

# Federally Mandated Independent Fish Passage Review Panel

### An Illustrative Case Study



# **Case Study Outline**

- Goal: Present a Case Study of the Freeman Dam Fish Passage Conceptual Design Study

   Observations on Process and Results
- Outline
  - History of Diversion
  - 2008 Freeman Biological Opinion
  - Independent Fish Passage Panel
  - Study Plan
  - Fish Passage Alternatives Analysis
  - Results



### **Freeman Diversion History**

- Water has been diverted from the Santa Clara River since the late 1800s for irrigation and since the 1930s for groundwater recharge.
- Until 1991 the diversion was constructed of river material and would be compromised during large storm events.
- A concrete diversion structure was constructed in 1991.



Construction of the earth berm in the Santa Clara River prior to the present Freeman Diversion. The berm would be rebuilt when river flows dropped below 2,000 CFS.



## **Objectives for Permanent Diversion**

• Channel bed downcutting from historic gravel mining resulted in a need for grade control at diversion headworks.



Headworks moved upstream to address downcutting.

- Create permanent diversion that would not be compromised during storm events.
- Provide fish passage over structure.



### Permitting and Design of Current Passage Facility

- Approximately two decades to plan, permit and finance entire project.
- Fish passage required by project permits.
- No federally listed fish species at time of project design and construction.
- Fish passage alternatives reviewed.
- Denil fishway chosen based on costs and other factors.
- The USBR funds the project. Loan paid off in 2011.







REPORT ON PROPOSED FREEMAN DIVERSION IMPROVEMENT PROJECT PUBLIC LAW 84-984 OCTOBER 1983

PREPARED BY PRICE ENGINEERING COMPANY - WATER ENGINEERING CONSULTANTS



### Southern CA Steelhead ESA Listing and Consultation

- Southern California steelhead were federally listed as endangered in 1997.
- United Water Conservation District via the USBR enters into Section 7 consultation with the NMFS.
- Jeopardy Biological Opinion completed in 2008.
- Reasonable and Prudent Alternative (RPA) included requirement for a fish passage panel to be convened.
- The Biological Opinion was made non-binding when the Bureau of Reclamation separated from the project in 2008.
- United Water Conservation District continued with development and implementation of fish passage panel.





### **BiOP – Fish Panel Requirement**

- Terry Roelofs, Ph.D (facilitator)
- Facilitator to convene a panel of qualified fish-passage engineers, hydrologists, and fish biologists. RPA Required agency approval of candidates.
- At least one NMFS fish-passage specialist will be on the panel.
- The panel and facilitator shall function independently and perform science based analyses as necessary to identify the specific physical modification(s) of the Freeman Diversion Dam (including the fish ladder) that are necessary to attain the fish-passage objective as defined in this RPA.

#### **Panel Members**

- **Terry Rolelofs**, Ph.D., emeritus Professor of Fisheries Biology, Humboldt State University
- Kozmo Ken Bates, P.E. Kozmo, Inc.
- Dennis Dorratcague, P.E., MWH
- Jon Mann, P.E., HDR (now CDFW)
- Dana Postlewait, P.E., R2 Resource Consultants, Inc.
- Steve Thomas, P.E., NMFS
- **Bill Trush**, Ph.D., Biological Consultant, McBain and Trush (now Humboldt State University River Institute)





### **Fish Panel Technical Tasks**

- Conceptual Alternatives Study The panel shall conduct a formal conceptual alternative study for two purposes: (1) identification of interim physical modifications and (2) identification of long-term physical modifications.
- **Feasibility Study**—Once the conceptual alternatives study is complete, the panel will undertake a feasibility study.
- **Preliminary Design Development**—a preliminary design for a fish-passage facility (or interim modifications) must be developed in an interactive process with NMFS' Southwest Region engineering and biological staff.
- **Detailed Design Phase**—Using elements of the preliminary design, the panel shall proceed to a detailed design phase and prepare the final design and specifications package suitable for a bid-solicitation process.
- Implementation—The Bureau and United shall implement the final design developed by the panel and with written agreement from NMFS' Southwest Regional Office.
- Monitoring and Maintenance



