RFP BREIFING: Hanson Russian River Ponds Floodplain Restoration, Feasibility Study and Conceptual Design

Brian Cluer
John McKeon

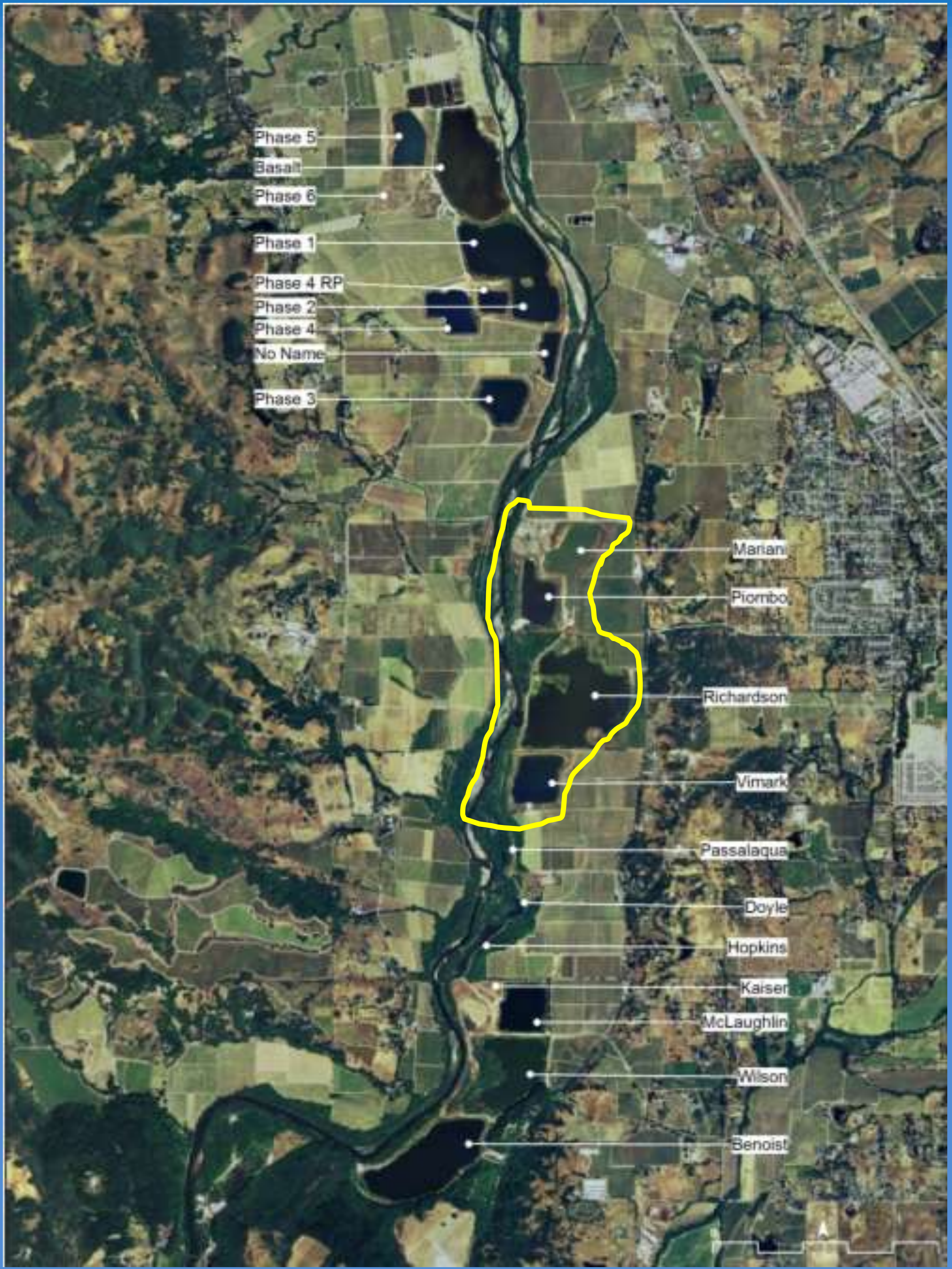
June 23, 2017

View looking North

Wohler
Narrows

Middle Valley Pits

- ~900 acres



Project Goals

- **Re-establish a stable river / floodplain connection in order to restore essential ecological processes** crucial for recovery of fish and wildlife, particularly ESA -listed coho, Chinook and steelhead populations.

- **Establish science-driven standards** for similar river restorations projects.

- **Promote use of the Surface Mining and Reclamation Act (SMARA**) to include ecosystem restoration.

- **Accommodate public access** for recreation and environmental education compatible with the ecological restoration goals.

Feasibility Study Goal

Assess the feasibility of a range of restoration alternatives and develop a preferred restoration scenario.

- The highest ranking scenario would maximize natural physical and biotic processes into a landscape-level ecosystem restoration strategy to provide critical seasonal niche habitat for multiple ESA-listed species' life history stages.

- The study goal envisions a self-sustaining, dynamic floodplain complex of riverine and floodplain-associated habitats evolving over time.

Feasibility Study Objectives

1. **Evaluate the benefits and risks to ESA-listed native salmonid species** resulting from increasing available off-channel floodplain and associated habitats.

2. **Document the current status of biogeochemical processes of nutrient and metals cycling**. Incorporate findings into project design to identify viable strategies for assessing and remediating potential mercury methylation issues at the project site.

3. **Analyze current river hydraulics and project site geomorphology**. Analyze affects on biogeochemical processes, fine sediment processing, and water quality.

Feasibility Study Objectives

4. **Evaluate the surface and groundwater interactions** including the potential for aquifer recharge. Evaluate potential impacts to Sonoma County Water Agency and Town of Windsor operations. Evaluate potential impacts to local well use.

5. **Model impacts on flood elevations, frequency, and duration** at the project site and throughout the 8-mile Middle Reach.

6. **Evaluate impacts on hydraulics, sediment transport and processing, channel stability, and erosion throughout the eight miles of the Middle Reach Valley.**

Project Structure

Figure 2.1. Project structure for the Hanson Ponds Russian River Floodplain Restoration Feasibility Study.

Management Team

Jennifer Barrett, Sonoma County Permit & Resource Management Department
Michael Beck, Endangered Habitats Conservancy
Michael Bowen, California State Coastal Conservancy
Brian Cluer, NOAA National Marine Fisheries Service
Melanie Harrison, NOAA National Marine Fisheries Service
Amy Lyle, Sonoma County Permit & Resource Management Department
John McKeon, NOAA National Marine Fisheries Service
Nancy Schaefer, Endangered Habitats Conservancy consultant
Chris Seppeler, Sonoma County Permit & Resource Management Department

Partners Planning Group

Toni Bertolero, Town of Windsor
Carlo Bongio, Redwood Empire Trout Unlimited
Marc Bommersbach, Westside Association to Save Agriculture
Karen Gaffney, Sonoma County Agricultural Preservation & Open Space District
Caryl Hart, Sonoma County Regional Parks
Kara Heckert, Sonoma Resource Conservation District
Brian Hines, Redwood Empire Trout Unlimited
Jay Jasperse, Sonoma County Water Agency
Rick Jorgenson, Redwood Empire Trout Unlimited
Don McEnhill, Russian Riverkeeper
Mike McGuire, Sonoma County Supervisor, District 4
Doug Lipton, Russian Riverkeeper
Adam McKannay, California Department of Fish & Wildlife
Patrick Rutten, NOAA National Marine Fisheries Service
Ken Tam, Sonoma County Regional Parks
Bob Torre, Russian River Wild Steelhead Society
Leslie Vivian, Redwood Empire Trout Unlimited
Ryan Watanabe, California Department of Fish & Wildlife

Scientific Working Group

Brian Bair, US Forest Service, Watershed Restoration Team Leader
Peter Baye, Consulting Scientist, Botanist, coastal ecologist
Steve Butkus, North Coast Regional Water Quality Control Board, environmental engineer
Greg Carr, Sonoma County Planner (retired)
Wayne Chang, MS, PE, Chang Consultants, civil engineer
Joseph Dillon, NOAA National Marine Fisheries Service, water quality specialist
Michael Donahue, NOAA National Marine Fisheries Service, technical intern
Tom Gardali, Point Blue Conservation Science, avian ecologist
Gregory Guensch, Sonoma County Water Agency, Water Resource Engineer, geomorphologist
Joshua Goodwin, Office of Mine Reclamation, Department of Conservation
Robin Grossinger, San Francisco Estuary Institute, historical ecologist
Melanie Harrison, PhD, NOAA National Marine Fisheries Service, biogeochemical expert
Sean Hayes, NOAA National Marine Fisheries Service, Southwest Fisheries Science Center, fisheries ecologist
Beth Hendrickson, Office of Mine Reclamation, Department of Conservation
Jacob Katz, Ph.D., CalTrout, fisheries biologist
Peter Kiffney, Ph.D., NOAA Northwest Fisheries Science Center, fisheries biologist
John Klochak, US Fish and Wildlife Service, fisheries biologist
Neil Lassiter, Sonoma County Water Agency, hydrologist & geomorphologist
Dave Manning, Sonoma County Water Agency, Environmental Resources Manager
Richard McDonald, US Geological Survey, Geomorphology & Sediment Transport Laboratory, hydrologist & modeling expert
Adam McKannay, California Department of Fish & Wildlife, fisheries biologist
Jonathan Nelson, Ph.D., US Geological Survey, Geomorphology & Sediment Transport Laboratory, hydrologist & modeling expert
Don Seymour, Sonoma County Water Agency, Principal Engineer
Mark Strudley, Ph.D., NOAA National Weather Service, hydrologist and fluvial geomorphologist
Marcus Trotta, Sonoma County Water Agency, hydrogeologist
Richard Wantuck, NOAA National Marine Fisheries, Supervisor, Engineering Branch
Gus Yates, Todd Engineers, hydrologist
Ryan Watanabe, California Department of Fish & Wildlife, fisheries biologist

Peer Review Panel

Tim Beechie, Ph.D., NOAA National Marine Fisheries Service, Northwest Fisheries Science Center, fisheries ecologist, geomorphologist
Blair Greimann, Ph.D., US Bureau of Reclamation, civil engineering, sediment transport
Joseph Kiernan, Ph.D., NOAA National Marine Fisheries Service, Southwest Fisheries Science Center, fisheries ecologist
Michael Pollock, Ph.D., NOAA National Marine Fisheries Service, Northwest Fisheries Science Center, ecosystem analyst, fluvial geomorphologist

Figure 2.1. Project structure for the Hanson Ponds Russian River Floodplain Restoration Feasibility Study.

Table 3.1. Summary of data compilation and collection.

Data	Source
Topography	
LiDAR Survey	GeoDigital, Inc., NOAA Fisheries
Hanson Ponds bathymetry	Affiliated Researchers, Inc.
Middle Reach bathymetry	Affiliated Researchers, Inc., USGS-NOAA Fisheries
Syar Ponds bathymetry	Syar Industries, Yolano Engineers
Soil and Sediment Sampling	
Particle size sampling and laboratory analysis	NOAA Fisheries
Hanson Pond sediment core sampling	Affiliated Researchers, Inc., EEI, Inc.
River bed sediment and bank soil sampling	Affiliated Researchers, Inc., NOAA Fisheries
Hanson Pond soil and sediment sampling analyses for nutrients, metals, organics	Sunstar Laboratories, Inc.
River bed, and bank soil and sediment samples analyses for nutrients, metals, organics	Alpha Analytical Laboratories, LLC
Water Sampling	
Hanson Ponds dissolved oxygen profiles	Affiliated Researchers, Inc., NOAA Fisheries
Hanson Ponds temperature profiles	Affiliated Researchers, Inc., NOAA Fisheries
Hanson Ponds water quality sampling for nutrients, metals, organics, chlorophyll-A	EEI, Inc., Affiliated Researchers, Inc., NOAA Fisheries
Russian River water quality sampling for nutrients, metals, organics	Affiliated Researchers, Inc., NOAA Fisheries
Analyses of Hanson Ponds water quality samples	Weck Laboratories, Inc.
Analyses of Russian River water quality samples	Alpha Analytical Laboratories, LLC
Fish Surveys	
Fish assemblage surveys and characterization of gravel pond fish populations	NOAA Fisheries, California Department of Fish and Wildlife, Sonoma County Water Agency
Hydrology and Hydraulics	
Russian River discharge records, at Healdsburg	USGS gage #11464000
Dry Creek discharge records, near mouth and near Geyserville	USGS gages # 11465350 and 11465200
Water surface elevations for a range of river flows	NOAA Fisheries and USGS

SFEI H.E. Reconnaissance Study

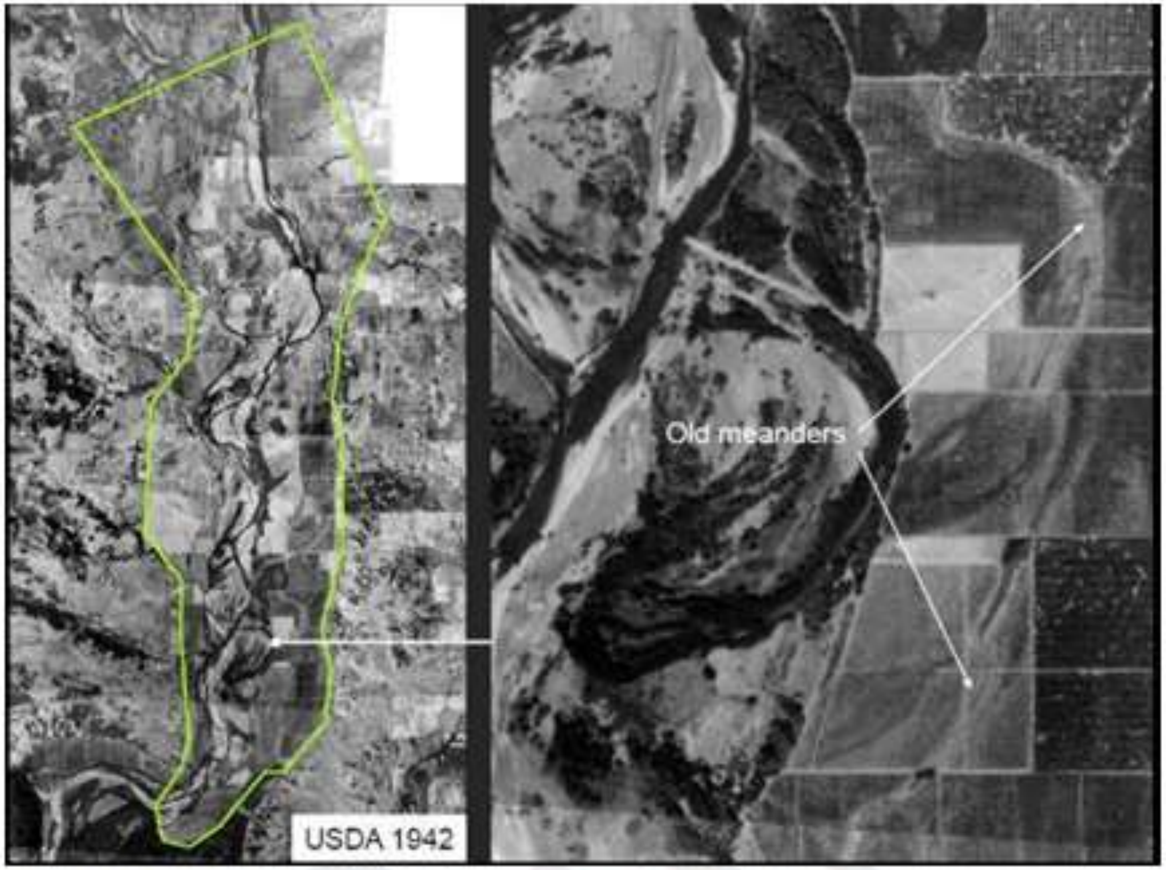


Figure 4.1.2. Historical ecology of the Middle Reach Valley of the Russian River. The San Francisco Estuary Institute completed an historical ecology reconnaissance of the Middle Reach Valley. The photos illustrate the greater sinuosity of the river and the cutoff oxbows (meanders) that probably provided calm edgewater habitats in winter and spring offering refuge and feeding areas for salmonids.

Last ½ Century River Management

Figure 4.1.3. Changes in the Middle Reach of the Russian River. The upper photo shows the Middle Reach in the mid-1950's (Press Democrat), and the lower photo is the same area in December 2013). The wide meanders were dredged, replacing the sinuous channel with a straightened alignment and then the gravel bars were mined. The channel was dredged 50-60 feet deep which drove incision along with its shorter and steeper path. Once incised, agriculture encroached tightly on the river bank, which has levees along most of its length along the Middle Reach channel. *Photo by Brian Cluer, NOAA Fisheries.*

Valley / Channel change series

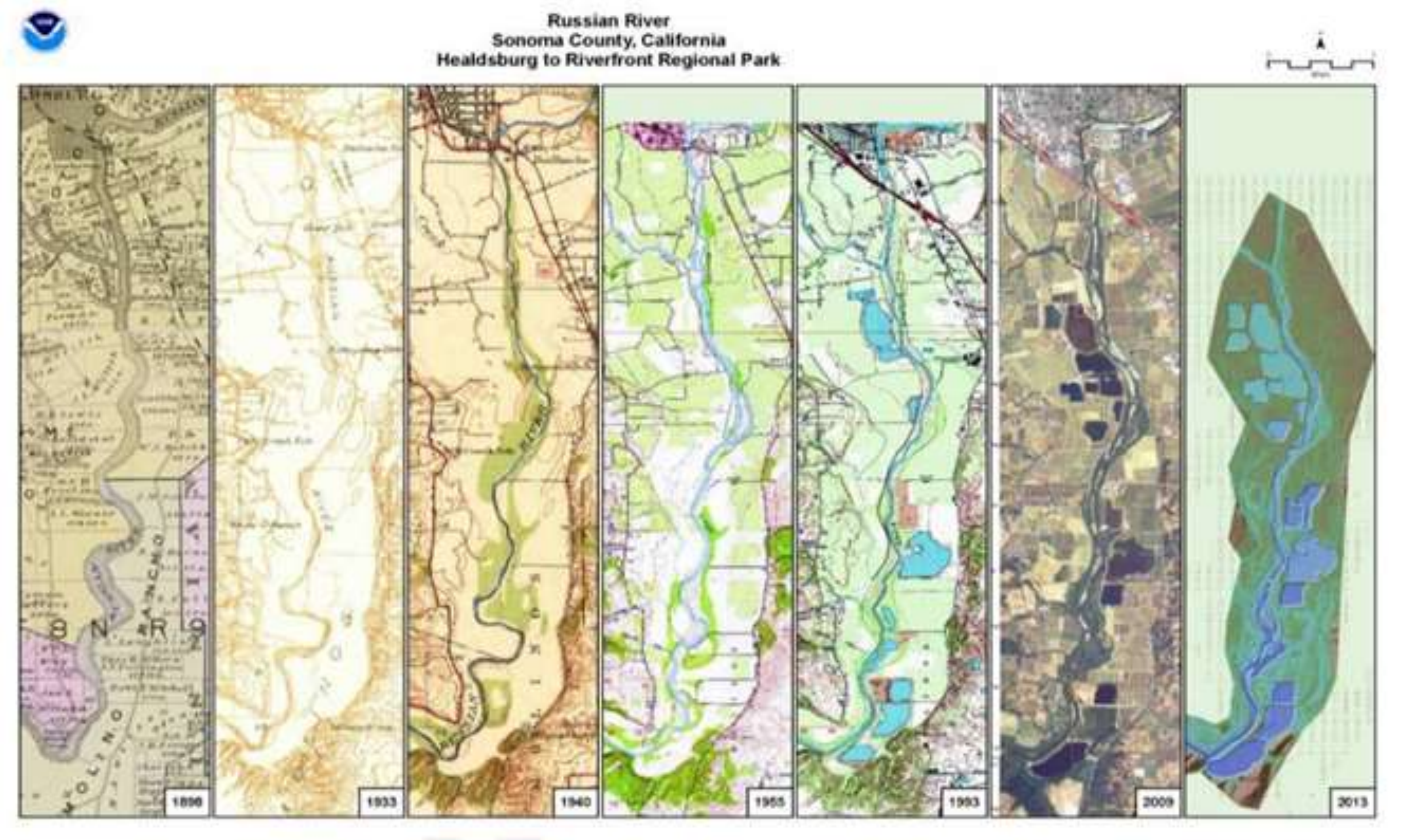


Figure 4.1.4. Topographic map series of the Middle Reach. This series of maps for the Middle Reach from 1898 to 2013 shows the tremendous changes to the Russian River channel and floodplain resulting from channel straightening, levee construction, gravel mining, and lastly agricultural encroachment post dam building.

slope

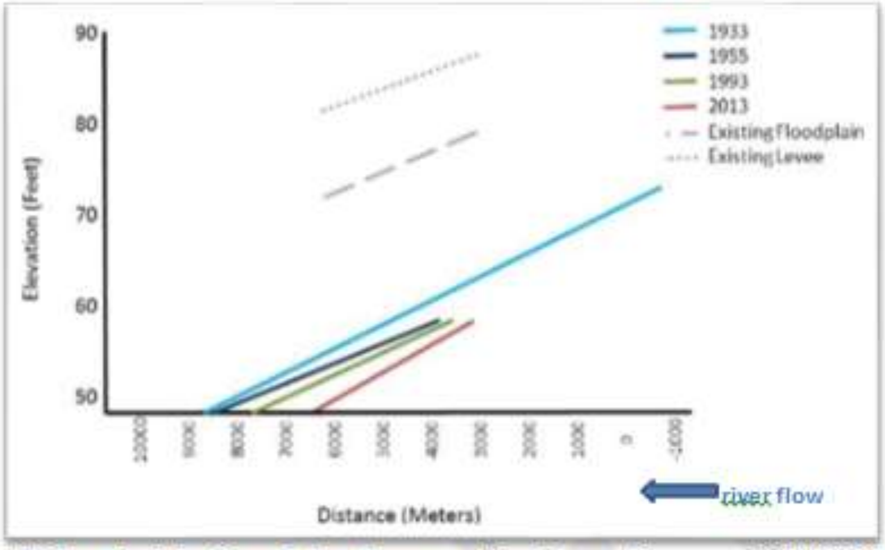


Figure 4.2.2. Channel bed elevation and slope changes over time. Topographic maps and 2013 LiDAR illustrate the progressive lowering of river bed elevations and increasingly steeper slopes with each successive map. As a result, the 50-60 foot elevation contour of the river bed moved upstream by nearly a half-mile between 1933 and 2013. The zero point of the x-axis is the location of Veterans Memorial Beach Dam in Healdsburg.

