Bonita Creek Fish Barrier

Phase 1 Investigations

January 2004

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

and

Submitted to: Bureau of Land Management
Gila Box Riparian National Conservation Area
Safford Field Office
711 14th Avenue
Safford, Arizona 85546

Inter-Agency Agreement No. 1425-97-AA-32-00410

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Bonita Creek Fish Barrier Conceptual Study

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I. Introduction

Bonita Creek is a tributary to the Gila River in Graham County, Arizona. The stream is perennial for several miles before it joins the Gila River near Safford, Arizona (see Figure 1). Native fish species found in Bonita Creek are the Gila chub (*Gila intermedia*), Sonora sucker (*Catostomus insignis*), desert sucker (*Pantosteus clarki*), speckled dace (*Rhinichthys osculus*), and longfin dace (*Agosia chrysogaster*). Razorback sucker (*Xyrauchen texanus*) was stocked into Bonita Creek in the 1980's, but none have been recaptured in recent collections.

U.S. Bureau of Reclamation, U.S. Fish and Wildlife Service, and U.S. Bureau of Land Management (BLM) have identified Bonita Creek as having potential for the placement of a fish barrier to prevent upstream movement of non-native fishes. This Phase 1 fish barrier investigation of Bonita Creek results from the provisions of the 1994 biological opinion on transportation and delivery of Central Arizona Project water to the Gila River basin. This report summarizes site investigations, discusses engineering and construction considerations, geology, hydrology, geomorphology, conceptual design, construction costs, National Environmental Policy Act (NEPA), Endangered Species Act (ESA), Clean Water Act (CWA) compliance, right-of-way, and provides recommendations for further action.

Bonita Creek drains 302 square miles and is gauged 6.3 miles upstream of the mouth. Two miles downstream of the gauge is an infiltration gallery that provides water for the City of Safford. Most of the surface flow is diverted into the City pipeline at the infiltration gallery.

Downstream of the infiltration gallery, the stream carries a perennial base flow of 1 to 3 cfs for about 4 miles. The flow becomes subterranean about 1,000 feet from the Gila River.

Site investigations took place during three one-day site visits. The first took place on July 8, 2002 and involved Reclamation staff. In an attempt to protect as many stream miles as possible from non-native fishes, the lowest stretch of Bonita Creek was examined. The most promising site was 140 feet across from canyon wall to canyon wall and was located about 200 yards upstream of the viewing ramada on the west canyon rim. The second site visit, on September 17, 2002, involved BLM and Reclamation personnel. BLM representatives expressed concern over the visibility of the previously selected site. Because of BLM's concerns, a 160-foot wide site was revisited near the point where the road drops into the canyon from the west in Section 16, T6S, R28E (see Figure 2). This site is about 1.5 river miles upstream of the mouth, and has become the proposed fish barrier site. The third site visit again involved BLM and Reclamation personnel, and the purpose was to gather survey, environmental, and archeological data at the proposed site. The stream channel cross-section and profile were surveyed, biology was evaluated, and the area was surveyed for cultural remains.

II. Proposed Fish Barrier Site

A. General - The proposed fish barrier site is located in Section 16, Township 6 South, Range 28 East on BLM land (see Figure 2). The site is within BLM's Gila Box Riparian National Conservation Area. The site is about 1.5 river miles upstream of the Gila River, and approximately 1,000 feet downstream of the road that enters the canyon from the west. The canyon walls narrow to within 160 feet of each other, providing the second narrowest point of the reaches investigated.

A fish barrier at this site protects about 30 stream miles of Bonita Creek, and approximately 13.5 miles to the San Carlos Apache Reservation boundary. Three miles upstream of the proposed fish barrier site is the scour control structure associated with the Safford infiltration gallery, which offers a level of redundant protection against non-native fish movement.

B. Stream morphology - The stream is entrenched within rock canyon walls. Within the lowest 1.5 miles of Bonita Creek, the canyon width ranges from 140 feet to an estimated 400 feet. The canyon bottom is comprised of alluvial materials, through which the stream meanders. Owing to the well established vegetation, the active stream channel is well defined. However, despite the vegetation, there is evidence that alignment shifts occur continuously with flood events. This stream type continues for about 3 miles above the barrier site.

C. Geology - The site for the fish barrier was selected at a point where the right abutment canyon wall projects northeast toward the left abutment resulting in a narrowing of the stream channel. A cross-section perpendicular to the stream and a stream profile of the thalweg were surveyed and are shown in Figure 3.

Stratigraphy - The dominant rock type at the fish barrier site is a fanglomerate generally referred to as basin fill. Fanglomerate forms the sides of the canyon and probably constitutes the bedrock beneath the alluvial channel deposits. The fish barrier ends would tie into the fanglomerate. A seventeen-foot-thick layer of andesite outcrops on the right abutment. The andesite represents a volcanic flow that interrupted the deposition of the fanglomerate and was later buried. Alluvium consisting of gravel with sand, cobbles and boulders up to 2 feet in diameter fills the channel.

The following geologic units were differentiated by engineering characteristics:

Alluvium (al): Alluvium consists of varying percentages of mostly sand and gravel with cobbles and boulders and minor amounts of fines. Boulders up to 2 feet in diameter and larger are present near the surface and may be encountered at depth. The alluvium fills the present channel to an unknown depth.

Andesite (and): Andesite overlies the fanglomerate at a point approximately 14 feet above the channel on the right abutment of the fish barrier and is about 17 feet thick. The

andesite represents a volcanic flow that interrupted the deposition of the fanglomerate. The andesite is gray, fine-grained, slightly weathered and hard (specimen requires a heavy hammer blow to break and scratches with difficulty from a sharp pick). The andesite is slightly to moderately fractured (fractures spaced 0.3 to 3.0 ft. apart) and fractures are randomly oriented. The lower contact with the fanglomerate strikes parallel to the canyon, dips slightly downstream and is irregular. The upper contact has a similar orientation.

Fanglomerate (fan): Fanglomerate will form the abutments of the fish barrier. The percentage of fragments differ considerably for each abutment and so do the engineering characteristics, therefore, each abutment is described separately.

