LOWER ALAMEDA CREEK/BART WEIR FISH PASSAGE ASSESSMENT

DRAFT ALTERNATIVES EVALUATION REPORT

Prepared For:

Alameda County Flood Control & Water Conservation District

August 29, 2006

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Introduction

In 1972, a grade stabilization structure was constructed across the Alameda Creek Flood Control Channel, otherwise referred to as the BART (Bay Area Regional Transit) Weir. The purpose of the structure was to protect the foundation elements of the Union Pacific Railroad (UPRR) and BART bridge crossings from scour and loss of stability. Since both rail crossings were designed to be supported by shallow foundations, i.e. piers atop spread footings, maintaining the geostructural integrity of subgrade beneath the footings was paramount. Accordingly, the channel was also armored to maintain streambed stability within the reach. The responsibility of ownership, operation, and maintenance of this flood control system was dedicated to the Alameda County Flood Control and Water Conservation District (ACFC&WCD) upon its completion.

At the same time the weir complex was being constructed, the Alameda County Water District's (ACWD) Middle Rubber Dam was installed immediately upstream of the BART Weir. The facility's role was to impound and divert raw water into ACWD's adjacent groundwater recharge reservoirs to offset the flood control project's adverse impacts on the Niles Cone Groundwater Basin. The combination of the weir and water supply facilities significantly affected the hydraulic gradient of the creek within this localized reach and compounded the vertical offset between upstream and downstream water surface elevations. When the dam is inflated and in service, the overall water surface differential across the collective facilities is approximately 22-feet. This drop is comprised of 9-feet at the weir plus 11-feet at the dam plus 2-feet at the rock weir downstream of BART Weir.

Prior to implementation of the flood control improvements, the U.S. Army Corps of Engineers (USACOE) determined that Alameda Creek and its tributaries did not sustain a viable anadromous fishery. Considerations for both upstream and downstream fish migration were therefore not included in the design of the structures. Since that time, anecdotal reports and actual field trappings suggest the contrary, as steelhead, Coho, and Chinook salmon have all been observed within the tailrace of the weir (Kidd, 2006).

In response to environmental concerns and the listing of steelhead within the respective ESU, a Technical Advisory Committee was created in 1999. The Committee is comprised of the ACFC&WCD, the ACWD, regulatory agencies, special interest groups, and various other stakeholders. The primary objectives of the group have been to restore access to former spawning habitat upstream of several artificial barriers in Lower Alameda Creek and to contribute to the overall population recovery of anadromous species within the watershed. Subordinate but important goals are keeping upstream water supply capabilities whole and making certain flood control functions are not compromised.

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In the wake of the above Committee being formed, several studies have been launched to assess environmental conditions at the site and the feasibility of various corrective alternatives aimed at achieving these objectives. Two plausible options for improving fish passage at the BART Weir complex have been studied at a concept level. The first concept involved a composite vertical slot/pool-and-weir fishway aimed at facilitating fish passage over the total 22-foot water surface differential at the complex. The second proposed solution involved a roughened channel fishway designed to provide fish passage at the BART Weir only.

The two concepts are markedly different in form and function and involve significantly different design approaches. The first allows water supply operations upstream of the weir to continue, whereas the latter is only viable when ACWD's dam is deflated and not in service. Since the two alternatives are at a preliminary design level, the ACFC&WCD is interested in comparing the two alternatives, including recommended design changes, as a step toward selecting a preferred alternative.

By applying a systematic approach, it is possible to identify the alternative that best achieves the outlined goals and objectives, while at the same time correlating cost with benefits. This document covers the following key elements as described below to achieve this purpose:

- Scope and purpose of evaluation
- Assessment of hydrology for which corrective fish passage measures should be designed
- Descriptions of alternatives considered and suggestions for improvement from former work
- System by which to appraise and compare alternatives based on a method of characteristics
- Detailed descriptions and comparisons of individual characteristics
- Summary of comparisons and scoring matrix
- Summary of recommended changes and analyses
- Concept level exhibits for each alternative
- Estimates of implementation costs for each alternative

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Statement of Scope & Purpose

Since a formal alternative development process has not been conducted, the ACFC&WCD is interested in confirming the validity of two fish passage concepts proposed to date and comparing their associated strengths and weaknesses. Accordingly, a third-party review and evaluation has been requested to assist the District in advancing a solution that best meets a variety of design, economic, environmental, and operating criterion.

The focus of this document is to present the alternatives in an equal light and to provide information to the District so they can determine which alternative best suits the project's objectives and goals. In order to do so, it requires development of a standardized schedule of criteria by which to compare the concepts. Therefore, a method of comparison, weighting, and ranking is developed so a comparison can be made based on a total cumulative score approach. The alternative ranking procedure allows for Committee input regarding level of importance each criterion plays in the contrast of these options.

To adequately demonstrate the scope of each alternative, concept-level illustrations have been developed for the two alternatives required within the scope of work. These exhibits are provided in Appendix A as supplemental information to the descriptions in this report. The drawings serve as the basis for quantity take-offs and provide the foundation for refining formerly developed cost estimates. As the concepts are not developed to a final stage and are based on a limited understanding of existing features and facilities, a contingency is included to conservatively account for the cost of potential unknowns and future design refinement.

The tools described above and the deliverables required within this scope of work lay the groundwork for providing the District with the information it needs to advance a preferred alternative to the final design stage. For the sake of objectivity, the selection of the preferred alternative can be rendered based on the aforementioned scoring procedure. However, the weighting and cumulative scoring is subject to opinion of the ACFC&WCD, ACWD, and regulatory agencies. Using this approach supports a heightened confidence level that the final recommendation is consistent with a comprehensive and equitable decision-making process, taking into account the interests and opinions of the Committee.

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Fish Passage Hydrology

An important task in fish passage design is estimating the design flows at which fish passage should be provided. Fish passage is generally tied to hydrologic characteristics of the particular watercourse for which it is to be provided. Selection of the design flow is determined in view of the actual migration period, statistical flow recurrence intervals, and acceptable risk resulting from delay caused by inadequate attraction into the fishway or other hydraulic conditions that hinder passage. Since the window of in-migration for fall-run salmon and steelhead in Lower Alameda Creek is presumed to historically fall between the months of December and May, the alternatives herein are evaluated with respect to the hydrologic record within these months. Considering the latest 50-year period of record of available data, a reasonable fish passage design flow can be determined.

The low fish passage design flow is the lowest streamflow at which the fishway must operate optimally. Normally a statistical analysis comparable to that used for the high fish passage design flow is appropriate. Since the low flow in Alameda Creek is controlled as a release from the rubber dam, a statistical analysis of historical flows may not be appropriate. Instead, for each fishway alternative considered here, a minimum flow is suggested. That flow would have to be released downstream of ACWD's dam during the migration period in order for the fishway to operate properly.

Conversely, The high fish passage design flow is typically defined as the greatest flow in the river or stream at which passage must be optimized. The high fish passage design flow is generally selected as the upper limit at which fish are actually migrating naturally, and/or the threshold in which greater flows occur so infrequently there is little consequence.

California Department of Fish and Game (CDFG) (1998) recommends, *"Fishways should be designed to pass fish during at least 90 percent of the flow conditions that will be encountered."* For culverts CDFG and NOAA Fisheries (2001) recommend a high fish passage design flow equal to the mean daily flow that is exceeded only 1% of the time.

According to the report entitled, "Fishway Design Guidelines for Pacific Salmon," by Ken M. Bates (2000), *"A variety of design flow criteria have been suggested or used. Gebhards and Fisher (1972) suggested an allowable migration delay of 6 consecutive days for salmon and trout. Dryden and Stein (1975) recommend that a 7 day impassable period should not be exceeded more than once in the* *design period of 50 years, and that a 3-day impassable period should not be exceeded during the average annual flood."*

An alternative approach as set forth in the reference, "Introduction to Fishway Design," authored by C. Katapodis (1998) is commonly used as well. The reference states, *"A delay period of less than three (consecutive) days in annual spawning migrations is usually accepted for several freshwater species. Delays longer than three (consecutive) days may be acceptable with a 1:10 year frequency. These two criteria are used whenever sufficient data exists to estimate the maximum flow that is likely to prevail at the time of fish migration."*

Once the high fish passage design flow has been established, the appropriate high design flow for the fishway can be estimated. The high fishway design flow is generally calculated to be 10% of the determined hydrologic design flow. This ratio has been found to provide reasonable attraction into the fishway entrance without subjecting in-migrants to excessive delays in their attempt to locate a navigable passage route.

The U.S. Geological Survey (USGS) has maintained a stream flow gage at Niles Canyon (#11179000) several miles upstream of the subject site since the late 1800's. According to average daily data over a 50-year period of record (July 1956 through July 2006), the 90% exceedance flow is estimated to be 180 cfs. In other words, stream flow was measured to be greater than or equal to 180 cfs for less than 10% of the time considered. This is consistent with the findings by Far West/WRECO (2005).

Narrowing in on the effective upstream migration period for the target species, generally considered to be December 1 through April 30 for coastal watercourses in the region, the 90% exceedance flow is estimated to be 530 cfs. It should be noted that upstream water supply re-operations in 1993 reduced the actual flow being measured at the gage in contrast to former operating conditions as described by Far West/WRECO. Therefore flow data pre-1993 was supposedly higher than it would be today, and the estimated design flow could be potentially influenced.

In light of the above criteria, the final design flow should be confirmed prior to final facility design. In 15 years out of the 50-year record reviewed, there have been periods of more than seven (7) consecutive days when stream flow exceeded 530 cfs, and a total of 13 events since 1993. Further consideration of the high fish passage design flow is therefore warranted. It is recommended a collaborative process be conducted with regulatory agency officials to establish concurrence on hydrologic/fishway design flow prior to final design of the Project.

In the meantime, for the purpose of this evaluation it is assumed that a 350 cfs to 450 cfs hydrologic design flow range is acceptable per the suggestion of Mr. George Heise (CDFG) at a Project coordination meeting on July 24, 2006. Accordingly, the alternatives evaluated herein will consider 35 cfs to 45 cfs as the minimum necessary fishway design flow for attraction and fish passage efficacy. This determination will be used as the basis for qualifying alternative viability and for identifying conceptual layouts and physical and operational requirements throughout this evaluation. On the other hand, for the roughened channel alternative a maximum design flow of 800 cfs is considered per the Far West/WRECO document since the entrance is located an extreme distance downstream of the BART Weir. For this option it is important the capacity of the fishway be great enough to single-handedly convey all streamflow when immigrants have been observed in the system. This ensures the entrance will not be bypassed by in-migrants and otherwise prevent them from staging at the apron of the BART Weir.

Description of Alternatives

The BART Weir complex consists of multiple obstructions in the channel which generate vertical offsets in the hydraulic profile. Traversing in the upstream direction starting below the complex, a rock weir is followed by an energy dissipating apron, a gravity concrete weir (BART Weir), and the ACWD inflatable middle dam. Each element produces its own impact to fish passage at varying degrees. The original scope of this exercise was to evaluate and compare two previously developed alternatives aimed at facilitating fish passage at these structures. These alternatives are herein termed the ***reduced vertical slot fishway*** (modified from that described by CH2M-Hill [2001]) and the ***roughened channel*** (natural fishway as described in the 2005 Far West/WRECO report).

Tasked with the responsibility of comparing alternatives, it is important to equalize the options with similar design objectives in order for comparisons to be fair. As the two alternatives involve significantly different approaches in their design and fish passage capabilities, it is necessary to reduce the vertical slot fishway concept to an equivalent passage route as that of the roughened channel alternative. Accordingly, the original hybrid fishway concept presented in the CH2M-Hill report must be reduced to facilitate fish passage at the BART Weir only and not over the entire complex. Likewise, the roughened channel alternative requires specific modifications to enable the necessary hydraulic conditions for fish passage. Detailed descriptions of the two alternatives and recommended modifications are provided below.

