Appendix J
Red Bluff Diversion Dam
Fishway Attraction Study
Spillway Operation Test

United States Department of the Interior

BUREAU OF RECLAMATION
Northern California Area Office
16349 Shasta Dam Boulevard
Shasta Lake, California 96019-8400

IN REPLY REFER TO:

APR 16 2002

NC-350
ENV-4.10/PRJ-8.10

To: Technical Advisory Group - Red Bluff Fish Passage Improvement Project

From: Max J. Stodolski
Chief, Red Bluff Division

Subject: Final Reports for the Fishway Attraction Study

Two reports, developed by Reclamation in conjunction with the Red Bluff Fish Passage Improvement Project, are attached for your information and use. Both reports provide the results of a study, conducted in August 2001, to evaluate the effects of mid-river dominated flows at the Red Bluff Diversion Dam (RBDD). The study objective was to determine if such flows would improve Chinook salmon attraction to the left and right abutment fish ladders. During the study the U.S. Fish and Wildlife Service, and the California Department of Fish and Game, evaluated the effects of these flows on fish passage. Hydraulic conditions, erosion, and the sedimentation associated with the mid-river flows, were evaluated by Reclamation, and are the topics of the enclosed reports.

The "*Red Bluff Diversion Dam, Fishway Attraction Study, Spillway Operation Test*" report summarizes the results of field tests conducted to evaluate hydraulic conditions resulting from the mid-river dominated flows. The "*Underwater Inspection of Red Bluff Diversion Dam, Fishway Attraction Study*" report summarizes the findings of a Reclamation dive team's inspection of erosion and sediment deposition in the stilling basin and river bed resulting from the mid-river flows.

If there are any questions or for clarification regarding the findings of these reports, please direct them either to me, at 530-529-3890, or to Ms. Sandy Borthwick, Red Bluff Division's Fishery Biologist, at 530-528-0512; TDD 530-275-8991.

Attachments - 2

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UNDERWATER INSPECTION OF RED BLUFF DIVERSION DAM

FISHWAY ATTRACTION STUDY

AUGUST 13 THROUGH 17, 2001

U.S. DEPARTMENT OF THE INTERIOR
BUREAU OF RECLAMATION
BUREAU OF RECLAMATION

U.S. BUREAU OF RECLAMATION
LOWER COLORADO REGION DIVE TEAM
DECEMBER 2001

September 16, 2001(Rev 11/01)

To: Max J. Stodolski, Chief, Red Bluff Division

From: Joel Sturm and Rodney Tang

Subject: **UNDERWATER INSPECTION OF RED BLUFF DIVERSION DAM STILLING BASIN -- AUGUST 13 THROUGH 17, 2001 FISHWAY ATTRACTION STUDY**

INTRODUCTION

The subject underwater inspection was conducted by members of the Lower Colorado Regional Dive Team as part of an ongoing effort to improve the attraction of spawning salmon to the right and left abutment fish ladders. All diving took place during a week-long test to observe three different gate configurations and their effects on fish attraction to the ladders and erosion and sediment deposition in the stilling basin and river bed. The asymmetric gate opening configurations (middle gates significantly more open than the outer gates) were intended to produce mid-river dominated releases (high flows in the mid channel and low flows near the channel edges) that would push fish toward the two abutments where they would encounter attraction flows from the fish ladders. Three separate gate configuration tests (Tests 1, 2 and 3) were conducted. Spillway releases for each test lasted approximately 20 hours. The Fishway Attraction Study and proposed testing are described in a letter from Max J. Stodolski to Rebecca Lent, PhD, National Marine Fisheries Service dated June 21, 2001.

STUDY OBJECTIVES

As stated in the June 21, 2001 letter,

The proposed study will investigate hydraulic conditions in the stilling basin and downstream river that result from non-uniform spillway gate operation. A field investigation will study the effect of center river dominated flow releases with respect to stability of the hydraulic jump, abrasion damage potential and erosion downstream of the endsill.

SCOPE OF WORK

Divers made four separate underwater inspections (dives) in the stilling basin as follows:

DIVE	DATE	TIME	PURPOSE
1	August 13	2 PM to 5 PM	Initial inspection to establish baseline (pre-test) conditions
2	August 15	8 AM to NOON	Followed Test 1
3	August 16	8 AM to 11 AM	Followed Test 2
4	August 17	8 AM to 11 AM	Followed Test 3

On each dive, divers inspected and documented:

- The distribution of bedload sediment within the stilling basin
- The condition of the endsill and extent of concrete erosion
- The condition of riprap downstream of the endsill

Divers also documented the sediment deposited at the base of the Pumping Plant Trashrack Structure at the request of Red Bluff Diversion Dam site personnel.

Documentation included continuous, real-time color video and detailed notes and sketch maps prepared by topside dive team personnel based on diver descriptions of underwater conditions received via a two-way communication system.

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DIVING EQUIPMENT AND PROCEDURES AND LOCK OUT/TAG OUT PROCEDURES

Described in Attachment 3.

DISCUSSION OF FINDINGS

Underwater conditions observed in the stilling basin are documented in Tables, Photographs and Figures as follows:

Table 1. Volume of Sediment in Spillway Stilling Basin
Table 2. Condition of Riprap, Concrete and Rebar in Spillway Stilling Basin

Table 3. Video Log – August 15, 2001 Inspection Dive
Photographs 1 through 27: Typical Underwater Stilling Basin Conditions
Figures 1 through 5. Distribution of Sediment in Stilling Basin

Table 2 also includes a list and definitions of descriptors used to describe riprap, concrete and rebar (ex. R = Rough Concrete; VSU = Very Severely Undercut rebar).

Concrete Erosion

1) Concrete erosion is most severe along the top of the stilling basin endsill and at the base of its upstream face (the cove area).

2) Erosion has exposed and severely undercut rebar along the top of the endsill. The average amount of vertical undercut below rebar is 1 to 2 inches.

3) Small eroded pockets and short lengths of exposed, but not undercut, rebar are present at the downstream bases of chute blocks in Gates 6 and 11.

4) The stilling basin apron is relatively uneroded and is mostly smooth or slightly rough concrete. Rough concrete is present on the apron near the downstream pier noses.

5) Erosion of the stilling basin endsill, chute blocks and apron - before and after the tests - appears unchanged from the last underwater inspection in 1999.

6) Observed erosion appears to be the result of over 50 years of operation and bedload movement.

7) No evidence of new or unusual erosion patterns was observed following the gate tests.

8) No evidence of significant "ball mill" erosion was observed during or following the testing.

Concrete Erosion During Test Period

In an effort to identify any changes in the pattern and rate of concrete erosion during the test period in response to the asymmetric gate opening configuration, divers observed, commented on and documented on video tape the condition of algae coatings at several locations on the stilling basin apron, on several chute blocks and on the endsill and cove areas in the course of each inspection dive. Prior to initiating the test, the algae coating on the apron was more evident downstream of the middle gates and less evident downstream of the outer gates. Over the course of the test period, algae coatings on the apron and chute blocks remained generally intact and unscarred indicating minimal to no erosion during the test period. Some degree of removal or thinning of the algae coating on the apron downstream of the middle gates was apparent, most likely as a result of the high releases through the middle gates. Algae coatings were absent in the cove area and on top of the endsill (where ongoing erosion is most active) and varied from absent to intact and unscarred on the upstream face of the endsill. From these observations, it can be

concluded that the pattern of erosion did not change appreciably during the test period and that what erosion, if any, may have occurred during the test period occurred in the same areas where ongoing erosion had been occurring prior to the test.

Sediment Distribution

1) Prior to the *center channel dominant* gate tests, most sediment in the stilling basin (volume estimated at 74 cubic yards) was deposited at the upstream toe of the endsill (the cove area), downstream of Gates 5, 6, 7 and 8 (the middle four gates). A large gravel bar was also present for a few hundred feet downstream of these gates. This distribution of sediment was the result of routing river flows through the outer gates while a temporary fish ladder was installed in Gate 6.

2) Following the week-long *center channel dominant* gate tests, much of this sediment was removed from the stilling basin and transported downstream to form a gravel bar that extended several hundred feet below the dam. Only a small amount of sediment remained in the cove area downstream of Gates 5, 6 and 7 (volume estimated at 3 cubic yards). An estimated 26 cubic yards of sediment were present downstream of Gates 8 and 10 (right side) and Gate 4 (left side) as follows:

- Gate 8 17 yds
- Gate 10 5 cubic yards
- Gate 4 4 cubic yards

3) A 9 cubic yard sediment deposit in the cove area of Gate 11, the sluice gate, was present prior to the gate tests and remained unchanged following the tests, despite releases of up to 8000 cfs through that gate.

Sediment at Base of Pumping Plant Trashracks

The Pumping Plant Trashracks were inspected on August 15 and 17. Observed underwater conditions are described in Table 4. Sediment consisting of rounded gravel and cobbles is present along the base of the entire trashrack structure. Sediment levels range from 1 foot below the concrete bottom slab to 5 feet above the slab and are typically even with or 1 foot above the slab. An approximately 3-foot high mound of gravel is present on the bottom slab a few feet upstream (inside) of the trashracks. All metalwork is in satisfactory condition. No damage, severe rusting or rust nodules were observed.

CONCLUSIONS AND RECOMMENDATIONS

1) The week-long *center channel dominant* gate tests had no adverse effect on the stilling basin including the endsill, apron and chute blocks.

2) Concrete erosion is an ongoing process caused by downstream transport of river bedload combined with ball-milling of gravel and cobbles in the stilling basin. This process was not accelerated or intensified as a result of the center dominant gate tests, nor was it reduced in intensity by the tests.

3) Long-term operation of Red Bluff Diversion Dam using a center channel dominant gate configuration is an acceptable mode of operation that should not accelerate or exacerbate the ongoing process of concrete erosion at the endsill.

4) Endsill erosion should continue at approximately the same rate as it has for the past 40 years. Rebar undercutting at the top of the endsill will increase. Breakage and loss of rebar should be expected.

5) If a center channel dominant gate setting is maintained, a gradual build-up of sediment should be expected in the cove areas downstream of the outer gates: Gates 1, 2, 3 and 4 (left side) and 8, 9 and 10 (right side).

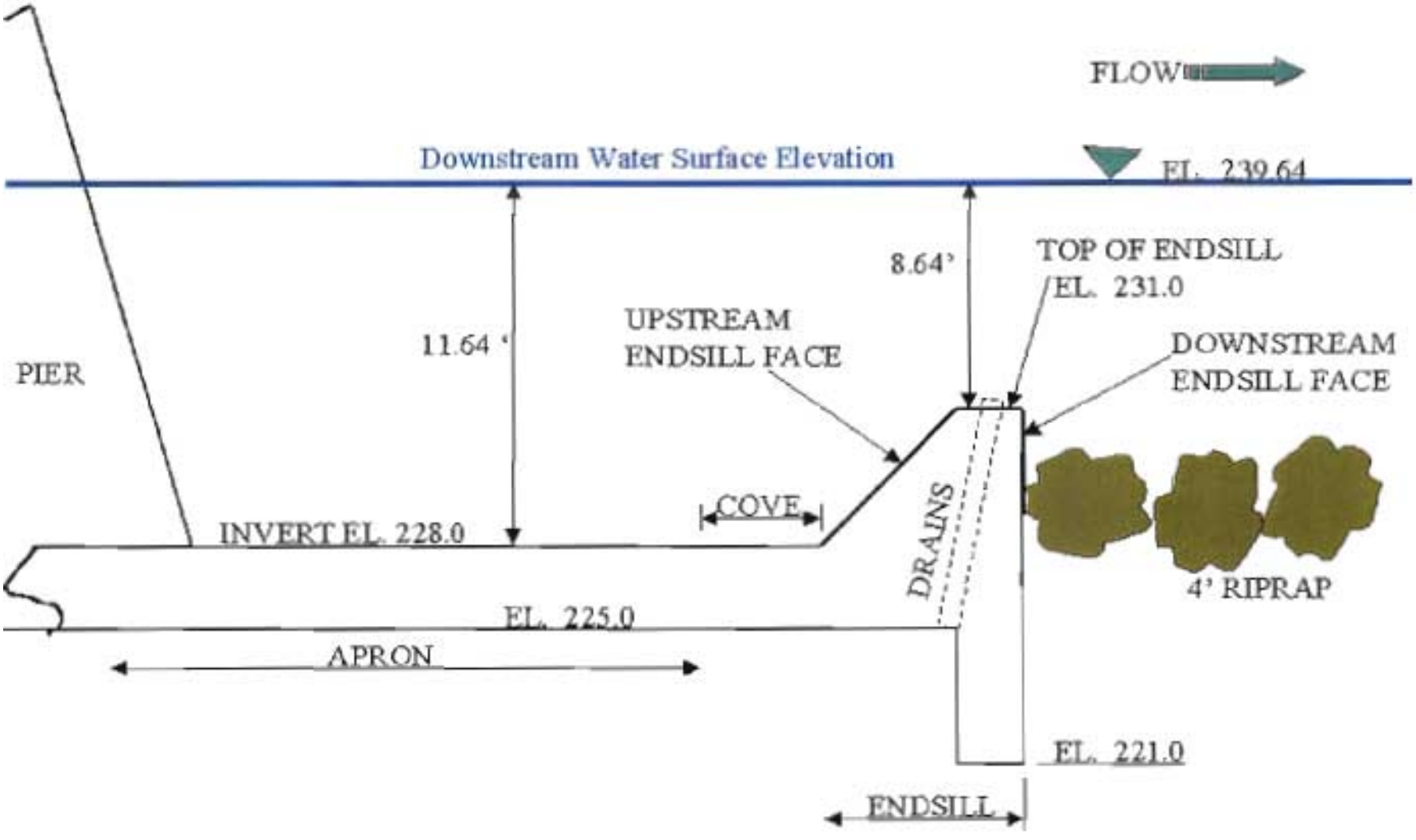
ATTACHMENTS

1) *Proposed Testing for Fishway Attraction Study at the Red Bluff Diversion Dam, June 21, 2001.* Letter from Max J. Stodolski, Chief, Red Bluff Division, to Rebecca Lent, PhD, Regional Administrator, National Marine Fisheries Service

2) *Request for Services of the Lower Colorado Regional Underwater Investigation Team (Dive Team).* Standard dive request, plan and hazard analysis.

