Granite Creek Fish Barrier

Site Investigation

June 2001

Submitted to: U.S. Fish and Wildlife Service
Arizona Ecological Services
2321 West Royal Palm Road, Suite 103
Phoenix, Arizona 85021-4951

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I. INTRODUCTION

Granite Creek, Yavapai Co., Arizona, is an interrupted perennial tributary to the headwaters of Verde River that was identified by Fish and Wildlife Service (FWS), Bureau of Reclamation (Reclamation), and Arizona Game and Fish Department (AZGFD) as a stream on which to evaluate a potential fish barrier site. The purpose of the barrier would be to prevent upstream movements of non-native fishes into habitats occupied by existing native fishes (principally longfin dace *Agosia chrysogaster* and desert sucker *Pantosteus clarki*) and potentially-repatriated loach minnow *Tiaroga cobitis*, spikedace *Meda fulgida*, or other native species. The barrier would also serve as a downstream control site should renovation of the existing fish fauna be needed. The lower section of the stream had been purchased by AZGFD for its high wildlife values and perennial hydrology. The stream's potential to contribute to recovery of native fishes in the Gila River basin was evaluated in this study.

The objective of this report is to present results of the fish barrier evaluation (Phase I) process, and provide a feasibility design analysis, preliminary cost estimates, and recommendations for further field investigation and construction. This project was funded under provisions of a reasonable and prudent alternative of the 1994 FWS biological opinion on transportation and delivery of Central Arizona Project water to the Gila River basin, Arizona and New Mexico.

II. STUDY AREA

Granite Creek originates in the northern Bradshaw Mountains near Prescott, and drains the Prescott and southern Chino valleys between the Black Hills on the east and Granite Mountain on the west, flowing north to Verde River below Sullivan Lake (Figures 1 and 2). With the exceptions of short perennial reaches of certain headwater tributaries, an effluent-dominated mainstem reach north of Prescott, and the lowermost few miles of the spring-fed mainstem on AZGFD property, the drainage is largely ephemeral. Several man-made impoundments in the Prescott area are used for water-based recreation, and contain a host of non-native sport and non-game fishes. Fish barrier investigations were conducted along the lowermost 1.5 miles of Granite Creek on AZGFD property.

According to the USGS Chino Valley North 7.5 minute series topographic map, the stream falls approximately 45 ft from an elevation of 4,280 ft at the lower spring over the 1.5 stream mile distance to its confluence with Verde River. Gradient in this reach thus averages 30 ft/mi, or approximately 0.5 %. Local gradients associated with specific fish barrier measurements are presented below. The study reach is largely canyon-bound, and riparian vegetation during our investigation in June 2000, consisted of variable-density cottonwood/willow/sycamore gallery forest, with a healthy understory of seepwillow, hackberry, and other woody and herbaceous shrubs. The study area lies within Sections 13 and 14, Township 17 North, Range 2 West.

III. INVESTIGATION METHODS

Specific tasks to be completed under the Phase I investigations include an initial site visit and evaluation of site characteristics (topography, geology, access, substrate, gradient, and other conditions necessary for engineering design and construction considerations of barrier configuration), summary and discussion of the site description (including hydrology) and design/construction considerations, provision of preliminary conceptual design, estimation of contract and non-contract costs for construction, consideration of construction prerequisites including National Environmental Policy Act (NEPA), Endangered Species Act (ESA), and Clean Water Act (CWA) compliance, right-of-way and permits acquisition, and recommendations for further action or inaction.

A one-day site investigation was performed on June 15, 2000. Participants consisted of Rob Clarkson (Fishery Biologist), Jeff Riley (Engineer), and Mike Miller (Geologist) of Reclamation. Several sites were considered; however only one site had the physical characteristics necessary for a reasonably cost effective barrier. The site was revisited by Mr. Miller on May 16, 2001 for additional geologic and photographic documentation.

The preferred site was photographed and surveyed. The cross-section of the channel at the proposed fish barrier site and the thalweg profile were surveyed using a Zeiss Ni 2 Level.

The geology was characterized utilizing Reclamation descriptors for rock hardness, weathering, bedding thickness, and reaction to hydrochloric acid.

Stream flow was estimated visually.

IV. RESULTS

A. Preferred Fish Barrier Site

Map 2 shows the fish barrier study area and the preferred site location. The map is from the U.S. Geologic Survey 7.5 minute quadrangle of Chino Valley North, 1979. The study area lies within Sections 13 and 14, Township 17 North, Range 2 West.

The preferred site is 850 feet upstream from the confluence with the Verde River. At this location, the canyon is approximately 900 feet wide and 180 feet deep. The active channel is approximately 80 feet wide and 4 feet deep. The stream appears to be perennial at the site. Riparian vegetation covers the lower stream channel, thinning quickly as the abutments rise. A small flow estimated at 5 gallons per minute was visible, however, upstream and downstream of the site the surface flows disappeared into the alluvium. A cross-section of the channel at the preferred site is shown on Figure 3.

The channel gradient at the site is rather flat, with a slope of about 0.0044. The thalweg profile, from the confluence with the Verde River to 350 feet upstream of the barrier site, is shown on Figure 4.

The site geology, discussed in detail below, is comprised of limestone rock on the left abutment and an alluvial terrace about 12 feet higher than the stream on the right abutment.

A barbed wire fence and gate near the barrier site appears to be the only improvements in the area that might be affected by increased flooding caused by the fish barrier structure.

B. Engineering and Design Considerations

The primary concern is ensuring that the fish barrier is stable during high flows. The structure must resist sliding forces, and be designed to prevent undercutting from scour action. Another concern is keying the right end of the structure far enough into the abutment to prevent the stream from cutting around the end.

The structure must adhere to the following physical criteria: a drop of at least 4 feet; a concrete apron downstream of the drop; flows up to the 100-year flood must pass over the drop. A sketch of the general structure configuration is shown in Figures 3 and 5.

The size and shape of the channel requires a fish barrier approximately 130 feet in length. Steel reinforcement is not shown in Figure 5, but will be necessary.

