CALIFORNIA COASTAL COMMISSION
NORTH COAST DISTRICT OFFICE
1385 EIGHTH STREET, SUITE 130
ARCATA, CA 95521
VOICE (707) 826-8950
FAX (707) 826-8960

F8b

1-09-050

(HUMBOLDT COUNTY)

NOVEMBER 6, 2020

EXHIBITS

Table of Contents

EXHIBIT NO. 1

CDP Application No. 1-09-050
(Humboldt County)
Regional Location Map

EXHIBIT NO. 2

CDP Application No. 1-09-050
(Humboldt County)
Aerial View & Emergency Plans
(page 1 of 11)

DEPARTMENT OF PUBLIC WORKS

COUNTY OF HUMBOLDT

MAILING ADDRESS: 1106 SECOND STREET, EUREKA, CA 95501-0579
AREA CODE 707 / FAX 445-7409

ARCATA-EUREKA AIRPORT TERMINAL McKINLEYVILLE		PUBLIC WORKS BUILDING SECOND & L ST., EUREKA			CLARK COMPLEX HARRIS & H ST., EUREKA	
AVIATION	839-5401	ADMINISTRATION	445-7491	NATURAL RESOURCES	445-7741	LAND USE 445-7205
		BUSINESS	445-7652	PARKS	445-7651	
		ENGINEERING	445-7377	ROADS & EQUIP MAINT	445-7421	
			ARCHITECT 445-7493			

Mad River Streambank Protection Project

Project Description
July 10, 2008

Location

The proposed emergency erosion control project is located on the right bank (facing downstream) of the Mad River near the intersection of School Road and Verwer Court in McKinleyville, Humboldt County (Figure 1). The proposed project site is located on or adjacent to the following properties:

- APN 508-021-007 (McKinleyville Community Services District)
- School Road right-of-way (County of Humboldt)
- APN 508-151-016 (Earls)
- APN 508-151-017 (Halewijn)
- APN 508-151-030 (Halewijn)
- APN 508-151-004 (Miller)
- APN 508-151-003 (Jones)

In addition, the following parcels, located directly east of the project site, have been identified by the United States Department of Agriculture-Natural Resources Conservation Service (NRCS) as being at risk for further bank erosion and bluff retreat:

- APN 508-151-025 (Earls)
- APN 508-151-024 (Feldman)
- APN 508-151-023 (Vandenbosch)
- APN 508-151-022 (Lasak)

The project site is situated approximately 1.5 miles upstream from the 2008 location of the mouth of the Mad River (west of Murray Road). The project site is a bluff ranging in height from approximately five feet above mean tide level at the southern end to nearly 50 feet above mean tide level at the northern end. The project site contains the Mad River channel and streambank and the adjacent upland terrace. Riparian vegetation is negligible within the project site due to the active erosion. The project site does not contain wetlands.

Background

An area of streambank along the right bank of the Mad River was damaged in December 2005 and January 2006 by high water flows caused by severe storms during a federal- and state-declared disaster. After experiencing substantial erosion during these storms, the top of the bluff is currently within 15 feet of a residence and in close proximity to several other residences as well as public infrastructure. A heavily vegetated bar situated immediately upstream of the project site near the left bank of the river is directing the channel thalweg (the area of deepest flow and highest velocities) in a northeast direction toward the right bank where the damage occurred. In addition, the bar causes a narrowing of the channel which results in higher velocities. These geomorphic conditions are expected to continue, and without intervention the bluff at the project site can be expected to experience substantial erosion during high-flow events.

Efforts to obtain funding for a bank stabilization project began immediately after the streambank damage in December 2005/January 2006. Allocation of funding and completion of the associated agreements between the participating agencies and affected landowners were completed in February 2008. The primary funding source for construction is the Emergency Watershed Protection program administered by the NRCS. NRCS developed a damage survey report for the site, and determined that emergency measures are warranted to relieve imminent hazards to life and property. Humboldt County is serving as local sponsor for the project. The cost-share for construction funding is being provided under the California Disaster Assistance Act administered by the Governor's Office of Emergency Services (OES).

In February 2008, Humboldt County retained LACO Associates to perform a geologic investigation of the site and provide a professional expert opinion regarding the level of urgency for a repair project. In their April 11, 2008 report, LACO Associates identified a strong correlation between flows in the Mad River above a certain threshold and events of significant bank erosion and bluff retreat. According to the report, "It is not a certainty that each and every such peak discharge event above the identified threshold will result in erosion and retreat of the bluff edge. However, there is, in our opinion, a greater than 50 percent probability that a peak discharge event will occur during the next winter season with a reasonable likelihood of causing at least 10 feet of bluff erosion, a 10 to 33 percent probability that a peak discharge event will occur that could cause up to 50 feet of bluff erosion, and a 5 percent probability that a peak discharge event will occur that could cause up to 90 feet of bluff erosion." LACO Associates concludes that "there is substantial evidence that potentially significant bluff erosion may occur in the next 12 months to threaten property, essential services, life and health at the Mad River bluff near the end of School Road."

During the winters of 2006/2007 and 2007/2008, there was localized erosion and sloughing up to a few feet at the project site but not major bluff retreat, as flows in the Mad River did not exceed the threshold (25,000 to 30,000 cubic feet per second) identified by LACO Associates as being strongly correlated with substantial erosion events. However, LACO Associates' analysis indicates that the probability of the flow threshold being exceeded in any given year is significant (greater than 50 percent). Based on LACO Associates' findings, Humboldt County determined that there is a high level or urgency to implement a bank stabilization project before the 2008-2009 winter season in order to avoid further bank erosion and bluff retreat and to mitigate the imminent threat to life, property, and essential public

the Humboldt County Board of Supervisors authorized the Public Works Department to develop the design for an emergency project (expanding upon a preliminary design provided by NRCS) and apply for emergency permits.

The Public Works Department developed the following design criteria for the project:

1. The project will enhance erosion resistance and stability for the damaged streambank
2. The project will not cause adverse impacts for downstream conditions
3. The project will provide aquatic habitat and water quality benefits

Criteria 1 will be achieved by armoring the lower portion of the bank with rock slope protection and bioengineered components, and re-grading the upper portion of the bank to a lower angle and stabilizing the slope surface with vegetation.

Criteria 2 will be achieved by designing the project to have minimal hydraulic effects on the channel. The project is focused on armoring and stabilizing the bank, and will not re-direct the channel nor cause a significant encroachment into the channel. To support this design objective, Humboldt County retained Stillwater Sciences in May 2008 to conduct a geomorphic evaluation of the project site and perform hydraulic modeling. The purpose of these studies was to gain an understanding of current conditions and potential future trajectory of the geomorphology of the project site; assess potential water velocities, sediment scour, and deposition patterns that may occur following the proposed project; and optimize the effectiveness of the bank stabilization design. Stillwater Sciences provided their findings at a meeting with Public Works on June 27, 2008. Based on this work, Public Works determined that there is sufficient evidence to conclude that the project should not result in adverse downstream effects. The findings of the geomorphic evaluation and hydraulic modeling are documented in two technical reports (Stillwater Sciences, 2008).

Criteria 3 will be achieved by reducing erosion and sedimentation to the lower Mad River, and by enhancing aquatic habitat through the incorporation of riparian vegetation and complex geomorphic features. The Mad River is listed as impaired for sediment and turbidity under Section 303(d) of the Clean Water Act, and the project will provide treatment for an active sediment source. The geomorphic features of the proposed project include rock groins with large woody debris to provide habitat complexity in a reach of the lower Mad River where such complexity is lacking.

Project Description

Project Design

The proposed project consists of emergency repair measures to stabilize an approximately 1,300-foot stretch of streambank. The lower portion of the bank will receive a stabilization structure composed of rock slope protection and bioengineered components, and the upper portion of the bank will be re-graded and re-vegetated.

The stabilization structure will have a continuous toe trench filled with four- to six-ton rocks extending along the base of the bluff for the length of the project site. The toe trench is designed

to protect the bank from scour and provide a stable foundation for the upper layers. The height of the toe trench will be approximately eight feet, extending from -8 to 0 feet elevation (NAVD 88).

The layer overlaying the toe trench will consist of an alternating series of groins and willow mattress/rock sections. The groins will be layered mounds of revetment with a slight protrusion (less than approximately 20 feet) riverward from the armored bank, spaced at approximately 60-foot intervals. The groins will be constructed with rock boulders in conjunction with large woody debris secured with threaded rebar and cable anchors. The rock will consist of four- to six-ton rock near the bottom, transitioning to half- to one-ton rock at the top. The top of the groins will reach an elevation of approximately 14 feet (NAVD 88).

The willow mattress/rock sections will be composite layers of rock and soil integrated with willow mattresses. One-ton rocks will be placed along the bank to anchor the sections. Willow mattresses are approximately four- to six-inch-thick bundles of willow branches or cuttings tied with twine or string. Materials will be placed in lifts, and the mattresses will be secured with four-inch-diameter willow stakes. Willow materials will be salt-tolerant and collected locally from Mad River County Park or vegetated bars within the channel.

Concrete debris placed previously by others along a portion of the project site will be incorporated into the structure, either as part of the rock groins or the anchor rock for the willow mattress/rock sections.

The upper layer of the bank will be re-graded to a lower angle, and the slope will be stabilized with vegetation. Soil generated from grading the upper layer will be incorporated into the willow mattress/rock sections as a growth matrix for riparian vegetation.

The bank stabilization structure will be keyed back into the native bank material at the upper and lower ends to prevent flanking.

The estimated total volume of fill material is 10,500 cubic yards, of which approximately 8,500 cubic yards will be placed below the mean tide level. The estimated area of impact is approximately 0.60 acres.

Construction Activities

Construction of the bank stabilization features will require the following activities:

- Development of a temporary access road at the south end of the project site, down to a natural bench feature situated at the bottom of the streambank.
- Mobilization of heavy equipment, including an excavator and dump trucks.
- Erection of a fish exclusion and sediment containment structure around the work area.
- Collection of willow cuttings from nearby vegetated areas within the lower Mad River floodplain.
- Temporary stockpiling of materials (rock, willow mattresses and stakes, large woody debris).
- Grading of the streambank to prepare the ground for placement of the rocked toe trench and rock slope protection.
- Placement of rock, soil, and anchored willow mattresses al

- Laying back the upper portion of the bank to achieve a more stable slope angle.
- Grading of streambank soils to provide a growth matrix for vegetation.
- Planting of vegetation.
- De-mobilization.

Fish Exclusion and Sediment Management

The primary protective measure to avoid impacts to fish, marine mammals, and water quality will be a temporary barrier structure placed within the channel adjacent to the work area. The barrier structure will be built with silt fencing to allow water to pass through while retaining sediment and excluding fish. The structure restricts the flow of sediment-laden water and keeps it contained in a limited area, allowing sediment settling to occur. In addition, sediment-laden water within the containment structure will be pumped out and discharged in an upland area in order to maintain the desired flow gradient (i.e., clean water flowing in). The containment structure will be monitored and maintained as needed.

The barrier structure will be installed in sections (approximately 150 to 300 feet long). Silt fencing will be attached to steel fence posts mounted into the channel bottom at approximately ten-foot intervals. Two methods of attachment may be used, depending on site conditions. The first method is a floating baffle curtain system in which weighted silt fencing is draped over floating baffles which rise and lower with the tides. The second method is a fixed-in-place system whereby the silt fencing is secured on the posts with hog wire and cable, and stabilized by mounting sand bags as appropriate. Each section will be built segment by segment until only the downstream end is open. Then fish exclusion procedures will be implemented to herd the fish out of the containment area, before closing off the open end.

For fish exclusion, a small-meshed seine will be used to herd fish through the open end and out of the containment area. The seine net will have a float on top and weights at the bottom to ensure sufficient coverage. Two seine nets will be used and a minimum of two passes will be conducted to ensure that fish are not entrapped within the containment structure. After the first pass of seining, the seine net will remain at the downstream opened end to prevent fish from re-entering the containment area. Next, a second seine will again slowly sweep the area towards the opened end of the structure. Once both seine nets are secured at the downstream end of the structure, the area will be visually examined for any fish that may still be within the containment area. If fish are observed, the first seine will be removed from the downstream end and used to re-sweep the area. The second seine will remain attached at the downstream end. This procedure will continue until seining efforts result in no fish being herded out of the containment area.

Longevity

Following completion of the project, the repaired bank's resistance to erosion is expected to be comparable to other reaches along the lower Mad River, and the repaired bank is expected to endure into the foreseeable future. However, unforeseen events, especially a major flood or significant shifting of the mouth of the Mad River, could result in conditions that overwhelm the implemented erosion control measures.

Anticipated Schedule

Phase	Target Completion Date
Design	July 22, 2008
Contracting	August 5, 2008
Permits	August 25, 2008
Begin Construction	August 25, 2008
End Construction	Early November 2008

Threatened, Endangered, and Protected Species

Fish

The Mad River supports three anadromous fish species which are listed as threatened under the federal Endangered Species Act: Southern Oregon/Northern California coho salmon (*Oncorhynchus Kisutch*); California coastal chinkook salmon (*Oncorhynchus tshawytscha*); and Northern California steelhead (*Oncorhynchus mykiss*). The Mad River also supports coast cutthroat trout (*Oncorhynchus clarkia clarkia*), which is a State species of special concern. It is assumed that salmonids will be present in the lower Mad River during implementation of the project.

Tidewater gobies prefers brackish lagoons, and the salinity in the project area exceeds the tolerance range for this species. Tidewater gobies are not expected to be present.

The expected work period for the project is late August through early November, and one or more threatened salmonid species are likely to be present in the lower Mad River during this time. Juvenile rearing for Steelhead occurs in the Mad River estuary throughout the summer. In addition, the expected work window intersects with the following migration times:

- Coho adult in-migration – October through February
- Chinook adult in-migration – September through December
- Chinook juvenile out-migration – October through November
- Steelhead adult in-migration – October through February

Mammals

Marine and freshwater mammals such as harbor seals and beavers may be present within the lower Mad River throughout the year.

Birds

Western snowy plovers breed on dune-backed sandy beaches and on gravel bars situated on rivers near the coast. The project site is not suitable habitat for snowy plovers, and plovers are not expected to be present.

Bank swallows nest within cavities dug into exposed soil on bluff faces. Bank swallows have been observed nesting within the project site. However, the project is scheduled to occur after nesting season is complete.

Endangered Species Consultation
NRCS is the lead federal action agency responsible for initiating consultation under the federal Endangered Species Act. Informal contact with the U.S. Fish and Wildlife Service and NOAA-National Marine Fisheries Service was made in April and May 2008.

Ray Bosch with the U.S. Fish and Wildlife Service indicated in an e-mail dated June 11, 2008, that there would be no effect for tidewater goby or other threatened or endangered species under the jurisdiction of U.S. Fish and Wildlife Service.

Leslie Wolff with NOAA-National Marine Fisheries Service indicated verbally on June 4, 2008, that emergency consultation for potential impacts to listed salmonids would be required. NRCS submitted a written request dated June 20, 2008, to NOAA-National Marine Fisheries Service for emergency endangered species consultation.

Potential Environmental Impacts

Direct Impacts to Listed Species
Listed salmonids are assumed to be present in the lower Mad River, but are not expected to be present within the work area after erection of the temporary barrier system. Heavy equipment work within the wet channel will occur behind the temporary barrier system to avoid direct impacts to fish and mammals.

The work area is a small portion of the lower Mad River, and a large amount of similar habitat is present in the immediate vicinity. This habitat contains little complexity, and is expected to have poor utilization by fish. Placement of the temporary barrier system will not take away crucial habitat or create a limitation for productivity.

Sediment and Erosion Control
The project may result in temporary increases in sediment and turbidity to the lower Mad River, however the temporary barrier system is designed to minimize these effects. Temporary effects from sediment that penetrates the temporary barrier system are expected to be short-term and minor due to dilution by the Mad River flows. The net effect of the project will be beneficial by reducing erosion and sediment loading to the Mad River. Beaches on the north coast are not limited by sand replenishment like beaches in other parts of California, so there will be no effect to coastal beaches.

Hydrology and Geomorphology
The lower Mad River is a dynamic physical environment that includes a meandering river, migrating river mouth, sediment transport, tidal action, evolving dune and coastal morphology, seismic activity, and a variety of bluff erosion mechanisms including river scour, direct rainfall, surface water runoff, and groundwater. Downstream from the project site, ocean waves penetrate the river mouth and have effects on the streambanks.

Baseline conditions within the lower Mad River were evaluated by documenting the geomorphic changes that have occurred in the area and identifying the geomorphic processes that affect site conditions (Stillwater Sciences, 2008a). In addition, hydraulic mo

potential water velocities and sedimentation patterns that may be experienced following the proposed project (Stillwater Sciences, 2008b). These studies concluded that the project will not change the general flow pattern, and that flow velocities will change less than 10% (less than 0.5 feet per second) as a result of the project. These studies indicate that the project will not have adverse downstream impacts.

Wetlands
Wetlands are not present at the project site.

Cultural resources
Loud (1918) identifies two Wiyot sites described as being located on the north side of the mouth of the Mad River. The mouth at this time was located southwest of the project site. Further information is being solicited from the applicable tribal historic preservation officers. If warranted, a cultural resources monitor will be on site during ground-disturbing activities.

References

LACO Associates. 2008. Mad River Bluffs, Geologic Investigation and Assessment.

Loud, Llewellyn. 1918. Ethnography and Archaeology of the Wiyot Territory. University Publications in American Archaeology and Ethnology 14:3. Reprint 1965: Kraus Reprint Corpration, New York.

Stillwater Sciences. 2008a. Mad River Streambank Stabilization Project Geomorphic Evaluation. Prepared by Stillwater Sciences for Humboldt County Public Works Department.

Stillwater Sciences. 2008b. River2D Simulation of the Mad River near School Road, McKinleyville, California.

U.S. Department of Agriculture-Natural Resources Conservation Service. June 20, 2008. Request for Emergency Section 7 Consultation for NRCS Emergency Watershed Protection Project in Humboldt County, California – DSR 01-06-1220.

U.S. Fish & Wildlife Service. June 11, 2008. E-mail from Ray Bosch.

EXHIBIT NO. 2

CDP Application No. 1-09-050
(page 10 of 11)

COUNTY OF HUMBOLDT
Department of Public Works

1106 Second Street
Eureka * CA * 95501
TEL (707) 445-7741
FAX (707) 445-7409

FIGURE 1 - SITE MAP
Mad River Streambank Protection Project
McKinleyville, California
1 inch equals 208 feet Date Prepared: July 9, 2008

N

EXHIBIT NO. 2

CDP Application No. 1-09-050
(page 11 of 11)

EXHIBIT NO. 3

CDP Application No. 1-09-050
(Humboldt County)
As Built Plans & Cross Sections
(page 1 of 7)

AS-BUILT
BY CJW
DATE 2/10/09

BAR IS ONE INCH ON ORIGINAL DRAWING	ROAD NAME:		DESIGN SECTION CHRIS WHITWORTH
	ROAD NO:	MILE POST:	
		OES NO:	DESIGNED BY: CJW
IF NOT ONE INCH ON THIS SHEET, ADJUST SCALES ACCORDINGLY	CONTRACT NO.: 251021	PPNO:	DRAWN BY: CJW
	DRAWING FILE NAME: L:\PROJECTS\MADBLUFFS\DWG\CDSHO1.DWG		REVIEWED BY:
	PLOT DATE: 07/08/2008	REVISION DATE:	APPROVED BY:

COUNTY DEPARTMENT
COVER SHEET
MAD RIVER BL

INDEX OF SHEETS

APPLICABLE STANDARD PLANS

REFERENCE CALTRANS STANDARD PLANS DATED MAY 2006.

A10A AND A10B	ABBREVIATIONS
A10C AND A10D	SYMBOLS
A62A	EXCAVATION AND BACKFILL MISCELLANEOUS DETAILS

NOTES

THE CONTRACTOR SHALL BE SPECIALIZED IN FISH HABITAT AND BIOSTABILIZATION FOR THIS PROJECT.

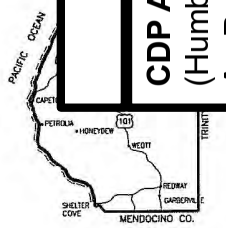
COUNTY OF HUMBOLDT
DEPARTMENT OF PUBLIC WORKS

PROJECT PLANS FOR CONSTRUCTION OF

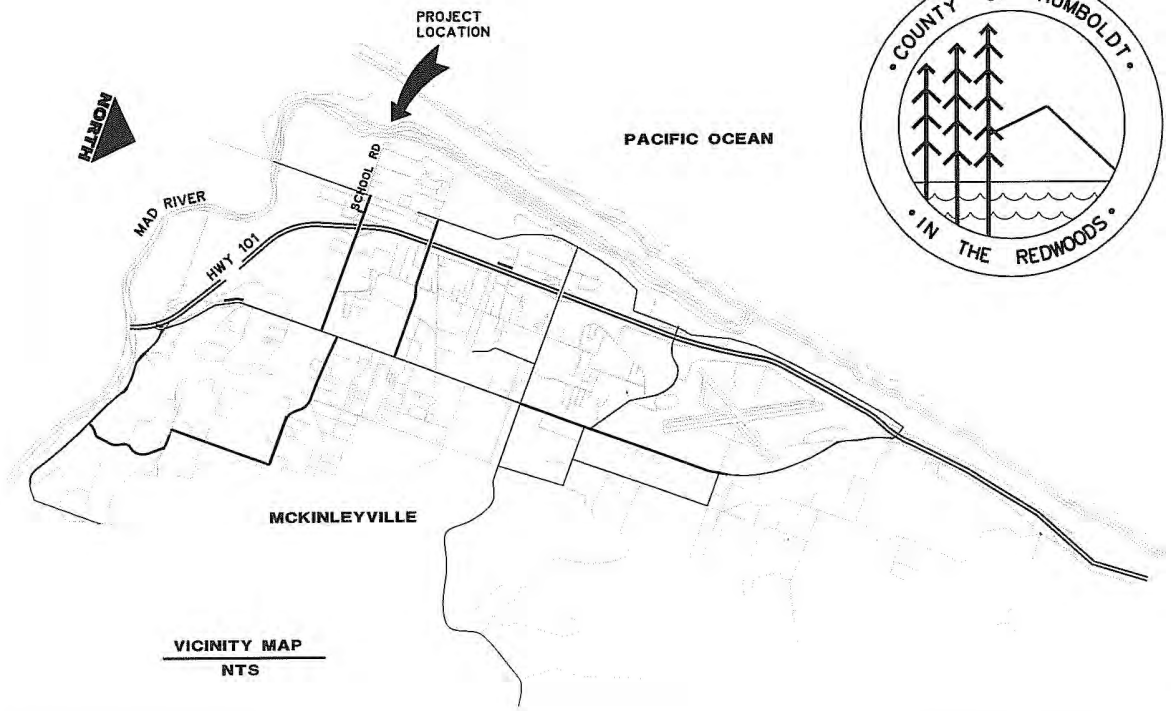
MAD RIVER BLUFFS STABILIZATION
CONTRACT NO. 251021

NORTH
1"=10± MI.