Additionally, the ACFC&WCD requested at the workshop on July 24, 2006 the original ***extended vertical slot fishway*** be included in the comparison**,** as it was described in the 2001 CH2M-Hill report. For the sake of the raw water diversion component being a critical topic and mitigating effects to the ACWD's water supply capability from the overall solution scheme, this alternative is included within the comparison as a third option. Some refinement is also recommended to simplify the original concept.

Lastly, a fourth alternative is suggested as an optional upstream fish passage technology for providing circumnavigation of the BART Weir only. It is termed a ***pool-and-chute fishway***. This concept was not applicable or considered in the CH2M-Hill feasibility study because it is a fish ladder type tailored to a lesser overall water surface differential. Since the fish passage objective in this evaluation is to address fish passage at the Bart Weir only, this fish ladder style has merit toward minimizing implementation cost and promoting high fish passage effectiveness. Therefore, it is included within the comparison herein. A more detailed description of this alternative is provided below to familiarize the reader with its composition and capabilities.

Alt 1 – Reduced Vertical Slot Fishway

Vertical slot fishways are a common design for adult salmonids throughout the West Coast. Their greatest advantage is they are self-calibrating over a wide range of streamflows. Their greatest disadvantage is they take only a small portion of the flow during high flows so attraction of fish into the fishway is diminished.

The reduced vertical slot fishway features a condensed footprint from the CH2M-Hill report as a result of simply decreasing the total head differential that it needs to accommodate. It is based on the basic layout of the extended vertical slot fishway described in Alternative No. 3 below, but it is downsized to provide passage over the BART Weir only. A concept-level exhibit illustrating the configuration and alignment of this fishway is provided in Appendix A. This alternative involves a guide channel and weir at the energy dissipating apron to allow passage up to the fishway entrance. The fishway includes entrance and exit transition pools to support sufficient depths suiting the necessary hydraulic profile. An additional upstream weir is required to support adequate depths for fish passage over ACWD's inflatable dam. The fishway is designed to support an approximate 30 cfs to 60 cfs flow range for fishway attraction.

Alt 2 – Roughened Channel Fishway

The roughened channel fishway is a relatively steep channel lined with random angular rock and boulders to produce high roughness at the wetted perimeter, and hence reduce velocities in the water column. The objective of design is to increase the water column depth and decrease the velocity in the channel to an acceptable level for the target species. It is similar to a natural riffle or cascading channel and emulates the diversity and complexion of a natural watercourse for optimum fish passage. The major exception being the roughened channel is an engineered channel designed and constructed for reliability and longevity.

This option was previously described in the 2005 Far West/WRECO report, and passage is provided only over the BART weir. Our evaluation is of this formerly studied fishway alternative, including specific design recommendations made herein. A concept-level exhibit illustrating the configuration and alignment of this fishway is provided in Appendix A. Per our recommendations, this alternative should be configured with a reduced-width triangular cross-section, an upstream weir for directing flow into the fishway, and a substantial channel transition needed to merge fishway to stream channel flowlines while maintaining comparable flow area and velocities. A retaining wall is also suggested as a more practical and reliable method for containment of the southeast or left side of the fishway. The fishway is designed to support an approximate 50 cfs to 800 cfs flow rate for fishway attraction.

Alt 3 – Extended Vertical Slot Fishway

This option was previously described in the CH2M-Hill Report. Passage is provided over the BART weir and the middle rubber dam, whether inflated or deflated. Some modifications are recommended herein to offer a simplified and more practical design configuration. Accordingly, it is recommended the vertical slot style fishway be used throughout the alignment thus simplifying construction and operations. It is recommended the pool-and-weir segment of fishway with the flow control weirs originally described in the CH2M-Hill report be simplified to a vertical slot design throughout for consistency and to avoid unneeded complexity. The vertical slot fishway is self-adjusting with respect to upstream and downstream water levels and therefore requires no control elements to maintain performance within operating design parameters. The fishway is designed to support an approximate 30 cfs to 60 cfs flow range for fishway attraction.

Alt 4 – Pool-and-Chute Fishway

In our review, it was identified that a pool-and-chute fishway alternative should be included in the comparison for further consideration. This fishway style operates over a much broader flow range than other ladder types and is well suited for the short drop over the BART Weir. It is recommended the fishway be located near center of the BART Weir to align it with the defined section of the channel downstream.

The pool-and-chute ladder was developed in the last decade and has been used for passage of adult steelhead and other adult salmonids on the West Coast for low barriers. The explanation of the pool-and-chute is more extensive here because it has not been considered or described in previous reports.

A pool-and-chute fishway is a cross between a pool-and-weir fishway and a roughened chute. It is made up of a concrete structure located within the stream channel and partitioned by a series of weirs with vee-shaped cross-sections and a notch at the apex of each vee.

The fish passage corridor is defined as the non-overflow area along the walls of the fishway that provide resting areas and good upstream passage conditions. It is measured as the horizontal distance from the inside wall to the edge of the water at the baffle. Because the baffle is sloped, the flow near the end is restricted and the downstream pool can be calm compared to the center section of the fishway that is streaming and turbulent. A passage corridor width of two feet is recommended.

At low flow, the fishway performs as a pool-and-weir fishway. The flow plunges over each weir and dissipates in each pool. At high flow, a streaming flow condition exists down the center of the fishway where the bulk of the flow passes. Plunging flow and good fish passage conditions can be maintained through a “passage corridor” at the edges of the pools. The economy of the concept is achieved by exceeding the usual fishway pool volume criteria based on energy dissipation in each pool, thus reducing the depth of the ladder while taking a greater flow in contrast with other fishway types. The configuration of the pool-and-chute accommodates a much greater range of flows through the structure than its vertical slot counterparts, thereby improving detection/attraction and self-cleaning operations. A pool-and-chute fish ladder suiting the site conditions and hydrology can be configured to operate effectively from a few cubic feet per second to over 100 cfs with good fish passage operating conditions throughout.

This style of fishway is also good at passing debris since the fishway and is substantially submerged at highest flows. The open design encourages debris to wash over the weirs and out of the fishway.

The hydraulic conditions that define passage success depend on the presence of a streaming flow regime at high flows and a separation of the streaming and plunging flow regimes. Empirical roughness coefficients have been developed from model studies and prototypes to assist in making this calculation. Application of the fishway is limited because of limited hydraulic verification. Bates (2000) recommends that the concept not be applied where the total drop exceeds about six feet until the concept is more thoroughly tested. It is not clear that uniform flow conditions at highest flows have been achieved in the modeling and prototypes so far tested. Higher velocities, flow instabilities and downstream channel impacts may be created with greater heads. In addition, with such high velocities, even minor disturbance of the desired flow patterns by dimensional error in design or construction can potentially cause flow instabilities throughout the entire fishway. The geometry of the BART Weir is within conditions recommended for its application, therefore the pool-and-chute fishway is suggested as an option.

Comparison of Alternatives

Process of Comparison

The four alternatives are compared using a weighted decision matrix or Pugh Method. This is a common decision-support tool allowing decision makers to solve their problem by evaluating, rating, and comparing different alternatives. There are four basic steps to a Pugh Method matrix.

1. General fishway and project characteristics have been chosen and are weighted based on their relative importance.
2. Each option is evaluated by how well it is expected to achieve each characteristic.
3. Each option is scored for each characteristic as the product of the weight and the evaluation.
4. The scores are summed for each option for comparison with the other alternatives.

This method of comparison provides an opportunity to look for possible improvements in design. The characteristics used for evaluating and comparing the alternatives are discussed in detail below. Any low-scoring characteristic can be further investigated to see if a modification to the design could raise the ranking score. Independent reviewers can modify the weights and resulting scores to reflect their interests.

The comparison of the reduced vertical slot, roughened channel, and pool-and-chute fishways is straightforward. These facilities will pass fish over the BART Weir with the assumption that either the ACWD's middle rubber dam will be deflated during the migration window or an additional passage mechanism will be provided to circumvent this barrier when it is in service. Evaluation of a supplemental fishway is not included within this exercise. Evaluation of the extended vertical slot is a bit different since passage is provided over both the BART Weir and the rubber dam, regardless of whether the rubber dam is inflated or deflated.

The alternative descriptions and evaluations in this document include some recommendations for design changes and/or further analysis of the previous CH2M-Hill and Far West/WRECO designs. To make the comparisons fair, the evaluations of those previous designs are made accounting for various recommendations offered herein to improve their capabilities.

The comparisons and recommendations for improvements and preferred alternative selection are based on professional judgments and a collective resume of over 40-years designing, evaluating, and constructing fish passage projects for all fishway types considered in this evaluation. The comparisons have been made “blind” meaning the cumulative scores were not calculated until after all fishways were evaluated and characteristics weighted appropriately.

The basis for analyzing the alternatives are supplemented by concept-level exhibits and cost estimates provided in the appendices. Exhibits are developed for Alternatives No. 1 and No. 2 per the original scope of work. Exhibits and updated cost estimates of Alternative No. 3 are included in the appropriate appendices as provided by ACWC&FCD. Since Alternative No. 4 is voluntarily offered for consideration, drawings or cost estimates are not provided for this alternative.

Characteristics Compared

As explained above, a Pugh comparison matrix was used to compare how alternatives meet all conditions and objectives deemed important to involved parties. Parameters are further explained below followed by associated weighting and ranking values as presented in the detailed schedule of Appendix B at the conclusion of this document. The evaluations are broken into six general categories as follows; fish passage, operation and maintenance, water supply, design and construction, flood control, and other. These categories were presented to ACFC&WCD, ACWD, and CDFG at a workshop on July 24, 2006 and have been modified somewhat from those discussions.

Fish Passage

The foremost objective of this project is to provide passage for adult steelhead over the BART Weir. Passage is broken into the characteristics described below for the purpose of comparison and evaluation of components.

- ***Attraction of adult steelhead to fishway***

An important key to fish passage is attraction of fish into the fishway. It could account for a high portion of the success of fish passage and it is often the most difficult to predict during the design phase. Fishway attraction depends on the entrance location, entrance flow, shape of entrance flow jet, and distraction or competition from other flows. Attraction into the fishway is evaluated for the entire fish passage design flow range.

Reduced Vertical Slot According to standard engineering practice, the selected fishway design flow (35 cfs to 45 cfs) will adequately attract immigrants to the entrance during a majority of the migration period. However , because the operating flow range of this fishway is limited, competing flow over the weir will diminish its effectiveness during higher flows, when fish have previously been observed in the proximity of the weir.

Attraction into the vertical slot option is scored lower because attraction to the entrance competes with flow over the weir crest. Since the high fish passage design flow (450 cfs) over the weir is only about 2.0 cfs/ft of weir length, the competition is not considered to be a significant issue. In addition, Alameda Creek is not overly wide at the site meaning opportunity for delay will be short. In-migrants will not have to travel far to locate the fishway entrance.

The vertical slot entrance is a tall narrow slot identical to the fishway vertical slots. It is therefore self-operating and will maintain a velocity that will attract fish. Because of its tall narrow shape the jet is more rapidly dissipated than would be a more concentrated jet however. It is recommended that the entrance shape be optimized in the final design.

Attraction will be improved with the recommendations as described in the **Fish Access** characteristic below. The recommendation would increase the fishway design flow and attraction

Roughened Channel The roughened channel ranks highest of all four alternatives for this characteristic because all of the flow in the stream up to the maximum flow when in-migrants have been observed in the creek (800 cfs) would be conveyed by the fishway This fishway would provide a single-source passage route when migration presumably occurs. Designing at a lesser flow rate might cause some fish to miss the fishway entrance and be delayed at the weir apron.

Extended Vertical Slot Attraction characteristics are identical to the reduced vertical slot.

Pool and Chute Attraction into the pool and chute at most flows would be very good since a high percentage of the creek flow would be routed through the fishway under the hydrologic design flow range considered. The pool and chute would have a lower flow capacity at the high fish passage flow than the roughened channel.

