Continuing Authorities Program
DRAFT Detailed Project Report with Integrated Environmental Assessment

Dry Creek Ecosystem Restoration, CAP 1135
Sonoma County, California

US Army
Corps of Engineers
San Francisco District

30 January 2017

EXECUTIVE SUMMARY

Purpose. This Detailed Project Report (DPR) with integrated Environmental Assessment is prepared under the authority of Section 1135 of the Water Resources Development Act (WRDA) of 1986, as amended, in response to a request for Federal assistance from assistance from the Sonoma County Water Agency (SCWA) for an ecosystem restoration project.

Project Location. The project is located in the Dry Creek watershed in the interior coast range of northern Sonoma County, approximately 30 miles from the Pacific Ocean and 60 miles north of San Francisco Bay. The Section 1135 Ecosystem Restoration Project is located along the approximately 14 miles of Dry Creek that meanders downstream of Warm Springs Dam (WSD) to its confluence with the Russian River near the City of Healdsburg (referred to as lower Dry Creek).

Background. The U.S. Army Corps of Engineers (Corps) constructed the WSD in 1983 to provide flood control, water storage, and outdoor recreation. During summer months, the WSD water supply releases into Dry Creek cause higher water levels at higher velocities than would naturally occur in summer. During the winter, WSD flood risk management operations reduce channel forming flows. The altered hydrology resulting from WSD regulation of stream flow on Dry Creek has, therefore, created ideal conditions for riparian vegetation overgrowth while failing to provide large enough flood events to erode vegetated bars and expose bare surfaces for primary vegetation succession. The combination of altered hydrology caused by the dam's regulation of the stream and vegetation growth patterns has curtailed the fluvial processes which would otherwise create complex channel and floodplain habitats. Without these fluvial processes, the creation of stream habitats such as alcoves, backwaters, and side channels that are important for all life stages of salmonids and other native fish and wildlife specis has been severely limited below the dam (Inter-Fluve 2011).

The construction and operation of the dam also directly resulted in the loss of upstream spawning and rearing habitat for the Russian River salmonids. Between 1995 and 1999, the three species of salmonids native to the Russian River watershed were listed under the Endangered Species Act (ESA) as threatened or endangered, including the endangered Central California Coast (CCC) coho salmon (*Oncorhynchus kisutch*) and the threatened California Coastal (CC) Chinook salmon (*O. tshawytscha*) and CCC steelhead (*O. mykiss*). Since this time, the Corps has been involved in many programs and partnerships aimed at restoring salmonid populations. A September 24, 2008 Biological Opinion issued by the National Oceanic and Atmospheric Administration (NOAA) requires that the Corps and SCWA perform various Reasonable and Prudent Alternatives to save threatened salmonid species in the Russian River Watershed. These include the enhancement of six miles of Dry

Creek between WSD and its confluence with the Russian River to provide near ideal summer rearing conditions for coho and steelhead.

While the 2008 BO is taken into consideration, the Federal objective for ecosystem restoration projects is to maximize net NER benefits. Further, Section 1135 Ecosystem Restoration Projects must not conflict with the authorized purposes of the existing project. The plan formulation process for this study identified the water and related land resources problems and opportunities in the study area and built on that foundation to develop planning objectives, constraints, measures and alternatives.

Project Goals and Objectives. The overall project goal is to restore the quality, complexity, and diversity of habitat along lower Dry Creek by restoring instream and floodplain and channel habitat complexity, riparian vegetation diversity, and productive backwater habitat by reconnecting Dry Creek to available floodplain. The following objectives will achieve this goal:

- Restoring and enhancing stream channel and floodplain complexity to benefit aquatic species along Dry Creek's mainstem.
- Restoring lateral and longitudinal instream-floodplain connectivity through side channels, backwaters, and lowered floodplain terraces along Dry Creek's mainstem
- Restoring high quality instream and floodplain habitat conditions along areas of Dry Creek's mainstem to benefit listed salmonid species throughout their life cycle
- Reducing non-native vegetation and increasing native riparian vegetation successional complexity in order to promote habitat diversity for riparian wildlife, to provide food and cover for aquatic wildlife, and to shade the river along Dry Creek's mainstem.

Alternatives Considered. Five action alternatives were considered in detail in addition to the no-action alternative. The considered action alternatives all address reconnecting the floodplain and increasing channel and floodplain complexity within various subreaches along the approximately 14 mile length of lower Dry Creek below WSD. The alternatives were evaluated and compared utilizing qualitative and quantitative screening criteria.

Cost Effectiveness and Incremental Cost Analysis. The benefits of these five alternatives were also evaluated using the US Fish and Wildlife Service's (USFWS) Habitat Evaluation Procedures (HEP) with a Habitat Suitability Index (HSI) for coho salmon. Each alternative's net annual benefits were combined with annualized cost estimates to determine their Cost Effectiveness using IWR Planning Suite software. The table below summarizes the

Incremental Cost Analysis results that identified the Best Buy alternatives, which are highlighted in blue.

Table ES- 1 Summary of Cost Effectiveness and Incremental Cost Analysis.

Alternative		Ave Annual Habitat Units (AAHU) (Square Feet)	Ave Annual Habitat Units (AAHU) (Acres)	Alternative Tototal cost, including contingency (1,000s)	Total Present Value Cost (1,000s)	Average Annual Cost (1,000s)	Average Annual Cost/AAHU (1,000s/acre)
1	**No Action**	0	0.00	$0	$0	$0.0	$0.0
2	**4a**	107,822	2.48	$3,710	$6,322	$240.0	$96.9
3	**14a**	43,616	1.00	$5,220	$5,220	$198.1	$197.8
4	**14b**	16,155	0.37	$2,720	$2,720	$103.2	$278.3
5	**4a, 14a**	151,438	3.48	$7,940	$11,542	$438.0	$126.0
6	**14a,14b**	59,771	1.37	$8,920	$7,940	$301.3	$219.6

Tentatively Selected Plan (TSP). Alternative 2 is the TSP. It is the Natinoal Evironmental Restoration (NER) plan that reasonably maximizes ecosystem restoration benefits compared to costs, considering the cost effectiveness and incremental cost of implementing other restoration options. Alterative 2 is efficient, acceptable, complete and is effective in meeting project objectives by increasing habitat complexity and connectivity, decreases invasive plant species, restoring riparian vegetation diversity, and restoring high quality instream and floodplain habitat conditions to benefit listed salmonid species throughout their life cycle.

The TSP consists of the construction of a combination of both off-channel and main channel habitat. in subreaches 4a a. Subreach 4a extends approximately 1700 feet upstream from River Mile 3. Off-channel restoration features include the creation of a side channel on both sides of Dry Creek. Each side channel will have an associated backwater alcove. The side channel proposed on the right bank is approximately twice as long as the one on the left bank and includes two mid channel connections to the mainstem. The subreach design also includes large woody debris (LWD) structures of varying sizes and complexities in the off channel features and the main channel as well as pool restoration, constructed riffles, and bolder fields in the main channel.

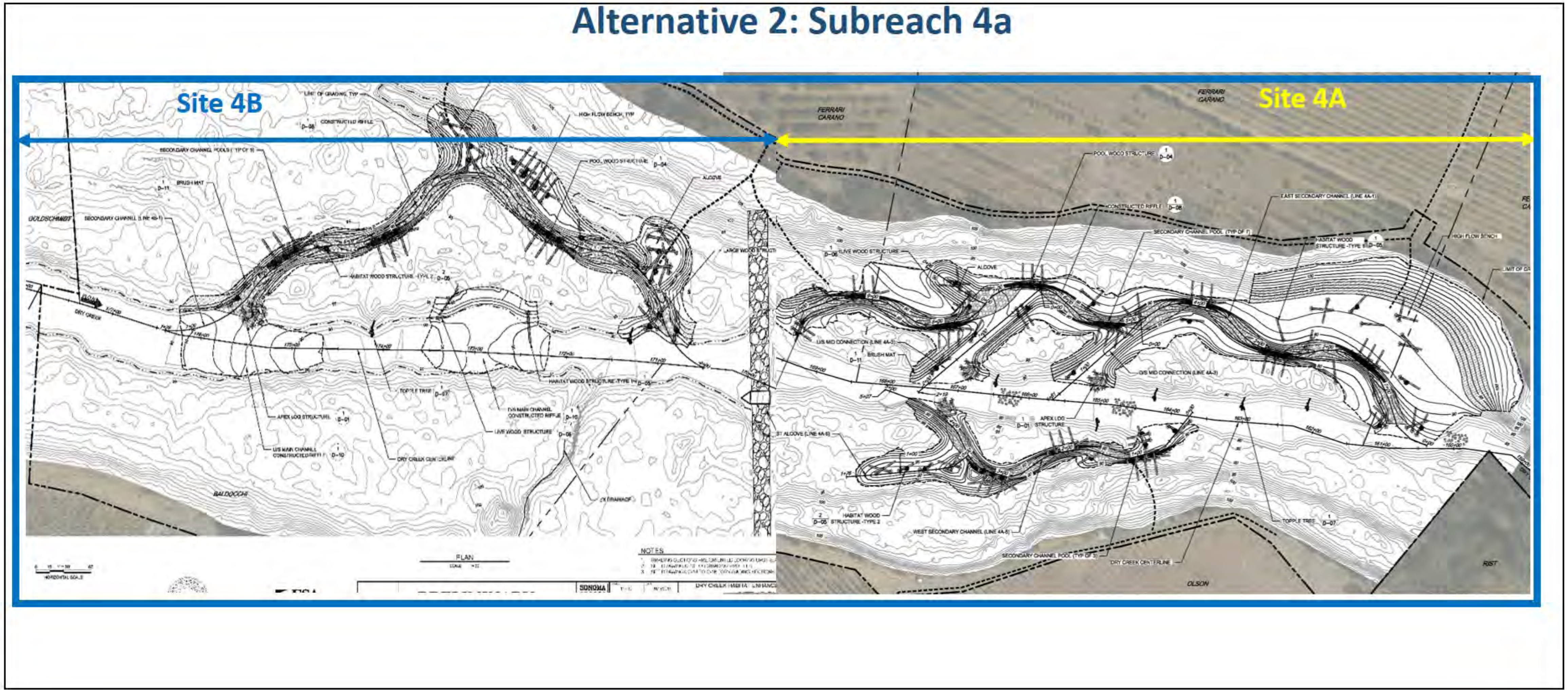

Figure ES- 1 Alternative 2, Tentatively Selected Plan.

P**roject Costs and benefits.** The fully funded cost for the tentatively selected plan, including inflation, is $7,605,546. The total project cost would be cost-shared 75/25, Federal/non-Federal. The Federal share is $5,354,160. The non-Federal share is $2,251,387. Of the total cost, the lands, easements and right-of-ways (LERRDS) costs are approximately $830,546, of which $755,546 is a non-Federal responsobilty and $75,000 is a Federal administration cost. Operation, maintenance, repair, replacement and rehabilitation costs (O&&MRRR) are approximately $662,000, or 25,100 per year. Total monitoring cost are estimated to be $1,560, with monitoring occurring on a 2-year cycle. The total area of available habitat created over the life of the project is 6.1 acres. The total annual NER (average annual habitat unit) are 2.48 at a cost of $96,900 per year per habitat unit.

Findings and Conclusions. Implementation of the Section 1135 Ecosystem Restoration Project proposed at the Dry Creek project will result in positive benefits to the environment by restoring ecosystem structure and function. This will be done through increasing aquatic and floodplain complexity, increasing lateral and longitudinal habitat connectivity, improving habitat listed species, and improving riparian vegetation complexity and diversity.

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(* required by NEPA)

FIGURES

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ACRONYMS

AAHU	Average Annual Habitat Units
ACE	Annual Chance Exceedance
APE	Area of Potential Effect
CAP	Continuing Authorities Program
CC	Central California
CCC	Central California Coast
CCC DPS	Central California Coast Distinct Population Segment
CEQ	Council for Env Quality
cfs	Cubic Feet per Second
CDFW	California Department of Fish and Wildlife
Corps	U.S. Army Corps of Engineers
CRLF	California Red–Legged Frog
CALVEG	Classification and Assessment with Landsat of Visible Ecological Groupings
D1610	Water Right Decision 1610
DEM	Digital Elevation Model
DCFH	Don Clauson Fish Hatchery
DPR	Detailed Project Report
DPR/EA	Detailed Project Report with integrated Environmental Assessment
EA	Environmental Assessment
EFH	Essential fish habitat
EPA	Environmental Protection Agency
ER	Engineering Regulation
ESA	Endangered Species Act
ESU	Evolutionarily Significant Unit
FCSA	Feasibility Cost Sharing Agreement
FONSI	Finding of No Significant Impact
ft	Feet
FY	Fiscal Year
FYLF	Foothill Yellow–Legged Frog
GHG	Green House Gas
GIS	Geographical Information System
HEP	Habitat Evaluation proceedures
HIS	Habitat Suitablity Index
HQUSACE	Head Quarters, United States Army Corps of Engineers
LWD	Large Woody Debris
NAHC	Native American Heritage Commission
NER	National Economic Restoration
NEPA	National Environmental Policy Act

NFS	Non-Federal Sponsor
NMFS	National Marine Fisheries Services
NOAA	National Oceanic and Atmospheric Administration
NTU	Nephelometric turbidity units
NCAB	North Coast Air Basin
APCD	Air Pollution Control District
O&MRRR	Operation, Maintenance, Repair, Replacement and Rehabilitation
P&G	Economic and Environmental Principles and Guidelines for Water and Related Land Resources Implementation Studies
PDT	Project Delivery Team
PED	Pre-Construction, Engineering, and Design
PGM	Project Guidance Memorandum
PM	Particulate Matter
PPFC	Public Policy Facilitating Committee
RWMG	Regional Water Management Group
RRIFR	Russian River Instream Flow and Restoration
SCWA	Sonoma County Water Agency
SPD	South Pacific Division
SPN	San Francisco District
SWRCB	State Water Resources Control Board
TMDLs	Total Maximum Daily Loads
TSP	Tentatively Selected Plan
USACE	United States Army Corps of Engineers
USFWS	United States Fish and Wildlife Service
USGS	United State Geological Survey
WRDA	Water Resources Development Act
WSD	Warm Springs Dam

1. INTRODUCTION

1.1. STUDY PURPOSE

The purpose of this Section 1135 Program feasibility study is to investigate and recommend cost-effective environmental restoration along Dry Creek. This Detailed Project Report with integrated Environmental Assessment (DPR/EA) addresses only those activities proposed for implementation by the Corps under the Section 1135 Program, not those proposed under the ongoing Dry Creek General Investigation study.

In compliance with the National Environmental Policy Act (NEPA) of 1969 (42 U.S.C. § 4321 *et seq*), as amended, the Council on Environmental Quality (CEQ) Regulations for Implementing the Procedural Provisions of the NEPA (40 C.F.R. §1500-1508), and U.S. Army Corps of Engineers (USACE) Planning Regulations (Engineering Regulation (ER) 200-2-2), an EA is integrated into this DPR. Sections marked with asterisk (*) next to their title are denoted to assist readers in identifying information that would commonly be provided as part of a standalone NEPA EA.

1.2. STUDY AUTHORIZATION*

This feasibility study is being conducted under authority of the Section 1135 Continuing of the Water Resources Development Act (WRDA) of 1986 (Public Law (PL) 99-662). The objective of this authority is to improve the quality of the environment through modification of the structures or operations of existing water resources projects constructed by the U.S. Army Corps of Engineers (Corps), providing modifications that are feasible and consistent with the original project purpose. Improvements in ecosystem structure and function in areas adversely affected by such projects are also included in the Study. The WRDA of 1986 (P.L. 99-662) states:

> *The Secretary of the Army is authorized to modify the structures and operations of water resources projects constructed by the Corps to improve the quality of the environment consistent with authorized purposes; and to undertake measures for restoration of environmental quality where the construction or operation of a water resources project built by the Corps has contributed to the degradation of the quality of the environment and such measures do not conflict with the authorized project purposes (Section 1135).*

Constructed in 1983 under the authority of Section 203 of the Flood Control Act of 1962, Pub. L. No. 87-874, WSD has contributed to the degradation of the instream, riparian, and floodplain ecosystem function and values. The WSD was constructed for the purposes of flood risk management, water supply, and recreation. The characteristic pattern of the natural flow regime for Dry Creek prior to operation of the dam (before 1984) was seasonal with the creek running nearly dry each year in the summer and early fall. Flow rates under natural conditions increased three orders of magnitude during the winter. After operation of the dam commenced in 1984, the flow regime changed to a perennial stream with much less variation in flow rates between summer and winter. Summers have consistent base flow while winter peak flows are reduced relative to natural flow conditions. The consistently high velocity base flow in the summer and fall and reduced frequency and intensity of overbank flood flows in the winter have contributed further to the degradation of the instream and riparian ecosystem functions and values in Dry Creek.

The statutory Federal participation limit is $10,000,000 for CAP 1135 projects.

1.3. LEAD FEDERAL AGENCY AND NON-FEDERAL SPONSORS*

The project's Non–Federal Sponsor is the Sonoma County Water Agency (SCWA). The SCWA submitted a letter of support for the Dry Creek CAP 1135 study on January 14, 2014. The study documented herein has been conducted jointly by the Corps (lead Federal agency) and the non-Federal sponsor, SCWA. As the non-Federal sponsor, SCWA contributes 50 percent of the total feasibility study costs in the form of cash or in-kind contributions; a feasibility cost sharing agreement was signed in 2015.

1.4. COOPERATING AGENCIES*

The National Marine Fisheries Service (NMFS), California Department of Fish and Wildlife (CDFW), and USFWS expressed willingness to consider a cooperating agency role; although this role was not formalized, all three agencies remain actively involved in the study.

1.5. STUDY AREA LOCATION*

A principle tributary of the Russian River, the Dry Creek watershed (Figure 1) is located in the interior coast range of northern Sonoma and southern Mendocino counties, approximately 30 miles from the Pacific Ocean and 60 miles north of San Francisco Bay. Dry Creek is 32 miles long and drains 217 square miles of rugged terrain in the southwestern portion of the Russian River Basin. The WSD at River Mile 13.9 divides the rugged terrain and steeper channel of the upper watershed from the relatively flat agricultural valley and lower gradient channel (lower Dry Creek) that is present below the dam (Figure 2).

The study area is located along the 13.9 miles of Dry Creek that meanders downstream of the WSD to its confluence with the Russian River near the City of Healdsburg (referred to as lower Dry Creek-Figure 2). Dry Creek is home to three fish species listed as endangered or threatened under the ESA, including the endangered CCC coho salmon and the threatened CC Chinook salmon and CCC steelhead. Dry Creek also serves as a conduit for water released from Lake Sonoma by the Corps for flood risk management purposes and for fish hatchery operations as well as by the SCWA for water supply and hydropower.

The Study area is located in Sonoma County and situated in the 2nd Congressional District of California, Representative Jared Huffman.

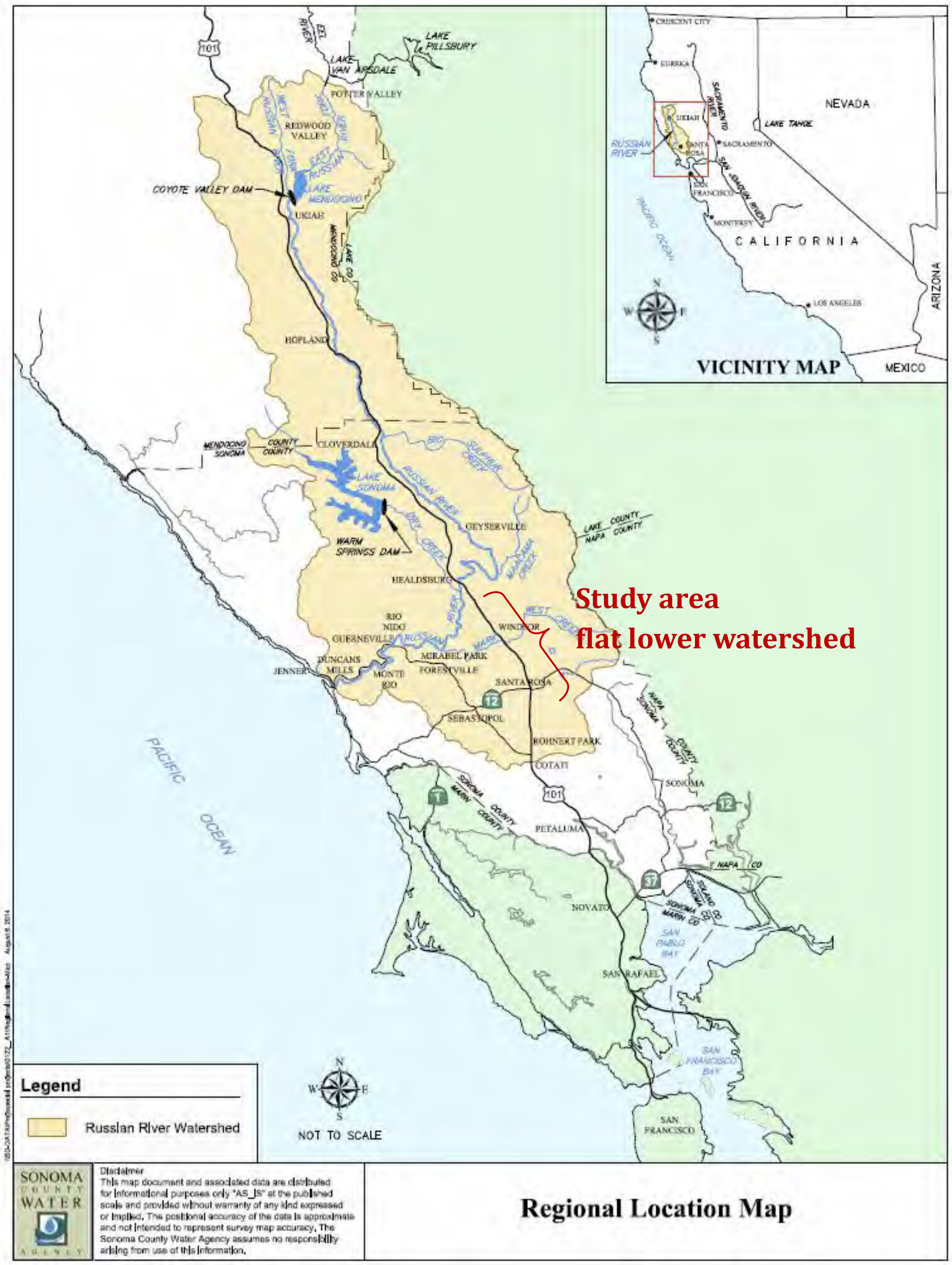


Figure 1. Dry Creek Project Location

Figure 2. Dry Creek Study area

1.6. Background and Related Projects

River systems and their attendant floodplains and riparian woodland communities provide significant resources for both wildlife and humans in the semi-arid western United States. Resilient river systems in the semi-arid west will become increasingly significant under changing climate conditions. Water resource management activities at WSD by Federal agencies and the Sponsor as well as historical and ongoing land use practices including agricultural, mining, and logging practices have significantly altered the hydraulic function and ecological health of Dry Creek and contributed to the degradation of its ecosystem function and values.

Currently, the modified hydrology and sediment regimes of lower Dry Creek diverge substantially from that which had sustained the creek and its attendant floodplains in the pre-development era and created the form and function of the channel corridor present at the time of dam closure. Historically, Dry Creek was a dynamic river system that had a wide braided channel which periodically went dry in the summer and fall. Over the past 150 years, Dry Creek has responded to substantial human-induced hydrologic and geomorphic change. Today, lower Dry Creek represents a highly modified, incised, single thread stream channel with perennial flow.

The present condition of lower Dry Creek expresses the legacy of management in the basin, beginning with the settlement of the valley in the 1850s. Prior to the construction of WSD, 125 years of land use impacts from logging, grazing, agriculture and gravel mining resulted widespread systemic incision. This led to the development of an incised stream system flowing through a narrow active channel zone inset 10 – 30 feet below the adjacent agricultural valley floor. However, near the time of dam closure in 1983, Dry Creek appeared to have reached its maximum level of alteration and had started on a geomorphic recovery trajectory. Based on assessments made near the time of dam closure (Harvey and Schumm 1985), although the channel was still substantially lower than its historic floodplain it had begun to develop complex floodplain features adjacent and accessible to the lowered channel. The construction and operation of WSD changed the course of that trajectory.

WSD's operation creates flood hydrology significantly altered from historical conditions, and is overall consistent with a much smaller stream with a narrower range of flow conditions. Construction of the dam stopped the supply of bed material from the upper watershed and dam operation reduces the magnitude of all floods by more than 70 percent, reducing channel forming flows in winter. Although lower Dry Creek experiences reduced peak flows, base flows have increased dramatically to provide continuous flow throughout the year along this traditionally seasonal stream. This altered hydrology has led to overbank areas that are densely vegetated (Figure 3). Without the regular disturbance of channel forming winter flood flows and supported through the dry season by unnaturally high summer base flows, the riparian vegetation has become an overgrown homogenous mature age group. This growth has stabilized the channel banks and focused flow into a narrow channel. These factors make Dry Creek competent at moving the coarse sediment at relatively low discharges as compared to the pre-WSD stream. The lower Dry Creek's ability to transport the limited coarse sediment supplied to it by its tributaries below WSD in combination with the overgrown vegetation along its banks has simplified its channel profile. Additionally, channel simplification has substantially reduced the frequency and size of riffles, depositional features important for native and special status aquatic species. The intervening sections of stream, while possessing some residual depth, lack the depth and low flow velocity characteristics of pools required by native aquatic species and are far out of balance in terms of their size relative to the riffles (Inter-Fluve 2013).

The habitat across the channel and floodplain laterally is as altered as the instream habitat is along the channel length. The combination of altered hydrology and vegetation growth patterns has curtailed the fluvial processes which erode and deposit bars in the active channel and floodplain needed to create lateral habitats such as alcoves, backwaters, and side channels. This has dramatically simplified floodplain habitat compared to historical conditions, resulting in decreased channel, floodplain, and riparian complexity and connectivity throughout lower Dry Creek important for native aquatic and riparian species including all life stages of salmonids (Inter-Fluve 2013).

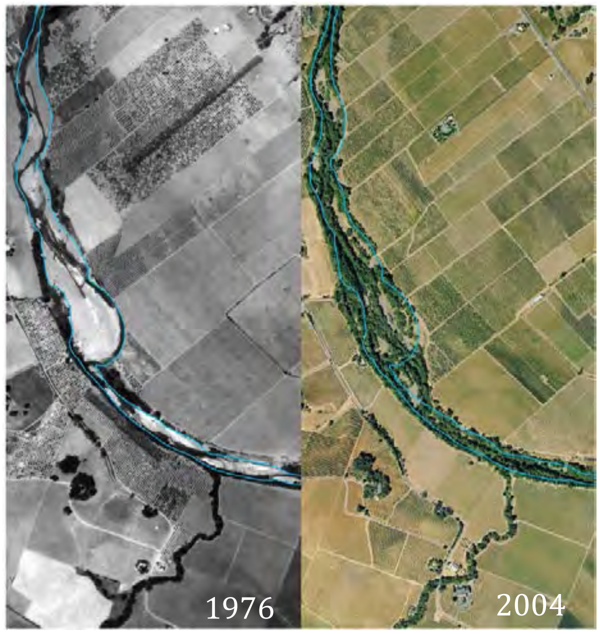


Figure 3. Example of vegetative establishment in relatively wider area of channel corridor leading to a narrowed active channel near the confluence of Grape Creek (river mile 7.3). Grape Creek is at bottom center of each frame. Dry Creek flow is from top to bottom. Left frame is from 1976, right frame is from 2004. Light blue line is estimated limit of active fluvial features in 1976 (Inter-Fluve, 2013).

The Russian River and its major tributaries, including Dry Creek, are home to three species of fish that are threatened or endangered: CCC steelhead, CCC coho salmon, and CC Chinook salmon. In addition to impacts to channel form and habitat discussed above, the construction and operation of the dam has also directly resulted in the loss of upstream spawning and rearing habitat for the Russian River salmonids. The Congressman Don Clausen Fish Hatchery (DCFH) was built at WSD shortly after the dam closure in order to mitigate for fish loses directly resulting from the loss of upstream habitat. Despite this, populations of the three species of salmonids native to the Russian River continued to decline and all three were listed under the ESA as threatened or endangered between 1995 and 1999.

There are many reasons for the decline of these species, including flood control and water supply projects in Dry Creek. Since the ESA listing of the Russian River salmonids, the Corps has been become involved in many programs and partnerships aimed at restoring salmonid populations. In 1997, the Corps, the Sponsor, and the NMFS signed a Memorandum of

Understanding for a collaborative ESA consultation for the Russian River water projects including WSD. By 2000, it became apparent that coho salmon in the Russian River were declining to the point of extinction. The next year, a collaborative partnership between the Corps, the Sponsor, NMFS, CDFW, and the University of California Cooperative Extension/California Sea Grant Extension Program established the Russian River Coho Salmon Captive Broodstock Program (the Broodstock Program) at the WSD DCFH. The program's objective was to supplement the wild Russian River coho population in the hope of restoring it to a sustainable size. As a result of the ESA consultation, NMFS determined that the operation of WSD could threaten the survival of coho salmon and steelhead trout in Dry Creek, and/or adversely affect their critical habitats.

In 2008 NMFS issued the Jeopardy Biological Opinion for Water Supply, Flood Control, and Channel Maintenance Activities for the Russian River Watershed (Biological Opinion; NMFS 2008). The Biological Opinion outlines a number of Reasonable and Prudent Alternatives including the enhancement of six miles of lower Dry Creek to provide near ideal summer rearing and winter refugia conditions for coho and steelhead. Dry Creek provides a significant opportunity for recovery of coho and steelhead in the region due to the relative abundance of cool water in the late summer months (provided by water supply operations) which is atypical of streams in the region. Late summer rearing conditions is an identified critical bottleneck for species recovery. This Study is one way to address the Biological Opinion. However, Corps restoration actions are predicated upon the Corps' authority to carry out the necessary actions and the scope and scale of this Study was not limited by the specific actions or requirements included in the Biological Opinion.

There are numerous ongoing restoration efforts currently occurring along lower Dry Creek. In response to the Biological Opinion, SCWA began an initial feasibility study in 2009 to explore options for habitat restoration in Dry Creek. The feasibility study was conducted in three phases including: (I) inventory and assessment of current conditions, (II) feasibility assessment of habitat restoration approaches, and (III) conceptual design of habitat restoration approaches deemed feasible. Phase I assessed current conditions based on a field inventory completed in summer 2009, detailed results of which can be found in the Current Conditions Inventory Report that concluded Phase I (Inter-Fluve 2010). Phase II, conducted in 2010 and 2011, provides a detailed feasibility assessment of habitat restoration approaches over the entire 14 miles of lower Dry Creek. The resulting feasibility study (Inter-Fluve 2013) includes the following primary components:

1. field survey of Dry Creek to support development of a one-dimensional planning-level hydraulic model over the project reach;
2. geotechnical subsurface exploration at select locations to inform the feasibility assessment;

3. quantitative assessment of the hydraulic and geomorphic processes in Dry Creek; and
4. assessment of the feasibility of habitat restoration based on geomorphic, hydraulic, engineering and construction considerations.

Finally, conceptual designs were developed in 2012 as a part of Phase III. The resulting Conceptual Design Report (Inter-Fluve 2012) outlines opportunities for logical groupings of off-channel and main-channel restoration measures based on the current understanding of geomorphic processes in Dry Creek, as described in the Dry Creek Feasibility Study Report (Inter-Fluve 2013).

Using the conceptual designs as a jumping off point, the Corps and the SCWA have already completed a small percentage of the Dry Creek restoration required by the Biological Opinion. In 2013, SCWA worked closely with a group of willing landowners to complete approximately one mile of habitat restoration (commonly referred to as the Demonstration Project). Additionally, in 2013 the Corps utilized Operations and Maintenance (environmental stewardship) funds to complete a smaller ecosystem restoration project (approximately 1,600-feet long) on Corps property immediately below the WSD. The SCWA continues to work with the Corps and supportive landowners to further their Dry Creek restoration goals and requirements, and is currently in the process of designing additional habitat restoration required by the Biological Opinion in tandem with the restoration proposed by this Study.

Much work has already occurred to improve habitat conditions in the tributaries of Dry Creek. As part of the SCWA's Fisheries Enhancement Program, the SCWA worked with the CDFW between 1997 and 2001 to implement habitat improvement projects at multiple sites in Felta Creek, Mill Creek, and Palmer Creek. These projects consist of log structures, plantings, rock weirs, and the reshaping of gravel roads to control erosion inputs. As part of the Russian River Biological Opinion, the SCWA also implemented habitat improvement projects in Grape Creek and passage improvement projects in Grape Creek and Crane Creek from 2009 to 2011. The SCWA is also providing funding towards the removal of the last major passage barrier along Mill Creek. Removal of this barrier along Mill Creek was completed in 2016.

In addition to work conducted by or in partnership with the SCWA, habitat improvement projects by private landowners in coordination by CDFW and local Resource Conservation Districts have occurred on Pena, Mill, Felta, and Grape Creeks. These projects consisted of log structures, rock weirs, removal of instream frost protection uses, and removal of passage barriers.

Due to the extensive work completed by others or planned to be completed in the near future, there are few (if any) opportunities for additional ecosystem restoration actions in the lower Dry Creek tributaries. For this reason, the PDT made a risk informed decision to limit the geographical scope of the Study to the mainstem Dry Creek below WSD.

1.6.1. Existing Water Resource Development Projects and Prior Reports

Warm Springs Dam

Constructed in 1983, WSD is located at river mile 13.9 of Dry Creek, approximately 14 miles west of Healdsburg, California and approximately 70 miles north of San Francisco (Figure 1). The 30-million cubic yard dam, which comprises compacted earth fill with an impervious core, measures 319-feet high and 3,000-feet long. Lake Sonoma, located at the confluence of the Russian River tributaries Dry Creek and Warm Springs Creek, has a storage capacity of 381,000 acre-feet and a total surface area of 3,600 acres. Since 1984, WSD has been operated by the Corps to manage flood risk and by the SCWA to supply potable water to 600,000 consumers in Sonoma and northern Marin Counties. While SCWA is the local cost-sharing partner for WSD and determines the amount of water to be released when the lake level is in the water supply pool, SCWA does not have designated Operations and Maintenance responsibilities at WSD. During severe storms, dam releases are coordinated to limit flows to 35,000 cfs at Guerneville so as to prevent flooding.

Authorized Purposes: Completed by the Corps and the SCWA, WSD was constructed under the authority of Section 203 of the Flood Control Act of 1962, Pub. L. No. 87-874. The authorized purposes of the project are flood control, water storage, and outdoor recreation.

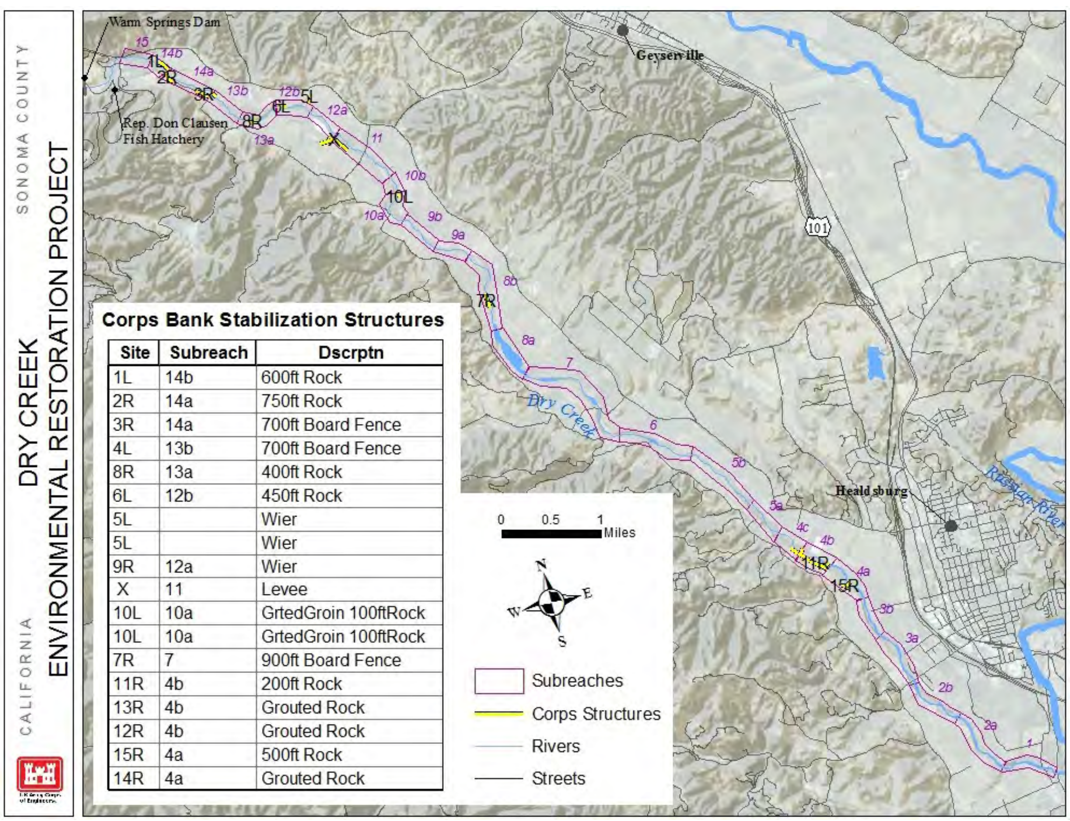
WSD Congressman Don Clausen Fish Hatchery

The WSD also includes DCFH. As authorized by Congress, the Corps' mission for this hatchery is to mitigate for the loss of fish as a direct result of the loss of upstream spawning and rearing habitat for the Russian River CCC steelhead and CC coho salmon (plus a recommended enhancement for Chinook salmon) because of the construction and operation of the dam. The Broodstock Program at the DCFH was established in the early 2000's as a collaborative partnership between the Corps, the Sponsor, NMFS, CDFW, and the University of California Cooperative Extension/California Sea Grant Extension Program. The program's objective was to supplement the wild Russian River coho population in the hope of restoring it to a sustainable size. Today, Corps' staff operates the Broodstock Program at the DCFH.

Authorized Purposes: The WSD Fish Hatchery was authorized by Section 95 of WRDA of 1974, Pub. L. No. 93-251, § 95, 88 Stat. 12 (1974) and constructed in 1979.

Bank Stabilization Structures

At the time of WSD's construction, the Corps recognized that "sustained flows of relatively clear water released from the reservoir might aggravate existing bank erosion problems along Dry Creek below the dam." In response, between 1981 and 1983 the Corps installed rip-rap bank protection, rock groins, pile walls, and willow planting as bank protection measures and built grouted rock sills (drop structures) with Denil fish ladders crossing Dry Creek near the Westside Road Bridge to protect streambanks against erosion and control ongoing streambed degradation (USACE 1991; Horizon 2012). These features were constructed downstream of the dam outlet from river mile 13.7 to the Mill Street Bridge (river mile 2.3) at Healdsburg (Figure 4). After completing their construction, the Corps transferred these channel improvement projects to the Sponsor for operations and maintenance in June 1988. The operations and maintenance protocols are stipulated in the WSD Dry and Lake Sonoma Project, Russian River Basin, Dry Creek Channel Improvements Sonoma County, California: Operation and Maintenance Manual (O&M Manual) (USACE 1991). It should be noted that in the past several private landowners have also constructed their own bank stabilization structures along lower Dry Creek using riprap and automobile bodies (not identified in Figure 4).



Site	Subreach	Dscrptn
1L	14b	600ft Rock
2R	14a	750ft Rock
3R	14a	700ft Board Fence
4L	13b	700ft Board Fence
8R	13a	400ft Rock
6L	12b	450ft Rock
5L		Wier
5L		Wier
9R	12a	Wier
X	11	Levee
10L	10a	GrtedGroin 100ftRock
10L	10a	GrtedGroin 100ftRock
7R	7	900ft Board Fence
11R	4b	200ft Rock
13R	4b	Grouted Rock
12R	4b	Grouted Rock
15R	4a	500ft Rock
14R	4a	Grouted Rock

Figure 4.Existing Corps bank stabilization structures along lower Dry Creek. Site 14R (subreach 4a) is referred to as a sill later in the document. It bisects subreach 4a.

1.6.2. Study Reaches

In order to facilitate the organization of study field efforts and plan formulation, , the study area was stratified into three process-delineated segments including: the upper segment (WSD to Pena Creek), the middle segment (Pena Creek to river mile 3), and the lower segment (river mile 3 to Russian River confluence) (Figure 5). The prevailing physical functions and implications for ecosystem restoration within each lower Dry Creek segment (upper, middle, lower) include the following:

- Upper Segment: The upper segment starts at the WSD (river mile 13.9) and ends at river mile 11. Due to the influence of the WSD upstream of Pena Creek (e.g. lack of sediment supply and highly regulated hydrology) this segment has a low risk of failure of ecosystem restoration constructed features relative to other segments. In other words, habitat features created as a result of the Study have a low likelihood of being compromised by nuisance sediment deposition or other factors. Conversely, habitat features that rely on natural channel processes to mature to peak performance are deemed to have low feasibility.
- Middle Segment: The middle segment stretching from river miles 3 - 11 has greater sediment supply than the upstream reach due to the unregulated tributaries which enter Dry Creek below WSD. The preferred restoration approach to each site is more variable in this segment than the other two segments. This increases the risk for nuisance sedimentation impacts to directly-constructed off-channel habitat. This risk can be mitigated through appropriate site selection and other considerations. In this segment, off-channel restoration may shift in character due to channel processes, again dependent upon the characteristics of each site. Conversely, several large off-channel opportunities may lend themselves to a more dynamic, process-focused approach, or combined approach. Careful consideration of the attributes of each proposed location will determine the corresponding advisable restoration strategy.
- Lower Segment: In the downstream segment (river mile 0-3); there is high risk that an engineered habitat construction approach would be compromised by sedimentation due to the backwater influence of the Russian River. Conversely, restoration that relies on a modified process-driven approach will likely provide the best option in this segment. Based on observations of existing intact rearing habitats, it is possible that fluvial processes may be sufficiently intact to create target habitats over time provided the stage is set for habitat development to occur.

Using existing data, verified in the field, sixteen (16) habitat inventory reaches were delineated and organized within these three segments (Figure 5). The reach delineation generally followed the protocol for stream segment identification developed by the State of Washington's Timber, Fish, and Wildlife Program (Pleus and Shuett-Hames 1998). This method is summarized below (”Reach Deliniation Methods” Section). In this protocol, the primary factors leading to delineation include geomorphic parameters (relative drainage area, channel gradient and channel confinement) and non-fluvial features (e.g. structures such as bridges). Reach 16, the trapezoidal channel in the tailwater below the spillway of WSD and upstream of Bord Bridge, was not investigated in the field. The remainder of this document will refer to reaches 1 through 15 where field efforts were focused. See Appendix A of the Inter-Fluve Current Conditions Report (2010) for a detailed summary for each reach.

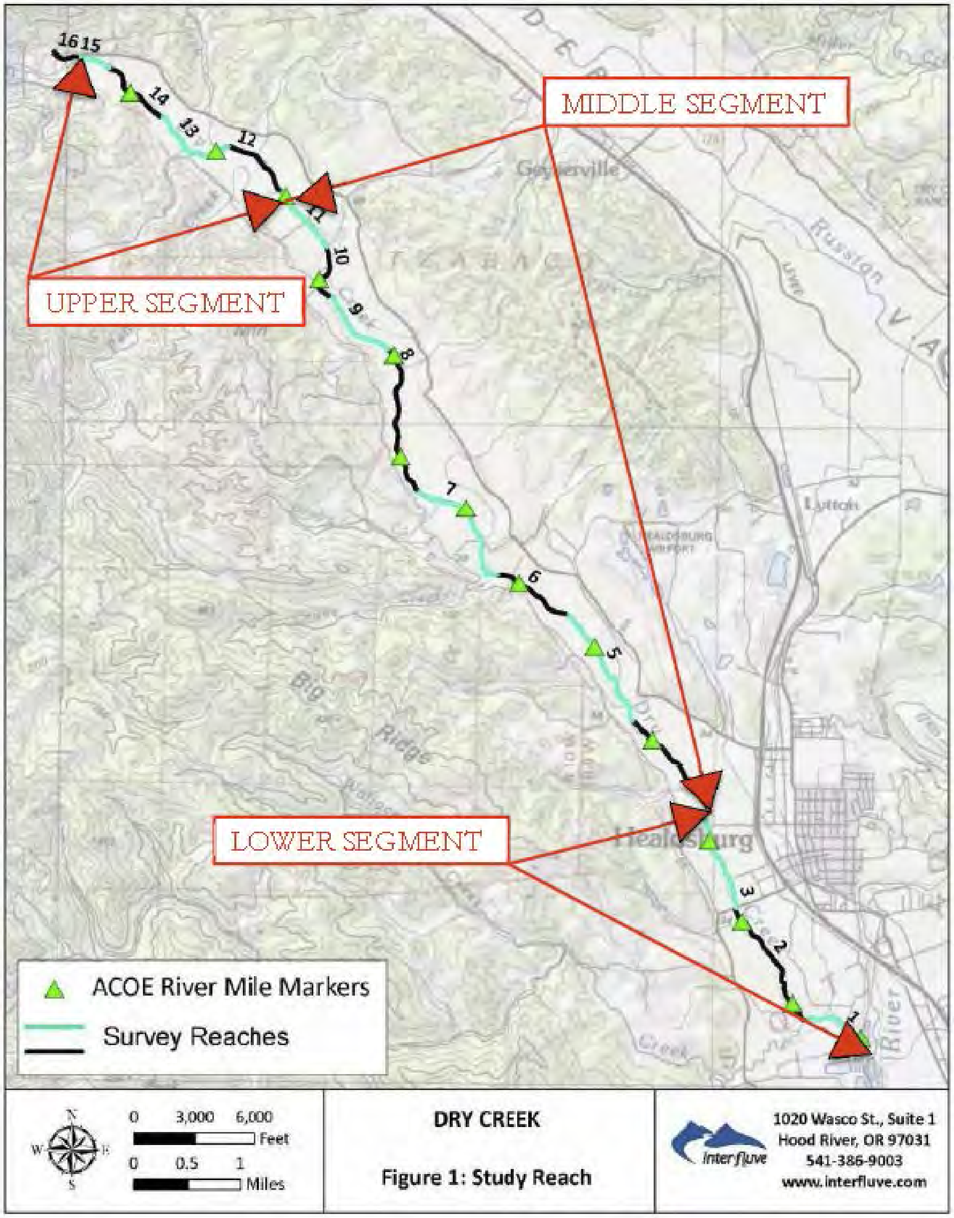


Figure 5. Dry Creek Study Reaches.
Reaches are designated by alternating black and blue lines and labeled with reach numbers. Note: The river miles (designated by the green triangle symbol) do not align exactly with the Reach numbers. The river miles are marked on the map with green triangles but are not labeled. The river miles do not align exactly with the Reach numbers. For reference, river mile 0 is at the confluence with the Russian River and WSD is located at river mile 13.9. Reach 16 (labeled) terminates at river mile 13.9 and includes the WSD spillway structure

Finally, in order to facilitate alternatives formulation, 25 subreaches were delineated based on spatial opportunities for logical groupings of potential off-channel and main-channel restoration measures. Additional constraints on restoration vary over the length of Dry Creek below WSD, and include local factors such as sediment supply, elevation relative to active channel, local grade control features, and the backwater influence of the Russian

River. While areas for potential restoration of pools, riffles and streambanks are numerous along lower Dry Creek, potential challenges are posed by Dry Creek's narrow and incised condition which provides limited lateral areas within close elevation range of the active channel. Therefore, subreach delineation was focused on identifying locations to enhance and create off channel alcove/backwater, side-channel, and winter refuge habitat. The delineated reaches (1-15) and subreaches (identified by using alphabetical nomenclature: 2a, 2b, etc.) are shown in Figure 6.

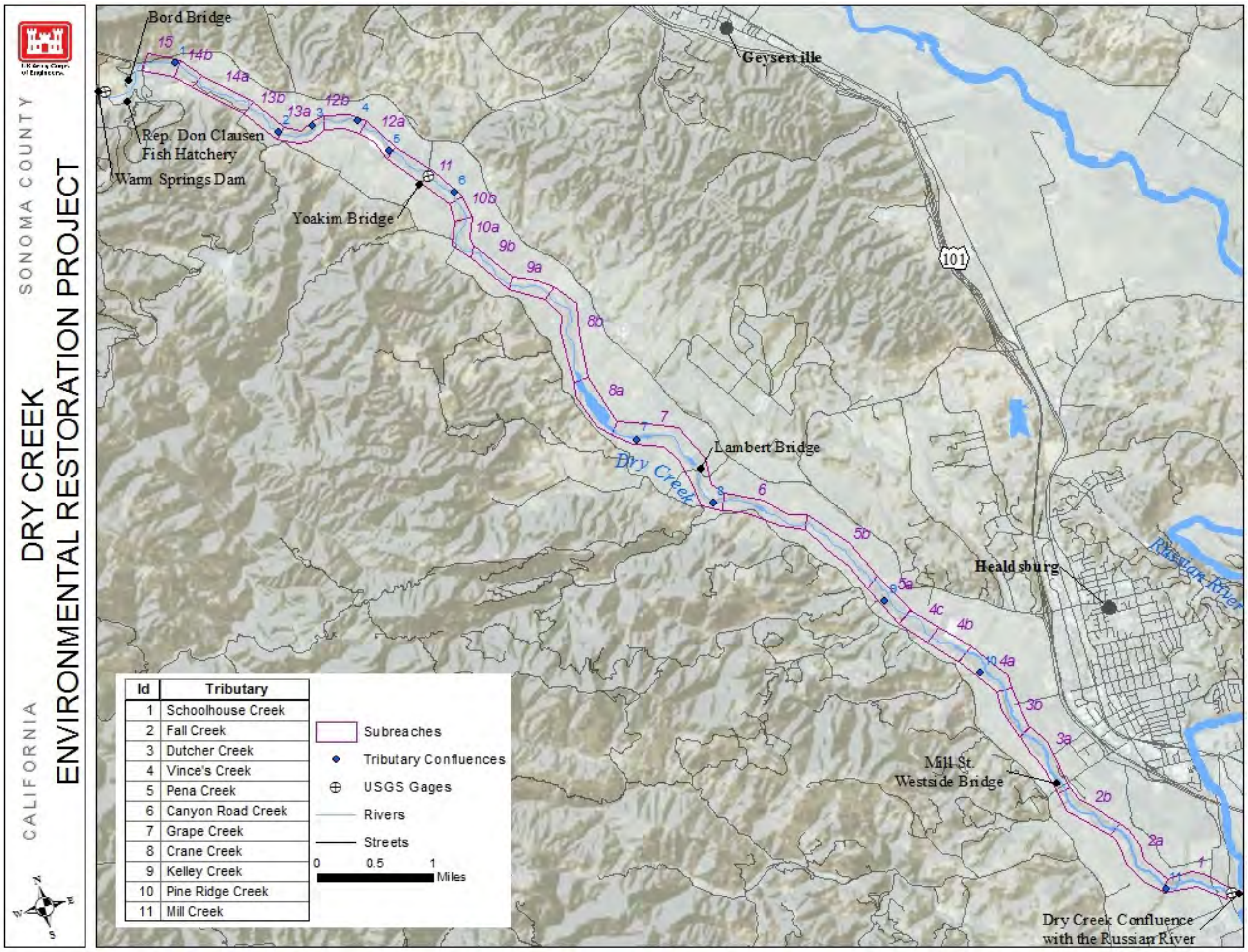


Figure 6. Lower Dry Creek Reaches and Subreaches

Reach Delineation Methods

Reach delineation generally followed the protocol for stream segment identification developed by the State of Washington's Timber, Fish and Wildlife Program (Pleus and Shuett-Hames 1998). In this protocol, the primary factors leading to delineation include geomorphic parameters (relative drainage area, channel gradient and channel confinement) and non-fluvial features (e.g. structures such as bridges). This effort resulted in a preliminary delineation which was field verified during the habitat and geomorphic inventory fieldwork (discussed in subsequent sections of this document), with adjustments made as appropriate.

Relative drainage area was assessed in terms of major tributary junctions, identified based on the Strahler method of stream order determination. A 1:100,000 hydrography Geographical Information System (GIS) layer obtained from the Russian River Interactive Information System was used as the basis for stream order determination for Dry Creek and the tributaries. At WSD, Dry Creek was determined to be a 4th order stream. Per the protocol, 2nd or higher order tributaries were then considered as significant tributaries in the reach delineation. Channel gradient was assessed by sampling 10-m United States Geological Survey (USGS) digital elevation model (DEM) data along the digitized alignment of Dry Creek at 200 foot intervals (the only terrain data available at the time of delineation). Per the protocol, the channel gradient results were then binned into six categories: (1) <1 percent, (2) 1-2 percent, (3) 2-4 percent, (4) 4-8 percent, (5) 8-20 percent, and (6) >20percent. The significant majority of gradient values (88percent) fell into the <1 percent bin, with average gradient value of 0.22 percent.

Channel confinement was assessed based on the 2004 aerial photography (the most recent high resolution aerial photography available at the time of delineation) and contours (0.25 meter (m) contour interval) generated from the 10m DEM data using GIS. Channel confinement was determined by the ratio of the active channel width of the stream to the width of the attendant flood prone surface. Confinement was determined at 200 foot intervals and binned into three categories: 1) less confined (flood prone width > 4 channel widths), 2) moderately confined (flood prone width >2 and <4 channel widths, and 3) confined (flood prone width <2 channel widths). Confinement values most typically fell into the moderately confined category, followed by a balance of confined and unconfined sections. Because Dry Creek is an incised stream, the flood prone surface was contained within the incised channel corridor.

Non-fluvial features were determined from aerial photographs, a GIS road layer, and a GIS surface diversion layer. No diversions were found that were greater than 5 cubic feet per second (cfs), thus these were eliminated from consideration in the reach delineation. Four road alignments cross lower Dry Creek. The geomorphic and non-fluvial factors were then combined sequentially to delineate the 16 reaches using lumping and splitting rules per the protocol. Delineated reaches were then reviewed in the field to result in the reach delineation reported below. The delineation includes 16 reaches, for an average length of approximately 0.9 miles. The delineated reaches are reported in Table 1.

Table 1. Reach delineation results for lower Dry Creek.

Reach	DS end (river mile)	DS end (landmark)	US end (river mile)	US end (landmark)	Length (feet)
1	0	Dry Creek Mouth	0.7	Mill Creek	3550
2	0.7	Mill Creek	2	Westside Road	7000
3	2	Westside Road	3	Fault lineament 1150' DS Sill 1	5450
4	3	Fault lineament 1150' DS Sill 1	4.1	1600' US Sill 3, US end check dam impoundment	5880
5	4.1	1600' US Sill 3, US end check dam impoundment	5.4	Fault lineament, 150' DS Kelley Ck	6640
6	5.4	Fault lineament, 150' DS Kelley Ck	6.2	Bedrock outcrop, 475' DS Crane Ck	4150
7	6.2	Bedrock outcrop, 475' DS Crane Ck	7.5	Bedrock outcrop, 950' US Grape Ck	6940
8	7.5	Bedrock outcrop, 950' US Grape Ck	9	Change in relative confinement	7700
9	9	Change in relative confinement	9.8	Change in relative confinement, and fault lineament	4220
10	9.8	Change in relative confinement, and fault lineament	10.3	Tributary location	3040
11	10.3	Tributary location	11	Pena Ck	3755
12	11	Pena Ck	11.7	Gradient shift, 700' DS Dutcher Ck	3700
13	11.7	Gradient shift, 700' DS Dutcher Ck	12.6	Steep riffle	4345
14	12.6	Steep riffle	13.3	Schoolhouse Creek confluence	3930
15	13.3	Schoolhouse Creek confluence	13.7	Bord Bridge	1680

DS end: Downstream end
US end: Upstream end

1.7. Proposal for Federal Action

The proposal to implement ecosystem restoration in the Dry Creek Basin triggered the NEPA process recorded in this document (40 CFR 1501.2). Based on study results, the Corps is proposing restoration of the Dry Creek in the lower Dry Creek Valley. The proposed Federal study area is focused on lower Dry Creek mainstem, below WSD, because various Federal and State agencies as well as local entities are addressing problems within their individual authorities and in specific areas of the Dry Creek tributaries.

1.8. Format of Report

This integrated DPR/EA is organized to follow a general problem-solving format. The purpose of the feasibility report is to identify the plan that reasonably maximizes ecosystem restoration benefits, is technically feasible, and preserves environmental and cultural values. The purpose of the EA portion of this report (Section 10) is to identify the proposed action, no action alternatives, and alternatives considered but eliminated from further environmental analysis; analyze the environmental effects of the proposed action and no action alternatives; and provide the Corps' determination[1] of whether the anticipated effects of the proposed action are significant or not. The EA also describes measures that will be adopted to minimize the environmental impacts of the proposed action. The six steps of the Corps planning process each align with a NEPA requirement (Table 2). The planning steps are listed below with the document chapter and NEPA element to which they relate:

Table 2. Overview of DPR/EA

Planning Step	Document Chapter and Analogous NEPA Requirement
Step One – **Specify Problems and Opportunities**	Appears in Chapter 2, described in the NEPA purpose and need for action.
Step Two – **Inventory and Forecast Conditions**	Chapter 3 describes the existing conditions of the study area and Chapter 4 describes the future without project conditions. Chapter 10 compares the proposed action alternative to the NEPA no-action alternative, also known as the future without-project condition.
Step Three – **Formulate Alternative Plans**	Appears in Chapter 5 in the description of the screening process and formulation of alternative plans.
Step Four – **Evaluate Effects of Alternative Plans**	Appears in Chapter 5, with a comparison of the effects of alternative plans, and Chapter 10, with an evaluation of the effects of the proposed action on the resources identified in Chapter 3.
Step Five – **Compare Alternative Plans**	Appears in Chapter 6 with a comparison of the alternative plans.
Step Six – **Select Tentatively Selected Plan**	Appears in Chapter 6 and 7 and includes details of the TSP (which is the agency preferred alternative and NEPA proposed action).

Development of the integrated DPR/EA follows the Corps six-step planning process specified in Engineering Regulation 1105-2-100. These steps include 1) identifying problems and opportunities, 2) inventorying and forecasting conditions, 3) formulating

[1] The determination of whether the anticipated effects of the proposed action are significant or not is considered preliminary until review and comments from other agencies, organizations, and the interested public have been solicited and any comments received have been addressed.

alternative plans, 4) evaluating alternative plans, 5) comparing alternative plans, and 6) selecting a plan. This process is used to identify and respond to problems and opportunities associated with the Federal objectives and specific State and local stakeholder concerns.

