US Army Corps of Engineers
Los Angeles District
South Pacific Division

PLANNING ASSISTANCE REPORT

Gila River Indian Community, Arizona

INDIAN ROUTE 3
GILA RIVER CROSSING

ALTERNATIVES ANALYSIS

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Final Report
June 1999

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TABLE OF CONTENTS

EXECUTIVE SUMMARY v

Chapter 1 - STUDY AUTHORITY
1.1 Study Authority 1

Chapter 2 - PURPOSE AND SCOPE
2.1 Purpose and Scope 2

Chapter 3 - PRIOR STUDIES AND REPORTS
3.1 Current Study 3
3.2 Prior Studies and Reports 3

Chapter 4 - STUDY AREA DESCRIPTION
4.1 Description of Gila River Indian Community 4
4.2 Description of Specific Study Area 4
4.3 Climate in Study Area 7
4.4 Hydrologic Data in Study Area 7

Chapter 5 - PROBLEM IDENTIFICATION
5.1 Problem Identification 8
5.2 Existing Conditions 8
5.3 Specific Problems 9
5.4 Opportunities 9
5.5 Constraints 10
5.6 Planning Objectives 11

Chapter 6 - METHODOLOGY AND ASSUMPTIONS
6.1 Methodology 12
6.2 Assumptions 15
6.3 Cost Estimates 19

Chapter 7 - SHORT-TERM PLAN FORMULATION
7.1 Proposed Short-Term Plans 21
7.1.1 Clearing Vegetation Within Bridge Limits 21
7.1.2 Cutting and/or Clearing Non-Native Vegetation 22
7.1.3 Channelization 22
7.1.4 Cutting and/or Clearing Non-Native Vegetation and Channelization 22
7.1.5 Cutting and/or Clearing Non-Native Vegetation, Adding Culverts, and Channelization 22
7.1.6 Cutting and/or Clearing Non-Native Vegetation and Deep Channelization 23
7.1.7 Raising Roadway Between and South of Bridges 23
7.1.8 Raising Roadway Between and South of Bridges with Cutting and/or Clearing Non-Native Vegetation 23

7.1.9 Raising Roadway Between and South of Bridges, Cutting and/or Clearing Non-Native Vegetation, and Channelization 24
7.1.10 Raising Roadway Between and South of the Bridges, Adding Bridge, and Channelization 24
7.1.11 Constructing Levees Parallel to Road 24
7.1.12 Independent Protection for South Bank 24

Chapter 8 - LONG-TERM PLAN FORMULATION AND EVALUATION
8.1 Proposed Long-term Plans 50
8.1.1 Non-Native Vegetation Management 50
8.1.2 Sediment Management 50
8.1.3 Replacing Non-Native Vegetation with Riparian Habitat 50
8.1.4 Replacing Non-Native Vegetation with Irrigated Riparian Habitat in a Recreational Setting 51
8.1.5 Modification of Transportation Infrastructure 51

Chapter 9 - PLAN EVALUATIONS AND CONCLUSIONS
9.1 Plan Evaluations 52
9.2 Conclusions 59

Chapter 10 - SELECTED PLAN
10.1 Plan Description 60
10.1.1 Hydraulic Elements 60
10.1.2 Environmental Restoration Elements 65
10.2 Summary of Impacts 68

APPENDICES

A Hydrological Data
B Environmental Baseline Conditions Report

LIST OF FIGURES

Number and Description		Page
Figure 1	Vicinity Map	5
Figure 2	Study Area	6
Figure 3	Baseline Stage-Discharge Curve	13
Figure 4	Baseline Cross-Section	14
Figure 5	Existing Conditions vs USGS Gauge Data	16
Figure 6	Study Area Cross-Sections	18
Figure 7	Typical Levee Section	20
Figure 8	Alternative 7.1.1 Stage-Discharge Curve	26
Figure 9	Alternative 7.1.1 Cross-Section	27
Figure 10	Alternative 7.1.2 Stage-Discharge Curve	28
Figure 11	Alternative 7.1.2 Cross-Section	29
Figure 12	Alternative 7.1.3 Stage-Discharge Curve	30
Figure 13	Alternative 7.1.3. Cross-Section	31
Figure 14	Alternative 7.1.4. Stage-Discharge Curve	32
Figure 15	Alternative 7.1.4 Cross-Section	33
Figure 16	Alternative 7.1.5 Stage-Discharge Curve	34
Figure 17	Alternative 7.1.5 Cross-Section	35
Figure 18	Third Channel Alignment	36
Figure 19	Alternative 7.1.6 Stage-Discharge Curve	37
Figure 20	Alternative 7.1.6 Cross-Section	38
Figure 21	Alternative 7.1.7 Levee Alignment	39
Figure 22	Alternative 7.1.7 Stage-Discharge Curve	40
Figure 23	Alternative 7.1.7 Cross-Section	41
Figure 24	Alternative 7.1.8 Stage-Discharge Curve	42
Figure 25	Alternative 7.1.8 Cross-Section	43
Figure 26	Alternative 7.1.9 Stage-Discharge Curve	44
Figure 27	Alternative 7.1.9 Cross-Section	45
Figure 28	Alternative 7.1.10 Stage-Discharge Curve	46
Figure 29	Alternative 7.1.10 Cross-Section	47
Figure 30	Alternative 7.1.11 Levee Alignments	48
Figure 31	Alternative 7.1.12 Levee Alignment	49
Figure 32	Alternative Capacity vs. Annual Cost	55
Figure 33	Selected Plan Hydraulic Elements	61
Figure 34	Roadway Profile	62
Figure 35	Typical Sections	63
Figure 36	Selected Plan Stage-Discharge Curve	64
Figure 37	Selected Plan Environmental Restoration Elements	66
Figure 38	Environmental Restoration Profile	67

LIST OF TABLES

Number and Description		Page
Table 1	Annual Cost of Alternatives	53
Table 2	Hydraulic Capacity of Alternatives	54
Table 3	Level of Protection for South Bank	56
Table 4	Planning Objectives Matrix	57
Table 5	Implementation Advantages and Disadvantages	58
Table 6	Annual Cost of Environmental Restoration	65
Table 7	Acreage Disturbed by Clearing	69

EXECUTIVE SUMMARY

The U.S. Army Corps of Engineers and the Gila River Indian Community executed an agreement in October 1996 to cost share studies under the Corps' Planning Assistance Program. The agreement is for a term of three years, the cost sharing requirement is 50% federal and 50% non-federal. The Planning Assistance Program is intended to provide technical products to non-federal interests, and monetary contributions only are required to execute the work based upon a negotiated scope of studies. The scope of studies under the current agreement includes comprehensive water and land resources planning up to the Corps' maximum programmatic amount allowable under the program, based upon a semi-yearly iterative scoping effort depending upon the ongoing needs of the Community.

Under the comprehensive scope of studies, a wide variety of planning, engineering, environmental, institutional, and other technical efforts have been identified to support long term and ongoing development of the Gila River Indian Community Land and Water Resources Comprehensive Plan. Within the overall effort, and at the request of the Community, the Corps of Engineers performs individual technical efforts. These individual technical analyses are conducted in close coordination with the Community based upon needs identified by the Community, and are scoped to explicitly support the comprehensive effort under the Planning Assistance Agreement.

This report describes the engineering and environmental development of alternatives to address flood protection, transportation, drainage, and channel capacity problems, including the proliferation of tamarisk. Problems and opportunities, both short-term and long-term, are identified and evaluated. The information in this report provided the basis for the Community to select a strategy that best meets their needs.

Alternatives to address the identified problems are developed, evaluated and compared relative to cost, hydraulic capacity, flood protection, and environmental impacts and issues. Alternatives consistent with both the short and long term objectives of the Community are presented. A total of 17 alternatives were evaluated to address access, channel capacity, tamarisk, flooding and damage to farms and homes on the south side of the river, and the planned irrigation system. The report includes an evaluation of the plan selected by the Community.

Chapter 1

STUDY AUTHORITY

1.1 Study Authority

This report is prepared under the authority of Section 22 of the Water Resources Development Act of 1974. This section is known as the Planning Assistance to States Program which authorizes the U. S. Army Corps of Engineers to assist States, their political subdivisions, and Indian Tribes in dealing with their water resource problems. Under this authority, Los Angeles District Corps of Engineers will provide a Planning Assistance Report for the development of drainage alternatives and environmental planning for the Department of Land and Water Resources of the Gila River Indian Community (GRIC), Maricopa County, Arizona.

Chapter 2

PURPOSE AND SCOPE

2.1 Purpose and Scope

The purpose of this report is to describe the engineering review and evaluation of alternatives developed to address problems associated with high flows at the Indian Route 3 crossing of the Gila River, within the Gila River Indian Community (GRIC).

The scope of work consists of identifying problems and needs for the study area; formulating corrective measures to address those problems; and presenting a range of actions which will achieve GRIC's objectives with consideration to future environmental and recreational opportunities in the project area.

The following specific tasks were accomplished for this report:

1) Identify problems and opportunities at the Indian Route 3 crossing
2) Review previously developed alternatives
3) Develop additional alternatives and possible solutions
4) Evaluate alternatives
5) Provide short- and long-term actions which address the problems at the crossing.

Chapter 3

PRIOR STUDIES AND REPORTS

3.1 Current Study

Under the current Planning Assistance to States Program, the Corps of Engineers is preparing this Gila River Crossing Report to address the current land and water resource concerns of the Community at Indian Route 3. The short-term and long-term solutions in this report are intended to provide the Community with guidance to reduce the local hazards and the potential for loss of life.

3.2 Prior Studies and Reports

Several reports and studies conducted by the Corps of Engineers and other agencies have been examined in the development of this report. Appropriate material from the sources listed below has been incorporated into this document:

- Basin Characteristics and Stream flow Statistics in Arizona as of 1989, U.S. Geological Survey, Water-Resources Investigations Report 91-40.
- Channel Migration in the Gila River, Central Arizona, William L. Graf, Arizona State University, Department of Geography, August 1980.
- Gila River, Gillespie Dam to Uma, Arizona, Reconnaissance Report U. S. Army Corps of Engineers, Los Angeles District, January 1995.
- Gila River Indian Community, Arizona, Reconnaissance Report, U.S. Army Corps of Engineers, Los Angeles District, July 1991.
- Gila River and Tributaries Reconnaissance Report, Salt-Gila, Arizona, U.S. Army Corps of Engineers, Los Angeles District, December 1989.
- Interim Feasibility Report for Lower Santa Cruz River Basin and Tributaries, Gila River and Tributaries, Arizona and New Mexico, U.S. Army Corps of Engineers, Los Angeles District, August 1983.
- Draft Indian Route 3 Bridge Crossings Report, US Army Corps of Engineers, Los Angeles District, South Pacific Division, February, 1998.

Chapter 4

STUDY AREA DESCRIPTION

4.1 Description of Gila River Indian Community

The Gila River Indian Community (GRIC) is located immediately south of the Phoenix Metropolitan Area and lies within both Maricopa and Pinal Counties. A vicinity map is provided as Figure 1. The Community itself is divided into seven (7) districts, east to west. District 1 is located at the eastern boundary, while District 7 is at the western boundary. As shown in Figure 1, the study area is located in District 6.

GRIC is adjacent to the rapidly developing communities of Ahwatukee, Chandler, and Gilbert, Arizona. Development, which includes residential, commercial, and industrial land uses, has occurred over the past 15 years at an annual rate of about six to eight (6 - 8%) percent.

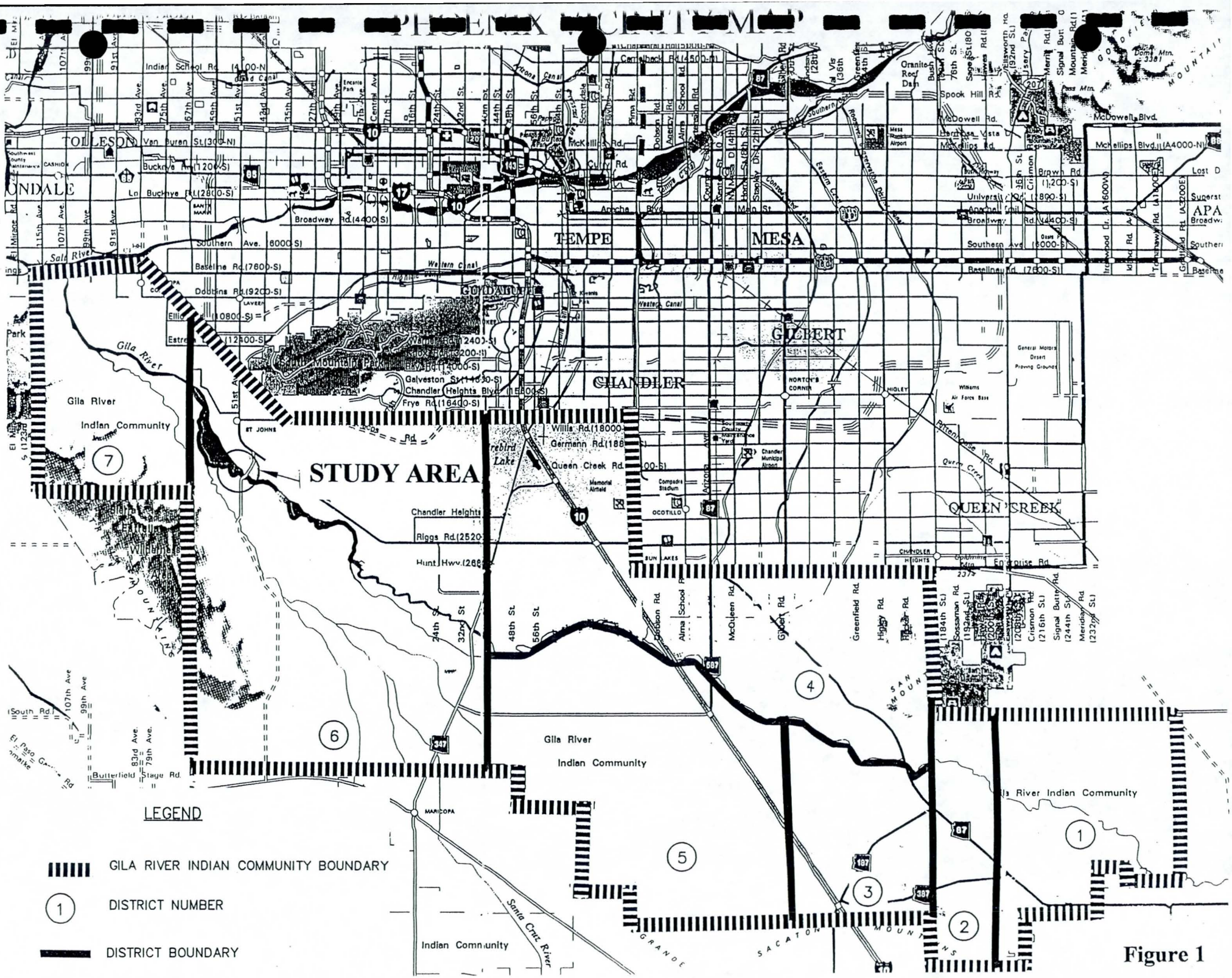
Within the Community, land use planning is directly tied to water resource planning. Three major watercourses, the Gila, Santa Cruz and Salt Rivers, flow through or border the community. Effective water resource planning must address multiple issues and concerns in order to develop a viable long-range plan for the Community which takes into account current and projected development, both adjacent to, and within, the Community's land.

4.2 Description of Specific Study Area

For purposes of this report, the "study area" is defined as follows:

> The area of the Gila River floodplain extending 1/4 mile (1,320 feet) upstream and 1/4 mile (1,320 feet) downstream of the Indian Route 3 crossing. The crossing is located just upstream of the Gila's confluence with the Santa Cruz River. It contains two bridges which are separated by approximately 1,500 feet of roadway. The width of the floodplain at this location is considered to be approximately 7,000 feet for the purposes of this report. Thus, the study area is about 2,640 feet long by 7,000 feet wide.

These limits, which are shown in Figure 2, have been chosen to focus the development of alternatives and facilitate consideration by GRIC.


PHOENIX
TOLLESON
TEMPE
MESA
GILBERT
CHANDLER
QUEEN CREEK
STUDY AREA
Gila River Indian Community
Salt River
Gila River
Indian Community
Santa Cruz River
Indian Community
Indian School Rd.
Broadway Rd.
Southern Ave.
Baseline Rd.
McDowell Rd.
McKellips Rd.
Queen Creek Rd.
Chandler Heights
Riggs Rd.
Hunt Hwy.
Germann Rd.
Williams Rd.
Frye Rd.
Galveston St.
Chandler Heights Blvd.
Dobson Rd.
Alma School Rd.
McQueen Rd.
Gilbert Rd.
Greenfield Rd.
Higley Rd.
Ellsworth Rd.
Crismon Rd.
Signal Butte Rd.
Meridian Rd.
Sossaman Rd.
Enterprise Rd.
Pecos Rd.
Ocotillo
Sun Lakes
Chandler Heights
Higley
Norton's Corner
Williams Air Force Base
General Motors Desert Proving Grounds
Chandler Municipal Airport
Compadre Stadium
Memorial Airfield
Maricopa
Butterfield Stage Rd.
Estrella Mountain Park
Gila River Indian Community
Santa Cruz River
Sacaton Mountains
Superstition Mountains
Eastern Canal
Western Canal
Roosevelt Dam
Granite Reef Dam
Spook Hill Rd.
Mesa Falcon Airport
Mesa Gateway Airport
Lost Dutchman State Park
Superstition Mountain Park
Dobson Rd.
Alma School Rd.
McQueen Rd.
Gilbert Rd.
Greenfield Rd.
Higley Rd.
Ellsworth Rd.
Crismon Rd.
Signal Butte Rd.
Meridian Rd.
Sossaman Rd.
Enterprise Rd.
Pecos Rd.
Ocotillo
Sun Lakes
Chandler Heights
Higley
Norton's Corner
Williams Air Force Base
General Motors Desert Proving Grounds
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Butterfield Stage Rd.
Estrella Mountain Park
Gila River Indian Community
Santa Cruz River
Sacaton Mountains
Superstition Mountains
Eastern Canal
Western Canal
Roosevelt Dam
Granite Reef Dam
Spook Hill Rd.
Mesa Falcon Airport
Mesa Gateway Airport
Lost Dutchman State Park
Superstition Mountain Park
LEGEND
GILA RIVER INDIAN COMMUNITY BOUNDARY
DISTRICT NUMBER
DISTRICT BOUNDARY
1
2
3
4
5
6
7

Figure 1

Indian Route 3 Study Area

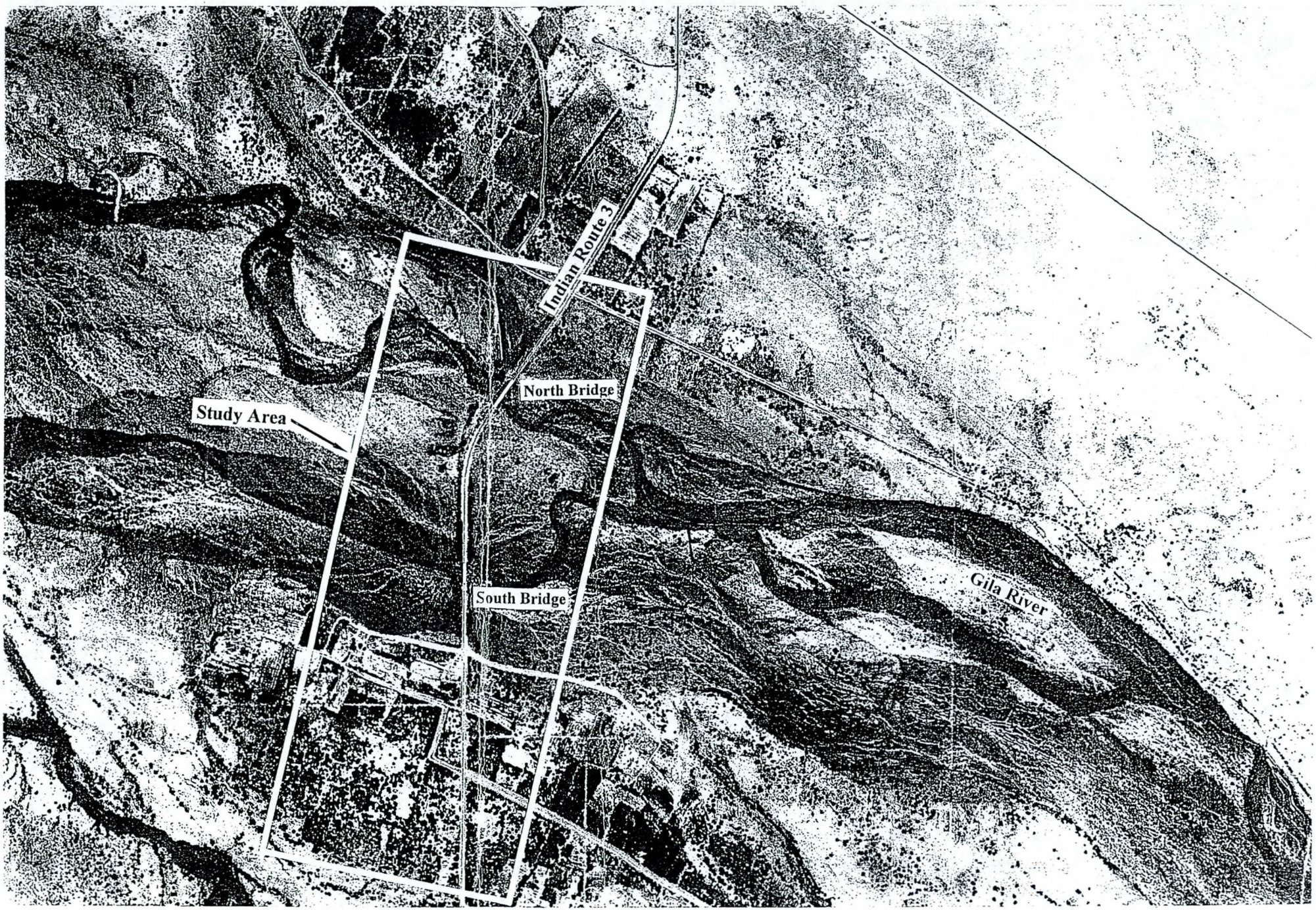


Figure 2

4.3 Climate in Study Area

The climate of the Gila River Indian Community is typical of a low elevation, low latitude, interior North American desert (Southwest Sonoran). The area experiences hot summers, mild winters, sparse rainfall, and high evaporation rates. Rainfall averages 7.5 inches per year, about evenly split between monsoonal seasons from July through September, and the winter storm season from November through April. Tropical storms during the August through October period occasionally produce heavy rains.

4.4 Hydrologic Data in Study Area

A USGS stream gauge for the Gila River is located just downstream of the Indian Route 3 crossing. Annual records of peak flows and daily flows date from the present back through 1940. A graphical representation of daily flows is shown in Appendix A. The largest flood event for the period of record occurred on January 20, 1993, when a daily flow of 36,500 cfs and a peak discharge of 41,600 cfs was recorded. During this flow event, the waters of the Gila River rose so high that Indian Route 3 was impassable.

Additional stream flow statistics for the Gila River at this gauge location are provided in Appendix A. The information provided is from USGS Water-Resources Investigations Report 91-4041, entitled, "Basin Characteristics and Stream Flow Statistics in Arizona as of 1989."

Chapter 5

PROBLEM IDENTIFICATION

5.1 Problem Identification

The Department of Land and Water Resources of the Gila River Indian Community has expressed concern about the following conditions at the Indian Route 3, Gila River crossing:

- Access during high flows
- Damage to homes and farmland from high flows
- Damage to the road and bridges from high flows
- Saltcedar proliferation.

The tribe recognizes the potential for loss of property, life, and transportation infrastructure should the crossing be subject to heavy flows in the future. Indian Route 3 is the only route in the area connecting the south side of the reservation with the north side. Should this crossing become impassible, the south side of the reservation will be isolated, resulting in compromised emergency assistance during the Community's most urgent time of need.

5.2 Existing Conditions

A site visit was conducted to visually inspect the current hydraulic and vegetative conditions at the two river bridges of particular interest to the tribe, as well as to inspect other areas within the floodplain which may benefit from future improvements at the crossing.

The current conditions at the two river bridges, which cross the Gila River upstream of the confluence with the Santa Cruz River, are similar due to their close proximity. Both bridges are constructed of concrete T-beams with 35-foot spans. The north bridge contains 10-spans for a total length of approximately 350 feet, while the south bridge contains six spans for a total length of approximately 210 feet. At the crossing, the Gila River floodplain is approximately 7,000 feet wide and is densely vegetated with non-native saltcedar. Each bridge crosses a low-flow channel, which can move seasonally, and ranges between 40 and 50 feet wide.

About seven miles upstream of Indian Route 3 crossing is the Maricopa Road (SR-347) crossing (see Figure 1). Maricopa Road is a four-lane divided expressway which contains dual bridges providing a single opening approximately 1250 feet long over the Gila River. The river's width at this location is approximately one-half mile. The design flow for this crossing is approximately 65,000 cfs.

The Indian Route 3 structures, their approaches, and the 1500-foot section of roadway between them appear to be in good condition. The low chord of both bridges is approximately ten feet above the low-flow channel inverts. Dense vegetation is present and significant sediment deposition has occurred making the low-flow channels difficult to define in the vicinity of the crossing. The segment of road between the two bridges dips down approximately 5 feet from the road surface on the bridges, allowing the roadway to be overtopped before the capacity of the bridges is exceeded.

5.3 Specific Problems

The concerns of the Gila River Indian Community at the Indian Route 3 crossing can be attributed to three specific problems. The first is the fact that the crossing was not designed to provide a high-level of service. The level of the Indian Route 3 roadway approaching from the south and connecting the two bridges is low compared to the elevation of the bridge decks and the floodplain. This indicates the roadway was designed to be overtopped by high flows before the bridges exceeded their capacities. The bridge foundations are likely designed accordingly. The Maricopa Road (SR-347) crossing is an example of a crossing with a high-level of service.

The second specific problem is the dense vegetation, particularly the saltcedar. The dense vegetation raises the water-surface elevation for a given discharge, and slows the flow of the river at all stages, due to the higher relative roughness. This allows the river to drop its sediment load. Large-scale clearing of all non-native vegetation would provide an immediate increase in hydraulic capacity at relatively low cost, but the saltcedar will soon re-dominate the floodplain, without a maintenance control plan. Planting and irrigating native vegetation, in addition to implementing a saltcedar control program, would yield greater habitat enhancement, yet it would be more costly.

The third specific problem is sediment deposition. Sediment deposition reduces the conveyance capacity of the Gila River channels, which raises flow levels and provides fertile ground for further growth of vegetation, particularly saltcedar. The saltcedar also chokes out the native riparian vegetation. The dense growth of saltcedar, in turn, traps more sediment, further exacerbating the problems. This cycle worsens the problems with time.

5.4 Opportunities

Opportunities exist to improve conditions at the Indian Route 3 crossing of the Gila River. They consist of various short- and long-term strategies, which can include environmental and recreational enhancements. These are itemized below. The feasibility and likelihood of these measures being implemented depend on several factors including regulatory requirements, available funding, and time constraints.

Short-Term Solutions - The short-term solutions include the following possible actions:

- cutting and/or clearing non-native vegetation;
- re-establishing existing channels through sediment excavation and removal; increasing hydraulic capacity by constructing new channels, culverts or bridges;
- raising the roadway to provide a higher level of service;
- building levees to provide protection;
- various combinations of the above.

It should be noted that raising the roadway profile to provide a higher level-of-service also increases upstream water-surface elevations for a given discharge. This will produce more frequent adverse impacts to residences on the south side of the crossing. Therefore, protection must be provided with this solution.

Combinations of the above actions have been developed into a number of alternatives which are described and evaluated in the following chapters of this report.

Long-term Strategies - Potential long-term (5 year) planning strategies, which can include environmental and recreational enhancements in the study area, are listed below:

- Cutting and/or clearing non-native vegetation on a regularly scheduled basis to control saltcedar, before it re-dominates the area.
- Cutting and/or clearing non-native vegetation and replacing it with a native plants. Irrigation may be required to support the native vegetation.
- Construction of parks or other recreational facilities using native plant species to enhance habitat while controlling growth of non-native vegetation. This would require irrigation to support vegetation.
- Periodic sediment removal to maintain hydraulic capacity at Indian Route 3.
- Modification of the transportation infrastructure by constructing a new high-level crossing for Indian Route 3.

5.5 Constraints

The following constraints may affect the implementation of any action plan:

- 404 Permit requirement for channel maintenance and vegetation control involving grubbing or tilling the channel and/or floodplain.
- Time-line required for planning, regulatory approval, and implementation of alternatives

- Cost of alternative measures versus available funds.
- Unknown depth and capacity of existing bridge foundations.
- Other agencies' regulations including the U.S. Fish and Wildlife Service (USFWS) and the Environmental Protection Agency (EPA).

Impacts to the existing habitat, such as cutting and/or clearing vegetation in the project area, may require involvement with other federal and state agencies, including the U.S. Fish and Wildlife Service (USFWS). USFWS has responsibility under federal law to determine whether a proposed action will affect any endangered species. Portions of the study area have similar vegetation (but no permanent water) to areas known to support southwestern willow flycatchers, a species listed as endangered by USFWS. However, based on a 1978 report, the study area has not been included in surveys for this species coordinated by the Arizona Game and Fish Department (AGFD).

5.6 Planning Objectives

The following short and long-term planning objectives have been identified for this study:

1) Short-term Planning Objectives - Address GRIC's immediate concerns:
   - Increase hydraulic capacity of Indian Route 3 crossing
   - Protect lives of local residents
   - Reduce potential for damage to homes and agricultural lands
   - Protect crossing and bridges and preserve transportation infrastructure
   - Coordinate permitting issues.

2) Long-term Planning Objectives - Provide the maintenance needs for the short-term objectives listed above, and consider the environmental and recreational opportunities associated with implementing the following:
   - Restore native vegetation and eradicate non-native species
   - Provide sediment management strategy
   - Provide recreation and/or environmental educational facilities
   - Replace the Indian Route 3 crossing
   - Coordinate long-term permitting issues.

Chapter 6

METHODOLOGY AND ASSUMPTIONS

6.1 Methodology

The following describes the methodology and approach used to develop and evaluate improvement alternatives for the Indian Route 3 crossing of the Gila River. Previously developed alternatives, as well as new alternatives, were evaluated in a relative manner by comparing their hydraulic capacity and cost to each other and to a baseline condition. The hydraulic capacity of a given alternative is defined as the discharge at the overtopping elevation of the roadway (i.e., low-point of the crossing). The baseline condition is a "No-Action" alternative, which consists of existing conditions without the removal of sediment or vegetation, upstream or downstream of the bridges. The alternatives evaluated are described in Chapter 7 of this report.

A concept level hydraulic analysis was conducted for each alternative using the information provided by the previous study, a field visit, and the Corps' HEC-RAS water-surface profile model. The analysis included evaluating a range of discharges from 5,000 to 40,000 cfs, in increments of 5,000 cfs. The specific target or design discharge for the crossing was 40,000 cfs. Actions for further development of alternatives were made considering cost, hydraulic capacity, maintenance requirements, and potential regulatory involvement.

The available data for the crossing consisted of the following:

- USGS 7.5 minute quadrangle maps (Laveen and Montezuma Peak)
- Unrectified aerial photography from Kenney Aerial Mappings, Inc.
- January 1998 survey of roadway centerline and existing channels at, and between, the two bridges
- Historical flow data from USGS Internet site for stream gauge at Gila River near Laveen, Arizona.
- Bridge plans

The total hydraulic capacity of Indian Route 3 crossing for the baseline or No-Action condition is estimated to be 3,000 cfs. This is the maximum amount of flow which will pass through the bridges before the roadway section, between the two bridges, is overtopped. The stage-discharge curve for the baseline condition is shown in Figure 3. This capacity was estimated by running a HEC-RAS model based on the limited existing data for the study area, and assuming no maintenance being performed on the channel, floodplain, or bridge openings in the future. A cross-section depicting the estimated water-surface elevation for the baseline condition is shown in Figure 4. The Manning's "n" value selected for a totally un-maintained floodplain is 0.080.

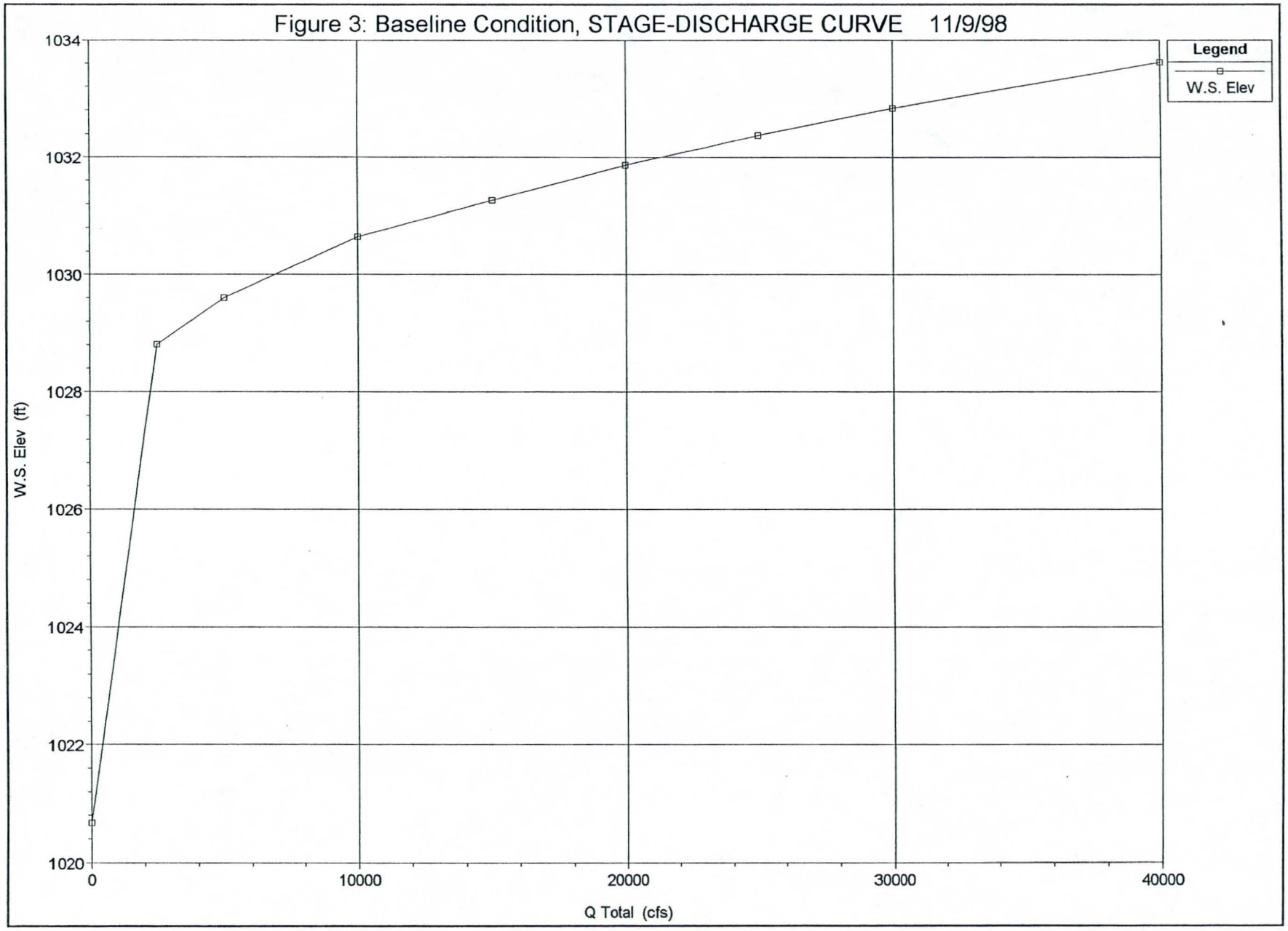


Figure 3: Baseline Condition, STAGE-DISCHARGE CURVE 11/9/98
Legend
W.S. Elev
W.S. Elev (ft)
1034
1032
1030
1028
1026
1024
1022
1020
0
10000
20000
30000
40000
Q Total (cfs)

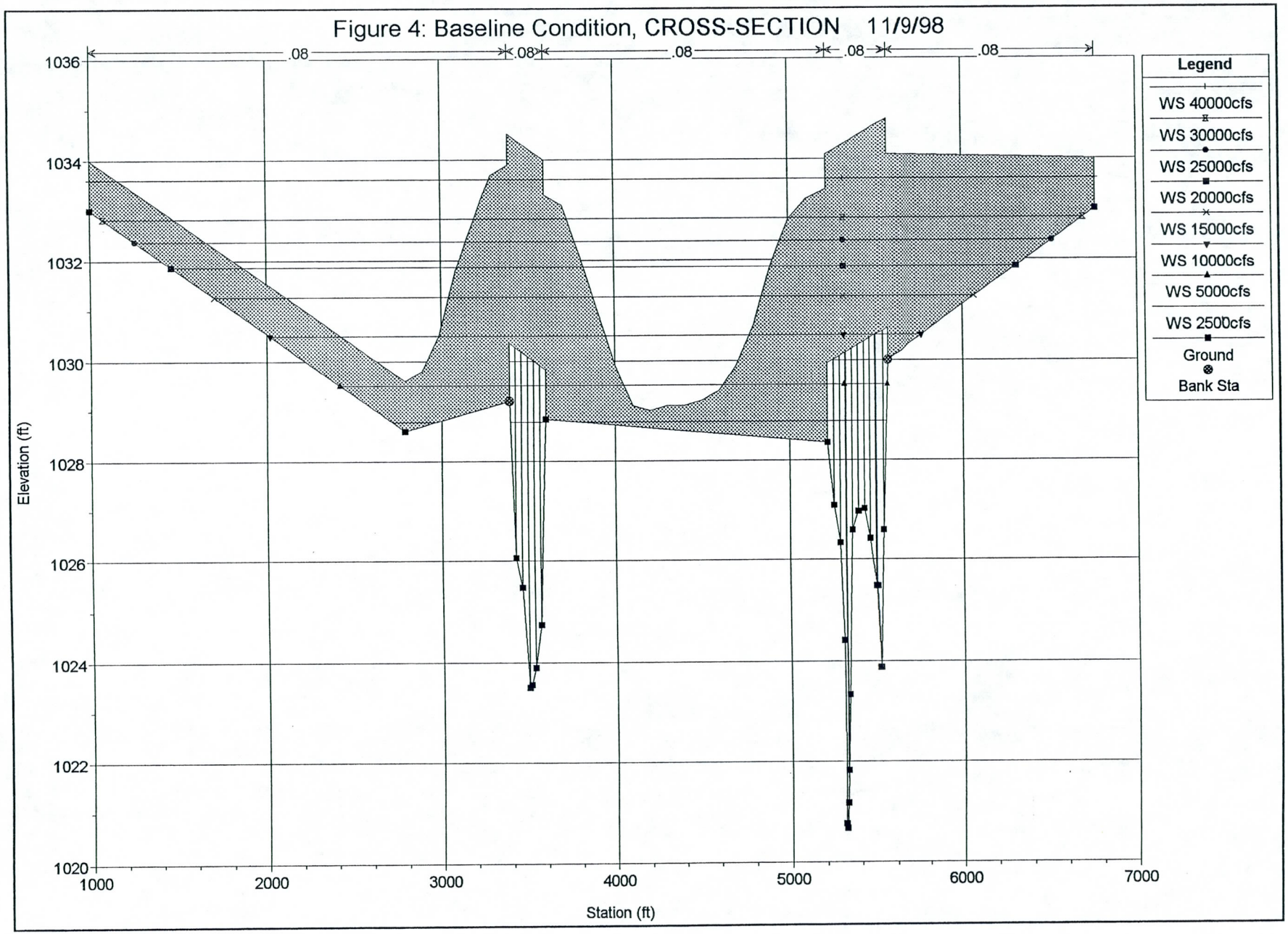


Figure 4: Baseline Condition, CROSS-SECTION 11/9/98
.08
.08
.08
.08
.08
Legend
WS 40000cfs
WS 30000cfs
WS 25000cfs
WS 20000cfs
WS 15000cfs
WS 10000cfs
WS 5000cfs
WS 2500cfs
Ground
Bank Sta
Elevation (ft)
1036
1034
1032
1030
1028
1026
1024
1022
1020
1000
2000
3000
4000
5000
6000
7000
Station (ft)

The rating curves for the existing and baseline conditions HEC-RAS models were compared to historical flow data from the USGS stream gauge at the crossing. If it is assumed the gauge datum and the selected bridge datum are the same, the HEC-RAS model generates water-surface elevations within approximately one foot of the gauge for a given discharge. This is shown in Figure 5 for existing conditions.

