CALFED Bay-Delta 2002 ERP Directed Actions -- Selection Panel Review

Proposal Number: 223DA
Applicant Organization: United States Bureau of Reclamation
Proposal Title: Battle Creek Salmon and Steelhead Restoration Project

Recommendation: Continue to consider for potential directed action

Brief explanation of recommendation:

The Selection Panel recommends that the Ecosystem Restoration Program continue to consider the Battle Creek Salmon and Steelhead Restoration Project as a potential directed action. The Selection Panel reviewed the Technical Review Panel Report recently completed for the project (Technical Review Panel Report, Battle Creek Salmon and Steelhead Restoration Project, September 2003). The Technical Review Panel examined the work completed to date and additional information provided to the panel by staff working on the project. The Selection Panel concurs with the Technical Review Panel’s comments.

The Selection Panel requests that the project managers respond to the Selection Panel by letter identifying how the project managers expect to modify project designs, planning and environmental documents, and implementation to address the Technical Review Panel’s comments. The letter should address the Technical Review Panel's general recommendations as well as their comments on specific design features. The project managers are strongly encouraged to address comments on monitoring and adaptive management, including recommendations to modify project features to enhance the ability to monitor fish. Project managers are also encouraged to identify how the issues will be addressed concerning potential complications (section 6 in the report, especially concerns about re-introduction of winter-run Chinook salmon) and other considerations (section 7, specifically consideration of more complete decommissioning as a project alternative).

The Selection Panel also expects that the managers will address any issues concerning restoration project design and implementation that may be raised by the Battle Creek Science Workshop scheduled for October 7th and 8th. The Selection Panel understands that the workshop will be focused on hatchery management rather than the restoration project design per se but believes that Battle Creek restoration can be most effective if hatchery efforts and habitat restoration are well coordinated.

Once the Selection Panel receives the project managers’ letter, the panel may ask for additional information and technical review prior to making an initial recommendation on funding. This initial funding recommendation will be made available to the public for a 30-day comment period, consistent with the ERP's standard process. At the same time, the ERP will also make all supporting materials, including the project managers' letter, available to the public. Consistent with the ERP's standard process, the Selection Panel expects to consider public comments prior to developing a final recommendation to forward to the California Bay-Delta Authority.

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Technical Review Panel Report
Battle Creek Salmon and Steelhead Restoration Project

1.0 INTRODUCTION

This document is a report of a Technical Panel (Panel) formed by the Bay-Delta Program to review a restoration project for the Battle Creek basin of the upper Sacramento River system. The Panel was formed to assist in the decision-making process for California Bay-Delta Authority Ecosystem Restoration Program. Members of the Panel include:

- Francis Borcalli Civil Engineer Wood Rodgers, Inc., Sacramento, CA
- Dennis Gathard Civil Engineer G & G Associates, Seattle, WA
- Stan Gregory Riparian Ecologist Oregon State University. Corvallis, OR
- Dennis Rondorf Fisheries Biologist U.S. Geological Survey, Cook, WA
- David Stensby Civil Engineer NCA Engineers, Inc., Bellevue, WA
- Ellen Wohl Geomorphologist Colorado State University, Fort Collins, CO

The Panel examined the work completed to date, information presented by the cooperating agencies, and additional materials requested by Panel members. The goal of the review was to provide a comprehensive evaluation of the technical merit of the Battle Creek Restoration Project and to strengthen the effort to restore salmon and steelhead in Battle Creek.

The Battle Creek Restoration Project, a large restoration project for salmon and steelhead, received $28 million in funding from the CALFED Bay-Delta Program in 1998. This level of funding was based on a reconnaissance-level engineering investigation performed by the California Department of Water Resources in 1998. Advanced design and environmental documentation were initiated in 1999. After designs were refined and revised, the Battle Creek Restoration Project determined that an additional $34 million would be required to complete the project. The California Bay-Delta Authority (CBDA) called for a technical review of the project.

1.1 Purpose

A technical review is a standard part of the review process used by the California Bay-Delta Authority for all projects. The Panel was asked to provide perspectives based upon its experience and expertise. The Panel was specifically directed to provide comments on the project as described in the documentation to answer the following questions.

- Are the costs for each of the features described in the project documents reasonable and justified? This analysis should focus on projected costs, but should also consider costs for completed tasks.

- Are the designs for each of the components of the project cost-effective given the performance and reliability specifications established in the Memorandum of Understanding (MOU) for the Battle Creek Salmon Restoration Project? Are there alternate designs or approaches that could be more cost-effective under the MOU?

The Panel was directed to make suggestions within the context of the MOU. The MOU is a detailed agreement between PG&E, the California Department of Fish and Game (CDFG), the U.S. Bureau of Reclamation (USBR), the U.S. Fish and Wildlife Service (USFWS), and NOAA Fisheries and represents the outcome of several years of negotiations between these entities. The MOU was based on the preferred alternative in the Battle Creek EIR/EIS.

1.2 Scope

The panel met on August 20-22, 2003, at the Red Bluff office of the U.S.Fish and Wildlife Service. The three-day review included:

- Overview and project description by project staff.
- Field tour of the basin and selected facilities.
- Aerial inspection of the basin and all facilities.
- Panel-directed question-and-answer session with project staff.
- Closed-session for panel deliberation and drafting initial recommendations.

The Panel based its assessment on the preferred alternative, conceptual and final design drawings, materials provided by the cooperating agencies, and relevant features beyond the specific project. Other Panel advice was based on the collective expertise and understanding of the objectives of the project.

The report of the Panel was submitted to CBDA and will be reviewed by a Selection Panel of the CBDA Ecosystem Restoration Program (ERP).

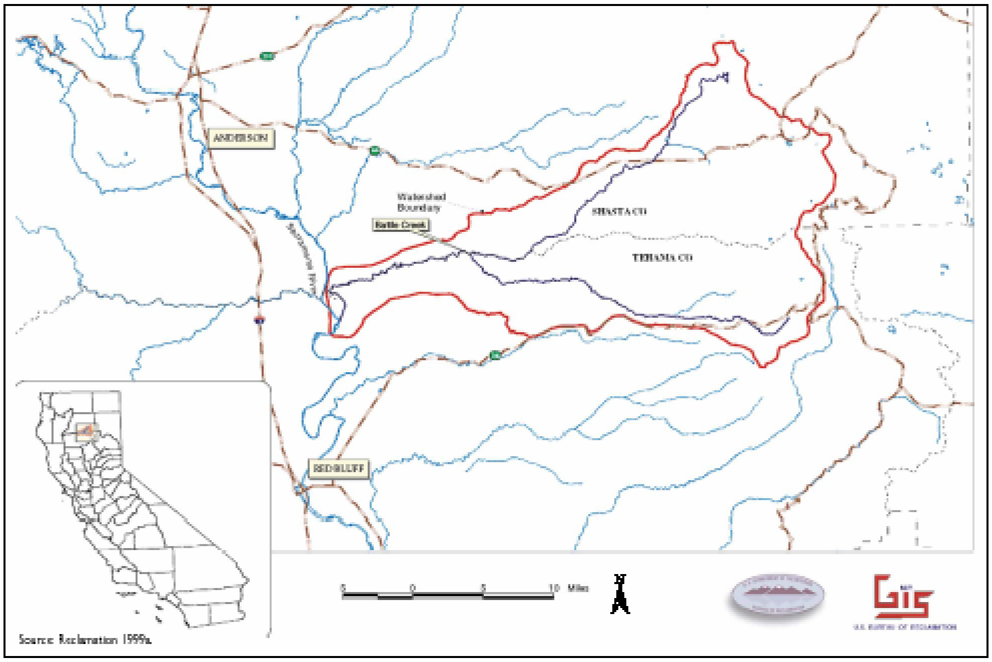
2.0 PROJECT EVALUATION

This report addresses the restoration project as described in the Preferred Alternative in the EIR/EIS and MOU between the cooperators. Some of the assumptions underlying the restoration project include that 1) a viable hydroelectric project will be maintained, 2) the project features will be “fail-safe”, meaning designed to ensure that fisheries resources will be protected in case of structure failure, and 3) the hydroelectric project will include structures and operations that guard against unstable habitat conditions associated with discharges during power system outages or altered environmental cues for fish migration during transbasin diversion of water from the North Fork Battle Creek to the South Fork. In general, the Panel recognized these design criteria, but did not limit its consideration of the issues for regional conservation and power generation only to the Battle Creek Restoration Project.

2.1 Goals

The purpose of the project, as stated in the DEIS/EIR, is to open 42 miles of Battle Creek riverine habitat above the Colman National Fish Hatchery, and 6 miles of tributary habitat to spring-run and winter-run Chinook salmon and steelhead trout. Battle Creek is a tributary to the Sacramento River northeast of Red Bluff, California (Figure 1).

Figure 1. Map of the Battle Creek Basin (Battle Creek DEIS/EIR).



The overall goals of the Battle Creek Restoration Project are to:

1. Sustain viable salmon and steelhead populations.
2. Maximize habitat availability and condition.
3. Provide reliable passage for adult and juvenile salmonids.

The Panel reviewed the major goals and 11 project objectives described for these goals in the DEIS/EIR and found the objectivesto be largely consistent with the DEIS/EIR, conceptual and final design documents, the Battle Creek Salmon and Steelhead Restoration Plan, the Battle Creek Hydroelectric Project Federal Energy Regulatory Commission (FERC) Draft License Amendment Application, and responses to questions asked of agency staff. The respective goals and objectives are addressed below.

The Adaptive Management Plan is critical to accomplishing the goals set forth for the project. Accordingly, the pertinent elements of the Adaptive Management Plan are referenced in relation to the respective goals.

2.2 Goals and Objectives

2.2.1 Sustain Viable Salmon and Steelhead Populations

The Adaptive Management Plan objectives are:

1. Ensure successful salmon and steelhead spawning and juvenile production.
2. Restore and recover the assemblage of anadromous salmonids that inhabit the stream’s cooler reaches during the dry season.

3. Restore and recover the assemblage of anadromous salmonids that enter the stream as adults in the wet season and spawn upon arrival.

4. Ensure salmon and steelhead fully use available habitat in a manner that benefits all life stages thereby maximizing natural production and full utilization of ecosystem-carrying capacity.

The restoration plan calls for sustaining viable populations, but does not set expectations for numbers of adult returning salmon. The Panel believes this failure to clearly identify the expected number of returning adult salmon in the objectives is a fundamental flaw of the Battle Creek Restoration Project. In the case of winter-run Chinook salmon, the NOAA-Fisheries Technical Recovery Team may be able to provide guidance to estimate viable salmon populations. In Battle Creek, the sampling period required to obtain the population estimate is unknown because the precision is unknown (EIS/EIR Appendix D 2001). The participants in the restoration plan could indicate they will seek guidance from the endangered species Technical Recovery Team. Other alternatives include updating the USFWS (1995) predictions of population sizes of Chinook salmon (winter-run Chinook salmon 2,500) and steelhead (5,700) in Battle Creek after implementing restoration measures. Unfortunately, the restoration plan seems to carefully avoid setting any expectations or performance criteria to meet the viable populations objectives.

