

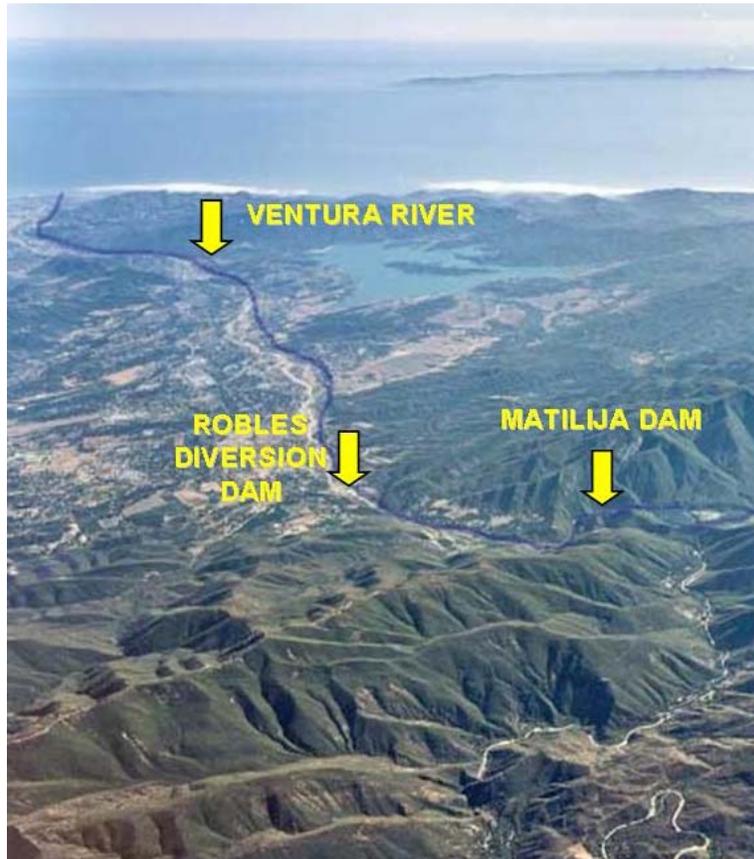


US Army Corps
of Engineers

OFFICE OF THE CHIEF OF ENGINEERS
VALUE ENGINEERING STUDY TEAM



VALUE ENGINEERING STUDY SUMMARY REPORT



ROBLES DIVERSION PROJECT ***Ventura River Basin, CA***

June 2007

Project Sponsors: U.S. Army Corps of Engineers
Los Angeles District

Ventura County Watershed
Protection District

VALUE ENGINEERING TEAM STUDY

DOD SERVICE: USACE
CONTROL NO: CESPL-VE-07-02
VALUE ENGINEERING OFFICER: Robert Conley

Value Engineering Study on the
ROBLES DIVERSION PROJECT
Ventura River Basin, CA

June 2007

U.S. Army Engineer District, Los Angeles
Ventura County Watershed Protection District

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VALUE ENGINEERING TEAM STUDY
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VALUE ENGINEERING TEAM STUDY
PROJECT DESCRIPTION AND BACKGROUND

The primary objective of the Matilija Dam Ecosystem Restoration Project is to improve habitat along the Ventura River and Matilija Creek in the vicinity of Matilija Dam to benefit native fish and wildlife (including the endangered southern steelhead trout).

The dam itself has deprived the streambed of sand and gravel-sized materials that are very critical to specific types of habitat, and has also altered some of the natural hydrologic processes. Also contributing to the degradation of stream habitats are urban, industrial and agricultural development.

In addition, there's been a proliferation of invasive plant species, especially the giant reed or *Arundo*, which overtake and displace native vegetation and seriously degrades the habitat quality.

Another objective is to restore sediment transport to the coast. Because sediment movement has been so hindered by the dam, there has been significant erosion in parts of the riverine system. Also less sediment ends up at the beaches.

Prior to removal of the Matilija Dam, one of the preparatory projects is a high flow diversion dam in conjunction with the existing Robles Canal and fish ladder. The purpose of the diversion dam, the subject of this value engineering study, is to allow high flows of water and sediment to continue down the Ventura River without sending excessive sediment through the Robles Canal to Casitas Lake and without disturbing fish passage upstream or downstream.

The following two pages show plan views of the recommended plan resulting from the feasibility study, and the existing fish ladder system. The weirs shown downstream from the fish ladder have not been constructed yet, and are not included in the diversion dam project.

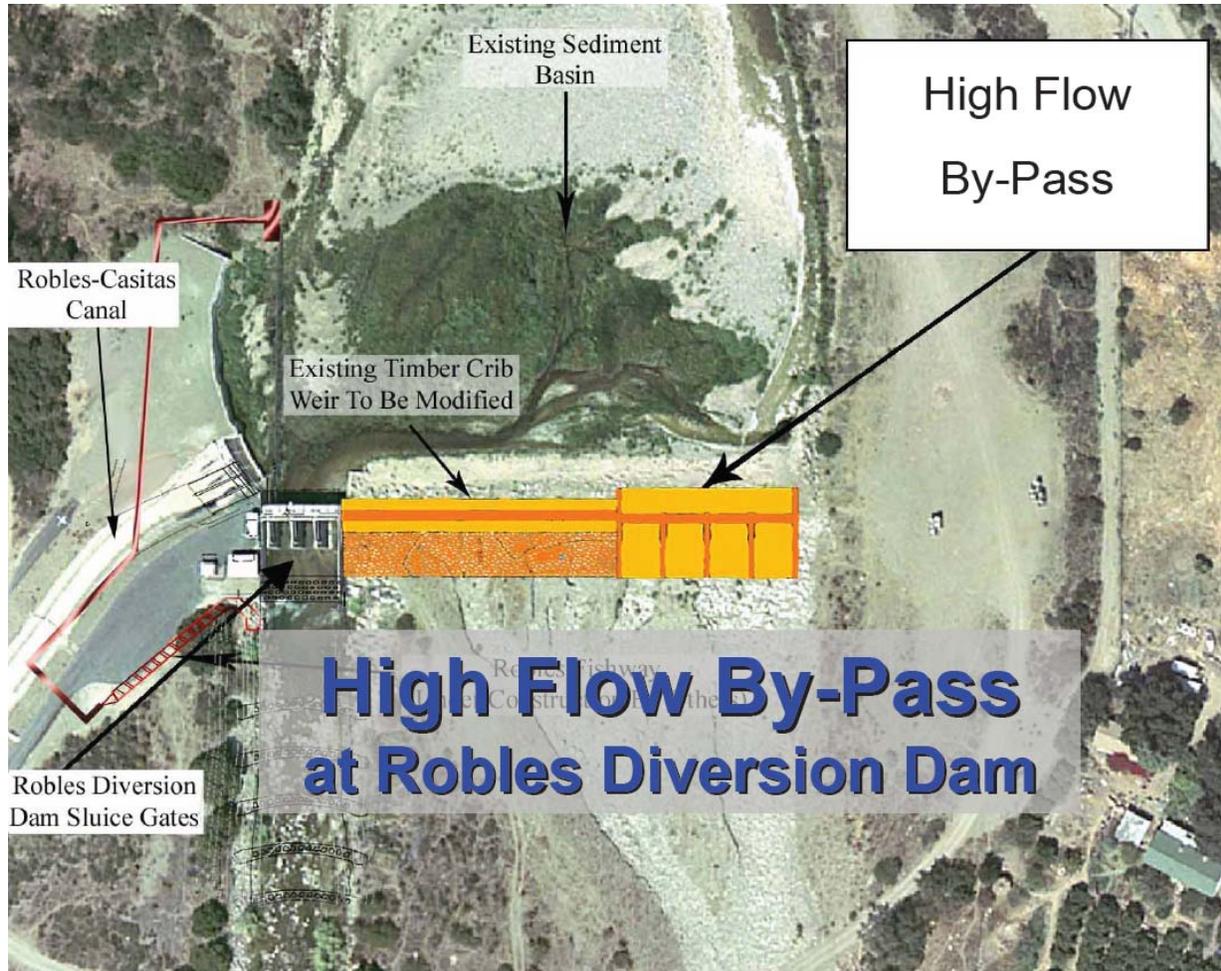
The Feasibility Report cost estimate for the Matilija Dam Ecosystem Restoration includes the following components for the Robles Diversion Dam:

