RECLAMATION

Managing Water in the West

PreDesign Memorandum
Barber Dam
Fish Protection Facilities

Boise River Project - Idaho
Trout Unlimited

U.S. Department of the Interior
Bureau of Reclamation
PN Region Design Group
1150 N Curtis Rd, Suite 100
Boise, ID 83706-1234

October 2008

BOISE RIVER

BARBER DAM FISH PASSAGE
BOISE RIVER, IDAHO

PREDESIGN MEMORANDUM

Introduction

The Bureau of Reclamation owns and operates several water facilities in the Boise River Basin, including Anderson Ranch, Arrowrock and Boise River Diversion Dams. The Bureau is authorized to investigate Habitat Restoration Associated with Reclamation Projects (16 U.S.C. §§ 661 *et seq*.). Section 1 of the Fish and Wildlife Coordination Act provides authorization to the Secretary to provide assistance to, and cooperate with, Federal, State and public or private agencies and organizations in the development, protection, rearing, and stocking of all species of wildlife, resources thereof, and their habitat. The Secretary of Interior in 1996 provided to the Commissioner of Reclamation a limited delegation of Section 1 authority "as is necessary to provide assistance, through grants or cooperative agreements, to public or private organizations for the improvement of fish and wildlife habitat associated with water systems or water supplies affected by Reclamation projects."

This particular project is a cooperative venture with Trout Unlimited to provide fish passage upstream and downstream of Barber Dam. Barber Pool is located immediately downstream of Reclamation's Boise River Diversion Dam. Barber Pool, in turn, is created by Barber Dam, an earthen embankment facility owned wholly by Ada County.

Construction of an artificial trout rearing and spawning habitat channel called Alta Harris Creek began in 2005. The creek starts just below the Nampa & Meridian Irrigation District's Ridenbaugh Canal main diversion check dam structure on the Boise River. The mouth of the channel is just above the Eckert Road crossing and extends upstream about a half-mile parallel to the river on lands owned by Harris Ranch and Idaho Power Company. The constructed channel lies within a protected Land Trust of the Treasure Valley Conservation Easement.

Water feeds this new side channel from springs and irrigation system overflow from the nearby Harris Ranch subdivisions, sufficient to irrigate the riparian plantings. Trout Unlimited and partners seek to connect Alta Harris Creek to Barber Pool and secure approximately 10 cfs flow for off-channel fish spawning and rearing habitat and fish passage between Barber Pool and the Boise River.

There has been a combined effort by a number of agencies to extend this channel and provide fish passage across the upstream Barber Dam embankment, into the reservoir and upstream river. The University of Idaho, Phillip Williams and Associates, Quadrant Consulting, Inc., and numerous other partners are assisting Trout Unlimited to provide survey and environmental

surveys of the construction and planting of the stream area. A master plan for the Barber Pool, developed by the Army Corps of Engineers for the Idaho Foundation for Parks and Lands (the major landowner of the shoreline) calls for restoration of fish passage between Barber Pool and the Boise River.

The Bureau of Reclamation has offered to provide initial technical assistance for concept design to provide fish passage through Barber Dam. Trout Unlimited has spearheaded the effort to raise funds and permitting for construction of the project.

Representatives Dave Jennings, Design Manager, and Don Moris, Predesign Engineer, from the Bureau of Reclamation meet with the parties concerned on site to define project requirements on April 30, 2008, with appraisal level design work scheduled for July – August of 2008. The stated goal is to provide an appraisal design study or predesign report with limited fiscal funding granted this fiscal year.

Existing Facilities and Operations

Project Description:

This pre-design report discusses options to provide fish passage to Barber Pool at an existing dam (Barber Dam) located at River Mile 58, Boise River in Ada County, Idaho. The dam is located about 1,500 feet south of Warm Spring Avenue at Lysted Road, about ¼ mile east of the intersection of Warm Springs Avenue and Eckert Road. Barber Dam is a complete barrier to migrating fish and other aquatic organisms.

Barber Dam was constructed starting in 1905 by the Barber Lumber Company to provide hydropower for the Barber sawmill, as well as a log storage pond. The dam formed a pond with a maximum depth of 25 to 30 feet and a length of about three miles and width that varies from about 500 to 1,200 feet. Most of the land around Barber Pool is in conservation status as the Barber Pool Conservation Area and owned by the Idaho Foundation for Parks and Lands.

The embankment dam is 37 feet high with a spillway crest height of 22.4 feet. The dam is 1,500 feet long with a 400 foot long timber crib, rock filled overflow spillway crest. An earthen embankment is 700 feet long. Ada County acquired the dam in 1977 and currently leases the site for power generation purposes to Enel North American of Andover, Massachusetts. The dam is capable of generating 4.14 megawatts of power. A lease agreement with Ada County dates from December 1986, for a term of 35 years. The Federal Energy Regulatory Commission (FERC) license (# 4881-001) for operation of the dam was granted for the period of 40 years (1983 to November 30, 2023.)

According to the Barber Pool Master Plan, in 1978 the face of the dam, a crib and timber structure in poor condition, was sprayed with gunnite (sprayed-on concrete), and the control

gates at the top of the dam were removed. This action reportedly dropped the level of Barber Pool 11 feet (other information indicates the gates were removed prior to 1972). Self-regulating flashboard gates were installed in 1989, raising the pool elevation by 3 feet. The face of the dam was sprayed with gunnite once again in 1997. Further repairs were made to the spillway section adjacent to the powerhouse in 2008, and to a portion of the spillway.

In 1984, a portion of the old log storage pond area of Barber Pool was excavated and converted into a sewage seepage pond on the right abutment above the dam and river. This pond lies south of a portion of the earthen embankment and the historic railroad bed where logs were dumped from during the operation of Barber Mill in the 1920's and 1930's.

At present Barber Dam completely blocks any upstream fish passage, while fish can go downstream over the overflow spillway when flows are adequate or through the unscreened generating turbines. Fish that migrate downstream through the dam are then exposed to the Ridenbaugh Canal diversion ½ mile downstream, which diverts up to one-third of the river flow during irrigation season. This diversion is also unscreened.

In 2005, construction began on Alta Harris Creek. Construction initiated at the downstream confluence with the Boise River just below the Nampa & Meridian Irrigation District's Ridenbaugh Diversion and upstream of Eckert Road. Construction continues in an upstream direction toward Barber Dam.

Hydrology

Historical flow records – Data for Lucky Peak dam outflows -- a short distance up stream from Barber Dam – serves as a starting point to estimate Barber Pool inflows. Daily average releases from Lucky Peak dam are available beginning January 1, 1954, and retrieved from the Bureau of Reclamation's (BOR) website.[1] These data were used to derive average monthly flows for the 1989-2006 period.

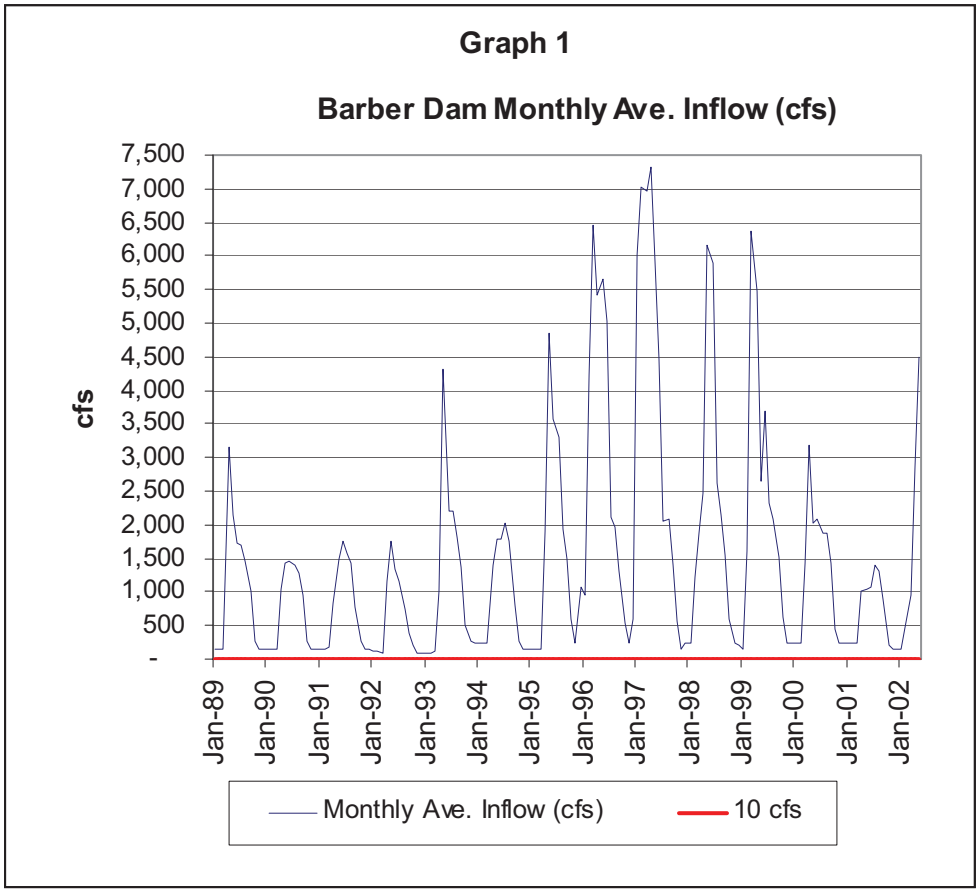
Between Lucky Peak Dam and Barber Dam lies the Bureau of Reclamation's Boise River Diversion Dam, which provides for significant diversions into both the New York Canal and the Penitentiary Canal. These canals have been in place since 1909, and monthly data on total water volume diversions for these two canals were available for years 1929 - 2006.[2] Converting acre feet to flow volume (cfs), and subtracting the volumes arrives at an estimated monthly average inflow to Barber Pool.

River Flow Comparisons – The monthly average flow into Barber Dam for the period from the

1 Flow data originally accessed at http://mac1.pn.usbr.gov/hydromet/yearrpt.html

2 A third, more recent diversion is the pump station near the Highway 21 bridge, a jointly owned station between Micron Technology and United Water Idaho. The station reportedly has a pumping capacity of 26 cfs at full operation. It is not known at this time to what degree the pumping station is being used. United Water has historically relied on groundwater sources to meet municipal water needs in Boise, but in recent years has begun to rely more on surface water.

on line date of the Barber hydroelectric project in the spring of 1989 through May 2002 was 1,519 cfs (see Graph 1).