2.2.2 Maximize habitat availability and condition

The Adaptive Management Plan objectives are:

1. Maximize usable habitat quantity-volume.

2. Maximize usable habitat quantity-water temperature.

3. Minimize false attraction and harmful fluctuation in thermal and flow regimes due to planned outages or detectable leaks from the hydroelectric project.

4. Minimize stranding or isolation of salmon and steelhead due to variation in flow regimes caused by hydroelectric project operations.

The project sponsors have presented several bold objectives to maximize usable physical and thermal habitat and to address harmful fluctuations in flow and temperature regimes. The Panel believes these objectives are reasonable and prudent given the present conditions described for Battle Creek. Furthermore, the Panel found that the proposed actions would likely attain these objectives. However, the fourth objective about straying and hydroelectric project operations is vague. The operational constraints on PG&E to protect habitat during major hydropower maintenance events seem minimal and not adequately defined in any documents. This leads the Panel to conclude that this objective should be reexamined prior to full implementation of the restoration plan.

2.2.3 Provide reliable passage for adult and juvenile salmonids

The Adaptive Management Plan objectives are:

1. Provide reliable upstream passage of salmon and steelhead adults at the North Battle Creek Feeder, Eagle Canyon, and the Inskip diversion dams in accordance with contemporary engineering criteria and or standards/guidelines.

2. Provide reliable downstream passage of juveniles at the North Battle Creek Feeder, Eagle Canyon, and the Inskip diversion dams in accordance with contemporary criteria after the transfer of facilities to the Licensee.

3. Provide reliable upstream passage of adult salmon and steelhead to the appropriate habitat over natural obstacles within the restoration project area while maintaining an appropriate level of spatial separation among the runs.

Provisions for reliable passage of adults and juveniles are a critical part of the restoration project. Since the costs for the passage improvements are so high, it is very important that it function as well as possible. Although the design is described as fail-safe, the Panel did not find any design features that were beyond normal current practice, and in some cases, changes to the design may result in better performance.

To meet the passage objectives, the Panel believes designs should include specifications agreed to in earlier discussions, sometimes years prior to the drawings. During the review it became apparent that staff members involved in the conceptual designs were surprised at some small and some rather significant changes in the 95% designs. The Panel strongly encourages staff involved in the conceptual designs and interested parties to thoroughly review the final plans prior to contract award and construction. Although the Panel generally agreed that the plans would meet contemporary engineering criteria, standards, and guidelines, it had several specific comments on designs of passage structures that should be addressed. The third objective on passage noted above is vague and all documents that were examined lacked specific descriptions and measures regarding this objective.

Although this review was not intended as a detailed review of the project design, a number of design features were noted that should be reviewed. These issues range from those that may seriously affect the performance of the screens and project performance to those that are design preferences that might be considered but may not be used in the design due to schedule demands.

The plans do not indicate intended hydraulic conditions within the system such as maximum and minimum water levels. This makes it difficult to review the operational aspects of the design. Some hydraulic design information was available from preliminary design data, but in some cases the design had changed between the conceptual and final design documents.

2.3 Strategies to Achieve Objectives

The CDFG, USBR, USFWS, and NOAA-Fisheries identified a set of biological principles on which the strategies for restoration are based. The principals are: biological effectiveness, restoring natural processes, and biological certainty (Kier Associates 1999). The strategies are diverse because the restoration project faces numerous issues related to flow, stream function, fish passage, and continued hydroelectric production. However, the Panel concluded the strategies are reasonable because they are based on the sound biological principles identified by the resource agencies.

Furthermore, the strategies have a good balance between providing for instream flow and implementing construction for adult and juvenile salmonid passage.

2.3.1 Strategies for Restoration of Instream Flow

Instream flow is necessary to create usable wetted salmonid habitat for various life stages. Existing minimum flow as stipulated by FERC is 3 cfs below diversions in the North Fork and 5 cfs below diversions in the South Fork. The 1999 consensus proposal supported a minimum flow of 35 cfs in the North Fork and 40 cfs in the South Fork (DEIS/EIR 2003: Appendix A). These proposed increases would provide up to 95% of the maximum habitat available seasonally under unimpaired flow. These results were obtained through two study approaches: (1) an instream flow incremental methodology (IFIM) for different life stages of each species and (2) a study of natural barriers to migration. The two most common limiting factors for salmonid life history stages were spawning habitat and juvenile rearing habitat. The instream flow requirements have a sound biological basis. The Panel believes the key to meeting instream flow is the transfer and enforcement of water rights as described in the plan.

Decision makers should note that the endangered status of winter-run Chinook salmon gives this stock higher priority than other salmonid species and runs in the Sacramento River basin for actions by management agencies. This clear priority focuses the instream flow allocations and project activities. Considerable emphasis is placed on the potential benefits to winter-run Chinook salmon in the Battle Creek Restoration Project. However, Battle Creek is not included as federally-listed endangered species critical habitat for winter-run Chinook salmon. This however does not negate the potential importance of the project for regional conservation and recovery of winter-run Chinook salmon.

2.3.2 Strategies for Restoration of Stream Function

The current cross-basin transfer of water from the North Fork Battle Creek to the South Fork Battle Creek may at first examination seem like a relatively benign action that provides cool water to the South Fork. As juvenile salmon emigrate to the ocean a complex physiological change occurs (smoltification) that enables the salmon to imprint on natal steams. The imprinting provides olfactory cues to guide the salmon back to their natal streams. If North Fork waters are transferred to the South Fork, the juveniles may imprint and return to the South Fork years later during a drought when the South Fork is less desirable to migrating winter and spring-run Chinook salmon. Furthermore, North Fork transfers may cause false attraction or interception of the migration due to relatively low water temperature. Both of these scenarios of false attraction have a high probability of happening and could substantially reduce reproductive success in the long term. Elimination of cross-basin transfer of North Fork water into the South Fork would be a major benefit for adult and juvenile salmon. It appears, however, that this strategy is not adhered to for all conditions. Maintenance of facilities downstream of the South Fork powerhouse can cause North Fork water to be directed into the South Fork. Although costly, the isolation of North Fork water from South Fork instream flow is biologically reasonable to restore stream function for salmonids.

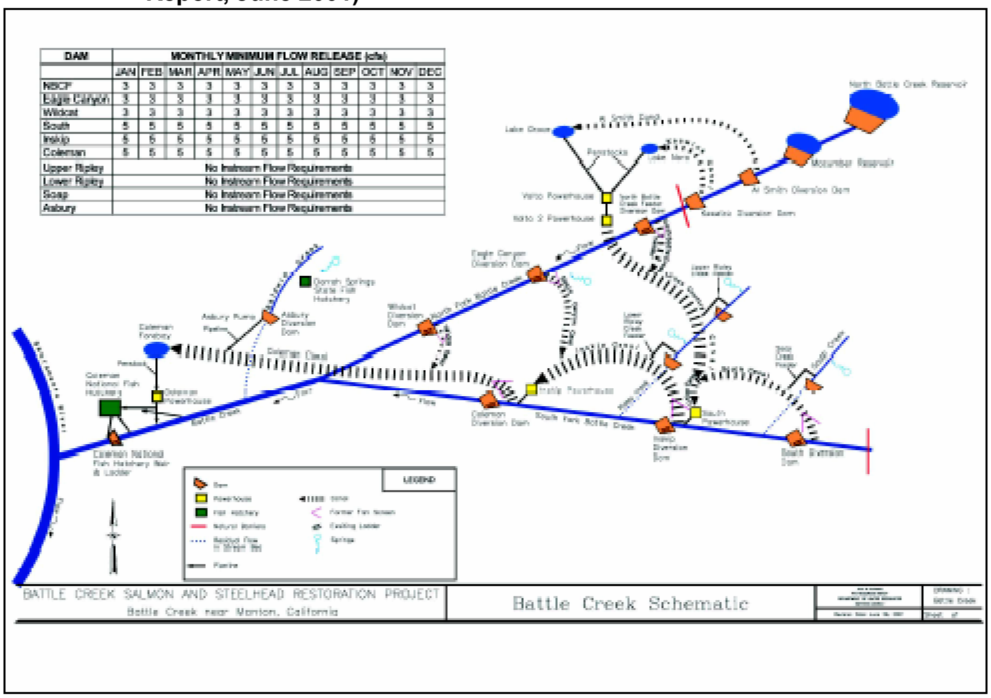
2.3.3 Strategies for Fish Passage at Dams

Fish passage ladders are necessary to enable adult salmon to move upstream and fish screens are necessary to prevent downstream migrating juvenile salmon from being entrained in water diversions. The Panel members visited some sites and thoroughly examined the 95% design drawings for all sites. The Panel concurs with reports that many of the existing fish passage structures are inadequate and outdated and do not meet the contemporary criteria, standards, or guidelines. The strategy of replacing inadequate adult ladders is reasonable, but the Panel has provided critical comments on some aspects of specific screen and ladder design (see Section 2.6, page 10). Using those ladders to bypass juveniles collected at screens is an often-used strategy in the Sacramento River basin. However, the Panel also had some concerns about predation on juveniles and egress from the ladders when all instream flow is going through the ladder (see Section 2.6.1.8, page 16). The strategy of reducing the volume of water needing to be screened by tailrace connectors also is practical.

2.4 Preferred Alternative

Given the restoration goals and strategies discussed above, the Project Technical Team evaluated the Battle Creek system of creeks, diversions, canals, pipelines, and powerhouses to determine how fish passage strategies could be implemented to assist in fulfilling the restoration goals (Figure 2).

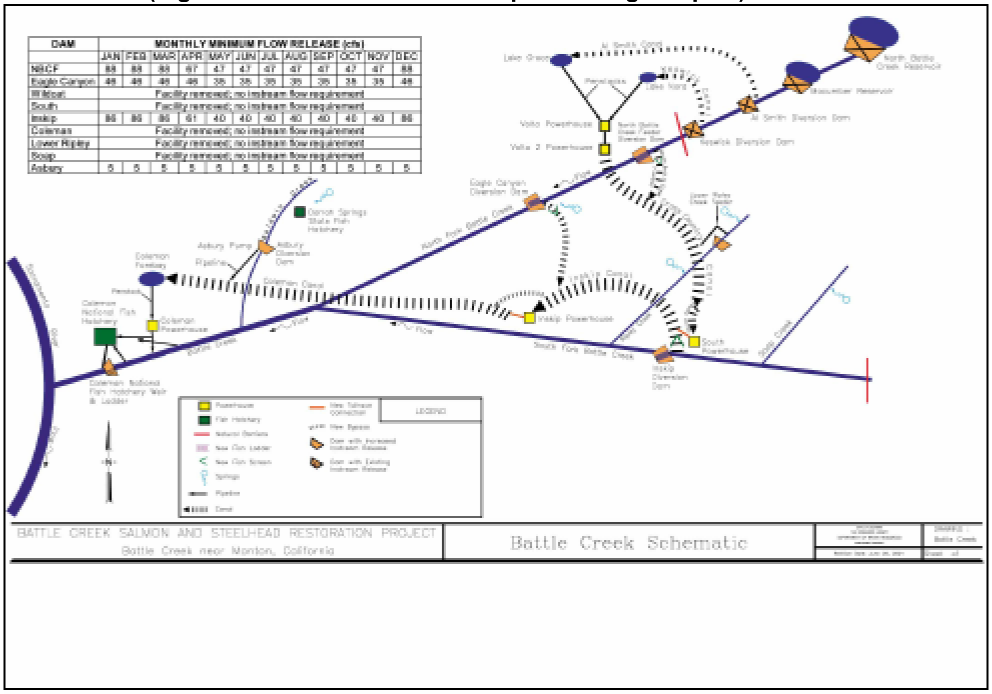
Figure 2. A Schematic of the Existing Facilities and Water Diversions in the Battle Creek Basins (Figure I-2 of the USBR's Conceptual Design Report, June 2001)



