20-Foot Crest Dike

Quantities/LF

1. Excv. & Fill:	780 CF/LF	30 CY/LF
2. Gabions:	13.5 CF/LF	0.5 CY/LF
3. Concrete Liner:	26.7 CF/LF	1 CY/LF
4. Right-of-Way:	1200 SF/LF	0.0275 AC/LF

Cost Est./LF

1. Excv. & Fill	$3.00/CY	$90/LF	32%
2. Gabions	$40/CY	$20/LF	7%
3. Class C Concrete	$120/CY	$120/LF	42%
4. R/W	$2000/AC	$55/LF	19%
Total		$285/LF	100%

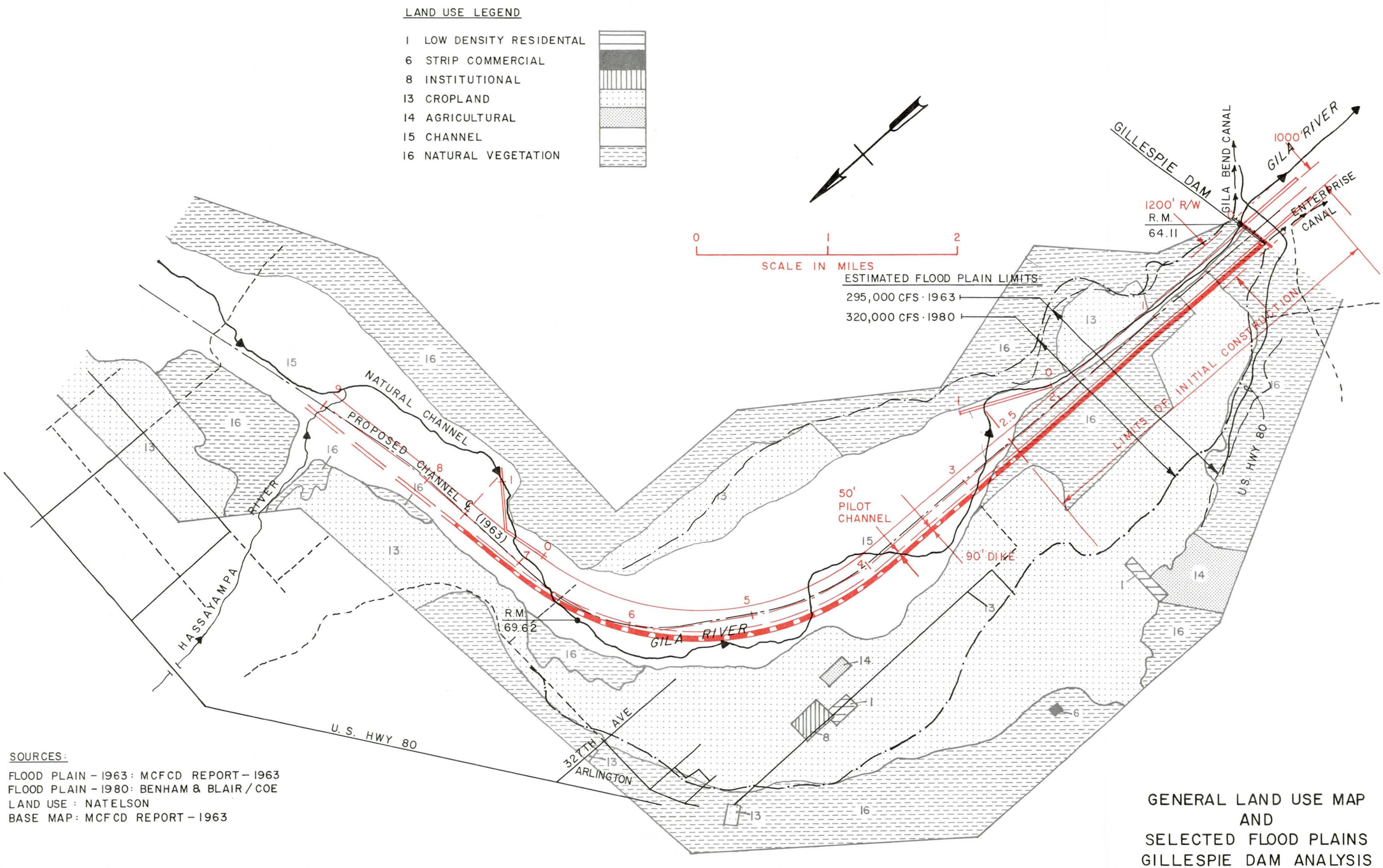
Cost Est./Mile

5280 LF x $285/LF =	$1,505,000/mile
Plus 20% Incidentals	301,000
Plus 20% Contingency	361,000
Total	$2,167,000/mile

PROPOSED GILA RIVER PILOT CHANNEL

GILLESPIE DAM ANALYSIS

Plate 6-1



SOURCES:

FLOOD PLAIN - 1963: MCFCD REPORT - 1963
FLOOD PLAIN - 1980: BENHAM & BLAIR / COE
LAND USE : NATELSON
BASE MAP: MCFCD REPORT - 1963

JOHN CAROLLO ENGINEERS - 1980

GENERAL LAND USE MAP
AND
SELECTED FLOOD PLAINS
GILLESPIE DAM ANALYSIS

PLATE 6-2

1.	Pilot Channel - 2.5 miles @ $230/LF =	$ 3,000,000
2.	Breach and Gate Dam	1,589,000
3.	Dike - 2 miles @ $144/LF =	1,500,000
	Subtotal	$ 6,089,000
4.	Right of Way - 3 miles @ $55/LF =	900,000
	Total Estimated Project Cost	$ 6,989,000

PROJECT BENEFITS EVAULATION PROCEDURE

The procedure to be followed in measuring the beneficial contributions to national economic development (NED) associated with urban flood hazard reduction features of water resource plans and projects is set forth in the Federal Register/Vol. 44 No. 242/December 14, 1979/Rules and Regulations, Subpart G, Article 713.5. Plate 6-3 presents a 10-step diagram of the principle topics to be considered and their interrelationships. The following 10 marginal headings correspond to the 10 topics.

DELINEATE AFFECTED AREA

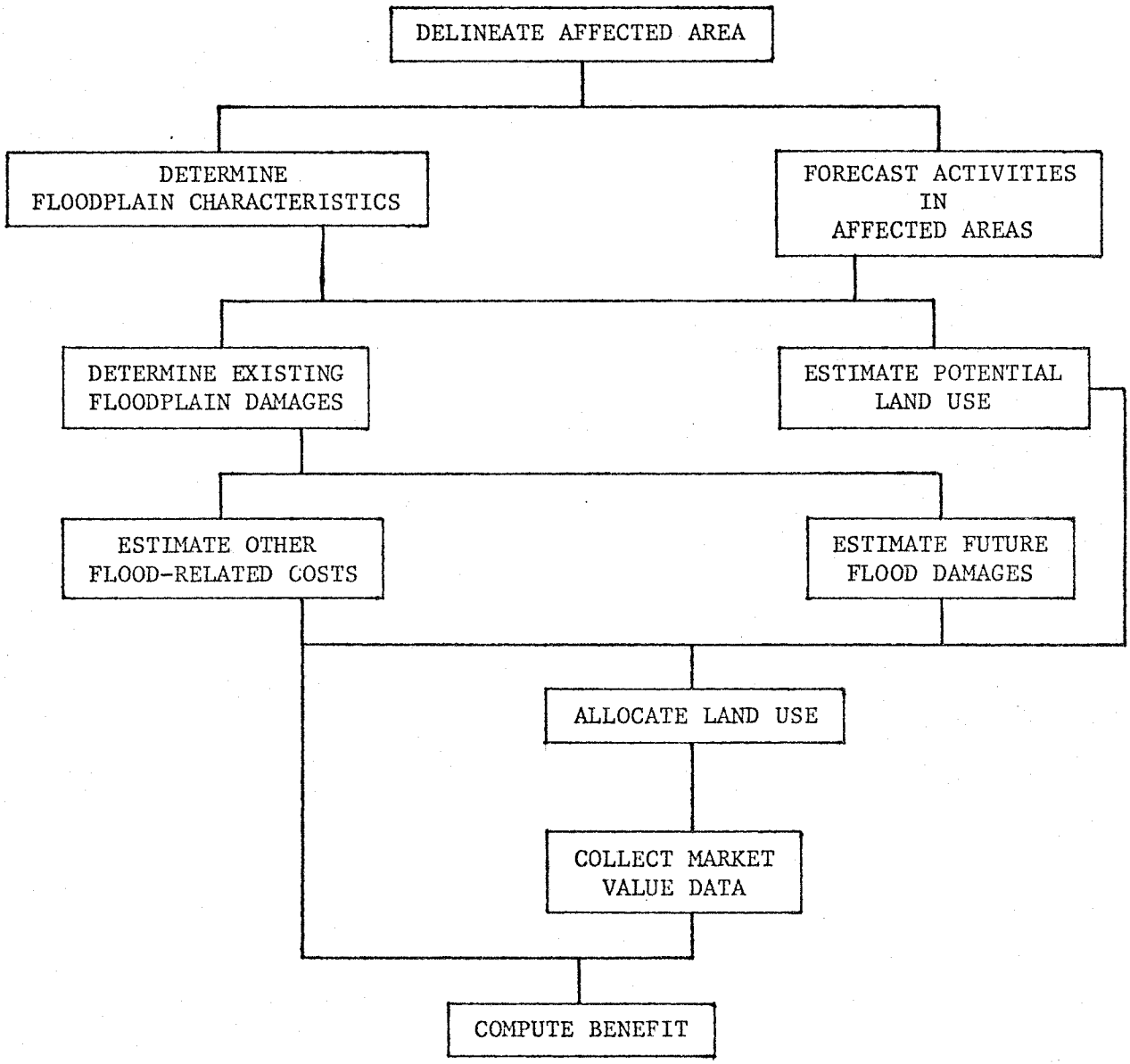
The affected area for this project is the upstream floodplain, the downstream channel, and the Gillespie Dam - dependent irrigated farmlands. The limits of the upstream floodplain are entered on Plate 6-2. The downstream stream bed is indicated on Plate 3-2. The irrigated farmlands general locations extend along the Enterprise (west) and Gila Bend (east) Canals. Those canals' locations are also noted on Plate 3-2.