## **Process Observations**

- Specific and reasonable approach/scope.
  - Typical of other fish passage design studies through implementation.
- Panel selection was interesting, took some time.
  - Facilitator worked with industry to identify potential candidates.
  - Nominees submitted professional resumes which were reviewed and had to be accepted by all parties.
  - Work started after panel was in place.
- Panel Independence
  - Coordinated with all parties, but worked and reached conclusions independently.
  - Logistics of schedules a bit of a challenge, but group worked well together.
  - Used transparent tools for all decisions, Pugh Matrix



## **Alternatives Analysis Study**





# **Alternatives Analysis Study**

- Made a Plan
  - Tasks, Deliverables
  - Schedule

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				Ver	n Freeman Dam Fish Passage Assessment Study	7.2	Crown Mostin
D	Task Name	Duration	Start	Finish		1.5	Group Meetin
1	Panel Finalize Scope and Schedule	20 days	Mon 4/20/09	Fri 5/15/09		7.4	
2	Submit Draft Scope to UW	0 days	Fri 5/15/09	Fri 5/15/09	€115	/.4	Group Meetin
3	Scope Review and Budget Authorization	15 wks	Mon 5/18/09	Fri 8/28/09			
4	Revise Scope & Schedule	2 wks	Mon 8/31/09	Fri 9/11/09		6.2	L Alternative E
5	Study Start Date	0 days	Fri 9/11/09	Fri 9/11/09	<b>●</b> <sup>1</sup> <sup>1</sup>	0.2	1 Heeffidative E
6	Task 1 - Compile Background Info	50 days	Mon 8/31/09	Fri 11/6/09		75	Group Meetin
7	Compile and Prepare Workshop Info	4 wks	Mon 9/14/09	Fri 10/9/09		1.5	Oloup Meetin
8	Recommend any additonal interim measures	1.5 wks	Mon 8/31/09	Wed 9/9/09		7.0	
9	Panel members review information	1 wk	Mon 10/12/09	Fri 10/16/09		0. /	Final Group r
10	Conference call	1 wk	Mon 10/19/09	Fri 10/23/09			<b>1</b>
11	Fill in any missing data	1 wk	Mon 10/26/09	Fri 10/30/09	L L		
12	Panel members prepare for meeting	1 wk	Mon 11/2/09	Fri 11/6/09	Line and Lin		
13	Task 2 - Risk Assessment	238 days	Wed 9/2/09	Fri 7/30/10			
14	Sample Calculation	19 days	Wed 9/2/09	Mon 9/28/09			
15	Develop study plan w/ Agency Input	12 wks	Tue 9/29/09	Mon 12/21/09		1	_
16	Develop hydrographs	13 wks	Tue 12/22/09	Mon 3/22/10			<b>L</b>
17	Develop interim data for Panel use	2 wks	Tue 3/23/10	Mon 4/5/10			<b></b>
18	Interim results to Panel	0 days	Mon 4/5/10	Mon 4/5/10			€14/5
19	Estimate green line days	12 wks	Tue 4/6/10	Mon 6/28/10			<u></u>
20	Develop ascendograph analysis	24 days	Tue 6/29/10	Fn 7/30/10			
21	Draft report	0 days	Fri 7/30/10	Fri 7/30/10			7/3
22	Task 3 - Concept ID, Brainstorm Workshop	9 days	Mon 11/9/09	Thu 11/19/09			
23	Oreners and diskilude meeting notes	1 WK	Mon 11/9/09	Thu 11/13/09	Line Line Line Line Line Line Line Line		
24	Task 4 - Concept Development	4 days	Mon 11/16/09	Eri 1/29/10			
20	Develop individual consects	B uses	Mon 11/16/09	Eri 1/8/10			
20	Assemble and distribute desument	o wks	Mag 4/44/40	Fr 4/45/40		<b>_</b>	
20	Panel members review and pren for min	2 496	Mon 1/19/10	En 1/29/10		<b>4</b>	
20	Task 5 - Concent Refinement Workshop	60 days	Mon 2/1/10	Eri 4/23/10			
30	Window for 1-day workshop	1 wk	Mon 2/1/10	Eri 2/5/10			
31	Prepare and distribute meeting notes	1 wk	Mon 2/8/10	Fri 2/12/10		<b>k</b>	
32	Finalize concepts	10 wks	Mon 2/15/10	Fri 4/23/10			
33	Task 6 - Report	64 days	Mon 4/26/10	Thu 7/22/10			
34	Conduct final evaluation of alternatives	2 wks	Mon 4/26/10	Fri 5/7/10			¥ ¥
35	Alternative Evaluation Meeting	1 wk	Mon 5/10/10	Fri 5/14/10			
36	Panel edits to the alternatives	2 wks	Mon 5/17/10	Fri 5/28/10			1 <b>1</b>
37	Prepare & distribute draft report within Panel	4 wks	Mon 5/31/10	Fri 6/25/10			
38	Passage Group Review draft	2 wks	Mon 6/28/10	Fri 7/9/10			
39	Finalize report	9 days	Mon 7/12/10	Thu 7/22/10			
40	Task 7 - Passage Group Meetings	243 days	Wed 8/26/09	Fri 7/30/10			
41	Kick off Meeting	1 day	Wed 8/26/09	Wed 8/26/09			
42	Group Meeting #1: Brainstorming Workshop	1 day	Mon 11/16/09	Mon 11/16/09	· · · · · · · · · · · · · · · · · · ·		
43	Group Meeting #2: Concept Refinement	1 day	Mon 2/8/10	Mon 2/8/10		+ t	
44	Group Meeting #3: Final Concepts	1 day	Mon 4/26/10	Mon 4/26/10			<b>†</b>
45	Group Meeting #4	1 day	Mon 5/17/10	Mon 5/17/10			· †
46	Final Group Meeting	1 day	Fri 7/30/10	Fri 7/30/10			7/30
	Taet		Prograes		Summany External Tasks		
Project: Date: T	Freeman Dam V5 kkm edits		Milostor		Droject Summany External Milectone	aume 🗸	
	Jule		Milestone	•	Project Summary		
1					Page 1		