- ***Fish Access Into and Out of Fishway***

This characteristic pertains to physical access into and out of the fishway. Depth of flow is the only limitation to access for these designs. Generally a minimum depth of four feet is preferred in fish passage channels for adult salmonids. Measures are required to facilitate access into the fishway entrance and out of the exit.

Assurance that the appropriate flow will pass into the fishway, assuming normal maintenance is performed, is also covered by this characteristic. As with all fishways, there is a low flow threshold by which they will perform adequately for fish passage. It is expected natural barriers will exist downstream (i.e critical riffles, braided channels, broad shallows) below the low-flow capabilities of the alternatives considered. Accordingly, deliberate focus is not given to this topic, however this assumption should be verified before proceeding with final design.

Reduced Vertical Slot Attraction to the fishway necessitates location of the entrance as near the physical/hydraulic barrier as possible. In this case, the entrance is located at the downstream sloping face of the BART weir within the energy-dissipating apron. A combined low-flow guide channel and weir (See Appendix A) are considered per the CH2M-Hill Report to prevent shallow, high-velocity sheet flow over the apron. The system will provide appropriate hydraulics to allow in-migrants access to the entrance. The weir will back up water to provide roughly two feet of depth and velocities consistent with adult salmonid swimming capabilities. The weir notch will concentrate flow to the right bankline thus improving access and fishway discovery. The shallow water does not prevent access but some fish may be delayed or avert from the fishway. Access would be improved if a channel is cut into the apron to provide fish a deeper path to the fishway entrance. If the fishway entrance is lowered to about the same level as the guide channel fishway access would be significantly improved. This would also facilitate construction and provide a cost reduction to the project by eliminating the need for the weir.

Fish must also exit the fishway into the creek channel where water depth is typically shallow. A cross-channel weir or curb is suggested immediately downstream of the fishway exit to provide adequate upstream depth in the creek for fish to continue their travel and pass over the ACWD dam upstream. A transition pool is also necessary to provide an adequate flow/depth relationship in the ladder exit while at the same time addressing the resulting grade transition between creek thalweg and fishway invert. Alternatively, a channel could be excavated into the bed from the fishway exit to the sill of the rubber dam. The upstream end of the channel would be located just below a low sill with a notch located on the apron of the rubber dam and as suggested by CH2M-Hill. Either method could affect flood levels and would need further hydraulic analysis.

Roughened Channel The exit of the roughened channel is downstream of the ACWD dam and has similar design considerations as those described for the reduced vertical slot fishway. In this case, since the design flow is so much greater (800 cfs max), a significant channel transition is required to maintain a constant flow area throughout the transition and make up the difference between proposed roughened channel invert and creek thalweg. In addition, a weir is needed to simply force all creek flow into the roughened channel up to the design flow capacity.

Since the fishway entrance is located downstream of the Bart Weir complex and daylights within the existing creek channel, access into the fishway is ideal. Access and attraction into this fishway option are determined to be the best of all options considered.

Due to supposed downstream grade control, it is presumed there is little risk the downstream channel will degrade in the future. However, there is some risk as evidenced by the 4-foot scour hole below the BART Weir complex that presumably was constructed to halt degradation at the bridge piers. A better understanding of the probability and extent of future degradation and a design of the fishway that is long and deep enough to accommodate future degradation can manage this risk.

<u>Extended Vertical Slot</u> Access into the fishway and attraction at its entrance are identical as those for the reduced vertical slot. This is the only alternative offering egress from the fishway when the rubber dam is inflated, as this option has provisions for exiting within the deep forebay of the dam. When the dam is out of service, appropriate hydraulic conditions will be created by the proposed weir sill at the rubber dam.

<u>Pool and Chute</u> Access considerations for the pool-and-chute are similar to those for the reduced vertical slot. A weir and guide channel from the tailwater pool to the apron would be required. Since a high-velocity jet is produced at the downstream end of the ladder, considerable pool volume is required to dissipate the energy. With the ladder entrance located at the upstream limit of the apron, sufficient space exists to form a good energy dissipating pool.

- ***Passage of adult steelhead through fishway***

Passage of adult steelhead through the fishway is the certainty of passage.

<u>Reduced Vertical Slot</u> The vertical slot fishways score the highest of all options for this characteristic given the considerable positive experience of this style of fishway for passage of steelhead and other species of adult fish throughout the West Coast.

<u>Roughened Channel</u> There is less experience in the design and construction of large roughened channel fishways considered here. Since there is some randomness in the materials and design, there is some uncertainty in performance and passage effectiveness. The

channel should be configured with a triangular cross section to concentrate flow toward its center and maintain necessary water depth during low flows. A liner is also recommended to prevent subsurface flow. Placement and the ability to reposition boulders offers convenient flexibility in the field toward optimizing hydraulic conditions for fish passage.

<u>Extended Vertical Slot</u> The design includes a pool-and-weir fishway in the extended segment. There is some risk that steelhead will delay or reject the change in hydraulics within the fishway. We recommend a vertical slot ladder throughout. An extended vertical slot ladder will also eliminate the need for the control gates on the upper three weirs.

<u>Pool and Chute</u> There is less experience with design and operation of pool and chute fishways than the other designs considered here. Passage at high flows depends on there being a passage corridor within the fishway adjacent to a high velocity, high turbulence streaming flow. There is a small risk that passage for some individual fish is not successful or is delayed during high flows.

- ***Attraction and passage of non-target species***

Though the target species for fish passage is adult steelhead, there is ecological value in providing for or blocking passage of other species and life stages. No other species have been specifically identified for passage. There might be value of upstream passage of salmonid juveniles since there is no rearing habitat in the vicinity.

CDFG (Atkinson, 2006) suggests that carp and striped bass be blocked from upstream passage if it can be done without compromising adult steelhead passage. The objective of blocking these fish is to minimize predation on steelhead smolts in the channel upstream.

There are several ways to block fish; height and velocity barriers are the most common. If there is a distinctive difference in swimming or leaping ability between species, undesirable fish might be blocked and steelhead passed. Gates could easily be installed on the vertical slot entrances to create a velocity barrier. Structures could also be built within the vertical slot fishways for the same purpose. These features would likely compromise passage of steelhead to some extent and we have therefore not included such a feature in our recommendations or evaluation.

<u>Reduced Vertical Slot</u> The vertical slot fishway is less desirable for passing weak species or juvenile salmonids. A relative high velocity (8 fps) and narrow slot dimensions (12 inches) through the vertical slots prevent weaker fish from either swimming or leaping from one pool to the next.

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<u>Roughened Channel</u> The diversity of hydraulic conditions within the roughened channel makes it potentially suitable for passage of some weaker and juvenile fish.

<u>Extended Vertical Slot</u> Attraction and passage of other species is similar to the vertical slot fishway.

<u>Pool and Chute</u> Hydraulic conditions within the fishway are good for passage of a variety of species and sizes of fish up to a moderate flow. Fish that do not leap will not use the fishway.

Safety of fish

This characteristic is the physical safety of fish passing through the fishway. This includes safety of juvenile fish migrating downstream.

<u>Reduced Vertical Slot</u> Fish in the vertical slot are safer since the fishway is enclosed and access is more difficult. There is some risk of poachers building a fish trap within the fishway and not being visible from the outside. Fish will be exposed as they enter and exit the fishway through shallow areas. The apron and weir crest modifications described in **Fish Access** will reduce that risk.

<u>Roughened Channel</u> Fish in the roughened channel are exposed to slightly greater risk of predation and poaching within the fishway. The exposure is presumed to be slightly higher than in the creek channel downstream because flow is confined to the narrow fishway and boulders allow access for avian predators and poachers to get close. Fish will also be exposed as they exit into a shallow area just above the BART weir. The sill described in **Fish Access** will reduce that risk.

<u>Extended Vertical Slot</u> Safety of fish within the fishway is no different than the vertical slot fishway. Fish will be exposed as they enter the fishway over the shallow apron. The apron sill described in **Fish Access** will reduce that risk. Fish exit into a deep pool above the rubber dam.

<u>Pool and Chute</u> Though the fishway is open, fish are protected by the depths of the pools and the cover of turbulent water. Fish could be trapped within the fishway but any activity there would be very visible.

Potential for Fish Passage Evaluation

This characteristic is the ability to monitor or evaluate passage through the fishway and to assess hydraulic performance in light of design criteria. There is no stated intent of doing such an evaluation at this time though monitoring and evaluation facilities are often added to fishways later for various reasons. The purposes of such monitoring could be to monitor fish escapement and population in Alameda Creek or to evaluate the fishway itself.

Reduced Vertical Slot A portion of the vertical slot has access, geometry, and flow characteristics suitable for the installation of a monitoring trap or bio-mass monitoring instrument. This fishway is the easiest of all four alternatives for conducting a hydraulic performance evaluation.

Roughened Channel The roughened channel would be much more difficult to evaluate; there are no vertical walls, flow is distributed through a number of pathways, a trap would be susceptible to debris and flood flows, and the fishway is located away from the bankline so it is not easily accessible for construction or operation. However, a quantitative approach could be provided to estimate passage effectiveness. Using a velocity profiler and performing velocity surveys throughout the water column at selected transects, velocity distribution and hydraulic conditions could be measured and evaluated with respect to swimming characteristics.

Extended Vertical Slot Potential for evaluation is slightly better than the reduced vertical slot because there is more space for a trap/instrument and access is easier. The same method for conducting a hydraulic performance evaluation at the reduced vertical slot fishway would apply.

Pool and Chute The pool and chute would be slightly easier to evaluate than the roughened channel because it is contained within concrete walls. Access and hydraulic evaluations would be more difficult than the vertical slot fishways.

Operation and Maintenance

Fishway Flow Control

A fishway with good flow control is one that is self-operating and needs little to no intervention for proper flow control, operating conditions, and performance.

Reduced Vertical Slot A benefit of vertical slot fishways is that, if designed correctly, they operate at optimum condition through the entire range of fish passage design flows without a need for operational adjustment. Flow will self-adjust within the fishway commensurate with varying depth in Alameda Creek.

Multiple entrances are shown in the design. Multiple entrances are often provided with the intent of opening and closing specific entrances to accommodate varying tailwater conditions through the range of fish passage flows. Since even at the expected high fish

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passage flow the unit discharge is about 2.0 cfs/ft, it is expected only a single entrance will be used for attraction. From the standpoint of fish preference, it makes sense to construct at least two entrances to allow flexibility in determining which entrance is most effective based on field observations. If the recommendation for deepening a portion of the apron is implemented, the deepening and the entrance location must be coordinated and may lead to a single entrance in the final design.

Roughened Channel As this is a quasi-natural open channel, no flow control operations are needed for the roughened channel.

Extended Vertical Slot The benefits of this alternative are the same as for the reduced vertical slot fishway. It is recommended the design be modified from the CH2M-Hill report as a continuous vertical slot fishway for its entire length. This will greatly facilitate operations and improve reliability by omitting actuated slide gates.

The fishway exit would be manually switched between two gates when the dam is inflated or deflated. When the dam is deflated the upper portion of the fishway must be inspected and any stranded fish moved out of the fishway.

Pool and Chute No flow control operations are needed for the pool and chute.

Required Operating Flow

The required operating flow is the minimum flow required in the channel and fishway for the fishway to operate. Again, the minimum operable limit is assumed to be above that required for passage of natural barriers downstream of the project.

Reduced Vertical Slot Flow requirements through a vertical slot fishway is certain. It depends on the depth of the fishway and width of the slots. Depending on water levels within the creek, the fishway will operate in accordance with industry standard design criteria from roughly 30 cfs with 5-feet of depth in the ladder to roughly 60 cfs with 9-feet of depth in ladder. Flow in the creek below this limit will result in impassable conditions at the ladder’s exit.

Roughened Channel A minimum flow is required to maintain optimum hydraulic conditions within the fishway. That flow is estimated be in the order of 50 cfs due to a minimum depth constraint in the creek channel upstream of the fishway. Flow in the creek below this limit will result in impassable conditions at the fishway’s exit.

