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Managing Water in the West

Elwha River Restoration through the Removal of Elwha and Glines Canyon Dams

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U.S. Department of the Interior
Bureau of Reclamation

Elwha Project Highlights

- **Largest dam removal and river restoration project in U.S. history**
 - Dam removal contract awarded Aug 2010 by NPS
- Removal of Elwha and Glines Canyon Dams will open up 70 miles of the Elwha River in northwestern Washington for fish passage
- Pacific salmon populations are estimated to climb from 3,000 to 400,000 within 25 years

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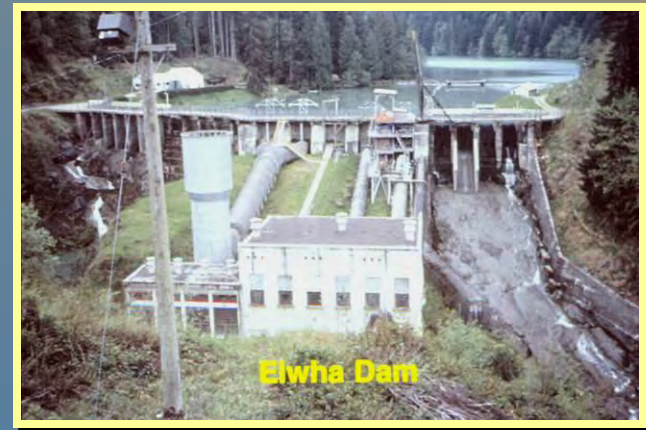
Elwha River Location and Sites



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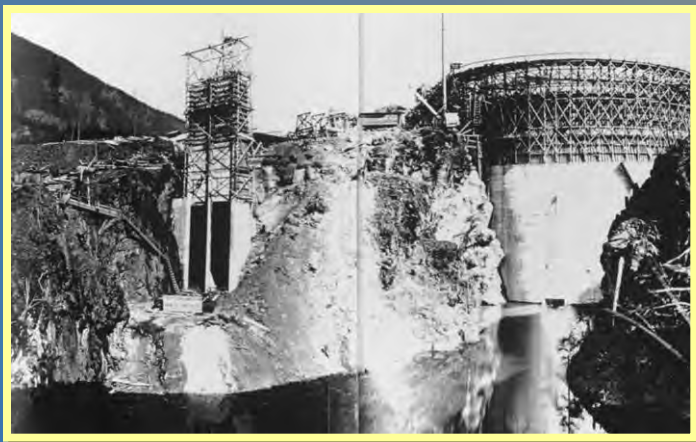
Elwha Dam

- **Built 1913 at RM 4.9**
- **Concrete gravity dam**
- **108 feet high**
- **Two gated spillways**
- **Stabilizing fill upstream
(200,000 cubic yards)**
- **Three high penstocks**
- **12 MW plant (four units)**
- **Run-of-river operation**
- **8,600 a-f storage
(Lake Aldwell)**

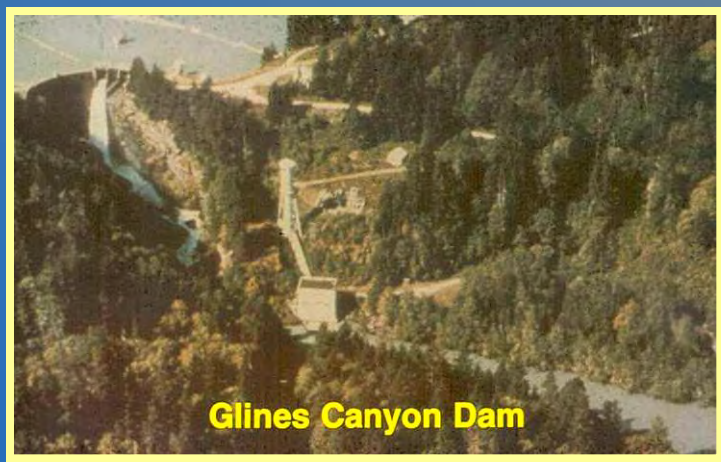


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Glines Canyon Dam



- Built 1927 at RM 13.4
- Concrete thin arch dam
- 210 feet high
- One gated spillway
- One mid-level penstock
- 16 MW plant (one unit)
- Run-of-river operation
- 25,800 a-f storage
(Lake Mills)



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Elwha Project Issues

FERC Licensing Issues:

- Glines Canyon Dam FERC license has expired
- Elwha Dam never licensed by FERC

Endangered Species Act (ESA) Issues:

- Fish passage blocked for listed species for 100 years

Native American trust responsibilities:

- Fishing rights granted under Treaty with U.S.
- Cultural site impacts for Lower Elwha Klallam Tribe
- Tribe first moved for removal of both dams in 1986

Dams blocked natural sediment transport to Ediz Hook

Glines Canyon Dam is within Olympic National Park

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Elwha Project Legislation - 1992

Elwha River Ecosystem and Fisheries Restoration Act:

- Suspended FERC relicensing issues
- Required Federal (DOI) studies to fully restore ecosystem and anadromous fisheries to Elwha River
- Provided for project acquisition by U.S. Government at a fixed price (\$29.5 million) from a private owner (James River paper mill in Port Angeles)
- Ensured affected parties would remain whole:
 - Maintain quantity and quality of water supplies
 - Maintain flood protection
 - Protect cultural resources

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Elwha Project – Removal Decision

NPS assigned lead responsibility to prepare EIS:

- **Programmatic EIS (1995) – Evaluated alternatives and supported removal of both dams**
- **Implementation EIS (1996) – Evaluated specific removal methods and supported sediment erosion**
- **Supplemental EIS (2005) – Updated EIS details**

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Reservoir Sediment Issues



**Lake Aldwell
(Elwha Dam)**



**Lake Mills
(Glines Canyon Dam)**

Deltas

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2010 Reservoir Sediment Volumes

