

**Matilija Dam Ecosystem Restoration Project
Fine Sediment Management Study Group**

Questionnaire for March 30 meeting

Name & Affiliation: Matilija Coalition

Based on the consolidated flip-chart notes from the February 2 and 24 meetings:

1. Are there any other **major** constraints (or concerns by your organization) to the three major management options, *other than those listed on the notes*?

Organizational constraints: The removal of Matilija Dam cannot proceed without first negotiating a binding cooperative agreement with the stakeholders. This will first require a refined project description to a level of detail that all parties are comfortable with.

Other project components: The discussion has been constrained to Fine Sediment Management, although there are benefits to taking a more holistic approach to the project. Cost savings may be realized with other project components that could offset sediment management cost increases. Long term O&M needs to be included.

Funding is the ultimate driver – an expensive and complex project may never be built, regardless of consensus. Developing an affordable alternative will be necessary in order to remove Matilija Dam, which remains a liability to the community.

2. Are there any other **major** data gaps or information needs, *other than those listed on the notes*?
 - i. **Restoration design for reservoir area and associated cost analysis**
 - ii. **Assessment of watershed-wide supply/demand balance and options for interim alternative water supplies during deconstruction if needed**
3. In your opinion, what are the **top three** data gaps or information needs that must be answered in order to develop a viable consensus solution to managing the fine sediments in Matilija Reservoir as part of the Matilija Dam removal project? *Please be as specific as possible and list them in descending order as you would prioritize them.* (1= first choice, 2=second, 3= third).

1. Constructability of Alt 4b Feasibility Plan – need more detailed design/analysis of BRDA sites for sediment storage capacity, temporary vs. permanent, revegetation, phasing, water sources, water supply impacts, and a corresponding independent 3rd party updated cost analysis. This is our ‘baseline project’ upon which to assess potential cost savings from the hybrid modifications.

2. Feasibility of Notching – need assessment of water supply and flooding impacts for an incremental notching scenario - requires conceptual design for controlling sediment releases and assessment of bypass pipeline concept.

3. Changes in 2004 baseline conditions: (a) current water quality conditions include ever-increasing loads of sediment and organic components (b) leaving the dam in place will continue to cause changes in water quality/quantity.

4. In complete sentences---but in either bullet-item or paragraph format---please draft a **summary request for proposal/scope of work**, including expertise needed, to respond to the top data gaps or information needs that you have identified in Question 3 above.

See Below

5. Looking forward, post Study Group: Do you have any other suggestions about *how* we should continue to develop solutions to the major data gaps on the fine sediments?

Convene a Technical Working Group to guide solutions and studies. This group should be comprised of engineering, restoration science, biological, and regulatory expertise, and include experts involved with current and recent dam removal projects.

Summary Request for Proposal/Scope of Work

1. Interim Notching Plan

Objective: Determine feasibility of near-term action to avoid further sediment accumulation

- i. Develop a plan for *Interim Notching* of the dam to the silt line
- ii. Determine permitting and construction constraints
- iii. Determine costs and timeline

2. Constructability of Alt 4b Feasibility Plan:

Objective: Determine constructability and cost of the approved plan – i.e. 'Run 4b to the Ground'

- i. Assess sediment storage capacity of modified BRDA sites 1&2. (See attached BRDA Concept description)
- ii. Design/analyze feasibility of temporary storage areas to allow erosion during future flood events. Analysis to include phasing plan, with projected volumes available for re-use following a large storm event.
- iii. Design/analyze feasibility and cost for revegetation of permanent disposal areas. Site design should minimize runoff/erosion potential and restore flood terrace/upland habitat to replicate/enhance current habitat value.
- iv. Conduct tradeoff analysis for costs of temporary vs. permanent storage
- v. Reassess trade-off analysis for slurry operation water sources, to include purchase from CMWD and pump from Lake Casitas, capture and store in Matilija Reservoir, etc.
- vi. Reassess water supply impacts, to include need for desilting basin on Robles canal, impacts to other water districts, and other concerns
- vii. Cost analysis to include updated costs and optimization from alternative water sources

3. Feasibility of Hybrid Alternative:

Objective: Optimize sediment management plan for a hybrid solution with slurry/upstream/notching components to reduce construction costs and account for water supply and water quality constraints.

- i. Conceptual design/analysis of notching
 1. Develop a plan for Phased Notching - see description below
- ii. Conceptual design of upstream sediment management
 1. Feasibility/capacity for fine sediment in reservoir area - restoration design to determine capacity for additional fine sediment within Alt. 4b upstream sediment storage areas
 2. Feasibility/capacity of permanent storage beneath Matilija Rd.
 3. Design/analysis for revegetation and natural streambank stabilization with associated sediment transport/water quality analysis

4. See attached '**Sediment Management and Restoration Opportunities**'
- iii. Cost analysis – determine optimal hybrid alternative
 1. Quantify future savings from Interim Notching to prevent additional accumulation of sediment above the 2004 baseline at the 10, 20, and 50 year horizon
 2. Cost analysis for implementation of a restoration-based plan for reservoir area using on-site resources (i.e. trees, boulders, etc). Include long-term O&M and compare to Feasibility Study concept of disposal of on-site resources and construction/ maintenance/ removal of soil cement
 3. Optimization of sediment management with the goal of reducing costly slurry operations by re-introduction of some fine sediment in upstream storage areas and opportunistic controlled flushing during flood events