able I	Meeting Schedule	
Fask	Meeting	Date
7.1	Group Kickoff Meeting	August 26, 2009
3.1	Workshop No. 1	Nov 9 to 13, 2009
7.2	Group Meeting #1	Nov 16, 2009
5.1	Workshop #2	Feb 1 to 5, 2010
7.3	Group Meeting #2	Feb 8, 2010
7.4	Group Meeting #3	April 26, 2010
6.2	Alternative Evaluation Meeting	May 10 to 14, 2010
7.5	Group Meeting #4	May 17, 2010
7.6	Final Group Meeting	July 30, 2010

- Worked the Plan
  - Meetings, Agendas
  - Meeting Notes
  - Correspondence
  - Reports
    - Draft, Final
- Began Fall, 2008
- Finished Dec, 2010



# **Collection of Existing Information**



**Background Information for the** 

#### Freeman Diversion Fish Passage Review Panel

VOLUME 1 REPORT

Under preparation by United Water Conservation District

#### PARTIAL VERY ROUGH DRAFT

For submittal to the fish passage review panel In preparation for its first meeting

May 31, 2012

Unitedwater.org (805) 525-4431

- United was Very Helpful
  - Compiled background information document
  - Site tour for Panel
  - Photos, videos
  - Data, reports
  - Drawings
  - Operations
  - Available to assist throughout process



# **Collection of Existing Information**

- Existing fish passage facility
- Diversion operations
- Hydrology
- Hydraulic information
- Steelhead and Pacific Lamprey information



# **Collection of Existing Information**

#### Table of Contents Needs to be updated...

Section 1 Background and information

- 1.1 Need for a fish passage review panel
- 1.2 Purpose of this document
- 1.3 Primary tasks of the fish passage review panel
- 1.4 Relationship to ESA jeopardy analysis
- 1.5 Major issue can fish find the fish ladder?
- 1.6 Summary of section 7 consultation
- 1.7 Habitat Conservation Plan
- 1.8 The Watershed in a nutshell
- 1.9 Current steelhead population in southern California

Section 2 Freeman diversion and fish passage facilities

- 2.1 Historical diversions
- 2.2 Brief History of the Freeman Fish Passage Facilities
- 2.3 Freeman diversion facilities
- 2.4 Fish Passage Facilities
- 2.5 Principal dimensions of the facilities
- 2.6 Crest Flow Rating Curves
- 2.7 Ground elevation data
- 2.8 Upstream facilities to be protected