PROJECT LOCATIO



LOCATION MAP
SCALE: 1"=10± MILE



VICINITY MAP
NTS

COUNTY OF HUMBOLDT
IN THE REDWOODS

APPROVED

CHRISTOPHER J. WHITWORTH DATE 2/13/09

REGISTERED PROFESSIONAL ENGINEER
CHRISTOPHER J. WHITWORTH
NO. 51931
EXP. 06/30/10
CIVIL
STATE OF CALIFORNIA

ORIGINAL LOW BID PRICE	CONSTRUCTED BY	RESIDENT ENGINEER
	PROJECT COMPLETED / /	CONSTRUCTION COST $

CUT / FILL VOLUMES

STATION	AREAS Square Feet CUT	AREAS Square Feet FILL	VOLUMES Cubic Yards CUT	VOLUMES Cubic Yards FILL
10+00	83.33	0.00	172.93	0.00
10+50	83.33	0.00	172.36	0.00
10+90.50	128.81	0.00	40.45	0.02
11+00	125.71	0.12	7.90	0.01
11+01.69	125.53	0.15	225.00	0.27
11+50	125.53	0.15	201.45	0.14
12+00	92.05	0.00	170.45	0.00
12+50	92.05	0.00	11.97	0.00
12+53.67	93.91	0.00	27.52	0.00
12+61.12	75.20	0.00	50.87	0.00
12+76.78	97.52	0.00	44.95	0.00
12+92.13	108.86	0.00	31.06	0.00
13+00	104.27	0.00	30.56	0.00
13+08.62	87.25	0.00	67.26	0.00
13+28.45	81.81	0.00	65.13	0.00
13+50	81.61	0.00	37.23	0.00
13+52.28	82.37	0.13	97.37	0.37
13+92.86	99.26	0.00	25.42	0.00
14+00	93.03	0.00	172.28	0.00
14+50	93.03	0.00	18.48	0.01
14+55.86	58.81	0.12	15.90	0.03
14+82.93	82.36	0.01	65.65	0.03
15+00	62.40	0.03	115.56	0.06
15+50	62.40	0.03	11.48	0.03
15+62.36	115.81	0.12	85.37	0.05
15+85.44	74.48	0.00	17.08	0.00
15+91.19	71.97	0.00	74.1	0.00
16+00	78.41	0.01	99.82	0.13
16+13.41	51.00	0.51	109.76	0.69
16+50	81.00	0.51	117.15	0.66
16+82.56	67.67	0.33	18.55	0.09
17+00	70.55	0.31	0.45	0.00
17+00.13	70.67	0.31	130.44	0.57
17+50	70.67	0.31	70.40	0.10
17+75.39	79.03	0.00	11.25	0.00
17+78.71	81.21	0.00	71.21	0.00
18+00	99.44	0.00	184.15	0.00
18+50	99.44	0.00	204.12	0.00
19+00	121.01	0.00	224.09	0.00
19+50	121.01	0.00	3.86	0.00
19+50.53	77.84	0.00	10.74	0.00
19+55.50	74.[illegible]	0.00	111.23	0.08
20+00	80.27	0.10	111.83	0.18
20+50	80.27	0.10	75.35	0.07
20+88.97	4.20	0.00	13.90	0.01
21+00	40.92	0.03	2.03	0.00
21+01.68	40.26	0.04	13.47	0.03
21+10.14	45.73	0.18	35.08	0.06
21+27.19	48.22	0.00	40.68	0.00
21+50	48.22	0.00	81.15	0.00
22+00	39.42	0.00	72.99	0.00
22+50	39.42	0.00	143.84	0.00
23+00	115.93	0.00	0.00	0.00

STATION	VOLUMES Cubic Yards CUT	VOLUMES Cubic Yards FILL	
[illegible]	[illegible]	1254.67	0.43
[illegible]	[illegible]	1319.80	0.43
[illegible]	[illegible]	1357.03	0.46
[illegible]	[illegible]	1454.19	0.54
[illegible]	[illegible]	1479.61	0.54
[illegible]	[illegible]	1651.89	0.54
[illegible]	[illegible]	1668.37	0.55
[illegible]	[illegible]	1684.23	0.57
[illegible]	[illegible]	1769.52	0.65
[illegible]	[illegible]	1885.48	0.65
[illegible]	[illegible]	1926.94	0.68
[illegible]	[illegible]	2013.51	0.73
[illegible]	[illegible]	2029.10	0.73
[illegible]	[illegible]	2053.41	0.74
[illegible]	[illegible]	2093.02	0.86
[illegible]	[illegible]	2202.78	1.55
[illegible]	[illegible]	2319.96	2.21
[illegible]	[illegible]	2339.51	2.30
[illegible]	[illegible]	2339.96	2.30
[illegible]	[illegible]	2470.40	2.87
[illegible]	[illegible]	2540.79	3.01
[illegible]	[illegible]	2565.05	3.01
[illegible]	[illegible]	2623.26	3.01
[illegible]	[illegible]	2807.41	3.01
[illegible]	[illegible]	3011.53	3.01
[illegible]	[illegible]	3235.62	3.01
[illegible]	[illegible]	3337.58	3.01
[illegible]	[illegible]	3248.30	3.01
[illegible]	[illegible]	3359.02	3.09
[illegible]	[illegible]	3471.34	3.27
[illegible]	[illegible]	3546.67	3.34
[illegible]	[illegible]	3560.41	3.34
[illegible]	[illegible]	3562.44	3.34
[illegible]	[illegible]	3575.92	3.38
[illegible]	[illegible]	3610.99	3.44
[illegible]	[illegible]	3651.88	3.44
[illegible]	[illegible]	3733.03	3.44
[illegible]	[illegible]	3806.02	3.44
[illegible]	[illegible]	3949.85	3.44
0.00	0.00	3949.85	3.44

* FILL VOLUMES FOR EMBANKMENT NOT INCLUDED IN THIS TABLE OF QUANTITIES

QUANTITIES

ITEM NO.	ITEM CODE		ITEM DESCRIPTION	UNIT	QUANTITY
1	74016		Construction Site Management	LS	1
2	74017		Water Pollution Control	LS	1
3	74029		Temporary Silt Fence	LF	2,400
4	74035		Turbidity Exclusion Barrier (Baffle Curtain)	LS	1
5	160101		Clearing and Grubbing	SY	500
6	194001		~~Rock Excavation~~	~~CY~~	~~3,500~~
7	197001		~~Local Borrow~~	~~CY~~	~~3,000~~
8	198050		Embankment TON	~~CY~~	~~4,115~~
9	203001		Coir Erosion Control Blanket	SY	3,200
10	203016	S	Erosion Control (Type D)	SY	2,300
11	204017	S	Plant Willow Cuttings	SY	1,800
12	518000		Construct Temporary Access Road	LS	1
13	721004		Rock Slope Protection (1 Ton, Method B) TON	~~CY~~	2,000
14	721006		Rock Slope Protection (1/2 Ton, Method B) TON	~~CY~~	1,500
15	721017		Rock Slope Protection (2 Ton, Method B) TON	~~CY~~	4,600
16	721100		Rock Slope Protection (4 Ton, Method B) TON	~~CY~~	1,500
17	721102		Rock Slope Protection (6 Ton, Method B) TON	~~CY~~	1,500
18	999999		Mobilization	LS	1

10,676 tons river run & quarry pit run

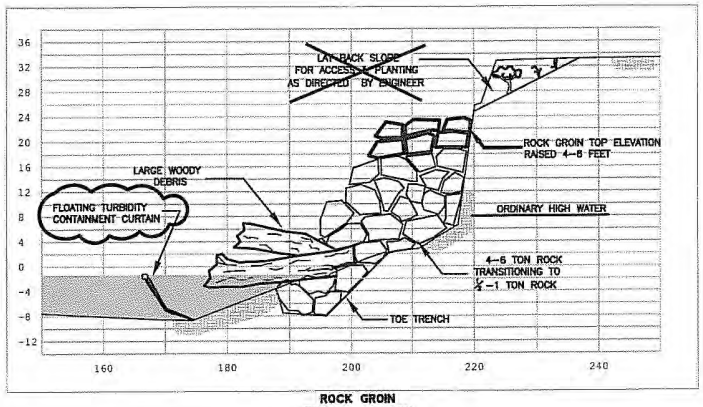
9,314 tons ½ to 6 ton RSP

EXHIBIT NO. 3

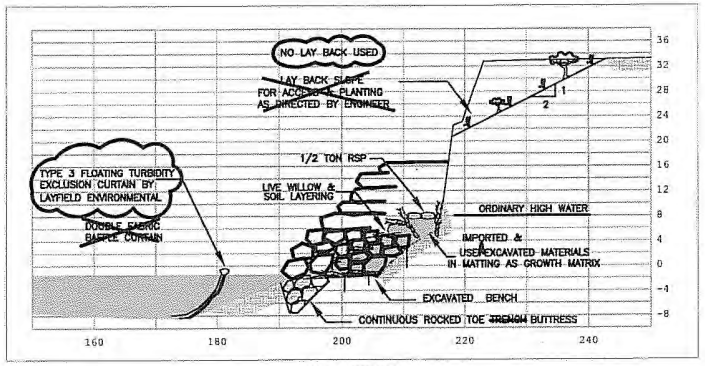
CDP Application No. 1-09-050
(page 2 of 7)

AS-BUILT
BY CJW
DATE 2/10/09

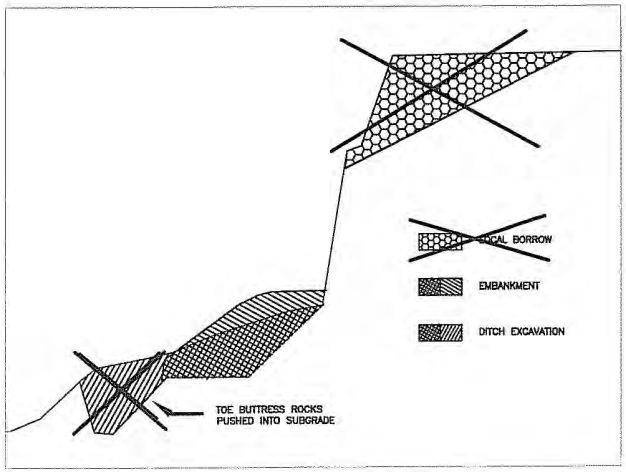
BAR IS ONE INCH ON ORIGINAL DRAWING	ROAD NAME: XXX		DESIGN SECTION CHRIS WHITWORTH	COUNTY OF HUMBOL DEPARTMENT OF PUBLIC
	ROAD NO: XXX	MILE POST: XXX		
IF NOT ONE INCH ON THIS SHEET, ADJUST SCALES ACCORDINGLY	PROJECT WORKSHEET NO: XXX	OES NO: XXX	DESIGNED BY: CJW	TYPICAL SECTIONS
	CONTRACT NO: 251021	PPNO: NA	DRAWN BY: CJW	
	DRAWING FILE NAME: L:\PROJECTS\MADBLUFFS\CDSNS3.DWG		REVIEWED BY: XXX	MAD RIVER BLUFF STABILIZ
	PLOT DATE: 07/08/2008	REVISION DATE: XX/XX/XXXX	APPROVED BY: XXX	



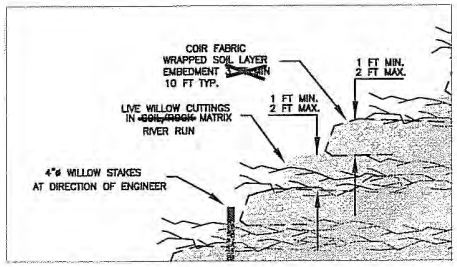
ROCK GROIN
TYPICAL SECTION
SCALE: 1"=10'



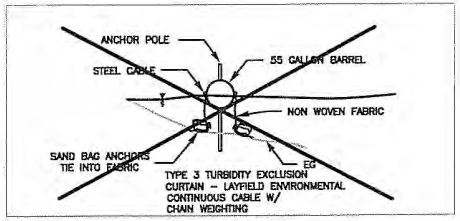
WILLOW MATTRESS
TYPICAL SECTION
SCALE: 1"=10'



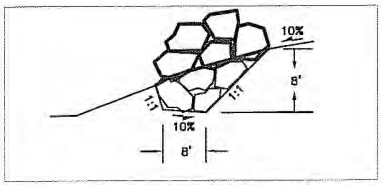
LIMITS OF PAYMENT
NTS



WILLOW MATTRESS
TYPICAL DETAIL
SCALE: 1"=2'



BAFFLE CURTAIN
TYPICAL SECTION
SCALE: 1"=5'



TOE TRENCH BUTTRESS
TYPICAL SECTION
SCALE: 1"=10'

EXHIBIT NO. 3

CDP Application No. 1-09-050
(page 3 of 7)

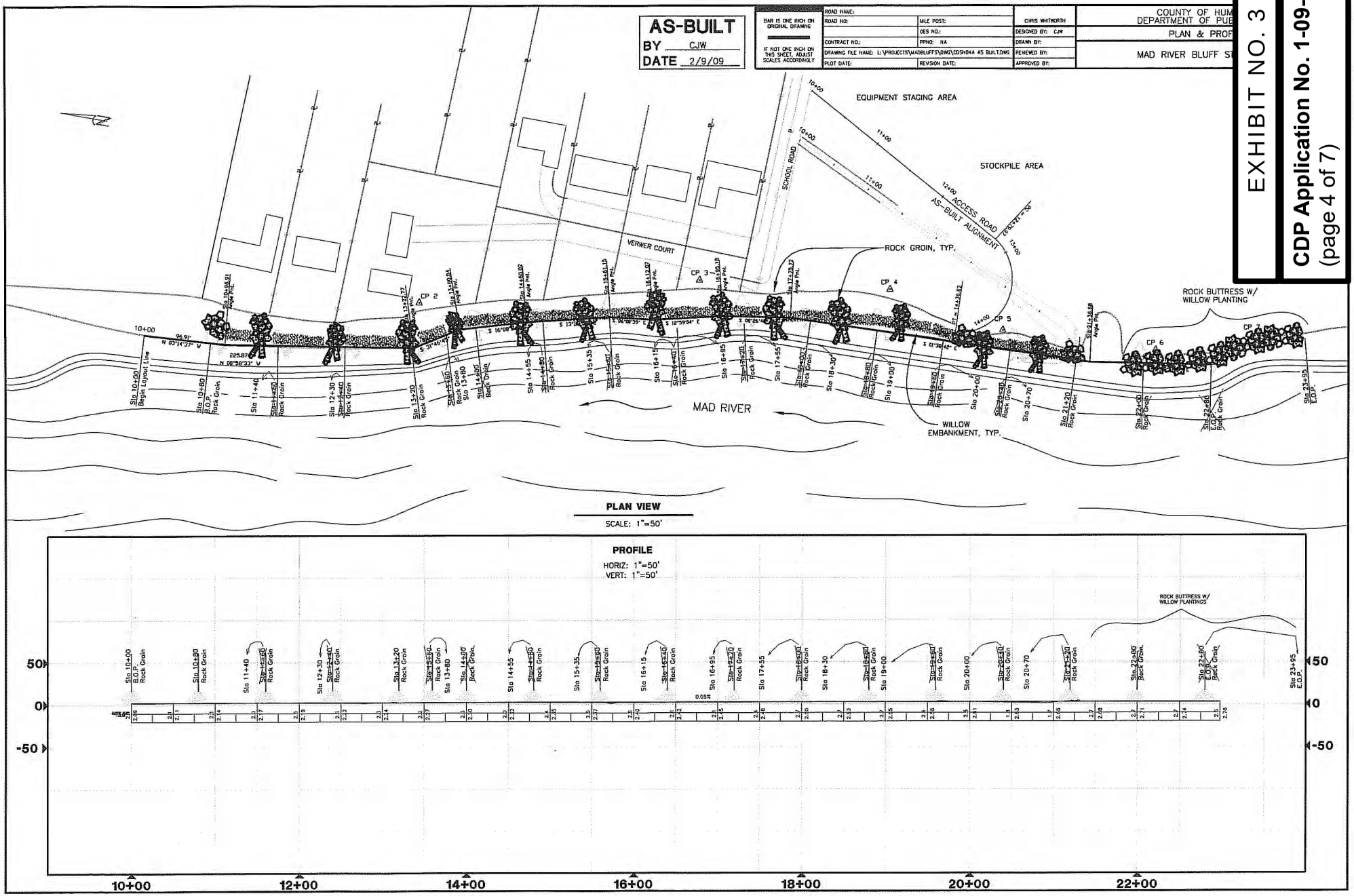


EXHIBIT NO. 3

CDP Application No. 1-09-050
(page 4 of 7)

AS-BUILT
BY CJW
DATE 2/10/09

BAR IS ONE INCH ON ORIGINAL DRAWING

IF NOT ONE INCH ON THIS SHEET, ADJUST SCALES ACCORDINGLY

ROAD NAME:		DESIGN SECTION CHRIS WHITWORTH	COUNTY OF HUMBO DEPARTMENT OF PUBLIC
ROAD NO:	MILE POST:	DESIGNED BY: CJW	
	DES NO.:	DRAWN BY: CJW	MAD RIVER BLUFF STABIL
CONTRACT NO.: 251021	PPNO:	REVIEWED BY:	
DRAWING FILE NAME:		APPROVED BY:	
PLOT DATE: 07/08/2008	REVISION DATE:		

CROSS SECTIONS

SCALE: 1"=20'

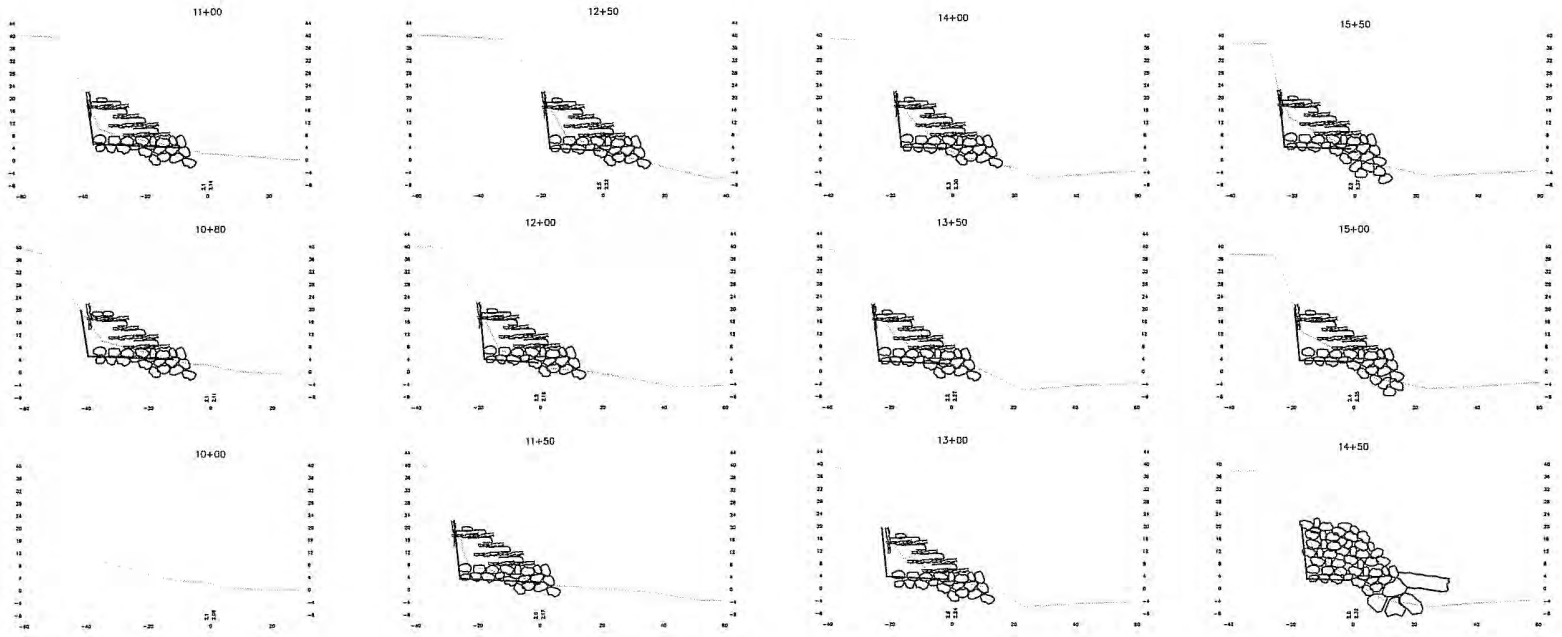
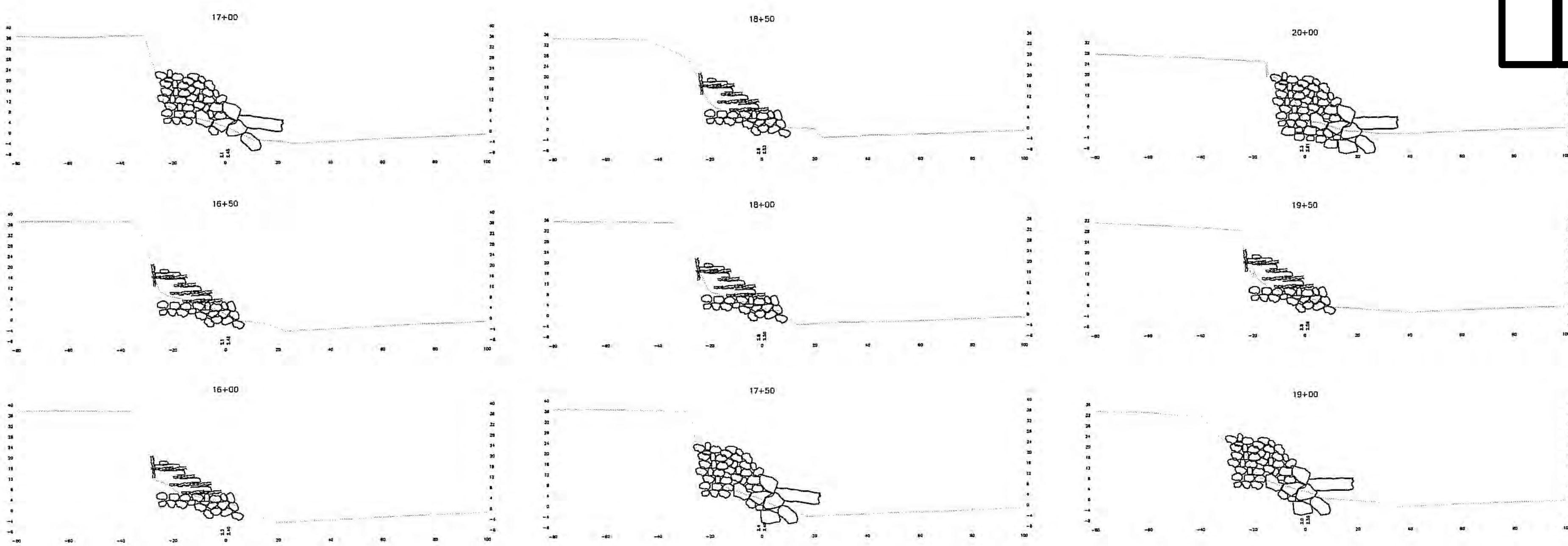


EXHIBIT NO. 3

CDP Application No. 1-09-050
(page 5 of 7)



AS-BUILT
BY CJW
DATE 2/10/09

BAR IS ONE INCH ON ORIGINAL DRAWING
IF NOT ONE INCH ON THIS SHEET, ADJUST SCALES ACCORDINGLY

ROAD NAME:		DESIGN SECTION CHRIS WHITWORTH	COUNTY OF HUMBOL[DT] DEPARTMENT OF PUBLIC [WORKS]
ROAD NO:	MILE POST:	DESIGNED BY: CJW	
	OES NO.:	DRAWN BY: CJW	MAD RIVER BLUFF STABILIZ[ATION]
CONTRACT NO.: 251021	PPNO:	REVIEWED BY:	
DRAWING FILE NAME:		APPROVED BY:	
PLOT DATE: 07/08/2008	REVISION DATE:		