As a part of identifying the proposed action, the PDT developed a number of alternative plans and compared them with the "no action alternative." This allowed for the ultimate identification of the TSP or NER Plan. The NER plan reasonably maximizes ecosystem restoration benefits compared to the costs, considering the cost-effectiveness and incremental cost of implementing other restoration options. In addition to considering the system benefits and costs, the NER considers unquantifiable information such as environmental significance and scarcity, socioeconomic impacts and historic properties information.

All NEPA compliance sections are marked in the table of contents with an asterisk. A Draft Finding of No Significant Impact (FONSI) and recommendation by the district commander follows. Figures, plates, and appendices have been furnished to provide sufficient detail to allow review of the existing features and the TSP.

1.9. Regulatory Compliance

This document was prepared by the Corps' San Francisco District in compliance with all the applicable Federal statutes, regulations, and Executive Orders, including the following:

- NEPA of 1969, as amended (42U.S.C. 4321 et seq.);
- U.S. Army Corps of Engineers' Procedures for Implementing NEPA (33 CFR 230; Engineering Regulation 200-2-2);
- Regulations for implementing Procedural Provisions of NEPA (40 CFR 1500 et seq.);
- Clean Air Act of 1972, as amended (42 U.S.C. 7401 et seq.);
- Clean Water Act of 1972, as amended (33 U.S.C. 1251 et seq.);
- Endangered Species Act of 1973, (ESA) as amended (16 U.S.C. 1531 et seq.);
- Fish and Wildlife Coordination Act (16 U.S.C. 661 et seq.);
- Floodplain Management (Executive Order 11988);
- Protections of Wetlands (Executive Order 11990);
- Federal Noxious Weed Act (7 U.S.C. 2801-2814 et seq.);
- Section 106 of the national Historic Preservation Act, as amended (16 U.S.C. 470 et seq.);
- Protection of Historic Properties (36 CFR 800);

- Protection and Enhancement of the Cultural Environment (Executive Order 11593);
- American Indian Religious Freedom Act (42 U.S.C. 1996);
- Native American Graves Protection and Repatriation Act of 1990 (25 U.S.C. 3001 et seq.).

This DPR/EA is also in compliance with applicable tribal, State of California, and local regulations, statutes, policies, and standards for conserving the environment and environmental resources such as water and air quality, endangered plants and animals, and cultural resources. A Detailed discussion of environmental regulatory compliance is included in section 10.9.

2. NEED FOR AND OBJECTIVES OF ACTION

This chapter presents results of the first step of the planning process, the specification of water and related land resources problems and opportunities in the study area. The chapter also establishes the planning objectives, constraints, and consideration, which are the basis for formulation of alternative plans.

2.1. Problem and Opportunities

Stream channelization, road construction along stream margins, bank stabilization, and water diversions in tributaries has significantly degraded stream habitats throughout the watershed. The problems and opportunities in this section describe public concerns related to these water and land resource management issues in the study area. Problems are those undesirable conditions to be changed through the implementation of an alternative plan, and opportunities are those positive conditions to be achieved by an alternative plan. The identified problems are:

PROBLEM I: Lower Dry Creek provides limited quantity and quality of complex and diverse aquatic habitat important for listed species.

Development in the Russian River watershed as well as altered hydrology and the resulting simplification of natural geomorphic processes have simplified and straightened Dry Creek's stream channel. This has resulted in reduced channel complexity and habitat heterogeneity in general and contributed specifically to the following adverse conditions for native aquatic and riparian species along Dry Creek's mainstem:

- Limited quantity and quality of summer and winter rearing habitat for listed salmonid species.
- Limited resting and refugia pool habitat important to listed salmonid species, juvenile salmonids in particular, in addition to an array of other native aquatic and riparian species.
- Reduced or eliminated aquatic and riparian cover important for the moderation of stream temperatures and for creating resting habitat, providing refugia from predators, and providing allocthonous input of organic matter integral to the stream's food web.

PROBLEM II: Altered hydrology and channel simplification has resulted in limited stream channel – floodplain lateral connectivity and the development of quality off channel seasonal habitat important for listed species and native aquatic and riparian species along Dry Creek's mainstem below WSD.

Altered hydrology and the resulting simplification of natural geomorphic processes have led to sedimentation on already limited undeveloped floodplain areas. This sedimentation has built up the adjacent floodplains until they have become effectively cut off from all but the highest stream flows. This has curtailed nutrient cycling, ground water recharge, and plant succession processes. It has also diminished the formation and availability of refugia from high velocity in-stream flows for many aquatic species, including listed salmonids. This has been exacerbated by the colonization of floodplain areas by mature vegetation growth and invasive plant species.

PROBLEM III: Altered hydrology has limited riparian habitat complexity along lower Dry Creek.

Altered hydrology and the resulting simplification of natural geomorphic processes have limited bar formation and scour. As a consequence, riparian vegetation secession is inhibited. This lack of a natural disturbance regime in combination with the WSD water supply operations, which sustain high base flows in even the driest part of the year, has resulted in the overgrowth of the riparian vegetation, including invasive plant species. As a result, the riparian vegetation has developed into a static mid-successional state. This static vegetation provides limited riparian habitat complexity important for riparian terrestrial species. It also limits the input of mobile large wood important for the development of instream habitat complexity.

PROBLEM IV: Altered hydrology and the decline of the complex aquatic habitat has contributed to the drastic decline of the critically endangered CCC coho salmon populations and has impacted the recovery of threatened steelhead and Chinook salmon populations.

During the low flow season in particular (approximately late May through October) releases from WSD for water supply significantly affect stream flow and available rearing habitat for steelhead and coho salmon, which rear in freshwater habitats throughout the summer months. Flow management at WSD during late spring, summer, and fall has a clear adverse effect on the availability of rearing habitat for steelhead in lower Dry Creek. The project's proposed flow management also adversely affects the quality and quantity of rearing habitat and survival of juvenile coho salmon in Dry Creek. Although the upper main stem Russian River and Dry Creek support good quality spawning habitat for listed salmonid species, salmonid fry that emerge from the gravels of Dry Creek and the upper Russian River will encounter limited suitable quality rearing habitats because much of the stream areas have excessive current velocities. This will lead to increased mortality of juvenile steelhead and coho salmon. The flow regime also affects the survival of juvenile salmonids that emigrate downstream from tributaries into Dry Creek. Juvenile Chinook salmon rear in freshwater only until late spring or early summer when they then enter the ocean environment. For that reason, regulation of late spring and summer flows has much less effect on rearing juvenile Chinook than the other two species.

2.1.1. Opportunities

Identified ecosystem restoration opportunities include:

- To take advantage of the relative abundance of cool water released by WSD in the late summer/early fall months when many tributary streams are intermittent.
- To take advantage of the relative stability of channel form.
- To take advantage of wide areas within the lowered floodplain to modify the lower mainstem Dry Creek channel to accommodate high summer flows.
- To reduce channel velocities.
- To take advantage of available land area.
- To take advantage of connectivity with tributaries.
- To increase groundwater/surface water connectivity and improve aquifer recharge, hyporheic exchange, and water quality.
- To promote watershed level management/control of invasive species.
- To contribute to State/Federal listed species recovery plans.
- To remove old/unneeded structures that no longer serve their purpose or impede restoration opportunities.
- To reduce maintenance requirements and increase the long term success of constructed habitat restoration measures by taking advantage of the moderated flood flows released by WSD.
- To take advantage of SCWA's positive relationships with property owners and important stakeholders.
- To take advantage of NMFS Safe Harbor Agreement(s) which would authorize incidental take for landowners viticulture operations if they manage their land in accordance with their farm plan and BMP's and allow restoration on their property.
- To create a model for cooperation between diverse interests.
- To provide public access to Dry Creek and increase passive recreation opportunities (wildlife watching, creek viewing, etc.) on public property within the study area.

2.2. NEPA Purpose and Need for Action*

The need for the proposed Federal action arises from the significant degradation of natural processes that sustain the ecological functions of the watershed as described in the previous section. The purpose of the Federal action is to work within the defined study area to restore ecosystem process, structure, and function in the aquatic environment through solutions that are within the Corps' authority.

Effort toward improving the aquatic ecosystem may include addressing lack of floodplain habitat, increasing channel complexity, increasing large woody debris, increasing pool depth and frequency, and restoring degraded riparian conditions to the maximum extent practicable. Restoration of ecosystem structures, functions, and processes will benefit nationally significant resources in the study area.

2.3. Resource Significance – Technical, Institutional, Public

The Dry Creek is the largest tributary to the Russian River and supports vital natural resources. Significant resources in the Russian River Basin have declined to a point that the ecosystem may no longer be self-sustaining without immediate intervention to curtail considerable ecological degradation. These resources are technically, institutionally, and publicly significant as described in the following sections.

There are three species of primary concern that have institutional, technical, and public significance. They include three salmonids that are native to the Russian River that have been listed as threatened or endangered under the under the ESA: CCC coho salmon, CCC steelhead, and CC Chinook. All three species are recognized as significant resources in the Biological Opinion.

- The CCC coho salmon, which is listed as endangered, faces the highest risk of extinction of the three salmonid species. This is evidenced by the precipitous decline in their abundance during the past several decades and the poor status of population viability metrics (abundance, population growth rates, spatial structure, and genetic diversity). The cause of this decline is likely the widespread degradation of habitat, particularly those habitat attributes that support freshwater rearing life stages. Habitat loss and the concurrent extirpation of local populations have resulted in a high degree of isolation for the remaining populations. There are currently no viable populations[2] of CCC coho salmon anywhere. According to technical and scientific experts, the Russian River

[2] "A viable salmonid population is an independent population of any Pacific salmonid (genus *Onchorhynchus*) that has a negligible risk of extinction due to threats for demographic variation (random or directional), local environmental variation, and genetic diversity changes (random or directional) over a 100-year time frame" (McElhaney et al. 2000).

population was the largest historically viable population of CCC coho salmon in the 19th century, and it is now decimated. Almost the entire remaining gene pool for the Russian River population of coho is in those individuals that are reared and stocked (and then return from the ocean as adults) as part of the Broodstock Breeding Program[3].

- The CCC steelhead is listed as a threatened species, and the species' habitat is degraded throughout the Distinct Population Segment. However, the diverse life-history strategies of steelhead have helped reduce this species' overall extinction risk.
- The possible extinction risk for CC Chinook salmon, which is listed as a threatened species, is likely intermediate between that of CCC coho salmon and CCC steelhead. The CC Chinook salmon's habitat condition is somewhat better than the habitat condition for the other species mainly because its range lies well north of San Francisco Bay and it does not occupy rearing habitats throughout the summer when stream flows can be low or negligible. Habitat degradation, however, is still widespread within its range.

2.3.1. Technical Significance

The California coast ecoregion is home to many species of the Salmonidae family. These fish serve as an indicator of the overall health of not only the aquatic environment where they dwell, but also the connected riparian, wetland, and upland habitats. A comprehensive restoration plan for all species in the Salmonidae family, as keystone species, effectively restores habitat and nutrient input for a broad suite animal species (Cederholm et al. 1999). Keystone species play a unique and crucial role in the way an ecosystem functions; these fish are extremely sensitive to changes in water quality, trophic webs, and perturbations to the river flow, turbidity, and temperature. Pacific salmon are a food source for a variety of marine, freshwater, and land animals and provide a source of marine-derived nutrients to freshwater environments after spawning (Cederholm et al. 1999). Juvenile salmonids feed on aquatic invertebrates that are indicators of water quality.

Generally, the more pristine, diverse, and productive the ecosystem is, the healthier the salmon stocks. A decline in the capacity of a watershed to support juvenile salmonids is one indication of declining ecosystem health. Restoration planning centered on habitat for the Salmonidae family reinstitutes dynamic processes that tend to maintain healthy ecosystem characteristics.

[3] See Obedzinkski et al. (2009):*Russian River coho Salmon Captive Broodstock Program Monitoring Activities: Annual Report.*

2.3.2. Institutional Significance

Three ESA-listed fish species of the Russian River Basin occur in Dry Creek River. The decline of these particularly sensitive species indicates degradation of environmental health of Dry Creek and the Russian River Basin aquatic systems, representing an urgent need to address degradation in the study area.

NMFS designated Essential Fish Habitat (EFH) within the Dry Creek watershed under the Magnuson-Stevens Fishery Conservation and Management Act. EFH includes all CCC coho and CC Chinook salmon habitat.

2.3.3. Public Significance

Members of the public have recognized the significance of Dry Creek's resources both formally and informally. Ecosystem restoration was a common theme during public meetings that were held throughout the course of the study and prior to the study during and following the issuance of the Biological Opinion. For instance, the Public Policy Facilitating Committee (PPFC) has been meeting annually since 1999 to discuss, disseminate information, and take public comment on the implementation of Section 7 of the federal ESA as called for in a Memorandum of Understanding with the Corps, NMFS, and the SCWA. PPFC Committee Members include: three members of the Sonoma County Board of Supervisors; one member of Mendocino County Board of Supervisors; an official from the CDFW; and official from the NMFS; an official from the California North Coast Regional Water Quality Control Board; and a representative from the Mendocino Farm Bureau and the Mendocino County Russian River Flood Control and Water Conservation Improvement District. Additionally, the Dry Creek Advisory Group, representing a range of interests to inform efforts to implement the Biological Opinion in the Dry Creek watershed, met eight times from August 2009 through December 2011.This extraordinary collaborative effort and recognition of a need for restoration is indicative of the public significance of the resources of Dry Creek. Table 3 summarizes the technically, institutionally, and publicly valued resources in the study area.

Table 3. Technical, Institutional, and Public Significance

Technical Significance	Institutional Significance	Public Significance
Salmon – keystone species; indicators of overall ecosystem health	Three ESA-listed salmon species represented	Public concern for ecosystem restoration
Consistent water supply under a changing climate	NMFS Essential Fish Habitat	Public concern for special status species
	Russian River Jeopardy Biological Opinion	

2.4. Objectives and Constraints

Ecosystem restoration is one of the primary missions of the Corps' Civil Works program. The Corps objective in ecosystem restoration planning is to contribute to NER. Contributions to national ecosystem restoration (NER outputs) are increases in the net quantity and/or quality of desired ecosystem resources. Measurement of NER is based on changes in ecological resource quality.

The national objective is a general statement and is not specific enough for direct use in plan formulation. The water and related land resource problems and opportunities identified in this study are refined and stated as specific planning objectives to provide focus for the formulation of alternatives. These planning objectives reflect the problems and opportunities and represent desired positive changes in the without project conditions. All objectives will be evaluated based on the Corps period of analysis, which is defined as 50 years, starting at base year of project completion.

OBJECTIVE I- Habitat Complexity: To restore and enhance stream channel and floodplain complexity and increase submerged and closely overhanging cover to benefit aquatic species along Dry Creek's mainstem.

This will include but not be limited to the construction of pool, riffle, side channel, and backwater habitats along areas of Dry Creek's mainstem in order to promote habitat diversity for aquatic, floodplain, and riparian wildlife and to provide refuge for aquatic species from high velocity summer and winter flows. This will also include the restoration of fluvial geomorphic processes where conditions will support a process driven approach such as the restoration of patterns of current direction and velocity within the relatively straight channel that will scour pools and form bars in the stream bed, lend greater hydraulic diversity to the river, and concentrate the stream's current to the bank areas where hiding fish can feed.

OBJECTIVE II – Habitat Connectivity: To improve lateral instream-floodplain connectivity through side channels, backwaters, and lowered floodplain terraces along Dry Creek's mainstem where there is adequate channel width and accessible floodplain terraces.

OBJECTIVE III – Riparian Vegetation Diversity and Complexity: To reduce non-native vegetation and increase native riparian vegetation successional complexity in order to promote habitat diversity for riparian wildlife, to provide food and cover for aquatic wildlife, and to shade Dry Creek and associated floodplain features such as backwaters and side channels.

OBJECTIVE IV – Salmonid Specific Restoration: To restore and enhance high quality instream and floodplain habitat conditions along areas of Dry Creek's mainstem to benefit listed salmonid species throughout their life cycle.

2.4.1. Planning Constraints

Planning constraints represent restrictions that limit the extent of the planning process. Constraints are designed to avoid undesirable changes between future with and without project conditions. Study-specific planning constraints are statements of things unique to a specific planning study that alternative plans should avoid. The following constraints (i.e. limitations on the range of measures and alternatives that can be proposed) have been identified for the study:

- Universal Constraint: The project design, construction, and operations and maintenance plan must comply with applicable Federal laws, regulations, and policies such as the NEPA, ESA, Fish and Wildlife Coordination Act, Clean Water Act, and the National Historic Preservation Act.
- Study–Specific Constraint: Dry Creek is a designated floodway and, therefore, the project cannot increase the water surface elevation/flood risk in study area or downstream.
- Study–Specific Constraint: WSD operations must maintain base summer flows required for water supply, hatchery, and hydropower operations.
- Study–Specific Constraint: WSD operations must maintain State mandated minimum environmental flows established under the requirements of the State Water Resources Control Board's (SWRCB) Decision 1610 (D1610) for water supply.
- Study–Specific Constraint: The Dry Creek watershed is critical to the long–term sustainability of three species of federally listed salmonids. This project cannot jeopardize the continued existence of the federally listed salmonids or any other federally listed species. This project cannot adversely modify designated critical habitat for the threatened salmonids or any other federally listed species in Dry Creek and its tributaries.

2.4.2. Planning Considerations

The following issues will inform, but not necessarily direct or constrain, the planning process:

- Jeopardy Biological Opinion

The 2008 Jeopardy Biological Opinion issued by the National Oceanic and Atmospheric Administration requires the Corps and SCWA to perform various actions to save threatened salmonid species on Dry Creek. Corps actions are predicated upon the Corps' authority to carry them out. The Biological Opinion outlines a number of Reasonable and Prudent Alternatives, including the enhancement of six miles of lower Dry Creek to provide near ideal summer rearing conditions for coho and steelhead. The scope and scale of the Study will not be limited by the requirements included in the Biological Opinion, however, the Corps and the SCWA have already completed a small percentage of the six miles of restoration required by the Biological Opinion. Based on these requirements, the Corps utilized Operations and Maintenance (environmental stewardship) funds to complete an ecosystem restoration project (1,600-feet long) on the Corp's property immediately below the WSD. Construction was completed in two phases: summer 2012 and summer 2013. In addition to the Corps' restoration effort, the SCWA worked closely with a group of willing landowners to complete approximately one mile of additional habitat restoration. The SCWA continues to work with supportive landowners to further their Dry Creek restoration goals and requirements, and is currently in the process of designing the second and third miles of habitat restoration required by the Biological Opinion.

- Coordination with Other Restoration Efforts

The 2008 Biological Opinion issued by NOAA requires that the Corps and SCWA perform various actions to save threatened salmonid species on Dry Creek. Corps actions are predicated upon the Corps' authority to carry out the necessary actions. While the Biological Opinion outlines a number of Reasonable and Prudent Alternatives, the scope and scale of this Feasibility study will not be limited by the specific actions or requirements included in the Biological Opinion.

In the Dry Creek watershed, the Biological Opinion requires six miles of fish habitat enhancements to be implemented over the approximately 14 mile long study area. Generally, Dry Creek currently lacks high quality main channel and off-channel habitats which are critical for juvenile coho and steelhead rearing. The habitat enhancements required by the Reasonable and Prudent Alternatives in the Biological Opinion aim to directly address these deficiencies. In order to meet the requirements of the Biological Opinion, the Sponsor has an ongoing restoration effort within the study area through its Russian River Instream Flow and Restoration (RRIFR) program. The RRIFR program addresses river management in relationship to agency operations per the requirements of the Biological Opinion. This feasibility study is one component of their programmatic restoration effort in the study area. Close coordination will be required during feasibility to ensure assumptions regarding the without-project and future without-project conditions are captured adequately. The Biological Opinion lays out a timeline, including three milestones for the habitat work, which will ultimately result in over six miles of habitat enhancement in Dry Creek implemented through three phases by 2020. Milestone 1 requires that one mile of restoration be constructed by 2014. The Sponsor commonly refers to this as "Mile 1." The Milestone 2 requires the restoration of two additional miles by 2017, collectively referred to as Miles 2 and 3. Finally, Milestone 3 requires the restoration of 3 additional miles of Dry Creek, referred to as Miles 4-6. Figure 7 summarizes these milestones and the work that has been completed.

The SCWA and the Corps met Milestone 1 of the Biological after SCWA's completion of the demonstration site in subreach 7 and the 1600 foot restoration completed by the Corps on the Corps' property immediately below the WSD. The Sponsor continues to work closely with a group of willing landowners and is currently in the process of designing parts of Miles 2 and 3 of habitat restoration required in Milestone 2. The Dry Creek CAP 1135 project is expected to contribute to the completion of Milestone 2. As of the summer of 2016, SCWA has begun construction of a habitat restoration project on their own in subreach 8b. In 2017, SCWA plans to complete construction on their own of a habitat restoration project in subreach 2b. Both of these subreaches will no longer be considered as a part of this study.

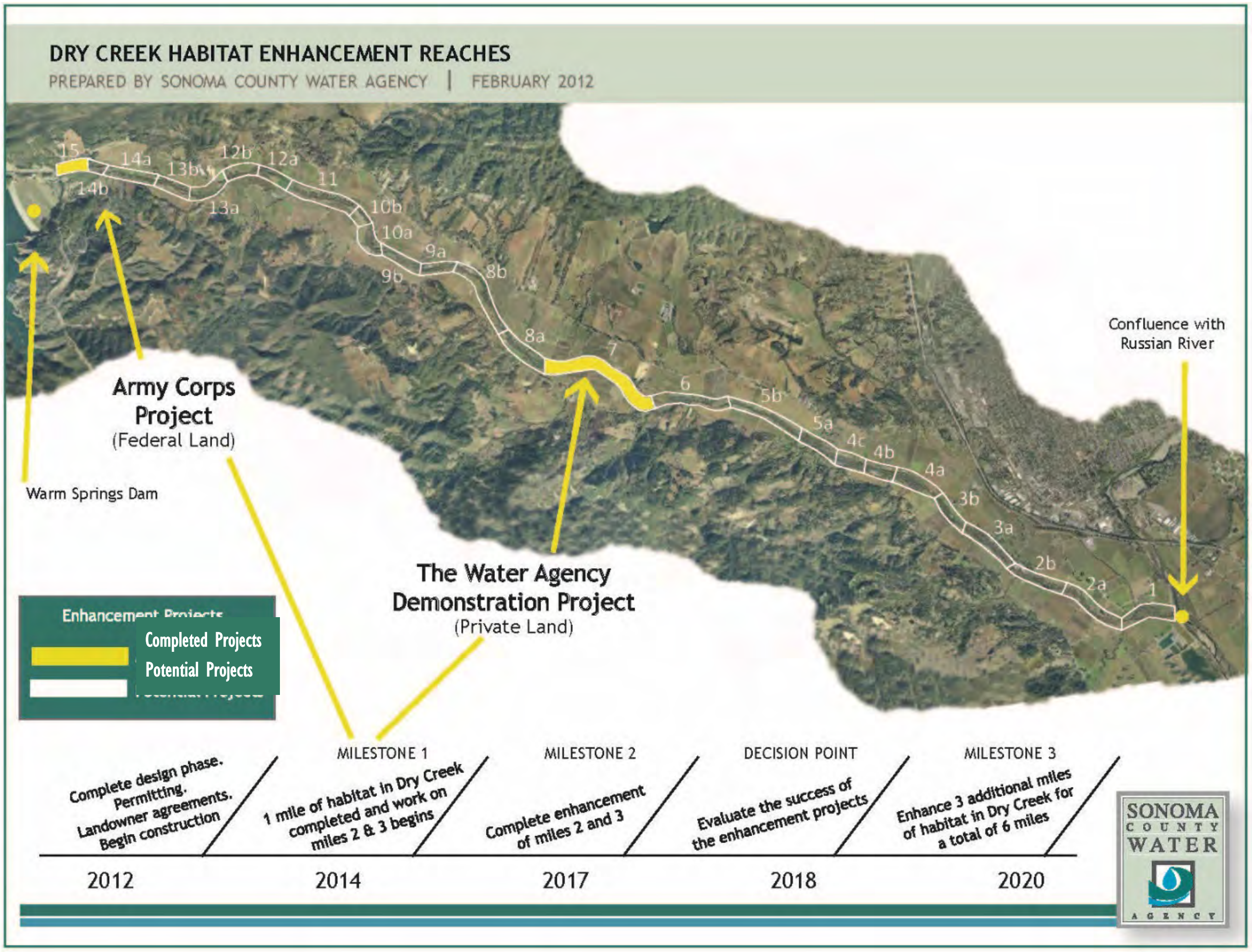


Figure 7. Dry Creek Restoration Milestones for Russian River Biological Opinion Requirements.

- Ongoing Corps Studies

Because there is an ongoing Corps feasibility study within the study area, the Dry Creek Ecosystem Restoration General Investigation, close coordination will be required during feasibility to ensure assumptions regarding the without-project and future-without project conditions are adequately captured.

- Land Availability

Implementation will be subject to land availability. Given the high percentage of land in private ownership, identification of feasible and available restoration sites and coordination with willing landowners could delay project delivery. The Sponsor has worked extensively since 2008 to landowners adjacent to lower Dry Creek and continues to work with supportive landowners to further their Dry Creek restoration goals and requirements.

- Real estate costs

The study area is about 95% privately owned. The cost to acquire land within the study area will be exorbitant as the majority of the land adjacent to the mainstem of Dry Creek consists of prime vineyards.

- Corps real estate requirements (e.g. the Standard Estate)

The standard estate for ecosystem restoration projects is Fee simple in accordance with ER 405-1-12, 12-9 b(6)). Although there is strong support throughout the community for the ecosystem restoration efforts, resentment towards the Corps has been expressed by local landowners in regards to the impacts to the Dry Creek system and private property from the construction and operation of WSD. Through ongoing landowner outreach over the past several years, SCWA has found that landowners as a whole are adamant that while they support the Federal ecosystem restoration projects they are not willing to provide fee title for project-required lands. The reasons are varied, but primarily center around maintaining clear, uncomplicated access to riparian water rights, a strong sense of personal connection with the creek, and the integral effect that ownership of the underlying creek bed and banks has on overall property values.

Based on this, it was recommended that a non-standard estate, i.e., perpetual easement, be considered. The guidance does allow for flexibility. For CAP 1135 projects, exceptions to this estate are provided in planning regulations ER 1109-2-100, Appendix F, Section F-20, 31 January 2007. It also provides that "the MSC may approve use of a permanent easement instead of fee for the implementation of the CAP ecosystem restoration project where use of such easement will satisfy project requirements and protect the project benefits." Changing an estate from fee to easement requires a final determination by Corps Headquarters. (ER 405-1-12). Water Rights related to fee title for construction and water right

Property owners rely heavily upon longstanding riparian water rights to irrigate their vineyards and view Dry Creek as a vital element of the local landscape and their property values. They will likely be unwilling to participate in the project if it limits these rights in any way. Under the non-standard estate perpetual easement purposed (see above) water rights should remain with the property owners, alleviating this concern.

- Design Consideration

Design cannot increase erosion from released wood as the project should avoid impacts to critical infrastructure such as bridges as well as to private property. Limiting erosion potential is being considered as a part of the project feature designs.

3. EXISTING ENVIRONMENTAL SETTING*

This chapter assesses the existing conditions project area and resources within the Dry Creek study area. It is organized by resource topic. This is not a comprehensive discussion of every resource within the study area, but rather focuses on those aspects of the environment that were identified as relevant issues during scoping or may be affected by the considered action alternatives. An analysis of the potential environmental effects of the proposed action is presented in Section 10.

3.1. PHYSIOGRAPHY

The Dry Creek basin drains 217 square miles from the interior Coast Ranges of northern Sonoma and southern Mendocino counties before entering the Russian River near the city of Healdsburg, 30 miles upstream of the Pacific Ocean (Figure 1) (Harvey and Schumm 1985). The northwest trending Dry Creek basin is 32 miles long and 7 miles across at its widest point, with elevations ranging from 3,000 feet (feet) at the drainage divide to 70 feet near the confluence with the Russian River (Figure 8). Dry Creek is the second largest tributary by area within the Russian River basin, but contributes the largest amount of annual runoff (USACE 1984). Current land use is dominated by agriculture (viticulture), but historical land uses, including forestry, grazing, and gravel mining, still influence the landscape.

WSD bisects and controls the upper 131 square miles of the basin (USACE 1984). The dam is located 13.9 miles upstream from the confluence of Dry Creek with the Russian River. Terrain upstream of the dam is steep and mountainous, with hillslopes exceeding 30 percent and channel slope ranging from 0.2 to 4 percent (Inter-Fluve 2010). Downstream of the dam, Dry Creek flows through a flat, relatively narrow alluvial valley with a channel slope ranging from 0.2 percent downstream near the Russian River to greater than 2 percent upstream near the dam (Inter-Fluve 2010). Major tributaries to Dry Creek are Cherry and Warm Spring creeks upstream of the dam and Pena and Mill creeks below WSD. Construction of WSD altered basin hydrology by reducing peak flows during wet periods and increasing base flow during dry periods. Dam emplacement also interrupted sediment transport, leading to incision and bed coarsening in downstream reaches (USACE 1987).

Figure 8. Dry Creek Watershed Boundary (in red)

3.2. GEOLOGY

The study area is a structurally-controlled valley bordered by the Great Valley Complex (Healdsburg terrane) to the east and Coast Range ophiolite and metamorphic rock units of the Franciscan Complex to the west (Table 4; Figure 9) (Inter-Fluve 2010). The sedimentary (Great Valley Complex) and volcanic and intrusive rock (Coast Range ophiolite) formations lie beneath the Quaternary alluvium of the lower Dry Creek floodplain. These alluvial deposits include the most recent stream channel and floodplain deposits and up to three terrace deposits dating back approximately 1,000 years (Harvey and Schumm 1985). The presence of intrusive and volcanic rock of the Coast Range ophiolite within the Dry Creek Valley is thought to be caused from depositional contact with the sedimentary rock of the Great Valley Complex, and is limited to the western flank of the valley. Therefore, it can be assumed that underneath the alluvial deposits the bedrock of the Dry Creek Valley is composed of sedimentary rock associated with the Great Valley Complex (Harvey and Schumm 1985).

Table 4. Potential rock types that may underlie Dry Creek.

River Reach	Adjacent Bedrock Type	Geologic Unit Affiliation
2	metagraywacke sandstone	Franciscan Complex
3, 4	graywacke sandstone, greenstone, and chert	Franciscan Complex
5	graywacke sandstone, greenstone	Franciscan Complex
5	basalt, diabase, gabbro, diorite, and serpentinite	Coast Range ophiolite
5, 6, 7, 8	sandstone, siltstone, and shale	Great Valley Complex
8	basalt	Coast Range ophiolite
9, 13	diabase, gabbro, and diorite	Coast Range ophiolite
14	diabase, gabbro, diorite, and serpentinite	Coast Range ophiolite
14, 15	graywacke sandstone	Great Valley Complex

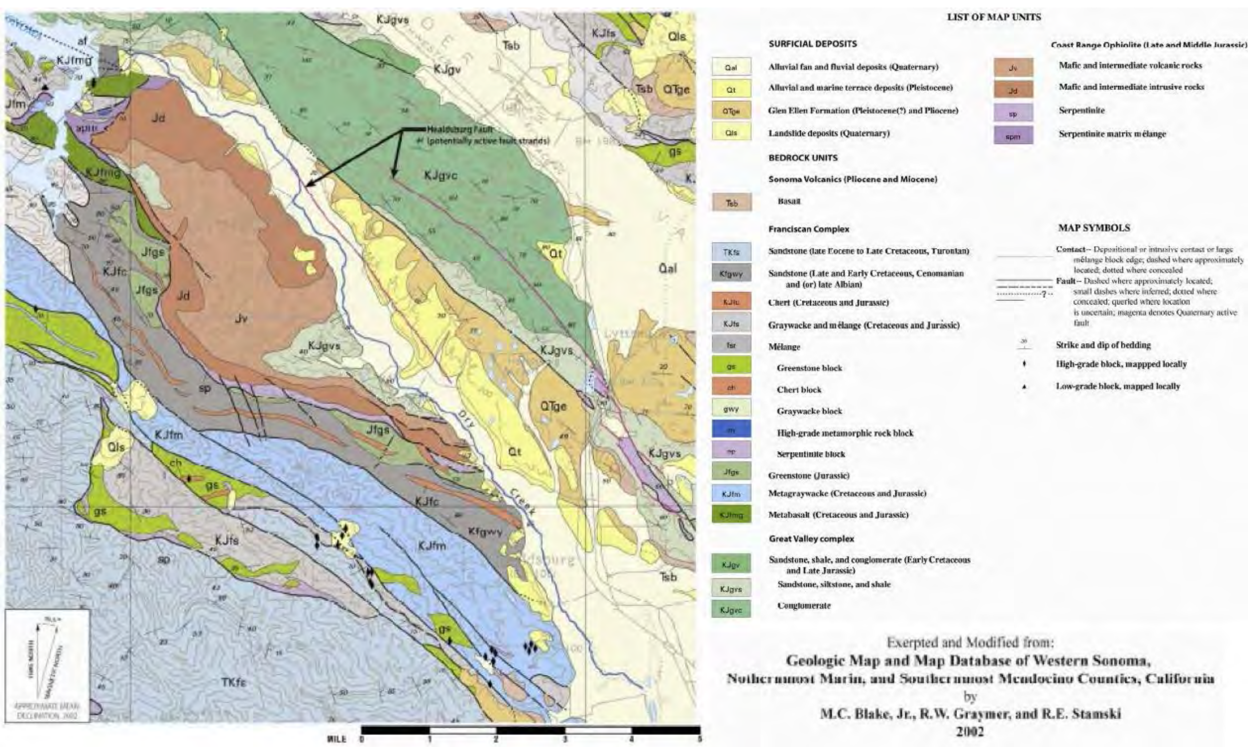


Figure 9. Geologic Map of the Lower Dry Creek Valley and Surrounding Areas, Sonoma County, California

3.3. Seismicity and Seismic Hazards

The seismic environment in the study area is characterized by the San Andreas Fault system, which formed at the boundary between the Pacific Plate and the North American

Plate. The major active faults in the vicinity of the study area include the aforementioned San Andreas Fault, as well as the Rodgers Creek, Healdsburg, and Maacama faults. The 1997 Uniform Building Code locates the study area and the greater San Francisco Bay Area within Seismic Risk Zone 4; areas within Zone 4 are expected to experience maximum magnitudes and damage in the event of an earthquake (International Conference of Building Officials, 1997).

Several strands of the Healdsburg fault are located within and immediately adjacent to Dry Creek (Bryant 1982). The Healdsburg fault system is a northwest trending, 1-2 kilometers wide extension of the Rodgers Creek fault to the south and is connected to the Maacama fault to the east by a lateral step-over (McLaughlin and Sarna-Wojcicki 2003). While the Healdsburg fault is not listed as active under the California Alquist-Priolo (AP) Earthquake Fault Zoning Act (Bryant and Hart 2007), both the Rodgers Creek and Maacama systems are zoned as active. Based on the evidence of structural relationship of the Healdsburg fault and the Rodgers Creek and Maacama fault systems, it should be considered potentially active (Inter-Fluve 2010).

Based on stereoscopic analysis of the aerial photos and digital imagery of the Dry Creek basin, Inter-Fluve (2010) found that one or more reaches of Dry Creek may be structurally controlled along traces of the Healdsburg fault or other features inferred to be associated with the fault. Several sections of lower Dry Creek have unusually low sinuosity for a stream in a dominantly alluvial drainage and Inter-Fluve interpreted these reaches to coincide with and/or parallel to mapped strands of the Healdsburg fault (Figure 10). In the upper segment, reaches 10–12 have portions located on or along the projected trace of a mapped fault strand and reaches 13–15 are generally aligned along a linear trend that parallels mapped strands of the Healdsburg fault. In the middle segment, low sinuosity portions of reaches 3–5 and 8–9 are also aligned parallel to the mapped strands of the Healdsburg fault (Inter-Fluve 2010).

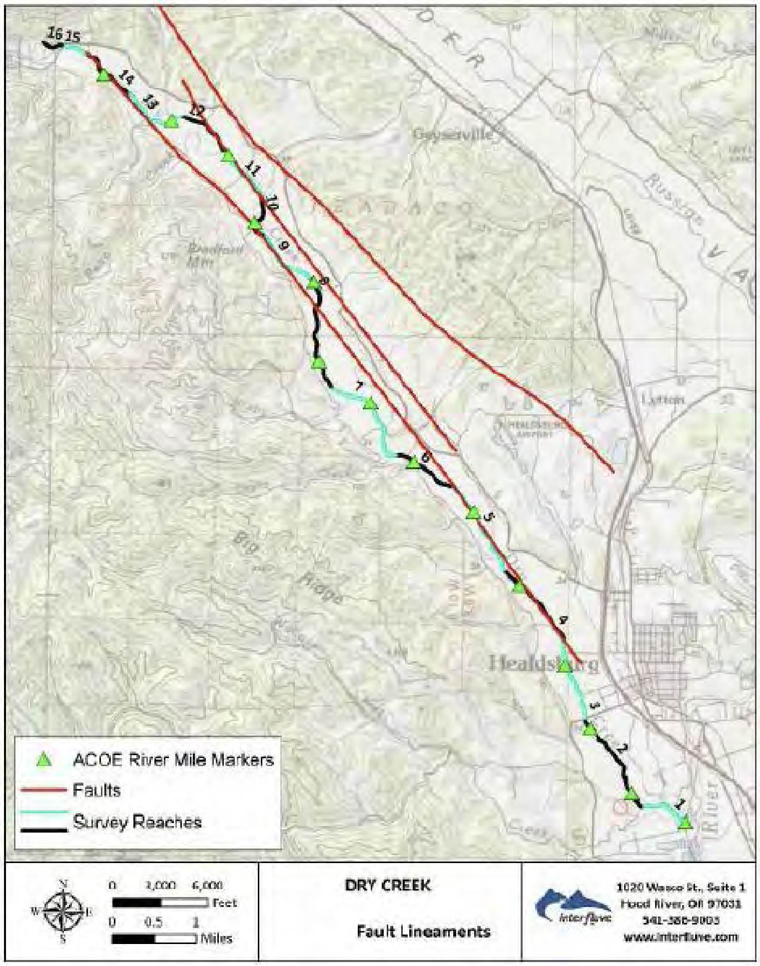


Figure 10. Lineaments of the Healdsburg fault along the Dry Creek Study area (from Inter-Fluve 2013).

3.4. SOILS

The soils found in the lower Dry Creek alluvial terraces and channels are sand, gravel and cobbles of varying types originating from tributaries and the adjacent deposits from Coast Range ophiolite, Great Valley Complex, and Franciscan Complex assemblages (Inter-Fluve 2010). The Yolo-Cortina-Pleasanton Association is the soil association found within Dry Creek Valley (Miller 1972). Surficial soils exhibit various characteristics dependent on location, slope, parent rock, climate, and drainage. Certain soils may have characteristics that could be problematic to buildings and infrastructure if not appropriately engineered. These characteristics include low permeability or susceptibility to expansion or soil erosion.

3.5. CLIMATE

The Dry Creek watershed lies within a region of Mediterranean climate, characterized by warm, dry summers and cool wet winters. Average monthly temperatures range from 47 degrees Fahrenheit in December to 70.5 degrees Fahrenheit in July (Figure 11). Mean annual precipitation ranges from 41.3 inches (Healdsburg) to 45.4 inches (WSD) in the vicinity of the study area, to greater than 60 inches in the coastal mountains that form the western boundary of the watershed. Over 90 percent of the precipitation falls between the months of October and April, with approximately 70 percent occurring between November and February (Western Regional Climate Center 2009). Snowfall is uncommon except in the highest elevations of the Coast Range.

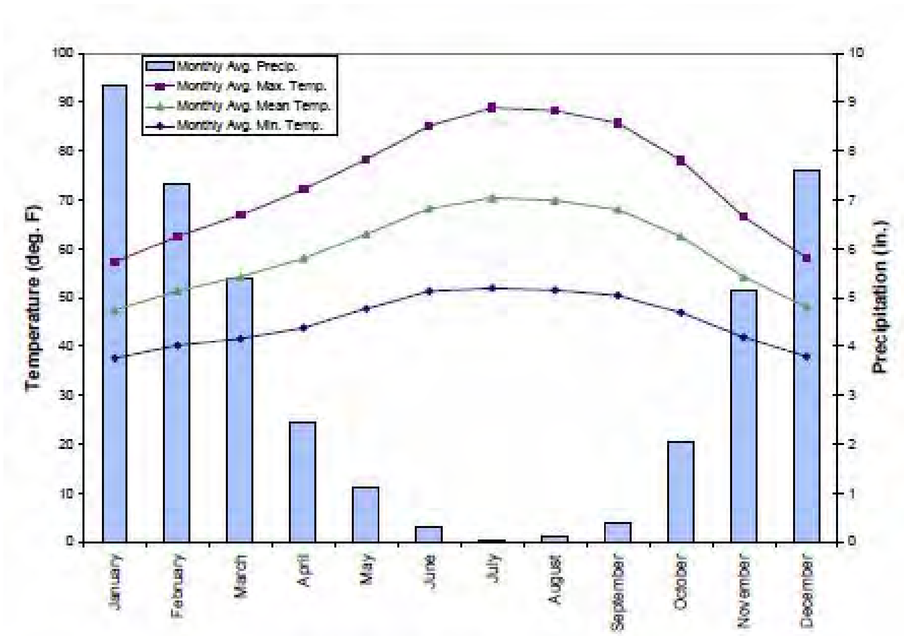


Figure 11. Mean monthly temperature and precipitation at Healdsburg (Station 043875) for the period 1893-2009.

3.6. HYDROLOGY

A 217 square mile watershed generates streamflow in lower Dry Creek. This area includes a 130 square mile area regulated by WSD and 87 square miles of unregulated catchments downstream of the dam. The unregulated catchments downstream of WSD consist of tributary watersheds and areas draining directly to Dry Creek from local agricultural areas (Figure 12). Principal tributaries to Dry Creek below WSD are Fall, Dutcher, Peña, Grape, Crane, and Mill creeks. The largest of these are Pena Creek (river mile 11) and Mill Creek (river mile 0.6).

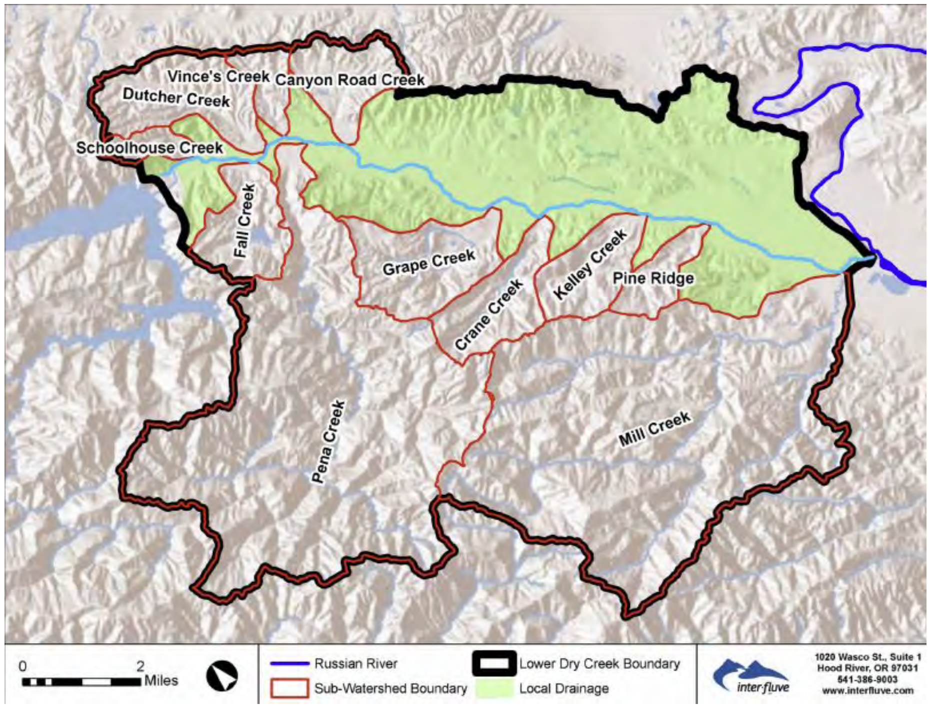


Figure 12. Sub-watershed boundaries in lower Dry Creek. Named tributaries outlined in red, while other areas directly tributary to Dry Creek are outlined in green.

Dry Creek has a seasonal hydrology pattern consistent with the Mediterranean climate and regulation by the WSD. Dry Creek experiences the greatest flows during late-fall and early winter and the lowest from summer to early-fall. The period of record for the Dry Creek near the Geyserville stream gage (October 1959 to present) encompasses pre- and post-dam hydrologic conditions (Figure 13). The characteristic pattern of the natural flow regime for Dry Creek prior to operation of the dam (before 1984) was seasonal with the creek running nearly dry each year in the summer and early fall (Figure 13). Flow rates under natural conditions increased three orders of magnitude during the winter. After operation of the dam commenced in 1984, the hydrologic regime converted from a seasonal runoff-based regime to a regime that combines moderate winter floods, year-round flows, and sustained, relatively high base flow conditions (Figure 13).

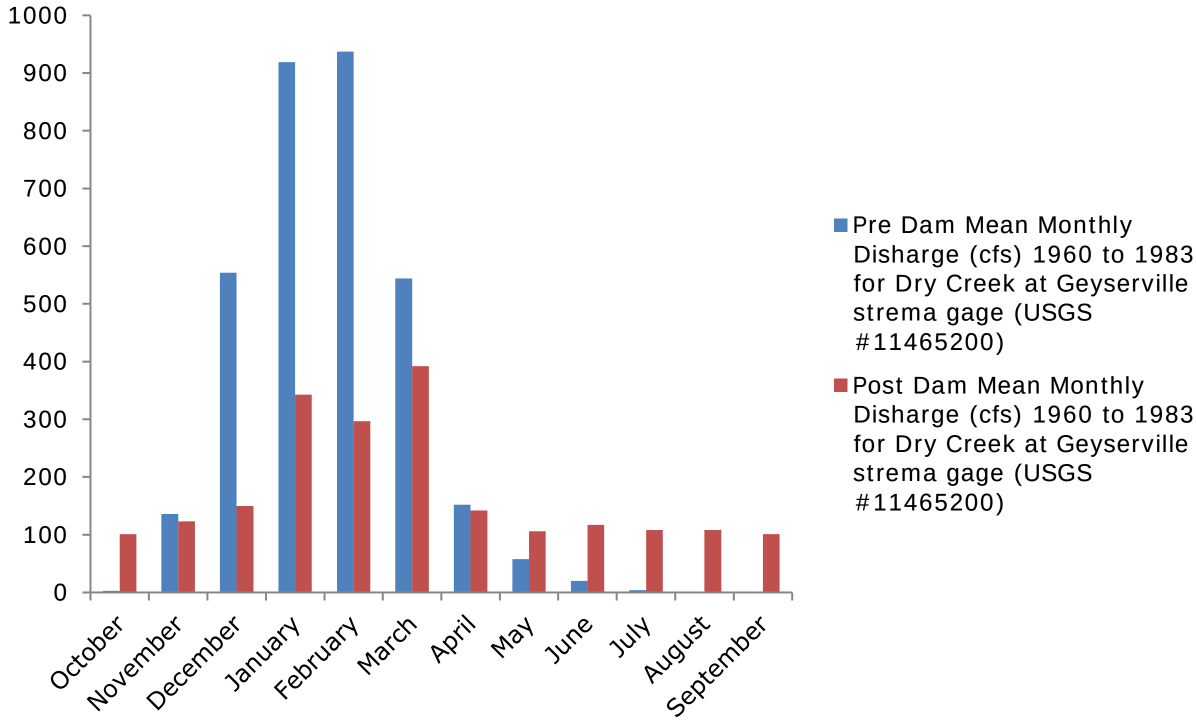


Figure 13. Median monthly flows (CFS) for Dry Creek at Geyserville stream gage (USGS #11465200) – Pre and Post WSD.

Regional hydrology dominated by winter flood events still occur in this November to March timeframe; however, the magnitude of such events are severely reduced compared to the unregulated period preceding dam construction. Prior to WSD, the Dry Creek near Geyserville stream gage showed a median annual peak flow of 16,600 cfs, with peak flows regularly exceeding 7,500 cfs (Figure 14; 20 out of 24 years from water year (WY) 1960 to WY 1983)[4]. After dam completion, median annual peak flow fell to 3,900 cfs and due to dam operations did not exceed 7,500 from WY 1984 to WY 2013.

[4] The instantaneous peak flow differs from the mean monthly flow peak described above. The instantaneous peak flow is the maximum flow reached during a water year [WY; October 1 through September 30]. The mean monthly flow peak is the average daily flow over an entire month.

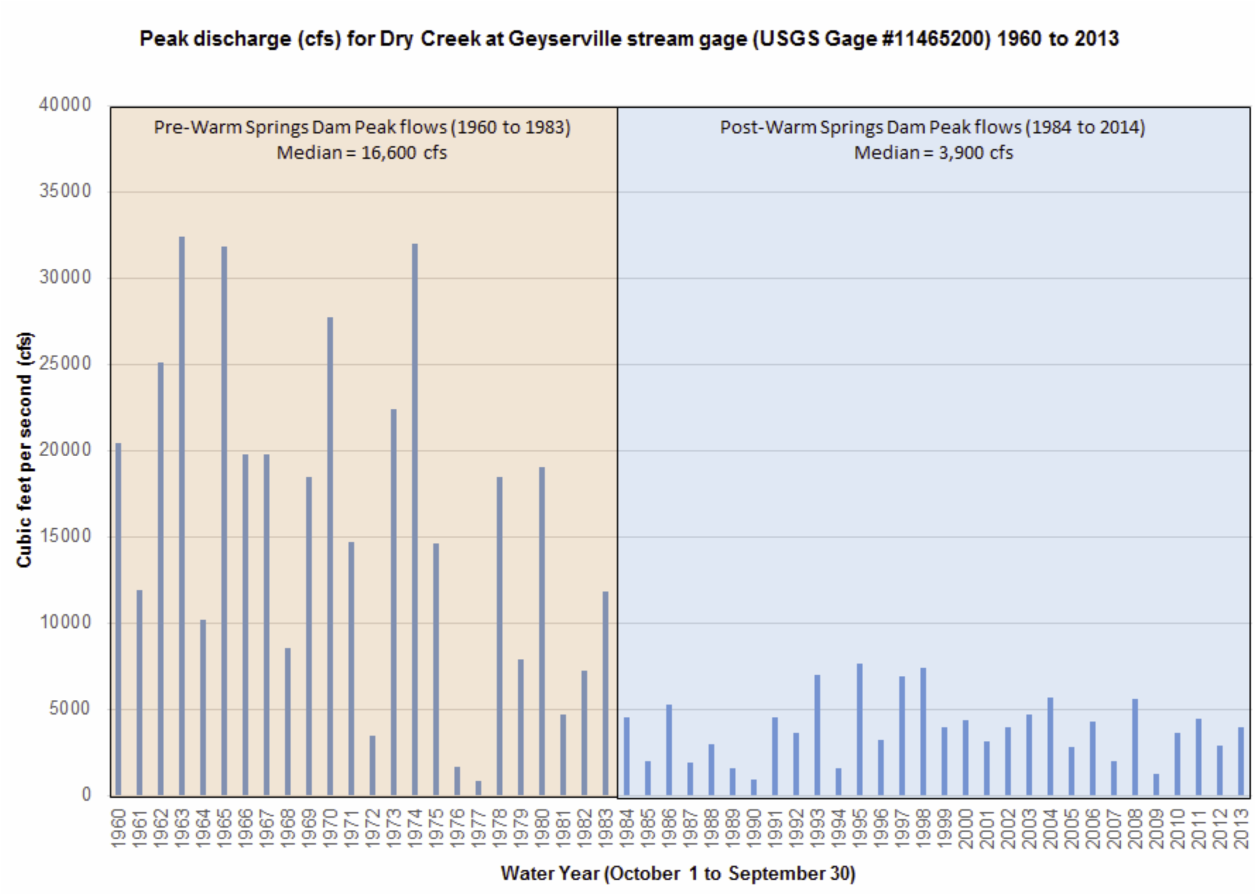


Figure 14.Pre- and Post-Warm Springs Dam Peak discharge (cubic feet per second) for Dry Creek at Geyserville stream gage (United States Geological Survey Gage #11465200) 1960 to 2013.

In addition to reducing the magnitude of peak flows by a factor of about four, regulation by WSD has substantially elevated base flow during the summer and fall seasons (Figure 14) SCWA holds water right permits issued by the State Water Resources Control Board (SWRCB) to divert[5] Dry Creek flows and to re-divert[6] water stored and released from within Lake Sonoma. The Lake Sonoma conservation pool holds 245,000 acre feet that constitute the principal municipal, domestic, and industrial water supply for most of the lower Russian River, and parts of Sonoma and Marin counties (SWRCB 1986; NMFS 2008). Whenever the lake elevation is within the water conservation pool, the SCWA directs the Corps to release from Lake Sonoma into Dry Creek and downstream into the Russian River. In 1986, the SWRCB released Decision 1610 which updated all minimum instream flow

[5] Divert – refers to water diverted directly from stream flows into distribution systems for beneficial uses or into storage in reservoirs.

[6] Re-divert – refers to water that has been diverted to storage in a reservoir, then is released and diverted again at a point downstream.

requirements for normal, dry, and critically dry water years for the Russian River basin. In normal water years, California State mandated minimum instream flow requirement in Dry Creek between WSD and the Russian River varies between 105 cfs in winter months and 80 cfs in the summer months. In dry and critically dry year conditions, the required summer instream flow on Dry Creek is 25 cfs. Typical flow rates are generally higher than these limits because of water supply requirements downstream of the Dry Creek and the mainstem Russian River confluence or because of flood control operations. The SCWA sets release levels to meet water supply needs in accordance with its water rights permits, SWRCB Decision 1610, and the Biological Opinion which sets maximum flow levels in order to avoid take of endangered species.

3.7. GEOMORPHOLOGY

Lower Dry Creek is an incised, perennial, alluvial gravel bed stream that has responded to significant human induced hydrologic and geomorphic change over the past 150 years.

3.7.1. Historic Watershed Management and Geomorphic Influence

The present condition of lower Dry Creek expresses the legacy of management in the basin, which extends back to the settlement of the valley starting in the 1850s. Harvey and Schumm (1985) conducted a geomorphic assessment of Dry Creek that described cross-sectional and longitudinal response to changes in land-use since 1850, the beginning of European settlement (Figure 15). At the time of European settlement, lower Dry Creek regularly spilled over its banks onto the historic floodplain, which is the area utilized for agricultural production today. Prior to 1850, forests covered 50 percent of the Dry Creek basin (Ritter and Brown 1971, as cited in Harvey and Schumm 1985). Settlers cleared up to 40 percent of these forests for grazing, resulting in increased surface and hill slope erosion and sediment delivery to the stream channel. This land-use change also increased stream discharge through decreases in infiltration and more efficient delivery of runoff from agricultural drainage systems. The stream channel responded by aggrading up to 3 feet, then degrading approximately 12 feet to reach an equilibrium base-level by 1900. The onset of gravel mining from the channel and floodplains caused further channel degradation in response to base-level lowering in the Russian River, an increase in extraction rates in Dry Creek from the 1950s to 1960s, and record annual runoff. By 1964 the Dry Creek channel incised another 10feet, resulting in channel instability and increased sediment yield to the Russian River. The rate of channel incision decreased by 1974, with Harvey and Schumm (1985) noting further degradation (2.4 feet) from the 1964 base-level. But, the systemic incision ceased just upstream of Lambert Bridge due to the presence of grade controlling Franciscan Formation bedrock outcrops. By 1984, Dry Creek downstream of Lambert Bridge lowered another 2feet, but appeared to reach a new equilibrium with the formation of a sinuous channel and adjacent gravel bars within the recently incised valleys.

The changes in land-use and the bed-level response also affected adjacent streambanks and tributaries entering Dry Creek. The systemic incision leading to a post-disturbance equilibrium, created a new fluvial and riparian environment, but also increased channel migration and bank erosion. The steep banks created by the (geomorphically) rapid incision were susceptible to failure from toe erosion (erosion at the base of the bank), leading adjacent landowners to armor banks with hard material, such as rip-rap and automobile bodies. The Corps added rip-rap bank protection, rock groins, pile walls, and willow planting as bank protection measures, and built drop structures crossing Dry Creek near the Westside Road Bridge to prevent channel degradation (USACE 1984). In response to base-level lowering in Dry Creek, tributaries to Dry Creek incised much like the incision of Dry Creek in response to base-level lowering in the Russian River. Consequently, tributaries experienced a similar channel evolution and management response as Dry Creek, with incision followed by widening and erosion, bank armoring to protect streambanks, and installation of grade control structures at the mouths of tributaries to prevent headward (upstream) erosion. The geomorphic response by Dry Creek and its tributaries to historical changes in land-use largely subsided by 1984.