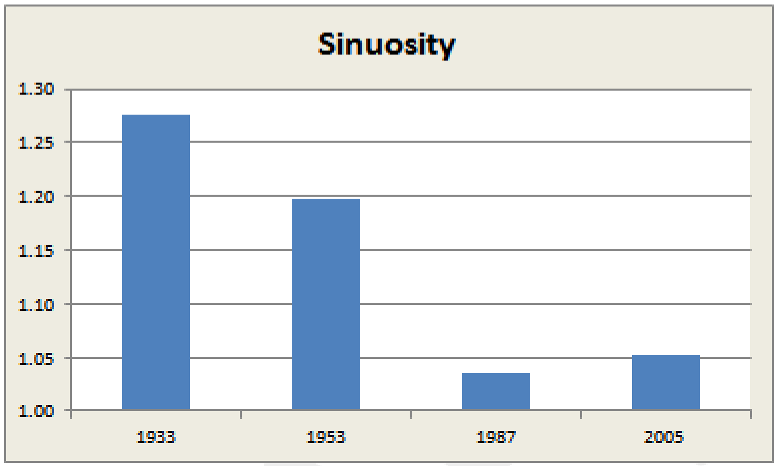


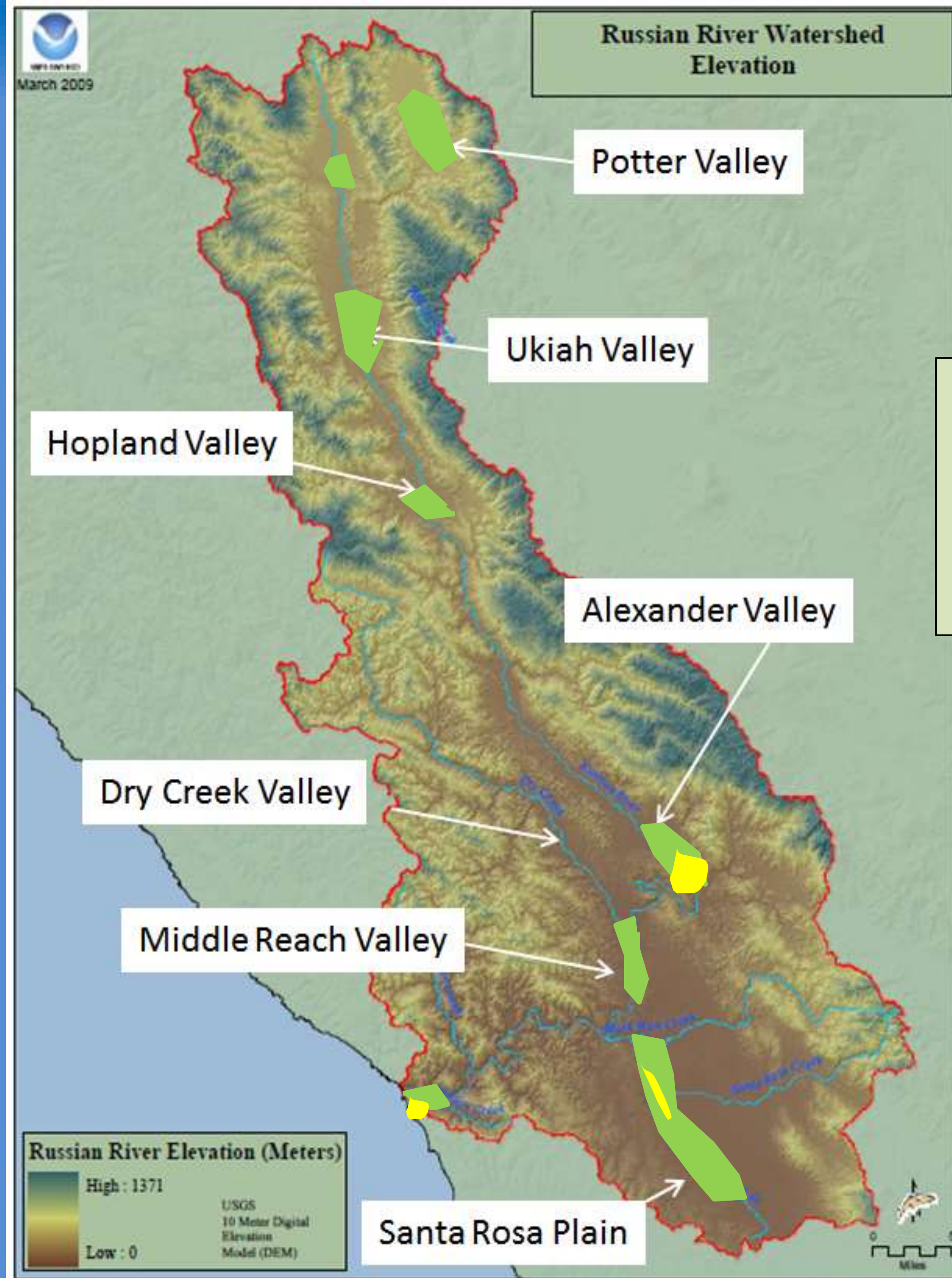
Figure 4.2.1. Changes in sinuosity of the Russian River Middle Reach. The slope of the river has been increased by cutting off its meanders and straightening its path. This is quantified by a metric called sinuosity, which is the ratio of river channel length to valley length. Locally the sinuosity of the river has been reduced from approximately 2 to 1, particularly in the lower end of the valley.

depth

Figure 4.2.3. Channel incision at Storey Creek, a tributary in the middle of the study reach. Approximately 20-24 feet of channel incision is evident from the height difference of the concrete stabilized channel bed at the mouth of Storey Creek (upper right) that would have connected with the river bed when constructed. If not for the concrete culvert, this tributary would have incised along with the river, as did Dry Creek and other tributaries to the Russian River channel.

Figure 4.2.5. Bank erosion in the Middle Reach. A bank erosion site along the Middle Reach channel in 2012-2013. A Syar mining pond is seen in upper right of the photo. The Hanson site ponds are just downstream of the photo on river left.

Watershed Evaluation



Historic floodplain wetlands habitat.

Off-channel habitat not depicted.

Historic Habitat in lower RR

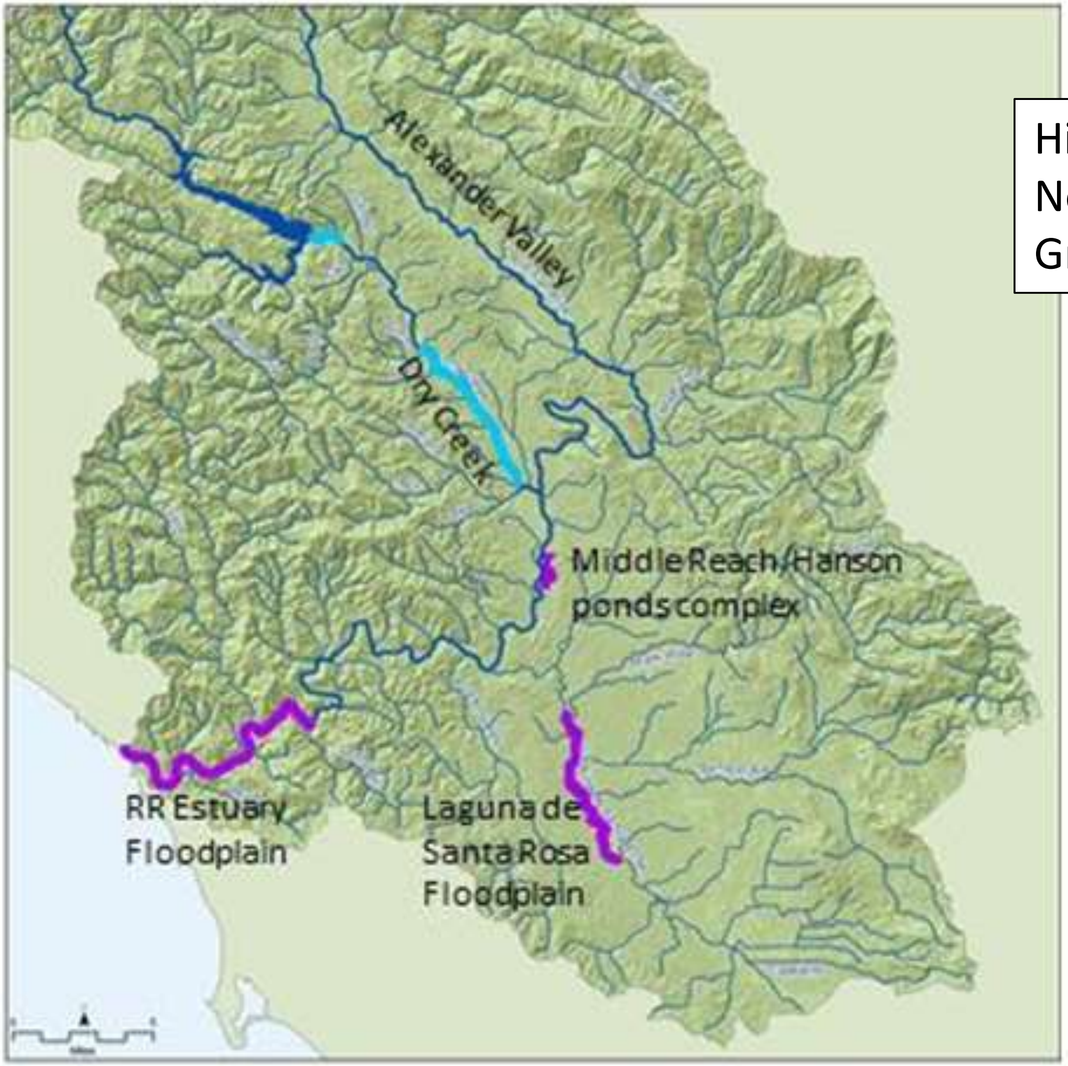


Figure 4.2.23. Potential areas for significant restoration of floodplain rearing habitat in the lower Russian River watershed, highlighted in light blue and purple.

Historically Keystone Habitats,
Not Functioning Today,
Greatest Restoration Opportunities

Chapter 5
Literature Review

5x density
6x growth rate

Environ Biol Fish (2008) 83:449–458
DOI 10.1007/s10641-008-9367-1

2008

Ephemeral floodplain habitats provide best growth conditions for juvenile Chinook salmon in a California river

Carson A. Jeffres · Jeff J. Opperman ·
Peter B. Moyle

Fig. 7 Comparison of a single enclosure of fish reared in intertidal river habitat below floodplain (*left*) and a single enclosure of fish reared in the floodplain vegetation (*right*) after 54 days in respective habitats at the end of the second year of the study

Salmonid Status

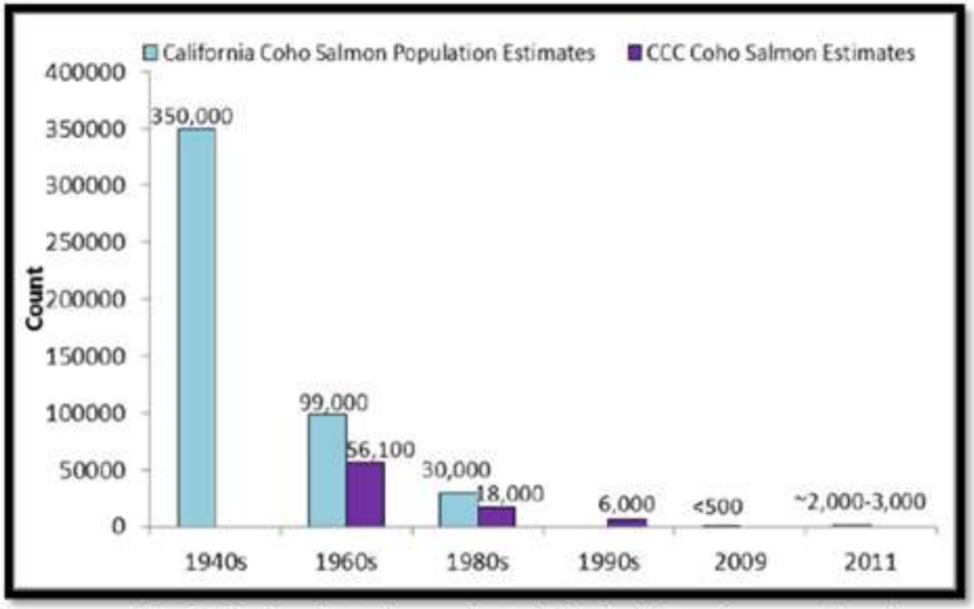


Figure 4.2.17. Decline of California and Central Coast Coho populations in the late 20th century. The Russian River historically had the largest population of the CCC coho ESU. Figure from NMFS Coho Recovery Plan (2012).

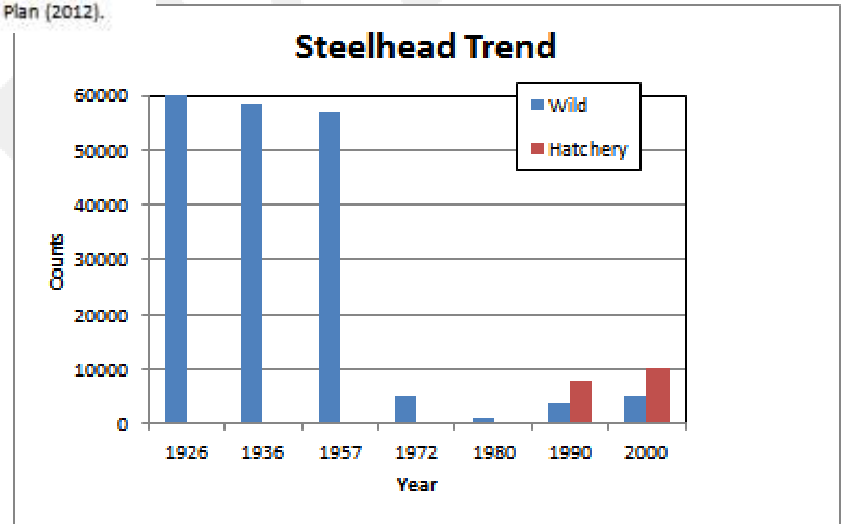


Figure 4.2.21. Russian River steelhead: early century California Department of Fish and Game estimates/counts. 1957-2000 wild fish estimates, and 1980-2000 combined hatchery returns (counts) to Warm Springs Dam (Lake Sonoma) on Dry Creek, and to Coyote Valley Dam (Lake Mendocino) on the East Fork Russian River.

Geology and Channel Hydrology

Figure 4.2.10. Geologic map of the Middle Reach Valley. *Source: California Geological Survey.*

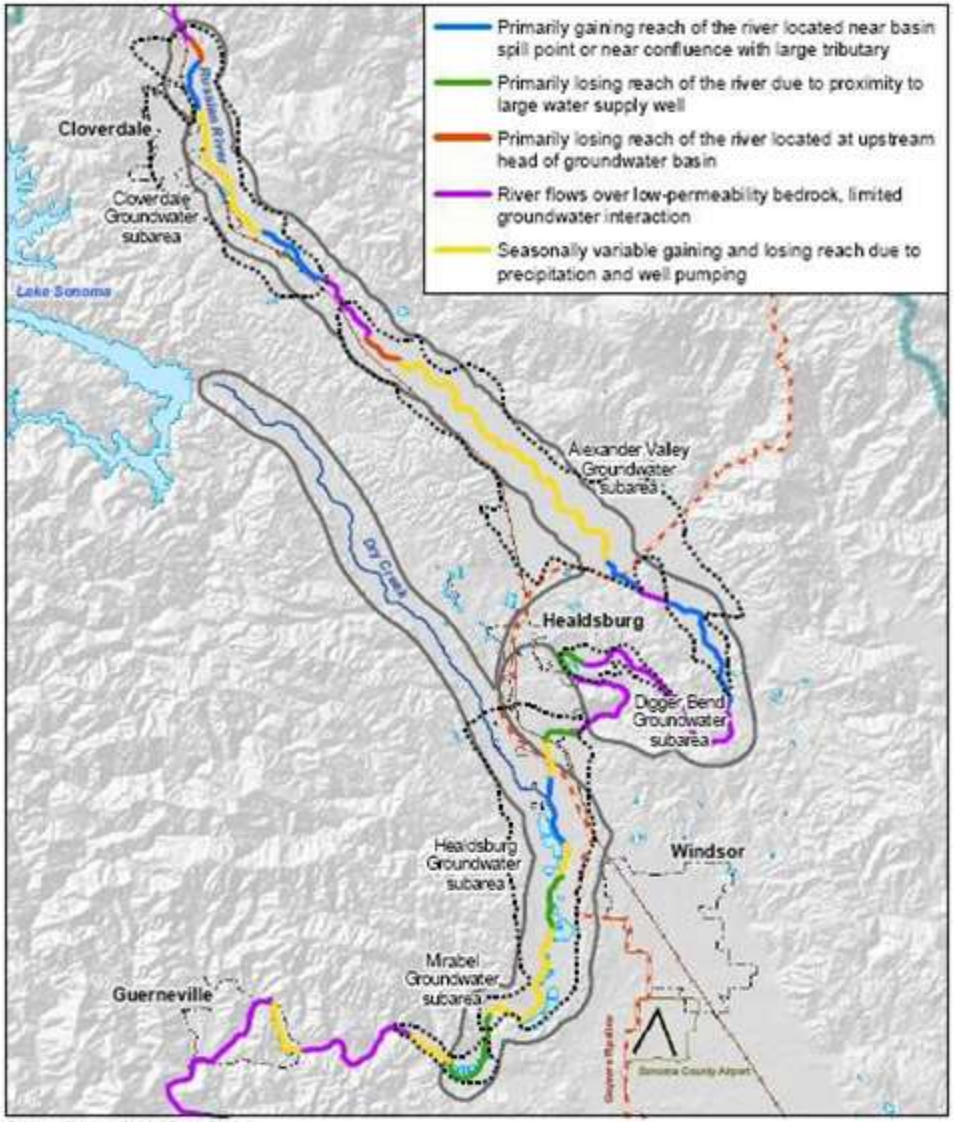
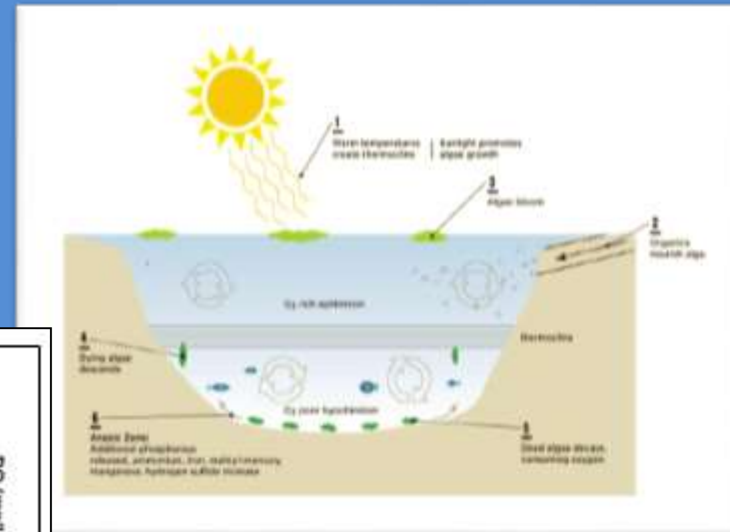


Figure 4.2.11. Gaining and losing reaches of the Russian River. *Source: Sonoma County Water Agency.*

Figure 4.2.14. Thermal stratification of the ponds. Thermal stratification creates the redox conditions for anaerobic decay of cyclic algal blooms, cycling of nutrients (P) and metals (Hg), and hydrogen sulfide production.



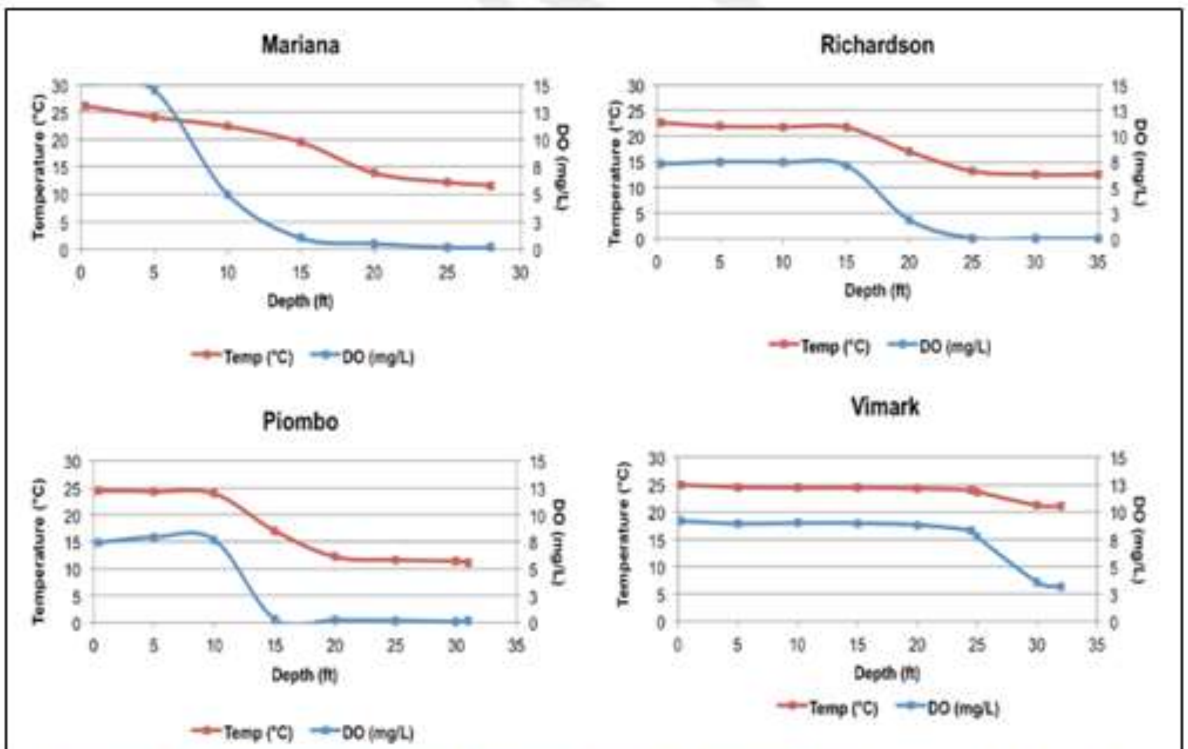


Figure 4.3.15. Temperature and dissolved oxygen stratification in the Hanson ponds. Steep declines in DO occur at approximately 10-15 feet depth and anoxic conditions exist on the pond bottoms, with the exception of the Vimark pond, which may be explained by warm water flow from the Richardson pond into the Vimark pond.

Fish Assemblage

Figure 4.4.1. Electro-fishing results in Hopkins pond. A non-native salmonid predator species, largemouth bass comprised the majority of biomass caught during boat-electrofishing sampling of the Hopkins Pond.

Figure 4.4.2. Hopkins pond. Hopkins Pond within the high flow channel of the Russian River has well developed riparian vegetation and wide fringe of invasive floating aquatic vegetation. The pond, excavated in the early 1970s, is connected with the Russian River at flows greater than about 800 cfs.

Figure 4.4.3. Drift boat setting a beach seine in the Richardson pond.

Figure 4.4.4. Results from beach seining in the Richardson pond at the Hanson property. A largemouth bass, an introduced species is shown in the photo.

Figure 4.2.29. **Existing vegetation types of the Hanson property.** In spite of mining on the site, the Hanson property has roughly 96 acres of developing to mature riparian forest.

Topography
LiDAR
Echosounder

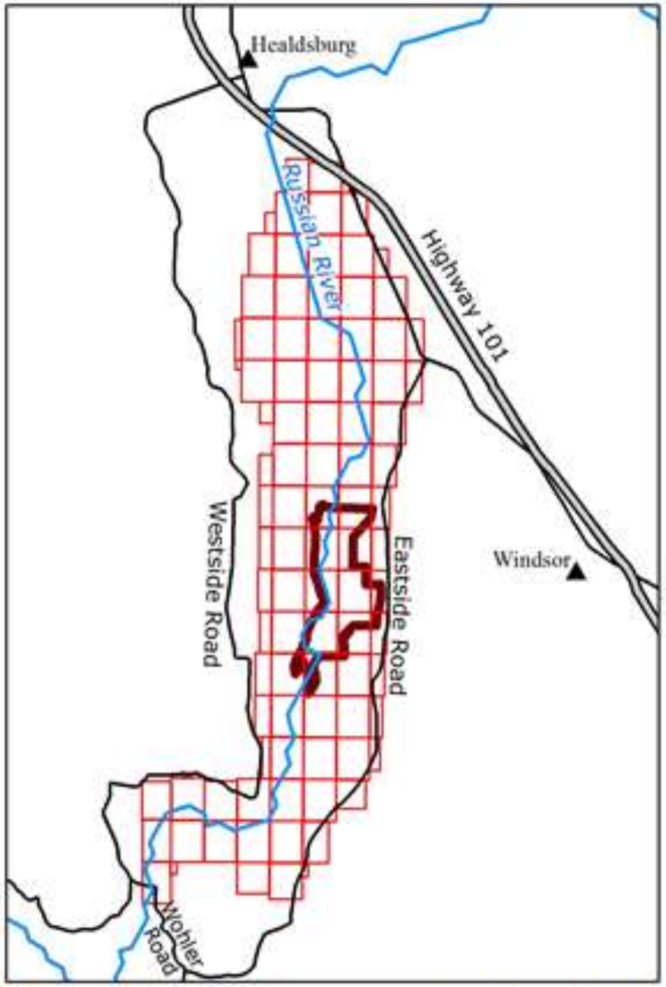


Figure 3.1. LiDAR coverage. With funding from Sonoma County, GeoDigital, Inc. flew LiDAR for the Middle Reach Valley extending from the Healdsburg Highway 101 Bridge south to the Wohler Bridge.