4. **Feasibility of Incremental Notching:**

Objective: Determine cost and feasibility of a full notching scenario

- i. Conceptual design/analysis of '**Incremental Notching**'
 1. Design/analysis of methods to control sediment releases with upstream sediment management as described in Alt 4b.
 2. Flashboards or other mechanism to control notch depth to facilitate timing with large storm events
 3. Design/analysis of diverting clean water from upstream via coffer dam and slurry/water supply pipeline to downstream water users while deconstruction is in process (**see attached 'Bypass Pipeline Concept' description**)
- ii. Analysis and mitigation plan for water supply impacts
 1. Analysis of timing and duration of potential water quality impacts
 2. Assess potential effectiveness of timed releases, diversion protocols, high flow bypass, desilting basin, bypass pipeline, and alternative water supplies

5. **Expertise for all of above:**

- i. Planning for the Ecosystem Restoration project should include a multi-disciplinary team of hydrologists/geomorphic analysts, construction engineers, mining engineers, riverine habitat restoration specialists, and technical experts with involvement in other recent and ongoing dam removal efforts. This should be conducted in coordination with the regulatory agencies to ensure permit compliance.
- ii. Utilize sediment transport models developed specifically for dam removal and sediment management (**See attached 'Dam Removal Sediment Management Examples and Considerations'**)



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December 16, 2008

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Additional Comments on Matilija Dam Final Design – Slurry Disposal

During the Design Oversight Group meeting of December 4, 2008, project managers indicated that a decision would be made on slurry disposal (by February 2009) based upon the alternatives presented at the meeting. These alternatives are as follows:

Alt	Description	Sub-Sites	Acreage for stockpile (ACR)	Ht above existing ground (ft)	Quantity of Material (CY)
1	MODA - 94 acre (as proposed in Feasibility)		94	15	2,100,000
		BRDA 1	50	10	800,000
2	BRDA (as proposed in Feasibility)	BRDA 2	25	13	500,000
		BRDA 3	11	13	240,000
		BRDA 4	32	14	700,000
3	MODA - 74 acre, Cozy Dell re-routed		78	20	2,100,000
4	MODA split - Cozy Dell to remain in primary alignment	MODA East	48	25	1,500,000
		MODA West	28	20	600,000
5	MODA east, BRDA 2	MODA East	48	26	1,600,000
		BRDA 2	25	13	500,000
6	BRDA 1 - 2	BRDA 1	50	19	1,400,000
		BRDA 2	25	20	700,000
7	MODA - East of Cozy Dell		48	33	2,100,000
8	MODA SE (ch prop E of Cozy Dell), BRDA 1 - 2	MODA east - ch.	33	17	1,000,000
		BRDA 1	50	11	700,000
		BRDA 2	25	12	400,000
9	MODA East, BRDA 1	MODA East	48	19	1,400,000
		BRDA 1	50	11	700,000
10	MODA SE, BRDA 1	MODA east - ch.	33	17	1,000,000
		BRDA 1	50	15	1,100,000

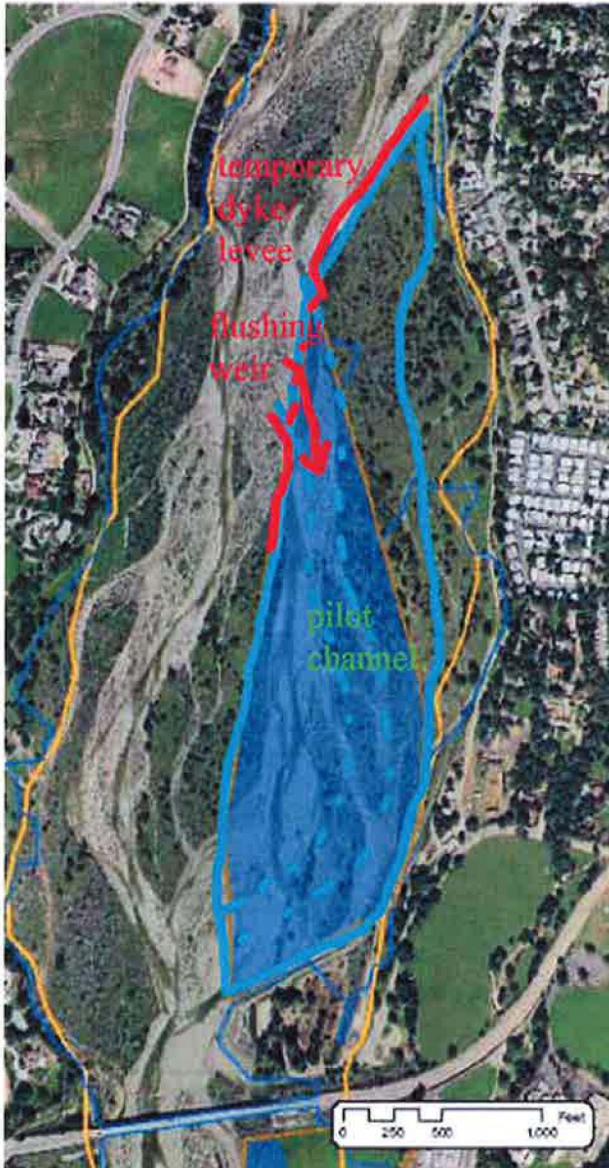
We suggest that Alternative 6 be modified to reflect the parameters that we proposed in our comment letter of October 20, 2008.