DETERMINE FLOODPLAIN CHARACTERISTICS

Upstream floodplain land uses are indicated on Plate 6-2. Table 6-1 indicates that the land acreage was derived by planimetering and accumulated to subtotals by land use categories. Of the 24,800 acres in the floodplain, 3 categories of land use dominate the distribution:

PROJECT BENEFIT EVALUATION PROCEDURES

10-STEP GENERAL DIAGRAM



Source: FR Art. 713.501 Subpart G

Plate 6-3

TABLE 6-1

FLOODPLAIN LAND USE AREAS

GILLESPIE DAM ANALYSIS

Land Use Category No.	Land Use Category Description	Planimeter Reading (1.05 = 1 Acre)	Area Acres (1.05 = 1 Acre)	Total By Categories Acres	Total By Categories %
1-1	Low Dens. Res.	11	12		
1-2	Low Dens. Res.	9	9		
1	Total Low Dens. Res.			21	0.08
6	Strip Comm.	2	2	2	0.01
8	Institutional	22	23	23	0.09
13-1	Cropland	180	189		
13-2	Cropland	5,309	5,583		
13-3	Cropland	448	471		
13-4	Cropland	6	6		
13-5	Cropland	9	9		
13-6	Cropland	2,281	2,399		
13-7	Cropland	137	144		
13-8	Cropland	183	192		
13	Total Cropland			8,993	36.23
14-1	Agriculture, other than	132	139		
14-2	Cropland or Pastures	29	30		
14	Total Agr-14			169	0.68
15	Water Bodies or Channel	6,490	6,825	6,825	27.50
16-1	Natural Vegetation	689	725		
16-2	Natural Vegetation	647	680		
16-3	Natural Vegetation	170	179		
16-4	Natural Vegetation	1,690	1,777		
16-5	Natural Vegetation	4,027	4,235		
16-6	Natural Vegetation	93	98		
16-7	Natural Vegetation	20	21		
16-8	Natural Vegetation	61	64		
16-9	Natural Vegetation	380	400		
16-10	Natural Vegetation	120	126		
16-11	Natural Vegetation	457	481		
16	Total Natural Vegetation Area			8,786	35.41
TOTAL FLOODPLAIN ACREAGE				24,807	100.00

Source: Natelson-Supplied Land Use Categories.

Cropland	9,000 Acs	36%
Channel	6,800 Acs	28%
Natural vegetation	8,800 Acs	35%
Other	200 Acs	1%
Total	24,800 Acs	100%

The recommended project should be considered a first stage of the larger project which will traverse this floodplain. The flood protection provided by the larger project will be substantial but this first stage project can, because of inadequate channel capacity, provide flood protection only at relatively low flow stages. The pilot channel capacity would be on the order of 10,000 cfs. The significant effect of breaching the Gillespie Dam is to lower, by 20 feet, the stream bed profile near the Dam and increase the energy gradient and flow rate velocity. The water surface profile would be lowered significantly for flood stages for about one mile upstream from the Dam. Flood damage reduction, in response to the first stage project, is considered to be significant only in this one-mile reach. Floodplain land uses along this one-mile reach are natural vegetation and cropland.

FORECAST OF ACTIVITIES IN AFFECTED AREA

The affected floodplain area, River Mile 64.11 to 65.11, supports smaller wildlife in the natural vegetation and that may attract some infrequent human traffic. The cropland should be considered an enduring land use, except for about 30 acres destroyed by pilot channel and dike construction. The remaining contiguous cropland would not be protected from channel meanders or inundation until the larger project is completed.

The affected downstream areas are the diversion-dependent irrigated lands, for which the diversion capability would be preserved, and the downstream channels, bridge crossings, and underground pipeline crossing.

The downstream channel should be expected to aggrade by deposition of sediment in the first 1/2 mile, because upstream ponding would no longer occur at flow rates in excess of about 200 cfs (the approximate diversion rate). Aggradation should be expected to restore the stream bed to its approximate natural condition elevation, from its existing degraded elevation, in the vicinity of the identified bridge structures. Maintenance of the bridge structures would be continued in the reach, R.M. 64.11 to 63.81, stabilized by dikes spaced by the 1,000 foot channel width.

Between R.M. 63.81 and Painted Rock Dam the river channel could remain unaffected by the recommended project if the gates were held in closed position during flood stage, equivalent to an unbreached dam condition. Open gates, at flood stage occurring prior to completion of the larger project, could induce transport of additional sediment, from that impounded by Gillespie Dam, toward the forming pool above Painted Rock Dam. Unfavorable deposition of sediment could induce excessive channel meanders and/or farmland damage. Farming and wildlife-related recreational activities are expected to be affected downstream in, and adjacent to, the stream bed.

DETERMINED EXISTING FLOODPLAIN DAMAGES

Only a generalized statement can be made in reference to documented floodplain damages in the one-mile reach under consideration. Deposition of Gila River silt and sand on croplands and natural vegetation lands can be beneficial to related production potential. Excess deformation of cropland, graded for surface-flow irrigation, can be damaging. Prevention of detrimental sedimentation cannot be assured by the first stage project recommended. Isolation of historical floodplain damages cannot be accomplished for the limited area being considered.

ESTIMATE POTENTIAL LAND USE

Potential land uses, in the limited area under consideration, are expected to remain natural vegetation and cropland.

ESTIMATE OTHER FLOOD-RELATED COSTS

Other flood-related costs in the reach considered have not been identified.

ESTIMATED FUTURE FLOOD DAMAGES

The HEC-2 water surface profile computer program can be used to project the various land use areas expected to be inundated after completion of the first stage project. Prior to that design study, which can include optimization of pilot channel profiles, the improved floodplain limits cannot be defined.

ALLOCATE LAND USE, COLLECT MARKET VALUE DATA, AND COMPUTE BENEFIT

These titles refer to judgments and calculations which cannot be made until the larger project is defined and the preceding topics have been addressed adequately to quantify the factors involved in those required judgments and calculations.

SUMMARY, BENEFIT EVALUATION

It is concluded that benefit evaluation, by this assigned procedure, is not applicable to this conceptual study of structural modifications to Gillespie Dam and nominal consideration of channelization remaining to be defined in related but subsequent studies.

In compliance with the Scope of Work, the known benefit data and cost data has been included in this Section 6.

When the channelization studies are completed, in coordination with the adopted upstream flood control projects, the data presented in this Section 6 can be integrated into a Benefit/Cost Ratio analysis for the combined project of Dam modification with coordinated channel project(s).

GILLESPIE DAM MODIFICATIONS REPORT

APPENDICES

APPENDIX A

DIVERSION DAMS

Reference: IRRIGATION ENGINEERING, VOLUME II,
Projects, Conduits, Structures - 1956
Ivan E. Houk, Consulting Engineer, Denver, Colorado
DIVERSION DAMS AND STRUCTURES (Chapter 13)

DIVERSION DAMS DIVERT STREAM FLOW TO CANALS

Generally low dams maintain gravity flow to canals.

Canal intake structures include control gates.

Sluice gates control dam releases below spillway elevation and provide for sediment scour.

River channel flood gates may be required.

Special features may include control of floating debris, sand and silt, and fish travel.

For diversion at each end, the dam is usually located in a straight channel reach.

Capacities for diversion and to pass excess flow establish elevations of water surfaces to plan for.

Where upstream inundations would be damaging large flood gates are valuable to minimize high water surface elevations.

DIVERSION DAM TYPES

Principal types of concrete dams include single arch, multiple arch, slab-and-buttress, overflow gravity, and nonoverflow gravity with separate spillway.

Imperial Dam on the Colorado River is a good example of a slab-and-buttress diversion dam constructed on water-bearing sand and gravel beds. The 1,200 foot long weir is designed to pass 142,000 cfs with a 10 foot depth over the weir. The crest is 25 feet above the natural streambed.

Open diversion dams usually include several gate controlled bays on concrete floors, separated by concrete piers and surmounted by operating bridges. This type is desirable when low and normal stream flows carry appreciable loads of sand and silt and where rises in head water levels at flood stage must be kept as small as possible.

STREAMBED AGGRADATION AND DEGRADATION

Streambed retrogression (degradation) is erosion of sediment from a reach below a new dam by cleaner water passing the dam as a result of sediment deposit in the pool above the dam and diversion of sediment to canals. After a time, measured in years, the process reverses and equilibrium is established near the original downstream streambed elevation. The reverse of retrogression is aggradation.

CANAL INTAKES

Canal intakes usually include a gated head works structure, an operating platform, and a hydraulic transition section to reduce gate velocity to canal velocity. Trash racks can be utilized to prevent intake of debris and skimming weirs to maintain intake above the sediment transporting lower depths.

Operating diversion water surface elevation must be adequate for all entrance losses plus depth in canal section.

SLUICEWAYS

Gated sluiceways provide for upstream sediment flushing. For closed type dams, sluiceways at diversion structures are needed. Gates in open type dams can be designed for sluicing sediment without special sluicing gates.

REVIEW COMMENTS

EFFECTS OF DAM REMOVAL: An Approach to Sedimentation
David T. Williams, 1977, Technical Paper No. 50
The Hydrologic Engineering Center, COE-USA

EXTRACTS:

A one dimensional mathematical model was created to simulate sediment scour, transport, and deposition resulting from removal of a river dam. Data was available in relation to removal of the Washington Water Power Dam on Clearwater River near Lewiston, Idaho. Further research was recommended.

Some conclusions are that:

1. The model is applicable if only long range average bed elevation changes are needed. "Long range" is on the order of ten years. Seasonal changes with extreme flow rate conditions are of concern with removal of Gillespie Dam.

2. Bed particle distribution is a sensitive input to the program and representative samples in cross-sections of the meandering Gila River would be expensive to take, process, and study.

3. The natural streambed condition and the post-dam contruction streambed condition is not documented above Gillespie Dam.

4. Therefore, the modeling program (HEC-6) does not seem to be applicable to the data available for the Gillespie Dam site and too many assumptions would have to be made to expect a reliable prediction of sediment scour and downstream deposition.

REVIEW COMMENTS

SUSPENDED SEDIMENT YIELD, March 1968
Hydrologic Engineering Center Computer Program 23-J2-L256

PROGRAM PURPOSE: A suspended sediment transport study at a stream gaging station. The daily load equation applied to mean daily flows provides the estimated annual suspended load at the station. Provisions within the program adjust for bank sloughing and channel alterations during extreme flow rate.

Input requirements include a suspended load record for a time period in years and the size distribution of representative sediment samples. Too many assumptions would have to be made to apply this program to the Gillespie Dam removal site and its consequent unstable channel during initial significant flow rates.

REVIEW COMMENTS

DEPOSIT OF SUSPENDED SEDIMENT IN RESERVOIRS
June 1967 HEC, USA-COE
Computer Program 23-J2-L264

PROGRAM PURPOSE: Determine the reservoir distribution of sediments deposited, sediment inflow load, trap efficiency of the reservoir, and size distribution of passing sediment.

