Yakima River Basin Study

Fish Passage at Clear Lake Dam
Technical Memorandum

U.S. Bureau of Reclamation
Contract No. 08CA10677A ID/IQ, Task 4.1

Prepared by

Reclamation

HDR Engineering, Inc.

U.S. Department of the Interior
Bureau of Reclamation
Pacific Northwest Region
Columbia-Cascades Area Office

State of Washington
Department of Ecology
Office of Columbia River

March 2011

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The mission of the Department of the Interior is to protect and provide access to our Nation's natural and cultural heritage and honor our trust responsibilities to Indian tribes and our commitments to island communities.

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1.0 Introduction

This technical memorandum summarizes proposed fish passage facilities at Clear Lake Dam, a Bureau of Reclamation (Reclamation) water storage dam in the Yakima River Basin, southwest Washington (see Figure 1). Key elements for the storage facility are listed below (Reclamation 2005a, 2005b).

Table 1. Proposed Elements of Fish Passage Facility

Downstream Passage	see Fish Ladder
Upstream Passage/Adult Collection	see Fish Ladder
Barrier Dam	Not Applicable
Fish Ladder – Pool/Weir	Ladder, 55-pools, 1 foot w/s drop, Q = 5 to 25 cfs
Fish Conduit	157-foot-long, 5-foot-diameter HDPE pipe with light wells
Auxiliary System	10 cfs

This memorandum assimilates two fish passage documents prepared by Reclamation into one summary document. The two individual documents are as follows:

- Predesign Memorandum [Addendum] Clear Creek Dam Fish Passage Facilities, June 2005
- Predesign Memorandum [Temperature Control Curtain] Clear Creek Dam Fish Passage Facilities, August 2005

Technical content and conceptual design approach have not been altered. Some of the text has been modified for clarity.

1.1 Background

Clear Lake Dam is a small water storage facility with a pool/weir fish ladder. The entrance to this fish ladder is located approximately 1,000 feet downstream from the dam outlet, at the confluence of the emergency spillway and the river (see Figure 2). This exit of the existing fish ladder is at least 500 feet to the north of the dam within a shallow cove. During periods of low pool water levels, the fish ladder exit receives warm water from the shallow cove. The fish ladder is not used by migrating salmon due to potentially two reasons: the first is the small ladder supply water enters the river 1,000 feet downstream of the dam outlet; and the fish ladder's water supply is substantially warmer water than river water discharging from the dam outlet. Upstream migrating fish appear to stage where the colder water is released from the dam outlet works. Lack of passage also prevents fish such as bull trout from moving throughout the basin.