6.2 Assumptions

The following assumptions were made in developing the HEC-RAS computer model and in analyzing the hydraulic characteristics of the various alternatives:

- Given the extreme level of vegetation growth, a Manning's coefficient of 0.080 was assigned to un-maintained channel and overbank sections within the study area.

- For conditions after the removal of non-native vegetation, a Manning's coefficient of 0.050 was used for channel and overbank areas.

- A Manning's coefficient of 0.035 was used for existing conditions where vegetation and sediment is minimal, immediately upstream and downstream of the bridges.

- For proposed channelization (i.e., sediment excavation and removal), a Manning's coefficient of 0.030 was used.

- The geometry of channels at the bridges was surveyed. However, the channels were not surveyed further upstream and downstream of the bridges. USGS topographic data was used to estimate channel slopes, but the 10-foot contour intervals could not reveal any channel cross-section information. Therefore, the channel sections at the bridges were used to develop the upstream and downstream geometry.

- The cross-sections were projected 1/4 mile upstream. The elevations of the upstream sections were raised according to the average channel slope from the USGS topography (S = 0.0010). Additionally, since the low-flow channels converge upstream of the bridges, the distance between the channels was reduced in the upstream direction. Similarly, for the downstream channel approximation, the known channel sections were projected downstream at a slope of 0.00156 (the average channel slope from USGS maps). The low-flow channels were assumed to be parallel in the downstream direction.

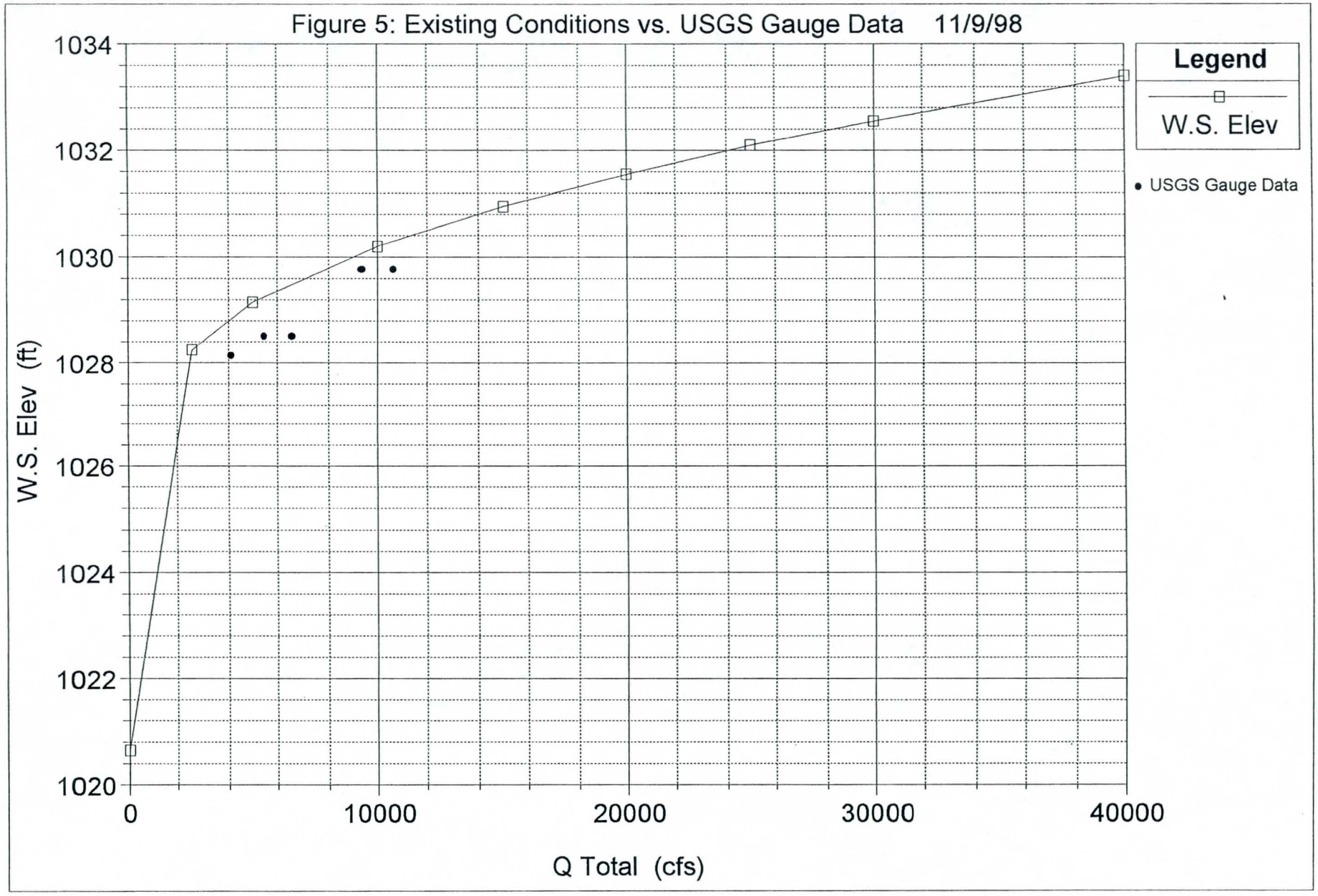


Figure 5: Existing Conditions vs. USGS Gauge Data 11/9/98
1034
1032
1030
1028
1026
1024
1022
1020
W.S. Elev (ft)
0
10000
20000
30000
40000
Q Total (cfs)
Legend
W.S. Elev
USGS Gauge Data

- The off-road areas between the bridges were not surveyed. From observations during the site visits, these areas seemed relatively flat. Therefore, a straight-line approximation was used to define the overbank area between the two channels.

- The downstream cross-section at the crossing was projected ½ mile downstream to establish the starting water-surface elevation for the HEC-RAS computations. Normal depth for a totally un-maintained cross-section (No-Action, n = 0.08) was assumed.

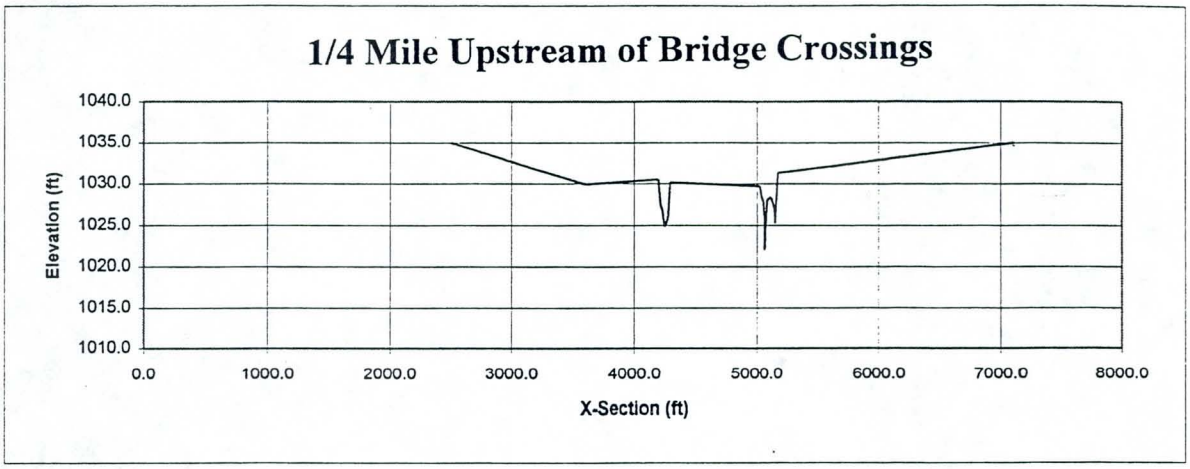
- Since a benchmark elevation could not be found for the bridges, an assumed datum was used, based on the USGS maps. South of the southern bridge, the elevation 1,030 contour line crosses the roadway very close to where the southern most survey point was taken. The 1,030 contour line also forms a loop between the two bridges. The channel elevations at the bridges are very close to the 1,020-foot contour lines. An assumed benchmark elevation of 1,034 feet at the south bridge provided relatively close agreement between the surveyed elevations of the roadway and channels, and the contours on the USGS map.

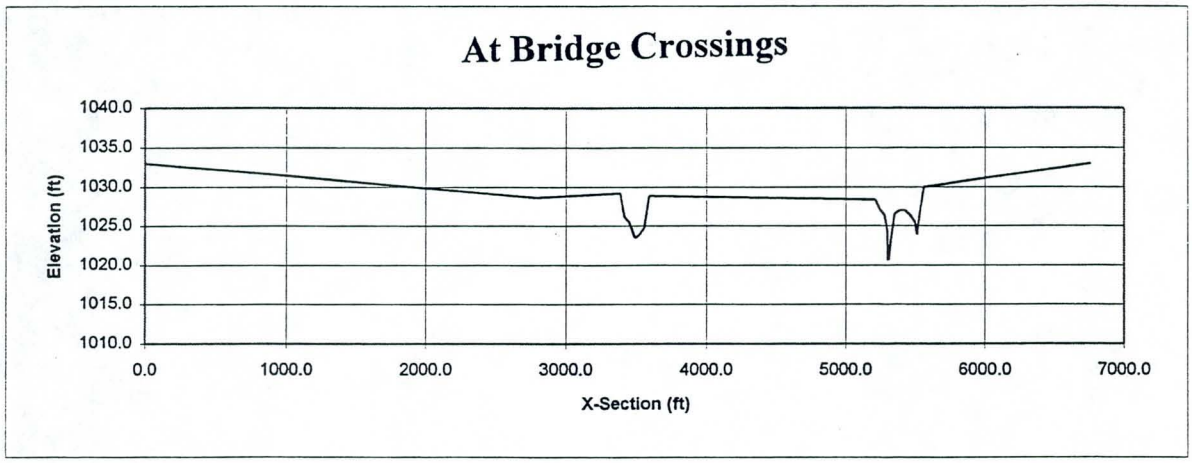
- The January, 1998, survey at the bridges extended over a lateral distance of about 2,700 feet. However, the elevation of the southern most survey point was nearly as low as the roadway low-point between the two bridges. As a result, the cross-section would not contain flow over the roadway. Consequently, an additional point was added to the roadway centerline data to create a southern-most road elevation at least as high as bridge elevation 1034. A point approximately 1,700 feet south of the southern bridge was selected from the USGS map.

- High end-point elevations to fully contain high flows, as described above, were also added to the upstream and downstream projected cross-sections. Points where overbank elevations were near 1,034 feet, were selected from the USGS maps 1/4 mile up and downstream of the crossing. The cross-sections used at the Indian Route 3 crossing and at the upstream and downstream limits of the study area are shown in Figure 6.

- Because the depth of the existing bridge foundations is unknown, the bridges could not be evaluated for scour susceptibility. Therefore, it has been assumed that the velocity through the existing bridges for any alternative cannot significantly exceed the estimated design velocity of 4.0 to 5.0 fps, without endangering the stability of the structures. This range represents the average velocities through the bridges when channelizing existing conditions to the thalweg depth and bridge-opening width, through the study area. This HEC-RAS model was assumed to represent the original design conditions.

Study Area Cross Sections





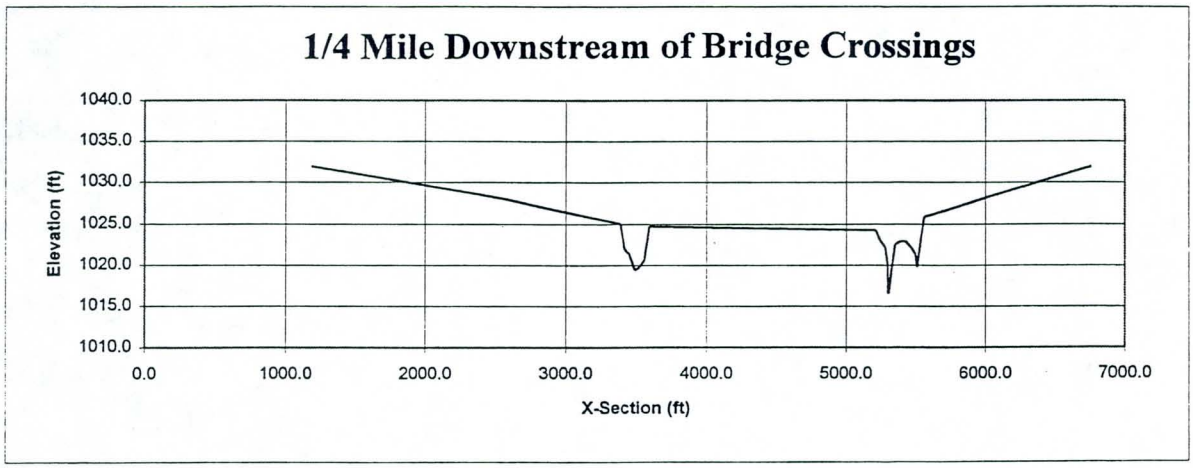


Figure 6

- Protection for residences on the south side of the crossing has been assumed necessary for a particular alternative when the roadway overtopping elevation exceeds 1031. This is the ground elevation of the lowest residence, as estimated from the USGS quadrangle maps. It has been assumed that standard levees will be constructed to provide the protection equal to the crossing design. A typical levee section is shown in Figure 7.

6.3 Cost estimates

The following information was used to develop cost estimates for the alternatives evaluation:

Unit Costs:

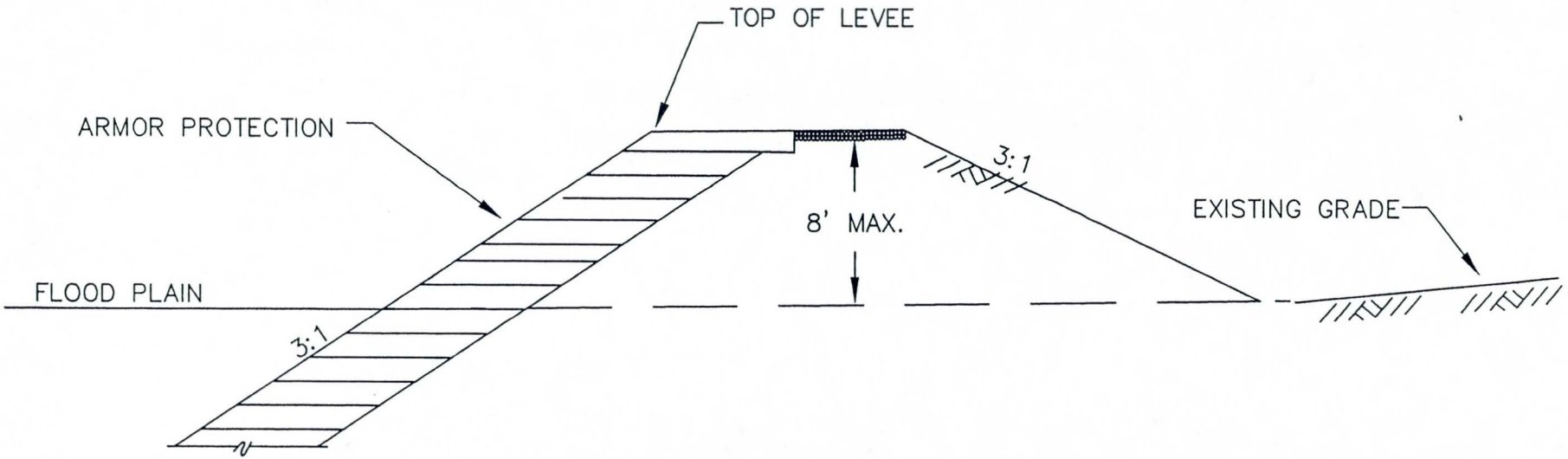
- Vegetation clearing - $1000 per acre
- Channelization/sediment removal - $5 per cubic yard
- Roadway construction - $285 per foot
- Levee construction - $380 per foot
- Bridge construction - $80 per square foot
- Box culvert (10' x 6') construction - $4400 per foot

Maintenance Intervals:

- Vegetation removal - twice annually
- Sediment removal - average 6 inches from channel bottoms annually

Annualized Costs:

- 50-year term
- 6.875% interest rate.



TYPICAL LEVEE SECTION

NTS

FIGURE 7

Chapter 7

SHORT-TERM PLAN FORMULATION

7.1 Proposed Short-Term Plans

In the interest of providing immediate relief at the Indian Route 3 Gila River crossing, several short-term alternatives have been suggested in previous Corps efforts. These alternatives, with some modifications, along with some newly developed alternatives, have been evaluated for effectiveness, cost, and regulatory constraints. The alternatives have been formulated as possible interim solutions which will fit into a larger scale water resources and land use plan that the Community will implement in the future. Not all the alternatives will provide the desired design capacity of 40,000 cfs at the crossing. Again, the hydraulic capacity of a given alternative is defined as the discharge at the overtopping elevation of the roadway (i.e., the low-point of the crossing).

A description of each short-term alternative considered is given in the following paragraphs. The alternatives typically become progressively more costly, while adding more capacity for the crossing and addressing the problems more fully. The rating curves developed and cross-sections depicted are located immediately upstream of the crossing.

7.1.1 Clearing Vegetation Within Bridge Limits

A common and relatively inexpensive action, which can be taken to provide more hydraulic capacity at the Indian Route 3 crossing, is to clear all the vegetation immediately within the bridge limits. This would cover only the area within the bridge openings, and one bridge length up and downstream. Such an action will reduce the channel roughness coefficient, or Manning's "n" value, allowing the water to flow more effectively. Doing this would provide a hydraulic capacity of approximately 4,400 cfs, or about 1,400 cfs more than the baseline condition. This is the maximum amount of flow which will pass through the bridges before the roadway section, between the two bridges, is overtopped. This stage-discharge curve for this alternative is shown in Figure 8. The hydraulic capacity was estimated using the HEC-RAS model and the limited existing data for the study area. A cross-section depicting the estimated water-surface elevations is shown in Figure 9. The coefficients of 0.035 and 0.08 appearing at the top of this figure reflect Manning's "n" value for the cleared area, immediately upstream and downstream of the bridges, and the remaining floodplain, respectively.

7.1.2 Cutting and/or Clearing Non-Native Vegetation

A simple measure, which can be taken to provide more hydraulic capacity at the Indian Route 3 crossing, is to cut and/or clear all the non-native vegetation within and between the bridge limits. This would be an area, approximately 2200-feet wide, extending 1/4 mile upstream and downstream of the crossing. The cutting and/or clearing will reduce the floodway roughness coefficient, or Manning's "n" value, allowing the water to flow more effectively. By doing this, the total conveyance capacity of the crossing would be approximately 4600 cfs, an improvement of 1600 cfs over the No-Action capacity of 3000 cfs. The stage-discharge curve for this improved condition is shown in Figure 10. Figure 11 shows the cross-section and estimated water-surface elevations.

7.1.3 Channelization

Another measure that may be used to improve conditions at the crossings would be to increase channel capacity by removing sediment and re-establishing well-defined channels within the study reach and beneath the two existing bridges. The north bridge channel would be excavated to the current thalweg elevation of 1,020 feet, with a bottom width of approximately 300 feet. The south bridge channel would be excavated to the current thalweg elevation of 1,020.5 feet, with a bottom width of approximately 160 feet. Vegetative clearing outside the channel is not assumed in this alternative. The channel excavation described above will provide a total conveyance capacity at the crossing of approximately 12,700 cfs, an improvement of 9,700 cfs over the No-Action capacity of 3000 cfs. The stage-discharge curve for this alternative is shown in Figure 12. Figure 13 shows the cross-section and estimated water-surface elevations over the range of discharges.

7.1.4 Cutting and/or Clearing Non-Native Vegetation and Channelization

When the Alternatives 7.1.2 and 7.1.3 are combined, further hydraulic capacity can be achieved at the Indian Route 3 crossing. After cutting and/or clearing the non-native vegetation and channelizing beneath the two bridges, the total conveyance capacity of the crossing will be approximately 12,800 cfs, an improvement of 9800 cfs over the No-Action capacity of 3000 cfs. The stage-discharge curve for this alternative is shown in Figure 14. Figure 15 shows the cross-section and estimated water-surface elevations for the range of discharges.

7.1.5 Cutting and/or Clearing Non-Native Vegetation, Adding Culverts, and Channelization

Another alternative that could be implemented to improve capacity would be to install culverts beneath the existing roadway surface, between the two bridges. The vertical distance between the existing channel inverts and the roadway profile, between the two bridges, will allow a six-foot deep box culvert to be constructed. By adding six box culverts measuring 10' x 6' and the associated third channel (90-foot bottom width) to Alternative 7.1.4, the total conveyance capacity of the crossing

can be increased to approximately 13,100 cfs, an improvement of 10,100 cfs over the No-Action capacity of 3000 cfs. The stage-discharge curve for this alternative is shown in Figure 16. Figure 17 shows the cross-section and estimated water-surface elevations and Figure 18 depicts the approximate alignment of the required third channel.

7.1.6 Cutting and/or Clearing Non-Native Vegetation with Deep Channelization

In Alternatives 7.1.3 and 7.1.4, the improved channels beneath the bridges were within one foot of the minimum observed channel invert elevation of 1,020.7 feet. Further investigation of the depth of the existing bridge foundations may indicate it is feasible to lower the inverts an additional one foot. Assuming this is feasible, the south bridge channel would be excavated to an elevation of 1,019.5 feet, and the north bridge channel would be excavated to an elevation of 1,019 feet. The capacity of the existing crossing would be increased to approximately 13,200 cfs. The stage-discharge curve for this alternative is shown in Figure 19. Figure 20 shows the cross-section and the estimated water-surface elevations.

7.1.7 Raising Roadway Between and South of Bridges

By raising the elevation of the roadway south of and between the two bridges, more flow will be forced through the bridges before overtopping Indian Route 3. Between the two bridges, the roadway surface dips down about five feet to an elevation of 1,029 feet. The low point on the south approach is at about elevation 1,029.5 feet. Approximately 4,000 feet of road would need to be raised to approximately match the bridge elevations across the floodplain. This alternative does not include any channelization or removal of vegetation. However, it does include constructing a levee, with three feet of freeboard, to protect the south side residences and farm land. The approximate levee alignment is shown on Figure 21.

After raising these segments of road, the total conveyance capacity of the crossing would be approximately 20,000 cfs, an improvement of 17,000 cfs over the No-Action capacity of 3000 cfs. The stage-discharge curve for this alternative is shown in Figure 22. Figure 23 shows the cross-section and estimated water-surface elevations.

7.1.8 Raising Roadway Between and South of Bridges with Cutting and/or Clearing Non-Native Vegetation

This alternative is the same as Alternative 7.1.7, except the non-native vegetation is cleared within and between the limits of the bridges through the study area. The resulting total conveyance capacity of the crossing would be approximately 23,100 cfs, an improvement of 20,100 cfs over the No-Action capacity. The stage-discharge curve for this alternative is shown in Figure 24. Figure 25 shows the cross-section and the estimated water-surface elevations.

7.1.9 Raising Roadway Between and South of Bridges, Cutting and/or Clearing Non-Native Vegetation, and Channelization

This alternative is the same as Alternative 7.1.8, except that additional capacity would be provided by the channelization beneath the two bridges, as described in Alternative 7.1.3. The south bridge channel would be excavated to an elevation of 1,020.5 feet, and the north bridge channel would be excavated to an elevation of 1,020 feet, Under this scenario, the total conveyance capacity of the crossing would be approximately the 40,000 cfs target. The stage-discharge curve for this alternative is shown in Figure 26. Figure 27 shows the cross-section and the estimated water-surface elevations.

7.1.10 Raising Roadway Between and South of Bridges, Adding Bridge, and Channelization

This alternative is the same as Alternate 7.1.7, except additional capacity is provided by constructing a new 400-foot bridge and an associated channel between the existing bridges on Indian Route 3. The length of the bridge is dictated by the limiting velocities through the existing bridges in Alternate 7.1.3. These velocities are assumed to reflect those for which the existing foundations have been designed. Higher velocities may jeopardize the stability of the existing bridges. By improving the crossing in this manner, the total conveyance capacity can be increased to the design discharge of 40,000 cfs. The stage-discharge curve for this alternative is shown in Figure 28. Figure 29 shows the cross-section and estimated water-surface elevations. The approximate location of the required third channel is shown in Figure 18.

7.1.11 Constructing Levees Parallel to Road

It is possible to increase capacity at the Indian Route 3 crossing without reconstructing the roadway itself to a higher profile. Levees can be constructed parallel to the roadway, both up and downstream, to prevent overtopping until the water level rises to the roadway elevation at the existing bridges. This alternative also includes constructing a levee, with three feet of freeboard, to protect the south side residences and farm land. The net effect of this alternative on hydraulic capacity would be identical to Alternative 7.1.7. The approximate levee alignments are shown on Figure 30.

7.1.12 Independent Protection for South Bank

This alternative considers providing protection to the design discharge of 40,000 cfs for the residences along the south bank of the crossing, regardless of the level of improvement made to the Route 3 crossing. In the previous alternatives, protection for the south bank was provided to a level equal to the capacity of the crossing. Therefore, protection for the south bank was only included if the overtopping elevation of the alternative exceeded elevation 1031 - the lowest estimated ground

elevation at a residence. For this alternative, protection by levee construction along the south bank is provided for the highest water-surface elevation associated with 40,000 cfs for all alternatives evaluated. The highest water-surface elevation associated with 40,000 cfs is 1035. Assuming three feet of freeboard, the top of the levee would be approximately elevation 1038. This would result in a maximum levee height of about eight (8) feet (see Figure 7). A plan view depicting the location and extent of the proposed levee is shown in Figure 31.

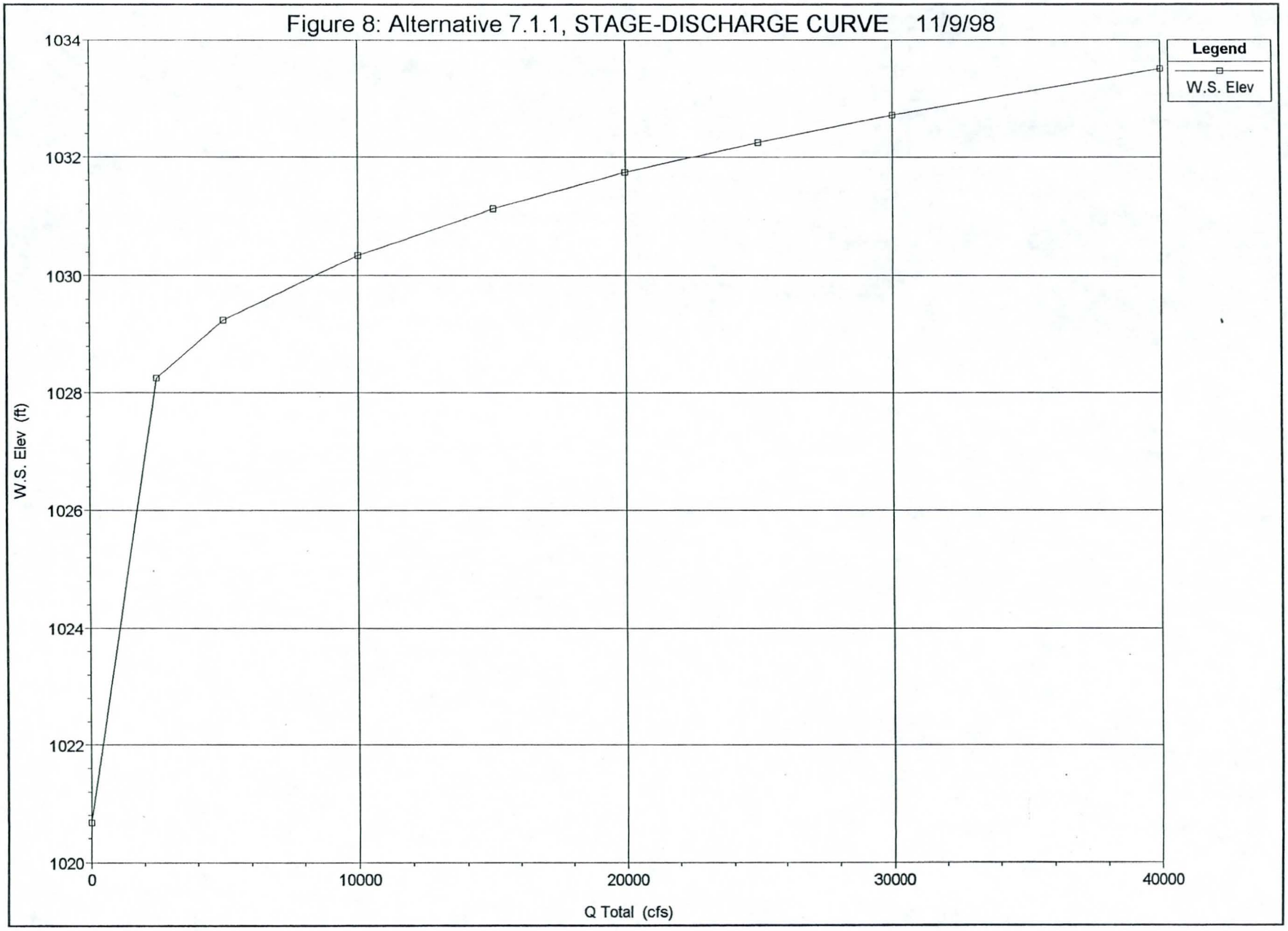


Figure 8: Alternative 7.1.1, STAGE-DISCHARGE CURVE 11/9/98
Legend
W.S. Elev
W.S. Elev (ft)
1034
1032
1030
1028
1026
1024
1022
1020
0
10000
20000
30000
40000
Q Total (cfs)

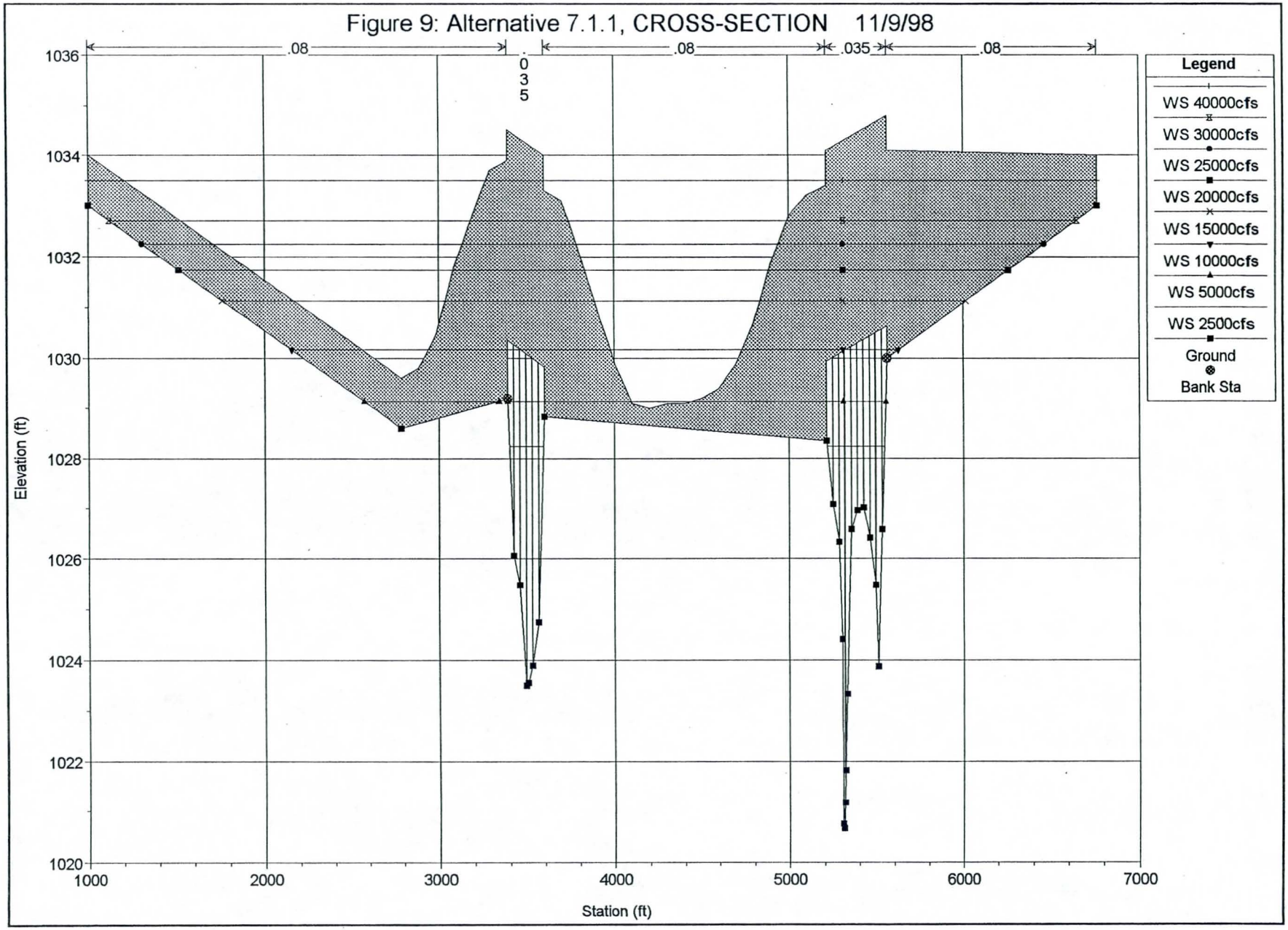


Figure 9: Alternative 7.1.1, CROSS-SECTION 11/9/98
.08
.035
.08
.035
.08
Legend
WS 40000cfs
WS 30000cfs
WS 25000cfs
WS 20000cfs
WS 15000cfs
WS 10000cfs
WS 5000cfs
WS 2500cfs
Ground
Bank Sta
Elevation (ft)
1036
1034
1032
1030
1028
1026
1024
1022
1020
1000
2000
3000
4000
5000
6000
7000
Station (ft)