PAINTED ROCK DAM APPLICATION: This program appears to be applicable to the study of sediment deposit at Painted Rock Dam in response to Gillespie Dam breaching with and without addition of spillway gates. It is assumed that the program has been run for Painted Rock Dam without breaching of Gillespie Dam.

The flood release rates from Painted Rock Dam would enter the program and could be varied to account for release rate changes as the downstream channel progressive improvements permit.

Estimates of sediment loads expected to enter the Painted Rock reservoir would be made for alternate study conditions and would introduce corresponding reliability concerns.

JOHN CAROLLO ENGINEERS

PHOENIX ARIZONA | WALNUT CREEK CALIFORNIA | FOUNTAIN VALLEY CALIFORNIA | VISALIA CALIFORNIA

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GEORGE E. SHIRLEY, P.E.
DENNIS K. WOOD, P.E.

October 16, 1980
P02400.A0

Mr. Wesley E. Steiner, Director
Arizona Department of Water Resources
222 North Central Avenue
Phoenix, Arizona 85004

Subject: Surface Water Rights/Gila River/Paloma Ranch Joint Venture

Dear Mr. Steiner:

Our firm has contracted with the Maricopa County Flood Control District to evaluate the feasibility of making structural modifications to Gillespie Dam on the Gila River as a part of their flood control program. Gillespie Dam is a surface water diversion structure with a long history of diversions to the Gila Bend Canal and the Enterprise Canal for agricultural irrigation.

We request a general statement, from the Arizona Department of Water Resources, of the present status of surface water diversion rights at the Gillespie Dam. This statement would be quoted in our Report as one basis for maintaining or developing specific structural features of the Dam to provide for the appropriate diversion function.

Our firm has obtained only an oral statement, from a representative of the Gila Bend and Enterprise Canal operators (Paloma Ranch Joint Venture), of their understanding of their surface water diversion rights: 100 percent of the Gila River Flowrate at Gillespie Dam with a plan to divert up to 10 CFS to the Enterprise Canal and the right to divert the remainder to the Gila Bend Canal.

Our interest at this time is to report the present status of recognized water rights and potential changes. We can work with a range of probable values because our interest is considering alternate structural modifications to the Dam.

We have two weeks to compile this information and enter its effects into an evaluation of alternate modifications.

3308 NORTH THIRD STREET PHOENIX, ARIZONA 85012 AREA CODE: (602) 248-0400

Gila River flooding and irrigated agriculture production are both very important elements of our study. We will appreciate your response to this request and any comments you may care to add. Thank you.

Very truly yours,

JOHN CAROLLO ENGINEERS

Maurice L. Malick

MLM/sf
cc: Mr. Lionel Lewis, Project Engineer
Maricopa County Flood Control District

Mr. Doug Nelson, Attorney
Rollins, Ellis, Burrus, and Kiewit

WATER RIGHTS - ARIZONA STATE DEPARTMENT/WATER RESOURCES

11/12/80

Priority	Enterprise cfs	Enterprise AFY *	Gila Bend cfs	Gila Bend AFY *	Downstream cfs	Downstream AFY *	Cumulative cfs	Cumulative AFY *
1. Enterprise Ranch (1,000 Acs)	10	7,227					10	7,227
2. Gila R. Ranch			(13.1)[3]	9,450			23.1	16,677
3. Pierpont Ranch (960 Acs)					(8.0)[3]	5,768	31.1	22,445
4. Gila River Ranch[2] (25,779 Acs)			(149.8)[3]	108,418			180.9	130,863
5. Enterprise	10[1]	7,227					190.9	138,090
Total		14,454		117,868		5,768		138,090

MLM Deductions

3a. Dam underflow + overflow must be at least 8 cfs when 1 & 2 sum is 23.2 cfs or more.

5a. 138,090 AcFt/Yr x 0.00138 = 190.7 cfs constant rate.

Totals: 117,868 AcFt/Yr x 0.00138 = 162.8 cfs constant rate with about 200 cfs to Dam, and without storage all 5 rights can be satisfied on the average annual basis.

* Up to this cumulative annual limit.

1. Assume Enterprise Canal capacity = 20 cfs, then 20 - 10 = 10 after second, third and fourth are satisfied.
2. Capacity of Gila Bend (east) Canal is given as 160 cfs.
3. Constant rate equivalent to cumulative annual right.

State of Arizona

DEPARTMENT OF WATER RESOURCES

222 North Central Avenue, Suite 850, Phoenix, Arizona 85004

Rec'd
11/14/80
MHL

November 12, 1980

Mr. Maurice L. Malick
c/o John Carollo Engineers
3308 North Third Street
Phoenix, Arizona 85012

Dear Mr. Malick:

Please forgive the error in responding to your letter of October 16, 1980. Through inadvertence, your letter was addressed to Wesley E. Steiner, bearing the date of November 5, 1980.

This error is now corrected by our enclosing a Xerox copy of the November 5, 1980 letter erroneously sent to Wesley Steiner. Also enclosed is a legal memorandum explained in the November 5 letter.

Very truly yours,

W. Don Maughan
Deputy Director

WDW/sm

November 5, 1980

Mr. Wesley E. Steiner, Director
Arizona Department of Water Resources
222 North Central Avenue
Phoenix, Arizona 85004

In Re: Surface water rights/Gila River/Paloma Ranch Joint Venture

Dear Mr. Steiner:

In response to your letter of October 16, 1980, indexed PO2400.AO, please excuse the delay in responding to your inquiry; but at the time of receipt of your letter, this department was in the process of adjudicating two applications to appropriate public waters, one the Pierpont et al., which is A-4940 and Northwestern Mutual 33-41745.

We have prepared a memorandum that will direct your attention to the decreed rights and the statutory adjudicated rights pursuant to the laws of the State of Arizona. The memorandum consists of four pages which points out a first priority, second priority, third priority, fourth priority, and, under certain circumstances, a fifth priority.

If you have any questions concerning the same, feel free to contact me at 255-1581.

Very truly yours,

W. Don Maughan
Deputy Director

WDM/sm
cc: Mr. Lionel Lewis, Project Engineer
Maricopa County Flood Control District

Mr. Doug Nelson, Attorney
Rollins, Ellis, Burrus, and Kiewit

"As a result of these Decisions and Orders, taken together with the amended decree in Maricopa County Superior Court, Case No. 14994, the waters of the Gila River at and below Gillespie Dam are allocated according to the following appropriations and priorities:

"First priority: 10 cubic feet per second up to 7,227 acre-feet per annum, at Gillespie Dam, irrigation use upon approximately 1000 acres of land which are a part of the Enterprise Ranch.

"Second priority: Up to 9,450 acre-feet per annum (13.2 plus c.f.s. constant flow) at Gillespie Dam, to Northwestern for irrigation upon the Gila River Ranch.

"Third Priority: Up to 5,768 acre-feet per annum (8. plus c.f.s., constant flow), divertible below Gillespie Dam only from Gila River water flowing over, through and under Gillespie Dam, to the Pierponts for domestic and stock watering uses, and for irrigation use upon approximately 960 acres of farm land.

"Fourth priority: Up to 108,418 acre-feet of Gila River water per annum (160. plus c.f.s.), at Gillespie Dam, for stock watering and for irrigation use upon approximately 25,779 acres of farm land of the Gila River Ranch.

"Fifth priority1/.: When water is flowing over the Gillespie Dam which would go down the river bed if not more than 10 second feet were taken into the Enterprise Canal, then the operators of the Enterprise Canal may take from such overflowing waters an amount up to the capacity of said canal, subject to the rights of the Pierponts under the Third priority set forth above. (Second and Fourth Seasonal)"

FLOOD CONTROL DISTRICT
of
MARICOPA COUNTY
1959

FLOOD CONTROL DISTRICT
of
Maricopa County

3335 West Durango Street • Phoenix, Arizona 85009
Telephone (602) 262-1501

William D. Mathews, P.E., Chief Engineer and General Manager

B-7

BOARD of DIRECTORS
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George L. Campbell
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Ed Pastor

August 29, 1980

John Carollo Engineers
3308 North Third Street
Phoenix, Arizona 85012

Attn: Donald R. Preisler, P. E.

Re: Contract FCD 80-6
Salt-Gila Clearing, Gillespie Dam Analysis

Dear Mr. Preisler:

Enclosed is one copy of the entry permission for the Gillespie Dam site fully executed and one copy of the HEC-2 computer run of the breaching analysis prepared by the United States Army Corps of Engineers. The requested land use data was transmitted to you earlier by the Natelson Company and the statement of water rights will be forwarded as soon as it is available.

You should consider this letter as formal notice to proceed under the contract with a date of September 2, 1980.

Sincerely,

D Sugamoto

FOR W. D. Mathews, P. E.

Enclosure

Paloma Ranch
Star Route 1, Box 175
Gila Bend, Arizona 85337
August 21, 1980

Mr. Lionel C. Lewis
Project Engineer
Flood Control District
of Maricopa County
3335 West Durango Street
Phoenix, Arizona 85009

Re: Gillespie Dam Analysis

Dear Mr. Lewis:

On behalf of the Flood Control District of Maricopa County (the "District"), you have requested permission from Paloma Ranch Joint Venture ("PRJV") and CRANCO to enter upon and inspect Gillespie Dam, which is owned by PRJV and leased by CRANCO. It is our understanding that the District has employed a certain engineering firm, John Carollo Engineers, to inspect Gillespie Dam (the "Contractor").

By this letter, PRJV and CRANCO grant the District and Contractor a temporary and limited right-of-entry for the purposes stated in the preceeding paragraph. This right-of-entry shall terminate automatically ninety (90) days from the date hereof.

The District and Contractor and any director, officer, agent, or employee of the District or Contractor involved in the above-referenced inspections, jointly and severally, shall indemnify and hold PRJV and CRANCO harmless from, and PRJV and CRANCO in no event shall be liable for, any fines, suits, claims, demands, damages and actions (including reasonable attorneys' fees) of any kind or nature whatsoever brought by or on behalf of anyone whomsoever, by reason of any accident or injury (including death) to any person or damage to property which shall occur due to your inspection in any manner whatsoever on or about the Gillespie Dam.

The District and Contractor, and any and all directors, officers, agents and employees of the District or Contractor involved in the above-referenced inspection further waive any and all right or claim you or any person or entity claiming under you, including but not limited to your employees, agents, or guests, may have against PRJV or CRANCO on ac-

count of any accident or injury (including death) to any person or damage to property which shall occur due to your inspection in any manner whatsoever on or about Gillespie Dam or arise out of the condition, maintenance, disrepair, operation, control, or use of Gillespie Dam.