24 million yd³ ± 4 million yd³

Lake Aldwell – 4 mcy

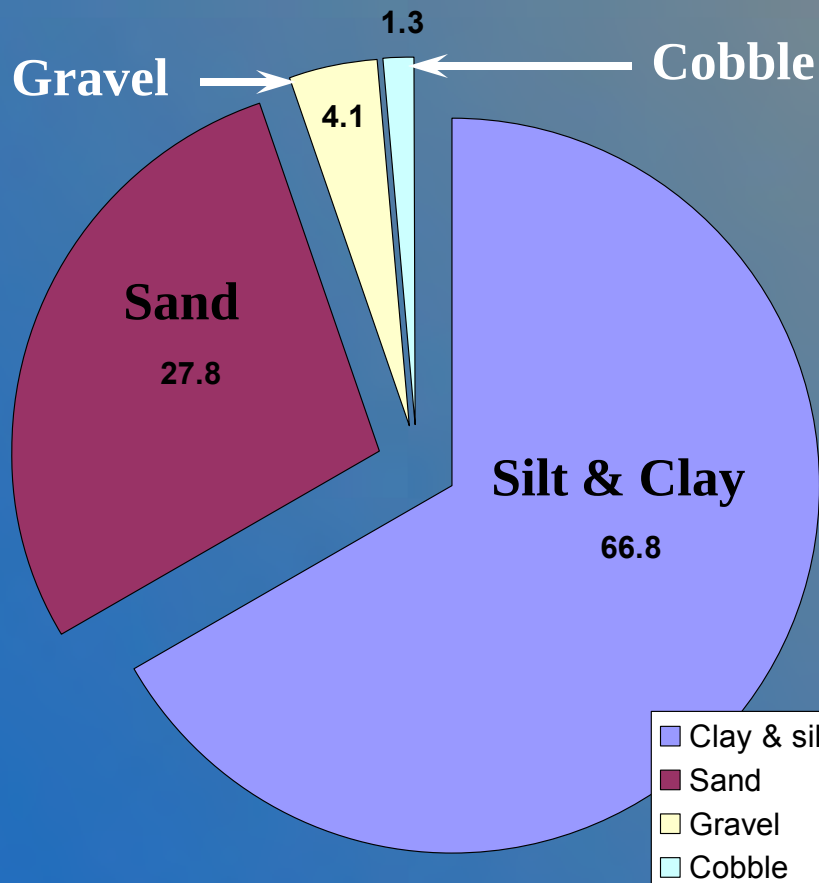
Lake Mills – 20 mcy



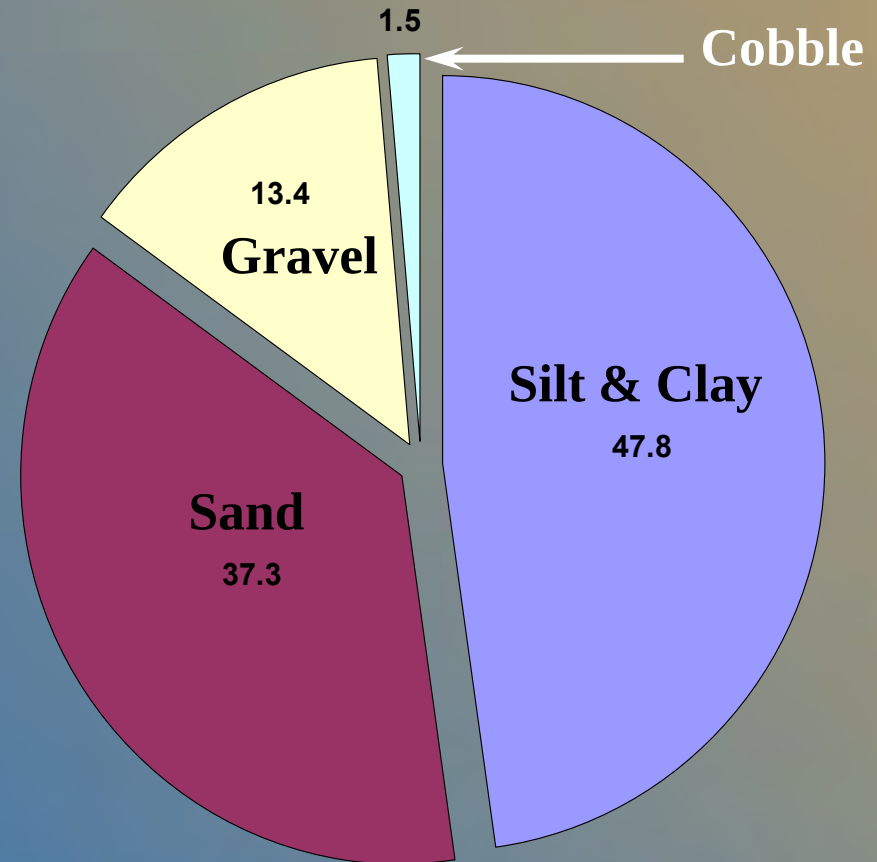
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Sediment Grain Size Distributions