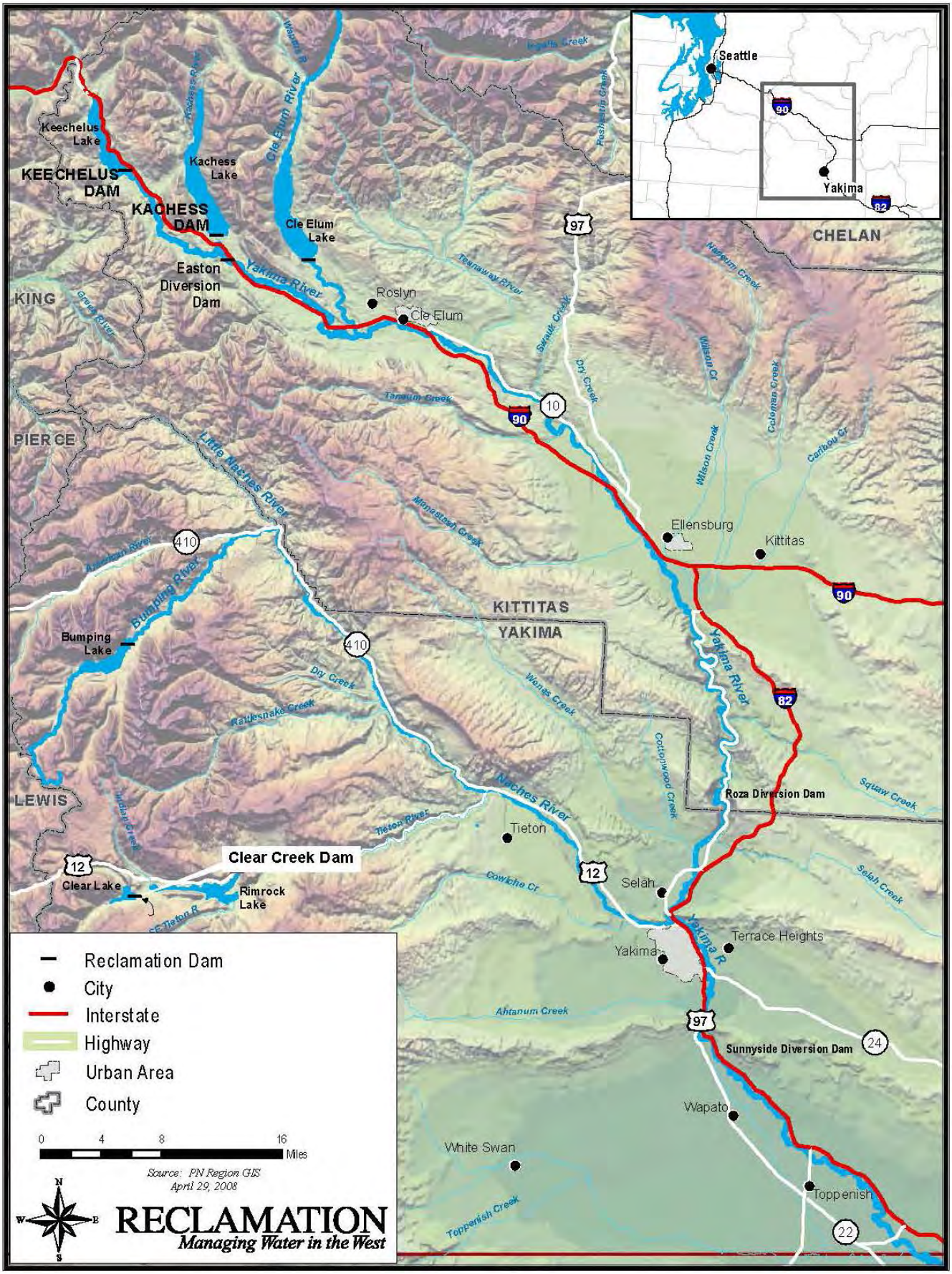

Figure 1. Clear Lake Dam Location

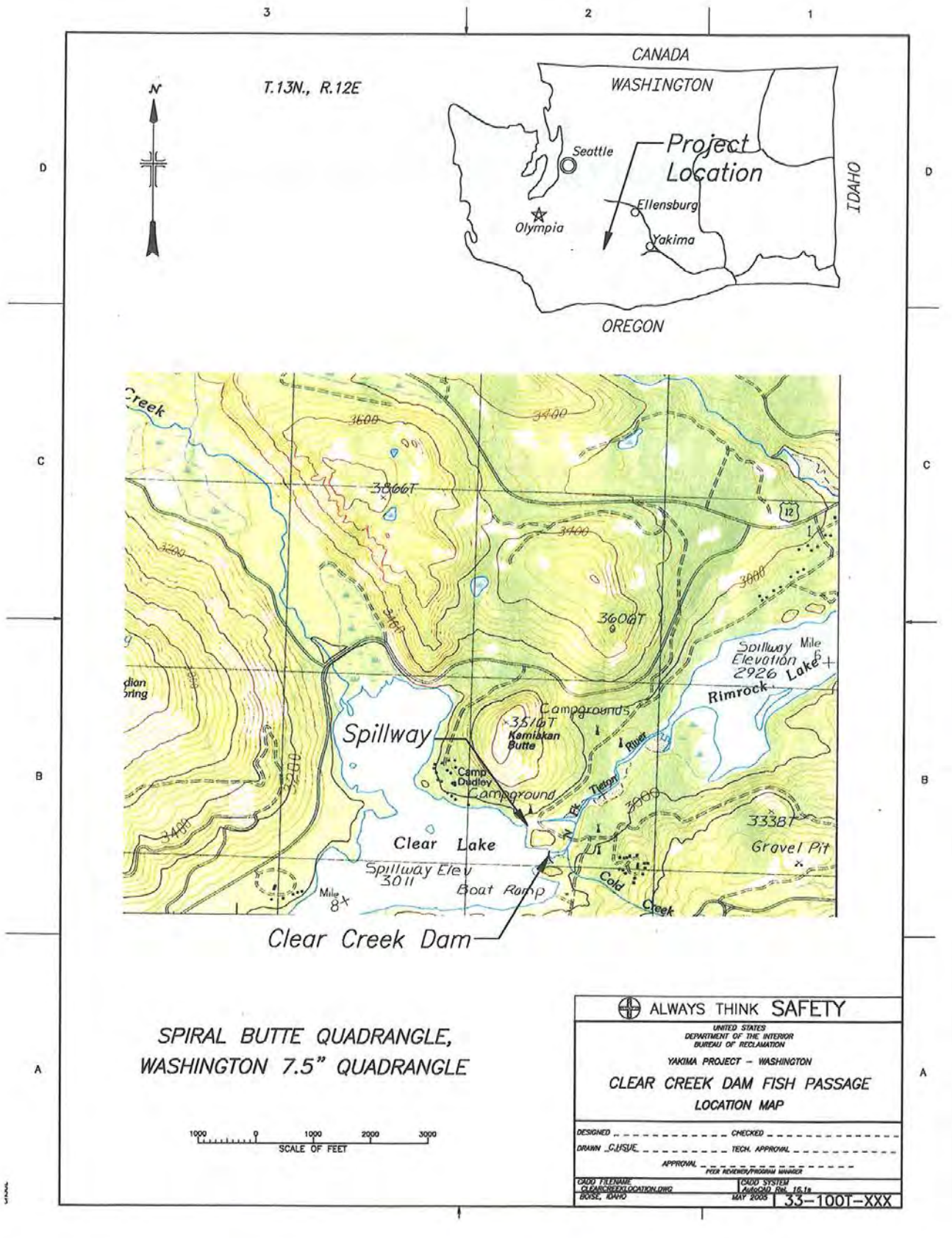

Figure 2. Clear Lake Dam and Spillway

2.0 Fish Passage Facilities

Clear Lake Dam is located upstream from Rimrock Reservoir on the Tieton River. Forest Service road 746 leads to the dam site from Highway 12. A staging area exists near the intersection of these two roads. An access road drops down off the Forest Service road just upstream from the bridge on the river and leads upstream toward the dam.

Releases from Clear Lake occur at the dam and spillway. Typically, spillway flow is much greater than dam flow in the spring, and then decreases by fall. The spillway has a pool/weir fish ladder that can be controlled at the upstream exit with 2-foot flashboards. The fishway can convey approximately 20 cfs before the spillway starts to spill. For the 5- and 95-percent exceedance condition, the combined exceedance flows are about 800 and 100 cfs, respectively. When providing passage at the dam, it is assumed that the upper spillway ladder would be shut down with flashboards and the flow that normally would occur at this structure would be reused at the dam for passage.

The dam outlet works has four gates that convey flow through the dam (two are 36-by-36 inches, one 18-by-18 inches, and one 48-by-48 inches). For the available period June 15, 1995 through November 30, 2003 (June through November only) the left 36-inch gate was the primary gate used to convey flows through the dam. Operation of these gates would not change if fish passage facilities were installed at the dam.