DAM	MONTHLY MINIMUM FLOW RELEASE (cfs)											
	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
NBCF	3	3	3	3	3	3	3	3	3	3	3	3
Eagle Canyon	3	3	3	3	3	3	3	3	3	3	3	3
Wildcat	3	3	3	3	3	3	3	3	3	3	3	3
South	5	5	5	5	5	5	5	5	5	5	5	5
Inskip	5	5	5	5	5	5	5	5	5	5	5	5
Coleman	5	5	5	5	5	5	5	5	5	5	5	5
Upper Ripley	No Instream Flow Requirements											
Lower Ripley	No Instream Flow Requirements											
Soap	No Instream Flow Requirements											
Asbury	No Instream Flow Requirements											

Physical modifications included in the project that were reviewed by the Panel are illustrated on Figure 3. An important aspect of the overall restoration project not reflected on Figure 2 is the instream flow schedule that is incorporated in the MOU. The instream flow negotiated for various reaches of the Battle Creek mainstem and the North Fork and South Fork were based upon IFIM studies performed by Thomas Payne Associates. It was the product of the IFIM studies that provided the basis for characterizing the habitat preferences of Battle Creek, thus flow, in relation to the target species (Kier Associates, January 1999).

Figure 3. A Schematic of the Modified Facilities and Water Diversions in the Battle Creek Basins as Described in the Preferred Alternative, Also Described as the 5-Dam Removal Alternative (Figure I-3 of the USBR's Conceptual Design Report)



DAM	MONTHLY MINIMUM FLOW RELEASE (cfs)											
	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
NBCF	88	88	88	67	47	47	47	47	47	47	47	88
Eagle Canyon	46	46	46	46	35	35	35	35	35	35	35	46
Wildcat	Facility removed; no instream flow requirement											
South	Facility removed; no instream flow requirement											
Inskip	86	86	86	61	40	40	40	40	40	40	40	86
Coleman	Facility removed; no instream flow requirement											
Lower Ripley	Facility removed; no instream flow requirement											
Soap	Facility removed; no instream flow requirement											
Asbury	5	5	5	5	5	5	5	5	5	5	5	5

The Panel agreed that it was worth noting that the project as defined for this review does not incorporate a barrier to fish passage into the Coleman Powerhouse tailrace. The general location of this facility is illustrated on Figure 1 and Figure 2. At present, the discharge from the Coleman Powerhouse is a mix of water from North Fork and South Fork Battle Creek. With the project implemented, the discharge from the Coleman Powerhouse will consist mainly of water from_the North Fork, except for some water from Baldwin Creek. Attraction of adult salmonids into the tailrace channel is currently a problem and fish are captured and transported to the mainstem.

With the project implemented, the proportion of water from the North Fork being discharged into the Coleman Powerhouse tailrace will be greater and, at certain flow regimes, can exert an even greater influence on upstream migrating adult salmonids of North Fork origin. According to the Project Technical Team, the barrier on the Coleman Powerhouse tailrace is being investigated; however, as noted above, this structure is not a part of the project defined for the Panel's review. In view of the attention given in the project configuration to prevent false attraction, the Panel feels this barrier should be scheduled and implemented as an integral part of the project.

2.5 Project Features

As a means of accomplishing the objective discussed above, the project includes features in three general categories: (1) improving fish passage, (2) increasing stream flow by reducing water diverted for power production, and (3) eliminating instream mixing of water from the North Fork and South Fork of Battle Creek. Methods used to create these features are discussed below. The Panel found that the cost and design of some of the features were reasonable and justified and some appeared to require additional consideration to meet the "reasonable and justified" criteria.

2.5.1 Fish Passage Improvements

To implement better passage for upstream and downstream migrants, the project employed three elements: dam removal, elimination of mixing north and south fork waters, and installation of ladders and screens at remaining dams.

2.5.1.1 *Dam Removal:*

- South Diversion Dam and Coleman Diversion Dam on South Battle Creek.
- Lower Ripley Feeder Dam and Soap Creek Dam, tributaries to South Battle Creek.
- Wildcat Diversion Dam on North Battle Creek.

Each dam removal proposed under the preferred alternative scenario will result in the release of a wedge of sediment stored upstream of the dam. The exact volume and grain-size distribution of each sediment wedge is presently unknown. The volume and grain-size distribution, along with the flow regime during and after dam removal, and channel geometry downstream from each dam, will control the rate and manner of sediment movement downstream of the dam. Due to the uncertainty with respect to these features, exact quantitative predictions of sediment transfer, deposition, and storage are not included in the project proposal. In addition, existing available hydraulic and sediment transport models are not suitable for simulating conditions present along Battle Creek; specifically, coarse sediment movement along steep channels.

Complete removal is planned for each dam, rather than partial removal. Hepler et al. (2001) suggest that a small pilot channel be excavated through the sediment upstream from each reservoir, with excavated sediment left on the stream banks. Preliminary studies completed as part of developing the preferred alternative scenario suggest that the Battle Creek drainage has low sediment production rates, with concentrations of spawning gravel greater than 2 ft^2/ft of stream length in lower gradient reaches along the mainstem and along parts of the North Fork (Kondolf and Katzel 1991). Spawning gravels are mobilized on average every two to three years (Kondolf and Katzel 1991). Grain sizes less than 10 mm are supply limited, whereas grains greater than 100 mm in diameter are transport limited (Greimann, 2001). Computations of current sediment transport using a flow-duration curve and Yang's sediment transport formula suggest approximately 100,000 yd^3 of annual sediment transport. Of this, approximately 8% is gravel size or larger (greater than 2 mm in diameter) (Greimann 2001). Using these values, Greimann (2001) estimates sediment storage behind dams as 5% (Wildcat), 30% (South), and 25% (Coleman) of the total annual volume of sediment transport. However, sediment storage behind dams forms much greater percentages of the annual gravel and cobble transport volume; 250% storage at Coleman, for example.

The relatively small amounts of fine sediment stored behind each dam, and the existing supply limitations to fine sediment transport, suggest that turbidity and downstream siltation will not create problems during and following dam removal, particularly if dam removals are conducted at high to moderate flows, and are separated by at least two days as suggested by Hepler et al. (2001). If dam removal occurs during low flow conditions, downstream siltation will reduce primary production from periphyton; macroinvertebrate habitat and community diversity; and abundance of interstitial habitat in gravels. The duration of this impact will be an important control on the impact's severity.

Potential problems caused by the increased supply and movement of coarse sediment, are much less well-constrained, as discussed in Section 6.4. Sluicing is currently performed on a daily basis during the winter months at Coleman Dam. Based on visual observations, up to 10,000 yd3 of material is sluiced during winter months, which represents 36% of total storage behind the dam (Greimann 2001). Downstream water users or people along the creek have not reported any adverse impacts, but no monitoring has been conducted to test for adverse impacts to fish habitat or populations.

2.5.1.2 *Upstream Ladders and Screens on Water Diverted From the Streams*

Ladders and screens are designed to current passage and maintenance requirements and will be constructed at the following locations:

- Inskip Diversion Dam on South Battle Creek.
- Eagle Canyon Diversion Dam and North Battle Creek Feeder Dam on North Battle Creek.

2.5.1.3 *Elimination of In-Stream Mixing*

To eliminate release of water originating from North Battle Creek and South Battle Creek into South Battle Creek upstream of the confluence, and to avoid having to rescreen the water, the project incorporates several features to keep mixed water in the Inskip Canal. These features include:

- New tunnel from the tailrace of South Powerhouse to the beginning of Inskip Canal.
- Tailrace barrier to collect overflow from the entrance to the South Powerhouse penstock and divert collected water and effluent from the South Powerhouse into the tunnel.
- New tailrace facility and diversion tunnel to direct flow out of the powerhouse the into Inskip Canal rather than into South Battle Creek.
- New penstock bypass pipe to use during maintenance and repair at the Inskip Powerhouse.

2.6 Project facilities

The following section discusses how the three strategies discussed above could attain better fish passage.

2.6.1 *Design Considerations*

2.6.1.1 *Inskip Dam and Diversion*

The Inskip Powerhouse currently operates at about 380 feet of head from water supplied by a steel 72-inch-diameter pressure penstock. Water from the North Fork is released into the South Fork after use for generation at Inskip Powerhouse. An 84-inch buried pipe tailrace connector, between the Inskip tailrace and the Coleman Canal, is proposed to eliminate mixing water from the North Fork and South Fork. The cost for the pipe and tailrace diversion appears reasonable and is justified to eliminate mixing the water.

For a few days each spring, and for periodic maintenance of turbines, the steel high-pressure penstock that supplies water to the powerhouse will be shut down for maintenance. Currently no facility exists to divert_water from the Inskip Canal. For reasons not fully discussed in the

Conceptual Design Report, the project includes a bypass structure to bypass water when the penstock is shut down. At least 11 alternatives were reviewed including a "do nothing" alternative." The "do nothing" alternative was considered too severe because of economic and environmental concerns. However, considering the overall cost of the bypass facility, the economics may not be completely justified. The cost of the structure appears to be approximately $1.5 million (actual construction costs were impossible to determine because costs were not delineated by element of the project), or about 6% of the total construction budget. Less cost might be incurred by simply paying for the lost power production due to the infrequent outages associated with maintaining the facility.

The facilities at the Inskip Diversion include new screens to supply 220 cfs to the diversion to the Inskip Powerhouse. The screens also supply up to 131 cfs for the attraction water supply to the fish ladder. The design flow through the fish ladder is about 40 cfs. The ladder type is a modified half Ice Harbor ladder design. The ladder is used for the juvenile bypass for the screens.

The design of this facility is very important since most of the creek flow passes through the screens and ladder much of the time. The design appears to meet the general requirements for operation as stated in the MOU.

The Preliminary Technical Report indicates the orifice size in the fish ladder has been changed from 15 inches to 24 inches. It does not indicate why that change was made. It should be confirmed that this would not adversely affect the performance of the ladder. The report indicates this ladder design was selected for its previous performance, but does not indicate what effect this change might make.

2.6.1.1.1 Inskip Ladder-Type Selection:

A "half Ice Harbor" fish ladder was selected for the Inskip fish ladder. Discussions with preliminary designers indicated the decision was based on eliminating a vertical slot due to concern with debris conditions. The advantage to a vertical slot fishway is that it is self-regulating to a large degree. That is, it maintains good fish passage conditions over a range of forebay and tailrace water elevations. However, the Ice Harbor-type fish ladder does not share this characteristic. Each weir should have close to one foot of head to provide the desired plunging flow conditions.