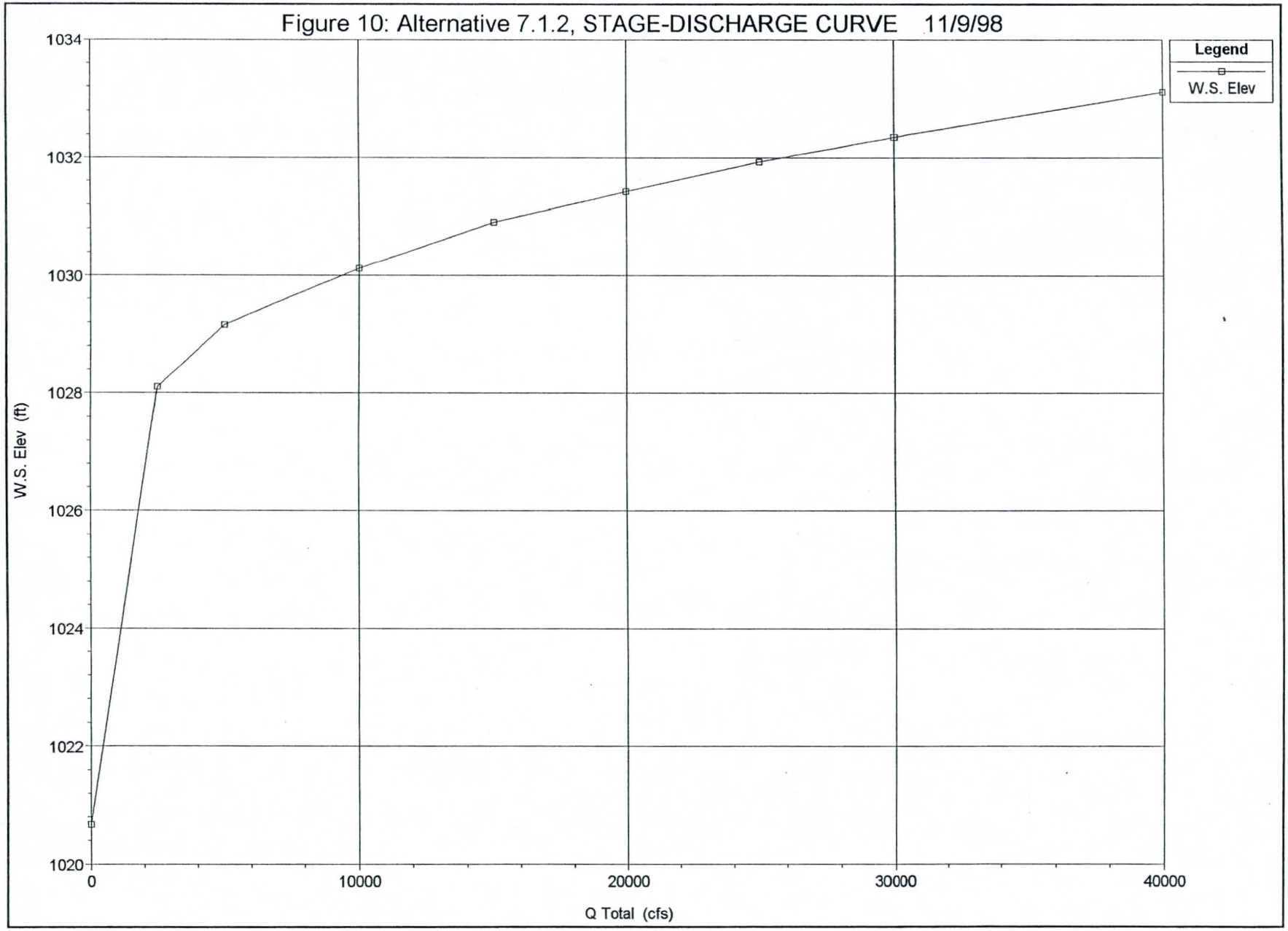


Figure 10: Alternative 7.1.2, STAGE-DISCHARGE CURVE 11/9/98
Legend
W.S. Elev
W.S. Elev (ft)
1034
1032
1030
1028
1026
1024
1022
1020
0
10000
20000
30000
40000
Q Total (cfs)

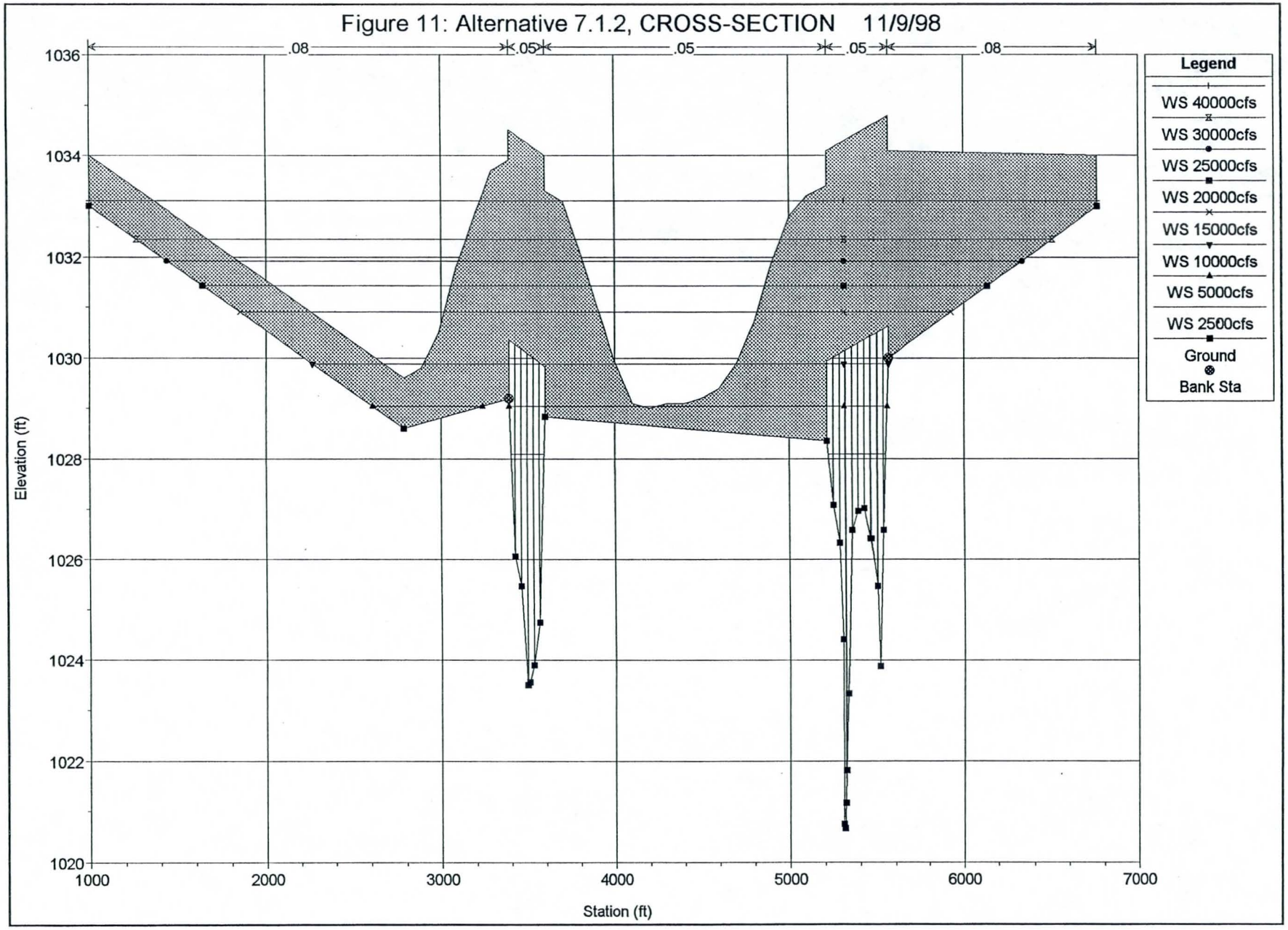


Figure 11: Alternative 7.1.2, CROSS-SECTION 11/9/98
.08
.05
.05
.05
.08
Legend
WS 40000cfs
WS 30000cfs
WS 25000cfs
WS 20000cfs
WS 15000cfs
WS 10000cfs
WS 5000cfs
WS 2500cfs
Ground
Bank Sta
Elevation (ft)
1036
1034
1032
1030
1028
1026
1024
1022
1020
1000
2000
3000
4000
5000
6000
7000
Station (ft)

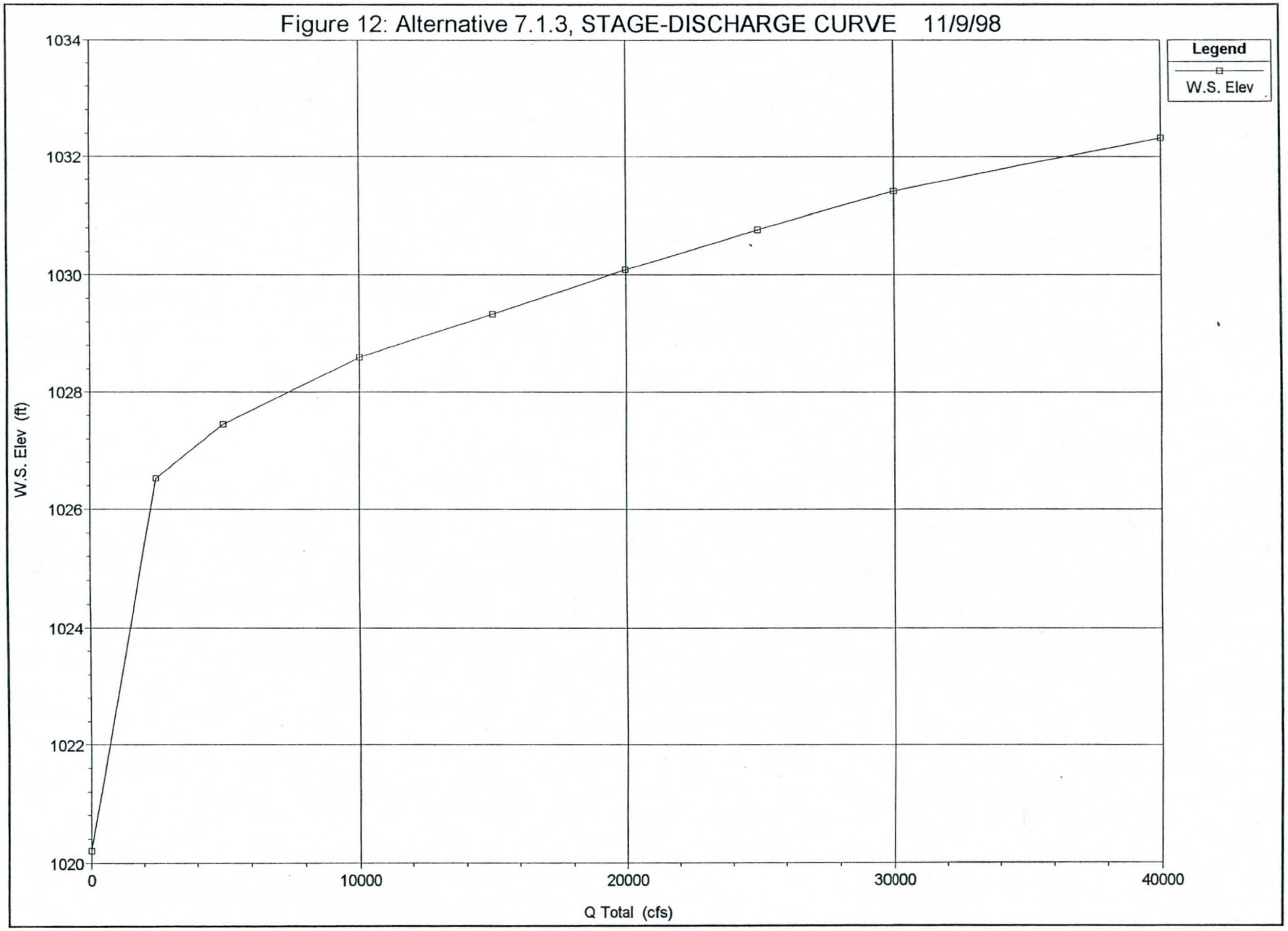
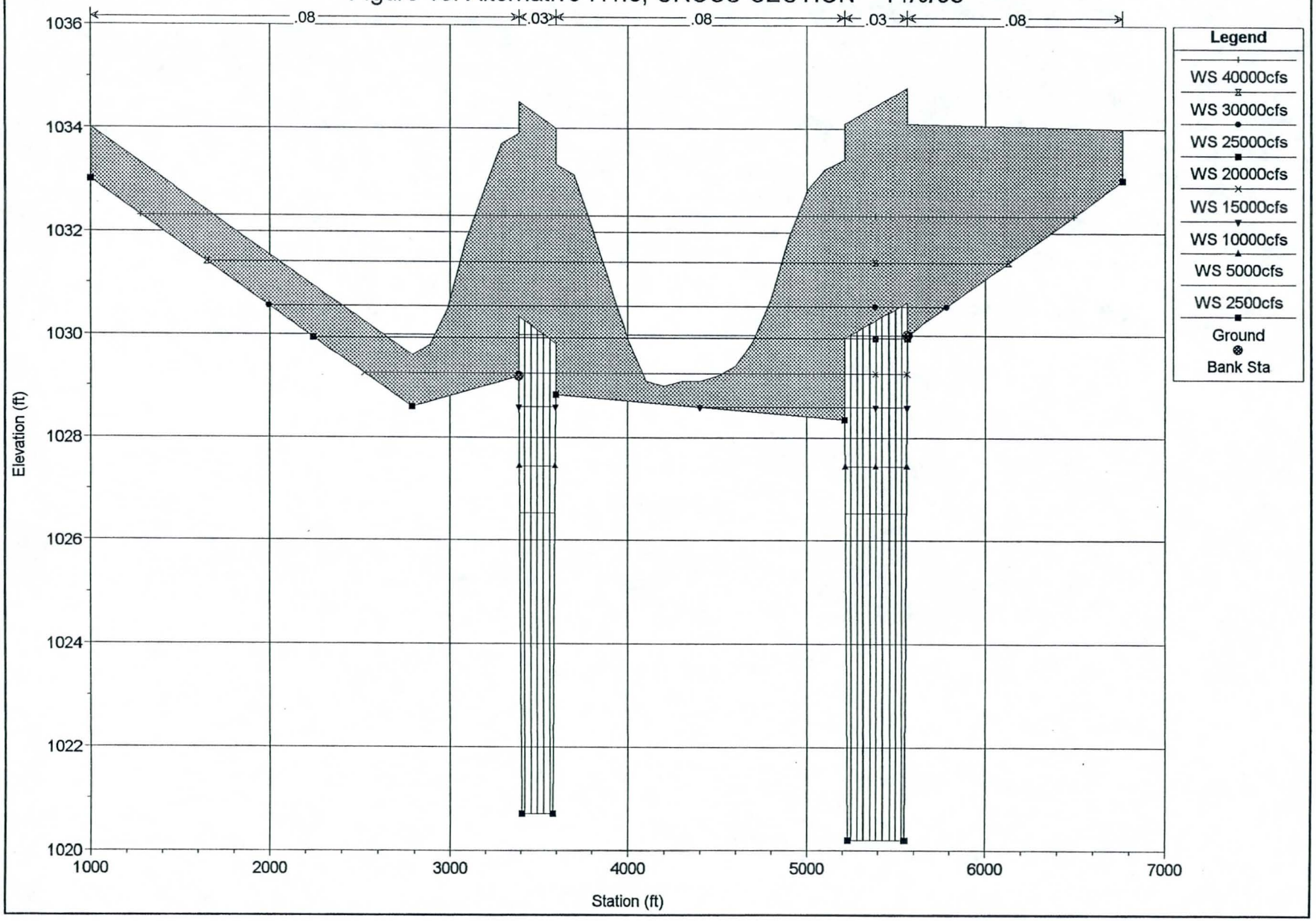


Figure 12: Alternative 7.1.3, STAGE-DISCHARGE CURVE 11/9/98
Legend
W.S. Elev
W.S. Elev (ft)
1034
1032
1030
1028
1026
1024
1022
1020
0
10000
20000
30000
40000
Q Total (cfs)

Figure 13: Alternative 7.1.3, CROSS-SECTION 11/9/98



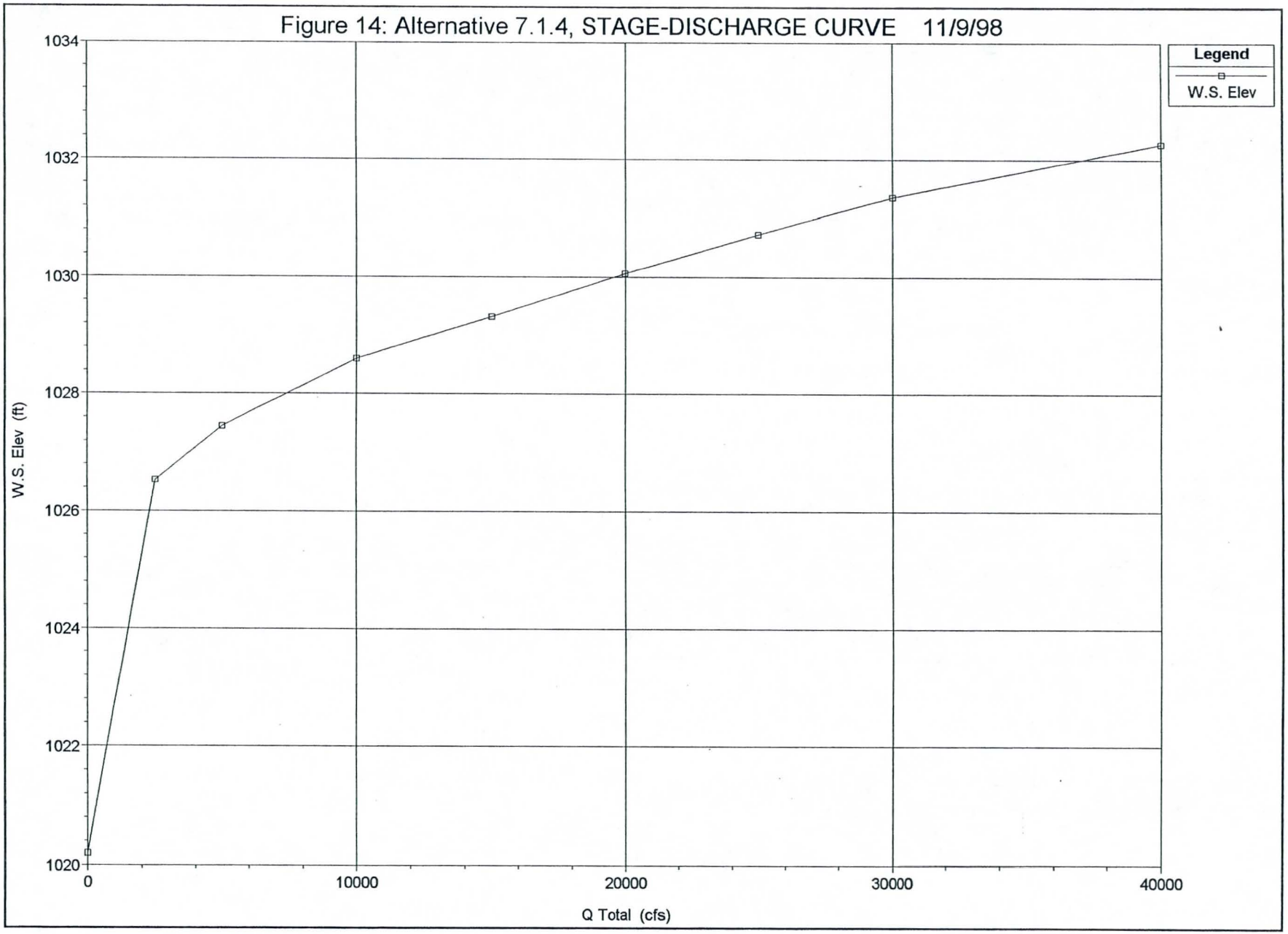
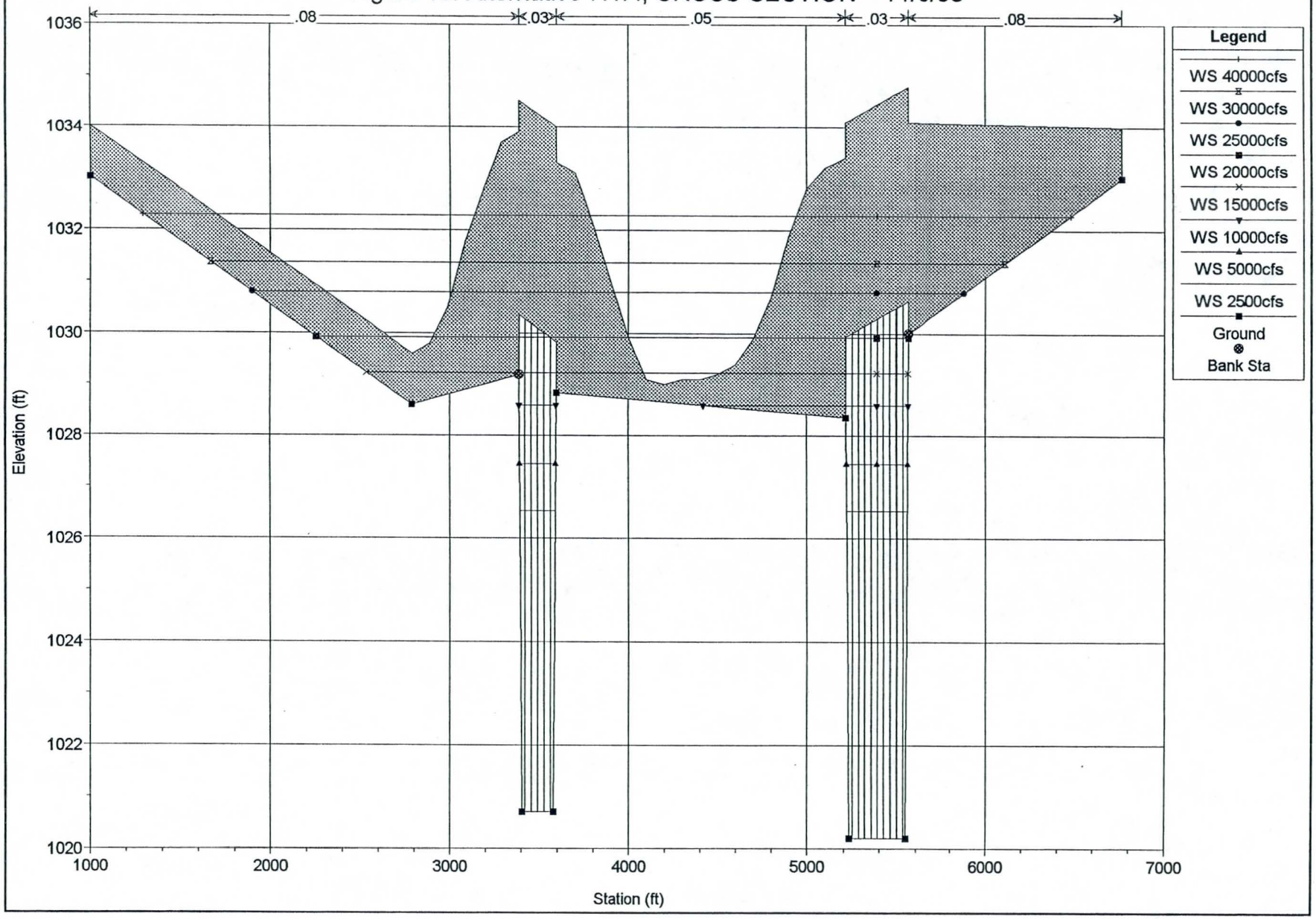


Figure 14: Alternative 7.1.4, STAGE-DISCHARGE CURVE 11/9/98
Legend
W.S. Elev
W.S. Elev (ft)
1034
1032
1030
1028
1026
1024
1022
1020
0
10000
20000
30000
40000
Q Total (cfs)

Figure 15: Alternative 7.1.4, CROSS-SECTION 11/9/98



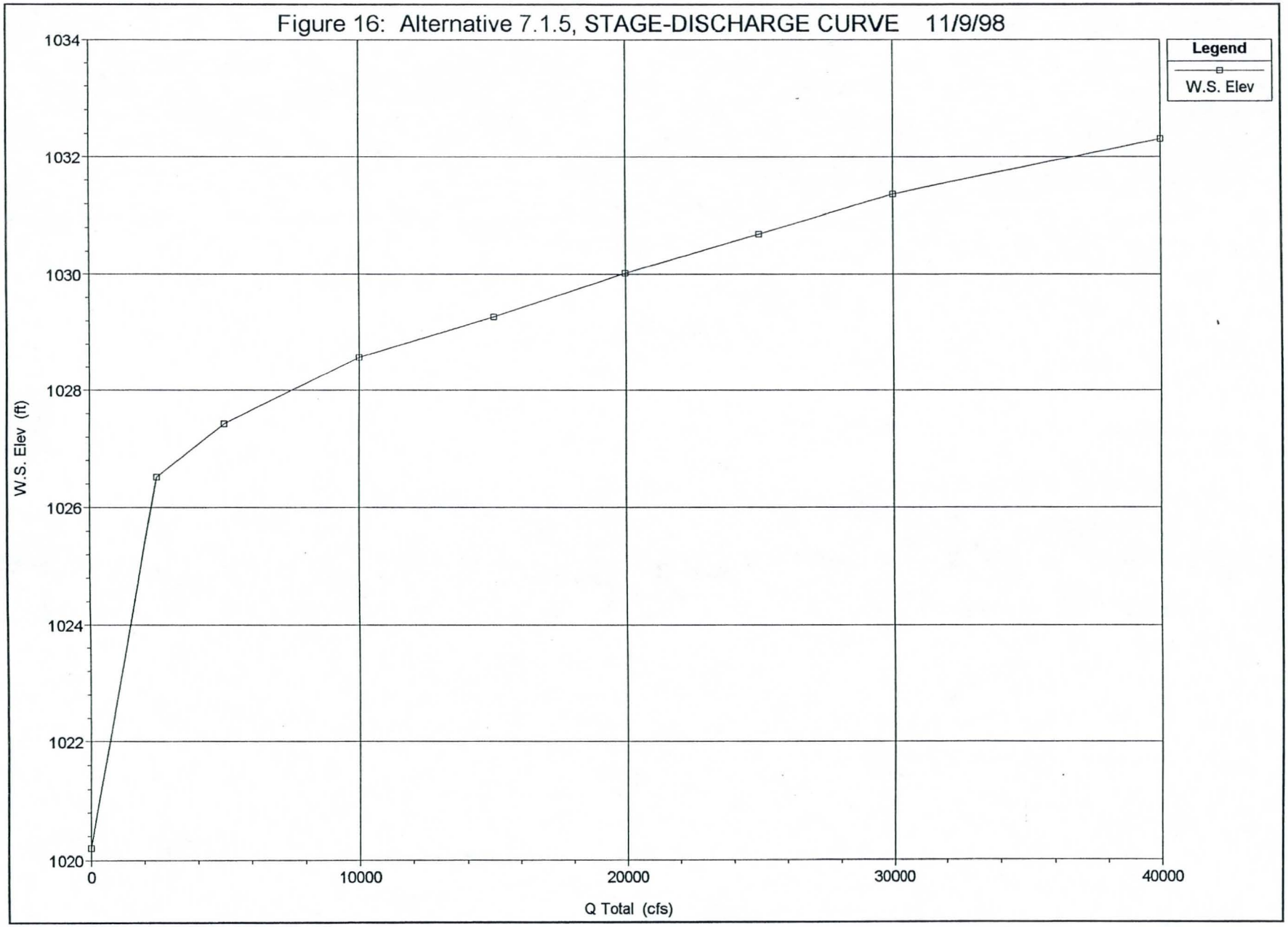
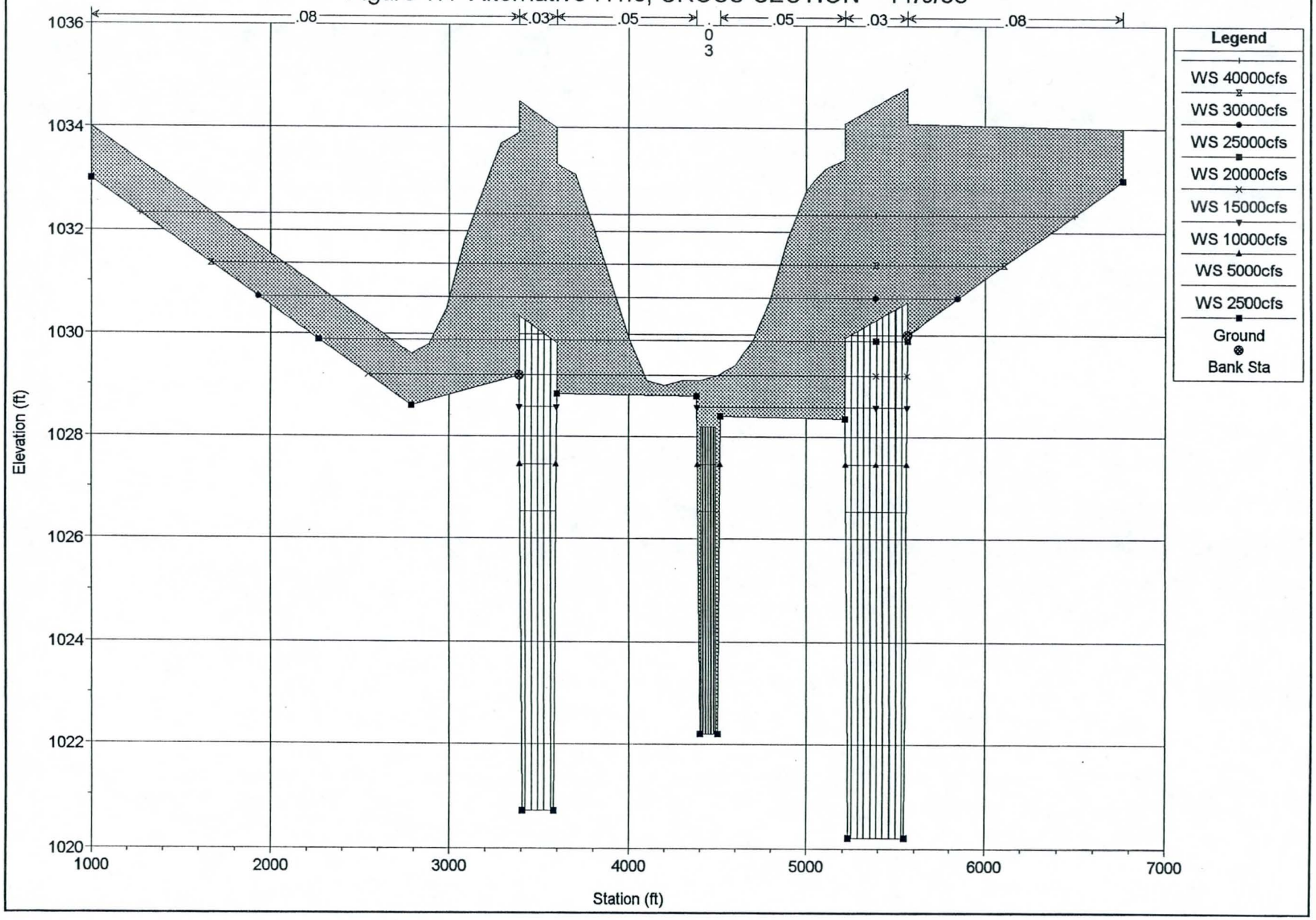
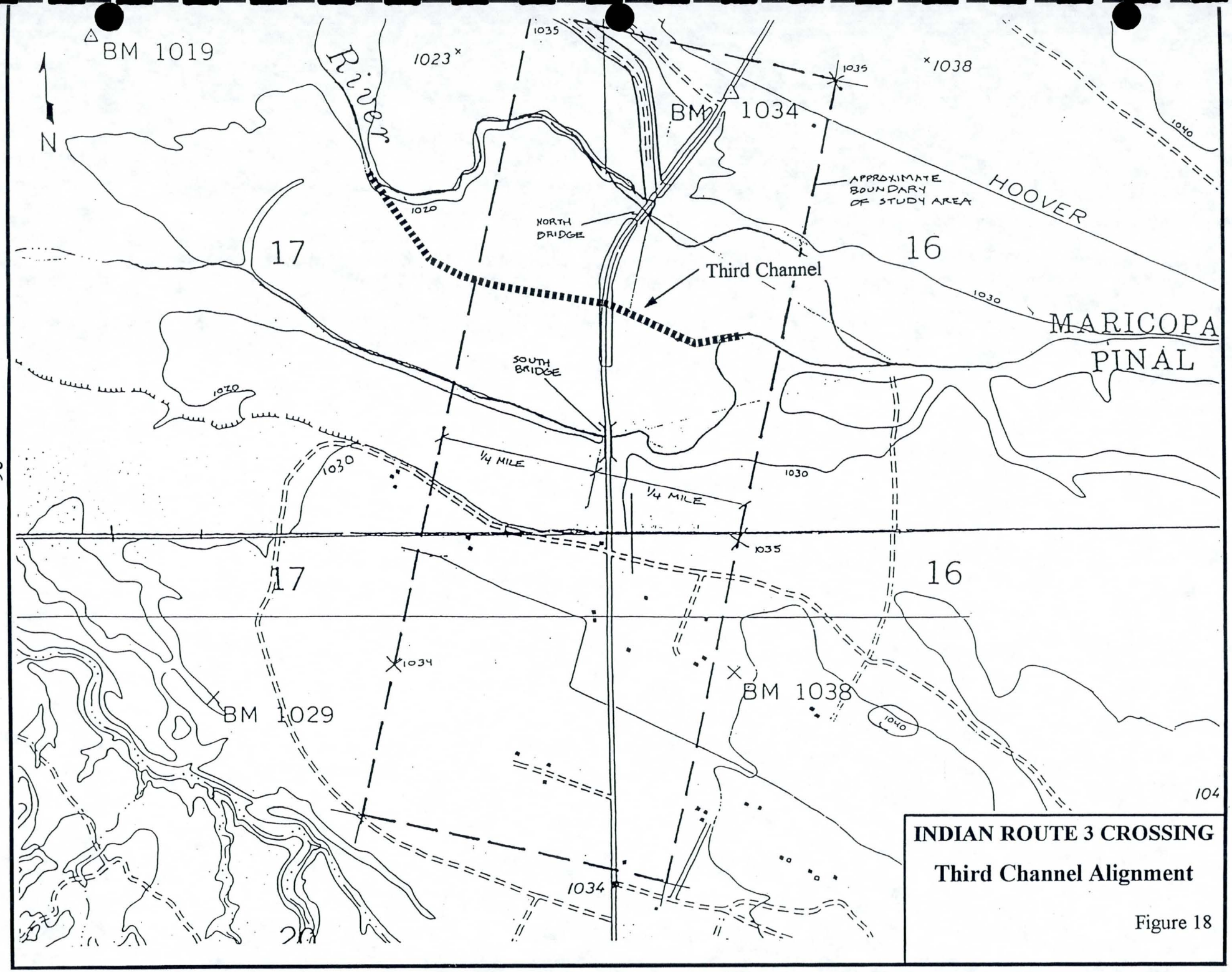


Figure 16: Alternative 7.1.5, STAGE-DISCHARGE CURVE 11/9/98
Legend
W.S. Elev
W.S. Elev (ft)
1034
1032
1030
1028
1026
1024
1022
1020
0
10000
20000
30000
40000
Q Total (cfs)

Figure 17: Alternative 7.1.5, CROSS-SECTION 11/9/98





INDIAN ROUTE 3 CROSSING

Third Channel Alignment

Figure 18

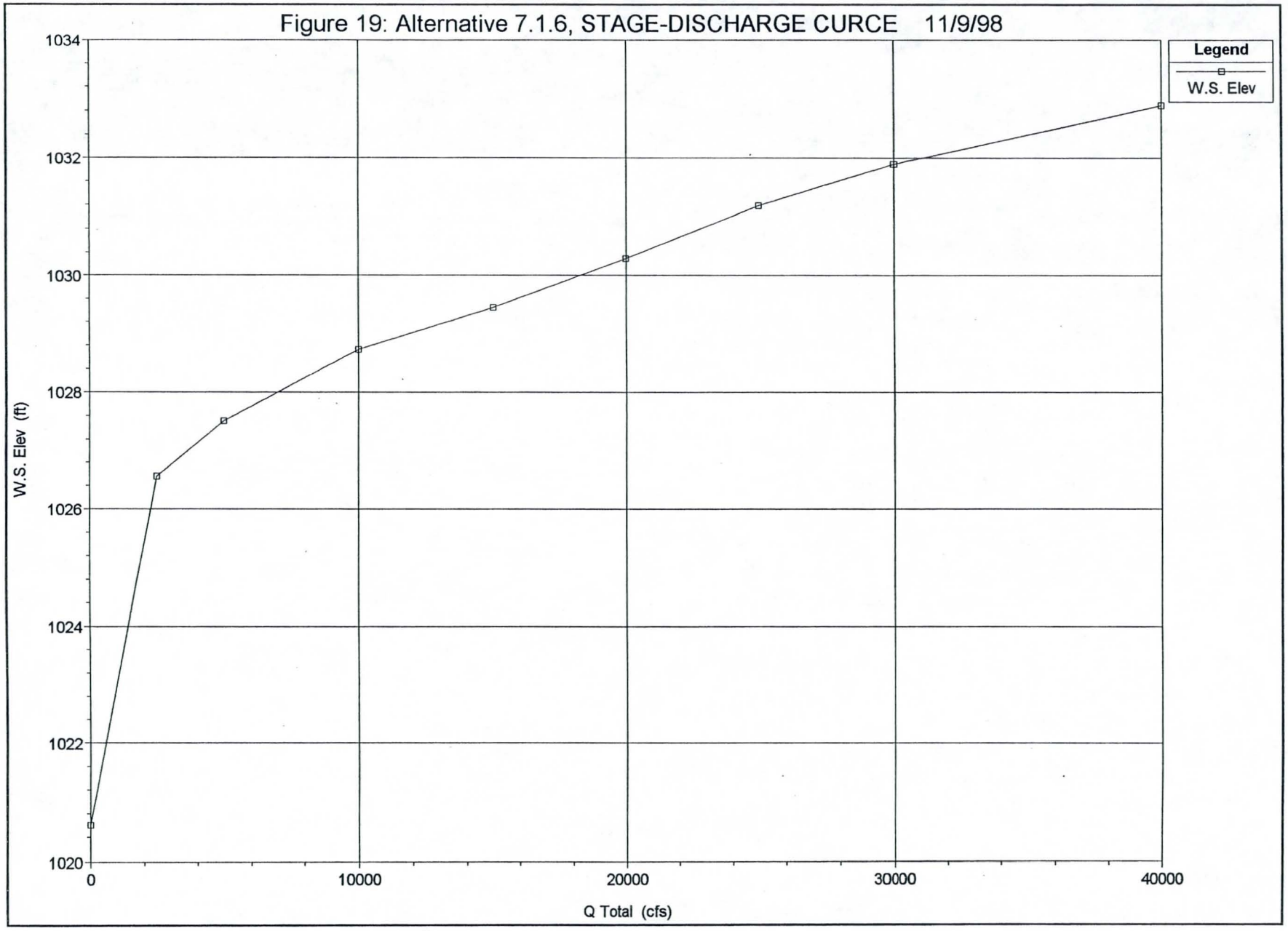


Figure 19: Alternative 7.1.6, STAGE-DISCHARGE CURCE 11/9/98
Legend
W.S. Elev
W.S. Elev (ft)
1034
1032
1030
1028
1026
1024
1022
1020
0
10000
20000
30000
40000
Q Total (cfs)