Lake Aldwell



Lake Mills



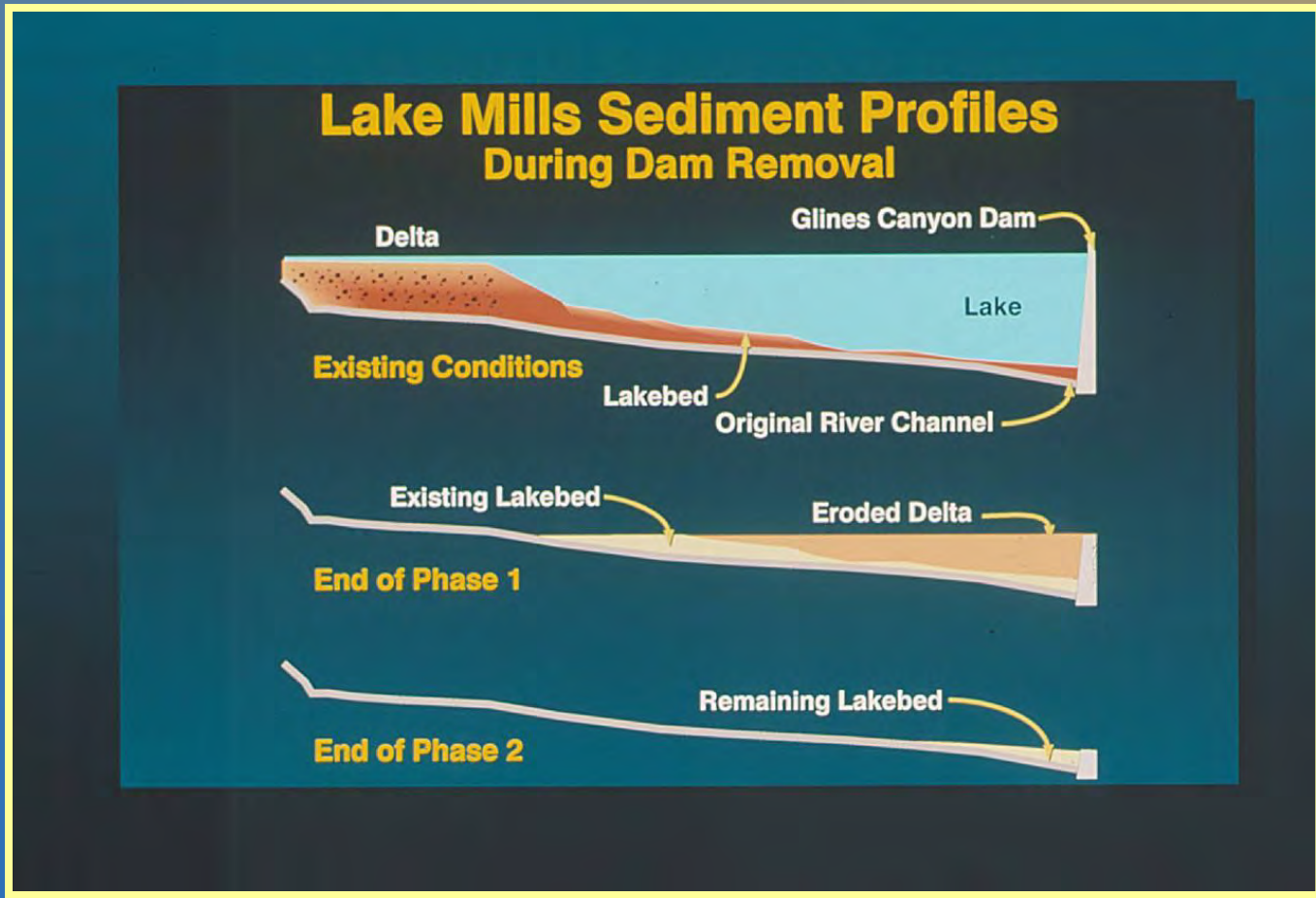
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Sediment Management Plan

- **Remove Elwha and Glines Canyon Dams concurrently, in controlled increments, over a 2 to 3 year period**
- Limit reservoir drawdown rate to 1.5 or 2 feet per day for slope stability and sediment erosion
- Provide reservoir hold periods at 10 – 20 foot intervals for up to 14 days
- No reservoir drawdown and sediment release during critical migration periods for fish: May – June, August – September 15, and November – December (5.5 months)
- Limit turbidity to 40,000 ppm at downstream intake for water treatment plant

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Staged Drawdown – Lake Mills



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Environmental Mitigation

Flood Protection - due to coarse sediment deposition

- Raise existing levees up to 3 feet
- Replace existing wells and septic systems

Water Quality Protection - from increased turbidity

- Construct new surface diversion intake on river
- Construct new water treatment plants for city and industrial users – Port Angeles and Nippon Paper Mill
- Maintain water supply to State and Tribal hatcheries

Fish Hatchery Improvements – to protect broodstock

- Improvements to State fish-rearing facility
- Replacement of Tribal fish hatchery

Replacement Power – from Bonneville Power Admin

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Fish Ramp and Diversion Weir

(River Mile 3)



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Elwha Water Treatment Plant



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Elwha Westside Levee



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New Tribal Hatchery and Rearing Pens



Source: Keith Thorpe, Peninsula Daily News

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Dam Removal Project Objectives

- Safely remove Elwha and Glines Canyon Dams to provide a free-flowing river at both sites
- Pass river flows throughout dam removal
- Facilitate sediment management through controlled releases and construction work schedules
- Minimize downstream impacts to fisheries
- Restore Elwha Dam site to near pre-dam conditions
- Remove Glines Canyon arch dam section but retain gated spillway and thrust block on the abutments for historical preservation and public viewing

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Dam Removal Process

- Acquisition by DOI (February 2000)
 - Obtained property and water rights
 - Responsible for O&M, Dam Safety (BOR)
- Designs and Specifications (BOR)
 - Established removal limits and sequence
 - Schedule constraints (seasonal, environmental)
 - Cost estimates based on assumed methods
- Permitting (BOR)
 - Clean Water Act (401- WDOE, 404 - USACE)
 - Hydraulic Project Approval (WDFW)
- Dam Removal Solicitation issued March 2010 by NPS

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Contracting Method for Dam Removal

Request for Proposals (Negotiated Procurement)

- **Technical Proposal**
 - Alternative channel alignment(s) at Elwha Dam
 - Alternative notching methods for Glines
 - Concrete demolition methods
 - Waste removal methods (cranes, cableway)
 - Proposed schedule
- **Cost Proposal**

Awarded to Barnard Construction based on technical and cost factors providing “best value” to Govt.

Construction management contract to URS Corp.