For purposes of this letter, PRJV and CRANCO shall mean those entities and their co-venturers, partners, officers, directors, employees, and agents.

By the granting of this right-of-entry, PRJV and CRANCO neither consent to the modification of Gillespie Dam, nor admit that Gillespie Dam has caused or will cause any appreciable effect on floodwater flows or inundation of property by those floodwaters. It is further understood by the parties hereto that the granting of this right-of-entry shall not be construed as an approval of the Contractor's conclusions and analytical results.

The right-of-entry as set forth in this letter may be terminated, at any time and for any reason whatsoever, by PRJV or CRANCO, at its sole and exclusive discretion, by giving written notice to the District.

In consideration for the granting of this limited right-of-entry, the District shall provide PRJV with seven (7) copies of any and all reports, work papers, correspondence, drawings, surveys, and all other documents prepared by the Contractor, in connection with or relating to the inspection of Gillespie Dam.

We would appreciate your executing this document, and through such execution agreeing to its terms, conditions and covenants, and returning it to us.

PALOMA RANCH JOINT VENTURE and
CRANCO

By W. J. Wolf
Its General Manager

FLOOD CONTROL DISTRICT OF
MARICOPA COUNTY

By W. D. Mathews
Its CHIEF ENGINEER AND GENERAL MANAGER

JOHN CAROLLO ENGINEERS

By Donald A. Parish
Its Partner

Encl.: Copy of this letter

JOHN CAROLLO ENGINEERS

PHOENIX ARIZONA | WALNUT CREEK CALIFORNIA | FOUNTAIN VALLEY CALIFORNIA | VISALIA CALIFORNIA

JOHN A. CAROLLO, P.E. (1906-1971)
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GEORGE E. SHIRLEY, P.E.
DENNIS K. WOOD, P.E.

October 16, 1980
P02400.A0

Paloma Ranch/Field Office
Rural Route 1
P. O. Box 175
Gila Bend, Arizona 85337

Attention: Mr. Bob Stiles, Engineer

Re: Gillespie Dam Analysis Report
Maricopa County Flood Control District

Gentlemen:

On September 17, we discussed by telephone, our firm's desire for information concerning Gillespie Dam surface water diversions to your canals. At your suggestion, we called Mr. Doug Nelson about surface water diversion rights.

We understood you were to send us a brief of your development status and projected developments which we could use in demonstrating benefits of the diversion dam function. We have obtained long-term records of monthly diversions to the Enterprise and Gila Bend Canals. If you could provide a statement of present irrigated acreage and your long-term (to year 1990 or year 2000, for example) projected acreage and water requirements it would provide a substantial base for evaluating benefits of maintaining maximum diversion capability.

For your information, our study to date indicates that existing Gillespie Dam structural foundations are probably not adequate to support radial gates and new piling to bedrock would be required to breach the arch sections and install flood relief gates while maintaining the equivalent of existing diversion capability.

Please respond to the extent that you consider reasonable for the purpose of our study. We will appreciate your effort.

Very truly yours,

JOHN CAROLLO ENGINEERS

M. L. Malick

MLM/mh

3308 NORTH THIRD STREET PHOENIX, ARIZONA 85012 AREA CODE: (602) 248-0400

JOHN CAROLLO ENGINEERS

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DENNIS K. WOOD, P.E.

September 11, 1980
P02400.AO

El Paso Natural Gas Company
P. O. Box 6
Casa Grande, Arizona 85222

Subject: Engineering Data Request
EPNG Crossings Gila River Below
Gillespie Dam

Attention: Mr. A. E. Stratman

Gentlemen:

Our firm is preparing a report for the Maricopa County Flood Control District on structural modifications to Gillespie Dam on the Gila River. We are to evaluate the effects of any recommended changes on the highway bridge and EPNG Co. pipeline crossings of the Gila River just downstream from Gillespie Dam. We need to know the location, spans, vertical clearance, and foundation details for suspension bridges plus location, size, material, and protection of buried pipe under the streambed.

The Gillespie Dam is located in Section 28, T 2 S, R 5 W, G&SRB&M. The pipeline appears to be in the same section on our small scale map.

EPNG Co. may have plans for changes because of recent Gila River floods and, if so, we would like to have that information for consideration also.

Very truly yours,

JOHN CAROLLO ENGINEERS

Maurice L. Malick

Maurice L. Malick

MLM/mh

3308 NORTH THIRD STREET PHOENIX, ARIZONA 85012 AREA CODE: (602) 248-0400

EL PASO NATURAL GAS COMPANY PIPELINE CROSSINGS

Two suspension bridges support aerial pipeline crossings of the Gila River. EPNGCO provided construction drawings for each bridge. The first structure drawings are dated "1947" and the second, "1950". Both bridges appear to be in sound condition and well maintained.

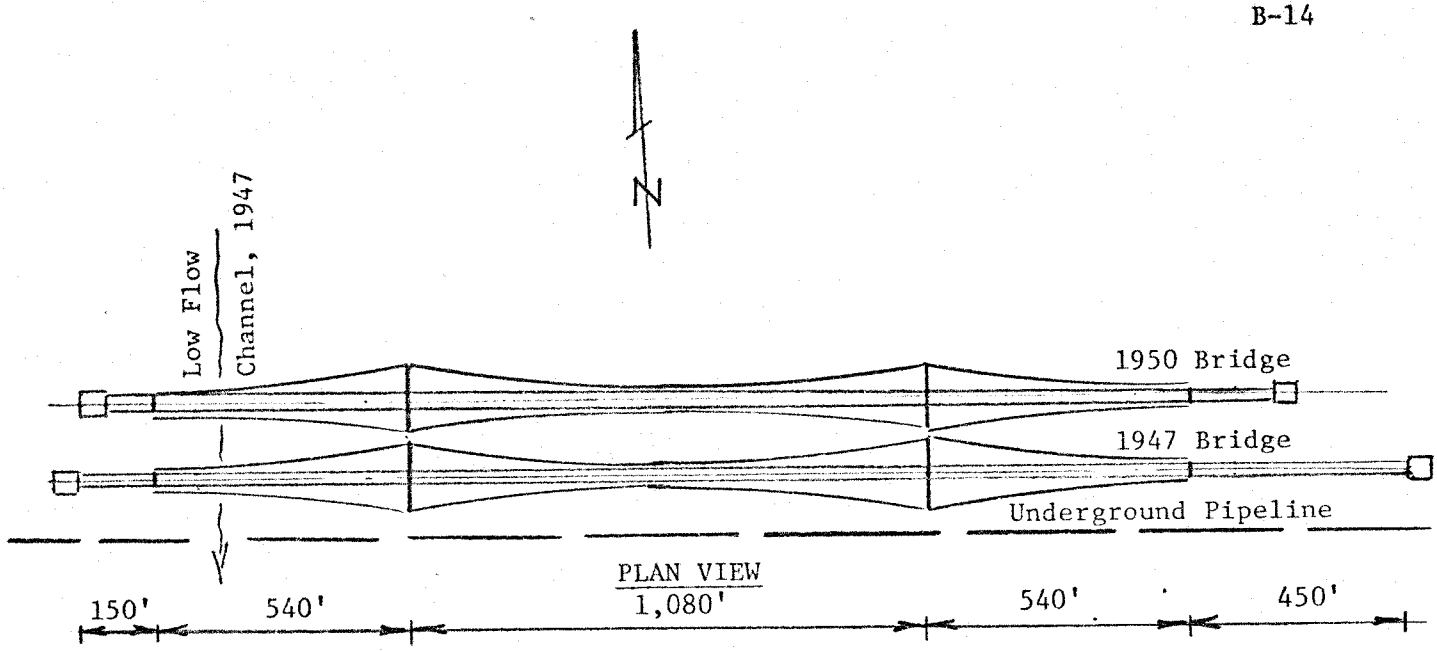
A 1,000 foot wide channel could be centered below the bridge center span of 1,080 feet. EPNGCO requested, in their data transmittal letter, that diversion facilities be constructed to maintain streamflow towards the center of the river.

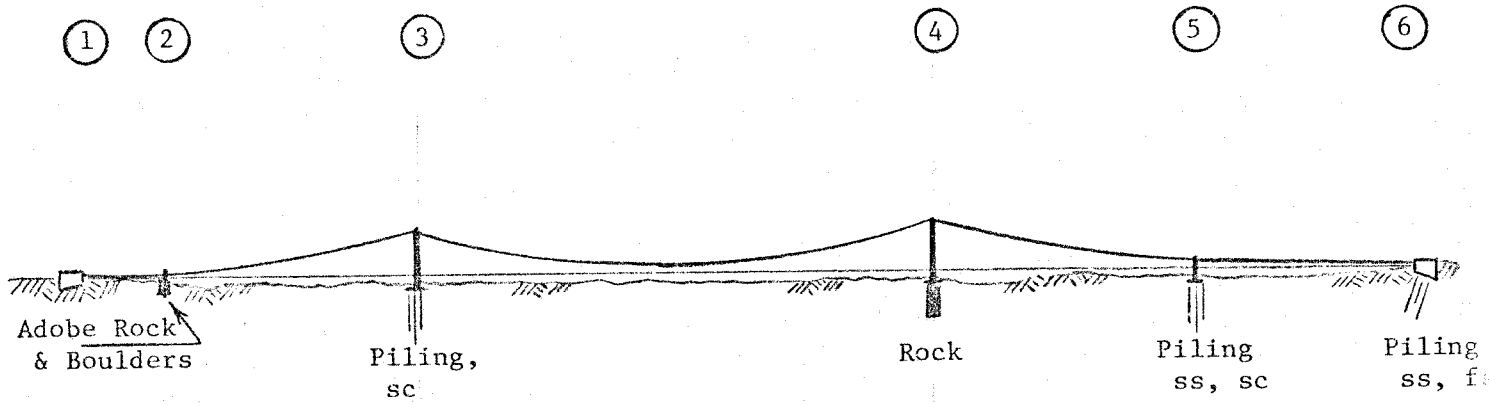
The following Plate B-1 includes a sketch and notes derived from EPNGCO drawings. Notes concerning the highway grade crossing are opinions derived from field observations.

An underground pipeline, Gila River crossing profile drawing supplied by EPNGCO indicates that a special design detail for 30-inch O.D. steel pipe of 0.450-inch wall thickness, Class X-60, was placed with 7.5 feet average depth of cover, in the riverbed, for a distance of 2,710 feet. Seventy-five concrete river weights are located at 25 feet on centers.