Proposed fish passage facilities for Clear Lake Dam (see Figures 3 and 4) consist of a new pool/weir fish ladder located on the left abutment of the dam (Reclamation 2005a, 2005b).

The pool/weir fish ladder would provide both upstream and downstream fish passage across Clear Lake Dam. Fish passage operations would be June 15 through October 15. Target fish for the ladder design are bull trout with size ranging from about 8 to 47 inches long. The following criteria were used to design the new pool/weir fishway:

CRITERIA	VALUE
Design Flow Condition	5- and 95-percent exceedance
Hydraulic Drop	12 inches
Weir Minimum Flow Depth	6 to 12 inches
Pool Minimum Flow Depth	4 feet
Pool Energy Dissipation Factor (EDF)	3 ft-lb/sec/cubic feet/second (cfs)
Pool Minimum Length	10 feet
Maximum Ladder Slope	10 percent
Maximum Orifice Velocity	5 fps
Fish Screen Approach Velocity	0.2 fps (max)
Fishway Exit Trashrack Bars	5- to 10-inch bar spacing
Fishway Exit Velocity	2 fps (max)

The existing pool/weir ladder in the spillway was analyzed for the 5- and 95-percent exceedance elevations in the lake. The river downstream from the dam was re-modeled to determine the proposed dam ladder's tailwater for the 5- and 95-percent conditions. Fish passage flow for the 5- and 95-percent condition was calculated to be 25 and 5 cfs, respectively, and added to the existing 5- and 95-percent dam spill flows of 103 and 11 cfs.