It is recommended the cross-section of the fishway be configured with a triangular cross section to optimize conditions at low flow and therefore minimize the low flow requirement.

Extended Vertical Slot Flow requirements are the same as for the reduced vertical slot fishway alternative.

Pool and Chute There are no low flow limitations of the pool and chute. It can operate effectively with flows down to a few cfs.

Sediment and Bed Load Management

Reduced Vertical Slot Sediment is not expected to deposit within the fishway nor affect its performance. Due to the full-height vertical slots at the fishway baffles, the vertical slot fishway is more self-maintaining than pool-and-weir type fish ladders. Some sediment may accumulate at the fishway inlet and transition pool. The proposed sluice gates at the exit can be manually operated to produce higher velocity flow at the invert of the exit structure and assist with moving accumulated material downstream through the ladder. They also serve to isolate the fishway for personnel admittance should access be needed for maintenance.

Roughened Channel No sediment is expected to accumulate in the roughened channel. It should be relatively self-sustaining.

Extended Vertical Slot Since it is recommended the entire fishway be configured as a vertical slot style throughout, sediment management issues are the same as for the reduced vertical slot fishway.

Pool and Chute No sediment is expected to accumulate in the pool and chute fishway.

Debris

A fish ladder within a natural watercourse is vulnerable to the natural debris load within the system. Debris can impair operations and performance if allowed to accumulate unchecked, thus compromising its passage effectiveness. This characteristic describes the likelihood and consequence of debris accumulation at the exit of or within the fishway.

Reduced Vertical Slot Debris will accumulate at the fishway trashrack(s) and need to be removed. With trash rack(s) in place it is expected significant debris will not be transported into fish ladder. The trash racks should be sized with consideration of manual removal in mind.

Small debris may pass through the trash racks and become lodged in slots of the vertical slot fishway which could affect passage. The fishway must be inspected periodically and debris removed as necessary.

Debris could accumulate in the exit transition pool and affect the function of the fishway. Large woody debris that falls out at the fishway exit will be easily accessible to heavy equipment from the adjacent operating road.

Roughened Channel Logs could become stranded in the roughened channel and could affect flow and passage through the fishway. Because access for regular maintenance is poor, they would likely have to be removed but cutting into pieces. At low flow even accumulations of small debris could be an issue at specific points within the channel.

Extended Vertical Slot Debris issues are similar to the vertical slot fishway. This option scores slightly higher than the reduced vertical slot fishway because the trash rack can be larger given the exit structure in the impoundment upstream of the ACWD dam. The structure would also be more accessible for debris removal.

Pool and Chute Debris issues are similar to the roughened channel alternative. The pool and chute is less accessible than the roughened channel so maintenance would be more problematic.

- ***Durability of Structure***

Reduced Vertical Slot Durability/longevity of the cast-in-place concrete fishway is high.

Roughened Channel There is some risk that individual boulders in the roughened channel could become dislodged. Anchorage of the boulders may be needed in the design but could affect the desired flexibility of repositioning and relocating the boulders. There is also some risk that the channel seal could fail and cause excess leakage from the fishway.

Extended Vertical Slot Durability/longevity of the cast-in-place concrete fishway is high.

Pool and Chute Durability/longevity of the cast-in-place concrete fishway is high.

- ***Accommodates extension to above the middle weir***

This characteristic describes the ease of extending the BART weir fishway to pass fish above the rubber dam at some time in the future.

Reduced Vertical Slot The vertical slot ladder could easily be extended if initially designed with that in mind.

Roughened Channel The roughened channel does not easily accommodate an extension to above the rubber dam. An entire second fishway would have to be constructed similar to the upper portion of the to the extended vertical slot fishway.

Extended Vertical Slot This design provides passage to above the rubber weir; an extension beyond this is irrelevant.

Pool and Chute The pool and chute does not easily accommodate an extension to above the rubber dam. An entire second fishway would have to be constructed similar to the upper portion of the extended vertical slot fishway.

Water Supply

A secondary objective in this evaluation is to maintain the diversion operations at ACWD's Middle Dam. This characteristic describes whether the alternative will allow the dam to remain in operation while providing for fish passage. It is closely related to the previous characteristic of extending the fishway to above the middle dam.

Reduced Vertical Slot The reduced vertical slot ladder precludes operation of the ACWD's Middle Dam.

Extended Vertical Slot This design provides passage over both the BART Weir and the ACWD's Middle Dam.

Roughened Channel The roughened channel precludes operation of the ACWD's Middle Dam.

Pool and Chute The pool and chute ladder precludes operation of the ACWD's Middle Dam.

Design and Construction

Construction Complexities

Complexities of construction include the extent of work, access and spatial constraints, depths of excavations, public and construction personnel safety, disturbance to existing improvements, conflicts with and selective demolition of existing structures, bypassing and dewatering, cofferdamming requirements, and allowable duration of construction. These complexities are also reflected in the construction cost estimates provided in Appendix C.

Reduced Vertical Slot Cofferdamming and dewatering is less difficult than the roughened channel as the footprint of the fish ladder alternative is smaller. Disturbance to existing structures and magnitude of demolition would likewise be less. Deep excavations are needed adjacent to the high retaining wall and both the BART and the UPRR crossing piers and abutments and structural connections to those facilities may be required.

Roughened Channel Construction of the roughened channel includes more in-stream construction and a larger footprint; construction extends 200 feet further downstream than the other options. A notch will be cut into the weir crest. Selection of boulders and their placement into the roughened channel are critical elements of the success of this option. Placement is not a standard construction practice and is not easy to specify. It is recommended that a source of boulders be located for the contractor and that the design engineer assist in supervising placement.

Extended Vertical Slot Construction complexities are similar to the reduced vertical slot fishway. Construction of the extended segment will require an excavation through or underneath the abutment of the rubber dam, as well as cofferdamming and dewatering in the forebay. Preventing interference with the ACWD's on-going diversion operations would be complicated.

Pool and Chute Construction of the pool and chute includes the least amount of in-stream construction and relatively the same size footprint as the reduced vertical slot. Construction will involve similar issues as the reduced vertical slot fishway though excavations will likely be shallower. Access, bypassing and dewatering would be complicated given the location be sited in the center of the channel.

Certainty of Structural Design

There will have to be high certainty of the final structural design. This characteristic describes the complexities of the design and the certainty that components won't fail.

Reduced Vertical Slot Certainty in the design of cast-in-place concrete is high. Structural complexities of cutting into the weir apron and crest and tying to the adjacent retaining wall need further investigation. Construction of the vertical slots is complex but can be simplified by re-using custom forms or pre-cast elements.

Roughened Channel As mentioned previously, boulder placement is not a standard construction practice and is not easy to specify. The design may require trade-offs between passage of fish (diversity of boulders) and stability (large boulders). There is some uncertainty in the stability of individual boulders and their anchorages. There is some uncertainty in the grouted rock fill required to line the roughened channel.

Extended Vertical Slot Structural considerations are similar to the reduced vertical slot fishway with some added exposure or risk around the abutment of the rubber dam.

Pool and Chute Certainty in the design of cast-in-place concrete is high. Structural complexities of cutting into the weir apron and crest need further investigation.

Flood Control

Affect on flood control

This characteristic describes the impacts to the hydraulic stream profiles upstream of the BART Weir .

Reduced Vertical Slot No flood analysis has been done for hydraulic effect of the reduced vertical slot fishway option. The fishway, as designed, will effectively block roughly 60 square feet (3%) of the available flow area at the BART Weir crest during the 100-year event (per Far West/WRECO report existing conditions hydraulic model). The fishway will block roughly 1.5% of the flow area of the USACOE design flood. The fishway will block roughly the same percentages of the flow area at the downstream energy dissipating apron as well. ACFC&WCD has reportedly been told by USACOE representatives this option is not expected to not have a significant flood effect. A 2-foot sill or weir at the downstream end of the apron is recommended and may have a greater effect on upstream flood elevations. It is not clear whether the USACOE considered that sill in their statement.

A low sill or weir is also recommended upstream of the BART Weir to provide additional depth in that area for fish to pass ACWD's Middle Dam. That sill may have an effect on upstream flood levels; the effect should be analyzed prior to design.

Roughened Channel The Far West/WRECO conceptual design report includes the description of a HEC-RAS model of the roughened channel. Their results show a rise of water level of 0.5 feet 75 upstream of the BART weir and about 0.2 foot 500 feet upstream during the 100-year flood event. These are likely within the error of the model. In fact they show the water level being lowered by the project during the Corps of Engineers design flood. Flood effects for this option would have to be addressed prior to final design but it is not expected to have a measurable effect.

A 2-foot weir is required upstream of the BART Weir to channel the design flow through the fishway and also provide additional depth upstream for fish passage over ACWD's Middle Dam. That sill may have an effect on upstream flood levels; the effect should be analyzed prior to design.

Extended Vertical Slot This option will have a similar effect on flood capacity as the reduced vertical slot fishway through the subject reach. Again, the proposed weirs may affect flood levels and require further hydraulic analysis.

Pool and Chute The flood considerations of a pool and chute are similar to the reduced vertical slot fishway alternative.

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Other

Public safety

Reduced Vertical Slot Access to the vertical slot fishway is limited as it would be covered by grating. The exit trashrack(s) and the relatively small size of the entrance ports or slots would make entry into the fishway difficult, if at all. Removable handrail and signage are recommended to deter loitering at the ladder and to provide fall protection.

Roughened Channel The roughened channel fishway is exposed and access to it by the public is unrestricted though not easy. The fishway may attract people to enter it and possibly try to float down it. There is some risk of injury or drowning if a person is trapped between boulders.

Extended Vertical Slot Access, safety, and liability are similar to the reduced vertical slot fishway.

Pool and Chute The pool and chute fishway has the greatest concerns for public safety. Like the roughened channel it is exposed and accessible. Deep pools and plunging flow are more dangerous than the shallow flow through the boulders of the roughened channel. It is more difficult to prevent human entry from this type of fishway.

Aesthetics, Education

Roughened Channel The roughened channel offers visual diversity in the Alameda Creek channel and gives a better opportunity for public education. The channel itself appears more natural than the other alternatives but it is constructed within a confined width of the Alameda Creek channel and would not necessarily appear like a natural channel. The fishway is visible from the levees and offers an opportunity for educational signing.

Pool and Chute The pool and chute is also visible from the levees and offers an opportunity for educational signing.

The other alternatives would have more structural and engineered appearances, which is already characteristic of the site.

Permitting

Most of the permitting issues are included in other characteristics described and evaluated here. Standard provisions for in-stream work would be applied to any of the designs and will not tend to vary much. Environmental compliance and regulatory permits such as the USACOE 404, CDFG 1600, and Water Quality Control Board 401 permits would involve the same processes and efforts for each alternative.

A consideration that isn't included elsewhere is the acceptability and preferences by the permitting resource agencies of specific designs. CDFG, NOAA Fisheries, and local jurisdictions should be queried for their concerns and preferences as it relates to obtain necessary permissions and approvals. Input from these entities should be obtained prior to final alternative selection and design.

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Comparison Summary Table

The characteristics described above are weighted by their levels of importance and multiplied by how well each option scored for the respective characteristic. The resulting weighted scores are then summed for each alternative. Table B-1 is provided in Appendix B presenting the input weights and scores for each alternative. The first column lists the characteristics, and the second column indicates the weight applied to each option for each characteristic. The weighting scale is from 0 to 10 with 0 meaning the characteristic is of no importance and 10 meaning it is essential to the success of the project. The weighting is applied based on Committee input.

Scores are also on a scale of 0 to 10, with 0 meaning the option does not at all satisfy the characteristic and 10 meaning that it satisfies the characteristic to the point that it could not be further enhanced.

Table 1 below summarizes two sets of totals from Table B-1 in Appendix B. The overall score is shown, and a second score considering only the fish passage characteristics is provided as well. The scores in Table 1 are normalized to 100 for easier interpretation so the highest overall score and the highest fish passage score are each 100.