Right Abutment: The fanglomerate forming the right abutment consists of 40 percent subangular to subrounded gravel, 40 percent subangular cobbles, 10 percent subangular boulders and 10 percent silt to coarse sand. The silt and sand forms a matrix that is moderately soft to moderately hard and the cobbles and boulders are generally moderately hard to hard. Fragments are well-cemented, presumably by calcium carbonate, and the matrix has a predominantly strong reaction with HCl. The fanglomerate is thinly to thickly bedded (0.2. to 2.0 ft. thick) and beds are indistinct. The maximum boulder size is approximately 2 feet in diameter.

The upper foot of the fanglomerate on the right abutment consists of silt and sand that is pinkish in color and may represent a paleosol or buried soil horizon that was baked during placement of the andesite. The fine-grained material is undercut by up to 1 foot.

Left Abutment: The fanglomerate forming the left abutment consists of 60 to 70 percent fine to coarse, angular to subrounded gravel, 30 percent fine to coarse sand, and a trace of subrounded cobbles with a maximum size of six inches. The percentages of sand, gravel and cobbles vary considerably over short distances. Fragments are well-cemented presumably by calcium carbonate and the matrix has a predominantly strong reaction with HCl. The fanglomerate is thinly to thickly bedded (0.2. to 2.0 ft. thick) and exhibits some cross-bedding. Fanglomerate exposures are commonly slightly weathered and moderately soft to moderately hard.

The face of the fanglomerate has been undercut by erosion, forming a slightly concave shape which may extend below the ground surface.

A layer of mostly sand outcrops approximately 25 feet upstream of centerline. The sand layer is undercut slightly and probably extends downstream to the centerline beneath the alluvium.

Ground water - Bonita Creek flows year round and, therefore, ground water is very near the surface in the alluvium that fills the channel. Ground water will be encountered during excavation of the alluvium.

Additional information regarding regional geology can be found within the technical report "Resource Inventory for the Gila River Complex, Eastern Arizona" by W. L. Minckley, M. R. Sommerfeld, and others (1979).

D. Hydrology - The streamflow is perennial at the site, with base flows estimated at 1 to 3 cfs. The watershed is uncontrolled and prone to sudden flooding. A U.S. Geologic Survey (USGS) stream gauge is located about 5 miles upstream of the proposed fish barrier site. USGS has computed frequency floods at the gauge site as follows:

Recurrence interval	Instantaneous Peak Flow (cfs)
2-year	2,320
5-year	5,680
10-year	9,070
25-year	15,000
50-year	20,600
100-year	27,600

The drainage area above the gauge is 302 square miles. Two significant drainages enter Bonita Creek during the 5 miles between the gauge and the proposed fish barrier site. So frequency floods at the site will be somewhat higher than those shown and will be calculated at a later date.. The period of record for the gauge is from August 1981 to present.

E. Access - The proposed fish barrier site can be accessed via the road in Section 16 that enters the canyon from the west. The road can be followed downstream for about 1000 feet to the site. The road is within the stream for about 50 yards. The road is currently adequate for construction traffic, with minor grading.

F. Vegetation - The proposed fish barrier site contains dense vegetation consisting primarily of cottonwood and willow. Construction would necessitate removal of vegetation within a 100-foot wide band across the canyon. Additional impacts would occur about 300 feet upstream in order to divert the stream during construction and install the dewatering well points.

III. Engineering and Design Considerations

A. General - The principle engineering challenge at this site is to prevent flood flow scour from undercutting and damaging the structure. The expected depth of alluvium makes tying the structure to bedrock prohibitively expensive. The structure must be engineered to "float" on the alluvium, while being anchored to rock only at the canyon walls. Additionally, scour prevention walls need to extend far enough down into the alluvium to prevent flood flows from undercutting and destabilizing the structure.

B. Site investigations - Before the engineering and design work begins, certain information needs to be gathered at the site. The channel cross-section and stream profile have already been surveyed (see Figure 3). The competency of the canyon rock walls has been evaluated. The information still required is data regarding the channel materials, and the depth of alluvium to bedrock. The channel materials will be classified and gradations determined in order to evaluate scour potential. The test pits would be excavated with a backhoe. Samples would be tested in Reclamation's Phoenix lab. To determine the depth to bedrock, exploratory drilling needs to be performed. A drill rig would auger down to bedrock, stopping at a maximum of 100 deep. Drilling below 100 feet requires a special aquifer protection permit, and is well beyond the depth any work would extend, even if piles are considered. The work would be done by Reclamation's drill crew from the Yuma office.

C. Engineering methods - The design flood used would probably be the 100-year flood, instantaneous peak flow. The flow would be adjusted up slightly from the USGS figure to account for the drainages that enter Bonita Creek downstream of the gauge. After the design flood is determined, scour, sliding, and overturning forces can be evaluated.

There are three types of scour that need to be evaluated: natural bed scour associated with the depth of alluvial material that is in motion during the design flood; bridge pier type scour that occurs when the flow contacts the fish barrier structure; and downstream scour from the erosive action created by the structure. Scour will be accounted for with scour prevention walls extending below the channel surface, riprap armoring, stilling basin, piles, or a combination of these.

Sliding and overturning forces are a function of the force of the water and alluvium impacting the upstream face of the structure. Sliding forces can be counteracted by curving the structure upstream so the arch action transfers the forces into the rock walls. Piles can be also be used to resist sliding. Overturning is primarily a function of the weight of the structure and is not anticipated to be a problem, but will be evaluated.

The crest of the structure would be built about 4 to 5 feet above the general contours of the existing channel cross-section. There is a ridge of material between the existing thalweg and an abandoned channel near the right abutment. This ridge would be removed during construction such that the crest would not have a high point in the middle of the canyon. It is desirable for stream bank stability to have the high points of the crest

at the ends. A notch capable of passing the bankfull flow (about 1.5-year flood) will be constructed in the crest. This maintains the stream in its current location and limits deep scour to the notch area, thereby allowing vegetation to reestablish and create a more stable stream channel.

D. Conceptual fish barrier - A conceptual cross-section of a fish barrier structure is depicted in Figure 4. Dimensions shown on the drawing are only for magnitude reference, and will change during the engineering phase.

E. Road considerations - The City Pipeline Road is currently aligned near the right abutment of the site. City of Safford crews will require access through the construction site at all times and over the fish barrier following completion. Access needs after construction will be probably be met with the use of ramps on the upstream and downstream side of the barrier crest.