	BRDA 1	BRDA 2	BRDA 2A	Total
acres	50	25	15	75
height (ft)	15	15	15	
	56%	28%	17%	100%
capacity (cu yd)	1,210,000	605,000	363,000	2,178,000
capacity (AF)	750	375	225	1350

The following is a description of this alternative:

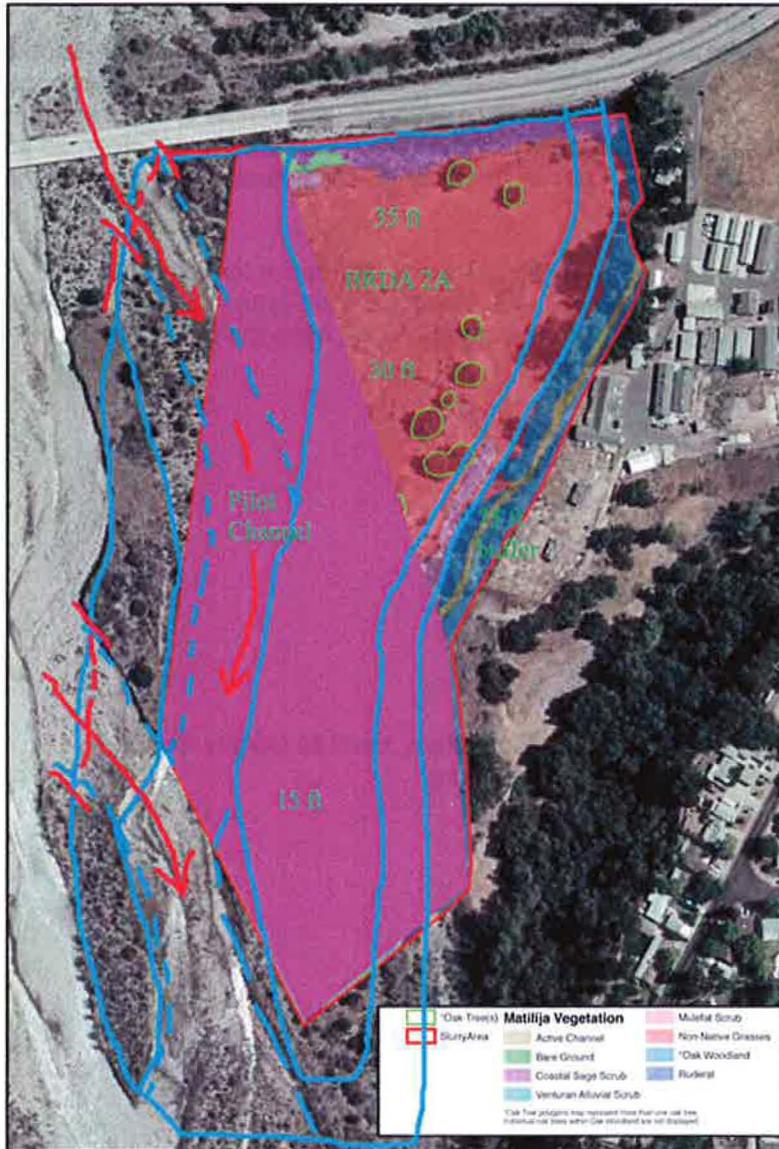
BRDA 1 would provide *temporary storage of 750 AF of fine sediments*, intended to be completely transported downstream following a series of flood events. This is accomplished by managing a pilot channel that follows the alignment of the existing river side-channel. This pilot channel will direct high flows from the mainstem channel through the disposal area to initiate and actively erode the sediments. This is controlled with a temporary levee (or containment dyke) that includes a 'flushing weir' at the upstream end of the pilot channel.

The footprint outlined in blue in this figure includes expansion of the disposal area onto the floodplain terrace to the east of the active channel. This would provide greater insurance that flows would not enter behind the disposal area and threaten downstream infrastructure. This area will also provide a staging area and additional capacity to account for the pilot channel, which would necessarily be an area of lower fill depth.



Adaptive management of this area would include monitoring the containment dyke and erosion to ensure release of fine sediments downstream occurs during predetermined flow events. The weir entry is designed to direct flows into the pilot channel during such events to facilitate removal of stored sediments. In this manner a large flood event may effectively remove a large portion of the temporary sediments (highlighted in blue.) In the dry season following such an event the remaining sediment could be re-distributed within this erosion zone in preparation for the next flood. *Eventually this area would return to natural floodplain with little evidence of the slurry activities.*

The BRDA 2 disposal area may store 600 AF of sediment (BRDA 2 with BRDA 2A superimposed.) BRDA 2A is a 15-acre sub-area in which the total deposition would average 30 ft deep. The erodable area (pink) includes a pilot channel designed in the same manner as BRDA 1. The fill is deepest adjacent to Baldwin Rd, which could be used as a containment dyke. The east edge of the disposal area will taper down to leave a 75 ft buffer/channel from the toe of the bluff to accommodate existing flows and maintain the mature sycamore and oak trees. The disposal area is expanded slightly to the west and south to provide additional capacity to account for the buffer zone and pilot channel.