The project drawings reviewed did not have information concerning water surface profiles, so the following comments are approximate in nature. At Inskip, the headwater varies from El. 1439 at minimum flow to 1442 at the design flow. The design indicates that the first weir is at approximately El. 1437.4. This seems to provide excessive head even at the minimum water elevation of 1439. At the design flow elevation of 1442, the head on the first weir would be approximately four feet. To throttle this excessive head, the design does provide a gate at the end of the screen section. The technical report provided information that the entrance gates would also be used to throttle the flow into the structure during high flow conditions. Throttling several feet of head with these gates may not provide appropriate fish passage conditions. Fortunately, most of the adult target fish may not have a problem with this condition since the adults are relatively good swimmers.

The use of this gate at the exit as a bypass presents additional concern. The National Marine Fisheries Service (NMFS) criterion requires that the bypass entrance extend from the floor to the water surface. The intent of this is to avoid a vertical surface in the flow that would provide an area of low velocity for juveniles to hold in. When the gate is in place, it provides the vertical surface, which is not allowed. Further information regarding bypass entrance concerns is included with the description of the screen system.

Apparently, the conceptual design anticipated a vertical swing gate, which would have provided better bypass flow conditions than the vertical slide gate used in the final design. Discussion indicated that the gate was changed based on cost considerations. Even the vertical gate still presents flow concerns with these high head drops since a vortex can occur behind the gate.

When this type of fishway is typically used, there is a control section upstream of the fixed weir portion of the ladder. These essentially provide a series of vertical slot pools in which the slot is adjustable and the head at each pool can be varied. Approximately one adjustable slot pool is required for each foot of variability. This solution is generally used for larger ladders with more total vertical dimension.

For this installation, a fixed vertical slot fishway should be reconsidered. It is used at the Eagle Creek Diversion Dam on this project. No controls would be necessary, if properly designed.

The fishway is used as the juvenile bypass route. The possibility of negative effects on juvenile fish passing through the ladder such as predation by resident fish should be considered. In this project where the total flows are very low, it offers important advantages and is likely the best solution.

2.6.1.1.2 <u>Access to the Inskip Diversion Dam</u>

Access to the dam site would be improved from the existing dirt path to include a full-sized 16-foot wide paved roadway section with railing. Roadway slopes are maintained at less than 12% by cutting and filling. Considering the frequency of use of this facility it is difficult to understand the justification for the design standards.

For instance, roadway widths could easily be 12 feet rather than 16 feet. Railings seem unnecessary. The roadway section (4 inches of asphalt with a 6-inch base coarse) is a design that would be used to carry a much higher volume of traffic than the number of trips this roadway will experience. While the terrain is clearly difficult for road construction, the longitudinal grade of the roadway is limited to 12%, while city streets in Seattle and San Francisco have much steeper longitudinal slopes and still accommodate heavy truck traffic. A different horizontal alignment, while somewhat steeper, might result in less cost.

2.6.1.1.3 <u>Fish Screens</u>

The fish screen design is typical of current practice and should provide adequate performance. The large amount of incline may make flow balancing more difficult. The lower portion of the screen is somewhat shadowed by the floor behind it. Placing the screens on a sill or lowering the floor in the area between the screens and the control louvers could lower this effect.

The approach velocity of the screens is designed to be 0.33 fps, which is slightly less than the required 0.4 fps but a reasonable design selection that allows for some uneven distribution of velocities through the screen or blockage with debris.

The area at the end of the screens is the bypass entrance. The hydraulic conditions at the bypass entrance are important to the adequate performance of the screen system. The basic goal is to provide gradual increases in the velocity so that juveniles will not avoid the bypass and enough velocity to remove the juveniles from the area in front of the screens. If the juveniles reject the entrance they remain in front of the screens and must keep swimming to avoid impingement on the screens. The NMFS screen criteria contains the following provisions.

1. *Each bypass entrance shall be provided with independent flow control, acceptable to NMFS.*

It is not clear that this requirement is being met by the proposed design. The flow at the bypass is controlled by the fishway, which cannot be adjusted to control the bypass flow without affecting its performance.

2. *Bypass entrance velocity must equal or exceed the maximum velocity vector resultant along the screen, upstream of the entrance. A gradual and efficient acceleration into the bypass is required to minimize delay of out-migrants.*

Flow conditions with the current design do not appear to meet this intent, based on the material and information provided to the Panel. One problem is the short transition from the inclined screens to the vertical bypass section. It is difficult to predict the flow conditions at this location. The acceleration will not necessarily be gradual or efficient.

Several screen facilities have flashboards just upstream of the bypass entrance to control flow. The flow conditions at these flashboards would not meet the intent of the NMFS design criteria.

At the entrance to the bypass, the floor is often sloped upward to provide acceleration to the bypass flow, which captures juveniles. The floor transitions smoothly into the flume, which is designed with a velocity in the 5 fps to 10 fps range that prevents delay. By sloping the floor upwards, the amount of water in the bypass is reduced while still maintaining adequate velocities.

There are provisions for video counting of adults in the ladder. Discussions indicated that the fish would be crowded to the surface to facilitate counting, but the plans did not show this feature. This should be reviewed.

The plans include an access road that will facilitate construction. Although the site is on difficult terrain, and costs will be relatively high, the design appears to be constructible.

The screen and ladder facility will have significant maintenance due to its complexity and the need to remove debris. However, these requirements are typical of this type of construction.

2.6.1.2 *South Dam and Powerhouse*

The South Dam is located on South Battle Creek about 6 miles southeast of Manton and 11.8 miles upstream of Coleman Dam. The dam consists of two steel walls across the stream to form a steel “bin-wall” with an overflow crest width of 16.5 feet. The structure rises 20 feet above the streambed. The structure is approximately 155 feet long. A denil-type fish ladder is attached to the downstream face of the dam. The reservoir behind the dam is essentially filled with sediment.

Tunnels and flumes deliver approximately 100 cfs of South Battle Creek flow to the South Powerhouse. Approximately 2,400 lineal feet of the delivery system is comprised of metal flumes. The South Canal transports water diverted at the South Dam nearly 6 miles to the Cross-Country Canal, which provides water for the South Powerhouse.

The South Powerhouse is located just upstream of the Inskip Diversion Dam. Approximately 222 cfs of flow from the North Fork and South Fork Battle Creek are used for power production at the powerhouse. After passing through the powerhouse, the mixed water is returned to the South Fork Battle Creek immediately downstream through a short open channel.

To eliminate mixing water from the North Fork and South Fork of Battle Creek, a new roller-compacted concrete (RCC) wall would be constructed from the tailrace of the powerhouse to a new tunnel connecting to the Inskip Canal. This strategy for separating water from the North Fork and the South Fork appears reasonable. However, the culvert through the wall of the RCC wall allows water from the North Fork to be diverted into the South Fork during maintenance of the tunnel. Discussions with power company personnel suggest this could occur for over a week at a time. It is not clear that this is a reasonable strategy considering the stated objectives of the project to not mix these waters. Alternatives would include negotiating a cost and prepaying for shutting down power production.

While it appears that several alternatives for transporting water from the tailrace to Inskip Canal were investigated, it is not apparent that the decision to construct a tunnel was made on the basis of costs. Surface piping is in general much less expensive than tunneling. A pipe in the river or for direct connection to the tunnel was investigated and rejected. A pipe from the powerhouse directly to the Inskip Canal was not discussed in documents available to the Panel. For instance, a pipeline mechanically secured to the hillside could conceivably be substantially less expensive than a tunnel. Tunnel construction is nearly 8% of the overall project construction costs.

RCC is used for the construction of a dike to contain effluent from the South Powerhouse and direct the flow into the tunnel. This cost item alone represents over 4% of the total project construction cost of $24 million. Numerous alternative methods of dike construction are possible, including pre-cast concrete, steel sheet piles, and earthen construction. Most dikes are earthen and have some sort of surface protection. Considering the remote location, RCC appears to be an unusual choice for dike construction. This may have resulted from the "fail-safe" concept. Since conducting an alternative design is beyond the scope of the Panel's investigation, it is not possible to definitely determine costs for other systems but other equally secure dike construction materials are generally feasible at lower costs in most conditions. For instance, riprap surfacing of earthen dikes, which may or may not contain a central steel sheet pile cut-off wall may be less expensive.

The cost for features at the South Powerhouse appears to be among the reasonable alternatives for the features chosen. That is not to say that less expensive alternatives do not exist. However, due to the long process of developing the alternatives, it is not possible for the Panel to know all the considerations that were included in the "fail-safe" concept. The features appear justifiable only on the basis that the design concepts go beyond typical design approaches. Typically the design would consider the coincidence of the frequency of failure with the reliability (strength) of the design. For example, for structures used in the transportation industry, such as bridges, this safety against failure has been thoroughly investigated and factors of safety set so that the load on a structure exceeds the strength is less than 1%. In this situation it appears that very conservative designs were used but the exact rationale for the extra design strength was not documented. The design solutions developed may or may not be justified depending on the extent that equally efficient but less expensive alternatives were investigated but not documented.

2.6.1.3 *Soap Creek Feeder Dam*

The Soap Creek Feeder Dam is located on Soap Creek approximately 1 mile upstream of its confluence with South Battle Creek. The structure diverts about 15 cfs to the South Canal via a 24-inch-diameter pipeline. The dam is a concrete gravity structure with a maximum height of 10 feet and a crest length of 41 feet.

The removal approach and costs appear reasonable and justified for this element of the project.

2.6.1.4 *Lower Ripley Creek Diversion Dam*

The Lower Ripley Creek Diversion Dam is located on Ripley Creek about 1 mile upstream of its confluence with South Battle Creek. The diversion provides about 3 cfs to the Inskip Canal. The dam consists of a 17-inch-thick concrete wall with a maximum height of about 5 feet and a crest length of 44 feet.

The removal approach and costs appear reasonable and justified for this element of the project.

2.6.1.5 *Coleman Diversion Dam*

The Coleman Diversion Dam is the lowest dam on South Battle Creek located about 2.5 miles upstream of its confluence with North Battle Creek. The dam diverts approximately 340 cfs to the Coleman Canal for hydropower production at the Coleman Powerhouse.

The dam is a masonry gravity structure with a concrete overlay. The structure is 87.5 feet long with a width at the crest of approximately 4 feet and a base width of about 19 feet. The structure rises about 13 feet above the original streambed surface. The structure includes a 14-foot by 8-foot radial sluice gate, an abandoned concrete fish ladder, and an operational fish ladder. The reservoir behind the dam is essentially full of sediment.

A 4-foot-wide by 12-foot-high masonry gravity weir extends 44 feet upstream and 200 feet downstream along the right abutment to divert water to the Coleman Canal.

No plans were provided for the dam removal. Specifications call for excavating a small pilot channel through the sediment upstream from each reservoir, with excavated sediment left on the stream banks. A buried wood pile cofferdam is also to be removed down to the excavated pilot channel elevation. However, streambed erosion subsequent to pilot excavation may result in wood piles protruding above the streambed if not removed to some level below the pilot channel grade.

Specifications (02221) discuss placing rubble from dam demolition immediately downstream of the dam in the stream. Without further information on how sediment will erode and a timeline showing how the streambed would aggrade to cover this material, it is not possible to determine what considerations were made regarding possible impediments to fish passage. Similar dam removal projects attempt to minimize the concrete and rubble in the streambed, since rubble will tend to be more angular and have sharper edges and may cause injury to fish.