IV. Construction Considerations

A. Access - The proposed fish barrier site has good construction access via a BLM maintained road that enters the canyon from the west, about 1.5 miles upstream of the Gila River. The road has two switchback turns during the 300-foot drop to the stream. The grade is about 8% for the 0.7-mile long descent. The steep section is wide enough for two-way traffic and not particularly rough, though some grading would be done during construction. The road then joins the City Pipeline Road for about 1,000 feet downstream to the fish barrier site. About 150 feet of the City Pipeline Road was within the stream at the time of our visit, which could change with a flood event.

After turning off US Highway 70, the road to the fish barrier site from Solomon is paved for more than half the distance. The remaining portion of the road is gravel and provides excellent access. The only exceptions are where the road crosses Spring Canyon and Baker Canyon, where the grades appear to exceed 10% and the widths narrow to one-way traffic in spots. The road is surfaced on the steepest two of these grades.

Transit mixers, vehicles pulling low-boy trailers, and other construction equipment should have no difficulty accessing the site.

B. Construction Equipment - The following is a list of expected construction equipment that would be on-site at certain times during construction. The equipment actually used may vary somewhat depending on the contractor's approach to the work and equipment availability.

Front end loader
Dozer
Dump truck
Excavator
Excavator hoe-ram attachment
Concrete transit mixers
Crane
Small drill rig
Dewatering pumps

C. Excavation - The material in the channel can be excavated using common methods, like an excavator. The excavated area will need to be dewatered to maintain the excavated slopes. Excavated materials will be stockpiled at the canyon walls to prevent washing downstream during runoff events. The stockpiled material will be used for backfill around the structure.

Rock excavation, where the structure ties into the canyon walls, will be done using a hoe-ram, or blasting if allowable. The structure will be keyed into the rock at least 3 feet. Anchor bars will tie the concrete to the rock for further anchorage. Care must be taken not to impact the Safford waterline during the abutment activities.

D. Diversion and dewatering - The above-ground stream flows will need to be diverted away from construction activities. To accomplish this, the river will be diverted as far to one side of the channel as possible, while work occurs on the other side. The flows will eventually be diverted to the other side to finish the work. A dozer would likely be used to create the diversion channels and associated berms.

Dewatering will be required to maintain an open excavation in the alluvial material. The contractor will likely install a line of well points just upstream of the barrier. A downstream line may be installed, but is probably not necessary. The pumps in the well points will probably be placed about 5 feet below the lowest excavation. The pumps will need to operate 24 hours a day. Power will probably come from generators, which will need to be placed outside of the floodway. We are unaware of powerlines in the vicinity. Dewatering is one of the most critical activities on this job and a thorough plan needs to be developed by the contractor.

E. Concrete availability - There are several sources of concrete in the Safford area. Some research should be done to determine the reliability of these plants, from a production and quality standpoint. Those plants meeting the necessary criteria should be listed in the construction specifications as approved sources.

V. Potential Road Issues

BLM has informed us that that they are considering a new Bonita Creek road crossing involving the road on the east side of Bonita Creek that continues to the uplands near Turtle Mountain. Currently, to access the east side road, vehicles must enter the canyon via the proposed construction access road, then drive almost a mile down the stream channel to join the road. BLM is considering a new west side access road further downstream that would eliminate most of the in-stream travel.

Reclamation supports this plan as it reduces public interaction at the barrier site. This is advantageous for public safety reasons and lessens the chances of fish being moved above the barrier by people.

VI. NEPA, ESA, and Clean Water Act

Consideration of a Bonita Creek fish barrier beyond the feasibility stage must include provisions for compliance with NEPA, ESA, and CWA. Reclamation is ultimately the action agency for a potential fish barrier project, with BLM proposed as the co-lead agency. Compliance activities will be undertaken primarily by Reclamation or a private consultant, in cooperation with BLM. The NEPA process entails writing draft and final Environmental Assessments of the preferred project and its considered alternatives, and potentially presenting the preferred and alternative projects at public meetings. The NEPA process can take 6-12 months to complete. Reclamation estimates that its performance of all NEPA-required activities would cost approximately $40,000.

ESA compliance likely will involve writing a Biological Assessment that determines effects of the project to federally-listed species and designated critical habitat for species such as loach minnow and spikedace. Although Bonita Creek is unoccupied by these species, the fish barrier project will affect their critical habitat, and thus project impacts likely must be formally consulted on with U.S. Fish and Wildlife Service (FWS). 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 and Fossil Creek fish barrier projects. 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.

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 CWA compliance will be reduced from the normal 6-12 months to about 2-3 months because Reclamation has obtained an individual 404 permit for 13 future fish barriers, including Bonita Creek. The individual 404 permit (No. 2000-01742-MB) was issued on October 30, 2003. The permitting process involved purchasing a conservation easement from The Nature Conservancy to mitigate for environmental impacts. As such, Reclamation estimates that compliance costs associated with CWA regulations would be reduced from the typical $30,000 to about $10,000.

VII. Conclusions and Recommendations

The proposed fish barrier site has two major factors in its favor; a narrow spot in the canyon to reduce costs, and far enough downstream to protect a substantial length of stream (30 miles). There were no another sites further downstream that were of comparable width and visually acceptable to BLM. Although a site with reachable bedrock would be desirable, there were no apparent sites in the vicinity. A stable structure can be designed despite the foundation, as was done at Aravaipa Creek.

The abutment rock appears adequate for the barrier to tie into. Although the rock is not extremely hard, it has ample strength to support the loads from the barrier.

Access to the site is good and should not cause construction difficulties or discourage bidding. The new road crossing configuration that BLM is considering also lends additional weight to this site by providing less reason for the public to have contact with the barrier.

Overall, the fish barrier is constructible at this site without a high degree of difficulty.

VIII. Construction Cost Estimate

A. Construction Cost Estimate - This cost estimate is largely based on the actual construction costs for a similar barrier concept that was built at Aravaipa Creek near Dudleyville, Arizona in 2000.