The 1970 ground line profile and the April 22, 1980 ground line profile, both entered on the profile drawing, indicate that substantial degradation of the channel occurred and probably stressed the steel pipeline significantly during the last major flood.

The top of pipeline is about 720 feet elevation. Gillespie Dam top of sill is 732.5 feet elevation, about 12.5 feet higher than the top of the underground pipeline in the stream bed. The top of deck on the old highway bridge is recorded at 752 feet elevation, 19.5 feet above the Dam sill.





ELEVATION (1947)

NOTES:

Foundations 1, 2, & 4 extend to rock bases.
Foundations 3, 5, & 6 are set on piling in sand or sandy clay.
Piling depth from top of concrete: F3, 95'.
Rock depth from top of concrete: F4, 54'.

PRINCIPLE FEATURES OF EPNGCO SUSPENSION BRIDGES

Gillespie Dam Modifications Report

Source: EPNGCO Construction Drawings.

Plate B-1

It appears that a properly designed flood control channel can be constructed from the Dam downstream compatible with the existing highway bridge, both pipeline suspension bridges and the underground pipeline. The highway grade crossing will be subject to extensive damage after the Dam is breached and gated but no more nor less than under existing conditions.

The transmittal letter from EPNGCO is reproduced on the following two pages.

El Paso NATURAL GAS COMPANY

P. O. BOX 1492
EL PASO, TEXAS 79978
PHONE: 915-543-2600

November 20, 1980

JOHN ... ENGINEERS
NOV 24 1980
RECEIVED

John Carollo Engineers
3308 North Third Street
Phoenix, Arizona 85012

Attention: Mr. Maurice L. Malick

Re: R/W 801740 Encroachment: Structural Modifications to Gillespie Dam-Gila River California Lines M.P. 625 Maricopa County, Arizona

Gentlemen:

Reference is made to your letter dated September 11, 1980, concerning the captioned.

In response to the information you requested, the following is provided:

30" O.D. Waha-Ehrenberg Line

1. Attached is a copy of drawing numbered 1600.2-16 showing El Paso's profile of its 30" pipeline across the Gila River. The drawing shows the as-built top of pipe, ground line at time of construction and ground after the flood in the early part of this year.
2. Location - Section 28, Township 2 South, Range 5 West, G.&S.R.B.&M.
3. Size - 30" O.D., .450 w.t., X-60 pipe (2,807.8').
4. Protection - Average depth across river of 7.5' with 72 set on river weights at 25' O.C.

26" (1100) and 30" (1103) California Lines

1. Attached are the foundation detailed drawings of El Paso's bridge crossings.
2. Location - Same as above.
3. Spans - Line 1100 - 2,163.5' of 26" O.D., .375 w.t., X-52 pipe.
   Line 1103 - 2,432.7' of 30" O.D., .375 w.t., X-52 pipe.
4. Minimum vertical clearance - 18'2".

John Carollo Engineers
Attn: Mr. Maurice L. Malick

November 20, 1980
Page 2

We respectfully request that the Maricopa County Flood Control District consider some sort of diversion such as rock wings in order to direct the water flow towards the center of the river.

At such time that your final detailed report and plans are available, we would appreciate your sending us two (2) sets for our review and comment.

Very truly yours,

Allen Gattis
Manager
Titles-Controls Division
Right of Way Department

LPL/em
Attachments

cc: A. E. Stratman

APPENDIX C

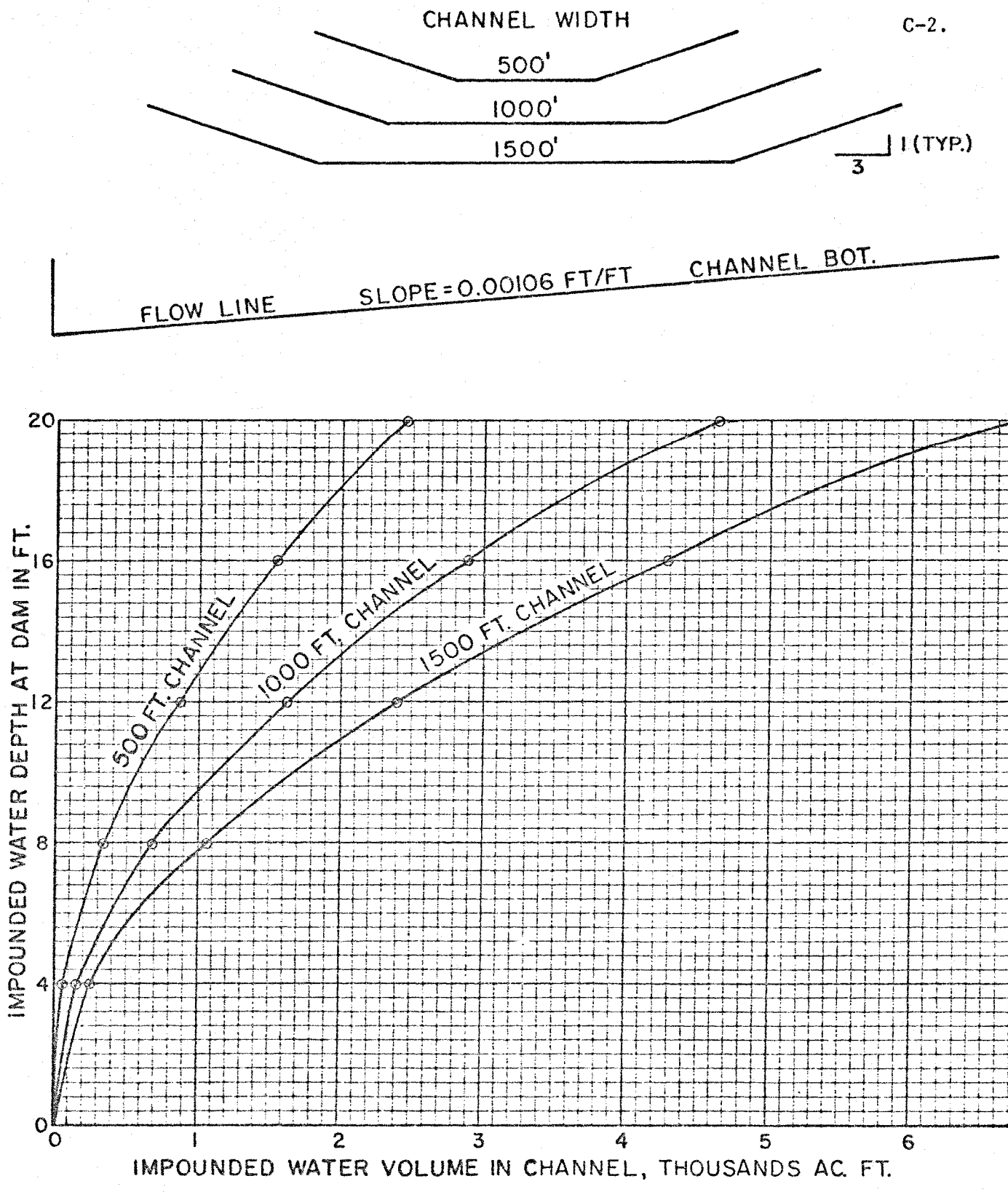
TABLE C-1

MAXIMUM IMPOUNDED WATER VOLUMES IN ALTERNATE CHANNELS

GILLESPIE DAM ANALYSIS

		Volumes in Acre-Feet							
		500-Ft. Channel		1,000-Ft. Channel		1,500-Ft. Channel		2,000-Ft. Channel	
Max. Water Depth Feet	Reach Feet	Avg. End Area	Volume	Avg. End Area	Volume	Avg. End Area	Volume	Avg. End Area	Volume
20	18,868	5,600	2,426	10,600	4,591	15,600	6,757	20,600	8,923
16	15,094	4,384	1,519	8,384	2,905	12,384	4,291	16,384	5,677
12	11,321	3,216	836	6,216	1,616	9,216	2,395	12,216	3,175
8	7,547	2,096	363	4,096	710	6,096	1,056	8,096	1,403
4	3,773	1,024	89	2,024	175	3,024	262	4,024	349
0	0	0	0	0	0	0	0	0	0

NOTES: Channel bottom slope: 0.00106 feet per foot.
Channel side slopes: 1 - vertical; 3 - horizontal.



MAXIMUM IMPOUNDED WATER VOLUMES
THREE ALTERNATE CHANNEL WIDTHS

GILLESPIE DAM ANALYSIS

Salt River Project
WATER < - POWER

BOX 1980 PHOENIX, ARIZONA 85001

TELEPHONE 273-5900

File: D-all.2

JOHN CAROLLO ENGINEERS
SEP 30 1980
RECEIVED

September 29, 1980

Mr. John Shannon
c/o John Carollo Engineers
3308 N. 3rd Street
Phoenix, Arizona 85012

Dear Mr. Shannon:

Please find enclosed a copy of a drawing of "General Plans of Works" at Horseshoe Dam. This drawing contains a discharge capacity curve for the spillway gates which you requested for use in your modification study of Gillespie Dam.

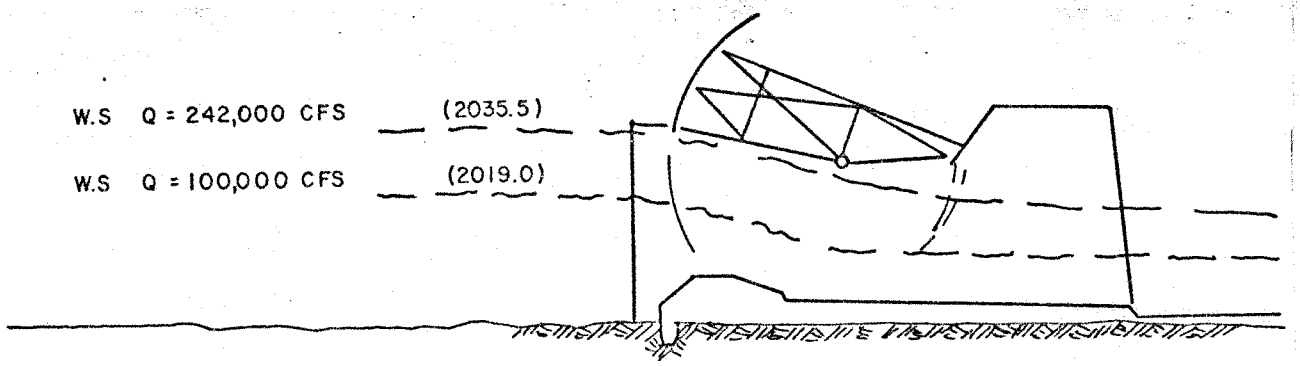
If I can be of further assistance to you, please call me.