Consideration of effects of mobilizing relatively large amounts of sediment that could affect rearing and spawning habitat should be reviewed. Alternatives such as mechanical excavation of all material could reduce possible impacts to habitat. Additional costs for these activities would be compared to overall project costs.

As an alternative to allowing sediment to erode immediately upon dam removal and possibly cause downstream fisheries impacts, sediment could be excavated and temporarily placed on embankments at an elevation that would allow it to be mobilized only in runoff events that would generally mobilize spawning material.

Retaining abandoned fish ladders on the abutments may also involve some risk. Without the strength of the dam to secure the structure, the ladder could be undermined and ultimately create a block to fish passage. Removal costs should be relatively minor compared to overall project costs.

The cost of removing Coleman Dam appears reasonable and justified based on the approach presented. Considering the goals of the project, it is not apparent that the fail-safe concept has been applied to this element of the overall project to the same degree it has been applied elsewhere in the design process. For instance, mechanically removing more sediment to decrease potential downstream sediment impacts to fisheries would be relatively inexpensive. Placing concrete rubble out of the stream on the banks would also be inexpensive. Both would increase the safety of fisheries.

2.6.1.6 *Wildcat Diversion Dam*

The Wildcat Diversion Dam is the lowest dam on North Battle Creek located in a steep gorge about 2.5 miles upstream of its confluence with South Battle Creek. The dam is 2 feet wide at the crest by 55 feet long. The masonry gravity structure rises about 8 feet above the streambed surface and is about 6 feet wide at the base. Masonry is capped with concrete. The dam includes a sluiceway on the right abutment, a concrete fish ladder on the left abutment, and an Alaska steeppass fish ladder. The reservoir pool is filled with approximately 5,000 cubic yards of sediment.

While a relatively small volume of sediment is trapped behind the dam, this dam is located in the reach where some of the best winter-run Chinook salmon habitat exists. Potential effects on spawning habitat and redds from movement of this sediment should be reviewed. If the distribution of annual sediment load is equally distributed between the North Fork and the South Fork, approximately 50,000 cubic yards moves downstream annually. Dam sediment would represent about 10% of the annual load. Moving the sediment during or shortly after the spawning season might negatively impact the few remaining winter-run Chinook salmon.

As an alternative to allowing sediment erode immediately and possibly cause downstream fisheries impacts, sediment could be excavated and temporarily placed on embankments at an elevation that would allow it to be mobilized only in flood events that would mobilize spawning material.

The major cost item for the Wildcat Dam removal is retrieving the pipe containing the diverted flow. The cost of removing this pipe represents 1/3 of the cost of the Wildcat Dam removal and 1% of the total project construction cost. This element of the removal represents a high cost for relatively low project value. As such, it does not seem justified. Placing angular pieces of the masonry dam also presents possible short-term conflicts for fish passage and spawning in this critical reach for winter-run Chinook salmon. This may not be reasonable when considering the importance and tenuous condition of this stock.

2.6.1.7 *North Fork Creek Feeder Diversion Dam*

2.6.1.7.1 Fish Screen Structure

The fish screen structure is designed to divert 55 cfs to the North Battle Creek Feeder Dam and 7.5 cfs for the juvenile bypass. The fish screen assembly includes stainless steel wedge-wire screen panels installed at 60 degrees from vertical. Adjustable louvers are to be installed on the downstream side of the screens to facilitate adjustments to achieve approach velocities complying with the design criteria. Traveling screen brushes (2 sets) with a two-brush assembly are proposed. The fish screen structure incorporates a juvenile bypass that consists of an 18-inch pipe projecting 19 feet out from the structure to discharge into the creek. The invert of the pipe will be submerged under design conditions.

The floor of the screen structure downstream of the screen panel should be lowered so as not to impede flow through the lower portion of the screen and to allow the louvers to be effective throughout the full depth of the screen. This modification will assist in complying with the design criteria for approach velocities.

The brush-cleaning proposed is a positive cleaning mechanism. The dual-brush assembly however, provides no opportunity for debris that is trapped between the brushes to get removed and the debris will tend to accumulate and will adversely affect the performance of the brushes. Also, the brush assembly should be equipped with provisions to remove material from the brush at the end of brush travel. (An inverted brush can be effective for this purpose.)

The juvenile bypass outfall at the North Battle Creek Feeder Dam uses a closed pipe for the outfall, unlike the other screens that place the juveniles back into the fish ladder. The plans seem to indicate that the pipe outfall would be submerged. This raises concerns with regard to predators entering the structure upstream of the pipe, and debris clogging the pipe, which could injure juveniles. Inspection of the pipe is a problem. Although the pipe is a nearly straight run, it is still possible for debris to clog the pipe, which is a potential source of juvenile injury.

The plunge pool shown on the plans is not adequately detailed. The details of the depth and size of the pool are important since you do not want to provide a large low velocity pool that can help predators, or create a situation that has the potential for injuries. This should not be left up to decisions in the field, without careful control of who will make those decisions. At minimum, there should be enough information on the plans to allow the contractor to provide for this effort in his bid.

The plans show a pipe with very little cantilever. It appears that the flow will end up on the footing for the outboard pipe support. The section shows very small footings, but the details show a much larger footing, which will extend farther into the flow. The potential for damage to the pipe should be considered in the design. The plans show another pipe connection to the well, which has a blind flange. If this is for sluicing sediment out of the well, it would be difficult to use. A small gate would be more likely to be used.

Outfalls that are above water eliminate many of these concerns. If it is above water, an open flume may be substituted for the closed pipe. This simplifies inspection and removal of debris.

The flume would collect flow at the bypass exit and eliminate the well in the current design, which is a potential delay area for juveniles.

2.6.1.7.2 Fish Ladder Structure

The fish ladder selected for this site is a pool and chute type. The design capacity for the ladder is 110 cfs, which is 10 percent of the design flow for fish passage at this location. Fish attraction to the ladder entrance should be effective.

2.6.1.7.3 Access

A 10-foot access road is proposed as an extension of the existing Volta 2 Powerhouse access road. The road will be used for construction and subsequent operations and maintenance. The fish screen structure is located on the south side of the creek and the fish ladder structure is located in the south central portion of the creek. Pedestrian access to both structures will be provided by construction of a pedestrian bridge 130 feet in length. Walkways are proposed for access along the entire length of both structures as well. Access to the site and structures is essential.

2.6.1.7.4 Operations and Maintenance

Operations and maintenance of the proposed structures is essential to ensure reliability in performance. Certainly, the demands for operations and maintenance will be greater during the higher runoff seasons of winter and spring. The project, as configured, will facilitate operation and maintenance of the fish screen and fish ladder structures.

2.6.1.8 *Eagle Canyon Dam*

2.6.1.8.1 Fish Screen Structure

The fish screen structure is designed to divert 70 cfs to the Eagle Canyon Canal, a tributary to the Cross Country Canal. Juveniles passing the fish screen will be directed into the fish ladder, which serves as the juvenile bypass. The fish screen assembly includes stainless steel wedge-wire screen panels installed at 83 degrees from horizontal. Adjustable louvers are to be installed on the downstream side of the screens to facilitate adjustments to achieve approach velocities complying with the design criteria. Traveling screen brushes (two sets) with a two-brush assembly are proposed.

The layout for the Eagle Canyon fish screen is identified in the preliminary engineering report as an “in canal” type installation and, thus, uses an approach velocity of 0.40 fps to size the screen area. This installation is no different than that proposed for the fish screen for the North Battle Creek Feeder installation where an approach velocity of 0.33 fps is used. The selection and application of the established criteria should be reexamined for this facility.

Although the screen for Eagle Canyon is 83 degrees from horizontal, unlike the 60 degrees shown for the North Battle Creek Feeder fish screen, similar considerations apply. The floor of the fish screen structure downstream of the screen panel should be lowered so flow is not impeded through the lower portion of the screen and allows the louvers to be effective throughout the full depth of the screen. This modification will assist in complying with the design criteria for approach velocities.

The brush cleaning proposed is a positive cleaning mechanism. The dual-brush assembly, however, provides no opportunity for debris that is trapped between the brushes to get removed and the debris will tend to accumulate and will adversely affect the performance of the brushes. Also, the brush assembly should be equipped with provisions to remove material from the brush at the end of the brush travel. (An inverted brush can be effective for this purpose.)

The Eagle Canyon bypass uses a design where the bypass flow from the screens is reintroduced into the fishway flow about two thirds of the way down the ladder. This is done using a downwell. The plans do not show operating information for the hydraulics but, apparently, the bypass flow falls into the well. This is a complex design with the variable head on the screens. Once in the downwell, the juveniles must exit through one of two openings into the ladder. The section apparently shows a false floor in the downwell, which allows juveniles to exit through the upper opening and gravel to be sluiced under the downwell for maintenance. The resulting geometry provides a large space for juveniles to hold, and the potential for predation. There is not enough information on the plans to quickly evaluate the flow conditions in the pool but this is also a concern since some energy is being dissipated in the downwell. Since the only exits from the well are below the surface, debris is a concern. Floating debris has no way to exit the downwell, and neutrally buoyant debris may circulate in the downwell for some time before being flushed into the ladder. The combination of debris, turbulent energy dissipation, potential predators, and juveniles needs to be carefully considered.

There are provisions for video counting adults in the ladder. Discussions indicated that the fish would be crowded to the surface to facilitate counting, but the plans did not show this feature. This should be reviewed.

2.6.1.8.2 Fish Ladder Structure

The fish ladder selected for this structure is a vertical slot type. The design capacity for the ladder is 50 to 60 cfs. The determination of the ladder capacity for this site deviates somewhat from the other sites and from accepted guidelines; however, the rationale and considerations given to other constraints affecting fish passage within the natural channel appear reasonable. The entrance to the ladder would appear to be problematic during the higher flow regimes. This may actually be aggravated by setting the lip on the right side of the dam slightly higher than on the left side. It would appear this should be reversed in an effort to create less turbulence at the ladder entrance through a greater range in flow. Further attention should be given to the hydraulic conditions associated with the ladder entrance.

2.6.1.8.3 Access

The site conditions do not allow for constructing a vehicular access road thus, a crane or helicopter is proposed as the means for construction to avoid damage to the canyon walls. Access is available by a footpath, which is proposed for improvement as part of the project.

2.6.1.8.4 Operations and Maintenance

Access to the site is limited to foot traffic; however, the design incorporates features such as hydraulic protection and grating to minimize problems associated with debris to the extent practical. Similar to other facilities in the system, greater attention will be required of operations and maintenance personnel during the higher runoff seasons of winter and spring.

2.6.1.8.5 Adult Ladder Design

Juvenile salmon will use the adult ladder for egress after collection and bypass from the fish screens. The Panel has comments on two flow conditions, the first when instream flows are greater than the capacity of the ladder and the second when the instream flows are in the ladder and there is no flow over the dam. In the first case, the design of the ladder appears fairly benign as it is designed to have a sweeping flow past the downstream end of the ladder. However, in the second case, when no sweeping flows will be available, juvenile salmon will enter an excavated pool with flow from the ladder entering upstream or at best perhaps laterally. The Panel is concerned that should the pool contain large predatory fish and the juveniles go around in an eddy before exiting the pool downstream, predation losses could be high. The Panel also recognizes the space for the ladder is limited, but sees no innovation in design modification of the ladder to meet the site or biological concerns.