3) *Gate and Diving Operations and Lock Out/Tag Out Procedure, August 8, 2001.* Prepared by diver Joel F. Sturm as part of the pre-dive planning.

RED BLUFF DIVERSION DAM



STILLING BASIN CROSS SECTION

TABLE 1. VOLUME OF SEDIMENT IN SPILLWAY STILLING BASIN (1)

GATE NUMBER	BASELINE VOLUME (cubic yards) 8/13/01	VOLUME FOLLOWING : (cubic yards)		
		TEST 1 8/15/01	TEST 2 8/16/01	TEST 3 8/17/01
1				
2				
3		7	1	
4		13	3	4
5	22	9		
6	22			1
7	20			2
8	10	5	8	17
9				
10				5
11	9	9	9	9
TOTAL	83	43	21	38

(1) Based on measurements by divers as shown on Figures 1 through 5.

TABLE 2. CONDITION OF RIPRAP, CONCRETE AND REBAR IN SPILLWAY STILLING BASIN

GATE NUMBER	RIPRAP	ENDSILL			APRON	CHUTE BLOCKS		COMMENTS
		TOP		COVE				
		REBAR	CONCRETE			REBAR	CONCRETE	
1	I, F, R	EX/U	VR	S/R	S			
2	WS, F. R/SR	U/VSU	VR	VR				7' transverse x 3' longitudinal area of exposed rebar in cove downstream of Pier 1/2
3	WS, F	EX/SU	R	VR				
4	WS, F	SU/VSU		VR	S/R			
5	WS, F, R/SR	SU/VSU		R				Exposed rebar in cove
6	I, O	SU		R	S/R		VR	Erosion at bases of chute blocks
7	I	SU	R	R/VR				
8	I, F	SU	VR	R	S/R			
9	I, F	EX/SU	VR	R	S/R			
10	I/WS, R/SR	EX/U	VR	R/VR	S/R			

RIPRAP DESCRIPTORS

I	INTERLOCKED	4-foot diameter blocks of hard basalt riprap tightly interlocked to barely touching, apparently unchanged from their original condition.
WS	WIDELY SPACED	4-foot diameter basalt blocks spaced 4 to 5 feet apart.
R	ROUNDED	Basalt blocks are smooth and rounded with no edges.
SR	SUBROUNDED	Edges of basalt blocks are defined but blunt; surfaces are smooth.
SA	SUBANGULAR	Edges of basalt blocks are defined and slightly sharp; surfaces are smooth.
O	OPEN	Interstitial spaces or gaps between blocks of riprap are empty.
F	FILLED	Interstitial spaces or gaps between blocks of riprap are filled with 1/4- to 3-inch gravel.

CONCRETE DESCRIPTORS

S	SMOOTH	Relief less than ½ inch
R	ROUGH	1- to 2-inch relief
VR	VERY ROUGH	2- to 3-inch relief

REBAR DESCRIPTORS

EX	EXPOSED	Rebar exposed but not undercut
U	UNDERCUT	Rebar undercut ½ to 1 inch
SU	SEVERELY UNDERCUT	Rebar undercut 1 to 3 inches
VSU	VERY SEVERELY UNDERCUT	Rebar undercut 3 to 5 inches. Bar diameter ranges from 1/4 to ½ inch (normal diameter is ½ inch [#4 bar])

TABLE 3. VIDEO LOG – AUGUST 15, 2001 INSPECTION DIVE

TAPE 1			GATES 1 - 8
GATE	PIER	TIME	COMMENTS
1		5:00 to 10:00	10:00: 7' transverse x 3' longitudinal area of exposed rebar at cove invert Transverse = Cross Channel Longitudinal = Parallel to Channel
	1/2		
2			13.33: Centerline of Gate 2 14.59. Severely Undercut (SU) rebar
	2/3		
3		16:16 to 24:25	16:51: Rebar exposed but not undercut (EX) 18:09: Very Rough (VR) concrete in cove 22:00: Gravel deposit
	3/4	24:25	
4		26:03 to 32:33	26:03-29:00. Left longitudinal joint 29:30: Cobble deposit; 3-6" cobbles
	4/5	32:33	
5		35:31 to 45:05	40:38: Rounded to Subrounded (R/SR) riprap 41.15: Very Severely Undercut (VSU) rebar
	5/6	45:05	
6			46:57-48:00: Riprap near left longitudinal joint 48:48: Bent exposed rebar 50:03: Right longitudinal joint 50:50: Intersection of transverse joint and right longitudinal joint 51:10: Vertical pin 1:18-1:21: Chute Blocks
	6/7	51:30 1:17:44	
7			52:00: Intersection of transverse joint and left longitudinal joint 53:00 to 54.45: Sheetpile cofferdam 55:08: Rough toVery Rough (R/VR) concrete at cove 58:06: 5' deep hole near cofferdam 59:24: Centerline Gate 7 1:00:00: Relief Drain on top of endsill 1:15-1:17: Chute Blocks
	7/8	1:01:20	
8			1:02:05: Gravel/cobble deposit; 1-6" gravel and cobbles 1:03:29-1:05.55: Left longitudinal joint 1:06:40: Intersection of transverse joint and left longitudinal joint; relief on apron 1:08.20: Right longitudinal joint 1:11:00: Very Rough (VR) concrete on top of endsill
	8/9		

TAPE 2			PUMPING PLANT TRASHRACKS & GATES 9 - 11
GATE	PIER	TIME	COMMENTS
PUMPING PLANT TRASH RACKS		0:00 to 12:18	Underwater conditions at the base of the Pumping Plant Trashracks as viewed by divers on 8/15 and 8/17 are described in Table 3. 2:50: Base of Upstream End Guide 3:30: Base of Intermediate Guide 1 12:18. Base of Intermediate Guide 6 **Note: Video documents diver's inspection route from PP Trashracks to Gate 11, Gate 10 and Gate 9 (last).**
11		18.11 to 42:22	18:15. Left endsill 19:00: Riprap on downstream side of endsill 21:00: Right longitudinal joint 22:24: Rough concrete 23:20: 1/8- to 3-inch gravel deposited upstream of endsill 24:15: 3, 2-foot diameter concrete cores 29:50 - 34:12: **Downstream Chute Blocks** 29.50: Chute Block 1 (left block) 30:00. Chute Block 2 30:10: Chute Block 3 30:37-31.46: Chute Block 4 34:12: Chute Block 7. Rough (R) concrete. 34:33: Chute Block 6. Rough (R) concrete 34:50: Chute Block 5. 2-inch length of Exposed (EX) rebar. 40:15: Apron. Smooth (S) concrete. 40:29 - 42:22: **Upstream Chute Blocks** 40:29: Chute Block 2 40:56: Chute Block 1 41:25: Chute Block 3 41:35: Chute Block 4 41:46: Chute Block 5 41:57: Chute Block 6 42:07: Chute Block 7 42:22: Chute Block 8
	10/11	45:27	
10		45.27 to 52:11	48:25: **Top of endsill.** Very Rough (VR) concrete. Widely Spaced (WS) Riprap with interstitial spaces Filled (F) with gravel. 49:30: **Centerline of Gate 10** 51:40. **Left longitudinal joint**
	9/10	52:11	
9		52:11 to 1:03:08	54:17. Riprap and Undercut to Severely Undercut (U/SU) rebar. 54:30. Centerline Gate 9 55.48: Left longitudinal joint 56:50: Exposed (EX) rebar
	8/9	1:03:23	

TABLE 4.
DEPTH OF SEDIMENT AT BASE OF PUMPING PLANT TRASHRACK STRUCTURE

NUMBER OF GUIDE (1)	**8/15/01**			**8/17/01**		
	DEPTH SEDIMENT (ft) (2)	TYPE SEDIMENT (3)	HEIGHT OF INTERIOR MOUND (ft)	DEPTH SEDIMENT (ft) (2)	TYPE SEDIMENT (3)	HEIGHT OF INTERIOR MOUND (ft)
U/S END GUIDE	- 1.5	g/c	2 (4)	-1.5	g/c	(4)
INTER GUIDE 1	- 1.5	g/c	2	-1.5	g/c	
INTER GUIDE 2	- 1.0	g/c	2	-1.0	g/c	+/- 3
INTER GUIDE 3	- 0.5	g/c	2	-1.0	g/c	
INTER GUIDE 4	- 0.5	g/c	2	-0.7	g/c	Range: 2.5-3.5
INTER GUIDE 5	0	g/c	1-2	-0.5	g/c	
INTER GUIDE 6	0	s/g	1-2	0	s/g	
INTER GUIDE 7	+1.0	s/g	1-2	+1.0	s/g	
D/S END GUIDE	+2.5	s/g	2	+3.0	s/g	

NOTES:
1) INTER = INTERMEDIATE
2) - = vertical distance **below** concrete base slab; + = vertical distance **above** base slab: 0 = **even** with base slab.
3) g/c = gravel and cobbles; s/g = sand and gravel
4) Interior mound consists of sand and minus 3-inch gravel; located about 3 feet inside of trashracks; height is vertical distance above base slab (estimated).

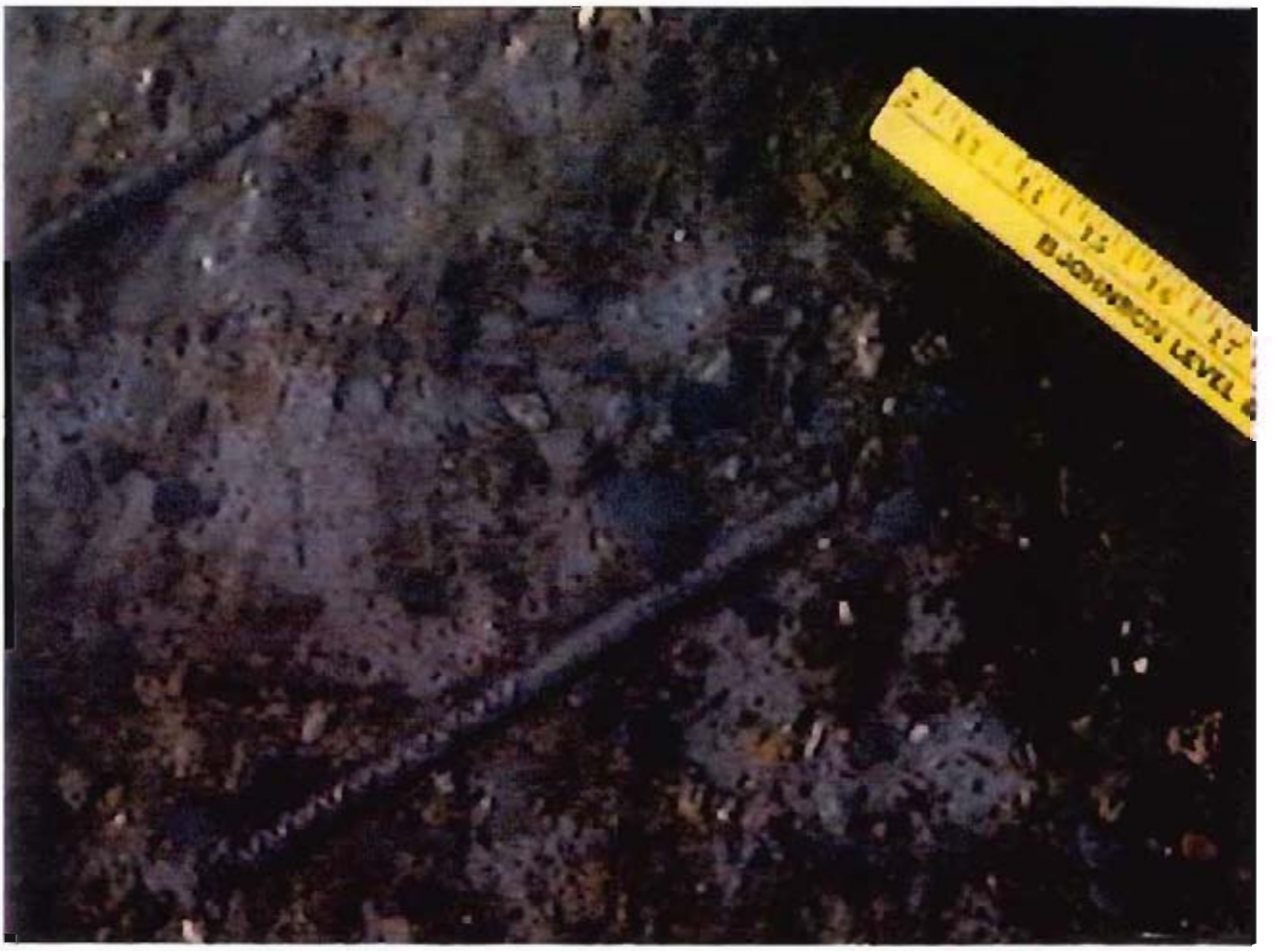


Photo 1

Fishway Attraction Study
Red Bluff Diversion Dam Stilling Basin

EXPOSED REBAR – GATE 1

Exposed Rebar (EX) on top of endsill downstream of Gate 1.

Rodney Tang

August 15, 2001

Photo 2

Fishway Attraction Study
Red Bluff Diversion Dam Stilling Basin

RIPRAP – GATE 1

Interlocked, Rounded to Subrounded (I, R/SR) blocks of hard basalt riprap downstream of Gate 1.

Rodney Tang

August 15, 2001

Photo 3

Fishway Attraction Study
Red Bluff Diversion Dam Stilling Basin

EXPOSED REBAR – COVE AREA -- GATE 1

A 7-foot long (transverse direction) by 3-foot wide (longitudinal direction) area of Exposed Rebar (EX) is present in the cove area of Gate 1, approximately downstream of Pier 1/2. Endsill is at photo left. View is toward the right abutment, parallel to the endsill.

Rodney Tang

August 15, 2001

Photo 4

Fishway Attraction Study
Red Bluff Diversion Dam Stilling Basin

SEVERELY UNDERCUT REBAR – GATE 2

Severely Undercut Rebar (SU) on top of endsill downstream of Gate 2. The ruler shows 3 to 4 inches of undercutting. Loose fine and coarse gravel covers much of the endsill.