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Plant shutdown June 1, 2011



Source: Keith Thorpe, Peninsula Daily News

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Elwha Dam – Drawdown Capacity



- Nine 13.75-foot-wide by 19-foot-high spillway gates available (123.75' crest length)
- Penstocks ineffective – intakes too high
- Four original diversion outlets plugged, buried

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Lake Aldwell Initial Drawdown



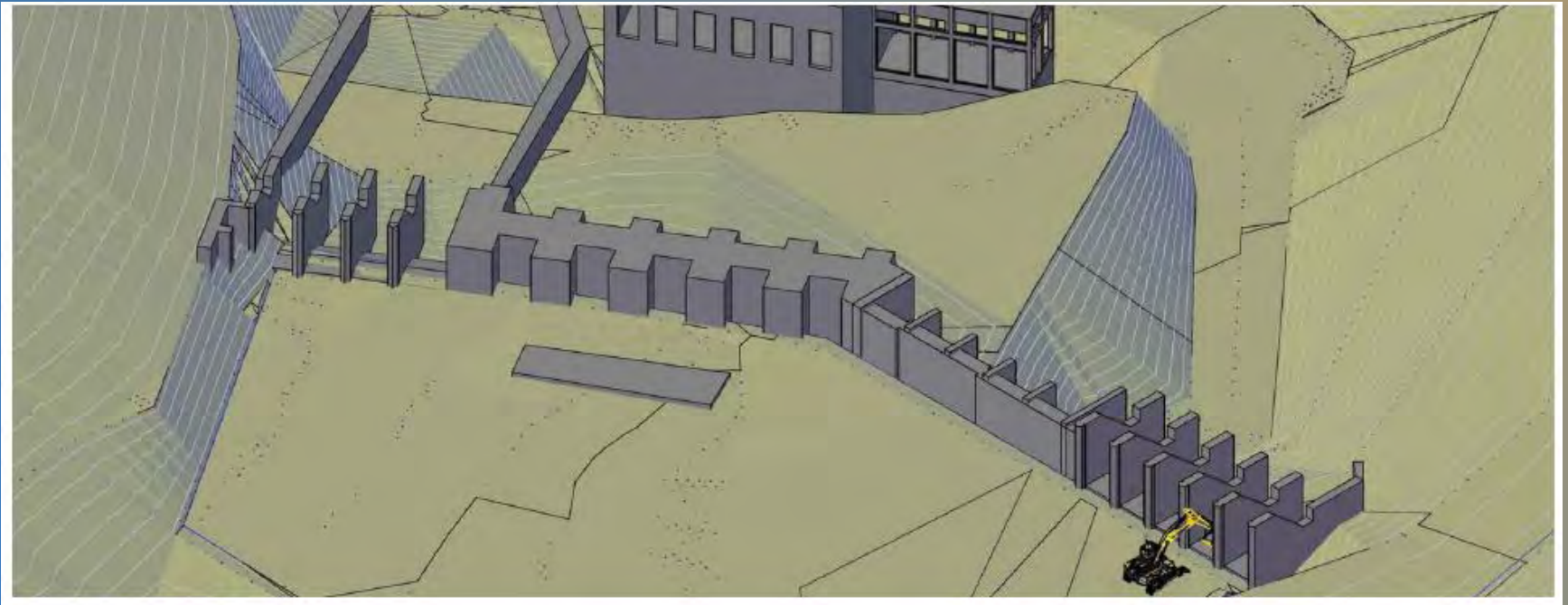
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Elwha Dam – Unwatered Forebay



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1. Remove Right Spillway to Grade, Divert Through Left Spillway



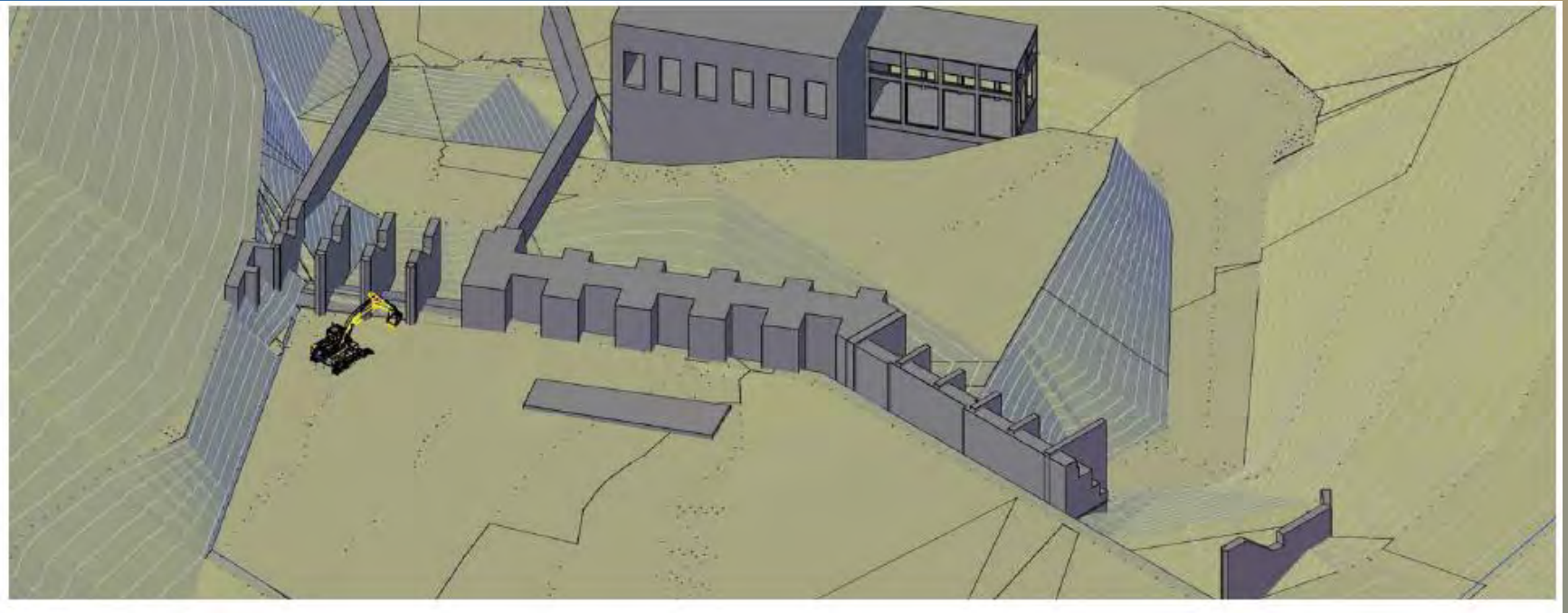
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Elwha Demolition - Sept 19, 2011