As noted above, the right end of the structure will need to be well keyed into the right abutment.

Additionally the right abutment will require some riprap bank stabilization to maintain the bank and prevent erosion of the bank around the barrier. The left abutment is composed of rock, so keying the barrier into the rock will anchor the left end of the structure. Riprap should not be necessary at the left abutment.

The cutoff walls should extend to bedrock as much as possible for stability and sliding resistance. If bedrock is too deep to economically tie into, and the cutoff walls do not offer adequate sliding resistance, piles may be necessary.

Granite Creek is gaged at two locations; one at the northeast boundary of the City of Prescott (gage number 09502960), the other about 2 miles north of Prescott (gage number 09503000). According to the U.S. Geological Survey, the 100-year flood (instantaneous peak flow) for gage number 09503000 is 7,710 cubic feet per second. The highest flow at the gage site of 6,600 cfs occurred on August 19, 1963. However, there is approximately 20 miles of stream between the northernmost stream gage and the preferred barrier location. Several drainages enter Granite Creek within this 20 mile reach, including Willow Creek. Therefore, a hydrologic analysis will be necessary to determine the 100-year flood at the preferred barrier site.

Another hydrologic issue is whether the fish barrier structure would be inundated by large flows in the Verde River. Our initial survey indicated a ground elevation rise of only about 4 feet from the Verde River thalweg to the proposed barrier site. This situation would need to be evaluated to ensure that the Verde flows do not effect the operation of the barrier.

C. Geology

The site for the fish barrier was selected at a narrowing of the canyon walls. Profiles perpendicular to the stream (along the centerline of the proposed fish barrier) and along the thalweg of Granite Creek were conducted and are shown on Figures 3 and 4. The canyon walls are approximately 180 feet high and consist of limestone with thin (less than 6 in. thick) interbeds of shale.

The limestone is brown (7.5YR5/3)[1], aphanic, moderately hard (scratches with moderate pressure from a geologic pick, breaks with moderate hammer blow), and slightly weathered. The limestone is laminated to moderately bedded (less than 0.03 to 0.6 ft. thick), and has a strong reaction to hydrochloric acid (HCl).

The shale is dark greenish gray (10Y4/1), aphanic, soft to moderately soft (scratches with light pressure from a geologic pick, breaks with light manual pressure), and slightly weathered. The shale is laminated and has no reaction to HCl.

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[1] Colors identifiers were chosen by comparing wet rock samples to the Munsell Soil Color Chart.

Right Abutment - The right abutment of the proposed fish barrier will be founded in alluvium. The alluvium at the surface is mostly sand with gravel and minor amounts of cobbles and boulders. Large boulders up to 7 yd^3 in size have accumulated on the ground surface at the bottom of the right canyon wall. Boulders may also be encountered in the excavation.

Stream Channel - The stream channel is filled with alluvium consisting mostly of sand and gravel. Due to the proximity of the left canyon wall, cobbles and boulders may also be encountered in the excavation.

Left Abutment - The left abutment will be founded on limestone with thin (less than 6 in. thick) interbeds of shale. The limestone is moderately hard and will require hard rock methods to excavate. The presence of the shale interbeds may permit a backhoe to pluck out blocks of limestone, especially near the surface.

Geologic Investigations - If this project advances to the engineering and design phase, geologic investigations will be necessary. Augering will be required to determine the top of rock to develop anchoring methods, and backhoe test pits will be necessary to determine materials gradation for scour analyses.

Foundation Excavation - Most of the excavation would be in alluvium consisting of sand to boulder-size material. Excavation of the right abutment would also be in alluvium. Boulders up to 7 yd^3 are seen at the ground surface near the right canyon wall and may be in the subsurface. Excavation of the left abutment would be founded on limestone with interbedded shale and would require cleanup prior to placing concrete.

D. Construction Considerations

There is vehicular access to the preferred site. Although portions of the roadway are primitive, construction equipment can navigate the road. Vehicles can drive directly to the upper terrace on the right abutment. After leaving the paved roads, vehicles travel about 1.8 miles on good gravel roads. The remaining 0.9 miles to the site is dirt road. There is a short steep section of dirt road that may need some reworking for concrete mixers to negotiate. 700 feet upstream from the barrier site, the road crosses a usually dry stretch of Granite Creek where sand could create problems for large trucks unless the material is adequately moistened. This crossing could also be a problem during runoff events.

Portions of the road lie on private land, so negotiations with owners regarding access should be anticipated. There is a locked gate along the road.

The City of Prescott, 22 miles from the site, has commerce capable of providing all necessary materials for construction, like concrete, lumber, and riprap. There may be closer facilities in Chino Valley or Paulden.

There may be adequate water at the site for small construction needs, depending on water rights. But activities requiring large volumes of water, such as dust abatement on roads, will probably need more reliable and abundant sources.

Stream diversion should not be difficult during normal flows, which appear to be only 5 to 10 gallons per minute. A diversion berm will be necessary to direct the flows around the work. However, storm runoff could be damaging to the work if the flows exceed the capacity of the diversion berm.

A dewatering system will be necessary to allow excavation, maintenance of excavated slopes, and placement of cutoff wall concrete below the water table. The alluvial material should drain reasonably well and two wells may be adequate. The dewatering system will require obtaining a State of Arizona 402 permit, which provides water quality standards for construction. An Army Corps of Engineers 404 Permit will be necessary to perform the work. This work may fall under a nationwide 404 permit.

E. Environmental Compliance

Consideration of a Granite Creek fish barrier beyond the feasibility stage must include provisions for compliance with National Environmental Policy Act (NEPA), Endangered Species Act (ESA), and Clean Water Act (CWA). AZGFD is ultimately the action agency for a potential fish barrier project on their land, but delegation of much of any compliance activities could be made to Reclamation or a private consultant. The NEPA process entails writing draft and final Environmental Assessments of the preferred project and its considered alternatives, and presenting the preferred and alternative projects at public meetings. The NEPA process can take 6-12 months to complete.