Adaptive management would be used to optimize the erosion of temporary storage areas as described for BRDA1. The upland terrace would be revegetated, but the pilot channel and erosion zone would require minimal restoration. *In the future, the BRDA 2A area may be all that remains as a permanent feature of the landscape, so full restoration efforts need only be focused on this 15-acre area.*

Benefits of modified Alternative 6:

- a) Does not interfere with existing public access and recreation
- b) Simplified land acquisition (County and OVLC)
- c) Majority of slurry is placed in temporary storage for natural transport
- d) Minimized restoration costs
- e) Minimized disturbance of side channels and mature trees
- f) Minimized long-term disturbance

Other considerations:

It is unclear how the slurried sediment will compress after drying at the disposal areas. Discussion during the December 4th meeting suggested that the material may reduce from 70lb/sq.ft to 150 lb/sq.ft, perhaps resulting in as much as a 50% reduction in disposal height. How this will affect revegetation/restoration is not clear, so adaptive management of revegetation efforts needs to be considered in the planning process.

We submit this concept to clarify our preferred alternative for slurry disposal. We believe that temporary sediment storage, while having a short-term impact, will provide the greatest opportunity for ecosystem restoration and have the least impact on the affected community.

Sincerely,



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Sediment Management and Restoration Opportunities
for the
Matilija Dam Ecosystem Restoration Project
- Matilija Coalition -

The Matilija Dam Ecosystem Restoration Project has been delayed by lack of funding and difficulties associated with the management of approximately two million cubic yards of fine sediment (approximately one third of the total sediment) that has accumulated behind the dam. Despite the current uncertainty regarding sediment management, there remains an opportunity to design and implement a project that could serve as an international showcase of ecosystem restoration. The key is to maintain the approach and intent of the consensus plan already approved through the Feasibility process, and to retain the support of all stakeholders. It is important to recognize that achieving this goal will require a collaborative effort with a multi-disciplinary team of experts in the fields of river and habitat restoration, fluvial processes, and fisheries and wildlife restoration, as well as the engineers and resource agencies responsible for the outcome of this project.

ECOSYSTEM RESTORATION PROJECT OBJECTIVES:

- Improve Aquatic And Terrestrial Habitat Along Matilija Creek And Ventura River
- Restore Fish Passage to Benefit the Endangered Southern Steelhead
- Restore Natural Processes To Support Beach Sand Replenishment
- Enhance Public Outdoor Recreational Opportunities

The area upstream of Matilija Dam is one of the primary restoration sites within the Ecosystem Restoration Project, and the ultimate success of the project hinges on how this reach of the river is managed. The conceptual design for upstream sediment management described in the 2004 Feasibility Report specifies *temporary* sediment disposal areas, which were carefully selected to minimize impacts to the existing habitat and provide for the restoration of a naturally meandering and shifting stream channel upstream of the current dam site. This restored temporary ‘pilot’ channel is intended to provide a quasi-equilibrium starting point to provide for the natural evolution of the canyon following dam removal.

In response to the recent proposal to attempt to *permanently* sequester the fine sediments in Matilija Canyon, it is useful to re-frame the question as follows:

Can the RESTORATION of Matilija Canyon be designed in a manner consistent with the Feasibility Study plan so that (a) a meandering stream channel is constructed of natural material upstream of the current dam site, and (b) sediments are managed so that downstream interests are not unduly impacted and project objectives are optimized?

The following outline includes potential solutions to the sediment management issues and brainstorming ideas intended to optimize the Ecosystem Restoration objectives for the removal of Matilija Dam. We look forward to the opportunity to discuss these concepts and move forward with the Matilija Dam Ecosystem Restoration Project.

1) Sediment Management:

The full suite of sediment management alternatives should be reconsidered within the framework of the approved consensus plan. There may be potential for a combination of strategies to optimize restoration opportunities and minimize overall project impacts and cost.

