KLAMATH BRIEFING
January 18, 2007

The State Coastal Conservancy (Conservancy) and the Ocean Protection Council (OPC) initiated a study to characterize sediment behind four dams of the Klamath River Hydroelectric Project on the Klamath River, and examine the possibility of dam removal. This study investigates removal of the four most downstream dams: Iron Gate, Copco 2, Copco 1 and J.C. Boyle. Results were filed with the Federal Energy Regulatory Commission (see attached compact disk for complete filing) and provided to the Dam Removal Subgroup of the Klamath Settlement Group.

The investigation included the following tasks:

- Review of the history and nature of upland river basin activities to determine possible sources of reservoir sediment contamination;
- Preparation of a plan for sampling and testing sediment;
- Retrieving sediment samples;
- Analysis of sediment samples for chemical and grain size characteristics;
- Development of a feasible method of removing the four dams;
- Review of the downstream effects of reservoir sediment erosion;
- Development of cost estimates and schedules for removal.

The study was divided into several key phases. Gathard Engineering Consulting (GEC) and Shannon & Wilson, Inc. (S&W) cooperatively pursued the planning and implementation of the sediment evaluation and dam removal feasibility analysis in accord with their respective contracts awarded by Conservancy. The study phases are summarized below:

1) GEC initiated the dam removal evaluation, including the search for relevant project information.
2) S&W conducted an Upland Study to identify possible sources of contamination in the project area resulting from activities or natural features in the drainage surrounding the reservoirs.
3) GEC and S&W developed a sediment sampling plan guided partially by the Upland Study.
4) S&W retained a drilling contractor to extract sediment samples from three of the four reservoirs (Copco 2 has no sediment).

5) The driller, under supervision of S&W, extracted samples from the reservoirs and S&W conveyed them to a laboratory for chemical testing and grain size analysis.
6) Analytical Resources Incorporated (ARI) performed laboratory tests on the samples to analyze chemical and grain size characteristics.
7) S&W performed Atterberg limit and water content tests on sediment samples.
8) GEC evaluated the field results and updated earlier estimates of sediment volume.
9) Stillwater Sciences reviewed sediment volume and grain size information developed in the above activities and compared results to assumptions made in their previous analysis of downstream effects of dam removal.
10) GEC developed this report based upon the available information and developed a table of additional studies, analyses, and reports that would need to be conducted to complete the investigation.
11) PanGeo reviewed dam construction information and conducted a preliminary analysis of the stability of Iron Gate Dam during drawdown.