Flows into Barber Pool are largely regulated by three large storage reservoirs upstream in the Boise Watershed: Lucky Peak, Arrowrock and Anderson Ranch. These reservoirs are managed for multiple purposes by the Bureau, except in the case of Lucky Peak, which is an Army Corps of Engineers project. The three upstream dams include the following authorized uses: irrigation, flood control, recreation and power generation.

Storage reservoir operations alter the timing of water flows into the Boise valley. The graphic above shows how flows peak in the spring months and also provide higher summertime flows for irrigation deliveries. Wintertime flows are maintained at 240 cubic feet per second in most years, unless drought conditions necessitate flows of 150 cfs or flood risks require higher releases.

The Boise River flows released from the upstream Lucky Peak Dam are normally maintained in the 250 to 2,000 cfs range throughout the year. The 5 year event flow has been estimated at 6,500 cfs, while the 100 year flood is estimated to be 16,600 cfs.

The existing capacity of the hydropower plant operated on Barber Dam has a physical capacity up to 3,000 cfs, (although the water right capacity is 2,154 cfs and produces full hydroelectric generation). The hydropower facility can divert all 2,154 cfs with minimal spilling over the uncontrolled ogee spillway at elevation 2778.0. This figure is based on the 1999 USGS topographic survey used to revise the original FEMA Flood Insurance Study for the Boise River. Figure 6 in the Hydrology Section of this report shows a stage/discharge curve for this dam based on recorded water surface elevations in 2006 with a normal high flow water surface elevation of 2779.6 at 6,000 cfs river flow and elevation 2777.4 for flows ranging from 274 cfs up to a 3,000 cfs flow. For the purpose of this fish passage project, the design intent is to operate satisfactorily, with the reservoir fluctuating between elevation 2777.4 and 2779.0, respectively.

River Elevations

The Barber Dam original design elements, as depicted in plan drawings from 1904, and included in the 1982 FERC license application, were examined to determine relative changes in operation range of Barber Pool. Between 1982 and present day the elevation measures have been corrected 3.2 feet higher due to the datum change between NGVD 29 and NAVD 88.

Element or feature found on Exhibit F-7-E from August 18, 1982 submittal to FERC (original drawing dated October 26, 1904)	Relative elevation	Added to datum 2,660.74 MSL	near Barber Dam: NAVD 88 - NGVD 29 = 3.20 ft
Base of dam	81.65	2,742.39	2,745.59
Extreme low water	93.0	2,753.74	2,756.94
Bottom of cutoff trench (estimate)	<93.0	<2,753.74	<2,756.94
Original ground line (estimate, varies)	99	2,759.74	2,762.94
Floor of generating room	103	2,763.74	2,766.94
Crest of spillway overflow	114.0	2,774.74	2,777.94
Extreme high water (40,000 cfs)	123.25	2,783.99	2,787.19
Top of earth gravel embankment	128.0	2,788.74	2,791.94

Element or feature found on Exhibit F-4 from August 18, 1982 submittal to FERC	1982 Reported elevation	NAVD 88 - NGVD 29 = 3.20 ft
Low Tailwater Elevation	2,753.0	2,756.2
Crest of spillway overflow	2,774.74	2,777.94
Normal Reservoir Elevation	2,775.50	2,778.70
100 Year Flood Elevation	2,779.75	2,782.95

Information prepared for FERC in the 1990s modeled a flow/spillway rating curve to determine spillway capacity and potential for overtopping the earthen embankment. These elevations are also displayed with a column noting the 3.2 feet elevation correction.

Corrected Elevation (feet) NAVD 88 - NGVD 29 = 3.20 ft	1995 Report Elevation (feet)	Head (feet)	Flows (cfs) Spillway	Embankment	Total
2777.9	2774.7	0.0	0	0	
2778.9	2775.7	1.0	1,200	0	1,200
2779.9	2776.7	2.0	3,490	0	3,490
2780.9	2777.7	3.0	6,770	0	6,770
2781.9	2778.7	4.0	10,900	0	10,900
2782.9	2779.7	5.0	14,400	0	14,400
2783.9	2780.7	6.0	20,700	0	20,700
2786.9	2783.7	9.0	38,600	0	38,600
2789.9	2786.7	12.0	60,000	3,000	63,000
2792.9	2789.7	15.0	84,300	33,100	117,400
2795.9	2792.7	18.0	111,300	102,800	241,100

The above table appears to overlook the 3,000 cfs flow capacity of the powerhouse and may overstate the flood flow elevations by that increment. Nonetheless, the 100 year flood (16,600 cfs) approximate elevation in Barber Pool is 2,783 MSL. Powerhouse and spillway capacity is more than adequate for river flows of 16,600 and maintaining sufficient freeboard along the earthen embankment.

A second important factor concerning the earthen embankment is found through a review of historical information on the operation of Barber Pool during the early period of Barber Lumber Company compared to present day. After the sawmill was closed in 1939, the 11-foot tall control gates across the top of the dam's spillway were removed. As mentioned earlier, this action reportedly dropped the level of Barber Pool by 11 feet. The Barber Pool Conservation Plan claims this occurrence dates from 1978. In 1989, self-regulating flashboard gates were installed, raising the pool elevation by three feet.

The Barber Pool Conservation Area Master Plan includes illustrations showing the Barber Pool shoreline over the past 100 years, and information appears to show the pool elevations dropped between 1950 and 1972, which would date the removal of the spillway control gates to at least six years earlier than the master plan indicates. Photographic evidence (cover of 1976 IDWR report on Barber Dam) appears corroborative. Whatever date the gates were removed, the pool elevation dropped and the shoreline of Barber Pool has now receded to more than 100 feet away from the embankment at it's northern end. Thus the earthen embankment shows 14 feet of freeboard, much higher than when Barber Pool operated as a log storage pond for the Barber mill. (See Appendix A).

Problems and Needs

The major design problem associated with the fish passage around Barber Dam involves penetrating the existing embankment with the least possible impact and concern to owners and operators. A further variable in the layout requires accommodating the proposed future Barber Dam deflection berm. A final conceptual proposal for the berm has been submitted by Enel for

approval by FERC. There is considerable land area between the proposed deflection berm and the Boise River, room enough for a channel and fish passage facility. Therefore, neither of the above matters appears insurmountable.

Penetrating the existing Barber Dam embankment should be made at a point which requires the least amount of excavation of the embankment but at an elevation suitable to provide gravity flow from the forebay water surface to the downstream habitat channel. The total water surface differential between the upstream side of the dam and the eastern extent of the existing Alta Harris Creek channel is approximately 14 feet. The design for fish passage requires a system to accommodate this differential in a way that will be manageable for upstream migrating fish and that will also accommodate a variation in water surface elevation at Barber pool. Appendix A provides the information on the historic and current shoreline of Barber Pool and the decreasing differential in land elevations as one moves north along the embankment. This factor when coupled with the decreased risk of embankment breach due to distance from Barber Pool helps determine a location for the fish passage facility with minimal impacts to other resources. Bureau of Reclamation experience with fish passage construction at Derby Dam on the Truckee River in Nevada provides an analogue, as that bypass channel is bordered by a berm and was involved a new outlet structure through an existing embankment (see Appendix B).

Biological Information

The target fish species at this site are resident rainbow and brown trout species. Mountain white fish are native to the Boise River and are expected to enter the Alta Creek side channel from the river. Periodically chinook salmon and steelhead are released below at the Barber Park and could migrate up a fishway. The target migration season is year-around. Safe upstream passage is required at this site. Downstream passage is also possible, a portion will go over the unregulated spillway during higher flows and part through the unscreened generating turbines.

Fish Passage Criteria

The design criteria utilized in this predesign report include various sources for components of the project. Where possible, an attempt to meet the criteria should be made to the extent possible. The criteria are:

1. Design criteria used for passage through any new diversion comes from NOAA Fisheries (NOAAF) " Salmonid Passage Facility Guidelines and Criteria", February 2008.

   Upstream Passage Criteria recommends fishway drops of 0.5 – 0.7 feet, where passage of juveniles is required.

2. Pool and Chute Fishways Discussion and Design Process by Patrick Powers, 2000 Washington State Department of Fish and Wildlife

3. Idaho Department of Fish and Game recommended criteria

Proposed Improvements

Features – Meandering lined channel extending upstream from Alta Harris Creek, pool & chute fishway drop structures, box culvert through dam embankment, vertical slot fishway on upstream side of dam, excavated channel connecting to the river (see Drawings 1 through 4).

The fish passage system detailed in this section is described starting at the downstream end at the existing Alta Harris Creek and continuing upstream to the Barber Pool. This is the path of an upstream migrating fish. After conducting an initial hydraulic analysis, the design focused on a passage system with flows ranging from 12 to 24 cfs. The flow will be 12 cfs for most normal flows in the Boise River and increase to 24 cfs for the high river design flow.

The new passage channel begins at the existing Alta Harris Creek and extends upstream approximately 900 feet. This channel is intended to be a "natural" meandering channel with a 3 foot bottom width, 2:1 side slopes and about a 0.2% slope. Planting riparian vegetation along this channel is anticipated. The channel invert below the embankment dam varies from elevation 2760.0 to about elevation 2761.8. The water surface at the upstream end of the channel will be approximately elevation 2765.0.

At the upstream end of the natural channel are a series of four sets of pool and chute fishways. The lower two sets will consist of four steel plates embedded in the channel and the upper two sets will consist of five steel weirs welded in a steel sheet pile flume as shown on the drawings. The weir plates embedded in the channel may require a small embankment to contain flows, particularly at the upstream weirs. The weir plates will contain a 2 foot wide low flow notch. The elevation of the crest of each notch will increase by 0.7 feet as will the step-up in water surface elevation as fish swim up the fishway. There is an approximately 50 foot length of channel between each set of weirs to provide resting pools for upstream migrating fish. It is anticipated these areas will be planted with riparian vegetation. The following table illustrates the key elevations of the fishway.