EXHIBIT NO. 3

CDP Application No. 1-09-050
(page 6 of 7)

AS-BUILT
BY CJW
DATE 2/10/09

BAR IS ONE INCH ON ORIGINAL DRAWING

IF NOT ONE INCH ON THIS SHEET, ADJUST SCALES ACCORDINGLY

ROAD NAME:		DESIGN SECTION CHRIS WHITWORTH	COUNTY OF HUMBO DEPARTMENT OF PUBLIC
ROAD NO:	MILE POST:		
	CES NO.:	DESIGNED BY: CJW	
CONTRACT NO.: 251021	PPNO:	DRAWN BY: CJW	MAD RIVER BLUFF STABIL
DRAWING FILE NAME:		REVIEWED BY:	
PLOT DATE: 07/08/2008	REVISION DATE:	APPROVED BY:	

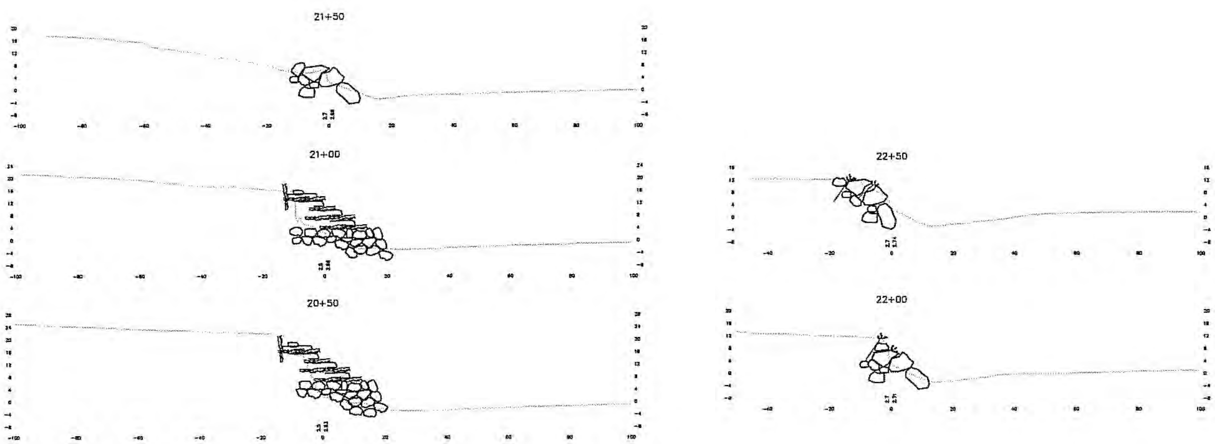


EXHIBIT NO. 3

CDP Application No. 1-09-050
(page 7 of 7)

STATE OF CALIFORNIA – THE RESOURCES AGENCY ARNOLD SCHWARZENEGGER, GOVERNOR

CALIFORNIA COASTAL COMMISSION
NORTH COAST DISTRICT OFFICE
710 E STREET • SUITE 200
EUREKA, CA 95501-1865
VOICE (707) 445-7833
FACSIMILE (707) 445-7877

MAILING ADDRESS:
P. O. BOX 4908
EUREKA, CA 95502-4908

EMERGENCY PERMIT ACCEPTANCE FORM

TO: CALIFORNIA COASTAL COMMISSION
NORTH COAST DISTRICT OFFICE
710 E STREET, SUITE 200
EUREKA, CA 95501
(707) 445-7833

RECEIVED
AUG 26 2008
CALIFORNIA
COASTAL COMMISSION

RE: **Emergency Permit No. 1-08-035-G**

INSTRUCTIONS: After reading the attached Emergency Permit, please sign this form and return to the North Coast District Office within 15 working days from the permit's date.

I hereby understand all of the conditions of the emergency permit being issued to me and agree to abide by them.

I also understand that the emergency work is TEMPORARY and that a regular Coastal Permit is necessary to make it a permanent installation. I agree to apply for a regular Coastal Permit, OR I will remove the emergency work authorized by such permit in its entirety within 180 days of the date of the emergency permit.

Hank Seeman
Signature of property owner or authorized representative

Hank Seemann
Name

Humboldt Co. Public Works Department
Address

1106 2nd Street, Eureka CA 95501

August 26, 2008
Date of Signing

EXHIBIT NO. 4

CDP Application No. 1-09-050
(Humboldt County)
Emergency Permit Conditions
(page 1 of 6)

CALIFORNIA COASTAL COMMISSION
NORTH COAST DISTRICT OFFICE
710 E STREET • SUITE 200
EUREKA, CA 95501-6813
VOICE (707) 445-7833
FACSIMILE (707) 445-7877
www.coastal.ca.gov

MAILING ADDRESS:
P. O. BOX 4908
EUREKA, CA 95502-4908

EMERGENCY PERMIT

Humboldt County Public Works Dept.
Attn: Hank Seemann
1106 Second Street
Eureka, CA 95501

Date: August 22, 2008
Emergency Permit No. **1-08-035-G**

LOCATION OF EMERGENCY WORK:

An approximately 1,300-foot stretch of a 5-foot-high to 50-foot-high (above mean tide level) bluff along the right bank of the Mad River (including the river channel, bank and adjacent upland terrace), approximately 1.5 miles upstream from the 2008 location of the mouth of the Mad River, near the intersection of School Road and Verwer Court, in McKinleyville, Humboldt County (on or adjacent to APNs 508-021-007, 508-151-016, -017, -030, -004, -003, and the County of Humboldt's School Road right-of-way).

WORK PROPOSED:

Repair measures to stabilize the bank, including a stabilization structure composed of rock slope protection and bioengineered components along the lower portion of the bank and re-grading and revegetation along the upper portion of the bank. The stabilization structure will have a continuous toe trench (~8 feet high, extending from -8 to 0 ft elevation, NAVD 88) filled with 4- to 6-ton rocks extending along the base of the bluff for the length of the project site (~1,300 feet). The layer overlaying the toe trench will consist of an alternating series of groins and willow mattress/rock sections (composite layers of rock and soil integrated with willow mattresses, which are ~4- to 6-inch-thick bundles of willow branches or cuttings tied with twine or string, placed in lifts, and secured with 4-inch-diameter willow stakes). The groins will be layered mounds of revetment with a slight protrusion (less than ~20 feet) riverward from the armored bank, spaced at approximately 60-foot intervals. The groins will be constructed with rock boulders in conjunction with large woody debris secured with threaded rebar and cable anchors. The rock will consist of 4- to 6-ton rock near the bottom, transitioning to half- to 1-ton rock at the top. The top of the groins will reach an elevation of ~14 feet (NAVD 88). The estimated total volume of fill material is 10,500 cubic yards, of which approximately 8,500 cubic yards will be placed below the mean tide level. The estimated area of impact is ~0.60 acres.

PERMIT RATIONALE:

This letter constitutes approval of the emergency work you have requested to be done at the location listed above. I understand from your information that due to bluff erosion along the right bank of the Mad River in the project area the top of the bluff has retreated to within 15 feet of an occupied residence and is in close proximity to several other residences as well as public infrastructure. According to geotechnical information you have provided, there is a greater than 50 percent probability that a peak discharge event will occur during the next winter season with a reasonable likelihood of causing at least 10 feet of bluff erosion, a 10 to 33 percent probability that a peak discharge event will occur that could cause up to 50 feet of bluff erosion, and a 5 percent probability that a beak discharge event will occur that could cause up to 90 feet of bluff erosion. Such storms will occur suddenly, unpredictably, and with relatively little warning

EXHIBIT NO. 4

CDP Application No. 1-09-050
(page 2 of 6)

Consequently, if timely repairs to the identified stretch of river bank are not conducted within an expedited timeframe, the likelihood of a catastrophic bluff retreat during the on-coming winter season would be substantially increased. Such a event could result in a threat to residential structures, public roads, essential services including sewer and water infrastructure, life, and health at the Mad River bluff near the end of School Road. Therefore, the situation requires immediate action to prevent damage to private property and public infrastructure.

Pursuant to Title 14 of the California code of Regulations, Section 13009, the Executive Director of the Coastal Commission hereby finds that:

(a) An emergency exists which requires action more quickly than permitted by the procedures for administrative or ordinary permits and the development can and will be completed within 30 days unless otherwise specified by the terms of this permit; and

(b) Public comment on the proposed emergency action has been reviewed as time allows; and

(c) As conditioned, the work proposed would be consistent with the requirements of the California Coastal Act of 1976.

The work is hereby approved, subject to the conditions listed on the attached page.

Sincerely,

PETER M. DOUGLAS
Executive Director

MELISSA B. KRAEMER
Coastal Planner

EXHIBIT NO. 4

CDP Application No. 1-09-050
(page 3 of 6)

CONDITIONS OF APPROVAL:

1. The enclosed Emergency Permit Acceptance form must be signed by the APPLICANT and returned within 15 days.

2. Only work specifically described in this permit and for the specific property listed above is authorized. The project shall be undertaken in accordance with the plans and other information submitted to the Coastal Commission. Any additional work requires separate authorization from the Executive Director.

3. All construction activities shall be completed by November 15. Any construction activity conducted between October 16 and November 15 shall be subject to the following conditions: (1) All work shall cease upon the onset of precipitation at the project site and shall not recommence until the predicted chance of rain is less than 50 percent for the Arcata/McKinleyville area portion of the National Weather Service's forecast for Northwestern California; (2) The work site(s) shall be winterized between work cessation periods by installing stormwater runoff and erosion control barriers around the perimeter of each construction site to prevent the entrainment of sediment into coastal waters; and (3) Adequate stocks of stormwater runoff and erosion control barrier materials shall be kept onsite and made available for immediate use.

4. The existing unpermitted rock fill that is located in the project area shall either be incorporated into the proposed emergency stabilization structure (if possible) or removed from the site entirely prior to project completion.

5. Any materials used in project construction that slump or become ineffective and a hazard to coastal recreation shall be immediately removed.

6. All equipment and materials staging and stockpiling shall occur within the upland portions on the project area only.

7. Construction activities shall be conducted during periods of low tide only.

8. Any fueling and maintenance of construction equipment shall occur within upland areas outside of environmentally sensitive habitat areas or within designated staging areas.

9. Fuels, lubricants, and solvents shall not be allowed to enter coastal waters or wetlands. Hazardous materials management equipment including oil containment booms and absorbent pads shall be available immediately on-hand at the project site, and a registered first-response, professional hazardous materials clean-up/remediation service shall be locally available on call.

10. The permittee shall use relevant best management practices (BMPs) as detailed in the "California Storm Water Best Management (Construction and Industrial/Commercial) Handbooks, developed by Camp, Dresser & McKee, et al. for the Storm Water Quality Task Force (see http://www.cabmphandbooks.com).

11. Effective erosion control measures shall be in place at all times during construction. Construction must not commence until all temporary erosion control devices (e.g., silt fences) are in place. A supply of erosion control materials shall be maintained on site to facilitate a quick response to unanticipated storm events or emergencies. If continued erosion is likely to occur after construction is completed, then appropriate erosion prevention measures shall be implemented and maintained until erosion has subsided. Erosion control devices are temporary structures and shall be removed after completion of construction.

12. Erosion controls shall be used to protect and stabilize stockpiles and exposed soils to prevent movement of materials.

13. Work sites shall be winterized at the end of each day when significant rains are forecast that may cause unfinished excavation to erode.

14. After project completion, all exposed soils present in and around the project site which may deliver sediment to the river or a coastal wetland shall be stabilized with mulch, seeding, and/or placement of erosion control blankets. Erosion control seeding shall include only native, regionally appropriate species or noninvasive agricultural species. No plant species listed as problematic and/or invasive by the California Native Plant Society, the California Invasive Plant Council, or as may be identified from time to time by the State of California, shall be employed or allowed to naturalize or persist on the site. No plant species listed as a "noxious weed" by the governments of the State of California or the United States shall be utilized within the property.

15. All measures specified by NOAA-Fisheries in its technical assistance comments dated July 30, 2008 shall be implemented. Installation and removal of the temporary barrier system and fish herding, seining, and relocation shall be conducted according to NOAA-Fisheries guidance. A copy of monitoring data on salmonid presence/abundance and habitat feature use related to project disturbance collected during the course of construction shall be provided to Commission staff at the North Coast District Office.

16. All new revetment material to be used shall consist only of clean rock that is free of debris and fine sediment.

17. During construction, all trash shall be properly contained, removed from the work site, and disposed of on a regular basis to avoid contamination of habitat during restoration activities. Following construction, all trash and construction debris shall be removed from work areas and disposed of properly.

18. All construction debris shall be removed and disposed of in an upland location at an approved disposal facility within 10 days of project completion.

19. In exercising this permit, the applicant agrees to hold the California Coastal Commission harmless of any liabilities for damage to public or private properties or personal injury that may result from the project.

20. This permit does not obviate the need to obtain necessary authorizations and/or permits from other agencies, including the U.S. Army Corps of Engineers, the California Department of Fish and Game, the County of Humboldt, the North Coast Regional Water Quality Control Board, or other applicable agencies.

The emergency work is considered to be temporary work done in an emergency situation. **If the permittee wishes to have the emergency work become a permanent development, a regular Coastal Development Permit or permit amendment must be obtained.** A regular permit or permit amendment would be subject to all of the provisions of the California Coastal Act and may be conditioned accordingly. These conditions may include provisions for public access (such as an offer to dedicate an easement) and/or a requirement that a deed restriction be placed on the property assuming liability for damages incurred from storm waves.

If you have any questions about the provisions of this emergency permit, please call the Commission's North Coast District Office at the address and telephone number list on the first page.

Encl.: Emergency Permit Acceptance Form, Regular Application Form

cc w/out encl.: Steve Werner, Humboldt County Planning Division, Eureka
Carol Heidsiek, U.S. Army Corps of Engineers, Eureka
Scott Bauer, Department of Fish and Game, Eureka
Dean Prat, Regional Water Quality Control Board, Santa Rosa
Leslie Wolff, NOAA-Fisheries, Arcata
Ray Bosch, U.S. Fish & Wildlife Service, Arcata

EXHIBIT NO. 4

CDP Application No. 1-09-050
(page 6 of 6)

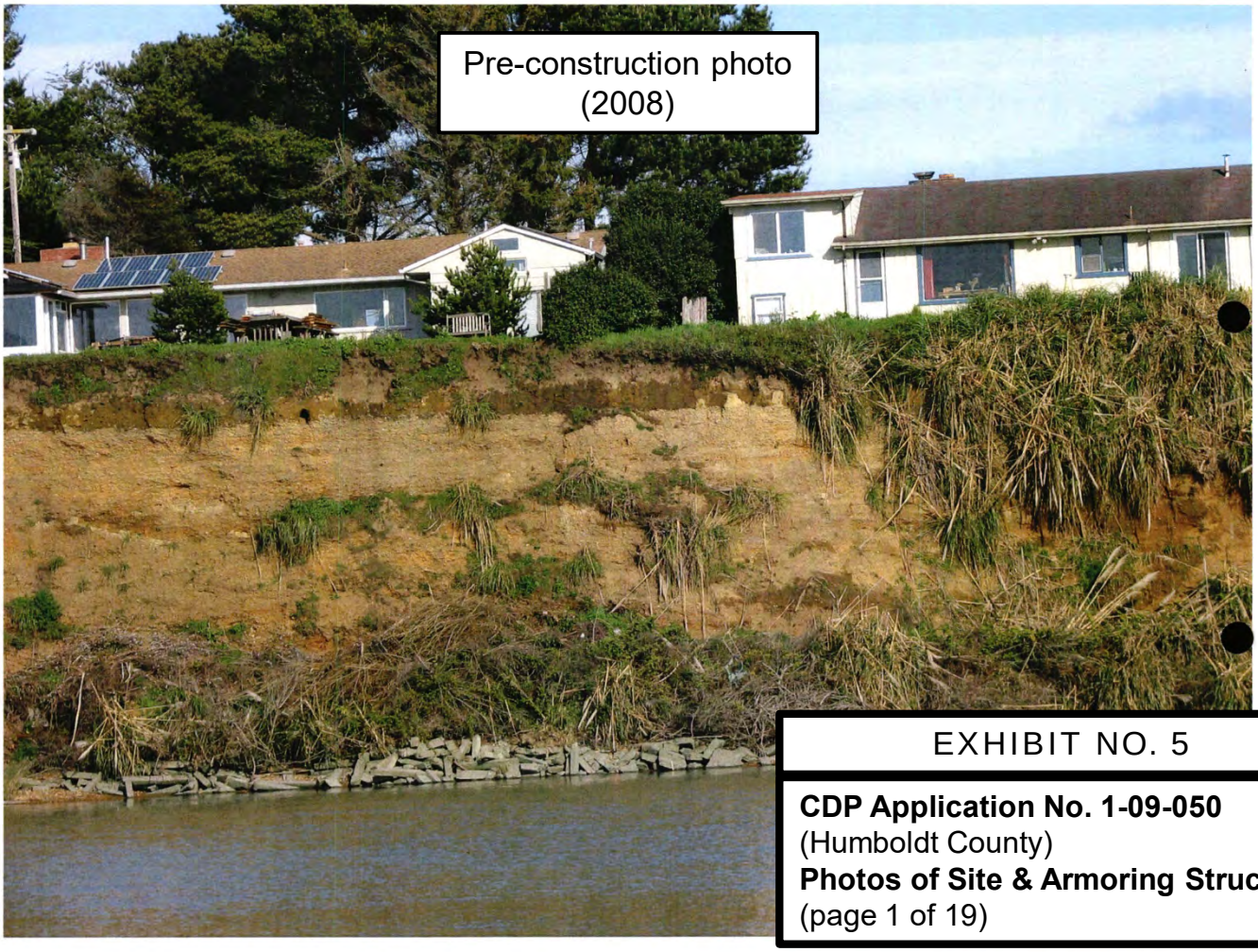


EXHIBIT NO. 5

CDP Application No. 1-09-050
(Humboldt County)
Photos of Site & Armoring Structure
(page 1 of 19)

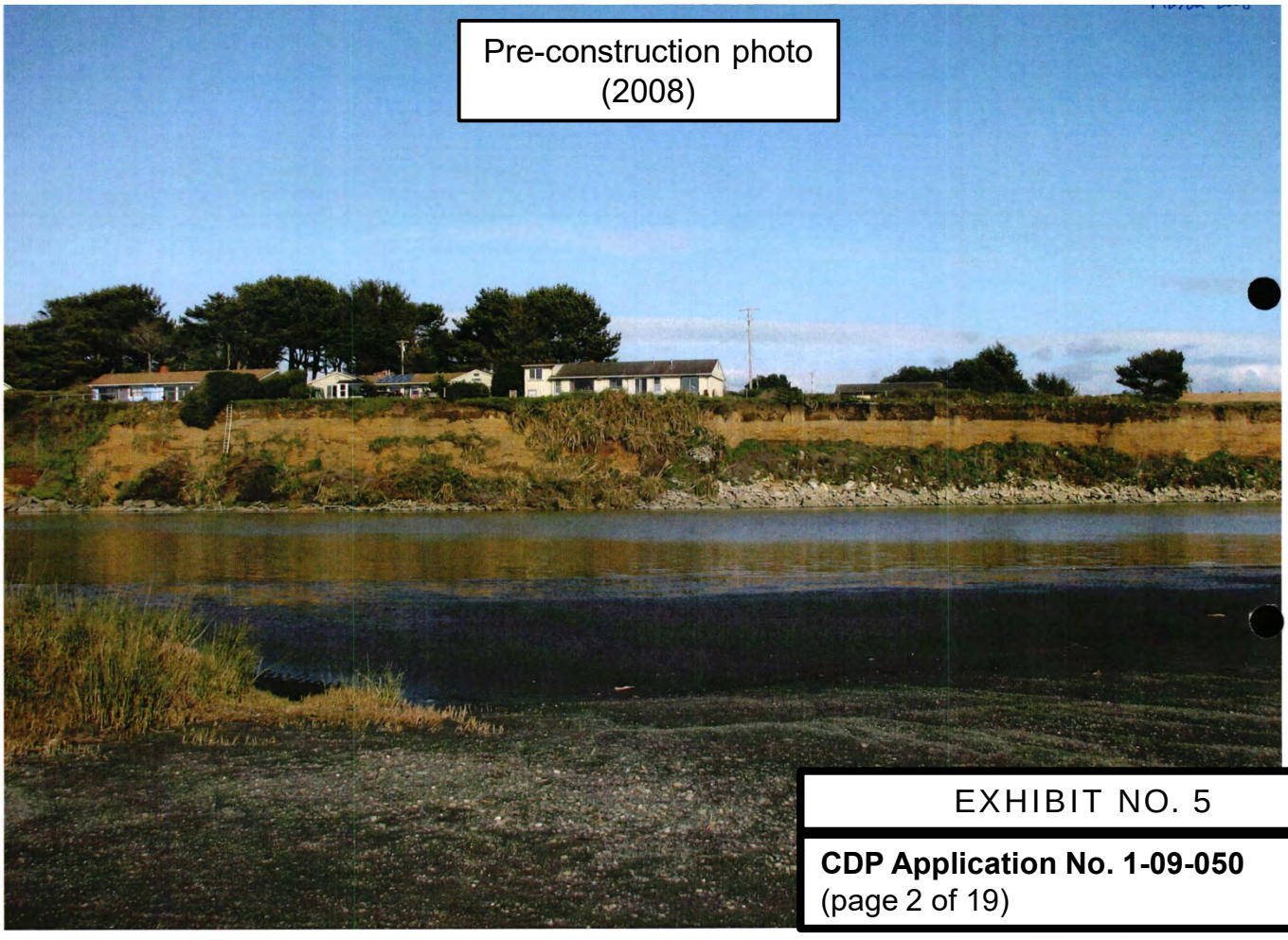


EXHIBIT NO. 5

CDP Application No. 1-09-050
(page 2 of 19)

Photograph Log

Mad River Streambank Protection Project
School Road
McKinleyville, Humboldt County, California

Photograph 1. Mad River Bluff Streambank Protection Project post-construction circa summer 2011. Image taken facing east.

EXHIBIT NO. 5

CDP Application No. 1-09-050
(page 3 of 19)

Photograph 2. School Road stormwater outfall February 2005. Note width of bluff between fence post and the Mad River. Image taken facing north and downstream.

EXHIBIT NO. 5

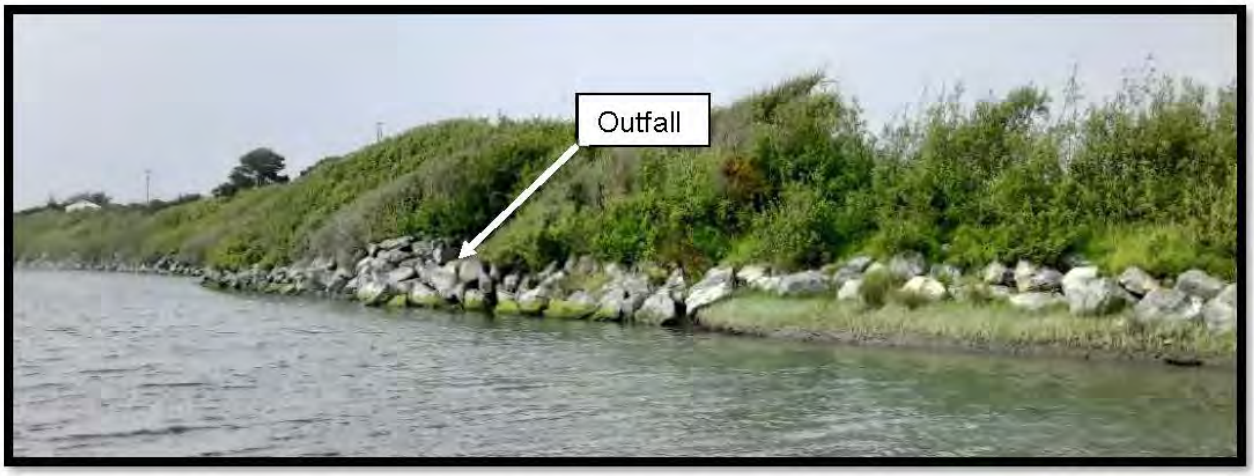
CDP Application No. 1-09-050
(page 4 of 19)

Photograph 3. School Road stormwater outfall January 2006. Note reduced width of bluff between fence post and the Mad River when compared to Photograph 2. Image taken facing north and downstream.