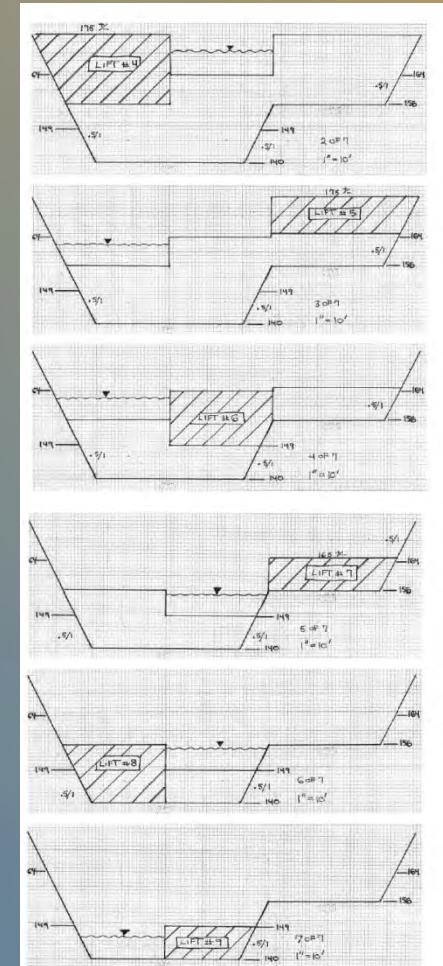
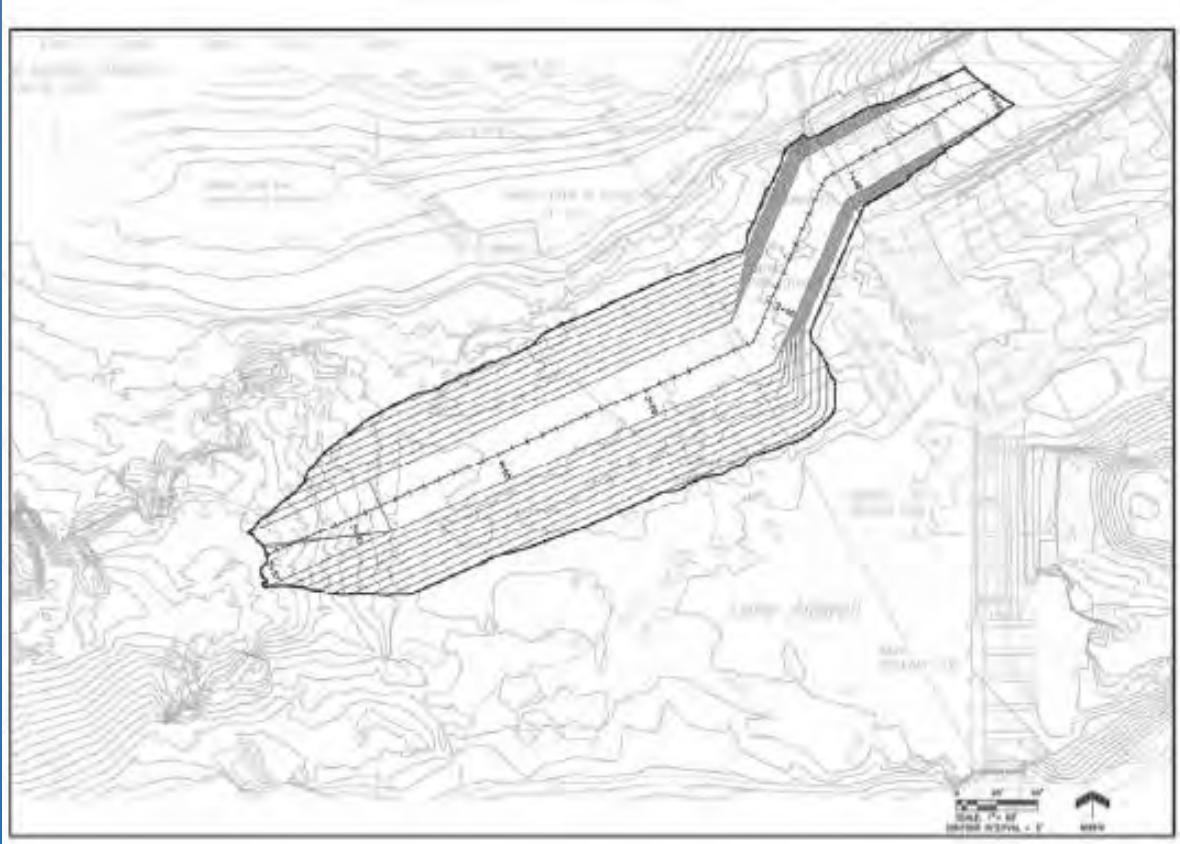
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2. Remove Left Spillway to Grade, Divert Through Right Side