Radial gate (120' section)	\$3,400,000
Timber Crib Replacement	\$1,300,000

The estimate also lists the total for the diversion dam to be \$5,700,000, but doesn't document the missing \$1,000,000.

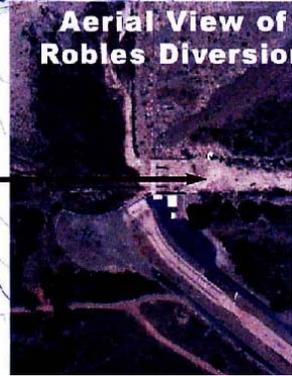
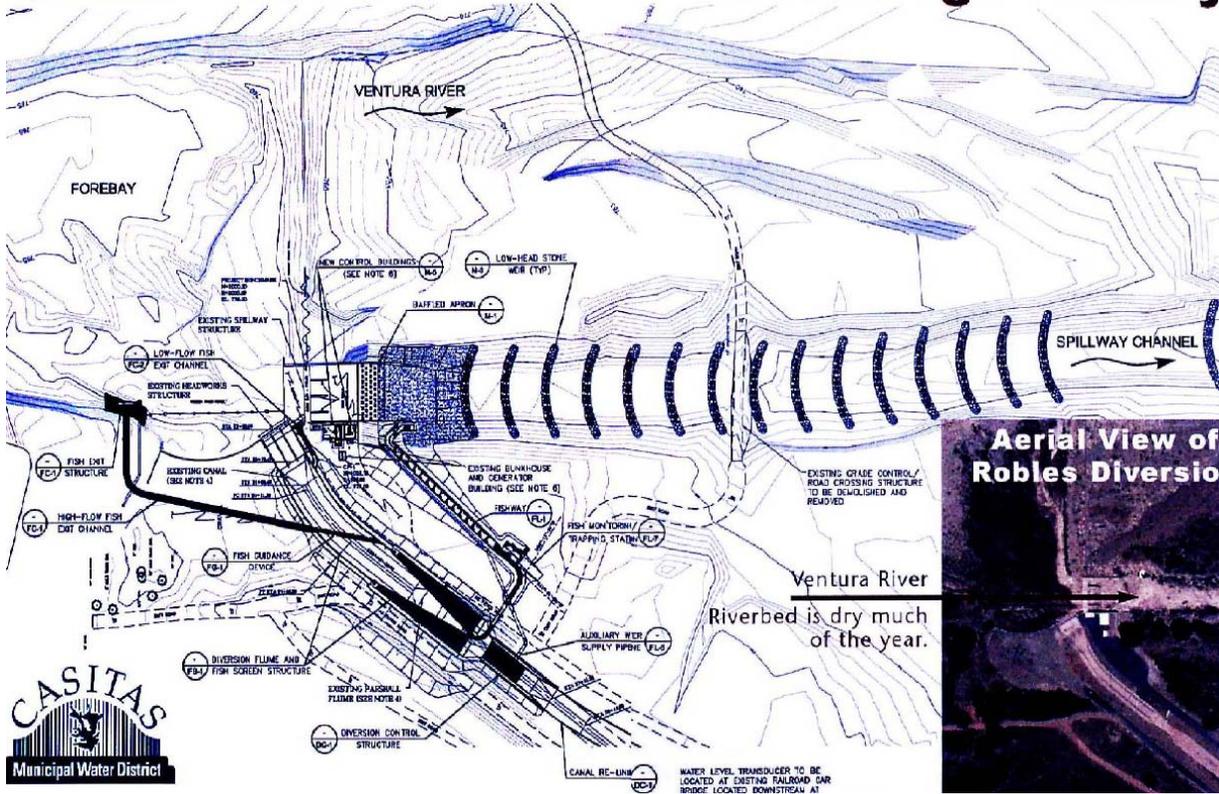
VALUE ENGINEERING TEAM STUDY
PROJECT DESCRIPTION AND BACKGROUND

RECOMMENDED PLAN



VALUE ENGINEERING TEAM STUDY
PROJECT DESCRIPTION AND BACKGROUND

SITE PLAN—Robles Fish Passage Facility



VALUE ENGINEERING TEAM STUDY
EXECUTIVE SUMMARY

Value Engineering (VE) is a process used to study the functions a project is to provide. As a result, it takes a critical look at how these functions are met and develops alternative ways to achieve the same function while increasing the value of the project. In the end, it is hoped that the project will realize a reduction in cost, but adding value over reducing cost is the focus of VE.

The Value Engineering Study was initiated during the week of 12 Jun to 14 Jun 2007 at the Ventura County Public Works office in Saticoy, California. The agenda is listed on the following page. The project was studied using the Corps of Engineers standard Value Engineering (VE) methodology, consisting of five phases:

Information Phase: The VE Team and participating stakeholders discussed the Matilija Dam removal project and related phases, including the Robles Diversion Project, the subject of this study, and issues and concerns related to project design. Issues and concerns are noted following the agenda below. The Information Phase concluded with development of a Function Analysis System Technique (FAST) diagram, attached in Appendix C.