Pool and Chute Fishway

Location	Channel Invert Elev.	12 cfs W. S. Elev.	24 cfs W. S. Elev.	Weir Notch Elev.	Top of Embankment Elev.	Approx. Existing Ground El.
d/s Weir 1	2761.8	2765	2765 +			
Weir 1	2761.44	2765	2765.24	2763.94	N/A	2770
Weir 2	2762.14	2765.6	2765.94	2764.64	N/A	2770
Weir 3	2762.84	2766.3	2766.64	2765.34	N/A	2770
Weir 4	2763.54	2767.0	2767.34	2766.04	N/A	2770
d/s Weir 5	2763.54	2767.0	2767.34			
Weir 5	2764.24	2767.7	2768.04	2766.74	N/A	2771
Weir 6	2764.94	2768.4	2768.74	2767.44	2771.74	2771
Weir 7	2765.64	2769.1	2769.44	2768.14	2772.44	2771
Weir 8	2766.34	2769.8	2770.14	2768.84	2773.14	2771
d/s Weir 9	2766.34	2769.8	2770.14			
Weir 9	2767.04	2770.5	2770.84	2769.54	2774.54*	2772
Weir 10	2767.74	2771.2	2771.54	2770.24	2775.24*	2772
Weir 11	2768.44	2771.9	2772.24	2770.94	2775.94*	2772
Weir 12	2769.14	2772.6	2772.94	2771.64	2776.64*	2772
Weir 13	2769.84	2773.3	2773.64	2772.34	2777.34*	2772
d/s Weir 14	2769.84	2773.3	2773.64			
Weir 14	2770.54	2774.0	2774.34	2773.04	2778.04*	2773
Weir 15	2771.24	2774.7	2775.04	2773.74	2778.74*	2773
Weir 16	2771.94	2775.4	2775.74	2774.44	2779.44*	2773
Weir 17	2772.2	2776.1	2776.44	2775.14	2780.14*	2773
Weir 18	2772.2	2776.8	2777.14	2775.84	2780.84*	2773

* Indicates the top of the steel sheet pile fishway

At the upstream end of the upstream steel sheet pile pool and chute fishway, the passage system transitions into a 3 feet wide by 6 feet tall flume. The flume becomes a box culvert under the dam and power house access maintenance road. A gate is provided on the upstream end of the box culvert to provide the ability to shut off all flow in a large flood event. This predesign does not address the methods and requirements necessary to excavate and construct the box culvert through the dam embankment.

On the upstream end of the box culvert, the passage system transitions into a vertical slot fish ladder. The vertical slot ladder is designed to accommodate a fluctuating river water surface elevation. It consists of two 12 inch wide vertical slots and two bays 6 feet wide by 10 feet long. A 3 foot wide by 5 foot tall fish exit gate is located on the upstream side of the upstream slot. The gate provides a method to shut off flow in the ladder for maintenance. A trash rack is provided upstream of the gate to prevent debris from entering the ladder.

Fish migrating upstream from the vertical slot ladder enter an excavated channel which extends approximately 250 feet to an existing side channel of the river. The excavated channel can be

constructed as a meandering "natural" channel. The existing side channel may need clearing and excavating to connect to the main river channel.

Permits Required to Begin Construction

Trout Unlimited will coordinate all permit requirements and will work with the project partners. To date, permits for the constructed Alta Harris Creek have included Army Corps 404 wetlands permit, Boise River System Ordinance Permit and Floodplain review issued by the City of Boise, and state historic preservation office review. Future permits would include those above plus either a non-project facility modification permit from FERC or an amendment to the FERC license, and a water right from Idaho Department of Water Resources for a non-consumptive diversion of water from the Boise River for fish and wildlife purposes. A City of Boise grading permit and an erosion and sediment control permit will also be required for this project.

Construction Considerations

The entire dam penetration and construction of vertical slot control structure, box culvert crossing, pool and chute drop, and roughened channel can all be constructed in the dry with minimal danger from flooding. Once these features are constructed, the work could be followed by the upstream channel excavations. The steel sheetpiles for the pool and chute fishway can be vibrated into the ground using common construction backhoe equipment.

SURVEYS

ALTA HARRIS CREEK

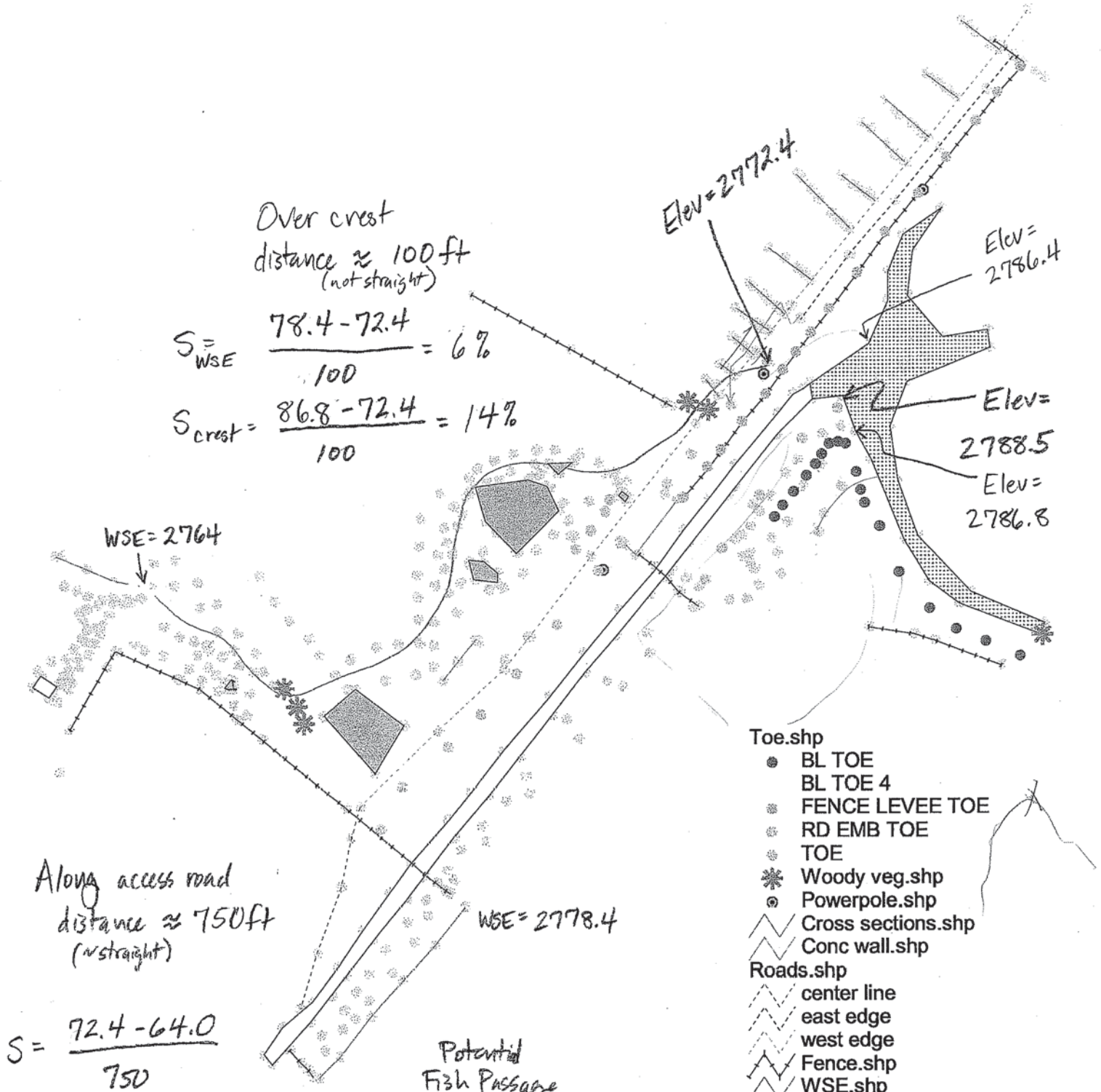
BOISE RIVER SIDE CHANNEL AND CONSERVATION EASEMENT LOCATIONS

Quadrant Consulting, Inc.

SHEET 1 OF 1

FIGURE 2

Boise River Side Channel
Draft Discussion Drawing
June 11,2004, Survey by University of Idaho, Ecohydraulics Research Group
Digitizing by Steve Clayton, PWA



Notes by SRC 7/15/04

PHOTOGRAPHS

FIGURE 3

FIGURE 4

FIGURE 5

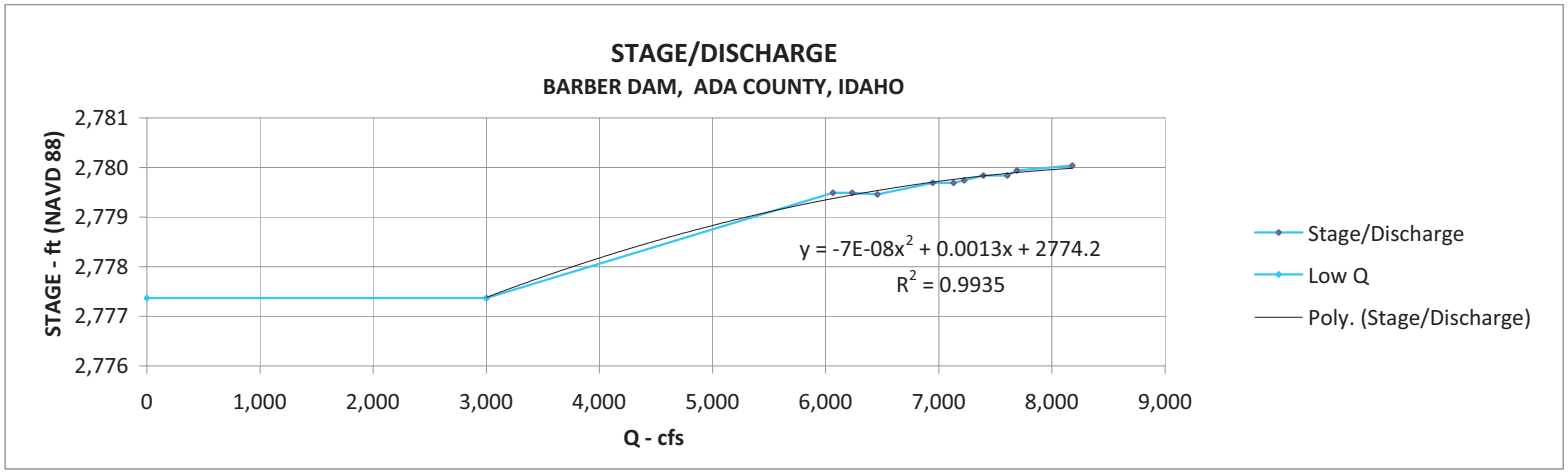
HYDROLOGY

Quadrant Consulting, Inc.