Rodney Tang

August 15, 2001

Photo 5

Fishway Attraction Study
Red Bluff Diversion Dam Stilling Basin

GRAVEL DEPOSIT – GATE 3

Deposit of fine and coarse gravel in cove area downstream of Gate 3.

Rodney Tang

August 15, 2001

Photo 6

Fishway Attraction Study
Red Bluff Diversion Dam Stilling Basin

EXPOSED REBAR AND ROUGH CONCRETE -- GATE 3

Exposed Rebar (EX) and Rough Concrete (R) with 1- to 2-inch relief on top of endsill downstream of Gate 3.

Rodney Tang

August 15, 2001

Photo 7

Fishway Attraction Study
Red Bluff Diversion Dam Stilling Basin

VERY ROUGH CONCRETE IN COVE – GATE 3

Very Rough Concrete (VR) in cove area downstream of Gate 3.

Rodney Tang

August 15, 2001

Photo 8

Fishway Attraction Study
Red Bluff Diversion Dam Stilling Basin

ROUGH CONCRETE ON APRON -- GATE 4

Rough Concrete (R) is present to either side of the left longitudinal joint in Gate 4, near the downstream nose of Pier 3/4.

Rodney Tang

August 15, 2001

Photo 9

Fishway Attraction Study
Red Bluff Diversion Dam Stilling Basin

COBBLE DEPOSIT – GATE 4

Deposit of 3- to 6-inch diameter rounded cobbles and coarse, rounded gravel in cove area downstream of Gate 4.

Rodney Tang

August 15, 2001

Photo 10

Fishway Attraction Study
Red Bluff Diversion Dam Stilling Basin

RIPRAP – GATE 5

Widely Spaced (WS), Rounded to Subrounded (R/SR) blocks of hard basalt riprap downstream of Gate 5.

Rodney Tang

August 15, 2001

Photo 11

Fishway Attraction Study
Red Bluff Diversion Dam Stilling Basin

VERY SEVERELY UNDERCUT REBAR – GATE 5

Very Severely Undercut Rebar (VSU) on top of endsill downstream of Gate 5. Ruler shows 4 to 5 inches of undercutting which is extensive downstream of Gate 5. Top of endsill is covered by fine and coarse gravel.

Rodney Tang

August 15, 2001

Photo 12

Fishway Attraction Study
Red Bluff Diversion Dam Stilling Basin

JOINT INTERSECTION AND SMOOTH TO ROUGH APRON CONCRETE – GATE 6

Intersection of right longitudinal joint and transverse joint downstream of Gate 6. Concrete on apron is Smooth to Rough (S/R)

Rodney Tang

August 15, 2001

Photo 13

Fishway Attraction Study
Red Bluff Diversion Dam Stilling Basin

ROUGH TO VERY ROUGH CONCRETE IN COVE – GATE 7

Rough to Very Rough Concrete (R/VR) with 1- to 3-inch relief is present in the cove area at the right longitudinal joint (under diver's fingers) downstream of Gate 7.

Rodney Tang

August 15, 2001

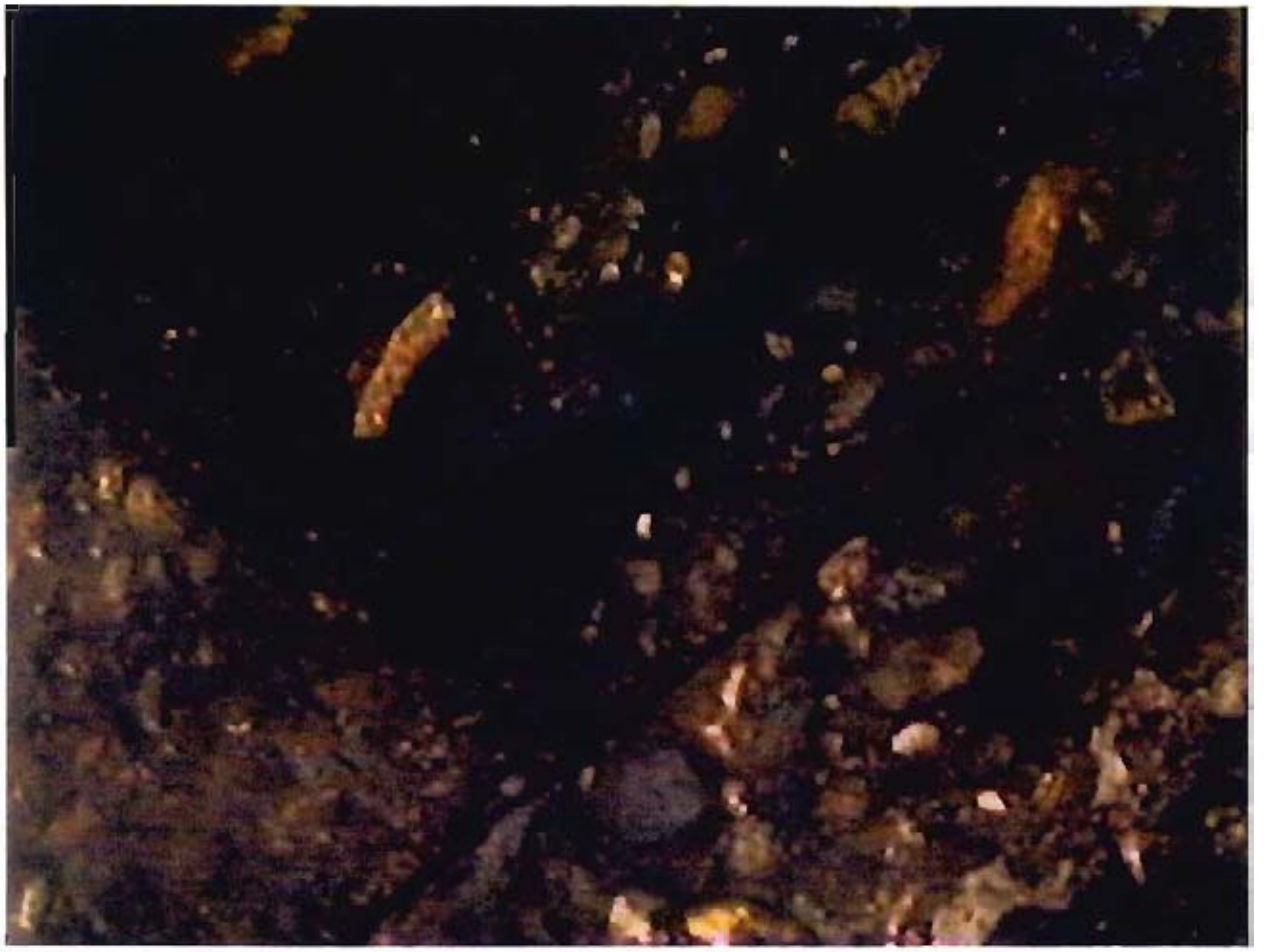


Photo 14

Fishway Attraction Study
Red Bluff Diversion Dam Stilling Basin

CHUTE BLOCK – GATE 7

Very Rough Concrete (VR) at base of a chute block downstream of Gate 7.

Rodney

August 15, 2001

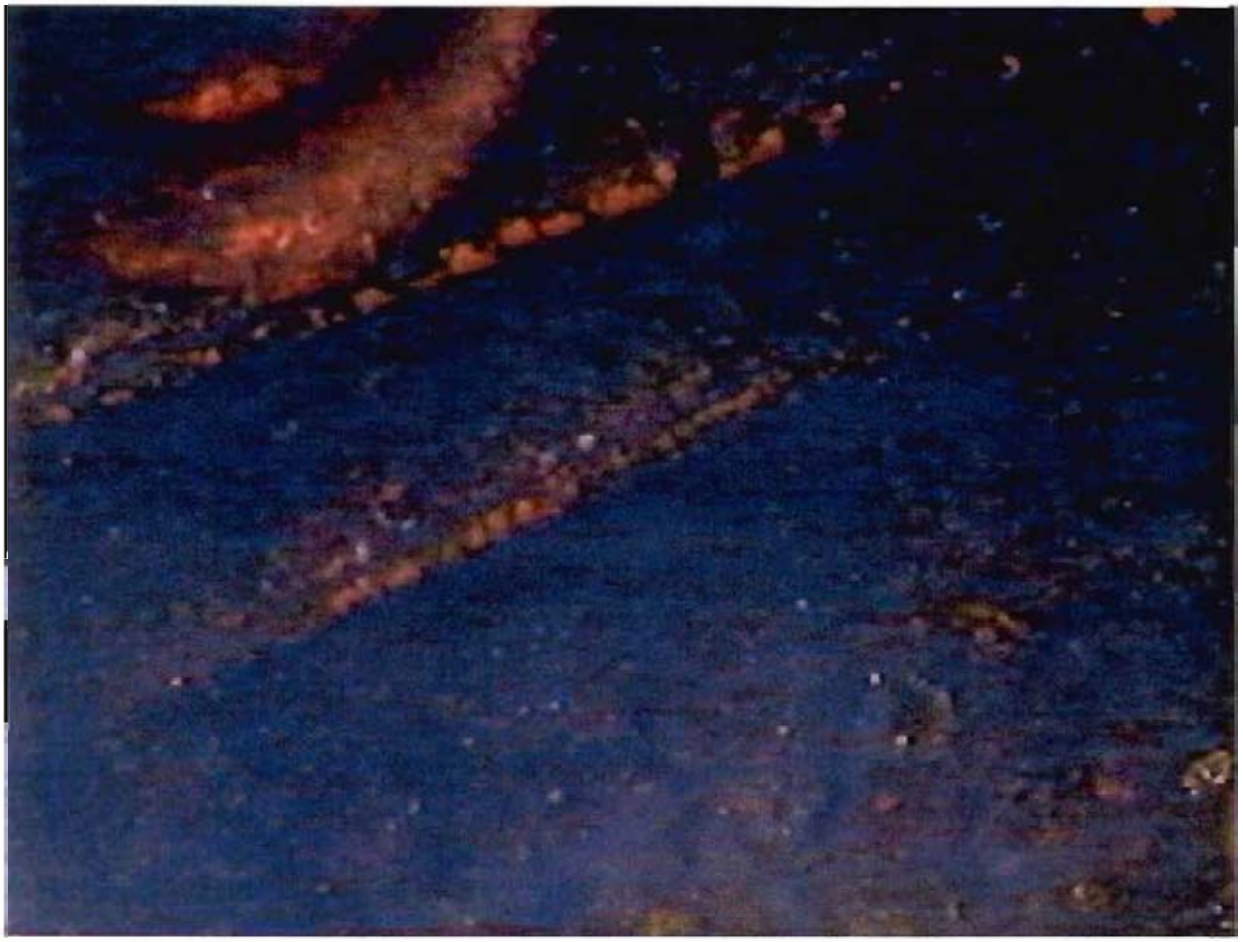


Photo 15

Fishway Attraction Study
Red Bluff Diversion Dam Stilling Basin

CHUTE BLOCK – GATE 7

Exposed Rebar (EX) at base of a chute block downstream of Gate 7. A relief drain is visible at the upper left.

Rodney Tang

August 15, 2001

Photo 16

Fishway Attraction Study
Red Bluff Diversion Dam Stilling Basin

SEVERELY UNDERCUT REBAR – GATE 9

Severely Undercut Rebar (SU) and loose gravel and cobbles on top of endsill downstream of Gate 9.

Rodney Tang

August 15, 2001

Photo 17

Fishway Attraction Study
Red Bluff Diversion Dam Stilling Basin

VERY ROUGH CONCRETE – GATE 9

Very Rough Concrete (VR) on top of endsill downstream of Gate 9.

Randy Calvert

August 15, 2001

Photo 18

Fishway Attraction Study
Red Bluff Diversion Dam Stilling Basin

VERY ROUGH CONCRETE – GATE 10

Very Rough Concrete (VR) on top of endsill downstream of Gate 10. A relief drain is visible at the lower edge. The downstream face of the endsill and fine gravel deposited on the downstream side are visible at upper right

Randy

August 15, 2001

Photo 19

Fishway Attraction Study
Red Bluff Diversion Dam Stilling Basin

RIPRAP – GATE 10

Widely Spaced, Filled, Subrounded riprap (WS, F, SR) downstream of Gate 10. Riprap blocks are spaced about 5 feet. Spaces between riprap blocks are filled with fine and coarse gravel.

Randy

August 15, 2001

Photo 20

Fishway Attraction Study
Red Bluff Diversion Dam Stilling Basin

RIPRAP – GATE 11

Interlocked, Subrounded to Subangular (I, SR/SA) riprap downstream of Gate 11. Riprap blocks are in direct contact with the endsill (at photo right).

Randy Calvert

August 15, 2001

Photo 21

Fishway Attraction Study
Red Bluff Diversion Dam Stilling Basin

RIPRAP – GATE 11

Interlocked, Subrounded to Subangular (I, SR/SA) riprap downstream of Gate 11.

Randy Calvert

August 15, 2001

Photo 22

Fishway Attraction Study
Red Bluff Diversion Dam Stilling Basin

GRAVEL DEPOSIT AND CONCRETE ROUNDS -- GATE 11

Fine and coarse gravel deposited in cove area downstream of Gate 11. Concrete "rounds" came from 2-foot diameter holes drilled through the extreme right edge of the concrete apron to accommodate H-Piles as part of the pumping plant project in the 1980's.

Randy Calvert

August 15, 2001

Photo 23

Fishway Attraction Study
Red Bluff Diversion Dam Stilling Basin

DOWNSTREAM CHUTE BLOCKS – GATE 11

Exposed Rebar (EX) at the base of Chute Block 3 (downstream row of chute blocks) downstream of Gate 11. Rebar is angled at 45 degrees. Similar concrete erosion and exposed rebar is present at most downstream chute blocks in Gate 11.