EXHIBIT NO. 5

CDP Application No. 1-09-050
(page 5 of 19)

Photograph 4. School Road stormwater outfall June 2008. Bluff between fence post and the Mad River has completely eroded when compared to Photographs 2 and 3. The once bluff-embedded post concrete base is now suspended off the bluff edge; an estimated three feet of retreat occurred at this point between 2005 and 2008. Image taken facing north and downstream.



Photograph 5. View of stabilized bank at School Road stormwater outfall and upstream flank bay 15 in April 2020. Note that fencing present in Photographs 2, 3, and 4 was removed as part of the 2008 bluff stabilization project. Image taken facing north and downstream.

Photograph 6. Completed revetment segment north of School Road, and a portion of the revetment south of School Road as viewed from top of terrace in September 2009. Image taken facing north and downstream.

EXHIBIT NO. 5

CDP Application No. 1-09-050
(page 7 of 19)

Photograph 7. Groins and vegetated bays as viewed from top of the revetment structure in September 2009. Image taken facing north and downstream.

EXHIBIT NO. 5

CDP Application No. 1-09-050
(page 8 of 19)

Photograph 8. Groins and vegetated bays as viewed from top of the structure in September 2009. Image taken facing south and upstream.

Photograph 9. Completed revetment bays 13 and 14 south of School Road as viewed from top of the bluff terrace in September 2009. Image taken facing south and upstream.

EXHIBIT NO. 5

CDP Application No. 1-09-050
(page 9 of 19)

Photograph 10. Completed revetment bay 15 as viewed from north of the School Road stormwater outfall in September 2009. Image taken facing south and upstream.

EXHIBIT NO. 5

CDP Application No. 1-09-050
(page 10 of 19)

Photograph 11. Evidence of post-construction erosion of the right bank south (upstream) of revetment bay 15 in April 2010. Visible right bank erosion evident in this image has since stabilized, as is apparent in Photographs 19 and 21. Image taken facing north and downstream.

Photograph 12. Revetment as viewed from top of structure in December 2010 during a high discharge event; recorded discharge exceeded 30,000 cfs on this date. Image taken facing north and downstream.

EXHIBIT NO. 5

CDP Application No. 1-09-050
(page 11 of 19)

Photograph 13. Revetment south of School Road in December 2010 during a high discharge event; recorded discharge exceeded 30,000 cfs on this date.
Image taken facing south and upstream.

EXHIBIT NO. 5

CDP Application No. 1-09-050
(page 12 of 19)

Photograph 14. Upstream revetment bay 15 south of School Road in December 2010 during a high discharge event; recorded discharge exceeded 30,000 cfs on this date. The Mad River access trail from School Road is visible on the left-hand side of the image; the current state of the access trail is presented in Photograph 28. Image taken facing south and upstream.

Photograph 15. Public access overlook and vegetative growth on the bluff terrace south of School Road circa April 2018. Image taken facing northwesterly.

EXHIBIT NO. 5

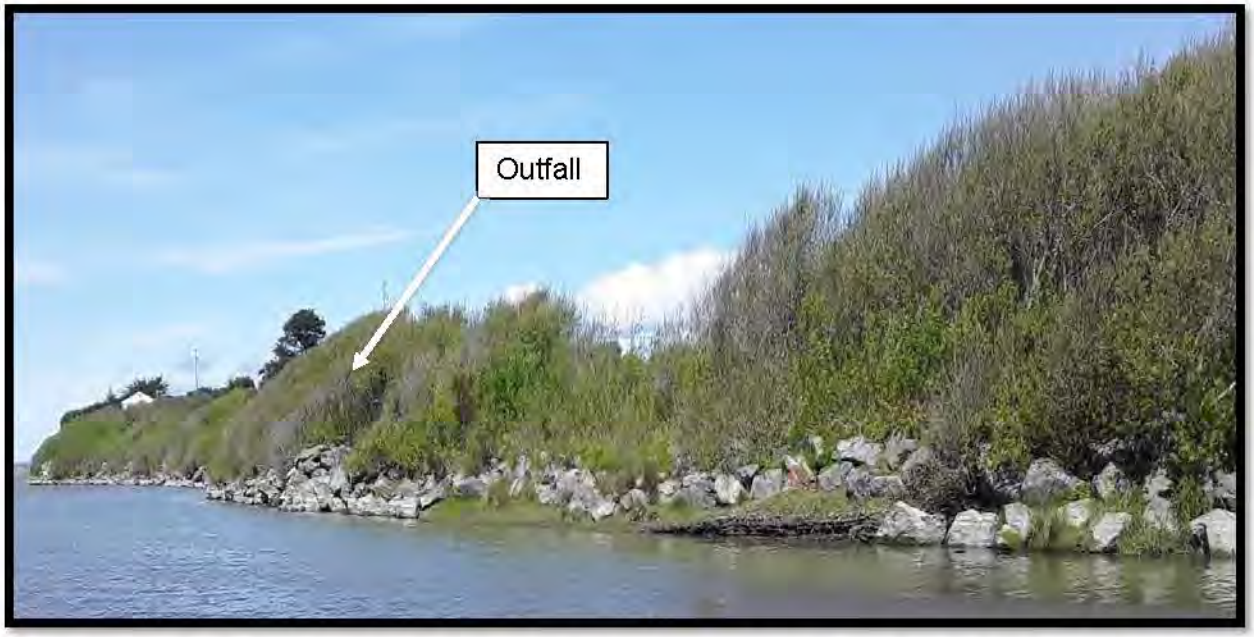
CDP Application No. 1-09-050
(page 13 of 19)

Photograph 16. Revetment as viewed from top of the bluff terrace in April 2018. Willow growth to bluff edge provides added layer of safety for members of public using this public space when compared to exposed vertical edge pre-construction. Image taken facing north and downstream.

Photograph 17. Bluff protecting revetment north of School Road as viewed from the western bank of the Mad River in April 2020. Image taken facing southeasterly.

Photograph 18. Bluff protecting revetment south of School Road as viewed from the western bank of the Mad River in April 2020. Overlook in Photograph 17 is visible in gap in trees; stormwater outfall is located on the right-hand side of the image. Image taken facing southeasterly.

Photograph 19. Revetment upstream extent as viewed from the western bank of the Mad River in April 2020. Revetment flanking protection is provided by vegetated bay 15 upstream of the stormwater outfall. Image taken facing southeasterly.



Photograph 20. Revetment as viewed from an upstream Mad River gravel bar in April 2020. Image taken facing north and downstream.

Photograph 21. Revetment bay 15 as viewed from an upstream Mad River gravel bar in April 2020. Note scour channel adjacent to bank. Mad River access path from School Road noted in Photographs 14 and 25 is in the willows along the bank. Image taken facing north and downstream.

EXHIBIT NO. 5

CDP Application No. 1-09-050
(page 17 of 19)

Photograph 22. School Road public access to the Project area, overlook, and river access trail in 2005. Image taken facing southwesterly.

Photograph 23. Public path accessing the overlook, Mad River and other riparian area trails in 2005. Image taken facing south.

EXHIBIT NO. 5

CDP Application No. 1-09-050
(page 18 of 19)

Photograph 24. Mad River overlook on terrace south of School Road circa 2018. Image taken facing northwesterly.

Photograph 25. Mad River access path south of School Road April 2020. Mad River is visible through willows on the left-hand side. Image taken facing northwesterly.

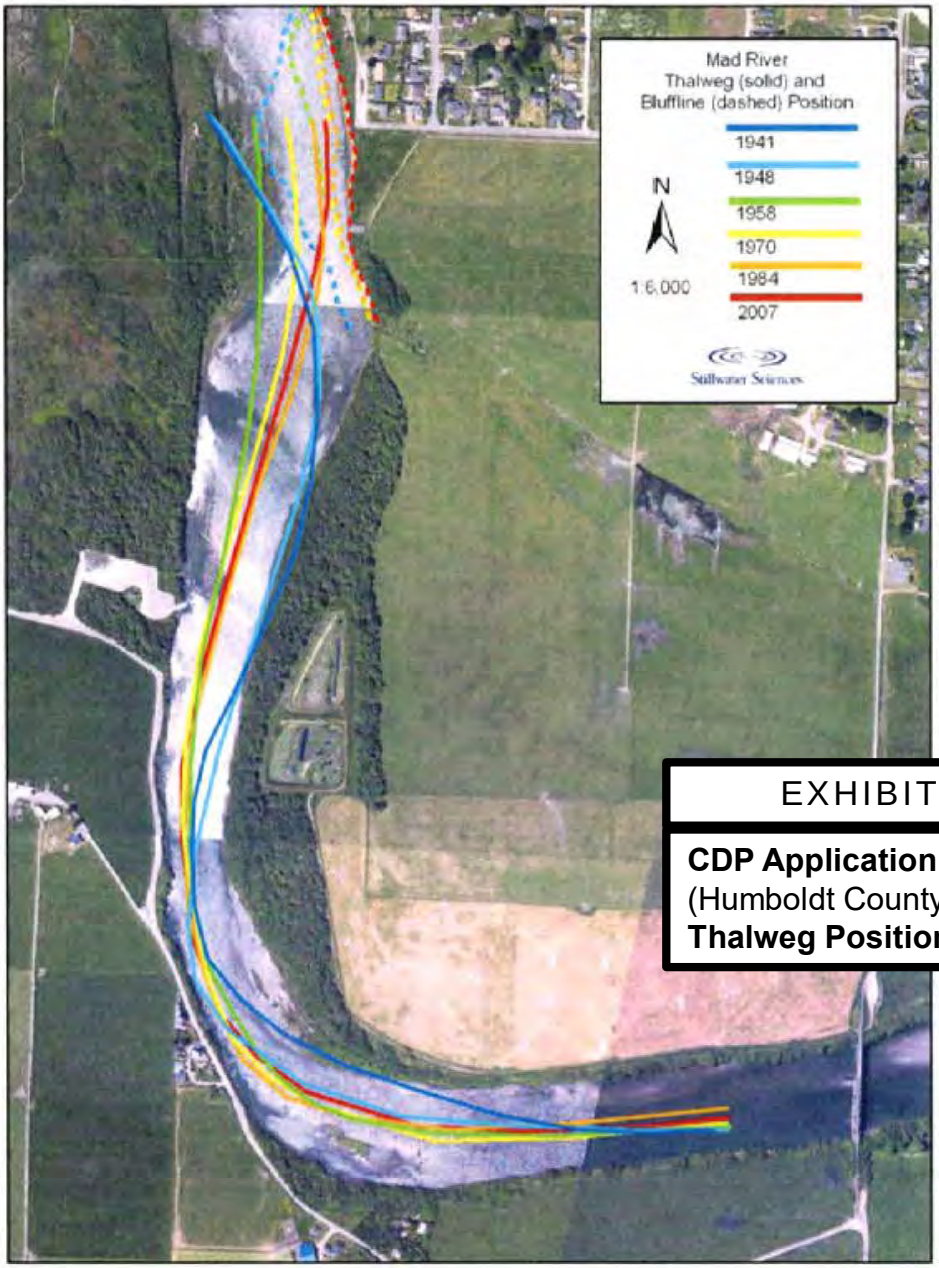
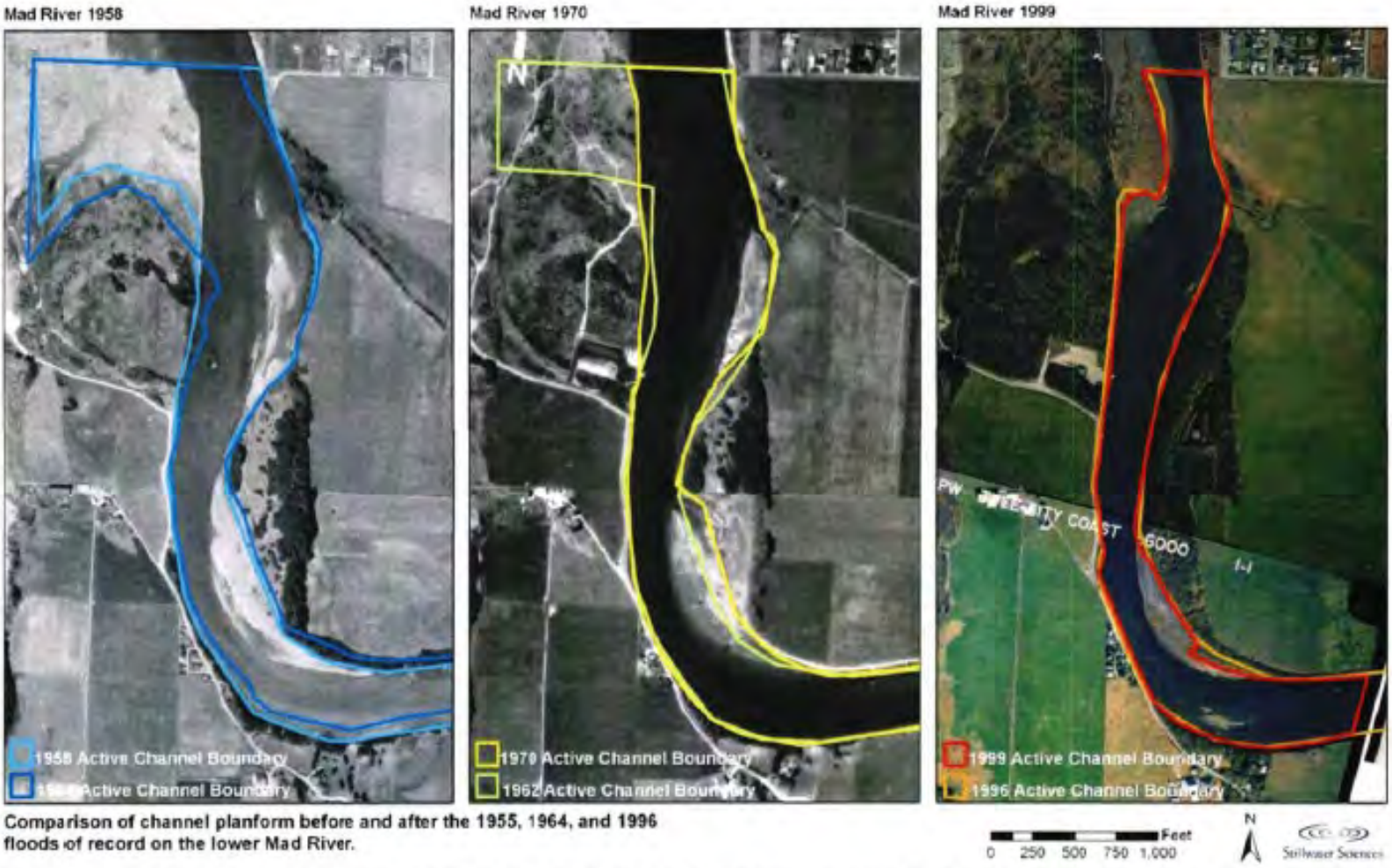


EXHIBIT NO. 6

CDP Application No. 1-09-050
(Humboldt County)
Thalweg Positions, 1941-2007

Figure 7. A comparison of sequential thalweg and bluff position for select years from 1941 to 2007 in the lower Mad River. Bluff positions were determined by LACO (2008).



Comparison of channel planform before and after the 1955, 1964, and 1996 floods of record on the lower Mad River.

Figure 8. Comparison of the Mad River planform in the vicinity of the School Road erosion site before and after the 1955, 1964, and 1996 floods.

EXHIBIT NO. 7

CDP Application No. 1-09-050
(Humboldt County)
Channel Planform Before and After Major Flood Events

HUMBOLDT FISH ACTION COUNCIL

Native Plant Nursery

HFAC Nursery Location:
1280 Hatchery Rd.
Blue Lake
95521

HFAC Nursery Phone:
825-746 or 498-2123
HFAC Office Phone
822-3834

Prepared For: Humboldt County Public Works
1106 Second Street
Eureka, CA 95501

Prepared By: Suzanne Isaacs,
Humboldt Fish Action Council (HFAC)
Nursery Manager
and Revegetation Specialist
sli@reninet.com

Subject: Salt Marsh Assessment, Mad River Streambank Protection Project

Submitted: November 7, 2008

Introduction

Humboldt Fish Action Council (HFAC) has prepared the following report in response to a request by Humboldt County Public Works regarding construction work proposed for the Mad River Streambank Protection Project. Prior to placing rock to reinforce the base of a slope on a bench of salt marsh habitat south of the main construction site, a survey was done during low tide on October 16, 2008, to characterize the vegetation. The site was again surveyed on November 5 to assess post disturbance effects on the salt marsh.

1. Preconstruction Salt Marsh Vegetation

1.1: **Area Description:** The area affected by placement of rock rip rap includes an area approximately 8ft wide by 85ft long or 640 ft. ^2. The affected area contains salt marsh vegetation located on a narrow strip of densely consolidated substrate which, according to Tom Marking of McKinleyville Community Services District, has remained unchanged for many years.

1.2: **Vegetation:** The plant species found there are indicative of those which occur in high salt marsh habitat. Species located highest on the bank growing in a narrow three foot wide strip included patches of coastal hairgrass (*Deschampsia cespitosa)*, cinquefoil (*Potentillia anserina*) and the invasive plant Chilean Cord Grass (*Spartina densiflora*). Growing closer to the water's edge was a contiguous five foot wide patch of American three-square (*Scirpus americanus)* which is going into winter dormancy.

1.3: **Recommendations for Construction Impacts:** In order to minimize disturbance to the salt marsh vegetation, reinforcement of the bank behind the bench will be accomplished by adjusting the alignment of the rip rap and placing rock along the back of the bench, away from the vegetation which is primarily located near the water's edge.

1.4 **Mitigation for Potential Disturbance of Salt March Vegetation:** Any vegetation affected by placement of the rock will be salvaged and replanted once placement of the rock has been completed.

Figure 1: Site Location Map (Photo Date: May 9, 2008)

EXHIBIT NO. 8

CDP Application No. 1-09-050
(page 3 of 5)

Figure 2: Salt Marsh Preconstruction

Figure 3: Salt Marsh Post-construction

EXHIBIT NO. 8

CDP Application No. 1-09-050
(page 4 of 5)

2. Post Construction Effects on Salt Marsh Vegetation

2.1: **As-Built Area Description:** Construction affected an area approximately 3ft. wide by 80ft long or 240 ft^2 along the bank side of the strip of salt marsh habitat. The remainder of the salt marsh area was not disturbed.

2.2 **Vegetation:** The species growing along the highest portion of the salt marsh were most affected by construction. The lower salt marsh habitat which contained the most intact vegetation was minimally impacted.

2.3 **Post Construction Mitigation:** The contractor was able to salvage large clumps (2ft x 2ft) of American three-square (*Scirpus americanus*) rhizomes which were then placed along the base of the rock rip rap.

Figure 4: Salvaged Rhizomes of *Scirpus americanus*

EXHIBIT NO. 8

CDP Application No. 1-09-050
(page 5 of 5)

DEPARTMENT OF PUBLIC WORKS

COUNTY OF HUMBOLDT

MAILING ADDRESS: 1106 SECOND STREET, EUREKA, CA 95501-0579
AREA CODE 707 / FAX 445-7409

ARCATA-EUREKA AIRPORT TERMINAL
McKINLEYVILLE
AVIATION 839-5401

PUBLIC WORKS BUILDING
SECOND & L ST., EUREKA

ADMINISTRATION	445-7491	NATURAL RESOURCES	445-7741
BUSINESS	445-7652	PARKS	445-7651
ENGINEERING	445-7377	ROADS & EQUIP MAINT.	445-7421
	ARCHITECT 445-7493		

CLARK COMPLEX
HARRIS & H ST., EUREKA
LAND USE 445-7205

FINAL REPORT

Mad River Streambank Protection Project, McKinleyville, CA
February 13, 2009

Prepared for:
USDA-Natural Resources Conservation Service
Emergency Watershed Protection Program
DSR No. 01-16-1220

Purpose

The purpose of this emergency repair project was to stabilize a quarter mile length of riverbank in the lower reach of the Mad River. A dual benefit was sought through the completion of this project: The first was to safeguard threatened homes and public infrastructure, and secondly to achieve the stabilization using means that would enhance the riparian bank habitat and eliminate a major source of sediment to the river.

Location

The project is located on the easterly shore of the Mad River approximately 1.5 miles upstream of its confluence with the Pacific Ocean and is close enough to the river mouth to be tidally influenced. The stabilized bank is directly west of the intersection of School Road and Verwer Court in McKinleyville, Humboldt County (Figure 1).

The river is eroding the foot of bluffs created by uplifted marine terraces ranging in height from five feet above mean tide level at the southern end to nearly 50 feet at the northern end. The project encompasses the Mad River channel, streambank and the adjacent upland terrace.

Background

The subject area of streambank was severely eroded during the high water events of the 2005-2006 winter. The severe storms of this winter resulted in a declaration of disaster at both the State and Federal level. By the end of winter the erosion was within 15 feet of a residence and was within imminent reach of public infrastructure including roads, water

Efforts to obtain funding for a bank stabilization project began immediately after the damaging winter storms subsided. The Natural Resources Conservation Services (NRCS) developed a damage survey report for the site and determined that emergency measures were warranted to relieve imminent hazards to life and property. The primary funding for construction of stabilization measures came from the NRCS Emergency Watershed Protection program. The Governor's Office of Emergency Services (OES) also prepared a damage survey and provided a majority of the cost-share for construction of the project. Property owners along the project reach supplied the remaining funding on a prorated basis. Humboldt County served as the local sponsor, administering the design and construction of the project. Allocation of funding and completion of the associated agreements between the participating agencies and affected landowners was completed in August 2008.

The following is a brief timetable of project milestones:

DATE	ACTIVITY
Winter 2005-06	Storm damage results in State and Federal declaration of a disaster. Severe erosion of Mad River bluffs documented
February 2006	Humboldt County Board of Supervisors sends letter to NRCS requesting funding eligibility determination.
February 2006	NRCS writes Damage Survey Report for the Mad River Bluffs erosion
February 2007	NRCS notifies Humboldt county of funding through the Emergency Watershed Protection Program.
August 2007	State Office of Emergency Services authorizes project funding match
January 2008	Affected property owners accept project agreement
August 2008	Board of Supervisors declares emergency due to the imminent threat of erosion limiting access to essential services
September 2008	Contract signed with Bioengineering Consultants
September 2, 2008	Construction begins
October 24, 2008	Construction completed

Preliminary Studies

In February 2008, Humboldt County retained LACO Associates to perform a geologic investigation of the site to determine the level of urgency for repair efforts. Their report (April 2008) identified a strong correlation between high river flows and bank erosion. The report estimated that in any given winter there was a 50 percent probability of a flow event of sufficient magnitude to cause at least 10 feet of bluff erosion, a 10 to 33 percent probability that a peak flow could cause up to 50 feet and a 5 percent probability of river flows causing up to 90 feet of bluff erosion. The LACO report concluded, "there is substantial evidence that potentially significant bluff erosion may occur in the next 12 months to threaten property, essential services, life and health at the Mad River bluff near the end of School Road."

