M & T / Llano Seco Fish Screen Facility
Short-Term/Long-Term Protection Project

Technical Review and Recommendation Workshop

March 17 - 19, 2004
Llano Seco Ranch Headquarters
Chico, CA

M I N U T E S

Wednesday
March 17, 2004

Yantao Cui, Research Scientist, Hydrology/Geomorphology
Dennis Dorratcague, MWH Americas Dennis Dorratcague, MWH Americas
Kevin Foerster, Project Leader, Sacramento National Wildlife Refuge Complex
Michael Harvey, Principal Geomorphologist, Mussetter Engineering, Inc.
Les Heringer, Manager, M&T Chico Ranch
Eric Larsen, Research Scientist Geology
Chris Leininger, Project Development, Ducks Unlimited, Inc.
Robert Mussetter, Principal Engineer, Mussetter Engineering, Inc.
Vickie Newlin, Sacramento Valley Regional Coordinator, California Bay-Delta Authority
Neil Schild, Principal Engineer, MWH Americas
David Sieperda, Manager, Rancho Llano Seco
Robert Strand, MWH Americas
Paul Ward, Association Fishery Biologist, Region 2, California Department of Fish and Game
Olen Zirkle, Manager, Conservation Programs, Ducks Unlimited, Inc.

Introductions

Working Lunch
Group discussions regarding review and summary of Orientation and Information Workshop in November, 2004.

Site visit along river to evaluate changes over the winter months.

Thursday
March 18, 2004

Introductions

Howard Brown, Fishery Biologist, National Oceanic & Atmospheric Agency
Koll Buer, Chief, Gelogic Investigations Section, California Dept. of Water Resources
Burt Bundy, Manager, Sacramento River Conservation Area Forum
Stephen Caswell, Project Engineer, Carolla Engineers
Stacy Cepello, Environmental Scientist, California Dept. of Water Resources
Yantao Cui, Research Scientist, Hydrology/Geomorphology
Dennis Dorratcague, MWH Americas
Woody Elliott, District Resource Ecologist, California Dept. of Parks & Recreation, No. Buttes District
Kevin Foerster, Project Leader, Sacramento National Wildlife Refuge Complex
Michael Harvey, Principal Geomorphologist, Mussetter Engineering, Inc.
Les Heringer, Manager, M&T Chico Ranch
Eric Larsen, Research Scientist Geology
Chris Leininger, Project Development, Ducks Unlimited, Inc.
Robert Mussetter, Principal Engineer, Mussetter Engineering, Inc.

Scott Parker, Project Manager, Carollo Enginerrs
Bruce Ross, Engineer Geologist, California Dept. of Water Resources
Neil Schild, Principal Engineer, MWH Americas
David Sieperda, Manager, Rancho Llano Seco
John Skowronek, Engineer, MWH Americas
Robert Strand, MWH Americas
Jonathan Walters, Engineer, California Dept. of Water Resources
Paul Ward, Association Fishery Biologist, Region 2, California Department of Fish and Game
Olen Zirkle, Manager, Conservation Programs, Ducks Unlimited, Inc.

Review of Steering Committee Charge – Olen reviewed the following elements of the Steering Committee charge:

- Fundamental Questions to be addressed;
- Goals and Objectives;
- Working hypotheses and Investigative Approaches – Hypothesis Testing; and,
- Purpose of the Steering Committee.

Presentation of Preliminary Technical Reviews of River Meander and Sediment Deposition

The following technical white papers where presented to the group by the Steering Committee by reviewing the contents of the papers and answering questions from the other members of the Steering Committee. The following technical reports are provided as attachments to the minutes:

Geologic and Geomorphic Setting
Michael Harvey, Principal Geomorphologist, Mussetter Engineering, Inc.

Meander Bend and Gravel Bar Migration near River Mile 192.75 of the Sacramento River
Eric Larsen, Research Scientist Geology

River Realignment and Bank Protection
Michael Harvey, Principal Geomorphologist, Mussetter Engineering, Inc.