Bathymetry

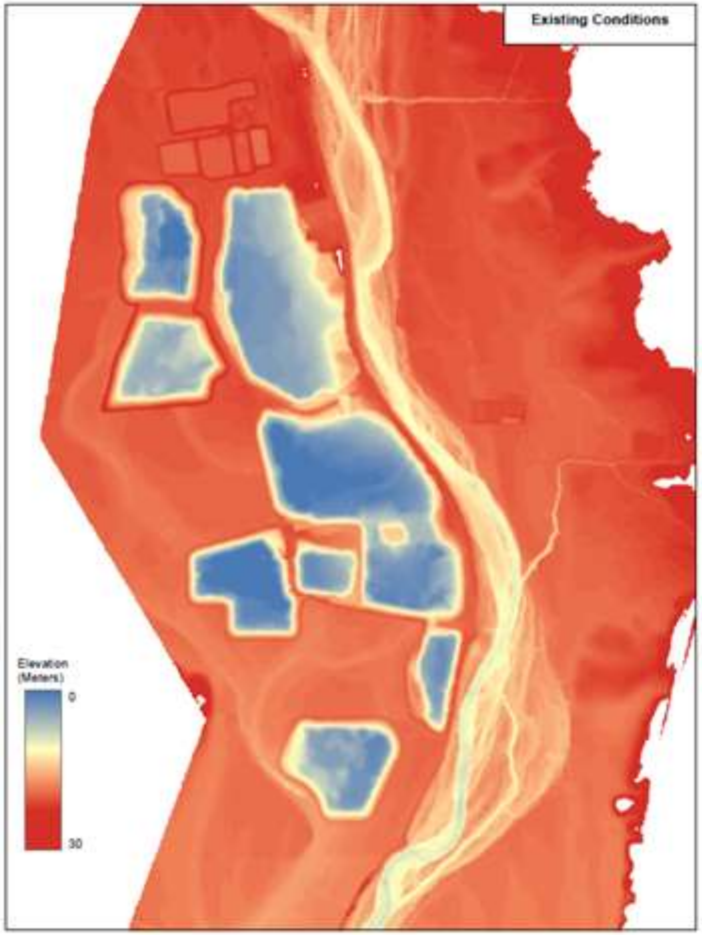


Figure 4.3.5. Topographic map of the Syar ponds showing bottom elevations in meters (NAVD88).

PONDS

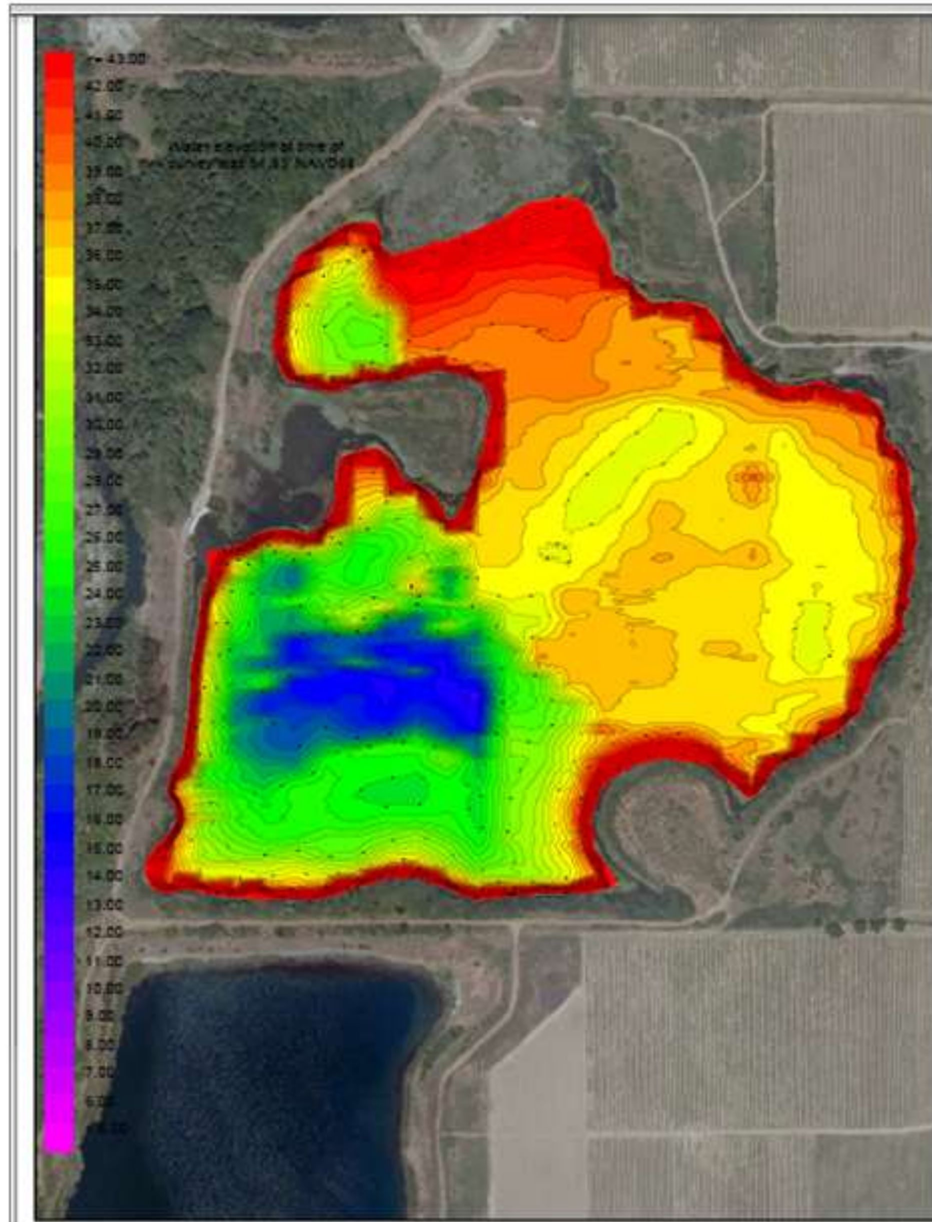


Figure 4.3.3. Topographic map of the Hanson Richardson pond showing bottom elevations in feet (NAVD88).

RIVER

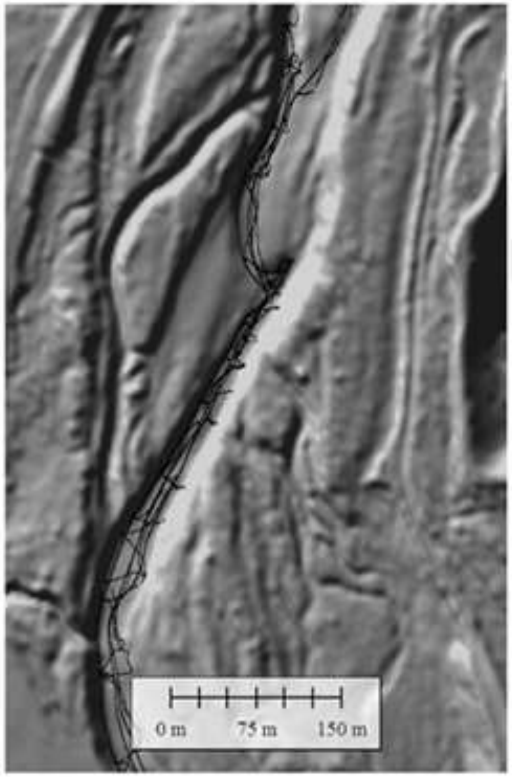


Figure 4.3.6. Bathymetry traces for a short example reach of the river channel, in the vicinity of the Richardson pond.

DTM

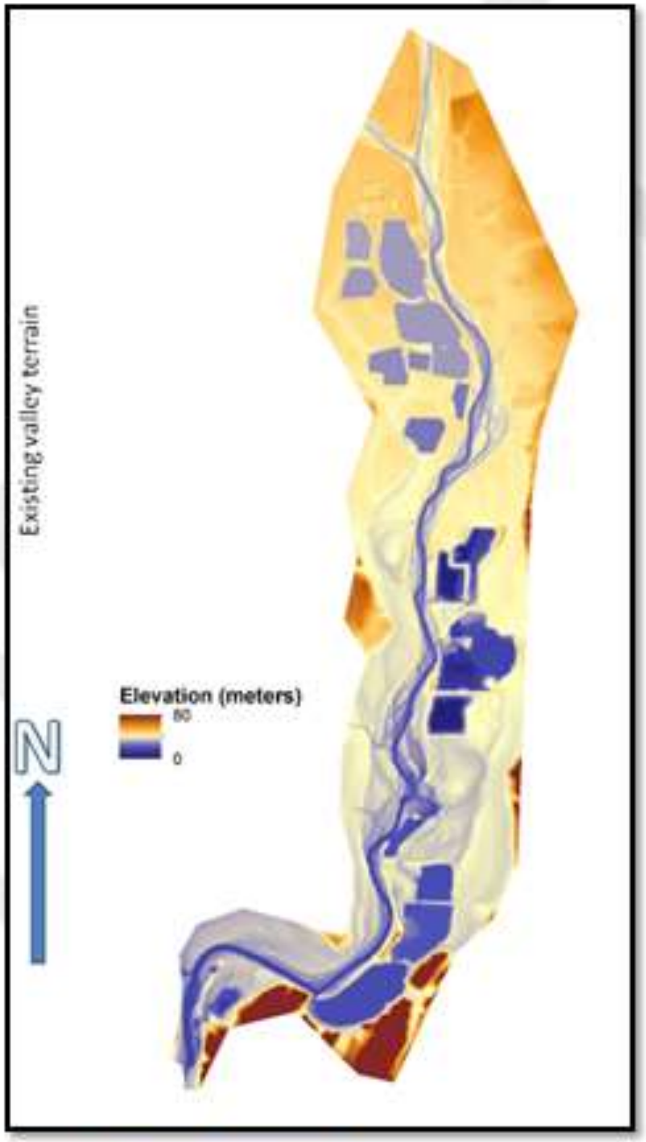


Figure 4.3.1. Middle Reach Valley Digital Terrain Model. The figure includes the entire study reach floodplain area, merged from LiDAR, and bathymetry of the river and ponds. The only features on this map with unconstrained elevations are the County Riverfront Park ponds at the southern end. Note, the colors represent elevations derived from topographic and bathymetric surveys, not depths of aquatic features. Thus, the Riverfront Park pond elevations depicted are of the LiDAR derived water surface elevations.

Trenches Sediment

Figure 4.3.11. Terrestrial sediment sampling locations around the Hanson ponds. Trench and test pits locations for soil samples were taken from the 45 locations shown below for characterization of the Hanson site levees and upland soils to characterize grain size distribution and stratigraphy. Sampling locations and sample identifiers are referenced in Table 4.3.1.

Table 4.3.1. Terrestrial material sample properties. Cohesive and low porosity materials are indicated in red text. Sample locations are mapped in figure 4.3.11.

Sample Name	Depth (ft)	d80 (mm)	d50 (mm)	d20 (mm)	Classification
A	0-8	na	na	na	Fine Gravel
B	0-6	na	na	na	Silt-Clay
C	0-11	na	na	na	Fine Sand
D1	0-8	na	na	na	Silt-Clay
E5	6-9	3.00	0.55	0.28	Medium Sand
F1	0-3.5	na	na	na	Fine Gravel
F2(a)	0-3.5	na	na	na	Fine Sand
F2(b)	3.5-7	na	na	na	Silt-Clay
G1(a)	0-3	3.60	0.32	na	Medium Sand
G1(b)	3-9	0.34	0.21	na	Medium Sand
G2	0-7	15.00	5.00	0.65	Fine Gravel
H1	0-7	0.46	0.30	na	Medium Sand
H2(a)	0-5	1.40	0.51	0.35	Medium Sand
H2(b)	5-9	6.00	0.50	0.31	Medium Sand
H3	0-6	12.00	3.75	1.10	Fine Gravel
I1	0-7	20.20	9.00	2.10	Medium Gravel
I2	0-7	20.20	7.00	1.75	Medium Gravel
I3	na	17.00	4.30	0.72	Fine Gravel
J1	0-9	na	na	na	Sandy-Clay
J2(a)	0-7	na	na	na	Sandy-Clay
J2(b)	7-9	8.90	0.59	0.36	Medium Sand
J3	na	10.05	3.50	0.89	Fine Gravel
K1	0-9	na	na	na	Coarse Gravel
K2	na	10.00	2.97	0.68	Fine Gravel
K3(c)	na	18.20	7.00	2.00	Medium Gravel
L1(a)	0-1	3.63	1.58	0.63	Coarse Sand
L1(c)	2-9	0.65	0.49	0.35	Medium Sand
L2(a)	0-2	6.95	0.95	0.44	Coarse Sand
L2(b)	2-8	6.10	1.10	0.45	Coarse Sand
L3	0-9	na	na	na	Fine Sand
M1	0-2	9.60	2.85	0.87	Fine Gravel
N1(a)	0-1	2.13	0.81	0.28	Medium Sand
N1(b)	na	4.50	0.59	0.29	Medium Sand
N2(a)	0-1	10.00	3.10	0.51	Fine Gravel
N2(b)	1-10	1.10	0.45	0.18	Medium Sand
N3	0-9	na	na	na	Coarse Sand
N4	0-9	na	na	na	Fine Gravel

cores

Figure 4.3.12. Hanson pond core sampling locations for both sediment texture and geochemical analyses

Table 4.3.3. Texture of Hanson pond sediment core samples. Sample locations shown in Figure 4.3.12.

Sample Number	Pond Name	Length/Depth in inches	Textural Description, from bottom to top, in inches
1	Mariani	60	0-8 dark grey clay, 8-15 fine tan sand, 16-29 tan clay, 30-36 grey clay, 37-60 tan to gray clay
2		64	0-7 clean tan sand, 7-10 tan clay, 10-12 sandy tan clay, 12-16 sandy grey clay, 16-17 tan clay, 17-19 clean tan sand, 19-21 tan clay, 21-28 gray clay, 28-35 gray sandy gravel, 35-48 sandy tan clay, 48-64 gray clay
3		48	0-8 clean tan sand, 8-9 tan clay, 9-16 tan to gray clay in many layers, 16-48 indistinct gray clay
4		45	0-13 tan sand, 13-16 layers of tan clay, 16-21 layers of gray clay, 21-30 thick layers of gray clay, 30-45 massive gray clay
5		21	0-5 tan sandy gravel -24mm particle, 5-10 tan to gray layers of clay, 10-21 massive gray clay
6		41	0-14 gray clay, 14-41 gray sandy clay
7	Piombo	93	0-12 tan clay, 12-20 tan to gray clay layers, 20-30 gray clay, 30-31 fine gray sand, 31-93 gray clay and a few dark layers
8		84	0-14 tan sand, 14-19 gray sand, 19-31 tan clay in thin layers, 31-33 gray clay, 33-37 gray sand, 37-84 gray clay
9		53	0-6 gray clay, 6-6.05 tan sand, 6.05-9 gray clay, 9-9.05 light gray clay, 9.05-13 gray clay, 13-16 gray sand, 16-23 gray clay, 23-53 ten layers of gray clay with ten thin black layers
10		90	0-6 tan clay, 6-8 gray clay, 8-20 multiple thin layers of tan to gray clay, 26-30 gray sand, 30-41 gray clay, 41-43 gray sand, 43-90 thin gray clay in layers
11		60	0-8 gray sand, 8-15 gray clay, 15-17 gray sand, 17-21 gray clay, 21-23 gray sand, 23-62 thin gray clay layers
12	Richardson	90	0-5 gray clay, 5-90 tan clay layers 2-4mm thick
13		57	0-20 gray sand and gravel - 24mm particle, 20-31 gray sand, 31-57 soft tan clay
14 R		57	0-17 gray clay, 17-20 gray sand, 20-57 soft gray clay
15		60	0-12 gray clay, 12-15 gray sand, 15-40 gray clay, 40-60 layered tan clay
16		46	0-9 gray clay, 9-26 silty gray gravel, 26-46 soft gray clay
17		46	0-5 gray clay, 5-8 gray sand, 8-21 gray clay, 21-23 gray sand, 23-46 soft gray clay
18		46	0-4 gray sand, 4-46 gray clay in 4" layers with 1" fine sand layers
19		28	0-4 gray sand, 8-46 gray clay
20		46	0-8 gray sand, 8-48 gray clay
22	Vimark	40	0-14 tan sand and gravel, 14-40 soft tan and gray clay in layers 1-3mm thick
24		96	0-96 tan clay in layers 1-3mm thick
25		36	tan sand, 8-36 tan clay in layers 1-3mm thick

River Sediment

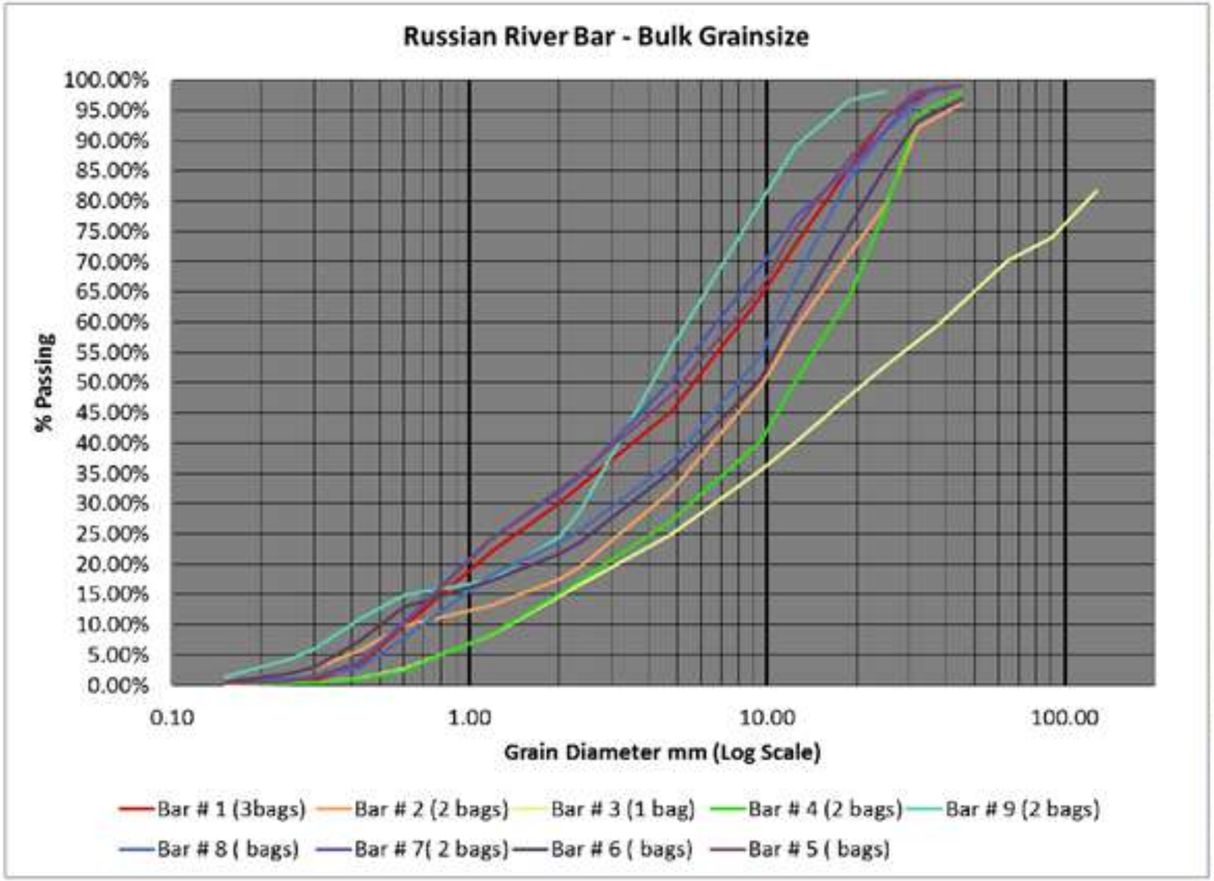


Figure 2 Bulk grainsize distributions and sampling locations

Hydrology and Project Hydraulics

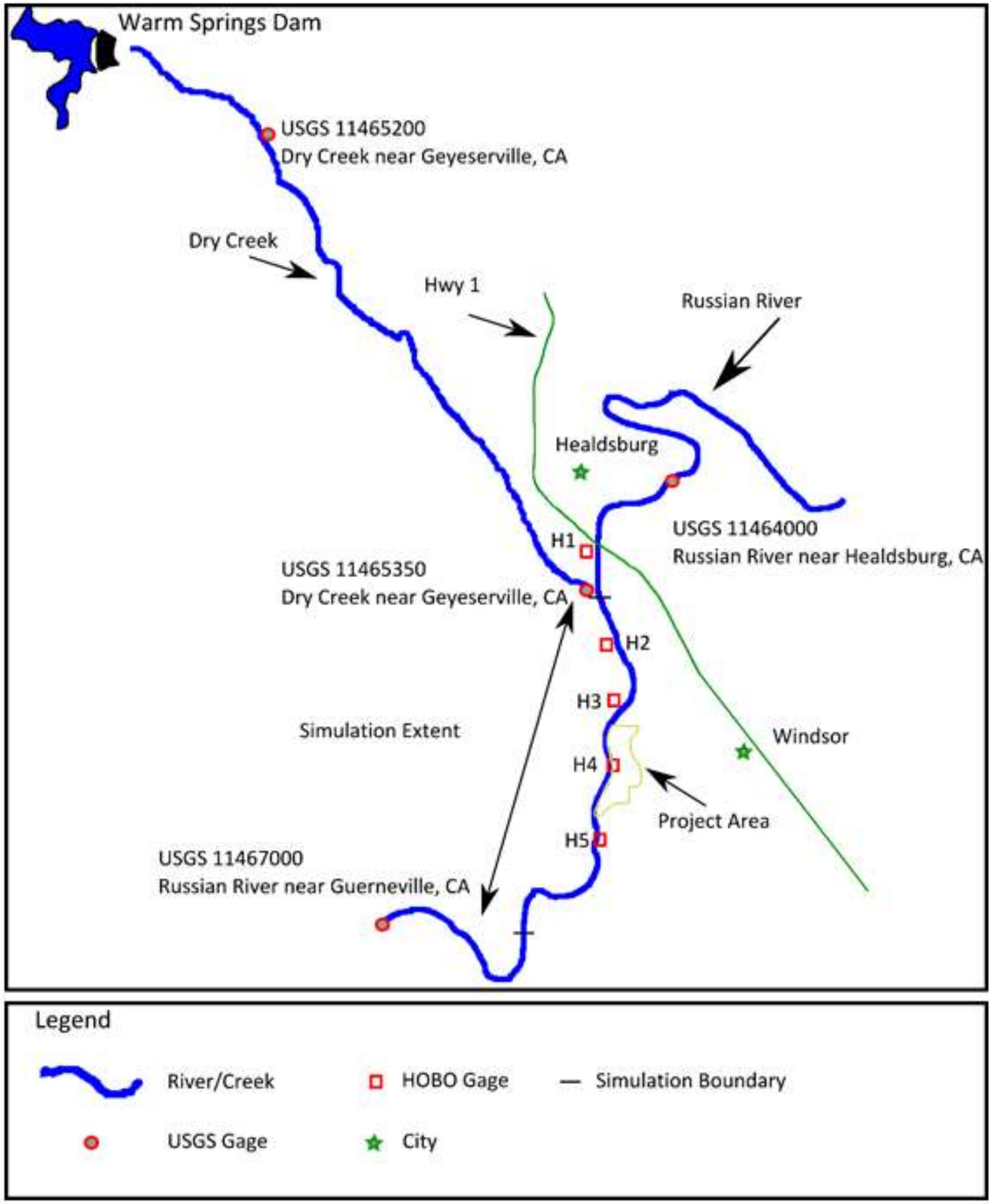
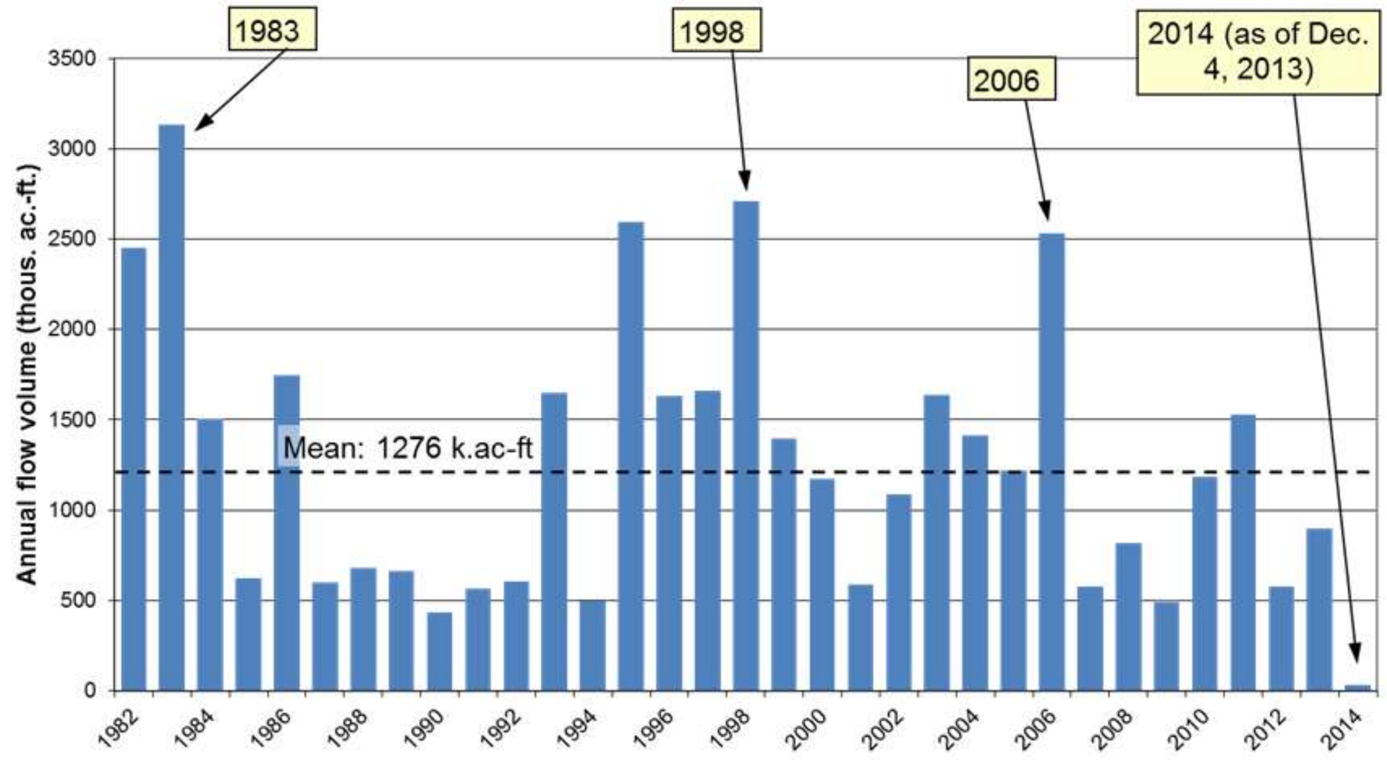