- a. **Slurry of Fine Sediment:** This is the approved plan, and serious consideration of the design, management, feasibility, and optimization of the temporary sediment storage sites in the vicinity of Baldwin Road should be a priority. (One option may be phased slurry to allow opportunity for natural flushing and reuse of these areas following a storm event.) Any significant deviation from this plan may result in further significant delays and potential cost increases.
- b. **Upstream Sediment Management:** Fine sediment may be dewatered and mixed with coarse sediment for deposition within previously designated upstream temporary storage areas.
 - i. Dewatering will facilitate aerobic processes and reduce real or perceived risk of downstream transport of organic components.
 - ii. This material will provide rich topsoil, which is essential for revegetation of the disposal areas.
 - iii. Revegetation will be necessary to control surface erosion and stabilize slopes, as well as reduce invasive non-native plants.
- c. **Permanent Stabilization:** Any attempt to construct permanent structures in the floodplain will have far-reaching negative consequences. However, there may be an opportunity to sequester a portion of the fine sediments beneath Matilija Road on the left bank of the creek. This would provide the benefit of raising the road out of the floodplain and may provide an opportunity for permanent stabilization of some material outside of the active channel, while making use of an already impacted site.
- d. **Other Mechanical Transport Options:** Some fine sediment may be trucked or slurried to off site locations for temporary storage, resale, agricultural, or other use. For example, gravel trucks that currently return empty to Cuyama Valley may be available to transport some sediment over Hwy 33.
- e. **Other Sediment Management Options - Natural Transport:** This is the most cost-effective approach for managing sediments accumulated behind the dam, and it is important to recognize that the river's large capacity to transport sediment during major (though irregular) flood events. The Hydraulics and Hydrology reports indicate that high flows are capable of transporting virtually all of the fine sediments to the ocean in a single event. The potential for incremental removal of the dam combined with upstream sediment management should be seriously reconsidered within the context of Water Supply Considerations (see section 2 below) to prevent future build up of sediments and to remove accumulated sediments in the Matilija Reservoir.
 - i. **Interim Notching:** Removing the upper portion of the dam down to the current reservoir sediment level would prevent the further accumulation of sediment (potentially up to an additional 3 million cubic yards). This would reduce the potential increase of costs associated with any of the potential sediment management options, provide valuable experience in removing and re-cycling large amounts of concrete, and help build momentum for the project.
 - ii. **Incremental Notching:** Incremental removal of a small portion of the dam below the silt-line would allow the natural transport of currently stored sediments

during high flow events. A vertical 'slot' could be constructed in the dam to a level below the silt line with a gate to provide timed controlled release of sediments. This would increase the sluicing efficiency of flows, both through the slot, and in the channel that would be cut upstream through the reservoir sediments. Sluicing through this slot could be coordinated with the operation of the high-flow sediment bypass to ensure fine sediments would be transported downstream of the Robles Diversion. Incremental notching could be a supplement to Alternative 4b, and not necessarily a substitute.

2) Water Supply Considerations:

The Feasibility Plan was designed around concerns related to the Robles Diversion Dam downstream of Matilija Dam. The discussion has become unnecessarily constrained due to concerns of releasing fine sediments, despite the fact that the district currently diverts turbid water from both the North Fork Matilija Creek and flows overtopping Matilija Dam. Natural upland erosion (particularly during major flows following wildfires) and chronic artificial sources such as the Ojai Rock Quarry contribute to existing high turbidity during storm events, and Matilija Reservoir often impacts water quality for weeks after such storms. Temporary incremental increases in turbidity may be tolerated if technical analysis can quantify the impact and mitigation.

- a. Bypassing of flow at Robles diversion during planned high turbidity events
 - i. Mitigation for CMWD operations within the Feasibility Plan includes the High Flow Sediment Bypass and fine sediment 'Desilting Basin.'
 - ii. Casitas Water District has already committed to the use of 4,500 AF of water for slurry in the Feasibility Plan. If slurry is not used, this water could be available for mitigation.
 - iii. Analysis should be conducted to consider optimizing operations of the CMWD diversion with the new Desilting Basin and High Flow Bypass to minimize the net loss of diversion opportunity.
- b. Other Mitigation
 - i. Increased treatment of water taken from Lake Casitas
 - ii. Future dredging potential at Casitas Reservoir to maintain capacity.

3) Restoration Design for Reservoir Area within Matilija Canyon:

- a. Channel alignment should be sensitive to existing habitat as described in the Feasibility Plan. The objectives are to provide:
 - i. A functional riparian and floodplain corridor.
 - ii. A quasi-equilibrium 'starting point' for future geomorphology and hydraulics/hydrology
- b. Upstream *temporary* sediment 'storage sites' should be designed to provide:
 - i. Stable slopes
 - ii. Natural erosion patterns
 - iii. Limit mass wasting to extreme (>10yr) events as agreed to in the Feasibility Plan

- c. Minimize the use of permanent or semi-permanent 'soil cement' or other hard streambank stabilization
 - i. Hard structures preclude re-established riparian vegetation and habitat restoration, and reduce beach nourishment benefits.
 - ii. Hard structures cause scour and increase the potential for failure.
 - iii. Future maintenance and management within the floodplain will disrupt ecosystem restoration.
- d. Existing resources in the project area should be protected and/or re-used based on a cost-effective bio-engineering design approach. Such methods are being used throughout the State of California and elsewhere. The intent would be to implement a project that would require minimal future 'adaptive management' and large-scale maintenance, hence also reducing overall costs of the project.
 - i. Large boulders and trees that need to be removed should be re-used for streambank and hillside stabilization or reused for restoration in the downstream river channel.
 - ii. Woody debris should be mulched and reused to minimize surface erosion and facilitate revegetation.
 - iii. Fine sediments should be combined with other sand/gravel and organic material to facilitate revegetation and minimize surface erosion.