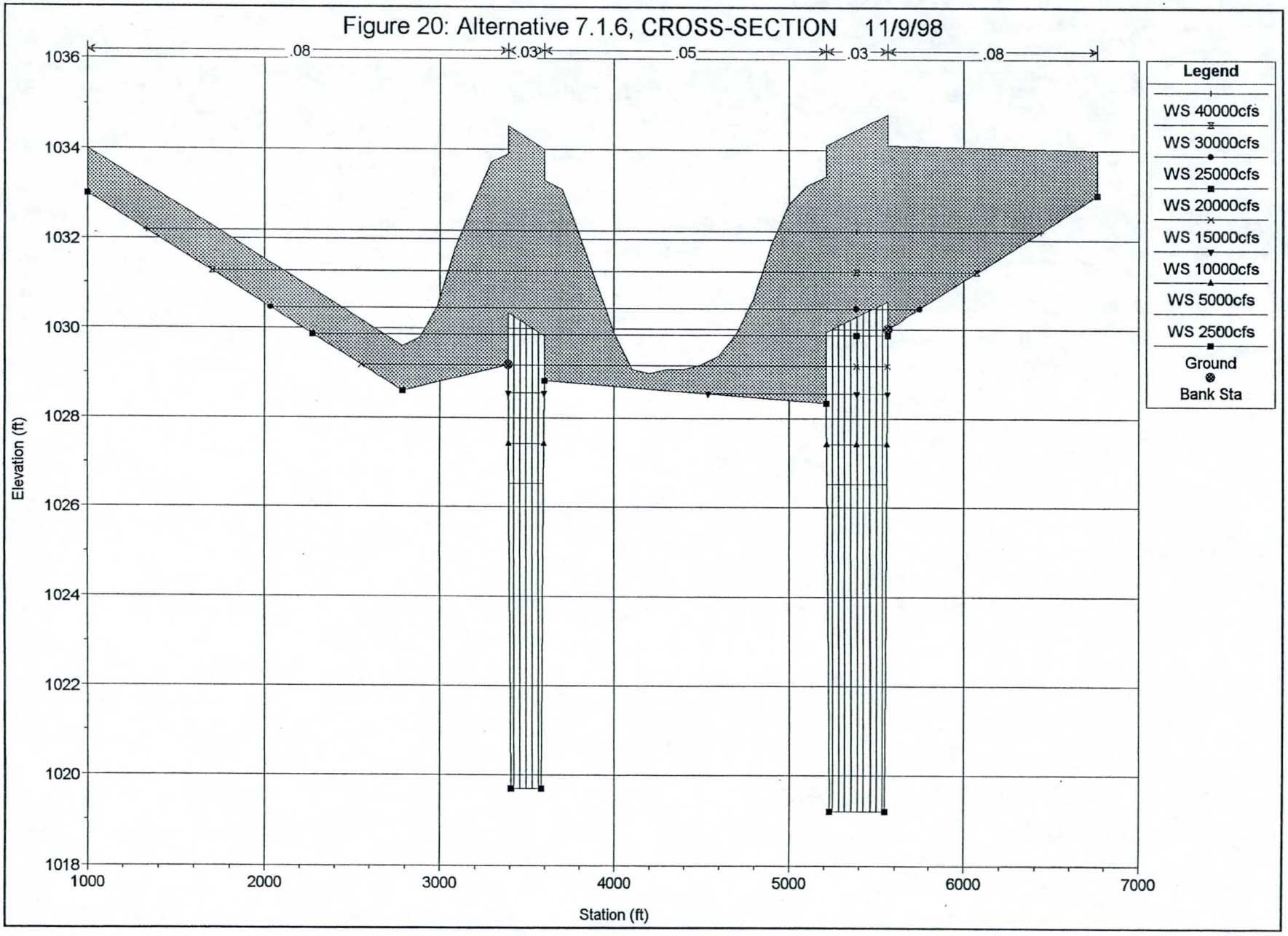
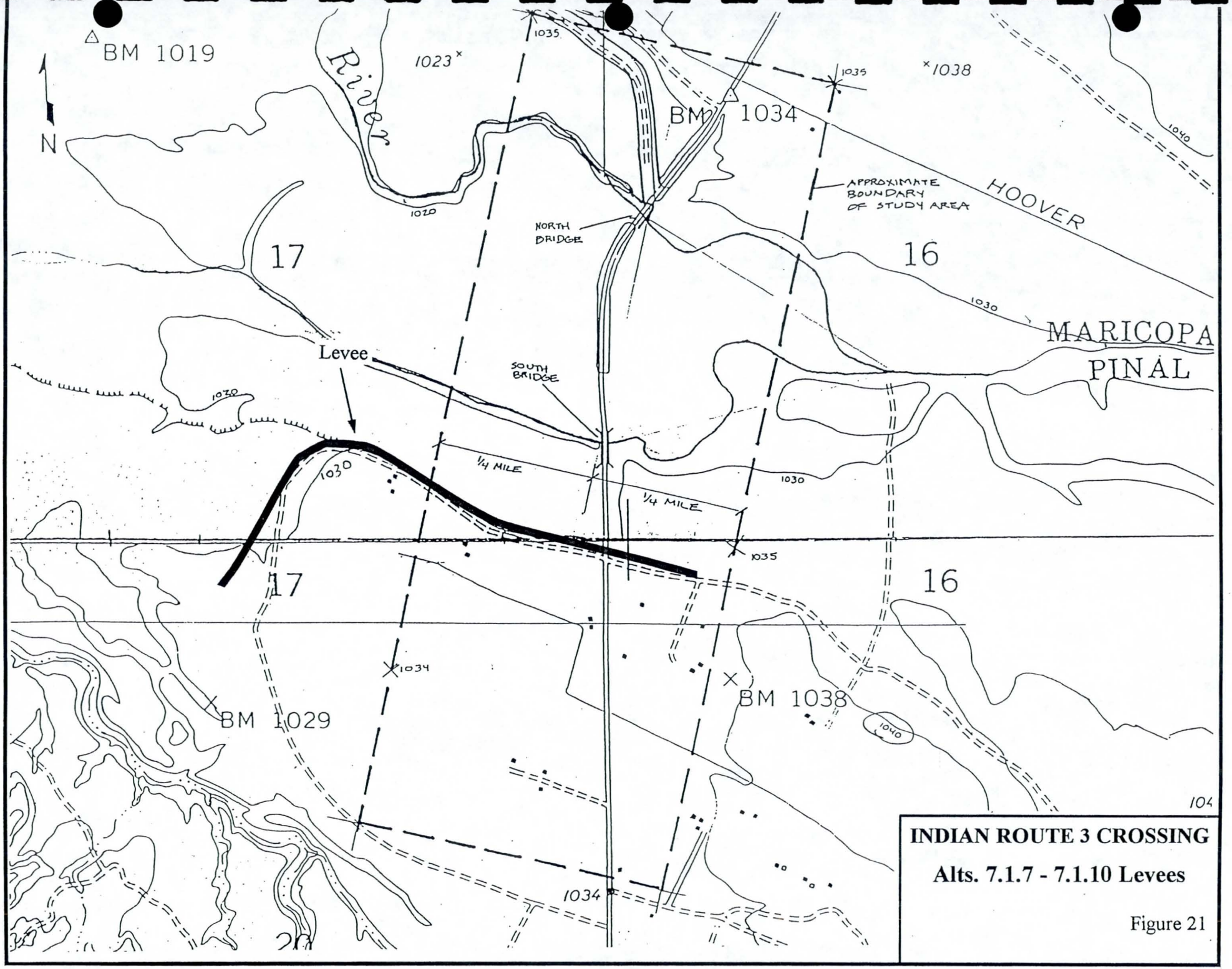


Figure 20: Alternative 7.1.6, CROSS-SECTION 11/9/98
.08
.03
.05
.03
.08
1036
1034
1032
1030
1028
1026
1024
1022
1020
1018
Elevation (ft)
1000
2000
3000
4000
5000
6000
7000
Station (ft)
Legend
WS 40000cfs
WS 30000cfs
WS 25000cfs
WS 20000cfs
WS 15000cfs
WS 10000cfs
WS 5000cfs
WS 2500cfs
Ground
Bank Sta



INDIAN ROUTE 3 CROSSING

Alts. 7.1.7 - 7.1.10 Levees

Figure 21

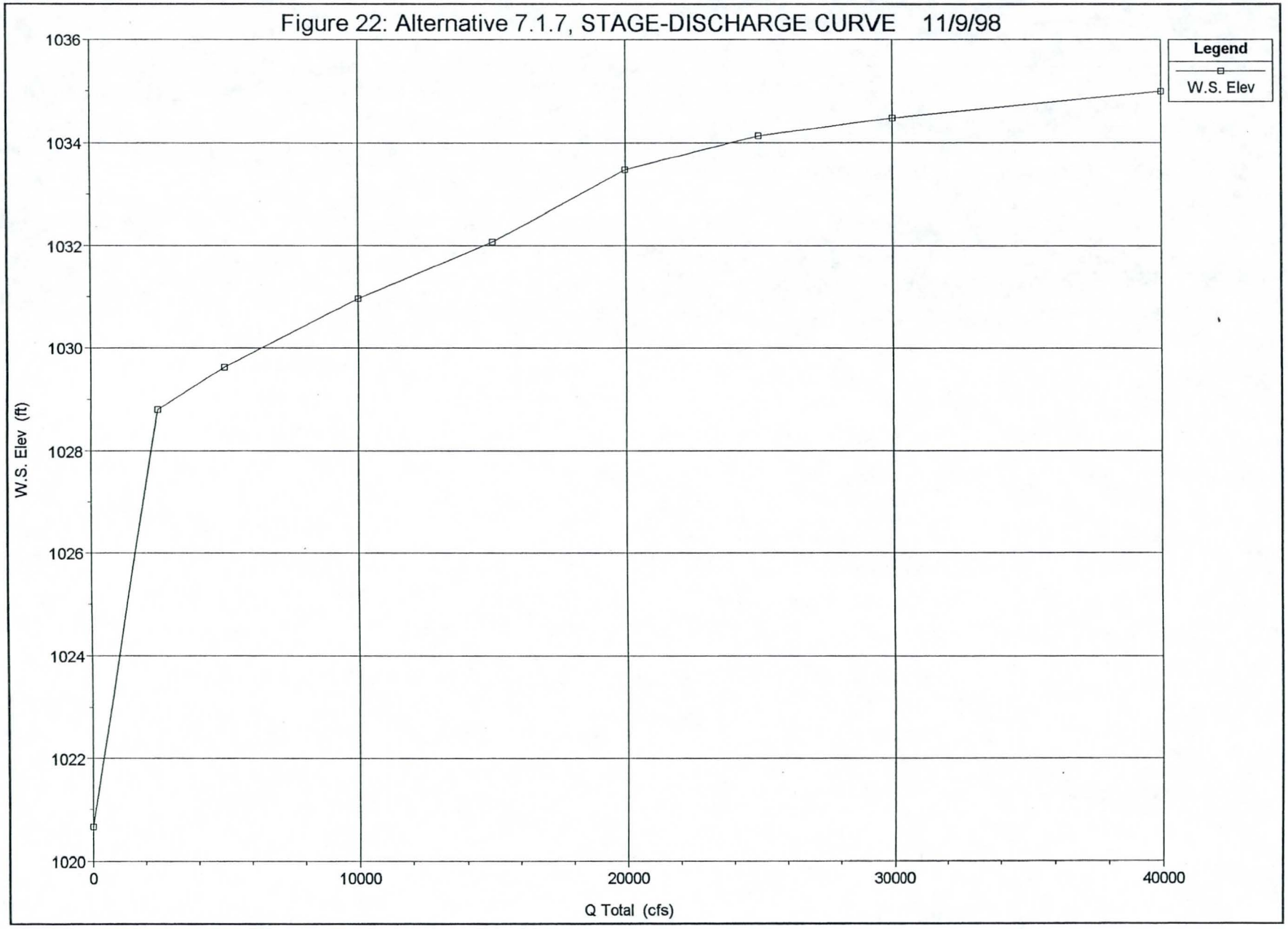
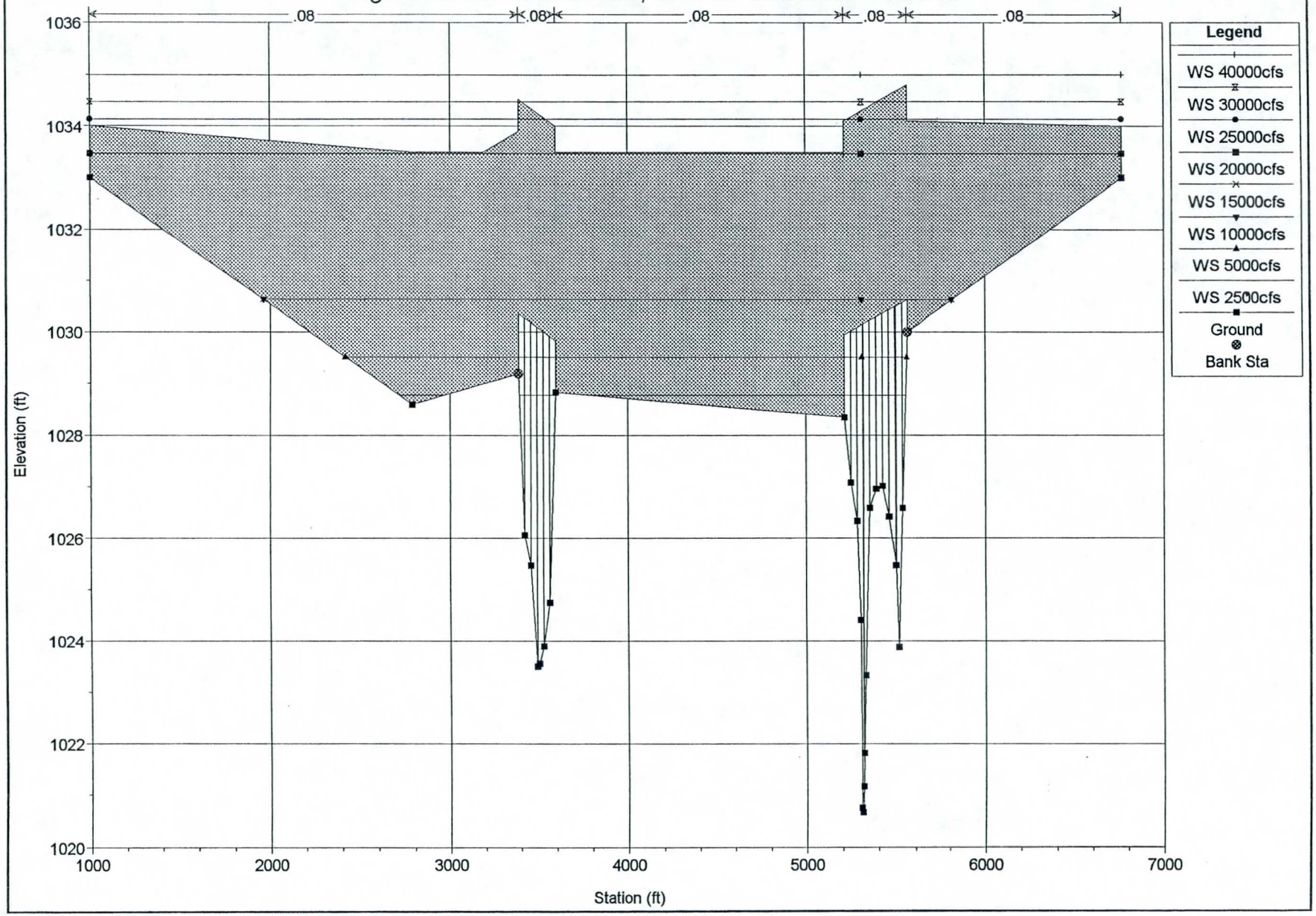


Figure 22: Alternative 7.1.7, STAGE-DISCHARGE CURVE 11/9/98
Legend
W.S. Elev
W.S. Elev (ft)
1036
1034
1032
1030
1028
1026
1024
1022
1020
0
10000
20000
30000
40000
Q Total (cfs)

Figure 23: Alternative 7.1.7, CROSS-SECTION 11/9/98



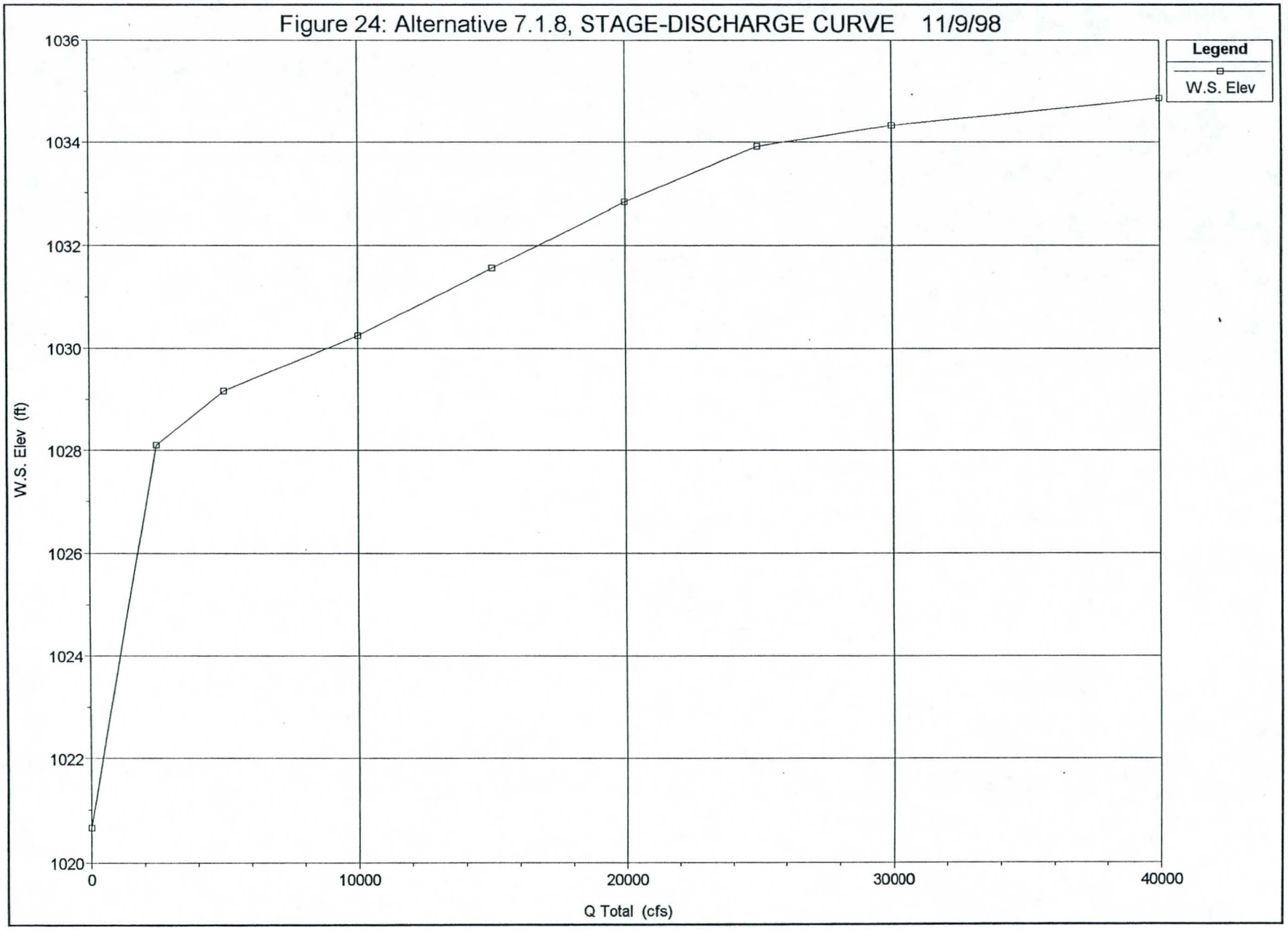
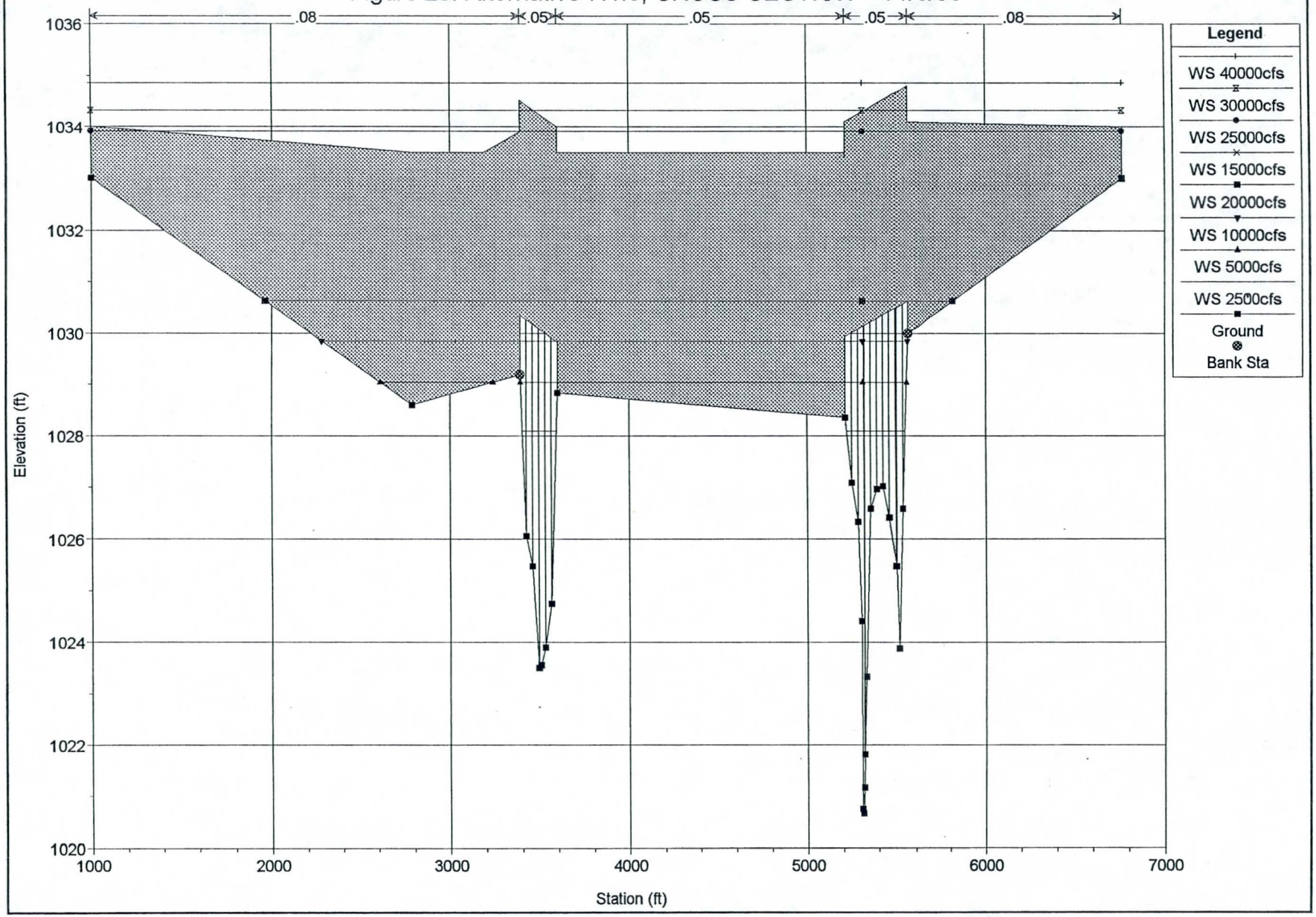


Figure 24: Alternative 7.1.8, STAGE-DISCHARGE CURVE 11/9/98
Legend
W.S. Elev
W.S. Elev (ft)
1036
1034
1032
1030
1028
1026
1024
1022
1020
0
10000
20000
30000
40000
Q Total (cfs)

Figure 25: Alternative 7.1.8, CROSS-SECTION 11/9/98



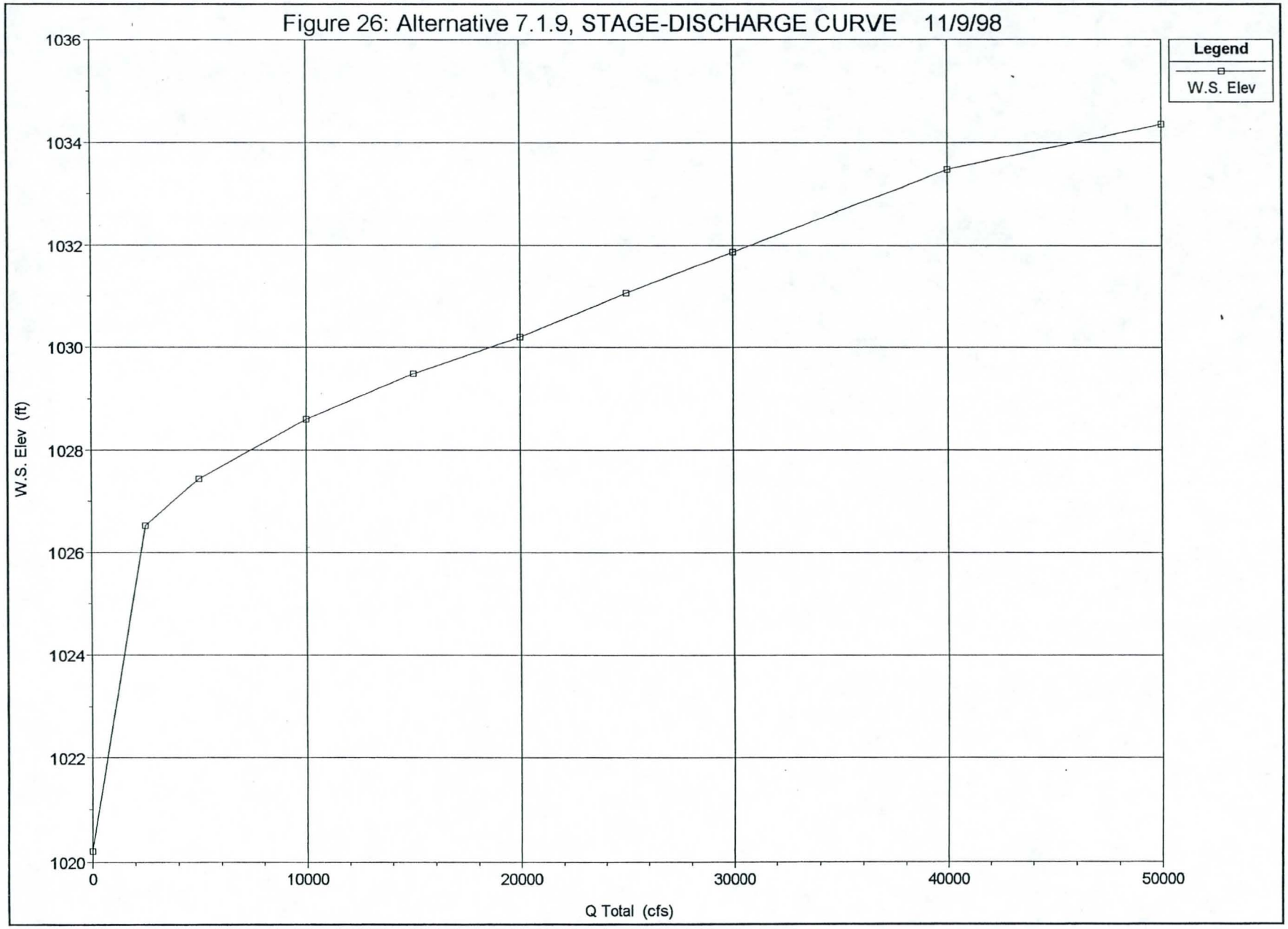
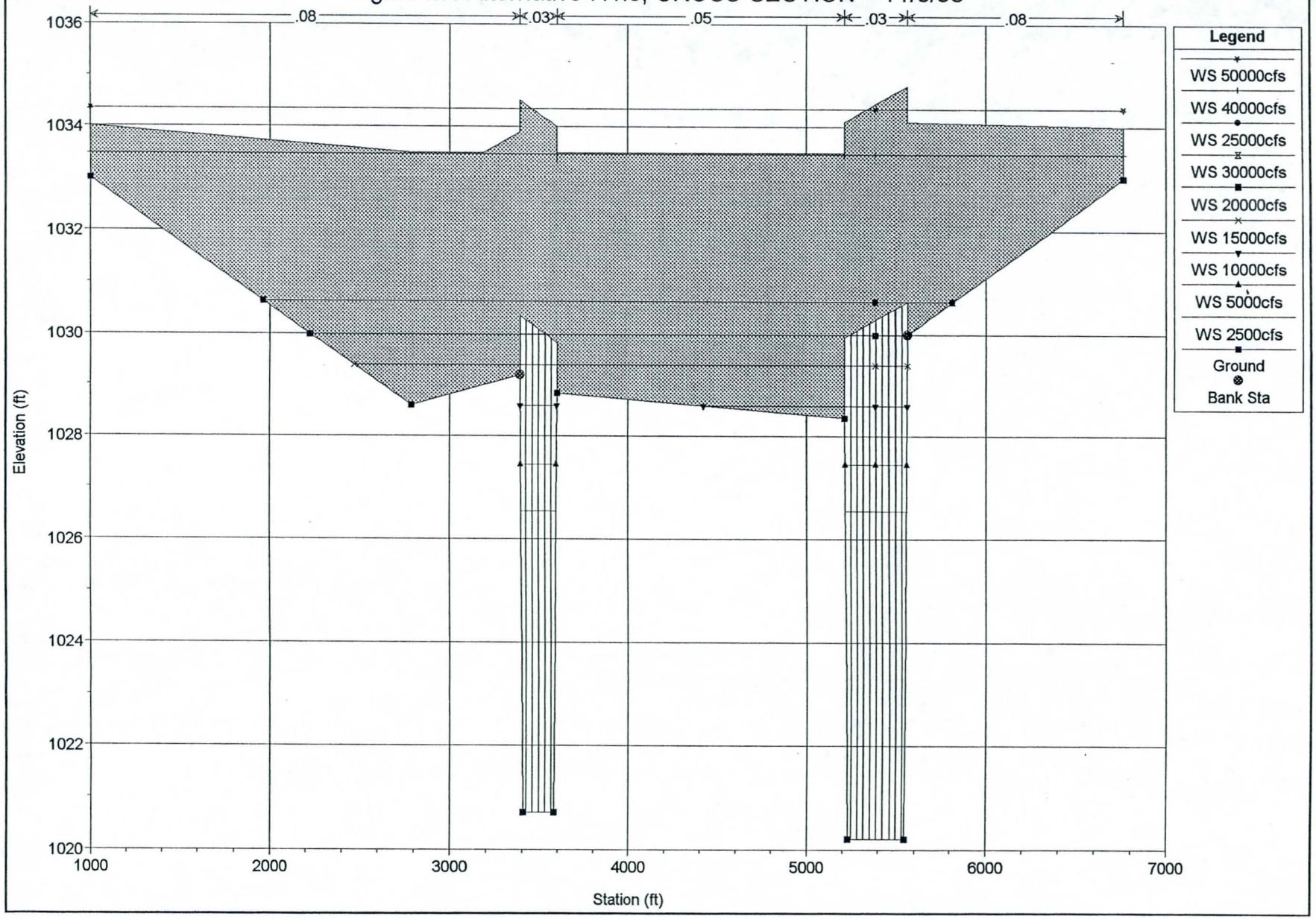


Figure 26: Alternative 7.1.9, STAGE-DISCHARGE CURVE 11/9/98
Legend
W.S. Elev
W.S. Elev (ft)
1036
1034
1032
1030
1028
1026
1024
1022
1020
0
10000
20000
30000
40000
50000
Q Total (cfs)