Figure 3 Overview map showing the locations of the USGS and HOBO gages used in the study

Project Flows



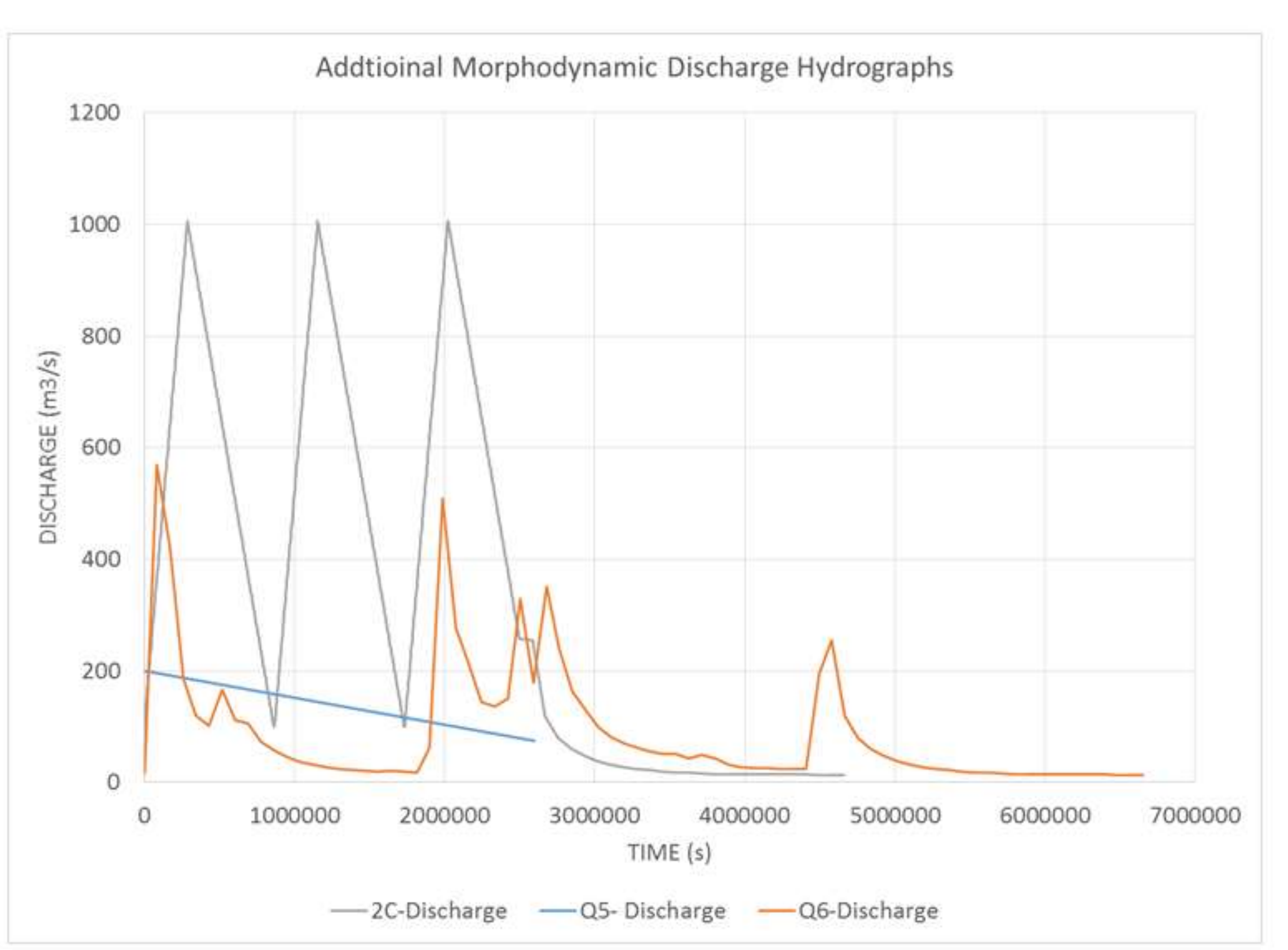
Total annual flow volume (based on mean daily data) for estimated total project inflow.

Courtesy of Mark Strudley NWS

Figure 43 The revised total annual flow volume based on mean daily data from USGS gaging station 114640000 (Russian River near Healdsburg, CA), and USGS gage 11465200 (Dry Creek near Geyserville, CA), Sonoma County, California. For the Phase 2 simulations, a high-year was represented by 1983, an average-year by 2005, and a low-year by 2009.

Model Steady and Dynamic Flows, collaboration with USGS Jon Nelson and Rich McDonald

Discharge M3/s	Discharge cfs
8	280
15	525
25	875
100	3500
200	7000
283	9900
425	14900
566	19825
708	25000
849	30000
1421	50000



Two Stage Modeling Approach

- Stage I
  - Explore physical constraints
  - Develop some design criteria, elevations, durations
  - Refine project Goals and Objectives
- Concept Design and Evaluation - Stage II
  - Terrain development WRT Goals and constraints
  - Vet with SWG, Peers, Partners
  - Revise, Vet, Revise,
  - Model performance
    - Stress-test the model
    - Interpret results for biological performance

Stage I

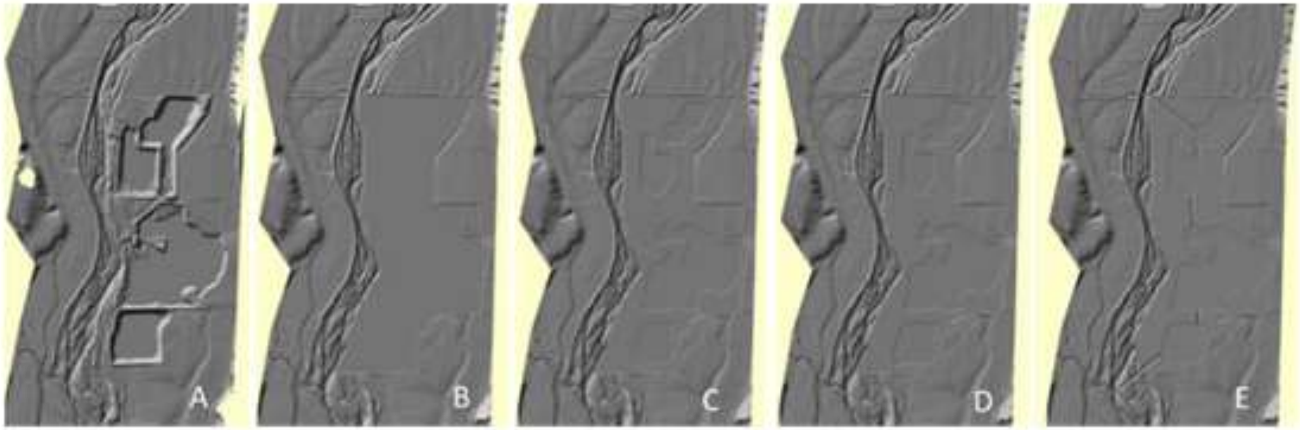


Figure 7.1. Shaded relief maps of the digital terrain models for Stage I scenarios.

Table 7.1. Digital terrain models developed for evaluation in Stage I of the feasibility study.

Scenario Name	Stage I digital terrain model descriptions.				
	I-A Existing Topography	I-B Floodplain Base Level	I-C Floodplain Base Level + 1 meter	I-D Floodplain Base Level + 2 meters	I-E Floodplain Base Level + 2 meters with channels connecting ponds
Scenario Description	Ponds and river levee remain. Also represents the outcomes from a modified reclamation plan configuration.	• flat floodplain across the site with a downstream gradient matching the river • no east-west slope • elevation 1.4 meters above the river bed • no river levee • no ponds remaining.	• flat floodplain across the site with a downstream gradient matching the river • no east-west slope • elevation 2.4 meters above the river bed • no river levee. • residual pond depths of ~ 1 meter.	• flat floodplain across the site with a downstream gradient matching the river • no east-west slope • elevation 3.4 meters above river bed. • no river levee • residual pond depths of ~ 2.5 meters.	• flat floodplain across the site with a downstream gradient matching the river • no east-west slope • elevation 3.4 meters above river bed. • no river levee • residual pond depths of ~ 2.5 meters. • low flow channels connecting residual ponds and river channel
Modeled by USGS	X	X	X	X	This scenario was refined for Stage II modeling

Table 7.2. Hydraulic modeling results. The table summarizes the number of days of floodplain inundation for the three floodplain elevations of Stage I analysis, during three climatic conditions (water year type) represented by the years 1983 (wet), 2008 (average), and 2009 (dry).

Scenario	Description	Inundation Discharge (m3/s)	Inundation Days		
			1983 (wet)	2008 (avg)	2009 (dry)
I-A	Existing Conditions	na			
I-B	Floodplain Base Level	30	164	48	30
I-C	Floodplain Base Level + 1m	100	99	31	12
I-D	Floodplain Base Level + 2m	190	63	10	8
I-E	Floodplain Base Level + 2m + Interconnecting Channels	42	140	42	21

SWG 1

The following recommendations were made:

1. Any residual ponds should not exceed 3 meters in depth during the dry season to minimize mercury methylation processes.
2. The Hanson site should dry out seasonally to prevent warm water fishes from proliferating or salmonids from perishing.
3. Gently sloping broad floodplain surfaces should be created to provide feeding habitat over a wide range of river stages.
4. The restoration design should include gentle transition slopes to the surrounding farmlands at approximately 1 h:10 v.

7.5 Stage II: Developing the superior terrain concept

After consulting with the Scientific Working Group and Peer Review Panel and weighing initial hydraulic elevations and inundation duration of Stage I modeling results with project goals and objectives, a more detailed topographic model was developed. Design criteria included:

1. Balanced cut and fill of onsite material.
2. Grading the entire site within the project boundaries.
3. Provide a gentle slope (1v:10h) from floodplain to farm field elevation around the agricultural perimeter.
4. Slope the floodplain in the down-valley direction parallel to the river slope.
5. Slope floodplain gently from the toe of the agriculture boundary slope to the river (east - west slope of 0.5%) or nearest drain.
6. Contour the inlet and outlet areas to conform to the river channel.
7. Completely fill the ponds with the on-site material so there is no standing water in the drier months.

Stage II terrain development

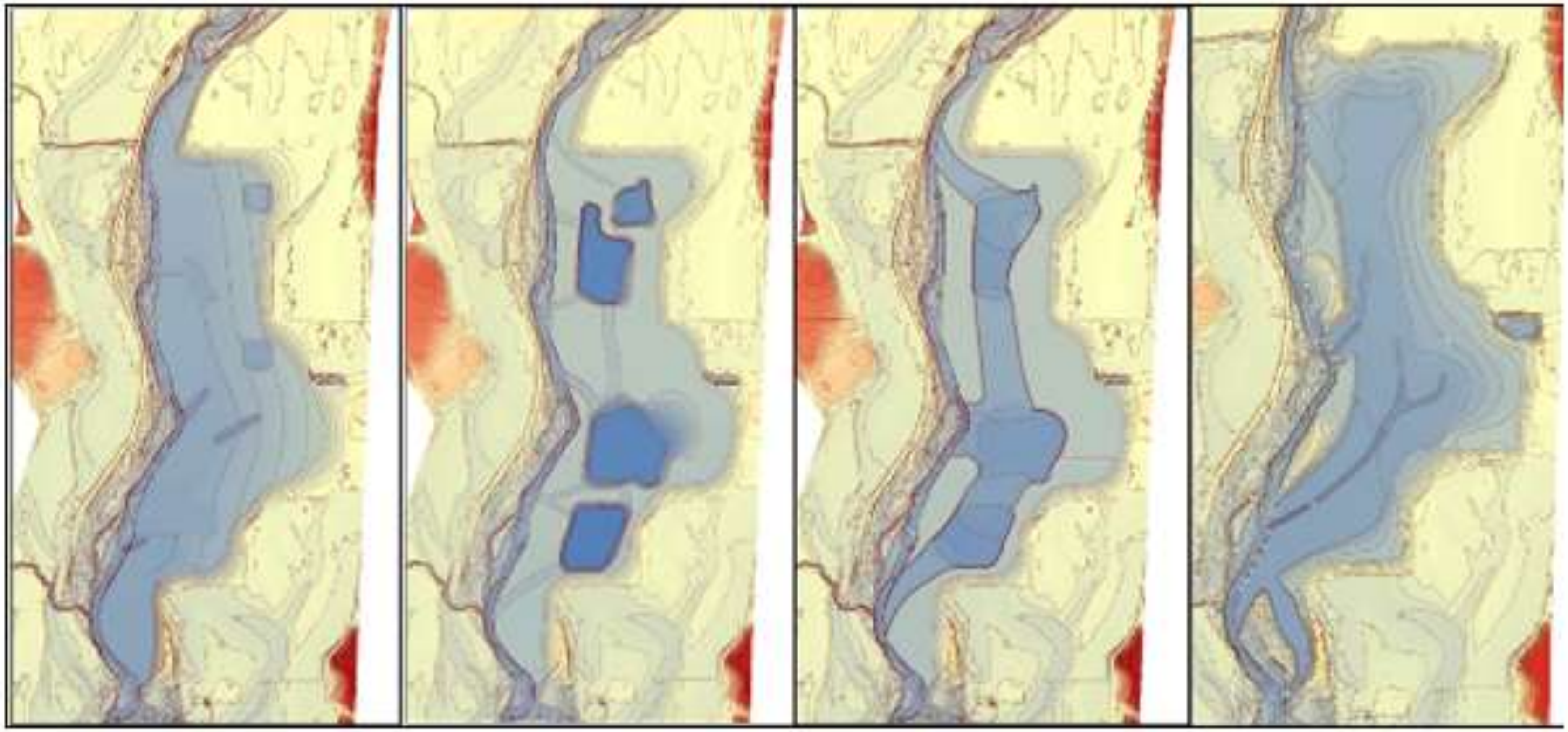
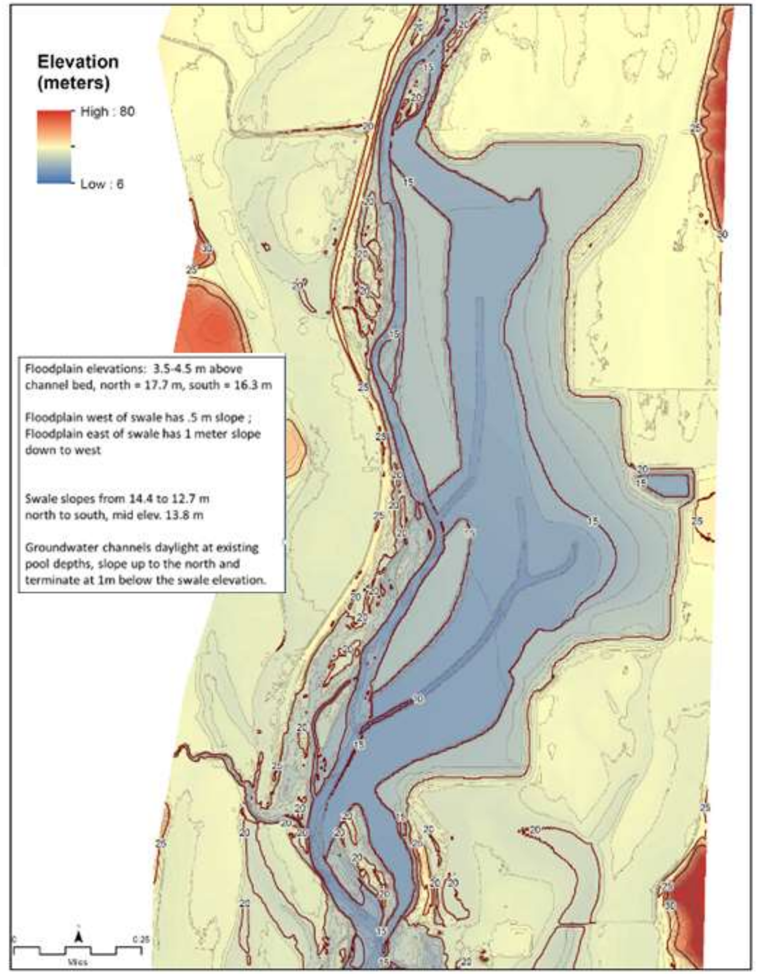


Figure 7.2. Stage II terrain concepts A-D. The panels, left to right, are II-A, II-B, II-C, and II-D as described above.

Table 7.4. Descriptions of terrain scenarios developed for consideration in Stage II of the feasibility study. Common attributes for all Stage II scenarios: 1) balanced cut and fill volume, 2) gentle 1v:10h slopes from floodplain to farm fields, 3) floodplain slope in downstream direction parallel to the river slope, 4) east-west floodplain slope from the toe of the 1v:10h slope to the nearest drain at 0.5%, and 5) contour of inlet and outlet areas graded to conform to the existing river channel and banks.

Scenario Name	Stage II Scenario descriptions				
	II-A Low elevation gently sloping floodplain	**II-B** Higher elevation sloping floodplain	**II-C** Broad floodplain swale interconnecting ponds	**II-D** Broad lower floodplain swale with no ponds	**II-E** Broad floodplain with 'abandoned channel' analogs
Scenario Description	• floodplain elevation 1.5 meters above river bed • no residual ponds	• floodplain elevation 4-5 meters above river bed • residual ponds ~5 meters deep during summer	• broad floodplain swale sloping from 14.4 to 12.7 meters N-S, interconnecting the residual ponds. • floodplain base elevation 4-5 meters above the river bed • residual ponds ~2.1 meters below swale invert with some perennial standing water	• broad floodplain swale about 0.2 m lower than II-C • floodplain base elevation 4-5 meters above the river bed • no ponds remaining • two drainage channels ~1 meters deep into the broad floodplain swale, daylighting into existing river channel pools, likely to intersect groundwater and be spring-fed.	• modified II-D with 2 lengthy 'abandoned channel' analogs with perennial alcoves connected to existing deep river pools • graded into the upstream and downstream terrain • floodplain base elevation 4-5 meters above river bed • no ponds remaining • 25 acre foot water supply pond (Jackson Pond) at NE corner of Richardson pond • 30' property line setback on N, E and S to allow a trail. • canoe launch & vehicle turn-around near river on NW side • campground pad along E boundary
Modeled by USGS					X



igure 7.3. Scenario II-E topography. Topographic map of Stage II-E scenario — the proposed superior approach › floodplain restoration of the Hanson property.