Randy Calvert

August 15, 2001

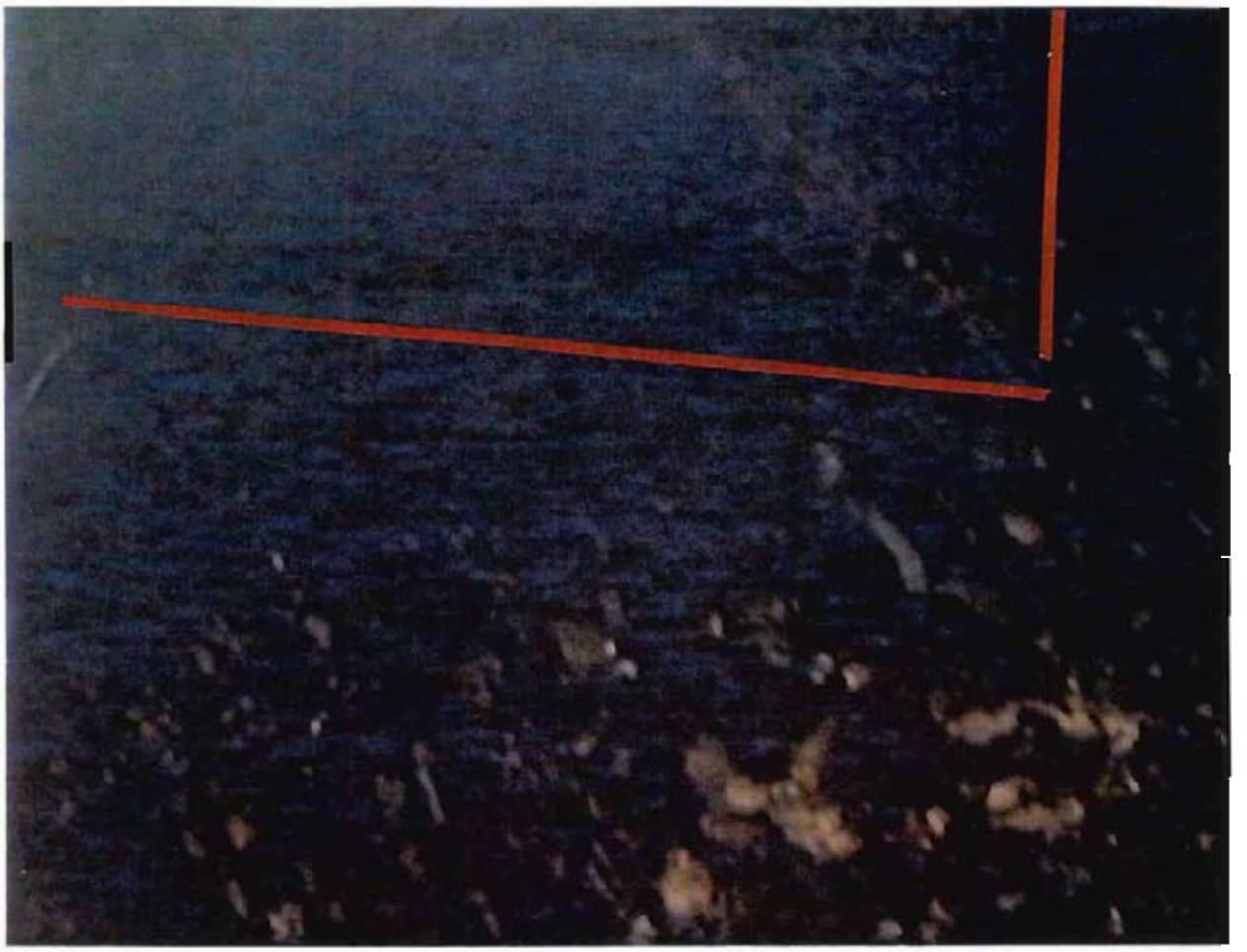


Photo 24

Fishway Attraction Study
Red Bluff Diversion Dam Stilling Basin

UPSTREAM CHUTE BLOCKS – GATE 11

Smooth, uneroded concrete (S) at base of Chute Block 3 (upstream row of chute blocks) downstream of Gate 11. The photo shows the downstream lower left corner of Chute Block 3 (outlined in red). All upstream chute blocks showed minimal to no erosion in Gate 11.

Randy Calvert

August 15, 2001

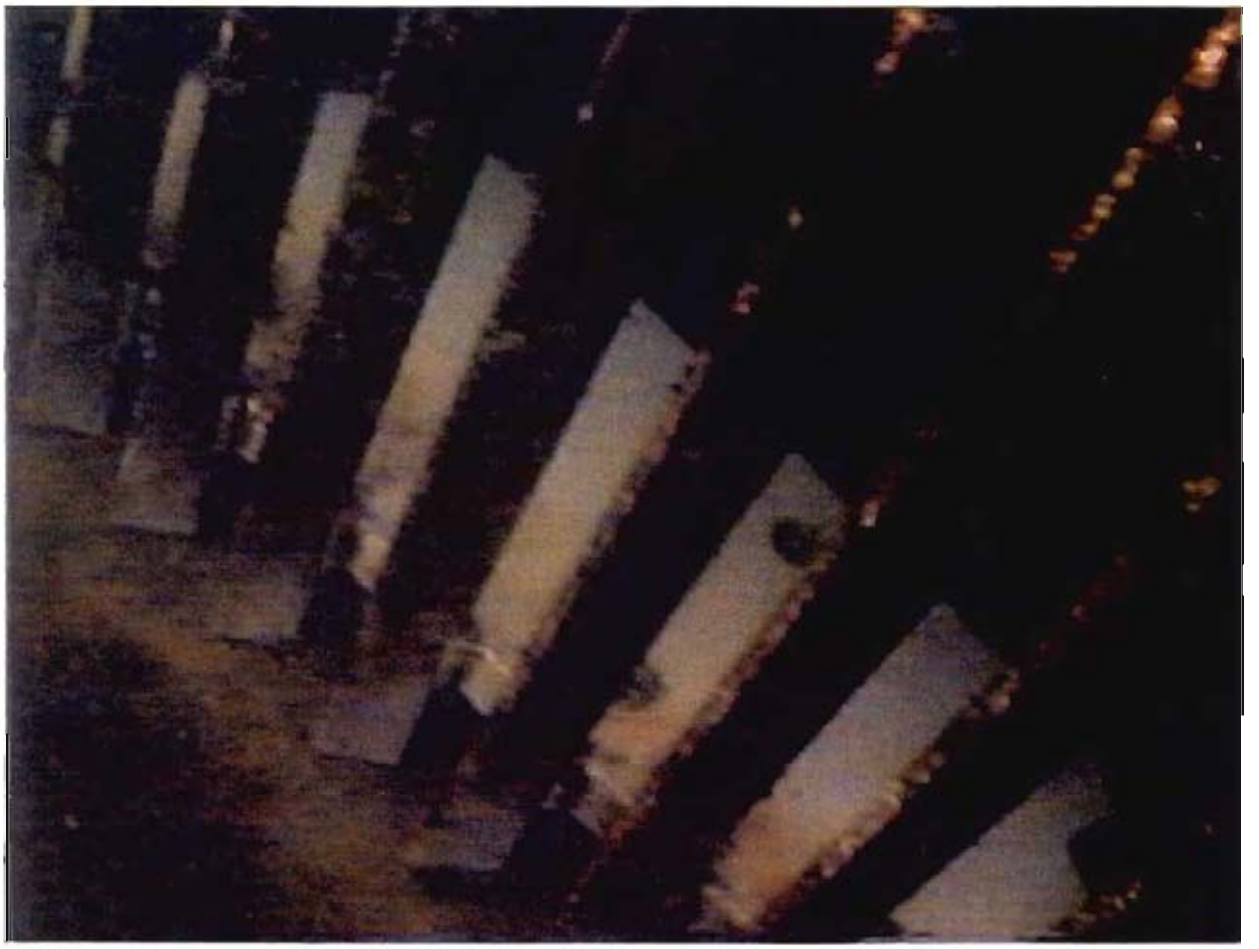


Photo 25

Fishway Attraction Study
Red Bluff Diversion Dam

PUMPING PLANT TRASHRACK STRUCTURE

Trashrack bars near the upstream end guide.

Randy Calvert

August 15, 2001

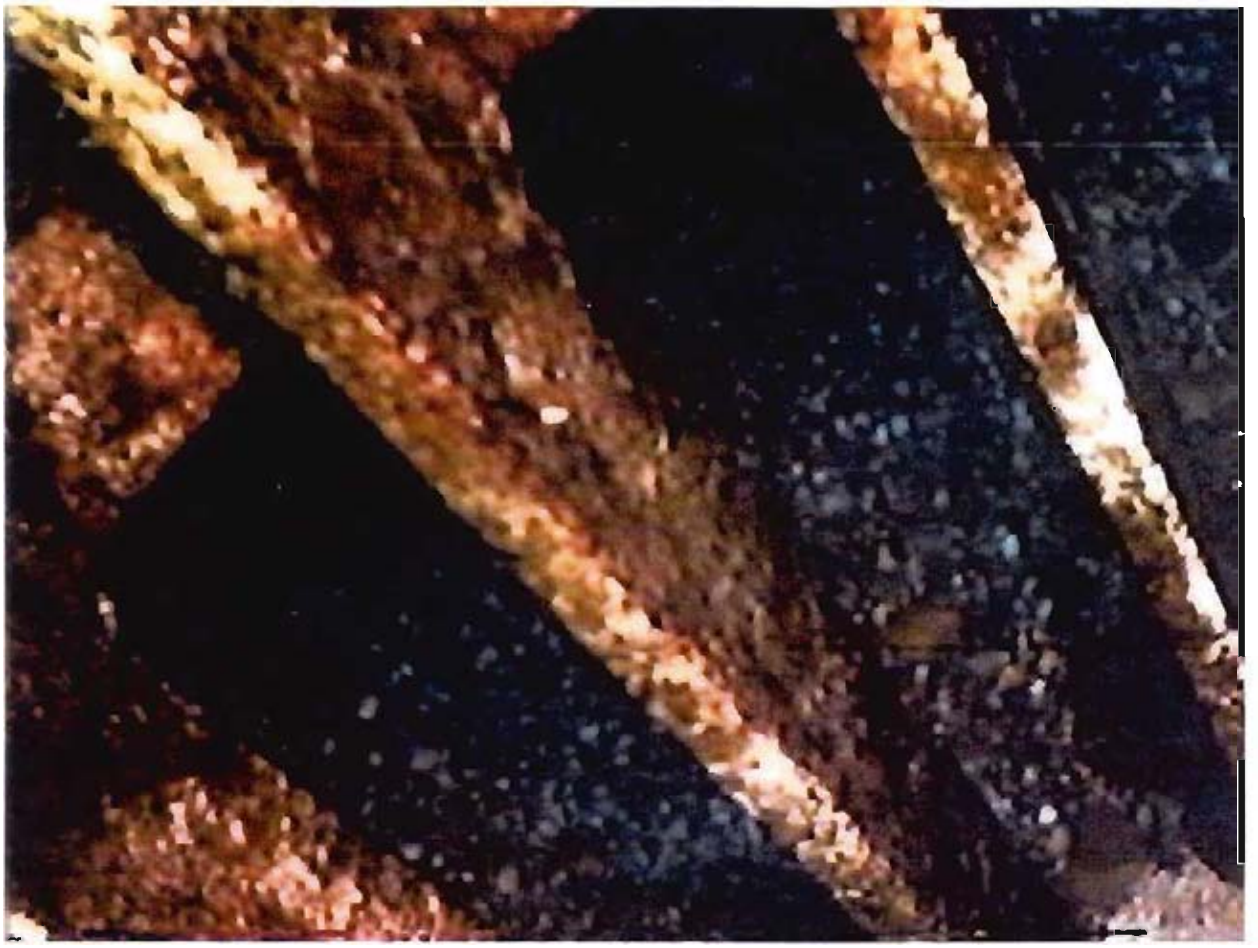


Photo 26

Fishway Attraction Study
Red Bluff Diversion Dam

PUMPING PLANT TRASHRACK STRUCTURE

2- to 3-foot thick mound of sand and fine gravel located a few feet inside of the trashracks.

Randy Calvert

August 15, 2001

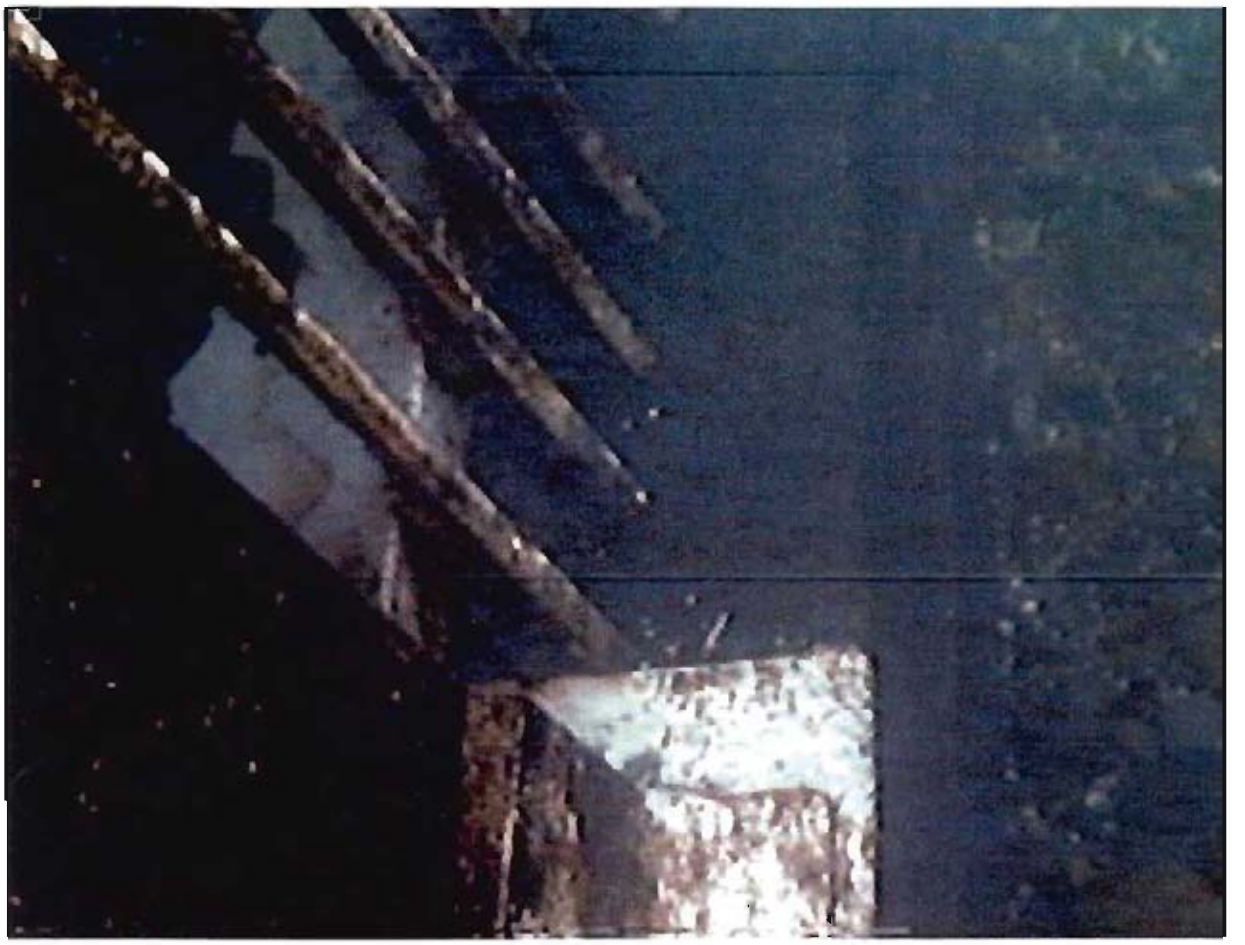


Photo 27

Fishway Attraction Study
Red Bluff Diversion Dam

PUMPING PLANT TRASHRACK STRUCTURE -- BASE OF INTERIOR GUIDE 1

Sediment consisting of gravel and cobbles was approximately 1.5 feet below the top of the concrete base slab at the base of interior guide 1 (the first guide downstream of the upstream end guide).