Figure 27: Alternative 7.1.9, CROSS-SECTION 11/9/98



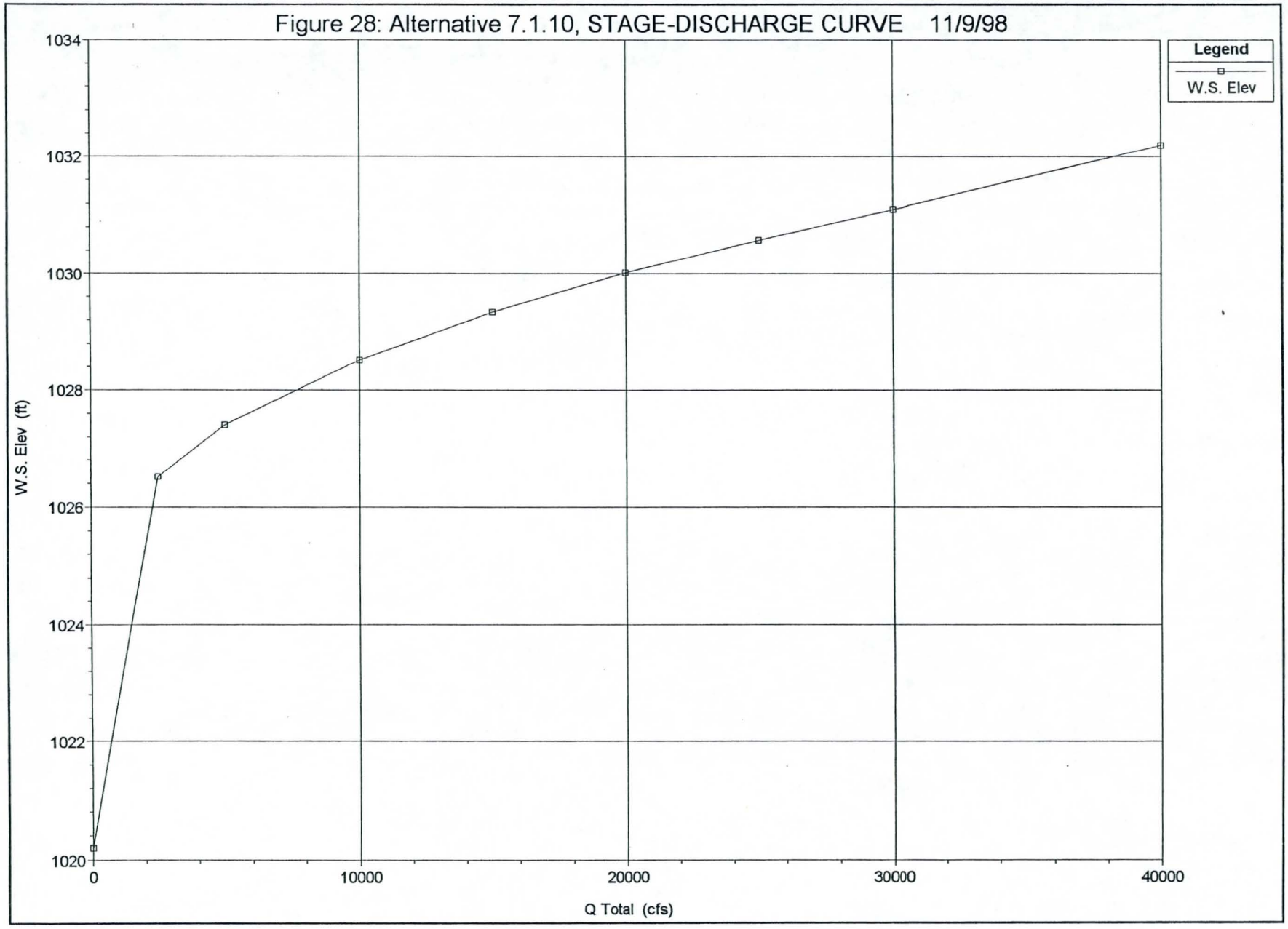
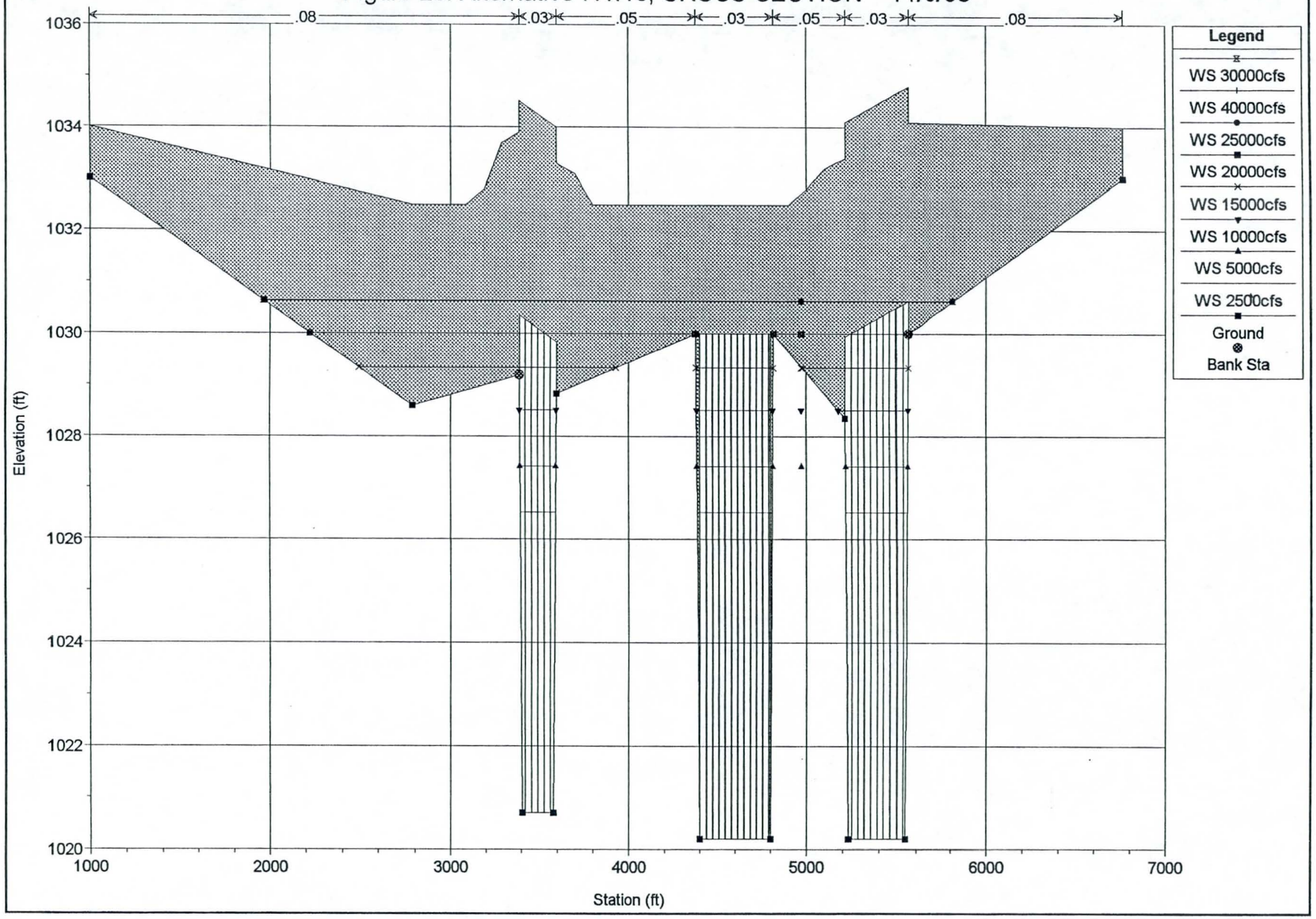
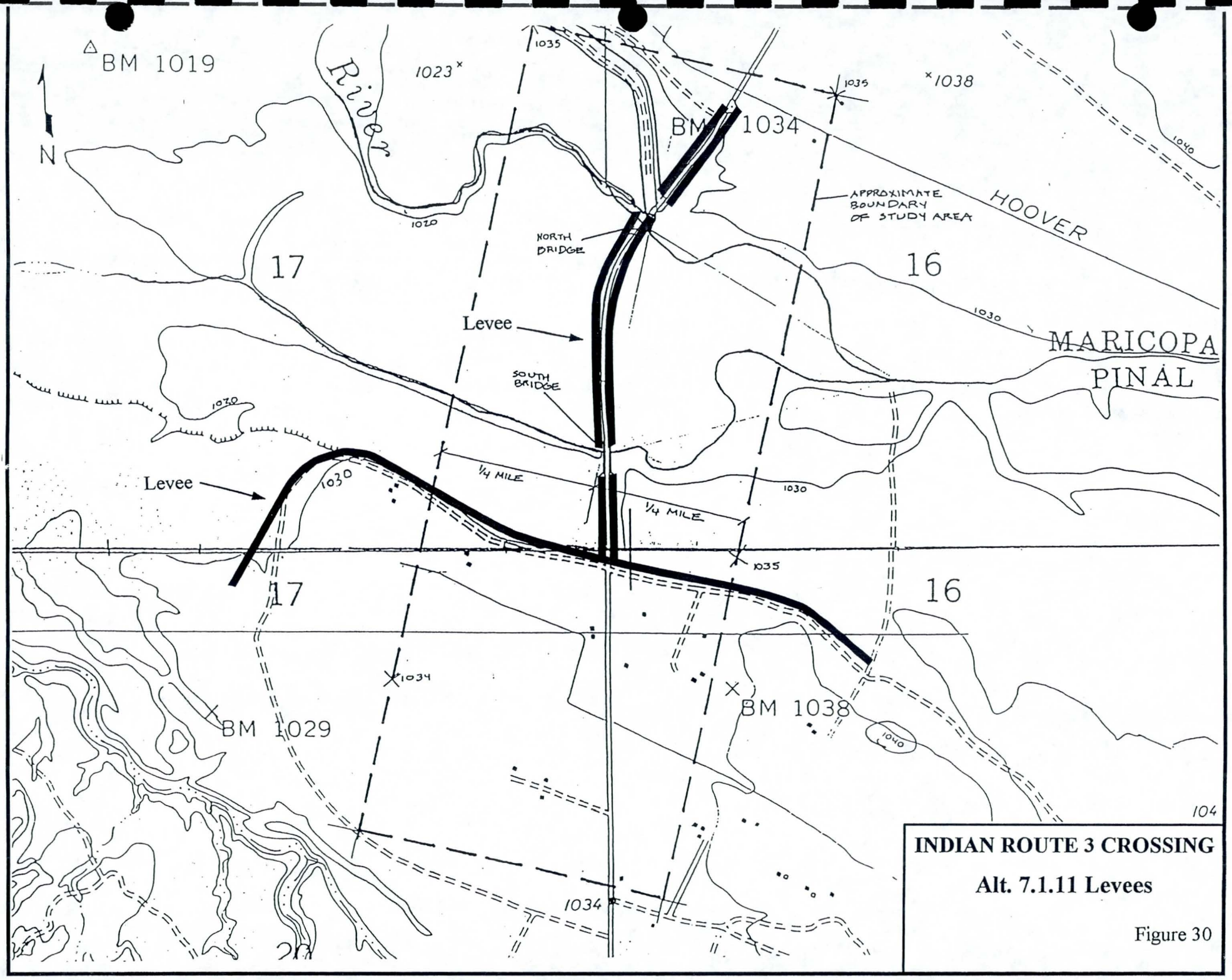


Figure 28: Alternative 7.1.10, STAGE-DISCHARGE CURVE 11/9/98
Legend
W.S. Elev
W.S. Elev (ft)
1034
1032
1030
1028
1026
1024
1022
1020
0
10000
20000
30000
40000
Q Total (cfs)

Figure 29: Alternative 7.1.10, CROSS-SECTION 11/9/98

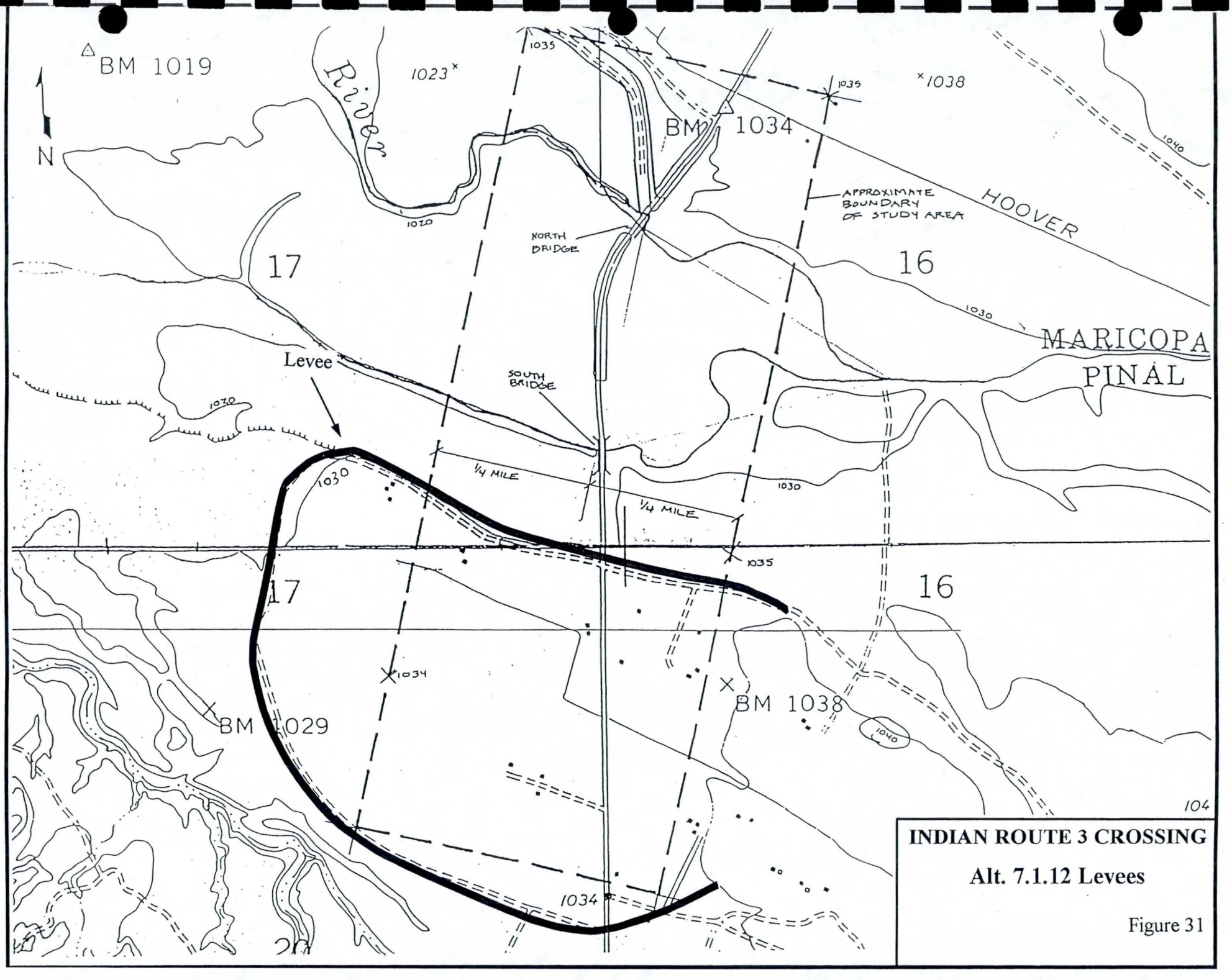




INDIAN ROUTE 3 CROSSING

Alt. 7.1.11 Levees

Figure 30



INDIAN ROUTE 3 CROSSING

Alt. 7.1.12 Levees

Figure 31

Chapter 8

LONG-TERM PLAN FORMULATION

8.1 Proposed Long-term Plans

Long-range options appropriate for implementation into a comprehensive water and land resource management plans are presented in this section. An option(s) which includes periodic removal of non-native vegetation and deposited sediment is required to maintain the short-term alternatives described earlier. Each of the short-term tactics presented in the previous chapter may be implemented as an initial phase of the long-term plans outlined below.

8.1.1 Non-Native Vegetation Management

Cutting and/or clearing the non-native vegetation in the study area on a regularly scheduled basis would control the saltcedar as it tries to re-dominate the area. Saltcedar growth is prolific in the river bed because its seeds are easily disseminated by both wind and water. Even if the study area is maintained clear of saltcedar, it is inevitable that seeds from upstream will find their way into the study area and reinstate growth. Thus, a regularly scheduled maintenance plan must be incorporated if the saltcedar is to be kept out of the study area on a long-term basis. It will be necessary to cut and/or clear the new non-native growth in the floodplain about twice every year. Depending on the method of clearing used, a permit may be necessary each time the area is disturbed. If the removal process involves grubbing or disking the soil, a Section 404 permit may be required.

8.1.2 Sediment Management

Periodic removal of accumulated sediment from within the primary conveyance channels must be done to maintain conveyance capacity and flow elevations. Such a program will also help manage the proliferation of saltcedar and other undesirable non-native vegetation. It is estimated that the initial quantity of sediment removed will accumulate every ten years without a management program. The annualized cost has been estimated assuming an average of six inches of sediment must be removed from the channel bottoms every year, within the study area, to prevent such an accumulation from occurring.

8.1.3 Replacing Non-Native Vegetation with Riparian Habitat

This plan is basically the same as that outlined in Paragraph 8.1.1, except that the study area would be revegetated with native riparian habitat after the saltcedar is removed. There is an added cost associated with re-vegetating the area, which may include an irrigation system to support the habitat.

The benefits of this plan are that habitat values would be increased, and maintenance costs, relating to saltcedar removal, would eventually decrease, due to a successfully established and maintained riparian habitat.

8.1.4 Replacing Non-Native Vegetation with Irrigated Riparian Habitat in a Recreational Setting

This plan is similar to that outlined in Paragraph 8.1.3, except that recreational and educational components would add further benefits to the plan. The study area is easily accessible to the Community, due to the proximity of the road, which makes it an ideal location for a regional park. Non-native species would be removed from the entire study area (2640' x 7000') and replaced with riparian habitat and the necessary irrigation system. Suggested facilities include a picnic area, educational signage describing the environment and the tribes' culture, as well as, recreational facilities, and restrooms.

8.1.5 Modification of Transportation Infrastructure

Another way to alleviated the hazards at the Indian Route 3 crossing of the Gila River would be to replace the existing crossing with a high-level roadway and bridge, similar to the Maricopa Road crossing located upstream. The Maricopa Road crossing has been designed for approximately 65,000 cfs. This option would include the necessary levees, or other protection strategy, to protect the residences on the south side of the crossing. Such an action would require the highest capital funding from the Community for design and construction, but, due to the high level of the design, it could effectively eliminate the annual maintenance required to control non-native vegetation and sediment deposition. The required permits and detouring issues would need to be addressed prior to actual construction.

Chapter 9

PLAN EVALUATIONS AND CONCLUSIONS

9.1 Plan Evaluations

All short-term plans to increase the hydraulic capacity at Indian Route 3 will require periodic maintenance to control non-native vegetation growth and sediment deposition. Removing non-native vegetation may or may not require a permit, depending on how the cutting and clearing is accomplished, and whether threatened or endangered species are present. If the clearing involves grubbing or tilling the earth a Section 404 permit may be required. If clearing the vegetation involves only cutting and removal, a 404 permit may not be required. However, if the non-native vegetation supports threatened or endangered species, permits from the US Fish and Wildlife Service may be required, regardless of the clearing method used.

All short-term alternatives were evaluated using the following criteria:

- Annualized Cost, including estimated capital and maintenance costs
- Hydraulic Capacity of Crossing
- Level of Protection for South Bank.

The long-term plans outlined in Paragraphs 8.1.1 through 8.1.5 all present reasonable long-term goals. The long-term plan selected must include both vegetation and sedimentation management strategies, if a short-term alternative is implemented, to keep the plan viable. The Gila River Indian Community must decide the extent to which environmental and recreational opportunities will be factored into the Communities' Water and Land Resource Management Plan. Once the levels of importance for these factors are established, the Community could implement the long-term plan which best suits their needs.

Table 1 itemizes the estimated capital and maintenance costs, by category, and provides the annualized cost of each of the short-term alternatives considered and long-term Alternative 8.1.5. Table 2 summarizes the hydraulic capacity and respective water-surface elevation for the applicable alternatives. Figure 32 is a graphical depiction of annualized cost of the alternatives vs. their hydraulic capacity. The figure allows the user to estimate the incremental costs and capacities of the alternatives, relative to one another and relative to the target design capacity of 40,000 cfs.

Alternative 7.1.12 is unique in that it focuses on providing protection for the residences on the south bank at the design discharge of 40,000 cfs, regardless of any improvement to the river crossing.

INDIAN ROUTE 3 GILA RIVER CROSSING

Table 1: Annual Cost of Alternatives

Alternative	Clear Veg. ACRE	Channelize CY	Roadway L.F.	Culverts L.F.	Bridge SQ.FT	Levee L.F.	Capital Cost $	Annual Clear Veg. $	Annual Clear Sedim. $	Total Annual Cost $
No Action							0	0	0	0
7.1.1	10						0	20,000	0	20,000
7.1.2	170						0	340,000	0	340,000
7.1.3	28	304,600					1,523,000	56,000	215,600	380,200
7.1.4	170	304,600					1,523,000	340,000	215,600	664,200
7.1.5	170	363,300		50			2,036,500	340,000	257,100	742,300
7.1.6	170	359,400					1,797,000	340,000	254,400	722,600
7.1.7			4,000			4,000	2,660,000	0	0	189,700
7.1.8	170		4,000			4,000	2,660,000	340,000	0	529,700
7.1.9	170	304,600	4,000			4,000	4,183,000	340,000	215,600	853,900
7.1.10	28	565,600	3,500		12,000	4,000	6,305,500	56,000	400,300	906,000
7.1.11						11,000	4,180,000	0	0	298,100
7.1.12						10,000	3,800,000	0	0	271,000
Long-Term			2,000		50,000	10,000	8,370,000	0	0	596,900
Unit Cost	$1,000	$5	$285	$4,400	$80	$380				

(Capital Costs amortized over 50 years at 6.875% interest)

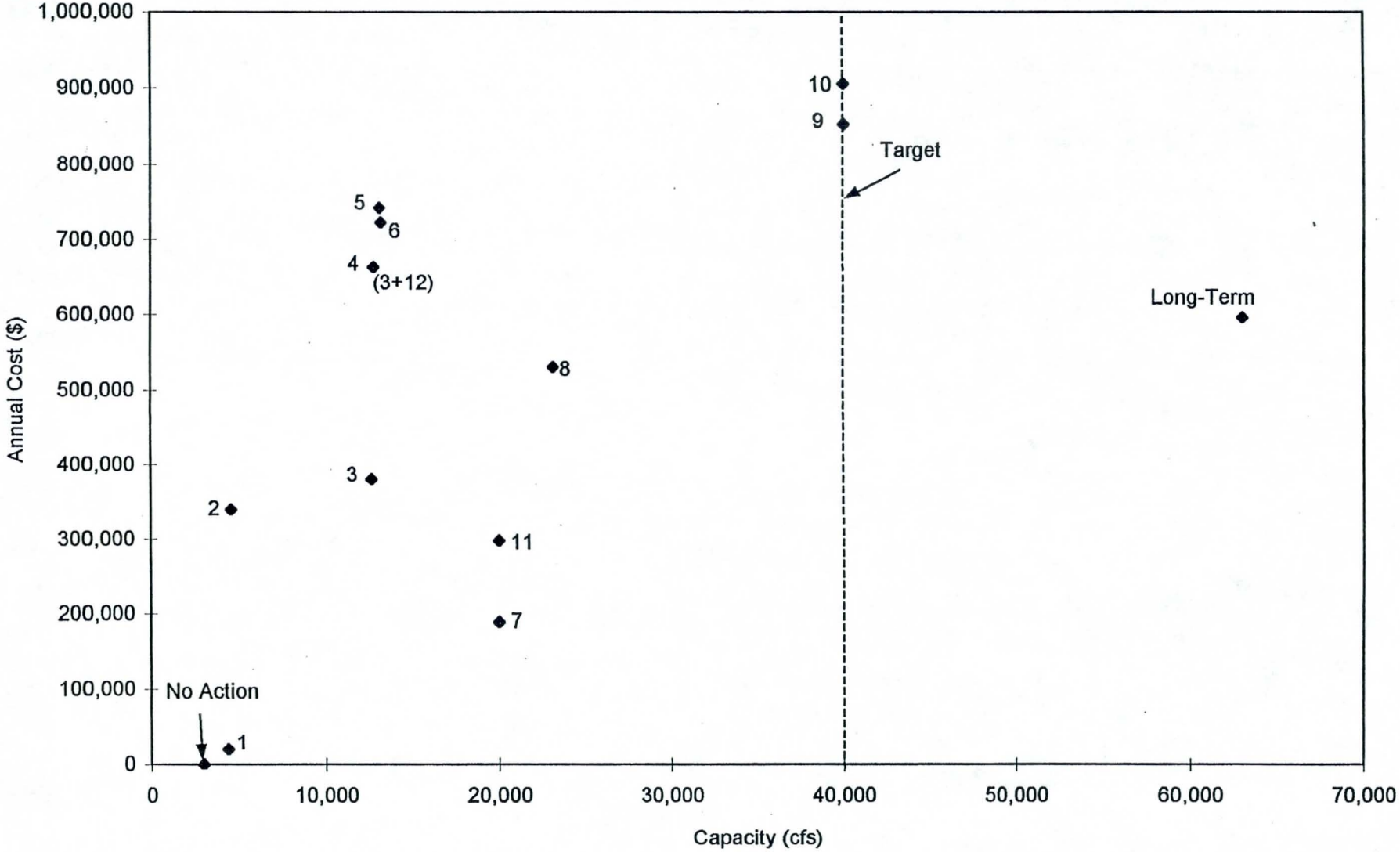
INDIAN ROUTE 3 GILA RIVER CROSSING

Table 2: Hydraulic Capacity of Alternatives

Alternative	Description	Flow Capacity CFS	Flow Increment CFS	Overtopping WSE FT	Annual Cost $	Annual Cost/Flow Incre. $/CFS
	No Action (Baseline)	3,000		1,029.0	0	0
7.1.1	Clearing Veg. at Bridge	4,400	1,400	1,029.0	20,000	14.3
7.1.2	Clearing Vegetation	4,600	1,600	1,029.0	340,000	212.5
7.1.3	Channelization	12,700	9,700	1,029.0	380,200	39.2
7.1.4	Clearing Vegetation and Channelzation	12,800	9,800	1,029.0	664,200	67.8
7.1.5	Clearing Vegetation, Channelzation and Adding Culverts	13,100	10,100	1,029.0	742,300	73.5
7.1.6	Clearing Vegetation and Deep Channelization	13,200	10,200	1,029.0	722,600	70.8
7.1.7	Raising Roadway Between and South of Bridges	20,000	17,000	1,033.5	189,700	11.2
7.1.8	Raising Roadway with Clearing Vegetation	23,100	20,100	1,033.5	529,700	26.4
7.1.9	Raising Roadway with Clearing Vegetation and Channelization	40,000	37,000	1,033.5	853,900	23.1
7.1.10	Raising Roadway, Channelization and Adding a Bridge	40,000	37,000	1,032.5	906,000	24.5
7.1.11	Constructing Parallel Levees	20,000	17,000	1,033.5	298,100	17.5
Long-Term	New Crossing	65,000	62,000	To Be Determined	596,900	9.6

INDIAN ROUTE 3 GILA RIVER CROSSING

Figure 32: Alternative Capacity vs Annual Cost



Therefore, it can be coupled with any of the short-term alternatives to improve conditions for the residences near the crossing. The cost of Alternative 7.1.12 is included in Table 1. In addition, Table 3 is included to provide information on the amount of protection associated with each alternative, in terms of capacity, without the independent levee described by Alternative 7.1.12. Table 3 also provides the water-surface elevation required for each alternative to convey 40,000 cfs. Note that elevation 1035 is the base elevation used to estimate the cost of Alternate 7.1.12.

INDIAN ROUTE 3 GILA RIVER CROSSING

Table 3: Level of Protection for South Bank

Alternative	Discharge (cfs)	WSE at 40,000 cfs (ft)
No Action	12,900	1033.6
7.1.1	14,200	1033.5
7.1.2	16,000	1033.1
7.1.3	26,800	1032.3
7.1.4	27,100	1032.3
7.1.5	27,300	1032.3
7.1.6	27,800	1032.2
7.1.7	30,800	1035.0
7.1.8	34,400	1034.9
7.1.9	40,000	1033.5
7.1.10	40,000	1032.5
7.1.11	30,800	1035.0
7.1.12	40,000	1035.0
Long-Term	65,000	To Be Determined

Table 4 identifies which planning objectives are met by the alternatives. The planning objectives of Protecting Lives, Reducing Damages, and Protecting the Crossing are evaluated relative to the design discharge of 40,000 cfs. It is assumed that the crossing will suffer some damage with any alternative that allows roadway overtopping at a discharge less than 40,000 cfs. It is also assumed that there is the potential for loss of life if the alternative allows roadway overtopping at a discharge less than 40,000 cfs. All alternatives which raise the roadway, but do not provide additional conveyance capacity through the crossing (7.1.7 - 7.1.9, and 7.1.11), do not protect lives or the crossing due to the resulting high velocities through the existing bridges. It is assumed that the foundations of these bridges cannot withstand such velocities, given the frequent overtopping allowed by the original design.

From Table 4 it can be seen that Alternatives 7.1.10 and the long-term plan of replacing Indian Route 3 with a new high-level crossing, similar to Maricopa Road (SR-347), fully meet all five planning objectives. Table 5 summarizes the major implementation advantages and disadvantages of each alternative, relative to one another and the context of the evaluation criteria.

Table 4: Planning Objectives Matrix

PLANNING OBJECTIVES	ALTERNATIVES												
	1	2	3	4	5	6	7	8	9	10	11	12	LT
Increase Hydraulic	X	X	X	X	X	X	X	X	X	X	X		X
Protect Lives										X		X	X
Reduce Damages	X	X	X	X	X	X	X	X	X	X	X	X	X
Protect Crossing										X			X
Coordinate Permits	X	X	X	X	X	X	X	X	X	X	X	X	X

Table 5: Short-Term Alternatives
Implementation Advantages and Disadvantages

Alt.	Description	Advantages	Disadvantages
7.1.1	Clearing at Bridge	▸ Least Costly	▸ Small Capacity Incr. over Baseline
7.1.2	Vegetation Removal	▸ May Not Require Permit	▸ Small Capacity Incr. over Baseline
7.1.3	Channelization	▸ Significant Capacity Incr. over Baseline	▸ Requires Permit
7.1.4	Vegetation Removal Channelization	▸ Significant Capacity Incr. over Baseline	▸ Small Cap. Incr. over Alt. 7.1.3 ▸ Requires Permit
7.1.5	Vegetation Removal Channelization Culverts	▸ Significant Capacity Incr. over Baseline	▸ Small Cap. Incr. over Alt. 7.1.3 ▸ Requires Permit
7.1.6	Vegetation Removal Deep Channelization	▸ Significant Capacity Incr. over Baseline	▸ Small Cap. Incr. over Alt. 7.1.3 ▸ Requires Permit ▸ May Endanger Ex. Bridges ▸ Creates Sediment Sink
7.1.7	Raise Roadway	▸ Significant Capacity Incr. over Alt. 7.1.3	▸ Significant Cost ▸ Endangers Ex. Bridges
7.1.8	Raise Roadway Vegetation Removal	▸ Significant Capacity Incr. over Alt. 7.1.3	▸ Small Cap. Incr. over Alt. 7.1.7 ▸ May Endanger Ex. Bridges
7.1.9	Raise Roadway Vegetation Removal Channelization	▸ Significant Capacity Incr. over Alt. 7.1.7	▸ Significant Cost ▸ May Endanger Ex. Bridges ▸ Requires Permit
7.1.10	Raise Roadway Add Bridge Channelization	▸ Significant Capacity Incr. over Alt. 7.1.7 ▸ Protects Ex. Bridges	▸ High Cost ▸ Requires Permit
7.1.11	Parallel Levees	▸ Significant Capacity Incr. over Alt. 7.1.3	▸ Cost Higher than Alt. 7.1.7 ▸ Endangers Ex. Bridges ▸ Requires Permit

Referencing Figure 32, Alternative 7.1.7 provides an intermediate level of hydraulic capacity (20,000 cfs) at the lowest annual cost. Alternative 7.1.3 combined with 7.1.12 provides a high level of protection for lives and property, along with the intermediate hydraulic capacity. Alternative 7.1.10 provides the desired design capacity of 40, 000 cfs, as well as, a high level of protection for lives and property at the highest annual cost, without endangering the stability of the existing

bridges. The long-term Alternative 8.1.5 provides a hydraulic capacity beyond the desired design, and a high level of protection for the south bank with minimal annual maintenance.

These alternatives cover a range of annual cost, hydraulic capacities, and protection for the south bank, and will allow the Indian Community flexibility in meeting their needs.

9.2 Conclusions

Both short and long-term opportunities to improve conditions at the Indian Route 3 crossing of the Gila River exist. Alternatives have been developed and evaluated. The information provided in this report will assist the Indian Community in selecting a strategy that best meets their needs. The information listed below is considered necessary for the final design and construction of the selected alternative:

- Topographic mapping at one-foot contours for the study area
- As-built location and depth of the existing bridge foundations
- Watershed sediment yield study
- Sediment transport/scour analysis
- Structural stability analysis on existing bridges for selected alternative
- Assessment of impacts from the Santa Cruz River system on the study area and the alternatives considered.

Chapter 10

SELECTED PLAN

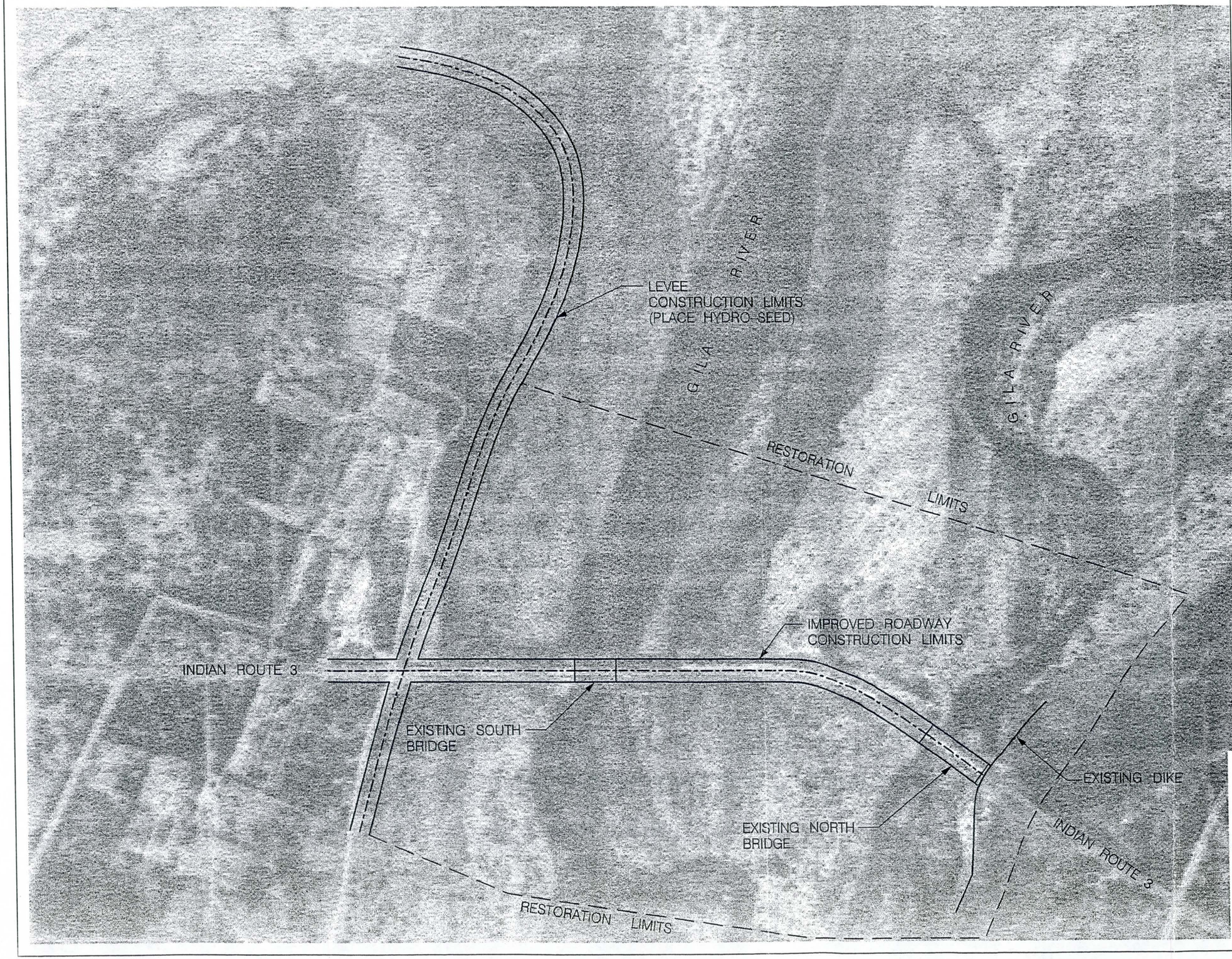
10.1 Plan Description

Representatives of the Gila River Indian Community have reviewed the hydraulic alternatives developed in this report to improve the drainage at the Gila River crossing, as well as the environmental restoration opportunities described in the Environmental Baseline Conditions Report included as Appendix B. As a result, they have selected Hydraulic Alternative 7.1.7 and Environment Restoration Alternative 3 for implementation. A detailed description of the elements within the selected plan follows.

10.1.1 Hydraulic Elements

The hydraulic elements associated with the selected plan include raising the roadway between and south of the existing bridges, and constructing a levee with three feet of freeboard above the roadway overtopping elevation to protect the residences and farmlands on the south overbank area. Approximately 3200 feet of roadway would be raised to a minimum elevation of 1033.5 feet and approximately 4500 feet of levee would be constructed to elevation 1036.5 feet. Figure 33 illustrates the extent and alignment of the proposed roadway improvements and levee. Figure 34 depicts the approximate roadway profile of the selected plan, and Figure 35 contains the typical sections used for the levee and roadway. It has been assumed the roadway will ramp up and over the proposed levee on an approximate grade of two percent.

The capital and annual costs associated with the selected hydraulic alternative (7.1.7) are summarized in Table 1 of Chapter 9. The total annualized cost amortized over 50 years is approximately $189,700. When combined with the environmental restoration elements described below, the selected plan will provide a hydraulic capacity of approximately 22,500 cfs before Indian Route 3 is overtopped. However, the increased height of the roadway embankment will produce velocities through the existing bridges that are higher than the original design. Consequently, detailed bridge scour and structural stability analyses should be conducted before the selected plan is implemented. Figure 36 contains the stage-discharge curve for the selected plan.