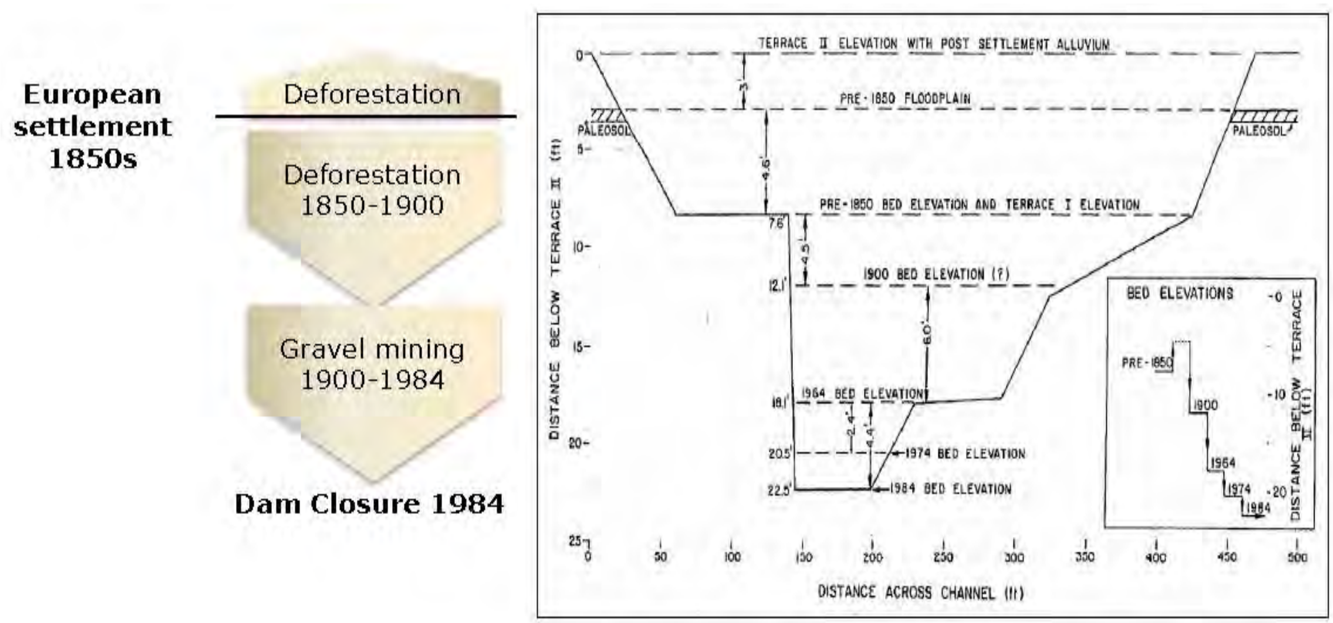


Figure 15. Dry Creek Channel evolution resulting from a history of geomorphic disturbance (from "Response of Dry Creek, California, to land use change, gravel mining and dam closure" Harvey and Schumm, 1987)

The completion of WSD in 1983 further altered the geomorphology of Dry Creek through changes in hydrology and sediment dynamics. The hydrology changed from seasonally runoff-based to moderate winter floods, perennial flows, and elevated summer base flows. Although peak flows are reduced, base flows have increased to provide continuous flow throughout the year along this traditionally seasonal stream (USACE 1987). The reduced peak flows prevented flooding downstream of the dam but still maintained the ability to transport sediment. Tributaries still contribute sediment to Dry Creek, but substantially less than Dry Creek in unregulated conditions. Channel incision in Dry Creek is moderated by the reduction of peak flows, but the current channel configuration is still effective at transporting current sediment load under regulated hydrology.

3.7.2. Current Dry Creek Geomorphic Conditions

At the time of this report, the study reach is primarily composed of pool-riffle and plane-bed morphology (Montgomery and Buffington 1997) with an average channel gradient of 0.18 percent. The channel corridor is generally narrow relative to the active channel width and relatively uniform in width over most of the study reach, with periodic wider reaches. Geomorphic function along Dry Creek varies according to the dominant processes at each location, and is determined by distance from WSD, location relative to unregulated tributaries downstream of WSD, and distance upstream of the Russian River. The unregulated tributaries moderate the influence of WSD on upstream sediment supply and flow regulation, while the backwater profile from the Russian River during floods directly affects the conditions in the downstream 3 miles of the study reach. The riparian-influenced channel form and regulated flows efficiently transport available sediment (Inter-Fluve 2013). Mobilization of bed sediment supports relatively infrequent, small riffles separated by long homogenous flatwater and pool habitats with high water velocities. Further, the discharge responsible for maintaining channel form is relatively frequent, occurring sub-annually, and of sustained duration, in contrast to large annual peak flows under an unregulated condition. Inter-Fluve (2013) calculated an effective discharge[7] of 2,500–3,500 cfs upstream of Peña Creek, approximate to a 2-yr recurrence interval flow[8]. Downstream of Peña Creek, effective discharge ranged from 700 to 1,500 cfs (<1-yr recurrence interval) at several locations, and approximately 3,000 cfs (approximate to a 2-yr recurrence interval flow) near Grape Creek, likely due to sediment input.

The current geomorphology of lower Dry Creek is a result of the interaction of local geology, watershed characteristics, hydrology, and vegetative characteristics; the legacy of channel evolution and response to land management changes; and the ongoing influence of flow management. The primary determinant of current geomorphic conditions is the influence of the dam, expressed through: modified sediment supply, altered hydrology, and the growth of riparian vegetation. Dam construction ceased delivery of bed material from

[7] The effective discharge is the discharge that transports the greatest volume of sediment over the long-term (Knighton 1998).

[8] Recurrence interval is the reciprocal probability of occurrence in any year. In other words, if a twice bankful flood is a 50-year recurrence interval (RI) flood, the probability of that flood happening in any one year is p=1/RI or 2%.

the upper 60 percent of the watershed. The hydrologic regime has been converted from a seasonal runoff-based regime to a regime that combines moderate winter floods, year-round flows, and sustained, relatively high base flow conditions. This shift substantially influences the mobility of the alluvial materials present in the creek. However, successive tributaries entering Dry Creek moderate the reduction in bed material supply. The regulated hydrology has also resulted in increased growth of riparian trees that influence bank erosion rates and sediment dynamics.

Assessments completed in close proximity to the time of dam closure concluded that systemic degradation of Dry Creek had generally ceased by the time the dam came online. The ability of Dry Creek to mobilize bed material varies throughout lower Dry Creek as some areas appear stable and other areas are slightly aggradational such as in Reaches 1 and 2 where backwater influences from the Russian River confluence are more pronounced. Field observations in combination with data collected during the field investigation provide a qualitative and quantitative perspective on the evolution of Dry Creek since closure of WSD, primarily with respect to channel degradation. These data are described in the Fish Habitat Enhancement Feasibility Study (Inter-Fluve 2013) and include repeat stream cross sections, longitudinal stream profiles, and USGS gaging station rating curves. These data show variability in channel position over time but do not suggest ongoing bed degradation except around Lambert Bridge where approximately 2-5 feet of bed lowering has been experienced since the original surveys performed in 1984.

Regulation has resulted in elevated summer base flow conditions that when combined with the Mediterranean climate produces near ideal conditions for growth of riparian trees and shrubs. Regulation has also resulted in severe curtailment of major floods, which limits disturbance and removal of newly recruited and established vegetation. The estimated highest maximum peak flow release from the dam (6000 cfs) is less than a 1-year flood for the unregulated period. Regionally, under unregulated conditions, riparian vegetation follows a successional pathway that begins with establishment on gravel bars (willow and cottonwood) and cut banks (alder) near or in contact with the streambed (McBride and Strahan 1984). Willows and cottonwoods dominate initially, but alders eventually dominate as they form a dense canopy that shades other species. As gravel bars grow laterally and horizontally due to deposition of fluvial sediment, rooting distance to ground and surface water increases, shifting species to those better adapted to floodplain and terrace environments. These later successional species, such as walnut, oak, and bay, eventually dominate the upper elevations of geomorphic surfaces once occupied by willow, cottonwood, and alder. The regulated hydrology interrupts this typical riparian succession.

The elevated summer base flows provide a constant water source for early-successional willow, cottonwood, and alders, and the lack of large peak flows prevents sediment deposition and the evolution of gravel bars to floodplains, and terraces. The combination of these effects has resulted in extensive vegetative colonization of formerly active bar surfaces – elevated base flow nurtures vegetative growth, while the lack of significant disturbance flows (floods) allows vegetation to flourish. Vegetative colonization of the bar surfaces has stabilized the formerly active morphologic features (Figure 16, right). This serves to limit lateral migration of the active channel within the channel corridor, and has the effect of sequestering a reservoir of gravel within the system. In lower Dry Creek, even-aged stands of alder trees dating to various eras (confirmed through selected tree coring) mark the elevations of terraces and bar surfaces that were abandoned or active at the time of dam closure (Figure 16, left). As such, riparian succession in Dry Creek remains in an early stage of succession dominated by a dense alder community that covers gravel bars and prevents lateral channel migration and concentrates flow (and velocity) within the channel (Inter-Fluve 2010). The result is a system with little lateral migration and a channel effective at transporting sediment supplied from tributaries (due to consistently high water velocity) despite regulated flow.

Figure 16. Example of riparian vegetation conditions and its impact on lower Dry Creek geomorphology (Source: Inter-Fluve 2010)

Right - Vegetative colonization of bar surface, river mile 12.3
Left - Riparian trees date alluvial features at river mile 10.3 near confluence of Canyon Road Creek. The larger tree at left on terrace dated to 1984-86. The smaller tree at right dated to 1995-97.

Mature vegetation and dense understory growth hydraulically roughen bank areas and concentrate high flow velocities in the channel during high flow events (Figure 17). Under the current flow regime, high flow events that do occur have longer durations than similar flows that occurred during the pre-dam period, further facilitating transport of sediment. Combined, these factors have likely contributed significantly to areas of local bed scour since the closure of the dam, as observed by long-time Dry Creek landowners (Rued 2009).

Figure 17. Example of vegetative narrowing of channel corridor near Lambert Bridge (river mile 6.6).

Lambert Bridge is seen at lower right of each frame. Dry Creek flow is from top to bottom. Left frame is from 1976, right frame is from 2004. Light blue line is estimated limit of active fluvial features in 1976.

The combined factors of regulated hydrology, altered sediment supply, and colonization by riparian vegetation have led to evolution of a contemporary channel shape that is significantly smaller than the historic channel. Today's 'active' lower Dry Creek channel is defined as the predominantly open channel, flanked by riparian vegetation in the overbank areas (Figure 18).

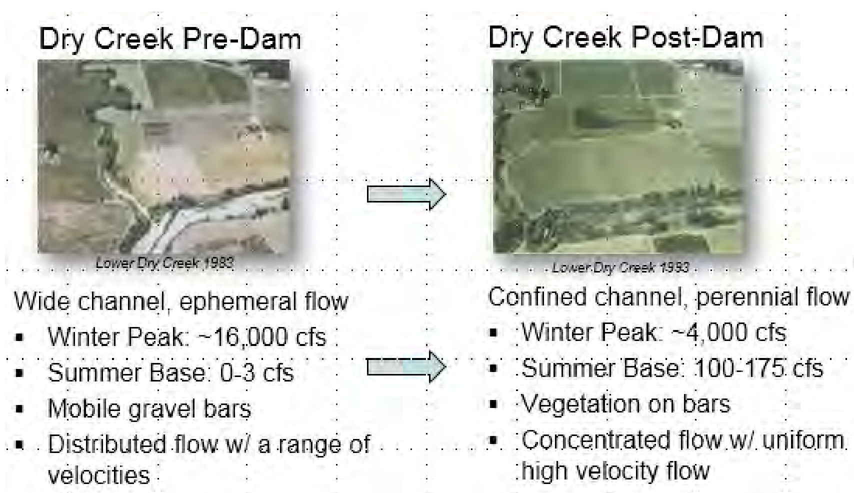


Figure 18. Pre and Post WSD Channel Conditions

3.7.3. Hydraulics and Sediment Transport

A planning-level one-dimensional hydraulic model was developed for the 13.9 mile study reach using bathymetric and topographic data collected during 2009 and 2010 field surveys, supplemented by LiDAR data. The model was calibrated to observed water surface elevations and surveyed high water marks. Model results were used to examine trends in sediment mobilization and effective discharge characteristics, and flood inundation patterns.

To evaluate general trends in the ability of Dry Creek to mobilize and convey sediment, channel competence-based calculations were completed. These calculations compared the shear stress needed to mobilize bed sediments with the shear stress exerted by flow in the channel at several discharge levels. The results suggest that surface substrate may be mobilized at all of the locations that were analyzed for the 2- and 10-year flood events, while moderately high flows occurring at a sub-annual frequency are able to mobilize surface sediments in select locations. The flow that is exceeded at least 20 percent of the time in winter months is able to transport the bed sediment load at many locations. These patterns are modified by the backwater profile created by the Russian River during large floods in the lower three miles of the study reach, which reduces the ability of Dry Creek to transport sediment in this stream segment.

Effective discharge, or the flow (or flow range) which transports the greatest cumulative volume of bed sediment over the long term, was estimated at several locations along the reach. The results reflect the influence of WSD and the unregulated tributaries below the dam on channel processes and are consistent with the results of the bed sediment mobility analysis. At select locations downstream of Pena Creek, the effective discharge is estimated to occur on a sub-annual basis. Between Pena Creek and WSD, the effective discharge is estimated in the range of a 2 – 3 year return interval flood event. The results of the effective discharge and sediment mobility calculations are consistent with field indications which suggest that Dry Creek has evolved to a condition which efficiently transports the bed sediment supplied to the reach despite the drastically reduced flood hydrology.

3.8. Water Quality

3.8.1. Temperature

The release of water from Lake Sonoma is not only regulated for flow, but also for temperature. Water released from the lake through a combination of inlet structures positioned at various depths provides for water temperatures that are suitable for the DCFH operations for hatching. These temperatures persist in lower Dry Creek. At the USGS Dry Creek below Lambert Bridge stream gage (USGS 11465240) in 2012, 2013, and 2014, maximum temperatures were observed to range from approximately 54°F (12°C) to 62°F (17°C) during those monitoring seasons.

3.8.2. Dissolved Oxygen

Current temperatures in Dry Creek compared to pre-dam conditions allow for higher concentrations of dissolved oxygen to be contained within the water column during the warmer dry season months. Consequently, dissolved oxygen data collected at Dry Creek below Lambert Bridge stream gage had concentrations that ranged between approximately 8.8 mg/L to 12.2 mg/L from May through October for the years 2012 through 2014. Dissolved oxygen concentrations of at least 7mg/L are typically considered suitable for rearing salmonids.

3.8.3. Suspended sediments

The term "suspended and settleable solids" is descriptive of the organic and inorganic particulate matter in water (USEPA 1986). Suspended sediments can affect temperature and dissolved oxygen concentrations, which in turn can affect the availability of suitable salmonid habitat. Water clarity can be affected by releases of solids into a stream course and by the disturbance of sediments within the stream from streambed alteration or modification activities. Turbidity is a measurement of the clarity of the water column and more turbid conditions are generally associated with elevated levels of suspended and settleable solids in the water column. Suspended sediment causes a range of environmental damage, including benthic smothering, and irritation of fish gills (Davies-Colley and Smith 2001).

The USGS has been collecting turbidity data along with temperature and dissolved oxygen data at Dry Creek below Lambert Bridge stream gage since 2012. Seasonal turbidity data collected at Dry Creek below Lambert Bridge stream gage in 2012 and 2013 were observed to have a maximum daily value of 5.4 Nephelometric turbidity units (NTU) and 6.8 NTU, respectively, whereas the maximum daily value observed in 2014 was 110 NTU. The 2014 maximum daily turbidity value of 110 NTU was recorded on 11 August and occurred during SCWA construction activities on the Demonstration Project, the first mile of restoration required by the Biological Opinion. Overall, there were several days between June and October with elevated turbidity levels that occurred during Demonstration Project construction activities in 2014. These elevated turbidity levels during construction were generally associated with times when creek flow was initially reintroduced back into a habitat feature area after it was constructed. Although daily maximum values were significantly higher in 2014 than in 2012 or 2013, during which time construction of the Demonstration Project also occurred, these elevated values were associated with brief spikes that typically lasted several minutes to a few hours. During these brief spikes in turbidity, temperatures and dissolved oxygen concentrations at the stream gage were observed to remain consistent with temperature and dissolved oxygen concentrations being recorded before and after Demonstration Project construction activities. Temperature and dissolved oxygen concentrations in 2014 also remained consistent with seasonal concentrations recorded during 2012 and 2013.

3.9. AIR QUALITY

Air quality is regulated by the National Ambient Air Quality Standards established by the Federal Clean Air Act, as amended in 1990. The Clear Air Act and its associated regulations were developed to protect the public from exposure to dangerous levels of six criteria air pollutants: ozone, particulate matter (PM10 and PM2.5), carbon monoxide, nitrogen dioxide, sulfur dioxide, and lead. The California Air Resources Board (CARB) is the agency responsible for coordination and oversight of state and local air pollution control programs and is primarily responsible for developing and implementing air pollution control plans to achieve and maintain the NAAQS.

The study area is located within the North Coast Air Basin (NCAB), which encompasses Del Norte, Humboldt, Trinity, and Mendocino counties, as well as the northern portion of Sonoma County. The NCAB is comprised of three air districts, the North Coast Unified Air Quality Management District (NCUAQMD), the Mendocino County Air Quality Management District, and the Northern Sonoma County Air Pollution Control District (Northern Sonoma County APCD). The study area is under the jurisdiction of the Northern Sonoma County APCD, which includes the northern portion of Sonoma County, the portion of the county that falls within the NCAB. Please see Figure 19 below that shows the boundaries of the districts and air basins within Sonoma County (SCWA 2015).

The Sonoma County portion of the NCAB is considered in attainment[9] or unclassified for all of the State and federal AAQS (NCUAQMD 2015). Under the California Clean Air Act, areas not in compliance with a State or federal standard must prepare an air pollution reduction plan. Since the northern Sonoma County portion of the NCAB is in attainment status for all criteria pollutants, it is not required to have an air pollution reduction plan.

Construction and demolition, mineral excavation and processing, agricultural activities, paved road dust, unpaved road dust, residential wood burning, and electric utilities released the majority of particulate matter detected in the Northern Sonoma County APCD in 2012 (CARB 2013). Measurements of ozone and PM10 by Northern Sonoma County

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[9] A region is considered an "attainment area" or "in attainment" if it meets or exceeds an air quality standard. An area is considered a "nonattainment area" or "in nonattainment" if it doesn't meet an air quality standard. An area may be in attainment for some criteria pollutants and in nonattainment for others simultaneously.

APCD at its two closest stations in the study area indicate there has been one exceedance of a state standards between 2012 and 2014; the highest 24 hour average for PM10 exceeded state standards during one day in 2013.

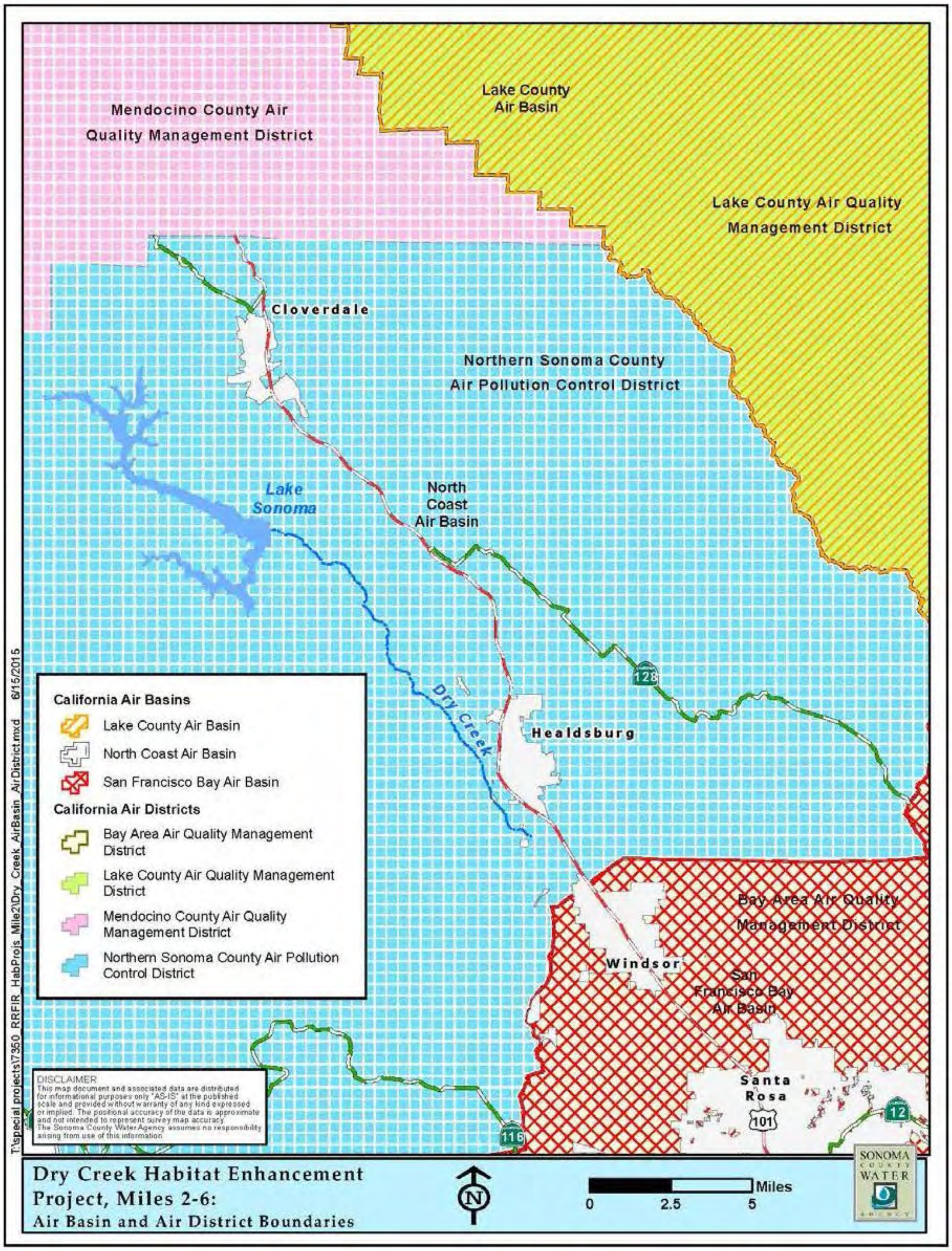

Figure 19. Air Basins and Air Districts in the study area.

3.10. CLIMATE CHANGE

Globally, climate change has the potential to impact related to future air temperatures and precipitation patterns numerous environmental resources. SCWA partnered with USGS to study the influence of climate change on the hydrology of the Russian River and, in particular, to develop downscaled climate futures for the Russian River and Sonoma County. Results of this study predict warmer temperatures overall; longer, drier summers; increased variability (and reduced reliability) in rainfall, which could indicate either an increase or a decrease in total rainfall; increased soil moisture deficit; and reduced groundwater recharge (USGS 2012).

A local consortium, the North Bay Climate Adaption Initiative, has incorporated the results of this USGS study to develop projections for Sonoma County climate and hydrology given a set of four potential scenarios:

1. high Green House Gas (GHG) emissions with more precipitation;
2. high GHG emissions with less precipitation;
3. mitigated GHG emissions with more precipitation; and
4. mitigated GHG emissions with less precipitation.

According to Climate Ready Sonoma County: Climate Hazards and Vulnerabilities (2015), in all four scenarios, the study area will likely experience, among other hazards:

1. More extreme heat events: longer and more frequent droughts, greater frequency and intensity of wildfires, and fewer winter nights that freeze.
2. More variable rain: bigger, more variable floods.

3.11. NOISE

The primary contributors to the noise environment in the Study area include vehicle traffic on adjacent roads; vineyard and winery operations; airplane over-flights; sounds emanating from residences; and naturally occurring sounds such as wind and wildlife, etc. Roadways in the study area include Dry Creek Road, West Dry Creek Road, Skaggs Spring Road, West Side Road, Lambert Bridge Road, Yoakim Bridge Road and Highway 101. The proposed project is located in an agricultural area that is subject to temporary and periodic increases in traffic-related noise as a result of the movement of farm equipment, the transport of grapes in heavy-duty trucks, tasting room operation, and special events.

In addition, noise related to vineyard and winery operations can be a concern during the harvest season, when farm equipment is used heavily and grapes are loaded and unloaded using forklifts and heavy duty trucks. Truck deliveries associated with bulk wine or bottled wine can also be a source of noise complaint from adjacent residential uses. Noise producing equipment used at wineries includes air compressors, grape presses, exhaust fans, chillers and bottling plants. Use of this equipment and other related activities may create noise levels above and different from the ambient noise environment. Nearby residents may complain about the noise from these activities, but given the seasonal nature of winery activities, noise impacts from normal winery operations are usually considered to be less than significant (Sonoma County Permit and Resource Management Department 2012). Additional noise sources may include other man-made localized sources or special events (i.e., weddings, the Annual Passport to Dry Creek Valley, the Annual Wine and Food Affair, the Annual Winter WINEland, and the Annual Barrel Tasting).

3.12. Ecological Setting and Resources

3.12.1. Vegetation Communities

Vegetation communities and wildlife habitats in the Dry Creek watershed include a mosaic of herbaceous, shrub, and tree dominated types as well as aquatic and developed types. Broad vegetative community categories within the watershed include scrubs and chaparrals, oak savannas and woodlands, coniferous forests and woodlands, grasslands, vineyards, and riparian communities. Historically, these communities provided habitat for a rich diversity of terrestrial and wetland plant and animal species. Although many of the species that historically occupied the watershed are still present, some are now non-existent or extremely rare, or have had their numbers substantially reduced. Such loss or reduction in species diversity has been attributed to habitat loss and a variety of other complex factors (Sonoma County Water Agency and Circuit Rider Productions, Inc. 1998).

Classification and Assessment with Landsat of Visible Ecological Groupings (CALVEG)[10] identifies three dominant vegetation communities in the Dry Creek Valley and several vegetation communities in the surrounding hills. The dominant vegetation communities in the surrounding hillsides from WSD to the confluence with the Russian River, as classified by CALVEG and the CDFW's California Wildlife-Habitat Relationships System, include: vineyard, montane hardwood, redwood, montane hardwood-conifer, douglas-fir, and mixed chaparral. Developed and landscaped riparian forest and woodland are the primary vegetation communities in the study area. Riparian vegetation occupies lands adjacent to streams, creeks, and rivers where water may be permanent or ephemeral. The composition of riparian vegetation is greatly influenced by the physical processes of the adjacent aquatic habitat; species that are found in the active channel are usually not the same as those found on the floodplain. The vegetated sections of stream banks within the study area are dominated by an overstory of red, arroyo and sandbar willows (*Salix laevigata*, *S. lasiolepis,*

[10] The CALVEG classification system adheres to a set of U.S. Forest Service standards and procedures established at the national and regional levels to classify existing vegetation in California.

and *S. exigua*), white alders (*Alnus rhombifolia*), cottonwood (*Populus fremontii*) and occasional box-elders (*Acer negundo*), buckeyes (*Aesculus californica*), and coast live oaks (*Quercus agrifolia*).

The frequency of natural disturbances is important in influencing natural successional stages and, consequently, diversity, of riparian ecosystem habitat (establishment and replacement phases illustrated in Figure 20). Plants in active channel areas, which are regularly flooded, are adapted to high levels of flood disturbance during the winter, often with substantial velocity and scour, while tolerating the dry conditions of the gravel bars during the summer.

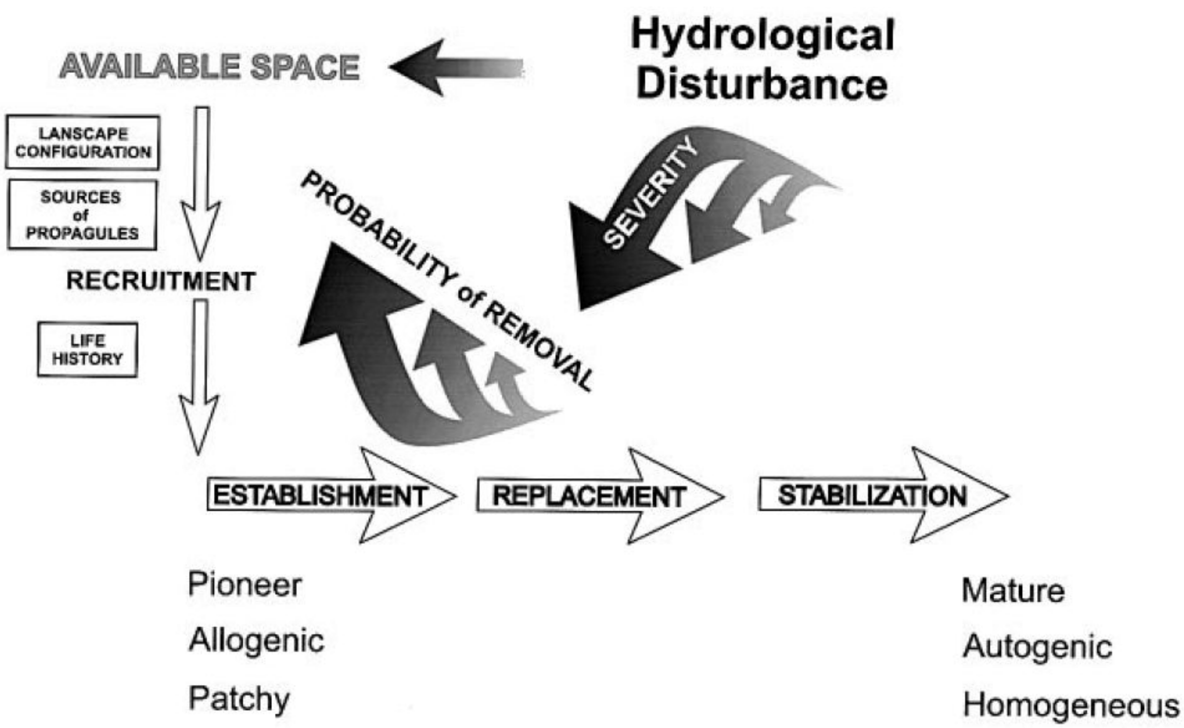

Figure 20. General scheme of plant succession in the riparian zone (Source: Tabacchi et al, 1998) Hydrological disturbance creates space available for recruitment of new individuals or species. At the opposite end, the stabilization of the succession tends to produce mature stands following autogenic changes to the Landscape.

Alternatively, floodplains are at higher elevations than the active channel and characterized by many more species and additional structural complexity (e.g., canopy layer, shrub layer, vine layer, and herbaceous layer) than the active channel. Such plants are adapted to flood scour and do not require as much summer moisture. Typical understory species occupying the floodplains within the Dry Creek study area include a mixture of Himalayan blackberry (*Rubus armeniacus*), California blackberry (*Rubus ursinus* var. *ursinus*), escaped grape (*Vitis vinifera*), mugwort (*Artemisia douglasiana*), and periwinkle (*Vinca major*). A few open areas without an overstory component exist within the study areas. These open areas are typically dominated by annual grasses (*Avena fatua, Bromus diandrus, Hordeum murinum, Lolium multiflorum*) and other herbaceous plants (*Verbascum thapsus, Melilotus albus, Hirschfeldia incana*).

The quality and range extent of plant communities in the Dry Creek watershed have been impacted over time by: habitat conversion and disruption of natural hydrological/ geomorphological processes; timber harvest; altered flood frequency; fire suppression; lack of regeneration and disease; overgrazing; invasion by exotic plant species; and altered hydrology. The combination of flood regulation and water supply operations, in particular, has resulted in extensive vegetative colonization of formerly active bar surfaces, stabilizing succession trends and leading to homogenous mature stands (stabilization phase illustrated in Figure 20). Colonization of the bar surfaces serves to limit lateral migration of the active channel within the channel corridor, and has the effect of sequestering a reservoir of gravel within the system. Mature vegetation and dense understory growth hydraulically roughen over bank areas and concentrate high flow velocities in the channel during high flow events. Additionally, all but the highest winter flood flows are able to access adjacent floodplain habitat already constrained by development. These high winter flood flows when slowed by the mature riparian vegetation causes sedimentation that builds up the floodplain terraces, further disconnecting them from the stream channel and limiting aquatic species access to important floodplain habitat.

Figure 21 provides a simplified diagram comparing a more natural riparian vegetation community (left) compared to the disturbed vegetation community (right) in the Dry Creek corridor.

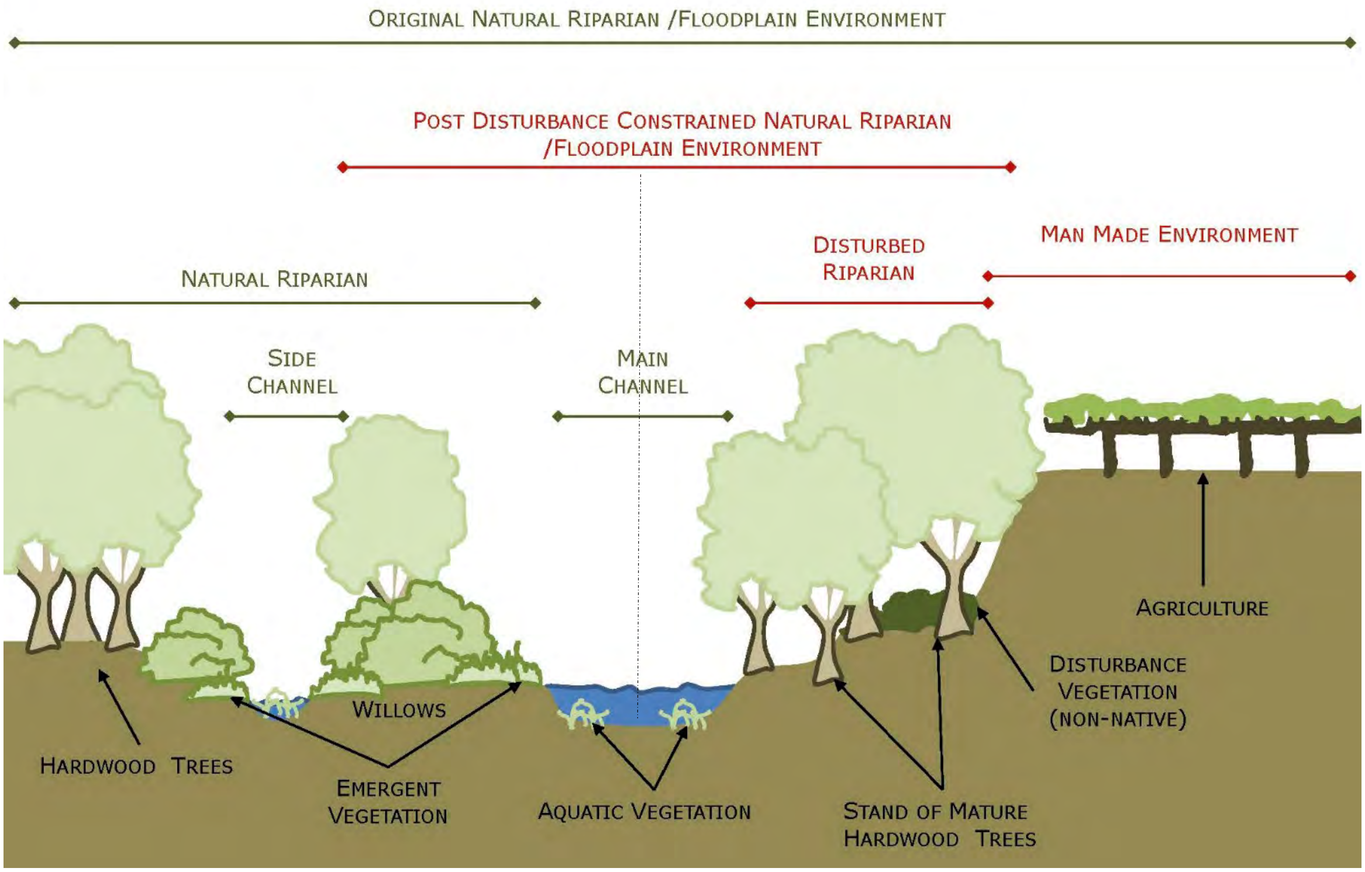

Figure 21. Natural (left side) versus disturbed (right side) riparian vegetation communities

Special Status Plant Species

In some cases, plant species have been locally extirpated from the watershed or are entirely extinct throughout their range. Two special-status plant species have been documented as occurring or potentially occurring in the vicinity of the study area[11]. These include the Northern California black walnut (*Juglans hindsii*) and Hayfield tarweed, also called white seaside tarplant, (*Hemizonia congesta ssp. congesta*). Seventy special-status species are considered unlikely to occur or to have a low potential to occur within the study area.

Invasive Plant Species

The Dry Creek watershed contains a number of invasive plant species that interfere with both economic activities and ecologic functions. Some of the species that most threaten native ecosystem function and structure include: giant reed (*Arundo donax*), yellow

[11] Based on review of the California Native Plant Society Electronic Inventory for special-status species (i.e. endemic, rare, threatened, or endangered) occurrences and a review of federally endangered and threatened species as identified by the USFWS as well as completion of field surveys.

starthistle (*Centaurea solstitialis*), jubata grass and pampas grass (*Cortaderia sp.*), Scotch broom, (Cytisus scoparius), cape-ivy (*Delairea odorata*), French broom (*Genista monspessulana*), Tamarisk species, Vinca species, water primrose (*Ludwigia sp*.), smooth cordgrass (*Spartina alterniflora*) dense-flowered cordgrass (*Spartina densiflora*), Spanish broom (*Spartium junceum*), pepperweed (*Lepidium latifolium*), and gorse (*Ulex europaeus*). Throughout the watershed, governmental and non-governmental agencies are collaborating to eradicate non-native plant populations where possible and stop their spread where eradication is not practicable.

3.12.2. Aquatic Habitat

By decreasing natural flow variability and simplifying basic geomorphic processes within the lower mainstem channel of Dry Creek, over time, land use impacts and WSD operations have led to a simplified straightened channel that is disconnected from its floodplain in most places. This has contributed to the reduction of aquatic habitat complexity along the lower Dry Creek mainstem important for native aquatic and riparian species. The combination of altered hydrology and vegetation growth patterns have curtailed the fluvial processes which erode and deposit bars in the active channel, and create lateral habitats such as alcoves, backwaters, and side channels (Inter-Fluve 2011). Specifically, this has led to a reduction of aquatic areas with low velocity summer and winter flows for native species to rest and a reduction in cover for fish and wildlife.

An aquatic habitat inventory performed by Inter-Fluve (2010) identified and characterized individual habitat units (main channel pool, scour pool, riffle, flatwater, cascade, alcove, and side-channel) along lower Dry Creek. The inventory adapted methods from Bisson et al. (1982), United States Forest Service Region 6 Level II stream survey methods (USFS 2006), and CDFW Salmonid Stream Habitat Restoration Manual (Flosi et al. 1998) to characterize aquatic habitat. The habitat inventory occurred in fall 2009 during summer operational discharge conditions of approximately 100 cfs from Warm Springs Dam.

Individual habitat units were defined as follows (Inter-Fluve 2010):

- Main Channel Pool (P): Pools are areas with very low velocities and multiple flow vectors, spanning at least 60% of the channel width, with minimum residual depths of 2.0 feet. Water surfaces are flat.
- Scour Pool (SP): Pools that consist of less than 60% of the channel width and are often associated with large wood, sharp meander bends, or boulders and have residual pool depths of at least 2.0 feet.
- Riffle (R): Riffles have obvious surface turbulence and are typically shallow water with low to moderate slopes (<4%). Water velocities are greater than 1 ft/s.

- Flatwater (F): Flatwaters have little surface turbulence and lack significant residual depth (less than 2 feet), with water velocities greater than pools. Flatwaters are deeper than riffles. Water surfaces are gently sloping, and velocity is less riffles.
- Cascade (C): Cascades are steep gradient (>4%) riffles with short falls, plunges or chutes typically dominated by boulders or bedrock.
- Alcove/Backwater Pool. (A): Alcove/backwater pools are pools located off the main channel in alcove or backwater areas. These units do not have a downstream flow component at the time of the survey.
- Side Channel Pool/Riffle/Flatwater (SC/P, SC/R, or SC/F): Side channels split from the main channel and reconnect downstream. These are categorized as side channel pools, riffles, or flatwaters based on the dominant habitat type in the side channel.

Another habitat type included in the current conditions assessment is winter refuge habitat. Winter refuge zones are floodplain areas where fish can escape high velocities in the main stream channel during high winter flow events. Juvenile fish have been shown to use inundated floodplain habitats and benefit from seasonal access to terrestrial food sources, such as insects that live in the soil or on terrestrial vegetation (Inter-Fluve 2015). The RRBO identifies restoration of winter rearing habitat to address the displacement of over-wintering coho by high flows associated with flood control releases as a primary objective of the Reasonable and Prudent Alternatives for Dry Creek (NMFS 2008). According to the RRBO, winter refuge habitat should provide high quality shelter during high flow releases.

Generally, the habitat inventory concluded that the availability of existing rearing habitat was limited in Dry Creek, particularly for coho salmon (Inter-Fluve 2011). Lower Dry Creek as a whole contains 23 percent pools, 7 percent scour pools, 26 percent riffles, and 44 percent flatwater, and less than 1 percent cascades by frequency of main channel habitats. Instream rearing habitat is limited primarily by the presence of swift velocities in the Dry Creek main channel and relatively limited habitat structure and complexity. Flow velocities on average are higher than those seen under unregulated, natural conditions. For instance, preliminary analysis indicates that pool velocities ranged from 0.2 to 1.3 feet per second (ft/s) with an average of 0.6 ft/s, higher than the 0.2 ft/s target pool velocity required by listed salmonid juveniles according to the RRBO (Inter-Fluve 2011; Figure 22). Average maximum and residual pool depths were 5.2 and 3.6 feet respectively. The overall quantity of pool habitat falls below the desired range for native species, and the pools may lack sufficient cover and structure. The primary instream rearing habitat was associated with overhanging and emergent vegetation along the margins of the channel in select sub-reaches.

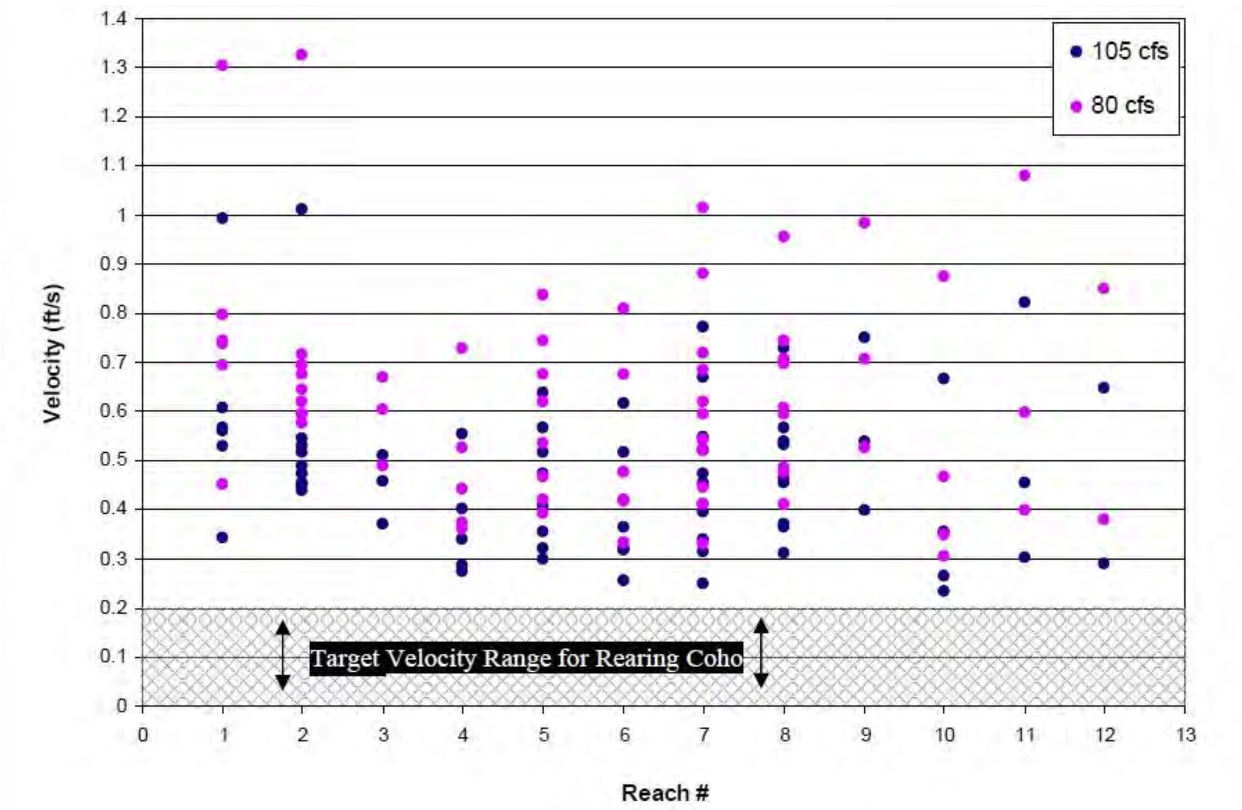

Figure 22. Estimated velocities for lower Dry Creek pools based on 2009 habitat inventory data. Velocities were calculated at 80 and 105 cfs to capture the typical range of discharge in Dry Creek during the time of the habitat inventory. The cross-hatched area is the target velocity range for coho rearing habitat (< 0.2 ft/s) (*Source: Inter-Fluve 2011*).

Using the data from the aquatic habitat inventory, the existing amount of available aquatic habitat is 153,747 square feet in subreach 4A; 160,140 square feet in subreach 14A; and 51, 093 square feet in subreach 14B. Please see Table 5 and Figures 23 and 24 below for a breakdown of these numbers by habitat type.

Table 5. Reach delineation results for Subreaches 4A, 14A, and 14B.

Subreach and Habitat Type	Area (ft^2)
Subreach 4A	
Backwater/Alcove	990
Flatwater	85,841
Pool	52,862
Riffle/Boulder Field	14,054
Side Channel	0
Winter	0
TOTAL	**153,747**
Subreach 14A	
Backwater/Alcove	1,458
Flatwater	39,601
Pool	64,008
Riffle/Boulder Field	55,073
Side Channel	0
Winter	0
TOTAL	**160,140**
Subreach 14B	
Backwater/Alcove	396
Flatwater	20,331
Pool	6,436
Riffle/Boulder Field	22,489
Side Channel	1,441
Winter	0
TOTAL	**51,093**

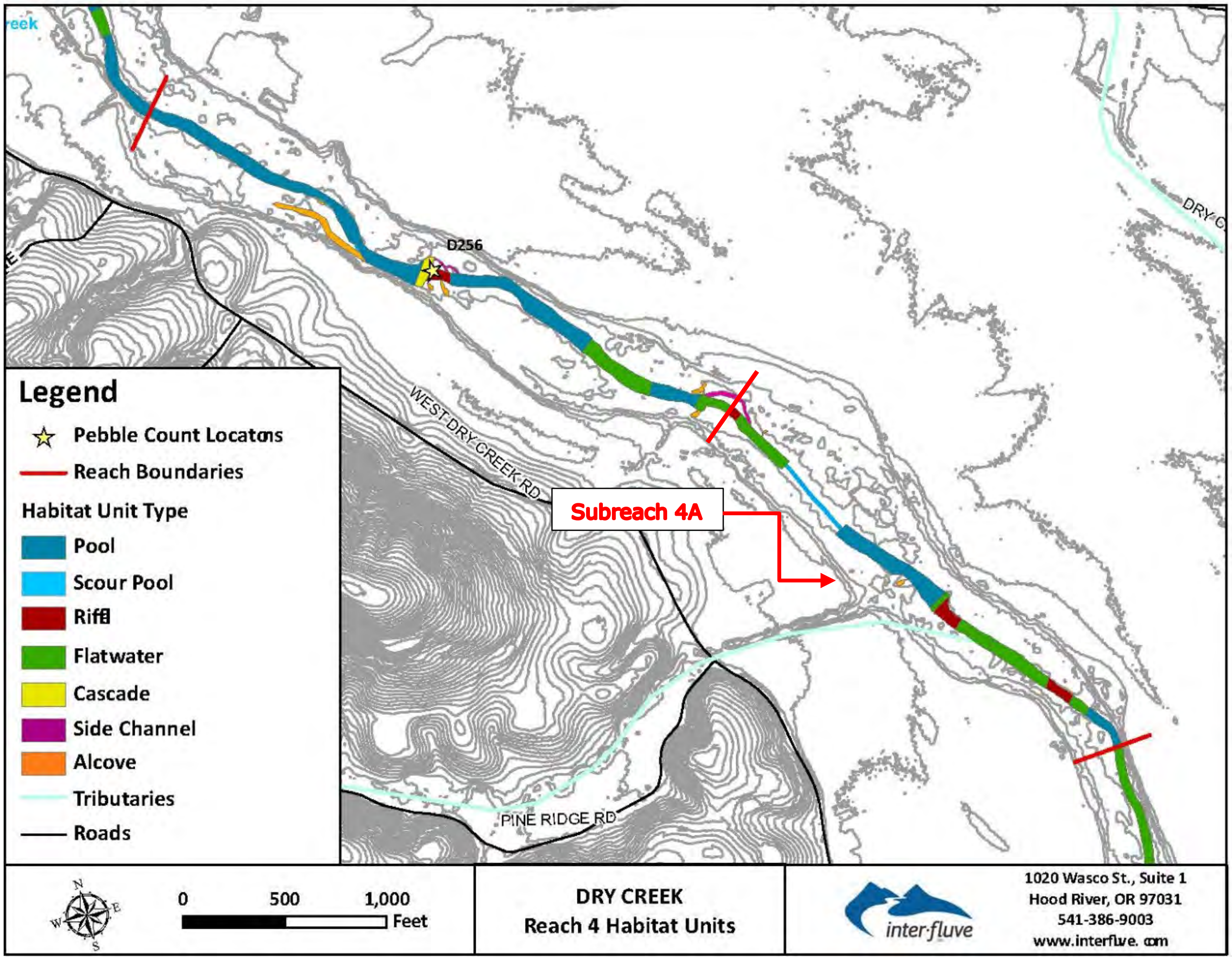

Figure 23. Existing Aquatic Habitat Features within Subreach 4A (from Inter-Fluve 2010).

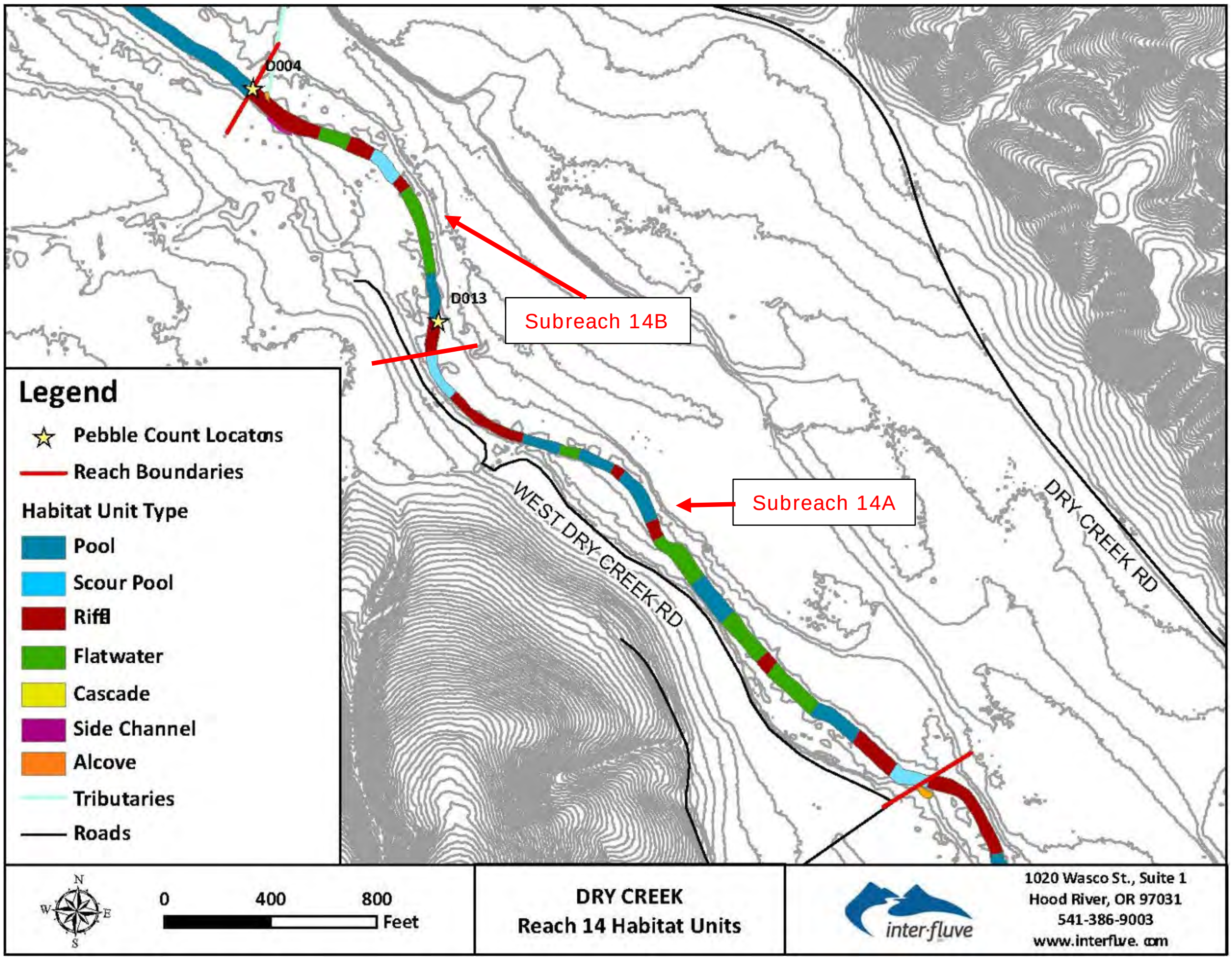

Figure 24. Existing Aquatic Habitat Features within Subreaches 14A and 14B (from Inter-Fluve 2010).

3.12.3. Fish

Surveys of the fish community in Dry Creek during the 1950s found only native fish species. Prior to WSD construction, most fish (84 percent) were warm water species, such as California roach (*Lavinia symmetricus*), Sacramento sucker (*Catostomus occidentalis*), etc. (Pintler & Johnson1958). In the 1950s, the CDFW attempted to increase trout populations in the Russian River and its tributaries by chemically eradicating other fish species using pesticide (rotenone). This action eradicated nearly all fish in Dry Creek and major tributaries, but within a few years most-salmonid species returned to Dry Creek (Pintler & Johnson 1958).

The construction of the WSD brought substantial hydrologic and geomorphic changes (see Section 3.8 through 3.10 above) and changed the fish species composition in Dry Creek. Water temperatures decreased due to releases from Lake Sonoma, which rarely exceed 60^0

F (15.6^{0}C) (USACE and SCWA 2004). Changes to the flow and temperature of Dry Creek (see Section 3.8 through 3.10 above) resulted in a shift in species composition from warm water to cold water species, mainly salmonids. SCWA downstream migrant trapping data have recorded native and nonnative species (Table 6).

Table 6. The fish species observed at a downstream migrant trap operated by the Water Agency in the spring and summer months in Dry Creek from 2009 to 2014.

	Common Name	Scientific Name
Native	California roach	*Lavinia symmetricus*
	Chinook salmon	*Oncorhynchus tshawytscha*
	coho salmon	*Oncorhynchus kisutch*
	hardhead	*Mylopharodon conocephalus*
	hitch	*Lavinia exilicauda*
	Pacific lamprey	*Lampetra tridentata*
	prickly sculpin	*Cottus asper*
	riffle sculpin	*Cottus gulosus*
	Russian River tule perch	*Hysterocarpus traskii pomo*
	Sacramento pikeminnow	*Ptychocheilus grandis*
	Sacramento sucker	*Catostomus occidentalis*
	steelhead	*Oncorhynchus mykiss*
	three-spine stickleback	*Gasterosteus aculeatus*
	western brook lamprey	*Lampetra richardsoni*
Non-Native	American shad	*Alosa sapidissima*
	bluegill	*Lepomis macrochirus*
	channel catfish	*Ictalurus punctatus*
	fathead minnow	*Pimephales promelas*
	golden shiner	*Notemigonus crysoleucas*
	green sunfish	*Lepomis cyanellus*
	largemouth bass	*Micropterus salmoides*
	smallmouth bass	*Micropterus Dolomieui*
	white catfish	*Ameiurus catus*

3.12.4. Special Status Fish Species

Three federally-listed fish species and their critical habitats (Table 7), as well as the Russian River tule perch - a state species of special concern, have the potential to occur in the study area (CDFW 2015). Critical habitat is defined as specific areas within the geographical area occupied by the species at the time of listing. Critical habitat includes habitat which contains physical or biological features essential to conservation and those features that may require special management considerations or protection as well as specific areas outside the geographical area occupied by the species if the agency (NMFS) determines that the area itself is essential for conservation (NMFS 1999).

Table 7. Threatened or Endangered Fish Species, and Associated Critical Habitat, potentially occurring within the Study area.

Common Name	Scientific Name	Status	Critical Habitat in or near Study area?
California Coastal Chinook salmon	*Oncorhynchus tshawytscha*	FT	Yes
Central California Coast coho salmon	*Oncorhynchus kisutch*	FE	Yes
Central California Coast steelhead	*Oncorhynchus mykiss*	FT	Yes

[1] FE= Federally Endangered, FT = Federally Threatened

Russian River tule perch (*Hysterocarpus traskii pomo*) presently inhabit the mainstem Russian River and the lower reaches of the larger tributaries, potentially including lower Dry Creek. They prefer cold, slow moving water with abundant cover. The construction of the WSD and the conversion of lower Dry Creek from a warm water stream to a cold water stream may have changed the distribution of tule perch in Dry Creek (Cook, Chase, & Manning 2010). There are records of tule perch in lower Dry Creek from the 1990s (Cook, Chase, & Manning 2010). However more recent surveys indicate that there are likely few in Dry Creek.

Dry Creek historically supported populations of endangered CCC coho (*Oncorhynchus kisutch)* and threatened CCC steelhead (*Oncorhynchus mykiss)*. Coho and steelhead are present in Dry Creek year-round. Adult coho and steelhead enter Dry Creek to spawn in the late fall and winter. Eggs deposited in gravel nests called redds incubate through the winter and early spring, and fry emerge in springtime. Juvenile coho and steelhead rear in Dry Creek for a minimum of one year before emigrating to the sea the following late winter or spring. Furthermore, it should be noted that Dry Creek currently supports a robust population of threatened CC Chinook salmon (*O. tshawytscha*).

Due to their complex life cycles and habitat requirements, salmonids are recognized as important proxy species for determining habitat suitability for a suite of native aquatic and riparian species. Further, with respect to contemporary conditions in the Russian River basin, lower Dry Creek is seen as a potential resource that is a key component of the regional recovery plan for ESA-listed coho and steelhead. This is due to the relative abundance of cool streamflow during the late summer months, which is regarded as a limiting factor for recovery of these fish in a region where water is scarce during the summer months and typically has water temperatures adverse to salmonid survival. Therefore, the status of each species as well as an assessment of the habitat requirements for the various life stages of listed salmonids native to Dry Creek is provided below.

California Coastal Chinook Salmon Status

Chinook salmon in the Dry Creek watershed are part of the Evolutionarily Significant Unit (ESU) which includes coastal watersheds from Redwood Creek in the north (Humboldt County) down to and including the Russian River basin (Bjorkstedt, et al. 2005). Dry Creek is identified as critical habitat for recovery of this ESU (NMFS 2005). Chinook salmon in the CC ESU are currently all fall-run; however, historical information suggests that spring-run Chinook salmon existed in the northern part of their range (Bjorkstedt, et al. 2005).