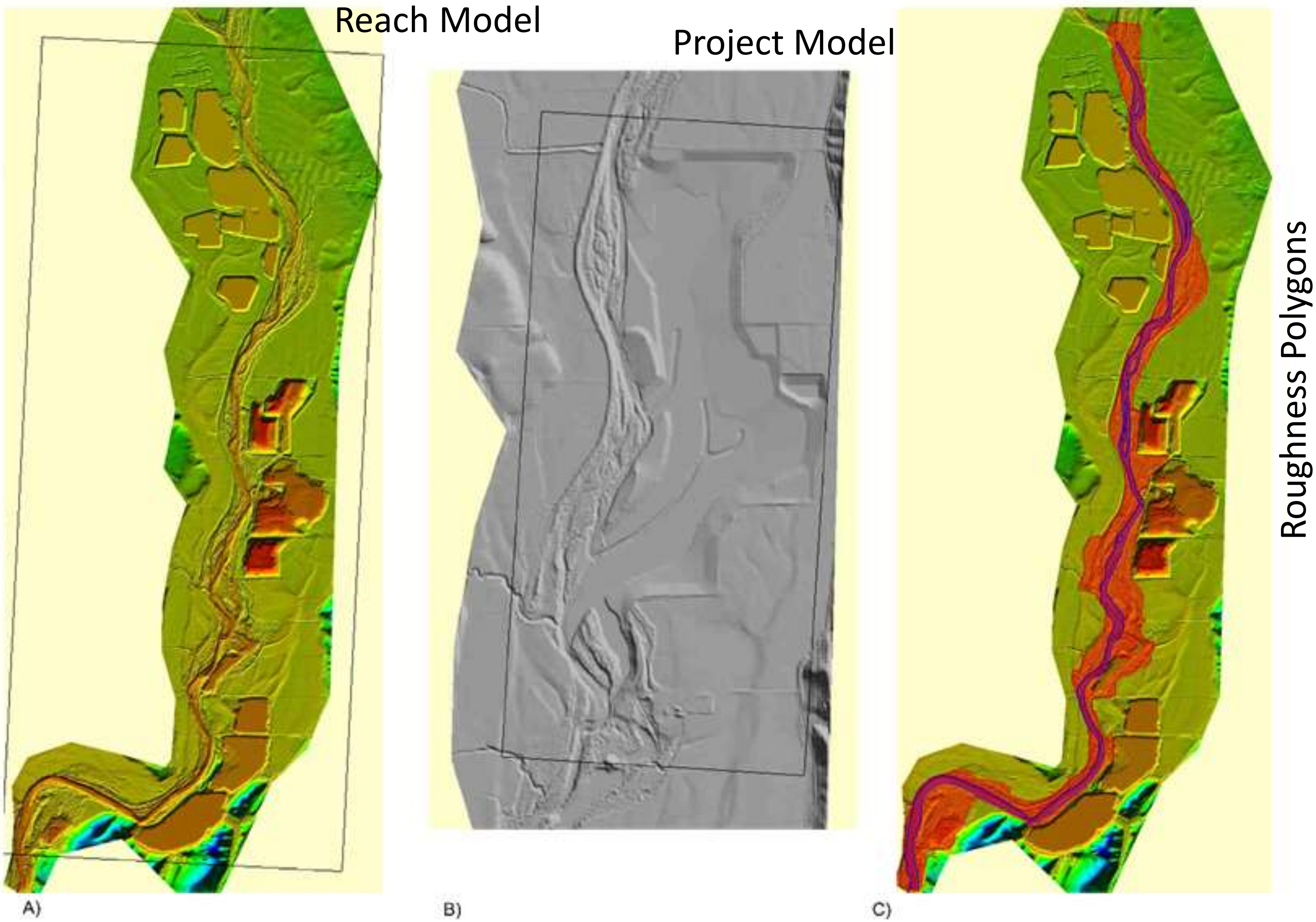
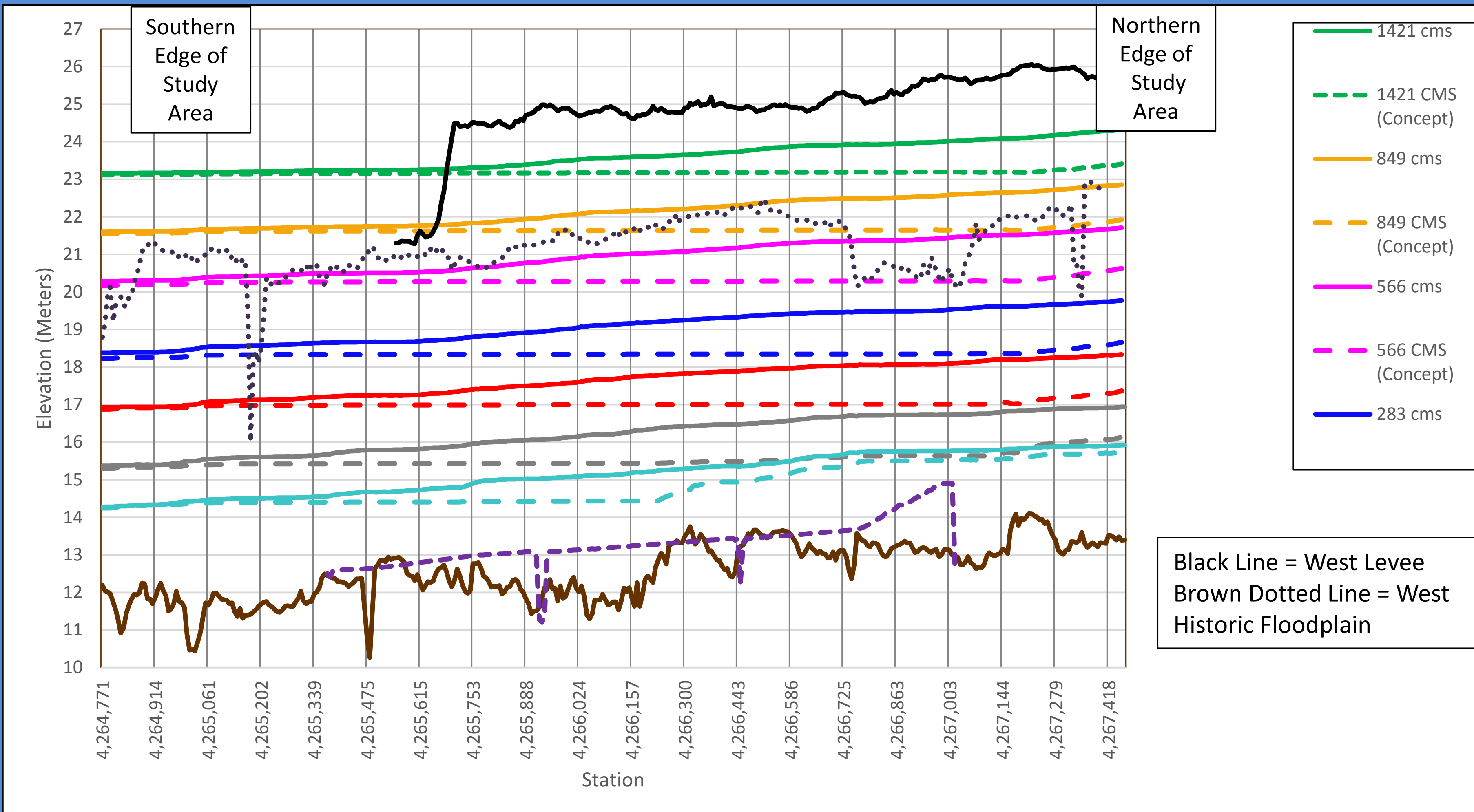


Figure 6 A) Location of the flow model grid over the existing topographic surface. B) The location of the short reach used in the morphodynamic simulations. C) The location roughness polygons used to define the un-vegetated channel (blue), the vegetated channel (red).



Sheet # 12 of 13

Title: **Topographic and Hydraulic Profiles for the Project Area**

Date Drawn: July 13, 2015

Project: **Hanson Russian River Ponds Floodplain Restoration Feasibility Study**

Scale:

Drawn by: C. Gavette

Location: **Near Windsor, Sonoma County**

Prepared for: **California Coastal Conservancy & Sonoma County Permit and Resource Management Department**

Checked by: B. Cluer

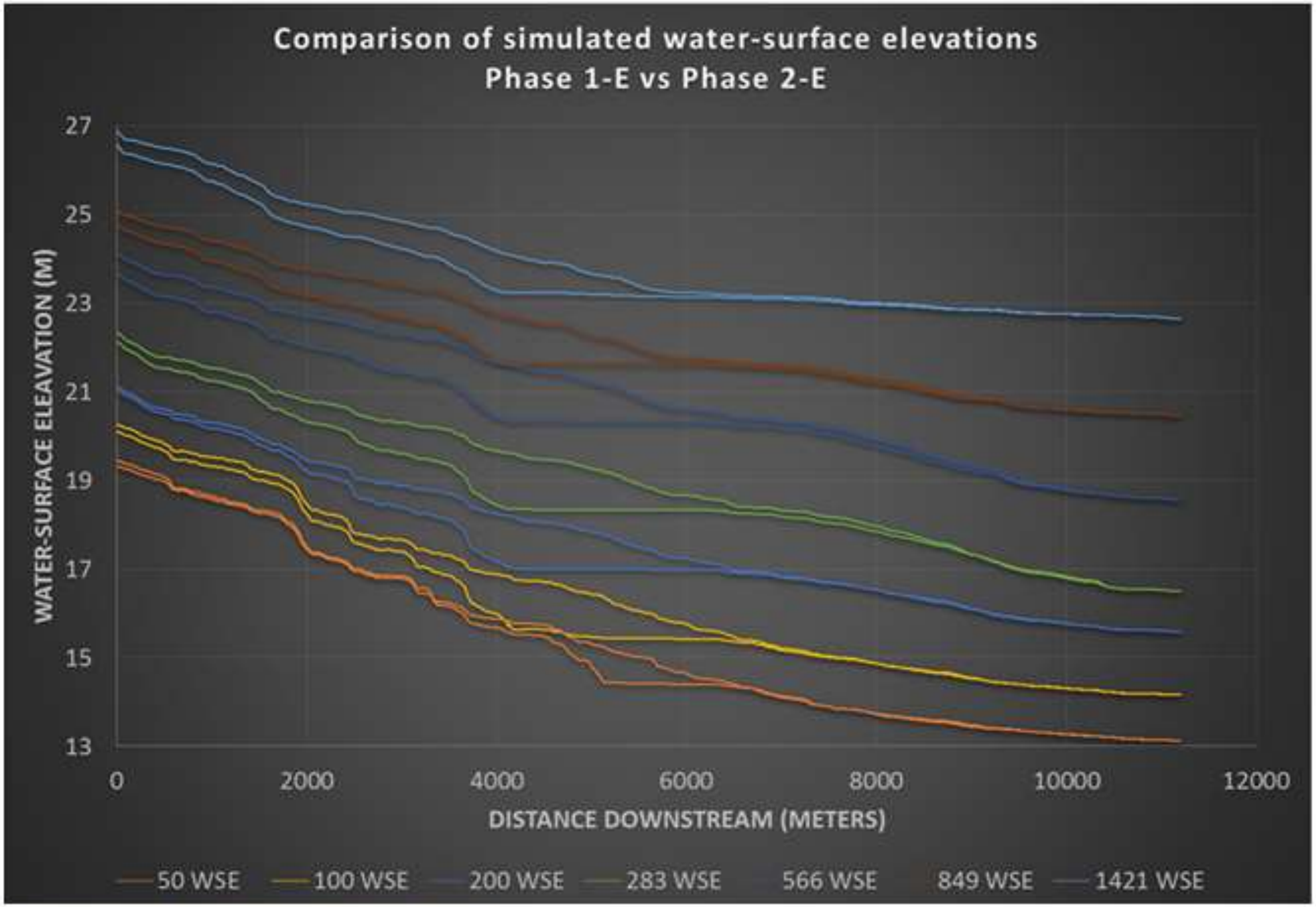


Figure 8.1. Simulated water-surface elevations. With implementation of floodplain restoration, water-surface elevations are reduced for all flows in the project area. This example is a comparison between Existing Conditions (Stage I-A) and the preferred scenario Stage II-E floodplain concept (shown as Phase 2-E in figure caption), but similar results occur for all floodplain restoration alternatives.

100-yr flood

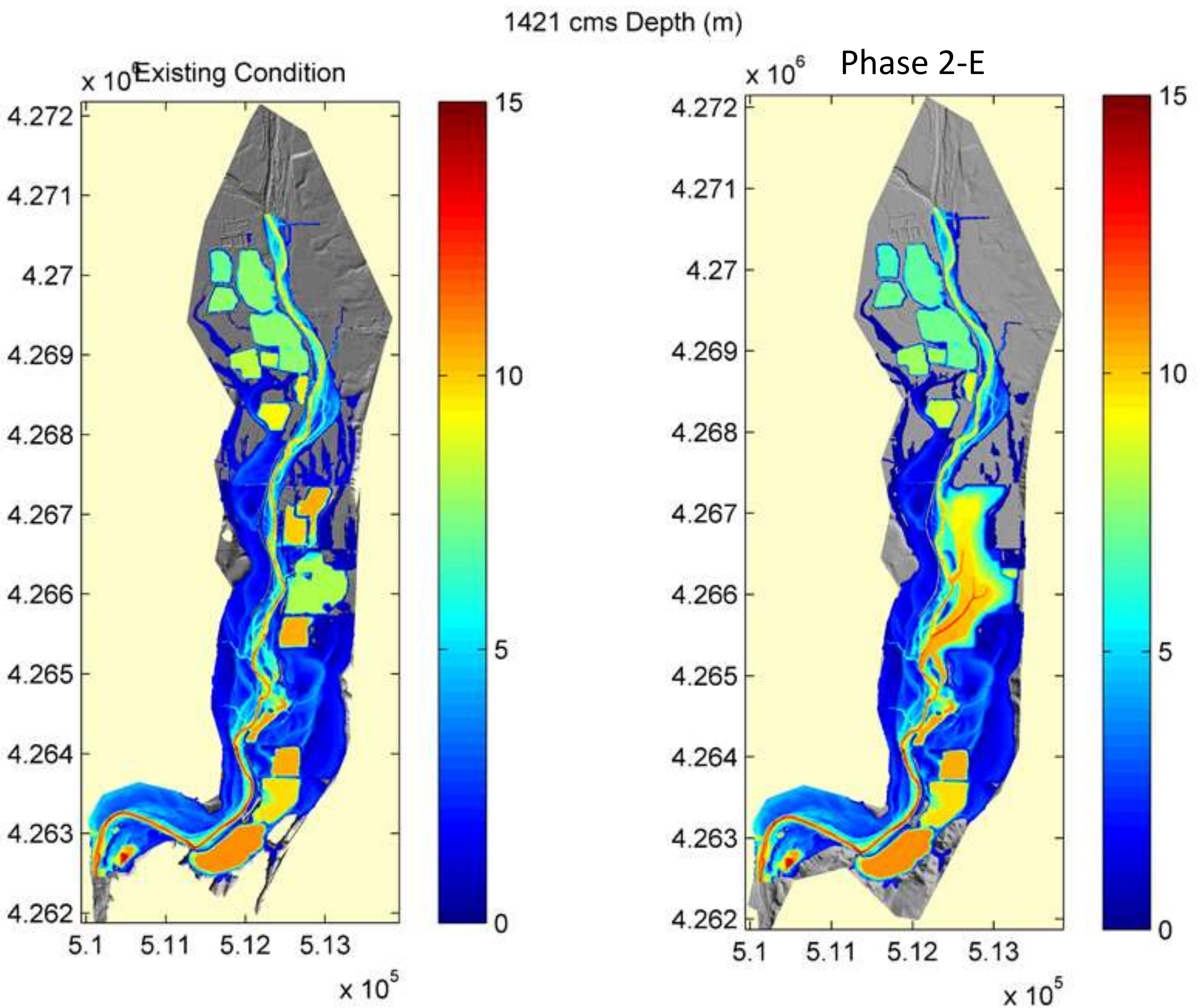


Figure 55 The simulated depth for the Phase 1-A and Phase 2-E surfaces at a discharge of 1421 m^3/s.

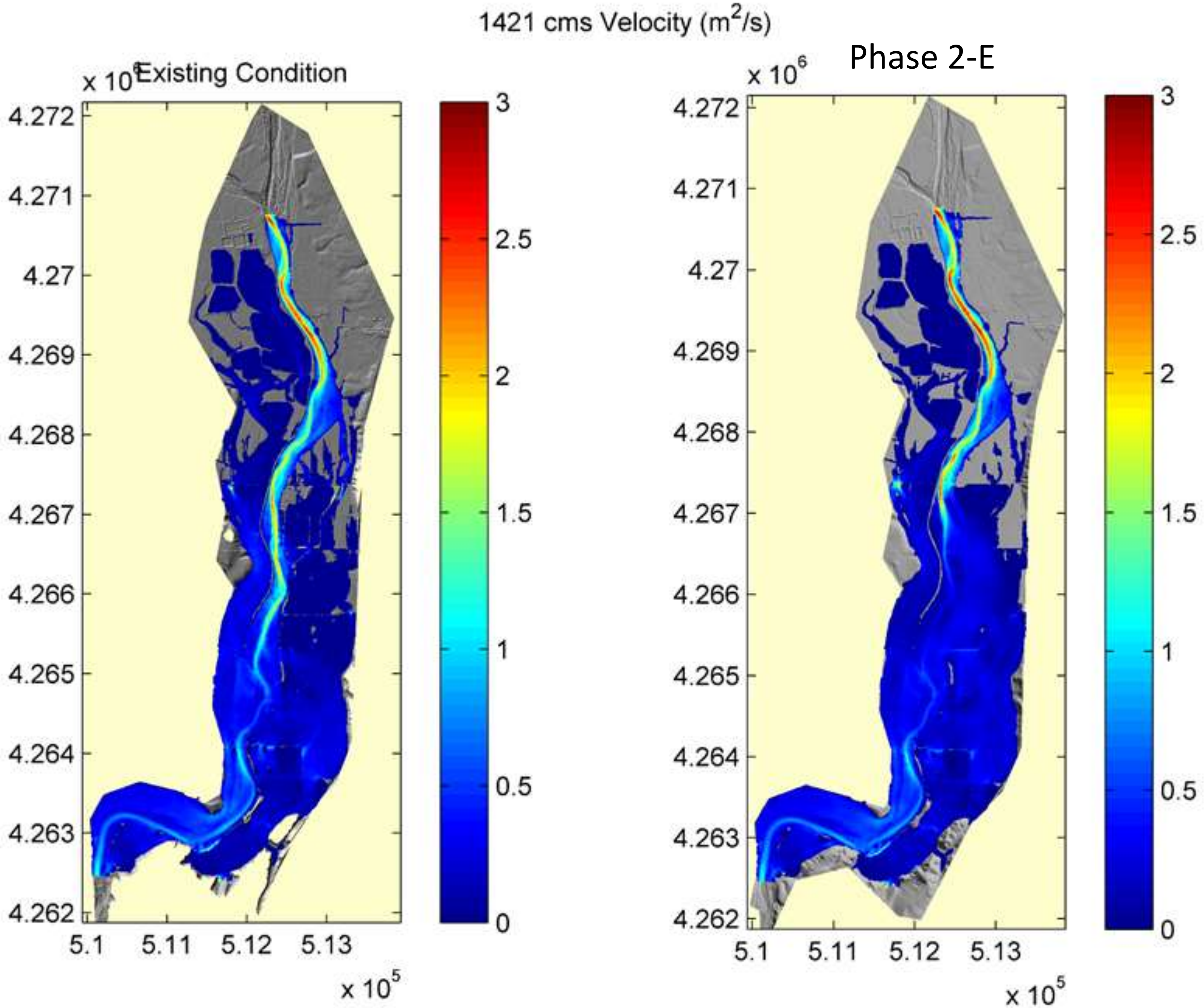


Figure 64 The simulated velocity for the Phase 1-A and Phase 2-E surfaces at a discharge of 1421 m³/s.

Bed Evolution - Model Flows

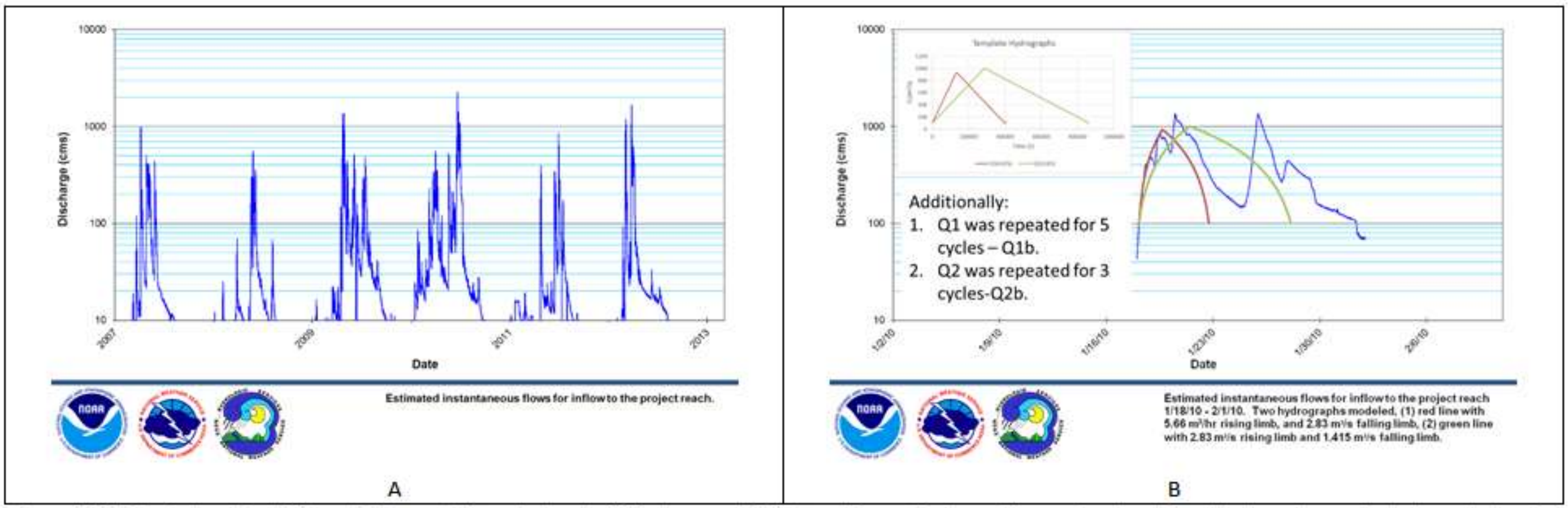


Figure 84 A) Estimated combined inflows (m³/s log scale) to project reach. B) Short segment of discharge time-series along with approximate and simple hydrographs used to test morphodynamic simulations. For the initial testing and simulations of the morphodynamic model four discharge hydrographs were used. Q1 (red) and Q2 (green) are linearly increasing and decreasing hydrographs. Q1b and Q2b are simply Q1 and Q2 repeated three times.

Provoked the model to predict the greatest changes by:
Using a smaller than observed grain size
Forcing multiple 'annual' peak flows back to back
Lowering the DS boundary 1m

Current Conditions - Bed Dynamics

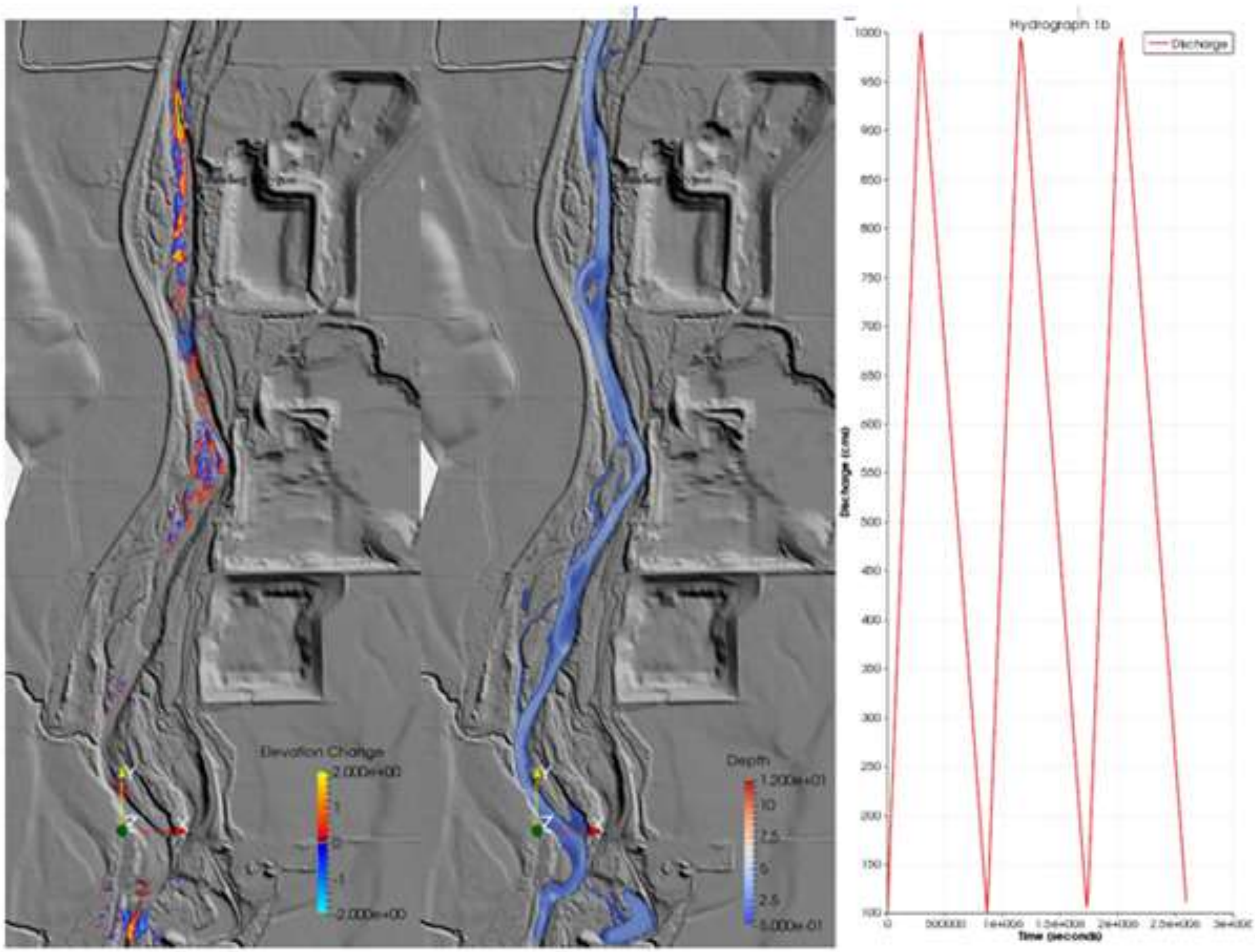


Figure 8.3. Erosion and deposition patterns for Existing Conditions simulation after three significant floods. Left panel - typical erosion, deposition pattern, and depth of the existing conditions model. Resulting predicted elevation changes are focused on the edges of the unvegetated channel. Middle panel – water depth at the end of simulation. Right panel – modeled hydrograph. See figure 86 in Appendix G for more details.