GILA RIVER
INDIAN COMMUMITY
PLANNING ASSISTANCE REPORT

INDIAN ROUTE 3
GILA RIVER CROSSING

ALTERNATIVES ANALYSIS

N

0 500' 1000'

SCALE: 1" = 500'

NO.	REVISION	BY	DATE
3			
2			
1			

SELECTED PLAN
HYDRAULIC ELEMENTS

	BY	DATE
DESIGNED	M.L.	05/05/99
CHECKED	M.L.	05/05/99

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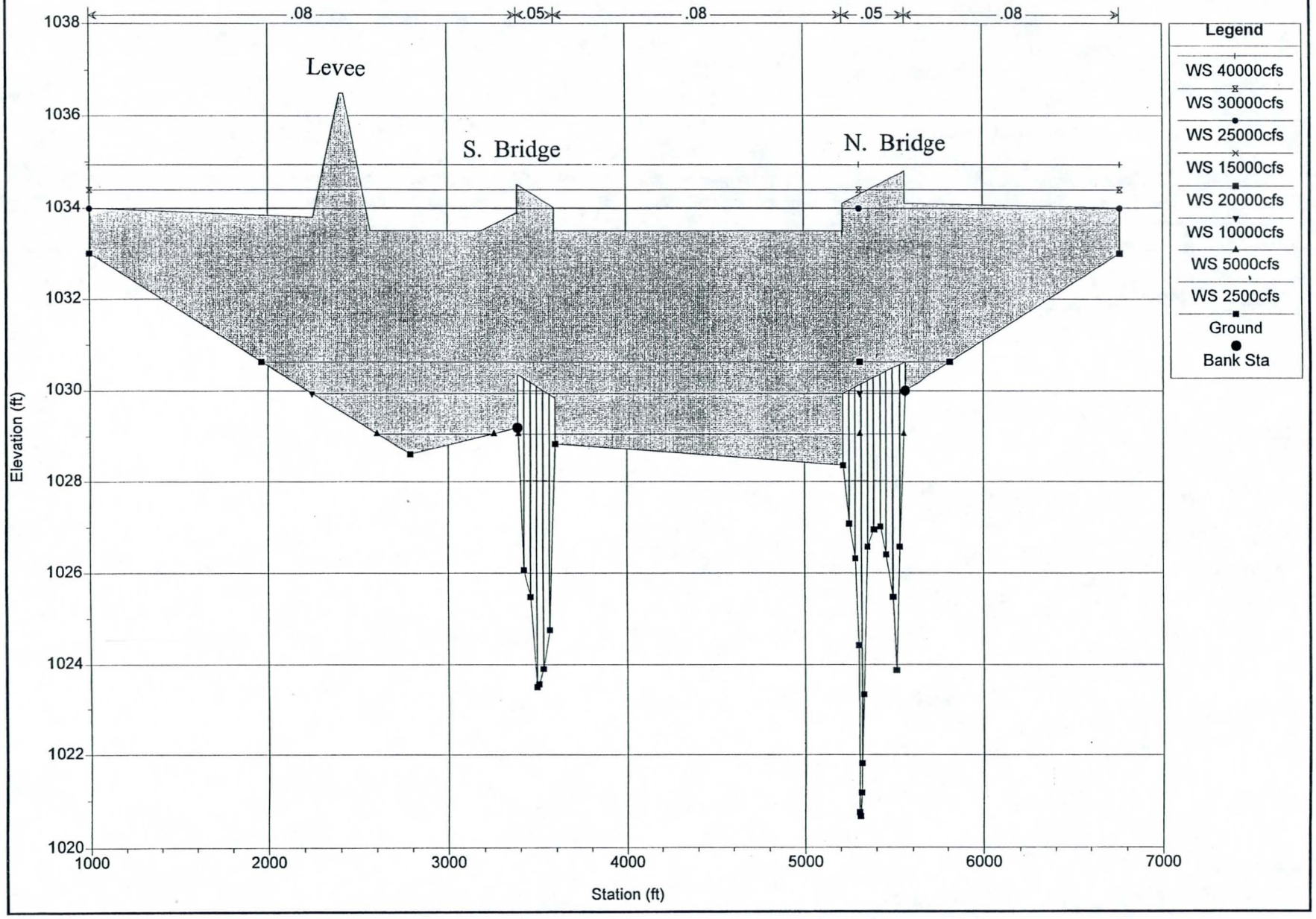
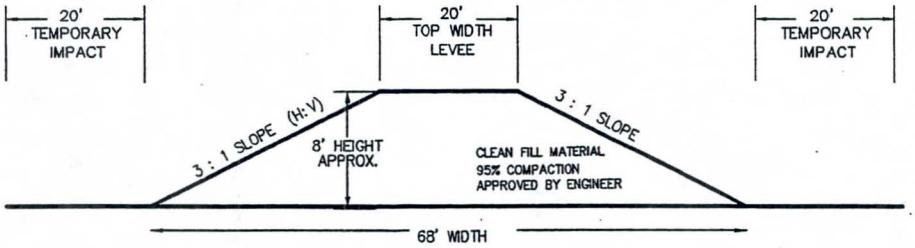
INFRASTRUCTURE SOUTHWEST GROUP
4600 South Mill Avenue, Suite 200, Tempe, AZ 85282
(602) 491-1393 FAX (602) 491-1396 sistempe@pol.com

FIGURE #33

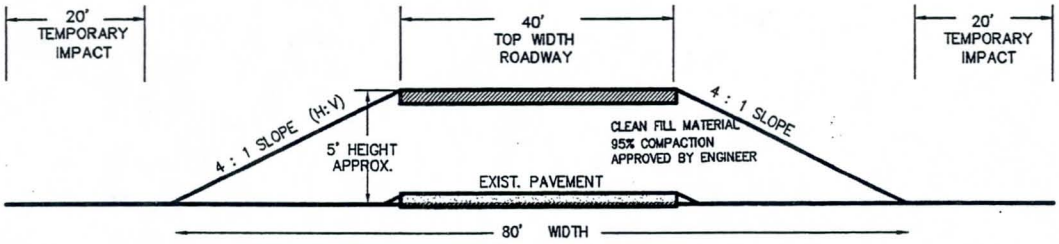
SHEET 1 OF 1

Figure 34: Selected Plan, CROSS-SECTION 4/22/99





LEVEE
TYPICAL SECTION



ROADWAY
TYPICAL SECTION

N.T.S.

GILA RIVER INDIAN COMMUNITY
IR–3 GILA RIVER CROSSING

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(602) 491-1393 FAX (602) 491-1396 slatempe@aol.com

FIGURE # 35

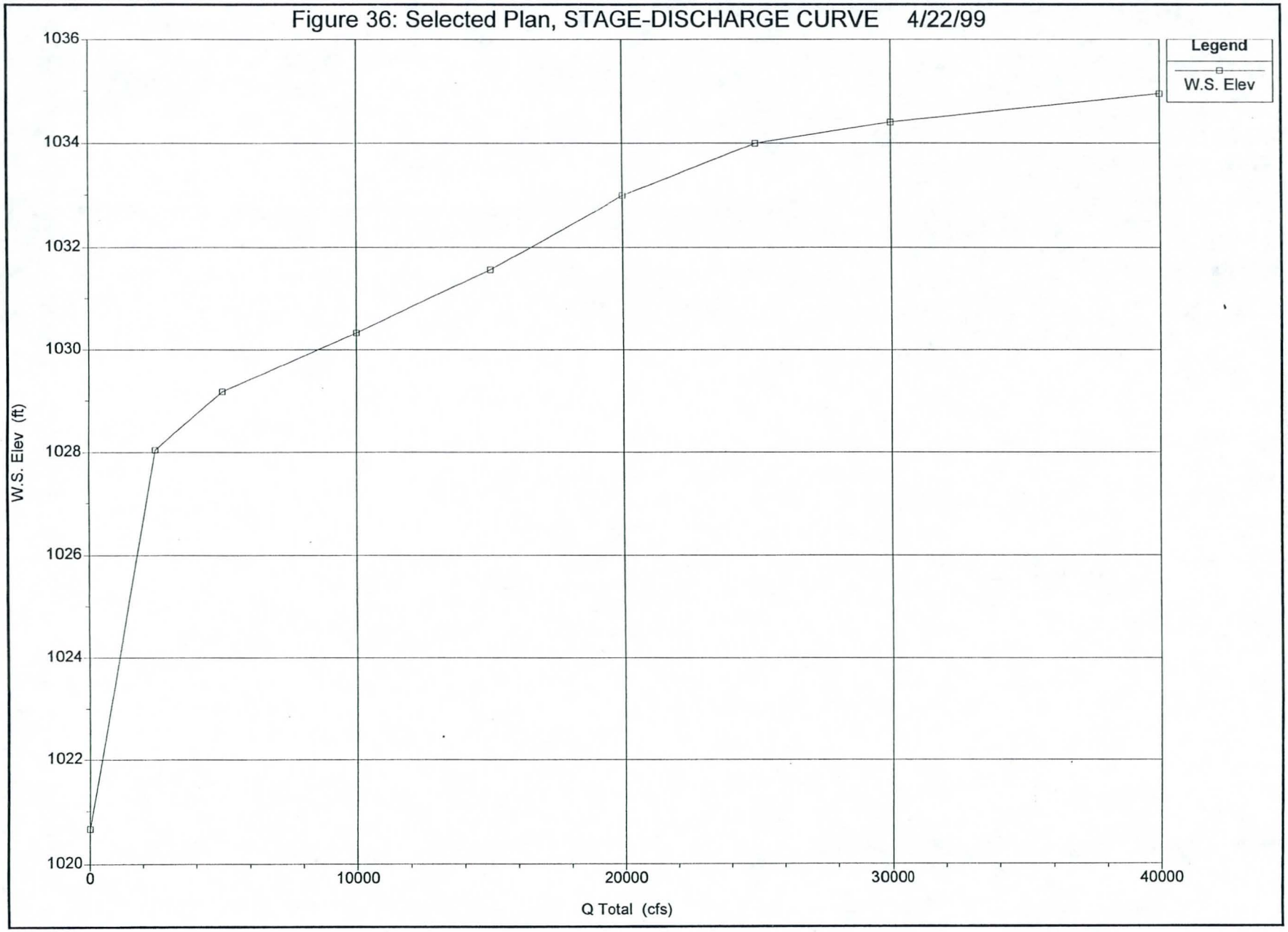


Figure 36: Selected Plan, STAGE-DISCHARGE CURVE 4/22/99
Legend
W.S. Elev
W.S. Elev (ft)
1036
1034
1032
1030
1028
1026
1024
1022
1020
0
10000
20000
30000
40000
Q Total (cfs)

10.1.2 Environmental Restoration Elements

The environmental restoration associated with the selected plan includes elements for creating conditions conducive to native riparian species, and elements for removing tamarisk. A general plan and profile of the proposed restoration area is provided in Figures 37 and 38, respectively. The elements for creating conditions conducive to native riparian species include tamarisk removal (without channelization) and preventing cattle from grazing in the restoration area. Fencing may be required to prevent cattle from grazing in the restoration area.

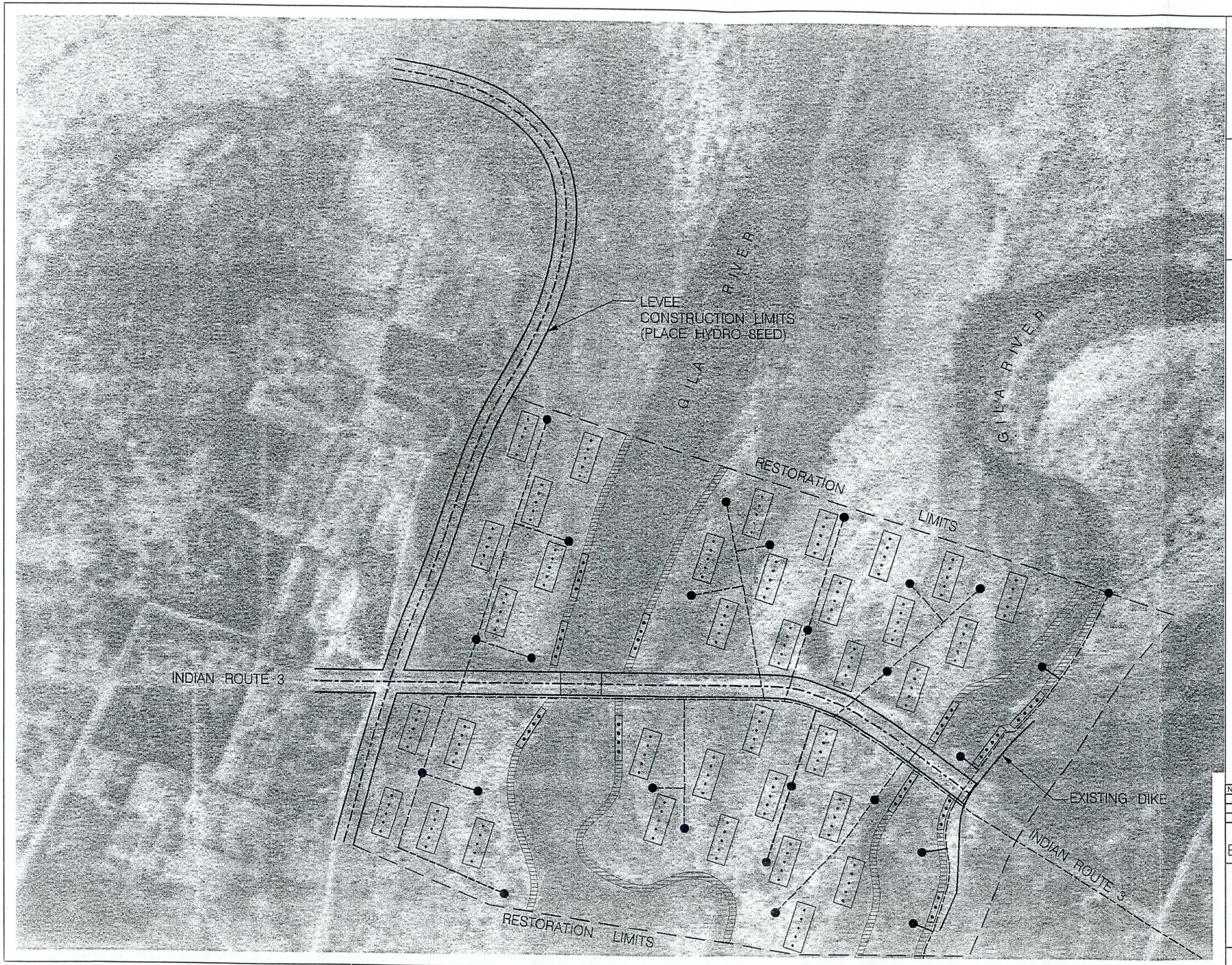
The elements for replacing tamarisk include providing pole plantings of Goodding willow and Fremont cottonwoods on the channel banks and overbank areas, hydro seeding the backside of the levees, and providing an irrigation system for a water source. It may become feasible to extend the planned CAP irrigation system to the restoration area in the future. This may provide a more cost-effective source of water. However, it is presently proposed to pipe the irrigation water to the restoration area from the existing water tower and associated distribution system located approximately one mile north in the community of Gila Crossing. It is assumed that the irrigation water line will run within the right-of-way of existing roadways to the restoration area.

The approximate quantities, unit costs, capital costs, and annual costs of the elements required for the environmental restoration plan are summarized in Table 6. As shown in Table 6, the total annualized cost of the restoration plan is $68,500. Combining this cost with the total annualized cost of the hydraulic elements described above, results in a grand total annualized cost of $258,200 for the selected plan.

Table 6: Annual Cost of Environmental Restoration

Item	Quantity	Unit Cost	Capital Cost	Annual Cost
Pole Plantings	170 Ac.	$2500/Ac.	$425,000	$30,300
Irrigation Piping	11,500 Ft.	$10/Ft.	$115,000	$ 8,200
Irrigation O & M		$1,500/Mo.		$18,000
Riparian Vegetation Maintenance (Tamarisk Removal)		$1,000/Mo.		$12,000
TOTAL			$540,000	$68,500

(Capital Costs amortized over 50 years at 6.875% interest)



GILA RIVER
INDIAN COMMUMITY
PLANNING ASSISTANCE REPORT

INDIAN ROUTE 3
GILA RIVER CROSSING

ALTERNATIVES ANALYSIS

POLE PLANTINGS

IRRIGATION PIPELINE

SPRINKER LOCATION

NOTE:

ALL TAMARISK WILL BE REMOVED AND ALL CATTLE GRAZING WILL BE PROHIBITED WITHIN THE RESTORATION BOUNDARY LIMITS.

N

0 500' 1000'

SCALE: 1" = 500'

NO.	REVISION	BY	DATE
3			
2			
1			

SELECTED PLAN
ENVIRONMENTAL RESTORATION ELEMENTS

	BY	DATE
DESIGNED	M.L.	04/16/99
CHECKED	M.L.	04/16/99

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(602) 491-1393 FAX (602) 491-1398 slotempe@aol.com

FIGURE #37

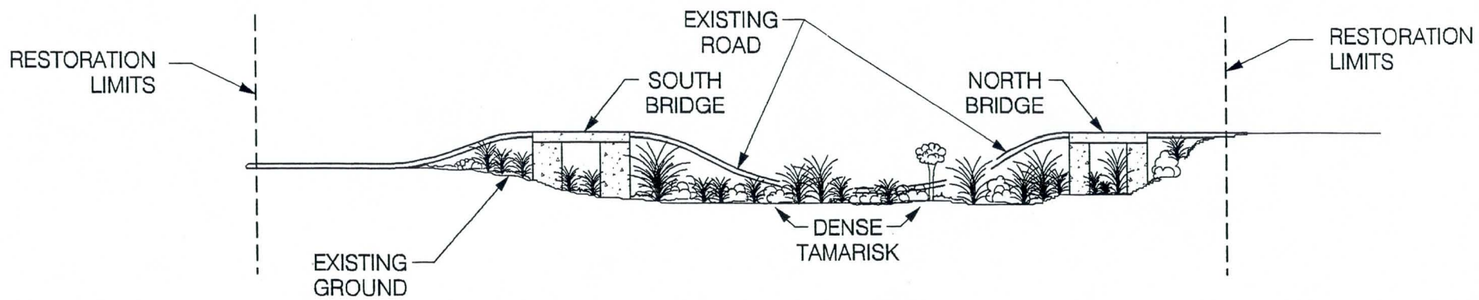
SHEET 1 OF 1

GILA RIVER
INDIAN COMMUMITY
PLANNING ASSISTANCE REPORT

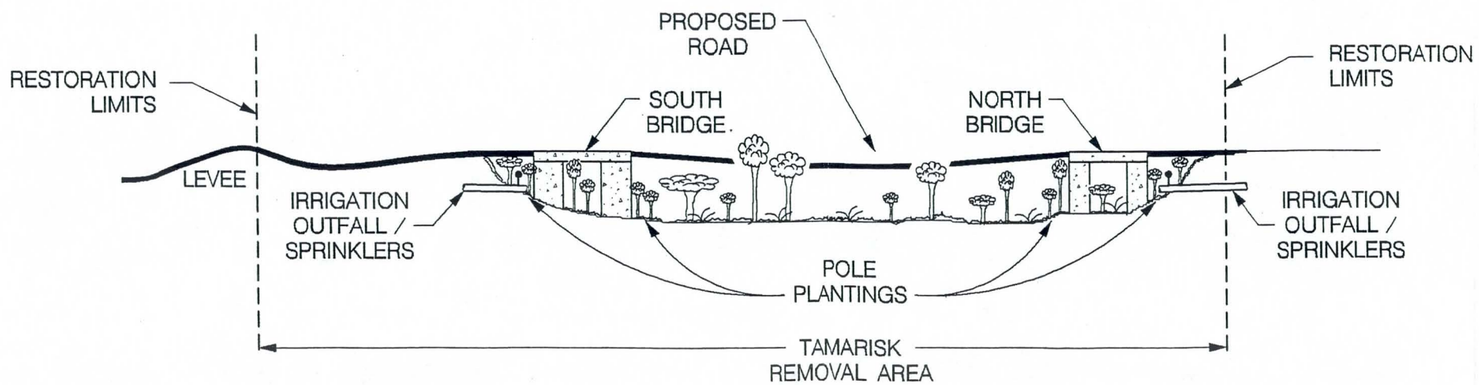
INDIAN ROUTE 3
GILA RIVER CROSSING

ALTERNATIVES ANALYSIS

GILA RIVER CROSSING EXISTING CONDITIONS
(Looking Downstream)



GILA RIVER CROSSING RESTORATION PROFILE
(Looking Downstream)



SCALE: N.T.S.

NO.	REVISION	BY	DATE
3			
2			
1			

ENVIRONMENTAL RESTORATION PROFILE

	BY	DATE
DESIGNED		04/16/99
CHECKED		04/16/99

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INFRASTRUCTURE SOUTHWEST GROUP
4600 South Mill Avenue, Suite 200, Tempe, AZ 85282
(602) 491-1393 FAX (602) 491-1396 sistempe@aol.com

FIGURE #38

SHEET 1 OF 1

10.2 Summary of Impacts

The selected plan will directly impact the existing Tamarisk-Mixed Deciduous habitat within the area to be cleared. The majority of this impact would be on Tamarisk. However, some native species, such as cottonwood, willow, and screwbean mesquite may also be removed. Indirect impacts could include occasional scouring of riparian vegetation adjacent to the cleared areas due to increased conveyance capacities and flow velocities.

With the clearing of Tamarisk, some wildlife typically found in the Tamarisk-Mixed Deciduous community would be adversely affected, but these impacts are not expected to reduce the viability of any population. Game species whose territories encompass large areas that include the channel may be temporarily impacted, but not significantly. Some smaller fauna, however, would be lost or displaced permanently.

Depending upon the final location of the levee, the selected plan could also impact some portions of the abandoned agricultural fields on the south bank. The areas immediately adjacent to the proposed levee will also be cleared for construction access. Also, the areas immediately adjacent to the existing roadway, both upstream and downstream, will be cleared for embankment construction and access roads (see Figure 35). These impacts will be very similar to those described above, with the exception that the disturbance for construction access roads will be temporary. The impacts will be minimized by hydro seeding desirable riparian vegetation on the proposed levee and other disturbed areas to stabilize slopes and soften visual impacts.

No special interest species are known to occur within the study area, therefore, the selected plan is not likely to adversely impact any listed species. However, as the federally listed southwestern willow flycatcher is known to nest in stands of Tamarisk-Mixed Deciduous, surveys for this species should be conducted prior to any clearing. The clearing should be completed during the late summer/early fall period when the migratory bird is not present. No proposed critical habitat for the cactus ferruginous pygmy owl would be impacted by the selected plan.

A 1998 Class I survey of the study area indicates the selected plan should not impact any known eligible historic resources.

A summary of the approximate acreage disturbed by clearing for the selected plan is provided in Table 7.

A complete evaluation and discussion of environmental issues and alternatives is in Appendix B, "Environmental Baseline Conditions Report."

Table 7: Acreage Disturbed by Clearing

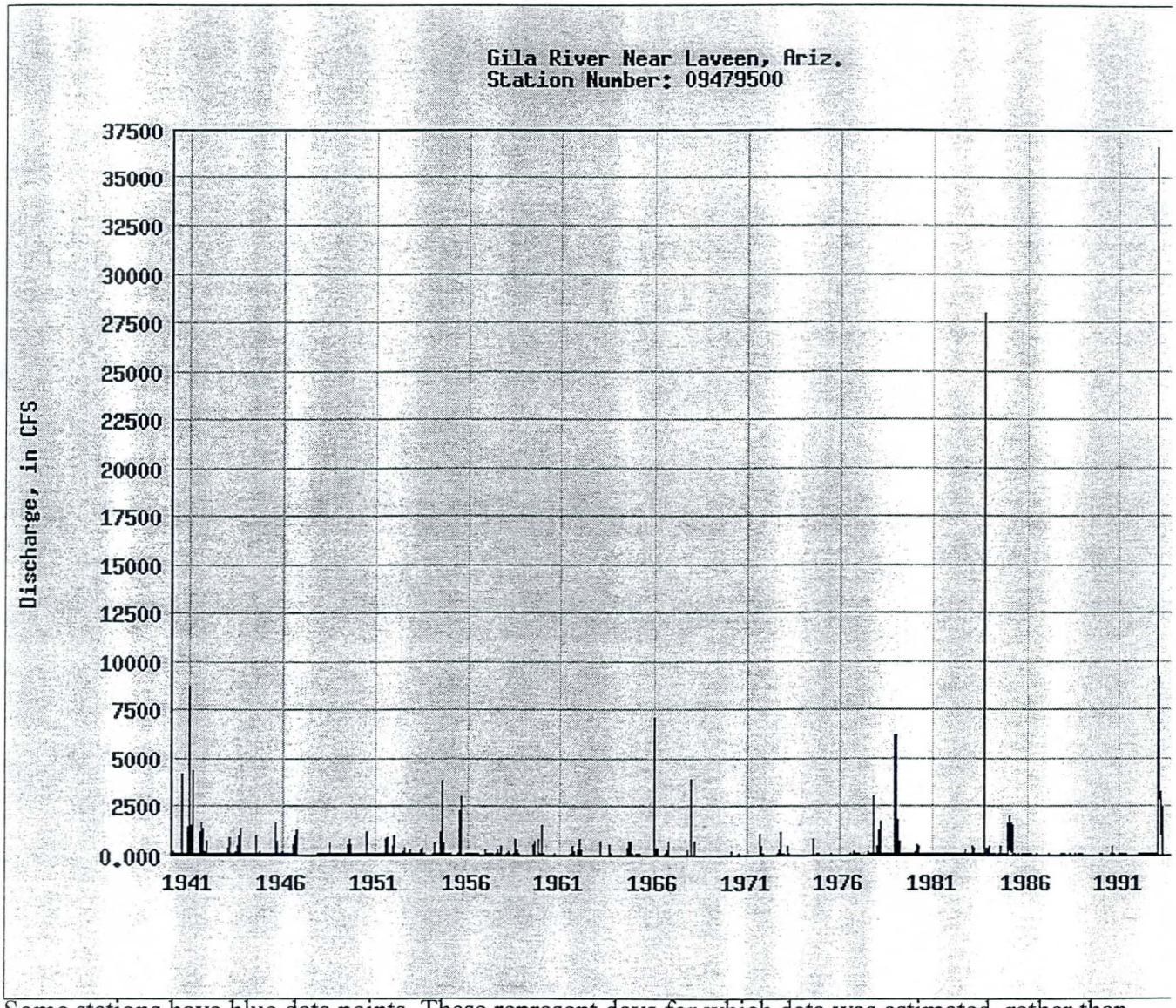
ELEMENT	TEMPORARY	PERMANENT	TOTAL
Channels/Overbanks	-	170.0 Ac.*	170.0 Ac.
Roadway	2.9 Ac.	2.9 Ac.	5.8 Ac.
Levee	4.1 Ac.	7.0 Ac.	11.1 Ac.
TOTAL	7.0 Ac.	179.9 Ac.	186.9 Ac.

Note: Cleaved tamarisk to be replaced with riparian habitat.

Appendix A

HYDROLOGIC DATA

Historical Streamflow Daily Values Graph for Gila River Near Laveen, Ariz.



Some stations have blue data points. These represent days for which data was estimated, rather than recorded.

For your searching convenience the master list of stations has been updated with about 3000 new stations. This means that stations which only have Peakflow data (but not Historical Daily Values) will now appear when you search for a station whereas before only stations with Historical Daily Values data would appear.

Please be sure that you always access NWIS-W via water.usgs.gov.

```
Z                                   USGS
H 09479500        331525112095900040402 1SW15050100  206157729.00 1018.90
N 09479500          GILA RIVER NEAR LAVEEN, ARIZ.
Y 09479500         700.00     -
2 09479500
3 09479500        19160120  6500027                        1907
3 09479500        19260928  4000027                        1916
3 09479500        19400817   87405                9.213
3 09479500        19410102  119005                9.333
4 09479500        19401120   16105                5.753
4 09479500        19401226   14405                5.493
4 09479500        19410113   10405                5.083
4 09479500        19410130   17205                5.723
4 09479500        19410209   18305                6.193
4 09479500        19410226   16005                5.213
4 09479500        19410317   47105                7.803
4 09479500        19410724   14205                5.003
4 09479500        19410811   17305                5.423
4 09479500        19410818   17505                5.433
4 09479500        19410919   15605                5.143
4 09479500        19410929   18005                5.623
3 09479500        19411212   11705                4.903
3 09479500        19430927   15705                5.783
4 09479500        19430125    7145                4.683
4 09479500        19430306   15505                5.133
4 09479500        19430804    7025                4.703
4 09479500        19430811   14705                5.413
4 09479500        19430815    7305                4.703
3 09479500        19440811   13305                5.833
3 09479500        19450813   28005                7.423
3 09479500        19460920   12605                6.263
4 09479500        19451006   12505                5.633
4 09479500        19460806   11805                5.763
3 09479500        19480805   14305                6.093
4 09479500        19480726   12805                5.703
3 09479500        19490810   12505                6.6423       0917     6.68
4 09479500        19490725    8805                6.223
4 09479500        19490801    7555                5.903
4 09479500        19490914    7765                5.963
4 09479500        19490917   12105                6.683
3 09479500        19500802   15005                7.223
4 09479500        19500709    7065                5.723
4 09479500        19500719    7775                6.083
4 09479500        19500723   10405                6.803
4 09479500        19500806   11605                7.023
3 09479500        19510829   12105                7.293
4 09479500        19510805   11005                6.933
3 09479500        19520120   10705                7.033
4 09479500        19520115    8715                6.703
3 09479500        19530731    5655                6.763
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4 09479500        19540723   14405                7.643
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4 09479500        19540817   15805                7.933
4 09479500        19540821   15205                7.873
4 09479500        19540926    7645                7.333
3 09479500        19550824   32305                8.763
4 09479500        19550727   21005                8.143
4 09479500        19550801   19005                8.083
4 09479500        19550805   16305                7.903
4 09479500        19550810   27005                8.543
```

4	09479500	19550817	10605	7.663
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3	09479500	19570820	4465	6.003
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4	09479500	19580809	9835	7.733
3	09479500	19590819	9345	7.543
3	09479500	19600114	17605	8.183
4	09479500	19591101	10805	7.703
4	09479500	19591228	16805	8.123
3	09479500	19610825	6555	7.193
3	09479500	19611218	10205	7.753
3	09479500	19630214	7985	7.633
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3	09479500	19671223	58905	9.623
4	09479500	19680216	8085	7.503
3	09479500	1969	0.005	
3	09479500	19700305	1785	4.466
3	09479500	19710823	11305	7.66
3	09479500	19711003	5445	7.37
3	09479500	19721023	15005	7.83
3	09479500	19740807	12205	8.06
4	09479500	19740805	12005	8.03
3	09479500	19741102	19.05	3.93
3	09479500	19760925	3975	6.65
3	09479500	19761022	4305	6.65
3	09479500	19771013	63605	9.64
4	09479500	19780118	7605	7.62
4	09479500	19780217	11605	8.02
4	09479500	19780306	19305	8.16
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4	09479500	19790103	9875	7.83
4	09479500	19790109	8405	
4	09479500	19790122	67805	9.59
4	09479500	19790128	28705	8.47
4	09479500	19790204	19105	8.19
3	09479500	19800223	5455	7.49
3	09479500	19810303	20.015	
3	09479500	19820915	19415	
3	09479500	19830209	3855	6.85
3	09479500	19831004	350005	
3	09479500	19850111	208015	7.96
3	09479500	19851210	10.05	3.93
3	09479500	19870225	7.105	3.91
3	09479500	19871218	16.05	3.96
3	09479500	19890105	12.05	3.94
3	09479500	19900817	4565	6.91
3	09479500	19910306	2035	4.44
3	09479500	19920724	2455	4.78
3	09479500	19930120	416005	12.41
3	09479500	19931117	12305	8.50

09479500 GILA RIVER NEAR LAVEEN, AZ

LOCATION.--Lat 33°15'25", long 112°09'59", in SW¼NW¼ sec.16, T.2 S., R.2 E., Pinal County, Hydrologic Unit 15050100, in Gila River Indian Reservation, on left abutment of highway bridge, 2.1 mi upstream from Santa Cruz River, 2.6 mi south of Komatke, and 7.3 mi south of Laveen.

DRAINAGE AREA.--20,615 mi^2, of which 696 mi^2 is in Mexico.

REMARKS.--Records include flow over dam and in overflow channel. Large diversions above station for irrigation. Most low flow is waste water from irrigated lands and from Chandler, Arizona treatment plant (1979-83). Flow partly regulated by storage in San Carlos Reservoir. (See elsewhere in this report.)

ANNUAL PEAK DISCHARGE

WATER YEAR	DATE	ANNUAL PEAK DISCHARGE (FT^3/S)	DISCHARGE CODES	WATER YEAR	DATE	ANNUAL PEAK DISCHARGE (FT^3/S)	DISCHARGE CODES
1916	01-20-16	[1]65,000	ES,HP	1965	02-09-65	85	UR
1926	09-28-26	[2]40,000	ES,HP	1966	12-26-65	10,900	UR
1940	08-17-40	8,740	UR	1967	09-28-67	350	UR
1941	01-02-41	11,900	UR	1968	12-23-67	5,890	UR
1942	12-12-41	1,170	UR	1969	00-00-69	0	UR
1943	09-27-43	1,570	UR	1970	03-05-70	178	UR
1944	08-11-44	1,330	UR	1971	08-23-71	1,130	UR
1945	08-13-45	2,800	UR	1972	10-03-71	544	UR
1946	09-20-46	1,260	UR	1973	10-23-72	1,500	UR
1948	08-05-48	1,430	UR	1974	08-07-74	1,220	UR
1949	08-10-49	1,250	UR	1975	11-02-74	19	UR
1950	08-02-50	1,500	UR	1976	09-25-76	397	UR
1951	08-29-51	1,210	UR	1977	10-22-76	430	UR
1952	01-20-52	1,070	UR	1978	10-13-77	6,360	UR
1953	07-31-53	565	UR	1979	12-21-78	9,720	UR
1954	08-08-54	4,510	UR	1980	02-23-80	545	UR
1955	08-24-55	3,230	UR	1981	03-03-81	20	MD,U
1956	01-31-56	46	UR	1982	09-15-82	194	MD,U
1957	08-20-57	446	UR	1983	02-09-83	385	UR
1958	08-19-58	995	UR	1984	10-04-83	35,000	UR
1959	08-19-59	934	UR	1985	01-11-85	2,080	MD,U
1960	01-14-60	1,760	UR	1986	12-10-85	10	UR
1961	08-25-61	655	UR	1987	02-25-87	7.1	UR
1962	12-18-61	1,020	UR	1988	12-18-87	16	UR
1963	02-14-63	798	UR	1989	01-05-89	12	UR
1964	08-17-64	996	UR				

[1]Highest since 1907.
[2]Highest since 1916.

MEAN MONTHLY AND ANNUAL DISCHARGES 1941-46, 1949-89

MONTH	MAXIMUM (FT^3/S)	MINIMUM (FT^3/S)	MEAN (FT^3/S)	STANDARD DEVIATION (FT^3/S)	COEFFICIENT OF VARIATION	PERCENT OF ANNUAL RUNOFF
OCTOBER	2,660	0.00	66	388	5.9	16.3
NOVEMBER	182	0.00	9.3	29	3.1	2.3
DECEMBER	518	0.00	43	115	2.7	10.6
JANUARY	1,100	0.00	70	210	3.0	17.2
FEBRUARY	1,300	0.00	58	201	3.5	14.4
MARCH	1,060	0.00	52	176	3.4	12.9
APRIL	98	0.00	6.5	18	2.7	1.6
MAY	26	0.00	2.0	4.6	2.3	0.5
JUNE	12	0.00	1.1	2.4	2.1	0.3
JULY	249	0.00	15	41	2.7	3.7
AUGUST	895	0.00	67	160	2.4	16.6
SEPTEMBER	106	0.00	15	26	1.8	3.6
ANNUAL	285	0.00	34	64	1.9	100

MAGNITUDE AND PROBABILITY OF ANNUAL LOW FLOW BASED ON PERIOD OF RECORD 1941-46, 1949-89

PERIOD (CONSECUTIVE DAYS)	DISCHARGE, IN FT^3/S, FOR INDICATED RECURRENCE INTERVAL, IN YEARS, AND NON-EXCEEDANCE PROBABILITY, IN PERCENT					
	2 50%	5 20%	10 10%	20 5%	50 2%	100† 1%
1	0.00	0.00	0.00	0.00	0.00	0.00
3	0.00	0.00	0.00	0.00	0.00	0.00
7	0.00	0.00	0.00	0.00	0.00	0.00
14	0.00	0.00	0.00	0.00	0.00	0.00
30	0.00	0.00	0.00	0.00	0.00	0.00
60	0.00	0.00	0.00	0.00	0.00	0.00
90	0.00	0.00	0.00	0.00	0.00	0.00
120	0.00	0.00	0.00	0.00	0.00	0.00
183	0.00	0.00	0.00	0.00	0.00	0.00

MAGNITUDE AND PROBABILITY OF INSTANTANEOUS PEAK FLOW BASED ON PERIOD OF RECORD

DISCHARGE, IN FT^3/S, FOR INDICATED RECURRENCE INTERVAL IN YEARS, AND EXCEEDANCE PROBABILITY, IN PERCENT					
2 50%	5 20%	10 10%	25 4%	50 2%	100 1%
---	---	----	----	----	----

WEIGHTED SKEW (LOGS)= ----
MEAN (LOGS)= ----
STANDARD DEV. (LOGS)= ----

MAGNITUDE AND PROBABILITY OF ANNUAL HIGH FLOW BASED ON PERIOD OF RECORD 1941-46, 1949-89

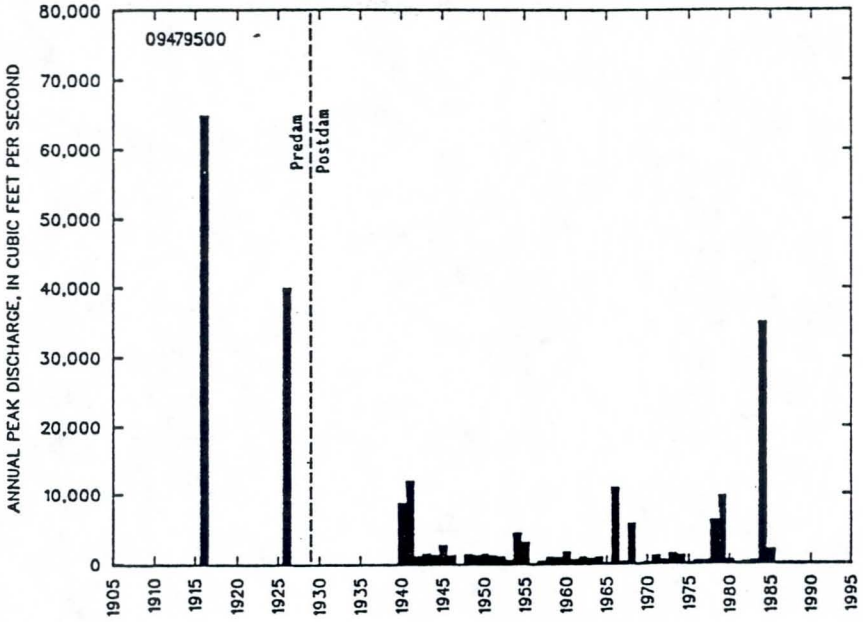
PERIOD (CONSECUTIVE DAYS)	DISCHARGE, IN FT^3/S, FOR INDICATED RECURRENCE INTERVAL, IN YEARS, AND EXCEEDANCE PROBABILITY, IN PERCENT					
	2 50%	5 20%	10 10%	25 4%	50 2%	100† 1%
1	546	2,500	4,850	8,970	12,800	17,100
3	344	1,650	3,270	6,150	8,830	11,900
7	185	943	1,920	3,710	5,410	7,370
15	100	542	1,150	2,310	3,470	4,870
30	62	348	748	1,530	2,320	3,270
60	36	210	459	957	1,470	2,090
90	25	151	338	726	1,140	1,660

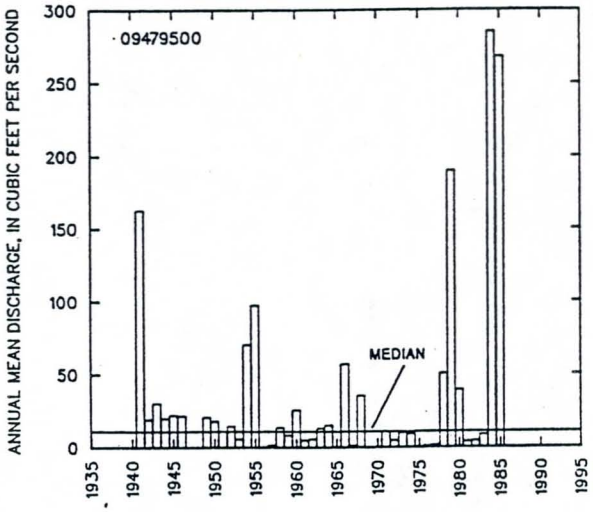
DURATION TABLE OF DAILY MEAN FLOW FOR PERIOD OF RECORD 1941-46, 1949-89

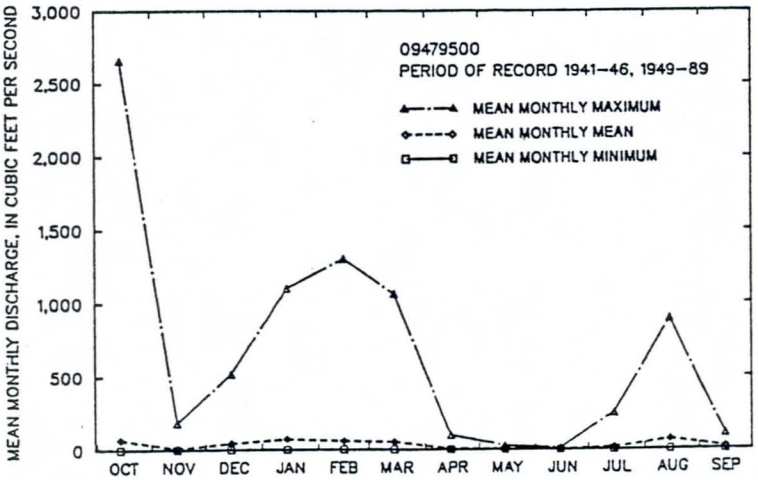
DISCHARGE, IN FT^3/S, WHICH WAS EQUALED OR EXCEEDED FOR INDICATED PERCENT OF TIME																
1%	5%	10%	15%	20%	30%	40%	50%	60%	70%	80%	90%	95%	98%	99%	99.5%	99.9%
869	48	17	9.3	6.1	2.4	0.09	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

† Reliability of values in column is uncertain, and potential errors are large.