2.7 Cost Issues

2.7.1 Cost Estimate

Concerns related to specific costs items include:

- Bid items 25 and 26 have the same quantities and unit costs – It is possible, but unlikely. Bid item 41 is large enough to make review difficult. This may be a reasonable bid item, but it is not much information to review.

- Bid item 52 – Same Issue – It seems that this quantity of pipe would be costed with excavation, back fill, installation and pipe as separate items. This is a big bid item, and if there are changed conditions in the field this lineal foot unit cost would make the negotiation more difficult.

- Bid item 120 – Having a lump sum line item for fish screens is difficult to evaluate. Is this for all the projects? Does it include the support structure?

- Bid item 107 is for metal fabrication at Inskip. This is probably the support structure, but it is hard to tell.

- Lump sum costs for water and water removal for various uses are very high but the Panel had no way to evaluate these costs. In general, the cost information did not provide enough detail to allow a detailed review. This item accounts for approximately 6% of the total project construction costs.

- Lump sum price compilations limited the Panel's ability to comment on the overall reasonableness of the costs for the project.

2.7.2 General Cost

Concerns related to general costs include:

- Cost estimates for the most expensive elements of the project were combined into one estimate. For many of the items the Panel had no means of determining to which part of the project the cost item applied. The total cost for these combined items accounted for 60% ($14,4 out $24 million) of the total construction costs. The items also accounted for the majority of the cost increase on the project. This also made it difficult and in some cases impossible to comment on the reasonableness of an element of the design.

3.0 MONITORING

One of the most fundamental deficiencies in the Battle Creek Restoration Project is the limited resources available for monitoring the implementation and success of the actions funded by the California Bay-Delta Authority. Monitoring for habitat conditions, habitat use by juvenile salmonids, habitat use by migrating juveniles and smolts, habitat use by adult salmon, and passage effectiveness at fish ladders and fish screens are minimal. Surprisingly, no funds or measurements are provided for monitoring sediment movement and stream flow at dam removal sites. The Monitoring Plan (Appendix D if the DEIS/EIR) is not adequate to: (1) identify deficiencies or critical actions for adaptive management, (2) document the degree of success of the project, or (3) identify key responses or relationships for planning and implementing similar projects throughout the region.

3.1 Fish

3.1.1 <u>Monitoring of juvenile salmon</u>

The Battle Creek Restoration Project is designed to increase habitat available for rearing juvenile salmon, yet limited funds are provided for measuring the abundance of juvenile salmonids and their use of the habitat restored by increasing flows in Battle Creek. The project assumes that upstream passage of adult salmon will seed the available habitat with young salmon, the additional volume of habitat will be occupied, and the increased availability of cool water habitats will increase the abundance of juvenile salmonids. Monitoring provides limited funds for operating two smolt traps and conducting snorkeling surveys for adult salmon and jacks. No monitoring is provided for juvenile salmonids, distributions, and abundances of juveniles within the Battle Creek drainage, or patterns of habitat use.

Downstream migrant traps will play a key role in the monitoring of juvenile salmonids. The monitoring agencies, USFWS and CDFG could consider Passive Integrated Transponder (PIT) tags to provide additional data on the rate of naturally produced adult returns. These monitoring approaches need to be weighed against the mortality rate associated with handling and tagging at different sizes and degree of smoltification. If juvenile out-migrant numbers increase as expected, tagging a carefully determined portion of the run can provide cost-effective information with a minimal impact on the population.

3.1.2 <u>Monitoring of adult returns</u>

Monitoring to obtain population estimates for adults and jacks will rely heavily on adult counts at fish ladders, carcass counts, snorkel surveys, and/or redd surveys. These monitoring approaches could usually be done at reasonable costs. In the Draft Adaptive Management Plan monitoring is increased once the anadromous salmonid populations reach “Viable Population Levels” (EIS/EIR 2003; Appendix D; Objective 4). At that time, monitoring will expand to estimate carrying capacity for each species and life stage of salmon and steelhead. Another major task is to estimate Cohort Recruitment Rate for a minimum of 16 years and this will likely extend for the “term of the Adaptive Management Plan. Once the populations reach viable population levels, monitoring for salmonids not listed under the Endangered Species Act do not require this intensive monitoring plan. In light of the fact that the Panel considers the post-construction evaluations for fish minimal and the funding for the monitoring inadequate, the proposed monitoring for this objective is excessive. In its recommendations on monitoring, Kier and Associates (1999) included comments on cost and level of monitoring, the authors of the proposed monitoring above would find useful.

The Licensee will conduct and/or fund adult counts at the fish ladders up to the Licensee's commitment in the initial three-year period of project operation. This level of monitoring is minimal considering the life history of salmonids. Post-construction evaluation should be prepared to address the movement and possible delay of adult salmon through fish ladders in the system. In the first three years of the project, returns may be so low that this may not be identified as an issue. However, to ensure that adult fish have the opportunity to maximize use of the habitat, the Panel suggests the monitoring agencies consider a small number of radio-tagged adult to test the assumption that delay and fallback are not issues.

The monitoring agencies should reconsider the cost of video monitoring if the analysis cannot be automated. Intermittent use of a fish trapping facility to sample fish was mentioned in the Biological and Environmental Monitoring (EIS/EIR 2003). The Panel suggests considering the possible use of PIT tag technology in the future as a monitoring tool. Considerable savings in funds could result if designs of ladders incorporate slots for inserts for adult traps or PIT tag detection coils.

3.2 Habitat

In spite of the fact that the Battle Creek Restoration Project is designed to increase the availability of habitat for anadromous salmonids, monitoring will provide little measurement of the physical habitat (channel morphology, sediments, cold water refugia). The minimal measurement of physical habitat conditions appears to be single measurements with no specific design to document the variability in those habitat conditions through time, either seasonally or interannually. Funds dedicated for all future monitoring of both implementation and physical and biological responses for the project totals only $1,000,000, plus some additional measurements by the Licensee, PG&E.

3.2.1 Physical Habitat

The Battle Creek Restoration Project is designed to increase stream flow from roughly 3 cfs to more than 30-50 cfs to provide habitat for anadromous salmonids. IFIM analyses predict that these flow increases will provide 90% of the potential habitat available under unimpaired flows. These predictions are based on fish habitat relationships and hydrologic models. Whether the planned actions will be successful or to what degree they will be successful will not be measured under the monitoring plan described in Appendix D of the DEIS/EIR.

3.2.2 Water Temperature

One of the major goals of increasing flow in the Battle Creek basin is to provide access to cold water refuges for winter-run and spring-run Chinook and maintain cooler instream temperatures. Again, there is no temperature monitoring plan, and any information on stream temperature will come from existing measurement stations operated by the Licensee or cooperating agencies. The project has relied on relatively simple models of stream temperature, but monitoring of stream temperature at a network of sites is relatively cost-effective given the low cost of temperature loggers and more robust models available for the region.

3.3 Flow

No monitoring plan has been suggested for flow conditions during and following proposed dam removal. The Panel strongly suggests that flow conditions be monitored in association with monitoring of sediment dynamics and fish populations. The most thorough and useful plan for flow monitoring would be to gage flows at several locations throughout the Battle Creek watershed, including upstream and downstream from Wildcat, South, Coleman, Soap Creek, and Lower Ripley Creek dams, respectively, as well as below the confluence of the North Fork and South Fork of Battle Creek. At a minimum, flow could be monitored using crest-stage gages that are read after each flow that exceeds a specified base flow. Alternatively, the crest-stage gages could be supplemented with stilling-well gages installed at selected locations to monitor flow stage at shorter intervals, such as 15 minutes or 24 hours. Regardless of the specific design, it will be important to tie measured sediment movement and channel change, as well as fish habitat use and population dynamics, to flow conditions. Consequently, gage sites should coincide with sites of periodic cross-section surveys to facilitate development of stage-discharge rating curves. Repeat measurements of flow depth and velocity used in constructing stage-discharge curves will also be applicable to characterizations of fish habitat.

3.4 Sediment dynamics

Existing available hydraulic and sediment transport models such as HEC-RAS, HEC-6, and GSTARS 2.0 are not suitable for simulating the movement of coarse sediment along steep channels. These models do not adequately simulate processes acting along Battle Creek, including differential scour and deposition across a cross section; entrainment and deposition of gravel and larger particles; strongly three-dimensional turbulent flow in pools; and changes in grain-size distribution of bedload and bed sediment downstream and with time (Rathburn and Wohl, 2001). Existing studies of coarse sediment movement in steep channels indicate that bedload sometimes moves as discrete waves or pulses, although such movement is highly stochastic (Wohl, 2000). Bedload movement is also likely to be episodic in time and space, as a function of channel geometry and flow regime. For example, coarse sediment moves from successive riffle/bar to riffle/bar depositional sites during high flows, with riffle/bar dissection during waning stages (Harvey et al., 1993). Cobble/gravel sediment is deposited in pools during waning stages, and scoured during succeeding high flows (Wohl and Cenderelli, 2000). All of these characteristics of coarse sediment movement in steep channels make it problematic to accurately simulate sediment dynamics in this type of environment.

The removal of five dams along Battle Creek, and the consequent release of wedges of sediment with a mixed grain-size distribution, presents an excellent opportunity to collect a detailed dataset of sediment dynamics and channel response. Such a dataset could be used to calibrate/develop better models of sediment dynamics in steep channels, and to better predict sediment dynamics following dam removal in other, analogous channels.

Hepler et al. (2001) include the following suggested monitoring activities:

1. Time-lapse photography in the reservoir region.

2. Additional surveys during the dry season preceding dam removal (cross-sectional surveys every 100 feet for one mile downstream from each dam, as well as bed sediment sampling).

3. Continue monitoring turbidity and total suspended solids.

These activities are crucial, and should be supplemented by surveys of at least five pools immediately upstream and downstream from each removed dam. Pools form critical spawning and low-flow habitat for fish, and should thus be a focus of monitoring. Monitoring data should be collected in a manner that will facilitate use in existing hydraulic and sediment transport models. Monitoring must begin prior to dam removal; be conducted at intervals that provide sufficient information to model sediment processes (i.e., at a minimum, following each flow capable of transport spawning gravels); and continue until the channel has reached a state of relative equilibrium in which no net aggradation or erosion occurs at monitoring cross sections during an average flow year. A state of relative equilibrium could potentially be reached within a year of dam removal, but is more likely to require several years.

If sediment mobilization substantially impacts spawning habitat downstream from a dam for more than a year, adaptive management could be implemented to remove or retain sediment within the channel. For example, Hepler et al. (2001) suggest that dam removal include excavation of a small pilot channel through the reservoir sediment, with excavated material left along the streambanks. If partial mobilization of reservoir sediment creates substantial loss of downstream spawning habitat, remaining reservoir sediment could be mechanically removed from the channel, as well.

4.0 MITIGATION

The Panel recognizes the importance of mitigation in a project that requires extensive construction and site modification. Several aspects of the proposed mitigation measures and costs raise serious questions. The original proposal included $1,000,000 for mitigation and that funding request was increased to $4,300,000 in the new proposal. Several of the mitigation efforts seem excessively costly, provide redundant benefits to the restoration benefits of the project, and call for almost as much new funding for monitoring mitigation as is provided in the entire project for monitoring of all project elements.