Play Existing Condition

Floodplain Project Bed Dynamics

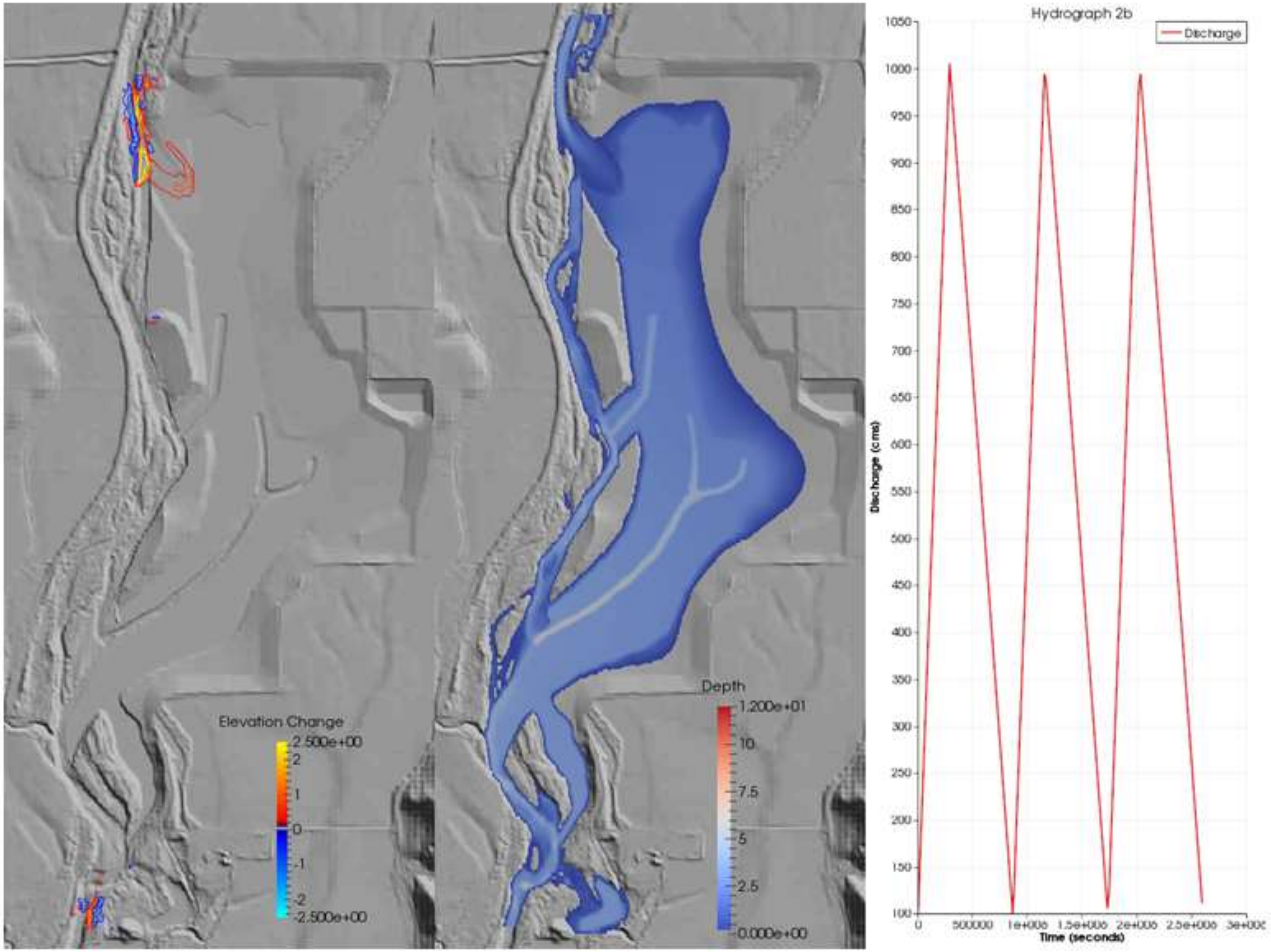


Figure 90 Simulation Ex_SRM_Q2b_GS1b_Stg2 (Table 3). Panels from Left to right are: Elevation Change (m), Depth (m), and Discharge vs. Time (s). These are final values at the end of the simulation period.

Play Stressed Model

Close up of inlet – biggest change

Play New Gravel & New Channel

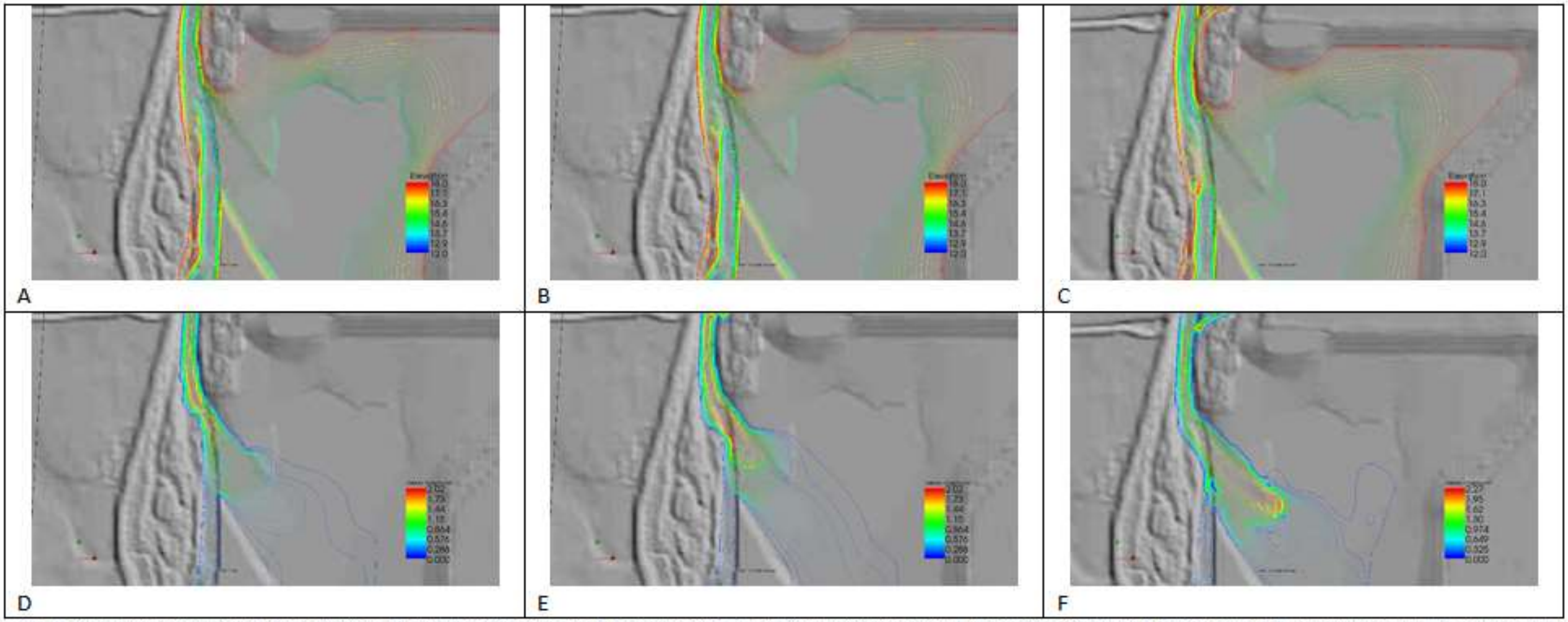


Figure 91 A) Initial elevation, B) final elevation of SRM_Q2b_GS1b (Table 1 and Figure 88), and C) final elevation of SRM_Q2b_GS1b_Stg2 (Table 1 and Figure 89). D) Initial velocity, B) final velocity of SRM_Q2b_GS1b (Table 3), and C) final velocity of SRM_Q2b_GS1b_Stg2 (Table 3).

Figure 8.5. Predicted area of greatest topographic change. The upstream floodplain inlet and adjacent channel are predicted to have the greatest topographic change. A gravel delta will form during floods and a channel will form in the delta deposit as the flood recedes. See Appendix G, Figure 91 for more details.

New Gravel Deposits - Spawning Habitat

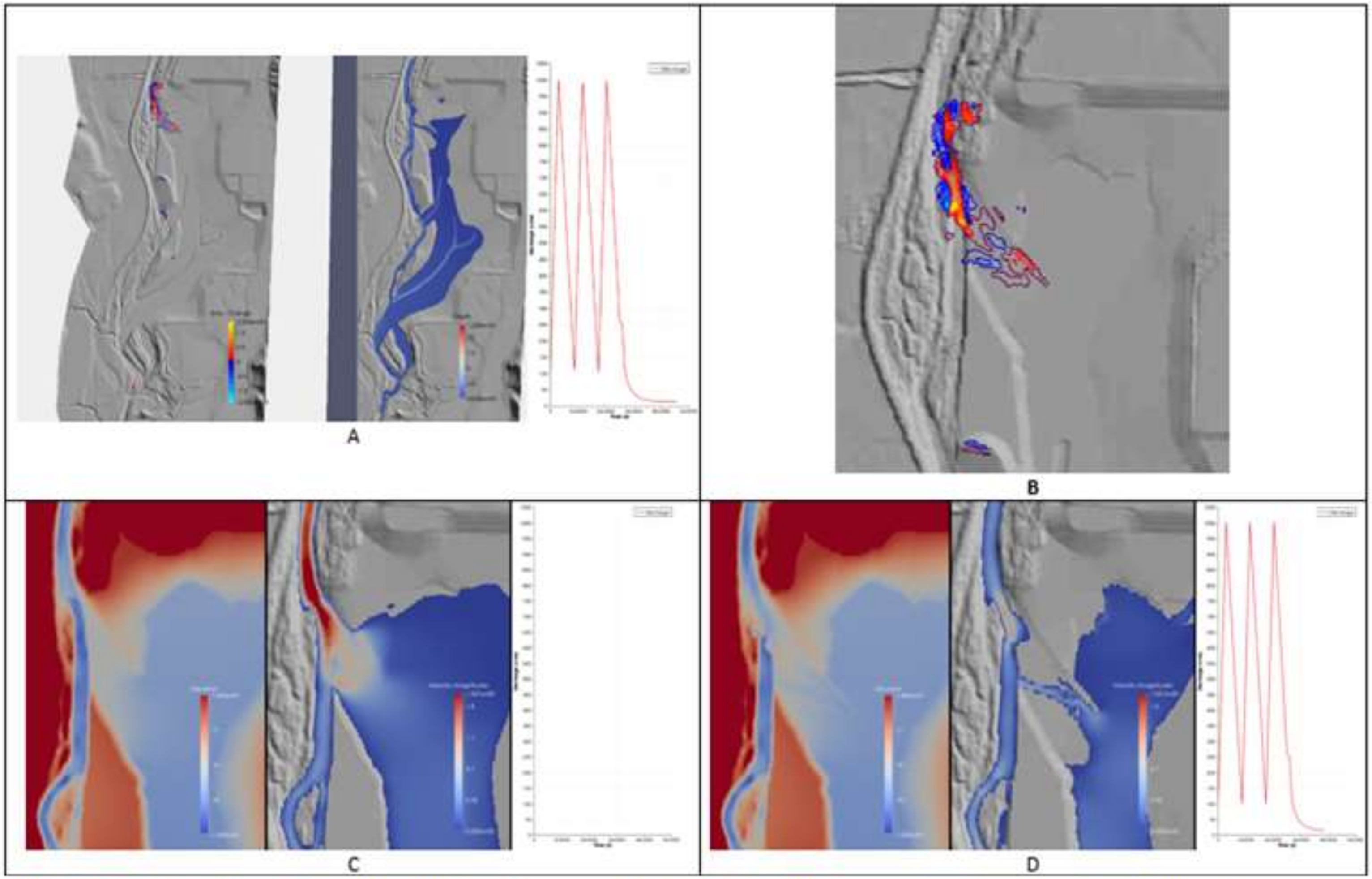


Figure 8.24. Potential evolution of spawning habitat. A gravel delta form is predicted at the upper floodplain inlet that will cycle between deposition and re-working with the passing of normal floods. This area may become suitable spawning habitat, a relatively rare habitat for this reach of river. See Appendix G figure 93 for more details.

Habitat

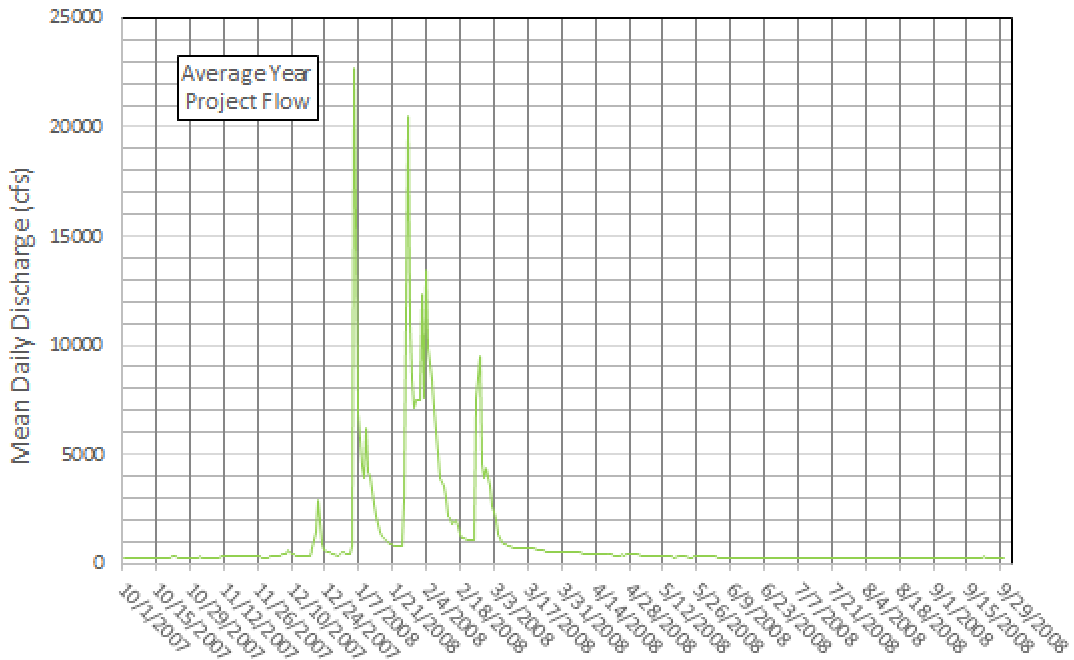


Figure 8.8. Mean daily flow at the project site for an average water year.

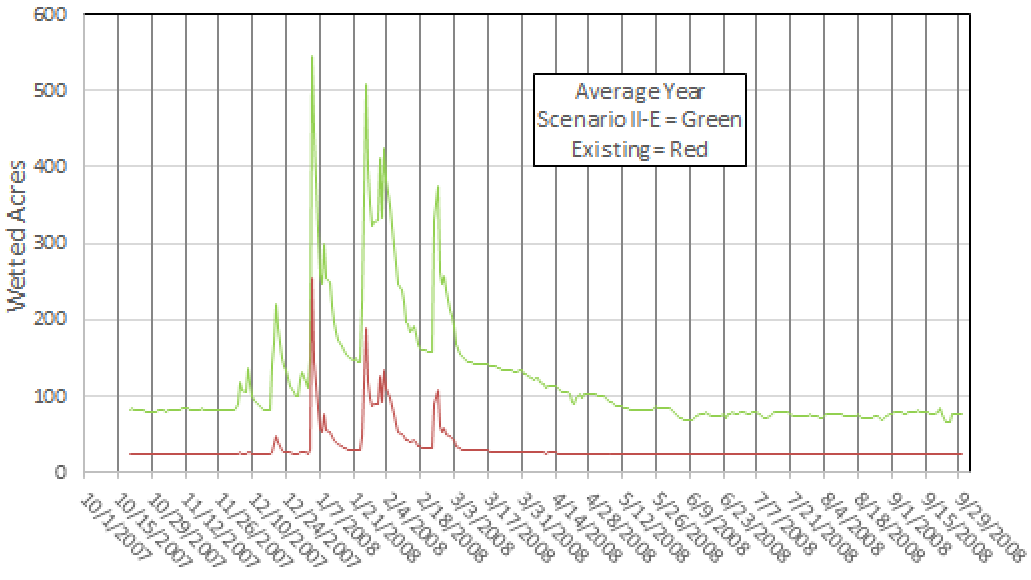


Figure 8.9. Mean daily inundated area over time for an average water year.

Habitat

Wetted areas
1m or shallower
1/3 m/s or slower

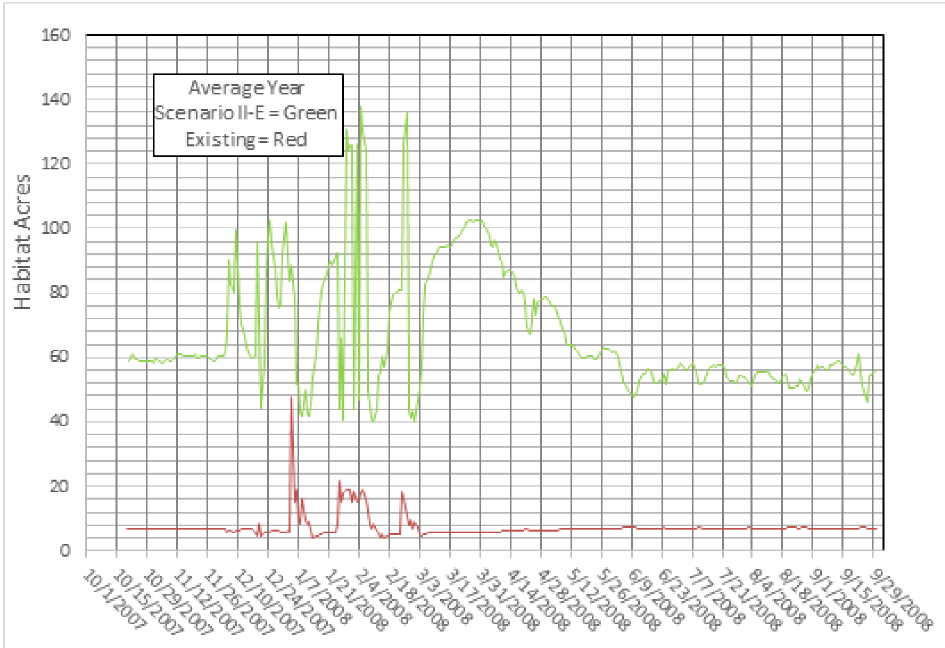


Figure 8.10. Juvenile rearing habitat area over time for an average water year.

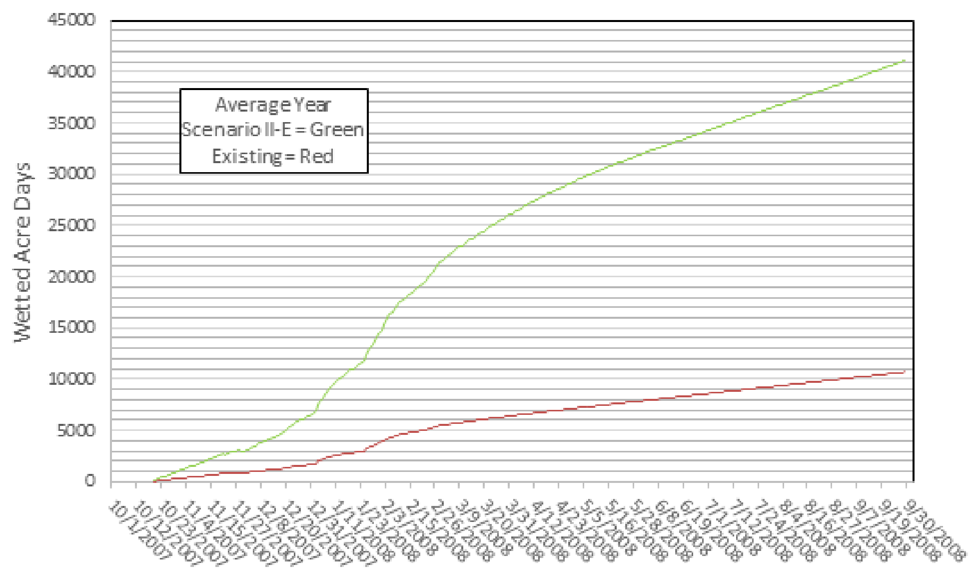


Figure 8.11. Cumulative inundated area for an average water year.

Habitat

Wetted areas
1m or shallower
1/3 m/s or slower

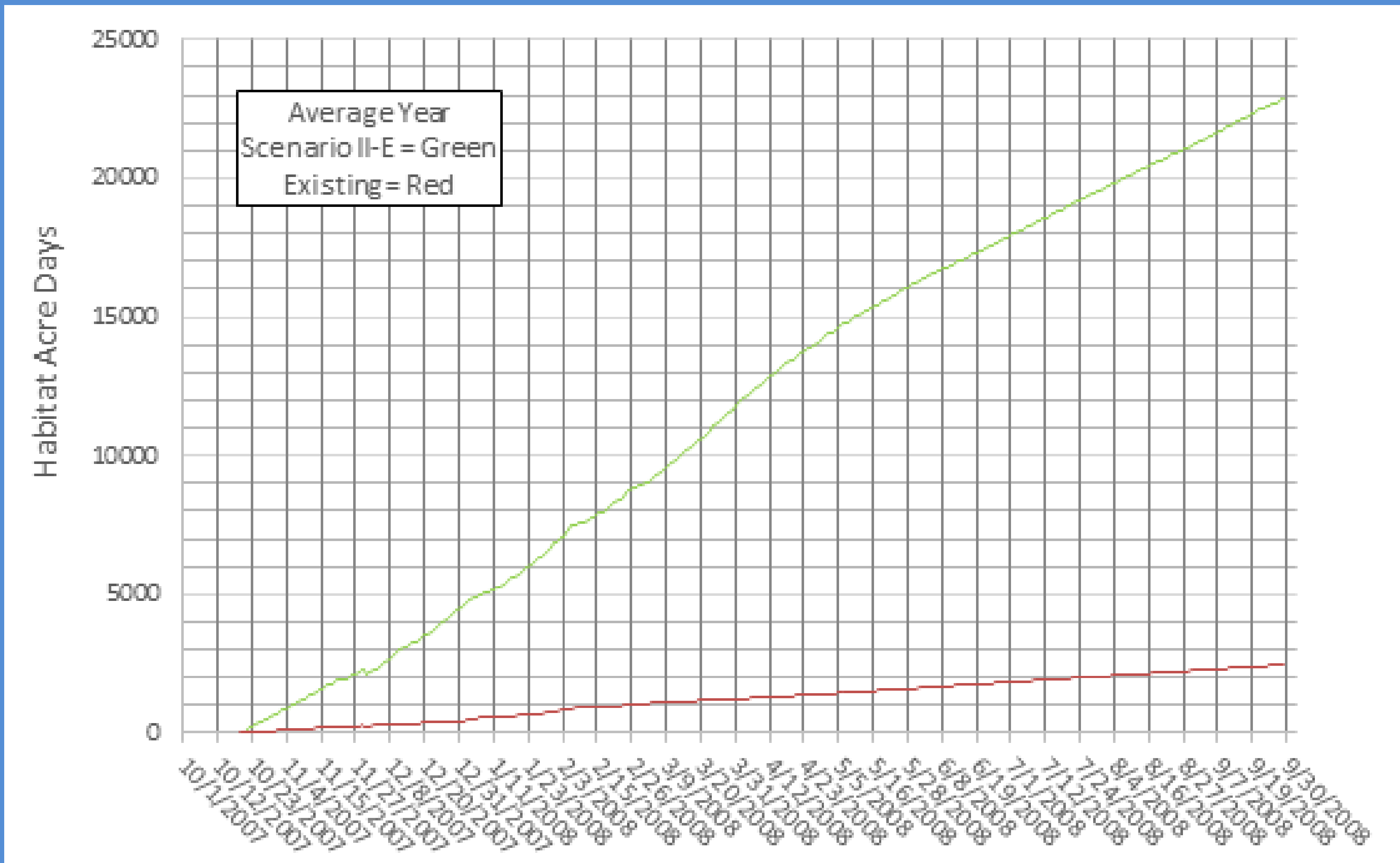


Figure 8.12. Cumulative juvenile rearing habitat for an average water year.