Very truly yours,

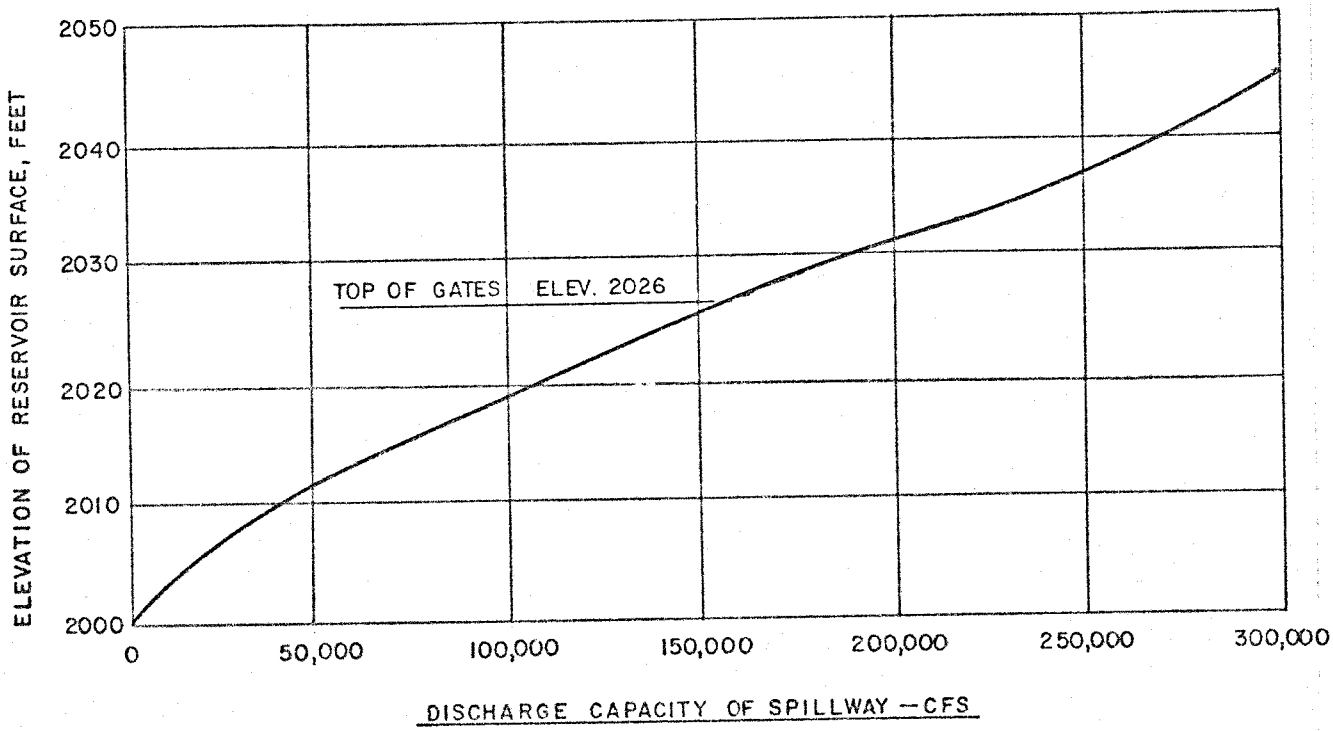
Paul Cherrington

Paul Cherrington

cmm
Attachment



SECTION ALONG ℄ SPILLWAY



RATING CURVE
HORSESHOE DAM SPILLWAY DISCHARGE CAPACITY
SOURCE: SALT RIVER VALLEY WATER USERS ASSOCIATION

REVIEW COMMENTS

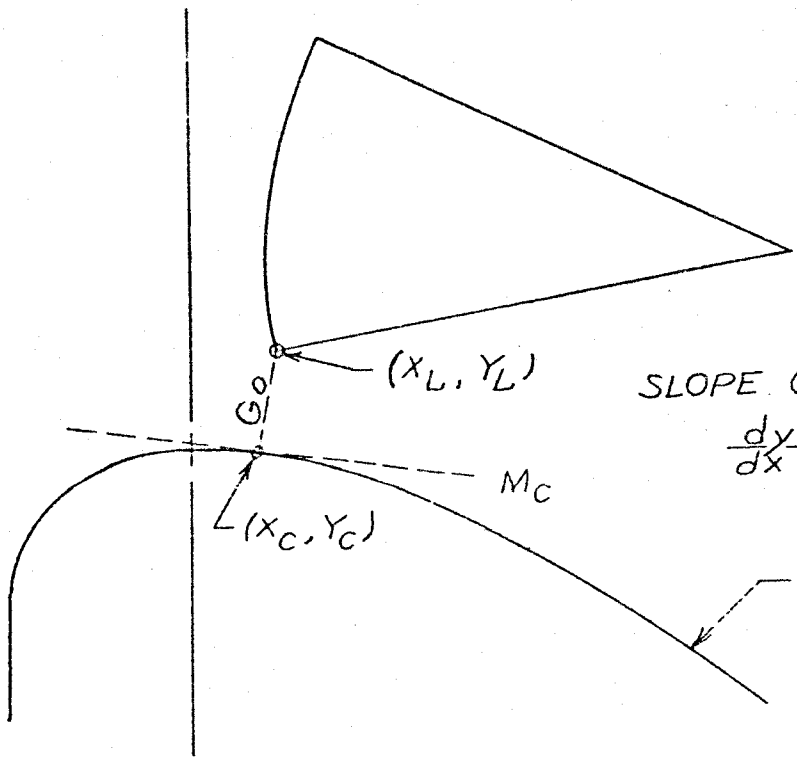
SPILLWAY RATING - PARTIAL TAINTER GATE OPENINGS
July 1966, HEC, USA-COE
Computer Program 22-J2-L225

PROGRAM PURPOSE: Compute the discharge for ogee-type weirs with partial tainter gate openings. The accuracy of the input prescribes the accuracy of the output.

GILLESPIE DAM APPLICATION: The method is applicable to overflow spillway crests with sloping upstream faces. Gate opening increments of 0.50 and 1.00 feet are input followed by desired openings. Pool elevations can be varied from full to weir elevation.

Output from the IBM 1620 program is a tabulation of discharge per gate and all gates. The Fortran IV program will take elevation increments of 1, 0.1, or .01 feet. Other output can serve in design calculations.

The program uses gate opening, G_o, as indicated on Exhibit 3.1, attached.



SLOPE OF G_o

$$\frac{dy}{dx} = \frac{Y_L - Y_C}{X_L - X_C}$$

$$-Y_C = KX_C^P$$

$$\frac{dy}{dx} = -PKX_C^{P-1}$$

GIVEN: X_L, Y_L, P & K.

SLOPE OF M_C $= -\dfrac{X_L - X_C}{Y_L - Y_C} = -PKX_C^{P-1}$

SUBSTITUTING: $\dfrac{X_L - X_C}{Y_L + KX_C^P} = PKX_C^{P-1}$

SOLVING: $\boxed{X_L = PKX_C^{P-1}Y_L + PKX_C^{P-1} \cdot KX_C^P + X_C}$

ASSUME VALUES OF X_C TO SATISFY A KNOWN X_L!

$$\boxed{G_o = \sqrt{(X_L - X_C)^2 + (Y_L - Y_C)^2}}$$

PARTIAL GATE OPENING METHOD USED IN PROGRAM FOR DETERMINATION OF G_o

22-J 2-L225 Exhibit 3.1

APPENDIX E

SUMMARY WORKSHEETS

Received September 2, 1980 From

FLOOD CONTROL DISTRICT OF MARICOPA COUNTY

Prepared By

UNITED STATES ARMY CORPS OF ENGINEERS

Contents:

OVERFLOW STUDY FOR DAM BREACHING & CHANNELIZATION AT GILLESPIE DAM

1. Q = 320,000 cfs

   Channel Widths: 2,000', 1,500', 1,000', 500'

2. Q = 200,000 cfs

   Channel Widths: 2,000', 1,500', 1,000', 500'

3. Sketch: 8-Mile River Profile

   Approximate X-Section

SUBJECT: OVERFLOW STUDY FOR DAM BREACHING & CHANNELIZATION @ GILLESPIE DAM AREA

DATE:

PAGE 1 OF 2 PAGES

SOURCE OF DATA: Q=320,000 CFS

E-2

COMPUTED BY:

CHECKED BY:

SECTION:

X-SECT.	W.S. EL. NATURAL COND.	W.S. EL. 2000'	Δ DEPTH	1500'	Δ DEPTH	1000'	Δ DEPTH	500'	Δ DEPTH
		DAM BREACHING AND WITH CHANNELIZATION							
64.11									
64.25	765.0	743.6	22.6	744.8	20.8	748.2	16.8	758.0	7.0
64.53	768.3	749.5	18.8	752.2	16.1	756.4	11.9	764.5	3.8
64.78	769.5	751.5	18.0	754.2	15.3	759.2	10.3	766.5	3.0
65.03	769.8	753.2	16.6	756.2	13.6	760.6	9.2	767.0	2.8
65.28	770.0	754.8	15.2	757.5	12.5	761.3	8.7	767.4	2.6
65.53	770.4	756.4	14.0	759.0	11.4	762.3	8.1	767.9	2.5
65.78	770.8	757.9	12.9	760.4	10.4	763.6	7.2	768.3	2.5
66.02	771.2	759.3	11.9	761.7	9.5	764.7	6.5	768.9	2.3
66.27	771.6	760.3	11.3	762.6	9.0	765.4	6.2	769.3	2.3
66.55	772.2	761.9	10.3	764.0	8.2	766.5	5.7	769.9	2.3
66.76	772.5	762.6	9.9	764.5	8.0	766.9	5.6	770.2	2.3
67.02	773.1	764.1	9.0	765.9	7.2	768.1	5.0	771.0	2.1
67.27	773.8	765.8	8.0	767.4	6.4	769.2	4.6	771.6	2.2
67.52	774.9	767.3	7.6	769.1	5.8	771.1	3.8	773.1	1.8
67.76	775.6	768.7	6.9	770.5	5.1	772.3	3.3	774.1	1.5
68.01	776.3	769.9	6.4	771.5	4.8	773.2	3.1	774.8	1.5
68.25	777.0	771.1	5.9	772.5	4.5	774.0	3.0	775.6	1.4
68.49	777.9	772.5	5.4	773.9	4.0	775.3	2.6	776.7	1.2
68.74	778.7	774.0	4.7	775.3	3.4	776.5	2.2	777.7	1.0
69.00	779.4	775.0	4.4	776.2	3.2	777.4	2.0	778.5	0.9