4.1 Wetland Mitigation

The Battle Creek Restoration Project will increase stream flows from 3 cfs to 30-50 cfs and restore extensive riparian wetlands along its margins. However, the project will impact only 10.5 acres of existing wetlands. The mitigation plan calls for construction of new wetlands to mitigate for those impacts of the project and do not balance the impacts on wetlands with the riparian wetlands created by the project. In addition, the estimated costs of wetland construction are extremely high based on the experience of the Panel. The Panel recommends the California Bay-Delta Authority check with consulting agencies to see if the wetlands created by the project can be considered in the mitigation plan and if wetland construction is required, discuss more cost-effective approaches.

4.2 Elderberry Mitigation

Mitigation is requested for the impacts of the project on three elderberry shrubs. This plant is the host for an endangered beetle in California. The Panel does not question the importance of maintaining habitat for this listed species, but the replacement costs are exorbitantly high (even considering the costs of irrigation and monitoring). The Panel recommends the California Bay-Delta Authority check with consulting agencies to see if the shrubs can be replaced in a more cost-effective manner.

4.3 Mitigation Monitoring

The mitigation plan identifies funds for monitoring the mitigation efforts of the project that almost equal the total funds ($1,000,000) available for all future monitoring of project facilities and environmental and ecological responses to the project restoration efforts. The Panel encourages the California Bay-Delta Authority to require monitoring of the mitigation efforts, however, these are secondary to monitoring the effectiveness of the project. This relative importance in monitoring information should be reflected in the budget.

5.0 ADAPTIVE MANAGEMENT

The Battle Creek Restoration Project has developed an Adaptive Management Plan (Appendix D in DEIS/EIR), which calls for a systematic program of monitoring, review, and adaptive response. The funds available for adaptive management include $1,000,000 from the California Bay-Delta Authority Monitoring Fund, $3,000,000 from the Water Acquisition Fund, and up to $6,000,000 from the Licensee for responding to adaptive management needs. The California Bay-Delta Authority Monitoring Fund is dedicated to monitoring the implementation and ecological responses to the project. The Water Acquisition Fund is a $3,000,000 federal fund dedicated solely to acquiring additional instream flow releases in Battle Creek if recommended by the Adaptive Management Plan agencies during a 10-year period following the project. Funds from the Licensee are to be used after all other funds are exhausted.

Fundamentally, there is little adaptive management in the Adaptive Management Plan for the Battle Creek Restoration Project. Essentially all of the adaptive actions will be directed at correcting design problems for the facilities or solving operating problems associated with the facility. The remainder of the adaptive management is directed at guaranteeing the minimum instream flows targeted by the project.

The project does not identify specific objectives, targets, or performances related to fish or sediment dynamics, even though fish are the primary goal of the Project. The Adaptive Management Plan identifies a series of extremely general measures and criteria for their performance:

<u>Fish Population Objective 1 Metrics:</u>

- Estimates of juvenile out-migrant production upstream of the CNFH and at the terminus of each fork of the creek.
- Estimates of adult and jack population sizes and distribution.
- Evaluations of physical and biological conditions within habitats by reach.

<u>Fish Population Objective 1 Criteria:</u>

- Estimates of juvenile outmigrant production will be compared to: (1) expected production levels based on adult spawning populations, (2) production levels in Reference Watersheds, and (3) relevant ecological factors.

Salmon and Steelhead Habitat Objective 2

Habitat Objective 2 Metrics:

- Climatic conditions within the South Fork watershed.
- Longitudinal water temperature regime of stream.
- Flow at springs to which CDFG has conservation water rights.

Habitat Objective 2 Criteria:

- Observed water temperature regimes will be compared to water temperatures predicted by the best available contemporary water temperature models at target points within the stream.
- Please refer to individual population, habitat, and fish passage objectives for a complete understanding of the diverse criteria that will be used to gage the success of the restoration project.

The Panel can find no basis for the lack of explicit performance measures and specific monitoring measurements that will indicate the degree of success. The Plan describes several measures that are available that could be used as criteria for monitoring success. "For example, Hallock (1987) recommended that a salmon restoration plan be developed for Battle Creek upstream of the CNFH. He felt that the major factor suppressing salmon populations was decreased instream flows caused by the PG&E hydroelectric project and that restoration of stream flows could support populations of between 6,000 and 10,000 fall-run salmon, 2,500 spring-run salmon, and 1,000 steelhead."

The Plan indicates that projected salmonid recovery estimates may be used (Table 2), but does not clearly identify the measures of success that will be used or a specific process for adapting to trends. "The AMTT will work to identify when salmon and steelhead are fully utilizing the restored habitat of Battle Creek. The AMTT may use USFWS (1995; Table 9) as guidance. USFWS (1995) predicted population sizes of Chinook salmon and steelhead in Battle Creek after implementing restoration measures that were less comprehensive than those proposed under the Restoration Project."

Table 2. Predicted population sizes of adult Chinook salmon and steelhead in Battle Creek after implementing restoration measures outlined in USFWS (1995)(Table 9 from Appendix D).

Winter-run Chinook Salmon	2,500
Spring-run Chinook Salmon	2,500
Fall-run Chinook Salmon	4,500
Late-fall-run Chinook Salmon	4,500
Steelhead	5,700
Total Adult Salmon and Trout	19,700

Another important reference for the performance of salmon in Battle Creek would be the guidance developed by the Technical Recovery Teams of NOAA Fisheries for central California.

Though many sources for performance measures are available, the project and Adaptive Management Plan specifies none and does not provide a clear and explicit process for monitoring, assessment, review, and adaptive actions. This criticism is not new (Healy 2001) and the Adaptive Management Plan cites Healy's criticisms and lists the six steps of passive adaptive management (Table 3).

Table 3. The six steps of passive adaptive management identified by the CALFED Independent Science Board (Healey 2001)(Table 9 from Appendix D).

1. Review the available information to define the problem as precisely as possible.

2. Develop plausible solutions to the management problem. Describe these in terms of conceptual models of system behavior and its response to possible management interventions.

3. Subject these solutions to some form of structured analysis (simulation modeling is a useful analytic tool) to determine which offers the greatest promise of success.

4. Specify criteria (indicators, measures) of success or failure of the most promising solution.

5. Implement the most promising solution and monitor the system response according to the criteria developed in Step 4.

6. Adjust the design of the solution from time to time according to the results of monitoring in an attempt to make it work better.

The Plan that follows adheres to almost none of the steps of adaptive management. It dismisses experimentation or explicit testable questions. The Adaptive Management Plan emphasizes that "Adaptive Management used in this plan could more technically be defined as 'passive' adaptive management, where changes in management are made in response to monitoring results, versus an 'active' type of adaptive management where specific experiments are conducted in order to learn about ecological processes." The Panel was surprised to find that the Adaptive Management Plan asserts that so much is known about the salmon and aquatic ecosystems in Battle Creek that such scientific approaches in adaptive management are unnecessary. "Due to the existing knowledge regarding the aquatic ecosystems in Battle Creek, no specific experiments are contemplated. For example, this AMP does not consider experimental changes in instream flow designed to elucidate relationships between flow and salmonid habitat use."

The Panel finds that the Adaptive Management Plan lacks explicit targets or yardsticks of performance. Many objectives will not be monitored. The process for adaptive management is vague and simply calls for annual meetings of the participating agencies. The timeframe for reviews and subsequent actions are not stated. Decision-making process is by general consensus and responsibilities are unclear. There is no process to define new questions and measures. The Panel could find no direct links between monitoring measurements, data analysis, modeling, open reporting, and decision making in relation to maximizing the opportunity for success. Funding for adaptive management is focused on limited monitoring actions or water acquisition, but no funds are available for a structured analysis within an adaptive management system (i.e., data analysis, modeling) or the public decision-making process.

6.0 POTENTIAL COMPLICATIONS

The Panel discussed several factors that are not addressed in the DEIS/EIR or Adaptive Management Plan, but that could affect the success of the Battle Creek Restoration Project. The Panel encourages the California Bay Delta Authority and cooperating agencies to consider these broader influences on salmonid recovery in the region when interpreting the responses of anadromous salmon and stream channels after implementing the project.

6.1 Hatchery Effects

The Coleman National Fish Hatchery (NFH) and the NFH barrier weir are near the lower limits of the restoration project and generally under separate improvement projects. The Panel did not review the genetic impacts of hatchery fish on the restoration program because a separate technical review panel will review that aspect in the near future.

Winter-run Chinook salmon were given the highest rank of all salmonids for restoration in Battle Creek. The USFWS imposed a moratorium on the capture of natural adult winter Chinook salmon in 1996 and 1997, at Coleman NFH. Production of winter-run Chinook salmon at Coleman NFH has been terminated and Livingston Stone NFH first released juvenile winter-run Chinook salmon in April 1998 (USFWS 2001). Consequently, in a 2001 survey the USFWS estimated zero to few adults returned to Battle Creek (Brown and Newton 2002). The Panel reviewed the performance standards to evaluate benefits and risks of propagation of winter-run Chinook salmon at Coleman NFH and Livingston Stone NFH, but did not find an explanation of the role of Livingston Stone NFH in the Battle Creek restoration project. Very few natural winter-run Chinook salmon are returning to Battle Creek as adults and the potential use of Livingston Stone NFH propagated juveniles or adults is not discussed. The plan does not provide an explanation or even a proposal as to how the endangered and highest ranked salmonid species, winter-run Chinook salmon will be reintroduced in a timely manner.

6.2 Harvest Management

Although it is difficult to precisely identify individual runs of Chinook because of overlaps in migration timing between runs, the USFWS in reporting the results of its monitoring from March through October 2001, presented the following estimates: 0 to 4 late-fall Chinook, 0 to few winter Chinook, approximately 100 spring Chinook, and 9 to 14 fall Chinook. While acknowledging the information is not precise, it is, however, indicative of the relative abundance of the stocks available for recovery. Accordingly, harvest of the target species is a critical factor potentially affecting the success of the recovery effort irrespective of how effective the project may be in habitat restoration and amplifies the need for an effective monitoring program.

It appears significant attention is being devoted to harvest management by virtue of the existence of various federal and state technical recovery teams established to provide guidance to the Pacific Fisheries Management Council in setting harvest seasons and limits. This Panel has no information about the effectiveness of the Battle Creek cooperators in coordinating its activities with the PFMC, however, the guidance provided can only be as good as the data on which the information is based. As discussed earlier under sections dealing with monitoring and adaptive management, data is extremely important to determine the effectiveness of the restoration/recovery effort with harvest management being a critical element. Measures taken, or to be taken, in management of harvest to allow the project to be successful must be identified and reported regularly to the Bay-Delta Program. This is especially important for the restoration of salmon and steelhead in Battle Creek, but generally for the overall fish restoration program. The Panel encourages the California Bay-Delta Authority to request and receive reports from the regional technical recovery teams to track adaptive management and regional coordination of the project.