Bed-Load Transport in Sacramento River Near the M&T Pumping Plant
Robert Musseetter, Mussetter Engineering, Inc.
Yantao Cui, Research Scientist Hydrology/Geomorphology

Summary
Michael Harvey, Principal Geomorphologist, Mussetter Engineering, Inc.

One of the alternatives is the prevention of erosion of the opposite bank that will probably result in further deposition on the gravel bar. Based on Eric Larsen's model of bar migration, another possibility is the use dikes to hold the existing bank alignment. We know that the existing bank alignment is not particularly good. If we use Bob Mussetter's numbers we may be looking at somewhere around 40,000 to 50,000 tons of deposition per year in the vicintiy of the M&T pumps. That status quo is not particularly acceptable. This condition can probably be improved structurally. The way to approach the problem is with dikes or groins.

Typically, dikes and groins have not been used on the Sacramento River system, but they have been used successfully in many other places; both to locally hold the bank and to change the alignment of the river. A dike is something that sticks out perpendicular from the bank the objective of which is to change the near field velocities. It provides some protection of the bank and it also forces and keeps the flow further out from the bank. The dikes are not usually put in the river singly, they are usually put in as a field. Generally, they are designed and constructed in multiples.

The biggest advantage to dikes over full-bank revetments is the minimal amount of bank preparation. The environmental costs associated with putting in dikes for bank protection is somewhat lower. The quantity of rock that you use is probably no less on dikes than you would use on full bank revetments. But the beauty of dikes is that they give you a hard point and then they leave the banks soft before you get to the next dike. So the soft bank is not totally eliminated. Generally, you will get deposition between the dikes and vegetation tends to come in and occupy those areas. The other advantage of the dikes is the ability to change the channel alignment. You can actually force the river back over to a given location. They are flexible. If you don't get it quite right the first time, you can extend them or you can cut them back. And they will give you the added benefit of sufficient deposition between them that effectively reduces the height of the bank and buttresses the toe of the bank and you get some mass stability eventually.

There are some disadvantages to dikes. If the bank failure is caused by the bank being too high -- dikes are not appropriate. At least not immediately. They are definitely a navigation and a recreational hazard. Especially when you think of Scotty's upstream and the recreational tubers coming down the river. They are somewhat more difficult to construct because there are not a standardized designs. They require a contractor that knows what he is doing to construct dikes. And, because there is a lower level of design, they do require monitoring.

Generally, dikes are either permeable or impermeable. An impermeable dike is generally just a rock dike. A local example of permeable dikes is the palisades that were built in the 1980's up at Woodson Bridge. The bottom line is that permeable dikes only really work very well when there is a very high suspended sediment load in the river. The Sacramento River, at least at the Woodson Bridge site, obviously didn't have a high enough suspended sediment load for them to function. So, if we are thinking about dikes, we probably need to be thinking about impermeable rock dikes as opposed to some of the alternatives. [Mike presented photos of dikes.] These are some examples of well designed and built dikes in Indonesia. In this example, there is a really high sediment load due to mining. As you can see, the sediment filled up the entire bank between the dikes. These dikes worked they way they were supposed to. A picture of one of three dikes on the Yuba River that have induced sedimentation in the areas between the dikes and created good vegetation growth was also shown. (River Mile 6).

Pictures of the recently built dikes in the Sacramento River at the GCID Pumping Facility were shown. The gradient restoration facility has been put in from the head of Montgomery Island and the dikes were emplaced to protect the left bank to prevent flanking of the structure. Three rock dikes were constructed that work pretty well. They are not massive dikes, they are small dikes but the point is they are hard points they weren't put in to try to change the alignment of the river, they were put in just to hold that bank.

A little farther down the river, river mile 186, a local landowner has created a dike field with concrete rubble. These are perpendicular dikes. They work pretty well, just piles of concrete rubble. The landowner also dumped rubble between the dikes. Unfortunately, he was not prepared for the on-going erosion that occurs below the dike.