SUBJECT

DATE

SOURCE OF DATA Q = 320000 CFS

E-3

COMPUTED BY

CHECKED BY

SECTION

X-SECT.	W.S.EL NATURAL COND.	W.S.EL. 2000'	Δ DEPTH	1500'	Δ DEPTH	1000'	Δ DEPTH	500'	Δ DEPTH
		DAM BREACHING AND WITH CHANNELIZATION							
69.17	780.0	775.8	4.2	777.0	3.0	778.0	2.0	779.1	0.9
69.37	780.6	777.1	3.5	778.0	2.6	779.0	1.6	779.9	0.7
69.62	781.4	777.7	3.7	778.8	2.6	779.7	1.7	780.6	0.8

SUBJECT: OVERFLOW STUDY FOR DAM BREACHING & CHANNELIZATION @ THE AREA OF GILLESPIE DAM

PAGE 1 OF 2 PAGES

SOURCE OF DATA: Q = 200,000 CFS

E-4

COMPUTED BY | CHECKED BY | SECTION

X-SECT.	W.S. EL. NATURAL COND.	W.S. EL. DAM BREACHING AND WITH CHANNELIZA							
		2000'	Δ DEPTH	1500'	Δ DEPTH	1000'	Δ DEPTH	500'	Δ DEPTH
64.11									
64.25	762.5	741.8	20.70	741.8	20.70	744.3	18.20	750.1	12.40
64.53	765.0	746.2	18.80	748.4	16.60	751.5	13.50	759.5	5.50
64.78	766.0	748.0	17.00	750.1	15.90	753.5	12.50	761.5	4.50
65.03	766.2	749.6	16.60	751.7	14.30	755.5	10.70	762.1	4.10
65.28	766.4	751.1	15.30	753.3	13.10	756.8	9.60	762.6	3.80
65.53	766.8	752.6	14.20	754.8	12.00	758.3	8.50	763.2	3.60
65.78	767.4	754.1	13.30	756.3	11.10	759.6	7.80	764.0	3.40
66.02	767.9	755.5	12.40	757.8	10.10	760.9	7.00	764.9	3.00
66.27	768.3	756.8	11.50	758.8	9.50	761.7	6.60	765.3	3.00
66.55	768.9	758.4	10.50	760.3	8.60	762.9	6.00	766.2	2.70
66.76	769.3	759.3	10.00	761.1	8.20	763.4	5.90	766.4	2.90
67.02	770.1	761.0	9.10	762.7	7.40	764.8	5.30	767.5	2.60
67.27	771.0	762.5	8.50	764.4	6.70	766.5	4.50	768.6	2.40
67.52	772.2	763.9	8.30	765.9	6.30	768.3	3.90	770.5	1.70
67.76	773.0	765.3	7.70	767.4	5.60	769.6	3.40	771.6	1.40
68.01	773.7	766.7	7.00	768.5	5.20	770.5	3.20	772.3	1.40
68.25	774.7	768.0	6.70	769.7	5.00	771.4	3.30	773.1	1.60
68.49	775.8	769.4	6.40	771.3	4.50	773.1	2.70	774.7	1.10
68.74	776.7	770.9	5.80	772.8	3.90	774.5	2.20	775.8	0.90
69.00	777.5	772.0	5.50	773.7	3.80	775.2	2.30	776.5	1.00

U.S. FORM NO. 1114

SUBJECT

DATE

PAGE 2 OF 2 PAGES

SOURCE OF DATA Q=200000 cfs

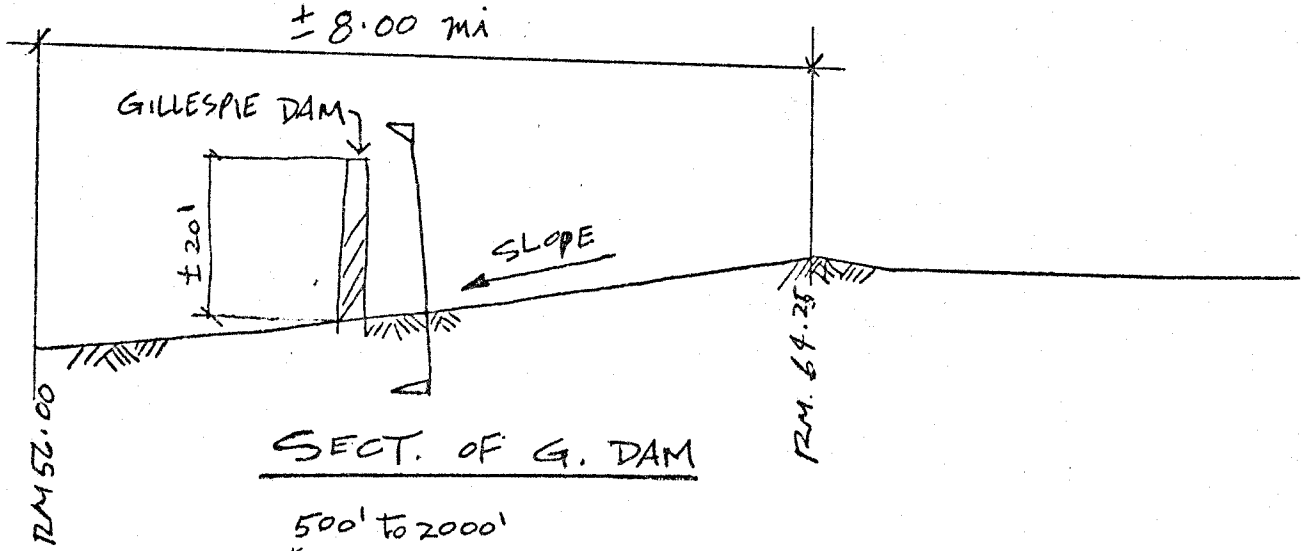
E-5

COMPUTED BY

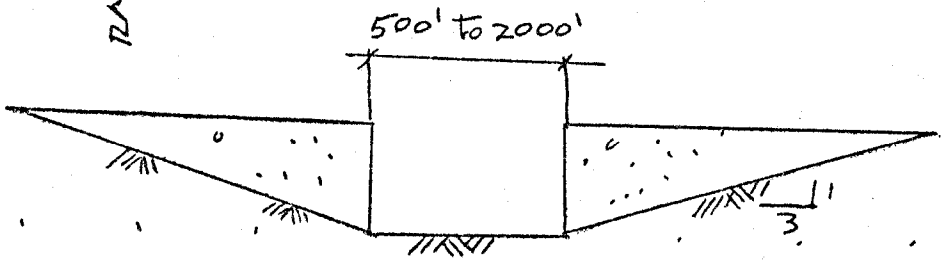
CHECKED BY

SECTION

X-SEC.	W.S. El. NATURAL COND.	W.S. EL. DAM BREACHING AND WITH CHANNELIZATION 2000'	Δ DEPTH	1500'	Δ DEPTH	1000'	Δ DEPTH	500'	Δ DEPTH
69.17	778.1	773.0	5.10	774.5	3.60	775.9	2.20	777.1	1.00
69.37	778.6	774.3	4.30	775.6	3.00	776.9	1.70	777.9	0.70
69.62	779.4	775.1	4.30	776.4	3.00	777.6	1.80	778.6	0.80



SECT. OF G. DAM



ELEV. OF G. DAM

SUBJECT:
COMPUTED BY:
CHECKED BY:
DATE:
SHEET:
PROJECT NO.

732

APPENDIX F

CENTRAL ARIZONA WATER CONTROL STUDY
STAGE II ALTERNATIVES, CAWCS

The following information has been extracted from the November 1980 CAWCS status report. Elements considered in Stage I have been evaluated and surviving elements have been formed into 13 systems. To be selected in Stage II are 5 to 6 systems. Three systems include Gila River Levee construction upstream from Gillespie Dam. They all include Phoenix and Gila Levees and have been characterized as follows:

System	Dams	Flood cfs	Cost Estimates Construction	Cost Estimates Annual*
3A	New Waddell	295,000	$1,370,000,000	$155,000,000
4A	Enlarged Roosevelt	200,000	$1,510,000,000	$155,000,000
4B	New Stewart Mtn.	200,000	$1,560,000,000	$160,000,000

*100 years amortization at 7.375%

Four Salt and Verde control systems, 2A-2D, would reduce the project flood at the Verde-Salt confluence to 50,000 cfs and minimize channel requirements on the Gila River near Gillespie Dam.

Alternate systems have an estimated construction cost range from about 1 percent to 40 percent of alternatives 3A, 4A, and 4B. Six of those alternatives would reduce the projected flood peak from 295,000 cfs to the range 50,000 to 150,000 cfs.

The effects, of alternate selections, on Gillespie Dam modification alternatives are dependent upon the time schedules for Gillespie Dam modification and the selected upstream system. Completion of a selected project which limits channel flow rate at Gillespie Dam to 100,000 cfs would minimize the gated opening requirement to about 400 feet. The maximum gated opening requirement

would be about 1,000 feet to pass 320,000 cfs prior to upstream control. An intermediate flow rate of 200,000 cfs would require about 700 feet of gated opening. But the construction to attain that 200,000 cfs flow rate (at the Salt/Verde confluence) is estimated to cost about 1/2 billion dollars, or 45 million dollars per year for 100 years (Alternate 2A).

In this Gillespie Dam Modification Study the 295,000 cfs Verde-Salt confluence SPF is considered to correspond to the 320,000 cfs flood rate at Gillespie Dam. Therefore, 35,000 cfs is assumed to be contributed between the Verde-Salt confluence and Gillespie Dam. The least Verde-Salt confluence flood, 50,000 cfs, plus the 35,000 cfs, would be 85,000 cfs as the least design flood for Gillespie Dam and assumes the upstream controls in place concurrently with completion of Gillespie Dam modifications. A gated opening of 500 feet with water depth of 10 feet would require a velocity of 17 feet per second to pass 85,000 cfs. Additional HEC-2 computer runs can establish the design criteria for the selected conditions.

DATA EXTRACTS

CAWCS - PARTICIPANTS WORKBOOK, PUBLIC WORKSHOPS

April-May 1980

UPSTREAM/DOWNSTREAM CONCEPT

This concept includes modifications to Gillespie Dam and Gila River channel clearing in the area downstream from the Verde River/Salt River confluence.