Speculation Phase: The VE study participants conducted a brainstorming session to generate ideas for alternative designs. All team members contributed ideas and critical analysis of the ideas was discouraged (see Appendix B).

Analysis Phase: Evaluation and critical analysis of all ideas generated during speculation was painstakingly executed by both VE Team members and interested stakeholders to determine potential benefits, risks and/or savings. Ideas which did not survive critical analysis were deleted. Resolution of ideas is noted in Appendix B.

Development Phase: The viable ideas were developed into written proposals by study participants working in teams. Proposal descriptions, along with sketches, technical support documentation, and cost estimates, if applicable, were prepared to support implementation of ideas. Additional VE Team Comments were included for items of interest which were not developed as proposals, and these comments follow the study proposals.

Presentation Phase: Presentation is a two-step process. The published VE Study Report is distributed for review by project supporters and decision-makers. A briefing is later conducted to decide which proposals merit implementation into project design.

**VALUE ENGINEERING STUDY WORKSHOP AGENDA
ROBLES DIVERSION PROJECT, VENTURA, CA**

**All Meetings at Saticoy Operations Yard
11251-B Riverbank Drive, Ventura CA**

TUESDAY, 12 June 2007

- 8:00 AM Introductions and Agenda
Introduction to Value Engineering process
INFORMATION PHASE
Overview of Feasibility Study and Project Formulation
Jim Hutchison, project formulation
Recommendations and constraints
Hydraulics and Hydrology, Blair Greimann
Alternatives for Robles considered during Feasibility Study,
Brent Mefford
- 10:00 AM Field Trip to project location
Lunch on the road
- 2:00 – 5:00 PM Resume Information Phase, discussing any discoveries
from site visit and further questions
Function Analysis (What are we doing? Why? How?)
SPECULATION PHASE (If possible)
Begin brainstorming

OVERNIGHT HOMEWORK: Keep a pad on the night table to record any middle-of-the-night insights.

WEDNESDAY, 13 June 2007 (times are approximate)

- 8:00 AM – 12:00 PM SPECULATION PHASE (Continued)
Complete brainstorming
- 12:00 PM – 5:00 PM ANALYSIS PHASE
Screen ideas suggested during Speculation for Proposals or
Comments to be developed, ideas already being done, or
non-viable ideas

**VALUE ENGINEERING STUDY WORKSHOP AGENDA
ROBLES DIVERSION PROJECT, VENTURA, CA**

**All Meetings at Saticoy Operations Yard
11251-B Riverbank Drive, Ventura CA**

WEDNESDAY, 13 June 2007 (Continued)

Once Analysis is done, participants will be welcomed to assist in developing or writing proposals, but only the Value Engineering Team will be required to stay and work. Viable proposals and comments will be assigned to team members

Time required for speculation and analysis is extremely variable, so times are purposely not listed for breaks or lunch.

DEVELOPMENT PHASE

VE Team Members write up proposals and comments.
Laptops will be required.

THURSDAY, 14 June 2007 (all invited; only VE Team required)

8:00 AM – 10:00 AM **DEVELOPMENT PHASE** (Continued)

10:00 AM – 12:00 PM **PRESENTATION PHASE**
Outbriefing of VE study findings

VALUE ENGINEERING TEAM STUDY
ISSUES AND CONCERNS

Participants in the value engineering study were asked to identify their agencies' issues, concerns and goals related to the project. Since several of the concerns were shared between the agencies, many of the items listed by the first stakeholders to speak were not necessarily repeated by successive speakers:

NMFS:

- Steelhead survival
- Steelhead restoration
- Juvenile fish passage downstream
- Adult fish passage upstream
- Minimize maintenance and required intervention
- Weir construction downstream from existing fish ladder (not in Corps project)
- Stabilize geomorphology
- Prevent interruptions and sharp fluctuations in water flow
- Match natural flow patterns
- Construction schedule
- Prevent large fine sediment deposits downstream
- Consider effects on downstream estuaries
- Velocity vs. length of pools for fish to rest, i.e., stilling basin
- Depth is concern for both swimming mode and jumping mode

Ventura County Watershed Protection Division:

- Fish Restoration
- Stream Corridor stabilization
- No negative impacts
- Mitigate project impacts
- Restore habitats
- Minimize maintenance
- Minimize costs
- Avoid having to change EIR/EIS/Biological Opinion

Casitas Municipal Water District:

- Keep sediment moving
- Reasonable operations
- Longevity
- Maintainability
- Consider operation and maintenance impacts of sediments
- Timing of construction to avoid diversion season (wet season)
- Minimize downtime
- Consider remote operations

Casitas Municipal Water District (Continued):

- Remain whole for water resources, supply and quality
- Fisheries restoration through existing passage
- Monitor dissolved oxygen
- Control releases to minimize impacts from diversion operations
- Don't transfer same problem elsewhere as result of project
- Avoid entrapment in spillway pool

Matilija Coalition:

- Restore natural processes for fish passage and sediment transport
- Minimize maintenance
- Keep Casitas operations viable
- Improve operation of existing facility
- Focus on natural clearing of stream corridor, rather than mechanical ("The less front-end loaders in the stream bed, the better")
- Account for inadvertent habitat creation

Corps of Engineers:

- Make sure everyone understands operation procedures and design assumptions
- Ensure that diversion operators are qualified and trained on procedures
- Other issues and concerns which were noted above

Bureau of Reclamation:

- Keep communicating
- Minimize liability
- Other issues and concerns which were noted above

VALUE ENGINEERING TEAM STUDY
SUMMARY OF TEAM FINDINGS AND PROPOSALS

VE Study Results: Thirty-five ideas for ways to improve the projects or reduce costs were generated during the Speculation Phase of this study. During the Analysis Phase of the study, two of the original 35 ideas were categorized as Being Done (BD), since the ideas were already being investigated or modeled as part of the expected design process. Ten ideas were rejected as technically unacceptable, or because they increased cost without adequate justification or authorization. Fifteen ideas were identified for development as proposals, and the remaining eight ideas were designated as design comments. It should be noted that the numbers above may not match the number of proposals and comments in the report below, because several ideas were combined.