Randy Calvert

August 15, 2001

NC-350
ENV-4.10/PRJ-8.10

JUN 2 1 2001

Rebecca Lent, Ph.D.
Regional Administrator,
National Marine Fisheries Service
501 West Ocean Boulevard, Suite 4200
Long Beach, California 90802-4213

Subject: Proposed Testing for Fishway Attraction Study at the Red Bluff Diversion Dam

Dear Dr, Lent:

The Red Bluff Diversion Dam (RBDD), located on the Sacramento River near the town of Red Bluff, California, was constructed to provide irrigation water for agricultural lands in Tehama and Colusa counties. Since its construction in the mid-1960's, the dam has impeded passage of anadromous salmonids to their upstream spawning habitat.

Existing fish passage facilities at the RBDD consist of two primary fish ladders located on the right and left abutments of the RBDD, and a temporary center ladder located in bay six of the dam. Past studies have revealed that salmon passage has been significantly blocked or delayed due to the inability of salmon to locate the ladder entrances. Previous efforts to modify gate operations of the RBDD within the Standing Operating Procedure, in an attempt to improve fish attraction to the ladders, have had limited success.

To improve fish attraction to the right and left abutment ladders, Reclamation is proposing to conduct tests which would alter gate operations at the dam. A week-long test, consisting of three different gate configurations, is proposed for August, 2001, (reference the *Proposed Test Plan for Red Bluff Diversion Dam Fishway Attraction Study,* copy enclosed).

The gate settings for each of the three proposed tests would result in spillway releases that create mid-river dominated flows. This would test he concept that concentrating flows through the three gates in the center of the dam, with minimal or no flows through the other gates, would force salmon to the sides of the dam where they would encounter attraction flows from the fish ladders. Once fish locate ladder entrances, they usually swim up the ladders.

ATTACHMENT 1

The proposed tests will differ from previous gate manipulation tests. They will violate the Standing Operating Procedure for spillway gate operation by exceeding a 1-foot difference between openings of adjacent gates 1 through 10. During each test, surface flow patterns and velocities will be mapped, and the stilling basin and river bed will be inspected by divers to assess potential erosion and deposition. Details are outlined in the enclosed study plan.

The tests involve releasing the greatest amount of flow through the center gates of the dam; therefore, early removal of the center fish ladder would be required. Reclamation proposes initiating removal of the center ladder on August 1, 2001 to allow testing to begin on August 13, 2001.

Data provided by the California Department of Fish and Game, Red Bluff Office, reveals that adult spring-run chinook salmon migrate past the RBDD prior to August 1; therefore, the spring-run chinook salmon would not be impacted by early removal of the center ladder. The two other listed species in the Sacramento River, winter-run Chinook salmon and steelhead, migrate past the dam earlier in the year, and would not be impacted by early removal of the center ladder.

The center ladder was installed at the RBDD in 1984, and has been in use since then for some, or all, of the gates-lowered time periods. The 1993 Biological Opinion for the Operation of the Federal Central Valley Project and the California State Water Project describes the RBDD as operating with the center ladder in place during the gates-lowered period.

Reclamation requests an amendment to the 1993 Biological Opinion to allow removal of the center ladder to begin on August 1, 2001, 6 weeks before the gates are raised. This would allow Reclamation to evaluate the effects of mid-river dominated flows on the physical features of the dam and the downstream environment. Testing would occur over a 1-week period, after which the selected gate configuration would be in place for the remainder of the gates-in period (i.e., through September 15). The right and left abutment ladders would continue to operate during the study.

From early August through September 15, a companion study would be conducted to evaluate the effectiveness of the altered spill configurations in an effort to attract salmonids to the left and right abutment ladders. A separate investigation plan will be prepared for that study.

Reclamation appreciates your consideration of this request for an amendment to the 1993 Biological Opinion. Please respond by July 16, 2001, so we can complete final plans before August 1, 2001.

If you have any questions, or need further clarification, please call me at (530) 529-3890; TDD: (530) 275-8991.

Sincerely,

Max J. Stodolski
Chief, Red Bluff Division

Enclosure

cc: Mr. Randy Benthin
California Department of Fish & Game
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Redding, CA 96001

Mr. Harry Rectenwald
California Department of Fish & Game
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Redding CA 96001

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Mr. Ralph Hinton
California Department of Water Resources
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Mr. Tom Kisanuki
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Red Bluff CA 96080

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Santa Rosa CA 95404-6528

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Willows CA 95988

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Bureau of Reclamation
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Sacramento CA 95821

Mr. Joel Sturm
Bureau of Reclamation
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Sacramento CA 95821

Mr. Steve Herbst
U. S. Bureau of Reclamation
2800 Cottage Way, MP-430
Sacramento CA 95821

WBR:MStodolski:jel:06/18/2001:529-3890
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Proposed Test Plan for
Red Bluff Diversion Dam
Fishway Attraction Study

Background

Red Bluff Dam was constructed in the mid 1960's. The dam spans the Sacramento River with eleven 60-ft wide spillway gates. Plan and sections of Red Bluff Dam and stilling basin are presented in figure 1. Gates one through ten are not automated. These gates are changed in response to large changes in river flow. Downstream of gates one through ten is a Type Two hydraulic jump stilling basin with a sloping concrete apron and solid endsill. Gate 11 is automated and used for regulating the upstream watersurface for gravity diversion to the Tehama Colusa Canal. Downstream of gate 11 is a Type Three hydraulic jump stilling basin. The stilling basin has experienced significant abrasion damage over the past 40 years. Damage has occurred primarily near the basin chute blocks and endsill. The designer's operating criteria (DOC) for spillway gate operation was revised in 1970 to address the problem of concrete abrasion in the stilling basin. The criteria places two constraints on spillway operation. First, the DOC requires gate 11 (sluice gate) be operated at a minimum of 2,500 cfs prior to opening any of the other 10 spillway gates. This ensures hydraulic jump stability. Second, gate openings of adjacent gates 1 through 10 shall not exceed a 1.0 ft difference. These operating criteria ensure flow releases through the gates are sufficiently uniform to produce a stable hydraulic jump and reduce erosion and abrasion damage to the downstream apron.

Fishway attraction has been recognized as a problem at RedBluff Diversion Dam since about 1975. Previous work in this area includes a hydraulic model study of a concept for constructing enlarged ladders, (research report R-97-08) and a field study of the flow conditions at the entrance to the right bank ladder, (research report R-97-07). These studies show the fishway attraction flows are often masked by uniform spillway releases. Current spillway operating criteria limits lateral adjustment of flow releases that could improve attraction to the two abutment fishways.

Study Objective

The proposed study will investigate hydraulic conditions in the stilling basin and downstream river that result from non-uniform spillway gate operation. A field investigation will study the effect of center river dominated flow releases with respect to stability of the hydraulic jump, abrasion damage potential and erosion downstream of the endsill.

Test Plan

Proposed Test Conditions - Tests of three different gate operations are proposed for the field evaluation. Gate settings, gate discharge and estimated flow velocity at the stilling basin endsill for each test are given in table 1 and plotted in figure 2. The gate settings proposed for the field tests are designed to evaluate hydraulic performance of the stilling basin and fishway attraction for spillway releases that create mid-river dominated flows. Test 1 represents a sharply river

centered flow release assuming a minimum gate opening of 0.5 ft for all gates. The established 1 foot maximum difference in gate settings between adjacent gates is exceed for bays 4 through 8. Test 1 provides 63 percent of river flow releases through gates 5, 6 and 7 with 29 percent of the total river flow released through gate 6. Test 2 gate settings further concentrate flow releases toward the center of the river. Gate settings proposed for test 2 exceed the 1 ft maximum gate opening difference required between adjacent gates in bays 4 through 7. To increase mid-river centered flow, bays 1 and 10 will be closed. Test 2 provides 70 percent of river flow releases through gates 5, 6 and 7 with 30 percent of the total river flow released through gate 6. Test 3 has gates 1, 2, 9 and 10 closed. Test 3 provides 78 percent of river flow releases through gates 5, 6 and 7 with 32 percent of the total river flow released through gate 6. Gate settings proposed for bays 4,5 and 7,8 have a maximum difference between adjacent gates of 2.0 ft.

Flow surface mapping - After spillway gates are set for each test, a video record of the surface flow pattern will be recorded using three deck mounted video cameras. The video cameras will be solid mounted to achieve similar views for all tests.

Velocity Mapping - A boat mounted Acoustic Doppler Profiler will be used to map far field attraction velocities during each test. Flow velocities at multiple depths will be measured across the full river in an area lying between the pumping plant and the fishscreen bypass outfall.

Erosion and Deposition Inspection of the Stilling Basin and River Bed - During each test the location of gravel deposits within the stilling basin will be mapped by divers and boat mounted bottom survey equipment. A dive inspection is expected to provide the best indication of changes in material deposition or erosion near the basin chute blocks and endsill. The survey boat will be used to map bed elevation over a broad area of the basin apron and downstream river channel. The basin inspection will look for changes in deposition downstream of gates operated at small openings. The river bed survey will look for erosion downstream of gates operated at large openings. During stilling basin inspections river releases will have to be maintained. Therefore, the inspection will be conducted following protocol established during previous operation and maintenance inspections. Two to three adjacent gates will be closed while the downstream basin and river bed are inspected by divers and boat mounted fathometer. The sluiceway gate will be used to regulate river flow as gates are closed for the inspection. The area behind gates operated at small openings will be inspected first to minimize the potential for altering deposition patterns as a result of gate changes required for inspection. First, gates 1-3 will be closed for basin inspection. Second, gates 1-3 will be reopened and gates 8-10 closed for basin inspection. Third, Gates 8-10 will be reopened and gates 4-7 will be partially closed to permit boat access over the river bed downstream of these gates.

Test Plan Schedule

Aug. 1 through Aug. 11,

Remove the center ladder.

Aug. 13,

A.M. - Meet with divers,

P.M. - Conduct pretest dive and boat ADCP survey of stilling basin, setup cameras and GPS base station.

Aug. 14,

8 a.m. - Set gates for Test1 followed by far field boat survey of attraction velocity.

Aug. 15,

8 a.m. - Dive inspection of stilling basin and boat survey of downstream channel aggregation / degradation.

1p.m - Set gates for Test2 followed by far field boat survey of attraction velocity.

Aug. 16,

8 a.m. - Dive inspection of stilling basin and boat survey of downstream channel aggregation / degradation.

1p.m - Set gates for Test3 followed by far field boat survey of attraction velocity.

Aug. 17,

8 a.m. - Dive inspection of stilling basin and boat survey of downstream channel aggregation / degradation.