Section 3 Operating the diversion and fish passage facilities

- 3.1 Procedures for diverting water at the Freeman diversion
- 3.2 Flushing channel operations during storms
- 3.3 Routine Flushing Program
- 3.4 Flushing the Freeman Canal
- 3.5 Fish ladder operating criteria as agreed by United and NMFS
- 3.6 Additional criteria imposed in the BiOp
- 3.7 Interim Fish Ladder Operating Criteria
- 3.8 Early problems with fish ladder plugging
- 3.9 Preliminary assessment of the performance the fish screen

- Process for data gaps
  - Panel identified gaps
  - Panel prioritized information needs
  - Collaborative for entire process with all parties
  - Decision tools took into account any data gaps, and noted assumptions



# **Design Standard**

- 1. Design flow range of 45 to at least 6,000 cfs in the river.
- 2. Maximize attraction of fish to the fishway over the flow range.
- 3. Provide good fish access out of the fishway to the river upstream. Minimize fallback.
- 4. Maximize expeditious movement of steelhead through the fishway.
- 5. Minimize injury risk to juvenile steelhead moving downstream.
- 6. Minimize risk of sediment impairing fishway function.
- 7. Minimize fishway operation complexities.
- 8. Fishway must be durable, limiting down time due to component failure and maintenance.



### Migration Delay and Spawning Risk Assessment

 Goal - to recommend a range of migration streamflows at the diversion needed by adult steelhead to pass the diversion and spawn successfully in the Santa Clara River Basin.

#### **Assumptions and Data**

- Migration rates
- Barriers and delay locations
- Delay, wait criteria
- Spawning destinations chosen
- Incubation and emergence rates
- Green line can be different every year
- A single spawning destination was used (Howard Creek, upper Sespe)
- December 15 through April 30, assumed migration window for assessment





# Fish Passage Design Flows

#### Table 4.2-1. Ranges of flows evaluated.

Flow Range Descriptions	Flows	Weighting Factor
Low flow range	$40 - 500  \mathrm{cfs}$	10
Mid-low flow range	500 - 2,000  cfs	10
Mid-high flow range	2,000 - 6,000  cfs	6
High flow range	Over 6,000 cfs	2

- Attraction flow
- Design flow range
- High fish passage design flow
  - The 5% mean daily exceedance flow (~5,000 cfs) Jan-May
- Low fish passage design flow
  - The 95% mean daily exceedance flow (50 cfs) Jan-May



### **Development of Fish Passage Alternatives**

- Initial two-day brainstorming workshop
  - Develop criteria
  - Revisit design goals
  - Brainstorm alternatives
  - Develop short list
  - Document dropped alternatives
  - Divide up alternatives for further development
  - Next steps



### **Development of Fish Passage Alternatives**

#### **Initial Design Alternatives**

- Alternative 1: Dam removal and pipeline from Lake Piru
- Alternative 2: Replace diversion structure with a new, inflatable dam near Hwy 101
- Alternative 3: Left bank vertical slot fish ladder around diversion with notch in dam
- Alternative 4: Full depth notch in dam with new technical fishway
- Alternative 5: Full active channel width rock ramp with dam crest modifications
- Alternative 6: Partial width rock ramp with dam crest modifications
- Alternative 7: Left bank vertical slot fish ladder in expanded footprint of existing fish ladder
- Alternative 8: Left bank nature-like fishway
- Alternative 9: Trap and haul
- Alternative 10: Improve the existing fishway



# **Initial Dropped Concepts**

### • Documented in Final Report, Goal was Transparency

VFDD Fish Passage Group

VFDD Fish Passage Conceptual Design Report

#### **5.2 DOCUMENTATION OF DROPPED CONCEPTS**

In addition to the ten alternatives described above, an additional 13 initial concepts were initially considered by the Panel but were rejected. They, together with the four alternatives described above that were dropped in the second round of consideration, are listed in Table 5.2-1. If the faults of any of these are overcome, they could be pursued.

Table 5.2-1. Initial concepts that were dropped.