6.3 Sediment Impacts

Potential problems caused by the increased supply and movement of coarse sediment along Battle Creek following dam removal, are poorly constrained for the reasons discussed in Section 4.4.1. Under the best-case scenario, a wet year during or following dam removal would thoroughly redistribute sediment stored upstream from each dam along the downstream channel, and reservoir-derived sediment would then attain the same rate and frequency of mobility as other in-channel sediment. Under the worst-case scenario, the mobilization of stored sediment would result in substantial fining of riffle and pool-tail gravels and loss of spawning habitat; loss of pool volume and low-velocity habitats along the channel margins; and/or increased mobility of riffle and pool-tail gravels during winter high flows when alevins and fry use interstitial gravel habitat or during periods when eggs are present in the gravels. “Substantial” in this scenario could be a function of downstream extent and/or duration of impaired channel conditions. For example, stored sediment might be mobilized from each reservoir over a period of several years, rather than a single year, thus reducing downstream fish habitat at each of the five dams planned for removal over a prolonged period. Monitoring sediment movement and channel response during and following dam removal should be able to detect the occurrence of this worst-case scenario, and adaptive management could be used to mitigate the effects of continued sediment movement and consequent habitat loss.

6.4 Downstream Effects

The success of the project in terms of recovery of the target species will be affected by the success of fish migration – juveniles and adults – through the Sacramento-San Joaquin Delta, the Sacramento River, and the Red Buff Diversion Dam to Battle Creek. Substantial investment has been made in terms of allocation of water supplies, construction and operation of hydraulic control structures, and construction of fish screens on major water diversions to improve fish passage through the system downstream of Battle Creek. Although recent years have been favorable in terms of hydrology, the positive benefits of the investment, as well as harvest management decisions, have been evidenced by significant returns to hatcheries on tributaries to the Sacramento River. The absence of significant returns to the hatcheries would indicate the system, from the standpoint of fish passage and/or the harvest rates, was adversely impacting the natural production. This is not to say that both are not currently impacting fish, but to merely indicate the resources expended over the last 10 years appear to be making measurable positive progress. How effective the improvement will be during dry periods remains to be determined. Nevertheless, attention to operating and maintaining constructed facilities and implementing measures to correct identified or yet to be identified problems downstream of Battle Creek will be required on an ongoing basis to ensure the opportunity for success of the project.

6.5 Regional Climate Change

The Battle Creek Restoration Project is designed to provide cold-water refuges for Chinook salmon and steelhead in the upper Sacramento River basin. If regional climate follows a trend of increased warming due to human influences or global patterns, the Battle Creek Restoration Project may not be successful because salmon cannot migrate through the warming reaches of the Sacramento River system, regardless of the cold-water refugia provided by the project. On the other hand, the Battle Creek Restoration Project would provide a critical thermal refuge during that period if it is successful. The Panel does not consider climate issues to be a major risk to the success of the project, but regional climate and landscape trends should be considered when evaluating the success of the project.

7.0 OTHER CONSIDERATIONS

As discussed above, *within the context of the MOU*, the Panel finds that, with exceptions noted, the cost of the elements of the project are reasonable, justified, and cost-effective. This finding says nothing about the strategic approach taken in the MOU to develop this particular set of solutions to balance fisheries and power production needs. Therefore, the findings say nothing about the reasonableness, justification, and cost-effectiveness of the project relative to other strategies for producing the same amount of power by alternate means or hydropower at another location.

The Panel was instructed to evaluate the Battle Creek Restoration Project solely within the context of the MOU and the Preferred Alternative as described in the DEIS/EIR. As the review progressed, the panel of experts discussed the relative merits of the project and that discussion inevitably led to discussions of alternative strategies. The region and cooperators in the Battle Creek Restoration Project have conducted an evaluation of alternative strategies within the process of developing the DEIS/EIR. The Panel respects the efforts and complexity in developing the Preferred Alternative. At the same time, the Panel feels that it would not be providing a truly independent and objective review if it did not openly provide comments relevant to the questions of cost effectiveness and environmental benefits.

The Panel offers the following observations and emphasizes that these observations are outside the technical questions and boundaries set up for the Panel.

The strategic approach used for the project modifications and upgrades at Battle Creek appears to have been designed to satisfy the needs of disparate interests in the region. Fisheries are provided with more water, better access, and more habitat. Power interests are provided with newer more reliable diversion and conveyance facilities, but with substantially reduced power and energy production capability. The results of the negotiations represent substantial progress and are to be commended. Nevertheless, these changes in the system come at a relatively high cost. A review of the total cost for attaining the project goals using this approach suggests that consideration should be given to alternate strategies to accomplishing the project goals.

At the present time the overall project costs are estimated to be approximately $62 million with approximately $50 million of that total yet to be expended. Dependable capacity will be reduced from 16.6 MW to 7.4 MW following implementation of the project, a small fraction of PG&E's 4,500 MW of dependable hydropower capacity. The average annual energy production is estimated to be reduced from an annual average of 245.5 GWh to 162.2 GWh. The remaining funds are to be spent to produce hydropower that provides a better fisheries environment than present but still involves risks to both fisheries and hydropower production. Attempts to reduce that risk have resulted in some of the more expensive but marginal elements of the project such as the Inskip penstock bypass pipe. While fish screens and ladders are the largest project cost elements, more may need to be done to adequately protect fish.

An alternate strategy appears to be feasible that, for similar or reduced project cost, would increase benefits and reduce risk both for power production and fisheries. The strategy would involve producing electrical power from other sources, such as gas, wind, or solar energy and completely removing hydropower production facilities from the Battle Creek watershed. The benefits to the fisheries would be obvious. Battle Creek is the best habitat available for the endangered winter Chinook salmon. Removing impediments to passage, flow, and habitat would provide the best possible strategy for saving the winter Chinook species.

However, benefits to power production may also be significant. While it is beyond the scope of this investigation to assess alternate cost strategies, any number of other types of electrical energy production facilities could be constructed to produce the same power output as the proposed Battle Creek facilities for the cost anticipated for this upgrade. R.S. Means *Heavy Construction Cost Data*, lists cost for diesel generation at approximately $250,000 per MW not including costs for land, operation and maintenance, and distribution facilities. The *Technical Assessment Guide* of the Electric Power Research Institute provides a range of costs for gas-fired facilities around $200,000 per MW and $500,000 to $1,000,000 per MW for wind power. These costs are based on installed facilities. Higher operational costs could be offset by payment up front from the difference in the remaining cost of the Battle Creek Restoration Project. Wind power could also provide environmental benefits.

Advantages to construction of new facilities rather than upgrading existing facilities would include:

- More reliable operation and power production, which is especially important for peaking power use.

- Less maintenance and associated costs.

- Facilities that have a higher book value and resale value.

- Fewer hours lost to down time.

- Fewer complications and restrictions from regulatory issues.

Consideration could also be given to operating only the Volta facilities. Removing all facilities except Volta would significantly reduce impacts to fisheries. Dependable power production would still be 3.6 MW, about one-half of the proposed value resulting from changes based on the MOU.

Finally, offering PG&E a fixed price settlement to remove generation facilities from the watershed might also be a viable strategy. This approach would allow the company to find new power sources or increase efficiency of existing sources to replace lost power. This could also include buying power elsewhere and upgrading delivery facilities to the Red Bluff area to ensure that the local power facilities do not suffer a loss of capacity.

The Panel notes that these observations are outside the boundaries set by the California Bay-Delta Authority. The Panel feels that our findings and recommendations are valid within the limits established for this review, but these larger regional and operational issues are essential as a context for interpreting our findings.

8.0 FINDINGS AND RECOMMENDATION

The Panel initially had many questions about the expense of the project, amounts of water provided for instream flows, or the increase in new hydropower assets to a private corporation. As the review progressed, panel members recognized that the project objectives are a reasonable balance of a complex set of resource issues and the costs of restoration to all parties, within the context of the MOU.

The Panel was explicitly asked two fundamental questions:

- Are the costs for each of the features described in the project documents reasonable and justified?

- Are the designs for each of the components of the project cost-effective given the performance and reliability specifications established in the Memorandum of Understanding (MOU) for the Battle Creek Salmon Restoration Project? Are there alternate designs or approaches that could be more cost-effective under the MOU?

The Panel's review of the costs was general in nature and was not a detailed review of the cost estimate. Review of more detailed information would be required to rigorously check the validity of the current cost estimate.

Within the limits of the information presented during the review process, the Panel developed the following major findings and recommendations:

Findings

- The overall goals of the Battle Creek Restoration Project are appropriate for regional conservation.

- Strategies used for salmonid recovery and environmental restoration in the Battle Creek Restoration Project are reasonable given the goals and constraints of the MOU.

- Application of screens and ladders is reasonable and prudent.

- Many of the elements of the project appear to be reasonable to meet the goals of the project. Most of the cost estimates for the elements designed appear to be appropriate; however, the panel was unable to fully assess the costs because of lack of clarity or detail in the information provided to us. Some of the elements of the project should be re-examined based on the comments provided.

- Engineering designs of fish ladders do not explicitly consider fish trap installation and location requirements.

- Fish-counting designs are not the most effective and in some cases are more expensive.

- Mitigation costs are extremely high and do not account for net increases in habitat and species of special concern.

- Non-attainment of some objectives may not indicate failure of the project. Commercial and sport harvest of salmon, regional weather patterns and changes in stream flow, downstream effects, and regional climate change may influence the responses of salmon to the battle Creek Restoration Project and should be considered in the evaluation process of the Adaptive Management Plan.

- Monitoring efforts are severely under funded and seriously jeopardize the Adaptive Management Program. As a result, the Adaptive Management Plan focuses primarily on design and implementation of structures.

- The restoration plan calls for sustaining viable populations, but does not set expectations for numbers of adult returning salmon. The Panel believe this failure to clearly identify the expected number of returning adult salmon in the objectives is a fundamental flaw of the Battle Creek Restoration Project.

- Funding for monitoring is inadequate to measure the success of the project or support adaptive management. The proposed monitoring in the Draft Adaptive Management Plan Appendix D, Objective 4 calls for long-term (16+ years) high cost monitoring approaches inconsistent with other aspects of the monitoring plan and the funding level. The Plan recommends additional scrutiny and review before the California Bay-Delta Authority obligates funds to monitoring activities.

<u>Recommendations</u>

- Some portions of the design are deficient. The plans should be reviewed in detail for compliance with the best available design practice.

- Funds for monitoring the intended responses of fish, channel geomorphology, water quality and temperature, and sediment dynamics need to be included in the Battle Creek Restoration Project. These funds are not adequate in the current request to the California Bay Delta Program and several critical outcomes of the project are not monitored. If these funds are not part of the proposal, alternate sources for these funds should be identified and the funding secured.

- The Adaptive Management Plan should be strengthened and an explicit process for reviewing responses of salmon and sediment routing after dam removal need to identified and implemented.

- New ladders should include provisions for fish traps so that fish can be collected, examined, and marked.

- Trapping adult salmonids is proposed as a monitoring approach, but the plan underestimates the value of this option at all locations. The Panel recommends the design of fish ladders include an alternative for insertion of an adult fish trap where possible.

- The proposed adult fish passage monitoring program does not use radio telemetry or PIT tag technology to monitor adult fish behavior or adult returns. The Panel recommends the monitoring program use radio telemetry to confirm that adults do not delay below ladders and consider PIT tag technology as a long-term monitoring tool.

- Newly constructed fish ladders need to account for remote sensing locations and construction requirements (e.g., PIT tag sensors).

- The Coleman Powerhouse tailrace barrier should be planned and scheduled as an integral feature of the project.

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