Recorded extreme floods at the Verde River/Salt River confluence include:

Year	Peak Flow Rate, cfs
1891	300,000
Feb/80	170,000
Dec/78	140,000
Mar/78	122,000

(Standard Project Flood for Planning: 295,000 cfs)

Dam release rates for the study are 50,000, 100,000 and 150,000 cfs.

Flood intensities defined for the study are those three release rates plus two more:

Level	Intensity, cfs
I	300,000 (STP)
II	200,000
III	150,000
IV	100,000
V	50,000

Appendix, Page A-15, reports preliminary estimates of channel clearing costs upstream from Gillespie Dam for four alternate channel widths:

Width, Feet	Cost, Million $
2000	7-11
1500	5-8
1000	3-6
500	2-3

JOHN CAROLLO ENGINEERS

Title File: Funding Status

W. O. No.

Date

By

Page of

F-4

Senate OKs $144 million for CAP work

Bill for water-development, energy goes to president

Republic Washington Bureau

WASHINGTON — The Senate passed and sent to President Carter late Wednesday a $12.1 billion energy and water-developments appropriations bill for fiscal 1980, including $144,080,000 to continue work on the Central Arizona Project.

The measure, which also carries $38,112,000 for the Colorado River Salinity Control Program and its Yuma desalination plant, is the first appropriations bill for 1981 enacted by the Congress. Twelve more await final action and are unlikely to be completed before Congress recesses Oct. 4. The government will start business Oct. 1 on a resolution permitting spending at fiscal 1980 levels.

The last compromises between the House and Senate on the energy and water-development bill were concluded Tuesday afternoon by a conference committee. The House gave final approval to the bill early Wednesday and returned the bill to the Senate. Senate action was swift once the conference report was taken up.

Other Arizona items in the bill are:

- Gila River and tributaries, Army Corps of Engineers' general flood-control investigation, $870,000.
- Tucson metropolitan area, Corps of Engineers' general flood-control investigation, $310,000.
- Middle Gila River Channel, Corps of Engineers' study of deferred project, $200,000.
- Indian Bend Wash flood-control project, Scottsdale and Phoenix, $3,550,000 to continue the $27.8 million project.
- Phoenix area flood control, Stage 2 and remaining work on Stage 1, $10.9 million toward completing the $247 million project.
- Allenville flood control, $1.3 million.
- Alamo Lake, operation and maintenance, $423,000.
- Painted Rock Reservoir, operation and maintenance, $317,000.
- Whitlow Ranch Dam, operation and maintenance, $163,000.
- Boulder Dam, Hoover Power Plant modification, feasibility study by the Water and Power Resources Service, $500,000.
- Lower Colorado Water Conservation and Efficient Use Study, also by WPRS, $415,000.
- Reclamation and energy resources, wilderness designation, $140,000.
- Weilton-Mohawk Project, to continue improvements on the old Gila River channel, to facilitate drainage, $1.5 million.
- Gila River Farms, final part of a total $9,879,000 loan for improvements, $2,614,000.

08/25/8 REPUBLIC 24

THE ARIZONA REPUBLIC

Thursday, September 11, 1980

$150 million earmarked for all Arizona projects

By Ben Cole
Republic Washington Bureau

WASHINGTON — The Senate passed a $12.1 billion energy and water-resources development funding bill, including $1.44 million to continue the Central Arizona Project, by an 83-9 vote Wednesday.

The nearly $150 million in the bill for activities in Arizona also included $470,000 to expedite the Army Corps of Engineers' part of the Orme Dam alternative study, due for completion in 1982. The House, when passing the same money bill, increased the amount from the $400,000 budgeted by the Carter administration.

The Corps of Engineers is studying flood-control alternatives and the Water and Power Resources Service is concerned about CAP water regulations. The WPRS's share of the alternative study is funded from that agency's general budget.

The Senate, in reporting the bill, gave the following instruction offered by Sen. Dennis DeConcini, D-Ariz.:

"... The (Appropriations) committee directs the Water and Power Resources Service to begin the necessary preconstruction activities, including advance engineering and design, on a flood-control structure at the confluence of the Salt and Verde rivers in fiscal year 1981.

"These funds shall be made available from those funds appropriated for the Colorado River Basin Project. However, the committee does not intend to terminate or otherwise impede the completion of the study of alternatives to Orme Dam.

"In fact, the committee urged the Water and Power Resources Service to make every effort to ensure that the study is completed during fiscal year 1981."

The Senate version of the public-works measure also provided $500,000 to make a study of raising the height of Roosevelt Dam, a strategy proposed for controlling floods.

In addition to the funding of continued work on the $2 billion CAP, the bill carried $47.4 million for the Colorado River Salinity Control program, including $38.1 million for the Yuma Desalting Plant and its associated structures.

In the portion of the bill devoted to energy development, the Appropriations Committee said: "The committee is pleased with the reported results of the utility grid-connected residential photovoltaic project in Phoenix, Ariz. The committee urges the (Energy) Department to consider this concept with a project of sufficient size to demonstrate market potential for similar residential systems and allow an expanded technical analysis."

The Phoenix project to which the committee referred was developed in the northwest part of the city by builder John Long.

Other Arizona items included in the money bill, which now goes to a House-Senate conference committee for reconciliation of differences, are:

- Gila River and Tributaries, Army Engineers general investigation, $870,000.
- Metropolitan Area of Tucson, Army Engineers general investigation, $310,000.
- Middle Gila River Channel, Army Engineers' study of deferred project, $200,000.
- Indian Bend Wash flood-control project, Scottsdale, $3.55 million to continue the $27.8 million project.
- Phoenix and Vicinity Flood Control, Stage 2 and remaining work on Stage 1, $10.9 million toward completion of the $247 million project.
- Allenville flood control, $1.3 million.
- Alamo Lake, operation and maintenance, $423,000.
- Painted Rock Reservoir, operation and maintenance, $317,000.
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- Lower Colorado Water Conservation and efficient-use study, also by the WPRS, $415,000.
- Reclamation and energy resource, wilderness designation, $140,000.
- Wellton-Mohawk Project, to continue improvements to the Gila River channel to facilitate drainage, $1.5 million.
- Gila River Farms, the final part of a total $9.879 million loan for improvements, $2.614 million.

APPENDIX G

LIST OF AGENCIES AND PERSONS CONTACTED

AGENCIES PERSONS	Subject
USA Corps of Engineers - Phoenix, Arizona Donald Gross	Site Data
USA Corps of Engineers - Hydrologic Engineering Center, Davis, California	HEC-2 Manual
Maricopa County Flood Control District Lionel Lewis, Richard Perrault	Coordination
El Paso Natural Gas Co., Casa Grande, Arizona A. E. Stratmen	Pipe Crossings
Arizona Water Commission, State of Arizona Benson Scott and Kenneth Hussain	Dam Drawings
Arizona Department of Transportation, Photogrammetry Mike Hall	Aerial Photos, Dam Site
Paloma Ranch, Bob Stiles, Engineer Doug Nelson, Attorney	Irr. Needs Water Rights
Maricopa County Highway Department	Bridge Plans
Phoenix Blueprint Co., Dave Burris	Copy old prints of Dam
Benham-Blair, Consulting Engineers Vincent Smith	Channel Alignment
Salt River Project Paul Cherrington	Gate Capacity Curve
Arizona Public Service Co. Wes Reed	Elec. Transmission
Department of Water Resources, State of Arizona	Water Rights
John Carollo Engineers Donald Preisler, John Shannon Maurice Malick Bob Young, Ken Hunt Bob Clark Ken Martin	Study & Report Management Project Engineer Structural Electrical Mechanical

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MAY 15 1981

G-2

El Paso NATURAL GAS COMPANY JOHN CAROLLO ENGINEERS PHOENIX

P.O. BOX 1492
EL PASO, TEXAS 79978
PHONE 915-542-2600

May 7, 1981

Flood Control District
of Maricopa County
3335 West Durango St.
Phoenix, Arizona 85009

Attention: Mr. Richard G. Perreault
Project Engineer

Re: R/W 801740 Encroachment:
Structural Modifications to
Gillespie Dam - Gila River
California Lines M.P. 625
Maricopa County, Arizona

Gentlemen:

El Paso Natural Gas Company has completed its review of the Final Revised Draft Report by John Carollo Engineers, concerning the captioned.

The report submitted is acceptable to El Paso, and we respectfully request that the Company be advised of the status of the project as it progresses beyond the study stage.

Please notify our Casa Grande District Superintendent, Mr. Alfred E. Stratman, telephone A/C 602 836-8011, forty-eight (48) hours prior to commencing any construction in the vicinity of our pipelines in order that El Paso may have a representative present.

If you have any questions, please do not hesitate to call.

Very truly yours,

Allen Gattis
Manager
Titles-Controls Division
Right of Way Department

LPL/ko

cc: Mr. Alfred E. Stratman

John Carollo Engineers
Attention: Mr. Maurice L. Malick
3308 North Third Street
Phoenix, Arizona 85012

RECEIVED

MAY 15 1981

JOHN CAROLLO ENGINEERS
PHOENIX

ELLIS & BAKER, P.C.
ATTORNEYS AT LAW
SUITE 720
2845 EAST CAMELBACK ROAD
PHOENIX, ARIZONA 85016
(602) 956-8878

R. J. ELLIS
WILLIAM D. BAKER
ROBERT S. LYNCH
ROBERT S. PORTER
DOUG C. NELSON
SCOTT K. MIDGLEY
PAUL R. ORME

G-3.

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MAY 8

CH ENG	PMGRS
ASST	ENGR
ADMIN	SUPT
C & O	FIN
	DRFTMN

LG. 1.2.3

May 7, 1981

Mr. Richard G. Perreault
Project Engineer
Flood Control District of Maricopa County
3335 W. Durango Street
Phoenix, Arizona 85009

Re: Gillespie Dam Analysis

Dear Mr. Perreault:

Thank you for providing us with copies of the Final Revised Draft Report for the Gillespie Dam modification which was published by John Carollo Engineers.

In your cover letter which we received on March 16, 1981, you requested the comments of Paloma Ranch Joint Venture concerning that Final Revised Draft Report. Since Paloma Ranch Joint Venture is not a participant it does not deem it appropriate to comment. The position of Paloma Ranch Joint Venture should not be construed as an approval or concurrence of, or acquiescence in, the Scope of Work or any of its predetermined conclusions, or the Final Revised Draft Report or the Final Report.

Sincerely yours,

Doug C. Nelson

Doug C. Nelson
for
ELLIS & BAKER, P.C.

DCN/dab

CC: Mr. Max I. Wood
Mr. Robert Steil

Copy to be sent to
Carollo Engrs.

Jule
May 11, 1981