Other dikes on the Santa Inez River. These dikes were used to train the flow into the river bridge. An example of other permeable dikes are jetty jacks in the Middle Rio Grande. You wouldn't want tubers coming down here. They work here because of the high suspended sediment load.

The Butte City site looking downstream at the bridge, abutments both rock and sheet piling. The problem here is bank stabilization. Some physically modeling was conducted. The idea here is to hold the bank not necessarily to shift the direction of the river.

Dike design is an art rather than a hard science. There are not many hard design data on dikes. Generally, the permeability for this project would probably be pretty low. If you are going to just hold the bank alignment, the length shouldn't be more than 15% of the channel. In our case, if we want to push the channel over, we violate that because it's now a training dike rather than a bank protection dike. Spacing between dikes can be anything from one to six times the length of the dike. We have chosen to use a spacing of three times the dike length.

Dikes don't' work very well on very tight bends because you have to put so many in that you might as well do a full bank revetment. So the site at river mile 193 opposite the M&T is actually a good site for dikes. It has a high radius of curvature and it would work well. The other factor is the angle of the dike to the flow? It goes roughly from 190 to 50 degrees. There is some evidence that if you are going to train the river, you better to have the upstream dikes having a higher angle and as you go farther downstream you bring the angle out closer to 90 degrees to the bank. The height of the dike – the rule of thumb, 1/3 to 2/3 of the bank height. So we are looking at about 20 feet. The area where the dikes are most susceptible to structural problems is in the root. You have to somehow tie into the bank. The rule of thumb for how far you have to get them in to the bank -- the bank height plus some estimate of local scour depth. These features need to be tied in, otherwise they flank. If they flank, you just have a nice pile of rocks sitting in the middle of the river accelerating the erosion behind them.

The other thing you have to think about in dike design is the local scour protection. What you are doing is putting a feature out in the river that can be inducing local scouring. You have to beef up the structure to give it enough rock to self launch into the scour hole to provide the necessary tow protection for the structure.

With this approach in mind, we did a very preliminary design for the bank upstream and across from the M&T Pumping Plan. The objective of the design was to hold the bank and to also force the river alignment to the east to essential increase the transport capacity to this area. We used eight dikes and we tried to get the upstream dike behind the base of the island. One of the issues with the dike field is that you must have a secure upstream foundation. If you loose the upstream dike, you are going to lose the others. The flow alignment in the M&T pumps reach is due to flow deflection to the west from the downstream end of the revetment along River Road upstream of Bidwell State Park.

Discussions were held about the configuration of the potential dikes and bank conditions.

Mike continued by explaining that the design resulted in eight dikes at an estimated rock cost of $30/ton. No environmental costs and no additional costs in terms of access. Site preparation or mobilization. But we ended up with a unit cost as the bottom line. Approximately $500 per lineal foot. A site length of about 2,500 feet. Based on past experience the cost should be pushed up an additional $500 a lineal foot. About $2.6 million. (Adding some environmental costs and mitigation.).

The cost was compared to a Cal Trans project consisting of four dikes that are not as long as this dike scenario – the costs were estimated at $3.4 to $3.9 million. But they put a sheet pile down the center of each dike.

The previous dike scenario is based on just the rock cost based on the rock volume. The numbers were taken from the GCID project and obviously include no environmental costs at all. Throw in another $500,000 to protect the bank.

If the design works, ideally if it will push the river over far enough yo increase the transport capacity enough to move the gravel bar on and out. That's the objective. Hold the bank and eliminate the gravel bar hopefully for good.

A question was raised about using riverbed material for the inner part of the dike and surfacing it with rock. Mike explained he had no personal experience with that approach, however, was aware that it had been done. Some participants were unsure about the long-term stability of this approach.

More discussions were held about dike construction.