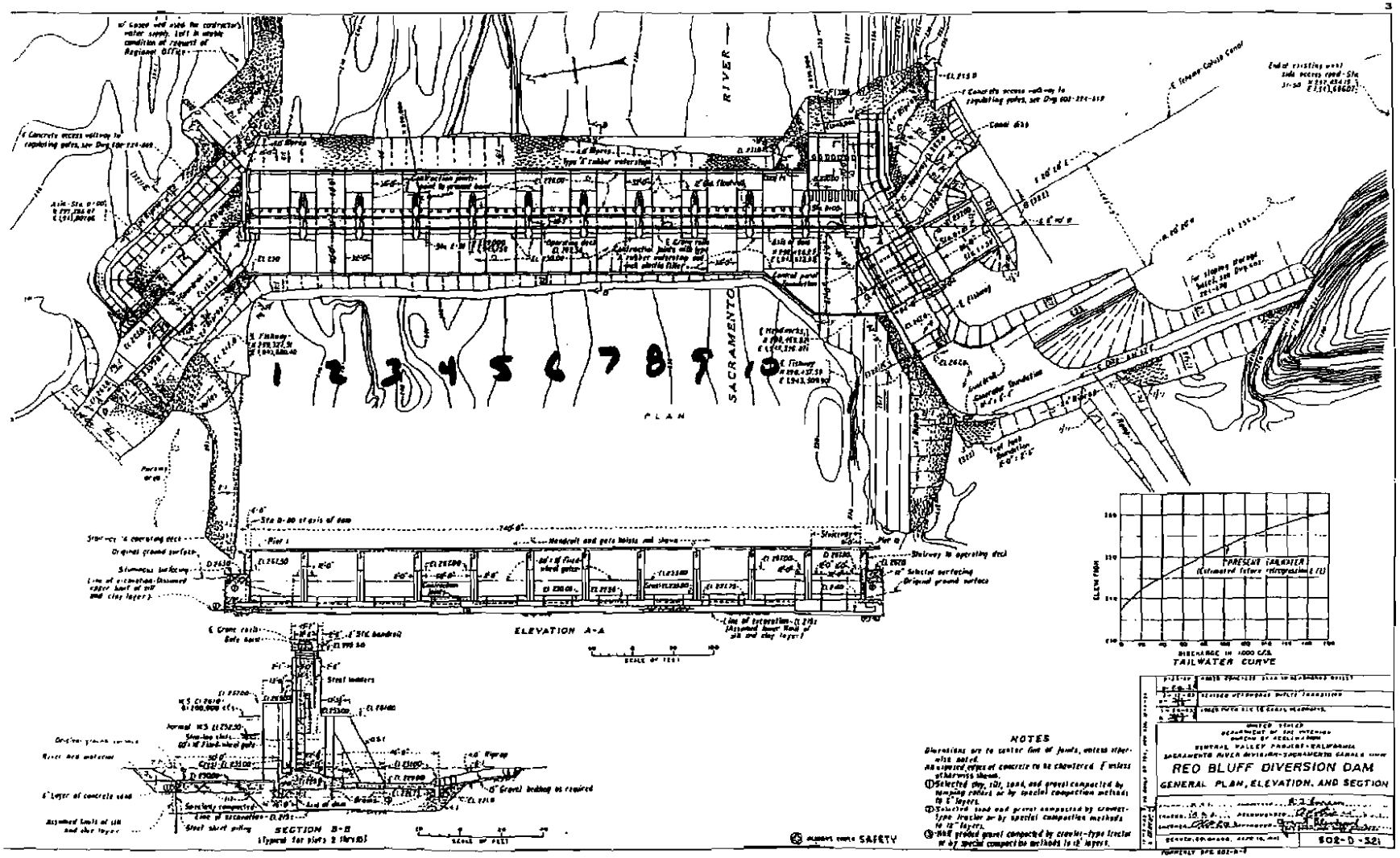
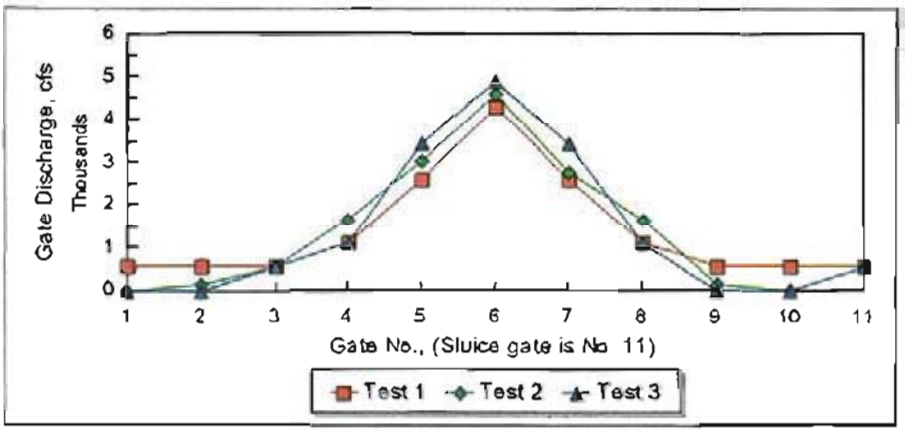


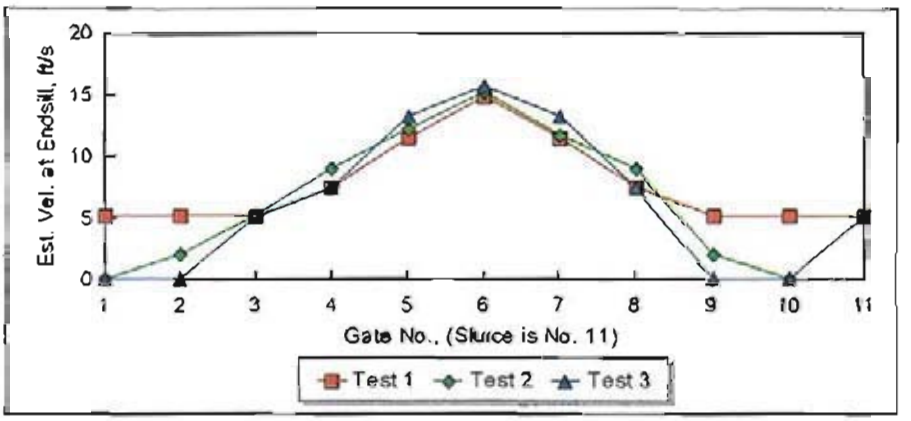
Figure 1- Plan and sections of Red Bluff Diversion Dam.

Table 1 - Proposed spillway gate releases for Red Bluff Diversion Dam stilling basin testing.

River Flow =	15000.00	cfs
Reservoir elevation =	252.00	ft
Tailwater elevation =	241.20	ft
Sill Elevation =	235.00	ft

					Gate No.							Total Flow cfs
Test # 1	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	
											Sluice	
Opening, ft	0.50	0.50	0.50	1.00	2.25	3.75	2.25	1.00	0.50	0.50	0.50	
H1/b	34.00	34.00	34.00	17.00	7.56	4.53	7.56	17.00	34.00	34.00	34.00	
H2/b	12.40	12.40	12.40	6.20	2.76	1.65	2.76	6.20	12.40	12.40	12.40	
Cd	0.55	0.55	0.55	0.56	0.58	0.58	0.58	0.56	0.55	0.55	0.55	
S/b	24.00	11.00	10.00	5.00	1.00	1.00	1.00	5.00	10.00	11.00	11.00	
Q/gate	545.95	545.95	545.95	1111.75	2590.77	4317.95	2590.77	1111.75	545.95	545.95	545.95	14998.68
Hd	5.00	11.50	12.00	12.00	14.75	13.25	14.75	12.00	12.00	11.50	11.50	
Vel. gate	26.00	26.00	26.00	26.47	27.42	27.42	27.42	26.47	26.00	26.00	26.00	
Endsill vel	5.08	5.08	5.08	7.32	11.37	14.68	11.37	7.32	5.08	5.08	5.08	
Test # 2	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	
											Sluice	
Opening, ft	0.00	0.25	0.50	1.50	2.75	4.00	2.50	1.50	0.25	0.00	0.50	
H1/b	0.00	68.00	34.00	11.33	6.18	4.25	6.80	11.33	68.00	0.00	34.00	
H2/b	0.00	24.80	12.40	4.13	2.25	1.55	2.48	4.13	24.80	0.00	12.40	
Cd	0.00	0.30	0.56	0.56	0.56	0.58	0.56	0.56	0.30	0.00	0.55	
S/b	0.00	11.00	7.00	7.00	7.00	5.00	1.00	1 00	1.00	0.00	5.00	
Q/gate	0.00	148.89	555.87	1667.62	3057.31	4605.82	2779.37	1667.62	148.89	0.00	545.95	15177.36
Hd	0.00	14.25	13.50	6.50	-2.25	-3.00	14.50	15.50	16.75	0.00	14.50	
Vel. gate	0.00	14.18	26.47	26.47	26.47	27.42	26.47	26.47	14.18	0.00	26.00	
Endsill vel	0.00	1.96	5.18	8.96	12.14	15.16	11.57	8 96	1.96	0.00	5.08	
Test # 3	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	
											Sluice	
Opening, ft	0.00	0.00	0.50	1.00	3.00	4.25	3.00	1.00	0.00	0.00	0.50	
H1/b	0.00	0.00	34.00	17.00	5.67	4.00	5.67	17.00	0.00	0 00	34.00	
H2/b	0.00	0.00	12.40	6.20	2.07	1.46	2.07	6.20	0.00	0.00	12.40	
Cd	0.00	0.00	0.55	0.56	0.58	0.58	0.58	0.56	0.00	0.00	0.55	
S/b	0.00	0.00	7.00	7.00	7.00	5.00	1.00	1.00	0.00	0.00	5.00	
Q/gate	0.00	0.00	545.95	1111.75	3454.36	4893.68	3454.36	1111.75	0.00	0.00	545.95	15117.80
Hd	0.00	0.00	13.50	10.00	-4.00	-4.25	14.00	16.00	0.00	0.00	14.50	





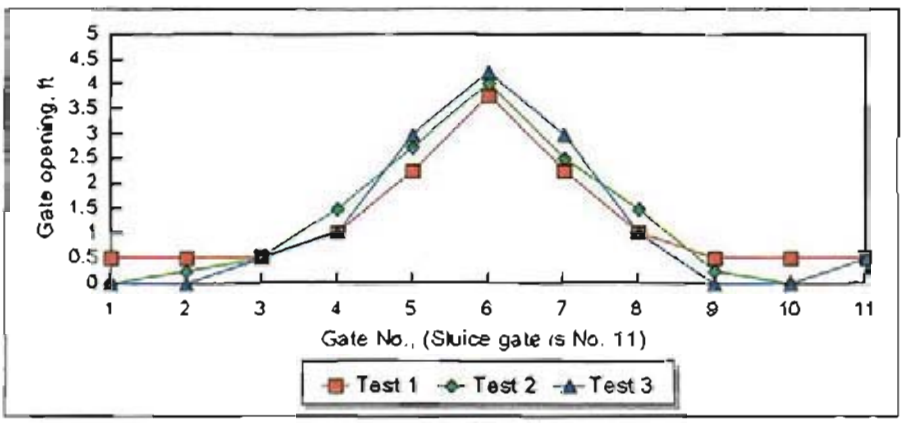


Figure 2 - Proposed tests for evaluating river centered flow through the Red Bluff spillway gates.

LC-4850
PRJ-12.00

MEMORANDUM

To: Chairman, Regional Diving Advisory Committee

From: Joel F. Sturm, Diver, Mid-Pacific Regional Office

Through: Rodney L. Tang, Divemaster

Through: Gregory Finnegan, Lower Colorado Region Dive Team Leader

Subject: Request for Services of the Lower Colorado Regional Underwater Investigation Team (Diving Team).

Note: A minimum of three divers for SCUBA dives and four divers for surface supplied air dives are required and approval of a diving request is subject to availability of divers as determined by their supervisors.

Date(s) of requested diving: August 13 through 17, 2001

Alternate date (s) requested: N/A

Deadline of requested diving: N/A

Is request of an emergency nature: No

Location(s) - list all - of requested diving: Red Bluff Diversion Dam, California

General diving conditions and any known hazards: All diving will be downstream of the dam, primarily on the downstream apron. Divers will stay downstream of a group of at least three adjacent, closed gates when submerged. Visibility is good (15 to over 20 feet). Some current will be present during the diving.

Purpose of dive: Describe and document the gradation and distribution of bottom sediment (gravel and cobbles) prior to and following each of three 24hr tests at specified different gate settings

Expertise required: Experience with Surface Supplied Air (SSA) and SCUBA diving. Operation of underwater still and video cameras. Boat operations.

Special equipment required: SSA and SCUBA diving equipment, underwater video and still cameras.

Cost authority number: A30-0725-6342-001-91-0-0-2

Will there be a series of multiple dives required for the same purpose or period reoccurring dives for minor maintenance or inspections? No

If so, estimate the number and time period of occurrence. N/A

Are other agencies involved? No If so, list them: N\A

Do they intend to participate in the diving? No

Are their divers certified by a nationally recognized agency? N\A

If so, name agency and certification level: N\A

Are they willing to participate under the restraints of the Bureau of Reclamation Diving Regulations? N\A

A dive plan must be completed and approved prior to providing services. Requesting office should provide assistance, as necessary.

Where a multiple dive request is approved by the Regional Diving Advisory Committee, each diving event must be further approved by the Regional Supervisor, Division of Water, Land, and Power.

Please contact Messrs. Greg Finnegan, at extension 702-293-8672 or Bill Rinne, at extension 8414, if there are any questions.

NOTE: ALL EMERGENCY NUMBERS WERE CONFIRMED ON JULY 26, 2001

Signed: _____ Date: _____
(Dive Team Leader)

ADDITIONAL REMARKS:

	Name	Title	Date
Approved:			
Approved:			
Approved:			
Approved:			
Approved:			
Approved:			

DIVE HAZARD ANALYSIS

ITEM	REMARKS
PREVIOUS DIVING IN AREA	Yes
ACCESS AND EXIT	Support boat equipped with swing-down dive ladder
DEPTH ACTUAL	25 feet
ALTITUDE	NWS: EL. 252.5
DEPTH CORRECTED	N\A
NON DECOMP LIMIT	310 min @ 30 feet
MAX BOTTOM TIME	2 hrs
BOTTOM CONDITION	Concrete variably covered by sand, gravel and cobbles.
ENTANGLEMENT	Downlines, monofilament fishing line and wood and brush debris. All divers carry knives.
BOAT TRAFFIC	One other Reclamation boat will be operating near the diving area. Divers will enter and exit the water from the dive support boat.
VERTICAL ASCENT	Yes
LIGHTS REQUIRED	No
TETHER LINE RECOMMENDED	Yes. Divers will be using SSA which includes a divers umbilical (air line, communications cable, pneumofathometer and strength member).
SURFACE SUPPORT	Yes. The diver's air, bottom time and depth will be monitored by the surface support crew. Diver to surface communication will be maintained throughout each dive.
EMERGENCY AID AT SITE OXYGEN BREATHER FIRST AID SUPPLIES AIR DECOMP TABLES	Yes
HOSPITAL	Mercy Medical Center, Redding, CA (530) 246-0400 St. Elizabeth Hospital, Red Bluff, CA ER: (530) 529-8300
PHYSICIAN	Dr. Fred Grabiel, Director ER: (530) 225-7247
RECOMP. CHAMBER	Hyperbaric Facility, Travis Air Force Base 101 Bodi Fairfield, CA (Air Base Pkwy South) (707) 423-3987
GROUND AMBULANCE	911 Ground Ambulance, Tehama Cty CDF, Red Bluff, CA
AIR AMBULANCE	(530) 225-6294 (Mercy Med Center, Redding, CA)
TELEPHONE	On site
RADIO	Yes. Boat to shore and boat to boat radio communication will be available.
LOCAL CONTACT	Max Stodolski, Chief, Red Bluff Division, USBR: (530) 529-3890

ITEM	REMARKS
Divers Alert Network (DAN)	**24hr Diving Emergency Hotline: (919) 684-8111** First Aid & Chamber Information

ALL DIVE PERSONNEL TRAINED IN DIVER FIRST AID, CPR, LIVE SUPPORT AND LIFE SAVING:	Yes

Signed: _____ Date: _____

(Dive Team Leader)

DIVE PLAN AND POST DIVE DATA

TEAM ASSIGNMENT BUDDY SYSTEM:

TEAM	NAMES	POST DIVE DATA (TRAVEL(date,time); TIMESHEET)
No. 1	Tang/divemaster /diver	
No. 2	Calvert/diver	
No. 3	Dewey/diver	
No. 4	Sturm/diver	
No. 5	Clune/diver	
		Notes: 1) Divers will make solo dives using SSA. A 3-person surface support crew (standby diver, tender and timekeeper/air manifold operator) will be provided for each dive. 2) All divers will be traveling via GOV. No flying is required. No high altitude passes are present on the route of travel.