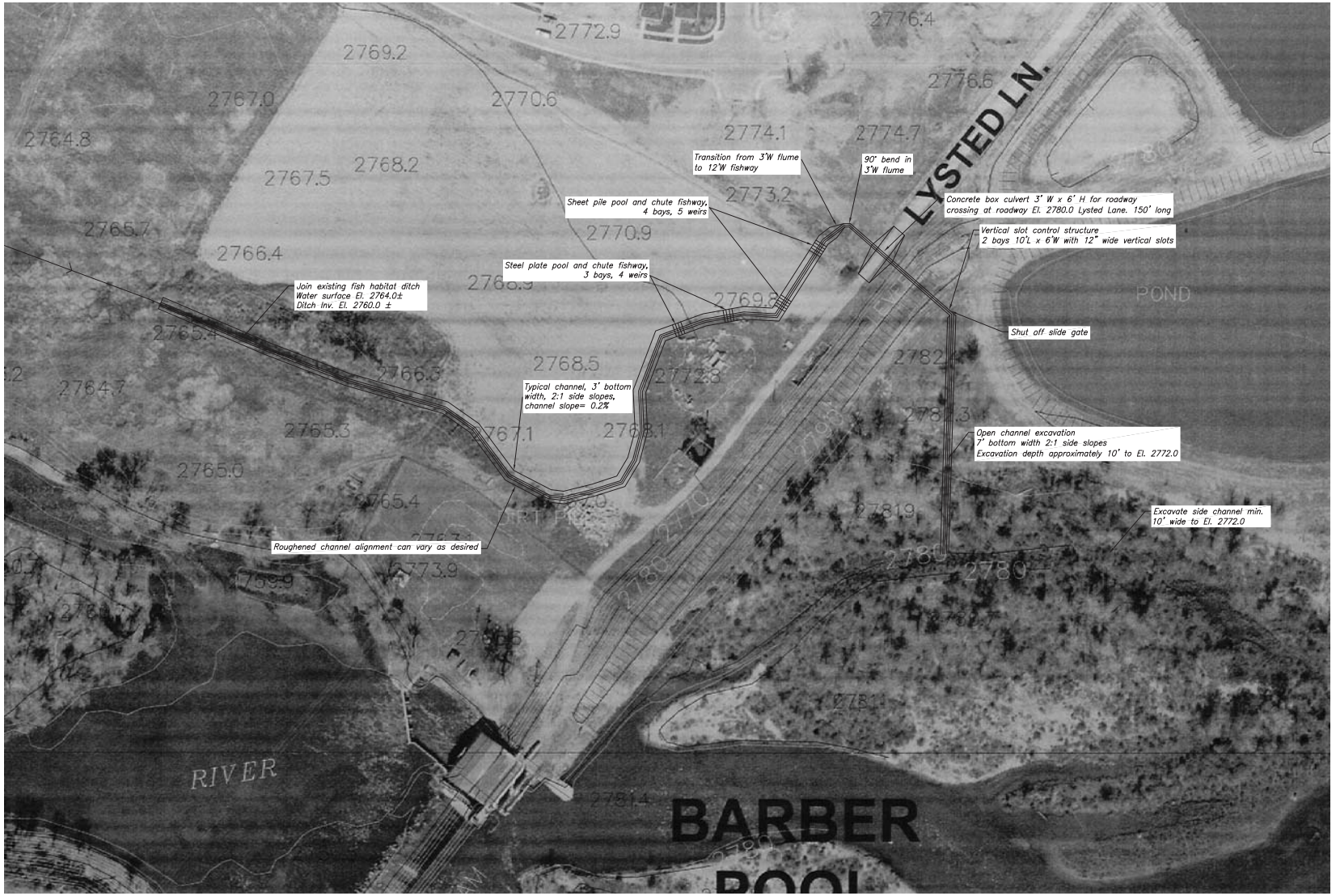
FIGURE 6

STAGE/DISCHARGE RELATIONSHIP - BARBER DAM
NAVD 88

SiteID	SiteName	Date	Time	DistanceFt	WaterElev	Q Lucky Peak Less New York Canal	Q Lucky Peak	Q New York Canal
3	Barber Dam	4/14/2006	430	-2.12	2779.49	6065	6497	432
3	Barber Dam	4/17/2006	835	-2.12	2779.49	6235	6819	584
3	Barber Dam	4/18/2006	915	-2.09	2779.46	6458	7313	854
3	Barber Dam	4/19/2006		-2.32	2779.69	6948	7907	959
3	Barber Dam	4/20/2006	900	-2.32	2779.69	7130	8090	960
3	Barber Dam	4/21/2006	800	-2.37	2779.74	7225	8186	962
3	Barber Dam	4/25/2006		-2.47	2779.84	7394	8292	898
3	Barber Dam	4/26/2006	815	-2.47	2779.84	7604	8657	1053
3	Barber Dam	4/27/2006	900	-2.57	2779.94	7690	8867	1177
3	Barber Dam	5/12/2006		-2.67	2780.04	8180	10537	2357
3	Barber Dam	12/21/2006	1113	0	2777.37	247	247	0
3	Barber Dam	n/a	n/a	0	2777.37	3000	n/a	n/a
3	Barber Dam	n/a	n/a	0	2777.37	0	n/a	n/a



DRAWINGS



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FEBRUARY 26, 2009 06:47
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CHRIS

CAD SYSTEM
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RECLAMATION
Managing Water in the West

ALWAYS THINK SAFETY

U.S. DEPARTMENT OF THE INTERIOR
BUREAU OF RECLAMATION
BOISE PROJECT – IDAHO

APPRAISAL REPORT

BARBER DAM FISH PASSAGE

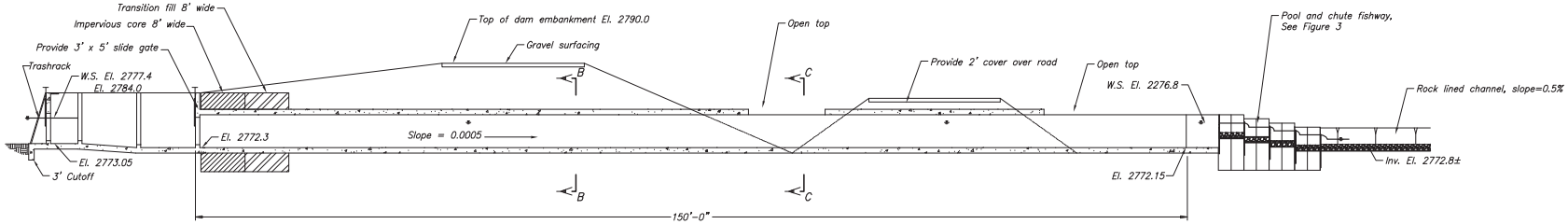
PLAN

BOISE, ID 2008-10-22

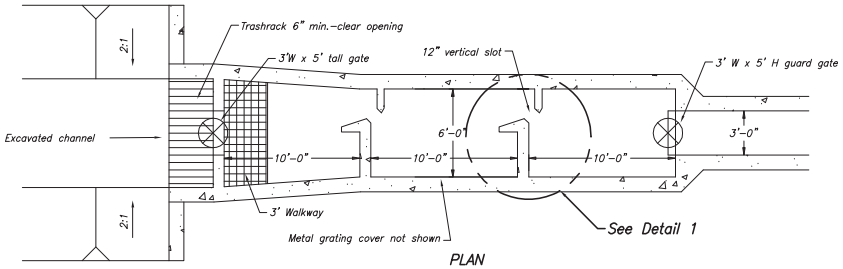
PLAN
OPTION 1

DRAWING 1

SHEET 1 OF 1

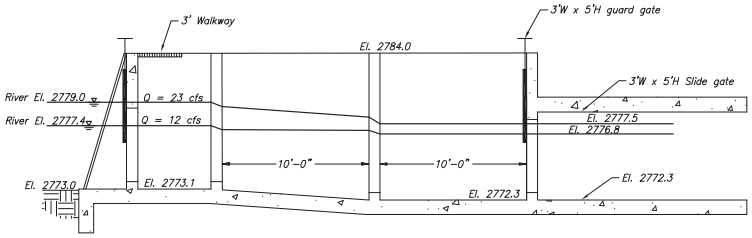


ELEVATION
NTS



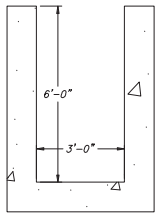
PLAN
VERTICAL SLOT FISH LADDER

4 0 4 8 12
SCALE OF FEET



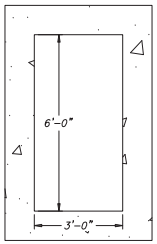
SECTION A-A
VERTICAL SLOT FISH LADDER

4 0 4 8 12
SCALE OF FEET



SECTION C-C
OPEN TOP SECTION

2 0 2 4 6
SCALE OF FEET



SECTION B-B
CLOSED BOX CULVERT SECTION

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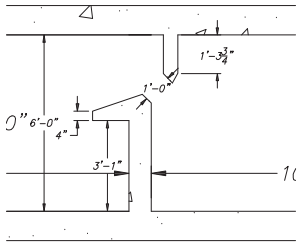
SCALE OF FEET