The question was raised about the possibility of windrow revetments as a solution. The group agreed that this scenario would not accomplish the training requirement for the river. They all agreed that holding the current alignment of the river doesn't help the current situation. You have to get the river back over to the east and increase the energy where the bar is located.

The question was raised about the potential solution to build dikes and to also go upstream and move the road back to the more resistant geological formation that is located to the east of the present revetment along River Road. Would the combination provide a better solution?

The problem is how far the river goes back and what it does to the alignment. The upstream pressure would be off the dikes by doing that, however, it would be forcing the river to be basically straight, and this state would likely change with time.

Mike suggested that the upstream revetment point was not really the issue. It's not just the point it's the whole general alignment. Eric's model shows that there is an inflexion at that point.

The point was raised that the land along the river purchased by U.S. Fish & Wildlife Service (USFWS) with CALFED funding would be managed according to the record of decision.

The question was raised that if something wasn't done with preventing erosion along the right bank on the USFWS property, that maybe an on-going problem exists regarding long-term dredging or finding another alternative. As long as the river is dynamic this problem only gets worse.

The point was made that there are many advantages to keeping the pumping plant in the same location, at least by removing water with adequate fish screens. The present location supports Butte Creek flows and the Llano Seco refuges, all relying on one point of diversion in the river. It was recommended that the group look at a total evaluation of all the potential impacts before making any radical changes.

The current location of the river is on the eastern margin of its Holocene meander belt (last 10,000 years) and that the probability is that with time it will move away from the M&T site. Where the river will move can be suggested by the Larsen modeling. There is not, however, a reliable estimate of actual rates of movement because rates are based on flood events. If the hydrology can be predicted, there is a much better chance. The best thing that can be predicted is to say that what has happened in the past is likely to happen again.

In terms of the sediment transport, the best numbers we've got plus or minus would suggest that on an average annual basis might have 40,000 to 50,000 tons. Which suggests again that on an average annual basis that we could replace the dredged volume within 4 to 5 years Keeping in mind if we have a dry sequence, it could last a lot longer if we have a wet sequence of events it could be replaced within a single year.

Much discussion was held regarding the potential movement of the mouth of Big Chico Creek and the continual movement of the gravel bar.

The following technical white papers where presented to the group by members of the Steering Committee. The Steering Committee members reviewed the contents of the papers and answered questions from the other members of the Steering Committee. The following technical reports are provided as attachments to the minutes:

Technical Memorandum
Introduction: Neil Schild, MWH Americans

Scenario #1 – Installation of Additional "Tee: Fish Screen approximately 500 ft West of the Existing Diversion
Neil Schild, MWH Americans

Scenario #2 – Groundwater Extracted from Production Wells
John Skowronek, Sr. Engineer, MWH Americas

Scenario #3 – Groundwater Extracted from Ranney Wells
Neil Schild, MWH Americas

Note: The suggestion was made to call Ranney Wells and consult with their representatives to help better understand how Ranney well may be adaptable to the M&T project.

Discussions were held with representatives from Carollo Engineers concerning potential alternatives that would benefit the City of Chico diffusers.

Scenario #4 Installation of Rock Groins Similar to the Cal-Trans Project at Butte City.
Michael Harvey, Principal Geomorphologist, Mussetter Engineering, Inc.

Lunch

Discussions were held with a Ranney representative by telephone about the characteristics and efficiencies of this technique to extract water in similar situations. Ranney agreed to work with the project to determine the levels of draw if the project would drill some test wells and monitoring wells. It was suggested that some of the project team go to Sonoma to evaluate an installed Ranney collector. More discussions were held about potential design, volume, construction, length and placement of laterals, permitting, impacts to water rights, increased costs of pumping water and determination of permeability.

The meeting continued with the following agenda items:

Fish Screen Criteria – Standards and Range of Flexibility
Paul Ward, Assoc. Fishery Biologist, Region 2, Calif. Dept. of Fish & Game
Dennis Dorratcauge, Principal Engineer, MWH Americas

The meeting continued with more discussions about potential placement of Ranney wells.