During the mild winters of 2006/2007 and 2007/2008, there was only localized erosion and sloughing at the project site but not major bluff retreat. During these winters the flows in the Mad River did not exceed the threshold of 25,000 to 30,000 cubic feet per second identified by LACO Associates as strongly correlated with substantial erosion events.

Based on the results of the geologic investigation, Humboldt County determined that there was a high level of urgency to implement a bank stabilization project before the 2008-2009 winter season in order to avoid the threat to life, property, and essential public services. On April 22, 2008, the Humboldt County Board of Supervisors authorized the Public Works Department to design and construct emergency bank stabilization measures along the bluff.

The Public Works Department developed the following design criteria for the project:

1. The project will enhance erosion resistance and stability for the damaged streambank
2. The project will not cause adverse impacts for downstream conditions
3. The project will provide aquatic habitat and water quality benefits

The first criterion was achieved by designing a project to armor the lower portion of the bank with a continuous toe buttress of large rock and constructing rock groins at intervals to protect the bio-stabilization structures. In addition to the use of rock, biodegradable geotextile was used to contain embankment materials for the plantings until root structures can grow.

Public Works developed a hydraulic model of the proposed groin system using the Army Corps of Engineers Hydraulics Engineering Center River Analysis System (HEC-RAS) software. The model was first run on the pre-project, existing condition to estimate what velocities and shear values were generated by 5, 50 and 100-year return flow events. The river cross-sections within the proposed project reach were then modified (Figure 2) to reflect the proposed design and the model was re-run to determine changes to the near-shore velocity and shear values. Figures 3 through 5 graphically represent the differences modeled in the project reach. The conclusions drawn from this modeling were: 1) the proposed project would not significantly alter the velocities nor shear along this reach of the riverbank, and 2) the shear values modeled were below published resistance levels for the proposed bioengineered structures (Figure 6, from Hoag and Fripp, 2002).

The second criterion was achieved by designing the project to have a minimal hydraulic profile in the channel. The project was focused on armoring and stabilizing the bank along its existing alignment, and avoided redirecting the river flows.

To support this second design objective, Humboldt County retained Stillwater Sciences in May 2008 to conduct a geomorphic evaluation of the project site and perform hydraulic modeling. These studies were performed to gain an understanding of the current and future trends of the geomorphology at the project site with and without the proposed installation to determine external effects and to optimize the bank stabilization design. Two reports were issued by Stillwater Sciences in July 2008. Based on the evidence from this study, Humboldt County concluded that the project would not result in adverse downstream effects.

The third criterion was achieved by reducing erosion and sedimentation to the lower Mad River, and by enhancing aquatic habitat through the incorporation of riparian vegetation and complex geomorphic features. The Mad River is listed as impaired for sediment and turbidity under Section 303(d) of the Clean Water Act, and the project has provided treatment for an active sediment source. The geomorphic features of the project include rock groins with large woody

debris to provide habitat complexity in a reach of the lower Mad River where such complexity is lacking.

Project Design

Project plans and specifications were developed in August 2008 based on the results of the preliminary studies and research of successful bio-stabilization efforts. As described below, modifications to enhance the project effectiveness and blend with the site conditions were incorporated as construction progressed. As-built plans are included in Attachment 1.

The first order of work in the design process was to obtain a comprehensive survey of the river channel. The resulting topographic map spanned a distance of over 6,800 feet centered on the project site. This information was used for construction plan development as well as the hydraulic modeling previously described.

A toe buttress of four- to six-ton rocks was extended along the base of the bluff for the length of the project site. The toe trench was designed to protect the bank from scour and provide a stable foundation for the upper layers. During construction the height of the toe trench was raised to an elevation sufficient to be above tidal inundation during construction and to place the biological structures above the high saline levels of the tidal waters.

The layered willow embankment was designed to begin at the top of the rock toe. The biological system is made of alternating layers of well-drained river gravel contained in coir (biodegradable coconut fiber) geotextile wrap and live willow cuttings covered with a rocky soil. The willow cuttings are long enough to extend beyond the face of the embankment 2 to 4 feet and to be buried a minimum of 4 to 6 feet. Each layer is 1.5 to 2 feet thick. The layered system was topped with 1.5 to 3 inch willow stakes and randomly spaced ½ ton rock.

Rock groins spaced at 60-foot intervals are constructed of 2-4 ton rock and extend from the top of the toe trench to an elevation 4-8 feet above the top of the willow embankment. Large redwood logs are placed into the structures to protrude 10-15 feet into the river. The rock stabilization structures were keyed into the shoreline at the upper and lower ends of the project to prevent flanking and present a smooth hydraulic interface with the existing riverbank.

The upper portion of the bank was originally designed to be re-graded and re-vegetated. This excavation and the excavation of material from the toe trench were estimated to be 2,000 cubic yards (cy) and 3,500cy respectively. Of these excavated materials 4,400 cy (~6,500 ton) were designed to be incorporated into the biological embankment. Concrete debris placed previously by others along a portion of the riverbank was also designed to be buried and incorporated into the structure as work progressed.

The estimated quantity of ½ to 6-ton rock required for the project was 11,100 ton (the original project plans mistakenly identify this total in units of cubic yards). The total estimated rock and soil to be included into the stabilization structure was estimated to total 17,600 ton (~10,000 cy).

Several potential in-stream silt barrier systems, including commercial products and custom-built configurations, were identified during the design process. A floating system that could fluctuate with the tides was determined to be the most desirable of these

Environmental Systems was the manufacturer of the selected system. This system proved to be very effective with both silt containment and fish exclusion, and was accepted by the resource agencies who observed it during construction. A manufacturer's brochure with product specifications is included in Attachment 2.

Standard erosion control measures were designed into the project to be implemented on those affected areas above the water line. These included silt fencing and strawing and seeding of exposed soils.

Due to the close proximity of construction operations to the Mad River, a Spill Prevention and Response Plan was prepared (Attachment 3).

Permits and Approvals
The following permits and approvals were issued for the project:

- U.S. Army Corps of Engineers – Nationwide Permit 37, File No. 2008-00190N (August 14, 2008)
- Coastal Commission – Emergency Permit No. 1-08-035-G (August 22, 2008)
- Department of Fish and Game – Streambed Alteration Agreement R1-08-0402 (August 26, 2008)
- North Coast Regional Water Quality Control Board – Water Quality Certification WDID No. 1B08119WNHU (August 29, 2008)

NRCS made informal contact with the U.S. Fish and Wildlife Service and NOAA-National Marine Fisheries Service in April and May 2008 with regard to potential effects to species listed under the federal Endangered Species Act. The U.S. Fish and Wildlife Service indicated in an e-mail dated June 11, 2008, that there would be no effect for tidewater goby or other threatened or endangered species under the jurisdiction of U.S. Fish and Wildlife Service. NRCS requested consultation from NOAA-National Marine Fisheries Service in a letter dated June 20, 2008, with respect to listed salmonids. NOAA-National Marine Fisheries Service provided technical assistance comments in a letter dated July 30, 2008.

Construction
Construction was initiated the first week of September 2008 and progressed along the following timeline. Photographs are included in Attachment 4.

Date	Activity
week 1	Mobilization of equipment
	Construct truck turn-around modify fencing
	Install tap and meter for water service
	Install silt curtain
week 2	Construct access ramp
	Begin toe buttress/access road construction
week 3	Complete toe buttress/access road construction
	Construct first rock structure at downstream limits of project
	Construct first "bay" of willow biological embankment
week 4	Complete construction of 3 "bays" of willow embankment
week 5	Complete construction of 4 "bays" of willow embankment
week 6	Complete construction of 4 "bays" of willow embankment

week 7	Complete construction of remaining willow embankment, fill and armor ramp access and begin upstream armoring.
week 8	Construct upstream rock buttress with tie-in to existing riverbank Install and activate timed irrigation system Demobilization & site clean-up

Equipment used in construction of the project varied through different phases of the work and as the methodologies used evolved and became more efficient. Below is a listing of the major equipment usage:

EQUIPMENT	HRS USED
330C Caterpillar Track Excavator	365
300LC Hitachi Track Excavator	100
200LC Hitachi Track Excavator	370
966G Caterpillar Rubber Tired Loader	360
L150E Volvo Rubber Tired Loader	325
Stake-side Flatbed Truck	280
Stake-side Flatbed Truck	250
Kubota KX161 Mini Excavator	50

The large number of excavators and loaders was a result of the limited access and the resulting need to shuttle materials along the foot of the bluff. The ability to deliver materials from the top of the bluff was limited by landowner desire to leave ground surfaces undisturbed and the existent homes. The need to deliver materials along the narrow strip at the toe of the bluff resulted in a larger toe structure than was originally designed. The following details some of the other changes made during construction.

Design Modifications

Several modifications were implemented during construction to enhance the efficacy of the project and to assist in its construction. These changes lessened the impacts of construction activities and will help extend the longevity of the stabilization efforts.

The most prominent of these changes is the configuration of the foundation rock buttress. This buttress was constructed as machinery moved downstream from the southerly access ramp. It served as the construction roadway along which rock, willows and embankment materials were transported to the northerly extreme of the project. To allow work to continue through high tides, this buttress/road was constructed to an elevation of 8-10 feet (NAVD88). This elevation, above the saline influence of the tides, was also best suited for the survival of the willows. The decision to begin the willow embankments at this elevation was reinforced by observations of willow growth in the project vicinity. The minimum elevation of the existing growth is distinctly limited by the upper elevation of the inter-tidal waters.

The methodology for establishment of the bottom of the toe buttress was also altered due to site conditions. The project plans show an idealized trench excavation for placement of the rock toe structure. However, site conditions precluded the open trench methodology envisioned. The saturated, unconsolidated sand and gravel at the base of the bluff could not be trenched. Attempts to excavate the material failed and muddied the water severely. The rock buttress was therefore

pushed into place initially by the lead excavator and packed to refusal by subsequent wheel rolling of heavily laden equipment packing construction materials.

The originally proposed excavation of the top of the bluff to lay it back and as a source of embankment material was discouraged by the regulatory agencies to maintain cavity nesting habitat for some bird species including swallows and owls. Therefore, river run and quarry rock were imported to supplant the originally proposed source.

The alignment of the stabilization structure near the upstream extent was adjusted to minimize impacts to a small area of native salt marsh vegetation that was discovered after construction work had begun. Public Works retained Humboldt Fish Action Council (HFAC) to survey the extent of the salt marsh and develop recommendations. HFAC's report is included in Attachment 5.

The final quantities of imported material are:

9,314 tons	**½ to 6 TON ROCK**
4,293 tons	**PIT RUN**
6,383 tons	**RIVER RUN**
19,990 tons	**IMPORTED MATERIALS**

McKinleyville Community Services District allowed construction activities to be staged on their property and the bluff access to be cut down to the bench. They also were cooperative in allowing willow cuttings to be taken from their properties immediately upstream of the stabilization project. This source for the willows assured that the trees were suited to the local environment and were the best bet for survival and proliferation.

An irrigation system was installed to accelerate establishment of the vegetation component of the project. Operation of the irrigation system is expected through the summer of 2009.

As-built Summary

The bioengineered embankment was composed of a rock buttress overlain by an alternating series of 15 rock groins and vegetated bays, with a total stream-wise length of 1,300 feet. For monitoring purposes, each groin/bay pair is numbered sequentially (1 to 15) starting at the northern end, as shown in Figure 7.

The height of the streambank decreases from approximately 40 feet (NAVD88) at the northern (downstream) end to less than 10 feet at the southern (downstream) end. The top elevation of the rock groins ranges from 25 feet (Groins 4 and 11) to 12 feet (Groin 15). Redwood logs are embedded within eight of the 15 groins and partially protrude riverward from the structure.

The upper portion of the streambank adjacent to Groin/Bay 1 through Groin/Bay 12 was not affected by the project and remains vertical or nearly vertical, retaining a "bluff" morphology. Bays 1 through 12 have a flat bench at the top of the structure adjacent to the vertical face of the streambank, with an elevation of approximately 17.5 feet (NAVD88). Bays 13, 14, and 15 have sloping surfaces that taper into the adjacent streambank.

Monitoring
A summary of fish monitoring efforts during project construction is included in Attachment 6. The post-construction Monitoring Plan is included in Attachment 7.

Attachments
1 As-built Plans
2 Turbidity Curtain Specifications
3 Spill Prevention and Response Plan
4 Construction Photographs
5 Salt Marsh Assessment
6 Fish Survey Monitoring Report
7 Monitoring Plan

References
LACO Associates. April 2008. Mad River Bluffs, Geologic Investigation and Assessment.

Stillwater Sciences. July 2008a. Mad River Streambank Stabilization Project Geomorphic Evaluation. Prepared by Stillwater Sciences for Humboldt County Public Works Department.

Stillwater Sciences. July 2008b. River2D Simulation of the Mad River near School Road, McKinleyville, California.

Hoag and Fripp. 2002. Streambank Soil Bioengineering Field Guide for Low Precipitation Areas, U.S. Department of Agriculture-Natural Resources Conservation Service, Aberdeen, Idaho.

DEPARTMENT OF PUBLIC WORKS

COUNTY OF HUMBOLDT

MAILING ADDRESS: 1106 SECOND STREET, EUREKA, CA 95501-0579
AREA CODE 707 / FAX 445-7409

ARCATA-EUREKA AIRPORT TERMINAL MCKINLEYVILLE		PUBLIC WORKS BUILDING SECOND & L ST., EUREKA			CLARK COMPLEX HARRIS & H ST., EUREKA	
AVIATION	839-5401	ADMINISTRATION	445-7491	NATURAL RESOURCES	445-7741	LAND USE 445-7205
		BUSINESS	445-7652	PARKS	445-7651	
		ENGINEERING	445-7377	ROADS & EQUIP MAINT.	445-7421	
			ARCHITECT 445-7493			

MONITORING REPORT No. 1

(December 2008 – October 2009)

Mad River Streambank Protection Project, McKinleyville, CA
November 25, 2009

Overview

This document is the first annual monitoring report for the Mad River Streambank Protection Project, which was constructed in September and October 2008 with funding from USDA-Natural Resources Conservation Service (NRCS), the Governor's Office of Emergency Services (OES), and adjacent landowners. The purpose of the monitoring is to evaluate and document the performance of the project for three years following construction, and to provide information to support future applications of the project design concepts.

A bioengineered embankment was constructed to stabilize an approximately 1,300-foot-long section of eroding streambank and provide aquatic habitat benefits. The embankment included a series of 15 rock groins and vegetated bays, with redwood logs embedded within eight of the 15 groins. Details regarding the project design and construction are included in the Final Report (February 13, 2009). Attachments to the Final Report include a Fish Survey Monitoring Report (November 6, 2008), which contains the results of fish survey work performed prior, during, and immediately following construction; and the project's Monitoring Plan (revised January 20, 2009). Maps of the site are provided in Figures 1 through 3.

Irrigation System Operation

A timer-controlled irrigation system to promote the growth of the planted willows was operated from project completion through November 2009 (Table 1). The typical watering schedule was one to two hours in the early morning and one to two hours in the late afternoon, with an additional hour of watering in the middle of the day during the dry season. The schedule was adjusted based on weather (precipitation, temperature, wind) and observations of the condition of the vegetation.

The system will be turned off for the 2009-2010 wet season, and i
of irrigation will not be necessary due to successful vegetation est

EXHIBIT NO. 10

CDP Application No. 1-09-050
(Humboldt County)
Final Monitoring Report (excerpt)
(page 1 of 10)

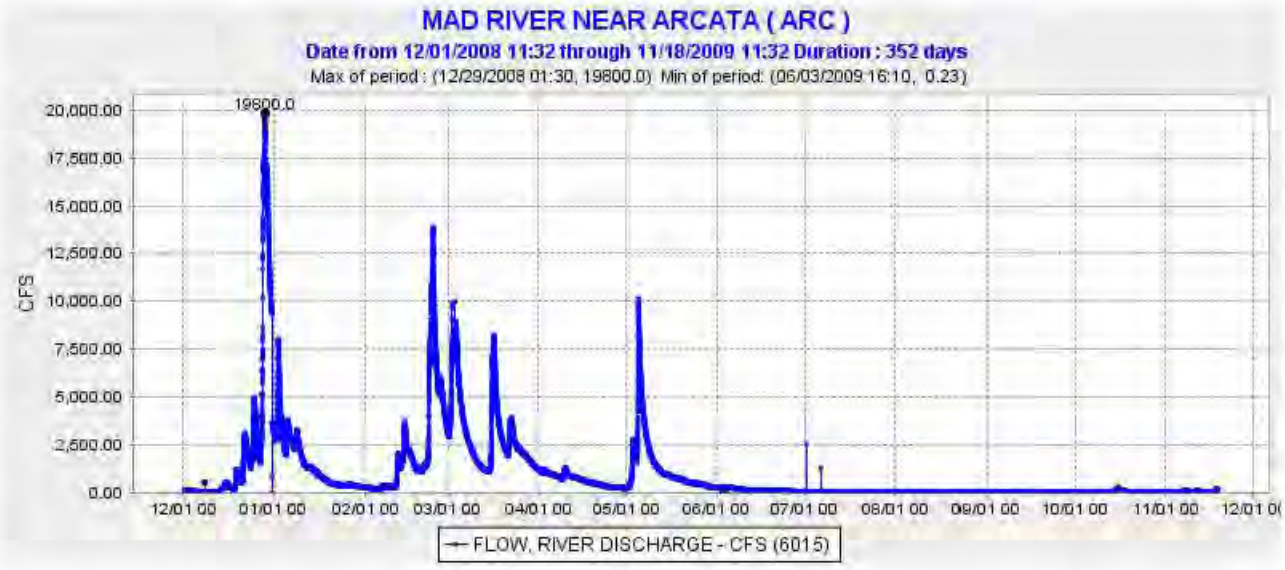
Table 1: Irrigation System Operation

Period		Usage	Total Cost
Start	End	(Gallons)	
9/15/2008	11/10/2008	9,028	$1,720
11/10/2008	12/8/2008	5,790	$1,114
12/8/2008	1/12/2009	2,581	$532
1/12/2009	2/9/2009	1,990	$417
2/9/2009	3/9/2009	1,533	$329
3/9/2009	5/11/2009	1,765	$394
5/11/2009	6/8/2009	3,194	$687
6/8/2009	7/13/2009	531	$149
7/13/2009	8/11/2009	3,149	$713
8/11/2009	9/8/2009	1,586	$376
9/8/2009	10/14/2009	598	$164
10/14/2009	11/10/2009	770	$201
	Total:	32,516	$6,796

The system was repaired as needed during the year due to frost damage, particulate clogging, vandalism, and damage associated with slumping soil from the upper portion of the bluff. The sprinkler head risers were raised to improve spray coverage as the vegetation increased in height.

Flows

According to the Department of Water Resources' California Data Exchange Center (queried November 18, 2009), the peak instantaneous (15-minute) flow during the monitoring period was 19,800 cfs, on December 29, 2008:



This maximum peak discharge has a recurrence interval of approximately 1.5 years; thus, the project did not experience a high-flow event during its first wet season.

EXHIBIT NO. 10

CDP Application No. 1-09-050
(page 2 of 10)

Monitoring
The Monitoring Plan calls for monitoring three parameters as summarized in Table 2:

Table 2: Summary of Monitoring Parameters

Monitoring Parameter	Measurable Attribute	Evaluation Technique
Bank Protection	Bank Stability	Visual assessment Aerial photographs
Vegetation Establishment	Live Material: - Percent live cover Dormant Material: - Basal sprouts - Bud scales - Turgidity and color	Visual assessment Photopoints
Fish Habitat	Boulders Large woody debris Willows Presence of salmonids	Underwater observation Streambank observation

Bank Protection
The bank stabilization structure was inspected regularly by Humboldt County personnel during the year, typically two to four times per month, for visual signs of erosion. No movement of the constructed portion of the project along the base of the bluff was observed. Occurrences of localized sloughing were observed from the upper (undisturbed) portion of the streambank, as expected. The sloughing occurrences did not affect the integrity of the stabilization structure.

Aerial photographs were collected on May 26, 2009, and a comparison of pre- and post-construction aerial photographs is shown in Figure 4. A photolog of ground-based photographs is included in Attachment A.

Vegetation Establishment
Vegetation monitoring was performed by Suzanne Isaacs, revegetation specialist with Humboldt Fish Action Council (HFAC). During the monitoring period, HFAC performed bi-monthly inspections (Attachment B) and three sampling events (Attachment C). The dates of the sampling events were December 16, 2008; June 30, 2009; and October 6, 2009.

The methodology for the sampling events is described in the Monitoring Plan. The monitoring attribute for live vegetation was percent live cover, and for dormant material the attributes included basal sprouts, bud scales, and turgidity and color. Success criteria for live cover were established for different areas within the project based on site-specific conditions.

Highlights from the vegetation monitoring include the following:
- All vegetation establishment success criteria for percent cover were met and surpassed.
- In addition to Sitka willow (*Salix sitchensis*) and Hookers willow (*Salix hookeriana*), a third willow species – Shining willow (*Salix lucida*) – and black cottonwood (*Populus balsamifera*) have established within the project area.
- Willow seedlings were observed, indicating local recruitment.

- Irrigation in the fall and early winter of 2008-2009 appeared to have the effect of delaying the onset of dormancy and shortening the dormancy period (some vegetation had already "broken bud" by January 2009).
- Due to orientation relative to the prevailing winds, some areas were subject to strong, dry, off-shore winds in the winter. Watering in the winter during stretches of dry weather, even when soils are nearly saturated, has the benefit of wetting down the plants and reducing the effects of wind burn and desiccation.
- The plantings likely would have been fine with less watering in the summer and fall of 2009, due to the mild temperatures and moist coastal air (as opposed to sites in more xeric environments). In addition, it is theorized that the willows tapped into the water table (the depth of which is controlled by the surface of the Mad River) by at least mid-summer 2009.

The next formal vegetation sampling event is tentatively planned for September 2010.

Preliminary salinity monitoring was performed by Jeff Anderson & Associates from December 2008 through February 2009 to characterize the potential salinity exposure to the willows, in anticipation of diagnosing potential growth problems. The monitoring results (Attachment D) indicate that the planted willows are not expected to be inundated by saline water, and therefore salt water exposure should not be an issue.

Fish Habitat

The performance criteria for fish habitat benefits are the extent of improved habitat features and complexity and the presence of salmonids. Baseline (pre-project) conditions at the site were evaluated by direct underwater observation on July 25, 2008, by fishery biologists from California Department of Fish and Game and Humboldt County Public Works Department (DFG, 2008). The baseline monitoring identified poor complexity, the absence of riparian vegetation, and the absence of salmonids. Post-project conditions were evaluated on June 23, 2009, through direct underwater observation (snorkel survey). The fish survey monitoring results (Attachment E) documented positive results in terms of the presence and extent of the habitat elements and utilization of these elements by salmonids and other fish species. The next snorkel survey is tentatively planned for June 2010.

Conclusion

Based on the monitoring activities conducted from December 2008 through November 2009, the project appears to be meeting its intended objectives for bank stability and aquatic habitat enhancement. The planted vegetation has met its success criteria and become established with robust woody tissue to the point where irrigation is no longer necessary. The project has only been subject to a 1.5-year recurrence interval flow, and thus has not been tested under high-flow conditions. The relatively light winter was fortuitous for helping the vegetation component of the project to become firmly established before it experiences a high-flow event.