The acquisition process for a 404 permit under requirements of CWA includes determining the impact footprint of the barriers (flooding, sedimentation, and construction zones), receiving a jurisdictional delineation from U.S. Army Corps of Engineers, further processing of a 404 permit application, and identification of possible mitigation for certain impacts to "waters of the US." Processing time for compliance with CWA can take 6 to 12 months. The 402 permit acquisition process will take 6 to 9 months.

ESA compliance likely will involve writing a Biological Assessment that determines effects of the project to federally-listed species and potential designated critical habitat. As the project is for the benefit of native fishes, consultation with FWS should proceed smoothly, as it did recently with Reclamation's Aravaipa Creek fish barrier project. Reclamation estimates that ESA compliance activities should not take more than 3-6 months, depending on the priority it receives from FWS. Estimated costs for ESA compliance is approximately $10,000.

All environmental compliance activities described above can be performed concurrently.

V. COST ESTIMATES

A. Construction Cost Estimate

Cost data for this estimate was obtained using actual rates from the Aravaipa Creek Fish Barrier contract. For the purposes of this estimate, the shape of the concrete structure was assumed to follow the shape of the channel cross-section. The length of the structure was set at 180 feet long. This configuration provides protection up to the 100-year storm (estimated at 10,000 cfs). Average scour depth was estimated to be 12 feet deep.

1. Mobilization - 10% of subtotal of cost = ($641,000)(10%) = $64,100

2. Water for dust abatement - $10,000

3. Diversion and care of stream - $20,000

4. Construction dewatering - 2 well points @ $40,000/well - $80,000

5. Clearing and grubbing - $4,000

6. Common excavation - (30 cy/linear feet)(180 feet)($3.00/cy) = $16,200

7. Rock excavation - (40 cy)($120/cy) = $4,800

8. Rock bolts - (80 ft)($140/ft) = $11,200

9. Compacted backfill - (2,100 cy)($7.00/cy) = $14,700

10. Backfill - (2,600 cy)($3.70/cy) = $9,620

11. Riprap - (2,000 cy)($40/cy) = $80,000

12. Concrete (includes rebar) - (1,000 cy)($300/cy) = $300,000

13. Anchor bars - (470 ft)($22/ft) = $10,340

14. Concrete piles (if necessary) - (100 ft)($800/ft) = $80,000

Total = $704,960, say $\underline{\$705,000}$

B. Engineering and Design Cost Estimate

Engineering and design costs to develop complete construction specifications normally run approximately 12% of the construction costs, or about $85,000. This includes any necessary surveys, geologic investigations, and engineering. More detailed engineering and design cost estimates can be provided if requested.

C. Environmental Compliance Cost Estimate

The following estimates are based on Reclamation staff performing the required activities.

NEPA activities	$20,000
CWA 404 permit acquisition process	$20,000
State 402 permit acquisition process	$7,000
Endangered Species Act compliance	$10,000
Total	$57,000

D. Construction Management Cost Estimate

Construction management costs include inspection, construction safety enforcement, and contract administration, which involves payments to the contractor, handling modifications and contract disputes, and scheduling. Reclamation field forces are present during all construction activities to ensure construction quality and enforce safety standards. These commitments result in construction management costs that are about 30% of the construction contract cost, or about $210,000. Construction management can also be contracted out to a private firm. These firms do not always maintain a constant field presence, so if this requirement is important, ensure that the contract with the construction management firm specifies such.

VI. CONCLUSIONS AND RECOMMENDATIONS

From an engineering standpoint, the preferred site offers a good location to construct a fish barrier structure. The channel is relatively narrow, the left abutment offers excellent anchorage, and access is easy. Barring inundation from large flood events in the Verde, there are no technical reasons for removing this site from consideration.

However, there are considerable biological considerations associated with the site that need to be addressed. First, the low channel gradient at the study area would be further reduced by emplacement of a 4-foot high fish barrier. As the purpose of the barrier is to ready and protect the stream for repatriation of native fishes such as spikedace and loach minnow, it is likely that resulting habitat conditions behind the barrier would not be suitable for these species, which tend to occupy much steeper gravel-bed streams. The low potential for establishment of quality riffle habitat for loach minnow in this reach especially casts doubt on the biological suitability of the site for barrier emplacement.

Second, the lack of plans and the complexity of the task to either prevent downstream invasions of non-native fishes from the upper Granite Creek basin, or to eradicate them, likely obviates the utility of any fish barrier. Attempts to stock and establish small-bodied native fishes into habitats already occupied by non-native fishes in Arizona have always been unsuccessful, and there is no reason to believe that the Granite Creek situation would be any different.

Finally, the reach of perennial water that would be protected by a Granite Creek fish barrier near its mouth is only a few miles long at best, and thus the cost:benefit ratio of the project may be excessive. This, coupled with the questionable habitat suitability at the site and an inability to control non-native fishes, biologically argues against emplacement of a fish barrier on lower Granite Creek, despite the technical feasibility of the project. We recommend against further consideration of a fish barrier on lower Granite Creek.