Historical records indicate that since 1881 over eight million Chinook salmon were planted in the Russian River watershed; most of these from out-of-basin stocks including the Sacramento, Mad, and Klamath rivers. The DCFH began operation in 1980 to mitigate for the loss of spawning and rearing habitat for anadromous salmonids in upper Dry Creek following the construction of WSD. From 1980 to 1989 only 15 percent of the Chinook salmon juveniles planted in the Russian River watershed were from adults returning to the DCFH at WSD. Beginning in 1990 only locally returning fish were used for hatchery spawning. The enhancement goal for Chinook salmon returns at the DCFH was set at 1,750 adult/year, however, return rates of 0-765 fish from 1980-1999 fell short of the goal (USACE and SCWA 2004). The DCFH no longer produces Chinook salmon broodstock and since 2002 all fish returning to the DCFH are naturally produced in the Dry Creek watershed (Chase, Manning, Cook, & White 2007).

California Central Coast Coho Salmon Status

Coho salmon within the Russian River basin are part of the central CCC ESU and are listed as endangered under the federal ESA and by the California ESA (NMFS 2005a). Critical habitat for CCC coho salmon encompasses all river reaches and estuarine areas accessible to coho salmon within the ESU's geographic area, including the Dry Creek watershed (NMFS 1999). Spence et al. (2008) categorized the CCC ESU and CCC coho salmon within the Russian River basin as having at least a high risk of extinction. Historical records indicate that coho salmon are native to the Russian River basin and spawned in Dry Creek, although it only provided marginal habitat compared to other tributaries closer to the coast (Hopkirk & Northen 1980).

The CCC Coho Salmon Recovery Plan (NMFS 2012) places CCC coho salmon within the North-Central California Recovery Domain and identifies the Russian River basin (including Dry Creek) coho salmon as a historically functionally independent population within the Coastal diversity stratum. The CCC Coho Salmon Recovery Plan (NMFS 2012) lists the greatest threats to coho salmon in the Russian River basin as those related to urban development and water diversion and impoundment. The CCC Coho Salmon Recovery Plan

(NMFS 2012) identified Dry Creek as a Core Area, which has the highest priority for near-term restoration projects and threat abatement actions.

The DCFH produced an average of 70,000 coho salmon annually between 1980 and 1998 (USACE and SCWA 2004). Broodstock sources for hatchery coho salmon included the Noyo, Klamath, Eel and Russian rivers, and some out-planting of coho salmon from Oregon and Washington into the Russian River occurred (USACE and SCWA 2004). Returns of adult coho salmon to the DCFH did not meet the enhancement goal of 1,000 fish per year leading to the termination of the program in 1998.

The Broodstock Program formed in 2001 with the goal of re-establishing self-sustaining runs of coho salmon in tributary streams of the Russian River (Obedzinski, Pecharich, Davis, Lewis, & Olin 2008). The program captures wild juvenile coho salmon, rears them to adulthood and spawns them at DCFH, releasing their progeny into streams that historically supported coho salmon. In 2004, the Broodstock Program began releasing progeny into three streams in the Russian River basin: Mill (a tributary of lower Dry Creek), Ward, and Sheephouse creeks (Conrad, Obedzinski, Lewis, & Olin 2006). Currently, the Broodstock Program releases coho salmon juveniles into mainstem Dry Creek, and several of its tributaries Grape, Peña, Mill, and Palmer creeks.

The SCWA began monitoring downstream migrating salmonids in Dry Creek in 2009. The number of coho salmon captured in downstream migrant traps and the number originating from Broodstock Program increased from 10 coho salmon (7 originating from the Broodstock Program) in 2009 to 214 (113 originated from the Broodstock Program) in 2011, and most recently 780 juvenile coho salmon (760 originated from the Broodstock Program) in 2013 (Manning & Martini-Lamb 2011; Manning & Martini-Lamb 2012; Martini-Lamb & Manning 2014).

California Central Coast Steelhead Status

Steelhead found in the Dry Creek basin belong to the CCC Distinct Population Segment (CCC DPS)[12] (NMFS 2008), which includes coastal drainages from the Russian River to Aptos Creek and the drainages of San Francisco and San Pablo bays, excluding the Sacramento-San Joaquin River watershed. The CCC DPS is federally listed as threatened under the ESA. Dry Creek is identified as critical habitat for the recovery of the CCC DPS (NMFS 2008).

[12] NMFS recently delineated steelhead populations as distinct population segments rather than ESUs. A DPS is a group of organisms that are discrete from other populations and are significant to their taxon (species or subspecies). A group of organisms is discrete if they are markedly separated from other populations of the same taxon as a consequence of physical, physiological, ecological, and behavioral factors (NMFS 2008).

Steelhead are native to the Russian River basin, however stocking of out-of-basin fish has occurred since the 1890s and continued until 1982 (USACE and SCWA 2004).

The timing and magnitude of the steelhead run in Dry Creek are unclear. Steelhead spawn in Dry Creek tributaries from December through March and parr occur throughout the summer in mainstem Dry Creek (Obedzinski, Pecharich, Davis, Lewis, & Olin 2008). A downstream migrant trap operated by the SCWA at the mouth of Dry Creek from March through June captured between 2,082 and 5,422 juvenile steelhead per year over the past five years (Martini-Lamb & Manning 2014).

Existing conditions of habitat for migrating salmonids

Although Dry Creek and its tributaries are generally accessible to salmonids, WSD is a complete barrier to migration and some small seasonal dams on tributaries may block migration. Flow in Dry Creek, augmented by WSD releases, is usually sufficiently deep to allow fish to easily pass most shallow areas. Water temperatures are generally sufficiently cool and suitable for migrating adult salmonids. However, because of a loss of riparian vegetation resulting in increased solar inputs to the stream, water temperature in the lower portion of Dry Creek in the late summer is not optimal for adult Chinook salmon that sometimes immigrate as early as September. Nevertheless, the majority of adult Chinook salmon migrate in October and November, a time with generally adequate water temperatures. Coho salmon and steelhead migrate later in the fall and winter; water temperatures in Dry Creek are adequate for immigration of adult coho salmon and steelhead.

Instream habitat structure is limited in Dry Creek, which may limit cover for migrating adults to escape predators. The absence of deep pools limits available resting areas for adult fish to escape from high flows. This is exacerbated by a lack of LWD and boulders, which would increase habitat complexity. Habitat conditions are sufficient for smolt emigration for all three species. However, the Corps sills crossing lower Dry Creek do pose as a passage barrier for juveniles.

Existing conditions of salmonid rearing habitat

Limited rearing habitat hinders the conservation of coho salmon and steelhead. Although conditions will be favorable for spawning and migrations of both adults and smolt stages, growth and survival of juvenile salmonids is minimal in Dry Creek because suitable and optimal quality habitats are very limited. Salmonid fry are weak swimmers that aggregate in shallow, low velocity areas along stream margins (Chapman and Bjornn 1969; Everest and Chapman 1972; Bjornn and Reiser 1991). Current (and anticipated future) water releases to Dry Creek in the summer and fall create high water velocities that severely limit the quantity and quality of salmonid rearing habitat in the Dry Creek mainstem. Sustained summer flows combined with the single channel characteristic of lower Dry Creek result in consistent areas of velocity above a suitable range for refuge of juvenile coho during summer months. The velocities in Figure 22 show the results of a planning-level, one-dimensional hydraulic model developed for the 13.9 mile reach of Dry Creek (Inter-Fluve 2011) for the upper and lower limits for minimum instream flow in Dry Creek during a normal water year. Without the addition of side channel habitat or local sheltering structures, the target velocity will not be met for required summer flows. Because low velocity rearing habitat is very limited in Dry Creek, most fry that originate from in-river spawning will be displaced into the lower main stem Russian River where predators abound and average summer water temperatures are unsuitable for juvenile salmonids. Very few or none of the young-of-year steelhead or coho salmon that are displaced downstream out of Dry Creek during summer are likely to survive.

While temperatures in Dry Creek are generally favorable for salmonid rearing, other rearing habitat attributes are lacking or in poor condition. Riparian vegetation provides shade and a source for nutrients along much of the stream and its tributaries. However, the riparian vegetation has been encroached upon by development and the width of the riparian areas has diminished as vegetation was removed primarily to benefit agriculture. The reduction of riparian vegetation is particularly noticeable on the lower portions of tributaries and the lower two miles of Dry Creek.

Dry Creek is also lacking in riffles, cover, and instream structure which severely limits salmonid production (Steiner Environmental Consulting 1996). The lack of these habitat elements result in limited areas where juveniles can find refuge from high water velocities and cover for escaping predators. This lack of cover also limits sites where there is deposition of loose gravels and cobbles which provide habitat for aquatic invertebrates – the preferred prey of juvenile salmonids (USACE and SCWA 2004). Additionally, flow management, bank stabilization, and blockage of sediment transport by WSD have led to channel incision, channel straightening, and bank instability. These factors work in concert to leave the creek lacking in complex habitat such as back water eddies and pools, and the creek is disconnected from its floodplain. The low incidence of pools in the creek limits rearing habitat for coho salmon in particular, since they prefer pool habitat over riffle habitat. The release of cold water from Lake Sonoma into Dry Creek could potentially provide valuable, abundant rearing habitat for listed salmonid species if habitat complexity was increased sufficiently to provide a greater number of pools, access to seasonal floodplain features, and (as a result) a diversity of flow velocities across the stream channel and floodplain's cross section.

Existing conditions of salmonid spawning habitat

Coho salmon redds, which are constructed from November through January, are more subject to scour because they are subjected to a higher frequency of winter flow events. Higher flows, occurring in the latter part of the spawning and incubation season (January), have the greatest potential to scour the most redds and incubating alevins (Corps and SCWA 2004). In an evaluation of potential scouring of salmonid redds conducted by the SCWA, coho salmon redds had the highest frequency of scour potential in Dry Creek. Water temperatures are good in Dry Creek for incubation and Dry Creek provides adequate depth and flow for salmonid spawning. However, pool/riffle habitat, which serves as prime spawning habitat for steelhead and salmon, is limited. Still, lack of cover and complexity has not precluded relatively large numbers of Chinook salmon from spawning in Dry Creek. Stream bank erosion on Dry Creek has caused increased delivery of fine sediment, negatively affecting the quality of spawning habitat. The availability of spawning habitat in Dry Creek is less for coho than for steelhead or Chinook salmon because coho salmon use smaller gravels for spawning than steelhead or Chinook salmon (Corps and SCWA 2004). These smaller gravels may be transported out of the upper reach of Dry Creek more readily due to the high flows in this creek (Corps and SCWA 2004).

3.12.5. Wildlife

Riparian habitats are extremely productive and have diverse values for animal species. Historically, these communities provided habitat for a rich diversity of terrestrial and wetland plant and animal species. The availability of water, the diversity and abundance of plant life, and the complex vegetation structure provide a number of animal species with food and water, and cover as well as breeding and resting sites. Riparian corridors also and facilitate wildlife movement (i.e., dispersal, seasonal migration, and local movements within home ranges). Terrestrial mammals, such as mule deer (and the Coast Range subspecies, black-tailed deer), use the cover of the riparian forests and woodlands for protection from predators as they move between foraging areas. Similarly, amphibians and reptiles use the protective cover of this habitat as they disperse from their aquatic breeding sites. Migratory waterfowl use the waters and wetlands for their food supplies during their seasonal migration. Animals typically found in riparian habitats include birds, such as Bewick's wren (*Thryomanes bewickii*), spotted towhee (*pipilo maculatus*), and tree swallow (*Tachycineta bicolor*); mammals, such as brush rabbit (*Sylvilagus bachmani*), deer mice (*Peromyscus maniculatus*), dusky footed woodrat (*Neotoma fuscipes*), and raccoon (*Procyon lotor*); and amphibians such as foothill yellow-legged frog (*Rana boylii*) (Warner and Hendrix 1984).

Although many of the species that historically occupied the watershed are still present, some have had their numbers substantially reduced. Such loss or reduction in species diversity has been attributed to habitat loss and a variety of other complex factors. The riparian corridor of modern Dry Creek is narrower, the channel more incised, and the interaction with the floodplain greatly reduced compared to Dry Creek as it was before European settlement. The overall effect in the Dry Creek Valley is degraded riparian habitat and greatly reduced acreage of both streamside and floodplain wetlands.

Special Status Wildlife

As documented in the special status wildlife species table in Appendix H, one federally threatened species, the California red-legged frog, and fifteen terrestrial animal species that are not federally listed as threatened or endangered, but are considered to be species of concern at the federal or state level have moderate to high potential to occur in the Dry Creek area. These species include:

1. California red-legged frog (*Rana [aurora] draytonii*), is federally listed as threatened (CDFW 2015) and a California species of special concern (CDFW 2015). The Dry Creek area is in the summer habitat range, however, the species is not found here currently and the Study area is not within designated critical habitat.
2. Bald Eagle (*Haliaeetus leucocephalus*), is state listed as endangered and fully protected. A pair is known to have maintained an active nest at Lake Sonoma from 2001 to the present. The species may occasionally forage in the Russian River area.
3. Allen’s hummingbird (*Selasphorus sasin*), currently included on the USFWS “Birds of Conservation Concern” list and previously categorized as a Federal Species of Concern, has been confirmed nesting in inland Sonoma County and the Dry Creek Valley.
4. Olive-sided flycatcher (*Contopus cooperi*), a California Species of Special Concern, has been observed in the vicinity of Dry Creek during summer bird surveys and is known to be a summer resident in Sonoma County.
5. Osprey (*Pandion haliaetus*), a species on the Califronia watch list, is known to nest at Lake Sonoma as well as throughout the Russian River. Possible breeding occurrences recorded in Dry Creek Valley however Dry Creek itself is largely covered by tree canopy and presents hazards due to a swift current, reducing the likelihood that Osprey would forage in the immediate area.
6. Red-breasted sapsucker (*Sphyrapicus ruber*) is on the CDFW “Special Animals List” and is common in the winter in Sonoma County. It has been observed on Dry Creek during bird surveys.
7. Yellow warbler (*Dendroica petechia*), considered a “Species of Special Concern” by CDFW and a “Bird of Conservation Concern” by USFWS, is considered a fairly common summer resident of riparian woodland from April through October.

8. Yellow-breasted chat (*Icteria virens*), considered a "Species of Special Concern" by CDFW, is considered an uncommon summer resident, present from April to early September, in thick riparian woodland with heavy undergrowth.
9. White-tailed kite (*Elanus leucurus*) is considered a fully protected species by the state of California and is a fairly common permanent resident and fall migrant in Sonoma County with numbers peaking in the winter.
10. Cooper's Hawk (*Accipiter cooperii*), on the California watch list, is known to be a year-round resident of Sonoma County, and suitable breeding habitat has been identified along Dry Creek.
11. Peregrine falcon (*Falco peregrinus anatum*) is included on the USFWS list of "Birds of Conservation Concern" and is considered a fully protected species in California. While no suitable nesting habitat exists within the Dry Creek area, suitable foraging habitat is present and SCWA staff observed one individual peregrine falcon soaring over Dry Creek Valley in 2014.
12. Merlin (*Falco columbarius*), a species categorized by CDFW as a "State Species of Special Concern," is an uncommon winter migrant from September to April. One individual was observed in the SCWA constructed restoration site on lower Dry Creek by a Water Agency biologist in January 2014.
13. Loggerhead shrike (*Lanius excubitor*), currently included on the USFWS list of "Birds of Conservation Concern" and is categorized by CDFW as a "State Species of Special Concern," is considered an uncommon permanent resident in Sonoma County with numbers declining over the last few decades.
14. Pallid bat (*Antrozous pallidus*) a federal species of concern, may roost in mature trees along Dry Creek.
15. Western pond turtle (*Actinemys [Emys] marmorata*), Suitable aquatic and upland habitat along the creek corridors exist for this California species of special concern.
16. Foothill yellow-legged frog (*Rana boylii*), a California species of special concern, Seventy-one occurrences have been reported in several locations throughout Sonoma County.

3.13. Cultural Resources

The current archaeological evidence indicates that Native American occupation in multiple areas of California began at least 11,000 years ago. Locally near the study area, the Corps of Engineers in 1979-80 sponsored archaeological excavations at sites inundated by Lake Sonoma, which identified the approximate period of initial settlement by hunter-gatherer groups in the Dry Creek watershed at approximately 3-5,000 years ago, continuing into the late 1800s. Many of these sites upstream of Warm Springs Dam, and additional prehistoric sites downstream in Dry Creek Valley in the study area, were determined eligible for listing in the National Register of Historic Places (National Register) and contribute to the Dry Creek-Warm Springs Valleys Archaeological District. There are up to twenty-six of the District archaeological sites located in Dry Creek Valley, though the locations are mapped near, and often away from, the water course between roughly 50 and 200 feet.

At the time of European exploration of California in the nineteenth century, ethnographic research identified the inhabitants of Dry Creek Valley, including the study area and environs, as speakers of the Southern Pomo language. The Southern Pomo language was one of seven distinct, but linguistically related languages, spoken in northern California. The Southern Pomo speakers were hunter-gatherers who lived in environments that allowed for dense populations with complex social structures. The primary socio-political unit of the Southern Pomo was a tribelet, an autonomous band of families who inhabited a specific tract of land. The principal tribelet in and around the study area was the Mihilakawna tribelet (referred to as Dry Creek Pomo), with the other tribelet to the north of the study area being the Makahmo, or Cloverdale Pomo.

The Dry Creek and Cloverdale Pomo settled in large, permanent villages that served as the political, economic, and religious center for the community, with the primary villages being occupied continually throughout the year. Seasonal camps and task-specific sites were distributed around the territory. Other sites were visited in order to procure particular resources that were especially abundant or available only during certain seasons. Sites often were situated near fresh water sources and in ecotones where plant and animal life were diverse and abundant.

Today, descendants of these two groups still live in the region and follow traditional cultural practices. The Pomo are recognized as one of the foremost basket weavers in the world, utilizing plants such as sedge and grasses that were collected from riparian corridors like those found along Dry Creek. The Dry Creek and Cloverdale Pomo maintain tribal governments and membership roles sanctioned as Federally Recognized Tribes.

The study area was situated within two Mexican landgrants, the 15,439-acre Rancho Tzabaco and the 48,837-acre Rancho Sotoyome. The Rancho Tzabaco was granted to José German Piña in 1843. Piña and his family built a one-story adobe dwelling on the Rancho (later remodeled); it is a significant historical resource located at 6630 Dry Creek Road that will not be included in any construction sites of the study area. Rancho Sotoyome was granted to Henry Fitch in 1841 and later confirmed to his widow, Josefa Carillo Fitch. Both ranchos were involved in the disputes jointly referred to as the "Squatters War" in 1860, in which court ordered seizures of several properties were met with armed resistance.

Besides the Piña adobe, there are no other recorded historic properties of the Mexican era known for the Dry Creek Valley study area.

During the subsequent American period following statehood, the Dry Creek Valley area was characterized by migrations of White settlers who purchased lands and established farms and ranches. The 1970s Corps-sponsored cultural studies for Warm Springs Dam also included archaeological investigations of the historical-period farmsteads and homesteads that are now under Lake Sonoma. The cultural resources records researched show that there are numerous privately owned historical buildings (some meeting the National Register criteria) located downstream of the Dam in Dry Creek Valley.

In addition, three bridges in the study area that span Dry Creek have been identified and evaluated for historical significance: Yoakim Road, Westside Road, and Lambert Road.. Sonoma State University in 1993 found Lambert Road Bridge to be historically significant at the local level, and thus, it was determined eligible for listing in the National Register. The California Department of Transportation concluded that Yoakim and Westside did not meet the criteria for inclusion on the National Register (2014 online database).

3.14. Socio-economics and Environmental Justice

3.14.1. Socio-economics

The study area is located entirely within Sonoma County. The population of Sonoma County in 2010 was 483,878. The rate of population increase in the county is lower than for the State of California as a whole, with the county increasing by 3.4 percent from 2000 to 2010, while the state increased by 4.2 percent (U.S. Census Bureau 2015). The median household income and per capita income is higher than the state, while the poverty level is slightly lower at the county versus the state levels. Table 8 shows relevant population data from the 2010 Census (U.S. Census Bureau 2015) and relevant socioeconomic data.

Table 8. Sonoma County and State of California Population and Income Statistics

Location	Population	Median Household Income	Per Capita Income	Individuals Below Poverty Line
Sonoma County	483,878	$63,356	$32,835	11.90%
State of California	37,253,956	$61,094	$29,527	15.90%

Note: 2010 Census data was only available for the population numbers, the remainder of the data are based on 2009-2013 estimates

Dry Creek Valley below WSD is held almost entirely in private ownership and is under agricultural production growing high quality wine grapes.

3.14.2. Environmental Justice

Executive Order 12898 (Federal Actions to Address Environmental Justice in Minority and Low-Income Populations; February 11, 1994) provides minority and low-income populations an opportunity to comment on the development and design of Federal activities and on the consequences of proposed Federal actions. This Executive Order requires that Federal agencies shall make achieving environmental justice part of their missions by identifying and addressing, as appropriate, disproportionately high and adverse human health or environmental effects of its programs, policies and activities on minority and low-income populations.

The Council on Environmental Quality (CEQ), identifies minority groups as Asian, American Indian or Alaskan Native, Pacific Islander, Black not of Hispanic origin, and Latino (CEQ 1997). It defines a minority population as any group of minorities that exceed 50 percent of the existing population within the market area or where a minority group comprises a meaningfully greater percentage of the local population than in the general population. Additionally, CEQ identifies low income using 2010 census data for "individuals living below the poverty level." For the purposes of this study, a low income population will be defined similarly as a local or market area population with more than 50 percent of people living below the poverty level. According to the data assembled in Table 8, there are no communities surrounding the study area which would quality as a minority or low income populations as defined by CEQ (1997) or for the purposes of this report.

3.15. Land Use

The land use designation within the agricultural valley surrounding Dry Creek is land intensive agriculture, land adjacent to the agricultural zone on the east and west side of the valley floor is designated primarily for resources and rural development. Land use designations in the project vicinity are described as follows:

- Land Intensive Agriculture is established to enhance and protect lands best suited for permanent agricultural use and capable of relatively high production per acre of land; and to implement the provisions of the land intensive agriculture land use category of the General Plan and the policies of the agricultural resources element.
- Resources and Rural Development provides protection of lands needed for commercial timber production, geothermal production, and aggregate resources production. It also provides protection of lands needed for protection of watersheds, fish and wildlife habitat, biotic resources, and for agricultural production activities that are not subject to all of the policies contained in the agricultural resources element of the General Plan. This land use designation allows very low density residential development and

recreational and visitor-serving uses where compatible with resource use and available public services.

The existing agricultural environment is classified by the following:

- The California Farmland Mapping and Monitoring Program (FMMP) which identifies the state's priority farmlands and monitors the conversion of farmland to and from agricultural use. Within the Dry Creek Valley, there are approximately:
    - 5,124 acres of Prime Farmland – land that has the best combination of physical and chemical characteristics for crop production,
    - 595 acres of Farmlands of Statewide Importance - land other than Prime Farmland that has a good combination of physical and chemical characteristics for crop production;
    - 3,212 acres of Unique Farmland – land that does not meet the criteria for Prime Farmland or Farmland of Statewide importance, but is land which has been used for the production of specific high economic value crops;
    - 550 acres of Farmland of Local Importance – land either currently producing crops, or has the capability of production, and does not meet the criteria of the categories above;
    - 3,360 acres of Grazing land - is land in which the existing vegetation is suited to the grazing of livestock;
    - 9,565 acres of Other Land; and
    - 2,340 of Urban and Built-up Land.
- There are approximately 85 parcels directly adjacent to Dry Creek that are currently enrolled under Williamson Act contract. Williamson Act (California Land Conservation Act of 1965) contracts are designed to preserve agricultural and open space lands by discouraging the unnecessary conversion of these lands to urban uses.

3.16. Recreation

Lake Sonoma and the Russian River provide recreational opportunities such as boating, swimming and fishing while tourism in the Dry Creek Valley is primarily associated with the wine industry. Unlike the Russian River, there is no public access to Dry Creek and, consequently, there are very few recreational opportunities along the creek itself. Nearly all of the land adjacent to Dry Creek is privately held and used for agriculture, particularly viticulture. The Corps owns and operates a small park immediately downstream of the WSD but a fence blocks access to the creek. The City of Healdsburg owns land adjacent to the creek, but these parcels are used for municipal purposes and are not open to the public.

There are four county roads in Dry Creek Valley that cross Dry Creek: Dry Creek Road near WSD, Yoakim Bridge Road, Lambert Bridge Road, and Westside Road. However, these locations do not include public access to Dry Creek. Fishing is not legal in Dry Creek. The mainstem Russian River downstream from the confluence of the east branch and the tributaries flowing into Lake Sonoma and Lake Mendocino are the only streams open to recreational fishing in the Russian River Basin (CDFW2014). While vehicles and cyclists access Lake Sonoma and wineries in the valley via roads in the Dry Creek Valley, the roads are also a destination in and of themselves for cyclists.

While the creek is unavailable to the general public for recreation, private access does allow for some use of Dry Creek for recreational purposes. For example, some wine tasting rooms along the creek provide limited access to the riparian corridor for customers to picnic and view the creek. Additionally, many private landowners along the creek enjoy direct access for picnicking, swimming, boating, and other recreational activities. Therefore, for the purposes of this analysis, it is assumed that most of the recreation that occurs in the wetted portion of Dry Creek is by private entities. A site visit to the section of Dry Creek from WSD to Lambert Bridge found 36 sites that appear to be used by private landowners for recreation. These sites range from trails that led to gravel beaches to areas that contain stairways, tables, chairs, fire rings, rope swings, and small boats such as kayaks and inflatable rafts. Typically these activates are limited to landowners, but the general public does have access to a few sections of the riparian corridor where they can access the stream while wine tasting. Some of the wineries in Dry Creek are open to the public and have tasting rooms and other facilities for their guests. In total, nine wineries are located within 1000 feet of Dry Creek based on aerial photos). Three of these wineries appeared to provide access for their guests to visit the creek to wine taste and picnic while viewing the stream. Despite access to the creek by private landowners, recreational boating (kayaking, canoeing, rafting) and swimming remains uncommon in Dry Creek due to difficult navigational and environmental conditions.

3.17. AESTHETICS

Aesthetics include the presence and appearance of landforms, water surfaces, vegetation, and human created features relative to the surroundings and settings of the area. These features are primary characteristics of an area or project that determine visual character and the manner in which people view the setting.

The Dry Creek Valley is a part of one of the three major landscape units designated in *Sonoma County General Plan 2020* (Sonoma County Permit and Resource Management Department 2012). Landscape units are based on combinations of physical and cultural features that result in similar visual quality. A landscape unit is a geographically distinct portion of an area that has a particular visual character or set of topographic features.

These units are strictly aesthetic delineations. Protection of the scenic beauty of the Dry Creek Valley landscape unit is not only important from an aesthetic standpoint, but also from an economic one as agricultural marketing is closely tied to the areas' scenic images. The hills along Highway 101 and above the valley floors are particularly sensitive. Preservation of these scenic resources is important to the quality of life of Sonoma County residents, and to the tourist and agricultural economies. In addition, the *Sonoma County General Plan 2020* identifies Dry Creek Road, Stewart Point-Skaggs Springs Road, Dutcher Creek Road, Canyon Road, Westside Road, and Highway 101 as scenic (Sonoma County Permit and Resource Management Department 2012).

3.18. Hazardous, Toxic, and Radioactive Wastes

The following sections discuss the existing environmental setting for hazard, toxic, and radioactive wastes that could be present or absent from the entirety of the Dry Creek Ecosystem Restoration Study Area (see Section 1.5 Study Area Location).

Land use adjacent to the study area is primarily agricultural, with a focus on vineyards. Agricultural operations have the potential to release hazardous materials from the use of fuel, pesticides, herbicides, fertilizer, and waste runoff. Other land uses within the project vicinity include residential, industrial, and government. In Dry Creek, as in many other watershed areas, historic erosion control methods included the use of car bodies, concrete debris, and a variety of other materials placed along the creek in an attempt to prevent erosion. The remnants of these past erosion control practices are still evident in many places along Dry Creek. The hazardous material potential of these materials is unknown due to the limited documentation of what and where these materials were placed. As part of the Dry Creek Demonstration Project at Reach 7 that was completed in 2013, old automobiles as well as a variety of other old debris were encountered during construction. Typically, debris encountered during construction consisted of rusted metal material and car tires. Debris encountered during construction was hauled off and properly disposed.

The draft technical memorandum completed by Kennedy/Jenks (2010) for SCWA for the Dry Creek Pipeline Feasibility Study was the primary source to identify recognized environmental conditions. A recognized environmental condition is the presence or likely presence of any hazardous wastes or substances or petroleum products under conditions that indicate an existing release, a past release, or the material threat of a release into structures, the ground, and groundwater or surface waters within the entirety of the Study Area.

For purposes of this section, the term "hazardous materials" refers to both hazardous substances and hazardous wastes. A hazardous material is defined as "a substance or material that…is capable of posing an unreasonable risk to health, safety, and property when transported in commerce" (49 CFR §171.8). California Health and Safety Code Section 25501 defines a hazardous material as follows:

> *"Hazardous material" means any material that, because of its quantity, concentration, or physical or chemical characteristics, poses a significant present or potential hazard to human health and safety or to the environment if released into the workplace or the environment. "Hazardous materials" include, but are not limited to, hazardous substances, hazardous waste, and any material which a handler or the administering agency has a reasonable basis for believing that it would be injurious to the health and safety of persons or harmful to the environment if released into the workplace or the environment.*

Hazardous wastes are defined in California Health and Safety Code Section 25141(b) as wastes that:

> *…because of their quantity, concentration, or physical, chemical, or infectious characteristics, [may either] cause, or significantly contribute to an increase in mortality or an increase in serious illness[, or] pose a substantial present or potential hazard to human health or the environment when improperly treated, stored, transported, disposed of, or otherwise managed.*

The aforementioned HTRW assessment (Kennedy/Jenks, 2010) compiled data collected from regulatory agency databases to identify federal, state, local and tribal hazardous material release, spill, storage and waste sites along Dry Creek. The SCWA and USACE conducted a review of the same regulatory agency databases to obtain updated information of the project areas in 2015. Table 9 summarizes the environmental databases that were reviewed. Sites included in the databases have a historical record of a potential recognized environmental condition.

The Kennedy/Jenks (2010) HTRW assessment includes a summary of all sites within a 1,000-foot buffer zone of the potential routes for a bypass pipeline listed in federal, state, local and tribal environmental databases. The entire length of Dry Creek from Warm Springs Dam to the confluence with the Russian River and nearly all of the Dry Creek Valley were included. The potential routes for the bypass pipeline included Dry Creek, West Dry Creek, and Canyon roads, which is larger than this project's Study Area footprint. Results were summarized to identify areas with recognized environmental conditions within the project area (Table 10).

Between the downstream end of Reach 15 and upstream of Reach 7, land uses are primarily agricultural (wine grapes), rural residential, and includes a portion of the USACE parcel surrounding Lake Sonoma. No potential recognized environmental conditions were identified for the subreaches located within this portion of Dry Creek.

Between the downstream end of Reach 7 and the downstream end of Reach 1 (confluence with the mainstem Russian River), land uses are primarily agricultural (wine grapes), rural residential, and industrial. Potential recognized environmental conditions were identified from residential, vineyard/winery, government, and commercial/industrial properties. Table 10 contains a detailed list of potential sites with potential environmental conditions that could affect the implementation of an ecosystem restoration project. Please note that all underground storage tanks that have no record or are closed in Geotracker (California State Water Resources Control Board database) and EnviroStor (California Department of Toxic Substances database) were not included in Table 10.

The types of hazardous waste records include solid and liquid waste disposal for waste containing oil, organic and inorganic residues, and PCBs. These waste disposal records include residential, vineyard, commercial and government properties. Other records include permitted discharges from wineries, an industrial gravel mining operation, residential and commercial construction, and stormwater runoff. A few locations have records of fuel tanks with leaks detected or tanks where spills have been reported. None of these locations have active clean-up remediation.

Table 9. Federal and State Records Databases used in HTRW Assessment.

Database	Description	Database Location
CA WDS	California Waste Discharge System (CA WDS) includes sites which have been issued waste discharge requirements by the SWRCB.	https://geotracker.waterboards.ca.gov/
CERCLIS	The CERCLIS database compiles facilities that the US Environmental Protection Agency (USEPA) has investigated or is currently investigation for the release or threatened release of hazardous substances.	http://www.epa.gov/enviro/facts/cerclis/search.html
CHMIRS	California Hazardous Materials Incident Report Subsystem (CHMIRS) of the Pipeline and Hazardous Materials Safety Administration, Department of Transportation	https://hazmatonline.phmsa.dot.gov/IncidentReportsSearch/
Cortese	The Cal EPA Office of Emergency Information previously maintained a list of sites designated as LUST, SWF/LF or CalSites. The list is no longer updated and cases are maintained by the SWRCB, CalRecycle (formerly the Integrated Waste Management Board) and DTSC.2	http://www.envirostor.dtsc.ca.gov/public/
ECHO	Enforcement and Compliance History Online (ECHO) database maintained by USEPA. ECHO contains enforcement and compliance data for regulated facilities nationwide with data on air emissions, surface water discharges, hazardous waste, and drinking water systems. Facility Registry Service now contained in this database, formerly FINDS.	http://echo.epa.gov/
ENVIRO-STOR	DTSC Site Mitigation and Brownfields Reuse Program's EnviroStor database identifies sites that have known contamination or sites that may need further investigation. The database includes the following	http://www.envirostor.dtsc.ca.gov/public/

	site types: Federal Superfund sites (National Priorities List [NPL]), State Response including Military Facilities, State Superfund, Voluntary Cleanup, and School sites. EnviroStor provides information including identification of formerly contaminated properties that have been released for reuse, properties with environmental deed restrictions, and risk characterization information used to assess potential impacts to public health and the environment at contaminated sites. Replaces the CalSites database no longer updated by the DTSC.	
ERNS	The Emergency Response Notification System (ERNS) records and stores information on reported releases of oil and hazardous substances.	http://www.rtknet.org/db/erns
HIST UST	The Hazardous Substance Storage Container Database is a historical listing of UST sites previously maintained by SWRCB. Current data can be found in the State or local UST database.	Found in https://geotracker.waterboards.ca.gov/
HWTS (formerly HAZNET)	Hazardous Waste Tracking System (formerly referred to as HAZNET) maintained by the California Department of Toxic Substances Control (DTSC).	http://hwts.dtsc.ca.gov/report_list.cfm
LUST	The State Water Resources Control Board (SWRCB) maintains an inventory of Leaking Underground Storage Tanks (LUST) Incident Reports.	Found in https://geotracker.waterboards.ca.gov/
NPDES	National Pollutant Discharge Elimination System (NPDES) permits, also referred to as Waste Discharge Requirements (WDR) issued by North Coast Regional Water Quality Control Board under jurisdiction of Cal EPA.	http://echo.epa.gov/
PADS	The USEPA maintains the PCB Activity Database System (PADS) which is a list of generators, transporters, commercial storers, and/or brokers and disposers of PCBs required to report to the USEPA.	http://www.epa.gov/epawaste/hazard/tsd/pcbs/pubs/data.htm
RCRA INFO	The USEPA maintains the RCRA INFO database to list facilities that generate hazardous waste as part of their normal business practice.	http://www.epa.gov/enviro/facts/rcrainfo/search.html
SLIC	The SWRCB maintains the statewide Spills, Leaks, Investigations and Cleanup (SLIC) program which is designated to protect and restore water quality from spills, leaks and similar discharges.	https://geotracker.waterboards.ca.gov/
State UST	SWRCB maintains a database of registered Underground Storage Tanks (UST). The database may also include registered Aboveground Storage Tanks.	https://geotracker.waterboards.ca.gov/
SWF/LF	CalRecycle (formerly the Integrated Waste Management Board) maintains a list of Solid Waste Facilities/Landfill (SWF/LF) sites, including active and inactive, permitted and non-permitted solid waste disposal facilities.	http://www.calrecycle.ca.gov/FacIT/Facility/Search.aspx
VCP Site Remediation Program	DTSC's Voluntary Cleanup Program (VCP) contains low treat level properties with either confirmed or unconfirmed releases and the project proponents have requested that DTSC oversee investigation and/or cleanup activities.	https://geotracker.waterboards.ca.gov/

Table 10. Sites Identified by the Records Search to Exhibit a Recognized Environmental Condition

River Mile	Kennedy/Jenks Data Source[a]	Current Data Source[b]	Location	Comments	Potential to Impact Proposed Project?
5.0-4.2	HAZNET	*not found*	Carrey	Oil containing waste disposed of via transfer station	No
5.0-4.2	Hist UST	*not found*	Laughlin	Fuel tank leak detection	No
5.0-4.2	UST	GeoTracker	*not provided*	Facility 49-000-002893	Active
4.1-3.0	CA WDS	*not found*	Montemaggiore Winery	Active facility that discharges winery waste continuously or seasonally under a Waste Discharge Requirement	No
4.1-3.0	NDPES	*not found*	White residence	Active - stormwater construction	No
4.1-3.0	HAZNET	*not found*	TDC Mobile Mechanic	Aqueous solution with <10% organic residues	Inactive
2.0-1.0	CA WDS; MINES; ERNS	ECHO	Syar Industries	Active industrial plant treats and disposes of wash water waste from onsite operations; non-coal mining; incident reported to Air Pollution Control District	Active
2.0-1.0	Hist Cortese; LUST	GeoTracker	Soiland Company	Gasoline and diesel spill (completed - case closed April 1995)	No
2.0-1.0	EMI, Hist UST; SWEEPS UST	*not found*	Healdsburg Sand and Gravel	Fuel tank leak detection	No
2.0-1.0	HazNet, Hist Cortese, SLIC, AST, LUST, CA WDS, CHMIRS, Hist UST, NPDES, SWEEPS UST	ECHO, GeoTracker, PADS, HWTS	City of Healdsburg Corporation Yard	Disposal of oil, PCB's and inorganic containing waste; potential oil contamination (case open-inactive as of March 2009); AST of unknown content, fuel tank leak detection, gasoline contaminated soil (completed - case closed August 1996); latex paint improperly disposed; active stormwater industrial; active facility that discharges stormwater runoff under a Waste Discharge Requirement	Active
2.0-1.0	HazNet	*not found*	Sonoma County Waste Management Agency	Disposal of household wastes and aqueous solution with <10% organic residues	No

2.0-1.0	FTTS, Hist FTTS,	*not found*	City of Healdsburg electric utility	Section 6 PCB investigation, no violations found	Inactive
2.0-1.0	Ca WDS, HazNet, NPDES	*not found*	Everett Ridge Winery	Active industrial treats and disposes of stormwater runoff under a Waste Discharge Requirement; disposal of organics, inorganics and pesticides; active stormwater industrial	Inactive
2.0-1.0	CaWDS, Hist UST	*not found*	Bellerose Vineyard	Active site treats and disposes of stormwater runoff under a Waste Discharge Requirement; leak detection	Inactive
2.0-1.0	NPDES	*not found*	Stanley residence	Active stormwater construction	No
2.0-1.0	LUST, Hist Cortese	*not found*	Barrett	Case closed, no further information	No
2.0-1.0	SLIC	GeoTracker	Carraro Property 1711 Westside Rd, Healdsburg, CA	A leak was discovered in 1999. No remedial actions have been initiated although the cleanup status is "open-inactive." http://geotracker.waterboards.ca.gov/profile_report.asp?global_id=T0609793465	No
2.0-1.0	LUST, SWPPPS UST	*not found*	North Coast Nursery	Fuel tank, no action information available	No
2.0-1.0	Hist UST	*not found*	Beeson	Fuel tank leak detection	No
2.0-1.0	CHMIRS	*not found*	unnamed	Sediment released into Mill Creek tributary	No
2.0-1.0	HazNet	HWTS	Portola Properties	Organic and inorganic waste disposal	No
2.0-1.0	HazNet	*not found*	Tolmasoff	Waste and mixed oil disposed of via recycler	No
2.0-1.0	Hist UST	*not found*	Dacha Vineyards	Fuel tank leak detection	No
2.0-1.0	UST	*not found*	not provided	Facility 49-000-005435	Inactive
2.0-1.0	Hist Cortese, LUST	GeoTracker	City of Healdsburg, lift station	Potential gasoline contamination (completed – case closed June 2013)	No
12.0-11.5	Hist UST	*not found*	Meeker vineyards	not provided	No
12.0-11.5	Hist UST	not found	Petersen	Fuel tank leak detection	No
10.6-11.0	Hist UST	not found	Rued Ranch	Fuel tank leak detection	No

7.4-8.1	UST	GeoTracker		Facilities 49-000-006018 and 49-000-003254	Active
7.4-8.1	SLIC, CA WDS	*not found*	Timber Crest Farms, 4791 Dry Creek Rd, Healdsburg, CA 95448	Located about 0.35 miles from Dry Creek.	No
7.4-8.1	Hist UST	*not found*	C. Hollis Black	Fuel tank leak detection	No
7.4-8.1	NPDES	*not found*	Lands of Valhall Vineyards	Active stormwater construction	No
7.4-8.1	NPDES	*not found*	Martorana Winery	Active stormwater construction	No
5.1-6.1	CaWDS, HazNet, NPDES	*not found*	Lambert Bridge Winery	Discharges stormwater runoff under a Waste Discharge Requirement, disposal of asbestos waste, active stormwater construction	No
5.1-6.1	Hist UST	*not found*	Maize	Fuel tank leak detection	Inactive
2.1-2.9	Hist UST	*not found*	Becker	Fuel tank leak detection	Active
2.1-2.9	NPDES	*not found*	Emerald Ridge Road Improvements	Active stormwater construction	Inactive
0.0-0.9	UST	Geotracker	291 Foreman Ln, Healdsburg 95448	Facility 49-000-003827 Permitted UST set back from Dry Creek	No
0.0-0.9	NPDES	*not found*	MacPhail Family Winery	Active stormwater construction	No

4. FUTURE WITHOUT PROJECT CONDITIONS

Future without project conditions were projected to characterize the "no action" alternative and its effects, and to form a basis for comparison of restoration benefits. The following summarizes future conditions for pertinent (i.e. hydrologic, geomorphic, and ecological) resources. The base year for this study (the first year the project is expected to start to realize net benefits) is conservatively expected to be 2017. The Study has a 50 year planning horizon and the project end of life is anticipated to be in 2067.

4.1. Hydrology and Geomorphology

The following assumptions are made regarding the future without-project conditions of the hydrology, hydraulics and sedimentation:

- Current hydrologic regime will not induce widespread erosion.
- The grade control structures in the Dry Creek channel appear to be partly functioning as planned though are expected to continue to degrade over time. The 2010 Existing Conditions Assessment for Dry Creek (Horizon 2012) concluded that with the exception of tributary headcutting, the current hydrologic regime is not likely to induce widespread erosion at rock bank protection sites. This assessment also found that the grade control structures in the Dry Creek channel appear to be partly functioning as planned, though the fish ladders will require maintenance and modification (Horizon 2012).
- The single incised channel will remain largely stable where adequate floodplain exists. Some bank sloughing may continue where banks are over-steepened and riparian vegetation has been lost or removed. The channel will likely continue to produce hydraulic conditions unsuitable to the sheltering of juvenile fish. (Inter-Fluve 2011)
- Some of the tributary channels to Dry Creek will continue to contribute sediments and some may experience further bank erosion.

4.2. Ecological Setting

Land use in the study area is expected to maintain the current mix of agriculture, municipal, and industrial uses under future without-project conditions. Some orchards may be transitioned into vineyards over the life of the project. Aquatic/riparian habitat in Dry Creek will likely be maintained at their current conditions due to the consistent flow from Lake Sonoma and the hatchery. All the tributary confluences to Dry Creek are expected to become intermittent in the summers, especially under a changing climate. However, there may be State actions that will require water management to improve flow conditions in tributaries in the summer. Climate Change will have an impact on ecological health of the Dry Creek watershed within the planning horizon.

Restoration actions by other entities will continue to occur in the Russian River Watershed. Restoration structures that result from these efforts are expected to be engineered to last the life of the project. However, without Corps involvement, the magnitude of those actions might not be sufficient to prevent extinction of the CCC coho salmon population. Hatchery operations are expected to continue and adjustments to water supply and flood risk management releases should occur according to the Biological Opinion, aiding in salmon recovery. Without sufficient concurrent Dry Creek mainstem improvements to habitat complexity, coho and steelhead populations will continue to be impacted. The following assumptions are made regarding the future without-project conditions of salmonid populations in lower Dry Creek:

- Coho: There are expected to be increases in rearing juvenile coho by 2023 and increases in spawners by 2073 under future without-project conditions due to hatchery operations and ongoing restoration work happening now. However, delisting within the project horizon is unlikely.
- Steelhead: There are expected to be increases in steelhead production under future without-project conditions but they are not expected to be as large relative to those for coho. The status quo is expected under future without-project conditions to the project planning horizon.
- Chinook: The status quo is expected under future without-project conditions to the project planning horizon.
- Current projections under climate change are not conclusive; however, a resilient population of native salmonids will be needed if they are to avoid extinction. Dry Creek will become more important as a strong hold habitat as it will likely persist as the coolest perennial stream in the driest years.

The status quo is expected for native wildlife species under future without-project conditions to the project planning horizon. The following assumptions are made regarding the future without-project conditions of the riparian shoreline:

- Lack of vegetation management is expected to continue under future without-project conditions and vegetation is expected to remain the status quo over the life of the project.
- The floodplain areas will continue to build up and become more disconnected from the stream.
- The spread of invasive plant species will continue to be a problem in the study area under without project conditions. Water Primrose (*Ludwigia hexapetala*) and Giant Cane (*Arundo donax L.*) are of particular concern. Invasive feral pigs are known to be in and around the upper watershed and are not expected to impact the lower watershed.

5. PLAN FORMULATION

5.1. THE PLANNING PROCESS

The guidance for conducting civil works planning studies, ER 1105-2-100, Planning Guidance Notebook, requires the systematic formulation of alternative plans that contribute to the Federal objective. To ensure that sound decisions are made with respect to development of alternatives and ultimately with respect to plan selection, the plan formulation process requires a systematic and repeatable approach. This chapter presents the results of the plan formulation process. Alternatives were developed in consideration of study area problems and opportunities as well as study objectives and constraints with respect to the four evaluation criteria described in the Principles and Guidelines (completeness, effectiveness, efficiency, and acceptability).

5.2. ALTERNATIVE FORMULATION PROCESS

An alternative plan is a set of one or more management measures functioning together to address one or more objectives. However, the majority of measures identified for this study are relatively small in physical size compared the study area. For example, side channels, the largest of the proposed measures, are at most around a couple thousand feet in length compared to approximately 13.9 miles of creek within the study area. Additionally, the accessible width of the available floodplain in lower Dry Creek to implement the various measures is relatively narrow across all subreaches and, therefore, the combinations of available measures within each subreach will be very similar. As a result, the Corps went through several iterations of alternative formulation during several meetings with the SCWA and resource agencies, including NMFS and CDFW. During these meetings, the array of identified measures were screened. In order to more effectively target the organization of project measures and facilitate the formulation of alternative plans to fit the limited scope of a CAP project, each of the 15 inventory reaches discussed in Section 1.6.1 “Reach Deliniation Methods” were sub-divided into twenty-six (26) ‘restoration subreaches’ (Figure 25). The Corps then used different combinations of subreaches, rather than individual measures, as building blocks for alternative formulation. Figure 26 provides a diagram of the alternative formulation process. The following subsections provide a detailed description for each step in the alternative formulation process.

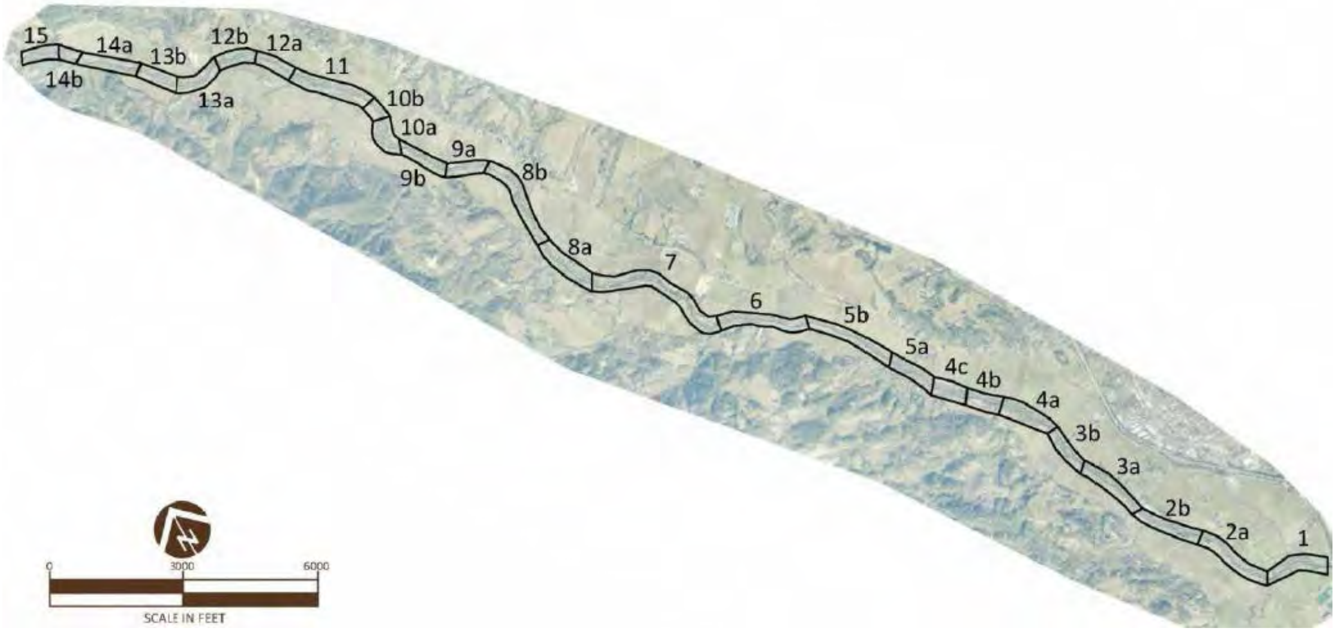

Figure 25. Overview of the ‘restoration’ 25 sub-reach

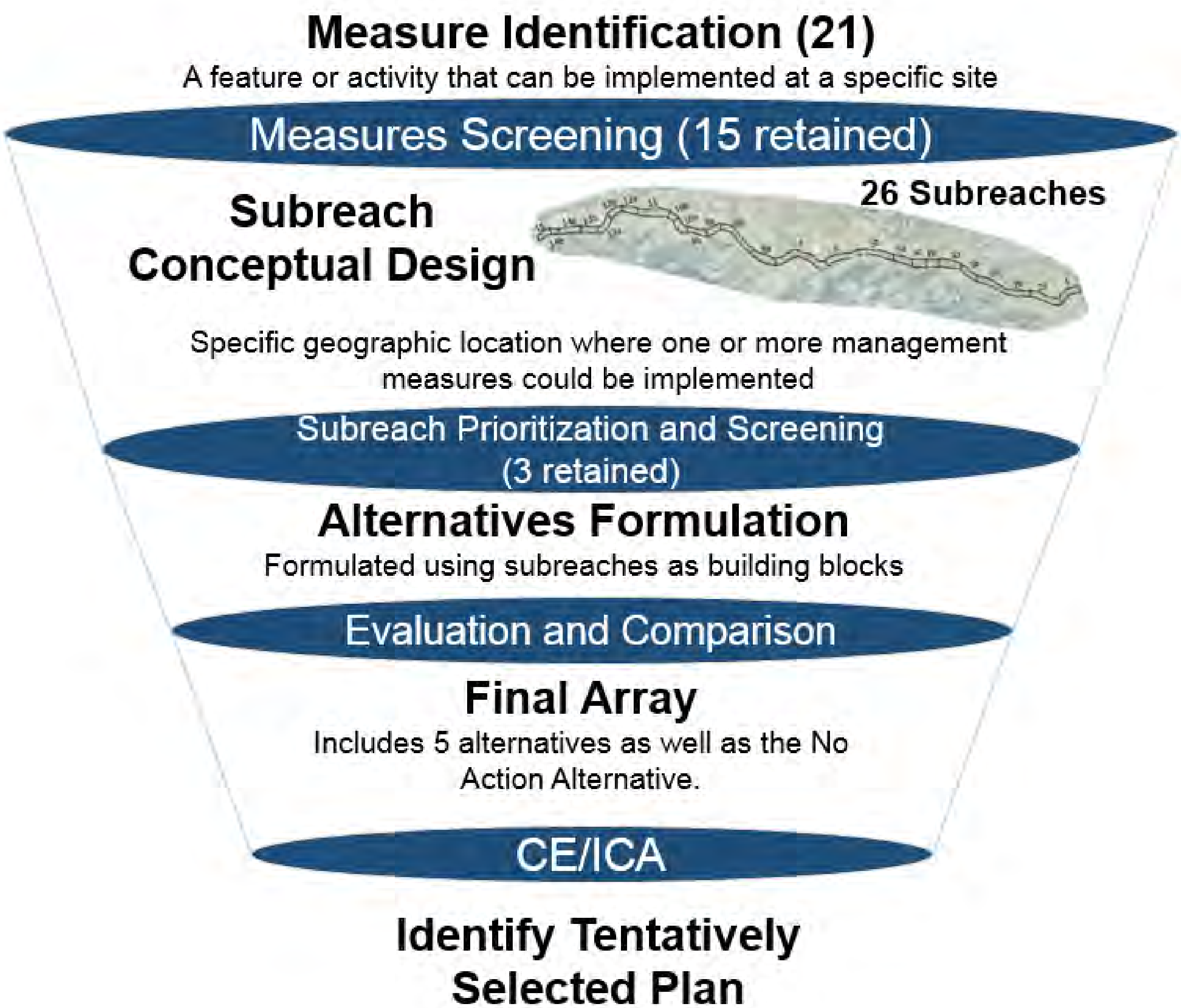

Figure 26. Dry Creek CAP 1135 Alternative Formulation Process.

5.3. Development and Screening of Measures

A measure is a feature or an activity that can be implemented at a specific geographic site to address one or more planning objectives. Measures are the building blocks that are grouped together to form alternative plans. Ecosystem Restoration measures can be nonstructural or structural. The following nonstructural and structural measures were considered as a part of the Study and were screened based on planning criteria described below in Section 5.3.3.

5.3.1. Nonstructural Measures

Non-Native Vegetation Removal (RETAINED): Removal of non-native or invasive species.

Re-Vegetation (RETAINED): Thinning of existing vegetation and replanting of native vegetation for structural complexity and biodiversity.

Vegetation Adaptive Management (RETAINED): Long term adaptive management of vegetation within the study area to maintain structural complexity and biodiversity.

Dam Operations (DROPPED): Modify the timing or volume of flow releases and optimize scheduled releases from WSD by incorporating “best practices” into the standard operating procedures that are within the current rules and limitations of the rule curves to improve habitat quality and quantity. In order to determine whether measure should be retained a special in-progress review was held and included team members with relevant expertise as well as experts from the Sponsor’s team and the SPN’s Dam Safety Program Manager. To determine the feasibility of this measure, meeting participants considered dam reoperations under the following two scenarios: water supply reoperations and flood control reoperations. Both scenarios for reoperations were screened out based on effectiveness and acceptability criteria.

In order to effectively meet project objectives, water supply and flood control operations would have to be changed so that they better resemble natural flows under unregulated conditions. In regards to water supply reoperations, low flows would naturally be between 0-3 cfs, far below the current minimum flow requirements stipulated by the D1610 minimum flow requirements (25 to 105 cfs). Natural flows are also below those required for hatchery operations requirement (>70 cfs) and hydropower operations (75 to 105 cfs) as well as SCWA requirements to meet water supply demand. Reoperation of water supply to meet the project objectives would violate the project constraints and is, therefore, unacceptable.

In regards to flood control reoperations, to provide benefits during flood periods flows would need to be large enough to geomorphically reconfigure the channel. Natural, pre-dam annual high flows were, on average, approximately 15,000cfs with flood flows reaching as much as 30,000cfs. The maximum flow authorized by the WSD Water Control Manual is 6000cfs. Based on the team's best professional judgment, bringing flood control releases up to the maximum permitted by the Water Control Manual would still not be sufficient to reactivate geomorphic processes. Additionally, this maximum cannot be increased without significantly increasing risk of flooding below WSD along Dry Creek and the mainstem Russian River and, therefore, violates the project constraints and was determined to be unacceptable.

Predator Removal (DROPPED): The removal of non-native predators that pose a threat to native species (ex. non-native bass). Non-native predators have not been identified as a problem in this study area and therefore this measure was screened out.

5.3.2. Structural Measures

Water supply diversion pipeline (DROPPED): Build a pipeline to route summer water supply dam releases around lower Dry Creek to reduce unnaturally high summer flow velocities. Although a pipeline will avoid the high flows that are detrimental to salmonids, it will not provide any other habitat benefits. SCWA has already performed a study to determine the cost for a proposed pipeline and has found the costs to be extensive. For these reasons, this measure was considered not only no effective or efficient but also outside the scope of a CAP project and was screened out.

Riffle Construction (RETAINED): Construct riffles with a well-mixed layer of small boulders, cobbles, gravel, and sand across the stream to provide in channel habitat complexity, increased pool-riffle ratio, substrate for a diversity of macroinvertebrates, locations for foraging in the main channel for fish and other aquatic species, key grade control for backwater habitats, and improvements to the quality of adjoining pools for aquatic species.

Boulder Clusters (RETAINED): Single or multiple boulders placed in wetted channel to create instream pools and cover for fish (steelhead, in particular).

Log Jams (RETAINED): Stacked and knit together logs, boulders, and root wads to anchor the stream's location, form deep pools for holding and rearing habitat for fish and aquatic wildlife, trap sediment, prevent erosion, restore floodplain and side channel habitat, and provide instream velocity refuge as well as complex cover for aquatic species.

Habitat Log Structures (RETAINED): Placement of logs and rootwads (LWD) to create complex cover for fish and aquatic wildlife, refuge from high flows, substrate for macroinvertebrates, and locations for foraging in the main channel for fish and other aquatic species.

Complexity and cover features (RETAINED): Place rootwads or simple log installations along the stream banks to provide cover, velocity refuge, shade, substrate for macroinvertebrates, and locations for foraging perennially in the main channel for fish and other aquatic species. The structures will be smaller than the habitat log structures and constructed using rootwads, small diameter logs, live wood, and boulders.

Backwater Channel Construction (RETAINED): Construct area off to the side of the stream that in the summer is only connected to the main stream at the downstream end to provide winter refuge over a large range of flows, increase habitat complexity, and provide refuge from high summer flows.