Test the Technical Review with the Hypothesis and Conceptual Model.

Olen continued the meeting with discussions about the conceptual model.

Olen asked the group if more data or information was necessary to understand sediment deposition. The question was raised about modeling a scenario concerning the set back of River Road. Other scenarios were also discussed and the challenges and uncertainties associated with putting rock along the river.

Questions were raised about maintaining or changing the existing alignment of river to protect the pumping plant.

Questions were also raised about changing fish screen criteria to accommodate a backwater facility.

Questions were raised about the uncertainties regarding predicted sediment deposition.

It was suggested that there is not enough information concerning the predictions of downstream changes resulting from dikes or rock groins. Olen confirmed that the committee agreed to model the dike alternative.

The committee agreed that there is sufficient information regarding fish screens and fish screen criteria

It was agreed that the committee should request an amendment to the project to conduct further modeling, data gathering and studies.

Mike Harvey suggested that the Reclamation Board be involved in the project to ensure that upstream modifications will be acceptable to downstream revetments. It was agreed that one of the information gaps inlcuded mitigation opportunities.

The following list of alternatives were evaluated by the committee regarding uncertainties / risks, fatal flaws and meeting criteria for fish screens, meander and capacity.

Collector Basin (Infiltration Gallery)

Meets fish screen criteria – yes
Compatible with meander – yes
Provides pumping capacity – needs more information, i.e., TEST WELL.
Low Cost – initial construction.
Compatible with present facility.
Minimal environmental impact.
Uncertainties:

- Permeability of gravels.
- Impact on draw downs.
- Estimated size of basin.

- Site selection.
- River movement.
- Economics
- Groundwater impacts.

Flaws:

- Large area required.
- Public safety.
- Liability – levee breach.
- Reclamation Board support.
- Impacts from river meander.
- Maintenance – siltation (no back-flush ability).

Extended Intake – Down the River

Meets fish screen criteria – yes
Compatible with meander – yes
Provides pumping capacity – maybe
Compatible with outfall.
Uncertainties:

- River meander – will it have to be moved.
- City of Chico selection of alternatives.
- Head loss / affects on pump state.

Flaws

- Project life.

Extended Intake – Across the River

Meets fish screen criteria – yes
Compatible with meander – yes
Provides pumping capacity – maybe
Maintains facility.
Uncertainties:

- Flood flows at the new location.
- Air burst.
- Scour depth.
- River meander.

Flaws

- River shift.
- Accessibility.

In-Conduit fish Screen

Meets fish screen criteria – yes
Compatible with meander – yes
Provides pumping capacity – yes
Maintains existing facility.
Pumping costs remain the same.
Known technology.
Uncertainties:

- Pipe extensions – cost/permitting/long-term maintenance.
- Capacity variables.
- Pumping costs.
- Acceptable state technology.

Flaws

- Bypass pipe / predation.
- Intake – chase meander.

Dredging / Stillwater Screen

Meets fish screen criteria – yes
Compatible with meander – yes
Provides pumping capacity – yes
Maintains existing pumping plant.
Low initial cost (new screens).
Uncertainties:
- How much dredging to maintain capacity.
- Dredging costs.
- Where do the spoils get deposited.
- Screen costs (flat plate?)

Flaws
- Annual dredging.
- Permit process.
- Dredging when endangered species are present.
- Other ownership issues – state parks.
- As river moves west, channel would need to increase in width and length.

Groins

Meets fish screen criteria – yes
Compatible with meander – no
Provides pumping capacity – yes
Protects outfall.
Maintains current operations.
Improves current situation.
Reasonable confidence in utility..
Uncertainties:
- Off-site impacts.
- Mitigation costs.
- Mitigation possibilities (trading).
- Authorities / maintenance.
- Cost.
- Short-term dredging costs.