Changes from Monitoring Plan

Variations from the Monitoring Plan included the following:

- The number of formal vegetation sampling events during the monitoring period was reduced from five to three, based on the observed success of establishment.

- Inspection forms were initially used for assessing bank stability, but based on the initial findings it was determined that the use of forms was unnecessary.
- The duration of the monitoring period was shifted from December 2008-September 2009 to December 2008-November 2009.

Distribution List

California Department of Fish & Game, c/o Scott Bauer
619 Second Street, Eureka, CA 95501

California Coastal Commission, c/o Melissa Kraemer
710 E Street, Suite 200, Eureka, CA 95501

North Coast Regional Water Quality Control Board, c/o Dean Prat
5550 Skylane Blvd., Ste. A Santa Rosa, CA 95403

U.S. Army Corps of Engineers, c/o Carol Heidsiek
P.O. Box 4863, Eureka, CA 95502

NOAA-National Marine Fisheries Service, c/o Leslie Wolff
1655 Heindon Road, Arcata, CA 95521

USDA-Natural Resources Conservation Service, c/o Bill Ward
430 G Street #4164, Davis, CA 95616

Attachments

A – Photographs
B – Vegetation Inspection Reports
C – Vegetation Sampling Reports
D – Salinity Monitoring Report (revised April 14, 2009)
E – Fish Survey Monitoring Report (July 9, 2009)

LEGEND

G = Groin
B = Vegetated Bay

Photo Date: 10/26/2008

FIGURE 2B
Site Features

Mad River Streambank Protection Project
McKinleyville, Humboldt County

LEGEND

G = Groin
B = Vegetated Bay

Photo Date: 10/26/2008

FIGURE 2A
Site Features

Mad River Streambank Protection Project
McKinleyville, Humboldt County

COUNTY OF HUMBOLDT
The Home of the Redwoods

EXHIBIT NO. 10

CDP Application No. 1-09-050
(page 8 of 10)

LEGEND

G = Groin
B = Vegetated Bay

Photo Date: 10/26/2008

FIGURE 2C
Site Features

Mad River Streambank Protection Project
McKinleyville, Humboldt County

COUNTY OF HUMBOLDT
The Home of the Redwoods

FIGURE 3
Plan View Map
Mad River Streambank Protection P
Humboldt County

Imagery: USDA NAIP (2009)
Date prepared: November 25, 2009

EXHIBIT NO. 10

CDP Application No. 1-09-050
(page 9 of 10)

Photo Date: May 9, 2008

Photo Date: May 26, 2009

FIGURE 4
Comparison of Pre- and Post-Project Conditions
Mad River Streambank Protection Project

EXHIBIT NO. 10
CDP Application No. 1-09-050
(page 10 of 10)

COUNTY OF HUMBOLDT

DEPARTMENT OF PUBLIC WORKS
ENVIRONMENTAL SERVICES DIVISION

1106 SECOND STREET
EUREKA, CA 95501-0579
(707) 445-7741 / FAX (707) 445-7409

Technical Memorandum
Mad River Streambank Protection Project (CDP No. 1-09-050)

September 3, 2020

Prepared by: John Wellik, Registered Professional Geologist, Senior Environmental Analyst
Hank Seemann, Deputy-Director (Environmental Services)

The purpose of this technical memorandum is to describe the design basis for the upstream portion of the Mad River Streambank Protection Project and to document post-construction and current conditions.

1 Project Overview

The Mad River Streambank Protection Project ("Project") was located along the right bank of the lower Mad River (Figure 1), near the west end of School Road in McKinleyville, California. The Project site experienced significant erosion in December 2005 and January 2006 caused by high water flows resulting from severe storms. Bioengineering methods were used to protect public infrastructure (roads and underground utilities) and residential structures from imminent future damage while also creating riparian vegetation and enhancing habitat complexity (Photograph 1). Funding was provided by the United States Department of Agriculture-Natural Resources Conservation Service, the Governor's Office of Emergency Services, and adjacent property owners benefiting from the Project. The Project was constructed from September 6, 2008 through October 24, 2008. Figures 2 through 4 present the Project area in 2019, 2018, and 2016. Figure 5 provides a close-up aerial view of the segments upstream of School Road.

The Project design incorporated traditional rock slope protection (RSP) along with bioengineered components to enhance erosion resistance and stability for the exposed streambank while simultaneously providing habitat and water quality benefits. The Project increased streambank stability by protecting the most vulnerable portion of the bank with rock and living material. The inert portion (rock) of the stabilization structure provided immediate bank protection. The live portion of the structure (planted willows) enhanced stability when it became fully established within the following year. The size and complexity of the vegetation has continued to increase with natural growth. The Project enhanced fish habitat through the incorporation of rock groins and large woody debris and by providing a riparian source for aquatic insects. The Project provided water quality benefits by reducing erosion and sedimentation to the lower Mad River and moderating water temperature through riparian shading.

2 Pre-Project Conditions

The right bank of the lower Mad River in the vicinity of School Road has a well-established history of relatively rapid bluff retreat correlated with erosion during peak discharge events. Bluff erosion initiated near the intersection of the surface expression of a fault trace of the Mad River Fault Zone and the right bank of the Mad River, approximately 700 feet south of School Road (Attachment A, U.S. Quaternary

Faults). South of the fault trace, surface deposits typically comprise unconsolidated Holocene Mad River gravel, sand, and silt deposits. North of the fault trace, the bluff is formed by late Pleistocene marine deposits comprised of moderately to poorly cemented interbedded silty sands and gravel conglomerate (Stillwater, 2008a). The bluff typically maintained a vertical to near-vertical profile down to the water surface along its length north of the fault. High-energy flow events frequently resulted in spalling of bluff walls and block falls from undercutting and destabilization. The National Oceanic and Atmospheric Administration California Nevada River Forecast Center recorded a New Year's Eve 2005 flooding event along this portion of the Mad River resulting in a gage height of 23.4 feet and discharge of approximately 50,000 cubic feet per second (cfs). LACO Associates (2008) estimated flows of 25,000 to 30,000 cfs as the lower threshold of discharges that would result in an increased rate of right bank retreat. Stillwater Sciences (2008b) identified the discharge rate of 27,900 cfs as having a two-year recurrence interval.

Historical imagery compiled by the McKinleyville Community Services District (MCSD) includes nine aerial images of the Mad River at School Road taken between 1941 to 1999 (Attachment B). MCSD sequenced the images by time to visually compare channel morphology as the system responded to natural and anthropomorphic influences. Two sets of images, 1941 vs. 1958 and 1941 vs. 1999, present graphical illustrations of right bank retreat after the 1955 flood and after 58 years of erosion, respectively. Changes in channel location and bluff position are apparent, both immediately after large flooding events and cumulatively over time.

Stillwater Sciences (2008a) provides a comprehensive discussion on right bank retreat in the Project area. Bluff retreat has been estimated at approximately 350 feet at the west end of School Road (Reference Line 4 of Figure 4 in LACO Associates [2008]) between 1941 and 2008, based on historical aerial imagery. Bluff retreat south of School Road (Reference Line 2 of Figure 4) is estimated at approximately 140 feet between 1941 and 2008. Up to 25 feet of right bank south of School Road was lost between 2005 and 2008 based on bank location as presented on Figure 4 in LACO Associates (2008). In addition, images of the bluff immediately prior to Project construction help illustrate the rate of bluff retreat south of School Road. Photographs 2 through 4 present bluff retreat south of School Road using a fence post for reference. The fence was installed during the construction of stormwater outfall infrastructure, which included the rock velocity dissipator visible in the photographs. Based on the width of the grassy surface between the post and the Mad River, one foot of retreat is estimated between February 10, 2005, and January 19, 2006. Photograph 4 from Spring 2008 depicts the fence post and its concrete base suspended due to bluff failure, interpreted as comprising an additional two feet of retreat over approximately two years. Photograph 5 is an image of the southern portion of the RSP and outfall velocity dissipator as it currently appears (note that the outfall fence was removed in 2008 as part of the Project).

The aggrading gravel bars along the Mad River left bank upstream of the Project and at the western end of School Road create a narrow channel with high velocities oriented directly at the base of the bluff south of School Road (Figure 6). The configuration of the gravel bars steers the orientation of the thalweg and focuses the river's erosive energy toward the upstream portion of the Project. As shown on Figure 6, the erosive forces are creating an incipient outside meander bend at the upstream extent of the Project. Due to these geomorphic conditions, easterly retreat of the right bank upstream of School Road would likely have continued without stabilization measures.

3 Basis of Design for Upstream Extent of Bank Stabilization Measures

The approximately 1,300-foot-long bioengineered streambank stabilization project can be subdivided into three segments:

1. Segment 1 – The steep bluff north of School Road (approximately 675 feet), directly adjacent to residences. Segment 1 comprises rock groins and vegetated bays 1 through 9 on Figure 7 of Attachment C (stations 10+80 through 17+55; Sheet 4 of Attachment C). This segment protects the bluff immediately adjacent to residences and public infrastructure.

2. Segment 2 – The steep bluff south of School Road and north of the outfall structure (approximately 365 feet), adjacent to undeveloped land and agricultural pasture. Segment 2 comprises rock groins 10 through 15 and vegetated bays 10 through 14 on Figure 7 of Attachment C (stations 17+55 through 21+20, Sheet 4 of Attachment C).
3. Segment 3 – The low-profile bank south of the outfall structure (approximately 210 feet), adjacent to undeveloped land and agricultural pasture. Segment 3 comprises bay 15 on Figure 7 of Attachment C (stations 21+85 through 23+95, Sheet 4 of Attachment C).

The purpose of Segment 1 was to stabilize the bank immediately adjacent to residences and public infrastructure. The purpose of Segments 2 and 3 was to prevent erosive forces from flanking the upstream end of Segment 1 and threatening the integrity of the Segment 1 stabilization structure and the stability of the bluff behind the structure.

Flanking can be defined as "erosion around the landward end of a stream stabilization countermeasure" (FHWA, 2001). Flanking is a common failure mechanism for protective shoreline structures, which are vulnerable to edge scour where there is an interface between protected and unprotected surfaces. Potential treatments to prevent edge scour and flanking include: placing deflectors (typically with rock or fill) within the channel to deflect flow away from the bank; keying the structure into the bank; constructing a more extensive "tieback" into the bank; and extending the longitudinal extent of the structure along the bank.

Based on the evidence of bank erosion south of School Road and the orientation of the upstream thalweg, the risk of continued erosion leading to scour behind the Segment 1 stabilization structure was determined to be high. Continued erosion along Segment 2 and Segment 3 would have reduced the effectiveness and lifespan of the Segment 1 structure and threatened School Road and the residential area along a new southern face. A longitudinal extension of the bioengineered structures upstream was determined to have the least ground disturbance and least environmental impacts compared to a deflector, tieback structure, or key-in into the bank. The structures along Segments 2 and 3 were designed for the purpose of preventing flanking of Segment 1, not to protect the undeveloped land immediately adjacent to Segments 2 and 3.

Project Elements

The underlying rock buttress for Segments 1 and 2 was built with four- to six-ton boulders, which protect the right bank from toe scour and provide a stable foundation for the upper layer (Attachment C). Above the rock buttress, the upper revetment layer comprised an alternating series of 15 rock groins and vegetated bays numbered sequentially starting at the northern end (Attachment C).

The groins are layered mounds of rock revetment spaced at approximately 60 to 80 feet. Redwood logs were embedded within eight of the 15 groins to partially protrude riverward from the structure. Vegetated bays 1 through 12, located between rock groins 1 through 13, are flat-laying rock, soil, and decomposable geotextile fabric layers integrated with willow branches, cuttings, and stakes. The flat benches of bays 1 through 12 were planted with willow stakes, and willow stems were planted against the face of the bluff in these bays. Bays 13 and 14, located where the vertical relief of the bluff decreases compared to bays 1 through 12, were constructed using the same materials but with sloping surfaces that taper into the adjacent streambank.

Bay 15 is the upstream portion of the Project, south of the existing stormwater outfall with an approximate length of 210 feet, composed of four- to six-ton rock boulders placed on the exposed river bank and intermixed with smaller rock, soil, and willow sprigs. This segment tapers into the streambank in an effort to mimic natural grade (Photographs 5, 19, 20, and 21). The top of the RSP was designed to

match the elevation of the opposite bank and floodplain elevation to minimize hydrologic impacts to the Mad River.

Revetment design was generally consistent with guidance presented in U.S. Department of Transportation, Federal Highway Administration [FHWA] (1989) and FHWA (2001). The County applied these standards based on site-specific factors and attempted to minimize the footprint and amount of fill material where appropriate. For example, according to Figure 15 of FHWA (1989), revetment protection should extend a minimum of one channel-width upstream of the tangent point of a meander bend. This hypothetical location is interpreted to be located significantly further upstream than the extent of the actual Project (Figure 7). The Project applied a less conservative design than the FHWA (1989) guidance based on actual site conditions. The Project did not attempt to abate all erosion on the right bank, but only the minimum amount needed to protect the integrity of the Segment 1 area. As shown on Photograph 11, the right bank upstream of the Project has continued to experience some erosion but not enough to represent a threat to the downstream portion of the Project.

4 Post-Project Conditions (2009-2010)

Stabilization of the right bank of the Mad River at School Road was visibly apparent shortly following Project completion. Willow growth was beginning to dominate the rock and fill, both along the water line and within the upper bench surface (Photographs 6 through 10). On the upper terrace surface, grass and flower growth improved aesthetic qualities and provided erosion protection. Photograph 11 from April 2010 includes the furthest upstream protection component after Project completion. A flooding event in late December 2010 resulted in discharges in excess of 30,000 cfs; Photographs 12 through 14 present conditions at the Project site during that event. In Photographs 12 and 13, turbulent flow along the base of the right bank is visible, and in Photograph 14 water is shallowly flooding the Mad River access path.

5 Current Conditions (2020)

Willow growth throughout the Project area is strong and the trees appear vigorous and healthy. Photographs 15 and 16 present conditions on the upper terrace and along Segment 1 in April 2018. Willows have grown to envelope both the upper revetment surface as well as the bluff face (Photograph 16). Willow growth to and above the upper bluff edge, and grass growth on the upper terrace, enhances erosion protection. Photographic documentation of the current state of the Project was performed in April 2020 and comprises Photographs 17 through 21. Extensive willow growth covers all but the lowermost portion of the RSP structure and blends with the local ecosystem and visual setting. Photographs 18 through 21 focus on Segments 2 and 3. The groin sections terminate in the general vicinity of the gap in the willows visible in Photographs 18 and 19; the gap is the location of the bench in Photograph 15.

Photograph 20 presents the full extent of the Project area as viewed from the gravel bar immediately upstream of the Project area. A scour channel at the base of the right bank is present upstream of the southern extent of the Project area (Photograph 21), showing persistence of the high-energy geomorphic conditions. No visual evidence of RSP displacement/movement has been observed during multiple inspections following the completion of construction in 2008. Though visual evidence of bank erosion upstream of bay 15 is present, no flanking of Project features has been observed to date.

Photograph 22 presents the public access point from School Road made available in 2005, and Photograph 23 presents the Mad River and riparian area access path as it appeared in 2005. Photograph 24 is of the bench on the bluff overlook, a regularly visited feature often occupied during site inspections. Photograph 25 presents the Mad River access path at the southern extent of the Project area. Members of the public utilize this path to access the river channel and other paths that meander through riverside habitat. Wildlife in and around the trail system is abundant.

6 Impacts and Risks Associated with Removing the Stabilization Structure South of School Road

If the stabilization structures constructed within Segment 2 and Segment 3 were to be removed, an access road network and staging areas would need to be developed within the riparian vegetation that was established as part of the Project. Ground disturbance associated with heavy equipment access, staging, and material stockpiling would be significant. Water quality within the Mad River would likely receive temporary impacts due to sediment discharge. The right bank would be de-stabilized and exposed to continued erosion. As discussed in Section 3, the stabilization structure in Segment 1 would be at risk for flanking and the bluff area adjacent to Segment 1 would be vulnerable to erosion from the south. The damaged riparian areas could be re-established; however, there would be at least one to two years of temporal loss. Removal of Segments 2 and 3 would be highly controversial. Many people would object that the costs and impacts of such a demolition project do not outweigh the benefits; create significant safety and property damage risks; and represent a poor use of public funds. The costs of removal would be borne upon the County rather than the original funders of the Project. Funding such a project would be controversial because the County is facing a major financial crisis due to the Covid-19 pandemic. If the structures along Segments 2 and 3 are removed and erosion begins to threaten the Segment 1 structure, then stakeholders would likely mobilize to advocate for a new stabilization project.

7 Conclusions

The purpose of the upstream portion of the Mad River Streambank Protection Project was to prevent flanking of the downstream structure that provided direct protection for residential development and public infrastructure. The risk of continued erosion along the right bank and flanking of the structure and/or threats to the residences and infrastructure was high to due geomorphic conditions. The upstream longitudinal extent was designed to impose the minimum amount of influence on the fluvial setting and ongoing natural processes while maximizing design life and return on community investment.

Figures

References

2008. LACO Associates. *Mad River Bluff, Geologic Investigation and Assessment.* Eureka, CA.

2020. *Mad River Fault Map,* accessed on August 20, 2020 at https://usgs.maps.arcgis.com/apps/webappviewer/index.html?id=5a6038b3a1684561a9b0aadf88412fcf

2008a. Stillwater Sciences, *Mad River Streambank Stabilization Project Geomorphic Evaluation*.

2008b. Stillwater Sciences, *River 2D simulation of Mad River near School Road, McKinleyville, California*

1989. U.S. Department of Transportation, Federal Highway Administration. Design of Riprap Revetment. Hydraulic Engineering Circular No.11, Publication No. FHWA-IP-89-016 https://www.usbr.gov/tsc/techreferences/hydraulics_lab/pubs/PAP/PAP-0798.pdf

2001. U.S. Department of Transportation, Federal Highway Administration. Bridge Scour and Stream Instability Countermeasures. Hydraulic Engineering Circular No. 23, Second Edition, Publication No. FHWA-NHI-09-111. (Note: the third edition of HEC-23 was published in 2009 and supersedes the second edition.) https://www.fhwa.dot.gov/engineering/hydraulics/pubs/09111/09111.pdf

Attachments

COUNTY OF HUMBOLDT

DEPARTMENT OF PUBLIC WORKS
ENVIRONMENTAL SERVICES DIVISION

1106 SECOND STREET
EUREKA, CA 95501-0579
(707) 445-7741 / FAX (707) 445-7409

Technical Memorandum
Mad River Streambank Protection Project (CDP No. 1-09-050)

October 12, 2020

Prepared by: John Wellik, Registered Professional Geologist, Senior Environmental Analyst
Hank Seemann, Deputy-Director (Environmental Services)

The purpose of this technical memorandum is to summarize the design options for the Mad River Streambank Protection Project (Project) and document post-construction conditions. This memorandum supersedes a previous draft dated September 3, 2020.

1 Project Overview

The Project was located along the right bank of the lower Mad River near the west end of School Road in McKinleyville, California ("School Road erosion site") (**Figure 1**). The site experienced significant erosion in December 2005 and January 2006 caused by high water flows resulting from severe storms ("2005-2006 New Year's Storm"). Approximately 1,250 feet of streambank was stabilized with rock and willow plantings to protect public infrastructure (roads and underground utilities) and residential structures from imminent future damage while also creating riparian vegetation and enhancing habitat complexity. The Project enhanced fish habitat through the incorporation of rock groins and large woody debris and by providing a riparian source for aquatic insects. The Project provided water quality benefits by reducing erosion and sedimentation to the lower Mad River and moderating water temperature through riparian shading. The size and complexity of the vegetation has continued to increase with natural growth.

The Project was constructed from September 6, 2008 through October 24, 2008. Funding was provided by the U.S. Department of Agriculture-Natural Resources Conservation Service (NRCS), the Governor's Office of Emergency Services, and adjacent property owners.

2 Pre-Project Conditions

Geologic Setting
Bluff erosion initiated near the intersection of the surface expression of a fault trace of the Mad River Fault Zone and the right bank of the Mad River, approximately 700 feet south of School Road. North of the fault trace, the bluff is formed by late Pleistocene marine deposits comprised of moderately to poorly cemented interbedded silty sands and gravel conglomerate (Stillwater, 2008). South of the fault trace, surface deposits typically comprise unconsolidated Holocene fluvial deposits (gravel, sand, and silt).

Photo 1: View facing east (January 22, 2006).

Photo 2: View facing north (January 19, 2006).

Project Area
The project area can be subdivided into four segments (**Figure 2**):

Segment	Description	Length	Stabilization Measures Constructed
1	Steep, near-vertical bluff north of School Road. Adjacent to residences and public infrastructure.	675 feet	Yes
2	Steep, near-vertical bluff south of School Road and north of a stormwater outfall structure. Adjacent to undeveloped land and riparian vegetation.	365 feet	Yes
3	Low-profile bank south of the outfall structure and north of right-bank gravel bar. Adjacent to riparian vegetation.	210 feet	Yes
4	Low-profile bank south of the 2008 project, adjacent to gravel bar (west) and riparian vegetation (east).	130 feet	No

Photo 3: Representative pre-project photo of Segment 1 (March 20, 2006).

Photo 4: View facing east of Segment 2 prior to the project (May 30, 2008).

Photo 5: Representative photo of Segment 3 prior to the project (March 20, 2006).

Geomorphic Factors

In May 2008, Humboldt County retained Stillwater Sciences to evaluate the geomorphic processes that affect site conditions and present a professional opinion regarding the potential future trajectory of the geomorphology of the area (Stillwater Sciences, 2008). Stillwater concluded that naturally occurring fluvial processes in response to the northward migration of the mouth of the Mad River initiated channel meander and point bar development, shifting of the thalweg orientation, and bank erosion of School Road. Formation of the current river planform began forming around 1970 with the emergence and growth of a gravel bar along the left bank opposite School Road, which caused the river thalweg (the deepest part with the highest velocities) to progress eastward and impinge directly against the bluff on the right bank in the vicinity of School Road. The thalweg of the river is angled toward the bluff at this location and the bluff functions as the outside of a meander bend. This planform resulted in high flow velocities pointed directly at the base of the School Road erosion site. Lenses of sand and gravel in the base of the bluff were vulnerable to scour and erosion by flowing water. The middle and upper portions of the bank became over-steepened and then failed as blocks through slumping. **Figures 3 and 4** identify the key geomorphic features of the site driving the patterns of erosion. The configuration of the gravel bars steers the orientation of the thalweg and focuses the river's erosive energy toward the bluff north and south of School Road. As the left bank gravel bar grows and becomes firmly established with vegetation, the channel is adjusting by creating a meander bend on the right bank near the upstream portion of the site.

Erosion History

In March 2008, Humboldt County retained LACO Associates to perform a geologic investigation and assessment of the site. **Figure 5** depicts the erosion history from 1941 through 2008 based on georeferenced historical photographs (1941-2005) and topographic survey (2008), as presented in LACO Associates (2008). Additional exhibits with historical imagery are provided in **Attachment A**. The largest amount of bluff retreat between 1941 and 2008 was located directly across from School Road, with a total length of approximately 350 feet. In the upstream portion of the project area (Segments 3 and 4), approximately 85 feet of bank erosion occurred between 1948 and 1954. After 1954, the bank in Segments 3 and 4 was relatively stable until approximately 10 to 20 feet of bank erosion occurred between 2005 and 2008. This movement likely occurred during the 2005-2006 New Year's Storm. In Segments 1 and 2, the bluff retreated approximately 20 to 30 feet during the 2005-2006 New Year's Storm. LACO Associates (2008) concluded that discharges of 25,000 to 30,000 cubic feet per second (cfs) or greater at the U.S. Geological Survey gauging station on the Mad River (11481000) correlate to erosion events within the project area, based on their analysis and interpretation of the recent historic record. The peak discharge during the 2005-2006 New Year's Storm was 47,500 cfs.