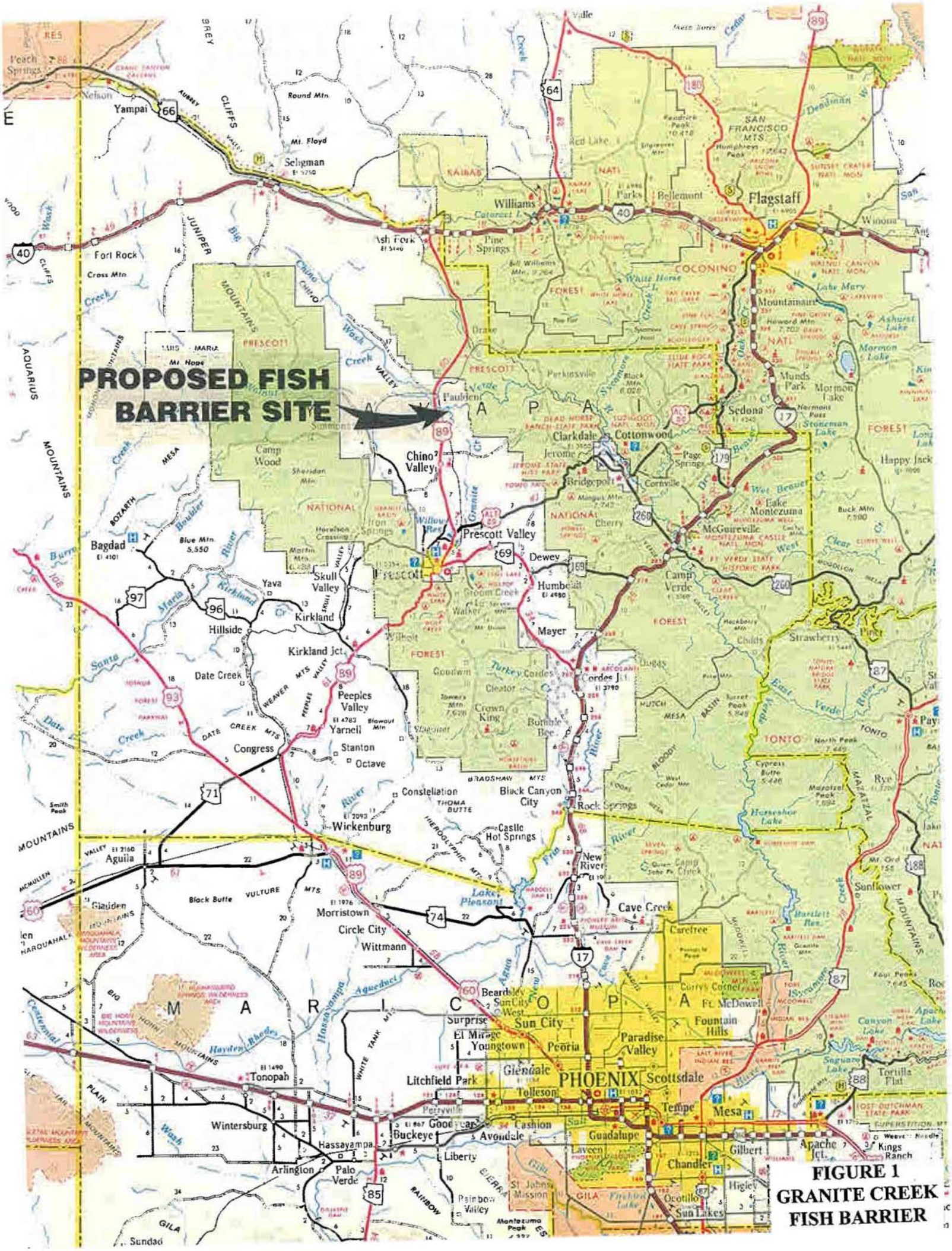


FIGURE 1
GRANITE CREEK
FISH BARRIER

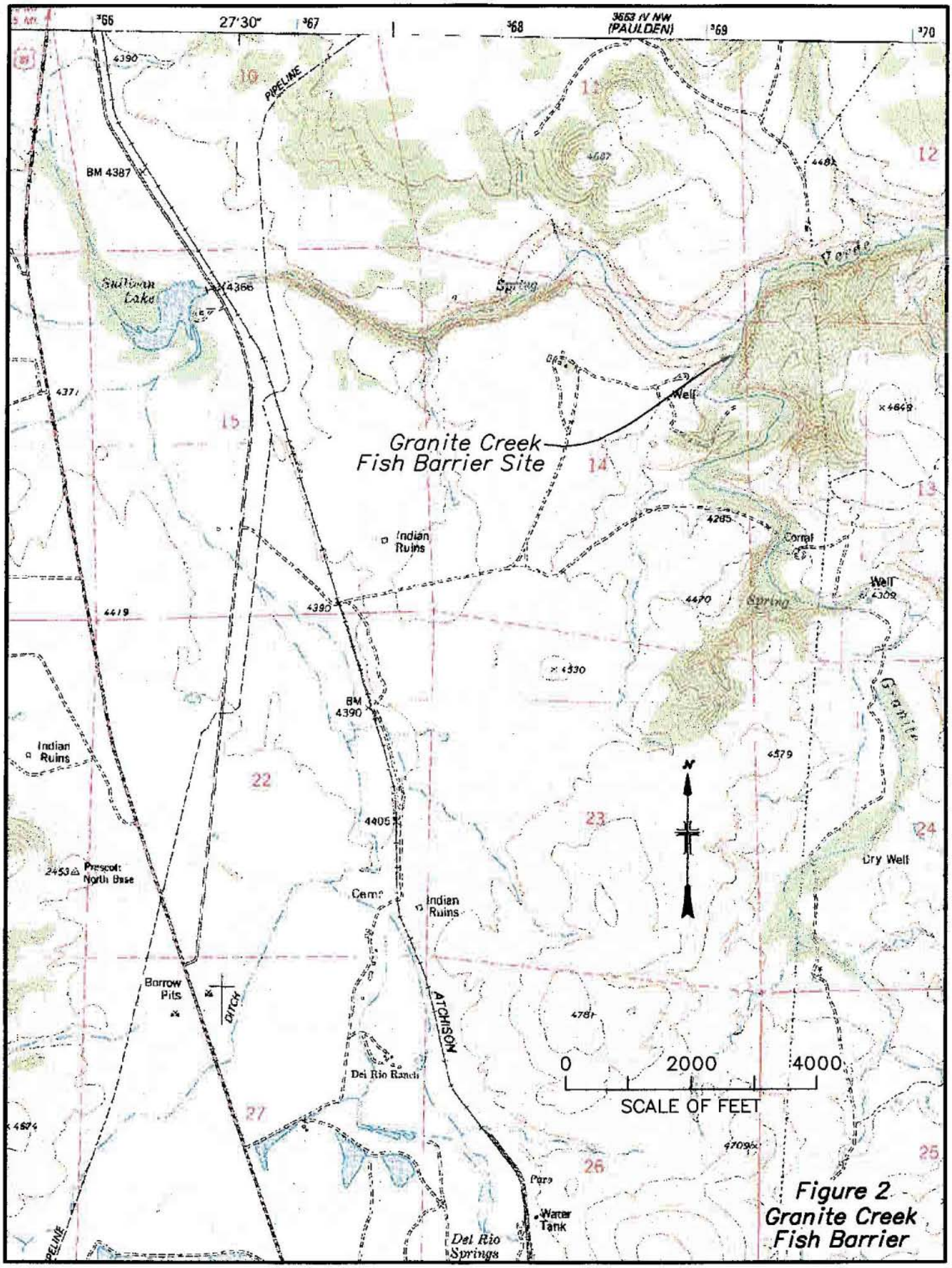
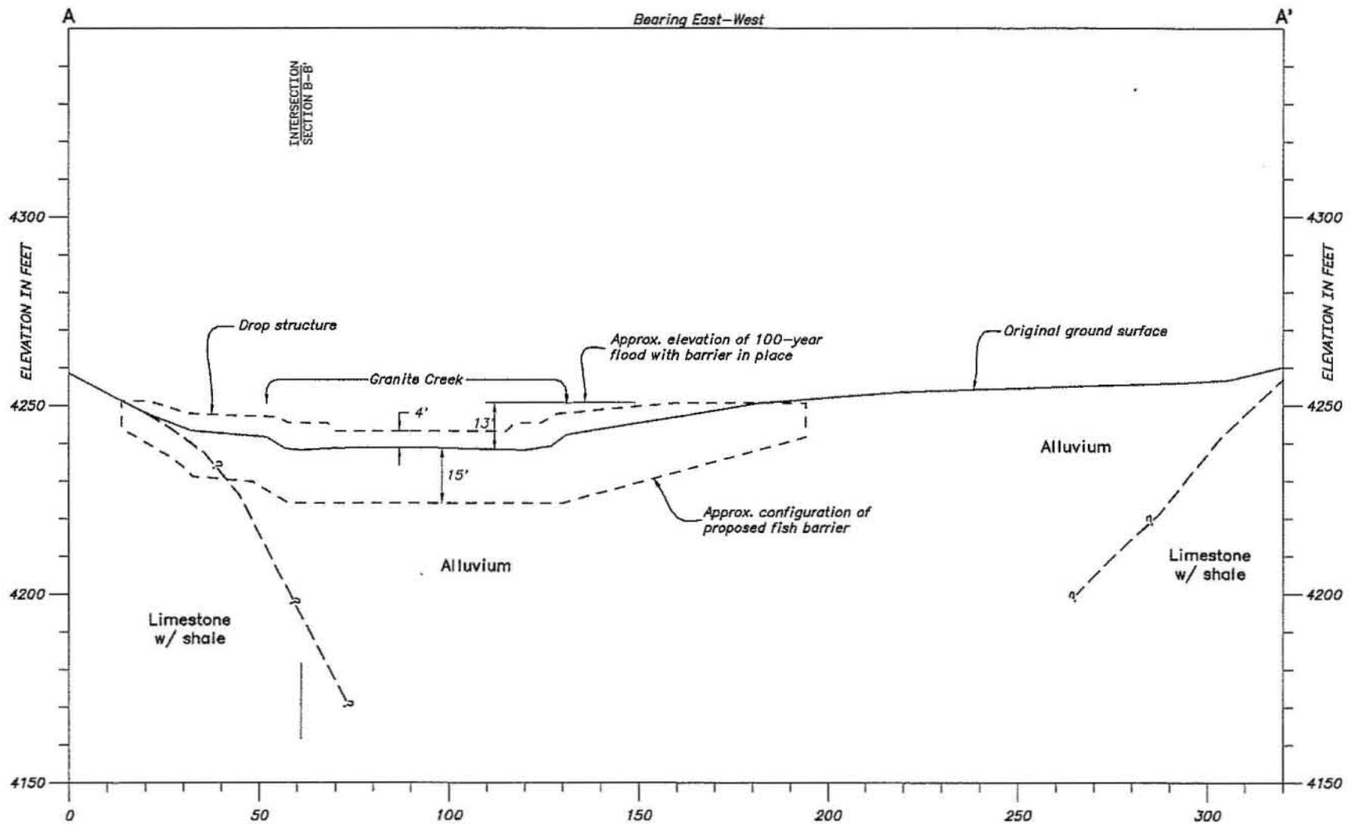


Figure 2
Granite Creek Fish Barrier

FIGURE 3



Cross–Section along Centerline of Proposed Fish Barrier
(looking downstream)

20 0 20 40 60
SCALE OF FEET

ALWAYS THINK SAFETY

UNITED STATES
DEPARTMENT OF THE INTERIOR
BUREAU OF RECLAMATION
CENTRAL ARIZONA PROJECT
TUCSON DIVISION – ARIZONA

GRANITE CREEK FISH BARRIERS
CROSS–SECTION A–A'