1. Mobilization (5% of subtotal) = $46,000

2. Water for dust abatement = $8,000

3. Diversion of stream = $29,000

4. Dewatering = $190,000

5. Clearing and grubbing = $3,000

6. Common excavation = ($4/cy)(34 cy/ft)(160 ft) = $22,000

7. Rock excavation = (80 cy)($140/cy) = $11,000

8. Rock bolts, assume 8 10-foot bolts = $6,000

9. Compacted backfill = ($10/cy)(13 cy/ft)(160 ft) = $21,000

10. Backfill = ($5/cy)(16 cy/ft)(160 ft) = $13,000

11. Riprap = ($48/cy)(1000 cy) = $48,000

12. Mass concrete (below ground) = ($260/cy)(3.5 cy/ft)(160 ft) = $146,000

13. Structural concrete (crest and apron) = ($230/cy)(2.7 cy/ft)(160 ft) = $100,000

14. Rebar = ($0.70/lb)(930 lb)(160 ft) = $104,000

15. Anchor bars = ($22/ft)(1,000 ft) = $22,000

16. Piles (if necessary) = $112,000

Subtotal (without inflation) = $834,000
Inflation index from 10-00 to 10-03 = 5.2%

Subtotal with inflation =	$877,368	
Mobilization (5%) =	$ 44,000	
	$921,368	
Contingencies (15%)	$138,205	
Total =	$1,059,573	Use $1,060,000

IX. Photos

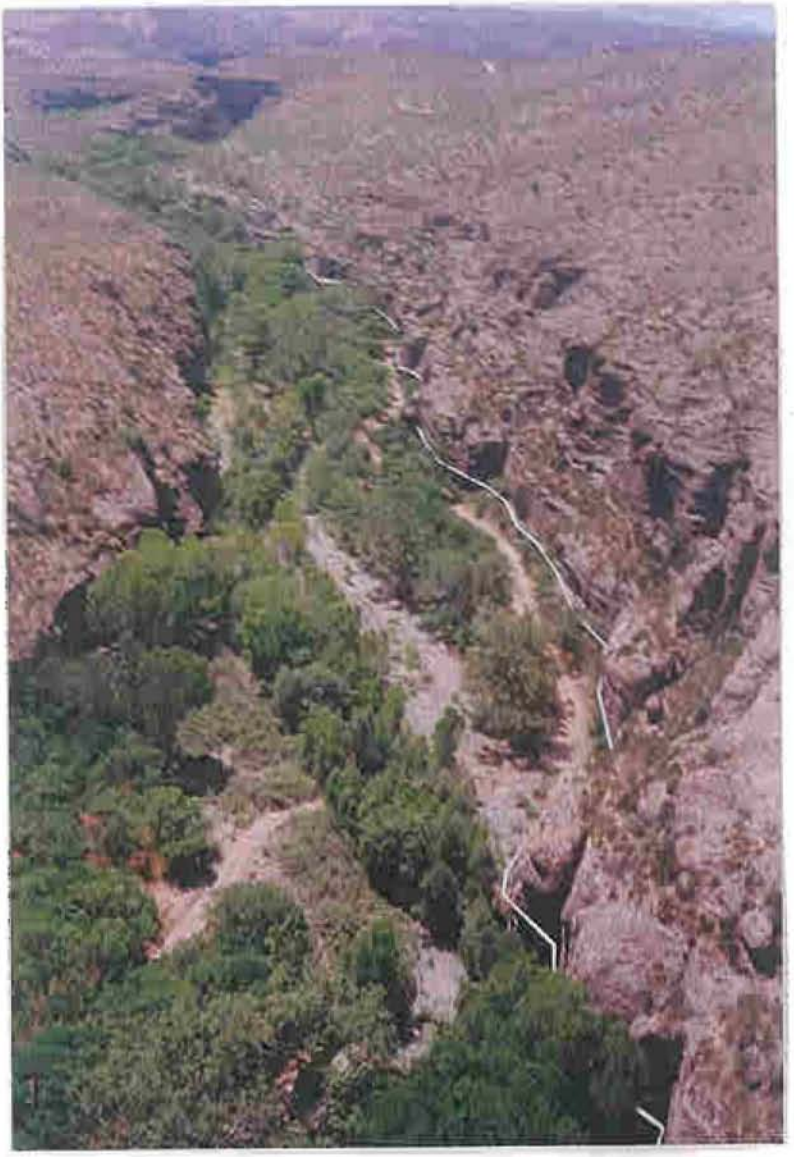


Photo 1 - Aerial view of Bonita Creek Canyon, looking downstream. The City of Safford pipeline is visible along the right canyon wall.

Photo 2 - Looking downstream toward the proposed fish barrier site.

Photo 3 - Looking upstream where road is within the stream, about 1000 feet upstream of proposed fish barrier site.