3 Project Design

Segments 1 and 2

For Segment 1 (vertical bluff north of School Road), there was a clear need for bank stabilization measures to protect homes and public infrastructure from continued erosion and bluff retreat from the west. For Segment 2 (vertical bluff south of School Road), there was a clear need to protect School Road and the residential areas from continued expansion and development of the meander bend from the southwest. The County chose a bioengineering approach that integrated rock slope protection with willow plantings. The design provided a longitudinal stone toe protection along the base of the bluff to resist scour where velocities are highest. The toe protection was built with four- to six-ton boulders and provided a stable foundation for the upper layer, comprised of an alternating series of rock groins and vegetated bays. The groins are layered mounds of rock spaced at approximately 60 to 80 feet. Redwood logs were embedded within eight of the 15 groins to partially protrude riverward from the structure. The vegetated bays were composed of layers of soil, smaller rock, and decomposable geotextile fabric integrated with willow branches, cuttings, and stakes. The flat benches of bays 1 through 12 were planted with willow stakes and willow stems were planted against the face of the bluff. Toward the southern portion of Segment 2, the vertical relief of the bluff decreases. Bays 13 and 14 were constructed with rock and willow plants but the profile was adjusted to transition to a more sloping surface that tapered into the

adjacent streambank. At the southern end of Segment 2, the stabilization measures were integrated with the existing rock slope protection at a stormwater outfall. Segment 1 comprises station 10+80 through 17+55 and Segment 2 comprises station 17+55 through 21+20 on the as-built drawings (**Attachment B**).

The project design initially proposed laying back the upper portion of the bluff to an angle of repose. However, this element was abandoned in order to avoid disturbing a large amount of soil and to avoid disturbing habitat for cavity-nesting birds.

Segments 3 and 4
Segments 3 and 4 comprise the upstream portion of the site where the streambank is composed of fluvial terrace deposits. The primary consideration here was to avoid flanking of the stabilization measures constructed for Segments 1 and 2. Flanking can be defined as "erosion around the landward end of a stream stabilization countermeasure" (FHWA, 2001). Flanking is a common failure mechanism for protective shoreline structures, which are vulnerable to edge scour where there is an interface between protected and unprotected surfaces. One of the most important design considerations for a bank stabilization project is the method of protecting this interface. If the upstream portion of the site had been left in its existing condition, the bank would continue to erode due to the geomorphic conditions described previously that promote the formation of a meander bend. Further erosion could have scoured the terrace deposits behind the constructed stabilization measures for Segment 2, leaving them unsupported and subject to displacement. During the design phase, the County and NRCS considered this a material risk to the effectiveness of the project based on the observed site conditions.

Design options
Options to protect against upstream flanking include:

1. In-stream Deflectors. This option involves the placement of rock or wood within the active channel to re-direct the high-energy flows away from the end transition.

2. Tieback Structure. This option involves constructing an extension of the project into the bank to "key in" the structure to stable ground. The Bureau of Reclamation's (BOR's) Bank Stabilization Design Guidelines (2015) recommends that the length of the tieback structure should be sufficient to protect the structure from upstream lateral movement within the range of expected meander migration. Typically a trench is constructed into the bank and filled with revetment. Tieback trenches should be angled approximately 30 degrees from the primary flow direction.

3. Longitudinal Extension. This option involves extending the stabilization measure along the bank. BOR (2015) recommends extending the upstream end to areas of non-eroding velocities and relatively stable banks.

Discussion
The feasibility of Option 1 was considered low because of the high magnitude of erosive forces with the Mad River flows. An in-stream structure would have had to be large and likely reinforced with anchoring such as cables or sheet piles. The effectiveness of this approach is questionable given the setting, and further hydraulic modeling and engineering design would have been needed. The prospect of placing over-sized rock and/or steel components within the active channel was considered highly undesirable due to environmental and aesthetic impacts. For these reasons this option was abandoned.

Option 2 was evaluated at a conceptual level only. Option 2 was considered potentially feasible, although further geotechnical and engineering design would have been required along with professional judgment to predict the future trajectory of the meander bend formation. Construction of the key trench would have involved substantial disturbance of the fluvial terrace deposits. The trench would need to extend down to an elevation corresponding to the toe of the nearby bank, in anticipation of bank erosion reaching that elevation. The trench would need to be wide enough to place a stable mound of rock. The trench would

require shoring during construction, likely by driving sheetpiles. While the right bank is relatively low along Segments 3 and 4, the grade of the terrace deposits rises gradually eastward. A conceptual layout is shown on **Figure 6**. As a rough estimate, the depth of excavation would range from approximately 10 feet at the streambank to a maximum depth of 20 feet (average of 15 feet). The trench would extend approximately 50 feet into the bank and have an average width of approximately 25 feet. The total volume of the key trench would be approximately 700 cubic yards (50 feet x 15 feet x 25 feet). The trench would be filled with a range of boulder sizes and then back-filled. Note that the volume estimate for Option 2 was not based on an engineered design.

Although the project site was not identified as a known Native American village site, the site was considered culturally sensitive due to the extensive utilization of the area by Native Americans for the abundant fishing, hunting, and gathering opportunities. Therefore, the potential for impacting a culturally sensitive site by implementing Option 2 was considered relatively high.

Option 3 was considered technically feasible and was the selected alternative. The design for this option did not attempt to abate all erosion along the right bank, but only the minimum amount needed to protect the integrity of the southern end of the Segment 2 bank stabilization measures. Stabilization measures were designed for Segment 3, while Segment 4 was left unprotected. The southern end of Segment 3 corresponded to the northern end of a gravel bar along the right bank. The northern end of the gravel bar was a logical end point because the bar appears to limit the velocities and scour potential of the Mad River flows along the bank of Segment 4. The improvements in Segment 3 correspond to Bay 15 and Stations 21+85 through 23+95 in the as-built drawings (**Attachment B**). The size of the improvements for Segment 3 was smaller than Segments 1 and 2. The improvements were composed of rock boulders placed along the toe of the bank incorporated with smaller rock, soil, and willow sprigs. The surface tapered into the streambank. The height of the improvements averaged approximately 10 feet. The average width was 7 feet. The total volume of fill material for Segment 3 was approximately 550 cubic yards (210 feet x 10 feet x 7 feet). Option 3 appears to have required less soil disturbance and less fill material than Option 2.

4 Post-Project Conditions

Photographs of the site following construction are provided below.

Photo 6: View facing east of post-construction conditions (summer 2011).

Photo 7: View facing north of Segment 1 and portions of Segment 2 (September 23, 2009).

Photo 8: View facing south of Segment 3 (September 23, 2009).

Photo 9: View facing northeast of Segments 3 and 4 (April 21, 2010).

Photo 10: View facing north of Segments 2 and 3 (March 24, 2018).

Photo 11: View facing east of Segment 1 (April 3, 2020).

Photo 12: View facing east of Segment 3 (April 3, 2020).

Photo 13: View facing northeast of Segment 3 and a portion of Segment 4 (April 3, 2020).

5 Current Conditions (2020)

Willow growth throughout the Project area is strong and the trees appear vigorous and healthy. In Segments 1 and 2, willows have grown to envelope both the upper surface of the stabilization structure as well as the bluff face. No visual evidence of displacement or movement of the stabilization measures has been observed following the completion of construction in 2008. No flanking of the stabilization measures has been observed. A scour channel is present at the base of Segment 3 (Photo 13), showing the persistence of high-energy conditions along the right bank.

6 Impacts and Risks Associated with Removing the Placed Rock in Segment 3

If the rock within Segment 3 were to be removed, an access road network and staging areas would need to be developed within the riparian vegetation that was established as part of the Project. Ground disturbance associated with heavy equipment access, staging, and material stockpiling would be significant. Water quality within the Mad River would likely receive temporary impacts due to sediment discharge. The damaged riparian areas could be re-established; however, there would be at least one to two years of temporal loss. The right bank would be de-stabilized and exposed to continued erosion. As discussed in Section 3, the stabilization structure in Segment 2 would be at risk for flanking. In addition, the bluff area near School Road would be vulnerable to erosion from the south. Removal of Segment 3 would be highly controversial. Many people would object that the costs and impacts of such a demolition project do not outweigh the benefits, create significant safety and property damage risks, and represent a poor use of public funds. The costs of removal would be borne upon the County rather than the original funders of the Project. Funding such a project would be controversial because the County is facing a financial crisis due to the Covid-19 pandemic. If the structures along Segment 3 are removed and erosion begins to threaten the Segment 2 structure, then stakeholders would likely mobilize to advocate for a new stabilization project.

7 Conclusions

The purpose of the upstream portion of the Mad River Streambank Protection Project was to prevent flanking of the downstream structure that provided direct protection for residential development and public infrastructure. The upstream longitudinal extent was designed to impose the minimum amount of influence on the fluvial setting and ongoing natural processes while maximizing design life and return on community investment.

Figures

References

LACO Associates, 2008. *Mad River Bluff, Geologic Investigation and Assessment.* Eureka, CA.

U.S. Geological Survey, Mad River Fault Map, accessed on August 20, 2020 at https://usgs.maps.arcgis.com/apps/webappviewer/index.html?id=5a6038b3a1684561a9b0aadf88412fcf

Stillwater Sciences, 2008. *Mad River Streambank Stabilization Project Geomorphic Evaluation*.

U.S. Department of Transportation, Federal Highway Administration, 1989. Design of Riprap Revetment. Hydraulic Engineering Circular No.11, Publication No. FHWA-IP-89-016
https://www.usbr.gov/tsc/techreferences/hydraulics_lab/pubs/PAP/PAP-0798.pdf

U.S. Department of Transportation, Federal Highway Administration, 2001. Bridge Scour and Stream Instability Countermeasures. Hydraulic Engineering Circular No. 23, Second Edition, Publication No. FHWA-NHI-09-111. (Note: the third edition of HEC-23 was published in 2009 and supersedes the second edition.)
https://www.fhwa.dot.gov/engineering/hydraulics/pubs/09111/09111.pdf

Bureau of Reclamation, 2015. Bank Stabilization Design Measures, Report No. SRH-2105-25.
https://www.usbr.gov/tsc/techreferences/mands/mands-pdfs/A-BankStab-final6-25-2015.pdf

Attachments

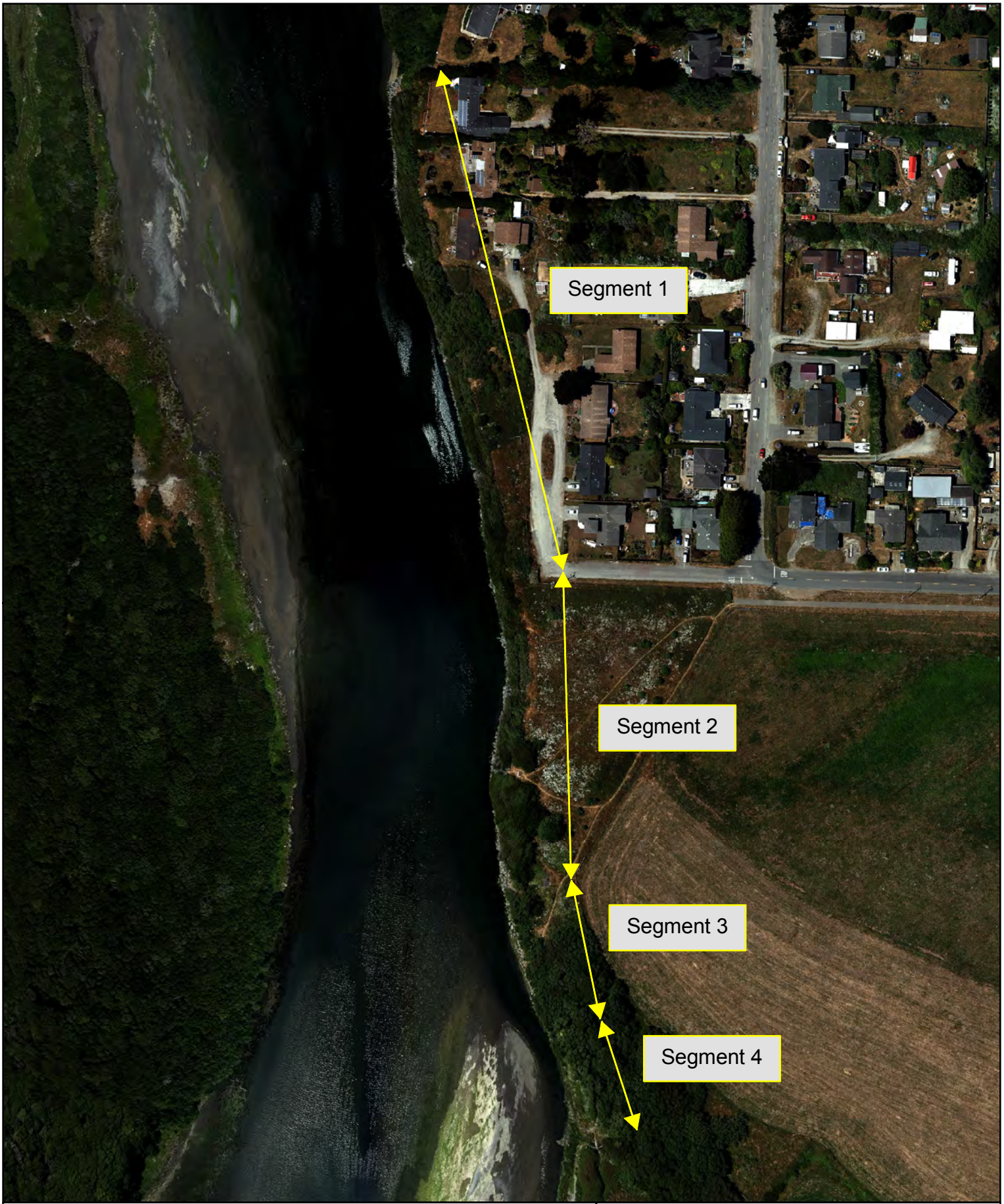
Mad River Streambank Protection Project

Site Location Map

Imagery: July 2019
Created: October 9, 2020
Humboldt County Public Works

0 310 620 Feet
1:7,200

Exhibit No. 12
CDP Application No. 1-09-050
(Humboldt County)
Figure 1
12/12/20 Design Technical Memo



Mad River Streambank Protection Project

Project Area

Imagery: July 2019
Created: October 9, 2020
Humboldt County Public Works

N
W E
S

0 85 170 Feet

1:2,000

Figure 2

Mad River Streambank Protection Project

Geomorphic Factors (2005 Imagery)

Imagery: USDA-NAIP (2005)
Created: October 9, 2020
Humboldt County Public Works

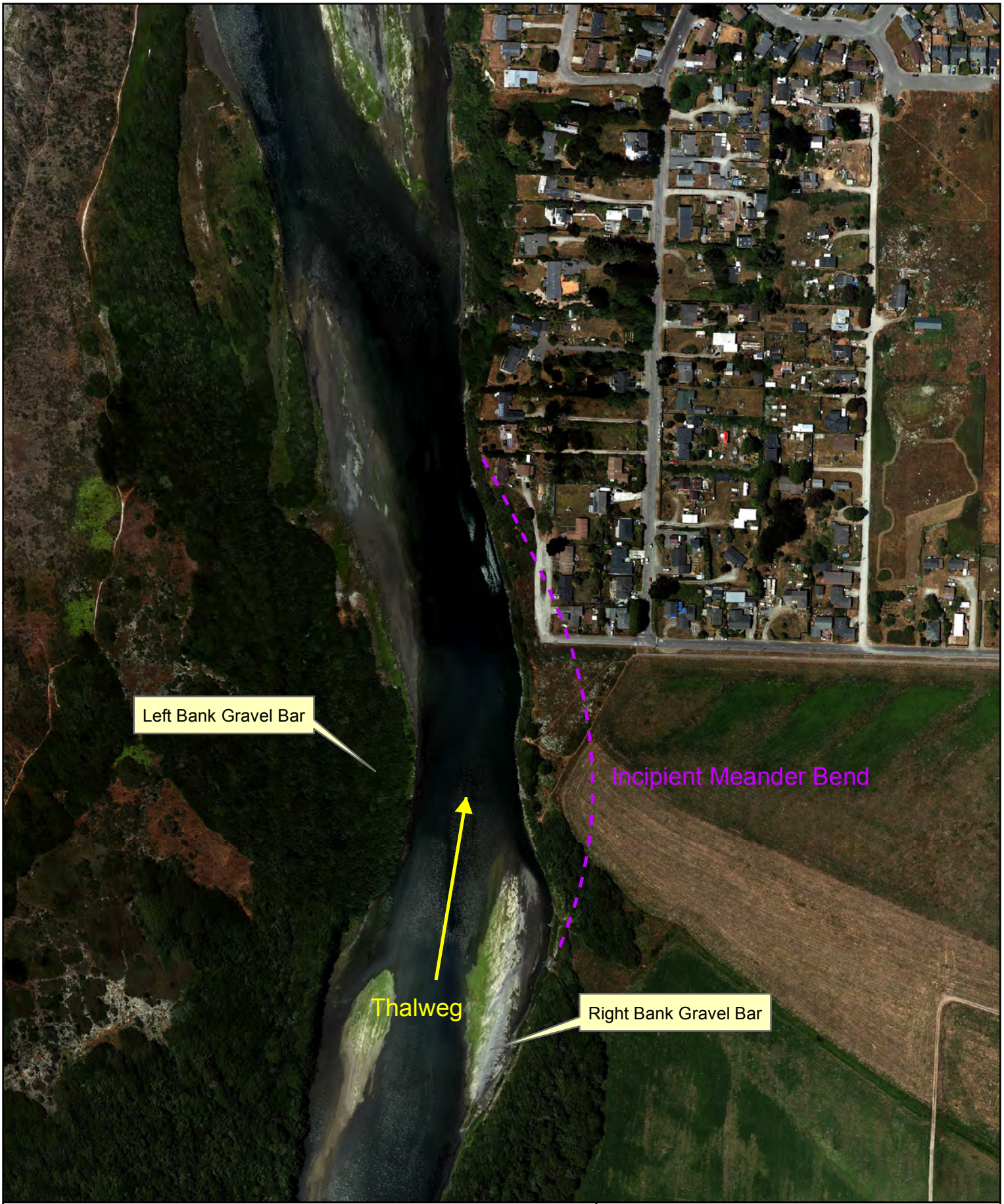
N W E S

0 170 340 Feet

1:4,000

Figure 3

Exhibit No. 12
CDP Application No. 1-09-050
(Humboldt County)
12/12/20 Design Technical Memo



Mad River Streambank Protection Project

Geomorphic Factors (2019 Imagery)

Imagery: July 2019
Created: October 9, 2020
Humboldt County Public Works

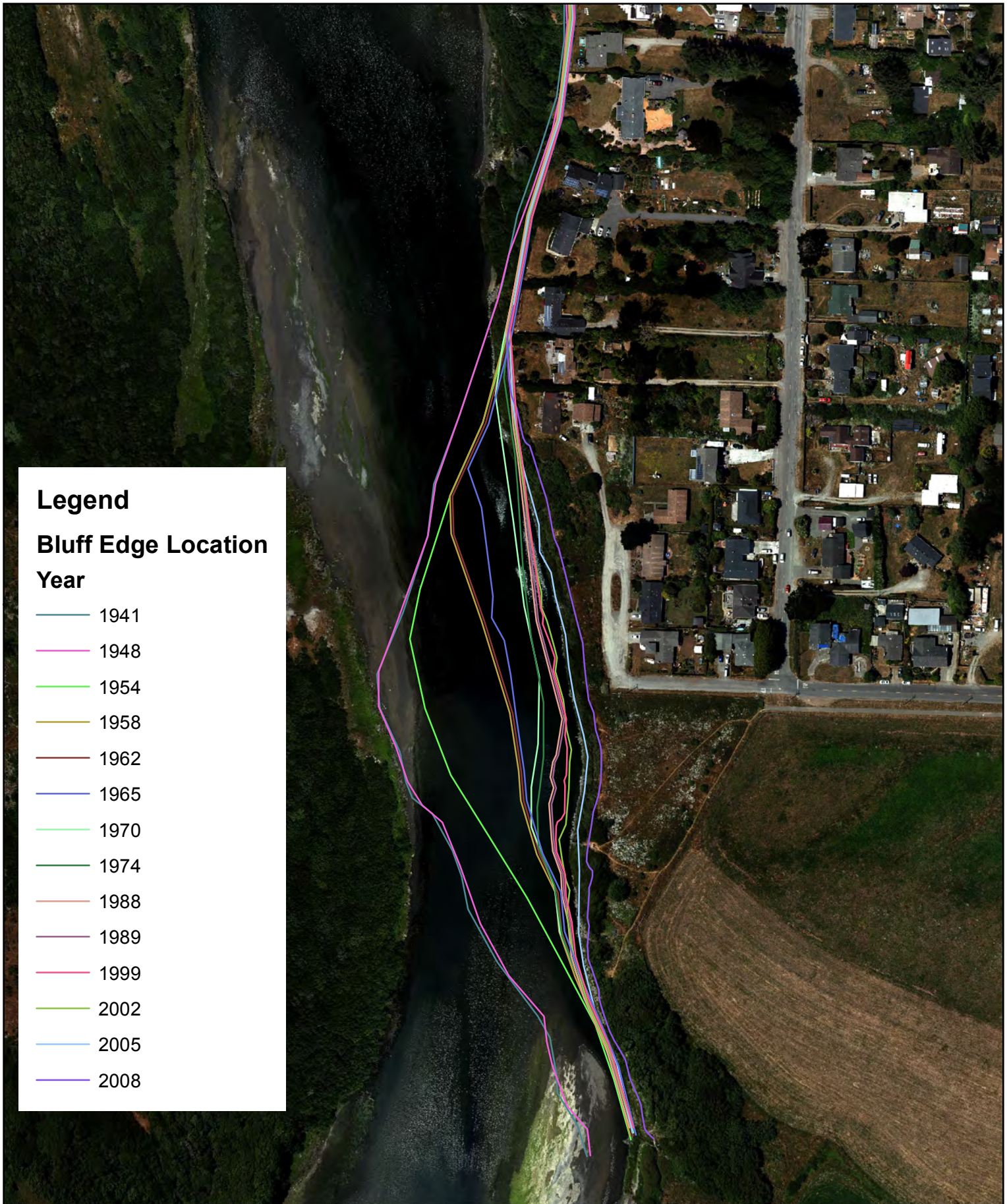
N W E S

0 170 340 Feet

1:4,000

Exhibit No. 12
CDP Application No. 1-09-050
(Humboldt County)
12/12/20 Design Technical Memo