DESIGNED J. Riley TECH. APPR.
DRAWN D. Miller SUBMITTED
CHECKED APPROVED
ADMINISTRATION

CADD SYSTEM	CADD FILENAME	DATE AND TIME PLOTTED
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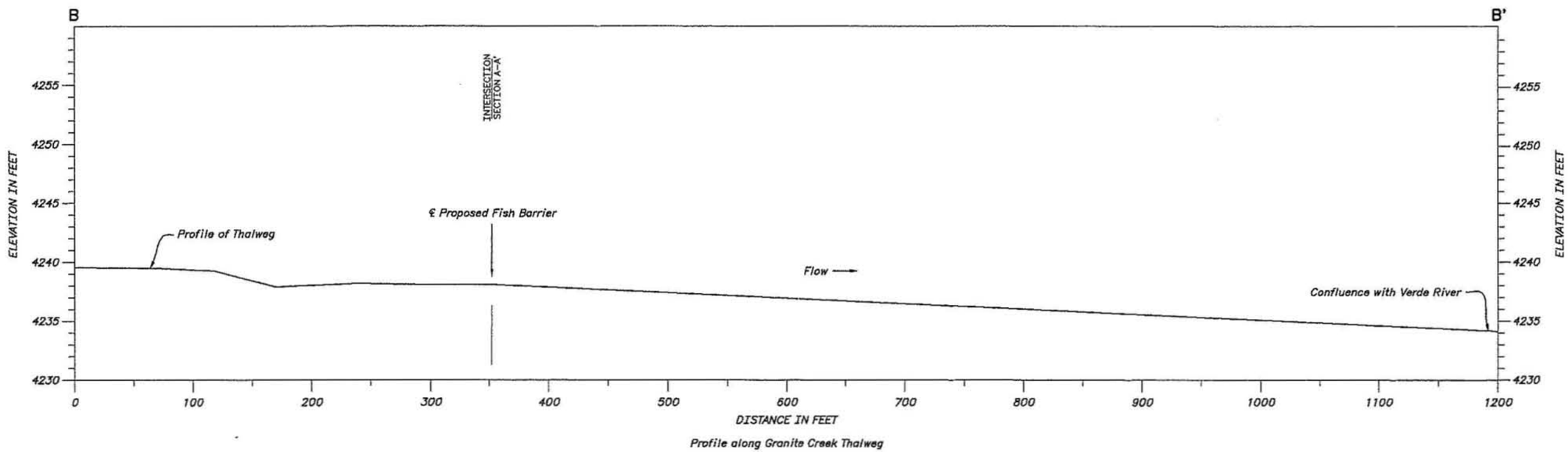
FIGURE 3

FIGURE 4



Profile along Granite Creek Thalweg

SCALE OF FEET
VERTICAL

SCALE OF FEET
HORIZONTAL

ALWAYS THINK SAFETY

UNITED STATES
DEPARTMENT OF THE INTERIOR
BUREAU OF RECLAMATION
CENTRAL ARIZONA PROJECT
TUCSON DIVISION – ARIZONA

GRANIT CREEK FISH BARRIERS

PROFILE ALONG GRANITE CREEK THALWEG

DESIGNED J. Riley — TECH. APPR.
DRAWN — SUBMITTED
CHECKED — APPROVED
ADMINISTRATOR

CADD SYSTEM	CADD FILENAME	DATE AND TIME PLOTTED
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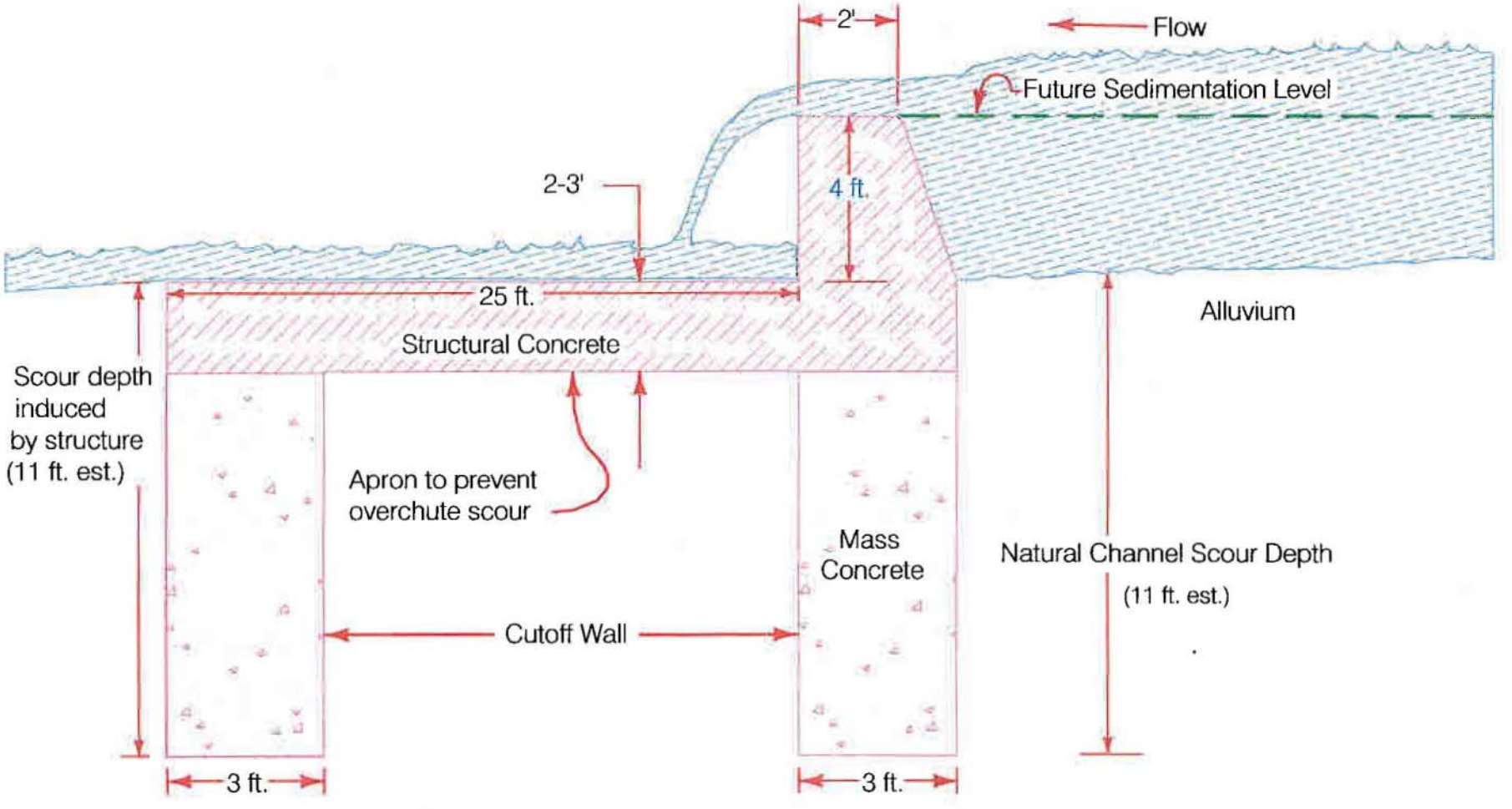
FIGURE 4