Side Channel Construction (RETAINED): Construct new side channel that runs parallel to mainstem and connects at both upstream and downstream ends; also includes excavation and reconnection of old, abandoned channels to restore meander patterns, increase habitat complexity, provide refuge from high flows, and increase pool-riffle ratio.

Winter Refuge Habitat (RETAINED): Lower certain portions of the floodplain in order to increase the frequency of inundation during flood flows; includes LWD placement to provide additional cover and provide flood refuge for fish and wildlife.

Creating/Reconnecting Meanders (DROPPED): Low gradient streams like Dry Creek typically meander across their floodplain overtime. This process eventually results in the creation of abandoned meander bends in the adjacent floodplain, providing complex floodplain habitat for riparian and stream species during high flood flows. As Dry Creek became straightened and incised due to dam operations and adjacent land use practices, the stream has been cut off from accessing remnant meander channels. The lower Dry Creek is now too incised (over ten feet) to restore access to the upper terrace, a large area of the historic floodplain where remnant meanders can be found. For this reason, this measure was dropped.

Gravel Augmentation (DROPPED): Addition of instream gravel to improve spawning habitat. Based on the Corps' experience implementing gravel augmentation in Reach 15, this measure was shown to provide limited benefit for potential large costs and was dropped for its low score during screening. Spawning gravels are not a limiting factor in Dry Creek and the cost to obtain, sort, and store the gravels as well as the Operation and Maintenance required to continually add gravels will incur great costs for limited benefits.

Modify/removal of existing bank erosion control structures, grade control structures sills), and fish ladders (RETAINED): There are several bank erosion control structures and grade control structures (sills) within the study area, including Denil fish ladders at several sills. The fish ladders were included when the sills was constructed to provide fish passage over the sills. However, the sills have mostly filled with sediment and no longer serve their purpose. They do, however, backwater flow and effectively drown out complex channel bed forms that would otherwise provide complex instream habitat such as pool riffle complexes. Additionally, although adult fish can use the fish ladders for part of the year, they collect debris causing maintenance and potentially fish passage issues. Due to the velocities in the fish ladders, juvenile fish have difficulty passing up or downstream over the sills. The bank erosion control structures (e.g. board fences and grouted rock) are in various stages of disrepair and have been overtaken by vegetation. The vegetation essentially serves the purpose of the structures and the harden structures degrade the habitat quality by limiting bank habitat complexity and cover and, in the case of the board fences, leak noxious chemicals into the water. Both the sill and the bank structures may be removed or altered as a part of this project to improve habitat quality and fish passage.

Grade control to control incision (DROPPED): Lower Dry Creek is no longer actively incising along most of its length because it has already incised to natural grade control features and has reached equilibrium, with the regulated stream flow from the WSD. However, on a site by site basis where incision is found to be problem, grade control structures will be considered.

Bank Stabilization (RETAINED): Prevent stream from migrating into high terraces by stabilizing bank with bioengineered structures.

Fine Sediment Control (DROPPED): Identify specific measures to control input of fines to stream channels. Fine sediment has not been identified as a problem in the study area and so this measure has been screened out.

5.3.3. Measure Screening

Screening is the ongoing process of eliminating measures based on planning criteria. Measures are screened based on the set of criteria described below. The criteria were derived for the specific planning study using planning objectives, constraints, and opportunities of the study area. The expertise of the PDT members was used to determine the screening ratings. The criteria for each measure was rated using a scoring metric (described below for each criteria). Table 11 summarizes the measures screening outcomes.

- **Effectiveness**. Effectiveness is the extent to which a measure or alternative plan achieves the planning objectives. Measures or alternative plans that clearly make little or no contribution to the planning objectives should be dropped from consideration.

Scoring Metrics

> ***3:*** The measure directly meets the objective (ex. riffles create complexity in the aquatic environment and, therefore, meets Objective 1- Habitat Complexity)
>
> ***2:*** The measure indirectly meets the objective (ex. riffles don't directly connect the floodplain to the channel (Objective 2 – Habitat Connectivity) but they can backwater flow into constructed alcoves that do create lateral connectivity with the floodplain).
>
> ***1:*** The measure does not meet the objective (ex. riffles do not restore riparian vegetation complexity and diversity (Objective 3 - Riparian Vegetation Diversity and Complexity).

- **Efficiency**. Efficiency is a measure of the cost effectiveness of the measure or plan expressed in net benefits. In the case of Ecosystem Restoration, benefits are non-monetary outputs expressed in the increased quality or quantity of habitat. Measures or alternative plans that provided little benefit relative to cost should be dropped from consideration.

Scoring Metrics

> ***3***: The measure provides the most benefits for the least cost or provides greater benefits/meets multiple objectives for similar costs to measures that provide more limited benefits/meets only a fewer objectives.
>
> ***2***: The measure provides benefits that meet one or more objectives but these benefits are more limited or more expensive than other similar measures.
>
> ***1***: The measure is costly and provides minimal output.

- **Acceptability**. Acceptability is a measure of the ability to implement a measure or alternative plan. In other words, acceptability means a measure or plan is technically, environmentally, economically, and socially feasible. The measures developed for all of the alternative plans are generally considered satisfactory methods of addressing ecosystem restoration problems. While some measures are more preferable than others to the public, all should be acceptable. Measures or plans that are clearly not feasible should be dropped from consideration. Unpopular measures or plans are not necessarily infeasible, just unpopular. However, we did want to capture in the screening process if a measure is extremely unpopular with key or multiple stakeholders to the extent that it may pose a major road block. In order to capture this, the Acceptability criterion is divided up into two sub-criteria:

Implement-ability (whether a measure or plan is technically, environmentally, economically, and socially feasible) and Satisfaction (whether key stakeholders such as the Sponsor, resource agencies, and the general public find the measure acceptable).

Implement-ability Scoring Metrics
3: Easy to implement

2: There would be some institutional barriers to implementing the measure (e.g. the measure would require additional agency permissions or permits).

1: There are legal barriers to implementing the measure.

Satisfaction Scoring Metrics
3: The measure is largely acceptable to all stakeholders.

2: There would be some political barriers to implementing the measure.

1: The measure would likely be totally unacceptable to major stakeholders.

Table 11. Measures Screening

Measure	Effectiveness by Objective				Efficiency	Acceptability		Total Score	Retained	Rationale
	Complexity	Connectivity	Native Species	Riparian		Implement-ability	Satisfaction			
Non–Structural										
Non-Native Vegetation Removal	3	2	2	3	3	3	3	19	Yes	
Re-Vegetation	3	2	2	3	3	3	3	19	Yes	
Vegetation Adaptive Management	3	1	3	3	2	3	3	18	Yes	
Dam Re-Operations	2	2	2	3	3	1	1	14	No	Not be effective or acceptable
Predator removal	NA	NA	NA	NA	NA	NA	NA	NA	No	Non-native predators have not been identified asproblem
Water supply diversion pipeline	1	1	2	1	1	2	1	9	No	Not Efficient.
Riffle Constrctn/ Pool devlpmnt	3	2	3	1	2	3	3	17	Yes	
Bolder Clusters fields	3	2	3	1	3	3	3	18	Yes	
Log Jam	3	2	3	2	2	3	3	18	Yes	
Habitat Log structures	3	2	3	2	3	3	3	19	Yes	
Complexity/ Cover Feature	3	3	3	2	3	3	3	20	Yes	
Backwater Channel Construction	3	3	3	3	3	3	3	21	Yes	

Side Channel Construction	3	3	3	3	3	3	3	21	Yes	
Winter Refuge Habitat	2	2	2	3	2	3	3	17	Yes	
Creating/ Reconnecting Meanders	NA	NA	NA	NA	NA	NA	NA	NA	No	Not feaible
Gravel Augmentation	2	1	2	1	1	2	2	11	No	Not cost effective
Removal or mod of Fish Ladder and/or sills	2	3	2	1	2	2	3	15	Yes	Although score low, would be beneficial and it would be relatively easy to implement.
Modify or remove bank erosion control structures	2	2	2	2	1	2	2	13	Yes	
Biotechnical Stabilization	2	1	2	2	1	3	3	14	Yes	Measure scores may be required to avoid erosion impacts.
Fine Sediment Control	1	1	2	2	1	3	3	13	No	Fine sediment not a limiting factor. Would require large scale land practice changes. Outside project scope

5.3.4. Subreach Formulation

The 25 restoration subreaches were delineated based on spatial opportunities for logical groupings of potential off-channel and main-channel restoration measures. Areas for potential restoration of pools, riffles and streambanks are numerous within the study area. Therefore, more effort was focused on identifying locations to enhance and create side-channel habitat and offchannel alcove backwaters, for which opportunities are more limited. While opportunities for these habitat types exist in lower Dry Creek, potential challenges are posed by Dry Creek's narrow and incised condition which provides limited lateral areas within close elevation range of the active channel. Additional constraints on restoration vary over the length of Dry Creek below WSD and include local factors such as sediment supply, elevation relative to active channel, local grade control features, and the backwater influence of the Russian River.

Appropriate *conceptual* groupings of measures were identified for each restoration subreach based on ongoing planning-level and detailed hydraulic modeling and ecological analysis of Dry Creek, as described in Inter-Fluve (2010, 2011, 2012). Multiple groupings of measures were identified for each subreach in order to effectively meet project objectives. The proposed groupings included combinations of mainstem pool development and riffle construction, off-channel backwater alcove construction, side-channel construction and stabilization of streambanks using bioengineering or similar techniques where appropriate. For example, based on the results of the habitat survey, restoration with large woody debris may improve pool quality in terms of percent cover and shelter complexity. Construction of riffles may include expanding existing riffles or constructing new 'seed' riffles in appropriate locations, which might be considered to supplement sediment supply in certain reaches. Streambank restoration may address chronic erosion in critical locations and provide additional cover along the channel margins. The resulting groupings reflect the best available information developed from a combination of ground survey and LiDAR data (Inter-Fluve 2011, 2012).

5.3.5. Subreach Evaluation, Comparison, and Prioritization

Once the groupings of measures for each subreach were identified, the 25 restoration subreaches were then prioritized to aid in the development of alternatives. In order to assist with subreach prioritization, the potential habitat benefits resulting from the groupings of measures for each subreach were summarized using four evaluation metrics. The first and second metrics address the inherent summer rearing and incremental winter refuge habitat development potential, respectively. Coho salmon specific metrics were utilized because coho salmon habitat needs provide a good proxy for a variety of important fish and wildlife habitat needs. These metrics also reflect riparian habitat quality at a systems level. For example, Western pond turtle habitat requirements overlap with those provided by features designed for coho including complex cover, refuge from high velocity flows, and substrate for food sources like macroinvertebrates. Additionally, quality coho summer and winter rearing habitat requires habitat complexity and connectivity across the stream channel and its floodplain and therefore reflect the project priority objectives. Finally, coho salmon are a significant resource on which the federal interest for this project is based. The third metric addresses the total habitat development potential. The methodology used to estimate the habitat benefits resulting from the restoration work are summarized in Table 12 and the scoring criteria for the habitat metrics are summarized in Table 13 (Inter-Fluve 2012).

Table 12. Methodology used to calculate enhanced habitat benefits (Inter-Fluve 2012).

Habitat Category	Included Habitats	Basis of Area Estimate
Summer coho rearing habitat	Alcove/backwater channel	Area within habitat inundated at 110 cfs.
	Main-channel LWD-margin	Area of LWD in the channel + 3 foot channel
	Side Channel	2/3 of habitat inundated at 110 cfs.
	Pilot off-channel	100% of pilot backwater habitats inundated at 110 cfs 2/3 of pilot side channel habitats inundated at 110 cfs
Incremental winter refuge habitat	Winter Refuge	Area of habitat inundated at 1000 cfs
	Pilot winter refuge	80% of overbank area inundated at 500 cfs
	Alcove/backwater channel	Additional area within grading inundated between 110 and 1000cfs
Total enhanced habitat	Alcove/backwater channel	Area within habitat inundated at 110 cfs.
	Main-channel LWD-margin	Area of LWD in the channel + 3 foot channel
	Side Channels	Area of habitat inundated at 110 cfs
	Winter Refuge	Area of habitat inundated at 1000 cfs
	Pilot winter refuge	Area of habitat inundated at 500 cfs
	Pilot off-channel	Area of habitat inundated at 110 cfs
	Riffle	Area of habitat inundated at 110 cfs
	Pool	Area of habitat inundated at 110 cfs

Table 13. Habitat restoration scoring criteria to evaluate subreaches in Dry Creek (Inter-Fluve 2012).

Score	Summer coho rearing habitat based criteria* (ft^2)	Incremental winter refuge habitat based criteria** (ft^2)	Total habitat based criteria*** (ft^2)
Low	< 20,000	< 30,000	< 80,000
Medium	20,000 - 80,000	30,000 - 90,000	80,000 - 150,000
High	>80,000	>90,000	>150,000

*Includes low water areas of backwater channels, LWD-margin habitat, side-channels and pilot off-channel habitat based (see Table 12).
**Includes high flow area of backwater channels, winter refuge habitat, and pilot winter refuge habitat (see Table 12).
***Includes all habitat restoration, including backwater channels, LWD-margin habitat, side channels, pilot offchannel habitat, riffles, enhanced pool area, winter refuge habitat (see Table 12).

The fourth metric addresses the predicted continuity of habitat benefits. The "continuity" score describes how well the measures in a subreach will be self-maintained over time and is largely based on the current understanding of fluvial processes in different locations along Dry Creek, as described in Section 1.6.2, in addition to subreach-specific channel and floodplain characteristics. Those subreaches closest to the WSD received a high continuity score because the geomorphic and hydrologic influences in those subreaches are controlled by the dam and therefore there is less uncertainty in how the features will perform over time. Table 14 summarizes the scores resulting from application of the evaluation metrics to each restoration subreach. Appendices A through N of Inter-Fluve (2012) provide detailed descriptions of the benefit outputs quantified for each subreach.

Table 14. Summary of restoration subreach scoring and associated potential habitat restoration areas.

Restoration Subreach	Rearing Habitat Potential	Winter Refuge Habitat	Total Habitat Potential Score	Continuity Score	Rearing Habitat (ft^2)	Winter Refuge Habitat (ft^2)	Total Habitat Restoration (ft^2)
15	Medium	Low	Low	High	38600	9550	63950
14b	Medium	Low	Low	High	56150	15350	77400
14a	High	Medium	High	High	89800	31050	169150
13b	Medium	Medium	Medium	High	59900	36200	130050
13a	Low	Low	Low	High	11000	0	29850
12b	Low	High	Medium	High	7000	96150	131350
12a	Low	Low	Low	High	4000	0	16600
11	Low	Medium	High	Medium	8000	64100	163850
10b	Medium	Low	Medium	Medium	47900	0	83300
10a	Medium	Low	Medium	High	74950	15650	146300
9b	Low	Medium	Low	Medium	6000	50950	69300
9a	Low	Low	Low	Medium	3000	0	27000
8b	High	Medium	High	Medium	87300	45900	211600
8a	Medium	High	High	High	59000	181900	253400
6	Low	High	High	Medium	8000	95100	158900
5b	Medium	Medium	High	Medium	37000	46450	168950
5a	High	Low	High	Medium	93650	24500	151650
4c	Medium	Low	Low	High	57650	8050	69550
4b	High	Low	Medium	Medium	108500	15050	134450
4a	High	Low	High	High	107850	24450	182500
3b	Medium	Low	Medium	Medium	65950	20350	121500
3a	Medium	Low	Medium	Medium	44250	18850	95050
2b	High	High	High	Low	103800	254280	367180
2a	High	High	High	Low	151800	296900	463000
1	High	High	High	Low	113150	360200	498400

Following application of these metrics, the restoration subreaches were ranked into 2 tiers. Tier 1 subreaches were determined to have greater potential for habitat restoration. A subreach was given a Tier 2 rank if it did not receive a high score for any of the criteria or if it scored low in the rearing habitat criteria. The rearing habitat criteria received a heavier weight because late rearing conditions are the most limited habitat type in lower Dry Creek and are considered a critical bottleneck for the recovery of significant listed species. Table 15 provides a summary of the subreach ranking. Appendices A through N of Inter-Fluve 2012 provides a synthesis of the conceptual suite of habitat measures and quantified habitat potential as well as a preliminary cost estimates for each subreach was created using parametric costs.

Table 15. Ranking of restoration subreaches in Dry Creek.

Ranking Tier	(Sub) Reach	Potential Coho Rearing Habitat Score	Winter Refuge & Rearing Habitat Score	Total Potential Habitat Score	Predicted Continuity Score
Tier 1	14a	High	Medium	High	High
	13b	Medium	Medium	Medium	High
	15	Medium	Low	Low	High
	14b	Medium	Low	Low	High
Tier 2	12b	Low	High	Medium	High
	13a	Low	Low	Low	High
	12a	Low	Low	Low	High
Tier 1	8b	High	Medium	High	Medium
	4a	High	Low	High	High
	5a	High	Low	High	Medium
	4b	High	Low	Medium	Medium
	8a	Medium	High	High	High
	5b	Medium	Medium	High	Medium
	10a	Medium	Low	Medium	High
	10b	Medium	Low	Medium	Medium
	4c	Medium	Low	Low	High
Tier 2	6	Low	High	High	Medium
	11	Low	Medium	High	Medium
	9b	Low	Medium	Low	Medium
	9a	Low	Low	Low	Medium
Tier 1	2b	High	High	High	Low
	2a	High	High	High	Low
	1	High	High	High	Low
Tier 2	3b	Medium	Low	Medium	Medium
	3a	Medium	Low	Medium	Medium

5.3.6. Subreach Screening and Alternative Formulation

Following the prioritization of the restoration subreaches based on ecosystem restoration potential, the team developed formulation strategies to help screen the subreaches. Formulation strategies are strategies for assembling alternatives to meet, fully or partially, the identified study planning objectives subject to the planning constraints and taking advantage of opportunities. At a workshop held in January 2015, the PDT developed six formulation strategies under which the 25 restoration subreaches were assessed (Table 16). These formulation strategies include:

17. **Maximize ecosystem restoration benefits**: This strategy was used to identify all subreaches which have the greatest potential for ecosystem restoration. All Tier 1 subreaches were identified as meeting this strategy.

18. **Take advantage of cooperating landowners**: This strategy was used to identify all the subreaches on the property of landowners who have cooperated and continued to cooperate with the Sponsor's restoration efforts along Dry Creek. Due to the high percentage of private landownership in the study area and negative local sentiments towards government involvement on private property, the sponsor has expended considerable effort reaching out to landowners along Dry Creek and garnering access agreements of varying degrees from many of them. For this strategy, subreaches were ranked as high, medium, and low in meeting the strategy. A subreach was ranked high if all the landowners are cooperating with restoration efforts through access agreements. A subreach was ranked as medium if only some of the landowners within the subreach are cooperating. A subreach was ranked low if few or no landowners are currently cooperating.

19. **Maximize ecosystem restoration benefits in places with cooperating landowners**: This strategy was used to identify those subreaches that meet both Strategy 1 and Strategy 2 (e.g. subreaches that are both Tier 1 and have cooperating landowners). A ranked approach was also used for this strategy. A subreach was ranked high if it was prioritized as Tier 1 and was ranked high under Strategy 2. A subreach was ranked medium if it was prioritized as Tier 1 but was ranked medium under Strategy 2. A subreach was ranked low if it was prioritized as Tier 2 or was ranked low under Strategy 2.

20. **Focus on subreaches located on Federal Land**: This strategy takes advantage of the opportunity to restore areas on land owned by the Corps where there will be no additional cost to the project for Real Estate. There is only one subreach located on Corp property, subreach 14b.

21. **Focus on subreaches where Corps structures exist (riprap, grade control, board fences, etc.)**: This strategy takes advantage of the identified opportunity to restore areas where there are existing Corps structures. This has two benefits. Firstly, restoration actions can possible address environmental problems potentially being exacerbated by the existing Corps structure such as the fish passage issues at the Corps sills. Secondly, property owners have been shown to be much more cooperative where the Corps has existing structures likely because they already have allowed access through maintenance easements and are therefore more comfortable with government involvement on their land. All subreaches within which there is an existing Corps structure were identified as meeting this strategy.

22. **Focus on subreaches with connectivity to adjacent restored sites**: This strategy takes advantage of existing restored sites along lower Dry Creek and helps meet our connectivity objective. A ranked approach was also used for this strategy. A subreach was ranked higher the more proximal it is to existing restored sites.

Table 16. Subreach Screening Matrix

Sub reaches	Tier	STRATEGIES #1 Max ER Benefits Green = H - Tier 1 subreach Red = L – Tier 2 subreach	#2 Restoration on Cooperating Landowner (CLO) Property Green = H - CLOs along entire subreach OR along areas where features are targeted Yellow = M - CLOs only along part of subreach Red = L - no or only very few CLOs along subreach	#3 Combine #1 and #2 Green = H - subreach is Green under both Strategies 1+2 Yellow = M - subreach is Yellow under strategies 1 or 2 Red = L - subreach ranked L under 1 and 2 strategies	#4 Restoration on Federal Property Green = H - subreach is on Federal Land Red = L - subreach is NOT on Federal Land	#5 Restoration were Corps projects exist Green = H - USACE structure present within the subreach Red = L - USACE structure NOT present within the subreach	#6 Restoration adjacent to existing quality habitat Scale = Designation gets darker green the closer the subreach is to restored habitat.
1	1	H	L	L	L	L	L
2a	1	H	M	M	L	L	L
2b	1	H	M	M	L	L	L
3a	2	L	L	L	L	L	L
3b	2	L	L	L	L	L	L
4a	1	H	H	H	L	H	ML
4b	1	H	L	L	L	H	ML
4c	1	H	M	M	L	L	M
5a	1	H	M	M	L	L	M
5b	1	H	M	M	L	L	M
6	2	L	L	L	L	L	H
7	**Complete**						
8a	1	H	L	L	L	L	H
8b	1	H	H	H	L	H	M
9a	2	H	H	H	L	L	M
9b	2	L	M	M	L	L	M
10a	1	H	L	L	L	H	ML
10b	1	H	H	H	L	L	ML
11	1	H	L	L	L	H	ML

Sub reaches	Tier	STRATEGIES #1 Max ER Benefits Green = H - Tier 1 subreach Red = L – Tier 2 subreach	#2 Restoration on Cooperating Landowner (CLO) Property Green = H - CLOs along entire subreach OR along areas where features are targeted Yellow = M - CLOs only along part of subreach Red = L - no or only very few CLOs along subreach	#3 Combine #1 and #2 Green = H - subreach is Green under both Strategies 1+2 Yellow = M - subreach is Yellow under strategies 1 or 2 Red = L - subreach ranked L under 1 and 2 strategies	#4 Restoration on Federal Property Green = H - subreach is on Federal Land Red = L - subreach is NOT on Federal Land	#5 Restoration were Corps projects exist Green = H - USACE structure present within the subreach Red = L - USACE structure NOT present within the subreach	#6 Restoration adjacent to existing quality habitat Scale = Designation gets darker green the closer the subreach is to restored habitat.
12a	2	L	L	L	L	L	L
12b	2	L	L	L	L	H	L
13a	2	L	M	M	L	H	ML
13b	1	H	H	H	L	L	M
14a	1	H	H	H	L	H	H
14b	1	H	H	H	H	L	H
15	Complete						

Using these strategies, the team (including the Corps, the SCWA, and representatives from NMFS and CDFW) evaluated each subreach. It was first decided that, due to the limited scope of the CAP, the project would focus on only those subreaches located either on Corps property or where Corps structures are located (represented by strategies 4 and 5). This was decided because access to these site is already established for the maintenance of these structures making implementation much more feasible. Additionally, at sites where Corps structures are located there is the added opportunity to address any detrimental environmental impacts these structures currently have on the creek such as limitations on fish passage at the Corps sills. All other subreaches were screened out. Next, the team screened out subreaches that scored Low or Medium under Strategies 1-3 as these subreaches represent areas that have either limited restoration opportunities, will have greater implementation challenges, or both.

Most of these were screened out because they were Tier 2 subreaches and therefore had limited opportunities to implement habitat features to meet the project objectives (i.e. they are narrow and confines offer little space for complex habitat features). Although subreaches 4b, 10a, and 11 are Tier 1 subreaches with federal structures, they have low landowner cooperation score. The PDT made a risk informed decision to screen these three reaches out. Construction of the Dry Creek CAP 1135 Project is anticipated for the summer of 2017. Based on SCWA extensive outreach efforts with landowners in the study area, the PDT determined that the majority of the landowners in these three reaches are resistant to participation in this study within the accelerated timeline of the CAP project. Therefore, there would be a high risk of project delay during the design and implementation phase. However, it was also determined that these landowners would likely become more amenable to a project on their property after seeing the success of restoration projects being constructed elsewhere along the creek in 2016 and 2017. Therefore, these subreach would be a better fit with the timeline of the ongoing Dry Creek General Investigation Project. Finally, the SCWA requested that 8b be screened out as they intend to complete restoration in this subreach on their own during the 2016 construction season.

Three subreaches remained following this screening process including: 14a, 14b, and 4a. All three subreaches are wide enough to provide significant opportunities for off channel features. All three subreaches have existing Corps erosion or grade control structures and present opportunities to address the impacts these structures currently have on the aquatic and riparian habitat. Additionally, subreaches 14a and 14b are adjacent to the constructed Reach 15 restoration thereby fulfilling the opportunity to improve the longitudinal connectivity of quality habitat identified in the project objectives. Alternatively, Subreach 4a is located approximately halfway between Dry Creek's confluences with the Russian River and SCWA's Demonstration Project in Reach 7. Therefore, Subreach 4a provides an opportunity to provide a quality refuge and resting habitat patch for native species, salmonids in particular, as they migrate up Dry Creek. Finally, subreaches 14a and 14b are located in the upper geomorphic segment of lower Dry Creek and represent an opportunity to constructed late successional habitat features while subreach 4a is located in the middle geomorphic segment and presents an opportunity for a more process based restoration approach.

5.3.7. Final Array of Alternatives

Subreaches 4a, 14a, and 14b were combined into a final array of five (5) action alternatives based on the following formulation strategies (Figures 27-31):

Alternative 1: No Action

Alternative 2: Restoration upstream and downstream of the existing Corps sill in subreach 4a (includes sites 4A and 4B) (Figure 27 and Figure 36)).

Alternative 3: Restoration along the longest single reach (includes the existing Corps board fence), Subreach 14a (Figure 28).

Alternative 4: Restoration on Federal property only, Subreach 14b (Figure 29).

Alternative 5: Restoration only where there are Corps structures (noncontiguous reaches), Subreaches 14a and 4a (Figure 30).

Alternative 6: Contiguous restoration on Corps property and where there is an existing Corps structure (board fence), Subreaches 14a and 14b (Figure 31).

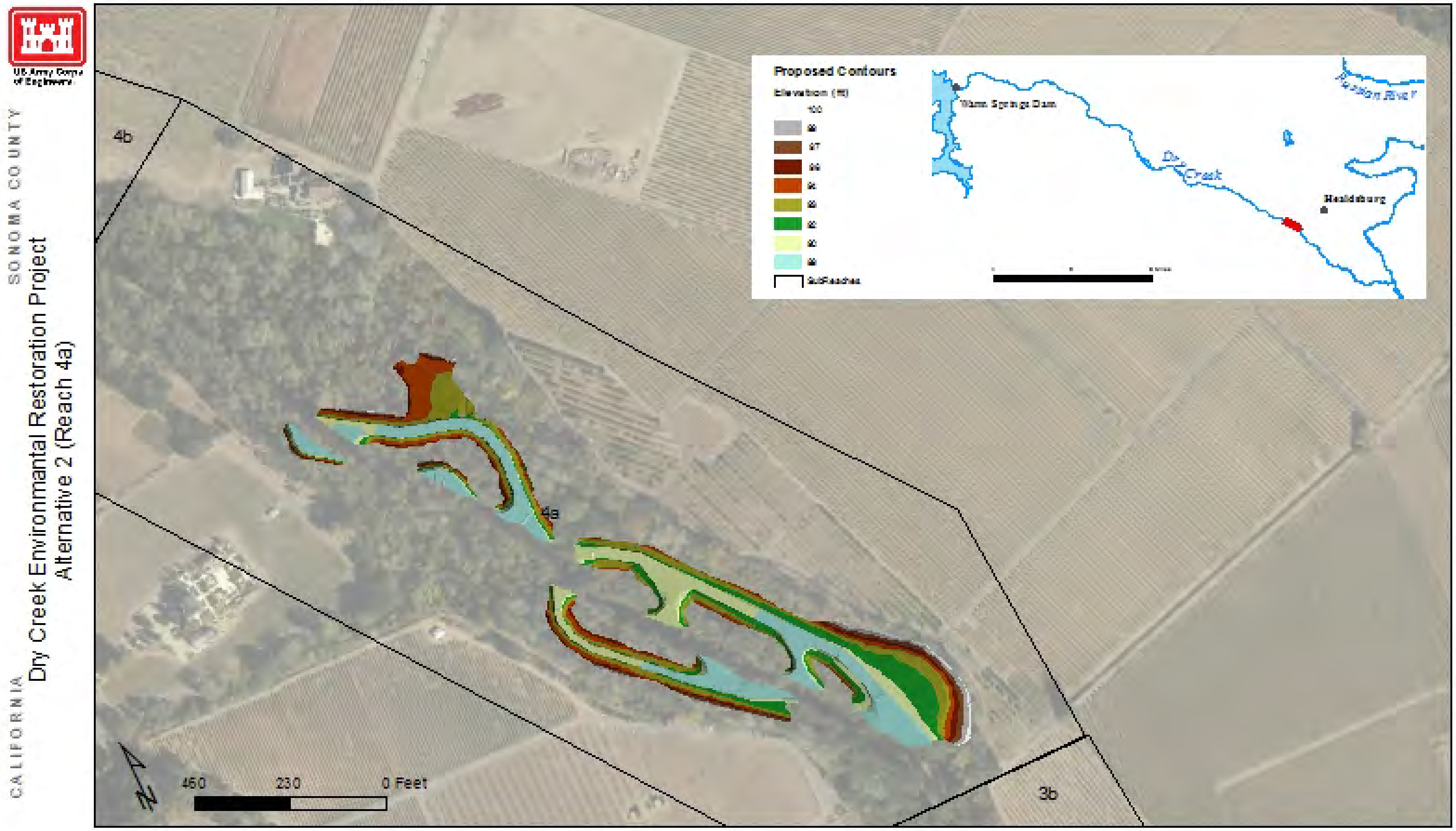

Figure 27. Alternative 2 – includes restoration measures in subreach 4a (includes sites 4A and 4 B).

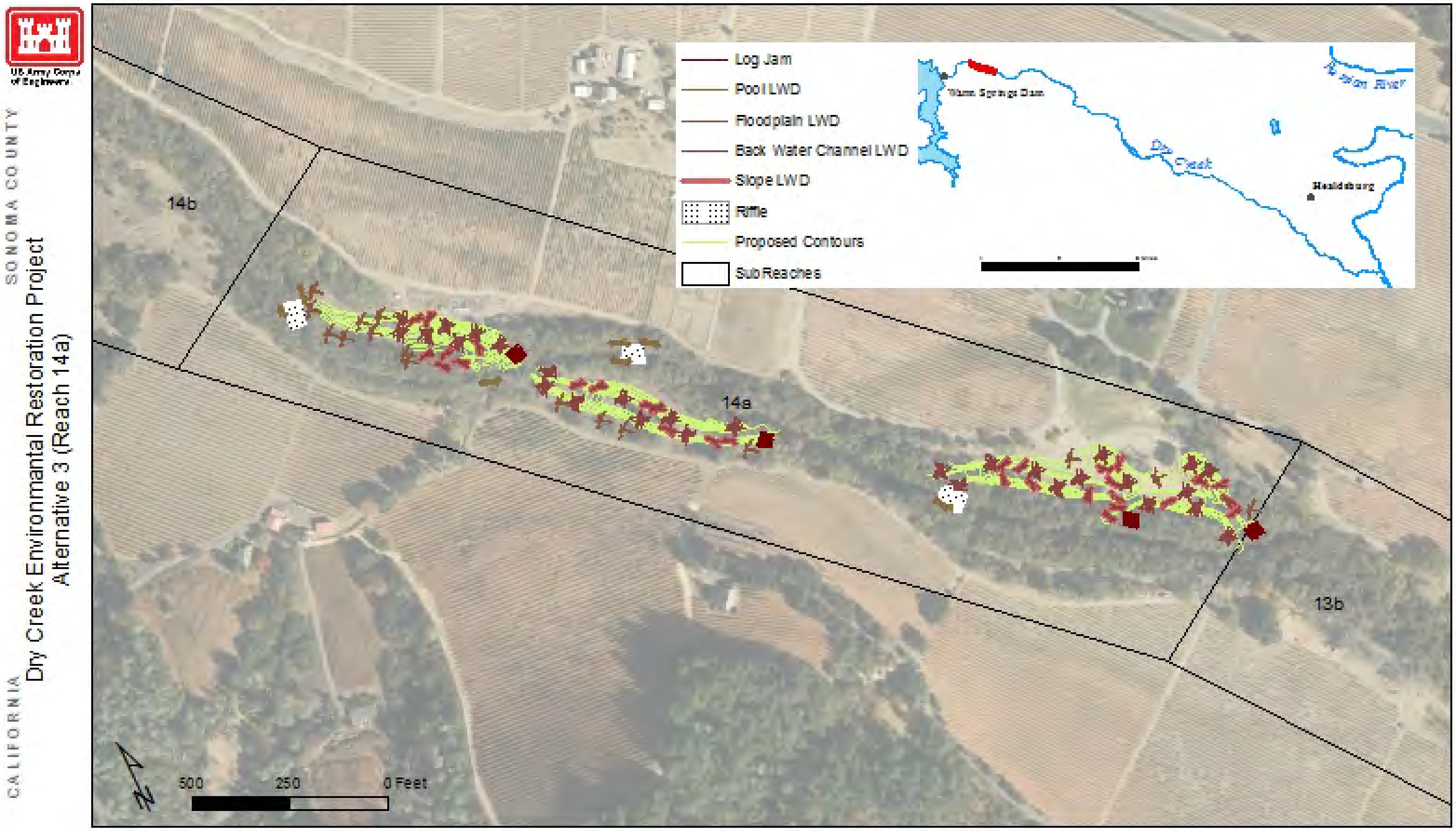

Figure 28. Alternative 3 – includes restoration measures in subreach 14a.

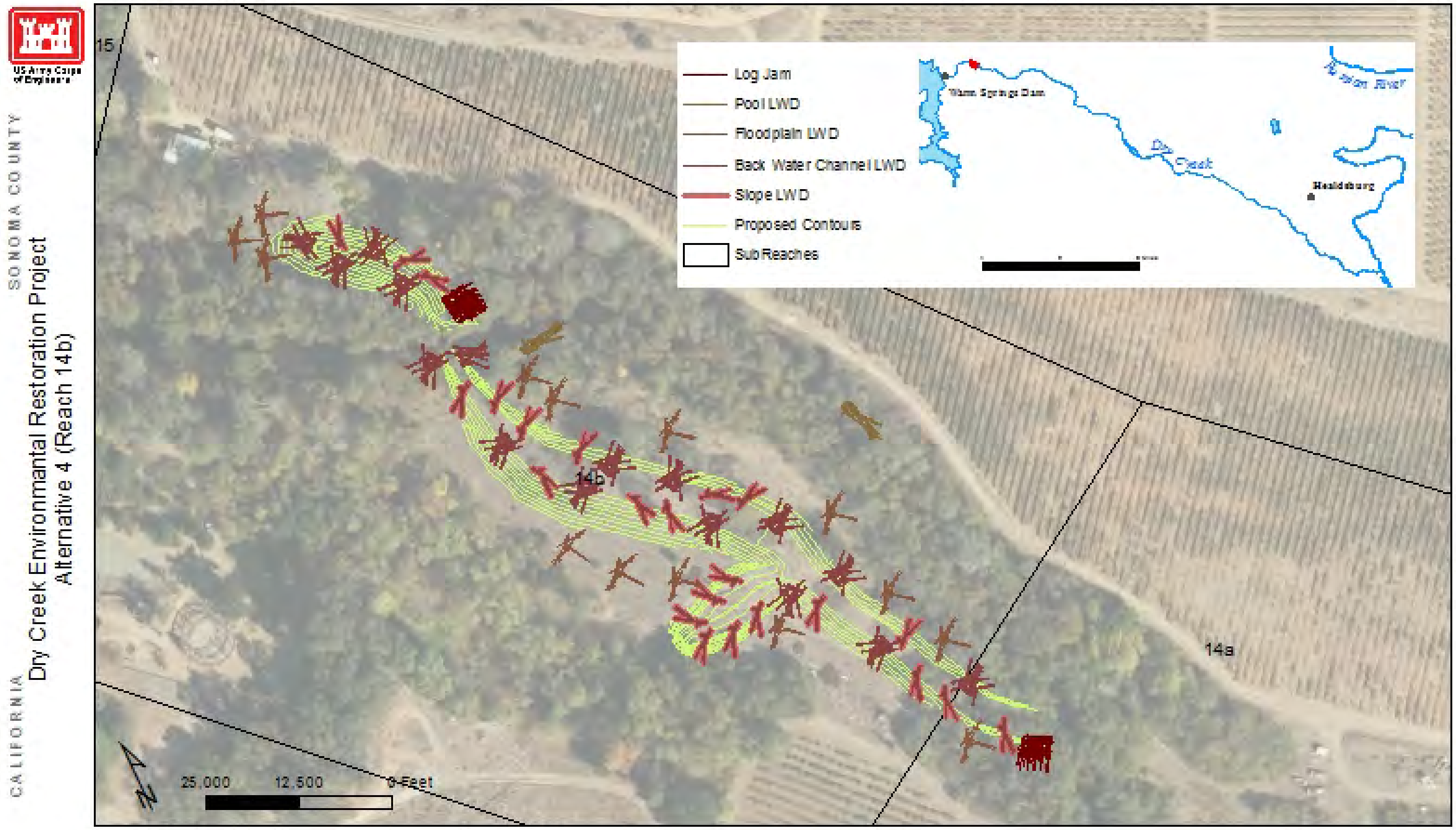

Figure 29. Alternative 4 – includes restoration measures in subreach 14b.

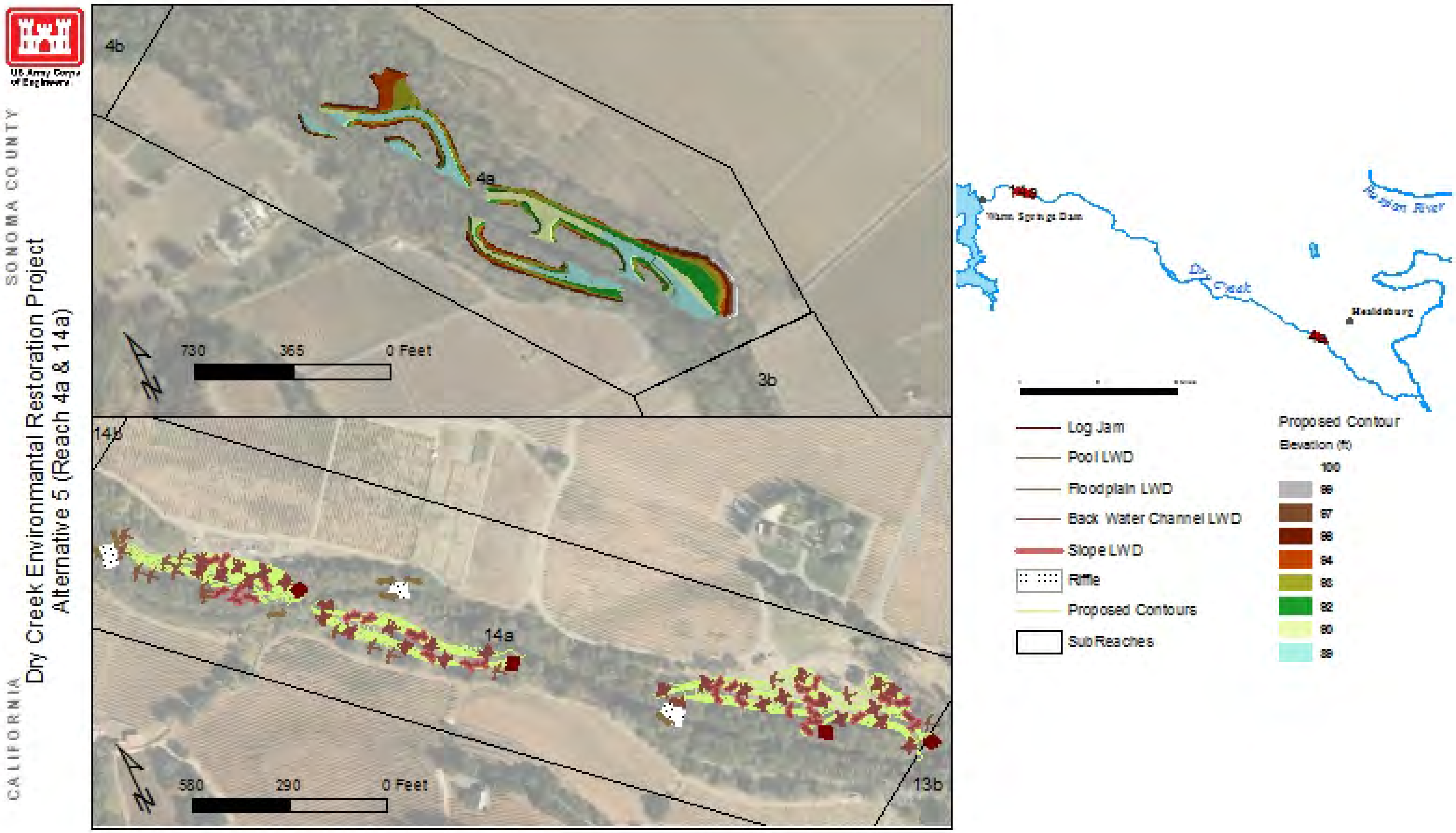

Figure 30. Alternative 5 – includes restoration measures in subreaches 14a and 4a.

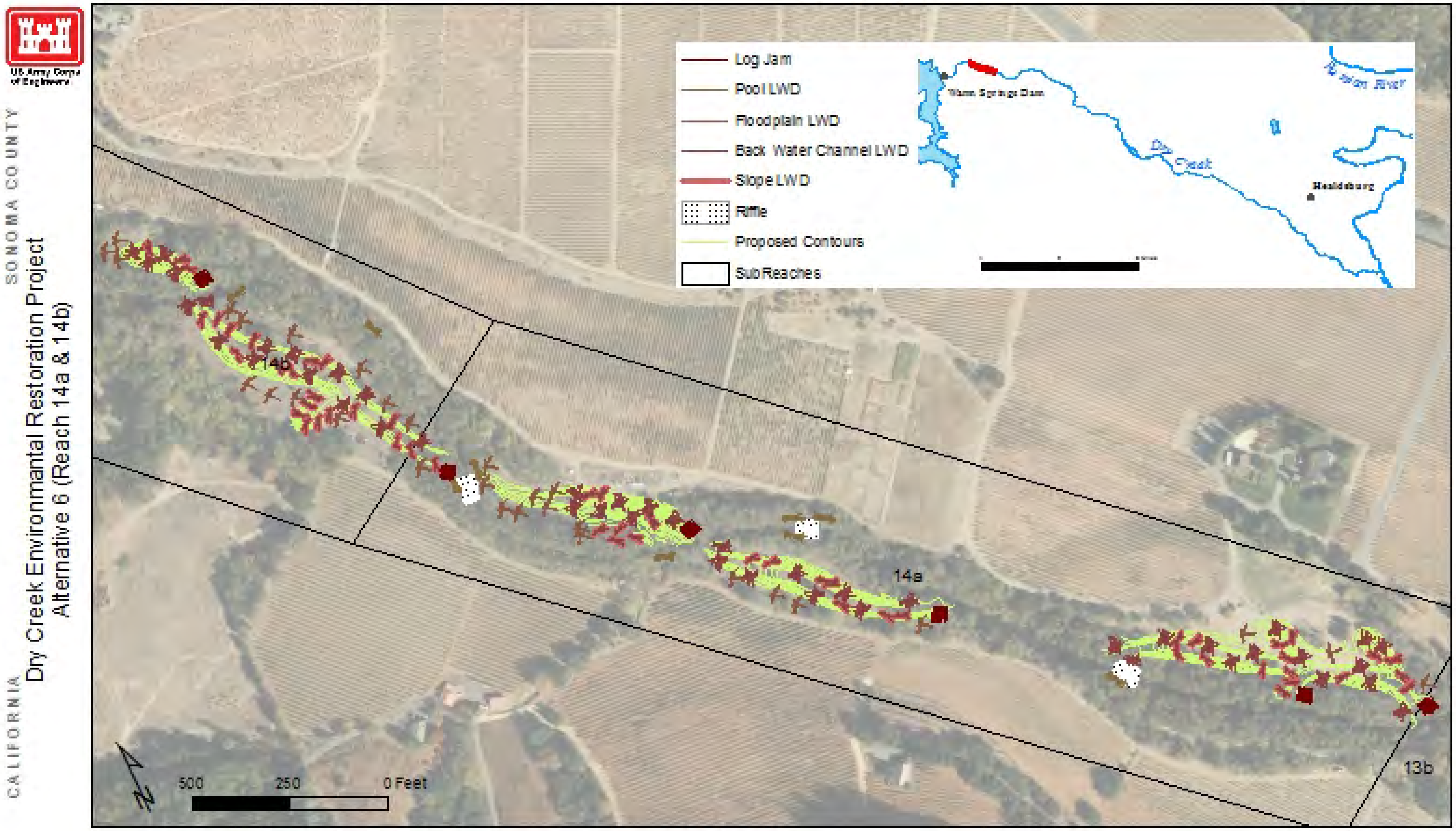

Figure 31. Alternative 6 – includes restoration measures in subreaches 14a and 14b.

5.3.8. Final Array Subreach Descriptions

Below, descriptions are provided for each subreach included in the Final Array of Alternatives. Each descriptions includes a discussion of the subreaches current conditions, the restoration approach taken during preliminary designs, and the features included in the preliminary design.

Subreach 14b

Subreach 14b Current Condition

Subreach 14b is located on Corps property and extends 1000 feet downstream from the Schoolhouse Creek (river mile 13.3) confluence (Figure 27). Subreach 14b is characterized by a flow expansion in the upstream end and a flow contraction in the downstream end. A large riffle at the downstream end of subreach 14a provides grade control for both subreaches 14a and 14b. As a consequence, the overbank ground elevations are in general much closer to the elevation of the summer operational discharge (110 cfs) than other areas located further downstream. Riprap armor was installed by the Corps in the early 1980s along the right bank near the downstream end of the reach for a total length of approximately 600 feet (Figure 4).

Subreach 14b Restoration Approach

Subreach 14b is located in the "upper segment" (Figure 5) of Dry Creek and receives little sediment from upstream due to the absence of tributary inputs and the discontinuity in sediment transport resulting from the installation of WSD. Channel processes are highly unlikely to develop high quality main channel or off-channel habitat. The focus of the restoration approach in this subreach is to construct late successional habitats**Error! Bookmark not defined.** given the limited risk of future sedimentation and channel migration. There is one exception to this approach where evidence of frequent sediment deposition was found due to the influence of Schoolhouse Creek and a small seasonal tributary which appears to discharge sediment onto this bar surface. A mixed constructed habitat and process based approach could be an alternative to constructing late-successional. This, however, is a very limited area and can be further refined in the final design phase.

Subreach 14b Preliminary Design

In order to improve the quality and quantity of aquatic and riparian habitat, a combination of both off-channel and main channel habitat restoration are proposed in the preliminary subreach 14b restoration design. The wider floodplain area in the middle of this subreach provides area for two off-channel habitat restoration opportunities for which is proposed:

- a backwater alcove on the left bank and

- a side channel on the right bank with two associated backwater alcoves.

The subreach design also includes LWD structures of varying sizes and complexities in the off channel features and the main channel as well as pool restoration in the main channel.

Subreaches 14a

Subreach 14a Current Condition

Subreach 14a extends 3,000 feet upstream from river mile 12.4. Subreach 14a is characterized by a relatively narrow active floodplain and a channel geometry that lacks sinuosity due to the history of incision in Dry Creek. A large riffle at the downstream end of subreach 14a provides grade control for the subreach. As a consequence, the overbank ground elevations are in general much closer to the elevation of the summer operational discharge (110 cfs) than other areas located further downstream. Riprap armor was installed by the Corps in the early 1980s along portions of the left bank near the upstream end of the subreach for a total length of approximately 750 feet (Figure 4). Board fence bank protection was also constructed by USACE along the lower 700 feet of the left bank of the downstream end of the subreach (Figure 32). Both these features limit lateral migration of the main channel.

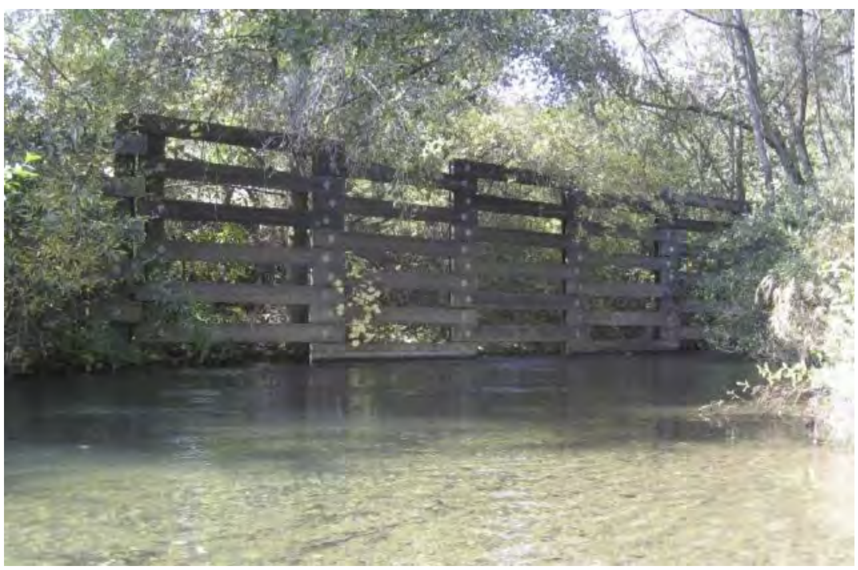

Figure 32. 700 foot board fence in subreach 14a

Subreach 14a Restoration Approach

Subreach 14a is located in the “upper segment” (Figure 5) of Dry Creek and receives little sediment from upstream due to the absence of tributary inputs and the discontinuity in sediment transport resulting from the installation of WSD. Channel processes are highly unlikely to develop high quality main channel or off-channel habitat. The focus of the restoration approach in this subreach is to construct late successional habitats given the limited risk of future sedimentation and channel migration.

Subreach 14a Preliminary Design

In order to improve the quality and quantity of aquatic and riparian habitat, a combination of both off-channel and main channel habitat restoration are proposed for the preliminary subreach 14a restoration design. Off-channel restoration features proposed include:

- three side channels alternating between the right and left bank from the upstream to downstream end of the subreach,
- three backwater alcoves associated with the most downstream of the proposed side channel

The subreach design also includes LWD structures of varying sizes and complexities in the off channel features and the main channel as well as pool restoration, constructed riffles, and bolder fields in the main channel.

Subreach 4a*

Subreach 4a Current Conditions

Subreach 4a includes sites 4A and 4B (Figure 36). Sites 4A and 4B are bisected by the existing concrete sill that was constructed by the Corps in 1981. Subreach 4a extends approximately 1700 feet upstream from river mile 3. It is located at the upstream limit of the backwater influence from the Russian River and, consequently, deposition due to backwater effects occurs less frequently in this reach than in reaches further downstream. The flow events that are backwatered in this subreach are typically very large, so when deposition does occur, it is likely to be less frequent but potentially greater magnitude than further downstream. After the construction of WSD, subreach 4a became less sinuous although some channel migration has occurred. A series of floodplain contractions and expansions have occurred, with active floodplain width varying from 300 – 600 feet. The subreach has undergone significant channel narrowing and flow concentration due to establishment of vegetation and stabilization of bar features. As a result, flows have a higher velocity than occurred prior to the dam.

The channel in this subreach is influenced by a Corps constructed grade control sill in the middle of the reach (Figure 36, river mile 3.5). The sill is 380 feet long though nearly half of the structure is keyed into the adjacent banks to prevent flanking from migration of the mainstem or side channel avulsion. The crest of the sill is 6 feet wide and 6 feet in height above the downstream armored plunge pool. The sill is one of three in the lower watershed that were installed to prevent headcut migration and systemic geomorphic instability. Each sill has a Denil fish ladder and trash rack to provide passage through the short cascades

(Figure 33 – left). The fish ladders and trash racks are in various states of degraded function due to debris accumulation, sediment deposition, and general degradation of the metal structures and pose as a passage barrier to juvenile salmonids. A short section of boulder riprap covers both banks upstream and downstream of each sill. The sills have a significant impact on the upstream channel and effectively drowning out bedform variability thus creating very long reaches of slow moving flatwater. These long runs were also observed to have fine sediment accumulation on the bed. The habitat downstream of the sills included split flow and secondary channel features as well as small alcoves near the channel margins

Figure 33. (left) ladder on middle sill, (right) middle sill.

This reach is close to sediment transport equilibrium and has a relatively long period of channel stability. The over-bank area in between the main channel and the slope up to the terrace provides significant opportunity for off channel habitat restoration features.

Subreach 4a Restoration Approach

Subreach 4a is located in the “middle segment” (Figure 5) of Dry Creek, characterized by the increased sediment and surface water contributed by tributaries. Restoration in subreach 4a will have to consider potential consequences of the larger sediment supplied by tributaries. The topography and existing channel alignment in this subreach provide opportunities for several habitat restoration approaches for both base flow and high flow conditions including perennial and high flow secondary channels, alcoves, high flow benches and mainstem connections and localized widening. The focus of restoration in subreach 4a will be to utilize relatively large floodplain areas for off-channel habitat development.

Subreach 4a Preliminary Design

In order to improve the quality and quantity of aquatic and riparian habitat, a combination of both off-channel and main channel habitat restoration are proposed for the preliminary

Subreach 4a restoration design. Off-channel restoration features include the creation of a side channel on both sides of Dry Creek. Each side channel will have an associated backwater alcove. The side channel proposed on the right bank is approximately twice as long as the one on the left bank and includes two mid channel connections to the mainstem. The subreach design also includes LWD structures of varying sizes and complexities in the off channel features and the main channel as well as pool restoration, constructed riffles, and bolder fields in the main channel. Proposed alcove and secondary channel features are anticipated to generally persist in their constructed condition for years to decades. However, there is potential for significant episodic deposition which could change the type and function of the habitat. The existing condition and compromised function of grade control sills and the Denil fish ladders provides opportunity to modify or rehabilitate both the sills and fish ladders to improve hydraulic conditions upstream. Modifications could include notching or lowering portions of the sill. There are also high terraces adjacent to the mainstem that separate the mainstem from topographic low points in the off channel area. These locations could be modified to create tree islands or notched to provide connections to the mainstem at a range of flows.

6. EVALUATION AND COMPARISON OF FINAL ARRAY OF ALTERNATIVES

Evaluation and comparison, which are the steps in the USACE planning process that follow plan formulation, are based on the assessment of the features and impacts of the alternatives. Under the evaluation step (USACE Planning Step 4), the “with-project condition” resulting from each alternative is compared to the “without-project condition” to quantify ecosystem restoration benefits and identify other impacts from implementing the alternative. In addition, each alternative is evaluated against the P&G criteria of completeness, effectiveness, efficiency, and acceptability. During the comparison step (USACE Planning Step 5), the benefits, impacts, and performance in consideration of the four P&G criteria are compared across alternatives.

Alternatives are evaluated by assessing or measuring the differences between each with- and without-plan condition and by appraising or weighting those differences. The following sections outlines and describes the final evaluation, comparison, and trade-off analyses to identify a TSP. Plans were evaluated based on the following criteria: outputs and cost effectiveness, the Planning Guidance Notebook’s four evaluation criteria (completeness, effectiveness, efficiency, and acceptability), and contributions to the Federal objective (NER). The following sections outline the results of the evaluation and comparison steps. The results of the evaluation and comparison of effects to significant resources and the evaluation of compliance with environmental protection requirements are presented in Chapter 10.

6.1. Corps Criteria Evaluation

Each alternative in the focused array was independently evaluated using a suite of quantitative and qualitative metrics for each of the Corps’ four screening criteria: completeness, effectiveness, efficiency, and acceptability (Table 17). A description of the metrics used to evaluate the effectiveness criteria is provided below.

Table 17. Summary of Planning Evaluation Criteria and Objective Ratings per Alternative.

Alternative		P&G Evaluation Criteria			
		Completeness	Effectiveness	Efficiency	Acceptability
1	No Action	Med	Low	Med	Low
2	Subreach 4a	High	High	High	High
3	Subreach 14a	High	Low	Low	High
4	Subreach 14b	High	Med	Low	High
5	Subreach 4a and 14b	High	Low	Med	High
6	Subreach 14a + 14b	High	Med	Low	High

- **Completeness** – The extent to which the plan provides and accounts for all necessary investments or other actions. To be complete, an alternative must not rely on other activities to function. An alternative plan is either complete or it is not complete. All of the action alternatives are considered complete.

- **Efficiency** – The extent to which an alternative is the most cost-effective means of alleviating problems and achieving opportunities. To be considered efficient, an alternative plan must be cost effective. For this metric, we will use the Cost Effectiveness and Incremental Cost Analysis that is summarized in section 6.3.2, below. For the final array of alternatives, the results of the CE/ICA indicated that the No Action Alternative, Alternative 2 and Alternative 5 are best buys and so are more cost effective than Alternatives 3, 4, and 6. Alternative 2 is the most cost effective plan. Please refer to section 6.3.2 for more detailed information.

- **Acceptability**. Acceptability is the workability and viability of the alternative plan with respect to acceptance by State and local entities and the public, as well as compatibility with existing laws, regulations, and public policies. All action alternatives are considered highly acceptable.

- **Effectiveness** – The extent to which the plan meets planning objectives. An alternative must contribute to at least one project objectives to be considered effective enough to be retained for further consideration. A detailed description of the effectiveness analysis is provided below:

6.1.1. Effectiveness:

In order to measure the effectiveness of each alternative, several metrics were created for each of the project objectives. The metrics are described below. To ensure one metric did not outweigh the others, once each metric was tallied for every alternative the tally was multiplied by a weighting factor in order to ensure all the metrics have approximately weighted equally. The weighted totals of all the metrics were summed for each alternative and this sum was normalized by dividing by the total length of restoration for each alternative. Finally, the Alternatives were rated as High (>40), Medium (20-40), or Low (0-20) used in Corps Criteria Comparison (Table17). Table 18 summarizes the screening scores.