PROPOSAL NO. and DESCRIPTION

- 1 Bifurcate flows upstream
- 2 Construct interim measures
- 3 Change angle of high flow bypass facility located on East Side.
- 4 Construct Infiltration gallery with perforated pipe
- 5 Use fuse-plug for high flow passage
- 6 Use resettable wickets for high flow passage

While most value engineering studies would normally include a list of potential savings with each proposal, it was agreed by the value engineering team and participating stakeholders that the evaluations included in this report should focus on the technical merits of each proposal and comment. The project is currently at too broad of a focus to pin down specific cost comparisons.

VALUE ENGINEERING PROPOSAL

PROPOSAL NO: 1 (Spec List Item 1, 2, 8, 23, and 31)
DESCRIPTION: Bifurcate flows upstream

PAGE NO: 1 OF 4

ORIGINAL DESIGN:

Current design calls for a major concrete diversion dam with high flow gates.

PROPOSED DESIGN:

Separate flows at the upstream boundary of existing diversion basin. Normal flows are directed through main channel constructed on the west bank of the river to provide habitat, permanent access to fish ladder, and water diversion facilities. High flows are released down channel on east bank of river via control structure. Design, illustrated in sketch below, would include the following features:

- Flows are separated by permanent landform upstream of existing diversion dam
- Main channel directs and constrains normal flows in channel rather than existing broad, flat floodplain
- Main channel provides fish habitat and passage upstream
- High flows are metered with control structure (may be radial gates)
- Control structure includes “pilot gate” for taper down of high flows
- Main gates provide for highest flows, while maintaining side flows into main channel for water diversion
- Automated operation may be aided by providing real-time flow gage upstream at Camino Cielo Bridge

Advantages:

- Sediment transport is directed through high flow channel separated from existing facilities.
- Sediment deposition is eliminated by providing constricted channel for high flows and eliminating stilling basin created by existing 300 ft wide diversion dam.
- Upstream control allows for increased head at diversion
- Fish passage is provided at high flows, and provision is made for controlling attraction flows during taper down
- Main channel is not subject to catastrophically high flows so pool and riffle/riparian habitat component is feasible

Disadvantages:

- Large infrastructure
- Requires coordinated operation with existing facility
- Change from current configuration
- Perhaps more expense than feasibility study design?

JUSTIFICATION:

Proposal would satisfy the following objectives:

- eliminate sediment stilling basin/existing sedimentation problem
- provide separate high flow channel to enhance natural sediment transport
- enhance fish passage and habitat
- provide low-maintenance water diversion operations

VALUE ENGINEERING PROPOSAL

PROPOSAL NO: 2 (Spec Item # 18)

PAGE NO: 1 OF 2

DESCRIPTION: Construct interim measures

ORIGINAL DESIGN:

Construct four 30-foot wide radial gates on the east side of the crib dam.

PROPOSED DESIGN:

Construct measures which do not require permanent concrete structures such as increasing the depth of the diversion basin and increasing slope in the reach, building natural fish and flow diversions. Delay construction of any permanent structures until monitoring is performed to analyze river response to determine necessity of high flow sediment bypass structure. Modify structures to accommodate changes in base elevations of stream bed as changes warrant.

ADVANTAGES:

- Optimizes cost.
- Maintain diversion.
- O&M potentially limited to mobilizing heavy equipment to excavate diversion channel.
- Pass sediment.
- Encourages natural processes.
- Allows bypass design to better meet long term environmental and physical conditions.
- Allows greater adaptability in response to geomorphic processes.

DISADVANTAGES:

- Does not fit normal COE funding procedures
- Shifts greater risk onto local sponsor
- Shifts greater financial burden onto local sponsor
- Potentially increases risk of sediment occluding diversion intake and fish ladder under certain storm scenarios.
- May challenge acquisition of funds for permanent baseline gate structure.
- Increases earthmoving activities within basin, potentially requiring special permitting.

VALUE ENGINEERING PROPOSAL

PROPOSAL NO: 2 (Spec Item # 18)

PAGE NO: 2 OF 2

JUSTIFICATION:

This proposal takes into account river response to increased sediment influx from removal of Matilija Dam, and reduces the likelihood that installed structure would be over-designed.

VALUE ENGINEERING PROPOSAL

PROPOSAL NO: 3 (Spec Items 9 and 17) PAGE NO: 1 OF 2
DESCRIPTION: Change angle of high flow bypass facility located on East Side.

ORIGINAL DESIGN: The original Alternative 1 design proposed in the Matilija Feasibility Report called for the radial gates on the East side of the channel. The gates would be oriented the same as the existing radial gates on the West side.

PROPOSED DESIGN: The alignment of the gates and embankment would be rotated in the downstream direction approximately 10 to 15 degrees.

ADVANTAGES:

- The flows may be more favorable for sediment sluicing because of increased downstream slope. The increased slope will allow flows to transport more sediment while preserving control of water surface elevations in basin.
- The distance from the diversion to the confluence will be shortened.
- The size of the cutoff wall can be reduced.
- Maintains natural high flow alignment of river.
- Increased sediment sluicing increases diversion reliability.
- It will re-direct flows away from the toe of the levee.