Table 1. Summary of Normalized Weighted Score Totals

Alternative	Overall Score	Score of Fish Passage Only
Reduced Vertical Slot	90	100
Roughened Channel	75	90
Extended Vertical Slot	100	100
Pool and Chute	79	90

This is a preliminary summary based on the consultants' ranking of the options. These conclusions may be modified if the evaluation weightings and/or scores are modified based on comments as a result of review of this draft.

It should be noted, the permitting characteristic is preliminarily set at a score of 5 for all alternatives in lieu of stated preferences from the resource agencies. These scores also do not consider costs. Since the value of cost is entirely subjective to the parties financing the project, implementation cost is not scored within the comparison matrix of Appendix B.

Values in the comparison matrix were reviewed to see if any individual parameters were significantly affecting the final rankings. The review of the matrix led to some of the design recommendations described above.

The extended vertical slot fishway scores the highest of the four alternatives. This is true for the overall score as well as when only the fish passage parameters are included in the comparison, though it ranks the same as the reduced vertical slot in this case because it is the same fish passage technology. This emphasizes that none of the alternatives, except the extended vertical slot, account for fish passage over the middle dam. Even though the reduced vertical slot scores as high as the extended vertical slot when only considering fish passage characteristics, the alternative is limited to passage over the BART Weir only and not ACWD’s Middle Dam when in operation.

As a side note, the extended vertical slot alternative continues to score highest even when the future fishway extension and/or the water supply characteristic are excluded from the comparison.

The second-ranked option is the reduced vertical slot fishway for the overall. It scores significantly higher than the remaining two alternatives both when considering all parameters as well as when considering fish passage parameters only.

The third-ranked option is the pool-and-chute fishway for the overall comparison and it is tied with the roughened channel when only fish passage parameters are considered.

Summary of Recommended Changes and Analyses

Within the explanations of the alternatives and their characteristics, design changes have been recommended to the original designs as described in the former CH2M-Hill and Far West/WRECO documents. These recommendations are summarized below. In addition, consideration of a pool-and-chute fishway has been included in the above.

Roughened Channel Fishway

- Investigate the probability and extent of future degradation of the downstream channel and design the roughened channel accordingly.
- Optimize the fishway cross-section of the fishway with a triangular cross section to create appropriate hydraulic conditions at lower flows.
- Construct a low sill upstream of the Bart Weir to divert all flow ainto the fishway.
- Investigate the flood effects of the recommended sill or weir.
- Provide a fishway operating plan.
- Select a source of boulders for the contractor and have the design engineer assist in supervising placement.
- Investigate the structural effect of notching the BART Weir for the fishway.

Vertical Slot Fishways – Reduced and Extended

- Optimize the shape of the entrance
- Lower the lower fishway floor about 2 feet for more attraction flow.
- Cut a channel into the apron or construct a weir to provide a deeper path to the fishway entrance.
- Configure the fish ladder as a vertical slot for the entire fishway length (extended version) to provide better flow control and reduce the likelihood of sediment deposition.

- Cut a channel into the bed between the weir crest and the rubber dam or construct a low sill just above the weir to divert all flow at low flow to the fishway.
- Investigate the flood effects of the fishway.
- Provide a fishway operating plan.
- Investigate the structural effect of cutting the toe of the retaining wall away for placement of the fishway.

Implementation Costs

Estimates of probable implementation costs are provided in Appendix C for the *Reduced Vertical Slot Fishway* and *Roughened Channel Fishway* alternatives. The recommendations made herein, relative to modifications from the original concepts, are accounted for in these estimates. Since the *Pool-and-Chute Fishway* alternative is suggested as a value-engineering option and not within the scope of work, an estimate has not been prepared for this option.

A cost estimate for the *Extended Vertical Slot* alternative was originally prepared by CH2M-Hill in 2001 and updated in 2006. A copy of the updated estimate is provided in Appendix C, not including the recommendations for improvement made within this report. In comparing against the other alternative cost estimates, the CH2M-Hill estimate reflects substantially larger contingencies, wholesale multipliers, professional services costs, and electrical equipment and monitoring instrumentation not required by the recommended project. Accordingly, these cost considerations are primarily responsible for the exaggerated cost differences. As a result, a revised *Extended Vertical Slot* estimate has been prepared and included in Appendix C to provide a closer commonality in cost items and contingencies. This adjusted estimate takes into account the recommendations made herein.

It should be noted the value of the *Extended Vertical Slot* fish ladder would not be a direct doubling of the reduced vertical slot alternative, as economies of scale play into the aggregate total. It should also be noted the final implementation cost of the *Extended Vertical Slot* alternative would be substantially less than implementing two separate fishways at different times, one at the BART Weir and one at ACWD's diversion dam.

Since project cost is a basic element of alternative comparison but the value of cost is entirely subjective to the parties financing the project, the cost factor is not scored as a characteristic within the comparison matrix. Values are simply provided in this report for informational purposes.

- **Reduced Vertical Slot Fishway: $1,328,000**
- **Roughened Channel Fishway: $1,863,000**
- **Extended Vertical Slot Fishway: $2,470,000**
- **Pool-and-Chute Fishway: TBD**

The budgeting-level cost estimates developed for each alternative include engineering and design, geotechnical investigation and laboratory testing, environmental compliance and permitting, bidding and contract award, surveying and staking, construction management, and materials testing. Additionally, all anticipated construction costs are accounted for including materials, activities, and services, contract administration, mobilization and demobilization, sureties and insurance premiums, overhead and profit, and a 20-percent contingency to account for budgeting at a preliminary design level.

Costs are developed based on the preliminary design information gathered from previous studies and the alternatives as presented in this report. The basis for estimating construction costs relies on data from cost indexes, vendors, and bid summaries from similar past projects. Generic construction activities and materials are based on either actual construction bids from past fish passage projects or unit pricing from RS Means 2006 Construction Cost Data. No attempt is made to predict competitive bidding influence, bidding climate, labor market conditions, value engineering possibilities, or potential escalation in raw material costs, such as the recent and dramatic increase in steel and oil prices.

Cost components are presented in Appendix C to properly convey and qualify the composition of costs considered. The costs of design and implementation services are tied directly to the construction cost of the project. Industry standard percentages are applied to account for such services.

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References Cited

- Atkinson, Kristine. CDFG Regional CDFG Biologist, pers. comm. August 7, 2006.
- Bates, K. 2000. Fishway guidelines for Washington State. Washington Department of Fish and Wildlife. Olympia, WA. Available: http://www.wdfw.wa.gov/hab/engineer/habeng.htm.
- California Fish and Game. 1998. "California Salmonid Stream Habitat Restoration Manual." third edition, 1998.
- California Fish and Game. "Culvert Criteria for Fish Passage." May 2002.
- CH2M-Hill, "Conceptual Fish Passage Designs & Cost Estimates for Lower Alameda Creek," January 2001.
- Far West/WRECO, "Conceptual Design and Feasibility of a Natural Fishway at the Fremont BART Weir, Alameda Creek, California," September 2005.
- Katapodis, C., "Introduction to Fishway Design," 1998.
- Kidd, Laura. Alameda County Flood Control and Water Conservation District, pers. comm. at site visit on June 2, 2006.
- NOAA Fisheries Southwest Region, "Guidelines for Salmonid Passage at Stream Crossings," 2001.