TEAM WORK ASSIGNMENT:

TEAM	ASSIGNMENT	POST DIVE DATA (ACTUAL WORK)
NO. 1		
NO. 2		
NO. 3		
No. 4		
No. 5		

TEAM EXPERIENCE FOR WORK ASSIGNMENT AND DIVE CONDITIONS:

TEAM	EXPERIENCE/PROF	POST DIVE DATA (ACTUAL NOTABLE CONDITIONS)
No. 1	All divers are experienced in the use of SSA and SCUBA. Sturm and Tang are certified ADC SSA Diving Supervisors.	
No. 2		
No. 3		
No. 4		
No. 5		ADC: Association of Diving Contractors

TEAM	DEPTH/TIME 1	DEPTH/TIME 2
No. 1		
No. 2		
No. 3		
No. 4		
No. 5		

WEATHER: Clear, hot WATER CONDITION: Calm ICE: No	AIR TEMP.: 90-100 deg WATER TEMP.: 70 deg VISIBILITY WATER:15-20'	WINDS: Light CURRENTS: Yes

RECOMMENDATIONS AND CONCLUSIONS: All divers have the required diving experience. The divers are familiar with the dive site, equipment and diving operations. All divers have obtained permission from their supervisors to participate in this diving activity. Divers Tang and Dewey are certified boat operator/trainers with experience operating small power boats in rivers and lakes. The requested diving is recommended.

Divers Review and Initial:

Signed: _____ Date: _____
(Dive Team Leader)

July 28, 2001
(Rev August 8, 2001)

To: Red Bluff Diversion Dam Dive Team Files

From: Joel F. Sturm, Supervisory Geologist/Diver, MP-221

Subject: **GATE AND DIVING OPERATIONS AND LOCK OUT/TAG OUT PROCEDURES** – Fishway Attraction Study, August 13 through 17, 2001 -- Red Bluff Diversion Dam, California

GENERAL INFORMATION

Red Bluff Diversion Dam is a 740-foot long, 67-foot high concrete gated weir that consists of 10, 60-foot wide fixed wheel gates (Gates 1 through 10 from left to right) and a 60-foot wide sluice gate adjacent to the right abutment (Gate 11). Each gate has a capacity of about 1200 cfs per foot of vertical gate opening. Total flow in the Sacramento River during the week of August 13 through 17 is anticipated to be about 12,000 to 14,000 cfs. NWS upstream of the dam is El. 252.5.

DIVING EQUIPMENT AND PROCEDURES

All diving will be staged from a 18-foot aluminum work boat equipped with a 150 hp outboard motor. All dives are currently planned as solo dives with Surface Supplied Air (SSA) diving equipment (Superlight 17 helmet, air hose, two-way communications system, pneumofathometer (depth gauge) and helmet-mounted submersible color video camera). As an alternative to SSA, SCUBA-equipped diver buddy pairs and a surface standby diver may be employed. Divers will observe, describe and photograph/videograph bottom sediment distribution, riprap condition and concrete erosion. Divers will establish their locations by following either construction joints in the downstream concrete apron (if visible) or a weighted , 100-foot-long line marked at 10 foot intervals. Diver movement will also be tracked by watching the divers' bubbles at the surface. A surface support team consisting of a tender, standby diver and air manifold operator/timekeeper and the divemaster will be present in the dive boat whenever a diver is in the water. Continuous communications will be maintained with the diver throughout each dive.

TERMINATION OF DIVING OPERATIONS

Diving can be terminated at any time by the divemaster or diver. Possible reasons for terminating the dive are:

- an unexpected increase in current velocity or direction
- the need to open a gate
- diver fatigue or extreme cold

GATE AND DIVING OPERATIONS

1) Depending on flow conditions, all flow will be routed through either four or five open gates

while the remaining six or seven gates will be closed (Example: Gates 1- 4 open, Gates 5-11 closed).
2) The lock out/tag out procedure described below will be put into effect.
3) The dive boat will be anchored near the mid-point of the closed gates (centerline of Gate 8 in the above example).
4) The diver will enter the water and conduct an underwater inspection of the apron, riprap and bottom sediment downstream of the closed gates (Gates 5-11).
5) The diver will exit the water into the dive boat and the divemaster will communicate this to the gate operator via radio who will temporarily remove the gate clearance while the gates are repositioned.
6) Gates 8-11 will be opened and Gates 1-7 closed.
7) The lock out/tag out procedure described below will be put into effect.
8) The dive boat will be anchored at the centerline of Gate 4.
9) The diver will enter the water and conduct an underwater inspection of the apron, riprap and bottom sediment downstream of closed Gates 1-7.
10) The diver will exit the water into the dive boat, the divemaster will communicate that diving operations have been completed and that the diver is in the dive boat to the gate operator via radio and the gate clearance will be removed.

LOCK OUT/TAG OUT PROCEDURES

1) Gates will positioned as described above by the designated Red Bluff Division employee (referred to here as the gate operator).
2) The gate hoists will be de-energized (i.e. electric power to all gates will be disconnected rendering raising of the gates impossible).
3) The electrical breakers will be red-tagged for non-operation with the clearance held by the gate operator.
4) The gate operator will communicate this to the divemaster in the dive boat who will then initiate diving operations.
5) Gate hoists will be de-energized and on clearance whenever a diver is in the water.

5/13

DISTRIBUTION OF SEDIMENT
AUGUST 13, 2001

SCALE: 1" = 50'

PLAN

RED BLUFF DIVERSION DAM

FIGURE 1

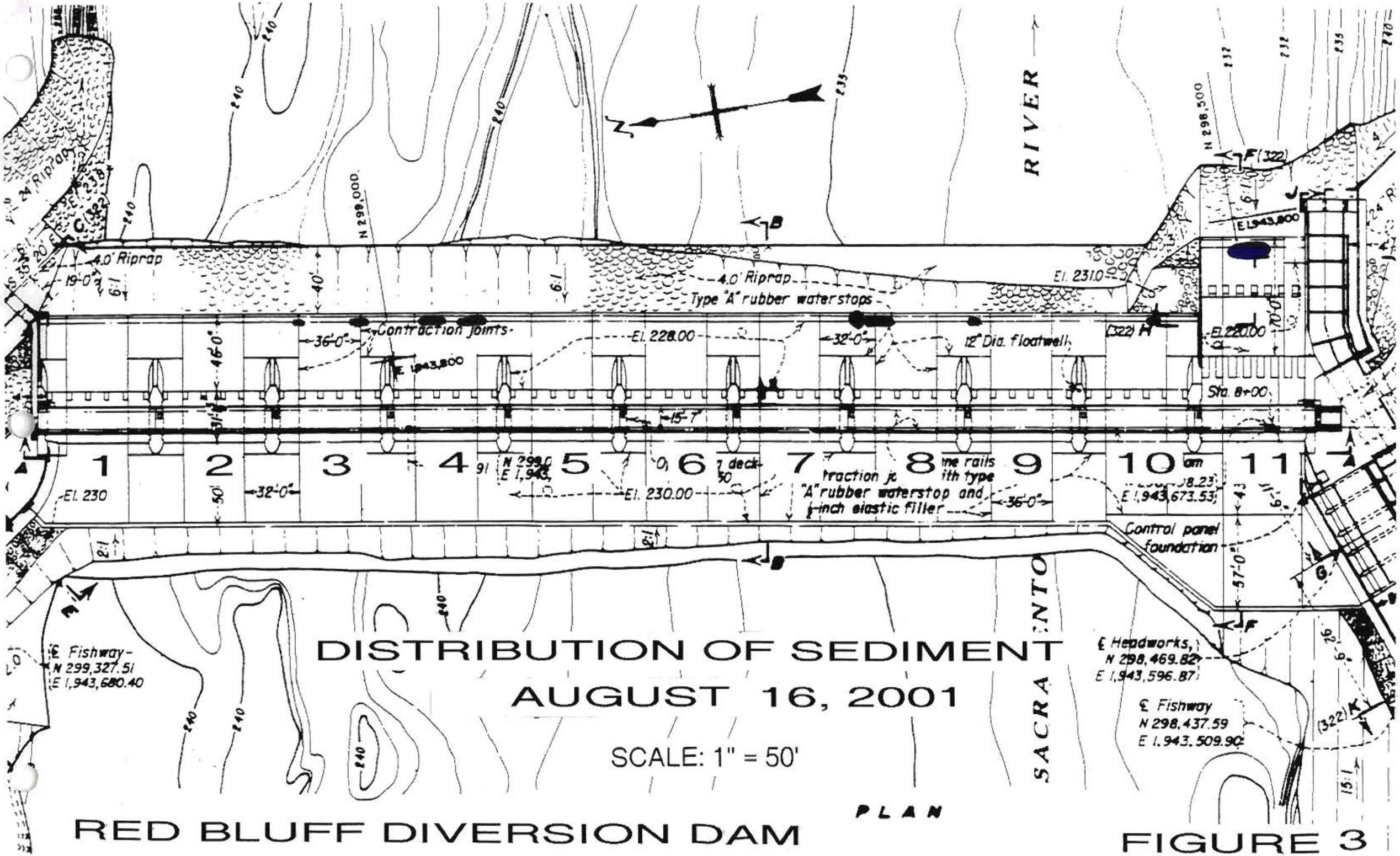
DISTRIBUTION OF SEDIMENT
AUGUST 15, 2001

SCALE: 1" = 50'

PLAN

RED BLUFF DIVERSION DAM

FIGURE 2



DISTRIBUTION OF SEDIMENT
AUGUST 16, 2001

SCALE: 1" = 50'

PLAN

RED BLUFF DIVERSION DAM

FIGURE 3

DISTRIBUTION OF SEDIMENT
AUGUST 17, 2001

SCALE: 1" = 50'