Cross Section of Conceptual Fish Barrier

FIGURE 5

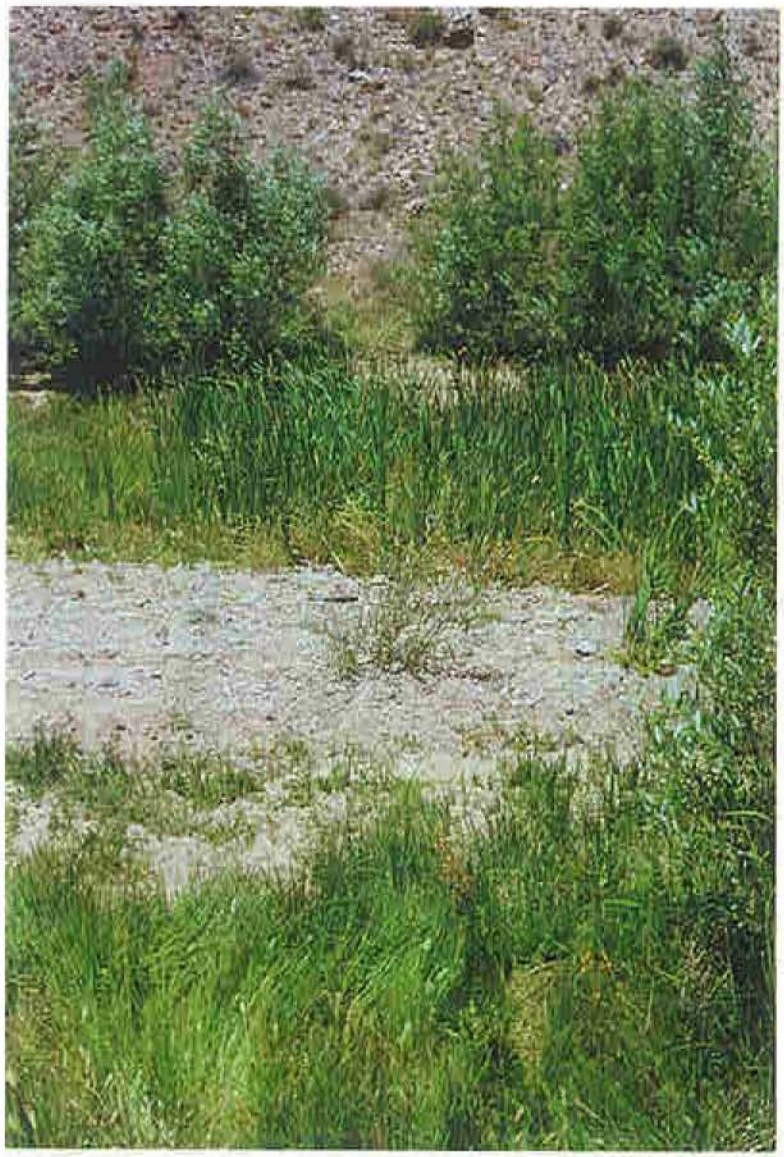
Photograph 1 Granite Creek Fish Barrier

Proposed fish barrier site, indicated in red, looking east and slightly upstream.
Photo by: M. Miller Date: May 16, 2001

Photograph 2 Granite Creek Fish Barrier

Granite Creek at proposed fish barrier site, indicated in red. Photo taken from left canyon wall.
Photo by: M. Miller Date: May 16, 2001

Photograph 3 Granite Creek Fish Barrier
Granite Creek just upstream of proposed fish barrier site. Taken from left canyon wall.
Photo by: M. Miller Date: May 16, 2001