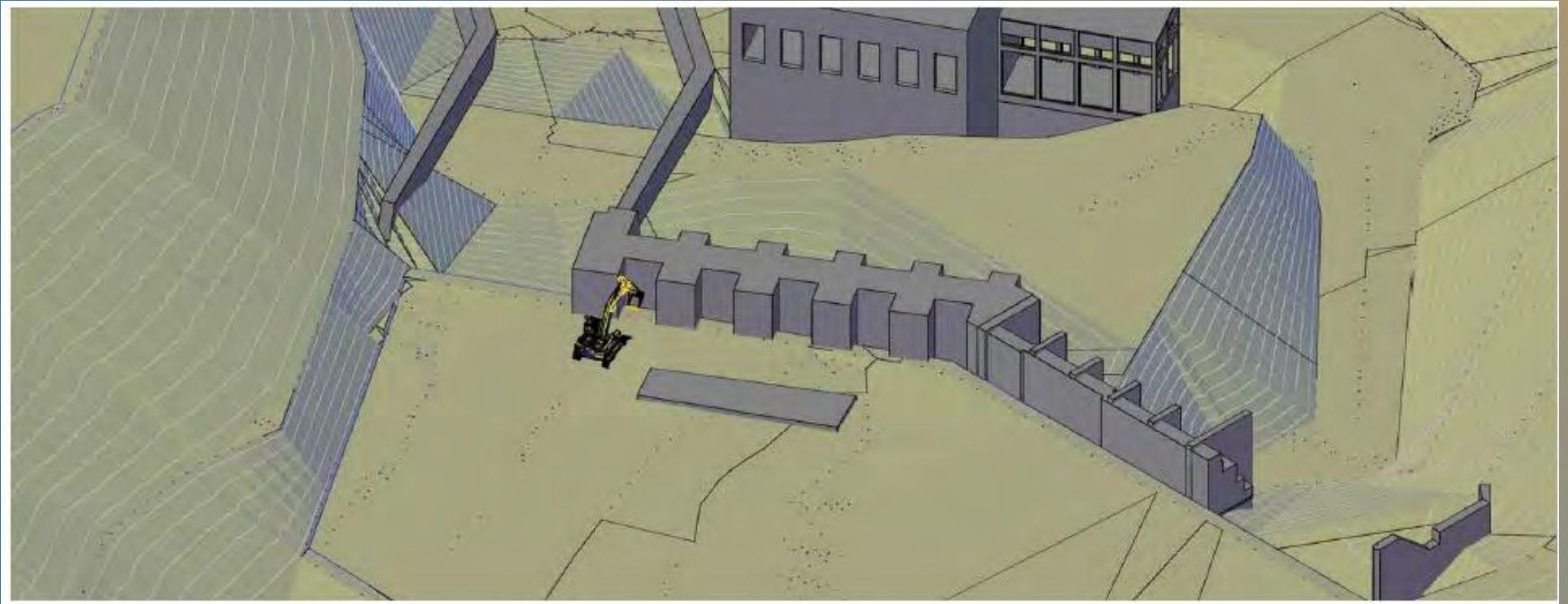
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3. Excavate Diversion Channel in Lifts



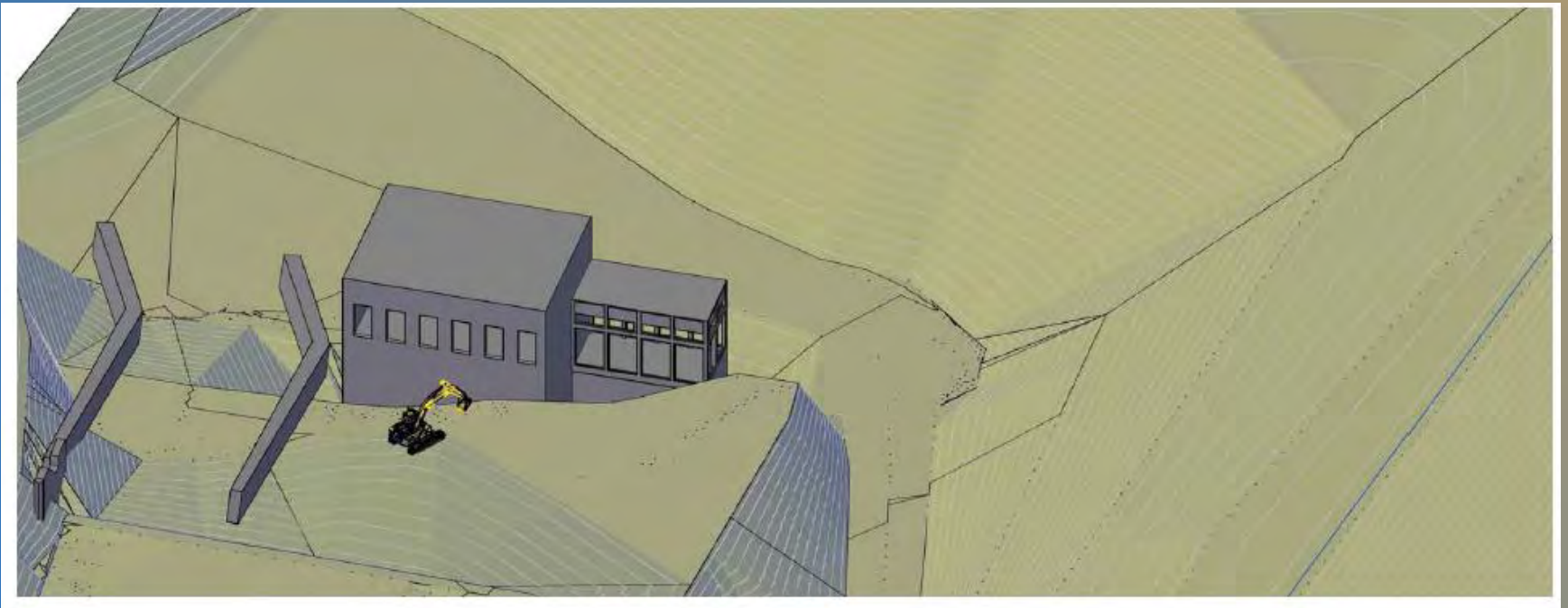
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4. Remove Intake Structure, Divert through Left Side



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5. Remove Steel Penstocks, Surge Tank, and Powerhouse

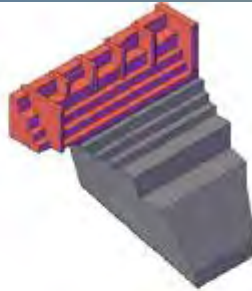


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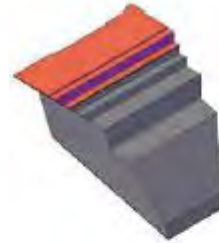
6. Remove Gravity Dam Section in Lifts and Divert to Right Side