Complexity Objective Metrics

- *Number for Floodplain Features* (side channels, backwater alcoves, and winter refuge habitat). This metric provides a measure of how complex each alternative is in regards to the overall lateral floodplain complexity of the habitat.

- *Density of LWD Structures* (including log jams, habitat complexity structures, and cover complexity structures). This metric provides a measure of how complex each alternative is in regards to microhabitats and cover for fish and wildlife. To measure this metric, the number of LWD structures proposed in the Inter-Fluve 2012 Conceptual Design Report was tallied for each subreach and the total within each alternative was divided by the total length of restoration proposed.

- *Number of Instream Features* (riffles and boulder clusters): this metric provides a measure of how complex each alternative is in regards to the instream complexity.

Connectivity Objective Metrics

- *Number of Side Channels, Backwater Alcoves, and Winter Refuge Habitat Features*: These metrics provide a measure of the lateral connectivity of each alternative. Each of the different off channel features were tallied individually under the connectivity objective as each of these features provide varying degrees of increased connectivity across the floodplain. Side channels are considered to have greater connectivity benefits as they have two or more connection points with the mainstem in comparison with backwater alcoves which only have one connection. Multiple connections with the mainstem allow for greater opportunities for fish and wildlife to access the offchannel feature as well as increase the area of exchange for physical resources including water, sediment, nutrients, and organic debris. Winter refuge habitat was given the lowest multiplier as it only becomes accessible during flood flows.
- *Presence of Tributary Confluences*: Alternatives gained points if they include subreaches where tributary confluences are present. Confluences are recognized as biological hotspots because they are areas of disturbance with periodic influxes of important resources including water, sediment, nutrients, and organic debris. Additionally, these areas provide access to additional habitat for fish and wildlife in the upstream reaches of the tributaries.
- *Connection to Existing or Planned Restoration*: This metric provides a measure of the longitudinal connectivity along the length of lower Dry Creek. Alternatives which include subreaches that are adjacent to existing restoration site or sites that are planned to be built in 2016-2017 received higher scores.
- *Contiguous Subreaches*: This metric provides a measure longitudinal connectivity along the length of lower Dry Creek of each alternative. Alternatives which include more than one contiguous subreaches (e.g. an alternative which includes both subreach 1 and subreach 2a) received higher scores. In order to avoid double counting, subreaches which overlap with those scored under the Connection to Existing or Planned Restoration metric where not given additional points.

- *Removes Existing Corps Structures:* This metric provides a measure of the how the alternative addresses existing structures that may impede lateral or longitudinal connectivity. Alternatives which include subreaches where Corps structures are located receive additional points as it is assumed the measures employed will take advantage of the opportunity to modify or remove potentially problematic structures.

High Quality Native Fish and Wildlife Habitat Objective

- *Area in square feet of summer rearing habitat, winter refuge, habitat and total habitat*: These metrics provides a measure of how well each alternative increases currently limited habitat types important for native fish and wildlife. The area for each habitat type is provided by the Inter-Fluve (2012) Conceptual Design Report.

Riparian Vegetation Objective

- *Area of Riparian Management:* This metric provides a measure of how well each alternative improves the riparian vegetation complexity and biodiversity. It is assumed the anywhere there is construction; the project will also remove non-native vegetation, plant native vegetation, and adaptively manage vegetation over the long term. It is also assumed that these planting will provide a diversity of species and that the adaptive management plan will ensure that the study area will maintain a diversity of successional ages. In order to measure this, the available LiDAR data was utilized to identify obvious breakpoints in the topography within each subreach between the high terraces and the lower floodplain terraces that will be made accessible to the creek. It was assumed that riparian management actions would be applied to most or all of the area within these breakpoints, therefore, the rough area between them was measured using ArcGIS.

Table 18.Effectiveness Criteria for the Focused Array of Alternatives

		Alt	**2**		3		**4**		**5**		**6**	
		Subreaches	**4a**		**14a**		**14b**		**4a, 14a**		**14a, 14b**	
		Length (ft²)	**1700**		**3000**		**1400**		**4700**		**4400**	
Objective	**Metric**	**Weight**	*tally*	*score*	*tally*	*tally*	*tally*	*score*	*tally*	*score*	*tally*	*score*
Complexity	**Floodplain feature**	10	4	40	5	9	9	30	9	90	8	80
	Connections to channel (not incl. entrance or exit)	5	2	10	1	3	3	0	3	15	1	5
	LDW feature	1	106	106	84	190	190	59	190	190	143	143
	Instream feature (riffles or boulder fields)	1	6	6	10	16	16	5	16	16	15	15
Connectivity	**Side channel**	15	3	45	3	6	6	15	6	90	4	60
	Backwater Alcove	10	1	10	2	3	3	20	3	30	4	40
		Weight	*ft²*	*score*	*ft²*	*score*	*ft²*	*score*	*ft²*	*score*	*ft²*	*score*
High Quality Salmon Habitat	**Summer Coho Rearing Habitat**[i]	0.001	152,384	152	93,404	245,788	245,788	53	245,788	246	146,239	146
	Winter Coho Rearing Habitat[ii]	0.001	152,385	152	93,405	245,789	245,789	120	245,789	246	146,240	146
Riparian	**Riparian Management**[iii]	0.001	152,386	152	93,406	245,790	245,790	67	245,790	246	146,241	146
	Sum		674		494		369		1,168		782	
Normalized	Sum/Alternative Length		**40**		**16**		**26**		**25**		**18**	
Effectiveness			**High**		**Low**		**Med**		**Med**		**Low**	

6.2. Alternative Cost Estimates

The basis of the cost estimates is conceptual design drawings prepared by the two consulting firms hired by SCWA, Inter-Fluve and ESA. Additional information developed by the PDT is incorporated into the estimate. The cost estimates were prepared consists of planning level cost estimates. All subreach designs consist of a combination of revegetation, vegetation management, construction of bank protection features, earthwork to create off channel features including side channels and backwater alcoves, and installation of LWD structures and mainstem features including pool enhancements, constructed riffles, and boulder fields. The estimate for each feature of the project alternatives has detailed prepared quantities. The unit cost used are based on parametric unit cost estimates provided by SCWA based on bids from previous like work in the study area. The costs for Real Estate, restoration work (e.g. Fish and Wildlife), Project Engineering and Development (PED), and Construction Management (CM) as well as the total project costs for each alternative are summarized in Table 19. These costs include a 25% contingency. It was assumed that the alternatives would require minimal if any maintenance expected to be approximately $2,500 per year or less assuming approximately 10% of the features fail in the 50 year life span of the project.

Table 19. Final Array of Alternative Cost Estimates, including 25% contingency

Alternatives	Real Estate	Fish & Wildlife	PED	CM	Total
No Action	$0	$0	$0	$0	$0
2 (4a)	$424,000	$2,463,000	$614,000	$209,000	$3,710,000
3 (14a)	$657,000	$3,418,000	$855,000	$290,000	$5,220,000
4 (14b)	$289,000	$1,821,000	$455,000	$155,000	$2,720,000
5 (4a, 14a)	$946,000	$5,239,000	$1,310,000	$445,000	$7,940,000
6 (14a, 14b)	$1,081,000	$5,872,000	$1,468,000	$499,000	$8,920,000

6.3. System of Accounts

In addition to establishing the four criteria to guide the formulation and evaluation of alternatives, the P&G established four "accounts" to report benefits and impacts:

- **National Ecosystem Restoration (NER)** – The NER account identifies the beneficial and adverse effects that alternatives may have on the national environment.
- **Environmental Quality (EQ)** – The EQ account reports the nonmonetary effects on ecological, cultural, and aesthetic resources. It reports both positive and adverse effects.
- **Regional Economic Development (RED)** – The RED account pertains to changes in the distribution of regional economic activity, mainly income and employment. It captures the transfer of income or employment from one region in the nation to another when there is no net increase in national value (net increase in national value is captured under the NED account).
- **Other Social Effects (OSE)** – The OSE account captures urban and community impacts such as life, health, and safety factors; displacement; long-term productivity; and energy requirements and energy conservation

6.3.1. National Environmental Restoration (NER)

The Planning Guidance Notebook describes the selection of the NER Plan as follows:

> For ecosystem restoration projects, a plan that reasonably maximizes ecosystem restoration benefits compared to costs, consistent with the Federal objective, shall be selected. The selected plan must be shown to be cost-effective and justified to achieve the desired level of output. This plan shall be identified as the National Ecosystem Restoration (NER) Plan.

Below is a description of how the environmental benefits were quantified and how the NER plan is identified.

Conceptual Habitat Model Framework and Environmental Benefits Evaluation Methodology

The purpose of the Environmental Benefits Evaluation described here is to provide quantification of the potential ecological improvement of proposed restoration alternatives so that the actions can be compared to each other, and to compare alternative suites of actions in the cost effectiveness and incremental cost analysis. Each habitat restoration measure was analyzed using the Habitat Evaluation Procedures (HEP) habitat assessment methodology (USFWS 1980) and the Habitat Suitability Index (HSI) model for coho salmon (McMahon 1983). The Corps National Ecosystem Planning Center of Expertise and Headquarters have approved both of the aforementioned ecosystem restoration planning models. A summary of the results is presented in Table 20. More detailed results are found below and a full explanation can be found in Appendix F.

Coho Salmon Habitat Suitability Index (HSI) Model Overview and Applicability

HSI models provide numeric scores for existing conditions at a project site, potential future without-project conditions, and various future with-project action alternatives for a species or assemblage of species in a particular geographic area. A suitable HSI model must include habitat variables for which data collection is possible or data are already available. Variables must also show a change in score between the existing and proposed condition. If the project does not affect the suitability index score for a species, it will not be possible to quantify an effect.

The best HSI model to capture the ecosystem restoration benefits of each Dry Creek CAP 1135 project alternative is the coho salmon model. Coho salmon habitat quality in this model is based on parameters assumed to affect habitat suitability for each of four life stages of coho salmon during residence in freshwater including: adult, smolt, parr, and spawning/embryo/alevin (McMahon 1983). For more information about the details of the HSIand HEP modeling, please refer to Appendix F.

Habitat Evaluation Procedures (HEP) Habitat Assessment – Net Impacts of the Subreaches

The HEP model is a habitat assessment methodology that was developed by USFWS to facilitate the identification of net impacts of various federal actions on fish and wildlife habitat. The ultimate output of the HEP habitat assessment methodology is the determination of the net impact of the action.

The HEP habitat assessment methodology quantifies wildlife habitat by calculating habitat units (HUs) for the evaluation species in the study area. The number of HUs is based on two primary variables, HSI and the total area of available habitat. The HSI score is multiplied by the total area of available habitat at various target years to determine the number of HUs throughout the life of the project. For each proposed subreach, the area of available habitat must be estimated for future years. The period of analysis for this project (i.e. the project life) is 50 years following construction completion. The ending target year is the end of the period of analysis for this project (target year 50). For more detailed information about the HEP assessment, please refer to Appendix F. The calculated HSI scores and total area of available habitat by habitat type for each subreach are provided in Table 20 below.

Table 20. Habitat Evaluation Procedures – Impact Assessment – Habitat Unit Analysis for 50 Year Time Period

Subreach		Target Year	Area of Available Habitat at the Target Year	Final HSI Score	Cumulative Habitat Units	Average Annual Habitat Units (AAHUs) (ft^2)	Average Annual Habitat Units (AAHUs) (acres)
4A	Future Without-Project (FWOP) Condition	0	153,747	0.25	N/A	38,437	
		50	153,747	0.25	1,921,838		
	Future With-Project (FWP) Condition	1	44,486	0.22	23,566	146,259	
		5	333,646	0.19	152,142		
		10	444,861	0.37	553,296		
		50	444,861	0.37	6,583,943		
	Net Annual Impact (With-Without Project)			**0.12**		**107,822**	**2.48**
14A	Future Without-Project (FWOP) Condition	0	160,140	0.2		32,028	
		50	160,140	0.2	1,601,400		
	Future With-Project (FWP) Condition	1	22,580	0.216	18,819	75,664	
		5	169,351	0.28	98,329		
		10	225,801	0.37	323,178		
		50	225,801	0.37	3,341,855		
	Net Annual Impact (With-Without Project)			**0.17**		**43,616**	**1.00**
14B	Future Without-Project (FWOP) Condition	0	51,093	0.2		10,219	
		50	51,093	0.2	510,930		
	Future With-Project (FWP) Condition	1	8,331	0.212	6,078	26,374	
		5	62,484	0.26	34,291		
		10	83,312	0.35	111,951		
		50	83,312	0.35	1,166,368		
	Net Annual Impact (With-Without Project)			**0.15**		**16,155**	**0.37**

As a result of the HEP habitat assessment, subreach 4A exhibits the highest number of average annual habitat units and, therefore, has the greatest net annual impact out of the subreaches included in the assessment. Subreach 4A also has the largest difference in area of available habitat between the future with-project and without-project conditions. The driving factor of this outcome is the addition of a large amount of winter refuge habitat in the future with-project condition at subreach 4A. The project team chose to keep winter habitat in the total area of available habitat calculation because a primary objective of the Reasonable and Prudent Alternatives for Dry Creek in the Biological Opinion is to restore winter rearing habitat to address the displacement of over-wintering coho by high flows associated with flood control releases (NMFS 2008).

Cost Effectiveness And Incremental Cost Analysis

Each alternative's net annual benefits[13] were combined with annualized cost estimates[14] to determine their Cost Effectiveness using IWR Planning Suite software. In order to be cost effective, an alternative must produce a given level of output at the lowest cost compared to all other alternatives. Cost effective alternatives are then evaluated sequentially in the Incremental Cost Analysis in order to determine which most efficiently produce environmental benefits; this subset of cost effective alternatives are called "Best Buys."

A total of six alternatives, including the No Action alternative, were evaluated in the CE/ICA analysis. Of the alternatives evaluated, Alternatives 1, 2, 3, 4, and 5 were found to be cost effective. Table 21 details the six alternatives and their net average annual benefits (Average Annual Habitat Units), total project costs, average annual costs, and average annual cost per unit of output. Cost effective alternatives, as identified by the CE/ICA analysis, are highlighted in bold.

[13] Net annual benefits are calculated as the without-project impacts subtracted from the with-project impacts, which represents the net annual increase in habitat units due to project implementation. In this case, the net annual benefits are calculated as average annual habitat units. See Table 17. Habitat Evaluation Procedures – Impact Assessment – Habitat Unit Analysis for 50 Year Time Period.

[14] Total average annual costs were calculated using the IWR Planning Suite Annualizer. The fiscal year 2017 discount rate is 2.875%, and a 50-year period of analysis is used to calculate average annual cost.

Table 21. Cost Effective Alternatives

Alternative		Ave Annual Habitat Units (AAHU) (Square Feet)	Ave Annual Habitat Units (AAHU) (Acres)	Alternative Tototal cost, including contingency (1,000s)	Total Present Value Cost (1,000s)	Average Annual Cost (1,000s)	Average Annual Cost/AAHU (1,000s/acre)
1	**No Action**	0	0.00	$0	$0	$0.0	$0.0
2	**4a**	107,822	2.48	$3,710	$6,322	$240.0	$96.9
3	**14a**	43,616	1.00	$5,220	$5,220	$198.1	$197.8
4	**14b**	16,155	0.37	$2,720	$2,720	$103.2	$278.3
5	**4a, 14a**	151,438	3.48	$7,940	$11,542	$438.0	$126.0
6	**14a,14b**	59,771	1.37	$8,920	$7,940	$301.3	$219.6

The Incremental Cost Analysis identified Alternatives 1, 2, and 5 as “Best Buys”, which are defined as those cost effective alternatives that provide the greatest incremental increase in output (benefits) for the lowest incremental increase in cost. All alternatives are displayed in Figure 34 where blue triangles denote cost effective alternatives, red squares represent Best Buys, and clear circles signify alternatives that are not cost effective.

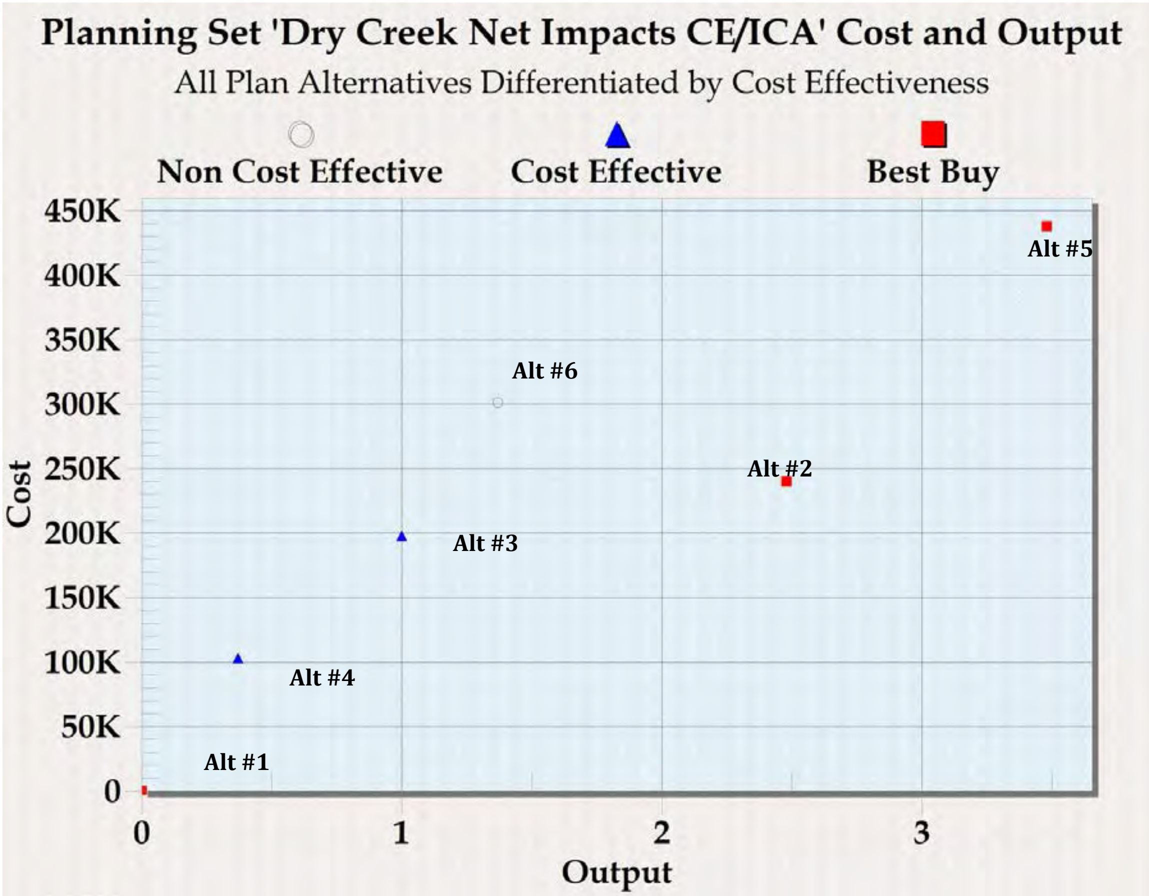

Figure 34. Cost Effectiveness Results

Table 22 summarizes the Incremental Cost Analysis results that identified the Best Buy alternatives, which are highlighted in blue. The No Action Alternative (1) represents the first Best Buy. Alternative 2 (Subreach 4a), with an average annual incremental cost per unit of $96,900 and incremental output equal to 2.48 average annual habitat units (acres) is the second Best Buy. The third and final best buy is Alternative 5 (combination of 4a and 14a), with an average annual incremental cost per acre of $198,100 and average annual incremental output of 1.00 acre. Figure 35 provides the Incremental Cost Analysis results as a bar graph.

Table 22. Incremental Costs Analysis: Best Buy Alternatives

Alternative #	Alternative Description	Total Output in AAHUs (acres)	Incremental Output in AAHUs (acres)	Incremental Cost/ Incremental Output (1,000s/AA HU)	Cost Effective and/or Best Buy?
1	No Action	0.00	n/a	n/a	Best Buy, 1
2	4a	2.48	2.48	$96.9	Best Buy, 2
3	14a	1.00	n/a	n/a	Cost Effective
4	14b	0.37	n/a	n/a	Cost Effective
5	4a and 14a	3.48	1	$198.1	Best Buy, 3
6	14a and 14b	1.37	n/a	n/a	No

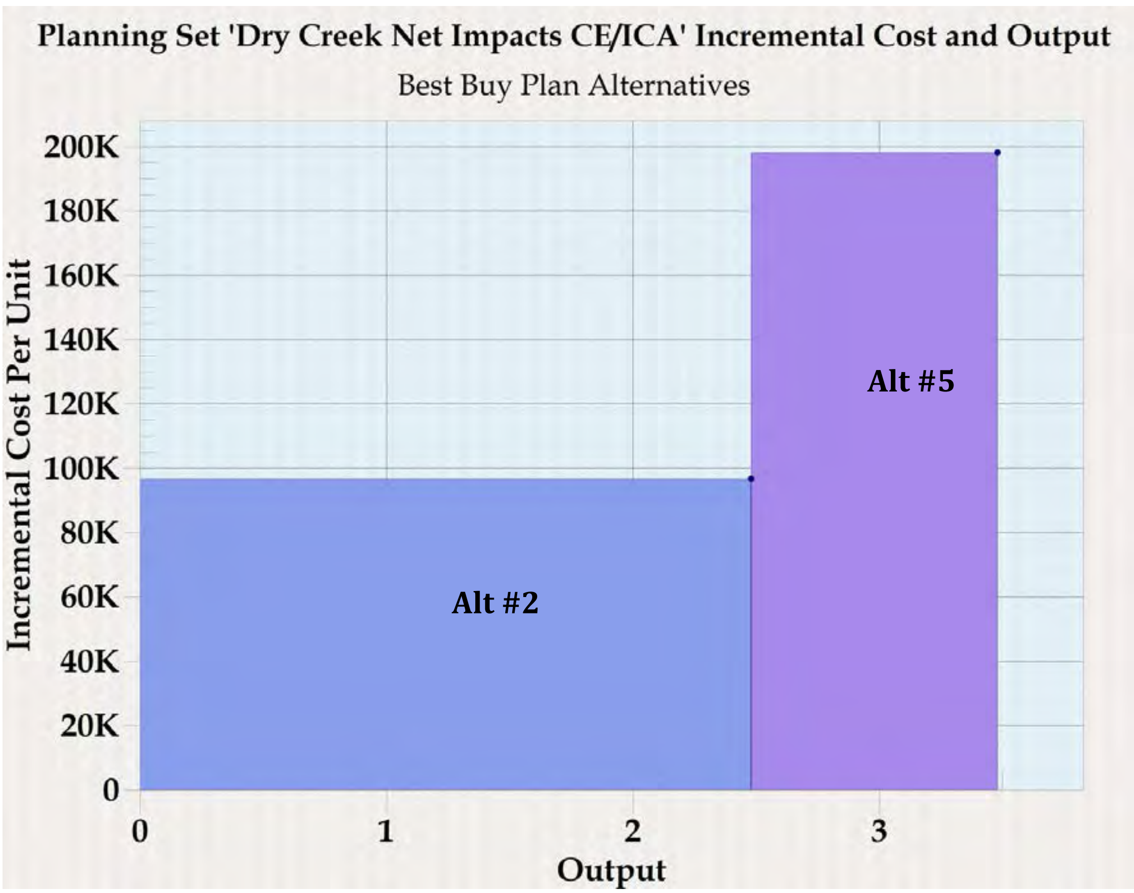

Figure 35. Incremental Costs and Outputs of Best Buy Alternatives

CE/ICA Summary

In summary, the results of CE/ICA indicate that the No Action Alternative and Alternatives 2 and 5 are Best Buys. Ultimately, the alternative with the smallest change in cost and maximum incremental habitat unit output should be chosen as the recommended alternative. Alternative 5 yields the highest level of output; however, the benefits are generated at the greatest cost. An additional 1.0 net AAHUs generated by Alternative 5 costs $5.2 million more than Alternative 2. By contrast, each additional net AAHU generated by Alternative 2 over the No Action Alternative costs $2.6 million.

National Ecosystem Restoration Plan

The NER for ecosystem restoration projects is the plan that reasonably maximizes ecosystem restoration benefits compared to costs, consistent with the Federal objective, shall be selected. The selected plan must be shown to be cost-effective and justified to achieve the desired level of output.

Alternative 2 is the NER Plan that reasonably maximizes ecosystem restoration benefits compared to costs, considering the cost effectiveness and incremental cost of implementing other restoration options. It is a best buy alternative that yields 2.48 average annual habitat unites with an average annual incremental cost per habitat unit of $92.40. It is also consistent with the Federal objective.

6.3.2. Environmental Quality (EQ)

Table 23. Environmental Quality

Alternative		Water Quality	Air Quality	Aquatic habitat and wildlife	T&E species	Noise	Riparian Habitat and wildlife
1	**No Action**	No Change	No Change	No Change	No Change	No Change	No Change
2	**4a**	No significant impacts with Best Management Practices (BMPs)	No significant impacts: Negligible emissions	No significant impacts; beneficial effects	No adverse effects; benefits species	No significant effect	No significant impacts; beneficial effects
3	**14a**	No significant impacts with BMPs	No significant impacts	No significant impacts; beneficial effects	No adverse effects; benefits species	No significant effect	No significant impacts; beneficial effects
4	**14b**	No significant impacts with BMPs	No significant impacts	No significant impacts; beneficial effects	No adverse effects; benefits species	No significant effect	No significant impacts; beneficial effects
5	**4a and 14a**	No significant impacts with BMPs	No significant impacts	No significant impacts; beneficial effects	No adverse effects; benefits species	No significant effect	No significant impacts; beneficial effects
6	14a and 14b	No significant impacts with BMPs	No significant impacts	No significant impacts; beneficial effects	No adverse effects; benefits species	No significant effect	No significant impacts; beneficial effects

6.3.3. Regional Economic Development (RED) and Other Social Effects (OSE)

All of the action alternatives are expected to have positive and temporary regional economic impacts resulting from the expenditure of funds to implement the project.

The OSE account typically includes long-term community impacts in the areas of public facilities and services, recreational opportunities, and traffic.

Table 24. Regional Economic Development and Other Social Effects

	Alt	RED Benefit to Regional Industry	RED Employment	RED Regional Construction Industry	OSE Public Facilities and Services	OSE Recreation Opportunity	OSE Traffic
1	**No Action**	No Change	No Change	No Change	No Change	No Change	No Change
2	**4a**	Temp benefits	Temp benefits	Temp benefits	No Change	No Change	No significant impact
3	**14a**	Temp benefits	Temp benefits	Temp benefits	No Change	No Change	No significant impact
4	**14b**	Temp benefits	Temp benefits	Temp benefits	No Change	No Change	No significant impact
5	**4a and 14a**	Temp benefits	Temp benefits	Temp benefits	No Change	No Change	No significant impact
6	**14a and 14b**	Temp benefits	Temp benefits	Temp benefits	No Change	No Change	No significant impact

6.3.4. Tentatively Selected Plan *

Alternative 2 is the TSP. It is the NER Plan and is efficient, acceptable, complete, and is effective in meeting project objectives.

6.3.5. Consistency with USACE Campaign Plan

The TSP is consistent with the USACE Campaign Plan. The Corps has developed a Campaign Plan with a mission to “provide vital public engineering services in peace and war to strengthen our Nation’s security, energize the economy, and reduce risk from disasters.” The second goal of the Corps Campaign Plan “Deliver enduring and essential water resource solutions…” is addressed by this project which collaborated with partners to develop a solution for the habitat degradation that has occurred from habitat simplification and invasive plant colonization. This solution should produce lasting benefits for the nation. The TSP is also consistent with the third goal “Deliver innovative, resilient, sustainable solutions…”. This project addresses the goal through the application of the planning process to formulate, analyze, and evaluate alternative designs in pursuit of a sustainable, environmentally beneficial, and cost-effective ecosystem restoration design.

6.3.6. Consistency with USACE Environmental Operating Principles.

The Corps has reaffirmed its commitment to the environment by formalizing a set of "Environmental Operating Principles" applicable to all its decision-making and programs. The formulation of all alternatives considered for implementation met all of the principles. As an ecosystem restoration project, the recommendation supports the Corps' Environmental Operating Principles.

7. RECOMMENDED PLAN*

The recommended plan (TSP) is Alternative 2, which includes subreach 4a (sites 4A and 4B). Sites 4A and 4B are bisected by a concrete sill that was constructed by the Corps in 1981. The TSP includes construction of several off channel features, high flow terraces, LWD structures, and vegetation management (Figure 36).

7.1. Restoration summary of Site 4A

Two secondary channels will be constructed in Site 4A (downstream of sill). The first one is a 500 ft long channel designed to the right (facing downstream) of the main channel between. The depth of the channel design grade varies from 2 to 8 ft from the existing ground level. The upstream connection will be immediately below the sill and the channel alignment will generally follow an existing preferential flow pathway. The channel side slopes for the secondary channels vary from approximately 1:1 to 2.5:1 (H:V). One Alcove will be constructed to the right of this secondary channel near the upstream section.

The second 1,100 ft long secondary channel will be constructed to the left (looking downstream) of the main channel. The depth of the channel design grade varies from 4 to 9 ft from existing ground and the side slopes vary approximately from 1:1 to 8:1(H:V). One small Alcove will be added to the left upstream section of this secondary channel. This left channel will also be connected to the main channel by means of two traverse (also called branch) channels. These two transvers channels are 150 ft long and are additional fluvial connections between the secondary channels and the main channel. Therefore the secondary channel will be connected to the main channel at 4 locations (upstream, two transverse, downstream). Log jams will be constructed to provide hydraulic control at the channel connections. A high flow terrace will be graded at the downstream end of this channel to provide additional off channel refugia at high flows. Three boulder fields will be constructed in the main channel to provide and maintain flow connectivity to the secondary channels.

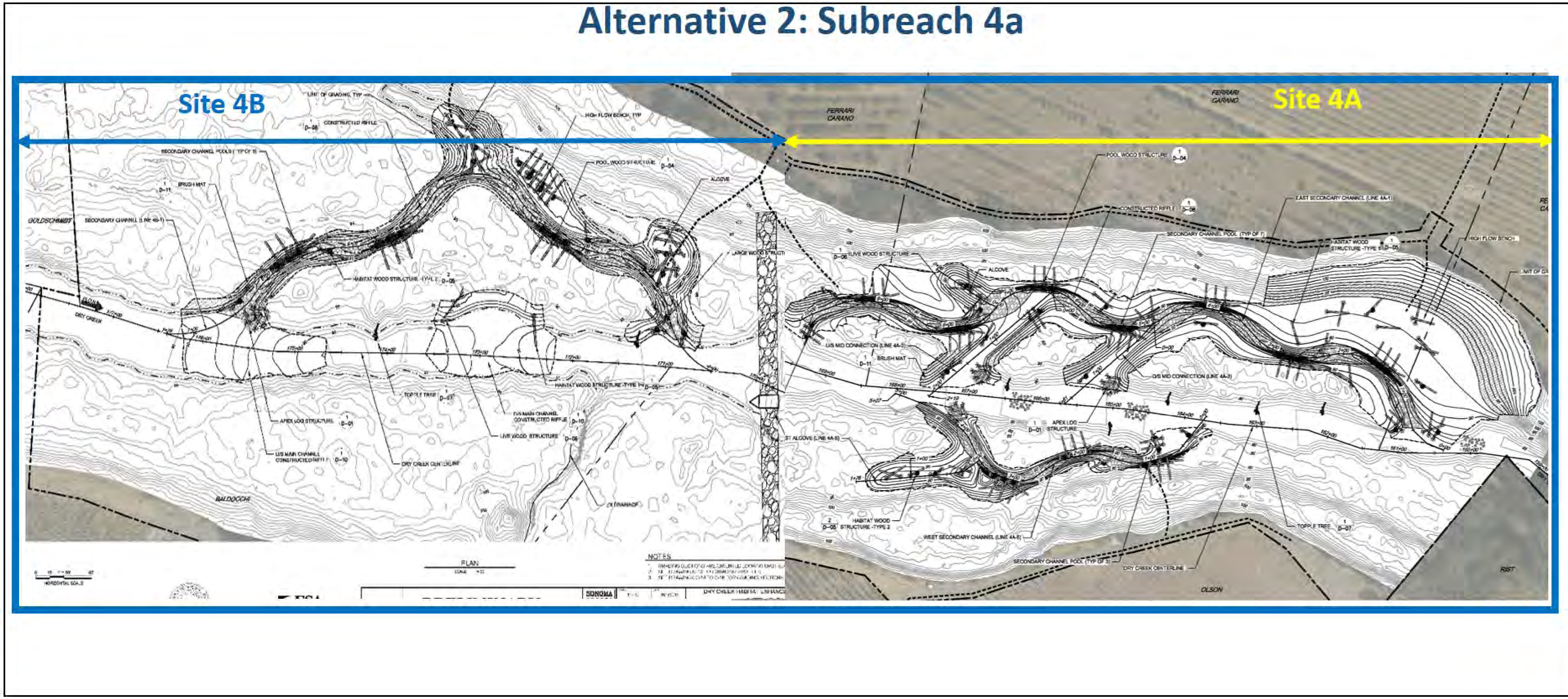

Figure 36. Tentatively Selected Plan: Alternative 2 Features

7.2. Restoration summary for Site 4B

Just upstream of the sill, an approximarly 650-ft long channel will be constructed on the left-bank (looking downstream). The side slopes of the channel vary approximately from 1:1 to 3.5:1(H:V). The depth of channel's design grade varies from 5 to 9 ft from existing ground. The channel will be graded to capture a long backwater depression that currently ponds water throughout the year. An alcove will be constructed immediately adjacent to the channel and will take advantage of a relatively flat area to create additional off-channel habitat. Two existing riffles in the main channel will be enhanced by placing riffle substrate. Log jams will be constructed to provide hydraulic control at the channel connections.

7.3. Features common to both Sites 4A and 4B

The elevation of all the secondary channels' bed is designed to closely match the main channel grade. Construction of the secondary channels will require excavation and grading of current topographic low points and abandoned or higher flow channels and lateral connection to the main channel through existing berms or bars. Biotechnical and Geotechnical / Biotechnical Bank stabilization structures will be included in the form of Brush Mat on both the main and secondary channel slopes at bends and at erosion prone areas. Further design refinements will be made to all the restoration features and Geotechnical / Biotechnical Bank stabilization structures during the future design stages.

7.4. Large Wood Structures

Approximately 115 large wood structures of various types are proposed as part of the selected alternative. Most of these large wood structures are immobile live and /or dead logs of different sizes assembled together in different technique to serve various purposes in the restoration effort. One of their main purposes is to create different types of non-structural covers for the habitats. When used for this purpose, the log structures are simple log installations that provide instream and margin habitat for fish and other aquatic species as well as add roughness to the channel and floodplain. The techniques used to create the large wood structures for this purposed include simple partial embedment into the channel bed, interlocking individual dead and live logs, and cabling or pinning to other logs, existing live mature trees or timber piles.

The second purpose of the large wood structures is to serve as structurally rigid element in forcing flows and influencing the hydraulics and the geomorphologic conditions of the creek. Apex log structure are specifically designed to serve this purpose. For the selected alternative, there are four proposed locations for Apex Log

Structures. Within Site 4A, two are provided at the two instream connection locations of the left proposed side channel and one is located at the splitting point of the right proposed side channel. Within Site 4B, one Apex Log Structure is situated at the upstream end serving as a flow splitting structure for the new left secondary channel. When serving this purpose, the large wood structures (Apex Log Structures) are placed in areas where it would be beneficial to initiate or stabilize the bedform of the channel. They are placed at the inlet of a proposed secondary channel for splitting the flow from the main channel towards the side channels. They also maintain interface between main and lateral habitats, limit flanking around the installations, and prevent bank erosions.

7.5. Restoration summary of fish ladder and grouted riprap sill

Modifications to the sill and fish ladder in the middle of subreach 4a may be performed to improve fish passage and hydrologic connectivity.[15] These modifications would likely include a notch to provide a connection between the two secondary channel features on the left bank (the left bank channels above and below the grade control sill and replacement of the two existing fish ladders running through the center of the grade control sill with a transitional structure to allow fish passage. However, modifications to the sill and fish ladder will be developed during the Design and Implementation Phase of the project.

7.6. Vegetation Management

Vegetation management at the site will consist primarily of removal of invasive species, protection of key native vegetation, and planting of additional natives. The area of revegetation for newly graded features is estimated at approximately 6 acres, based on all areas disturbed by grading. The area of invasive removal and replanting adjacent to newly graded areas is approximately 1.2 acres for a total of 7.2 acres of revegetation which is expected to increase slightly as the revegetation of access routes and staging areas. All vegetation management, revegetation, and associated irrigation will be performed by the non-federal sponsor during implementation as a part of Non-Federal work.

[15] If modification of the sill were included in the alternative analysis for this study, it would not change the TSP alternative. Modification for the sill would not change the benefit HEP results but would result in an increase in costs. The additional costs is roughly estimated to be $88,000. For the purpose of confirming that this additional feature would not modify the TSP, we rounded this estimate up to $100,000 and added that cost to both alternatives that include reach 4A (Alternative 2 and 5). With these costs added, the PDT determined that the results of the CE/ICA would not change. Alternative 2 would continue to be the TSP.

The following summarizes the key revegetation and vegetation management activity specifications:

- High priority native vegetation to be protected includes large, mature trees and native understory where it is robust and preventing the establishment of invasive species.
- Where feasible, trees to be removed for construction will be salvaged and incorporated into the planned large wood structures, for added complexity. Willows and cottonwoods can be used for live wood structures. If possible, other species such as rushes and sedges can also be salvaged and transplanted after construction.
- Planting of native vegetation will occur in all graded areas outside of active channels. Highest priority locations include locations where new channel construction will result in warm, exposed conditions, areas that require erosion control, and areas of invasive removal that need native plantings to help prevent reestablishment.
- High priority invasive species removal includes those plant s and stands that are detrimental to habitat conditions and/or that are currently limited in extent but have high potential to spread. These will be removed by mechanical means prior to or during construction in all areas that are graded. Per the USACE field direction, invasive removal may extend beyond the graded area, to reduce the likelihood that rapid re-establishment will occur. Also, isolated occurrences of highest-priority species such as arundo may be removed, at the Water Agency's discretion. Approximate extends of invasive removal beyond graded areas will be identified on the project plans and exact boundaries will be determined in the field.

7.7. Borrow Site and Disposal Area

It is anticipated that majority of the wood retrieved from clearing during construction can be reused for habitat structures. Excavated earthen material from the project site will be stored near the project site to be used as a bank stabilization and treatment fill. No hazardous material requiring special handling or disposal is anticipated on the project sites. It is anticipated that miscellaneous debris including concrete rubble, car bodies, rubber tires, piping may be encountered during construction. These materials will become the property of the contractor. It will be the responsibility of the contractor to identify appropriate landfill or other waste receiving agencies for excessive waste that can't be reused or recycled.

7.8. Flow Diversion

Design elements and approaches have been selected with the intent of minimizing the needs for dewatering and/or channel diversion. Based on previously constructed demonstration reaches, partial flow diversion will be required at multiple locations to allow installation of log jams, and during excavation of secondary channel and/or alcove connections along the main stem. These tasks are accomplished using coffer dams to isolate the work area from the main channel. Dewatering will be required when embedded log structures are anchored to ballast boulders.

7.9. Construction Access, Haul Routes and Staging Area

Proposed haul routes and construction staging areas for Sites 4A and 4B are shown in Appendix A and Figure 38 . Staging would occur in an abandoned vineyard adjacent to the left bank of the project site. The owner of this abandoned vineyard has granted a temporary easement for project staging in the area in exchange for removal of all the old vines and clearing of the land. Proposed ingress/egress to the project is expected to occur from the east via an existing paved road that connects to Kinley Drive and possibly from the west via an existing paved road that connects to West Dry Creek Road. All existing paved roads used during construction of the project will be protected from damage. All ramps connecting to the main streets will be improved to accommodate heavy construction vehicular traffic. Any damage resulting from the use of the roads will be repaired and restored to its original condition at the completion of the projects.

7.10. Design Considerations

7.10.1. Level of Detail in Designs

The study team has taken a common sense and risk-based approach to the level of design developed in the feasibility phase. The NFS have partnered closely with the design and planning team and have provided 60% designs to inform this integrated report. Details plans and cross-sections can be found in the Civil Design Appendix. The study team has identified the necessary studies and data collection to be performed in upcoming stages of the study to manage specific risks and uncertainties as well as meet the requirements outlined in ER 1110-2-1150 (Engineering and Design for Civil Works Projects).

7.10.2. Design approach

The subreach 4a design was developed to create and re-establish natural geomorphic conditions appropriate for creating the desired habitat. A dynamic, process-based design is considered to be most appropriate for alternative design in lower Dry Creek. The approach is primarily driven by the sediment and hydrologic inputs from the unregulated tributaries as well as the backwater effects of the Russian River. The current conditions, as described earlier in the report, in combination with the objectives of this project, provide a significant opportunity to reset the hydraulic, geomorphic and habitat conditions in this portion of Dry Creek in order to provide high quality habitat.

It is acknowledged and anticipated that the sites will evolve after construction and that changes will likely occur over a range of timeframes based primarily on flood flows and sediment transport conditions. The magnitude and extent of such changes cannot be predicted with absolute certainty. However, the design approach and detailed design will result in an appropriately designed system with redundancies to complement the dynamic nature of lower Dry Creek while also including structures that will persist to sustain design intent of the restoration measures.

7.11. Construction Considerations

The nature of land use and infrastructure along lower Dry Creek presents logistical challenges for the construction phase of the habitat restoration effort. Existing transportation corridors consist of relatively narrow, winding two-lane roads and few heavy load capacity stream crossings, with substantial recreational and farm traffic. Furthermore, the narrow incised creek corridor and proximity to vineyard operations limit available access corridors and staging areas. Dust control is also a significant issue due to the sensitivity of vines growing in close proximity to the creek. Nevertheless, the logistical challenges can be planned for in developing detailed restoration strategies.

The typical in-water work period for the region is June 15 to October 15 in order to minimize impacts on migrating adult salmonids and to concentrate ground disturbing activity during the dry season. In order to satisfactorily construct the restoration measures and prevent excessive turbidity to the active flowing stream, it may be necessary to divert the stream around and/or dewater active work zones. Pumped diversion systems provide the benefits of moving the water out of the creek corridor, and maximize the available work space in the corridor, which will facilitate efficient and competent completion of the work, including concurrent completion of work at multiple sites within a reach. However, the high daily expense of a pumped diversion system will need to be weighed during the Design and Implementation phase against the potential limitations of less expensive approaches as each project nears implementation.

7.12. Operation, Maintenance, Repair, Rehabilitation, and Replacement Cost Considerations

Per ER 1105-2-100, only limited OMRR&R requirements are desirable for ecosystem restoration projects because self-sustaining is a key goal of ecosystem restoration. The Corps and SCWA have emphasized their interests in designing and implementing the project to be being as maintenance free as possible. After completion of construction and the monitoring and adaptive management period, the non-Federal sponsor(s) will assume O&M responsibility for the entire project footprint. The non-Federal sponsor is responsible for all long-term project OMRR&R following completion of construction. OMRR&R costs have been estimated for the TSP. OMRR&R expenses is expected to be approximately $25,100 annually. Detailed O&M manuals will be developed for each site during the Project Engineering and Design phase. The total annual cost form O&M activities would be $22,880 assuming a charge-out rate of $130/hour. The O&M plan will include the following activities:

1. Inspection of features will occur after completion of construction. Follow-up inspections will then occur annually after geomorphically-effective flows occur (i.e. flows that deposit substantial sediment on the flood plain) or within every 3 years. Each inspection is estimated to require a team of two one day to conduct. This activity is expected to cost up to approximately $2,080 annually.

2. Vegetation Maintenance. Removal of non-native vegetation and managing vegetation for habitat needs. Frequency dependent on vegetation growth, typically every 2-5 years. Vegetation removal from site typically would require a team of five two days to conduct. This activity is expected to cost up to approximately $10,400 annually.

3. Structure maintenance. Tightening cables on log structures as necessary/available, minor erosion control repair. Structure maintenance activities would require a team of five two days to conduct. This activity is expected to cost up to approximately $10,400 annually.

Additionally, replacement costs over the 50 year life span of the project were also estimated. As an ecosystem restoration project, the project features were designed to be self-sustaining. Therefore, it was assumed that approximately 10% of these features may fail in the 50 year life span of the project, 12 total structures would require replacement at a total estimated cost of $111,000 over the entire 50 year period (Table 25).

Table 25. OMRR&R Estimates for Reach 4a (unit cost estimates are from SCWA engineering consultant ESA Associates 60% design)

Habitat Structure Type	Unit	Unit Cost	Quantity Constructed	Quantity Replaced in 50 years	Replacement Cost
Large Wood Structure	ea	$ 15,000.00	8	1	$ 15,000.00
Habitat Wood - Type 1	ea	$ 2,000.00	41	4	$ 8,000.00
Habitat Wood - Type 2	ea	$ 4,000.00	24	2	$ 8,000.00
Apex Log Structure	ea	$ 40,000.00	4	1	$ 40,000.00
Pool Wood Structure	ea	$ 10,000.00	39	4	$ 40,000.00
Total			116	12	$ 111,000.00
Cost per year		(total/50)			$ 2,220

OMRR&R is 100% the Sponsor's responsibility and is not cost shared.

7.13. Real Estate Considerations

A draft Real Estate plan is included for the TSP modifications as Appendix E. That work is limited to the assessment of Lands, Easements, Rights of Way (LER) credits for the project.

7.13.1. Description of LERRDS

The TSP Alternative 2 requires an estimated total of 27.929 acres from six parcels, based on the project cadastral maps and tract register dated 2 September 2016 (Appendix E). An estimated 3.257 acres is required for staging. An estimated 2.078 acres is required for permanent road easement. An estimated 22.594 acres is required for ecosystem restoration. The non-Federal sponsors will acquire the minimum interests in real estate to support the construction and subsequent operation and maintenance of the future USACE project. Once the project partnership agreement (PPA) process is complete, the San Francisco District Engineering Branch will prepare the final design for advertisement and construction. During this process the tract register and tract maps will be updated to reflect any modifications to include final staging areas, access requirements, construction haul routes, and recreation features. This information will be used for future crediting purposes. The cost for LERRDS is provide in Section 9.

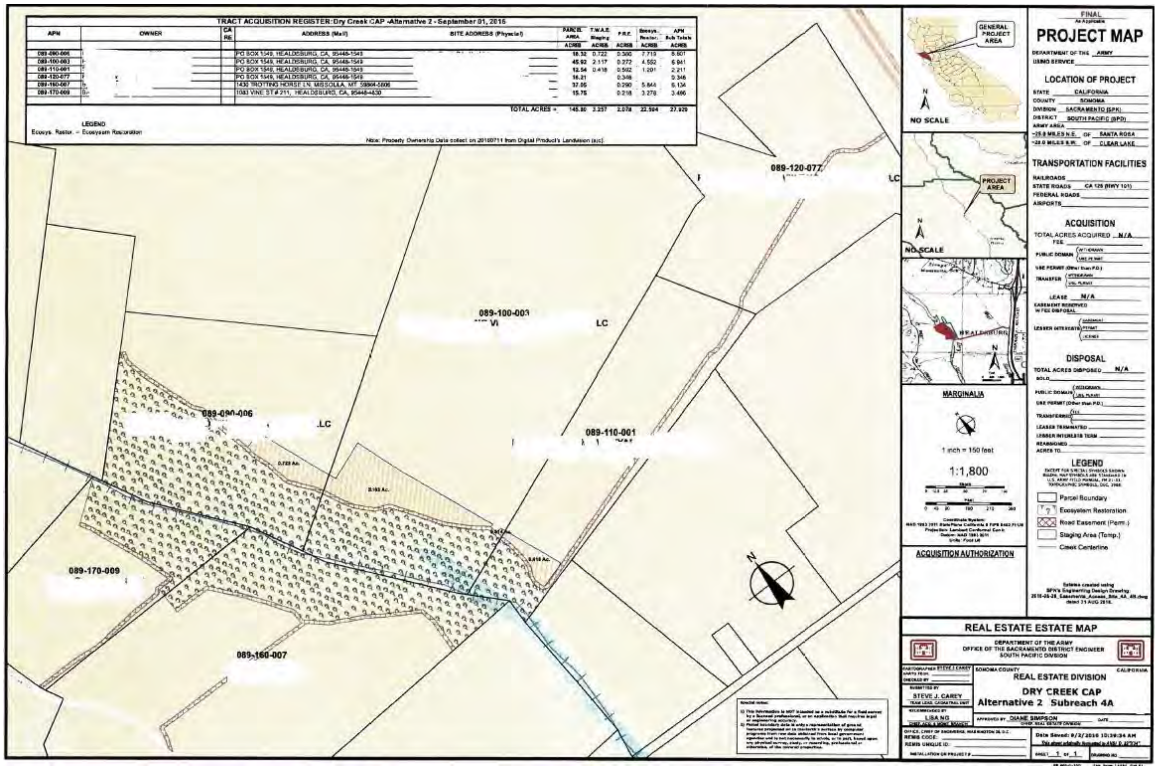

Figure 37.Tentatively Recommended Plan Required Lands, Easements, Rights of Way

7.13.2. Permanent Easement

The standard estate for ecosystem restoration projects is Fee simple in accordance with ER 405-1-12, 12-9 b(6)) However, for CAP 1135 projects, exceptions to this estate are provided in planning regulations ER 1109-2-100, Appendix F, Section F-20, 31 January 2007. It also provides, “the MSC may approve use of a permanent easement instead of fee for the implementation of the CAP ecosystem restoration project where use of such easement will satisfy project requirements and protect the project benefits.”

The SVWA has been actively engaging landowners along Dry Creek to implement the project as landowners were not willing to provide fee title for project required lands. Acquiring project lands in fee would sever the remainder by eliminating connection to the creek. The loss of the parcel size would potentially impact subdivision rights, thereby creating an additional loss of value to the remainder. However, through demonstrated project successes and ongoing public outreach, the sponsors have received an increase in landowner participation to accept an easement in perpetuity. Therefore, in order to avoid and minimize impact to the parcel, the proposed interest is the non-standard estate, Ecosystem Restoration Easement, a less than fee interest and in perpetuity. This situation is not adverse. There is no loss of value to the remaining parcel.

Due consideration was given to the overall project scope, the types of project features to be constructed, and the long term O&M requirements. It was determined that a perpetual easement in lieu of fee simple would convey sufficient rights to successfully construct and maintain the project and protect the Federal investment.

7.13.3. Potential Modification to Federal Bank Stabilization (Sill)

The Project may alter a portion of the Federal Bank Stabilization (the Sill) within the creek, which is within the project area. In 1983, the sponsor acquired an easement for an estimated 1 acre for the portion of the Sill, therefore the SCWA shall not receive credit for the value of any LER for this project that have been provided as an item of cooperation for another Federal project.

7.13.4. Relocations and Utilities

No features that require relocation were identified within the limits of the project. No major structures or utilities have been identified within the project footprints. If any additional utilities are discovered during the next phases of the project, they will be included on the next preliminary design stages.

7.14. Monitoring and Adaptive management

Section 2039 of WRDA 2007 states that when conducting a feasibility study for a project or component of a project for ecosystem restoration, the recommended Project includes a plan for monitoring the success of the ecosystem restoration. The implementation guidance for Section 2039 of WRDA 2007, in the form of a CECW-PB Memo dated 31 August 2009, also requires the Corps to develop an adaptive management plan for all of their ecosystem restoration projects. In accordance with Section 2039 WRDA 2007, monitoring would be cost-shared at 75/25 up to 10 years unless ecological success is achieved sooner. Any monitoring beyond 10 years would be the responsibility of the non-Federal sponsor.

As a part of the RRIFR program, SCWA has developed an extensive monitoring and adaptive management plan for all restoration activities occurring in the Dry Creek Watershed. Per the Monitoring and Adaptive Management Plan (Appendix J), monitoring activities include monitoring effectiveness of habitat features (depths, velocities, cover), vegetation establishment, and the spread of invasive plant species. Monitoring activities typically would require a team of three one day to conduct equaling approximately $390 on a 2.5 year cycle. Over the 10 year period of anticipated, cost-shared monitoring costs will total approximately $1,560.

8. SCHEDULE FOR DESIGN AND CONSTRUCTION

Table 26. Schedule for Design and Construction Phase

Action	Finish
DPR Approved	March-2017
PPA Executed	June-2017
DQC/ATR/BCOES Review Coordination and Review Plan Preparation	July-2017
DQC Concurrent (all disciplines) Reviews of 90+% design submittal	July-2017
NFS AE revises Plans and Specs from DQC comments and submits to USACE	August-2017
Backcheck and comment closing by DQC reviewers	August-2017
Real Estate starts Cadastral work	Dec-2017
ATR Concurrent (all disciplines) Reviews of 95+% design submittal	Sept-2017
NFS AE brings Plans and Specs up to 99+% design and submits to USACE	Oct-2017
Backcheck and comment closing by ATR reviewers	Oct-2017
BCOES Review of the 99+% design submittal	Oct-2017
Real Estate finalizes Track Register	Oct-2017
Contracting Prepares "Front End"	Oct-2017
Legal Sufficiency Review	Nov-2017
NFS AE brings Plans and Specs up to 100% design; submits to USACE for BCOES	Nov-2017
BCOES Certified	Nov-2017
Real Estate sends formal Take Letter to NFS	Novr-2017
NFS provides Real Estate Certification to USACE	Dec-2017
SPK Real Estate Certifies NFS submittal	Decr-2017
Legal Sufficiency Review	Dec-2017
Solicitation	Jan-2018
Bid Opening	Feb-2018
Contract Review, Negotiations, and Award	March-2018
Construction	Oct-2018
Note: instream construction can only occur between June 15-Oct 15. However, some work (i.e. staging area clearing, access road maintenance, vegetation clearing be able to be completed outside the environmental window.)	

9. COST ESTIMATES

Table 27 displays costs for the current working estimate derived from the Planning Level Cost Estimate. A Micro-Computer Aided Cost Estimated System (MCACES) level cost estimate was completed for the TSP. The cost estimate for the TSP includes clearing and grubbing, removals of debris, excavation and embankment to grade the channel, temporary access improvements, installation of erosion control, seeding, log structures, landscaping and irrigation. Costs are included for revegetation and irrigation for reference only as it is understood that the Water Agency will be implementing these components. These costs will be refined in subsequent phases of design and with additional coordination with the Water Agency.

Costs are presented in 2016 dollars and would need to be adjusted to account for price escalation for implementation in future years.

A contingency of 15% was applied to the opinion of probable construction costs to account for unknowns related to actual costs at the time of construction including but not limited to potential delays, availability of construction equipment and crews, construction materials, and fluctuation of supply prices at the time the work is bid.

Project Engineering Design (PED) contingency of 15% was applied because the project currently is moving towards the 90% Design. No permit and environmental costs have been included.

The initial Cost Estimate is based on the following: (1) Quantities that provided by sponsor; (2) MII Estimating System; (3) 2014 Region 7 Equipment Database and; (4) Past estimates from similar projects specifically the first two phases of the Dry Creek Habitat Enhancement Project estimator's experiences and judgment. Table 27 provides a cost summary for the recommended plan. Table 28 shows the cost breakout of Federal and non-Federal costs.

Table 27. Recommended Plan Project Cost Summary.

RECOMMENDED PLAN COSTS[1]	Alternative 2
DESIGN & IMPLEMENTATION COSTS	
LERRDs	
Land Acquisition	$575,546
Federal Administration	$75,000
Non-Federal Administration	$180,000
Disposal Areas	$0
LERRDs Subtotal	***$830,546***
Design Costs	
Preconstruction Engineering, Planning and Design (15% applied to construction costs)	$ 665,000
Design Costs Subtotal	***$ 665,000***
Construction Costs	
Construction (includes overhead, profit, bond & contingency)	$ 3,982,000
Construction Management (8.5% of construction cost)	$528,000
Construction Costs Subtotal	***$4,510,000***
Total Design and Implementation Cost	***$6,005,546***
Interest During Construction	***$305,404***
Total Gross Investment Cost	***$6,310,950***
O&MRRR	
Total O&MRRR	***$662,000***
MONITORING & ADAPTIVE MANAGEMENT	
Total Monitoring & Adaptive Management	***$1,560***
ANNUAL COSTS	
Annual cost of Gross Investment[2]	$239,488
Annual Cost of O&MRRR	$25,100
Annual Cost of Monitoring & Adaptive Management	$59
Total Annual Costs (AAC)	$264,647

[1]October 2016 Price Levels

[2] Annualized at the FY2017 Federal Discount Rate of 2.875% and a 50-year period of analysis.

Table 28. Project Cost Apportionment

Cost Apportionment			
Cost Item	**Federal Cost**	**Non-Federal Cost**	**Total Cost**
FEASIBILITY PHASE			
Initial 100% Federal Feasibility Cost	**$100,000**	**--**	**$100,000**
Cost-Shared Feasibility Costs			
Sponsor In-Kind Services	--	$750,000	$750,000
Cash Contribution	$750,000		$750,000
Total	**$750,000**	**$750,000**	**$1,500,000**
Percent of Total Cost-Shared Cost	*50%*	*50%*	*100%*
Total Feasibility Phase Costs	**$850,000**	**$750,000**	**$1,600,000**
DESIGN AND IMPLEMENTATION (D&I) PHASE			
LERRDS Costs	$75,000[1]	$755,546	**$830,546**
Design Costs			**$665,000**
Construction Costs			**$4,510,000**
Total Design and Implementation Costs	**$4,504,160**	**$1,501,387**	**$6,005,546**
Percent of Total Cost-Shared Cost	75%	25%	100%
Sponsor LERR Credit		*$755,546*	
Implementation Cash/In-kind Contribution	$4,504,160	*$745,841*	
TOTAL FEASIBILITY AND D&I COSTS	**$5,354,160**	**$2,251,387**	**$7,605,546**

1 Federal Administration of LERRDS

10. NEPA ENVIRONMENTAL ASSESSMENT *

This environmental assessment is written in compliance with the National Environmental Policy Act (NEPA) of 1969 (42 USC § 4321 *et seq*), as amended, the Council on Environmental Quality (CEQ) Regulations for Implementing the Procedural Provisions of the NEPA (40 C.F.R. §§1500-1508), and U.S. Army Corps of Engineers (USACE) Planning Regulations (Engineering Regulation (ER) 200-2-2). It presents an evaluation of the potential effects associated with the proposed restoration of subreach 4a of Dry Creek (“proposed action,” TSP).