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APPENDICES

Appendix A

Concept Level Drawings

Appendix B

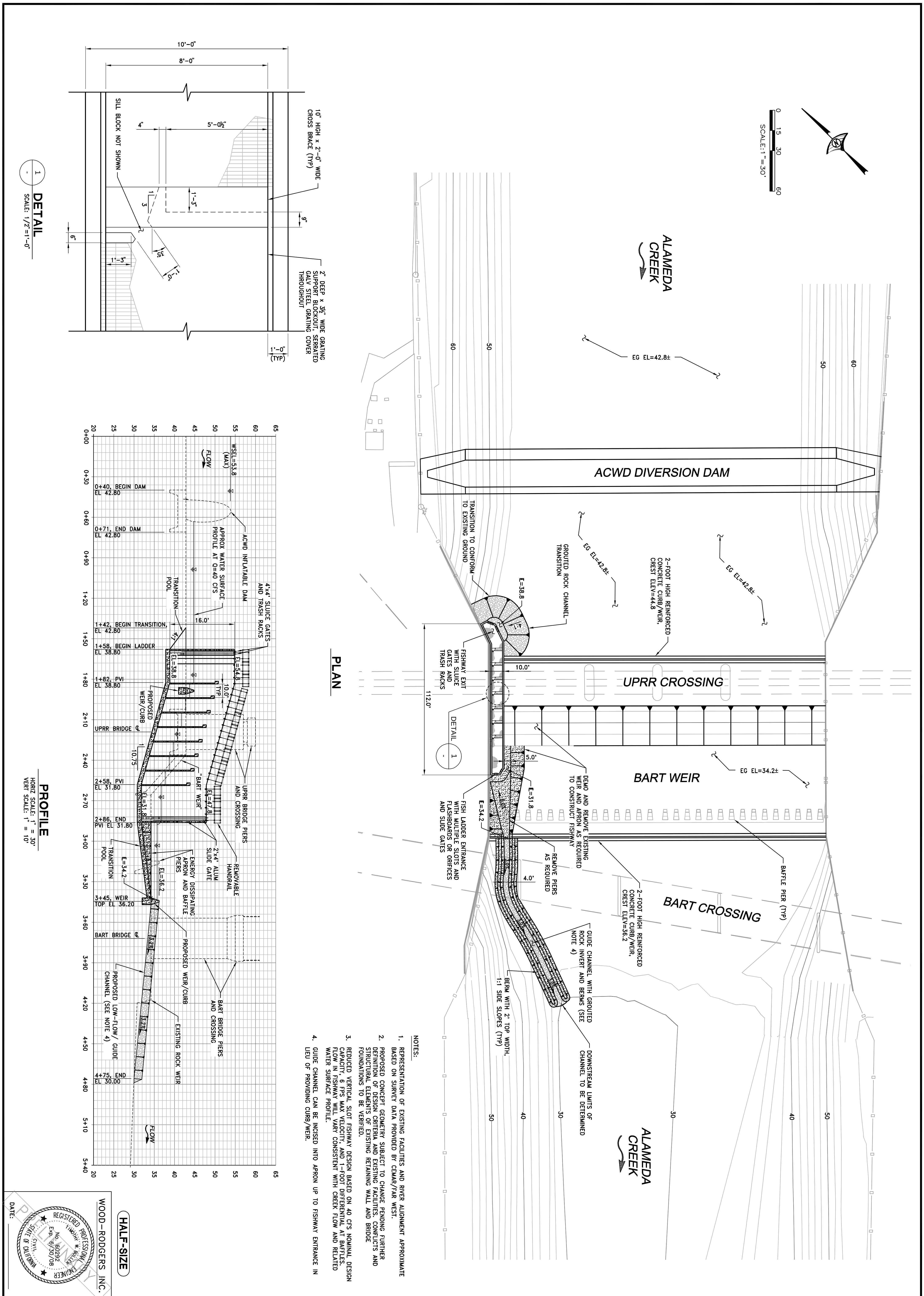
Scoring Matrix

Appendix C

Implementation Cost Estimates

APPENDIX A

Concept Level Drawings



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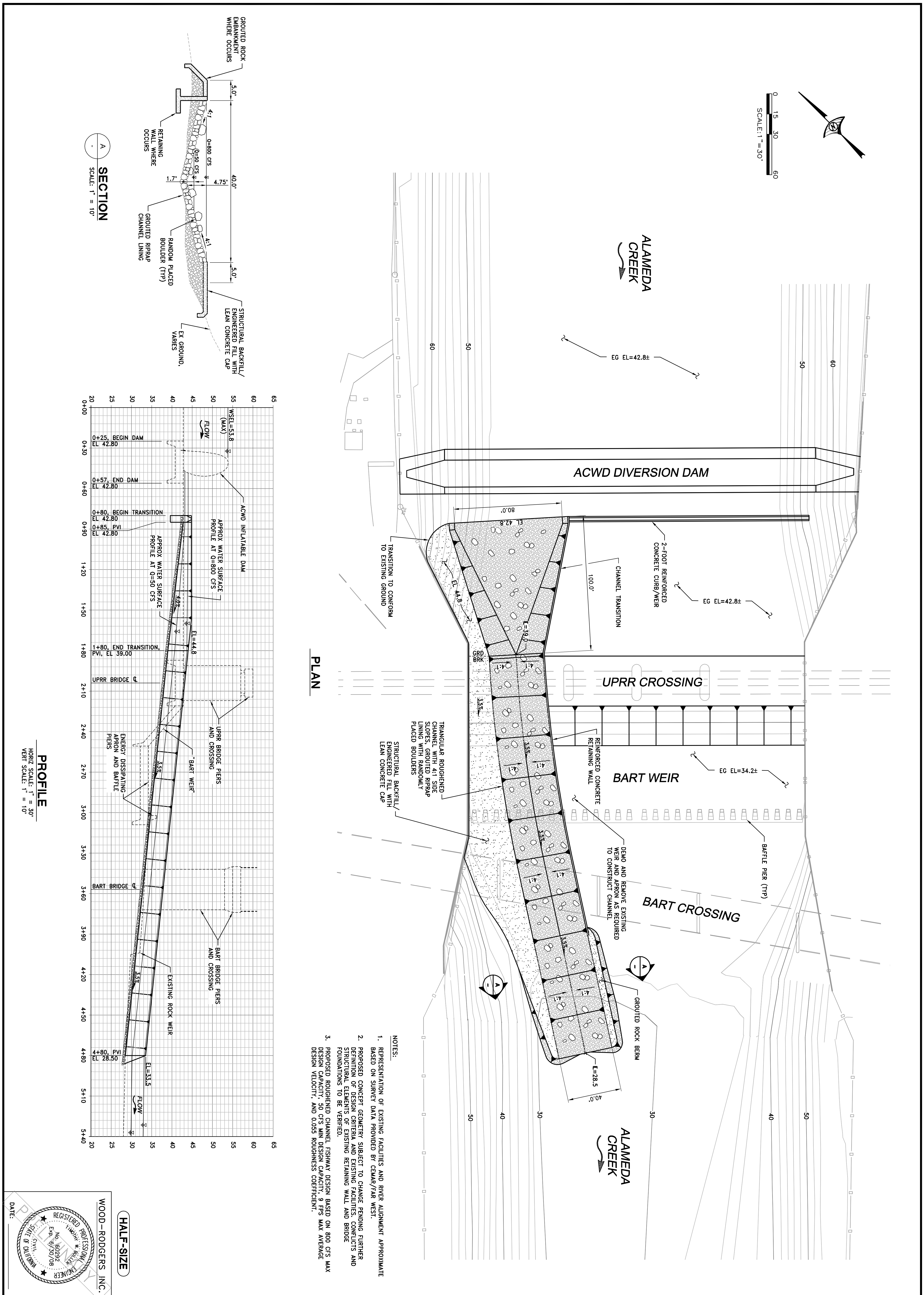
DRAWING A-1	ALAMEDA COUNTY FLOOD CONTROL DISTRICT	ENGINEERING • MAPPING • PLANNING • SURVEYING	SCALE: AS SHOWN
	ALAMEDA CREEK/BART WEIR FISH PASSAGE	3301 C St, Bldg. 100-B Tel 916.341.7760	DRAWN BY: T. BULLER
SHEET 1 OF 2	VERTICAL SLOT FISHWAY - PLAN & PROFILE	Sacramento, CA 95816 Fax 916.341.7767	DESIGNED BY: T. BULLER
	COUNTY OF ALAMEDA CALIFORNIA		CHECKED BY: T. BULLER

NO.	DESCRIPTION	ENGR INIT	BY COUNTY APPROVED	DATE



PROJECT NO. 8133.001	CONCEPTUAL EXHIBITS FOR **ALAMEDA COUNTY FLOOD CONTROL DISTRICT** **ALAMEDA CREEK/BART WEIR FISH PASSAGE** **ROUGHENED CHANNEL - PLAN & PROFILE** COUNTY OF ALAMEDA CALIFORNIA	WOOD RODGERS ENGINEERING • MAPPING • PLANNING • SURVEYING 3301 C St, Bldg. 100-B Tel 916.341.7760 Sacramento, CA 95816 Fax 916.341.7767
DRAWING **A-2**		
SHEET **2 OF 2**		

DATE:	8/22/06
SCALE:	AS SHOWN
DRAWN BY:	T. BULLER
DESIGNED BY:	T. BULLER
CHECKED BY:	T. BULLER

NO.	DESCRIPTION	ENGR INIT	BY COUNTY APPROVED	DATE

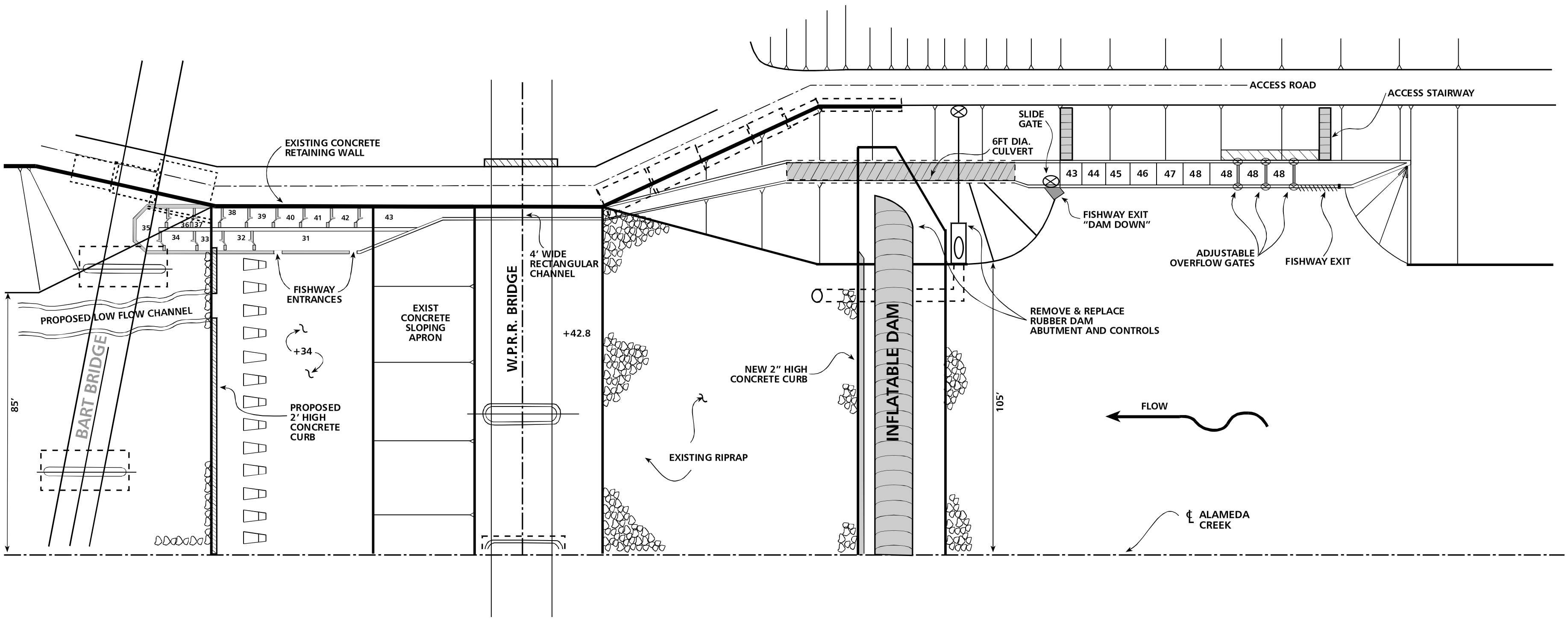


Figure 4-Plan
Proposed Fishway at B.A.R.T. WEIR and Middle Inflatable Dam
Alameda County Water District

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SAC-W-160108.ZZ.03 Figure 4. 11-21-00 tiffany

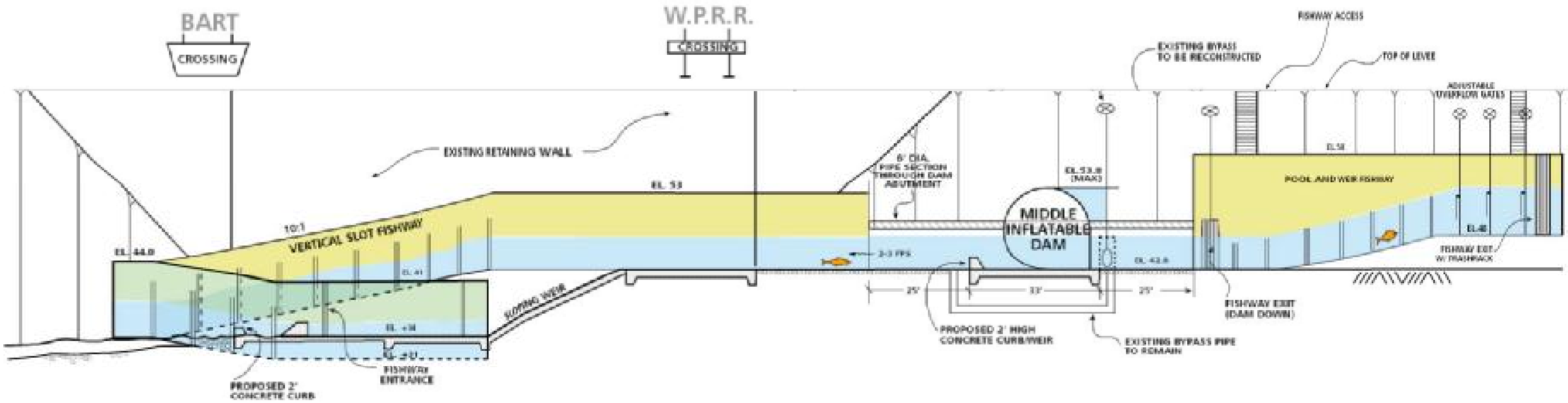

Figure 5-Elevation
Proposed Fishway at BART WEIR and Middle Inflatable Dam
Alameda Creek Fish Passage