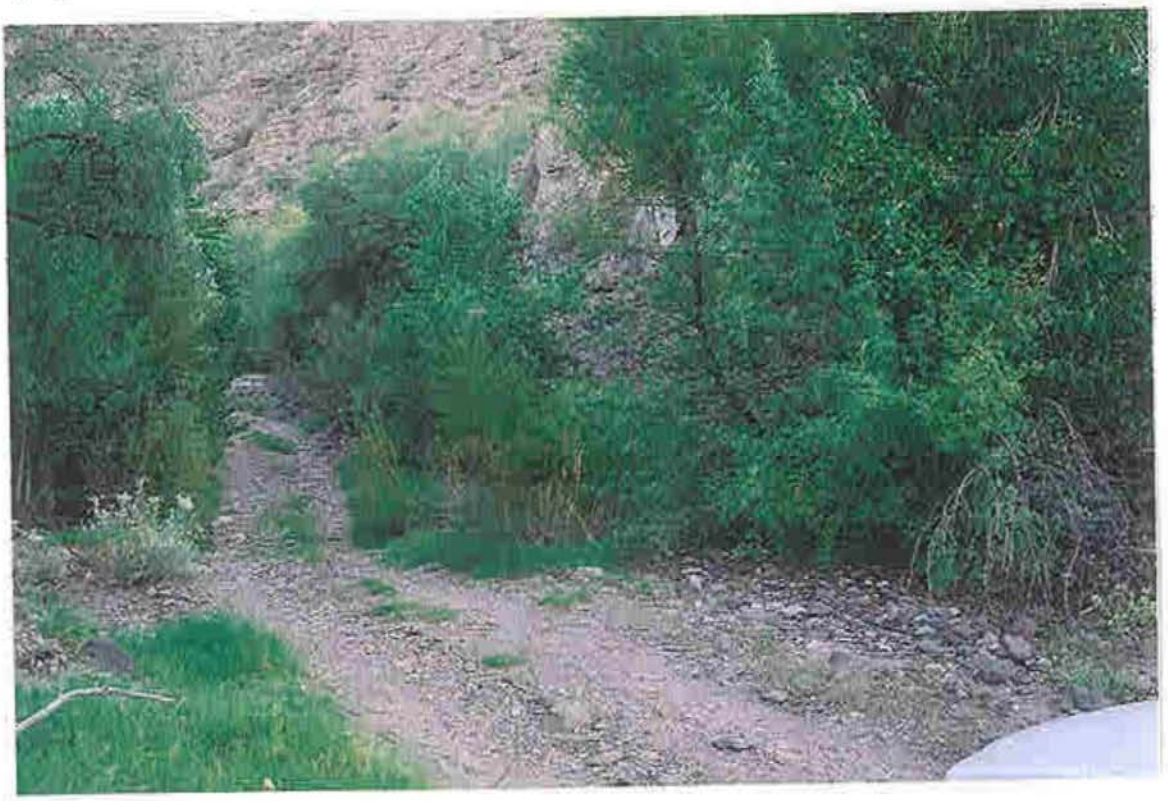


Photo 4 - Proposed fish barrier site. Looking downstream at the right abutment.

Photo 5 - Proposed fish barrier site, right abutment.

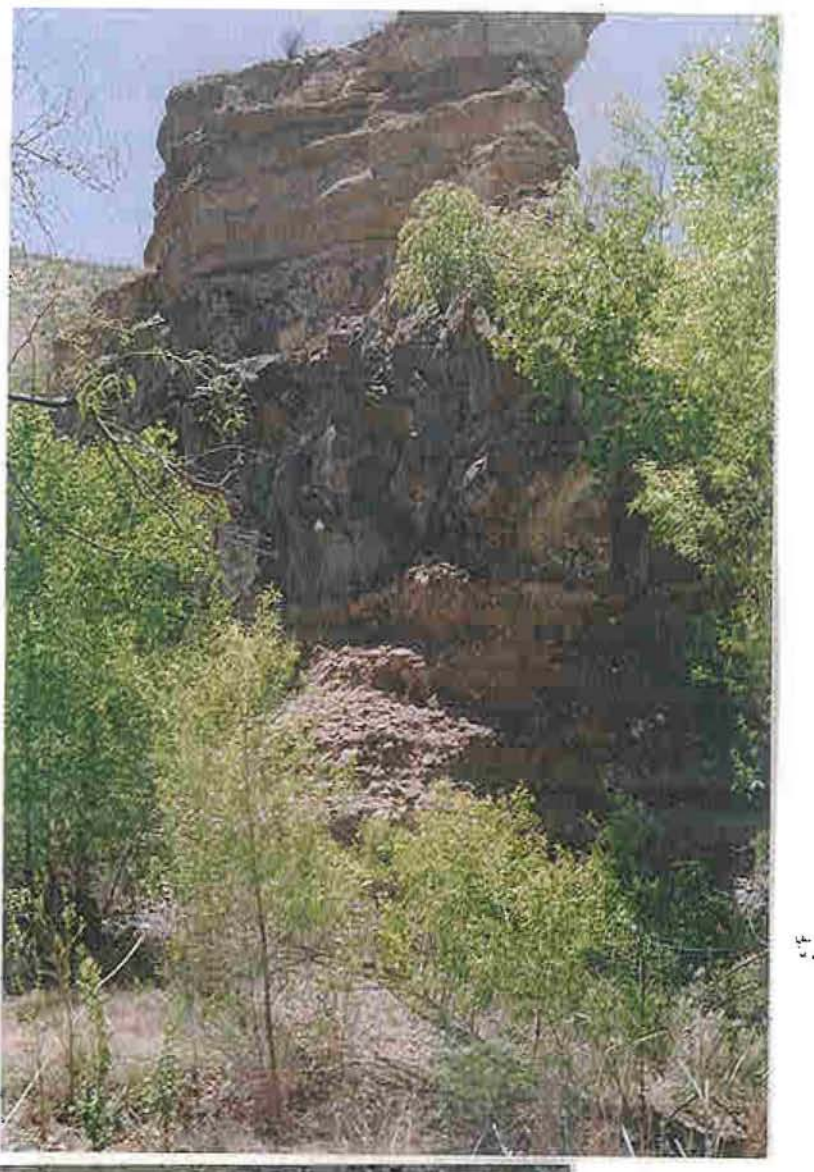


Photo 6 - Right abutment fanglomerate.

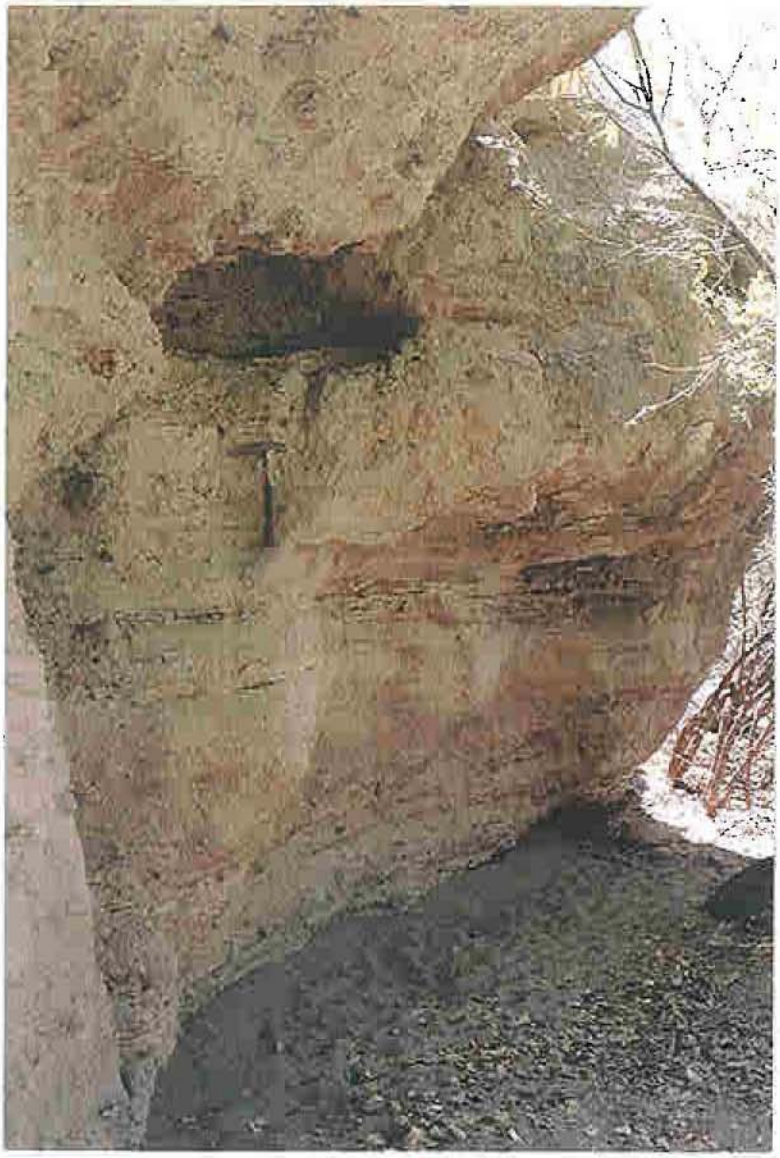


Photo 7 - Left abutment of proposed fish barrier, looking upstream.