10.1. Alternatives Evaluated

This section describes the Proposed Action and the No-Action Alternative, under which no new action would be taken. The preferred alternative is identified. Other alternatives considered but eliminated from further study are briefly discussed.

10.1.1. Proposed Action (Alternative 2)

The proposed action is Alternative 2 (NER Plan, TSP) which includes restoration in and adjacent to subreach 4a of Dry Creek (Figures 27 and 36). The proposed action is the Agency-Preferred Alternative and is described in section 7 (Recommended Plan). Construction activities would generally involve mobilization; vegetation removal; excavation and grading; installation of restoration features; revegetation; and site cleanup and demobilization.

As described in Sections 7.1 and 7.2, the primary restoration features would include three secondary channels across sites 4a and 4b (Figure 36): a 500 ft long secondary channel to the right of the main stem below the lower grade control sill (between Stations 164+50 and 168+00); a 1,100 ft long secondary channel to the left of the main stem below the lower grade control sill (between Stations 160+00 and 170+00); and a 650 ft long secondary channel to the left of the main stem immediately upstream of the lower grade control sill (between stations 171+00 and 176+50). Additionally, restoration would include a graded high flow terrace and alcoves along the secondary channels. Approximately 20,500 cubic yards of earthen material would be moved for construction of restoration features. Partial flow diversion would be required during excavation of secondary channel and/or alcove connections to the main stem, and such diversions would likely be accomplished using coffer dams and potentially pumps to remove excess water from the isolated area (Section 7.8). Excavated earthen material from the project site would be stored onsite or in the proposed staging area (Figure 38) to be used as a bank stabilization and fill where possible (section 7.7).

The proposed action would also include installation of large wood structures (Section 7.4), bank stabilizing brush mats (Section 7.3), riffle substrate (Section 7.2), and boulder clusters (Section 7.1) at various locations in the main and side channels. Moreover, the lower grade control sill would likely be modified to include a new notch and improved transitional structure to allow fish passage instead of the existing fish ladders (Section 7.5). Installation of certain large wood structures may require flow diversion using coffer dams or possibly dewatering (Section 7.8). Conversely, placement of large boulders may occur in the active flow of Dry Creek.

Vegetation management at the site (Section 7.6) would consist primarily of removal of invasive species, protection of key native vegetation, and some removal of native vegetation Where feasible, trees to be removed for construction would be salvaged and incorporated into the planned large wood structures or transplanted after construction.

Construction of the proposed project (Alternative 2) would take approximately one construction season and is expected to be completed largely in 2018. However, construction could take additional time, for example if there are delays due to weather or obtaining materials. As described in section 7.11, major ground disturbing activities would be limited to the typical dry season in-water work period (June 15 through October 15) . Other work such as staging, clearing, and grubbing at the site may be conducted outside of this timeframe. Proposed access routes and construction staging areas for Alternative 2 (Section 7.9) are shown in Figure 38 below. If necessary, temporary stream crossings may be installed to allow construction equipment and workers to cross over the main channel in subreach 4a.

While it is not anticipated that the habitat restoration measures will require regular maintenance work over the long term, temporary irrigation may be required to maintain newly-installed vegetation and periodic vegetation management may take place in certain locations. Maintenance activities (Section 7.12) may also include repair to damaged structures or adjustments to structures if they are not functioning as intended. Moreover, as described in Section 7.14, monitoring of ecosystem restoration performance (e.g. effectiveness of habitat features, vegetation establishment, and the spread of invasive plant species) and adaptive management would be performed at the project site. Appendix J includes the Monitoring and Adaptive Management Plan developed by SCWA for all restoration activities along Dry Creek.

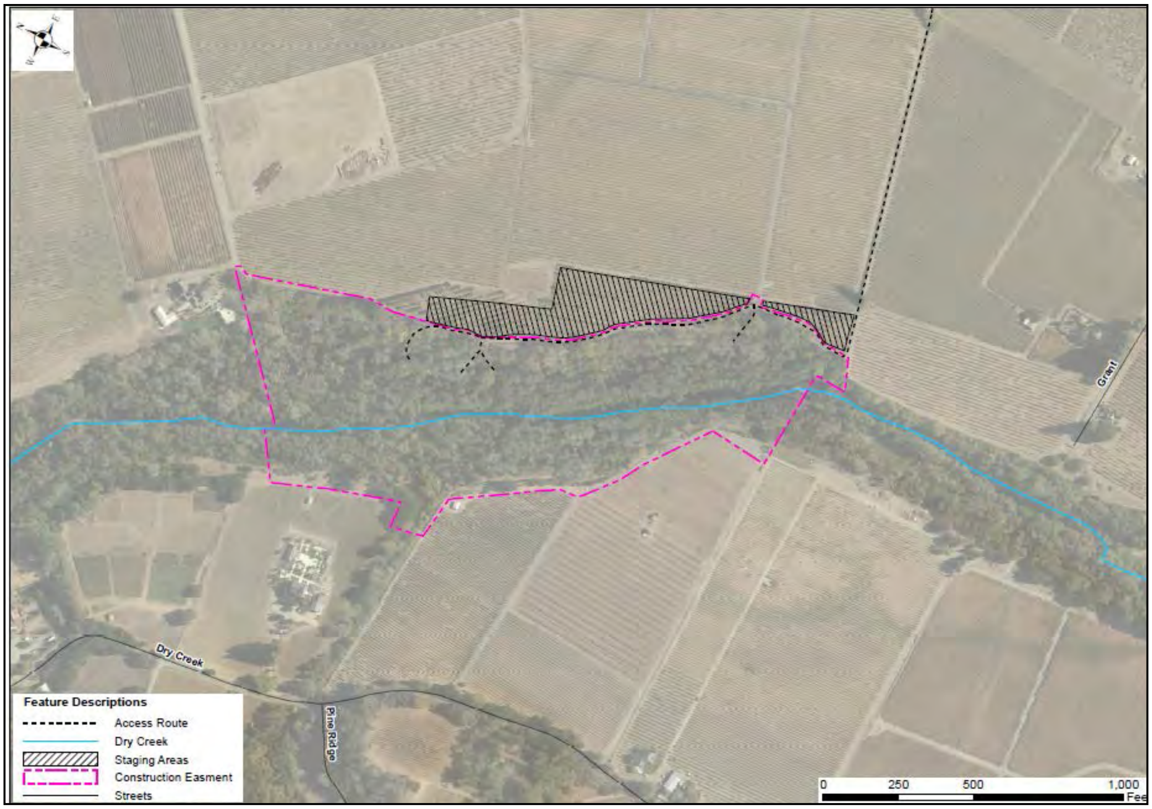

Figure 38. Proposed staging area and access routes.

10.1.2. No Action Alternative (Alternative 1)

Analysis of the no action alternative is required under NEPA to provide a comparative baseline against which other alternatives can be evaluated. Under the no action alternative (Alternative 1) there would be no restoration activities within subreach 4a of Dry Creek itself or within the adjacent riparian corridor. There would be no effects associated with project construction activities and the existing environmental conditions described in Section 3 would be expected to remain largely the same. Because the future without project (FWOP) condition for this feasibility study assumes that construction of Dry Creek restoration improvements will not take place in absence of a Federal project, the no action alternative would be expected to over time result in the FWOP conditions described in Section 4 of this DPR. For example, the no action alternative would continue to promote the current altered hydrology and simplification of natural geomorphic processes within Dry Creek. As a consequence, the Dry Creek mainstem channels would continue to produce hydraulic conditions unsuitable for the sheltering of juvenile fish and floodplain areas would likely further build up over time, becoming more disconnected from the stream. Moreover, none of the expected benefits to salmonid species and aquatic and riparian habitat associated with the proposed action would occur.

10.1.3. Alternatives Considered but Eliminated from Further Study

A number of alternatives to the proposed action were formulated, considered, and eliminated from further study in this EA. The alternative formulation and initial screening process undertaken as a part of this feasibility study is described in Section 5. Non-structural (Section 5.3.1) and structural (Section 5.3.2) measures were formulated and then initially screened. A group of measures were carried forward for each subreach after screening (Section 5.3.3), resulting in 25 restoration subreaches which were then prioritized based on ecosystem restoration potential to aid in the development of alternatives (Sections 5.3.4 and 5.3.5). Next, the subreaches were screened based on six criteria including maximization of ecosystem restoration benefits, cooperating landowners, location on Federal Land, presence of Corps structures, and connectivity to adjacent restored sites (Section 5.3.6). Based on these screening criteria, six alternatives (including the no action alternative) were included in a Final Array of Alternatives for further evaluation (Section 5.3.7 and 5.3.8). Based on this evaluation, four alternatives from the final array were eliminated from further study as described in Section 6, and thus are not analyzed in this EA. Alternative 2 has been identified as the recommended plan/ Tentatively Selected Plan (Section 6.3.4 and Chapter 7) and is carried forward in this EA as the proposed action along with the no action alternative (Alternative 1).

10.2. Scope of Environmental Assessment

The objective of this EA is to analyze whether the implementation of the proposed action (Alternative 2) would significantly affect the quality of the environment. The scope of the analysis is limited in time and space by the reasonably foreseeable direct, indirect, and cumulative impacts of the proposed action. Direct effects are caused by the action, and occur at the same time and place as the action (40 CFR 1508.8a) while indirect effects are caused by the action, but may occur later in time or further removed in distance (40 C.F.R. § 1508.8b). Cumulative effects “result from the incremental impact of the action when added to other past, present, and reasonably foreseeable future actions” (40 C.F.R. § 1508.7).

This environmental assessment is based on comparison of the effects of the proposed action to those of the no action alternative. The primary action areas for this analysis include subreach 4 of Dry Creek and the adjacent terrestrial zone; the proposed construction staging area; and the proposed access routes. For certain potential effects, such as those on ambient noise and air quality conditions, the analysis extends to adjacent properties and the greater North Coast Air Basin the vicinity of the action areas. Indirect effects on conditions within the greater Dry Creek (e.g. up or downstream) also fall within the scope of analysis in some cases. Additionally, this analysis includes evaluation of potential cumulative impacts associated with other past, current, or reasonably foreseeable (as of December 2016) future projects expected to occur within the vicinity of the action areas.

10.3. Affected Environment and Consequences

The existing conditions of the environmental resources evaluated in this EA (the affected environment) are largely described in Sections 3.0 and 5.3.8 of this DPR; references to any applicable portions of these sections are provided in the introduction of each resource discussion below. In some instances, neither the proposed action (Alternative 2) nor the no action alternative are expected have any effect on a given environmental resource. Such resources are identified at the beginning of the physical, biological, or human environment sub-sections below and are not discussed further.

10.4. Physical Environment

This section discusses the potential effects of the proposed action (Alternative 2) and no action alternative on components of the physical environment. The physical environment generally refers to properties of the land, water, and air within the vicinity of proposed action areas. Physical environmental resources include those such as topography, soils, geology and mineral resources, hydrology and water quality characteristics, air quality, and climate.[16] Neither the proposed action (Alternative 2) nor the no action alternative are anticipated to result in any change to geology (Section 3.2), soils (Section 3.4), mineral resources, climate[13] (Section 3.5), or seismicity and seismic hazards (Section 3.3). These resources are not further discussed in this section.

10.4.1. Physiography-Topography

The existing physical geography and topography of the dry creek watershed is described in Section 3.1. The proposed action (Alternative 2) would not affect the overall physiography or topography of the basin. However, the construction of side channels, alcoves, and a high flow terrace associated with the proposed action would intentionally alter the local topography of the project action area. These proposed

[16] Note that "Climate" is used herein to refer to meteorological conditions and is distinguished from "climate change" which is discussed in this document as a part of air quality.

topographic modifications are design features of Alternative 2 that are intended to increase the quantity and restore the quality of aquatic habitat. While local changes will occur, no significant adverse impacts to topography are expected. Under the No Action Alternative, there would be no restoration activities within the proposed action area and thus no change to local or regional topography and physiography.

10.4.2. Hydrology

Currents, Circulation, and Drainage Patterns

Drainage patterns of the Dry Creek watershed within which the proposed action areas are discussed at the beginning of Section 3.6. Figure 12in this section illustrates the approximately 30 square miles of catchment area within the watershed that drains directly to Dry Creek (in green) as well as the drainage areas contributing to principal Dry Creek tributaries below WSD. The majority of the runoff draining directly into Dry Creek is runoff from adjacent agricultural areas. Section 5.8 provides a description of existing conditions in subreach 4a which includes information on currents and circulation in the subreach. As described in this section, upstream of the sill in the middle of reach 4a (referred to as the lower sill) is a long stretch of slow moving, flatwater pool and an existing alcove off the right bank. Immediately below the sill (downstream) is an area of increased circulation with a riffle and connection from an unnamed tributary along the right bank. This is followed by more flatwater then another riffle area near the subreach’s boarder with subreach 3b.

The proposed action (Alternative 2) would intentionally change local drainage patterns immediately adjacent to the main stem in portions of subreach 4a through construction of the proposed off channel restoration features. Proposed restoration features such as side channels and alcoves by design divert drainage into existing floodplain areas to restore off-channel aquatic habitat. Alcoves are depressional features adjacent to the channel typically connected to the mainstem at their downstream end. Side channels carry flows from the mainstem through adjacent floodplain areas before reconnecting downstream. While construction of these features would permanently change the local drainage pattern in subreach 4a, the effect on local drainage would not be adverse or significant.

Construction and maintenance activities associated with the proposed action would involve clearing and grubbing of some existing vegetation in the project action areas, revegetation of the site at the end of construction, and possibly temporary irrigation to maintain newly-installed vegetation. These activities could change local drainage patterns by temporarily increasing runoff at the project site. However, best management practices would be employed to minimize any runoff from exposed, nonvegetated surfaces during construction. BMPs, for example, may include placement of geotextile fabric and bio-logs to increase infiltration and impede any runoff. Vegetation management, including the establishment of new native plantings adjacent to constructed off-channel habitats, would also maintain and potentially increase infiltration capacity within the proposed action areas thereby reducing surface runoff post construction. Moreover, the proposed action does not involve creation of new impervious surfaces (e.g. parking lots) that might significantly increase runoff on- or off-site and thus existing drainage patterns in the greater Dry Creek Watershed would remain unaffected. With implementation of BMPs during construction and revegetation of proposed action areas any increases in runoff associated with the proposed action would be temporary and minimal. Under the no action alternative there would be no restoration activities and thus no potential for permanent or temporary change in existing drainage patterns at the project site.

The proposed action will also change existing patterns of circulation and currents within subreach 4a of Dry Creek, but no significant adverse impacts are expected from these changes. Construction of features such as side channels, alcoves, riffles, boulder fields, LWD structures and the potential notching of the lower grade control sill in subreach 4a, will change existing current direction and velocity as well as circulation in the subreach. These changes are intended to create greater hydraulic diversity in the river to restore the quality of aquatic habitat for species including endangered salmonids. No significant detrimental effects to currents or circulation in subreach 4a or the greater Dry Creek are anticipated from the proposed action. The no action alternative would result in no changes to existing currents or circulation in subreach 4a.

Base Flow

As described in Sections 3.6 and 3.7, Dry Creek has reduced peak flows and year round, relatively-high base flow conditions as a result of the installation and operation of USACE's WSD. In addition to flows along the main stem from the operation of WSD, the portion of Dry Creek below WSD receives unregulated flows from its major tributaries including Fall, Dutcher, Peña, Grape, Crane, and Mill creeks. The alternative formulation process for this project included specific planning constraints (Section 2.4.1) that WSD operations must be able to continue maintaining the base summer flows and RWQCB mandated minimum environmental flows necessary for water supply, hatchery, and hydropower operations. As such, no effect to base flows would occur as a result of the proposed action. Additionally, the proposed action would not affect flow conditions from any tributaries connected to Dry Creek.

As indicated in Section 10.1.1, construction activities would involve temporary partial diversion of main channel flows for side channel connection and installation of LWD structures. However, design elements and approaches have been selected with the intent of minimizing the needs for dewatering and/or channel diversion. Thus, these diversions would be minimal, temporary, and would not have any significant or permanent impacts to flows along Dry Creek.

The no action alternative would not involve any change to existing base flow conditions in Dry Creek.

Groundwater and Aquifer Recharge

Aquifer recharge in the vicinity of Dry Creek has been diminished over time as flood plains have become developed or disconnected from the mainstem due to channel simplification and sedimentation (Section 2.1). Under the proposed action, off-channel restoration features (alcoves and side channels) would be excavated within the floodplain adjacent to the main Dry Creek channel in subreach 4a. The bottom grades of these features would be constructed at or slightly below (e.g. approximately 4 feet below) summer water surface elevations to maintain a perennial surface water connection. Geotechnical investigation of off-channel enhancement areas conducted for the SCWA's 2014 Dry Creek Demonstration Project (Mile 1) found groundwater occurring at approximately the same elevation as the adjacent water surface (Inter-Fluve 2011). Thus, excavation into the floodplain to create off-channel restoration features would likely intersect the groundwater table.

Groundwater (surface water) encountered in the bottom of excavated features during construction would be pumped out of localized work areas into adjacent areas (still within the excavated feature) and allowed to percolate back into the ground. These activities would not result in reducing aquifer volume or lowering the local groundwater table. The proposed action would increase the area of surface water in subreach 4a through the construction of side channels, alcoves, and a high flow terrace. While not specifically intended to do so, these features may contribute to slightly increased ground water recharge in the project action area which would be a minimal but beneficial effect. As the enhancement features would be excavated in close proximity to the main channel of Dry Creek, groundwater surface elevation would still be controlled by water surface elevation in the main channel. No significant effects to groundwater or to aquifer recharge would occur under the proposed action or the no action alternative.

Water Supplies and Conservation

Potable water supplies for municipal, domestic, and industrial customers in the lower Russian River and parts of Sonoma and northern Marin counties are provided by SCWA through joint operation of Warm Springs Dam and the Lake Sonoma reservoir with the USACE (Sections 1.6.1 and 3.6). The proposed action would not affect the operation of WSD or the amount of water supplied in the region. Similarly, the proposed action would not require any change in the existing quantity of water flowing through Dry Creek and does not involve any changes in water conservation in the region. No impacts to water supplies or conservation would occur as a result of the proposed action or the no action alternative.

Flood Control Functions

Section 1.6.1 describes Warm Springs Dam, the primary existing flood control feature associated with Dry Creek. The proposed action (Alternative 2) is not designed specifically for flood control functions and will not adversely impact any existing flood control features or alter the extent of the existing 100-year flood hazard zone. The proposed project would include the creation of side channels, alcoves, and a high-flow terrace as well as the installation of bank stabilization all of which would reduce water velocity and could result in slightly improved flood capacity for Dry Creek. Thus, the proposed action would not increase flood risk for people or structures and may provide some incidental flood-related benefits for immediately adjacent areas by reducing potential for bank loss or damage resulting from high flow events.

The proposed action would involve placement of large wood structures, boulder clusters, and constructed riffles within the dry creek channel. While the channel is located in the existing 100-yr flood hazard area, placement of these restoration features would not be expected to increase the water surface elevation of the 100-yr flood. Large wood structures, boulder clusters, and constructed riffles are permeable, allowing some flow into and through the structure, and are low profile, situated along the bankline (ESA-PWA 2014). Under the proposed action, these structures would be placed in conjunction with topographic adjustments (e.g., floodplain grading) that would reduce the overall profile of the reach 4a action area. Given this, there would be no adverse effect to 100-yr flood water elevations associated with the proposed action.

No significant effects on flood control features are expected to result from the construction or operation of the proposed action. Under the no action alternative there would be no change in existing flood control features or flood characteristics within the action areas or the Dry Creek region.

Erosion and Accretion Patterns

Erosion and accretion patterns in the greater Dry Creek area are discussed in Section 3.7 and existing erosion control features in Dry Creek are discussed in Section 1.6.1. Section 5.3.8 provides a description of existing conditions specific to subreach 4a, including a discussion of sedimentation patterns.

Historically, subreach 4a has undergone significant channel narrowing and flow concentration due to establishment of dense riparian vegetation and stabilization of bar features post-construction of WSD. The regulated hydrology has resulted in increased growth of mature riparian trees which hydraulically roughen bank areas and concentrate high flow velocities in the channel increasing erosion. Moreover, under the current flow regime, high flow events have longer durations than similar flows that occurred during the pre-dam period, further facilitating erosion and transport of sediment.

The construction of side channels and alcoves associated with the proposed action would change erosion and accretion patterns within and adjacent to the main channel in subreach 4a. As described in the above hydrology subsections of this EA, these features would change the drainage course in the action area as well as current velocities, directions, and circulation. These changes will contribute to a shift in sedimentation patterns in the subreach. The proposed side channels and alcoves are intended to create areas of low water velocity (hydraulic refuge) for juvenile salmonids. The lower water velocity in these areas will encourage sediment accretion, leading to increases in bed elevation. The proposed alcove and secondary channel features are anticipated to generally persist in their constructed condition for years to decades, however, there is the potential for significant episodic deposition which could eventually disconnect the feature from the low-flow channel.

Other components of the proposed action such as large wood structures and bank stabilization would reduce erosion in critical locations in the mainstem and newly constructed off-channel features within subreach 4a. Log jams would help to prevent erosion by dissipating flow force and bank stabilization features such as brush mats would prevent the stream from migrating into high terraces by stabilizing banks in the channels. While large wood structures would be installed as part of the proposed action, the planning process for this study included a design consideration (Section 2.4.2) noting that the proposed action cannot increase erosion from released wood. Thus large wood features will be anchored to prevent release during high flow events.

While the proposed action would result in changes in erosion and accretion patterns within subreach 4a, these changes are design considerations that are not expected to result in an adverse effect from or to the project. Under the no action alternative there would be no construction of off-channel or in-channel restoration features and erosion and accretion patterns in the subreach would likely remain the same given the largely stabilized condition of the channel and the existing grade control sills.

10.4.3. Water Quality

Existing water quality conditions in Dry Creek are discussed in Section 3.8, including temperature (Section 3.8.1), dissolved oxygen content (Section 3.8.2), and suspended solids (Section 3.8.3).

Pursuant to section 401 of the Clean Water Act (CWA; 33 U.S. Code 1251), the proposed action would require a Section 401 Water Quality Certification from the North Coast Regional Water Quality Control Board (NCRWQCB). The USACE has initiated coordination with the NCRWQB and is in the process of preparing an application for Section 401 Certification. The proposed action would adhere to any conditions set forth in the water quality certification in order to ensure consistency with the NCRWQCB's Water Quality Control Plan for the jurisdiction.

Suspended Particulates & Turbidity

Water clarity can be affected by releases of solids into a stream course and by the disturbance of sediments within the stream from streambed alteration or modification activities. Turbidity is a measurement of the clarity of the water column and more turbid conditions are generally associated with elevated levels of suspended and settleable particulates in the water column. As discussed in Section 3.8.3, Seasonal turbidity data collected from Dry Creek below the Lambert Bridge stream gage in 2012 and 2013 were observed to have a maximum daily value of 5.4 Nephelometric turbidity units (NTU) and 6.8 NTU, respectively.

Construction activities associated with the proposed action are likely to induce temporary increases in suspended and settleable particulates in the main Dry Creek channel, however the impact of these increases is expected to be less than significant. The SCWA's 2014 Dry Creek Demonstration Project (Mile 1) consists of features similar to those associated with the proposed action (alcoves, large wood structures etc.) and thus provides a good indication of the level of impact that could be expected under the proposed action. During construction of the Demonstration

Project, brief increases in suspended particulates and resulting spikes in turbidity were observed on several days and typically lasted from several minutes to a few hours following each occurrence. These elevated turbidity levels during construction were generally associated with times when creek flow was initially introduced into a habitat feature area after it was constructed. The maximum daily turbidity observed in 2014 occurred during the construction of the Dry Creek Demonstration Project and was recorded at 110 NTU. Despite brief spikes of turbidity in 2014 however, daily median turbidity values were not significantly impacted relative to those recorded in 2013 and 2012, illustrating the short-term nature of the effect. Moreover, no long-term chronic effects were observed, as daily minimum turbidity values during the 2014 construction season continued to be consistent with daily minimum values observed before and after construction of the Demonstration Project.

Similar to construction of the Demonstration Project, construction of the proposed action (Alternative 2) will likely result in temporary increases in suspended particulates and thus turbidity on the order of several minutes to hours, largely during the connection of newly constructed off-channel restoration features to the main stem. The proposed action would include bank stabilization components to minimize erosion in these newly constructed off-channel restoration features, which would help reduce the suspension of particulates from these features into the channel. Turbidity curtains may also be used as appropriate to separate in-channel work areas from the main channel. As was the case with the demonstration project, any potential increases in suspended particulates are not anticipated to affect daily median turbidity or result in long-term effects on minimum turbidity and thus their impact would be minimal.

Construction activities associated with the proposed action also have the potential to effect turbidity and suspended particulates during the construction period due to increased surface runoff/erosion carrying particulates into the channel. In order to minimize the potential for contribution of particulates from such runoff during construction, major ground disturbing activities would be limited to the typical dry season in-water work period (June 15 through October 15), however other work such as clearing and grubbing at the site may be conducted outside of this timeframe. Additionally, as discussed in the "Currents, Circulation, and Drainage" section of this EA, the proposed action would include implementation of BMPs to minimize surface runoff. Erosion control practices (such as covering stockpiles) and dust control measures (see Section 10.4.5 "Air Quality" below) would also be implemented within the proposed construction action areas to minimize water or airborne release of particulates into the channel. Additionally, the chosen construction contractor would be required to obtain and comply with a necessary National Pollutant Discharge Elimination System (NPDES) permit and prepare a storm water pollution prevention plan (SWPPP) prior to initiating project construction. These practices and project features would reduce the potential for increases in suspended particulates and turbidity during the construction period due to surface runoff or erosion to a minimal level.

Post construction, the proposed alcove and secondary channel features are anticipated to generally persist in their constructed condition for years to decades. Operation of the project would not be expected to significantly affect turbidity or suspended particulates in Dry Creek. Maintenance activities may require work within the main or off-channel restoration features at some point. If maintenance activities have the potential to affect turbidity or suspended particulates, then those activities would adhere to similar BMPs as those described above in order to prevent any significant impacts.

Only temporary, short-term increases in suspended particulates and turbidity are anticipated during construction of the proposed action, BMPs will be implemented to minimize particulate contributions from construction activities, and operation of the project is not expected to affect turbidity or suspended particulates. Thus any impacts on water quality due to suspended particulates and turbidity would be less than significant. In comparison, the no action alternative would involve no change in the existing channel in subreach 4a and no construction activities, therefore there would be no change in existing levels of suspended particulates or turbidity.

Temperature, Dissolved Oxygen Content

Water temperature in Dry Creek mirrors the temperature of the water released from Lake Sonoma, which is regulated along with flows to be suitable for fish hatchery operations. As indicated in Section 3.8.1 temperatures were observed to range from 54-62^{o}F at the Lambert Bridge stream gage between 2012 and 2014. Dissolved oxygen content for the same period ranged from 8.8mg/L to 12.2 mg/L (Section 3.8.2).

The proposed action primarily has the potential to affect temperature and dissolved oxygen concentrations through the suspension of sediments and removal of riparian vegetation providing shading, which can impact these parameters. The spikes in suspended sediments and turbidity as well as the removal of overhaning riparian vegetation associated with the Dry Creek Demonstration Project in 2014 (described under “suspended sediments and turbidity” above) were not observed to cause significant changes to temperature and dissolved oxygen concentrations.

Temperatures and dissolved oxygen concentrations at the Lambert Bridge stream gage during the 2014 construction season were observed to remain consistent with temperature and dissolved oxygen concentrations being recorded before and after the Demonstration Project construction activities. Temperature and dissolved oxygen concentrations in 2014 also remained consistent with seasonal concentrations recorded during 2012 and 2013.

Post-construction, side-channels and alcoves would be expected to have similar water temperature and dissolved oxygen parameters to those existing in Dry Creek currently. Water velocity through the side channel would be rapid enough to prevent nuisance sedimentation or increased water temperatures due to greater exposure to thermal radiation. These channels and alcoves would be hyporheically connected (i.e., connected through groundwater inputs) to Dry Creek as well and since hyporheic inputs are typically cooler than surface flow in rivers and streams, these features would be expected to remain cool.

Given the volume of cold water coming out of Lake Sonoma, the minimal and temporary increases in turbidity and loss of riparian screening expected during construction or maintenance, and the expected similarity in water quality parameters between Dry Creek and the newly constructed restoration features, the proposed action is not anticipated to have any impacts on temperatures and dissolved oxygen in the action areas or greater Dry Creek. The no action alternative would have no effect on existing temperature and dissolved oxygen water quality parameters in Dry Creek.

Pollutants

Construction activities in the vicinity of surface waters in general have the potential to introduce pollutants into water courses and impact water quality. Avoidance and minimization measures would be exercised throughout the proposed action to ensure no debris, rubbish, petroleum products, or other materials from construction or associated activities impact water quality in Dry Creek. Storage, maintenance, and staging of equipment would be limited to the designated staging areas (Figure 38) and conducted in a manner that will not result in a discharge of any substance to Dry Creek. Any fueling of equipment would occur at appropriate off-site facility or in designated locations in staging areas and would be implemented in a manner designed to ensure no pollution occurs (e.g. with secondary containment). Although spills are unanticipated, spill response equipment would be stored onsite for immediate implementation to minimize the impacts of any accidental spills. At the completion of construction, all construction wastes, debris, sediment, rubbish, trash, fencing, and materials would be removed from the site and transported to an authorized disposal area to prevent any materials from entering the waters of Dry Creek. Given these avoidance measures, the proposed action is not expected to have any significant adverse effects on water quality from pollutants. Because the no action alternative would not involve construction activities, it presents no potential for adverse effects on water quality from pollution.

10.4.4. Contaminants in Dredge or Fill Material

Approximately, 20,500 cubic yards of earthen material would be excavated for construction of the side channels, riffles, and pools associated with the proposed action. Excavated earthen material from the project site would be stored onsite or in the proposed staging area to be used as a bank stabilization and fill for other restoration features associated with the proposed action where possible, such as the high-flow terrace along the left bank side channel (below the grade control sill). As described in the "hazardous, toxic, and radioactive wastes" section of this EA (Section 10.6.10 below), no contaminants are expected in any of the material onsite. Moreover the material excavated onsite is expected to provide enough supply to construct the proposed features onsite, such that no additional material will need to be borrowed and brought to the site. Since the source and receiving sites would be one and the same, the fill material would be compatible (e.g. in terms of grain size and composition) with the site. If, although unexpected, additional fill material were necessary for the proposed action, it would undergo appropriate testing to ensure it was free of contaminates and compatible with the subreach 4a placement site. Similarly, if any material were leftover at the end of construction, disposal of such material would be the responsibility of the construction contractor to dispose of and that contractor would be required to perform adequate testing, if applicable, to identify an appropriate class of facility to which the material could be taken. The material is expected to be suitable for a class I landfill.

In addition to soil material, logs, boulders, and riffle material (gravel) would be placed in the main and side channels to create restoration features. Large wood features would be constructed from trees felled onsite or with imported large logs. Such logs would be natural material, inspected for pests, and not anticipated to introduce any contaminants to the site. Similarly, boulders and riffle material would be appropriately selected mineral types to be compatible with rock types and conditions in the proposed action areas. These natural materials would not introduce contaminants to the site.

Given that the soil onsite is not known or anticipated to have any contaminants; material excavated from the site is expected to supply the proposed construction of other features onsite; the proposed suitability testing of any material to be imported to or removed from the site (although this is considered unlikely), and the natural, inert nature of the logs, boulders, and riffle material to be used to construct in-channel restoration features, the proposed action is not anticipated to have any significant effects related to contaminants in dredge or fill material. The no action alternative would not involve any dredge or fill and thus would have no effects associated with contaminants in such material.

10.4.5. Air Quality and Climate Change

Section 176 (c) (42 U.S.C. 7506) of the Clean Air Act (CAA) requires federal agencies to ensure that their actions conform to the applicable State Implementation Plans (SIP) for attaining and maintaining the National Ambient Air Quality Standards (AAQS). Under these regulations, a federal agency is required to conduct an air quality applicability analysis (and potentially a general conformity analysis) for a proposed action unless that action is exempt (as defined in CFR 40 § 93.153(c)) or falls within an air district that is in compliance with all AAQS.

As described in Section 3.9 of this document, the proposed action falls within the North Coast Air Basin (NCAB) under the jurisdiction of the Northern Sonoma County Air Pollution Control District (ACPD; Figure 19). The Sonoma County portion of the NCAB is considered in attainment or unclassified (i.e. in compliance) for all state and federal AAQS (NCUAQMD 2015) and thus it is not required to and does not have an air pollution reduction plan. Because the Northern Sonoma County APCD is in attainment or unclassified for all AAQS, an air quality applicability analysis under the CAA is not required for the proposed action (Alternative 2).

While an air quality applicability analysis is not required, the proposed action (Alternative 2) would be expected to result in a temporary increase in air pollutant emissions in the air district from construction activities. SCWA (2015) estimated that construction of two miles of proposed habitat restoration along Dry Creek simultaneously in a single year would produce approximately 1.03 tons/yr of reactive organic gasses (ROG), 10.73 tons/year of carbon monoxide (CO), 33.06 tons/yr of nitrogen oxides (NOx), and 0.95 tons/yr of particulate matter (PM). These annual emission rates do not exceed the significance thresholds for criteria air pollutant emissions set for by the Northern Sonoma County APCD and the emissions from the proposed action would be well below the levels cited above given that the proposed restoration is less than one mile. No more than two miles of simultaneous restoration activities (including the proposed action) are expected to occur in the 2018 construction season, thus the proposed action is not expected to contribute to an exceedance of these thresholds.

Measures would also be implemented during construction to minimize such emissions. Construction activities have the potential to temporarily elevate levels of particulate matter (PM) from soil disturbance and wind erosion as well as temporarily increase emissions of from the combustion of diesel and gasoline fuels to operate heavy equipment, haul trucks, and worker commute vehicles (Construction-generated criteria air pollutant and precursor emissions 2009), Such pollutants may include exhaust emissions of coarse particulate matter (PM_{10}), fine particulate matter ($PM_{2.5}$), NOx, carbon dioxide (CO_2), CO, and sulfur dioxide (SO_2). In order to minimize these emissions associated with the proposed action, air quality best management practices would be employed such as requiring construction vehicles and equipment to meet California Air Resources Board idling limits and fleet emission standards for diesel fueled heavy equipment and trucks (CARB 2016), maintaining properly tuned equipment, and using alternatively fueled equipment when feasible.

A primary toxic air contaminant of concern associated with the combustion of diesel fuel during operation of heavy equipment is diesel particulate matter (DPM). Diesel particulate matter can pose health risks to individuals, particularly sensitive receptors, but such health risks are generally associated with chronic exposure (e.g. 70-year exposure). There are two sensitive receptors (residences) within the vicinity of subreach 4a and they are located approximately 350 feet west and 450 feet east of the dry creek mainstem. The amount of exposure associated with the construction of the proposed action (Alternative 2) would be temporary, largely confined to a single construction season, and minimized by the idling and fleet emission standards described above. The constructed project would not emit air pollutants itself and maintenance requirements that could potentially involve further emissions are expected to be infrequent and minimal. Given the temporary, short term nature of the DPM emissions associated with the proposed action, they would result in a negligible net increase in health risk, and impacts on nearby sensitive receptors would be minimal.

Similarly, there may be some temporary and minimal adverse effects from objectionable odors caused by the construction or maintenance of the proposed action. During construction and possibly maintenance activities, nuisance diesel odors associated with operation of construction equipment could occur and affect nearby receptors. However, this effect would be localized, possibly affecting the two residences in the vicinity of subreach 4a, and would be temporary in nature. Thus, this impact would be minimal.

Dust control is also a primary concern in the region due to the sensitivity of vines growing in close proximity to Dry Creek. Construction activities would comply with the dust control provisions of the Northern Sonoma County Air Pollution Control District's Rule 430, which regulates fugitive dust emissions. Measures to reduce dust emissions may include, but would not limited to, sprinkling unpaved construction areas with water; covering trucks hauling dirt; limiting dust generating activities during periods of high winds (greater than 15 miles per hour); replacing ground cover in disturbed areas as soon as possible; enclosing, covering, watering, or applying soil binders to exposed stock piles; removing earth tracked onto neighboring paved roads at least once daily; and limiting equipment speed to 10 miles per hour in unpaved areas. Through these provisions and measures, any effects associated with fugitive dust would be minimized to a less than significant level.

Finally, the proposed action would generate greenhouse gas emissions associated with construction and any maintenance activities involving fuel-burning equipment. The combustion of fuel to operate construction equipment releases carbon dioxide (CO_2), a greenhouse gas associated with climate change. For example, idling of construction equipment can emit approximately 20.7 pounds of CO_2 per hour, depending on engine size (Lyon 2012) Emissions of carbon dioxide would be minimized by enforcing idling limits and ensuring construction equipment meets fleet emissions standards. No emissions of greenhouse gasses would occur during operation of the constructed project. Given the proposed minimization measures, the impact of greenhouse gases emitted by the project would have a less than significant effect on climate change.

Based on the proposed best management practices and minimization measures, and the fact that the action areas fall within an air district that is in compliance with all AAQS, the proposed action would not violate any air quality standard or contribute substantially to an existing or projected air quality violation. Thus, the proposed action (Alternative 2) would not have a significant adverse effect on air quality or climate change. Under the no action alternative, there would be no construction activities and thus no increase in emissions above existing levels in the region.

10.5. Biological Environment

This section discusses the potential effects of the proposed action (Alternative 2) and no action alternative on components of the biological environment. The biological environment refers to ecological resources such as species and habitats, including terrestrial, aquatic, and special status species and sites.

10.5.1. Terrestrial Habitats and Wildlife

Terrestrial Habitats

Existing terrestrial habitats and vegetation communities along Dry Creek are described in Section 3.12.1 and Section 3.7. As described therein, riparian forest, riparian woodland, and developed habitats (including primarily agricultural, vineyard, and low density residential developments) occupy the immediate vicinity of much of Dry Creek. Similar to the rest of Dry Creek, the main channel in subreach 4a is bordered by dense riparian forest which transitions in a few areas to small zones of open space dominated by grasses and herbaceous plants. Immediately bordering the riparian forest or open space as one moves away from the channel is developed habitat, the majority of which is agricultural or vineyards and which is interspersed with a few buildings and paved and unpaved roadways.

The quality and extent of riparian habitat in the vicinity of Dry Creek including subreach 4a has been impacted over time. In particular, the combination of flood regulation and sustained summer base-flows associated with WSD has interrupted typical riparian succession resulting in overgrowth of largely homogenous, mature, dense stands of early-successional willow, cottonwood, and alder and the evolution of gravel bars to floodplains and terraces (see Figure 21). These conditions have also allowed invasive plant species to flourish and interfere with ecological function (Section 3.12.1 "Invasive Plant Species" subsection). Such static vegetation provides limited riparian habitat complexity which is important for healthy, functioning riparian ecosystems and riparian terrestrial species. However, as indicated in Section 3.12.1. "Special Status Plant Species" subsection) and the special status plant table in Appendix H, two plant species that are considered species of special concern by the California Native Plant Society, have the potential to occur in the vicinity of Dry Creek. These include the Northern California black walnut (*Juglans hindsii*) and Hayfield tarweed, also called white seaside tarplant, (*Hemizonia congesta ssp. congesta*).

The construction and maintenance activities associated with the proposed action (Alternative 2) would take place largely within the Dry Creek riparian corridor in subreach 4a and would result in temporary impacts to terrestrial habitats. Construction activities would include clearing of some existing riparian vegetation in order to construct off channel restoration features within the subreach and clearing then staging of equipment on an abandoned vineyard in the immediate vicinity. This would diminish the quality of the riparian habitat in subreach 4a during and for some time post-construction, and could result in removal or damage to special status plant species if any were to be present in the subreach. However, as described in Section 7.6, vegetation clearing would be carefully designed to preserve wherever feasible trees with high ecological value (snags, living trees with cavities, or other large, mature trees), as well as any special status plants, and to remove invasive species. Pre-construction surveys for special status plants and high ecological value native trees would be conducted to identify and preserve them where possible. Where practicable, trees to be removed for construction would be salvaged and incorporated into the planned large wood structures or transplanted after construction. Invasives would be removed by mechanical means in all areas that are graded and invasive removal may extend beyond the graded area, to reduce the likelihood that rapid re-establishment would occur.

Post-construction, all graded areas outside of active channels would be revegetated with native riparian species to restore habitat, control erosion, and prevent invasive reestablishment. It is anticipated that approximately 1.2 acres of invasive removal and replanting adjacent to newly graded areas and approximately 6.0 acres of revegetation for newly graded features would occur, for a total of around 7.2 acres of revegetation in the subreach. During revegetation, erosion control fabric, hydromulch, or other mechanisms would be applied as appropriate to provide protection to seeds and help them retain moisture. Revegetated areas would be regularly monitored for survival until minimum survival/cover is achieved. If soil moisture is deficient, new vegetation would be supplemented with water until vegetation is firmly established. .If invasive plant species colonize revegetated areas, hand and or mechanical removal and replanting with additional native species would be performed.

While construction and maintenance of the proposed action would result in temporary adverse effects to riparian habitat or plant species of concern from vegetation clearing, these effects would be minimized by the proposed measures described above. Moreover, operation of the project would benefit riparian habitats for the long term through improved ecological functioning. By restoring side channel and alcove features, removing invasives, and replanting with natives, the proposed action would re-introduce successional vegetation and complexity into the subreach which would restore some of the ecological functioning of the currently disturbed riparian habitat. Given that the abandoned vineyard proposed for staging is not in production and has been offered by the owner in exchange for clearing, no adverse impacts to this developed habitat are expected. Other developed habitats in the vicinity of subreach 4a such as agricultural and rural residential developments are not expected to be significantly affected by the proposed action. Thus, the proposed action would have temporary, less than significant adverse effects and long-term beneficial effects on terrestrial habitats in the proposed action areas. In comparison, the no action alternative would result in no change to existing terrestrial habitats in or around subreach 4a and thus would have no potential for adverse effects on such habitats but also none of the expected beneficial effects of restoration.

Wildlife Resources

Existing terrestrial wildlife in the vicinity of Dry Creek is described in Section 3.12.5 and includes species of birds, mammals (ungulates, rodents), amphibians, and reptiles. Many of these species rely on the availability of food; the cover, breeding, and resting sites; and the migration corridor provided by the riparian habitat in the vicinity of the creek. Some species of birds and mammals have adapted to surrounding vineyard habitats and feed on the vine fruit; use the vines for cover, nesting, or hunting perches; and drink the irrigation water. As described in Section 3.12.5 and the special status animals table in appendix H, fifteen terrestrial animal species that are not federally listed as threatened or endangered, but are considered to be species of special concern at the federal or state level have moderate to high potential to occur in the Dry Creek area (federally listed species are discussed in Section 10.5.3 below). These species are assumed to have the same possibility to occur in subreach 4a of Dry Creek.

Construction and maintenance of the proposed action would include vehicle trips, human activity, vegetation clearing, excavation, grading, and installation of restoration features adjacent to and within Dry Creek. These activities have the potential to disturb wildlife species in and around subreach 4a. Birds in the project areas could potentially be impacted through vegetation clearing as well as noise and other human disturbance. Such impacts would be minimal on birds that generally only forage along Dry Creek (such as the merlin, osprey, and peregrine falcon) because of the large extent of foraging habitat available to them along the creek outside of subreach 4a. Avian species that may nest in the proposed action areas (such as the Allen's hummingbird, Cooper's hawk, loggerhead shrike, olive-sided flycatcher, white-tailed kite, yellow warbler, and yellow-breasted chat) have the potential to be impacted through the temporary loss of nesting habitat and through direct impacts to the nest, either by accidental damage during vegetation clearing or through noise and human activity near the nest. Similar effects could potentially occur to the pallid bat which roosts in hallow trees; although surveys of Dry Creek mile 3 by SCWA staff found no signs of roosting pallid bats in the area (SCWA, 2015).

Construction activities also have the potential to impact species of migratory birds protected under the federal Migratory Bird Treaty Act (MBTA) which makes it illegal to "…pursue, hunt, take, capture, kill, attempt to take, capture or kill, possess…at any time, or in any manner, any migratory bird…or any part, nest, or egg of such bird."

(16 U.S.C. § 703). Migratory birds foraging or resting at the site would likely experience minimal impact given their ability to leave if disturbed by activities and the large extent of similar habitat available to them along the creek outside of subreach 4a. However, migratory birds generally nest between February 1 and August 31 of each year and active nests could be encountered in the Dry Creek vicinity.

For mobile terrestrial species such as deer, rodents, raccoons who may use the riparian habitat as a movement corridor or foraging area, construction activities could restrict movement through the action areas and preclude foraging in the vicinity. However, these temporary impacts would likely be negligible given that neighboring properties would serve as alternative corridors and the Dry Creek channel outside of Subreach 4a would provide ample alternative foraging area during construction and maintenance activities. For less mobile species that may occupy the riparian corridor such as the foothill yellow-legged frog or western pond turtle construction activities could potentially pose danger of injury to individuals unable to vacate the vicinity.

In order to avoid adverse impacts from the proposed action on terrestrial wildlife in subreach 4a, a qualified biologist would conduct a pre-construction biological resources survey no more than 1-week prior to ground disturbing activities to identify special-status amphibians, reptiles, and nesting birds present within 50 feet (or nesting raptors within 300 feet) of the proposed construction areas, staging areas, and private access roads utilized. Should foothill yellow-legged frog or western pond turtle be found within the proposed action areas, individuals will be relocated by a qualified biologist to an area of appropriate habitat outside of the action areas. If active bird nests are found a no-work buffer of 50 feet shall be maintained around nests located in trees or shrubs, a buffer of 35 feet shall be maintained around nests on the ground or in non-woody vegetation (e.g. grasses), and a buffer of 250 ft. shall be maintained for nesting raptors (or as recommended by the USFWS). Any active nests would be monitored weekly during construction activities until they are no longer active. If there is any break in construction activities, re-surveys for nesting birds would be conducted if more than two weeks will have lapsed between a survey and continued construction or maintenance activities within the subreach. If active bat roosts are found an appropriate no-work buffer would also be implemented to avoid disturbing the individuals. Onsite workers would also receive an environmental awareness training by a qualified biologist to aid them in identifying sensitive biological resources and inform them of their responsibilities regarding such resources.

In addition to these avoidance measures, as required under the federal Fish and Wildlife Coordination Act (FWCA), USACE has initiated coordination with the USFWS for this study and requested a Coordination Act Report (CAR) with recommendations for the conservation of fish and wildlife, including bird species protected under the MBTA. The USACE will consider and incorporate all feasible conservation recommendations into the design and implementation of the proposed action.

As described in the terrestrial habitat section above, post-construction disturbed terrestrial areas within subreach 4a would be revegetated with native plants and trees and the quality of the riparian habitat that many of these species depend on would return and likely be improved relative to the disturbed riparian habitat currently present. Additionally, the off-channel restoration features with low water velocities, such as side channels and alcoves would serve as additional beneficial habitat for amphibians, reptiles, foraging birds and other terrestrial species. Thus, while the proposed action could have temporary, less than significant adverse effects on terrestrial wildlife, these effects would be avoided or minimized by implementing the measures described above, and many terrestrial species would receive long-term befits from restored terrestrial habitat complexity and function post-construction. Therefore, no significant adverse effects to terrestrial wildlife are expected from the proposed action (Alternative 2). The no action alternative would result in no change to existing terrestrial wildlife conditions in or around subreach 4a. Overtime, simplification of the riparian ecosystem would be expected to continue and could lead to a decline in native wildlife using and occupying the subreach.

10.5.2. Aquatic Habitat and organisms

Aquatic Habitat[17]

Existing aquatic habitat conditions within Dry Creek and specifically within subreach 4a are described in section 3.12.2. In general, land use impacts and WSD operations have, over time, led to a simplified straightened channel that is disconnected from its floodplain and lacking aquatic habitat complexity. This has reduced the amount of aquatic area with low velocity summer and winter flows for native species to rest and reduced cover for fish and wildlife. A 2009 aquatic habitat inventory by Inter-Fluve (2010) characterized the area of existing aquatic habitat units in lower Dry Creek, including: backwater/alcoves, flatwater, pools, riffles and boulder fields, side channels, and winter refuge habitats (see Figure 23 in Section

[17] Designated Essential Fish Habitat (EFH) is discussed in section 10.5.3 "Threatened and Endangered Species, Critical Habitat, and Essential Fish Habitat."

3.12.2). Table 29 (below) provides the area (ft^2) of such habitats in Subreach 4a under existing conditions and as expected under future conditions with implementation of the proposed action (alternative 2). The aquatic habitat inventory indicated that existing instream rearing and wintering habitat for salmonid species is currently limited throughout Dry Creek (including in subreach 4a) and generally of poor quality (Inter-Fluve 2010). For example, flow velocities on average are higher than those seen under unregulated, natural conditions and habitat structure/complexity is lower. Similarly the existing amount of pool habitat falls below the desired range for native species, and the existing pools largely lack sufficient cover.

While construction and maintenance activities associated with the proposed action are likely to temporarily affect existing aquatic habitat within subreach 4a, the proposed action (alternative 2) would have long-term beneficial impacts on aquatic habitat by restoring the quality and area of such habitat in subreach 4a. Potential impacts to aquatic habitat from the proposed construction and associated maintenance activities could include increases in turbidity and suspended particulates, changes in water quality parameters such as temperature and dissolved oxygen, and partial isolation/dewatering of small areas of aquatic habitat to install or connect restoration features. The potential for the proposed action to affect turbidity, temperature, and dissolved oxygen, as well as measures that will be implemented to minimize any effects on these parameters, are discussed in the water quality section (Section 10.4.3.) above. Potential effects from temporary isolation and dewatering of small areas of the channel are discussed in the hydrology section (Section 10.4.2.). All of these impacts would be short-term, minimal, and would not result in any significant adverse effects and aquatic habitat.

Table 29. Reach delineation results for Subreach 4A.

Subreach and Habitat Type	Without Project Area (ft^2)	Future - With Project Area (ft^2)
Backwater/Alcove	990	10,844
Flatwater	85,841	65,447
Pool	52,862	20,096
Riffle/Boulder Field	14,054	28,208
Side Channel	0	22,687
Winter	0	297,579
TOTAL	**153,747**	**444,861**

As illustrated in Table 29, the proposed action (Alternative 2) would result in a large increase in the area (by approximately 291,000 ft^2 or 6.68 acres) and complexity of aquatic habitat in subreach 4a, which would be long-term, beneficial effects. The proposed action would restore side channel and winter refuge habitat types that are currently absent from the subreach, and would increase backwater/alcoves and riffle/boulder fields. Existing riffle habitat in the main channel would be enhanced with appropriate gravel substrate, which is intended to also enhance the adjacent pool habitat by slowing pool velocities. Installation of erosion control brush mats and revegetation with native riparian species as part of the proposed action would benefit aquatic habitat quality by reducing chronic erosion in critical locations and providing additional shading along the channel margins. Large woody structures and boulders would also benefit aquatic habitat by increasing complexity and slowing velocities in the channel, and creating area of aquatic substrate on which macro-invertebrates can attach.

Given the temporary, minor nature of the expected effects to aquatic habitat during construction and potentially some maintenance activities as well as the proposed measures to minimize these effects (as described in the hydrology and water quality sections), the proposed action is not expected to have significant adverse effects on aquatic habitat. Moreover, the proposed action would have long-term, beneficial effects associated with the restoration of aquatic habitat area and quality in subreach 4a. While the no action alternative would present no potential to temporarily impact aquatic habitat, it also would not provide the opportunity to benefit aquatic habitat in the subreach.

Special Aquatic Sites (sanctuaries and refuges, wetlands, mud flats, vegetated shallows, coral reefs, riffle and pool complexes)

The proposed action would take place within the main channel and riparian corridor along Dry Creek in subreach 4a. Special aquatic sites associated with the proposed action areas include wetlands and riffle and pool complexes. Wetlands are transitional areas between aquatic and terrestrial habitats and include portions of riparian corridors with wetland vegetation. Wetlands have high fish and wildlife habitat values, provide habitat for unique plant and animal species, and water recharge and filtration.

Section 404 of the Clean Water Act (33 USC §1344) regulates the discharge of dredge or fill material into waters of the U.S. and within the lateral extent of wetlands adjacent to such waters. A permit from USACE is generally required prior to discharging dredged or fill material into waters of the United States, which are defined in Title 33 CFR Part 328.3(a) and include a range of wet environments such as lakes, rivers, streams (including intermittent streams), mudflats, sandflats, wetlands, sloughs, prairie potholes, wet meadows, playa lakes, or natural ponds. In 2016, The SCWA obtained a preliminary jurisdictional wetland determination for all of Dry Creek below WSD. Based on this analysis, subreach 4b contains approximately 2.1 acres of perennial stream and 12.06 acres of riparian forest wetlands.

For proposed actions to be undertaken by USACE (as is the case here), the agency does not issue itself a permit but includes a discussion of section 404 applicability and a 404(b)(1) analysis in the NEPA document prepared for the action. In this case, the purpose of the proposed action is aquatic habitat restoration and it would involve grading and placement of material in riparian forest wetlands in subreach 4a for the construction of off-channel restoration features such as side channels and alcoves, as well as placement of large woody debris, boulders, and riffle material in the dry creek mainstem. Impacts to waters of the U.S. in the proposed action areas would be temporary and the proposed action would result in a beneficial net increase in waters of the United States within the subreach. Given this, the USACE has determined that the proposed action is consistent with the Department of the Army Nationwide Permit (NWP) 27 for *Aquatic Habitat Restoration, Establishment, and Enhancement Activities* (dated February 12, 2012) and therefore further 404(b)(1) analysis is not required.

Riffle and pool complexes create a vertical sinuosity and manage energy in a channel water column, with shallow riffles providing oxygenation and variable flow velocities adjacent to deep water pool areas. These complexes are important spawning areas. The potential effects and benefits to riffle-pool complexes are described under the aquatic habitat heading above. The proposed action could temporarily affect riffle-pool complexes via altered water quality parameters or temporary isolation from channel flows during construction. However, these impacts would be short-term and minor. The proposed action would also restore riffle-pool complex habitat (approximately 14,000 ft^2) and enhance the function of existing riffles in the main channel in subreach 4a.

No substantial adverse effects to wetlands, waters of the United States, or riffle-pool complexes are expected to result from the proposed action, and the proposed action would result in beneficial effects through the restoration of these special aquatic sites. The no action alternative would not result in any change to existing special aquatic sites, but also would not have the beneficial effect of restoring these sites within the subreach.

Fish

Fish communities common to Dry Creek are described in section 3.12.3. Both native and non-native fish species have been recorded by SCWA in annual downstream migrant trapping data (SCWA 2015) and these species are listed in Table 6 (in section 3.12.3). Federally-listed fish species that have the potential to occur in Dry Creek are discussed in the "threatened and endangered species, critical habitat, and essential fish habitat" Section below (10.5.3.). One state species of special concern, the Russian River tule perch, inhabits the main stem of the Russian River and could possibly be present in lower Dry Creek (see Section 3.12.3). However only four tuel perch were caught in the SCWA downstream migrant trap between 2009 and 2014 (SCWA 2015), so this species is considered unlikely in the project area.

Activities associated with the proposed action (Alternative 2) have the potential to temporarily impact fish species during construction and possibly maintenance. Construction activities could temporarily restrict fish movements into the project site, temporarily restrict use of areas for spawning and rearing habitat, or affect individuals through changes in water quality. However, the proposed action would provide long-term benefits to fish species by restoring aquatic habitat types that would support critical functions such as spawning, rearing, and resting.

Major ground disturbing activities associated with the proposed action would occur during the months of June through October when flows in the creek are expected to be at summer low-flow levels of approximately 100 to 120 cfs. As described in Section 10.1.1, during some activities such as excavation of secondary channel or alcove connections to the mainstem and installation of some types of large wood structures in the channel, partial flow diversion would be required. Work areas would likely be isolated from flows using coffer dams and pumps may be used to remove excess water from the isolated area. While the partial flow diversion would temporarily restrict fish that are present in the subreach from moving into the isolated area, the creek flow would be allowed to continue flowing adjacent to the isolated area so fish could access the large amount of aquatic habitat along the rest of Dry Creek. Similarly, it is possible that isolating areas from flows could temporarily inhibit fish from using potential spawning or rearing habitat in the isolated area, however this would be short term and represent a very small portion of potential spawning and rearing habitat within Dry Creek.

The proposed action is not expected to require bypassing of flows to achieve complete dewatering from bank to bank, however, were this found to be necessary, fish located within the section of the channel to be completely dewatered would be removed and relocated to appropriate habitat downstream of the project site. Qualified fisheries biologists, using methods approved by the National Marine Fisheries Service would perform the fish rescue and relocation. In some instances, such as placement of instream boulders, work in the flowing stream may occur as it would be less disruptive than isolating the work area from the flowing stream. Placement of such features could temporarily startle fish nearby causing them to avoid the area. However, this effect would be extremely short-term and given the large area of additional habitat along Dry Creek that fish could move into, this effect would be negligible.

Fish may also be affected by changes in water quality parameters such as turbidity, temperature, and dissolved oxygen. Suspended sediment can cause a range of effects on fish including smothering and irritation of gills (Davies-Colley and Smith 2001). However, as described in "Water Quality" section of this EA (10.4.3), increases in suspended sediment and turbidity associated with the proposed action would be infrequent, temporary, and short in duration. Based on monitoring of turbidity during SCWA's 2014 Demonstration Project construction, these increases in suspended sediments would not alter median daily turbidity or have chronic effects on turbidity by increasing minimum daily turbidly over the long term. Additionally, no significant changes to existing temperature and dissolved oxygen concentrations are expected to occur (Section 10.4.3). No significant adverse effects to fish species from construction activities are expected. If maintenance activities require in-stream construction activities, the same potential impacts and minimization measure described above for construction would occur. Moreover, as described in the aquatic habitat section above, post-construction the proposed action would result in beneficial effects for fish as it would restore aquatic habitat area and quality in subreach 4a, including important habitat types such as riffles that support spawning and winter high-flow refuge. The no action alternative would have no effect on existing fish species but would result in a missed opportunity to not benefit such species.