The ladder's tailwater elevations for the 5- and 95-percent design conditions were modeled to be 2,957.35 feet for the 5-percent design condition and 2,956.22 feet for the 95-percent design condition. The headwater conditions in the lake for the 5- and 95-percent exceedance conditions were 3,012.5 feet and 3,011.1 feet, respectively. The total head differential needed for a ladder to provide passage for fish was calculated to be 55.15 feet. Individual pool volume requirements (meeting National Marine Fisheries Service EDF of 3) resulted in a pool size 10 feet long, 6 feet wide, and approximately 5 feet deep. With 1 foot head loss across each weir, it would require a ladder 540 feet long (550, including the exit pool). A weir length of 30 inches was chosen with an orifice 14.2 inches square. Both the orifice and weir would flow for the 5-percent flow condition. At the 95-percent exceedance condition, only the orifice would flow.

2.1 Downstream/Upstream Fish Passage

As shown in Figure 3, the proposed pool/weir fish ladder would be constructed on the left abutment of the dam, which has considerable amounts of shallow bedrock that require techniques that minimize rock excavation. The existing concrete wall on the dam's left abutment would not be saw cut. The rock abutment next to this wall would be removed and a 5-foot-diameter HDPE pipeline with light wells would run for 157 feet to connect with a new fish ladder that would continue for 550 feet along the access road and around the hillside down to the river. The ladder would have 55 steel-plate weir drops (half Ice-Harbor style). The Ice-Harbor style uses an orifice below the weir to facilitate flow conveyance. Resting pools would be located along the 550-foot alignment. To be more benign, the ladder would be covered with HDPE dark grating and embankment placed against the walls wherever they extend above the existing ground surface.

An auxiliary attraction flow system would be employed to make the ladder more accessible to upstream migrating fish at higher river flows. This system would consist of a fixed-plate fish screen at the inlet in the ladder exit pool, 161 feet of 18-inch welded steel pipe anchored on the ground surface, a series of baffles for energy dissipation at the outlet in the fishway entrance pool, and a metal diffuser. It would be controlled with a 2-foot-square slide gate on the upstream end of the pipe. Two concrete thrust blocks would be constructed for the pipeline that would be encased in concrete at the beginning and ending points.

2.2 Fish Passage Conduit

A 5-foot-diameter HDPE pipeline would be used to connect the upstream ladder with the dam pool, minimize excavation and disturbance of the left rock abutment, and minimize cost (see Figures 3 and 4). The pipe would flow under pressurized conditions at velocities below 0.8 fps with high flow conditions, and below 0.4 fps under open channel conditions with low flow conditions.

2.3 Auxiliary Attraction Water

An auxiliary pipeline designed to convey a maximum of 10 cfs would be installed to create attraction to the fishway at higher river flows (see Figure 5). Auxiliary flow would enter the system in the fishway exit pool. The pipe would use a single fixed-flat plate fish screen 10 feet wide and 7 feet tall (including 2 feet of freeboard). Maximum design approach velocity through the screen is 0.20 fps. Lightweight grating would be used above the screen for accessibility and manual cleaning. It is not anticipated that there would be substantial floating debris due to drawing water under the proposed temperature curtain. Bedload is also assumed to be low.

A single 2-foot-square, manually-operated gate in the fishway exit pool would control flows to the auxiliary pipeline. The gate would be open 24 percent to convey 10 cfs when the lake is at the 5-percent

exceedance water surface elevation of 3,012.5. As the reservoir water surface declines, the gate can be adjusted open to maintain 10 cfs if desired. A single steel welded pipeline 161 feet long with inside diameter of 18 inches would be required to convey the maximum design flow of 10 cfs. The upstream and downstream invert elevations would be 3,006.1 and 2,951.2, respectively. Maximum velocity in the pipe would be 5.66 fps with 10 cfs flowing. The pipeline would require supports with saddles to anchor to the bedrock at 20-foot intervals. Two concrete thrust blocks would be located along the pipeline length.