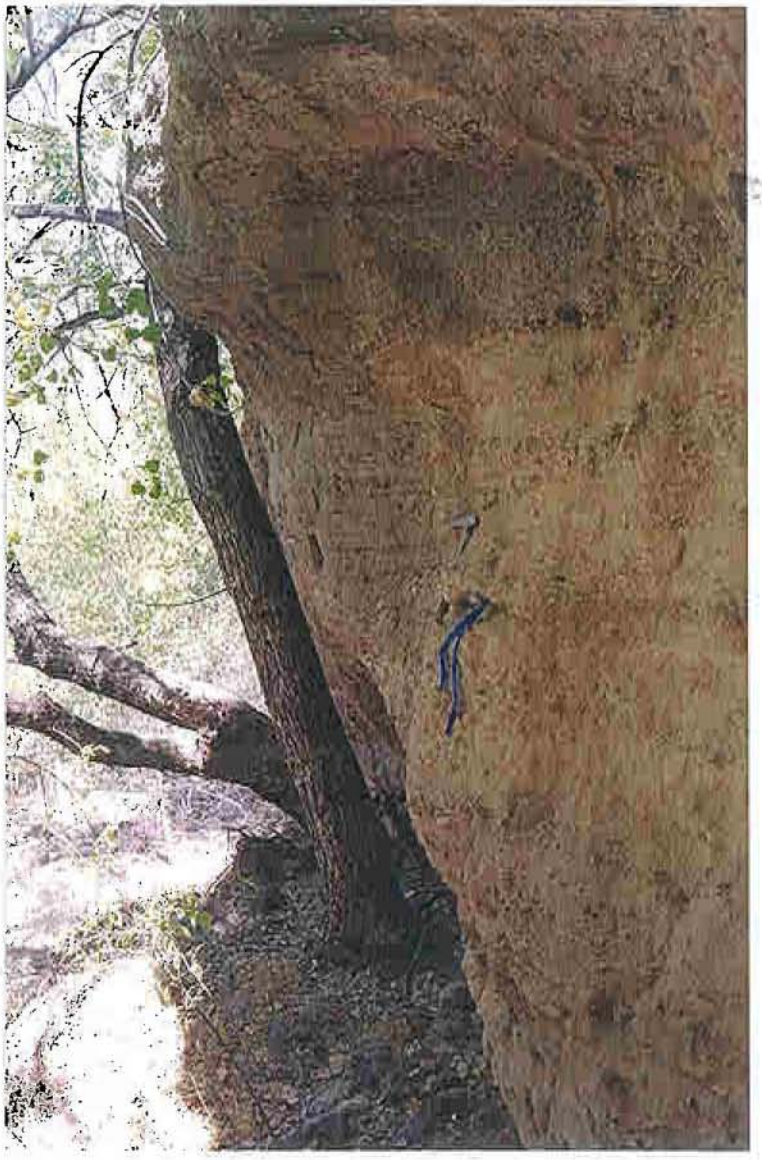
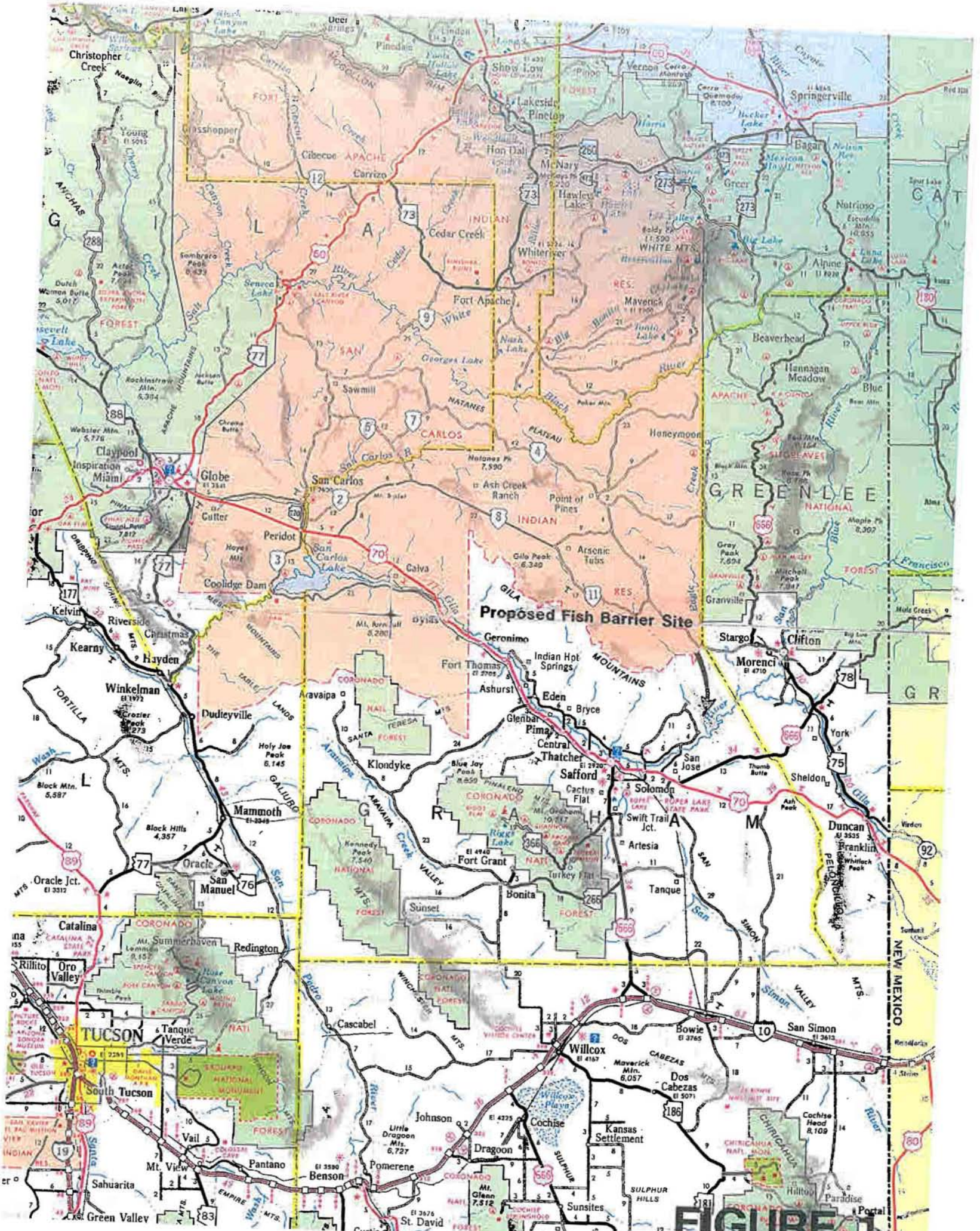