DETAIL 1
TYPICAL VERTICAL SLOT DIMENSIONS

2 0 2 4 6
SCALE OF FEET

RECLAMATION
Managing Water in the West

ALWAYS THINK SAFETY

U.S. DEPARTMENT OF THE INTERIOR
BUREAU OF RECLAMATION
BOISE PROJECT - IDAHO

APPRAISAL REPORT
BARBER DAM FISH PASSAGE
SECTIONS

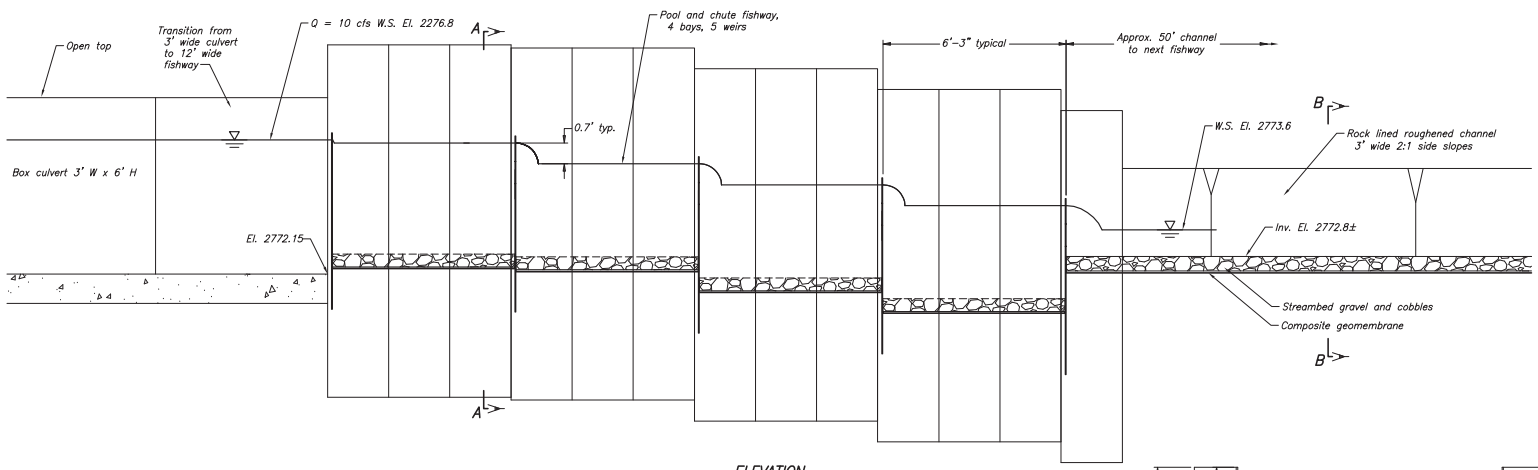
DESIGNED
DRAWN
CHECKED
TECH. APPR. NAME - TITLE
APPROVED ADMINISTRATIVE APPROVAL - NAME - TITLE
BOISE, ID 2008-12-31

OPTION 1

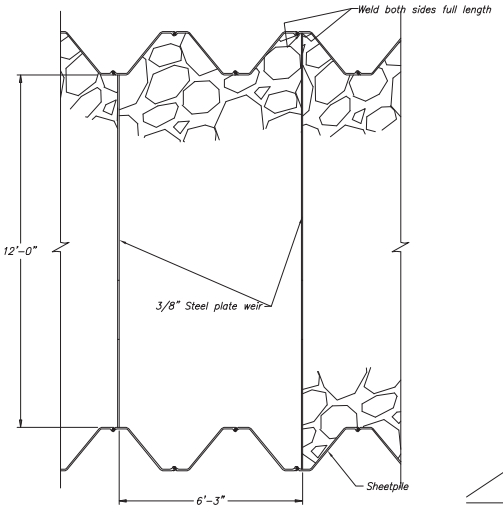
DRAWING 2
SHEET 1 OF 1

DATE AND TIME PLOTTED
FEBRUARY 26, 2009 0651
PLOTTED BY
DUKE

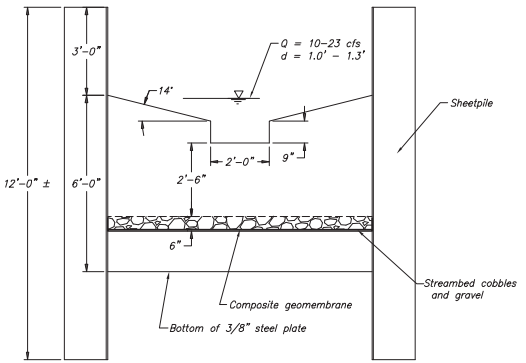
CAD SYSTEM
AutoCAD Rel. 17.2s
CAD FILENAME
Drawing 2.dwg



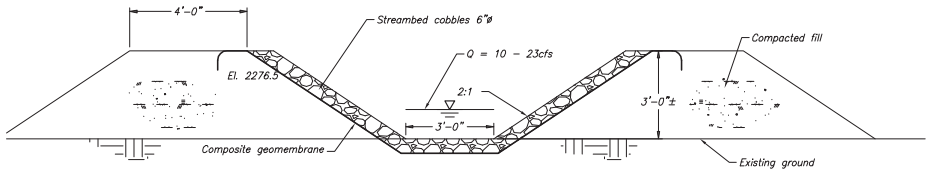
ELEVATION
Typical sheet pile Pool and Chute Fishway (Two required)
SCALE OF FEET



PLAN
Typical sheetpile pool and chute fishway (Two required)
SCALE OF FEET



SECTION A–A
SCALE OF FEET



SECTION B–B
SCALE OF FEET

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Managing Water in the West

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BOISE PROJECT - IDAHO

APPRAISAL REPORT
BARBER DAM FISH PASSAGE
DETAILS AND SECTIONS

DESIGNED
DRAWN
CHECKED
TECH. APPR. NAME - TITLE
APPROVED ADMINISTRATIVE APPROVAL - NAME - TITLE
BOISE, ID 2008-12-23

OPTION 1
DETAILS AND SECTIONS

DRAWING 3
SHEET 1 OF 1

DATE AND TIME PLOTTED
FEBRUARY 26, 2009 0654
PLOTTED BY
CHUCK

CAD SYSTEM
AutoCAD Rel. 17.2s
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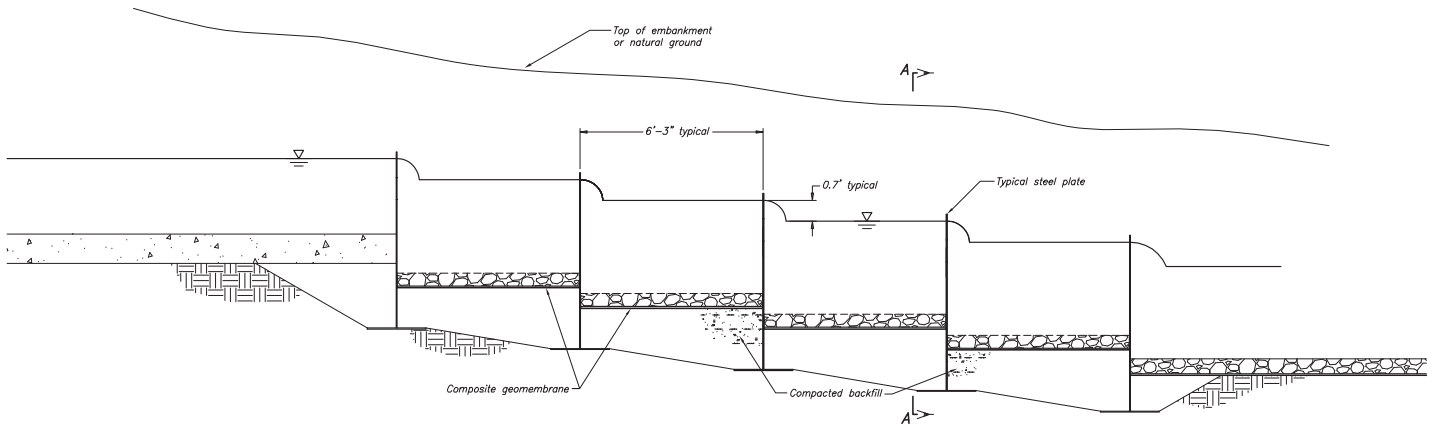
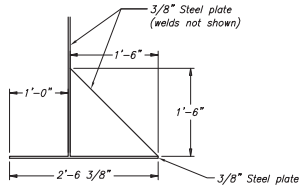
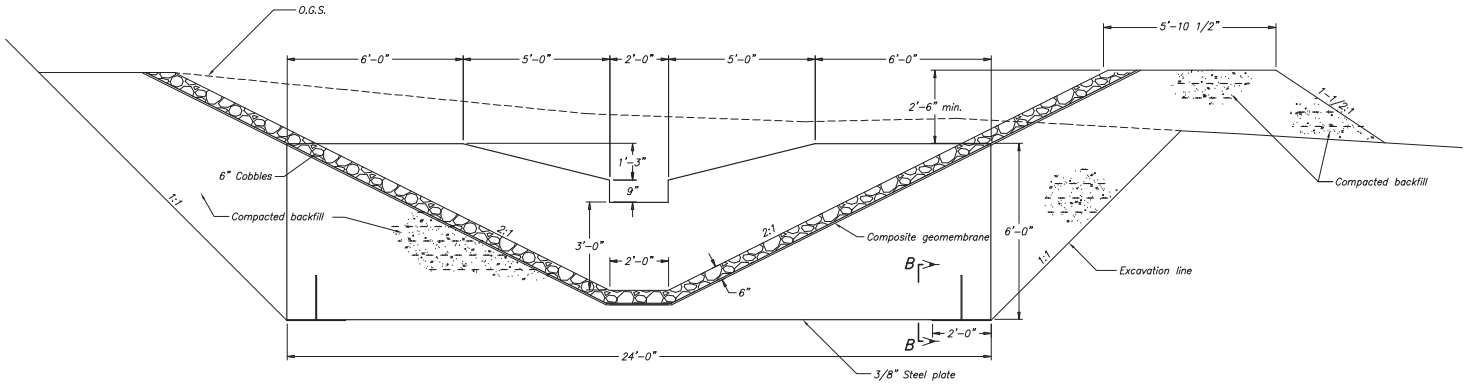


ELEVATION
Typical sheet pile Pool and Chute Fishway
(Two required)