09479500 GILA RIVER NEAR LAVEEN, AZ--CONTINUED



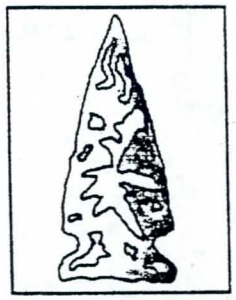


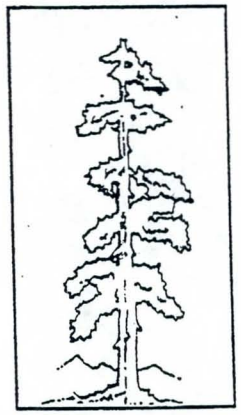


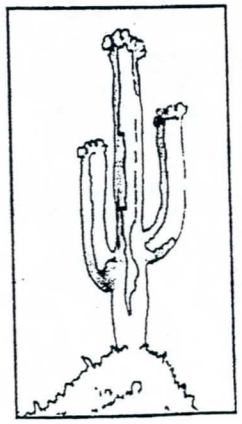
Appendix B

ENVIRONMENTAL BASELINE CONDITIONS REPORT

ENVIRONMENTAL BASELINE CONDITIONS REPORT FOR THE INDIAN ROUTE 3-GILA RIVER CROSSING, GILA RIVER INDIAN COMMUNITY, MARICOPA AND PINAL COUNTIES, ARIZONA







FEBRUARY 1999

TABLE OF CONTENTS

INTRODUCTION 1

A. BASELINE BIOLOGICAL CONDITIONS 1
METHODS 1
RESULTS 4
Ecological Overview 4
Vegetation Communities 4
SPECIAL INTEREST SPECIES 5
Federally Listed Species 5
WILDLIFE 11
WATER QUALITY 11
CULTURAL RESOURCES 13

B. ENVIRONMENTAL RESTORATION OPPORTUNITIES 13
ALTERNATIVES FOR CREATING CONDITIONS CONDUCIVE TO NATIVE RIPARIAN SPECIES 14
ALTERNATIVES FOR REPLACING TAMARISK 15
CONCEPTUAL RESTORATION LAYOUTS 16

C. PRELIMINARY ANALYSIS OF ALTERNATIVES 16
HYDRAULIC ALTERNATIVES SUMMARY 16
PRELIMINARY ANALYSIS OF IMPACTS 21

REFERENCES CITED 25

APPENDIX A - PLANT SPECIES OBSERVED IN THE STUDY AREA A-1

APPENDIX B - WILDLIFE SPECIES OBSERVED OR DETECTED IN THE STUDY AREA . . B-1

APPENDIX C - TAMARISK CONTROL METHOD C-1

List of Figures

Figure 1. Project location map 2
Figure 2. Restoration Alternative 1 17
Figure 3. Restoration Alternative 2 18
Figure 4. Restoration Alternative 3 19
Figure 5. Restoration Alternative 4 20

List of Tables

Table 1. Summary of Potential for Occurrence of Eighteen Special Interest Species Listed for Maricopa and Pinal Counties 3

INTRODUCTION

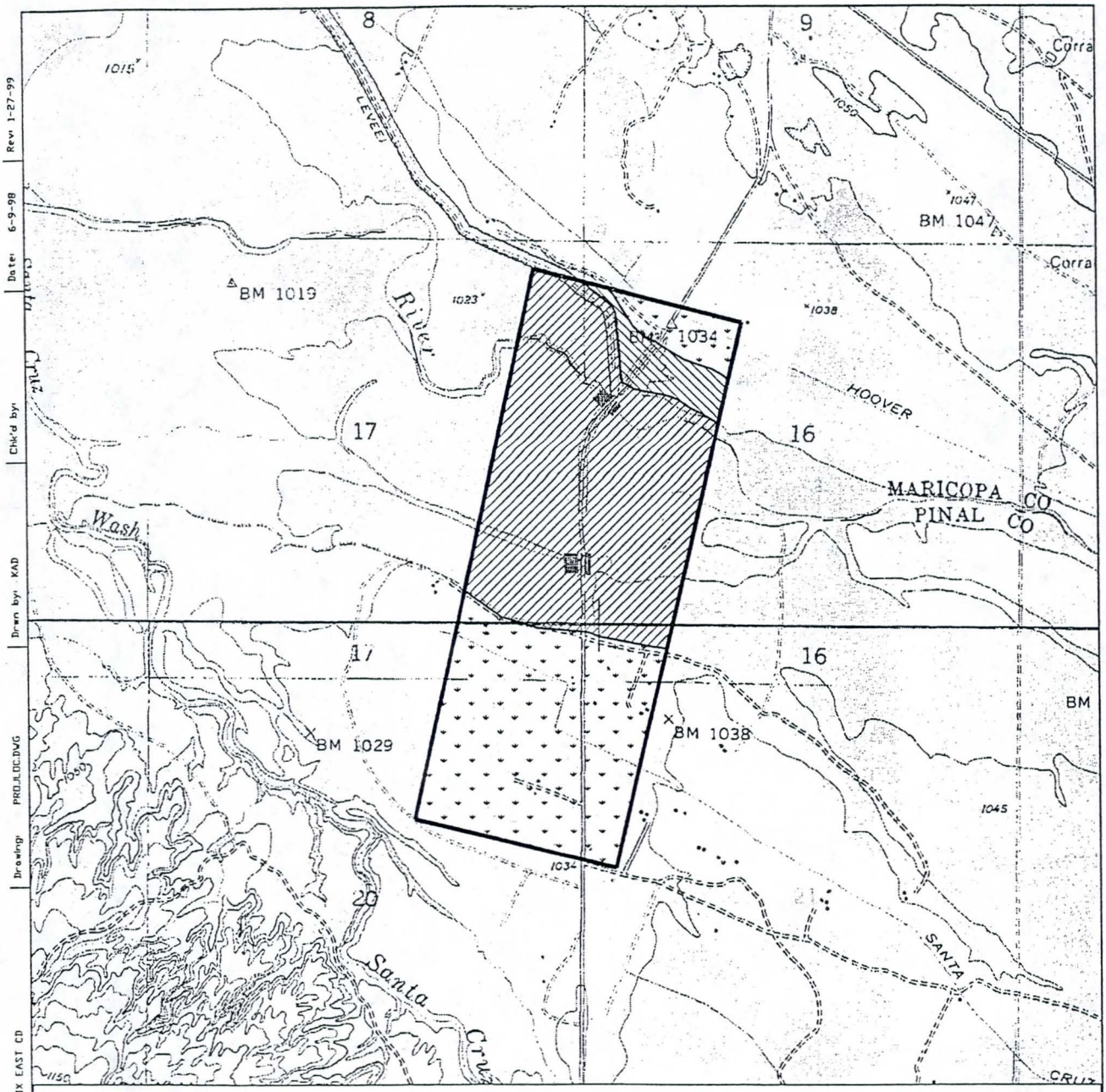
SWCA, Inc. Environmental Consultants (SWCA), as subcontractor to Black & Veatch, has completed this Environmental Baseline Conditions Report (EBCR) for two road crossings of the Gila River, on Hidden Valley Road on Gila River Indian Community (GRIC) reservation land, in Maricopa and Pinal counties, Arizona. The approximately 402-acre study site is located in portions of sections 16, 17, 20, and 21, T2S, R2E, within and adjacent to the floodplain of the Gila River (Figure 1) near its confluence with the Santa Cruz Wash. Objectives of this report are to: (1) classify and describe vegetation communities in the study area; (2) evaluate habitat suitability for special interest plant and animal species; 3) summarize existing available water quality data; 4) describe potential environmental restoration alternatives; and 5) analyze potential environmental impacts of preliminary hydraulic alternatives as provided in a Draft Planning Assistance Report. For the purposes of document organization, this report is presented in three sections: Baseline Biological Conditions (objectives 1, 2, and 3); Environmental Restoration Alternatives (objective 4); and Preliminary Alternatives Analysis (objective 5).

A. BASELINE BIOLOGICAL CONDITIONS

METHODS

A general field reconnaissance was conducted on 9 and 10 September 1998, within an approximate 402-acre study area (Figure 1). U.S. Geological Survey topographical maps (Laveen and Montezuma Peak, AZ; 1:24,000) and a color aerial photograph (year of photograph 1994; scale approximately 1" = 500') were used to locate the boundaries of the study area for general orientation, and to map vegetation within the study area. Vegetation was mapped and described following Brown (1994). Though no detailed species-specific plant or animal surveys were conducted in the study area, special attention was directed toward evaluating potential habitat for southwestern willow flycatcher (*Empidonax traillii extimus*), an endangered species.

A total of 18 special status species are addressed in this report (Table 1). This species list was compiled from the lists of endangered, threatened, proposed, and candidate species maintained by USFWS for Maricopa and Pinal counties (USFWS AESO/SE 2-21-98-I-295, letter dated 2 June 1998). Sixteen of the 18 special status species listed by the USFWS are considered very or extremely unlikely to occur within the study area because their known ranges are located well outside of the study area and/or the study area does not contain habitats similar to those known to support these species. These 16 species are listed in Table 1. Portions of the study area appear to have components of habitat requirements for the remaining two species, cactus ferruginous pygmy-owl (*Glaucidium brasilianum cactorum*) and southwestern willow flycatcher (*Empidonax traillii extimus*), which are considered in more detail in this report.



KEY

- PROJECT AREA BOUNDARY
- SALTBUSH BIOTIC COMMUNITY
- TAMARISK-MIXED DECIDUOUS RIPARIAN ASSOCIATION
- ABANDONED AGRICULTURAL FIELDS
- DISTURBED VEGETATION

QUADRANGLE LOCATION

LAVEEN AND MONTEZUMA PEAK
USGS 7.5' QUADRANGLE

SWCA Inc. Environmental Consultants

Scale

0 1000 2000
FEET

N

GRIC HABITAT RESTORATION

Pinal and Maricopa counties, Arizona
T.2 S. R.2 E. SEC 16, 17, 20 and 21

PROJECT LOCATION MAP

FIGURE 1

Rev: 1-27-99
Date: 6-9-98
Chk'd by:
Drawn by: KAD
Drawing: PROJLOC.DWG
PHOENIX EAST CD
File: G:\acad\2242
2242-2151
Proj. #:

Table 1. Summary of Potential for Occurrence of Eighteen Special Interest Species Listed for Maricopa and Pinal Counties (*USFWS Status: E=Endangered, T=Threatened, C=Candidate)

Species	Federal Status*	Evaluation of Species' Potential For Occurrence in the Study Area
Lesser long-nosed bat (*Leptonycteris curasoae yerbabuena*)	E	Study area supports no forage plants for this species and is below species' elevational range; extremely unlikely to occur
American peregrine falcon (*Falco peregrinus anatum*)	E	No breeding habitat present; study area is well below species' elevational range; very unlikely to occur
Southwestern willow flycatcher (*Empidonax traillii extimus*)	E	Few potentially suitable vegetation patches; no surface water within 200 m; unlikely to occur
Arizona hedgehog cactus (*Echinocereus triglochidiatus* var. *arizonicus*)	E	Study area is outside species' known range; elevation too low; extremely unlikely to occur
Arizona agave (*Agave arizonica*)	E	Study area is distant from known occurrences; habitat not typical; extremely unlikely to occur
Yuma clapper rail (*Rallus longirostris yumanensis*)	E	No perennial water; habitat not typical; study area outside species' known range; extremely unlikely to occur
Nichol's Turk's head cactus (*Echinocactus horizonthalonius* var. *Nicholii*)	E	Study area is outside species' known range; habitat not typical; very unlikely to occur
Arizona cliffrose (*Purshia subintergra*)	E	Habitat not typical and preferred substrate not present; study area is distant from known occurrences; extremely unlikely to occur
Sonoran pronghorn (*Antilocapra americana sonorensis*)	E	Habitat not typical; study area well outside species' known range; extremely unlikely to occur
Desert pupfish (*Thamnophis eques*)	E	No perennial water in or adjacent to study area; extremely unlikely to occur
Gila topminnow (*Poeciliopsis occidentalis occidentalis*)	E	No perennial water in or adjacent to study area; extremely unlikely to occur
Razorback sucker (*Xyrauchen texanus*)	E	No perennial water in or adjacent to study area; extremely unlikely to occur
Cactus ferruginous pygmy-owl (*Glaucidium brasilianum cactorum*)	E	Although a few large mesquite occur, habitat not typical; unlikely to occur
Mexican spotted owl (*Strix occidentalis lucida*)	T	Habitat not typical and elevation too low; extremely unlikely to occur
Bald eagle (*Haliaeetus leucocephalus*)	T	Study area contains no breeding or foraging habitat; extremely unlikely to occur
Spikedace (*Meda fulgida*)	T	No perennial water in or adjacent to study area; extremely unlikely to occur
Loach minnow (*Tiaroga cobitis*)	T	No perennial water in or adjacent to study area; extremely unlikely to occur
Acuna cactus (*Echinomastus erectocentrus acunensis*)	C	Habitat not typical; outside species' elevational range; very unlikely to occur

For each special interest species, a brief description of its habitat and range and a habitat suitability evaluation is provided. Habitat suitability evaluations were based on a qualitative comparison between the habitat requirements of each species and habitats found in the study area.

RESULTS

Ecological Overview

The study area is approximately 402 acres in size and covers roughly ¼ mile upstream and ¼ mile downstream of two bridge crossings of the Gila River at Hidden Valley Road, near Komatke, Arizona, within the Gila River Indian Community reservation lands. Elevations in the study area range from about 1,000 to 1,035 feet above mean sea level. The Gila River runs through the study area from the southeast (upstream) to the northwest (downstream). The study area is bisected by Hidden Valley Road (Santa Cruz Road), which runs approximately north-south and spans the two main channels of the Gila River. The vegetation within the river floodplain is fairly dense and is dominated by tamarisk (*Tamarix* spp.) of varying height. Because of the low height (8'-10') of the bridges and the dense vegetation, flows periodically back up and water floods over Hidden Valley Road around both of the bridges during large precipitation events (G. Brooks, GRIC Land and Water Department, pers. comm. 1998). During a field visit in September 1998, all vegetation in an area approximately 200 feet downstream and 100 feet upstream of each bridge appears to have been cleared.

Vegetation Communities

Three vegetation communities, two upland and one riparian, were identified in or adjacent to the study area. Approximately 177 acres (44%) of the study area consists of abandoned agricultural fields. In undisturbed upland areas, vegetation is characteristic of the Saltbush biotic community (Brown 1994) and encompasses approximately 19 acres (~5%). Riparian vegetation, which occurs along the Gila River channel and in most of its floodplain, is of the Saltcedar (Tamarisk)-Mixed Deciduous association, and encompasses approximately 206 acres (51%). The distribution of these vegetation communities within the study area is shown in Figure 1. A list of plant species observed in the study area is provided as Appendix A. This list does not represent a comprehensive summary of all plant species that may occur in the study area.

Upland Vegetation. The dominant upland plant community within the study area is abandoned agricultural fields. Dominant plant species within these fields are mesquite (*Prosopis velutina*), tamarisk (*Tamarix* sp.), and saltbush (*Atriplex* sp.). The minority upland plant community, the Saltbush biotic community, occurs in the upland portions of the region surrounding the study area. Dominant plants within this community are seep-weed (*Suaeda torreyana*), pickle-weed (*Allenrolfea occidentalis*), and saltbush (*Atriplex* spp.), all halophytes tolerant of high alkaline/saline conditions. A few residences with

non-native landscaping plants occur in the study area, but were not mapped separately. In addition, ruderal species such as Russian thistle (*Salsola* sp.) are present along the roadways.

Riparian Vegetation. Tamarisk-Mixed Deciduous Riparian association is present throughout the Gila River floodplain within the study area. While the dominant plant species occurring in this association is an exotic, tamarisk (*Tamarix* spp.), native riparian species such as cottonwood (*Populus fremontii*), Goodding willow (*Salix gooddingii*), arroweed (*Pluchea sericea*), and screwbean mesquite (*Prosopis pubescens*) are represented in the study area, especially near the thalweg of the river. Stringers of these riparian species have become established within the channel since the last major flood in 1993 and range from saplings to approximately 25 foot tall trees.

SPECIAL INTEREST SPECIES

Individual species accounts of the 18 species considered in this report are provided below. Each species' potential for occurrence in the study area is summarized in Table 1.

Federally Listed Species

Lesser long-nosed bat (*Leptonycteris curasoae yerbabuenae*) is listed as endangered by the USFWS. In Arizona, New Mexico, and northwestern Mexico, the lesser long-nosed bat is migratory. Pregnant females arrive in late April and early May and feed on the nectar and pollen of columnar cacti, especially saguaros (Wilson 1985). Maternity roosts are generally located in natural caves or abandoned mines. In late July and early August, adult males arrive to join females and young as they disperse from maternity roosts to feed on the nectar and pollen of agave flowers. At this time, the species range expands east and north (Cockrum and Petryszyn 1991). By mid- to late September, the majority of bats have left Arizona and New Mexico and returned to Mexico. Available information suggests that the foraging radius of *Leptonycteris* bats may be up to 50 or 100 km (USFWS 1993).

Potential for Occurrence in the Study Area: The potential for occurrence of this species in the study area is extremely low. No mine shafts or adits were observed in the study area nor are any depicted as occurring within the study area on the Laveen or Montezuma Peak, AZ, USGS 7.5 minute topographical maps. Prior to 1986, records of specimens were limited to one from Phoenix and one from Glendale (Hoffmeister 1986). The closest known roost is located approximately 40 miles south of the study area (Hoffmeister 1986; Cockrum and Petryszyn 1991). Both bridges within the study area were investigated for bat sign and none was observed. No potential food sources such as agaves (*Agave* spp.), saguaro (*Carnegiea gigantea*), or organ pipe (*Sternotherus thurberi*) are present within the study area.

American peregrine falcon (*Falco peregrinus anatum*) is listed as endangered by the USFWS. The most important breeding habitat characteristic of this species is probably the presence of tall cliffs (typically over 150 feet but sometimes as low as 60 feet), which serve both as nesting and perching sites (Johnsgard

1990). Although nests sometimes occur some distance from water (Monson and Phillips 1981), a source of water is usually close to the nest site, probably in association with an adequate prey base of small to medium-sized birds. In Arizona, breeding activity was documented at 206 locations in 1995 (Garrison and Spencer 1996).

Potential for Occurrence in the Study Area: Visits to the study area by this species are considered very unlikely. Although numerous rock outcrops occur in the Sierra Estrella outside the study area, none provide cliffs suitable for nesting by this species. Peregrine falcons may occasionally forage along portions of the Gila River, particularly in winter, but habitats in the study area are not likely to provide an important source of food for this species.

Southwestern willow flycatcher (*Empidonax traillii extimus*) is listed as endangered by the USFWS. In Arizona, willow flycatchers arrive in May and begin to nest in late May (Phillips et al. 1964) in riparian vegetation along streams, rivers, or other wetlands (Johnson et al. 1987). The following definition of potential survey habitat was provided by Arizona Partners in Flight (1996):

> "...suitable survey habitat for the southwestern willow flycatcher is characterized by patches of native riparian shrubs or trees including willow (*Salix* sp.), cottonwood (*Populus* sp.), box elder (*Acer negundo*), ash (*Fraxinus* sp.), or mixtures of these species; pure stands of tamarisk; or mixtures of native species and tamarisk characterized by high stem density or high foliage volume in the lowest stratum and/or mid-stratum. Tamarisk stands, particularly taller stands, may have a relatively open understory with a single stratum of foliage confined to the canopy. Patches may have either a single stratum and relatively low canopy (minimum canopy height of 12 feet) characteristic of an early- to mid-seral stage, or have several vegetation strata including a relatively tall canopy of cottonwood or willow (e.g. 50 feet). Riparian patches may be highly irregular in shape, but should have a minimum depth of 30 feet."

The nearest designated critical habitat for this species is at the inflow of the Verde River into Horseshoe Reservoir (Federal Register 62:39129-39147), about 70 miles northeast of the study area.

Potential for Occurrence in the Study Area: Potential for occurrence of willow flycatchers within the study area is considered low and breeding is considered very unlikely. Although a few riparian patches in the study area are similar in some respects to habitats known to support breeding southwestern willow flycatcher, these patches were dry. Flycatcher territories and nests are typically near open water or saturated soil; at some locations water or saturated soil is present early in the breeding season (NPS 1997). Individual flycatchers may migrate through the study area, but because the Gila River is ephemeral in this reach and no open water or saturated soil was apparent within the study area during the site visits, they are not expected to breed in the study area.

Arizona hedgehog cactus (*Echinocereus triglochidiatus arizonicus*) is listed as endangered by the USFWS. The species is known to occur in central Arizona in Maricopa, Gila, and Pinal counties. Plants are found in narrow cracks between boulders on open slopes and in the understory of shrubs in the ecotone between Madrean evergreen woodland and interior chaparral at elevations ranging from 3,300 to 5,700 feet (USFWS 1991, Cedar Creek Associates 1995). The preferred geological substrates of Arizona hedgehog cactus are dacite and granite (Cedar Creek Associates 1995).

Potential for Occurrence in the Study Area: The potential for occurrence of Arizona hedgehog cactus is extremely low. Habitats in the study area do not resemble habitats in which this species is found, and the study area is well below the elevational range of this species.

Arizona agave (*Agave arizonica*) is listed as endangered by the USFWS. The known range of this species is the New River Mountains in Maricopa and Yavapai counties and the Sierra Ancha in Gila County (USFWS 1991). Arizona agave is found in the transition zone between oak-juniper woodland and mountain mahogany-oak scrub at an elevation of 3,000 to 6,000 feet. Preferred habitats are steep rock slopes, but it also can occur in drainage bottoms or on relatively gentle slopes. It has been suggested that *A. arizonica* may have originated through hybridization, possibly between *A. chrysantha* and *A. toumeyana bella*, and that it should be looked for wherever the ranges of *A. chrysantha* and *A. toumeyana* overlap (USFWS 1992).

Potential for Occurrence in the Study Area: The potential for occurrence of Arizona agave is considered extremely low. The study area is well below the elevational range of this species and the study area habitats are not similar to those in which Arizona agave is found. No agaves were observed in the study area during field reconnaissance.

Mexican spotted owl (*Strix occidentalis lucida*) is listed as threatened by the USFWS. The spotted owl has a wide but patchy distribution throughout Arizona (except for the southwestern portion of the state) where it inhabits rocky canyonlands, coniferous forests, and oak woodlands. South of the Mogollon Rim in Arizona, spotted owls are found in montane conifer forests and in Madrean evergreen forest and woodlands (Ganey et al. 1992). Madrean evergreen habitats include the Encinal (oak) Series, Oak-Pine Series, and Cypress Series. Encinal is dominated by a variety of evergreen oaks, sometimes co-occurring with pinyon and juniper. Tree height in this habitat is usually less than 15 m, with an open canopy.

Potential for Occurrence in the Study Area: Mexican spotted owl is considered extremely unlikely to occur in the study area. The study area is well below the elevational range of this species and habitats do not resemble those known to be used by this species.

Bald eagle (*Haliaeetus leucocephalus*) is listed as threatened by the USFWS. In Arizona, bald eagles nest along the Salt, Verde, Gila, Bill Williams, and Agua Fria drainages (AGFD 1988). It is estimated that between 200 and 300 eagles winter in Arizona, primarily in the White Mountains and along the Mogollon

Rim (USFWS 1991). Habitat requirements include large trees, snags, or cliffs near water for nesting and near major rivers or reservoirs during winter. Bald eagles feed primarily on fish, but waterfowl, small mammals, and carrion are also eaten.

Potential for Occurrence in the Study Area: Visits by this species to the study area are considered extremely unlikely. Habitats in the study area do not resemble habitats known to be used by this species for breeding or foraging.

Cactus ferruginous pygmy-owl (*Glaucidium brasilianum cactorum)* is listed as endangered by the USFWS. The cactus ferruginous pygmy-owl (CFPO) occurs from southern Arizona east to extreme southeastern Texas, and southward in Mexico to Guerrero, Nuevo Leon, and southern Tamaulipas (Oberholser 1974, cited in Millsap and Johnson 1988). In Arizona, breeding pairs recently have been found only at Organ Pipe Cactus National Monument and northwest of Tucson. Historically, the owl was much more widespread in Arizona, occurring as far north as New River (Millsap and Johnson 1988) and was found in mesquite woodlands, cottonwood forests, and less commonly in paloverde-mixed cactus forest. However, most recent observations of this species are from habitats dominated by mesquite, paloverde, ironwood (*Olneya tesota*), catclaw acacia, and saguaros. The nearest known occupied location for the species is in northwest Tucson, approximately 100 miles south of the study area. Critical habitat for this species has recently been proposed by U.S. Fish and Wildlife Service (Federal Register Vol. 63, No. 250), but the study area is outside of any proposed critical habitat.

Potential for Occurrence in the Project Area: Although a few areas within the study area contain large mesquite trees, this owl is not known to occur within the Saltbush biotic community or in tamarisk thickets. Given the species' currently known range, its relative rarity, and its apparent preference for Arizona Upland plant communities, it is unlikely that CFPO occurs in the study area.

Nichol's Turk's head cactus (*Echinocactus horizonthalonius* var. *Nicholii*) is listed as endangered by the USFWS. This cactus occurs in unshaded microsites on alluvial fans, within Sonoran desertscub, at the foot of limestone mountains (USFWS 1998).

Potential for Occurrence in the Study Area: The presence of this species is considered very unlikely. The study area is below the elevational range of this species and the study area habitats are not similar to those in which Nichol's Turk's head cactus is found.

Yuma clapper rail (*Rallus longirostris yumanensis*) is listed as endangered by the USFWS. It inhabits freshwater stream-sides and marshlands, is associated with dense riparian and swamp vegetation, and needs a wet substrate having dense herbaceous or woody vegetation at least 15 inches tall (USFWS 1998).

Potential for Occurrence in the Study Area: Habitats in the study area do not resemble habitats known to be used by this species for breeding or foraging. It is considered extremely unlikely to occur.

Arizona cliffrose (*Purshia subintegra*) is listed as endangered by the USFWS. It grows only on Tertiary limestone lakebed deposits (USFWS 1998). The nearest known location for this species is at Horseshoe Reservoir, approximately 70 miles to the northeast.

Potential for Occurrence in the Study Area: The presence of this species is considered extremely unlikely. The study area habitats and substrate are not similar to those in which Arizona cliffrose is found.

Sonoran pronghorn *(Antilocarpa ameficana sonotiensis)* is listed as endangered by the USFWS. The currently known distribution of the Sonoran pronghorn is south of the Gila River, east of the Gila and Tinajas Atlas mountains, west of Highway 85, and north of the vicinity of Caborca in Mexico (Wright and Devos 1986). In Arizona, the Sonoran pronghorn occurs on the Cabeza Prieta National Wildlife Refuge, the Barry M. Goldwater Range, and Organ Pipe Cactus National Monument. Sonoran pronghorn typically occur in sparsely vegetated broad alluvial valleys where dominant vegetation typically includes creosote, bursage, and various cacti. Available succulent forage may be the dominant factor influencing the distribution and seasonal movement of Sonoran pronghorn. Based on aerial survey data collected from 1992 to 1994, an estimated 125 to 256 Sonoran pronghorn occur in Arizona (USFWS unpublished data). study area.

Potential For Occurrence In The Project Area: Sonoran pronghorn is extremely unlikely to occur in the study area. The study area is located approximately 80 miles northwest of the currently known range of Sonoran pronghorn. Habitats within the study area are not similar to those known to be used by this species.

Desert pupfish (*Cyprinodon macularius*) is listed as endangered by the USFWS. Desert pupfish occurred historically below about 5,000 feet elevation in the Gila River basin (AGFD 1996). The species was extirpated from Arizona, but since 1977 has been reintroduced into 13 localities. It is currently restricted to one natural reintroduction site.

Potential for Occurrence in the Project Area: It is extremely unlikely that desert pupfish occurs in the Gila River within the study area. There are no currently known populations of desert pupfish in the mainstem Gila River, and no perennial water exists in the Gila River within the study area.

Gila topminnow (*Poeciliopsis occidentalis occidentalis*) is listed as endangered by the USFWS. Gila topminnows occurred historically in low to mid-elevation streams in drainages associated with the Gila River (AGFD 1996). A fairly extensive reintroduction of this species was undertaken, with some success, in the 1970s (AGFD 1988). Gila topminnows now occur at 11 natural sites in southern Arizona (AGFD 1996).

Potential for Occurrence in the Project Area: It is extremely unlikely that Gila topminnow occurs in the Gila River within the study area. There are no currently known populations in the mainstem Gila River, and no perennial water exists within the study area.

Razorback sucker (*Xyrauchen texanus*) is listed as endangered by the USFWS. Formerly widespread in the Gila and Colorado river systems, this large fish has been extirpated from much of its former range including the Gila River and its tributaries (USFWS 1994). Some large individuals persist in impoundments in the lower Colorado River. Though successful reproductive activities have been observed, little or no recruitment has been documented. Specific reasons for extirpation are unknown, but various factors including physical and chemical alteration of habitats and the introduction of non-native fish species have been cited as possible reasons. Reintroductions of millions of fingerlings (mostly < 130 mm total length) and a few large (> 500 mm) razorback suckers were made into the Gila, Salt, and Verde rivers and some tributaries between 1981 and 1989 (Hendrickson 1993); all introductions into the Gila River were above the vicinity of Thatcher except for two sites west of Phoenix. No populations of razorbacks appear to have become established in any of the areas where they were reintroduced and little evidence has been found of individuals persisting for more than a few months. Marsh and Brooks (1989) found that a very high number of reintroduced razorbacks were eaten by channel and flathead catfish within a few days of stocking. The nearest critical habitat for this species is at Horseshoe Reservoir (Federal Register 59:13374-13400), about 70 miles northeast of the study area.

Potential for Occurrence in the Project Area: It is extremely unlikely that razorback sucker occurs in the Gila River within the study area. The nearest reintroduction sites for razorback sucker were made in the Gila River downstream of Phoenix and the Gila River is ephemeral in the reach within the study area.

Loach minnow (*Tiaroga cobitis*) is listed as threatened by the USFWS. Loach minnow formerly occupied streams throughout the Gila River system (AGFD 1996), but are now restricted to San Francisco River, Campbell Blue Creek, Blue River, North Fork of the White River, East Fork of the North Fork of the Black River, Eagle Creek, and Aravaipa Creek.

Potential for Occurrence in the Project Area: It is extremely unlikely that loach minnow occurs in the Gila River within the study area. There are no known populations of loach minnow in the mainstem Gila River, and no perennial water exists within the study area.

Spikedace (*Meda fulgida*) is listed as threatened by the USFWS. Critical habitat was designated in March 1994 (USFWS 1994), but the designation was set aside pending NEPA compliance by a court ruling in 1996. Critical habitat did not include any of the Gila River in Arizona. This small fish was formerly widely distributed in the Gila River drainage in Arizona and New Mexico, but is currently known only from Aravaipa Creek, Eagle Creek, and the upper Verde River in Arizona, and the upper Gila River in New Mexico. Spikedace typically inhabit slow to moderate velocity waters over gravel and rubble substrates in moderate to large perennial streams (USFWS 1991).

Potential for Occurrence in the Project Area: One spikedace was recently captured in the Gila River near the Cochran railroad crossing, below the Gila's confluence with the San Pedro River and above Ashurst-Hayden Dam (Rob Clarkson, Fisheries Biologist, Bureau of Reclamation, pers. comm. 1997). Whether this individual was a vagrant washed out of Aravaipa Creek via the San Pedro River or its capture indicates the presence of a population in the Gila River is unknown. Because no perennial water exists in the Gila River in or near the study area, it is extremely unlikely that spikedace occurs within the study area.

Acuña cactus (*Echinomastus erectrocentrus acunensis*) is a USFWS candidate species. This cactus occurs on well-drained knolls and gravel ridges primarily between 1,300 and 2,600 feet elevation in the paloverde-mixed cacti association of the Sonoran Desertscrub community, historically in Pinal and Pima counties USFWS 1992). It is frequently found on limestone (Benson 1982), but also grows on a variety of igneous rock types. In Pinal County, this species is found on granitic and andesitic soils (Heil and Melton 1994).

Potential for Occurrence in the Project Area: Acuña cactus is extremely unlikely to occur in the study area. The study area is below the known elevational range of this species, surface soils in the project area are alluvial in nature (i.e., not derived from granite or andesite), and the study area is more than 50 miles from the nearest known location for this species.

WILDLIFE

Game and nongame wildlife in the study area are expected to be typical of the Saltbush and the Tamarisk-Mixed Deciduous biotic communities. Large mammal species expected to occur include mule deer (*Odocoileus hemionus*), javelina (*Tayassu tajacu),* and coyote (*Canis latrans*), with numerous small mammal species (rodents and rabbits) also present. Two raptor species, turkey vulture (*Cathartes aura*) and red-tailed hawk (*Buteo jamaicensis*), were observed in the study area. The study area also provides habitats for a variety of nongame and neotropical bird species. A list of wildlife species observed during the field reconnaissance is included as Appendix B. No effort was made to compile a comprehensive list of all wildlife species potentially occurring in the study area.

WATER QUALITY

The following information on water quality in the study area comes from three sources: the Arizona Water Quality Assessment 1996 (ADEQ 1996), Gila River Indian Community Water Quality Assessment Report (CH2MHill 1993), and communications with personnel from the Gila River Indian Community's Department of Environmental Quality and Land and Water Resources Department.

The study area lies within the approximately 12,249-square mile Middle Gila Watershed roughly 60 river-miles upstream of the Painted Rock Reservoir and approximately 50 river- miles below the Ashurst-

Hayden Dam. Surface water diversions and groundwater pumping for agriculture and urban uses have lowered groundwater tables in the watershed, with resulting dry streambeds in the metropolitan Phoenix area. Because the basin receives limited rainfall, surface water flows in the Gila and Santa Cruz rivers are primarily attributable to agricultural return flows, occasional releases from upstream impoundments, and effluent from wastewater treatment plants.

Surface Water. No surface water was observed in the study area or is depicted on the USGS quadrangles of the study area. The Gila River in this area is ephemeral and flows following local precipitations events, or regional precipitation events of a large nature. A maximum discharge of 41,600 cubic feet per second (cfs) was recorded on January 20, 1993; generally, however, there is no flow at most times of most years (USGS 1996). Surface flows from one artificial source may occur occasionally at the Santa Cruz bridge crossing within the study area. The waters originate near the Pima Butte about eight miles upstream; their source is a combination of agricultural return flows and excess operational canal spillage (G. Stark, GRIC ADEQ, letter dated October 12, 1998). Flows at the crossing are usually less than two cubic feet per second (cfs). The study area is also upgradient from an area informally called the "Gila River Wetlands," an area in which flows are perennial and fish populations exist *(ibid.)*. Attempts to gather additional information about this wetland or its biological conditions were unsuccessful.