4) Procedural Considerations:

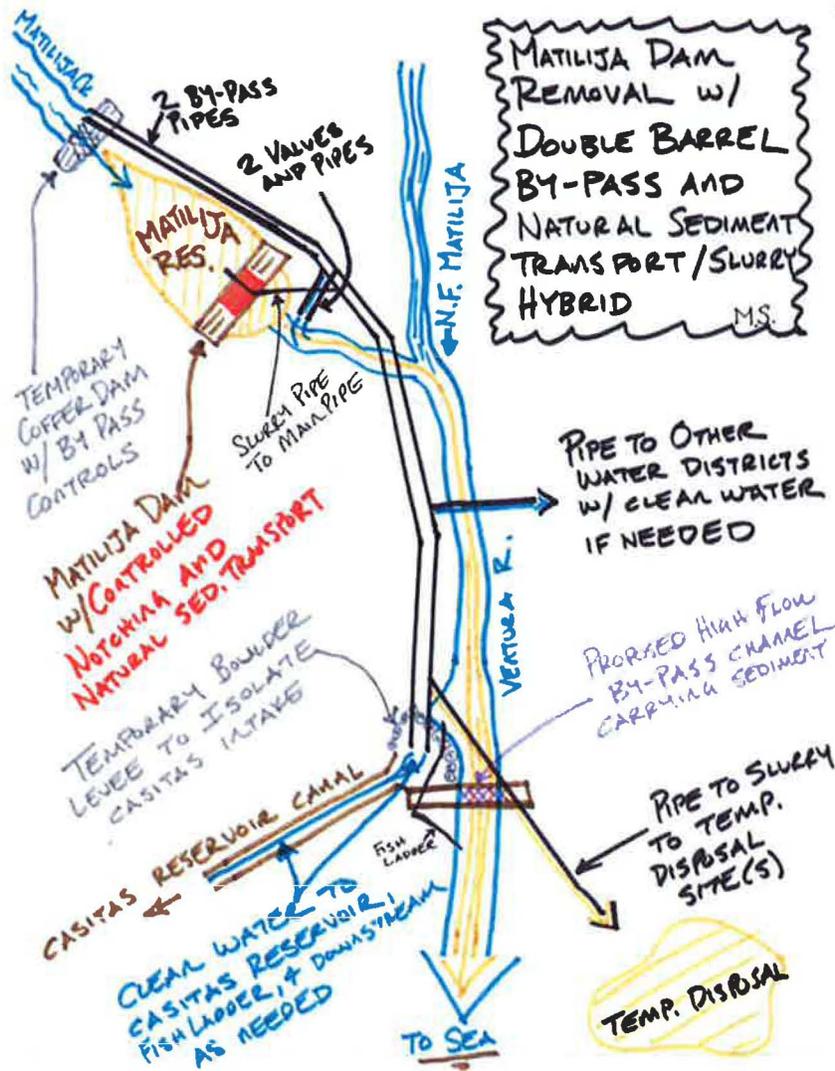
- a. Technical Steering Committee:
 - i. Technical and environmental working groups should be re-convened in a multi-agency stakeholder process separately from the political forum of the 'Design Oversight Group.'
 - ii. Technical team should include river and habitat restoration experts, fluvial geomorphologists, fish and wildlife scientists, dredge and mining experts, and others, as well as the responsible resource agencies.
- b. Independent Review
 - i. Technical and economic analysis should be conducted by a qualified independent consultant team.
 - ii. Project objectives should be optimized through an ecosystem-based restoration design approach.

5) Funding

- a. The following are central to securing funding:
 - i. Restoring stakeholder engagement and support.
 - ii. Developing a showcase Ecosystem Restoration project.
 - iii. Increasing cost effectiveness.
- b. Consider creative funding opportunities, such as private monies, resale of aggregate or other materials, demo-demonstration, military training, etc.

Bypass Pipeline Concept Summary for Matilija Dam Ecosystem Restoration Project (based on proposal by Matt Stoecker)

Alternative 4b (and other dam removal alternatives) incorporate an upstream cofferdam to dewater the reservoir area during sediment management and dam removal. The cofferdam could be enhanced to provide for high-flow diversion through two pipes linked with the slurry lines to supply “clean” water to Casitas and other water districts downstream. This clean water diversion would allow for controlled notching and opportunistic natural sediment transport when high-flow events occur during dam deconstruction.



Dam Removal Sediment Management Examples and Considerations

For the Matilija Fine Sediment Group

1-24-11

Hello all,

At the last couple meetings, and in personal conversations with some of you, I have spoken about a couple of dam removal and sediment management projects that were recently completed, are underway, or are in the planning phases. I told several folks that I would send more information about these projects for consideration in the Matilija Dam removal project and sediment management effort. Some of these projects will be familiar to a lot of you and I am not claiming to be an expert on any of them, but I have visited several of these sites during construction, know individuals involved with their planning or implementation, and have followed and reviewed some of the data and post-removal monitoring results with interest. I have also managed a few small dam removal projects in California and am monitoring sediment transport at one dam removal site locally.

Between the time of initiation of the Matilija Dam removal effort and now, much has been learned about dam removal and sediment management and impacts. Over the past decade, several large dams have been removed and the outcomes studied. Very large dams such as Elwha, Glines Canyon, and Condit in Washington State are scheduled to come out this summer and preparations have already begun. Our understanding of dam removal, sediment transport, and impacts to wildlife has improved greatly over the past few years. Some previous assumptions and predictions with dam removal projects have changed or been disproved. For these reasons, and as I think many folks involved with the Matilija effort agree, I believe we need to thoroughly consider the new information available in relation to Matilija Dam removal and sediment management alternatives. I am optimistic about the new data and examples available and about our ability to move forward collectively with the best possible alternative. Recent examples have shown that dam removal and sediment management can be far less technically complicated and expensive than some complex alternatives, and more desirable for funders and stakeholders.