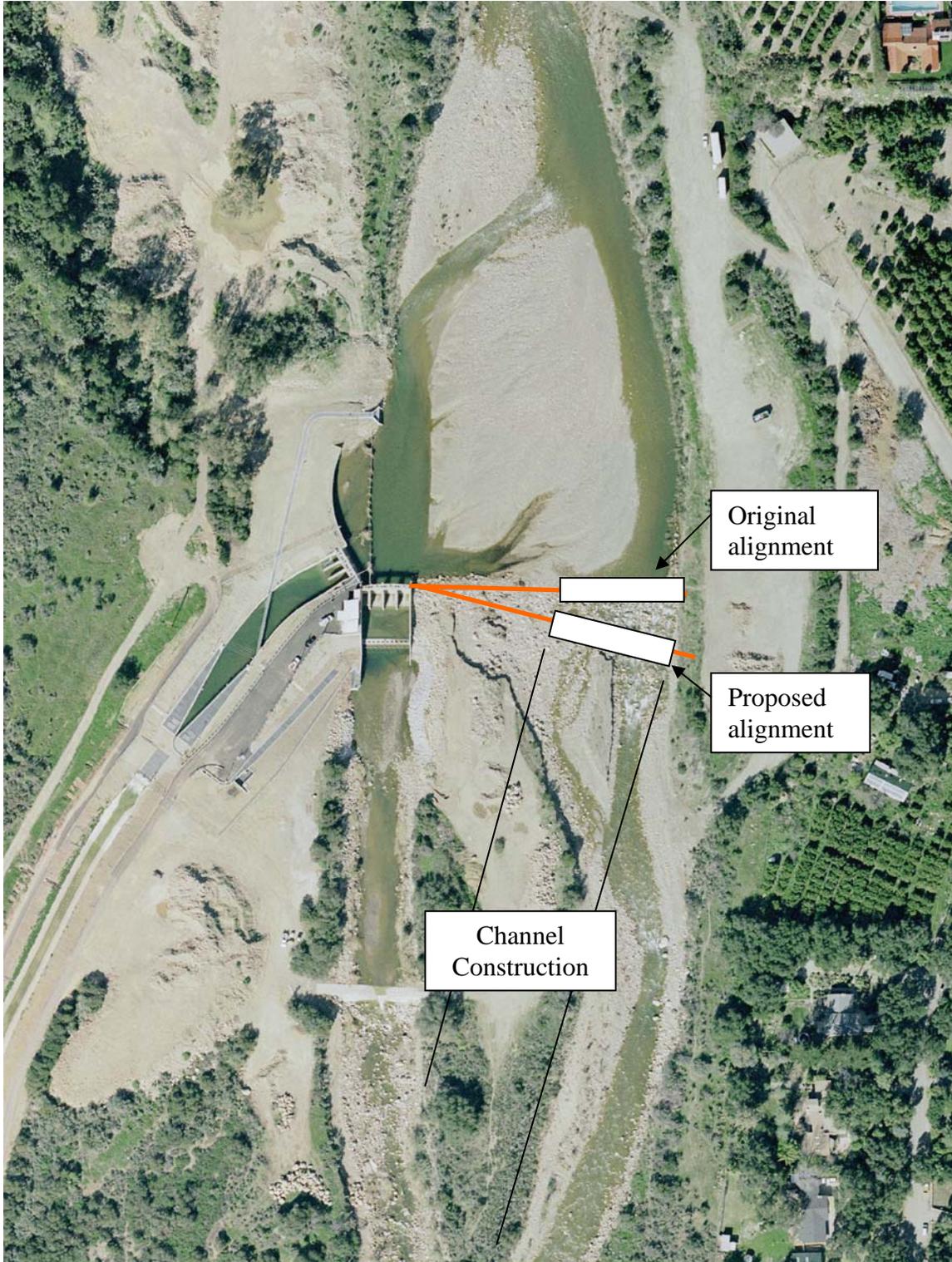
DISADVANTAGES:

- The crest length will have to be increased.
- There is a risk of split flow within the basin, limiting the amount of diversion.
- May require additional channel maintenance and or bank protection on the West side of the river.
- May intersect with downstream fish passage weirs in the west channel

JUSTIFICATION:

- Project function is improved at minimal cost. Sediment sluicing may be improved and the impact to downstream facilities is lessened.

2005 Aerial View of Robles Diversion



VALUE ENGINEERING PROPOSAL

PROPOSAL NO: 4 (Spec List Item 12)

PAGE NO: 1 OF 3

DESCRIPTION: Construct Infiltration gallery with perforated pipe

ORIGINAL DESIGN:

Maintain ability to divert (500 cfs) through Robles Canal and provide flow for existing fish passage without the need for major surface structures in river flows.

PROPOSED DESIGN:

The concept includes an underground basin to collect water below the surface. The basin would be topped by a concrete waffle slab that supports natural stone, rocks, and cobbles and would have to be designed to allow for additional sediment deposition as we anticipate continued to aggradation in this area. The slab holes would be designed to allow for adequate flow so that the 500 cfs, required diversion, would be maintained plus any safety factor and required diversion down the fish passage. The basin would have sufficient size to allow for the periodic cleanout of sediments and other maintenance (including the waffle slab). The water would flow to the diversion structure through piping using gravity and/or pumps. Water and sediment flows in excess of the designed level would simply pass over the structure. An operation assumption requires the basin to be full of water prior to any diversion down the canal to Lake Casitas and flows exceeding 50 cfs.

ADVANTAGES:

- No new significant structures above ground (in the river's path).
- More "natural" condition on the surface
- Allows recreation trail to pass Robles without confining width for other structures
- May reduce need for de-silting basin (Part of Feasibility Report Recommended Plan)
- More natural fish passage
- May allow for the removal of existing diversion structure (Depends on success)

DISADVANTAGES:

- High initial construction cost
- Uncertain and potentially costly long term maintenance
- Requires disposal area for sediments collected in basin
- Increased sedimentation above structure could reduce percolation rates limiting flow to basin then to the canal.
- Higher energy costs as pumps may be require

JUSTIFICATION:

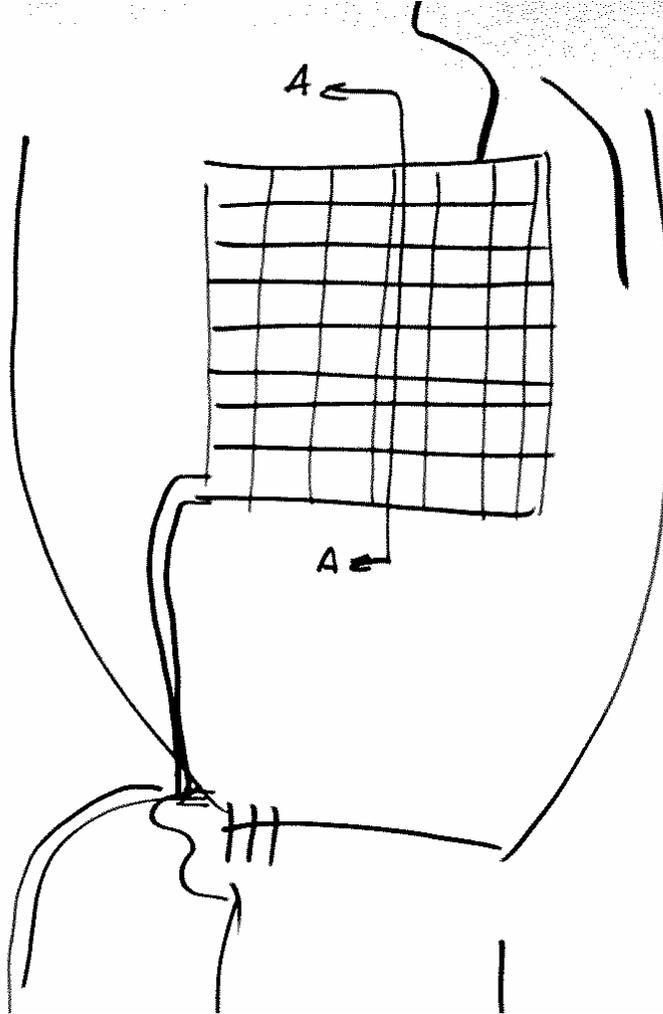
The proposed concept includes a system to collect water and move it to the diversion and fish passage facility while minimizing the need for any additional surface structure. This could allow sediment to flow relatively unimpeded, bypassing the existing Robles facility. It would add to the “natural” environment as there would be limited structures above ground.