Figure 4



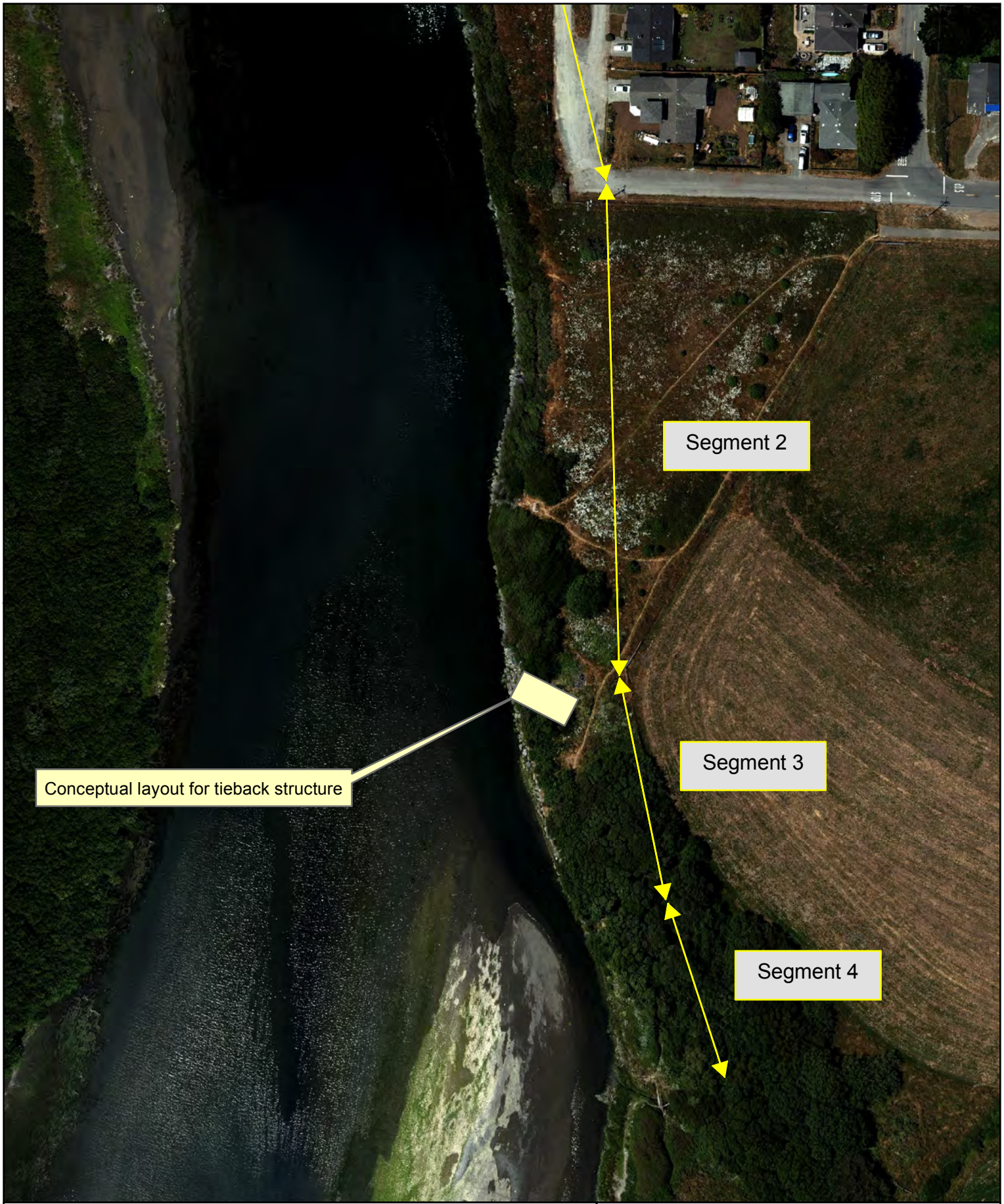
Mad River Streambank Protection Project

Right Bank Erosion History

Imagery: July 2019
Created: October 9, 2020
Humboldt County Public Works

0 105 210 Feet
1:2,500

Exhibit No. 12
CDP Application No. 1-09-050
(Humboldt County)
Figure 5
12/12/20 Design Technical Memo



Mad River Streambank Protection Project

Conceptual Tieback Layout

Imagery: July 2019
Created: October 9, 2020
Humboldt County Public Works

N W E S

0 50 100 Feet

1:1,250

Figure 6

Exhibit No. 12
CDP Application No. 1-09-050
(Humboldt County)
12/12/20 Design Technical Memo

ATTACHMENT A

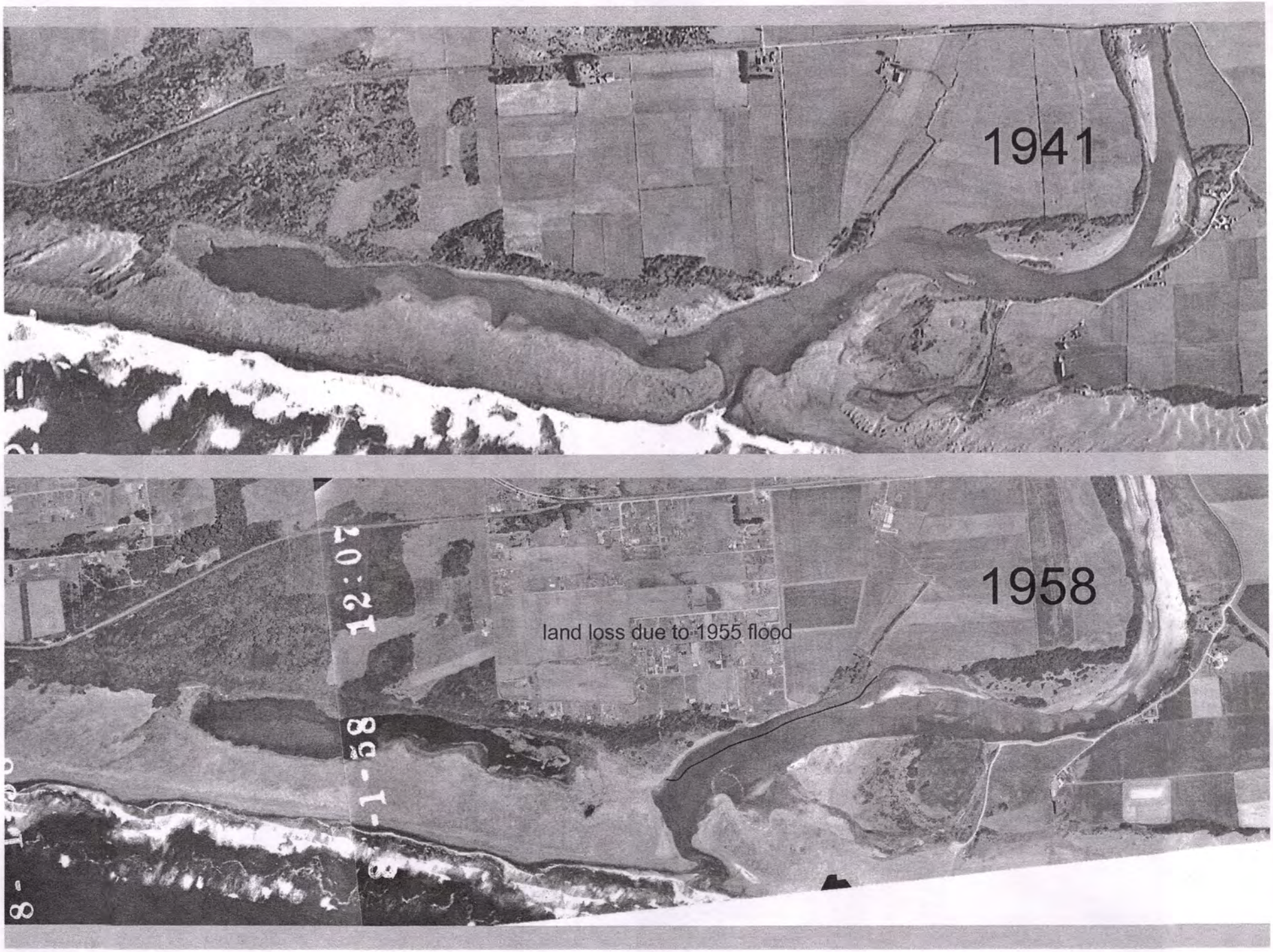


Exhibit No. 12
CDP Application No. 1-09-050
(Humboldt County)
12/12/20 Design Technical Memo

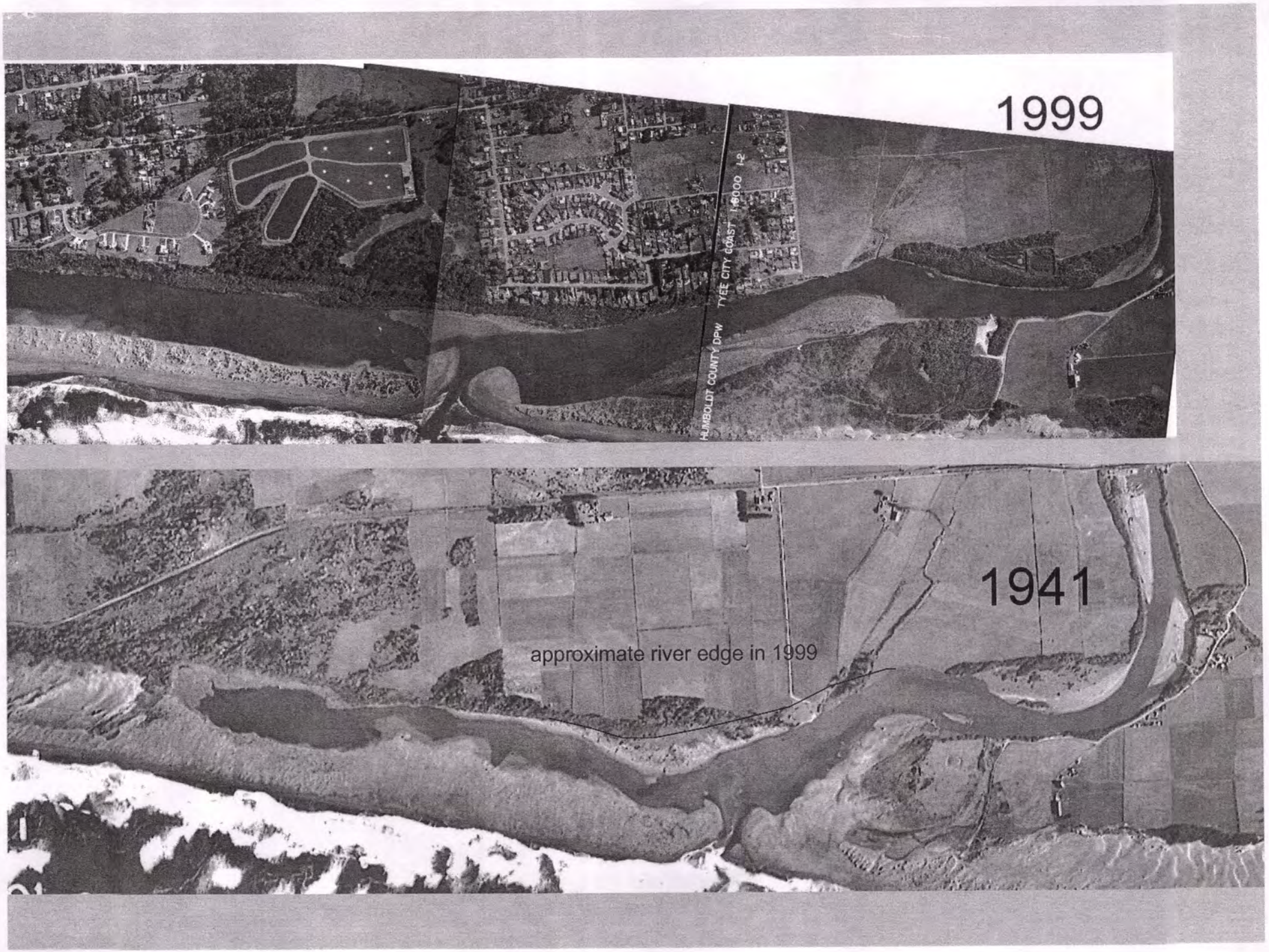


Exhibit No. 12
CDP Application No. 1-09-050
(Humboldt County)
12/12/20 Design Technical Memo

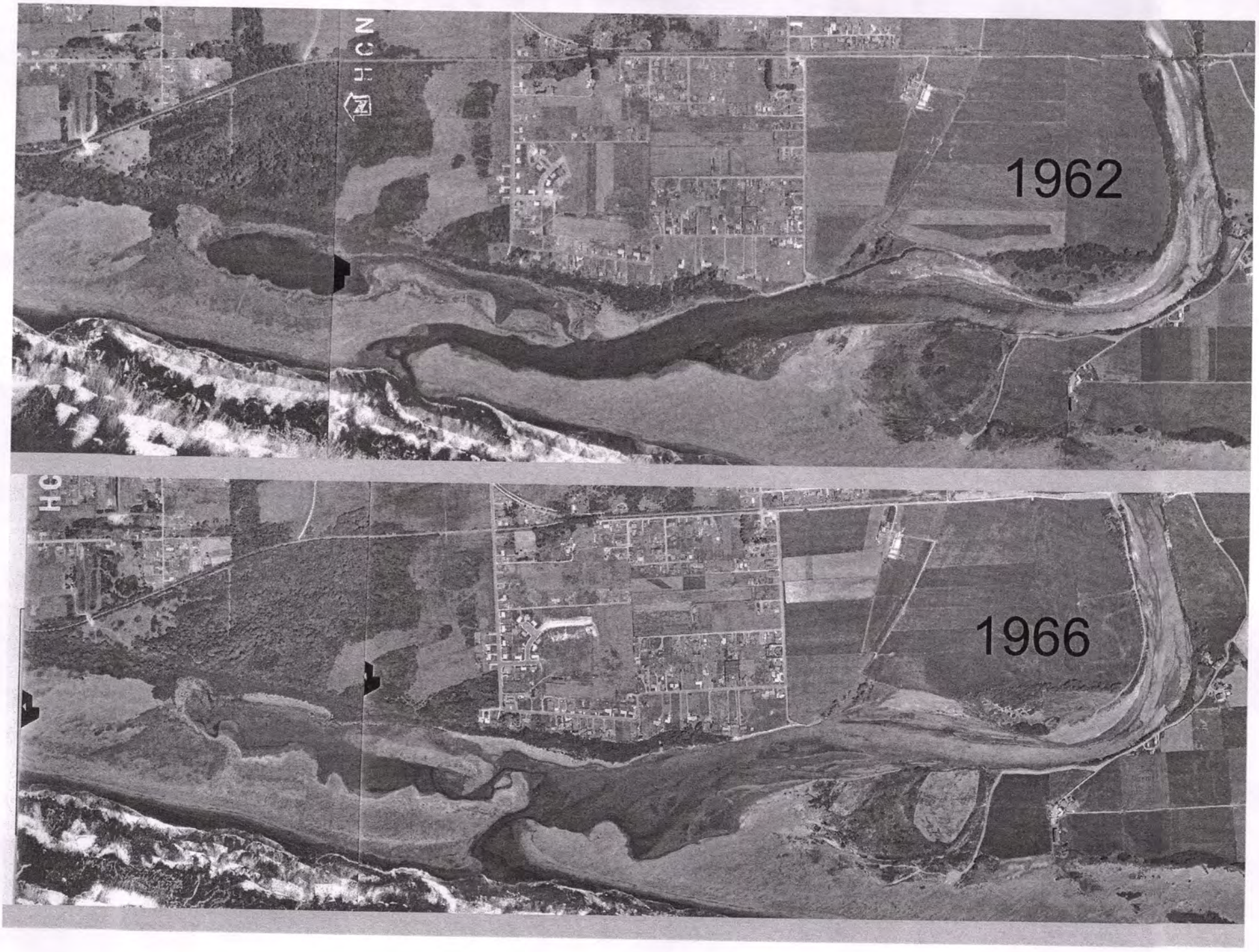


Exhibit No. 12
CDP Application No. 1-09-050
(Humboldt County)
12/12/20 Design Technical Memo

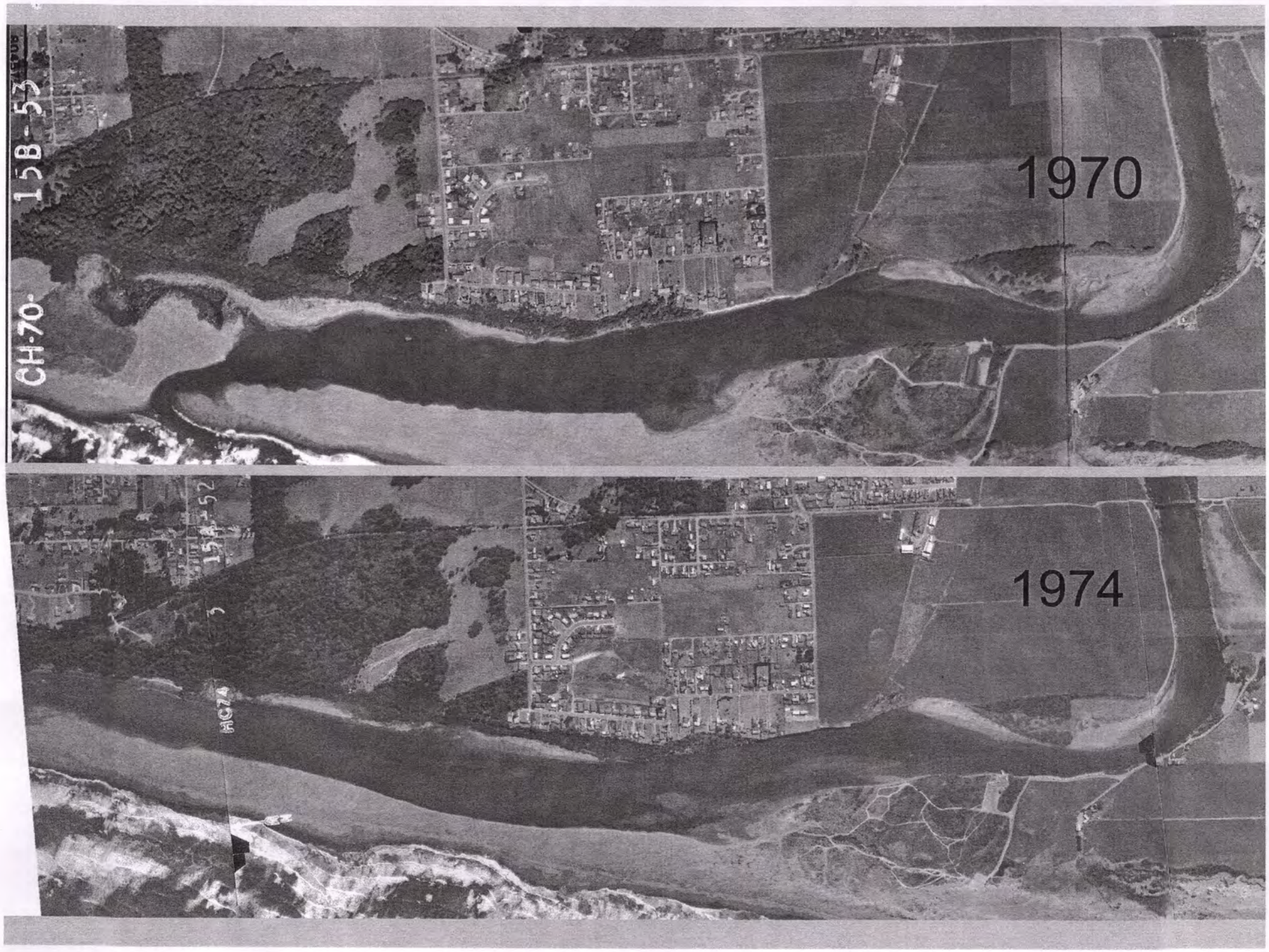


Exhibit No. 12
CDP Application No. 1-09-050
(Humboldt County)
12/12/20 Design Technical Memo

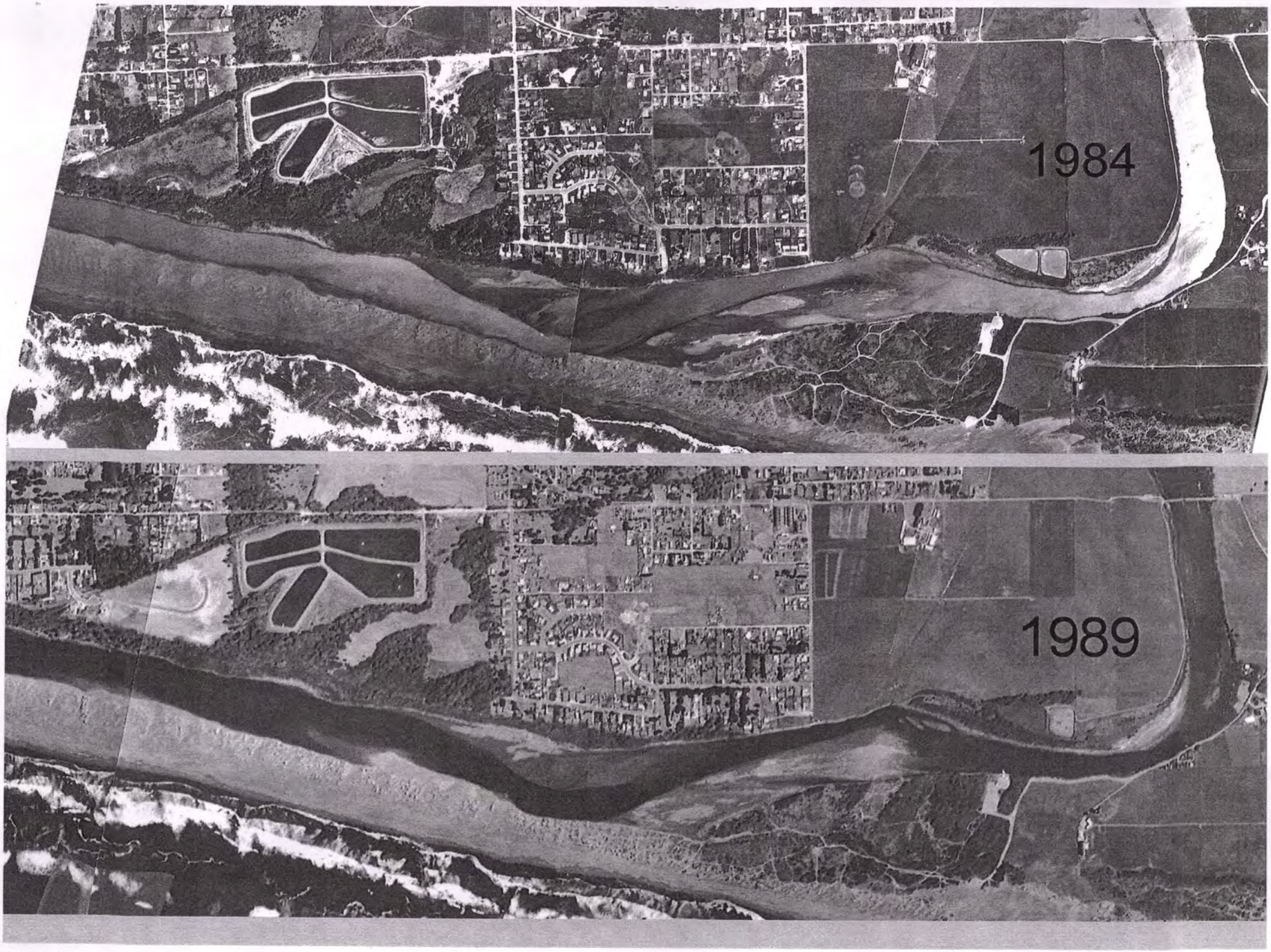


Exhibit No. 12
CDP Application No. 1-09-050
(Humboldt County)
12/12/20 Design Technical Memo