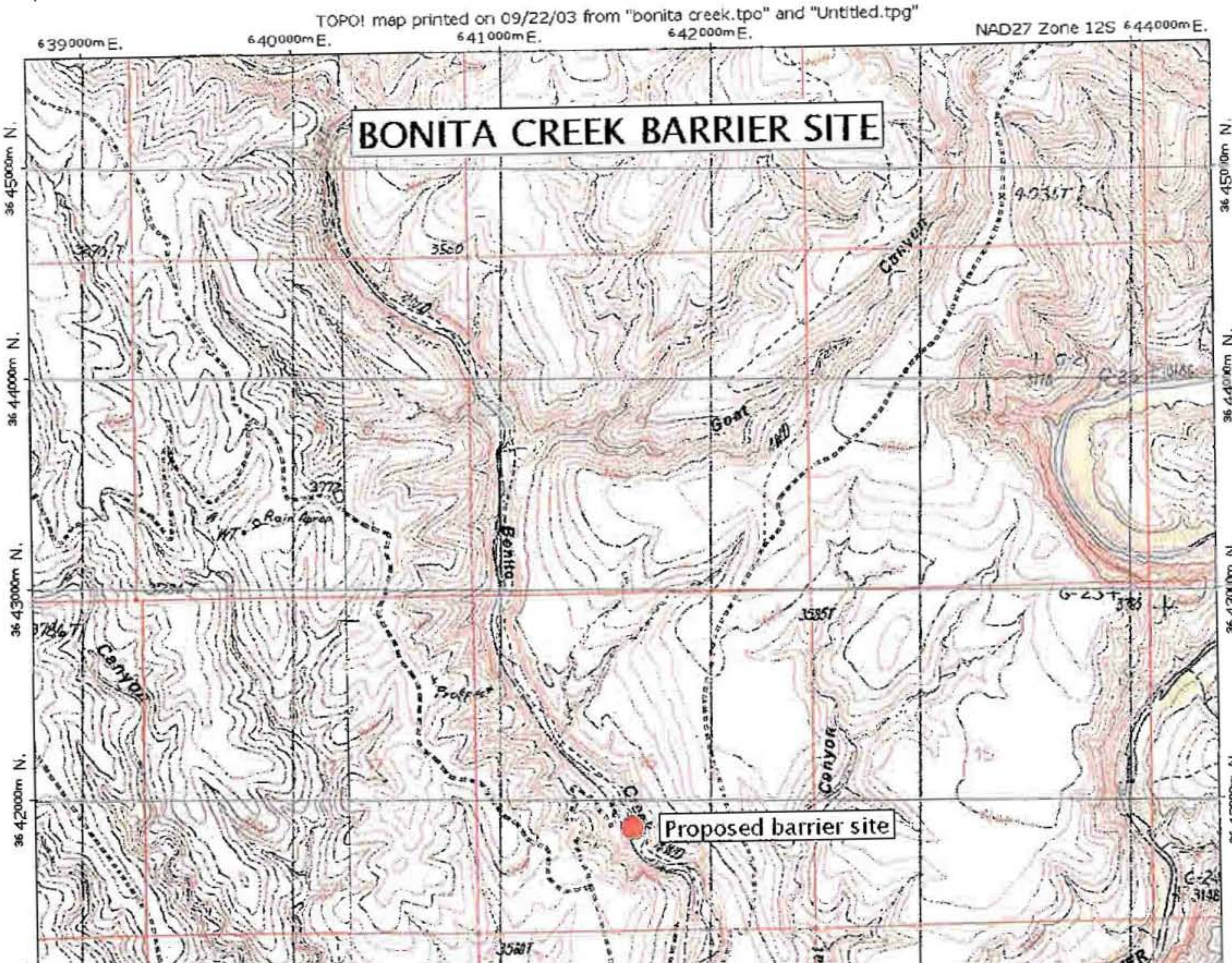