PLAN

RED BLUFF DIVERSION DAM

FIGURE 4

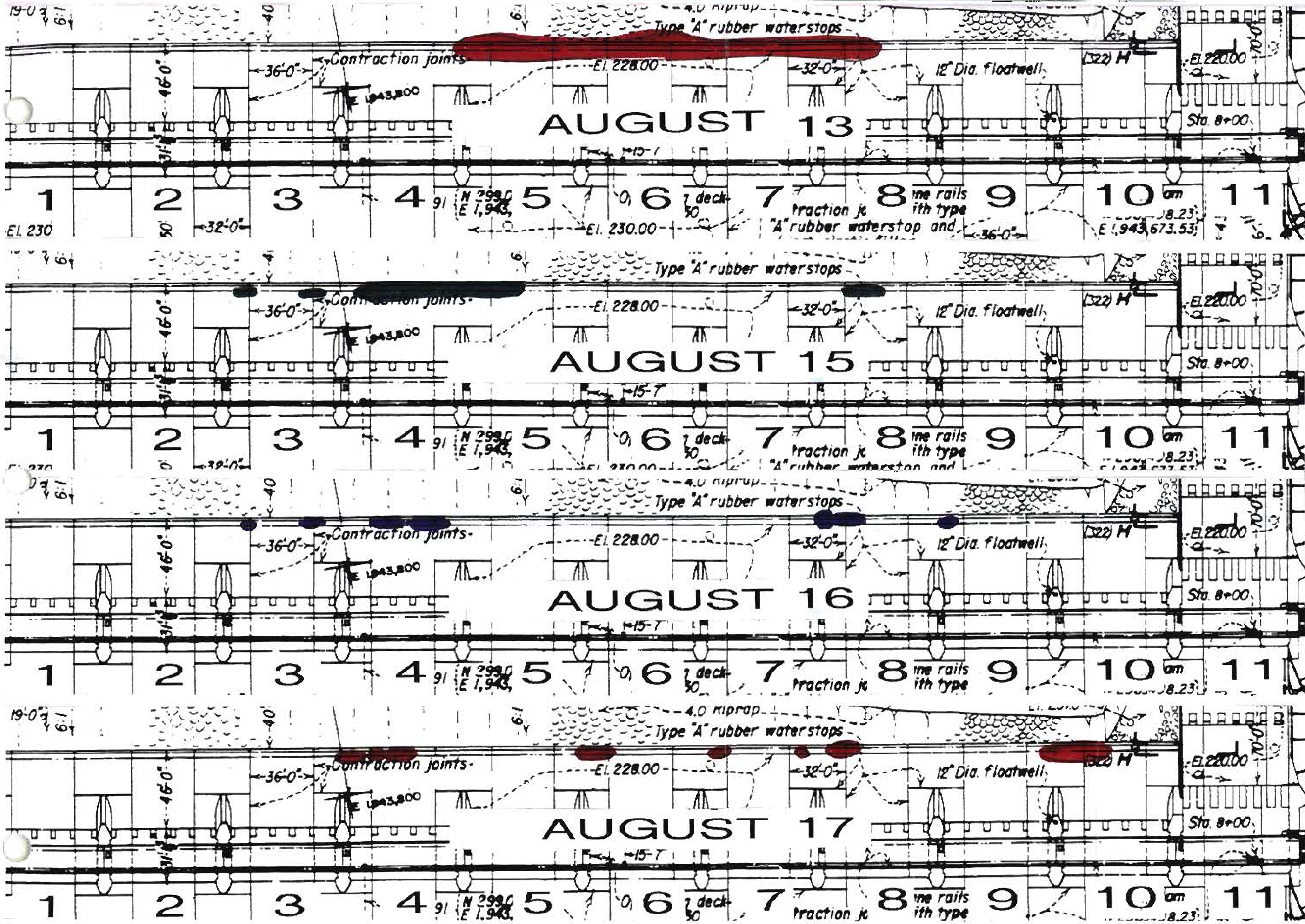
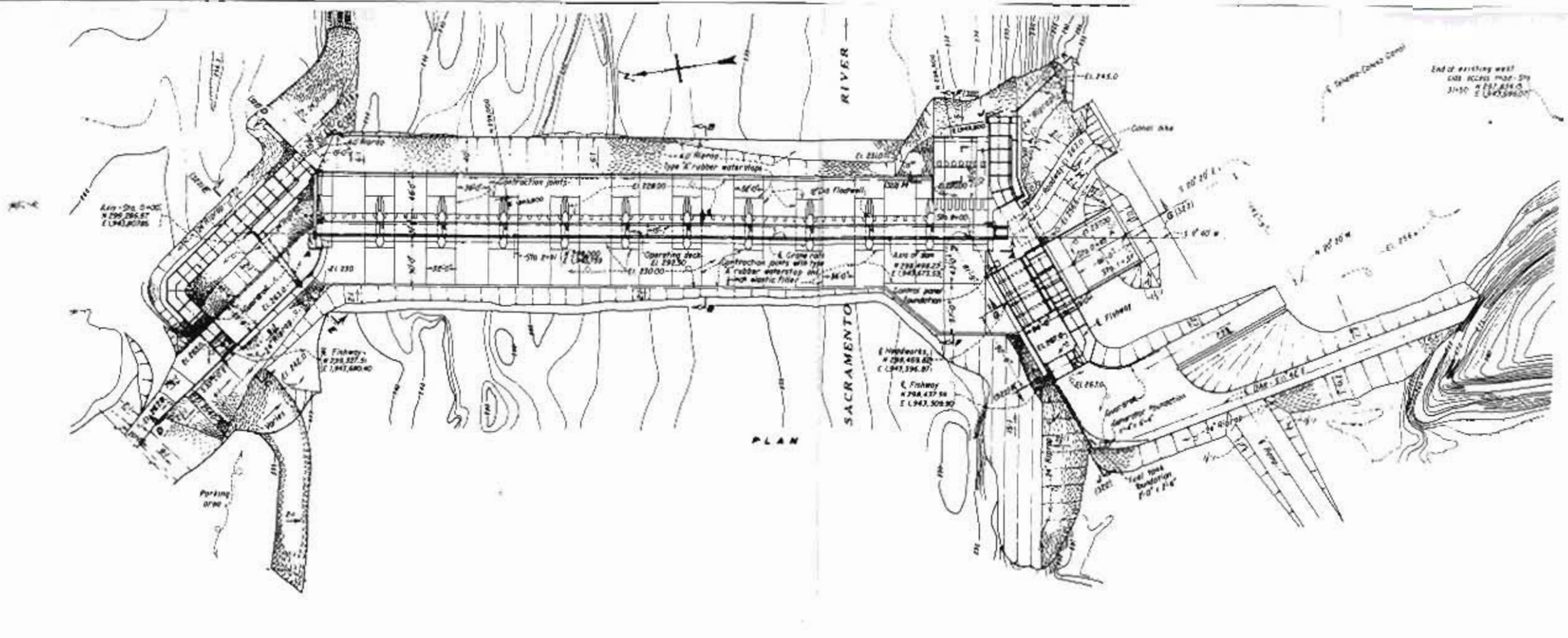
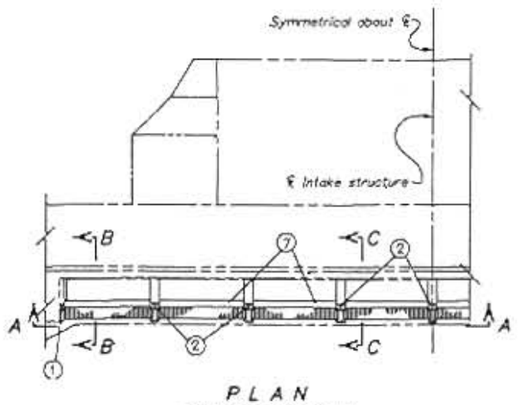


FIGURE 5
RED BLUFF DIVERSION DAM
DISTRIBUTION OF SEDIMENT
AUGUST 13–17, 2001

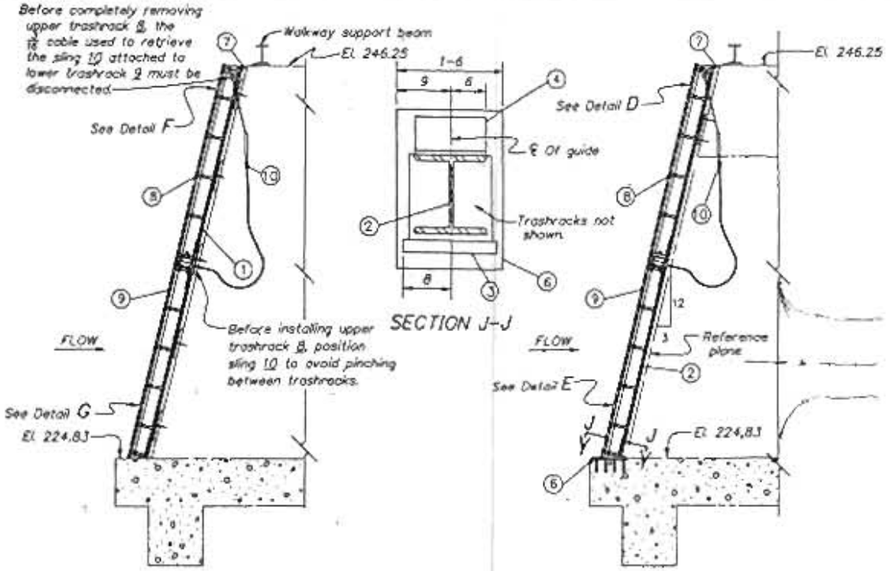


Red Bluff Diversion Dam, Plan and Sections



PLAN

TRASH COVERS & NOT SHOWN



SECTION B-B

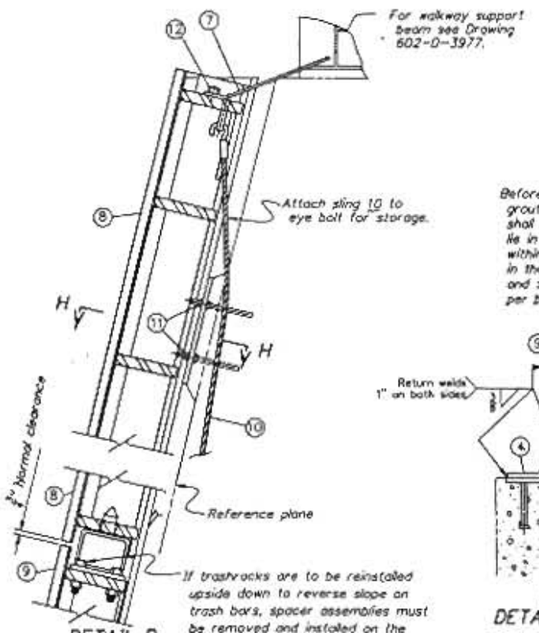
SECTION J-J

SECTION C-C

LIST OF PARTS

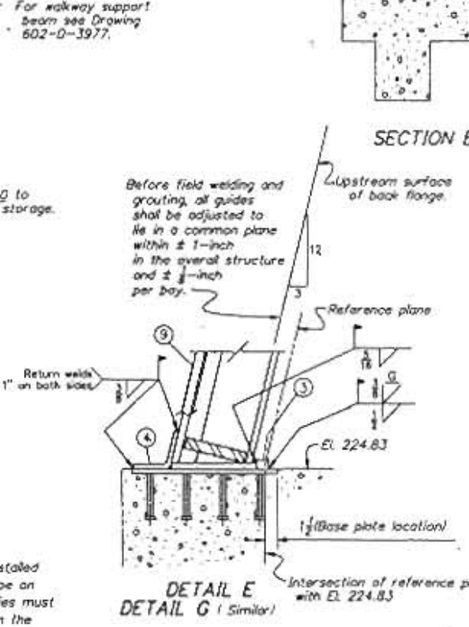
PART NO.	DRAWING NUMBER	NO. REQD	DESCRIPTION	MATERIAL*
1	602-D-4032	2	End guide	Structural steel
2	"	7	Intermediate guide	
3	"	7	Bar	
4	"	7	Angle	
5	"	24	Trash cover	Steel
6	"	7	Base plate	Structural steel
7	"	8	Trash plate	Steel
8	602-D-4033	8	Upper trashrack	Structural steel
9	"	8	Lower trashrack	
10	"	8	Sling	Steel
11	No Detail	48	¾ Dia. capsule anchor	Stainless Steel
12	-	72	¾-11UNC-2A x 1½ Hex. hd. cap screw	

* See detail of part for material specification.
† See Notes.
Estimated weight ..... 195,000 lbs.



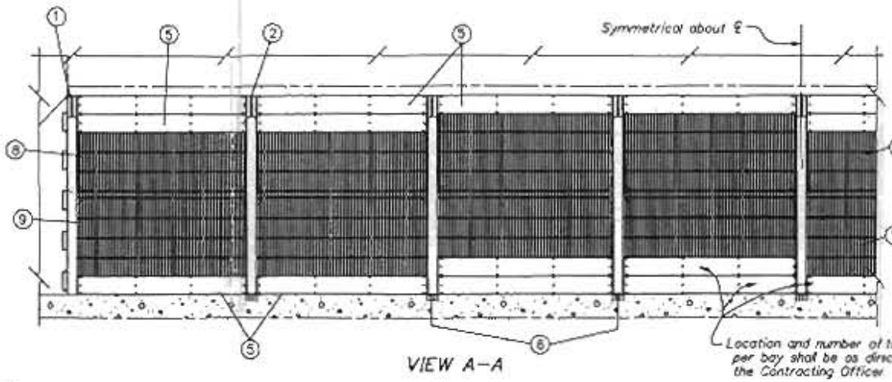
DETAIL D

DETAIL F (Similar)

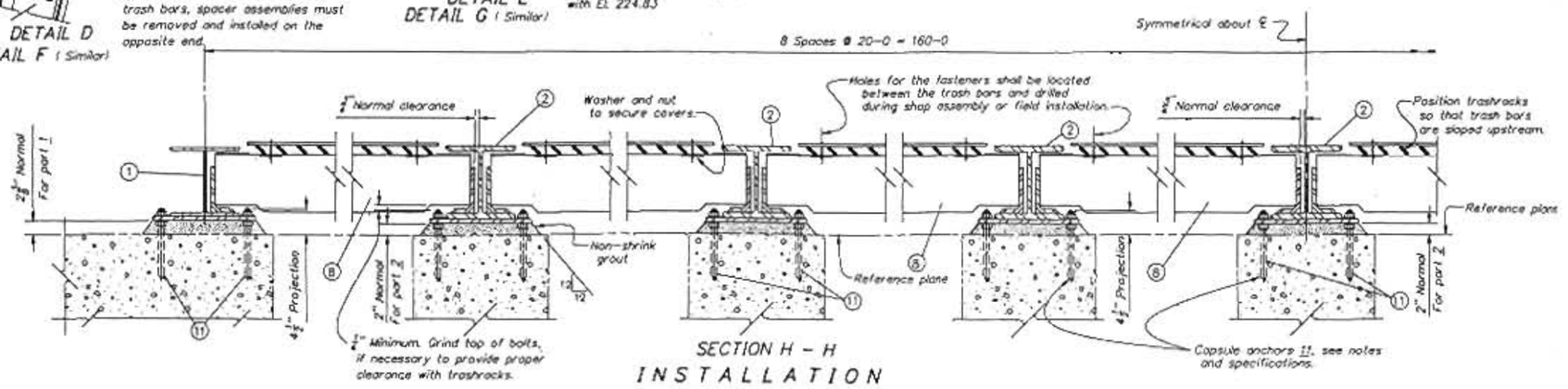


DETAIL E

DETAIL G (Similar)



VIEW A-A



SECTION H - H

INSTALLATION

NOTES

Capsule anchor shall be Molly Paraboard Capsule anchor as manufactured by Emhart, Molly Threaded Fastener Division, 504 Mt. Laurel Ave., Temple PA. 19560, or equal. Provide a stud assembly for each anchor consisting of a threaded S.S. rod, two bronze hex nuts, and two S.S. plain washers. The threaded rod shall have a double chamfered point and be of sufficient length for projection shown on the drawing plus the manufacturer's recommended embedment depth.

Repair all paint damage due to field welding.

LIST OF DRAWINGS

TRASHRACKS
INSTALLATION - ASSEMBLY - LIST OF PARTS 602-D-4031
GUIDES - BASE PLATE - DETAILS 602-D-4032
UPPER AND LOWER TRASHRACKS - SLING 602-D-4033

REFERENCE DRAWINGS

PUMP DEMONSTRATION PROJECT
INTAKE STRUCTURE
PLAN, SECTIONS AND DETAIL 602-D-3947
MISCELLANEOUS METAL WORK
INTAKE STRUCTURE WALKWAY 602-D-3977

ALWAYS THINK SAFETY

UNITED STATES
DEPARTMENT OF THE INTERIOR
BUREAU OF RECLAMATION
CENTRAL VALLEY PROJECT - CALIFORNIA
SACRAMENTO RIVER DIVISION - SACRAMENTO CANALS UNIT

RED BLUFF DIVERSION DAM
PUMP DEMONSTRATION PROJECT
INTAKE STRUCTURE
TRASHRACKS
INSTALLATION - ASSEMBLY - LIST OF PARTS

DESIGNED R.F. Brunell — TECHNICAL APPROVAL R.F. Brunell
DRAWN William Walker — SUBMITTED E.J. Trout
CHECKED G.J. Fauerbach — APPROVED [illegible] CHIEF, MECHANICAL BRANCH

Grid System Coord. = Datum NAD	602-D-4031 NEXT DRAWING TRASH	Date and Time (TYP) Dec. 8, 1982 11:57
DENVER, COLORADO NOVEMBER 30, 1982	SHEET 1 OF 3	602-D-4031

DFC&SO