Alternative	Description	<b>Reasons for Dropping</b>
<b>Dam removal</b> with pump intake on river	New screened pumping plant, and in-river constriction point to create pump forebay.	Sediment issues, ability to maintain pump sump is questionable
Though dam removal was not developed in detail, some sort of the dam removal alternative should be considered as a long- term goal. See the description		



### **Development of Fish Passage Alternatives**

#### **Initial Design Alternatives**

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## Selected Fish Passage Alternatives

- Alt 1 Dam Removal
  - (Not developed by Panel, but used for performance Comparison, can't do any better for fish passage)
- Alt 3 New Vertical Slot Fishway
- Alt 6A Partial Width Rock Ramp at 4% slope
- Alt 6B Hardened Ramp at 6% slope
- Alt 8 Nature-Like Fishway on Left Bank.



# **Alternative Development**

- Selected alternative were developed further:
  - Description
    - Functional level design drawings
    - Supporting text and photos
  - Operations and Maintenance Turnouts
  - Construction considerations
  - Opinion of probable construction cost
  - Evaluation
    - Strengths
    - Weaknesses
  - Next Steps to Advance



# Alt 6B – 6% Hardened Ramp



Sample Photo

Figure 6.4-1. Model of a hardened ramp constructed for hydraulic testing at U.S. Bureau of Reclamation's Technical Service Center. Photo: USBR-TSC.



# Alt 6B – 6% Hardened Ramp





## Alt 6B 6% Hardened Ramp Plan





## Hardened Ramp

### Profile





## Alt 6B 6% Hardened Ramp





## **Alternative Development**

- Helped Panel understand each
  - Strove for uniform understanding prior to evaluation
  - Iterative process, good back-and-forth discussions
  - Challenged ourselves to make each alternative so it would function the best



# **Comparison of Alternatives**

- Pugh comparison matrix
   Used to discuss and optimize designs
- Summary table of key attributes of each alternative



### **Evaluation and Comparison of Alternatives**

- Alternatives were evaluated and compared by estimating how each of 19 desirable characteristics would be achieved by each alternative.
- The 19 characteristics were considered in the development and evaluation of each alternative and then were used to compare each of the alternatives against the others.
- Of the 19 characteristics:
  - 9 were fish passage characteristics,
  - 6 were operations and maintenance characteristics,
  - 4 were characterized as others.



# **Nine Fish Passage Characteristics**

- Attraction of Adult Fish to Fishway High Flows (>6,000cfs)
- Attraction of Adult Fish to Fishway Mid-High Flows (2,000 to 6,000cfs)
- Attraction of Adult Fish to Fishway Mid-Low Flows (500 to 2,000cfs)
- Attraction of Adult Fish to Fishway Low Flows (40 to 500cfs)
- Fish Access Out of Fishway
- Passage of Adult Steelhead and Lamprey through Fishway
- Attraction and Passage of Non-target Species
- Safety of Juvenile Fish
- Potential for Fish Passage Evaluation or Biological Monitoring



### Percentage of Downstream Flow that is Effective Fishway Attraction





### Six Operations and Maintenance Characteristics

- Simplicity of Fish Passage Operations
- Sediment and Bed Load Management
- Debris Management
- Certainty of Diversion
- Simplicity of Operation
- Durability of Structure



# **Other Characteristics**

- Minimize Geomorphic Impacts
- Public Safety
- Aesthetics, Education
- Permitting