The below examples focus on natural sediment transport following dam removal or notching as well as newer sediment transport models being employed. It is interesting to note that I have not been able to find past or planned dam removal projects that employed more expensive and technically challenging alternatives such as slurring sediment to disposal sites or permanent sediment storage (except with the San Clemente Dam removal project where some sediment is being stored). Many of the dams effectively removed, and being planned, allowed transport of all sediment to habitat downstream with multiple salmonid species, including steelhead, with overall biological benefits and the earlier concerns about "biological devastation" not realized. In addition, several of the completed (and planned) dam removals (Rogue River, Elwha, others) implemented

significant infrastructure improvements to existing water diversion and treatment facilities and improved flood protection measures such as bridge modifications and levee improvements. Please see the links for images, videos, and associated reports.

Marmot Dam, Sandy River, Washington State

Removed in the summer of 2007, this 47-foot tall dam released close to 1 million cubic yards of sediment downstream; much of that occurred in the 24 hour period following the removal. This project has shown that large-scale releases of sediment can be accomplished without significant negative biological impacts downstream and major biological benefits overall. Continued monitoring has also shown the economic and logistical effectiveness of “natural” sediment transport downstream and compatibility with flood protection requirements.

http://www.stillwatersci.com/case_studies.php?cid=58
http://or.water.usgs.gov/projs_dir/marmot/index.html

Rogue River Dams Removed (4 total)

Elk Creek Dam (Army Corps)-

This Army Corps Dam was effectively “notched” with results that are comparable to a full dam removal with remnants of the dam on both banks. The dam was notched in 2008 and the stream channel was allowed to reclaim its natural stream bed. This is an example of the Army Corp blasting a dam to near streambed grade and allowing the river to “naturally” reestablish its channel.

http://www.oregonwild.org/waters/elk_creek_dam/elk-creek-dam-timeline
<http://waterwatch.org/programs/freeing-the-rogue-river/notching-the-elk-creek-dam>

Gold Hill Dam-

This dam removal took place in 2009 and also allowed natural sediment transport downstream along with a new water facility for the city.

<http://waterwatch.org/programs/freeing-the-rogue-river/rogue-river-dams>

Gold Ray Dam-

Removed last summer (2010), this 38-foot tall dam also allowed trapped sediment to flush downstream to where instream diversion intakes were modified to enable continued diversion effectiveness. Chinook salmon were observed spawning in the former reservoir site within days of the removal and while sediment was still flushing out.

http://www.rvcog.org/mn.asp?pg=NR_Gold_Ray_Dam

Savage Rapids Dam-

Removed in 2009, this project included the construction of a new water diversion and pumps that effectively divert water from the river without the need for the dam. It is noteworthy that several of the above-mentioned dams were removed from the Rogue River before and after Savage Rapids Dam was removed and the irrigation district was able to maintain their diversions with the improved facility while natural sediment transport occurred past the intake. At least \$28 million dollars in funding was obtained for this dam removal and water diversion upgrade project that the Bureau of Reclamation oversaw.

<http://waterwatch.org/programs/freeing-the-rogue-river/savage-rapids-dam-removal>

Elwha River Dams (Elwha and Glines Canyon)

Preparation for removing these two dams has begun and will commence in full force this summer (2011). This will be the largest dam removal project in the U.S. to date and includes natural sediment transport of over 18 million cubic yards (3 times Matilija) downstream, levee improvements, and new city water facilities before, during, and after removal. The project uses an innovative strategy and new facilities to ensure that naturally transported sediment does not negatively impact water supply. As noted below;

“Both treatment plants will protect water users from the turbidities that will occur upon **removal of the Glines Canyon and Elwha Dams.**” “The Elwha Water Facilities also provide for **local area flood protection.**”

“The facility is designed to remove sediment from the water supply”

“During high turbidity, it would allow the city to turn off the Ranney collector pumps to prevent plugging of the subsurface gravels. When times of high turbidity pass, the city could again send water from the Ranney collector to the PAWTP.”

<http://www.nps.gov/olym/naturescience/elwha-ecosystem-restoration.htm>

<http://www.nps.gov/olym/naturescience/water-treatment-overview.htm>

<http://www.nps.gov/olym/naturescience/elwha-water-facilities.htm>

<http://www.nps.gov/olym/naturescience/dam-removal-overview.htm>

Klamath Dams (4 total)

Scheduled for removal in 2020, this is looking to be the largest river restoration project in the world and involves the removal of 4 huge dams and natural sediment transport downstream. Studies have found that 11.5 to 15.3 million cubic yards of mostly fine sediment occur behind the dams (approximately

double, or more, than Matilija Dam, but mostly fines). Stillwater Sciences has done amazing work to assess sediment transport scenarios, impacts to wildlife, and determining optimal reservoir drawdown alternatives and sediment transport modeling using their DREAM-1 model below. Such analysis and modeling has been used (Marmot Dam removal) and it being used on the Klamath Dam removals to determine and implement ideal sediment transport strategies to effectively move sediment downstream without the need for expensive and challenging slurry-type options or permanent sediment storage.