Photo 8 - Left abutment fanglomerate.

IX. Maps and Figures


Proposed Fish Barrier Site
FIGURE 1

TOPO! map printed on 09/22/03 from "bonita creek.tpo" and "Untitled.tpg"



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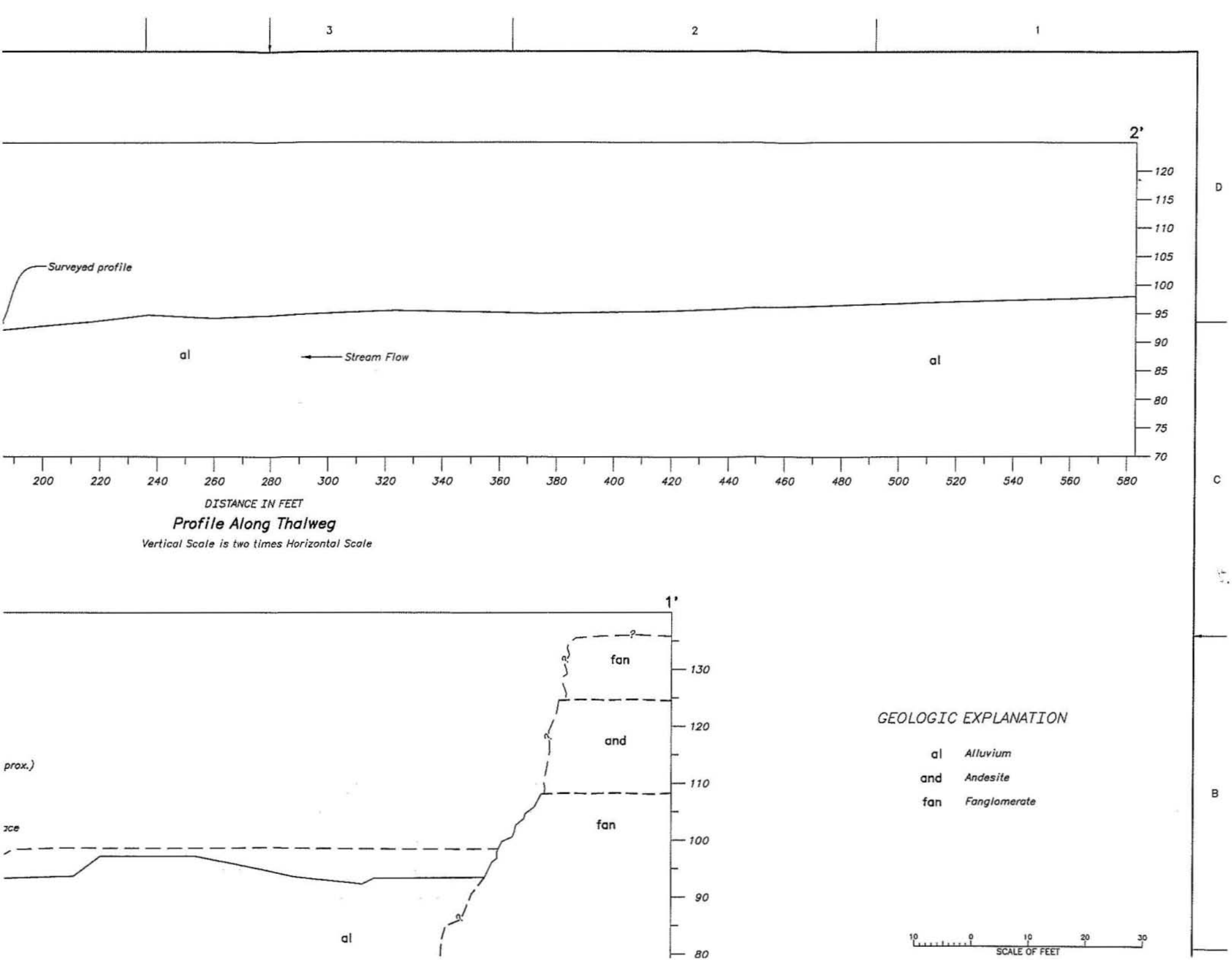
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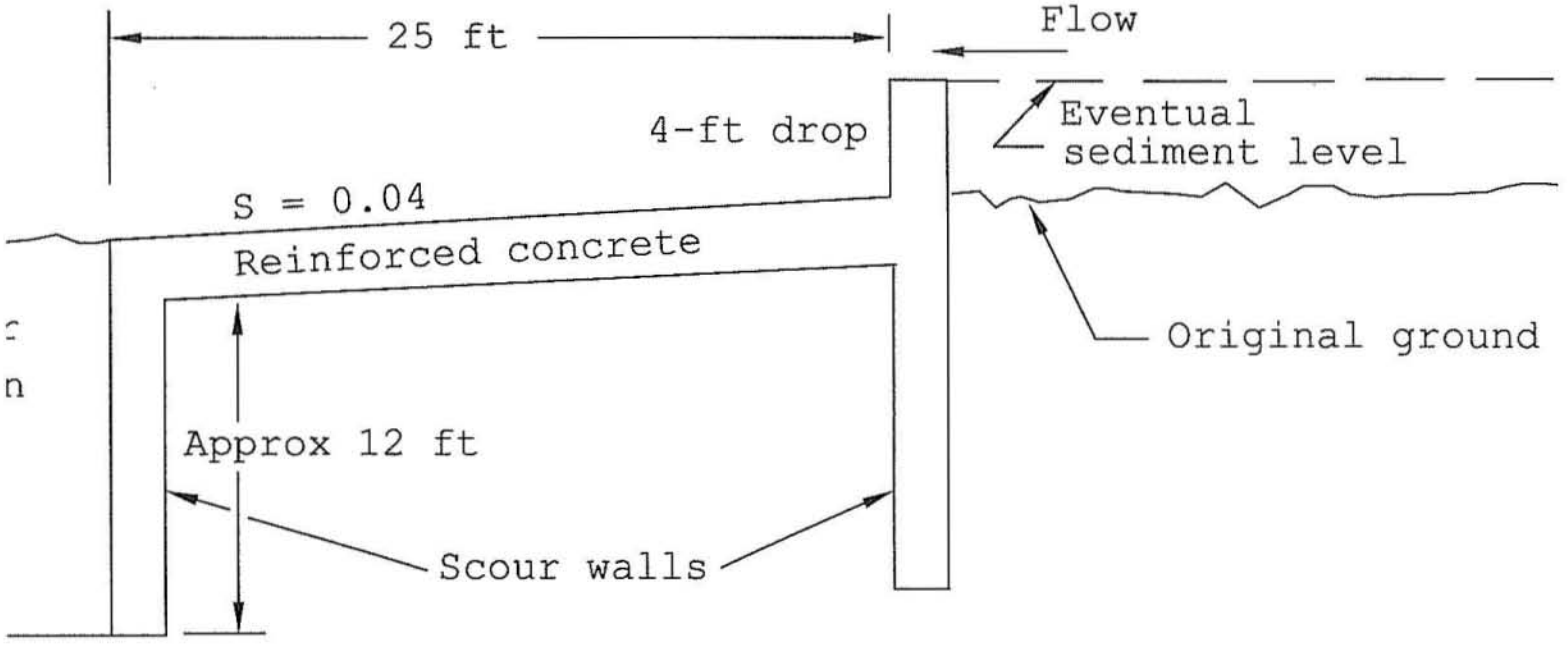

ual Bonita Creek Fish Barrier

Cross Section

Figure 4