The feasibility study determined that the preferred alternative is feasible and accomplishes the following project goals and objectives:

1. **Significantly increases salmonid spawning habitat**, and increases shallow off-channel calm water winter and spring nursery, rearing, and refuge habitat for salmonids by an order of magnitude.

2. **Makes a significant contribution to recovery** of the federally- and state-listed Central California Coho salmon population, and federally listed California Coastal Chinook salmon, and Central California Coast steelhead populations; Also provides population level benefits for multiple federally- or state-listed Species of Special Concern.

3. **Halts ongoing river bed degradation** and scour by significantly reducing Middle Reach river flood elevations and water velocities, thus minimizing the erosive scour potential which has resulted in ongoing channel bed incision and destabilization of banks during high flow events.

4. **Improves onsite and downstream water quality** by eliminating the artificial open water ponds, and by restoring annual seasonal floodplain sediment deposition to the reach.

5. **Stimulates ecosystem productivity** by restoring the natural seasonal floodplain pulse-flow dynamics of the valley, and increases aquifer recharge by restoring extensive annual floodplain inundation for significant durations in the winter and spring.

6. **Enhances overall ecosystem function** by restoring connectivity between the river channel and off-channel floodplain shallow water habitats, and seasonal aquatic ecotone interactions with riparian and upland habitats.

7. **Promotes recovery of native flora and fauna** by restoring the natural seasonal variability of floodplain and river channel habitat complexity, and the natural seasonal heterogeneity and connections of off-channel aquatic habitats under which native species have evolved and flourished.

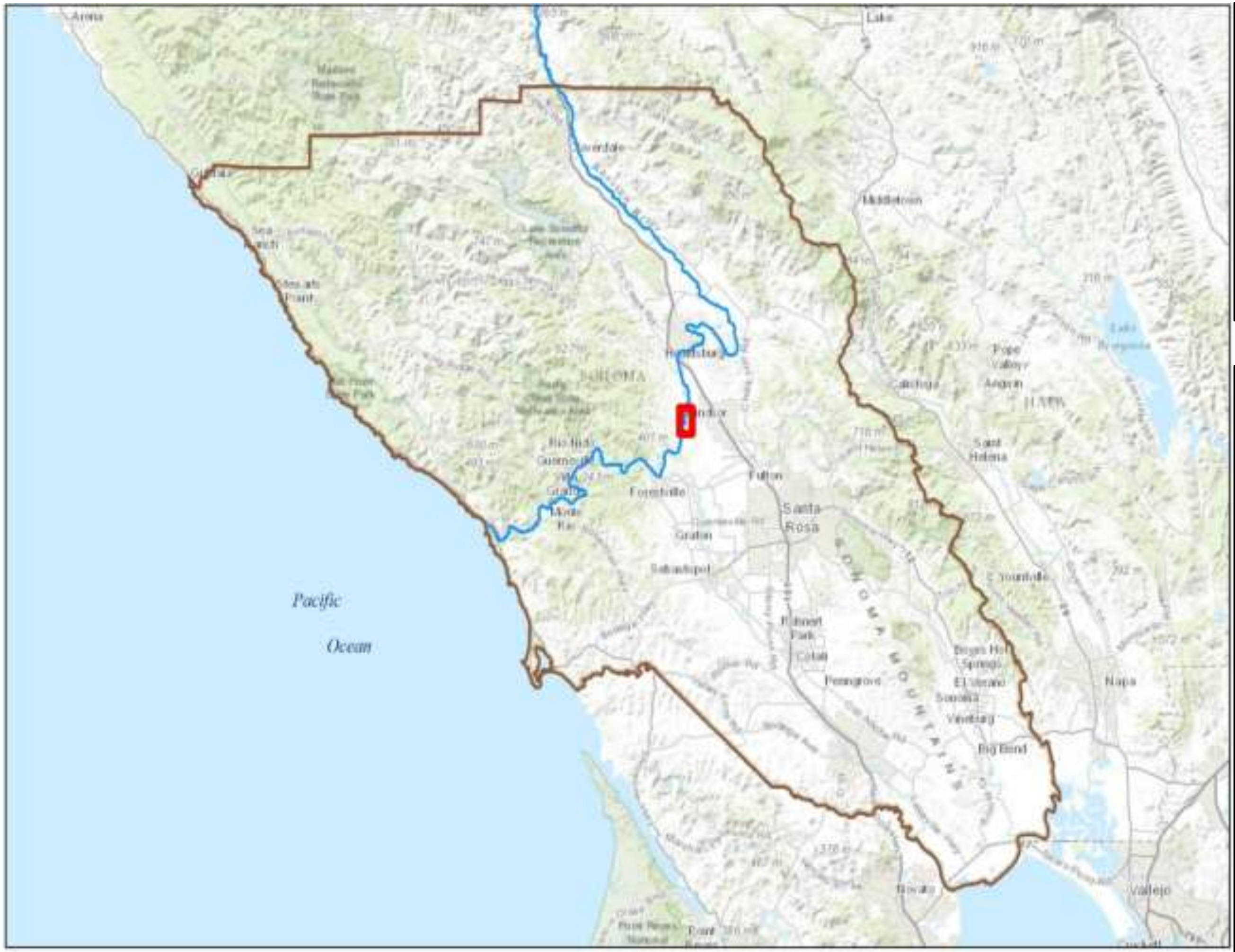
8. **Restores the structure and function of the riparian corridor** by restoring the landforms necessary for establishing a natural riparian vegetation progression from aquatic beds to mature seral stage upland riparian forests.

9. **Significantly reduces production of non-native fish populations** that prey on native fish species by eliminating the warm water habitats favored by the predators.

10. **Presents an ecologically superior, eminently feasible, and exemplary alternative to typical SMARA reclamation plans**, thus providing a science-based rationale to promote the use of SMARA to accomplish ecological restoration goals.

11. **Provides recreational and environmental education opportunities** compatible with ecosystem restoration.

Chapter 10
Conceptual Design Sheets



Conceptual Design – Plan Sheets Hanson Russian River Ponds, Floodplain Restoration Project

Pages:

1. Cover
2. Property Boundaries
3. Existing Land Cover and Property Lines
4. Existing Conditions Topography
5. Existing Conditions and Floodplain Scenario 2-E Topography
6. Scenario 2-E Topography
7. Existing Land Cover and Primary Vegetation Zones
8. Scenario 2-E Proposed Vegetation Zones
9. Generalized Cut and Fill
10. Cut and Fill Volumes
11. Topographic and Hydraulic Cross-sections for flow of 1421 cms
12. Topographic and Hydraulic Profiles
13. Habitat Considerations / Design Notes

Sheet # 1 of 13	*Title:* **Sonoma County and Hanson Project location**	*Date Drawn:* July 13, 2015
Project: **Hanson Russian River Ponds Floodplain Restoration Feasibility Study**	*Scale:*	*Drawn by:* C. Gavette
Location: **Near Windsor, Sonoma County**	*Prepared for:* **California Coastal Conservancy & Sonoma County Permit and Resource Management Department**	*Checked by:*

Hanson Parcels

White Lines Parcels

Project Boundary

0 250
meters

Sheet # 2 of 13	*Title:* **Property Boundary Map**	*Date Drawn:* July 13, 2015	
Project: **Hanson Russian River Ponds Floodplain Restoration Feasibility Study**	*Scale:* **1 centimeter = 65 meters**	*Drawn by:* C. Gavette	
Location: **Near Windsor, Sonoma County**	*Prepared for:* **California Coastal Conservancy & Sonoma County Permit and Resource Management Department**	*Checked by:* B. Cluer	

EHC

NOAA FISHERIES

Hanson

Hanson Parcels

White Lines Parcels

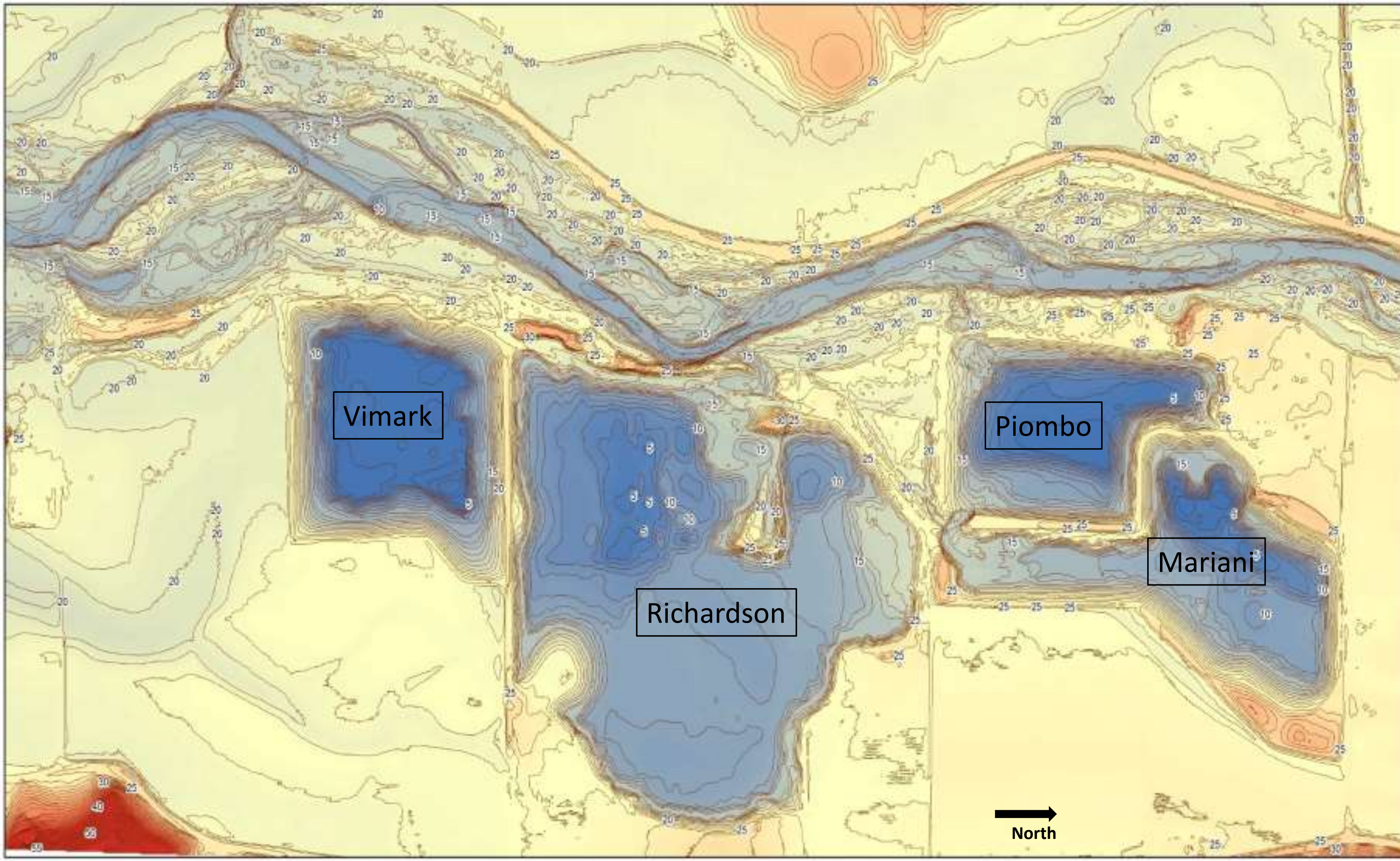
0 250 meters

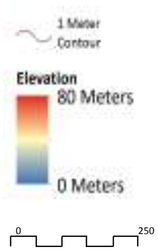
Sheet # 3 of 13	*Title:* **Existing Land Cover and Hanson Property Lines**	*Date Drawn:* July 13, 2015
Project: **Hanson Russian River Ponds Floodplain Restoration Feasibility Study**	*Scale:* **1 centimeter = 65 meters**	*Drawn by:* C. Gavette
Location: **Near Windsor, Sonoma County**	*Prepared for:* **California Coastal Conservancy & Sonoma County Permit and Resource Management Department**	*Checked by:* B. Cluer

EHC

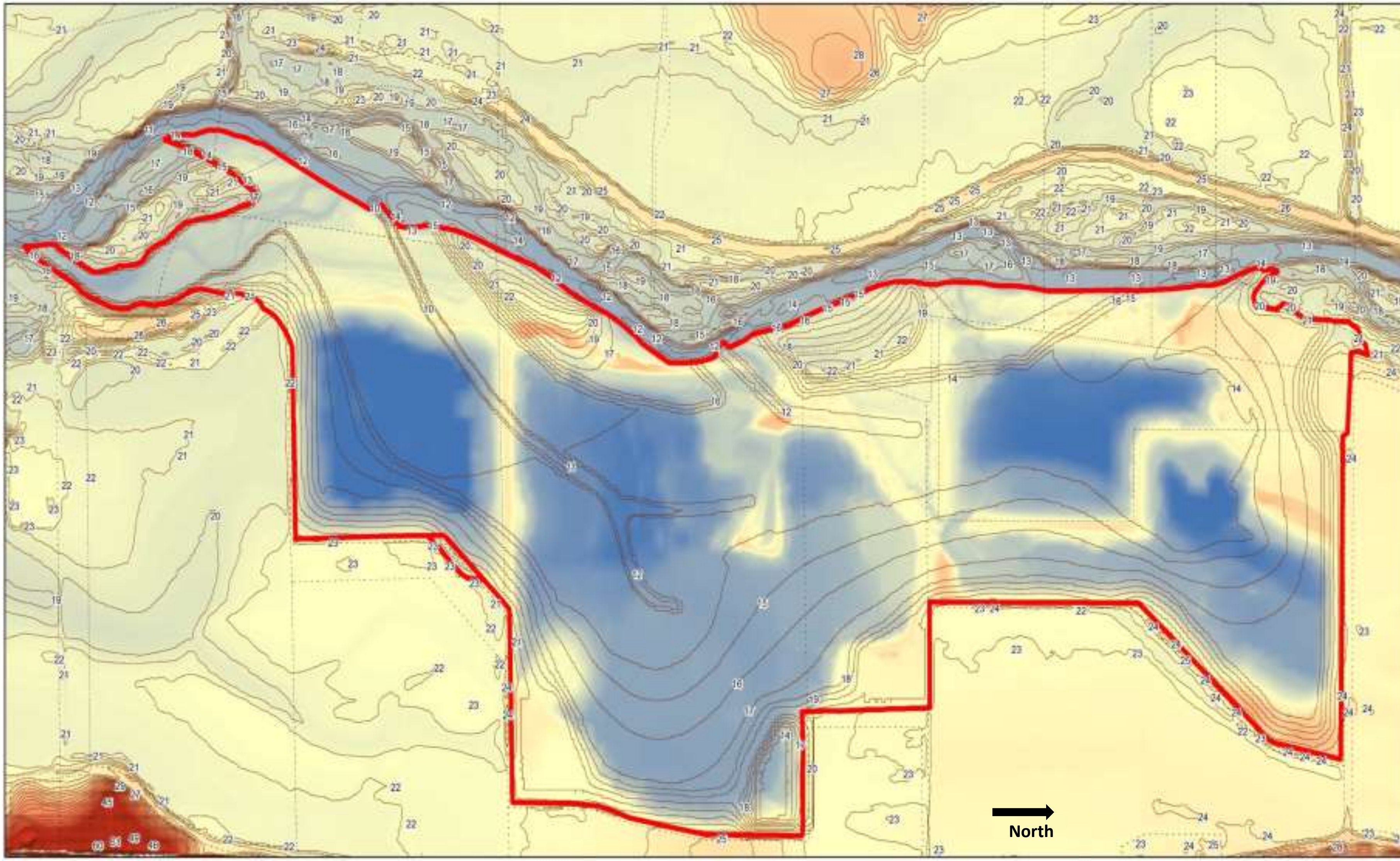
NOAA FISHERIES

Hanson



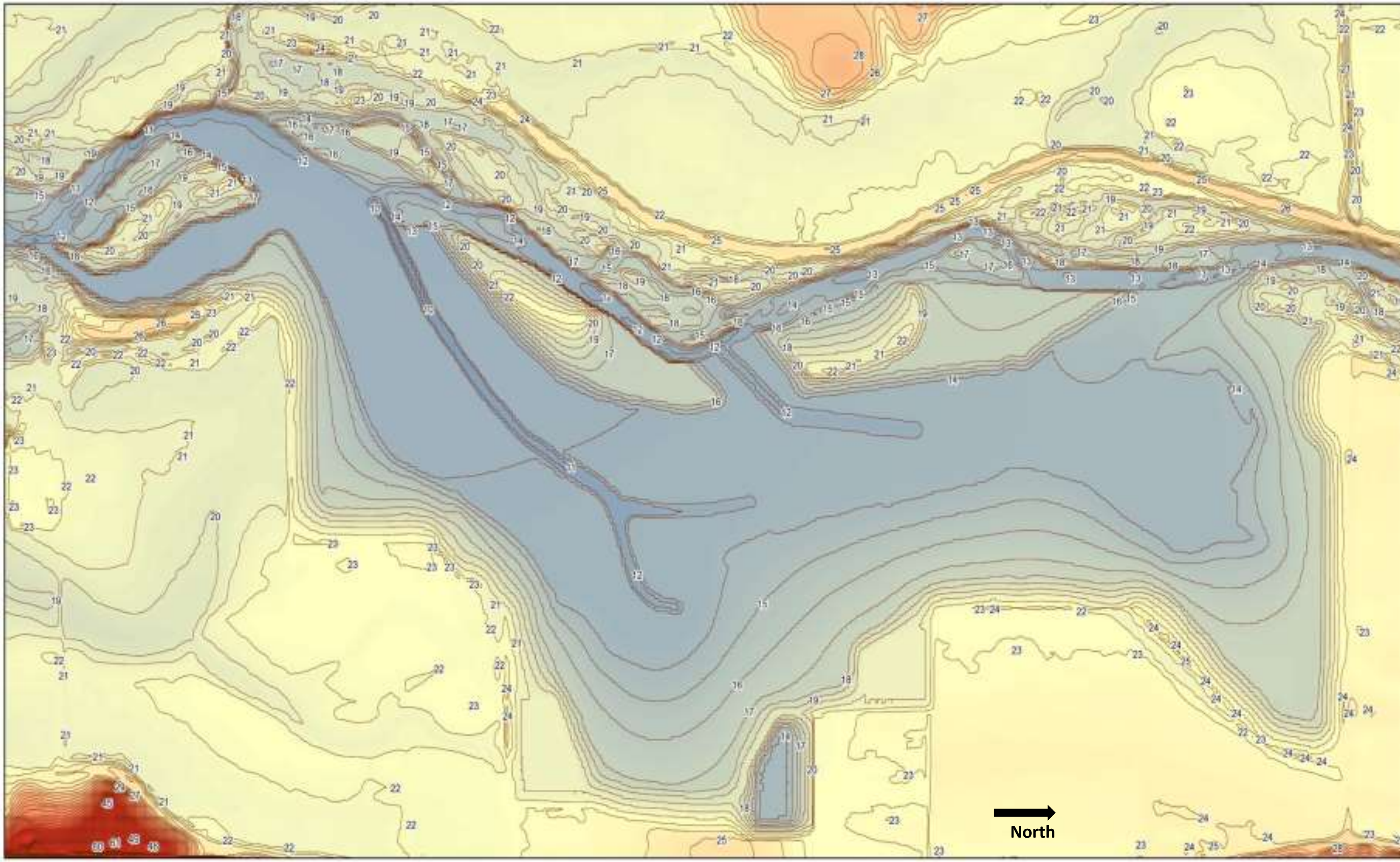


Sheet # 4 of 13	*Title:* **Existing Conditions Topography**	*Date Drawn:* July 13, 2015
Project: **Hanson Russian River Ponds Floodplain Restoration Feasibility Study**	*Scale:* **1 centimeter = 65 meters**	*Drawn by:* C. Gavette
Location: **Near Windsor, Sonoma County**	*Prepared for:* **California Coastal Conservancy & Sonoma County Permit and Resource Management Department**	*Checked by:* B. Cluer



1 Meter Contour
Parcels
Project Boundary
Elevation
80 Meters
0 Meters
0 250
meters

Sheet # 5 of 13	*Title:* **Existing Conditions with Concept E Topography**	*Date Drawn:* July 13, 2015
Project: **Hanson Russian River Ponds Floodplain Restoration Feasibility Study**	*Scale:* **1 centimeter = 65 meters**	*Drawn by:* C. Gavette
Location: **Near Windsor, Sonoma County**	*Prepared for:* **California Coastal Conservancy & Sonoma County Permit and Resource Management Department**	*Checked by:* B. Cluer



1 Meter Contour

Elevation

80 Meters

0 Meters

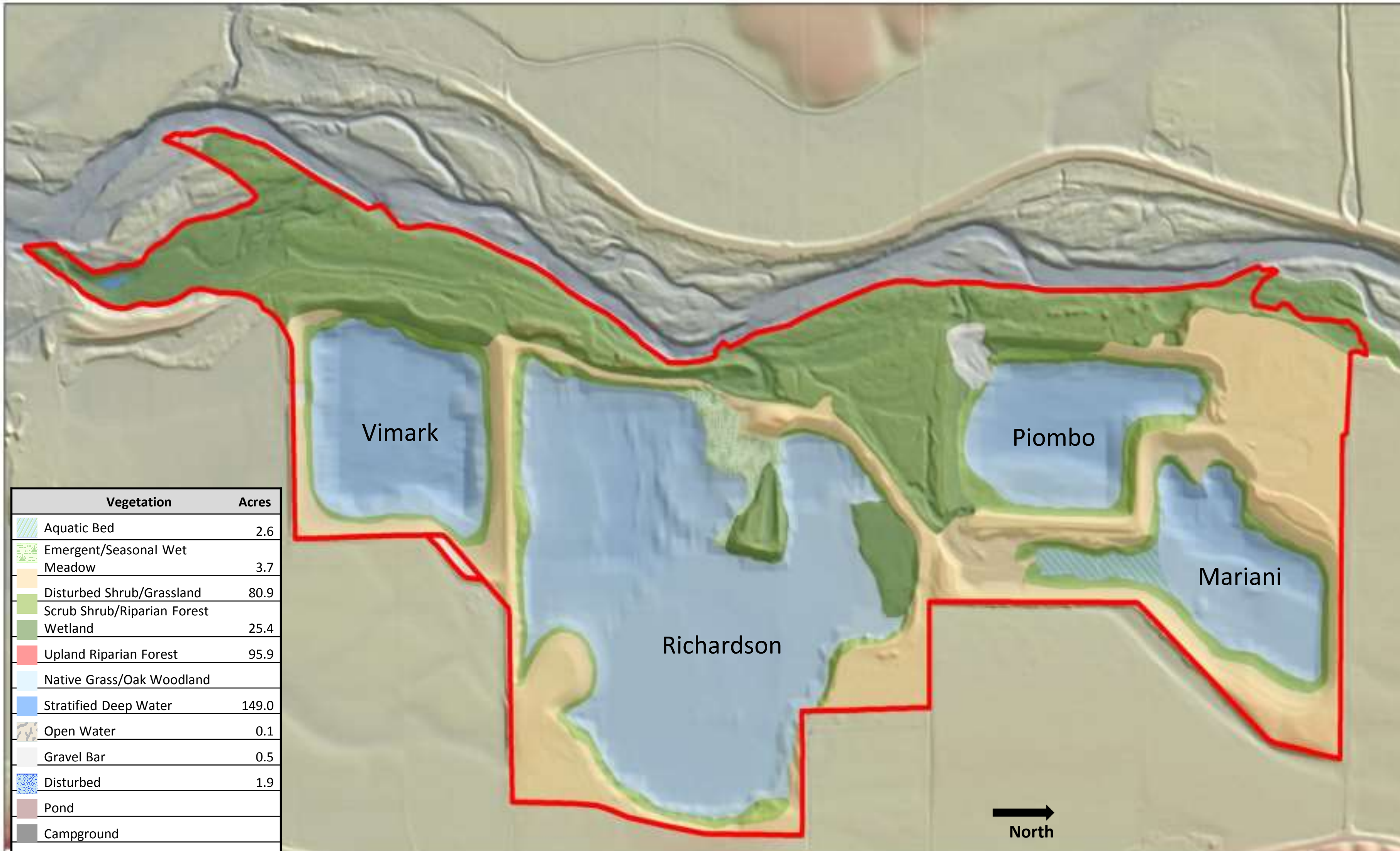
0 250 meters

Sheet # 6 of 13	*Title:* **Stage II-E Topography**	*Date Drawn:* July 13, 2015
Project: **Hanson Russian River Ponds Floodplain Restoration Feasibility Study**	*Scale:* **1 centimeter = 65 meters**	*Drawn by:* C. Gavette
Location: **Near Windsor, Sonoma County**	*Prepared for:* **California Coastal Conservancy & Sonoma County Permit and Resource Management Department**	*Checked by:* B. Cluer