From the Stillwater Sciences website:

“Although removing four dams on the Klamath River will have dramatic effects on the river ecosystem and may fundamentally alter riverine nutrient cycling downstream of the dams, our studies show that impacts of releasing the millions of tons of fine sediment stored behind the dams will be relatively short-lived and will not likely eradicate any species.”

“Sediment transport simulations- In order to arrive at an optimum reservoir drawdown scenario, Stillwater Sciences used the DREAM-1 dynamic sediment transport model (Cui et al. 2006) to analyze multiple concurrent drawdown alternatives, including a variety of different drawdown start dates and drawdown rates. For more information, download the full [Sediment Transport Technical Report](#). If you have questions about sediment transport modeling, contact [Dr. Yantao Cui](#).”

http://www.stillwatersci.com/case_studies.php?cid=55

Sediment Transport Models- From (Stillwater Sciences)

<http://www.stillwatersci.com/tools.php?tid=51>

Suite of Models Our sediment transport models are developed in-house, in conjunction with leading academics specializing in sediment transport dynamics. The models can be customized for a particular river system or condition, or to address specific questions. Model development, validation, and testing are described in several publications in some of the leading academic journals for sediment transport. Sediment transport models developed by Stillwater Sciences include: **TUGS** (The Unified Gravel-Sand) model simulates the transport of both gravel and sand in predominantly gravel-bedded rivers. TUGS model incorporates the latest research in sediment transport, including accurately predicting interactions between gravel and sand particles. TUGS can be useful in predicting changes to the river bed based on changes in sediment and water supply to a river. For more information about this model, download a [documentation](#) publication and a publication with [TUGS applied to the Sandy](#)

River, OR.

DREAM-1 (Dam Removal Express Assessment Model 1) was developed to simulate the movement of pulses of **fine sediment** (sand or finer) in rivers with different bed material conditions. The models were developed initially for simulating sediment transport following dam removal but have wide applicability to other questions of sediment transport (e.g., natural landslides or gravel augmentation downstream of dams), especially where the interactions of different sediment sizes have the potential to affect habitat conditions.

DREAM-2 (Dam Removal Express Assessment Model 2) was developed to simulate the movement of pulses of **coarse sediment** (gravel or coarser) in rivers with different bed material conditions. For more information about DREAM, download the [Model and Validation](#) publication and the [Sample Runs and Sensitivity Tests](#) publication, as well as a publication documenting flume experiments that validate DREAM.

Fine Sediment Needed for Coastal Marshes

I also mentioned a 2010 study and report by the U.S. Geological Survey and four partnering universities, titled *Limits on the Adaptability of Coastal Marshes to Sea Level Rise*, which found that coastal marshes, such as our local lagoons and estuaries, need fine sediment from nearby watersheds to survive rising sea levels. **“Marsh survival strongly depends on sediment availability,” it reads. “This raises the possibility that extensive marshes that are degrading today were stable ecosystems during periods of high sediment delivery, but would be unstable today even at relatively low sea level rise rates.”** With dams and other practices depriving coastal areas of much-needed suspended (fine) sediment, it says, sea level rise threatens coastal wetlands with ecological collapse.

This and other recent studies related to the benefits of fine sediment, as well as steelhead and other wildlife tolerability of high suspended sediment loads with natural events like fire, changes our understanding of fine sediment. A decade ago it was common to hear people talk about silt and “fines” as a bad thing, the dialog is changing to recognize the importance of all sediment types along with valid concerns about “unnatural” and damaging persistence or absence of some sediment scenarios. Clearly, as observed recently, our watersheds and wildlife are some of the most prone and adapted to periodic, “natural” pulses of massive amounts of sediment transport from fires and erosion (i.e. Sespe Creek, Sisquoc River, Mission Creek). As noted in previous meetings, the mobilization of all, or pulses of, sediment behind Matilija Dam may be comparable to, or less than, that

which is mobilized in periodic fire events in Matilija Canyon and the Ventura River watershed.

Summary

There are many completed dam removal projects not included in this short memo, but I hope that this information is useful in moving forward on the Matilija project. As shown with the above projects, and others, natural transport of all sediment downstream of dam removal sites is an effective and preferred alternative in almost all cases I have researched. These projects have included major funding for upgrades or new construction at existing water diversion facilities to facilitate and improve overall diversion function during and following dam removal. Many projects also incorporate funding to improve flood protection and safety at road crossing sites. Significant uncertainty and concerns were widespread only a decade ago about the possible negative biological impacts of relatively quick sediment flushing downstream of dam removal sites, but recently completed projects and monitoring have shown that populations of salmonids, such as steelhead, are very resilient, adapted to massive fire-related sediment transport events, and quickly take advantage of increasing their range upstream of dam removal sites as well as successfully spawn within and below the recently removed dam site (Rogue River and Sandy River removals). Other native wildlife is showing similar adaptability and resilience to high sediment transport following dam removal, in addition to increasing in population size and distribution. As such, some of the concerns about the biological, flooding, and water diversion impacts of dam notching or full removal and natural sediment transport downstream have been considered, addressed, and effectively dealt with and resulted in significant benefits to, and support from, various stakeholders involved. I look forward to discussing these and other issues as we move forward to find a solution that we can all support.

Thanks for your time and consideration,

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