Flaws
- Public safety.
- Environmental impact to river meander.
- Institution constraints.

Multiple Production Wells

Meets fish screen criteria – yes
Compatible with meander – yes
Provides pumping capacity – yes
Out of the river.
Minimal environmental impact.
Spread drought risks.
Uncertainties:
- Power.
- Distribution system.

- Groundwater
- Farmland impacts.
- Water rights / legal issues.

Flaws

- Required area.
- Higher maintenance costs.

Ranney Collectors

Meets fish screen criteria – yes
Compatible with meander – yes
Provides pumping capacity – yes
Minimal environmental impacts.
No loss of farmland.
Possible use of existing large pumps.
Out of the river.
Uncertainties:

- Permeability of gravels.
- Cost for pumping and long-term maintenance.
- Impacts – river meander.
- Capacity / cost.
- Life cycle costs.
- Water rights.

Flaws

- Additional pumping expense.
- Highest cost idea.

Combination of one Ranney Collector / Dredging

Supplemental supply
Two systems to ensure capacity.

Other alternatives briefly discussed:

- Alternative Water Source – Western Canal
- Collection Pond – Ranney Collector
- Additional Butte Creek water
- Dredging Fish-Friendly Pumps
- Redistribution – Scattered Production Wells / Ranney Collectors.

The group ended their discussions and agreed to summarize the discussions the following day.

Meeting was adjourned.

Friday
March 19, 2004

Howard Brown, Fishery Biologist, National Oceanic & Atmospheric Agency
Yantao Cui, Research Scientist, Hydrology/Geomorphology
Woody Elliott, District Resource Ecologist, California Dept. of Parks & Recreation, No. Buttes District
Jim Gaumer, Consultant Engineer, M&T Chico Ranch
Michael Harvey, Principal Geomorphologist, Mussetter Engineering, Inc.
Les Heringer, Manager, M&T Chico Ranch
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Paul Ward, Association Fishery Biologist, Region 2, California Department of Fish and Game
Olen Zirkle, Manager, Conservation Programs, Ducks Unlimited, Inc.

Introductions

Prioritize Major Findings and Recommendations

Olen began the meeting by summarizing that there seemed to be two categories of unknowns – outside the levee and inside the levee. Appropriate alternatives cannot be properly evaluated without having more data specified to the project site for each alternative.

The group had lengthy discussions about common information gaps associated with alternative approaches inside and outside the levee. The following is a list of unknowns / uncertainties:

Outside the Levee

- Permeability of gravels
- Impact on draw down
- Estimated size of basin
- Site selection
- River movement
- Economics
- Legal issues
- City of Chico Alternatives
- Additional pumping costs
- Canal (capacity) losses due to infiltration

Inside the Levee

- Level of dredging
- Costs of screens
- Forecast costs of dredging
- Spoils
- Flood flows
- Source depth
- Meander
- Model dikes (2-D)
- City of Chico alternatives
- Head loss
- Off-site impacts
- Mitigation costs/possibilities
- Authorities responsible for maintenance
- Construction costs / permits
- Short-term dredging costs
- Protect outfall (2-D model)
- ESA impacts to species / habitat (permits)
- Pipe extensions / costs / permits
- Long-term maintanance
- Capacity variables

- Pumping costs
- No acceptable technology to state
- Power costs (pumping)
- Distribution system
- Groundwater
- Impacts to farmland
- Water rights / legal issues

Olen summarized the discussions. The group agreed to conduct the following further studies to determine appropriate alternatives:

1. Test Well / Monitoring Well
    - Permeability of gravels
    - Impacts on draw down

2. Modeling River
    - Reach model (Larson Model)
    - Local model (2-D Model)
    -
3. Engineering / Legal / Permitting

Next Steps

The group agreed that Olen will develop a Scope of Work that will be presented to the CALFED Amendments Committee to advance the investigation for appropriate alternatives.

Meeting was adjourned.