CH2MHILL

SAC-W-160108.ZZ.03 Figure 9. 11-22-00 tiffany

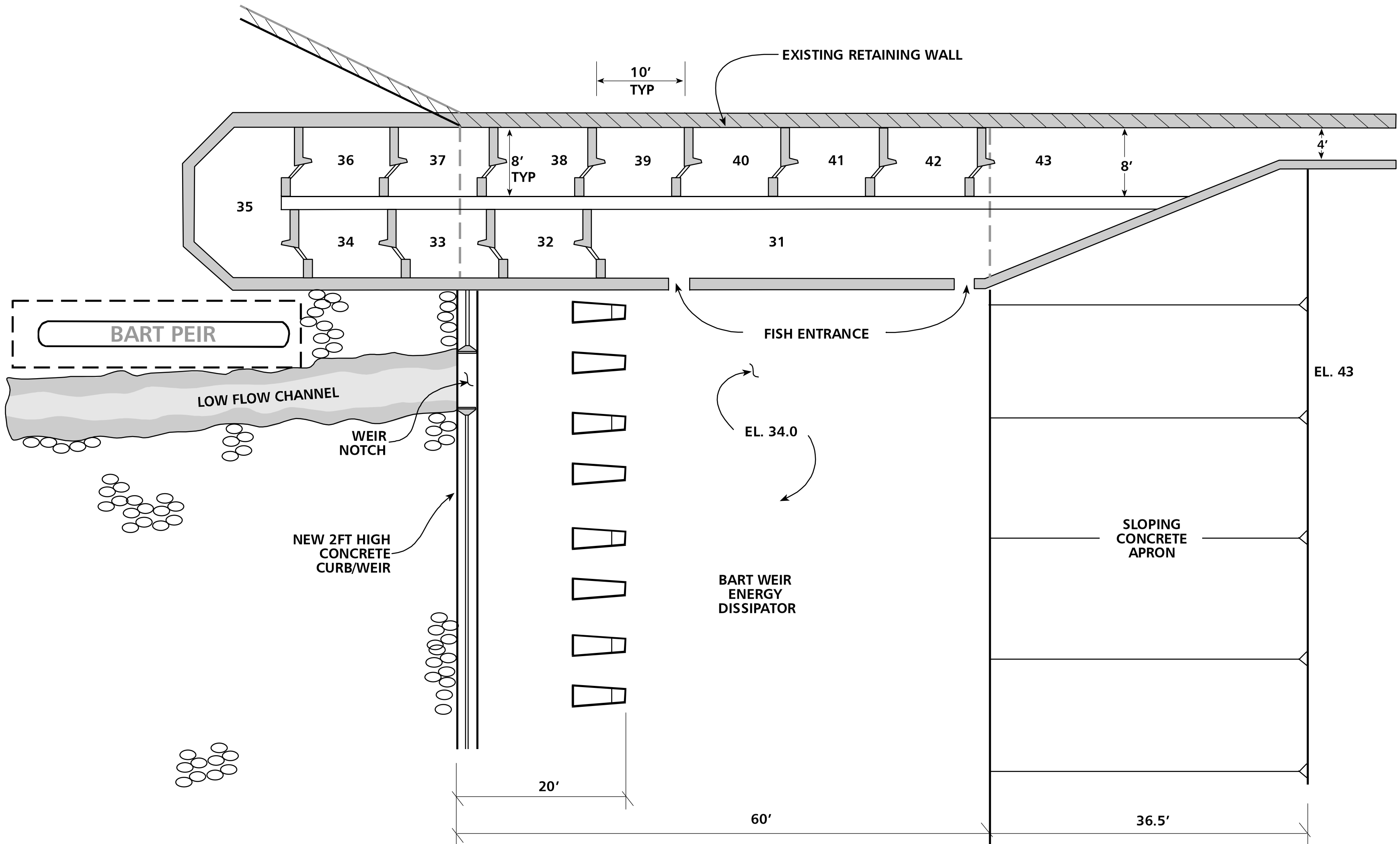

Figure 6-Detail Plan
Proposed Fishway at B.A.R.T. WEIR and MIDDLE Inflatable DAM
Alameda Creek Fish Passage

CH2MHILL

SAC-W-160108.ZZ.03 Figure 6. 10-02-00 tiffany

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APPENDIX B

Scoring Matrix

Table B-1 Comparison matrix of alternatives

BART Weir Fish Passage

Characteristic	Weight 0-10	Option 1 Reduced Vertical Slot		Option 2 Roughened Channel		Option 3 Extended Vertical Slot		Option 4 Pool and Chute	
		Score 0-10	Sum Value	Score 0-10	Sum Value	Score 0-10	Sum Value	Score 0-10	Sum Value
Fish passage									
Attraction of adult steelhead to fishway	10	7	70	9	90	7	70	9	90
Fish access into and out of fishway	10	9	90	8	80	8	80	8	80
Passage of Adult Steelhead Through Fishway	10	10	100	8	80	10	100	7	70
Attraction and Passage of Non-Target Species	2	3	6	8	16	3	6	3	6
Safety of Fish	7	8	56	5	35	9	63	7	49
Potential for Fish Passage Evaluation	3	7	21	3	9	8	24	4	12
Operation and maintenance									
Fishway Flow Control	9	10	90	10	90	10	90	10	90
Required Operating Flow	6	7	42	5	30	7	42	9	54
Sediment and Bedload Management	6	8	48	9	54	9	54	9	54
Debris	6	7	42	5	30	8	48	4	24
Durability of Structure	8	10	80	6	48	10	80	8	64
Accomodates Extension to Above Middle Weir	6	8	48	1	6	10	60	1	6
Water Supply									
Water Supply	6	0	0	0	0	10	60	0	0
Design and Construction									
Construction Complexities	4	5	20	6	24	4	16	6	24
Certainty of Structural Design	6	7	42	4	24	7	42	8	48
Flood Control									
Affect on flood control	10	6	60	8	80	9	90	7	70
Other									
Public safety	8	8	64	4	32	8	64	4	32
Aesthetics, Education	2	5	10	7	14	6	12	5	10
Permitting	6	5	30	5	30	5	30	5	30

Total - overall, normalized	89	75	100	79
Total - fish passage only, normalized	100	90	100	90

DRAFT

APPENDIX C

Implementation Cost Estimates

WOOD RODGERS

Alameda County Flood Control & Water Conservation District **Updated: 30-Aug-06**
Bart Weir Fish Passage - Reduced Vertical Slot Fishway Alternative
Opinion of Probable Implementation Costs
Project No. 8133.001

ITEM NO	DESCRIPTION	QUANTITY	UNIT	UNIT PRICE	TOTAL
	A. General				
1	Mobilization & Demobilization (5%)	1	LS	n/a	$43,500.00
2	Contract Admin/Submittals/RFI's/Schedules/Coordination (3%)	1	LS	n/a	$26,000.00
3	Liability Insurance (1%)	1	LS	n/a	$8,750.00
4	Performance and Payment Bonds (2%)	1	LS	n/a	$17,500.00
5	Temporary Facilities and Utilities	1	LS	n/a	$20,000.00
6	Surveying and Construction Staking	1	LS	n/a	$5,000.00
7	Cal Labor Code Section 6707 Sheeting, Shoring, and Bracing	1	LS	n/a	$10,000.00
8	Overhead and Profit (10%)	1	LS	n/a	$87,000.00
	General Subtotal				**$217,750.00**
	B. Civil Site Work				
9	Establish Creek Access	1	LS	$20,000.00	$20,000.00
10	Bypass and Dewatering System	1	LS	$40,000.00	$40,000.00
11	Demo Existing Weir/Apron and Dispose	110	CY	$1,000.00	$110,000.00
12	Miscellaneous Site Work/Finish Grading/Hydroseeding	1	LS	$10,000.00	$10,000.00
13	Roadway Resurfacing	1	LS	$10,000.00	$10,000.00
	Sitework Subtotal				**$190,000.00**
	C. Downstream Weir and Guide Channel				
14	Weir Excavation and Spoil	190	CY	$20.00	$3,800.00
15	Reinforced Concrete Weir/Curb	150	CY	$500.00	$75,000.00
16	Channel Excavation and Spoil	100	CY	$20.00	$2,000.00
17	Grouted Rock Berms and Channel Invert	200	CY	$150.00	$30,000.00
	Weir and Channel Subtotal				**$110,800.00**
	D. Vertical Slot Fishway				
18	Ladder Excavation and Spoil	500	CY	$20.00	$10,000.00
19	Foundation Prep and Subbase	1,200	SF	$2.00	$2,400.00
20	Entrance Transition (Doweling/Reinf/Concrete/Placement/Finish/Cure)	30	CY	$400.00	$12,000.00
20	Fishway Slab on Grade (Forming/Reinf/Concrete/Placement/Finish/Cure)	50	CY	$400.00	$20,000.00
21	Fishway Walls (Formwork/Reinf/Concrete/Placement/Finish/Cure)	150	CY	$700.00	$105,000.00
22	Fishway Baffles (Formwork/Reinf/Concrete/Placement/Finish/Cure)	20	CY	$900.00	$18,000.00
23	Fishway Mechanical - 4' x 4' Exit Sluice Gate with Manual Operator	2	EA	$10,000.00	$20,000.00
24	Fishway Mechanical - 2' x 4' Entrance Stop Gate with Operator	2	EA	$8,000.00	$16,000.00
25	Fishway Mechanical - Removable Handrail (Installed)	120	LF	$50.00	$6,000.00
26	Fishway Mechanical - Exit Trash Racks (Installed)	2	SF	$5,000.00	$10,000.00
27	Fishway Mechanical - 3/16" x 2" Galv Steel Grating (Installed)	960	SF	$25.00	$24,000.00
28	Fishway Mechanical - Ladders and Stairways	1	LS	$20,000.00	$20,000.00
	Fishway Subtotal				**$263,400.00**

ITEM NO	DESCRIPTION	QUANTITY	UNIT	UNIT PRICE	TOTAL
	E. Upstream Weir and Channel Transition				
29	Weir Excavation and Spoil	190	CY	$20.00	$3,800.00
30	Reinforced Concrete Weir/Curb	140	CY	$500.00	$70,000.00
31	Channel Excavation and Spoil	200	CY	$20.00	$4,000.00
32	Grouted Rock Invert	90	CY	$150.00	$13,500.00
	Weir and Channel Subtotal				**$91,300.00**
				Construction Subtotal :	**$873,250.00**
				Contingency (20%) :	**$174,700.00**
				Construction Subtotal :	**$1,048,000.00**
	F. Professional Services				
33	Engineering/Design/Construction Administration (20%)	1	LS	$210,000.00	$210,000.00
34	Environmental Compliance and Permitting	1	LS	$50,000.00	$50,000.00
35	Surveying and Mapping	1	LS	$10,000.00	$10,000.00
36	Geotechnical	1	LS	$10,000.00	$10,000.00
	Professional Services Subtotal				**$280,000.00**
				Total Estimated Implementation Cost :	**$1,328,000.00**

Note: The Opinion of Probable Cost above is based on Concept Level Drawings prepared by Wood Rodgers for ACFC&WCD. Neither Wood Rodgers nor the Client has any control over the cost of labor, materials, equipment, the Contractors' methods of determining bid prices, or other competitive bidding markets. Prices may vary from engineer's estimate due to bidding climate, competition, and materials escalation at time of receiving bids. The above cost estimate represents preliminary amounts that are subject to change pending confirmation of existing utilities, improvements, and existing structure conflicts with the proposed project. Wood Rodgers, Inc. does not assume responsibility for the use of these costs in budget analysis and will not be held liable for capital improvement cost increases associated with the development of this project.