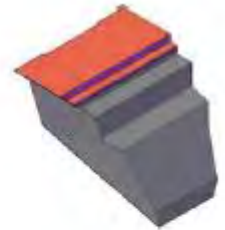
Existing



Step 1



Step 2



Step 3



Step 4



Step 5



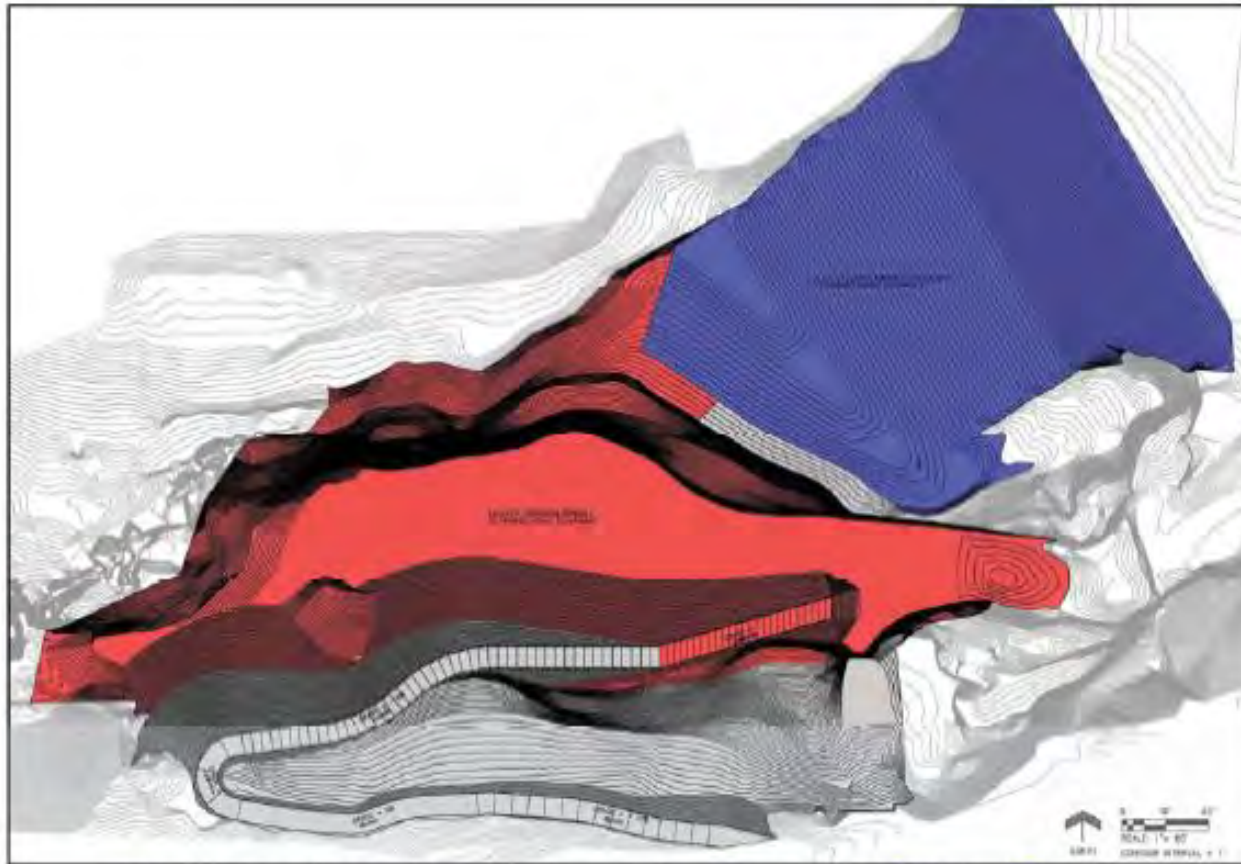
Step 6



Step 7

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7. Remove Forebay Materials and Construct Left Embankment



Finished Grading and Forebay/Gravity Dam Removal to Finished Elevation

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Elwha Dam – Full Removal

(Artist Rendition)



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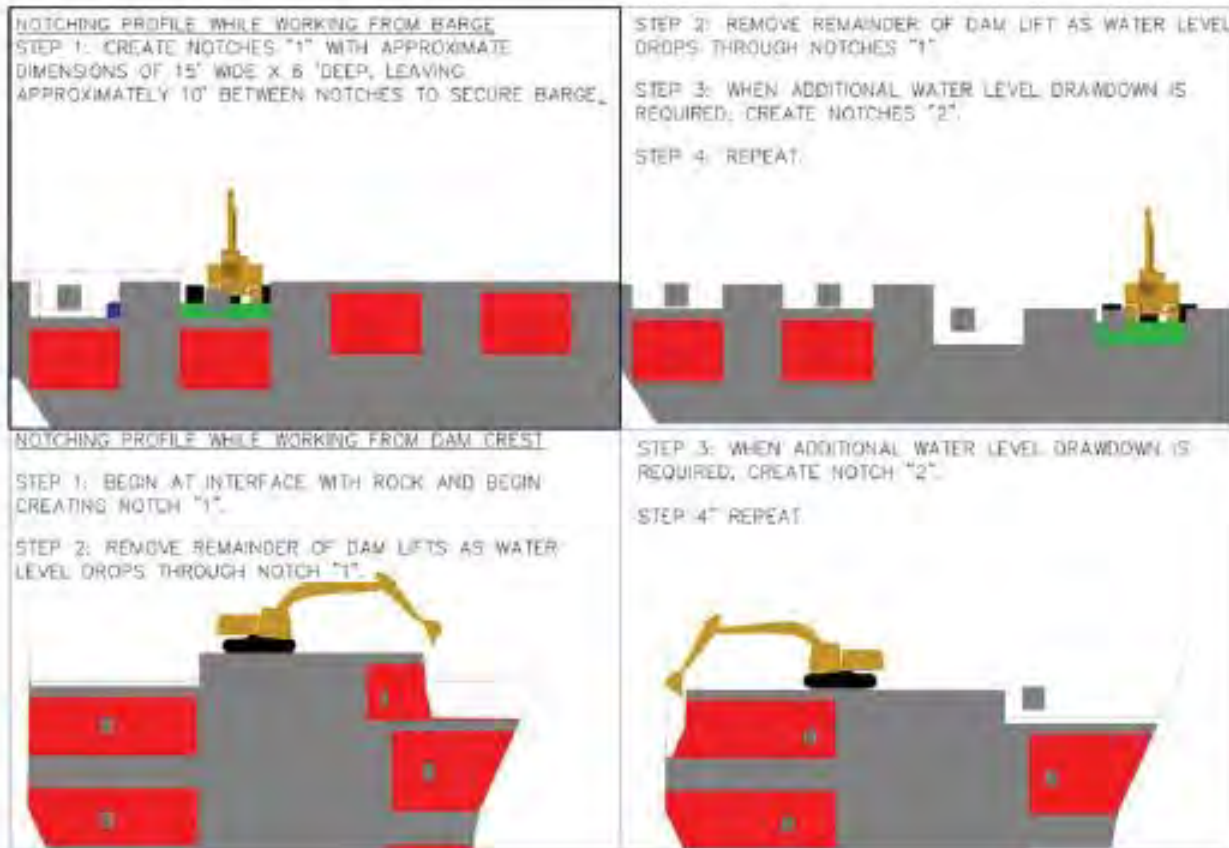
Glines Canyon – Drawdown Capacity