CALCULATIONS:

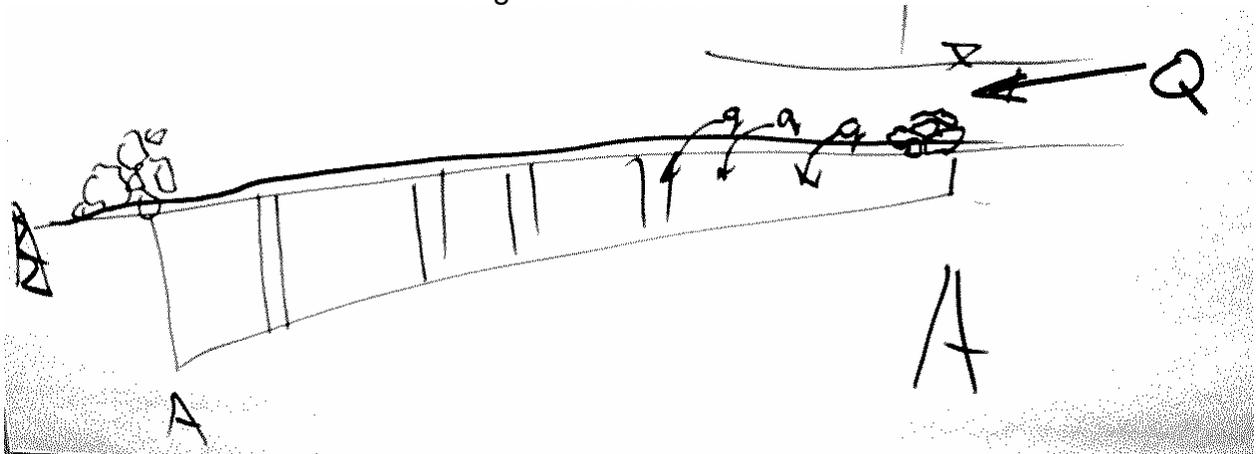
No calculations made for this proposal.

It was noted during the study that the City of San Buenaventura (Ventura) has a subsurface dam and collection pipe in the Foster Park area, however, that system uses a direct-buried perforated pipe system, which may not be comparable to the soil and flow conditions in the Robles Diversion area. There was concern that underground perforated pipes would clog very quickly, creating a continuous maintenance headache. This proposal is totally different, using an underground basin.

Plan View



Longitudinal Section A-A



VALUE ENGINEERING PROPOSAL

PROPOSAL NO: 5 (Spec List Item 34)

PAGE NO: 1 OF 1

DESCRIPTION: Use fuse-plug for high flow passage

ORIGINAL DESIGN:

Multiple (3 or 4) radial gates to provide high flow passage for discharges exceeding 7,000 cfs (or possibly lower). An Obermeyer inflatable bladder weir is also being considered.

PROPOSED DESIGN:

In lieu of radial gates use a fuse-plug design that would have to be reset or replaced only after rare use (7-10 year). The gate would be placed in approximately the same location as would have the radial gates. The fuse-plug would operate in a self-deploying mode and open at flows above a certain pre-determined threshold. The details of design could be worked out during the design phase, but the fuse-plug could potentially be a geotechnical design of engineered embankment or other impervious material designed to release at a particular pool level (presumably corresponding to 7,000 cfs or less).

ADVANTAGES:

- The fuse-plug has lower construction and maintenance cost than radial gates. Another advantage is the ability to perform automatically in the middle of the night or on weekends or other times when the project is unattended.
- The fuse-plug can be reset as part of normal post-event activities being carried out by the project staff.
- It could be sized and located as part of the proposed model study activities.
- The ability to reset invert elevation, post event as aggradation occurs in the channel is also an advantage.

DISADVANTAGES:

- Sensitivity of design to precision of engineered materials.
- Inability to throttle flows above 7,000 cfs (should such a need arise).
- Would have to be replaced or restored after every major flood event.
- Risk of opening prematurely, leading to loss of water for Casitas.

JUSTIFICATION: The justification is based on a cost versus reliability. This alternative would need to be analyzed for construction and maintenance cost to the selected alternative. In addition, the reliability of the fuse-plug would need to be thoroughly evaluated.

VALUE ENGINEERING PROPOSAL

PROPOSAL NO: 6 (Spec List Item 35)

PAGE NO: 1 OF 3

DESCRIPTION: Use resettable wickets for high flow passage

ORIGINAL DESIGN:

Recommended plan calls for three or four radial gates to provide high flow passage for discharges when flow hits a threshold of 7,000 cfs. The expected threshold could possibly be set lower. Alternative gates considered within the recommended plan include Obermeyer or other inflatable bladder for high flow passage over a single weir or multiple weirs.

PROPOSED DESIGN:

Use a multiple wicket design in lieu of Obermeyer. Steel wickets, hinged on the upstream end at a fixed invert would be placed in approximately in the same location as the Obermeyer. The wickets would operate in the up position potentially for years at a time and would be dropped prior to major events (or potentially forecast events) that would exceed the design capacity of the existing structure (7,000 cfs). Following major storm events, wickets would be reset in the up position using portable equipment such as back hoes or through the use of cables.

ADVANTAGES:

- Cost and reliability savings over the Obermeyer, in particular based on the extremely infrequent use and the failure mechanism.
- An Obermeyer would fail in the down position, which is very undesirable in terms of maintaining diversion flows.
- Failure of the wickets would only occur individually and lock in the up position.
- If this failure occurred at a low flow something as simple as plywood could be used to block the wicket until it can be repaired.
- The power and mechanical/electrical system requirements for the Obermeyer are significantly more demanding than the wickets, particularly for their rare use.
- The bladder would have to be kept inflated for extended periods (years) and would certainly require maintenance, electrical/mechanical, patching, etc.
- The lower cost of construction would also be an advantage.
- As the wickets are reset individually, flow can actually be throttled for a period as the channel is evaluated for any potentially stranded fish.
- There would also be a significant savings in construction cost over radial gates.