EHC

NOAA FISHERIES

Hanson



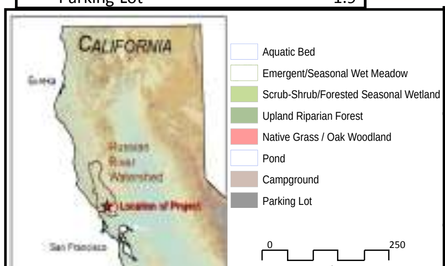
Vegetation	Acres
Aquatic Bed	2.6
Emergent/Seasonal Wet Meadow	3.7
Disturbed Shrub/Grassland	80.9
Scrub Shrub/Riparian Forest Wetland	25.4
Upland Riparian Forest	95.9
Native Grass/Oak Woodland	
Stratified Deep Water	149.0
Open Water	0.1
Gravel Bar	0.5
Disturbed	1.9
Pond	
Campground	
Parking Lot	

Aquatic Bed
Emergent/Seasonal Wet Meadow
Disturbed Shrub/Grassland
Scrub Shrub/Riparian Forest Wetland
Upland Riparian Forest
Stratified Deep Water
Open Water
Gravel Bar
Disturbed

0 250
meters

Sheet # 7 of 13	*Title:* **Existing Land Cover and Primary Vegetation Zones**	*Date Drawn:* July 13, 2015
Project: **Hanson Russian River Ponds Floodplain Restoration Feasibility Study**	*Scale:* **1 centimeter = 65 meters**	*Drawn by:* C. Gavette
Location: **Near Windsor, Sonoma County**	*Prepared for:* **California Coastal Conservancy & Sonoma County Permit and Resource Management Department**	*Checked by:* B. Cluer

Vegetation	Acres
Aquatic Bed	10.1
Emergent/Seasonal Wet Meadow	42.3
Disturbed Shrub/Grassland	
Scrub Shrub/Riparian Forest Wetland	140.8
Upland Riparian Forest	129.4
Native Grass/Oak Woodland	25.6
Stratified Deep Water	
Open Water	
Gravel Bar	
Disturbed	
Pond	4.8
Campground	4.9
Parking Lot	1.9



Sheet # 8 of 13

Project: **Hanson Russian River Ponds Floodplain Restoration Feasibility Study**

Location: **Near Windsor, Sonoma County**

Title: **Proposed Vegetation Zones and Land Features**

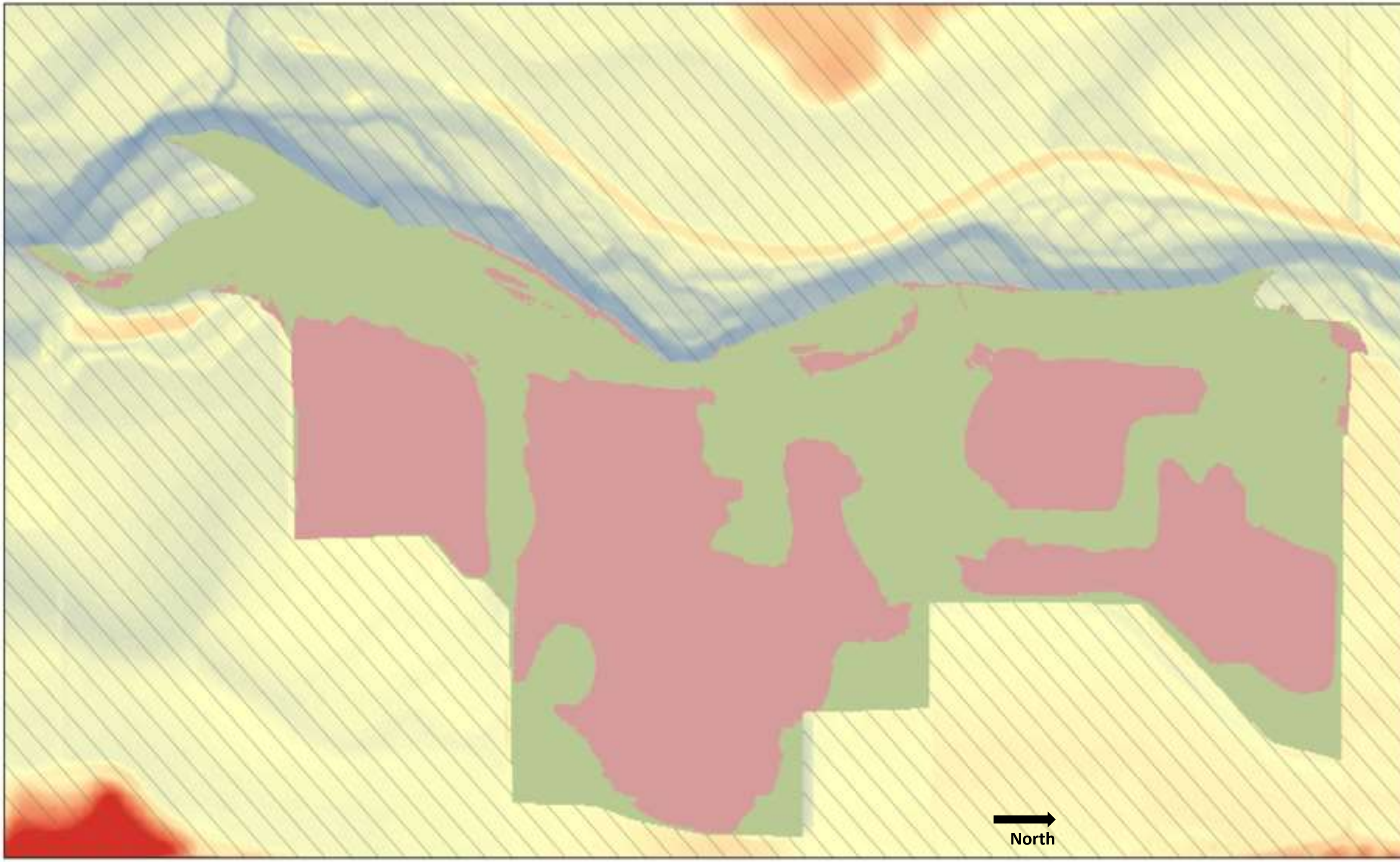
Scale: **1 centimeter = 65 meters**

Prepared for: **California Coastal Conservancy & Sonoma County Permit and Resource Management Department**

Date Drawn: July 13, 2015

Drawn by: C. Gavette

Checked by: B. Cluer



Material Cut / Fill

- Area of Fill
- Unchanged
- Area of Cut

0 250
meters

Sheet # 9 of 13

Title: **Generalized Material Cut / Fill**
Cut: 3,562,219 m^3 Fill: 3,569,880 m^3

Date Drawn:
July 13, 2015

Project: **Hanson Russian River Ponds Floodplain Restoration Feasibility Study**

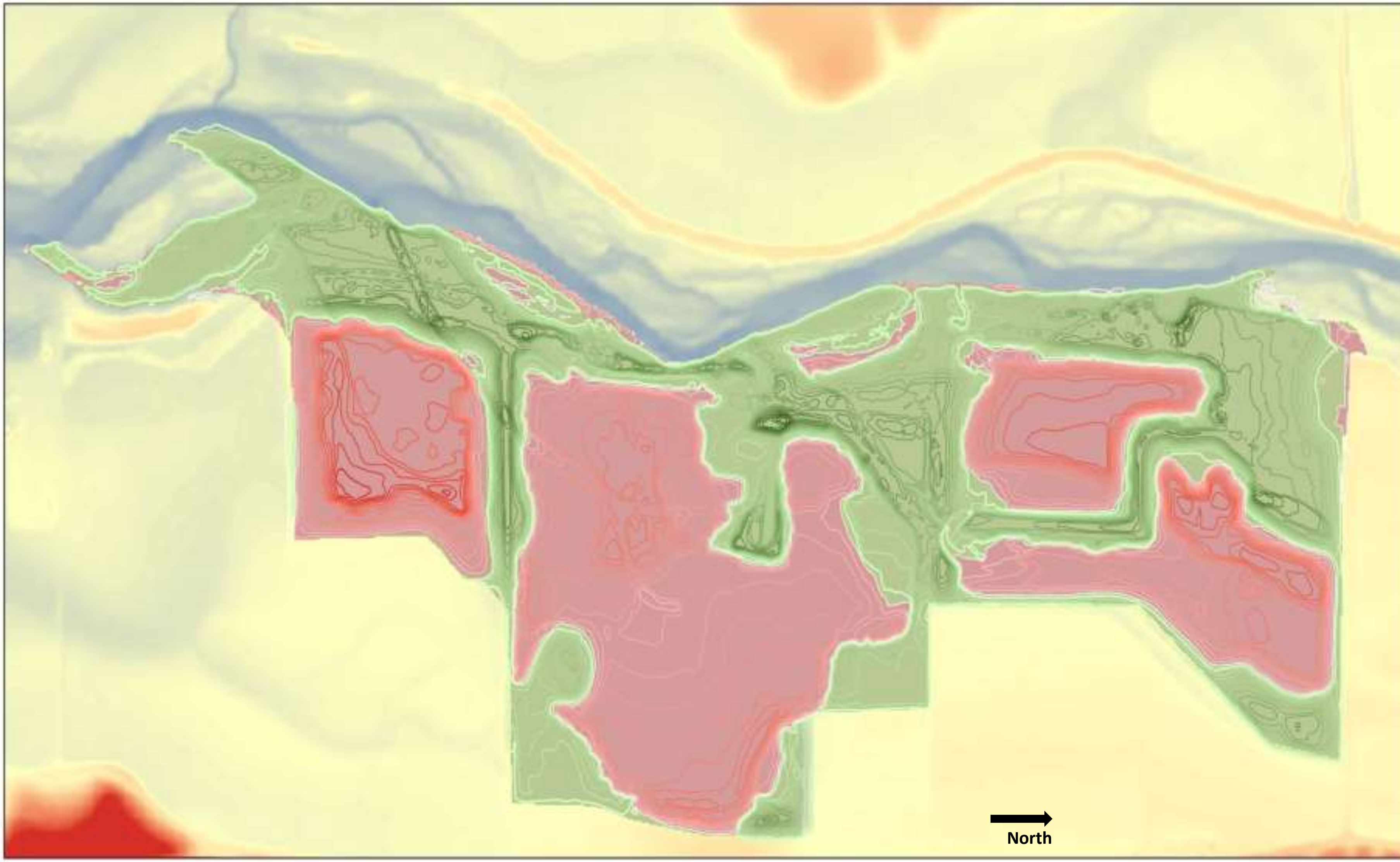
Scale:
1 centimeter = 65 meters

Drawn by:
C. Gavette

Location: **Near Windsor, Sonoma County**

Prepared for: **California Coastal Conservancy & Sonoma County Permit and Resource Management Department**

Checked by:
B. Cluer



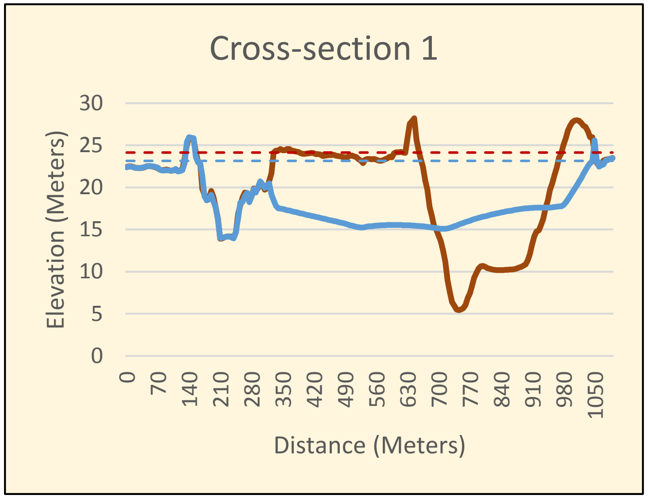
Change Contours

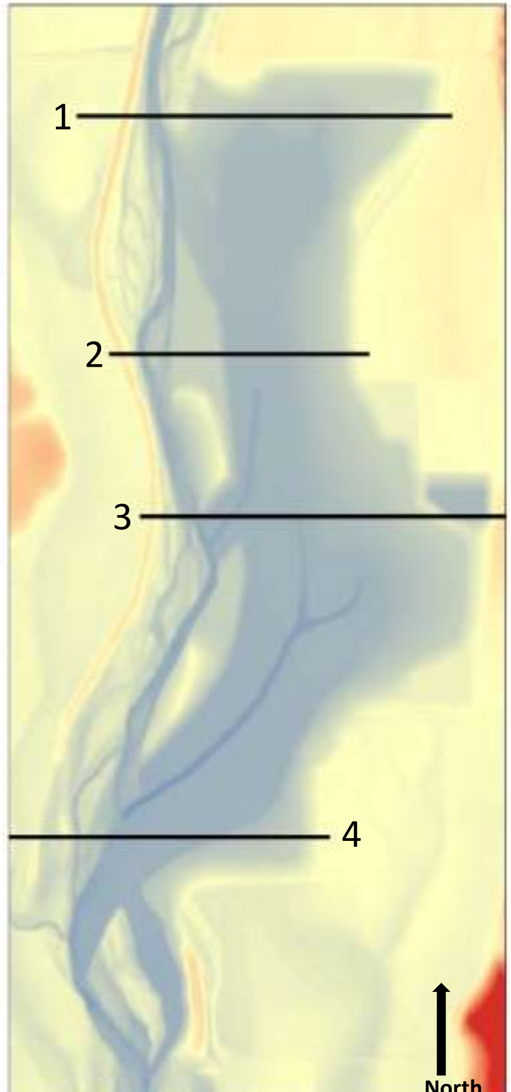
Increase in Elevation — 14 Meters

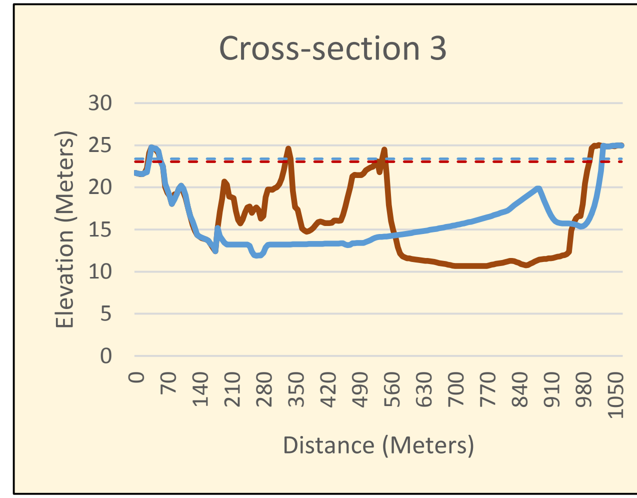
Decrease in Elevation — -17 Meters

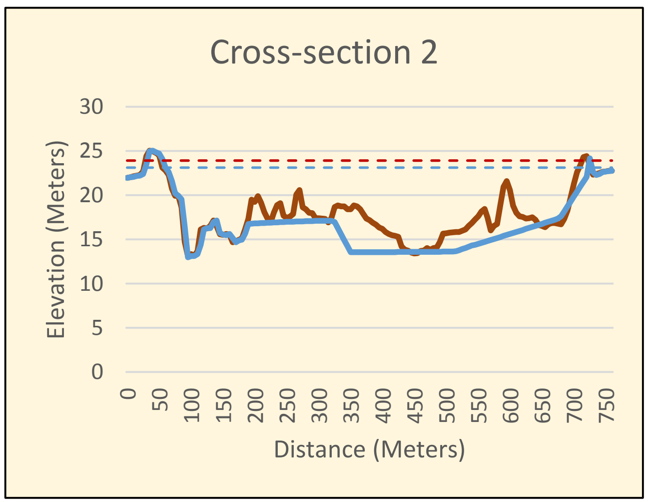
0 — 250 meters

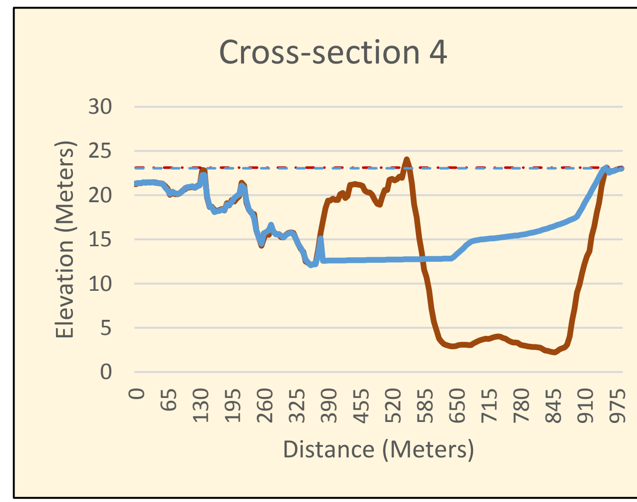
Sheet # 10 of 13	*Title:* **Material Cut / Fill with Change Contours**	*Date Drawn:* July 13, 2015
Project: **Hanson Russian River Ponds Floodplain Restoration Feasibility Study**	*Scale:* **1 centimeter = 65 meters**	*Drawn by:* C. Gavette
Location: **Near Windsor, Sonoma County**	*Prepared for:* **California Coastal Conservancy & Sonoma County Permit and Resource Management Department**	*Checked by:* B. Cluer





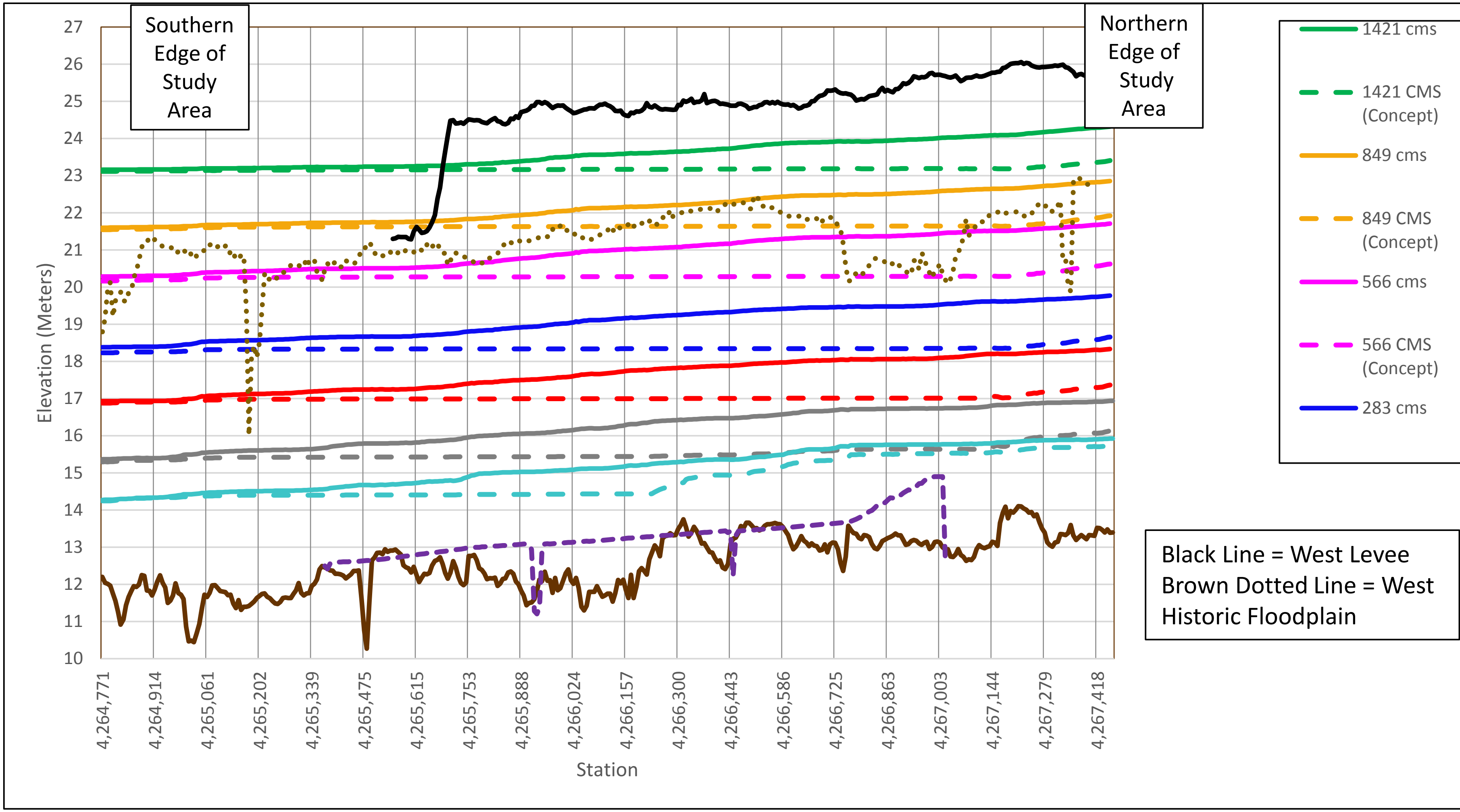






Existing
Concept E
WSE Existing
WSE Concept E
Flow = 1421 cms

Sheet # 11 of 13	*Title:* **Topographic and Hydraulic Cross-sections for 100-year flow 1421 cms**	*Date Drawn:* July 13, 2015
Project: **Hanson Russian River Ponds Floodplain Restoration Feasibility Study**	*Scale:*	*Drawn by:* C. Gavette
Location: **Near Windsor, Sonoma County**	*Prepared for:* **California Coastal Conservancy & Sonoma County Permit and Resource Management Department**	*Checked by:* B. Cluer



Thalweg Profile

Floodplain Profile

Sheet # 12 of 13	*Title:* **Topographic and Hydraulic Profiles for the Project Area**	*Date Drawn:* July 13, 2015
Project: **Hanson Russian River Ponds Floodplain Restoration Feasibility Study**	*Scale:*	*Drawn by:* C. Gavette
Location: **Near Windsor, Sonoma County**	*Prepared for:* **California Coastal Conservancy & Sonoma County Permit and Resource Management Department**	*Checked by:* B. Cluer

Design notes:

1. Sort earth materials, for placing porous fill in ponds, soil on vegetation slopes, gravel in swales for groundwater upwelling, silt-clay for new water storage pond, etc.
2. Macro topographic features graded during construction to immediately improve habitat function.
3. Rim trail incorporated in 1:10 outside slope.
4. Salvage existing vegetation in those zones where grading is within +1 and -1 meter cut/fill of the existing surface.
5. Retain woody debris grubbed from site for incorporation into surfaces and shallow burial habitat features.
6. Willow salvaged and kept alive for incorporating into new banks and macro habitat features such as debris piles, island head, etc.
7. Vegetation management to include control of non-native species, advance planting of desirable natives, particularly aquatic beds.

Sheet # 13 of 13	*Title:* **Habitat Features – Typical & Design Considerations**	*Date Drawn:* Sept 30, 2015
Project: **Hanson Ponds Russian River Floodplain Restoration Feasibility Study**	*Scale:*	*Drawn by:*
Location: **Near Windsor, Sonoma County**	*Prepared for:* **California Coastal Conservancy & Sonoma County Permit and Resource Management Department**	*Checked by:*