Two rows of baffles, with 6-inch clearance between baffles, would be located at the pipe outlet in the ladder entry pool. The baffles would be 7 feet tall and 4 feet wide. Maximum approach velocity to the baffles would be 5.6 fps. Maximum head loss across the baffles at maximum design flow would be 0.48 feet. A single diffuser, 7 feet high and 4 feet wide, would be required just downstream from the baffle in the entry pool of the fish ladder. The diffuser would be located near the first weir of the ladder to utilize ladder flow for diffuser sweeping flows. Velocity through the diffuser would be designed for 1 foot per second. The pipeline would have at least two concrete thrust blocks, about 3 to 4 cubic yards each, at the sharpest bends of the alignment.

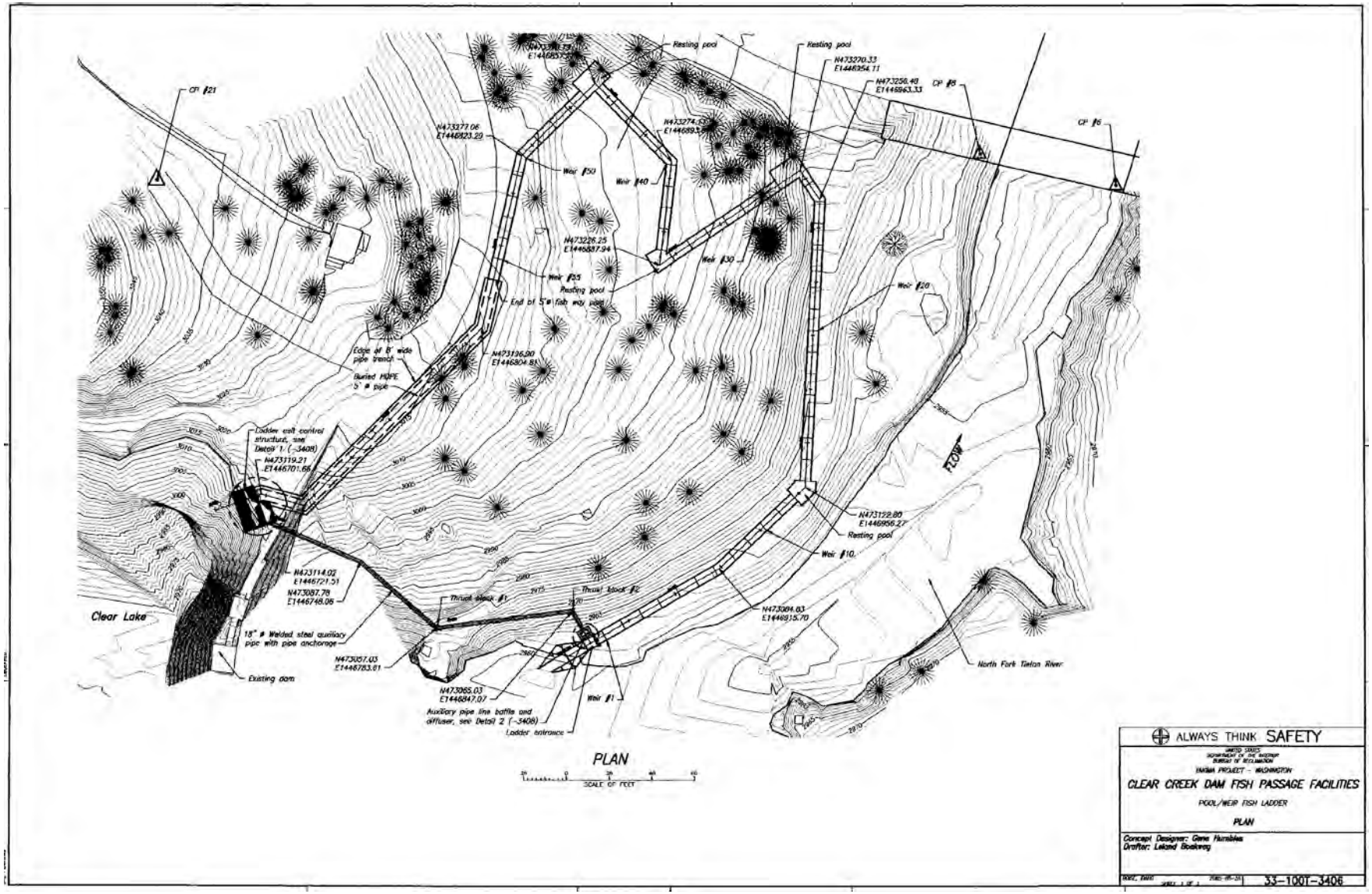

Figure 3. Proposed Plan of New Fish Ladder for Clear Lake Dam

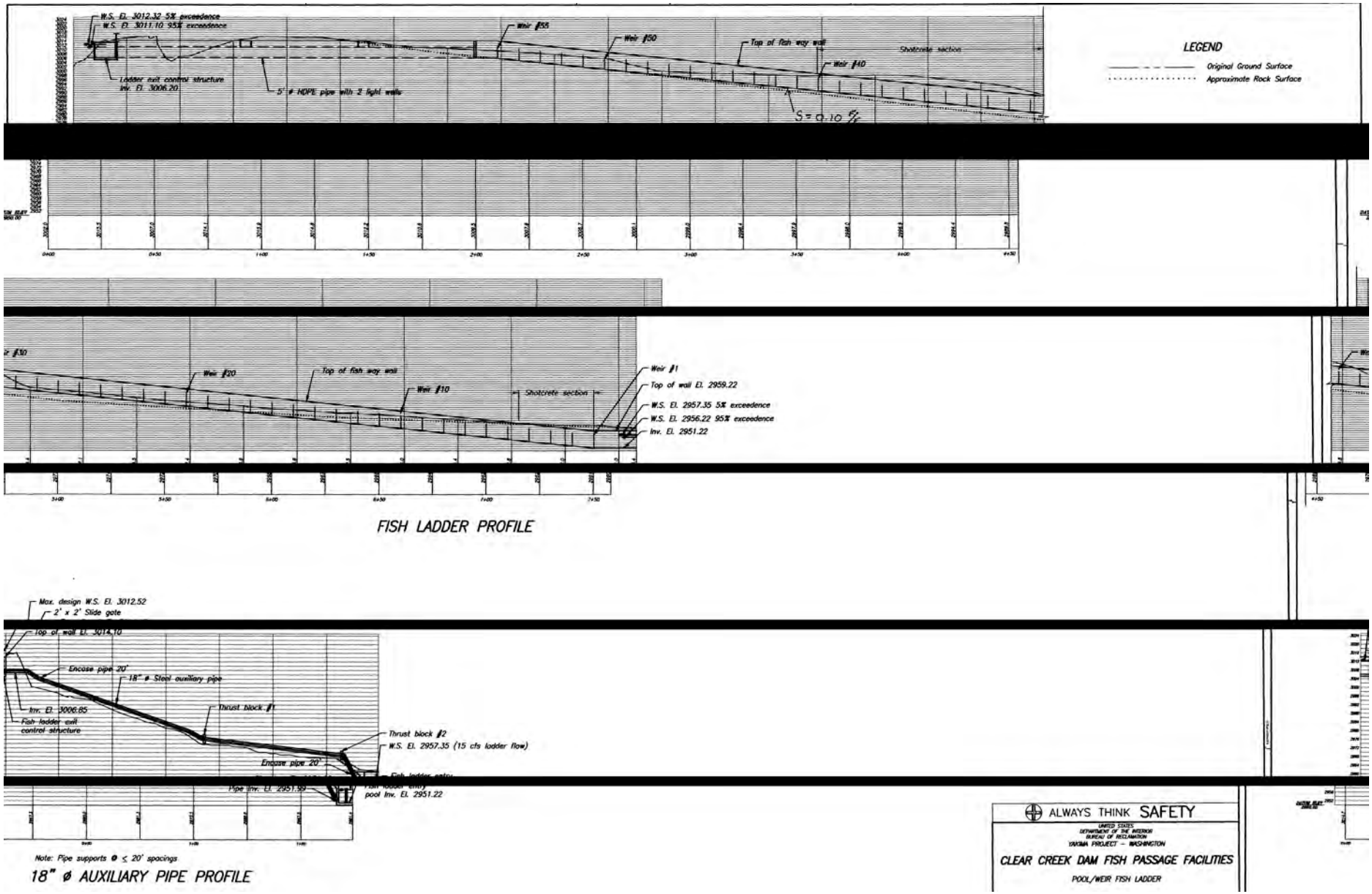

Figure 4. Proposed Sections of New Fish Ladder for Clear Lake Dam

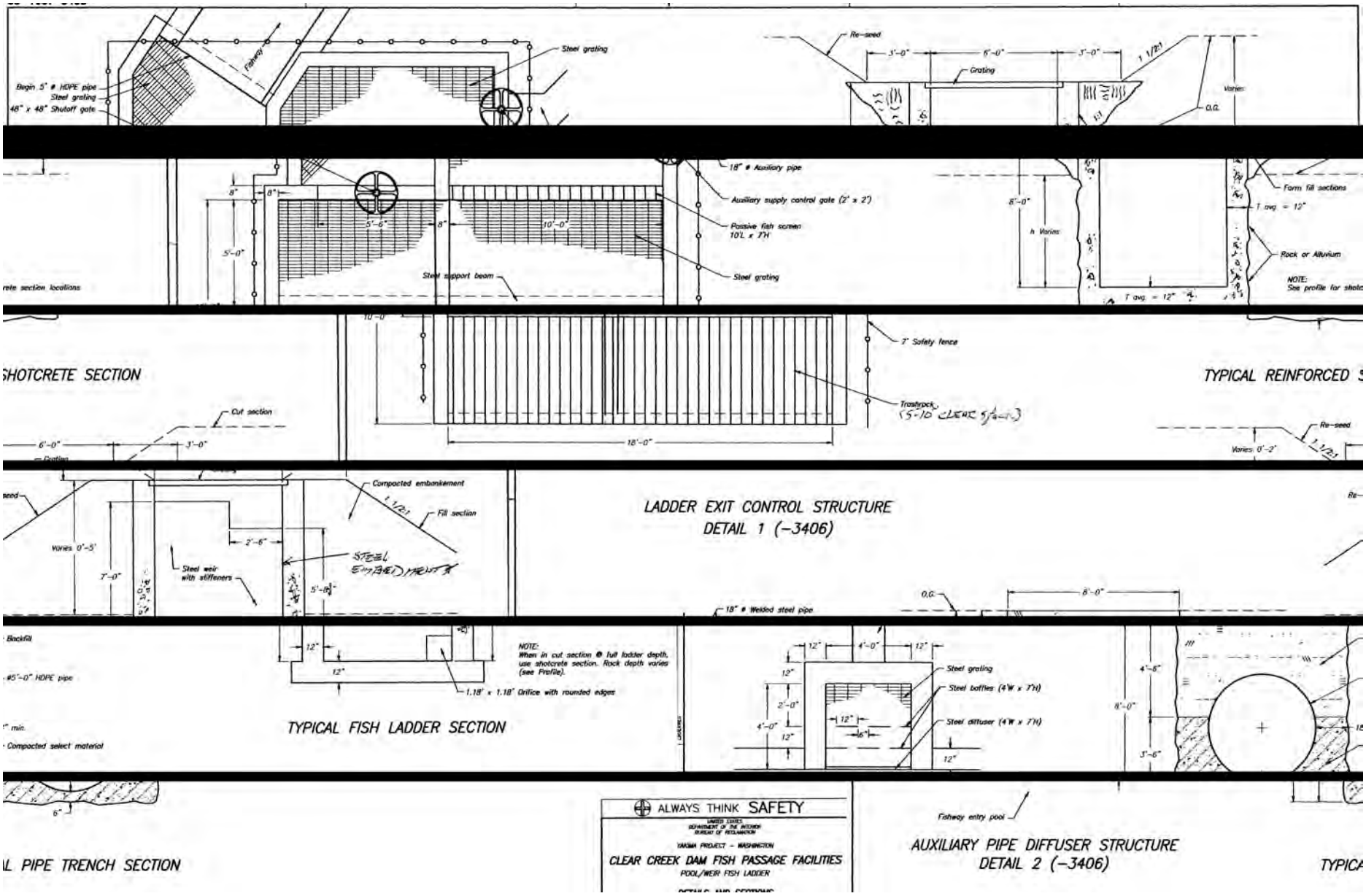

Figure 5. Auxiliary Water Supply Details for Proposed New Fish Ladder at Clear Lake Dam

3.0 References

Reclamation. 2005a. Predesign Memorandum (Addendum), Clear Creek Dam Fish Passage Facilities. June 2005. U.S. Department of Interior, Bureau of Reclamation.

Reclamation. 2005b. Predesign Memorandum (Temperature Control Curtain), Clear Creek Dam Fish Passage Facilities. August 2005. U.S. Department of Interior, Bureau of Reclamation.

4.0 List of Preparers

Name	Background	Responsibility
HDR Engineering, Inc.		
John Nelson	Fisheries Engineer	Fish Screening and Passage Designer