SCALE OF FEET



SECTION B–B



SECTION A–A

RECLAMATION
Managing Water in the West

ALWAYS THINK SAFETY

U.S. DEPARTMENT OF THE INTERIOR
BUREAU OF RECLAMATION
BOISE PROJECT – IDAHO

APPRAISAL REPORT

BARBER DAM FISH PASSAGE
ELEVATION AND SECTIONS

DESIGNED
DRAWN
CHECKED
TECH. APPR. NAME – TITLE
APPROVED ADMINISTRATIVE APPROVAL – NAME – TITLE
BOISE, ID 2008-12-31

OPTION 1

DRAWING 4
SHEET 1 OF 1

DATE AND TIME PLOTTED
FEBRUARY 26, 2009 06:57
PLOTTED BY
CHIEF

CAD SYSTEM
AutoCAD Rel. 17.2s
CAD FILENAME
Drawing 4.dwg

HYDRAULIC CALCULATIONS

Pool and Chute Fishway - Design Spreadsheet

Project: Barber Dam Fish Passag

Indicates data input needed

Design Flow: 12 **cfs**

Indicates values to check

Baffle Slope: **76.0** degrees (See Figure 2)
Drop Between Weirs: **0.70** For Salmonids varies from 0.5 to 1.0
Weir Discharge Coef: **3.33**
V-notch Coef. 3.33

FISHWAY LAYOUT

Fishway Width (ft) W	Pool Length (ft) L	Weir Width (ft) b	Weir Height (ft) Pw	Notch Depth(ft) Pn	Baffle Height Weir (ft) Pb	Baffle Height Wall (ft)	Select Depth (ft) d	Fishway Slope (ft/ft) S
12	6.25	2	2.5	0.75	3.25	4.5	0.96	0.112
	52%	17%				Maximum	2.0	
	% of W	% of W						

FISHWAY HYDRAULICS AT HIGH PASSAGE DESIGN FLOW

	Depth (ft) d	Flow Area A	Wetted Perim (ft) Wp	Hydraulic Radius (ft) R	Top Width (ft) Tw	Velocity (fps) V	Flow (cfs) Q	Roughness Coefficient C	
Weir Plunging Flow (dwp)	N/A						0.00	N/A	
Weir Streaming Flow (dws)	0.96	1.92	3.92	0.49	2.00	6.09	11.69	26	See Figure 2
Baffle Plunging Flow (dbp)	0.21						0.27	N/A	
Baffle Streaming Flow (dbs)	N/A	0.00	0.00	0.00	0.00	0.00	0.00	N/A	N/A
							Weir Flow	11.96	

Total Flow 11.96

Unit Streaming Flow Weir (cfs/ft): 5.8
Unit Streaming Flow Baffle (cfs/ft): N/A
Pool Volume Factor Baffle: 0.1 Should be four or less
Pool Volume Factor Weir: 2.0 Should be four or less
Streaming Transition Flow (cfs): 4.96 Equation From Rajaratnam (1988)
Streaming Transition Depth: (ft): 0.82 Based on weir equation
Fish Passage Corridor (ft): N/A Should be two or greater

Pool and Chute Fishway - Design Spreadsheet

Project: Barber Dam Fish Passag

Indicates data input needed

Design Flow: 24 **cfs**

Indicates values to check

Baffle Slope: **76.0** degrees (See Figure 2)
Drop Between Weirs: **0.70** For Salmonids varies from 0.5 to 1.0
Weir Discharge Coef: **3.33**
V-notch Coef. 3.33

FISHWAY LAYOUT

Fishway Width (ft) W	Pool Length (ft) L	Weir Width (ft) b	Weir Height (ft) Pw	Notch Depth(ft) Pn	Baffle Height Weir (ft) Pb	Baffle Height Wall (ft)	Select Depth (ft) d	Fishway Slope (ft/ft) S
12	6.25	2	2.5	0.75	3.25	4.5	1.30	0.112
	52%	17%				Maximum	2.0	
	% of W	% of W						

FISHWAY HYDRAULICS AT HIGH PASSAGE DESIGN FLOW

	Depth (ft) d	Flow Area A	Wetted Perim (ft) Wp	Hydraulic Radius (ft) R	Top Width (ft) Tw	Velocity (fps) V	Flow (cfs) Q	Roughness Coefficient C	
Weir Plunging Flow (dwp)	N/A						0.00	N/A	
Weir Streaming Flow (dws)	1.30	2.60	4.60	0.57	2.00	8.05	20.93	32	See Figure 2
Baffle Plunging Flow (dbp)	0.55						2.99	N/A	
Baffle Streaming Flow (dbs)	N/A	0.00	0.00	0.00	0.00	0.00	0.00	0.0	N/A
						Weir Flow	23.92		

Total Flow 23.92

Unit Streaming Flow Weir (cfs/ft): 10.5
Unit Streaming Flow Baffle (cfs/ft): N/A
Pool Volume Factor Baffle: 1.1 Should be four or less
Pool Volume Factor Weir: 3.7 Should be four or less
Streaming Transition Flow (cfs): 4.96 Equation From Rajaratnam (1988)
Streaming Transition Depth: (ft): 0.82 Based on weir equation
Fish Passage Corridor (ft): N/A Should be two or greater Note: Close, call O.K.

VERTICAL SLOT FISHLADDER SPREADSHEET

Project name:	Barber Dam Vertical Slot Fish Ladder				
Condition:	**[Low Flow]**				
Tailwater elev.=	2776.83	FT	Number of slots=	2	
Forebay elev.=	2777.40	FT	Entrance drop=	0.00	FT
Slot size=	1.00	FT	Slot sill height=	0.50	FT
Cd=	0.75		Fishway slope=	4.00	%
Trashrack loss=	0.10	FT	Pool length=	10.00	FT
EP slab elev.=	2772.30	FT	Pool width=	6.00	FT
Average delta H=	0.24	FT	Computed forebay=	2777.41	FT
Trial delta H=	0.23	FT	Actual forebay=	2777.40	FT
Total head loss=	0.58	FT	Difference=	0.01	FT

POOL#	WS	SLOT SIZE	SILL ELEV	SLOT DEPTH	DELTA HEAD	Q SLOT	Cd	EDF
TW	2776.83							
ENTRY	2776.83		2772.30	4.53	0.00		0.75	
1	2777.06	1.00	2772.80	4.03	0.23	11.63	0.75	0.6
2	2777.31	1.00	2773.20	3.86	0.25	11.63	0.75	0.7

VERTICAL SLOT FISHLADDER SPREADSHEET

Project name:	Barber Dam Vertical Slot Fish Ladder					
Condition:	**[High Flow]**					
Tailwater elev.=	2777.23	FT	Number of slots=	2		
Forebay elev.=	2778.80	FT	Entrance drop=	0.00	FT	
Slot size=	1.00	FT	Slot sill height=	0.50	FT	
Cd=	0.75		Fishway slope=	4.00	%	
Trashrack loss=	0.10	FT	Pool length=	10.00	FT	
EP slab elev.=	2772.30	FT	Pool width=	6.00	FT	
Average delta H=	0.74	FT	Computed forebay=	2778.80	FT	
Trial delta H=	0.80	FT	Actual forebay=	2778.80	FT	
Total head loss=	1.57	FT	Difference=	0.00	FT	

POOL#	WS	SLOT SIZE	SILL ELEV	SLOT DEPTH	DELTA HEAD	Q SLOT	Cd	EDF
TW	2777.23							
ENTRY	2777.23		2772.30	4.93	0.00		0.75	
1	2778.03	1.00	2772.80	4.43	0.80	23.85	0.75	4.0
2	2778.70	1.00	2773.20	4.83	0.67	23.85	0.75	3.1

APPENDIX A

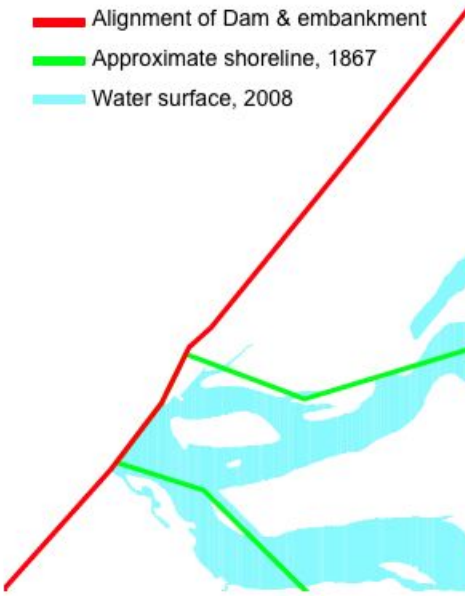
Barber Dam Embankment and Shoreline of Barber Pool area upstream of Barber Dam 1867 – 2008

The Bureau of Reclamation staff met with Trout Unlimited and other partners on site in April 2008 to inspect the project area and earthen embankment. The site visit aided in understanding site conditions and helped determine options for a local location for the outlet structure and fishway to connect Alta Harris Creek to Barber Pool.

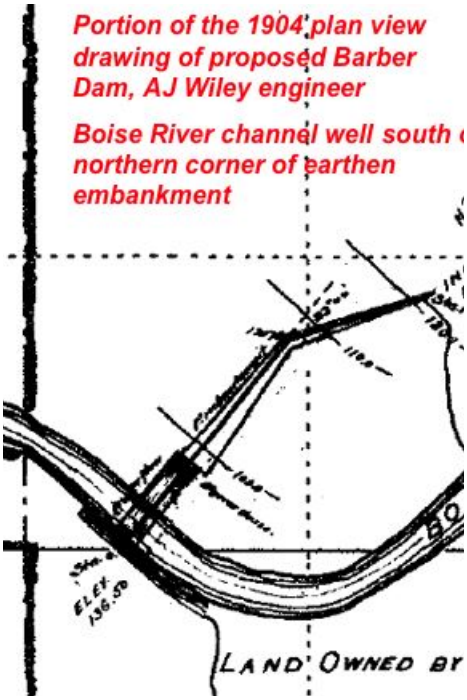
We also examined documents pertaining to Barber Dam and the earthen embankement, including the 1982 FERC license application, the *Barber Pool Conservation Area Master Plan and Inventory and Analysis* prepared by the US Army Corps of Engineers in 2002, as well as the *Barber Dam Hydraulic Analyses of Dam Breach Floods* prepared by the Montgomery Water Group, Inc. in 2000.

These documents and other sources including present day and historic photographs make it possible to understand changes along the shoreline of Barber Pool over time and the relationship with the earthen embankment.

The present day aerial photograph above shows the major features of the Barber Dam. At the southwest end lies a 400 foot wide spillway. In 1978, the face of the dam, a crib and timber structure then in poor condition, was sprayed with gunnite. Adjancent to to the spillway in a northeasterly direction is the powerhouse, which was reconstructed in the 1980s and put into operation in 1989. Between the powerhouse and spillway was a control gate and formerly a fish ladder which underwent major repair in 2008 after a significant leak was discovered in the dam. Finally, northeast of the powerhouse is a 750 foot long earthen embankment that is greatest in height net to the powerhouse and gradually tapers to its terminus with the wastewater lagoons and relic embankment/rail bed that served as a railroad spur.