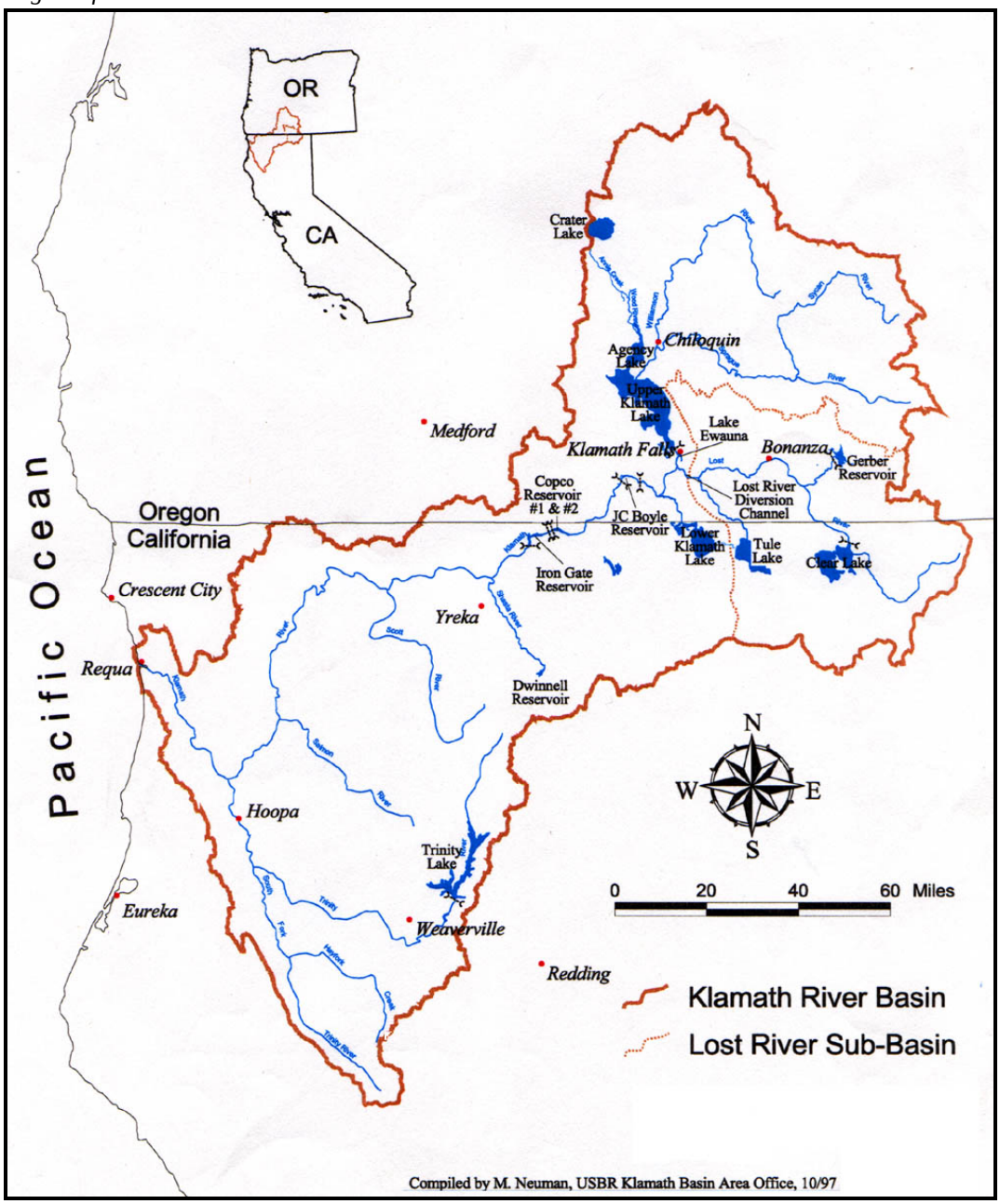
GEC's investigation of the feasibility of removing four dams on the Klamath River included analysis of the chemistry, grain size, and volume of sediment trapped in the reservoirs. It also included a feasibility investigation of sediment management and dam removal approaches. The study identified a feasible approach for dam removal and sediment management. The study also revealed that additional investigation would be required to refine this strategy.

The investigation concluded:

1. Approximately 20.4 million cubic yards of sediment is trapped in the four lower most reservoirs of the Klamath River Project. Most of the sediment, 78% of the total for all dams, is smaller than silt sized material.
2. Sediment located within the reservoirs poses no contamination risk if eroded downstream. With the exception of one location in Copco 1, none of the sediment tested exceeded PSDDA screening level criteria. That location contained volatile hydrocarbons that easily evaporate when exposed to air.
3. Pre-dredging sediments would fail to substantially reduce suspended sediment levels caused by reservoir drawdown, would substantially increase project cost, and may not be feasible due to dredging depth limitations and lack of spoils sites.
4. Eroding sediment in the path of the pre-dam river channel is a feasible approach to removing sediment following dam removal.
5. Erosion of sediment would occur as the reservoirs are drawn down. The small sediment particle size and high water content of the sediment will result in nearly instantaneous erosion of sediment in the path of flowing water. Once eroded, sediment would become suspended in the water column and remain in suspension in the river downstream of Iron Gate.