In general, major pollutants affecting surface water quality (with regard to meeting ADEQ assessment criteria for designated uses) include turbidity, arsenic, total dissolved solids, mercury, fecal coliform, pesticides, and copper (ADEQ 1996:106). Probable sources of these pollutants include natural conditions, rangeland practices, loss of riparian vegetation, and resource extraction (*ibid.*).

Groundwater. The nearest groundwater monitoring well (GC 1) is located approximately one mile upstream of the study area, north of the Gila River channel in an upland area. The depth to groundwater at this well is 14.0 feet (G. Stark, GRIC Department of Environmental Quality, pers. comm., 1998), which suggests that depth to groundwater within the channel would likely be somewhat lower. This well was recently installed, but had not been sampled for other water quality data as of early October 1998 (ibid.). However, several observations in the study area suggest groundwater in the immediate area is high in total dissolve solids (TDS): the predominance of halophytic vegetation within the study area (notably tamarisk and seepweed), preliminary groundwater test results showing high salt content (G. Brooks, GRIC Land and Water Resources Department, pers. comm. 1998), and top dieback in the majority of the 20-foot tall Goodding willows in the study area.

This conclusion is supported by earlier studies identified in the GRIC Water Quality Assessment Report (CH2MHill 1993:III-5), in which the following groundwater quality trends that were identified may be pertinent to the study area:

- Shallow ground water has high salinity along the entire Gila River.

- Groundwater with high total dissolved solids has moved northwestward from the northern boundary of the Community due to pumping to the north.
- Agricultural irrigation return flows (as sampled in perched water beneath fields near the northern boundary of the Community) are high in total dissolved solids (2000 to 2300 mg/l) and in nitrate (15 to 20 mg/l as nitrogen) which indicates a concentration factor of 2.4 (a 60 percent irrigation efficiency which is reasonable for this area).
- Municipal wastewater effluent discharged along the northwestern boundary of the Community typically has a total dissolved solids concentration of 800 mg/l and is less saline than shallow groundwater.

Other conclusions cited in the report that may be pertinent to the study area include:

- While fluoride concentrations ranged from 0.5 to 6.1 mg/l, the higher fluoride concentrations occurred in deeper wells and near the Sierra Estrella mountains.
- Groundwater quality data are very limited for all but TDS and nitrogen.
- TDS concentrations are typically well above the recommended level of 500 mg/l and the highest concentrations are found in the northwestern portions of the Community. TDS concentrations are occasionally above the recommended level of 3200 mg/l for irrigation.

CULTURAL RESOURCES

The Gila River Indian Community's Cultural Resource Management Program issued a Finding of No Historic Properties (Gila River Indian Community 1998) for the study area. Based on a Class I records search, "work within the floodplain will have *no effect* on any historic properties potentially eligible for the National Register of Historic Places" (ibid.). The Finding did note that one site (GR-770) and three historic irrigation canals (Hoover Ditch, Cooperative Canal, and Holden Ditch) are located within the study area on the north and/or south banks of the river; "any work adjacent to the site or canals should be monitored and the site and canals should be avoided" (ibid.).

B. ENVIRONMENTAL RESTORATION OPPORTUNITIES

As described in Section A of this report, the vegetation communities in study area reflect a high level of previous human disturbance (abandoned agricultural fields) and invasion of non-native species, specifically tamarisk (also called saltcedar), both of which have exacerbated hydraulic problems associated with the two bridge crossings on Indian Route 3. The objective of this section is to identify a minimum of four conceptual restoration opportunities that could be implemented, that, in conjunction with a selected hydraulic alternative, could improve the vegetative conditions of the study area. It should be noted that these conceptual restoration opportunities were developed without direct input from the Gila River Indian Community, and therefore, may or may not reflect the Tribe's preferences for environmental and human

health and safety improvements in the study area or their financial, logistical, or land use constraints. Furthermore, limited data were available regarding water quality, which could affect the outcome and success of some potential restoration opportunities.

It is important to note that opportunities for environmental restoration within the study area (the area of impact) are limited because it already supports dense riparian vegetation consisting primarily of tamarisk. The only real restoration opportunities are to 1) replace tamarisk with native species; 2) create conditions conducive to growing larger riparian tree species (i.e., provide more water or remove competing species); or 3) restore/enhance areas outside of the area of impact. As the third opportunity is not within the scope of this document, the five potential restoration concepts described below focus on the first and second types of restoration opportunities and can be used in various combinations with the study area to achieve an enhanced vegetation community less dominated by the invasive exotic, tamarisk.

ALTERNATIVES FOR CREATING CONDITIONS CONDUCIVE TO NATIVE RIPARIAN SPECIES

Three alternatives have been identified to create conditions conducive to the establishment and growth of native riparian species. These alternatives can be implemented individually or together, as funding and other constraints allow.

Selective Tamarisk Removal. By selective removal of the invasive non-native tamarisk within the study area, conditions more conducive to the growth of native riparian species would be created, thus giving the native species present within the study area an opportunity to grow. Large tamarisk stands could be mechanically cleared, with selective removal by hand implemented in areas in which pockets of tamarisk exist among native species. Some techniques for tamarisk removal are described in Appendix Q. This alternative can be extremely costly, especially in such a large area as the study site, and may create a perpetual need for annual maintenance in order to be effective.

Construct Backwaters, Check Dams, and Terraces. This alternative involves creating areas within the floodplain in which water can pond (backwaters, checkdams, terraces, etc.) to provide sites for growth of native riparian vegetation. This alternative would require coordination with a hydrologist to assist in designing and constructing the area to 1) ensure proper functioning so as not to defeat the other purpose of this project (increase hydraulic capacity of the crossings), and 2) maximize use of available surface flows and groundwater elevations. Within these created areas, any or all of the other alternatives for habitat restoration described herein could be implemented.

Remove Cows/Grazing. This alternative is more of a management action, but generally results in removing conditions that adversely affect riparian vegetation (trampling and grazing of native riparian vegetation). Removing cows from the river area has several costs associated with it, including but not limited to a reduction or loss of grazing, the potential need for fencing of the study area, and annual

maintenance of the fence(s). However, this alternative, in conjunction with others, may assist in "jumpstarting" the conditions conducive to the establishment of native riparian vegetation.

ALTERNATIVES FOR REPLACING TAMARISK

Two alternatives to replace tamarisk have been identified for habitat restoration: hydroseeding and tree planting. These alternatives can be implemented in conjunction with any of the alternatives described above, depending on funding, land use restrictions, and other factors.

Hydroseeding. This alternative is relatively inexpensive and can effectively cover a large area, but provides a fairly low level of success in terms of replacing tamarisk. Hydroseeding with native plant and shrub species could be implemented in areas outside of the cleared channel and on disturbed or sloped areas such as on levee. For highest success, hydroseeding should be done prior to summer or winter rains, with a Pure Live Seed (PLS) seed mix appropriate to cool or warm season germination.

Tree Planting. Two techniques are available to plant trees that would replace tamarisk: pole plantings and irrigated plantings. Each alternative is briefly described below.

- **Pole Plantings** - In areas with a high water table (< 10 ft, e.g., near the main channel), Goodding willow and Fremont cottonwood poles could be planted in a random pattern or clusters to provide a natural looking stand of native trees. For highest survivability, poles should be harvested from a nearby source during dormancy (January-February), must be long enough when planted to contact the groundwater saturated zone, and may need to be protected initially from wildlife/cow grazing. To achieve a more natural appearance, poles can be planted at random spacings and in clusters. This alternative is relatively costly to construct, but generally has a high rate of success if groundwater is available.

- **Irrigated Plantings** - In xeroriparian areas outside of the main channel or on the uplands adjacent to the river, one-gallon mesquites could be planted with irrigation support (either irrigation or truck-watering) until they became established. Nearer to the channel and in areas with a shallower water table (< 10 ft.), one-gallon cottonwoods could also be planted, with irrigation support continuing until the trees were established. Trees may need to be fenced or protected in some manner until tall/large enough to withstand grazing. This alternative is relatively costly, especially over large areas, but does provide a high-level of success.

Some of these alternatives (e.g., constructing backwaters, tamarisk removal, irrigation) may require a Section 404 permit from the U.S. Army Corps of Engineers if they could result in the placement of fill into the Gila River, a water of the U.S. With such a federal nexus, the provisions of the Endangered Species Act and National Historic Preservation Act would likely apply, therefore, prior to implementation

of any environmental restoration alternatives, consideration should be given to the applicable environmental compliance requirements.

CONCEPTUAL RESTORATION LAYOUTS

Four conceptual restoration layouts for the study area are depicted graphically in Figures 2, 3, 4, and 5. These layouts use the conceptual hydraulic alternatives as the basis for conceptual restoration alternatives that may be available to the Gila River Indian Community. Layouts are presented roughly from least cost-intensive (Restoration Alternative 1) to most cost-intensive (Restoration Alternative 4), although no real costs have been developed for each alternative.

C. PRELIMINARY ANALYSIS OF ALTERNATIVES

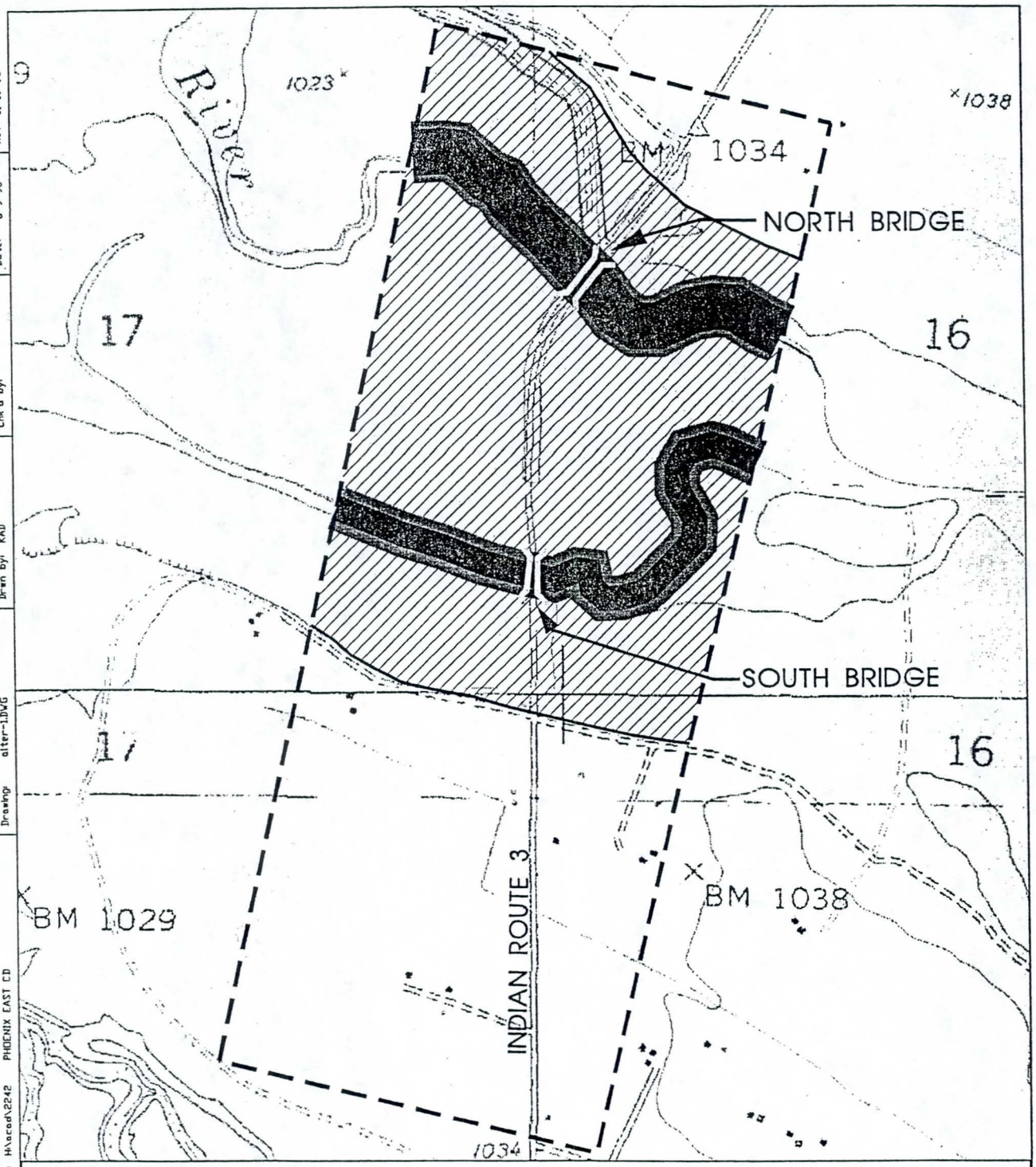
The objective of this section is to analyze the direct, indirect, and cumulative impacts on biological resources of four conceptual hydraulic alternatives recommended for further consideration in the Planning Assistance Report. A brief summary of these alternatives is provided to orient the reader.

HYDRAULIC ALTERNATIVES SUMMARY

A Planning Assistance Report provided by the U.S. Army Corps of Engineers identified 12 short-term and five long-term alternatives. A total of four alternatives (three short-term alternatives [Alternative 1; Alternative 2, and Alternative 3] and one long-term alternative [Alternative 4]) met three criteria to satisfy the project's planning objectives: annualized cost, hydraulic capacity, and level of protection for the southside of the crossing. The alternatives presented progressively provide higher hydraulic capacity and long-term solution to the problems, with subsequently higher capital costs. Each alternative is briefly summarized below.

1.1.3 **Alternative 1, Channelization.** This alternative involves increasing existing channel capacity by removing sediment and reestablishing well-defined channels within the study reach and beneath the two bridge crossings. The north channel (Gila River) would be excavated to the current thalweg elevation of 1,020 feet, with a bottom width of approximately 300 feet. The south bridge channel (Santa Cruz Wash) would be excavated to the current thalweg elevation of 1,020.5 feet, with a bottom width of approximately 160 feet. Vegetative clearing outside the channel is not assumed in this alternative. The channel excavation described above will provide a total conveyance capacity at the crossing of approximately 12,700 cfs, an improvement of 9,700 cfs over the existing capacity (No Action) of 3000 cfs. #1

1.1.10 **Alternative 2, Raising Roadway Between and South of Bridges, Adding Bridge, and Channelization.** This alternative proposes raising the elevation of the roadway south of and between the two bridges by about 500 feet and constructing a levee, with three feet of freeboard, to protect the south side residences #3



QUADRANGLE LOCATION

BASEMAP SOURCE
USGS 7.5' QUADRANGLES:
LAVEEN AND MONTEZUMA PEAK

N

0 500 1000 FEET

KEY

- PROJECT AREA
- TAMARISK AND CATTLE REMOVAL AREA
- GILA RIVER CHANNEL
- CATTLE REMOVAL AREA

GRIC HABITAT RESTORATION

Pinal and Maricopa counties, Arizona
T.2 S. R.2 E. SEC 16, 17, 20 and 21

RESTORATION ALTERNATIVE 1

FIGURE 2

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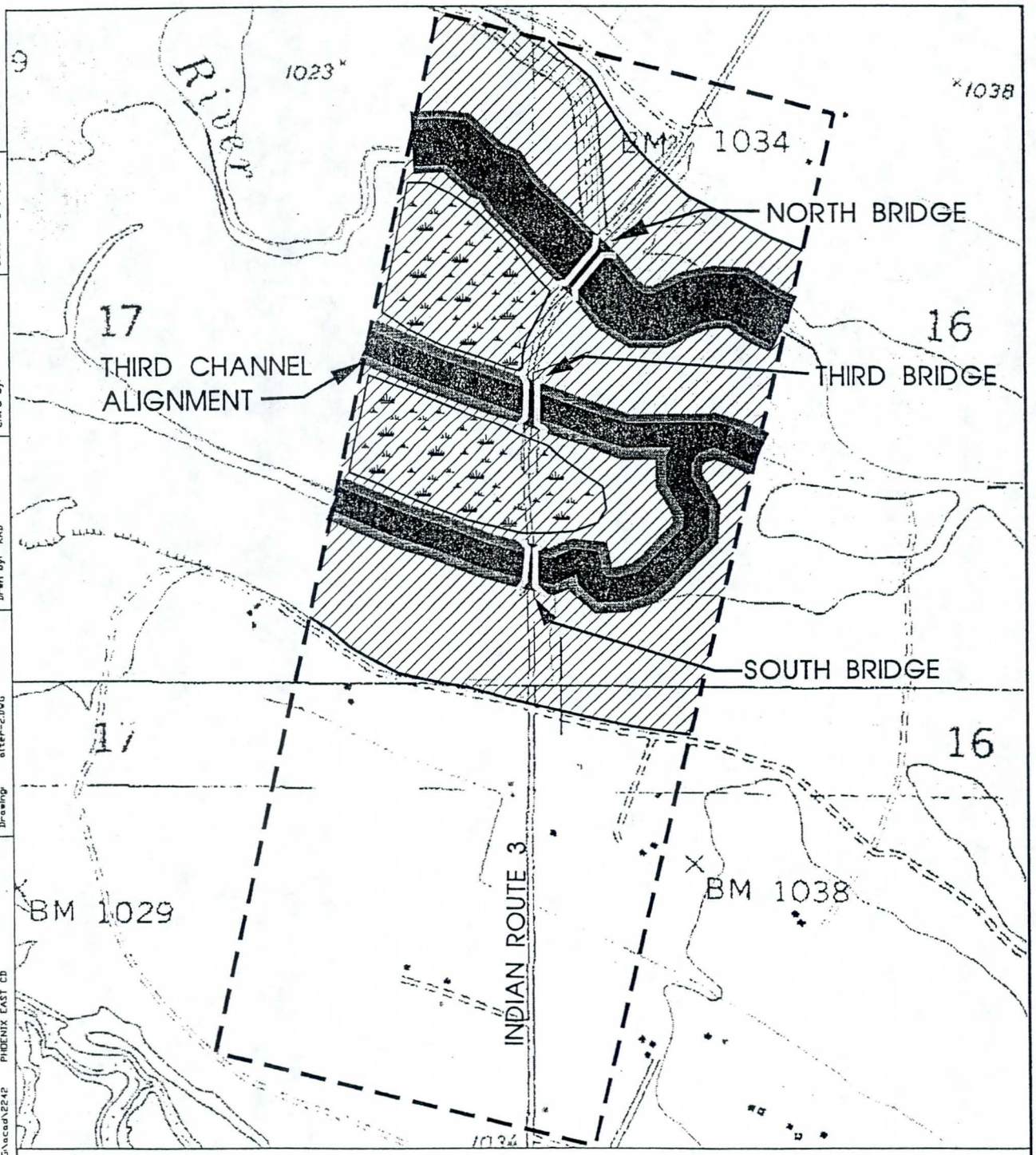
SWCA Inc. Environmental Consultants



QUADRANGLE LOCATION

N

BASEMAP SOURCE
USGS 7.5' QUADRANGLES:
LAVEEN AND MONTEZUMA PEAK

0 500 1000 FEET

KEY

- PROJECT AREA
- TAMARISK AND CATTLE REMOVAL AREA
- GILA RIVER CHANNEL
- CATTLE REMOVAL AREA
- CHECK DAMS AND TERRACES WITH HYDROSEEDING

GRIC HABITAT RESTORATION

Pinal and Maricopa counties, Arizona
T.2 S. R.2 E. SEC 16, 17, 20 and 21

RESTORATION ALTERNATIVE 2

FIGURE 3

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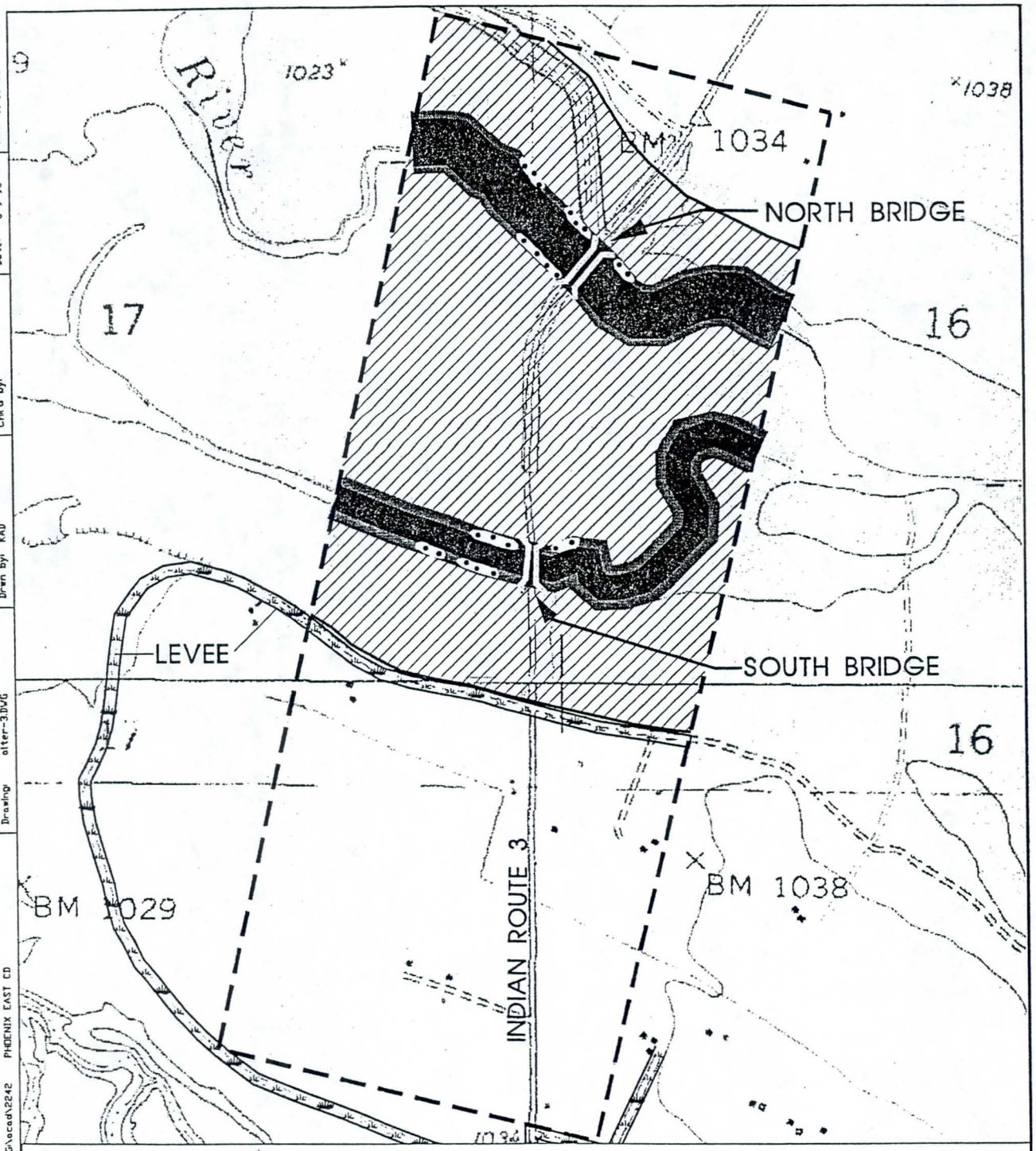

QUADRANGLE LOCATION

BASEMAP SOURCE
USGS 7.5' QUADRANGLES:
LAVEEN AND MONTEZUMA PEAK

N

0 500 1000 FEET

KEY

- PROJECT AREA
- TAMARISK AND CATTLE REMOVAL AREA
- GILA RIVER CHANNEL
- CATTLE REMOVAL AREA
- POLE PLANTING
- HYDROSEEDING

GRIC HABITAT RESTORATION

Pinal and Maricopa counties, Arizona
T.2 S. R.2 E. SEC 16, 17, 20 and 21

RESTORATION ALTERNATIVE 3

FIGURE 4

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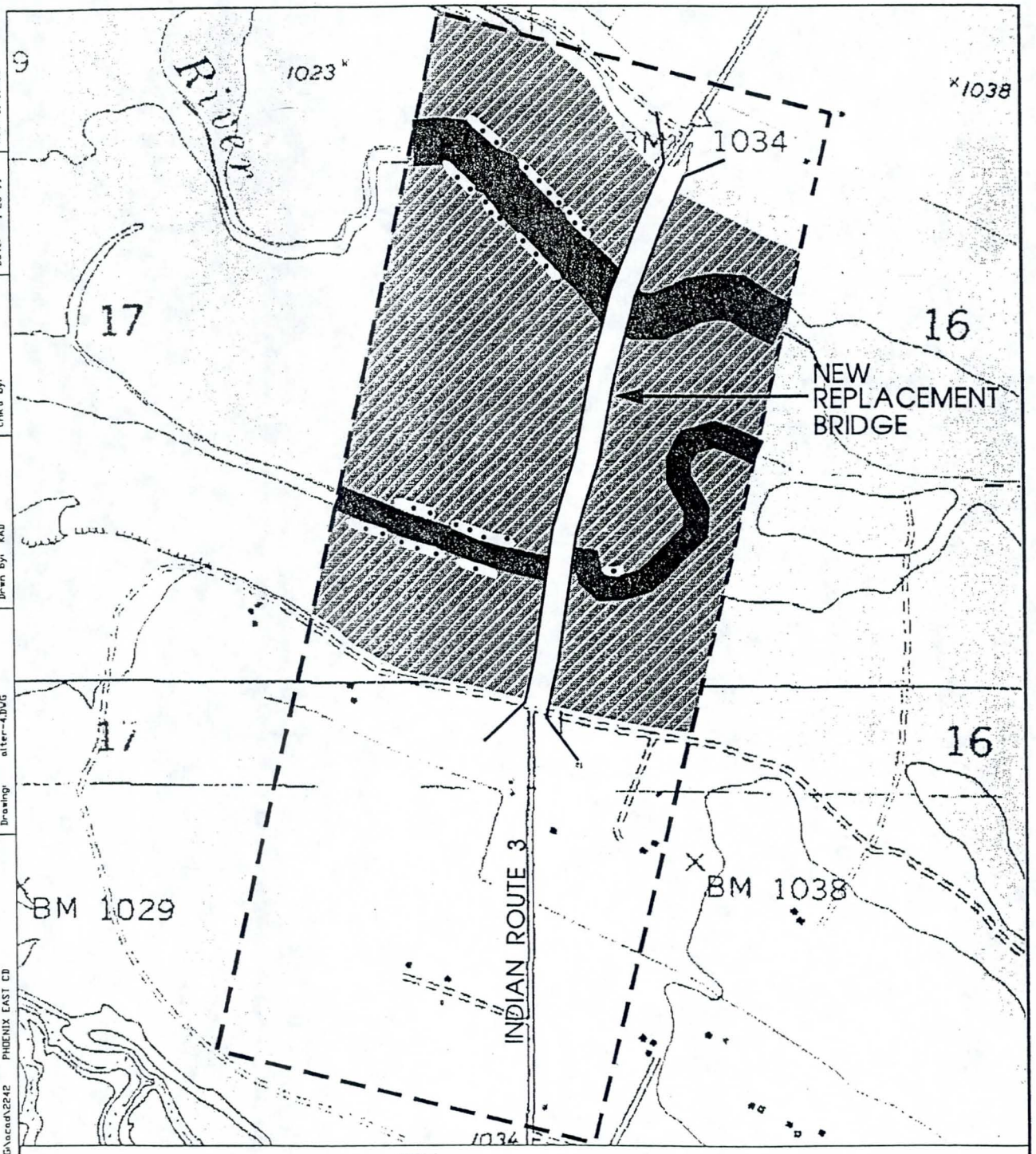
Proj. #: 2242-2151

SWCA Inc. Environmental Consultants



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Date: 1-26-99
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Drawing: alter-4.DWG
File: G:\acad\2242 PHOENIX EAST CD
Proj. #: 2242-2151

QUADRANGLE LOCATION

N

BASEMAP SOURCE
USGS 7.5' QUADRANGLES:
LAVEEN AND MONTEZUMA PEAK

0 500 1000 FEET

KEY

- PROJECT AREA
- GILA RIVER CHANNEL
- CATTLE AND TAMARISK REMOVAL AREA
- POLE PLANTING

GRIC HABITAT RESTORATION

Pinal and Maricopa counties, Arizona
T.2 S. R.2 E. SEC 16, 17, 20 and 21

RESTORATION ALTERNATIVE 4

FIGURE 5

SWCA Inc. Environmental Consultants

and farm land. Additional capacity would be provided under this alternative by constructing a new 400-ft bridge and an associated channel between the existing bridges on Indian Route 3. The length of the bridge is dictated by the limiting velocities through the existing bridges in Alternative 1. These velocities are assumed to reflect those for which the existing foundations have been designed as higher velocities may jeopardize the stability of the existing bridges. By improving the crossings in this manner, the total conveyance capacity can be increased to the design discharge of 40,000 cfs, an improvement of 37,000 cfs over the existing capacity.

Alternative 3, Independent Protection for South Bank plus Channelization. This alternative involves providing protection to the design discharge of 40,000 cfs for the residences along the south bank of the crossings, in addition to the channelization improvements made to the Route 3 crossings proposed under Alternative 1. The lowest ground elevation at a residence is currently estimated to be 1031ft. For this alternative, protection by levee construction along the south bank would be provided for the highest water-surface elevation associated with design flows of 40,000 cfs, which is estimated to be 1035 ft. Assuming three feet of freeboard, the top of the levee would be approximately 1038 ft, resulting in a maximum levee height of about 8 feet along the south bank. Like the previous alternative, this option would increase the hydraulic capacity of the channel by nearly 12 times, or 37,000 cfs over the existing capacity.

Alternative 4, Modification of Transportation Infrastructure. This long-term alternative involves replacing the existing crossing with a high-level roadway and bridge, similar to the Maricopa Road crossing located upstream. The Maricopa Road crossing has been designed for approximately 65,000 cfs. This alternative would include construction of the necessary levees, or other protection strategy, to protect the residences on the south side of the crossing. While requiring the highest capital funding of all alternatives, this option could effectively eliminate the annual maintenance required to control non-native vegetation and sediment deposition. At a design capacity of 65,000 cfs, this option would increase the hydraulic capacity of the channel nearly 22 times from its existing capacity of 3,000 cfs.

PRELIMINARY ANALYSIS OF IMPACTS

The following preliminary analysis of impacts is based on the existing biological conditions described in the first section of this document for the study area, Baseline Biological Conditions. Direct impacts are those that are caused by the action and occur at the same time and place (40 CFR 1508.8); indirect effects are those caused by the action and occur later in time or are farther removed in distance but are still reasonably foreseeable (ibid.). Because the four hydraulic conveyance alternatives have only been described conceptually (i.e., no detailed engineering or drawings), the following impact analysis, by necessity, is also conceptual but does provide for some level of comparison of environmental impact between alternatives.

Alternative 1: Channelization. This alternative would directly impact existing Tamarisk-Mixed Deciduous vegetation community in both the north and south channels to create the new 300-ft wide and

160-ft wide channels, respectively. While the majority of this impact would be on tamarisk, some native species such as cottonwood, willow, and screwbean mesquite may be also removed. Indirect impacts could include occasional scouring of riparian vegetation adjacent to the channelized areas due to increased conveyance capacities and flow velocities. This alternative would impact the least amount of riparian vegetation of all hydraulic alternatives.

With the clearing of vegetation and channelizing, some wildlife typically found in the Tamarisk-Mixed Deciduous community would be adversely affected but these impacts are not expected to reduce the viability of any population. Game species whose territories encompassed large areas that include the channel may be temporarily impacted but not significantly; some smaller fauna, however, would be lost or displaced permanently.

As no special interest species are known to occur within the study area, this alternative is not likely to adversely impact any listed species. However, as the federally listed southwestern willow flycatcher is known to nest in stands of Tamarisk-Mixed Deciduous, surveys for this species should be conducted prior to any clearing of this vegetation and clearing should be completed during the late summer/early fall period when this migratory bird is not present. No proposed critical habitat for cactus ferruginous pygmy owl would be impacted by this alternative.

This alternative would not impact any known eligible historic resources as a previous Class I survey of the study area indicates that no resources were found within the river channel (Gila River Indian Community 1998).

Alternative 2: Raising Roadway Between and South of Bridges, Adding Bridge, and Channelization. This alternative would have impacts to vegetation, wildlife, and special interest species similar to Alternative 1, except the extent of impacts would likely be several times greater due to additional disturbance associated with construction of a third-channel and bridge; raising the existing roadway; and constructing a levee on the southside of the river channel. Indirect impacts to vegetation from scouring associated with surface clearing may be reduced if increased conveyance is achieved by adding a channel rather than by widening or deepening the two existing channels. Temporary displacement of some wildlife would likely be increased over that of Alternative 1; this increase would be commensurate with the longer construction period associated with this alternative.

As no special interest species are known to occur within the study area, this alternative is not likely to adversely impact any protected species. However, as the federally listed southwestern willow flycatcher is known to nest in stands of Tamarisk-Mixed Deciduous, surveys for this species should be conducted prior to any clearing of this vegetation and clearing should be completed during the late summer/early fall period when this migratory bird is not present. No proposed critical habitat for cactus ferruginous pygmy owl would be impacted by this alternative.

This alternative would not impact any known eligible historic resources as a previous Class I survey of the study area indicates that no resources were found within the river channel (Gila River Indian Community 1998).

Alternative 3, Independent Protection for South Bank plus Channelization. This alternative would have adverse impacts on Tamarisk-Mixed Deciduous habitat and, depending upon the location of the levee, could also likely impact some portions of the abandoned agricultural fields on the south bank. This impact could be minimized by planting or hydroseeding desirable riparian vegetation on the proposed levee to both stabilize its slopes and soften its visual impact. Wildlife impacts would be similar to the other alternatives.

As no special interest species are known to occur within the study area, this alternative is not likely to adversely impact any protected species. However, as the federally listed southwestern willow flycatcher is known to nest in stands of Tamarisk-Mixed Deciduous, surveys for this species should be conducted prior to any clearing of this vegetation and clearing should be completed during the late summer/early fall period when this migratory bird is not present. No proposed critical habitat for cactus ferruginous pygmy owl would be impacted by this alternative.

The channelization element of this alternative would not likely impact any known eligible historic resources as a previous Class I survey of the study area indicates that no such resources were found within the river channel (Gila River Indian Community 1998). However, as no information is available regarding areas outside of the study area. construction of the levee on the south bank could potentially affect cultural resources and site-specific surveys should be completed prior to any surface disturbance.

Alternative 4, Modification of Transportation Infrastructure. This alternative would result in the greatest amount of surface disturbance, including removal of much of the Tamarisk-Mixed Deciduous vegetation within the study area and an unquantifiable portion of abandoned agricultural fields on both sides of the river, because of the significant reconstruction of the roadway and approaches. As an indirect result of clearing this much phreatophytic vegetation, local groundwater may rise in the vicinity as there would be reduced evapotranspiration but this effect may not be measurable. Wildlife, both game and non-game species, would be significantly and permanently impacted by the removal of cover in the channel. As no special interest species are known to occur within the study area, this alternative is not likely to adversely impact any protected species. However, as the federally listed southwestern willow flycatcher is known to nest in stands of Tamarisk-Mixed Deciduous, surveys for this species should be conducted prior to any clearing of this vegetation and clearing should be completed during the late summer/early fall period when this migratory bird is not present.

Although work within the channel is not likely to adversely affect eligible historic resources, this alternative has the greatest potential for impacting cultural resources, as it proposes the most land clearing and surface disturbance in the uplands outside of the river channel. It may be desirable and/or required to undertake site specific survey of lands at the north and south bank approaches to the new bridge prior to construction.

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APPENDIX A

PLANT SPECIES OBSERVED IN THE STUDY AREA

This list includes common plant species observed during site visits. It does not represent a comprehensive summary of all species that may occur in the study area.

Scientific Name	Common Name
Allenrolfea occidentalis	Pickle-weed
Atriplex lentiformis	Quailbush
Atriplex canescens	Four-wing saltbush
Baccharis salicifolia	Seep willow
Baccharis sarothroides	Desert broom
Lycium sp.	Wolfberry
Nicotiana glauca	Tree tobacco
Pluchea sericea	Arrowweed
Prosopis pubescens	Screwbean mesquite
Prosopis velutina	Velvet mesquite
Populus fremontii	Fremont cottonwood
Salix gooddingii	Goodding willow
Salsola iberis	Russian thistle
Suaeda torreyana	Seep weed
Tamarix ramossissima	Salt cedar

APPENDIX B

WILDLIFE SPECIES OBSERVED OR DETECTED IN THE STUDY AREA

This list includes those species observed directly or detected through sign during site visits. It does not represent a comprehensive summary of all species that may occur in the study area.

Scientific Name	Common Name
AMPHIBIANS	
Bufo alvarius	Sonoran desert toad
REPTILES	
Cnemidophorus sp.	Whiptail lizard
BIRDS	
Buteo jamaicensis	Red-tailed hawk
Callipepla gambelii	Gambel's quail
Zenaida asiatica	White-winged dove
Zenaida macroura	Mourning dove
Calypte anna	Anna's hummingbird
Melanerpes uropygials	Gila woodpecker
Corvus corax	Common raven
Pipilo aberti	Abert's towhee
Lanius ludovicianus	Loggerhead shrike
Carpodacus mexicanus	House finch
Campylorhynchus brunneicapillus	Cactus wren
Cathartes aura	Turkey vulture
Mimus polyglottos	Northern mockingbird
Geococcyx californicus	Greater roadrunner
Sayornis saya	Say's phoebe
MAMMALS	
Canis latrans	Coyote
Odocoileus hemionus	Mule deer
Sylvilagus audubonii	Desert cottontail

APPENDIX C

TAMARISK CONTROL METHOD

TO BE INSERTED WITH FINAL