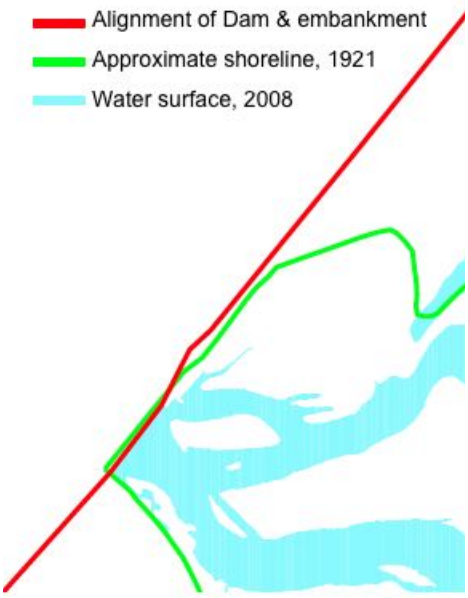


A cadastral survey of the Boise River in 1967 provides the basis to locate the shorline of the Boise River based on the notes maintained by survey workers (MacCoy and Blew 2005). The above illustration shows the approximate shoreline in 1867 (green lines) as very near that of the present day water surface of Barber Pool (blue). Barber Dam and embankment lie along a northeasterly direction under the red line.



By the turn of the 20th Century as plans for Barber Dam and sawmill were developed, the Boise River channel still lies in the same area as 1867, as shown in the 1904 plan view

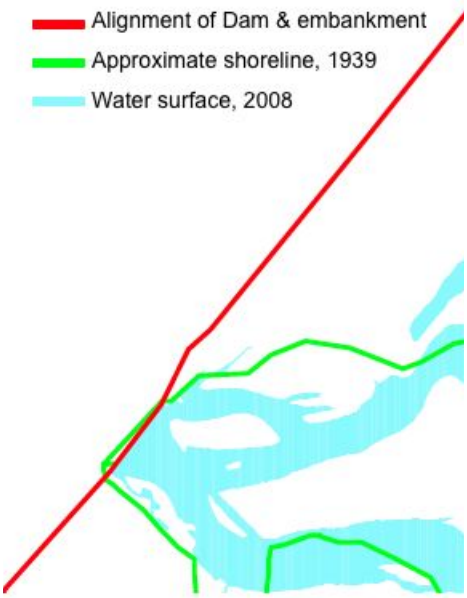
drawing of proposed Barber Dam. It is remarkable that in both illustrations that the earthen embankment portion of the dam lies considerable distance from the main river channel. Once constructed, however, the impoundment creates the Barber Pool that will back up water at a higher elevation.



By 1921 the Barber sawmill was in operation (for the second time) and log drives down the Boise River were abandoned in favor of a rail line built to the Boise Basin which brought logs to the mill. The water surface elevation is much higher and the surface area expands greatly along the upstream side of the Barber Dam and earthen embankement. As shown above in the green lines the shorline is adjacent to the embankment up to the point where the railroad spur line approached from a east-northeast direction.

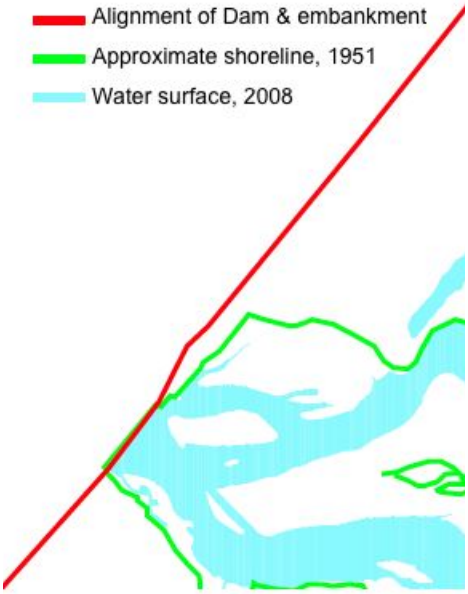
Historic photographs show that rail cars carrying logs were brought on the spur line up to the NE corner of the earthen embankment and the logs dumped into the Barber pool. By the time the most southern wastewater lagoon was constructed on the site, remains of logs were found in the area during excavation.

Other photographs show that gates were constructed across the spillway between 1907 when the sawmill operated for a few months before closing due to litigation, and 1915 when the mill reopened. A photograph from 1907 prior to the gates shows the water surface elevation similar to that of present day. With the gates in place by 1915 the water surface elevation was higher and surface area greater, consistent with the above illustration.

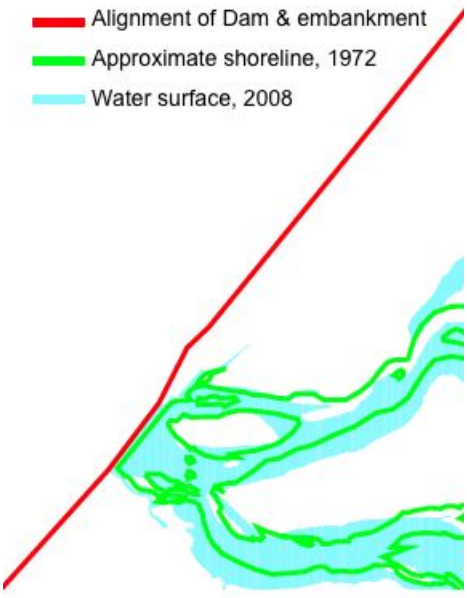


By the late 1930s the sawmill was long closed (operations moved to Emmett, ID) and much of the facility dismantled. The illustration above shows a change in the water surface area where the shoreline has receded from along much of the earthen embankement. To the south end the shoreline of an apparent island has taken shape.

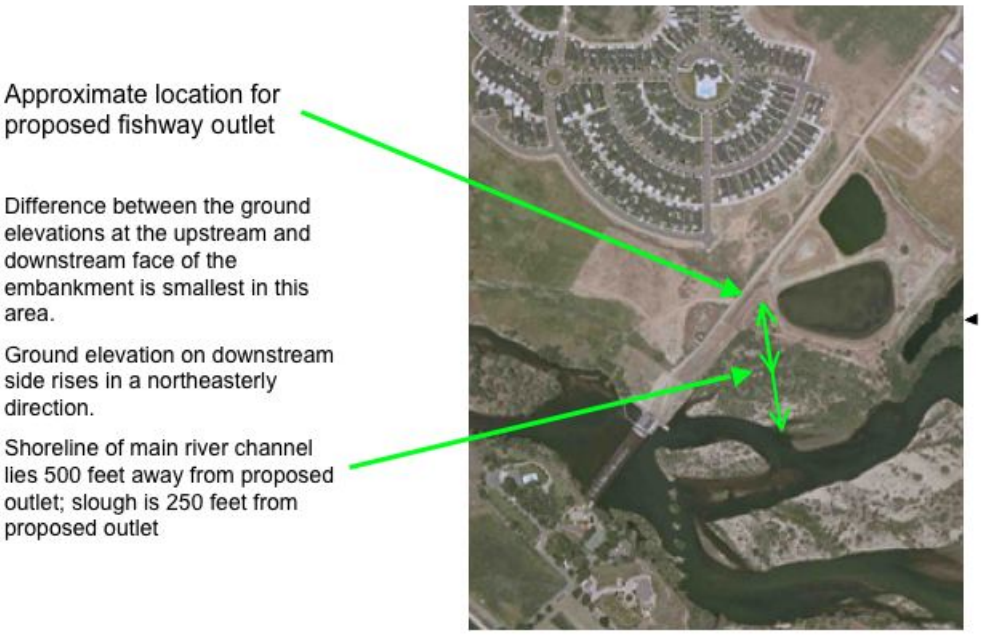
This aerial photograph from 1939 confirms the water area being lower and shoreline receded from the embankment.



Between 1939 and 1951 there is little apparent change in the shoreline with a portion of it next to the embankment at the southwest end near the powerhouse. One can surmise that the gates were still in place across the spillway in both years and water elevations somewhat lower than in 1921. Additional island areas also are appearing.



By 1972 the pool elevation and shoreline are very near the present day as reflected in the green lines close to the blue surface area. Except for the area immediately adjacent to the powerhouse the river once again lies a considerable distance from the earthen embankment just like the illustration from 1867 and 1904.



On the present day aerial photograph some features are pointed out indicating a proposed location for an outlet structure for a fishway that will connect Alta Harris Creek to Barber Pool. A small side channel or slough remains in the Barber Pool area approximately 250 feet, or halfway between the proposed outlet structure site and the main Boise River channel.

The Montgomery Water Group report notes that west of the earthen embankment that the ground elevations increase in a northeasterly direction until the end of the embankment. At this point the elevation of Lysted Road is 2772 MSL or about six feet higher than the yard next to the Barber Dam powerhouse. In it's analyses of dam breach scenarios the report selected the embankment immediately adjacent to the powerhouse as the point where a breach would occur because "This location has the largest difference between headwater and ground elevations and therefore represents the worst case for an embankment breach. If a breach occurs further north along the embankment, the ground elevation rises and a smaller breach flow would result."

The considerable distance from the main river channel to the northeast end of the embankment, and well as the closer match of ground elevation on the downstream side of the embankment make the northeast area of the embankment an attractive location for the outlet structure. Construction activity will have less impact on dam operations and can be done largely "in the dry" prior to conveying water to a new outlet structure.

APPENDIX B

Examples of Modifying Dams for Fish Passage
U.S. Bureau of Reclamation

When examining Barber Dam and the proposal for a fishway, Trout Unlimited became aware of the Bureau of Reclamation's considerable experience modifying existing dams for fish passage. A recent fishway project on Derby Dam is one appropriate example.

Derby Dam was constructed in 1903 through 1905 and is located on the Truckee River approximately 20 miles east of Reno, Nevada. The dam diverts Truckee River water into the Truckee Canal.