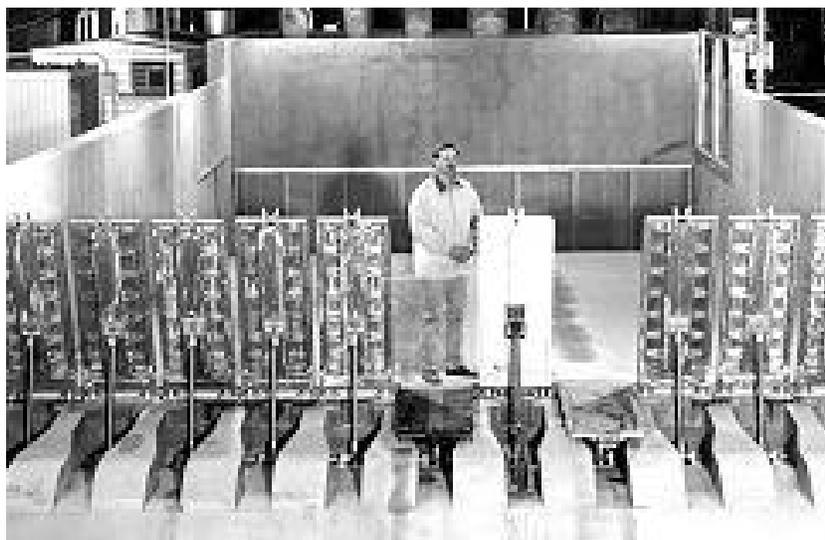
- As gates are operated individually, not all gates have to be opened at the same time.
- This allows flexibility in operation in terms of pool for a given discharge and allows the flows to be shaped in terms of sluicing operation for the forebay or scouring/spreading pattern for downstream.

DISADVANTAGES: Post-event flow in the high channel would have to drop adequately to get motorized equipment in the channel to reset the gates. Potentially some water would be lost to diversion waiting for the storm event to abate and allow equipment in the channel. This would be particularly true for an event with a drawn out hydrograph (infrequent in this area). Additionally, equipment would have to be mobilized to reset the gates. There may be an overburden of sediment to be removed from gates after event

JUSTIFICATION: The complexities and uncertainties associated with an Obermeyer make it an unreliable option in this application. It would perform much better in applications where it is operated up and down relatively frequently. The flexibility and simplicity of the wicket system will allow it to operate reliably and cheaply for years. If compared to the radial gates, the advantage is primarily cost, as it is significantly cheaper for initial construction and has lower maintenance costs.

Olmsted Wicket

420-m long with 140 x 2.95-m wide, boat-operated steel wicket gates



Denouval Wicket



Seine River, 30 wicket gates, 70 m width, 3.3 m height, 2.5 m width

1. **Construct sluicing channel to separate sediment and bypass it around fish chamber (Spec Item #13):**

There may be increases in the amount of suspended sediment entering the canal due to the project even if the high-flow bypass is in operation. A sediment sluice in the bottom of the canal before the fish screen could be used to return sediment to the downstream reach. A tunnel leading from the bottom of the screen forebay to the downstream channel would have to be constructed. It may have to go under or through the fish ladder channel.

2. **Use mechanical sluicing methods to occasionally resuspend sediment in forebay and channel it through fish ladder when flows permit (Spec Item # 32):**

Mechanical sluicing in the forebay/diversion channel of the fish passage facility consists of mechanically moving sediment in the area adjacent and upstream of the fish screens. This area is a sediment trap as the water velocities are slowed down to allow fish to swim past the fish screens. Sedimentation of sand and finer particles in this area can be a problem under current and will be made worse with the removal of Matilija Dam. If too much sediment settles in this area, the fish guidance device panels and the fish screen cleaning brushes can become stuck, resulting in a shutdown of the fish passage and diversion until the sediment can be removed.

The mechanical means would be either by air or water jetting. Pipes would be placed along the bottom of the forebay area. Air or water jet nozzles would be placed in the pipe. A compressor/pump would provide a stream of air or water through the nozzles, keeping the fine grain material in suspension. The suspended material will flow down the fish passage and into the river. The jet system would not operate all the time but would be used periodically when heavy sediment loads are present. To minimize compressor/pump size, the system would be designed with valving to allow for operation of the jetting system in zones and not all at the same time.

This comment needs to be reviewed during the design phase with any option that is selected.

3. **Raise Fish Ladder Entrance Elevation to allow for higher riverbed elevations downstream (Spec Item #16):**

. Since Robles construction in 1958, the elevation of the river bed downstream has decreased nearly 10 feet. The fish intakes were constructed based upon the 2005 degraded river bed elevations. After the removal of Matilija Dam, it is likely that the river bed may aggrade to the 1958 elevations. The fish ladder entrance elevations may have to be raised or risk being covered by sediment. No changes will be required on the upstream end.

4. **Decrease width of diversion dam (Spec Item #28):** The current diversion dam has a crest width of about 400 feet. The active channel width in the reach upstream of Robles is closer to 200 feet. Therefore, the wide section at the diversion may increase the deposition rates. A narrower diversion may provide the same function and require less maintenance.

5. **Consider features to prevent stranding of fish passage when gates are closed (6, 15):**

If a high flow sediment bypass structure is constructed on the east bank of the river, fish migrating upstream will likely be attracted into the resulting high flow east channel. Without passage facilities, e.g. a fish ladder, these fish would be required to fall back to the west channel and migrate up to the existing fish ladder. Those that failed to fall back could become stranded in the east channel and fall prey to predators or perish in receding, warming waters. Even those that succeeded in falling back to find the west channel fish ladder could have experienced significant delay, a real threat given the extremely flashy nature of the watershed. To protect steelhead, if a bypass facility is constructed on the east bank of the river either a fish ladder at the crib wall, or a fish barrier at the confluence of the east and west channels to prevent fish from entering the east channel is needed.

Details of a new fish ladder on the east bank would need to be determined at a later date when more information is available. The design of fish ladders requires knowledge of water surface elevations and substrate elevations upstream and downstream of the barrier. Because bed forms could change dramatically over the life of the bypass structure the fish ladder design would need to be adaptable to changing conditions.

A fish barrier weir could be beneficial with any of the proposed alternatives that include a high flow channel hydraulically isolated from the existing fish passage facilities.

Fish barriers are designed on one or more principles to prevent fish passage, including the following:

- Vertical leap barriers where the vertical leap required for passage is too great for the target species or the water depth downstream of a jump is too shallow to allow the target species to stage for a moderate jump,
- Velocity barriers where stream velocities exceed the target species' ability for a given distance,
- Physical barriers where inclined or horizontal grating filters water but doesn't allow fish to pass,
- A combination of the above factors.