6. The highest concentrations of suspended sediment will result from eroding reservoir sediments in the pre-dam river channel. Following drawdown, additional sediment will erode from newly exposed over-bank surfaces along the sides of the pre-dam river channel. Erosion of over-bank material can be minimized by re-vegetation and sediment stabilization actions taken after reservoirs are drawn down.
7. The duration and intensity of suspended sediment are closely related. Shorter durations result in higher suspended sediment concentrations and vice versa. The objective of this approach to dam removal and reservoir drawdown was to propose a feasible means of reducing the duration of suspended sediment levels resulting from reservoir drawdown and dam removal.
8. A more rapid drawdown would: 1) shorten the duration of Total Suspended Sediment (TSS) resulting from river channel formation; 2) increase short term sediment erosion due to slope instability, and; 3) decrease long term TSS resulting from bank erosion caused by post-drawdown high flow events.
9. Drawing down the reservoirs concurrently results in the shortest duration of highly elevated suspended sediment concentrations immediately downstream of Iron Gate Dam.
10. Limits on drawdown rates determine the duration of highly elevated suspended sediment concentrations immediately downstream of Iron Gate Dam. A rate of 1 foot per day drawdown would result in highly elevated suspended sediment concentrations lasting approximately 120 days. A more rapid drawdown would reduce the duration of elevated suspended sediment. A preliminary investigation of dam stability indicates that Iron Gate reservoir could be safely drawn down at a rate of 3 feet per day, resulting in highly elevated suspended sediment concentrations lasting approximately 40 days. More study regarding dam safety and slope stability is required to determine drawdown rate limits.
11. Sediment management approaches using higher reservoir drawdown rates may initially induce larger volumes of sediment to erode as sediment slopes fail. High drawdown rates may cause sediment on steeper slopes to flow into the river channel as reservoirs are drawn down. Consequently, less sediment remains in the reservoirs after drawdown. Less sediment remaining near the newly formed channel after drawdown would likely result in lower TSS levels subsequent to reservoir drawdown, due to the absence of material available for erosion caused by subsequent peak high flow events.
12. Iron Gate and J. C. Boyle dams have existing low level outlet facilities that would be used to lower reservoirs. Copco 1 Dam would require construction of a new low level outlet through the base of the dam. Iron Gate and Copco 1 would require new gated outlets to control drawdown rates.

13. All dams could be removed using conventional construction equipment. Material from dam demolition would be permanently stabilized at locations near the dam on property located within the project boundaries. Many of the materials salvaged from the dam removal would be available for sale or reuse.
14. Iron Gate Dam removal would be accomplished in low flow periods. High flows could overtop a partially demolished Iron Gate Dam if demolition were to occur in winter months. Copco 1 is a concrete dam that could survive overtopping if partially removed. J. C. Boyle dam contains only a relatively small volume of material that would be removed in low to moderate flows. Overtopping a partially removed J. C. Boyle Dam would not present a safety hazard.
15. Some protection for downstream water users may be required. A complete investigation of water quality protection was not undertaken. Water quality protection measures are feasible for downstream water users.
16. Dam removal and associated activities would take approximately 2 years to complete.
17. The cost for removing the dams including water quality protection measures, engineering, permitting, and construction management would be approximately $88 million.


OR
CA
Crater Lake
Chiloquin
Agency Lake
Upper Klamath Lake
Lake Ewauna
Medford
Klamath Falls
Bonanza
Gerber Reservoir
Copco Reservoir #1 & #2
JC Boyle Reservoir
Lost River Diversion Channel
Oregon
California
Lower Klamath Lake
Tule Lake
Clear Lake
Iron Gate Reservoir
Crescent City
Yreka
Requa
Dwinnell Reservoir
Pacific Ocean
N
W
E
S
Hoopa
Trinity Lake
0 20 40 60 Miles
Eureka
Weaverville
Redding
Klamath River Basin
Lost River Sub-Basin
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