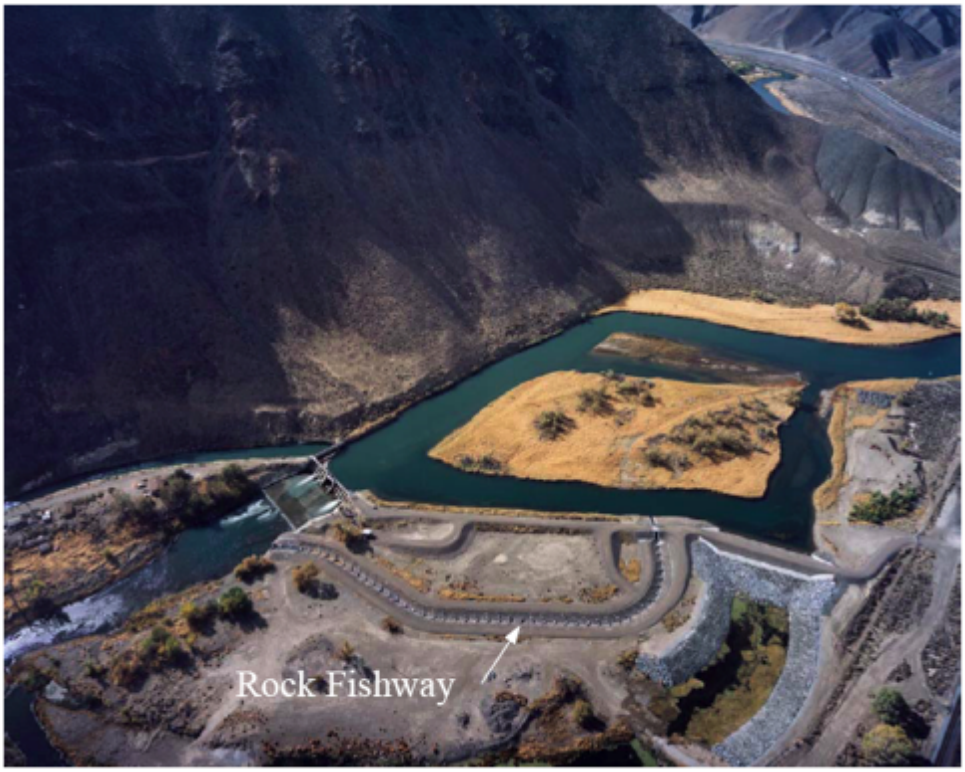
A late 1990s photo of Derby Dam with embankment area at the far side near parked cars. This area was identified for a new fishway.

Derby Dam is about the same height and age as Barber Dam, with a long earthen embankment, one that forms a shoreline for the Truckee River (unlike Barber Pool, which in some areas lies several hundred feet from Barber Dam.

Historically, the endangered cui-ui and threatened Lahontan cutthroat trout inhabited Pyramid Lake and migrated upstream in the Truckee River to spawn. Three structures impede fish movements between Pyramid Lake and the lower Truckee River: Marble Bluff Dam, immediately upstream of the lake; Numana Dam, 8.3 miles upstream; and Derby Dam about 34 miles upstream from Pyramid Lake. By the 1990s the fish ladder installed at Derby Dam 1908 was no longer present.

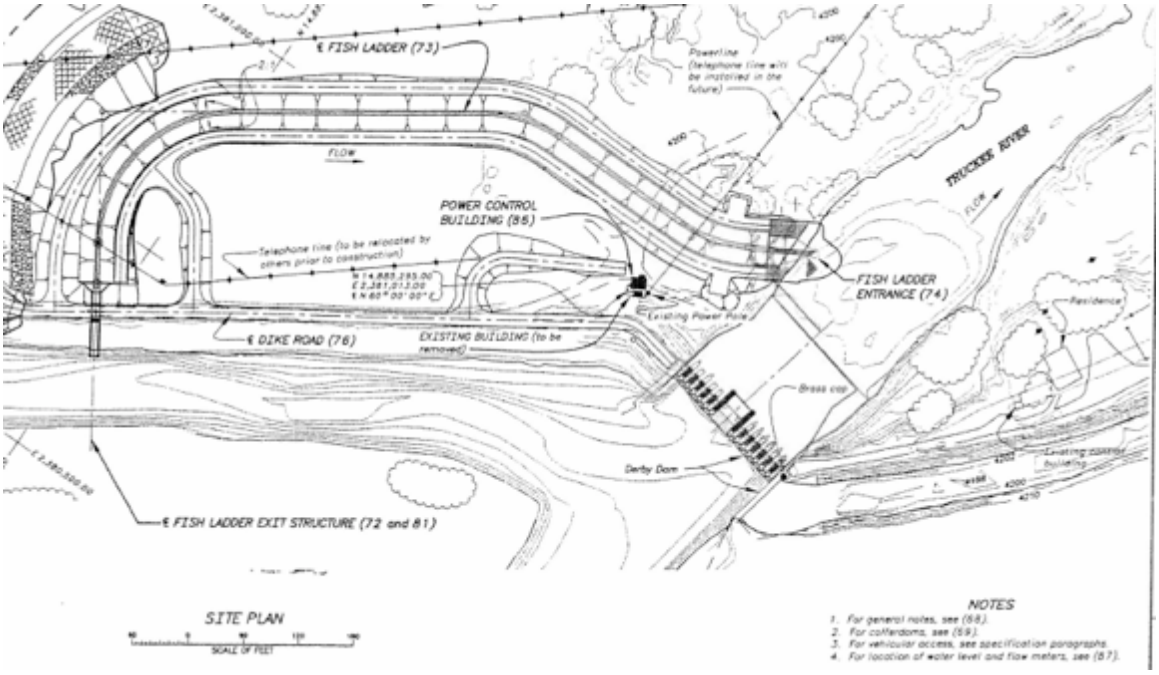
By the time of the dedication ceremony for the fish ladder and screen, the land on the far side along was graded and the embankment was modified to use for the fishway

With adequate room around the dam it was possible to locate an outlet structure in the embankment with enough length for the rock fishway to allow for the change in elevation.



This oblique aerial photo above demonstrates the use of the land along the embankment where the fishway was located. The photo below shows the outlet structure added into the embankment and its connection to the reservoir forebay supplying a gravity water flow to the rock fishway.

A plan view drawing for the Derby Dam Fish Passage Project. The outlet is shown where it will breach the dike.



Aerial photo below shows same location after fishway is constructed.

Photos of fishway construction.

Larger boulders in photos above and below provide the velocity cushions that aid in fish passage.

Above, fishway in operation.

Another Bureau Project on the San Juan River in New Mexico.

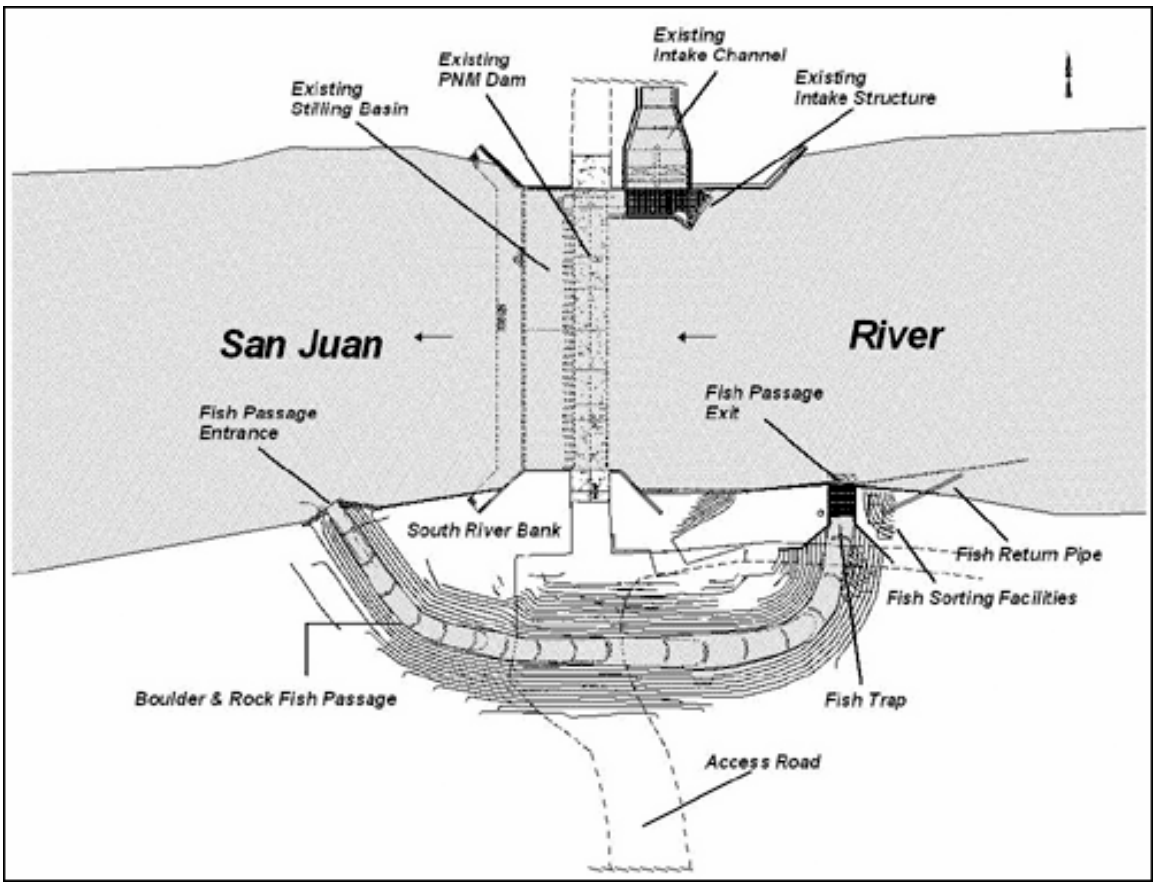


Figure 5-Public Service Company of New Mexico Diversion Dam Rock Fish Passage on the San Juan River, New Mexico

As with the Derby Dam project, the fishway on the San Juan River entails construction of an outlet structure into an existing embankment on the river bank.

Huntley Dam on the Yellowstone River in Montana was retrofitted with a bypass channel around the diversion that spans the river.

A closer view than the aerial shows the large rock used to armor the bypass channel.

The Bureau of Reclamation worked with the US Fish and Wildlife Service on this project, funded in part by the National Fish Passage Program.