Alameda County Flood Control & Water Conservation District **Updated: 30-Aug-06**
Bart Weir Fish Passage - Roughened Channel Fishway Alternative
Opinion of Probable Implementation Costs
Project No. 8133.001

ITEM NO	DESCRIPTION	QUANTITY	UNIT	UNIT PRICE	TOTAL
	A. General				
1	Mobilization & Demobilization (5%)	1	LS	n/a	$62,500.00
2	Contract Admin/Submittals/RFI's/Schedules/Coordination (3%)	1	LS	n/a	$37,500.00
3	Liability Insurance (1%)	1	LS	n/a	$12,500.00
4	Performance and Payment Bonds (2%)	1	LS	n/a	$25,000.00
5	Temporary Facilities and Utilities	1	LS	n/a	$20,000.00
6	Surveying and Construction Staking	1	LS	n/a	$10,000.00
7	Cal Labor Code Section 6707 Sheeting, Shoring, and Bracing	1	LS	n/a	$10,000.00
8	Overhead and Profit (10%)	1	LS	n/a	$125,000.00
	General Subtotal				**$302,500.00**
	B. Civil Site Work				
9	Establish Creek Access	1	LS	$20,000.00	$20,000.00
10	Bypass and Dewatering System	1	LS	$50,000.00	$50,000.00
11	Demo Existing Weir/Apron and Dispose	280	CY	$1,000.00	$280,000.00
12	Miscellaneous Site Work/Finish Grading/Hydroseeding	1	LS	$10,000.00	$10,000.00
13	Roadway Resurfacing	1	LS	$10,000.00	$10,000.00
	Sitework Subtotal				**$370,000.00**
	C. Roughened Channel Fishway				
14	Excavation and Spoil/Backfill	500	CY	$30.00	$15,000.00
15	Foundation Prep and Subbase	15,000	SF	$2.00	$30,000.00
16	Grouted Rock Channel Lining	750	CY	$150.00	$112,500.00
17	Imported Boulders and Placement	60	CY	$150.00	$9,000.00
18	Grouted Rock Berms	500	CY	$150.00	$75,000.00
19	Reinforced Concrete Retaining Wall	200	CY	$600.00	$120,000.00
	Fishway Subtotal				**$361,500.00**
	D. Upstream Weir and Channel Transition				
20	Weir Excavation and Spoil	140	CY	$20.00	$2,800.00
21	Reinforced Concrete Weir/Curb	110	CY	$500.00	$55,000.00
22	Channel Excavation and Spoil/Backfill	800	CY	$30.00	$24,000.00
23	Foundation Prep and Subbase	6,500	SF	$2.00	$13,000.00
24	Grouted Rock Channel Lining	370	CY	$150.00	$55,500.00
25	Reinforced Concrete Retaining Wall	100	CY	$600.00	$60,000.00
	Weir and Channel Subtotal				**$210,300.00**

ITEM NO	DESCRIPTION	QUANTITY	UNIT	UNIT PRICE	TOTAL
	Construction Subtotal :				**$1,244,300.00**
	Contingency (20%) :				**$248,900.00**
	Construction Subtotal :				**$1,494,000.00**
	F. Professional Services				
26	Engineering/Design/Construction Administration (20%)	1	LS	$299,000.00	$299,000.00
27	Environmental Compliance and Permitting	1	LS	$50,000.00	$50,000.00
28	Surveying and Mapping	1	LS	$10,000.00	$10,000.00
29	Geotechnical	1	LS	$10,000.00	$10,000.00
	Professional Services Subtotal				**$369,000.00**
	Total Estimated Implementation Cost :				**$1,863,000.00**

Note: The Opinion of Probable Cost above is based on Concept Level Drawings prepared by Wood Rodgers for ACFC&WCD. Neither Wood Rodgers nor the Client has any control over the cost of labor, materials, equipment, the Contractors' methods of determining bid prices, or other competitive bidding markets. Prices may vary from engineer's estimate due to bidding climate, competition, and materials escalation at time of receiving bids. The above cost estimate represents preliminary amounts that are subject to change pending confirmation of existing utilities, improvements, and existing structure conflicts with the proposed project. Wood Rodgers, Inc. does not assume responsibility for the use of these costs in budget analysis and will not be held liable for capital improvement cost increases associated with the development of this project.

CH2M Hill - Order-of-Magnitude Cost Estimate

Lower Alameda Creek Fish Passage Project — **Original Date** October 13,2000
near the city of Fremont, California — **Revised Date** May 9,2006
Prepared By: R Lawson/RDD
Project No: 160180.ZZ.03

Middle Dam Fish Ladder

Item No.	Description	Quantity	Unit	Unit Cost	Total Cost
A	General Items				
1	Mobilization/Demobilization	1	LS	$72,000.00	$72,000
2	Site Work, Access & Construction Staging	1	LS	$10,000.00	$10,000
3	Dewatering	1	LS	$75,000.00	$75,000
4	Remove & Reinstall Exist Rubber Dam Features	1	LS	$30,000.00	$30,000
5	Fish Monitoring Equipment & Items	1	LS	$75,000.00	$75,000
6	Electrical Service for Facility	1	LS	$25,000.00	$25,000
	Group Sub-Total			$287,000	
B	Lower Fish Ladder Structure				
7	Excavation Support, Cofferdam	1	LS	$135,000.00	$135,000
8	Excavation, General/Rock	1,800	CY	$50.00	$90,000
9	Concrete, Slabs & Footings	160	CY	$375.00	$60,000
10	Concrete, Walls (Normal)	400	CY	$760.00	$304,000
11	Concrete, Walls (Intricate)	30	CY	$950.00	$28,500
12	Patch Concrete Slabs @ Energy Dissipator	10	CY	$375.00	$3,750
13	Concrete Curb/Weir	20	CY	$570.00	$11,400
14	Fishway Entrance Openings	3	EA	$1,000.00	$3,000
15	72" CMP Fishway w/Light Openings	61	LF	$290.00	$17,545
16	Stairway/Ladder Access to Roadway w/Handrail	1	EA	$7,800.00	$7,800
17	Stairway/Ladder Access to Roadway w/Handrail	1	EA	$13,000.00	$13,000
18	Ladder Cover Grating	2,340	SF	$30.00	$70,200
19	Ladder Cover Handrailing	206	LF	$60.00	$12,360
	Group Sub-Total			$756,555	
C	Upper Fish Ladder Structure				
20	Excavation Support, Cofferdam	1	LS	$112,500.00	$112,500
21	Excavation, General/Rock	890	CY	$50.00	$44,500
22	Concrete, Slabs & Footings	90	CY	$375.00	$33,750
23	Concrete, Walls (Normal)	120	CY	$760.00	$91,200
24	Concrete, Walls (Intricate)	30	CY	$950.00	$28,500
25	Trash Rack, Fishway Exit w/Supports	60	SF	$100.00	$6,000
26	Stairway/Ladder Access to Roadway w/Handrail	2	EA	$5,200.00	$10,400
27	Ladder Cover Grating	1,350	SF	$30.00	$40,500
28	Ladder Cover Handrailing	168	LF	$60.00	$10,080
29	Adjustable Overflow Gate w/Operator	3	EA	$15,000.00	$45,000
30	Reinstall Dam Bypass Gate & Covers	1	LS	$25,000.00	$25,000
31	Install New Fishway Exit, Dam Out	1	LS	$15,000.00	$15,000

CH2M Hill - Order-of-Magnitude Cost Estimate

Lower Alameda Creek Fish Passage Project **Original Date** **October 13,2000**
near the city of Fremont, California **Revised Date** **May 9,2006**

Prepared By: R Lawson/RDD

Project No: 160180.ZZ.03 **Middle Dam Fish Ladder**

Item No.	Description	Quantity	Unit	Unit Cost	Total Cost
32	Regrade, Replace Rip-Rap and Slope Protection	1	LS	$10,000.00	$10,000
	Group Sub-Total			$472,430	
33	Construction Cost				$1,515,985
34	State Sales Tax on Materials	8.25%			$62,534
35	Contingency	30.00%			$473,556
36	Construction Cost Subtotal, Oct. 2000				$2,052,075
37	Escalation to April 2006	17.80%			$365,297
38	Construction Cost Subtotal, April 2006				$2,417,372
	Use Rounded Total for Construction Cost			$2,420,000	
39	Engineering	20%			$483,474
40	Environmental Mitigation	3%			$72,521
41	Services During Construction & Inspection	15%			$362,606
42	Contract Administration	5%			$120,869
	Use Rounded Total for Project Cost			$3,460,000	

Modified CH2M Hill - Order-of-Magnitude Cost Estimate

Lower Alameda Creek Fish Passage Project **Original Date** **October 13, 2000**

Revised Date **August 30, 2006**

Modified By: T. Buller

Project No: 8133.001 **Extended Vertical Slot Fishway Alternative**

Item No.	Description	Quantity	Unit	Unit Cost	Total Cost
A	General Items				
1	Mobilization/Demobilization (5%)	1	LS	$80,000.00	$80,000
2	Contract Admin/Submittals/RFI's/Coordination (3%)	1	LS	$48,000.00	$48,000
3	Liability Insurance (1%)	1	LS	$16,000.00	$16,000
4	Performance and Payment Bonds (2%)	1	LS	$32,000.00	$32,000
5	Site Work, Access & Construction Staging	1	LS	$20,000.00	$20,000
6	Dewatering	1	LS	$75,000.00	$75,000
7	Remove & Reinstall Exist Rubber Dam Features	1	LS	$30,000.00	$30,000
8	Temporary Facilities and Utilities	1	LS	$20,000.00	$20,000
9	Surveying and Construction Staking	1	LS	$10,000.00	$10,000
10	Cal Labor Code Sheeting, Shoring, and Bracing	1	LS	$20,000.00	$20,000
11	Overhead and Profit (10%)	1	LS	$160,000.00	$160,000
				Group Sub-Total	$511,000
B	Lower Fish Ladder Structure				
12	Cofferdam, Yard Bags	1	LS	$50,000.00	$50,000
13	Excavation, General/Rock	1,800	CY	$20.00	$36,000
14	Concrete, Slabs & Footings	160	CY	$400.00	$64,000
15	Concrete, Walls (Normal)	400	CY	$700.00	$280,000
16	Concrete, Walls (Intricate)	30	CY	$900.00	$27,000
17	Patch Concrete Slabs @ Energy Dissipator	10	CY	$400.00	$4,000
18	Concrete Curb/Weir	20	CY	$500.00	$10,000
19	Fishway Entrance Openings	3	EA	$10,000.00	$30,000
20	72" CMP Fishway w/Light Openings	61	LF	$290.00	$17,545
21	Stairway/Ladder Access to Roadway w/Handrail	1	EA	$7,800.00	$7,800
22	Stairway/Ladder Access to Roadway w/Handrail	1	EA	$13,000.00	$13,000
23	Ladder Cover Grating	2,340	SF	$30.00	$70,200
24	Ladder Cover Handrailing	206	LF	$60.00	$12,360
				Group Sub-Total	$622,000
C	Upper Fish Ladder Structure				
25	Excavation Support, Cofferdam	1	LS	$112,500.00	$112,500
26	Excavation, General/Rock	890	CY	$50.00	$44,500
27	Concrete, Slabs & Footings	90	CY	$400.00	$36,000
28	Concrete, Walls (Normal)	120	CY	$700.00	$84,000
29	Concrete, Walls (Intricate)	30	CY	$900.00	$27,000
30	Trash Rack, Fishway Exit w/Supports	60	SF	$200.00	$12,000
31	Stairway/Ladder Access to Roadway w/Handrail	2	EA	$5,200.00	$10,400
32	Ladder Cover Grating	1,350	SF	$30.00	$40,500

Modified CH2M Hill - Order-of-Magnitude Cost Estimate

Lower Alameda Creek Fish Passage Project **Original Date** **October 13, 2000**

Revised Date **August 30, 2006**

Modified By: T. Buller

Project No: 8133.001 **Extended Vertical Slot Fishway Alternative**

Item No.	Description	Quantity	Unit	Unit Cost	Total Cost
33	Ladder Cover Handrailing	168	LF	$60.00	$10,080
34	Adjustable Overflow Gate w/Operator	3	EA	$15,000.00	$45,000
35	Reinstall Dam Bypass Gate & Covers	1	LS	$25,000.00	$25,000
36	Install New Fishway Exit, Dam Out	1	LS	$15,000.00	$15,000
37	Regrade, Replace Rip-Rap and Slope Protection	1	LS	$10,000.00	$10,000
				Group Sub-Total	$472,000
38	Construction Cost				$1,605,000
39	Contingency	20%			$321,000
	Use Rounded Total for Construction Cost			$1,930,000	
40	Engineering	10%			$193,000
41	Environmental Mitigation	3%			$57,900
42	Services During Construction & Inspection	10%			$193,000
43	Miscellaneous Professional Services	5%			$96,500
				TOTAL PROJECT COST	$2,470,400

Note: The Estimate above is based on Concept Level Drawings prepared by CH2M-Hill for ACFC&WCD, and as adjusted to share common cost elements and contingencies as other estimates. Neither Wood Rodgers nor the Client has any control over the cost of labor, materials, equipment, the Contractors' methods of determining bid prices, or other competitive bidding markets. Prices may vary from engineer's estimate due to bidding climate, competition, and materials escalation at time of receiving bids. The above cost estimate represents preliminary amounts that are subject to change pending confirmation of existing utilities, improvements, and existing structure conflicts with the proposed project. Wood Rodgers, Inc. does not assume responsibility for the use of these costs in budget analysis and will not be held liable for capital improvement cost increases associated with the development of this project.