### **Evaluation and Comparison of Alternatives**

#### **Comparison Matrix With Each Characteristic**

Characteristic		Existing Fishway		Vertical Slot Ladder		Nature-Like Fishway		4% Rock Ramp		6% Hardened Ramp		Dam Removal		ard
		Score 0-10	Product	Score 0-10	Product	Score 0-10	Product	Score 0-10	Product	Score 0-10	Product	Score 0-10	Product	Stand
Fish passage	- 241	10 10 10 10												
Fish attraction at high flow (above 6.000 cfs)	2	02	0	3.0	6	34	7	52	10	6.2	12	10.0	20	3.0
Fish attraction at mid-high flow (2.000 to 6.000 cfs)	6	0.4	2	4.6	28	4.4	26	8.0	48	8.2	49	10.0	60	12.5
Fish attraction at mid-low flow (500 to 2.000 cfs)	10	2.4	24	6.0	60	6.0	60	8.6	86	8.8	88	10.0	100	15.6
Fish attraction at low flow (40 to 500 cfs)	10	5.2	52	8.6	86	8.6	86	9.2	92	9.2	92	10.0	100	3.5
Fish access out of fishway	6	3.0	18	6.4	38	6.4	38	6.8	41	6.8	41	10.0	60	1.4
Passage of steelhead, lamprey through Fishway	10	3.6	36	8.8	88	8.2	82	7.8	78	7.0	70	10.0	100	1.5
Attraction and Passage of Non-Target Species	3	2.0	6	4.8	14	5.4	16	6.0	18	4.2	13	10.0	30	2.3
Safety of juvenile fish	8	4.8	38	7.8	62	7.6	61	6.0	48	6.4	51	10.0	80	7.1
Potential for Biological Monitoring	2	7.0	14	9.8	20	9.4	19	0.8	2	0.8	2	0.0	0	10.2
Operation and maintenance														
Simplicity of fish passage operations	5	5.8	29	6.4	32	6.0	30	5.0	25	7.2	36	10.0	50	4.6
Sediment and Bedload Management	6	5.0	30	5.8	35	4.8	29	8.2	49	8.4	50	9.6	58	10.7
Debris management	5	1.6	38	6.4	32	1.2	36	7.8	39	7.8	39	10.0	50	3.3
Certainty of diversion	10	7.6	76	7.8	/8	7.8	/8	8.4	84	8.4	84	6.8	68	3.5
Simplicity and ease of diversion	4	6.4	26	6.6	26	6.4	26	1.4	30	7.6	30	4.2	1/	2.4
Durability of Structure 8		9.4	15	8.2	66	1.2	58	4.8	38	7.0	56	10.0	80	11.5
Other		- in	1								-			
Minimize geomorphic impacts	5	8.0	40	8.0	40	8.8	44	7.2	36	7.2	36	0.0	0	3.8
Public safety	0	8.2	0	7.6	0	7.8	0	5.0	0	4.2	0	10.0	0	0.0
Aesthetics, Education	0	8.0	0	6.8	0	8.2	0	4.4	0	4.6	0	10.0	0	0.0
Permitting	0	10.0	0	8.6	0	8.6	0	7.2	0	7.0	0	5.0	0	0.0
Cost														
Construction		0 0		10 3		3					4	0 0		
Operation and maintenance		0 10		· · · ·		6 S	2		3					
Certainty of cost				16								2	1	
Total Score Normalized to 100			58		82		80		83		86		100	1
Fish Passage Only Normalized to 100			35		73	200 12	72		77		76		100	



## **Normalized Comparison Matrix**





## **Conclusions and Recommendations**

### Technical Items

- The four alternatives scored within 6% of each other, and, at this level of detail and precision, they should be considered to have equal scores.
- The Panel recommended that additional work be focused on the development of the Vertical Slot Fishway and the Hardened Ramp alternatives.
- To better differentiate the alternatives would require further study and gathering more field data.



### **Compare/Contrast**

### Strengths & Weaknesses of two Recommended Alternatives

	Vertical Slot	6% Hard Ramp
Attraction flow	-	+
Passage at low river flow	+	-
Maintenance access	+	-
Ease of operation	0	+
Proven technology	+	-
Multiple fish passageways	-	+
Ease of construction	+	-
Fish passage monitoring	+	-

- + : Strength
  - : Weakness
- 0 : Not identified as either



## **Process Observations**

- Process worked
- Takes time, but study plan was effective
- Panel functioned well
- All parties participated at a high level
  - Good communication
  - Good exchange of information



## Thank You

### **Contact Information**

• Steve Howard

Sr. Fisheries Biologist 2456 Lexington Drive Ventura, CA 93003 (805) 320-5472 showard@r2usa.com

### • Dana Postlewait, P.E.

Vice President, Sr. Civil/Fisheries Engineer 15250 NE 95<sup>th</sup> St Redmond, WA 98052 (425) 556-1288 dpostlewait@r2usa.com