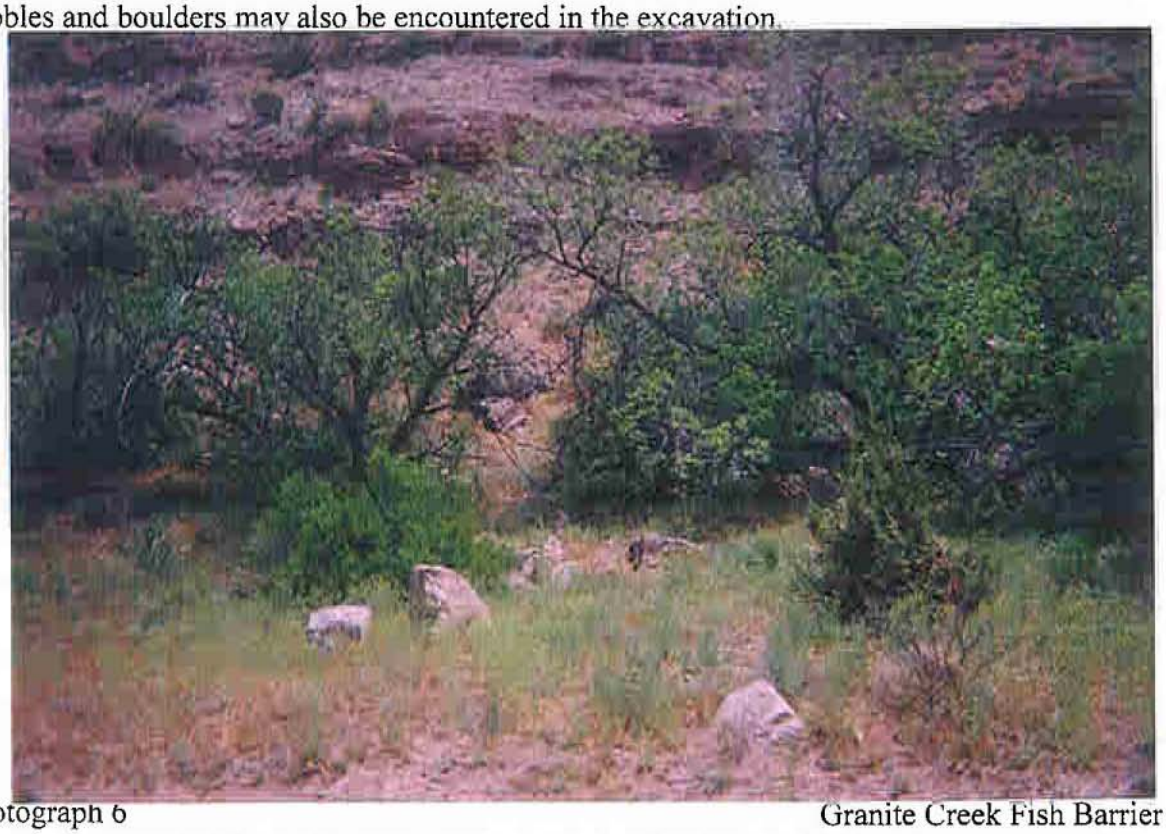
Photograph 4
Granite Creek Fish Barrier

Proposed fish barrier site from the right abutment.

Photo by: J. Riley
Date: June 15, 2001

Photograph 5 Granite Creek Fish Barrier

View looking west at the active channel of Granite Creek. The stream channel is filled with alluvium consisting mostly of sand and gravel. Due to the proximity of the left canyon wall, cobbles and boulders may also be encountered in the excavation.



Photograph 6 Granite Creek Fish Barrier

View looking east at the right canyon wall of Granite Creek. Interbedded limestone and shale forms the canyon walls. Large boulders up to 7 yd^3 in size have accumulated on the ground surface at the bottom of the right canyon wall.

Photos by: M. Miller Date: May 16, 2001

Photograph 7 Granite Creek Fish Barrier

View looking west along the centerline of the proposed fish barrier at the left canyon wall of Granite Creek. The site for the fish barrier was selected at a narrowing of the canyon walls. The canyon walls are approximately 180 feet high and consist of limestone with interbedded shale.

USBR Photo by: M. Miller Date: May 16, 2001

Photograph 8 Granite Creek Fish Barrier
View looking southwest at the left canyon wall of Granite Creek. The canyon walls slope at approximately 50 degrees and consist of limestone with interbedded shale.

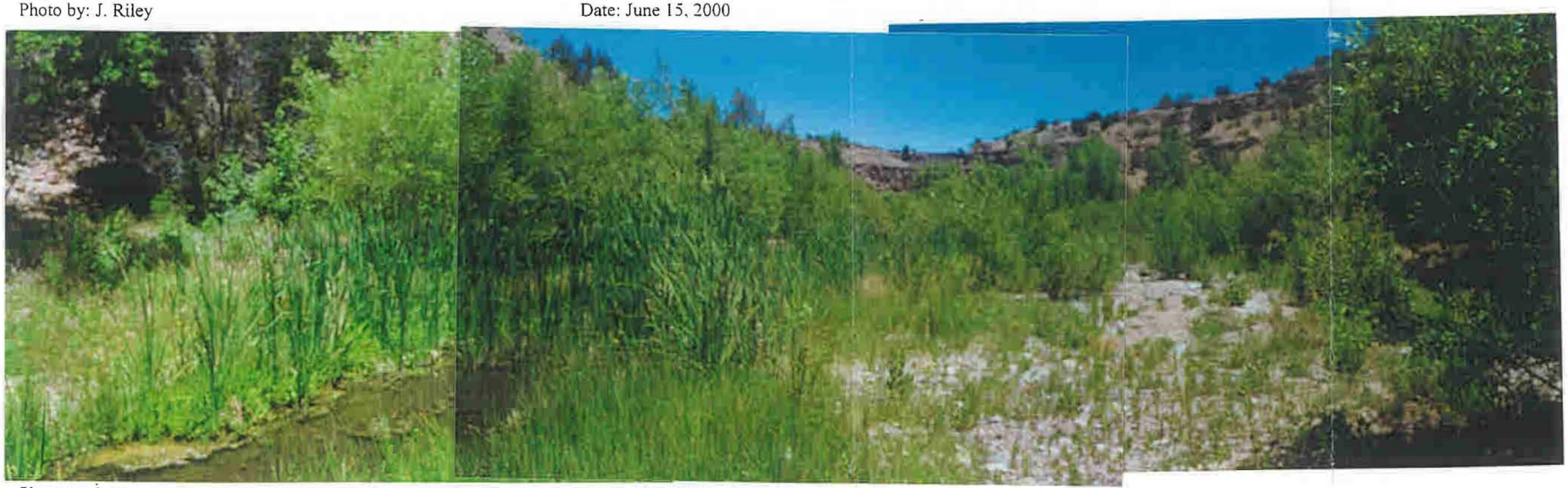
Photograph 9 Granite Creek Fish Barrier
Closeup of the interbedded limestone and shale forming the canyon walls. The limestone is brown, laminated to moderately bedded (bedding less than 0.03 to 0.6 ft. thick) and moderately hard. The shale is dark greenish gray, laminated and soft to moderately soft.
Photos by: M. Miller Date: May 16, 2001

Photograph 10 Granite Creek Fish Barrier
Proposed fish barrier site from terrace on right abutment.
Photo by: J. Riley Date: June 15, 2000

Photograph 11 Granite Creek Fish Barrier
Confluence of the Verde River and Granite Creek, looking down the Verde River. Granite Creek enters from the right.
Photo by: M. Miller Date: May 16, 2001

Photograph 12 Granite Creek Fish Barrier

Proposed fish barrier site from channel, looking upstream.
Photo by: J. Riley Date: June 15, 2000



Photograph 13 Granite Creek Fish Barrier

Proposed fish barrier site from channel, looking downstream.
Photo by: J. Riley Date: June 15, 2000