- Five 20-foot-wide by 20-foot-high spillway gates available (100' crest length)
- Mid-level penstock would require turbine runner modification (no bypass provided)
- Low-level sluiceway assumed not available



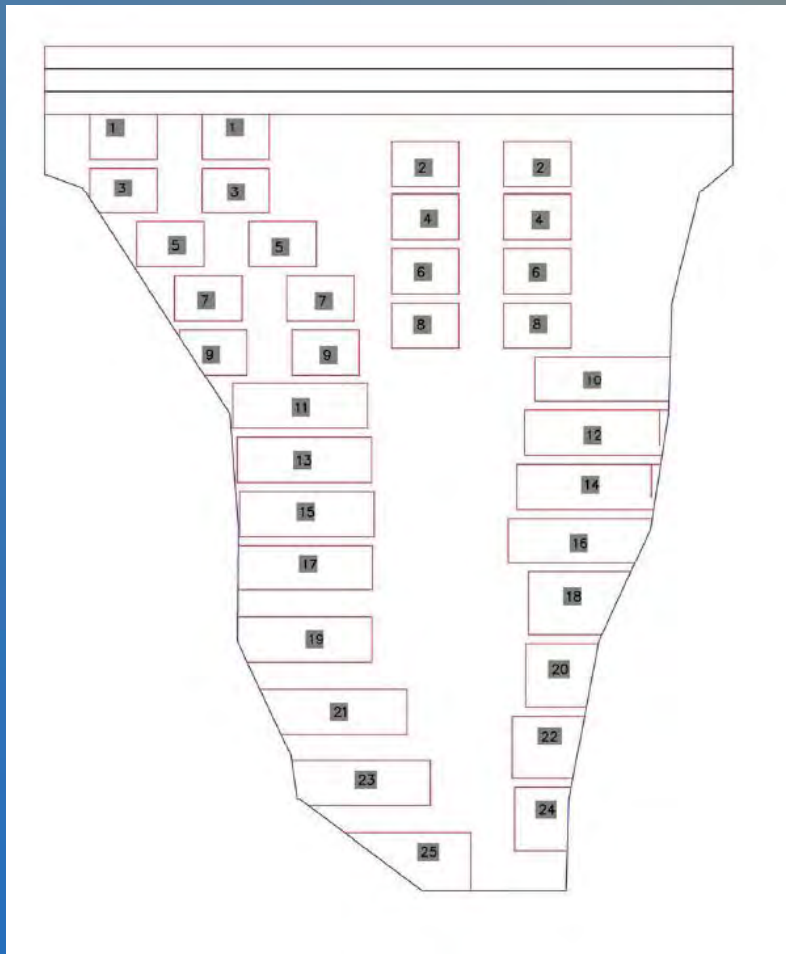
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Glines Canyon Dam Demolition



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Glines Canyon Notching Sequence



- Nine pairs of notches proposed from barge (above sediment level)
- Sixteen notches proposed from dam crest to foundation

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Glines Demolition – Sept 15, 2011



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Glines Canyon Dam – Arch Removal

(Artist Rendition)



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Elwha Project – Overall Budget

- Project Acquisition - \$29.9 million
- **Dam Removals – \$26.9 million (award)**
 - Elwha Dam Removal
 - Glines Canyon Dam Removal
 - Transmission Line Removal (7 miles)
- Water Quality Protection - \$106.6 million
 - Port Angeles Water Treatment Plant, \$27.6 million (complete)
 - Elwha Water Treatment Plant, \$79 million (complete)
- Flood Protection (Levees) - \$23.3 million
- Tribal Fish Hatchery - \$16.4 million (award)
- Ecosystem Restoration - \$15.9 million
- Numerous related contracts and non-contract costs
- TOTAL PROJECT BUDGET - \$325 million**

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Elwha Project – Overall Schedule

Water Quality Protection:

- Port Angeles Treatment Plant Completed 2009
- Industrial Treatment Plant Completed 2010

Tribal Fish Hatchery: Completed 2011

Flood Control Levees: Completed 2011

Dam Removals:

- Decommission Powerplants June 2011 – Sept 2011
- **Dam Removal contract Mar 2011 – Sept 2014**
(early completion anticipated)

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<http://www.video-monitoring.com/construction/olympic/js.htm>



Lake Mills Delta



Lower Lake Mills



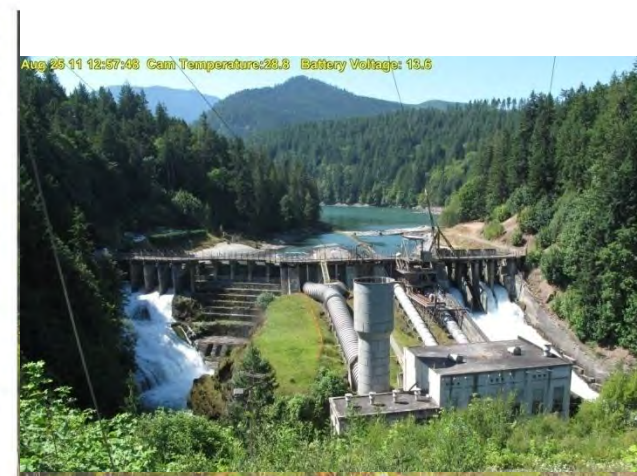
Glines Canyon Dam



Lake Aldwell Delta



Lower Lake Aldwell



Elwha Dam