VALUE ENGINEERING COMMENTS

For the Robles facility, the most probable design would likely include a ramp in the high flow channel discharging high flows into the main channel at super critical flows. Velocities on this ramp would be too great and depths would be too shallow for fish to swim upstream. Additionally, the structure would be positioned to guide fish upstream towards the fish existing fish passage facilities. The barrier would work best when the predominant flow emanated from the west channel.

6. **Use rocky ramp for fish passage (24):** Rocky ramps, also called nature-like fishways, excel for fish passage in riverine environments, because they:

- provide multiple passage routes so that if bed load or debris clogs one passage route, other routes are available for passage,
- pass debris and sediment efficiently,
- operate over a wide range of flows,
- don't require manual operations,
- require little maintenance, often limited to removing woody debris only after the high flow season.

A rocky ramp may be employed at several sites within this project. With Proposal 7, the no action alternative, a constructed rocky ramp on the east side of the crib wall could provide reliable passage for adult and juvenile steelhead as well as bed load and woody debris. Good fish passage was afforded steelhead in early 2005 when flows cresting the crib wall on the east side cascaded down a naturally created rocky ramp formed by naturally occurring bed load. That unplanned ramp was subsequently eliminated due to conflicts of the current low-flow road crossing which would also limit this route as a fish passage today. To act as a permanent or semi-permanent passage facility, a ramp would need to be constructed with appropriate materials such that the ramp would not be easily eroded in high flows.

A rocky ramp could also aide adult fish passage below high flow sediment gates. In any situation where upstream fish passage is desired or possible in a high flow channel hydraulically isolated from the existing fish passage facilities, the channel should be passable to allow fish access to new fish passage facilities or to pass directly through the bypass gates.

Rocky ramps have a high roughness value with large boulders to provide velocity refuge, and have an overall slope not to exceed 5%.

VALUE ENGINEERING COMMENTS

7. **Raise water surface by 1 to 2 feet (Spec Item #27):** .The current system has limited hydraulic head to push flow through the gates, fishway, and fish screens. If the gates become plugged or other head losses are encountered in the canal, the delivery of water to the canal may be hindered. If the operating water surface is raised another 1 to 2 feet, the reliability of delivering the design flow may be increased.

8. **Use pile dike upstream to block debris from existing canal entrance (Spec Item # 29):** The pile dike or similar structure would be constructed parallel to the flow of the river. The dike would begin at or near the cutoff wall (diversion dam) and continue upstream for several hundred feet. The pile dike would be a series of piles or similar structure with gaps to allow the passage of water. The pile dike dam would be designed to keep the majority of sediment on the east side of the channel where it would be passed downstream through a gate or over a sill. Velocities could also be kept higher on the east side, helping to sluice material downstream. The pile dike would create a sedimentation area for sand and smaller material in front of the entrance gates to the fish passage and diversion facility.

The pile dike is not a “stand alone” project, but should be considered to improve the efficiency of several other proposals and comments discussed within this report.

9. **Set invert elevation for high flow passage higher than existing fish channel (Spec Item # 11):** Rather than constructing expensive features to prevent stranding of fish upstream from the high flow diversion gates, if constructed on the east side, it is suggested to grade the approach channel to the gates to drain away from the gates as flow through the gates is throttled down.

10. **Use excavated material to construct weirs for fish passage channel (Spec Item # 22):** While the current fish passage channel appears to be successfully allowing fish passage up and down the Ventura River, further plans for the passage include boulder weirs to allow a more natural freshwater migration path. This feature is not included in the Federal portion of the project, but is highly desirable to stakeholders interested in fish migration. It is suggested that any excavated materials which would otherwise be spoiled could be used as the basis or core for these weirs, reducing the materials to be placed by the local sponsors to simply the natural-looking armoring to keep these weirs in place.

SUPPORTING DOCUMENTS

CONTACT DIRECTORY

VALUE ENGINEERING TEAM STUDY
 APPENDIX A: CONTACT DIRECTORY & VE STUDY TEAM MEMBERS

<u>NAME</u>	<u>ORGANIZATION</u>	<u>TELEPHONE</u>
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SPECULATION LIST

	#	Description
P/2	1	Bifurcate flows upstream
P/1	2	Move high flow bypass upstream
X	3	Add an additional diversion intake location upstream for use during high flow events
X	4	Add an additional diversion intake location along same dam alignment for use during high flow events
X	5	Add an additional high flow intake location with different intake elevation
P	6	Build new fish passage on east side for use during high flow events only
BD	7	Build nothing; just cut channel
P/1&2	8	Build vaned structure at bifurcation location (Iowa concept)
P	9	Increase depth of detention basin and increase slope in reach past diversion on east channel
BD	10	Modify existing diversion and fish passage to work with new sediment regime
C	11	Set invert elevation for high flow passage higher than existing fish channel
P	12	Construct Infiltration gallery with perforated pipe
C	13	Provide sediment sluicing within Robles Canal
X	14	Increase meandering to drop off more sediment
P	15	Construct fish barrier at downstream confluence of high flow and low flow channels for guidance
C	16	Raise fish intake structure to higher elevation to allow for higher downstream stream elevation
P	17	Angle structure and shorten length of run to confluence
P	18	Construct temporary interim measures to allow adaptation until equilibrium is established, i.e., # 4,5,7,16.
P	19	Increase capacity of existing system with new gates adjacent to existing (West channel)
X	20	Perform advanced maintenance (Excavate big hole for sediment to fill in; dig out later)
X	21	Construct debris basin upstream from Robles
C	22	Use excavated material to construct weirs for fish passage channel
P/1&2	23	Use stabilization between existing structure and upstream high flow structure
C	24	Use rocky ramp for fish passage
X	25	Use sill in lieu of gates
X	26	Use sill with compounded shapes
C	27	Elevate water surface by two feet
C	28	Use narrower weir
P	29	Use pile dike upstream to block debris from existing canal entrance

	#	Description
X	30	Use traveling bar screens to remove debris
C	31	Use pools and riffles in low flow channel
P	32	Use mechanical sluicing in forebay of fish passage facility, i.e, jet water
X	33	Use mechanical sluicing in river
P	34	Use fuse plug for high flow passage
P	35	Use resettable wickets for high flow passage
	36	
	37	
	38	
	39	
	40	

- P** Develop as Proposal
- C** Develop as Comment
- X** Reject
- BD** Being Done

FUNCTION ANALYSIS SYSTEM TECHNIQUE (FAST) DIAGRAM

FUNCTION ANALYSIS SYSTEM TECHNIQUE (FAST) DIAGRAM FOR ROBLES DIVERSION PROJECT, VENTURA COUNTY, CALIFORNIA