10.5.3. Threatened and Endangered Species, Critical Habitat, and Essential Fish Habitat

Species listed as threatened or endangered under the federal endangered species act (ESA) are described in sections 3.12.4 (fish) and 3.12.5 (wildlife). Three listed fish species and one listed amphibian have moderate to high potential to occur in Dry Creek or the immediate vicinity.[18]

[18] The SCWA prepared lists of special-status plant and animal species known or having the potential to occur in Sonoma County (SCWA 2015). These lists were primarily derived from the California Natural Diversity Database (CNDDB); California Native Plant Society (CNPS) Electronic Inventory for special-status species occurrences; and a review of federally endangered and threatened species as identified by the USFWS. Based on review of databases and completion of field surveys, SCWA identified those having the potential to occur in the vicinity of Dry Creek and evaluated the likelihood of occurrence (see special status plant and animal tables in appendix H). Fourteen animal species and 20 plant species currently listed as federally threatened or endangered have the potential to occur in Sonoma county and of those, one species, the California Red-Legged frog (listed as threatened), has moderate potential to occur in the Dry Creek area. The remaining federally listed

California red legged frog

The California red-legged frog (RLF) inhabits quiet pools with dense vegetation in streams, marshes, and ponds. Dispersal generally requires rains and adult frogs move seasonally between their egg-laying sites and foraging habitat, sometimes occurring long distances from their aquatic habitat. When disturbed, it will dive into the water and to the bottom of pools of at least 1 m (3 feet) in depth. In Sonoma County, breeding typically occurs from January to February. The California Natural Diversity Database (CNDDB) lists thirty-eight occurrences of California red-legged frog in Sonoma County. Russian River watershed occurrences were generally located in the lower watershed and no occurrences were listed for the Dry Creek watershed. Despite this Dry Creek falls within the species distributional range (although not it's designated critical habitat) and may provide habitat that could potentially be suitable for the species.

If RLFs were to occur in Subreach 4a of Dry Creek, the potential for effects from the proposed action could be similar to those described for other amphibian species in the terrestrial wildlife section of this EA above. In order to prevent any effects to RLF, the avoidance measures described for terrestrial wildlife species including pre-construction biological resource surveys would be implemented. If any RLF individuals were found in proposed action areas, no-work buffer zones would be established and USACE would coordinate with the USFWS to determine if relocation of individuals or other avoidance measures would be appropriate before any work in the vicinity commenced. Given that RLF are not known to be present in Dry Creek, the project is not located in their designated critical habitat, and the proposed avoidance measures, no effects to RLFs are expected from the proposed action. The no action alternative would also have no effect on RLF.

Salmonids

Three federally-listed species of salmonids and their critical habitats occur in Dry Creek: endangered Central California Coast (CCC) coho (*Oncorhynchus kisutch)*, threatened CCC steelhead (*Oncorhynchus mykiss)*, and threatened California Coastal Chinook salmon (*O. tshawytscha*). The status of each of these species of salmondis and their critical habitat in Dry Creek is described in Section 3.12.4. Existing

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plants and animal species are considered unlikely to occur or to have a low potential to occur in the Dry Creek Project area for reasons such as absence of essential habitat, distance to known occurrences, and/or the species distributional range.

salmonid migration, spawning, and rearing habitat conditions in Dry Creek are also described in Section 3.12.4.

The potential for the proposed action (Alternative 2) to affect listed salmonids and their critical habitat would mirror that described for fish species and aquatic habitat in Section 10.5.2 "Aquatic Habitat and Organisms" above.

Construction of instream restoration features could potentially affect the movement of adult or juvenile coho salmon, Chinook salmon and steelhead through the immediate work area (e.g. if an area were isolated from flows using a coffer dam). Construction in or near the streambed would occur during the months of June through October during summer low-flows. Adult Chinook salmon have the potential to be present in the project area; however, the proposed construction period is in the early portion of the Chinook salmon run in Dry Creek and instream work would be complete before the peak upstream migration periods for coho salmon, Chinook salmon, and steelhead. Juvenile steelhead, coho salmon, and to a lesser degree Chinook salmon, could potentially be present within the project area during these months. However, it is expected that only partial flow diversion would be required in subreach 4a and creek flow would be allowed to continue in the channel adjacent to the isolated area so salmonids could access the large amount of aquatic habitat along the rest of Dry Creek. As stated in Section 10.5.2, if (although unlikely) complete dewatering from bank to bank were necessary, fish located within the section of the channel to be completely dewatered would be removed and relocated to appropriate habitat downstream of the project site by qualified fisheries biologists using methods approved by the appropriate resource agencies. Given that work would not occur during a critical life stage for passage for these species, would be temporary and short in duration, and the existence of additional aquatic habitat along the rest of dry creek, no significant adverse effects to listed salmonids from installation of instream restoration features are expected.

In fact, the instream and off-channel restoration features associated with the proposed action would likely assist with migration of these anadromous species during moderate to high flows by providing hydraulic and escape cover (SCWA 2015). These features would provide resting places for upstream migrating adult salmonids where no resting places currently exist, likely improving migration success within and through the proposed action area to potential spawning habitat in Dry Creek and in tributaries. Thus the proposed action would provide a benefit to upstream migrating adult coho, Chinook, and steelhead.

Only a small portion of existing potential salmonid spawning habitat within Dry Creek occurs within subreach 4a and therefore, the potential for instream construction activities associated with the proposed action to adversely affect such spawning habitat usage and quality is less than significant. Moreover, the proposed action is expected to restore potential spawning habitat (e.g. riffle habitat) in the subreach.

The June to October work window would coincide with juvenile rearing periods for coho salmon and steelhead in the areas under construction. Because Chinook salmon do not rear over the summer in the Dry Creek system, construction activities are not expected to result in any effects to juvenile Chinook salmon. However, the majority of restoration features included as part of the proposed action are off-channel and adjacent to the existing active summer flow area of the creek. Thus, the total area of existing rearing habitat that may not be available as a result of construction activities is minor compared to the existing available rearing habitat area within Dry Creek. Thus, significant adverse effects to salmonid rearing habitat are not expected from the proposed action. Instead, the one objective of the proposed action is to restore summer rearing and winter refuge habitat for juvenile coho salmon and steelhead. Restoration features such as large woody debris would provide places for juvenile coho and steelhead (to avoid predators, escape high water velocities, and find food. Although Chinook salmon juveniles spend a relatively short time (compared to coho and steelhead) rearing in freshwater before migrating to the ocean, they would likely benefit from habitat enhancement as well due to the increased shelter opportunities the habitat features would provide (SCWA 2015).

No significant adverse effects to salmonids, or their migrating, spawning, or rearing habitats are expected from the proposed action, and the action would benefit these species by restoring the quantity and quality of these habitats in the action areas (particularly winter refuge and summer rearing habitat). Thus, the proposed action (Alternative 2) is not expected to have any significant impacts on listed salmonids or their critical habitats in Dry Creek.

It should be noted that Section 7 of the federal Endangered Species Act (ESA) requires federal agencies to ensure that action they carry out do no jeopardize the existence of any listed species or adversely modify designated critical habitat of such species. As described in Sections 1.6 and 2.4.2, NOAA issued a Jeopardy Biological Opinion in 2008 that requires the USACE and SCWA to perform various actions to save threatened salmonid species on Dry Creek, including restoring six miles of Dry Creek between WSD and its confluence with the Russian River. The proposed action would help to meet the USACE and SCWA responsibility as prescribed in the Reasonable and Prudent Alternatives (RPA) of the Russian River Biological Opinion issued by NOAA, which includes restoring summer rearing and winter refuge habitat for salmonids in Dry Creek. The USACE has coordinated with NOAA NMFS in regards to the proposed action and will conduct appropriate ESA consultation with NOAA as applicable.

Essential Fish Habitat

In addition to containing ESA critical habitat for listed salmonid species, the Dry Creek watershed is designated under the Magnuson-Stevens Fishery Conservation and Management Act (MSFCMA) as Essential Fish Habitat (EFH) for salmon managed under the Pacific Coast Salmon Fishery Management Plan (salmon FMP), including Chinook and Coho. As defined in the MSFCMA, the term "essential fish habitat" means those waters and substrate necessary to fish for spawning, breeding, feeding or growth to maturity. Under the MSFCMA, federal agencies are required to consult with NOAA's National Marine Fisheries Service (NMFS) with respect to any action proposed to be authorized, funded, or undertaken, that may adversely affect EFH. The regulatory guidance that implements the EFH provisions of the MSA (50 CFR 600) defines an "adverse effect" as any impact that reduces quality and/or quantity of EFH.

As described in the "aquatic habitat" (Section 10.5.2) and the "Salmonids" section above, the proposed action would restore aquatic habitat types in subreach 4a such that they better support spawning, migration, and especially summer rearing and winter refuge for salmon. Thus, the proposed action is expected to increase salmon EFH quantity and quality in the Dry Creek watershed. The USACE will coordinate with NOAA NMFS regarding this determination and identify if any further EFH assessment is necessary for the proposed action. If an EFH assessment is prepared and results in EFH conservation recommendations from NMFS, USACE will incorporate these measures into the proposed action to the maximum extent feasible.

10.6. Human Environment

This section discusses the potential effects of the proposed action (Alternative 2) and no action alternative on components of the human environment. The human environment refers to socio-environmental resources related to individuals, communities, cultural or historic features, modes of transportation, specially designated land uses, facilities, or services, as well as to established plans, policies, and controls.

Neither the proposed action (Alternative 2) nor the no action alternative would result in any change to certain components of the human environment including: land use classification (section 3.15); public facilities, utilities, or services; energy consumption or generation; socio-economic conditions or environmental justice (section 3.14); and community or regional growth. These resources are not further discussed in this section.

10.6.1. Noise

Existing noise conditions within the Dry Creek region are described in section 3.11. Noise levels surrounding the proposed action area are varied depending on the time of day activities occurring but generally range from 42-58 airborne decibels (dBA; SCWA 2015). Ambient noise contributors include vehicle traffic; vineyard and winery operations; airplanes; residences; and nature sounds such as those from wind and wildlife. Common activities that may cause elevated noise levels in the vicinity include running diesel powered generators, trucks, farming equipment, and hunting.

The proposed action (Alternative 2) would involve noise associated with the construction and periodic maintenance of the restoration features within and adjacent to subreach 4a of Dry Creek channel and on portions of private properties adjacent to Dry Creek (e.g. roadways used to access the action area). Such activities could result in temporary increases in noise levels in these areas above ambient conditions. Construction activity noise levels at and around the proposed action areas would fluctuate depending on the particular type, number, and duration of uses of various pieces of construction equipment and the distance between the source and listener.

According to the U.S. Department of Transportation's (US DOT's) Construction Noise Handbook (US DOT 2015), airborne noise associated with common pieces of construction equipment and those that may be used for the proposed action can range from 75 to 95 dBA at 50 ft (Table 30).

Table 30 Average airborne noise levels (dBA) associated with construction equipment that may be used for the proposed action

Equipment	Average Decibels in Air (dBA) at 50 feet[1]
Backhoe	78
Forklift	75
Crane	81
Jackhammer	89
Excavator	81
Front End Loader	79
Dump truck	76
Roller	80
Vibratory Pile Driver	95

[1]from DOT (2015)

Assuming that noise from a point source attenuates at a rate of approximately 7.5 dBA per doubling of distance due to absorption of noise waves by soft ground surfaces (e.g., dirt, grass, scattered vegetation) and intervening features and structures, the loudest construction sounds (from vibratory pile driving) would attenuate to 80 dBA at 150 ft from the source activity and 65 dBA at 200 ft from the source activity.

Generally, noise levels of 80 decibels (dBA) or above produce the following human responses: 80 to 90 dBA (annoying), 90 to 110 dBA (very loud), 110 to 120 dBA (extremely loud), 130 to 140 dBA (painfully loud) (Science Applications International Corporation, 2007). There are two sensitive noise receptors (buildings) within the vicinity of subreach 4a and they are located approximately 350 feet west and 450 feet east of the dry creek mainstem. At these distances, sounds from the highest noise-generating piece of equipment (the vibratory pile driver) at the closest buildings would be expected to measure below levels generally annoying to individuals (below 80 dBA) and below the Federal Transit Authority's significance criteria of 90 dBA for impacts to residences in the daytime.

While construction related noise levels at nearby residences would be below levels generally annoying to individuals, they would likely be 10 dBA or more above ambient noise levels in the region, and thus could be perceived as a nuisance. To minimize any potential effects from construction-related noise, equipment will located as far away from residences as possible and construction activities will be limited to between the hours of 7a.m. to 7 p.m. (except as noted in the following paragraph). Moreover, equipment employed during construction will utilize the best available noise control techniques whenever feasible (e.g., equipment redesign, use of intake silencers, ducts, engine enclosures and acoustically attenuating shields or shrouds).

While construction activities would be largely constrained to the hours of 7a.m. to 7 p.m., pumps associated with stream diversions around work areas could in some instances (although unlikely) run on a 24-hour basis. If such 24-hour pumping were necessary, the residences adjacent to subreach 4a could be exposed to increased ambient nighttime noise levels. However, the surrounding land uses are agricultural and existing noise-generating agricultural activities do occur at various hours over a 24-hour period depending upon needs (e.g. harvest, frost protection activities). The potential nighttime construction activities would be temporary and short-term, and would not represent a significant new source of noise in the project area. Moreover, if nighttime construction activities were required as a part of the proposed action, residents would be given advanced notice.

Construction-related material haul trips would raise ambient noise levels along haul routes, depending on the number of haul trips made and types of vehicles used. Noise levels that would occur along the vehicle routes associated with a passing vehicle would range from a high 60-dBA to high 80-dBA range, depending on the type of vehicle and distance to the listener. In order to minimize noise impacts from construction vehicles, they would employ available noise control techniques whenever feasible (e.g., improved mufflers). Given the limited amount of vehicles that would be associated with construction and maintenance of the proposed action, the limited amount of days per year that trips would occur, and that the dBA range would be below 90 dBA in the daytime, noise levels associated with off-site vehicle trips would be negligible and would result in a less than significant impact.

Operation of the project would resemble the natural functioning of Dry Creek and would not result in any noise-related impacts. While maintenance activities would primarily consist of vegetation management, they could infrequently include activities such as repairing or adjusting structures using heavy equipment. Given this, maintenance noise levels could intermittently and temporarily rise to levels generated during construction, but for a shorter duration. The avoidance and minimization measures described above for construction related noise would be applied for maintenance noise as well. Given the infrequent and temporary nature of maintenance activities and the proposed minimization measures, this impact would be insignificant.

Overall construction, operation, and maintenance for the proposed action (Alternative 2) is not expected to result in significant adverse noise impacts in the vicinity of the proposed action areas. The no action alternative would involve no change in existing ambient noise conditions in the region.

10.6.2. Traffic/Transportation Patterns

The major transportation artery in the Dry Creek region of Sonoma County is U.S. Highway 101, which located approximately half a mile from the mainstem of Dry Creek within subreach 4a. The majority of other roads in the vicinity of subreach 4a are minor rural collectors and rural roads. The proposed action areas will be accessed from Kinley Dr. to the east, possibly West Dry Creek Road to the west, and private paved roads off of these public arterials under temporary easements. With the exception of U.S. Highway 101, public roadways in the vicinity of Dry Creek consist of relatively narrow, winding two-lane roads and traffic along these corridors is generally related to agricultural, recreational, tourist activities. Private roadways in the vicinity of subreach 4a are used by property owners and their associates to access agricultural fields and buildings or residences onsite. Peak traffic volumes on roads in the region during the week are associated with commute traffic and fall between 7:00 and 9:00 A.M. and 4:00 and 6:00 P.M. Weekend traffic volumes in the region are very high due to recreational and tourist traffic. Traffic in the Dry Creek region also includes frequent large vehicles supporting agricultural operations.

In addition to automobiles, the Dry Creek region is a popular destination for bicyclists. Portions of West Dry Creek Road have a striped right-of-way designated for use by bicyclists. Pedestrian activity in the Dry Creek Valley in general and in the vicinity of the proposed action is minimal given long distances between amenities and lack of pedestrian infrastructure (roadway shoulders are the primary pedestrian infrastructure).

The proposed action (Alternative 2) would result in increased light and heavy duty truck traffic associated with transport of crews, contractors, equipment, materials, construction vehicles, and haul trucks on roadways used to access the project staging and construction action areas, Because the SCWA's Dry Creek Demonstration Project (mile 1)consists of activitiessimilar to those associated with the proposed action and was similar in size to the proposed restoration of Subreach 4a, it provides a good conservative indication of the level of increased vehicle trips that could be expected under the proposed action. The Demonstration Project, required an average of 45 vehicle trips per day over the period of construction (SCWA 2015). For comparison purposes, Dry Creek Road at Kinley Drive experiences 5,315 vehicle trips during a 24-hour period on a typical weekday (Sonoma County Public Works, as cited in SCWA 2015). The vast majority of the proposed construction will take place Monday through Friday from 7a.m. to 7p.m. (with possible infrequent work on weekends) and thus increases in traffic associated with the proposed action would be experienced primarily on weekdays.

Given that Dry Creek Valley does not experience traffic congestion on a typical weekday and the existing level of vehicle trips on nearby roadways, a temporary addition of up to 45 vehicle trips per day during construction would not cause a significant change in congestion on public roadways in the vicinity of subreach 4a. Maintenance-related traffic would be periodic and minimal compared to construction related traffic. It would similarly result in insignificant increases in traffic volumes on roadways in the project area. Operation of the project would result in no additional traffic in the vicinity.

In order to avoid any adverse effects from the vehicle traffic that would be associated with the proposed action, the selected construction contractor would be required to prepare a Traffic Control Plan to ensure safe and efficient traffic movement throughout the region. The Traffic Control Plan would identify access routes as well as alternative emergency routes, where necessary, to avoid areas most affected by construction-related traffic. The contractor would also be required to provide signage where appropriate to alert motorists, cyclists, and pedestrians of potential delays and alternative routes. Flagging for construction vehicles would be used if necessary to temporarily control traffic on roadways and protect public safety. Given these measures, the proposed action would not be expected to impact motorist, bicycle, or pedestrian safety.

Furthermore, transportation associated with the proposed action would not permanently degrade, damage, or wear down roadways used to access the proposed action areas. Public roadways in the project region are designed to accommodate the routine traffic of heavy vehicles associated with the operation of large vineyards in the area and thus the minimal increase in construction-related traffic would not be expected to affect such roadways. Private roads utilized for access to the construction site would be inspected for damage and restored to their original condition following completion of the proposed activities within subreach 4a.

Based on the minimal increase in weekday vehicle trips expected from the proposed action in relation to existing traffic levels in the vicinity of Subreach 4a and the measures proposed to provide traffic safety and protection of roadway conditions, the proposed action would have a less than significant effect on transportation and traffic. The no action alternative would induce any change in existing traffic patterns or transportation conditions in the region.

10.6.3. Aesthetics

The existing aesthetics of the Dry Creek region are described in Section 3.17. As stated in this section the Dry Creek Valley is part of a landscape aesthetic unit designated by the Sonoma County General Plan certain nearby roadways are considered scenic.

The proposed action may temporarily impact the aesthetic environment in and around Subreach 4a of Dry Creek, due to presence of construction equipment and the appearance of the restored subreach immediately post construction, but significant adverse impacts to aesthetics are not expected. Much of the construction and maintenance-related activity, such as the operation of heavy-duty equipment and hauling of materials, would be confined to the active high flow area of Dry Creek or areas directly adjacent to the creek, Staging of construction equipment and materials would take place in an abandoned vineyard to the east of the project site which would be cleared of existing vegetation. Heavy-duty and worker vehicles would primarily use major valley thoroughfares (Highway 101), West Dry Creek road, Kineley Drive, and paved private roadways to transport equipment and materials (see the "transportation" Section (10.6.2) of this EA).

Visibility of construction and maintenance activities would be primarily limited to the properties and two sets of buildings directly adjacent subreach 4a and may be visible from nearby roadways. These properties are aware of and in some cases are voluntarily participating in the proposed project (such as by allowing staging of equipment on their land). Moreover, the often dense and tall riparian vegetation along the active high-flow areas of Dry Creek provides a visual barrier between these areas and the properties. Although some vegetation would be cleared and grubbed during the proposed action, the remaining vegetation would help shield construction activities from visibility. Additionally, farming operations involving heavy machinery and large trucks are a common site in the Dry Creek Valley. Therefore, from afar, construction and maintenance activities would not appear to be particularly unique.

Immediately following construction portions of subreach 4a would include temporarily exposed soils, logs, rocks, and other natural materials that could be visible to residents at directly adjacent properties. However, areas with exposed soil would be replanted with native vegetation after construction or major maintenance activities are completed. Revegetation would help constructed features blend in with the surrounding natural features. After vegetation has established, the appearance of the site is not expected to be visually distinct from other portions of Dry Creek. Additionally, high winter flows will deposit natural material from upstream into subreach 4a, further blending constructed features with existing creek features.

Given that any aesthetic impacts from construction and maintenance activities would be temporary; landowners are aware of and largely support the proposed restoration; construction equipment would be similar to agricultural machinery used in the vicinity; and post-construction revegetation would help restore the natural visual appearance of subreach 4a; any potential aesthetic impact from the proposed action (Alternative 2) would be less than significant. Under the no action alternative, no change to existing aesthetics in subreach 4a would occur.

10.6.4. Recreation

Existing recreation along Dry Creek is described in Section 3.16 and is minimal given that there is no public access to Dry Creek and thus few recreational opportunities along the creek itself. While the creek is generally unavailable to public access, private ownership of the land along the creek does provide for some limited access and recreation, mainly by private entities. As described in Section 3.16, private landowners may picnic, swim, raft, kayak, and walk along or in Dry Creek at some locations and three wineries along the creek appear to provide access for their guests to wine taste and picnic while viewing the stream. Despite private access to the creek, recreational boating (kayaking, canoeing, rafting) and swimming remain uncommon due to difficult navigational and environmental conditions. Fishing in Dry Creek is prohibited.

The proposed action does not include any recreation features and would not significantly impact any existing recreation within the proposed action areas or in the Dry Creek vicinity. None of the wineries that allow public access to the creek are in the immediate vicinity of subreach 4a and the proposed action areas. Given the difficult navigational and environmental conditions as well as the limited residences near the subreach, recreational boating and swimming in this subreach is likely to be extremely limited, if it occurs at all. Any impacts to recreational activities by private landowners in the action areas (such as picnicking or walking along the bank) would primarily arise from construction activities and their associated noise and aesthetic effects. These impacts would be temporary and such recreational activities would presumably resume post-construction. Some of the main roads likely to be used by construction vehicle traffic are also commonly used by recreational bicyclists, however, as discussed in the "Transportation" section of this EA, no significant impacts to recreational bicycling are anticipated from the proposed action.

Given the limited levels of recreation that occur along Dry Creek and the temporary, short-term nature of any impacts that construction activities associated with the proposed action would have on private recreation occurring in subreach 4a or the Dry Creek vicinity, the proposed action would not significantly impact recreation.

The no action alternative would not involve no change to existing levels and types of recreation within or around Dry Creek.

10.6.5. Navigation

As noted in the “recreation” section (Section 10.6.4)of this EA, there is no public access to Dry Creek and despite private access to the creek, recreational boating (kayaking, canoeing, rafting) remains uncommon due to difficult navigational conditions. Potential effects on recreational boating are discussed in the “recreation” section of this EA. The waters of Dry Creek are not navigable for larger vessels. Neither the proposed action nor the no action alternative are expected to affect navigation.

10.6.6. Prime and Unique Farmland

Farmland, including prime and unique farmland, in the Dry Creek area is discussed in Section 3.15. The proposed action (Alternative 2) would not result in the conversion of any farmlands to other uses. The California Department of Conservation designates nearly the entire Dry Creek Valley as Prime Farmland with some areas designated as Farmland of Statewide Importance and Unique Farmland. The proposed action would include the construction of off-channel restoration features and minor maintenance within the active flow area of the Dry Creek channel in subreach 4a. Such areas are not currently under agricultural production. While the proposed construction areas are within the channel, staging for the proposed action would occur on an abandoned vineyard in the vicinity of subreach 4a. This property is farmland, however it has been offered by the property owner for staging purposes in exchange for clearing of the abandoned vines onsite. This area would be temporarily affected during construction but given its abandoned nature, any impacts would be minimal and it could be returned to agricultural use post-construction. Other vineyards and agricultural lands in the vicinity of the proposed construction, staging, and vehicle travel routes have the potential to be affected by dust or runoff from construction activities and the movement of equipment. However, these impacts would be temporary and given the implementation of dust and runoff control measures (discussed in the Air and Water Quality sections of this EA) and effect would be negligible. Moreover, because the proposed action would help to minimize future erosion in the subreach, the banks of the channel would be more stable and would help protect adjacent vineyard and agricultural lands from future erosional losses or damage. No significant adverse effects to prime or unique farmland are expected from the proposed action. The no action alternative would result in no change to existing designated farmlands or farmland conditions.

10.6.7. Parks, National and Historic Monuments, National Seashores, Wild and Scenic Rivers, Wilderness Areas, Research Sites, Etc.

The proposed action areas do not fall within any parks, national or historic monuments, or wilderness areas and Dry Creek is not designated as a wild and scenic river. No know research sites occur with subreach 4a. Neither the proposed action nor the no action alternative would adversely affect any of these types of sites.

10.6.8. Cultural Resources and Archaeological sites

The cultural history and existing cultural, historic, and archaeological resources in the vicinity of Dry Creek are discussed in Section 3.13. Dry Creek falls within the Dry Creek-Warm Springs Archaeological District and the region is the ancestral home of Pomo Native American tribelets. As described in Section 3.13 a cultural resources records search revealed privately owned historical buildings (some meeting the National Register criteria) located in Dry Creek Valley; a historical one-story rancho adobe dwelling along Dry Creek Road; and one bridge (Lambert Bridge) eligible for listing in the National Register of Historic Places. The Quaternary Alluvium soils of the Dry Creek Valley floor were deposited too recently to contain fossils and a search of the University of California Museum of Paleontology collections database found no discovered paleontological resources in the Dry Creek Valley.

The proposed restoration of subreach 4a (Alternative 2) is not expected to have any impacts on cultural, historic, or archeological resources. Known cultural resources such as the privately owned historical buildings, the adobe dwelling along Dry Creek Road, and Lambert Bridge are not within the proposed action areas or their immediate vicinity. These resources would not be affected by the proposed action. There are no known archeological sites within the proposed action areas. Though very unlikely, it is possible that the Dry Creek riparian corridor in Subreach 4a could contain unknown archaeological resources currently obscured from view. If archaeological remains are uncovered, work at the place of discovery would be halted immediately until a qualified archaeologist can evaluate the finds. If human remains are encountered, excavation or disturbance of the location would be halted and the county coroner and potentially the Native American Heritage Commission (if the remains were determined to be of Native American ancestry) would be contacted. Any discoveries would be properly evaluated, documented, and removed if applicable, prior to work in the vicinity taking place. Given the lack of any known cultural resources and archeological sites with the proposed action areas, and the proposed measures to avoid affects to any unknown resources discovered during the proposed action, no adverse effects to cultural, historic, or archeological resources are expected from the proposed action. The no action alternative would also have no effect on such resources.

Section 106 of the National Historic Preservation Act of 1966 (NHPA) requires Federal agencies to take into account the effects of their undertakings on cultural and historic resources, and afford the Advisory Council on Historic Preservation a reasonable opportunity to comment. In seeking to issue an ESA Enhancement of Survival Permit to the SCWA for the larger Dry Creek Habitat Enhancement Miles 2-6 project (which encompasses the proposed subreach 4a action areas along mile 3), the National Marine Fisheries Service (NMFS) initiated consultation with the State Historic Preservation Officer (SHPO) for habitat restoration activities on Dry Creek in 2015. The NMFS consultation included an area of potential effects (APE) covering nine portions of the Dry Creek channel comprising a total of approximately six miles between Warm Springs Dam and the Russian River as well as access and staging areas. This APE included the proposed action areas in and around subreach 4a and the analysis covered the types of restoration actions proposed under alternative 2 (construction of side-channels, pools, riffles, grading, clearing and revegetation, installing large wood structures and boulders, and erosion control).

In accordance with regulations implementing Section 106 of the NHPA, as amended, NMFS provided a consultation letter to the SHPO on December 24, 2015 documenting the type of proposed work, the APE, and a determination that the undertaking would not affect historic resources in the APE. On February 11, 2016, the SHPO responded and concurred with the described APE and determined that because the Dry Creek-Warm Springs Archaeological District is present within the APE, the proposed actions would affect but cause no adverse effect to historic resources in the APE (Appendix I)..

Because the NMFS consultation describes the APE and activities associated with the proposed action (Alternative 2), USACE has determined that the NMFS consultation encompasses the Proposed Action. The USACE concurs with the determinations made by NMFS and subsequently by the SHPO, thus USACE will seek to adopt this consultation as compliance under Section 106 of the NHPA. USACE has contacted the SHPO to identify how to proceed with adopting the consultation completed by NMFS, and will continue coordinating with SHPO as applicable. USACE would conduct additional consultation if the proposed action were to change significantly or an inadvertent discovery were made onsight. Additionally, the SHPO and Advisory Council on Historic Preservation will be notified of this DPR/EA and provided the opportunity to comment.

Consultation with Native American Tribes

During consultation on the SCWA's Dry Creek Habitat Enhancement Miles 2-6 project (which encompasses the proposed action), the Corps contacted the California Native American Heritage Commission (NAHC) for comment on the proposed enhancement actions. The Dry Creek, Stewarts Point, and Lytton tribes commented on the proposed habitat enhancement actions and the Dry Creek Rancheria was identified as the tribe with closest ancestral ties to this part of the Dry Creek Valley. The USACE and the SCWA jointly consulted with the Rancheria and have agreed to retain a tribal consultant who will be onsite to monitor the construction work to identify and protect cultural resources that may be unearthed. The Corps will continue to consult with the interested tribes throughout implementation of the proposed action (Alternative 2) to provide relevant information to them and to coordinate the tribal-monitoring opportunities. As noted above, if (although unexpected) remains are discovered onsite and determined to be of Native American Ancestry, the NAHC would be contacted to identify the person or persons believed to be most likely descended from the deceased Native American. That descendent would make recommendations regarding the treatment of the remains with appropriate dignity.

Given the implementation of these measures, no adverse impacts to Native American tribes are anticipated from the proposed action. No effects to Native American tribes would result from the no action alternative.

10.6.9. Public Health and Safety

The proposed action would take place primarily in the Dry Creek riparian corridor in Subreach 4a with staging at an abandoned vineyard on adjacent private lands. There is no designated public access to dry creek and very limited recreational use of the creek by private landowners bordering the channel so there is very minimal potential for the individuals of the public to be in the immediate vicinity of construction or maintenance activities associated with the proposed action. Even with the minimal potential for the public to be in the vicinity of construction activities, areas being used for staging during the Proposed Action would be fenced-off to protect public safety around construction equipment. Additionally, signs would be placed warning the public of the active construction site. The construction contractor would also be required to prepare a construction safety plan to protect the safety of onsite workers during construction activities. Measures to prevent adverse impacts to public safety on roadways used to access the site are discussed in the Transportation Section of this EA. As discussed in the Flood Control Function Section of this EA, the proposed action would not result in any changes to flood control functions and so no additional risk to public safety from flooding would occur.

Given the minimal potential for individuals to be in the proposed action areas and the proposed safety measures, no effects on public health and safety are expected from the proposed action. The no action alternative would involve no construction activities and no changes to existing conditions onsite, and thus have no effect on public health or safety.

10.6.10. Hazardous, Toxic, and Radioactive Wastes

Section 3.18 describes existing hazardous, toxic, and radioactive waste conditions in the vicinity of Dry Creek. The Kennedy/Jenks (2010) records search identified three locations with recognized environmental conditions (as defined in Section 3.18) falling within 1000 feet of Dry Creek between river miles 4.1 and 3.0 (Table 10), which would be in the vicinity of the proposed subreach 4a action areas. These included a winery with waste discharge permits on-file with the RWQCB, a private residence with a construction stormwater NPDES permit, and release of solution with less than 10% organic residues by a mobile mechanic company. A records search in 2015 by SCWA, could no longer find these three recognized environmental conditions in current data sources (Table 10) and found no new recognized environmental conditions between river miles 4.1 and 3.0 (SCWA 2015). Active remediation is no longer occurring at the mobile mechanic release site and no sites with ongoing stormwater management activities or permitted fuel tanks are expected to be impacted by the proposed action (Alternative 2).

Construction activities anywhere within Dry Creek, including within subreach 4a, have the potential to encounter historic erosion control debris placed along the channel banks (e.g. car bodies, concrete debris, rusted metal, car tires, and other materials as described in Section 3.18). Based on the condition, environment, and location, any hazardous materials associated with such historic debris are not likely to present a significant risk of release beyond what has existed since the materials were placed. Materials encountered during the proposed action would become the property of the contractor. It would be the responsibility of the contractor to identify an appropriate landfill or other waste receiving agency for such debris if it can't be reused or recycled. The debris would thus be removed from the system, which would benefit the environment.

During construction and maintenance activities associated with the proposed action, passenger vehicles, light trucks and construction equipment that use hazardous materials (i.e. gasoline, motor oil) would be used in the project areas and would travel along local roadways, creating a potential for accidental spills of oil or fuel. Accidental release of any such hazardous materials would not create a significant hazard to the public or environment because the project is located in a sparsely populated area and the quantity and toxicity of materials that could be released would be low, As discussed in the water quality section of this EA (Section 10.4.3), spill response equipment would be stored onsite for immediate implementation to minimize the impacts of any accidental spills. Additionally, best management practices would be employed to prevent any hazardous material release from occurring, including having the construction contractor prepare a safety plan that addresses hazardous materials; ensuring training of construction personnel in proper equipment and material handling, clean up, and disposal; regularly checking equipment for proper functioning and absence of any fluid leaks; and containing/disposing of all hazardous materials (e.g. oil and gasoline) in compliance with hazardous material waste disposal laws. Although unlikely, if any unknown materials thought to be potentially hazardous were encountered during the proposed action, construction or maintenance activities in the vicinity would stop and an appropriate abatement plan would be developed.

Given the lack of current recognized environmental conditions in the vicinity of subreach 4a, the fact that any historic erosion control debris found onsite during the proposed action would be removed, and the avoidance and minimization measures that would be implemented, the proposed action would not have significant effects related to hazardous, toxic, or radioactive wastes.

10.6.11. Conflict with other use plans, policies, or controls

The proposed restoration of Subreach 4a of Dry Creek (Alternative 2) is not expected to be in conflict with any other plans, policies, or controls in the Dry Creek region or Sonoma County. Construction and maintenance activities would abide by applicable local policies such as construction or noise ordinances and would be conducted in compliance with applicable Federal, state, and local laws. The proposed restoration appears to be consistent with the *Sonoma County General Plan 2020* goals, objectives, and policies as it will be beneficial to sensitive natural communities identified within the plan. Moreover, it would not conflict with any habitat conservation, natural community conservation, or any other conservation plans within Dry Creek region and would specifically support objectives of NMFS *Recovery Plan for the Evolutionary Significant Unit of Central California Coast Coho Salmon* (SCWA 2015). Additionally, the proposed action would help to meet the USACE and SCWA responsibility for enhancement of six miles of Dry Creek between WSD and its confluence with the Russian River as prescribed in the Reasonable and

Prudent Alternatives in the September 24, 2008 Russian River Biological Opinion issued by NOAA.

Because the proposed action would not conflict with other plans, policies, or controls in the region, no adverse impacts related to such plans, policies, or controls would occur. Under the no action alternative, it is assumed that the enhancement of six miles of Dry Creek required under the Russian River Biological Opinion would be achieved at other sites along Dry Creek and there would be no conflict with any plans, policies, or controls.

10.6.12. Irreversible Changes, Irretrievable commitment of Resources

The proposed action (Alternative 2) would result in some irretrievable commitment of resources, but the commitment would be minimal and insignificant. The types of resources generally considered irretrievable when committed include resources like fossil fuels, minerals, or timber. The use of fossil fuels to operate vehicles and equipment associated with construction and maintenance of the proposed action would constitute an irretrievable commitment of resources, but would be limited and minor. The proposed action does include the installation of large wood features within the mainstem and side-channels within Subreach 4a. While logs to be cleared from the site will be used for these purposes when possible, the installation of large wood features will also require importing large logs which would be an irretrievable commitment of timber resources. For example, the SCWA's Demonstration Project (Mile 1) required approximately 1,500 large logs for restoration feature construction. Assuming the proposed action would need the same quantity of logs, and an average length and diameter of 30 ft by 20 inches per log (SCWA 2015), this equates to approximately 720,000 board-feet of timber or approximately 0.005% of the 2014 Sonoma County timber harvest (SCWA 2015). Given the minor quantity of timber this represents compared to timber consumption in the region, the proposed action would not represent a significant irretrievable commitment of timber resources. Under the no action alternative there could be a small irretrievable commitment of fossil fuel resources for maintainence activities on the existing USACE sill in subreach 4a, but no other irretirvable commitment of resources would be expected.

The proposed action would result in restoration of the quality and quantity of riparian and aquatic habitat in subreach 4a. While this would be largely irreversible (although overtime the subreach would continue to evolve through natural processes), the effect would be beneficial for riparian and aquatic species including threatened and endangered salmonids. Under the no action alternative, without the proposed and other restoration efforts to support salmonids, it is likely the region would see a continued decline or possibly even extirpation of these species, which would be an irreversible change.

10.7. Cumulative Impacts

Cumulative impacts include those impacts on the environment which result from the incremental impact of an action when added to other past, present, and reasonably foreseeable future actions.

10.7.1. Occurred on-site historically

Section 3.7.1 describes the history of development in the vicinity of Dry Creek since 1850 and Section 1.6.1 describes the more contemporary installation of Warm Springs Dam and existing bank stabilization structures on Dry Creek and within subreach 4a. A number of habitat restoration and improvement projects have been undertaken in the region as well (as described in section 1.6), including prior restoration projects by SCWA and USACE along Dry Creek below WSD.

10.7.2. Likely to occur within the foreseeable future

Related projects that are currently planned and likely to occur in the region in the foreseeable future include continued restoration and habitat enhancement at other sites along Dry Creek to complete the six-miles prescribed as part of the Russian River Biological Opinion RPA; installation of up to 10 megawatts of solar photovoltaic power on USACE property adjacent to WSD, approximately 9 miles from the subreach 4a site; and the construction of the Hale Winery and Tasting Room along Dry Creek road, approximately 3.5 miles from the subreach 4a site.

10.7.3. Contextual relationship between the proposed action and actions that have or will occur on-site

As described in Section 2.1 (Problems and Opportunities), the historic development actions in and around Dry Creek since the 1850s have greatly reduced the extent of the floodplain, altered the natural hydrology of the creek, simplified and straightened the channel, and degraded the riparian and stream habitat quality. These effects have depressed populations or native species in the region including threatened and endangered salmonid species. These developments have also resulted in the existing human environmental conditions in the region including the existing land uses, aesthetics and noise conditions, recreational opportunities, agriculture, transportation networks, facilities, utilities, services, and socio economic conditions.

As described in this environmental assessment, the proposed action (Alternative 2) would result in less than significant, temporary impacts from construction and maintenance activities on hydrology, water quality, air quality, terrestrial habitats and wildlife, noise levels, transportation, aesthetics and recreation. It would also result in minor irretrievable commitment of timber and fossil fuel resources. However, it would restore aquatic wetlands and higher-quality riparian habitat, both of which would provide long-term benefits to native fish and wildlife species, especially salmonids.

Additional restoration at other sites along Dry Creek would be expected to involve similar features and have similar types of temporary impacts and long term benefits to the proposed action, but scaled to a greater or lesser degree depending on the project size. The installation of solar photovoltaic power on USACE property adjacent to WSD would likely have temporary impacts from construction on aesthetics, transportation, air quality, noise levels, recreation, and terrestrial habitats and species, but would have long term benefits for energy generation and air quality/climate change in the region once operational. The construction of Hale Winery and Tasting Room along Dry Creek road would include temporary construction impacts on a aesthetics, transportation, air quality, noise levels, and terrestrial habitats and species, and would also be expected to result in minor increases in traffic, recreation, and demand for public utilities and services once operational.

In light of historical actions in the region and the future expected projects currently foreseeable, the proposed action would not result in significant, adverse cumulative impacts in the region. It is unclear when the future expected projects will commence but it is possible that they could be under construction at the same time as the proposed action. Given the distance between the solar and winery projects and the proposed action, any cumulative effects from simultaneous construction activities would be less than significant. Simultaneous restoration projects along Dry creek would be expected to largely adhere to the same minimization measures described for the proposed action and thus, while closer in proximity, any cumulative construction effects would still be expected to be less than significant. With the historical degradation of the Dry creek channel from development in the region, the long-term restoration benefits of the proposed action and any future restoration actions along the creek would be beneficial cumulative effects.

10.8. DETERMINATION AND SUMMARY OF EFFECTS FROM THE PROPOSED ACTION

The proposed action (alternative 2) would take place in subreach 4a of Dry Creek and involve vegetation removal; excavation and grading; installation of restoration enhancements including side-channels, alcoves, large wood features, riffles, pool restoration, and bolder cluster; then revegetation post construction. The proposed action would have long-term, beneficial effects as well as some temporary, minor adverse impacts on environmental resources in the action areas and regional vicinity. Direct, long-term beneficial effects would include the restoration of aquatic habitat and high-quality riparian habitat for use by fish and wildlife in the Dry Creek Watershed, especially listed salmonid species.

The potential temporary adverse effects during construction and infrequent maintenance of the proposed action would include runoff, elevated suspended particulates and turbidity, air pollutant emissions, vegetation clearing, disturbing riparian and aquatic habitats, bothering or displacing aquatic and terrestrial wildlife, increased noise levels, traffic, and modifying aesthetic views. However, the described avoidance, minimization, and best management practices would be implemented during construction and maintenance to prevent any significant effects. Disturbed areas would be re-vegetated after construction with native vegetation and no acres currently listed as wetlands would be converted to non-wetland. Temporary impacts would cease with the completion of construction, and any impacts from maintenance would be infrequent. No significant adverse effects to special status species or habitats would occur. No adverse cumulative impacts are expected.

As such, no significant impacts are anticipated from the proposed action (alternative 2).   A Finding of No Significant Impact (FONSI) is anticipated (33 CFR Part 325). The determination of whether to prepare the FONSI will be made after agency and public comments are incorporated into this EA and environmental compliance has been completed. A Draft FONSI is included as Appendix G.

10.9. COMPLIANCE WITH ENVIRONMENTAL LAWS AND REGULATIONS

The USACE will ensure that the proposed action complies with applicable federal laws, regulations, and executive orders. Major environmental compliance regulations and status of compliance are summarized in Table 31 below. The SCWA is responsible for addressing State requirements including compliance with the California Environmental Quality Act.

Table 31. Summary of Environmental Compliance

Statute	Status of Compliance
National Environmental Policy Act (NEPA) of 1969 (42 USC 4321 *et seq*) Council on Environmental Quality (CEQ) Regulations for Implementing the Procedural Provisions of the NEPA (40 CFR 1500-1508) dated July 1986	This EA has been prepared in compliance with NEPA, CEQ, and USACE Planning regulations. All agency and public comments will be considered and evaluated. If appropriate, a Finding of No Significant Impact (FONSI) will be signed with a conclusion of no significant impacts from this proposed action. A Draft FONSI is provided in Appendix G.
Clean Air Act, as amended (42 USC 7401 *et seq*)	The proposed action would take place in the Northern Sonoma County Air Pollution Control District portion of the North Coast Air Basin which is considered in attainment or unclassified (i.e. in compliance) for all state and federal AAQS. An air quality applicability analysis is not required under the CAA for projects in attainment areas. Air emissions from the proposed action would be temporary and minimal.
Clean Water Act, as amended (33 USC 1251 *et seq*)	Pursuant to section 401 of the Clean Water Act (CWA), the proposed action will require a 401Certification from the North Coast Regional Water Quality Control Board (RWQCB) to ensure the project meets State water quality standards. The USACE has coordinated with the RWQCB and is in the process of preparing a 401 application for the proposed action. Section 404 of the Clean Water Act (33 USC §1344) regulates the discharge of dredge or fill material into waters of the U.S. and within the lateral extent of wetlands adjacent to such waters. Pursuant to section 404, USACE has determined that the proposed action is consistent with the Department of the Army Nationwide Permit (NWP) 27 for *Aquatic Habitat Restoration, Establishment, and Enhancement Activities* (dated February 12, 2012) and therefore further 404(b)(1) analysis is not required.
Rivers and Harbors Act of 1899 (33 USC 403)	See above. This project would be covered under NWP 27 and therefore be in compliance with Section 10 of the Rivers and Harbors Act.
Executive Order 11990, Protection of Wetlands, (42 FR 26961, 1977)	Under this Executive Order, Federal agencies shall take action to minimize the destruction, loss or degradation of wetlands, and to preserve and enhance the natural and beneficial values of wetlands. The proposed action would result in the restoration and enhancement of wetlands.
National Oceanic and Atmospheric Administration Federal Consistency Regulation (15 CFR 930) Coastal Zone Management Act of 1972 (16 USC 1451 *et seq*) California Coastal Act of 1976	The proposed action would not occur in or near coastal waters. These statues are not applicable.
Endangered Species Act as amended (16 USC 1531 *et seq*)	NOAA National Marine Fisheries Service (NMFS) issued a Jeopardy Biological Opinion in 2008 that requires the USACE and SCWA to perform various actions to

	save threatened salmonid species on Dry Creek, including restoring six miles of Dry Creek between WSD and its confluence with the Russian River. The proposed action would help to meet the USACE and SCWA responsibility as prescribed in the Reasonable and Prudent Alternatives (RPA) of the Russian River Biological Opinion issued by NMFS. The USACE has coordinated with NMFS and will conduct appropriate ESA consultation as applicable.
Fish and Wildlife Coordination Act (16 USC 661*et seq*)	USACE has initiated coordination with the USFWS and requested a Coordination Act Report for the proposed action with recommendations for the conservation of fish and wildlife. The USFWS, NMFS, and CDFW will be provided the opportunity to review and comment on this EA.
Magnuson-Stevens Fishery Conservation and Management Act - Fishery Conservation Amendments of 1996, (16 USC 1801 *et seq*) – Essential Fish Habitat (EFH)	The proposed action area includes EFH for salmonids managed under the Pacific Salmonid Fishery Management Plan, including Coho and Chinook Salmonids. The proposed action is expected to increase salmon EFH quantity and quality in the Dry Creek watershed. The USACE will coordinate with NOAA NMFS regarding this determination and identify if any further EFH assessment is necessary for the proposed action. If an EFH assessment is prepared and results in EFH conservation recommendations from NMFS, USACE will incorporate these measures into the proposed action to the maximum extent feasible.
Migratory Bird Treaty Act (16 USC 703-711)	Based on the avoidance measures proposed in this EA, no impacts to migratory birds are expected from the proposed action. USACE will coordinate with the USFWS through the Fish and Wildlife Coordination Act to ensure appropriate measures are undertaken to avoid impacts to MBTA species.
Marine Mammal Protection Act (16 USC 1361 *et seq)*	No marine mammals occur in or around the proposed action areas. Not applicable.
National Marine Sanctuaries Act (16 USC 1431 *et seq*) Marine Protection Research and Sanctuaries Act of 1972 (33 USC 1401 *et seq*)	The proposed action does not fall within a marine protected area or marine sanctuary. Not applicable.
National Historic Preservation Act (16 USC 470 and 36 CFR 800): Protection of Historic Properties	The NMFS initiated consultation with the State Historic Preservation Officer (SHPO) for habitat restoration activities on Dry Creek in 2015. The area of potential effects (APE) included the proposed action areas in and around subreach 4a and the analysis

	covered the types of restoration actions in the proposed action. NMFS provided a consultation letter to the SHPO on December 24, 2015 with a determination that the undertaking would not affect historic resources in the APE. On February 11, 2016, the SHPO responded and determined that the proposed actions would cause no adverse effect to historic resources in the APE. The SHPO letter is included as appendix F. Because the NMFS consultation describes the APE and activities associated with the proposed action (Alternative 2), and USACE concurs with the determinations made by NMFS and subsequently by the SHPO, USACE has determined that the NMFS consultation encompasses the Proposed Action and will seek to adopt this consultation as compliance under Section 106 of the NHPA. USACE has contacted the SHPO to identify how to proceed with adopting the consultation completed by NMFS, and will continue coordinating with SHPO as applicable.
Executive Order 11593: Protection and Enhancement of the Cultural Environment	See above.
Archaeological and Historic Preservation Act of 1974, (16 USC 469 *et seq*)	The proposed action will not affect any archaeological resources as none are known to occur within the proposed action area.
Farmland Protection Policy Act (7 U.S.C. 4201*et seq)*	The proposed action would not result in the conversion of any prime, unique state or locally important farmland to non-agricultural uses.
Abandoned Shipwreck Act of 1987, (43 USC 2101 *et seq*)	No abandoned shipwrecks as none are known to occur within the proposed action areas. Not applicable.
Submerged Lands Act, (Public Law 82-3167; 43 USC 1301 *et seq*)	No lands covered by the Submerged Lands Act occur within the project area. Not applicable.

11. FEDERAL RESPONSIBILITIES

Section 1135 of WRDA 1986, as amended, provides for project modifications for improvement of the environment. Project implementation under this authority includes requirements for the Federal government and the non-Federal sponsor. Federal responsibilities for the selected plan include project planning, design and construction. The authorized cost share is 75% Federal and 25% non-Federal for Design, and Implementation costs. Combined Feasibility Study, Design, and Implimentation costs can up to $10,000,000 can be cost shared. Costs over $10,000,000 are the responsibility of the non-federal sponsors.

12. NON-FEDERAL RESPONSIBILITIES

The non-Federal sponsor shall, prior to implementation, agree to perform all of the local cooperation requirements and non-Federal obligations. Local cooperation requirements are detailed below. The authorized cost share is 75% Federal and 25% non-Federal for Design and Implementtaion costs. OMRR&R costs shall be 100% non-Federal responsibility.

Federal implementation of the recommended plan would be subject to the sponsor agreeing to comply with applicable Federal laws and policies, including but not limited to:

a. The non-Federal sponsor shall not use funds from other Federal programs, including any non-Federal contribution required as matching share therefore, to meet any of the non-Federal construction obligations for the project unless the Federal agency providing the Federal portion of such funds verifies in writing that expenditure of such funds for such purpose is authorized.

b. The non-Federal sponsor shall prevent obstructions or encroachments on the project (including prescribing and enforcing regulations to prevent such obstructions or encroachments) such as any new developments on project lands, easements, and rights-of-way or the addition of facilities which might reduce the outputs produced by the project, hinder operation and maintenance of the project, or interfere with the project's proper function.

c. The non-Federal sponsor shall not use the project or lands, easements, and rights-of-way required for the project as a wetlands bank or mitigation credit for any other project.

d. The non-Federal sponsor shall comply with all applicable provisions of the Uniform Relocation Assistance and Real Property Acquisition Policies Act of 1970, Public Law 91-646, as amended (42 U.S.C. 4601-4655), and the Uniform Regulations contained in 49 CFR Part 24, in acquiring lands, easements, and rights-of-way required for construction, operation, and maintenance of the project, including those necessary for relocations, the borrowing of materials, or the disposal of dredged or excavated material; and inform all affected persons of applicable benefits, policies, and procedures in connection with said Act.

e. For so long as the project remains authorized, the non-Federal sponsor shall operate, maintain, repair, rehabilitate, and replace the project, or functional portions of the project, including any mitigation features, shall be performed at no cost to the Federal Government, in a manner compatible with the project's authorized purposes and in accordance with applicable Federal and State laws and regulations and any specific directions prescribed by the Federal Government.

f. The non-Federal sponsor shall give the Federal Government a right to enter, at reasonable times and in a reasonable manner, upon property that the non-Federal sponsor owns or controls for access to the project for the purpose of completing, inspecting, operating, maintaining, repairing, rehabilitating, or replacing the project.

g. The non-Federal sponsor shall hold and save the United States free from all damages arising from the construction, operation, maintenance, repair, rehabilitation, and replacement of the project and any betterments, except for damages due to the fault or negligence of the United States or its contractors.

h. The non-Federal sponsor shall maintain and keep books, records, documents, or other evidence pertaining to costs and expenses incurred pursuant to the project, for a minimum of 3 years after completion of the accounting for which such books, records, documents, or other evidence are required, to the extent and in such detail as will properly reflect Design and Implementation costs, and in accordance with the standards for financial management systems set forth in the Uniform Administrative Requirements for Grants and Cooperative Agreements to State and Local Governments at 32 Code of Federal Regulations (CFR) Section 33.20;

i. The non-Federal sponsor shall comply with all applicable Federal and State laws and regulations including, but not limited to: Section 601 of the Civil Rights Act of 1964, Public Law 88-352 (42 U.S.C. 2000d) and Department of Defense Directive 5500.11 issued pursuant thereto; Army Regulation 600-7, entitled "Nondiscrimination on the Basis of Handicap in Programs and Activities Assisted or Conducted by the Department of the Army"; and all applicable Federal labor standards requirements including, but not limited to, 40 U.S.C. 3141- 3148 and 40 U.S.C. 3701 – 3708 (revising, codifying and enacting without substantial change the provisions of the Davis-Bacon Act (formerly 40 U.S.C. 276a et seq.), the Contract Work Hours and Safety Standards Act (formerly 40 U.S.C. 327 et seq.), and the Copeland Anti-Kickback Act (formerly 40 U.S.C. 276c et seq.);

j. The non-Federal sponsor shall perform, or ensure performance of, any investigations for hazardous substances that are determined necessary to identify the existence and extent of any hazardous substances regulated under the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA), Public Law 96-510, as amended (42 U.S.C. 9601- 9675), that may exist in, on, or under lands, easements, or rights-of-way that the Federal Government determines to be required for construction, operation, and maintenance of the project. However, for lands that the Federal Government determines to be subject to the navigation servitude, only the Federal Government shall perform such investigations unless the Federal Government provides the non-Federal sponsor with prior specific written direction, in which case the non-Federal sponsor shall perform such investigations in accordance with such written direction.

k. The non-Federal sponsor shall assume, as between the Federal Government and the non- Federal sponsor, complete financial responsibility for all necessary cleanup and response costs of any hazardous substances regulated under CERCLA that are located in, on, or under lands, easements, or rights-of-way that the Federal Government determines to be required for construction, operation, and maintenance of the project.

l. The non-Federal sponsor shall agree, as between the Federal Government and the non-Federal sponsor, that the non-Federal sponsor shall be considered the operator of the project for the purpose of CERCLA liability, and to the maximum extent practicable, operate, maintain, repair, rehabilitate, and replace the project in a manner that will not cause liability to arise under CERCLA.

m. The non-Federal sponsor shall comply with Section 221 of Public Law 91-611, Flood Control Act of 1970, as amended (42 U.S.C. 1962d-5b), and Section 103(j) of the Water Resources Development Act of 1986, Public Law 99-662, as amended (33 U.S.C. 2213(j)), which provides that the Secretary of the Army shall not commence the construction of any water resources project or separable element thereof, until each non-Federal interest has entered into a written agreement to furnish its required cooperation for the project or separable element.

In addition to the items of local cooperation listed above, the following shall apply:
The feasibility phase study and plans and specifications costs shall be included as part of the total project modification costs to be shared 75% Federal and 25% non-Federal. As required by Section 1135(b) of Public Law 99-662, as amended, the non-Federal share of the costs of the modification shall be 25%.

In meeting this responsibility, the non-Federal sponsor shall provide all lands, easements, rights-of-way, relocations, and suitable borrow and dredged or excavated material disposal areas (LDPRD) required for the project modification which are not otherwise available due to the construction of the existing project.

Further, the non-Federal sponsor shall accomplish, or arrange for accomplishment at no cost to the Government, all relocations determined by the Government to be necessary for implementation of the project modification.

If the value of the LER plus work-in-kind does not equal or exceed 25% of the project cost, the sponsor must pay in cash or provide work in kind contributions equal to the additional amount necessary so the sponsor's total contribution equals 25% of the project cost and any additional costs over $10,000,000. All work in kind will be in accordance with ED 1165-2-208. Only in-kind contributions determined to be integral to the project will be considered eligible for credit. This determination will be completed prior to review and approval of the Project Partnership Agreement. At this time, no cash requirement from the sponsor is anticipated due to the projected LER value.

If the value of the LDPRD contributions alone exceeds 25% of the total project modification costs, the Major Subordinate Command (MSC), must evaluate the project formulation to ensure that the project properly utilizes USACE expertise and is not land intensive. As part of its evaluation, the MSC must ensure that the project plan requires only the lands necessary to implement the project and to reasonably assure that the benefits sufficient to justify the project are achieved. In addition, the non-Federal sponsor will provide a letter of intent to voluntarily waive reimbursement for the value of LER that exceeds the non-Federal sponsor's percentage share of Design and Implementation costs. If the non-Federal sponsor does not voluntarily waive reimbursement for the value of LER that exceeds its percentage share of Design and Implementation costs, any further efforts on the project could be suspended.

The non-Federal sponsor shall not receive any credit for LER previously provided as an item of cooperation for another Federal project. The non-Federal sponsor also shall not receive credit of the value of LER or other items to the extent that they are provided using Federal funds unless the Federal granting agency verifies in writing that such credit is expressly authorized by statute.

- Work-in-kind is limited to 80% of the non-Federal share and may be accepted as long as it does not result in any reimbursement of the non-Federal sponsor. The work-in-kind when combined with the non-Federal provision of LER cannot exceed 25% of project costs.
- Work-in-kind must be provided by the non-Federal project sponsor and can be accomplished by the staff of the non-Federal sponsor or by contract administered by the non-Federal sponsor.
- Items eligible for work-in-kind as part of the non-Federal sponsor's share include post-feasibility phase design, including plans and specifications, provision of materials, and project construction.
- With regard to work-in-kind, the non-Federal sponsor will comply with applicable Federal and state laws and regulations, including the requirements to secure competitive bids for all work to be performed by contract. Efforts credited as work-in-kind will be subject to audit.

Program funds will not be provided to local interests or be used to reimburse local interests for conducting studies or constructing projects nor shall contributions be made for features or benefits of projects constructed by another agency or by local interests. Local interests will not be reimbursed for work undertaken by them on an approved project except as approved by inclusion in the Project Partnership Agreement.

13. IMPLEMENTATION RESPONSIBILITIES

U.S. Army Corps of Engineers, San Francisco District. The Corps is responsible for project management and coordination with the SCWA, and other affected agencies. The Corps will submit this DPR; administer program funds; finalize plans and specifications; complete all NEPA requirements; advertise and award a construction contract; and perform construction contract supervision and administration. Section 1135 study efforts were continued under new legislation for Section 3064 of the WRDA of 2007 that included environmental restoration as a project purpose.

The proposed project would be funded and constructed under Section 1135, 1986 Water Resources Development Act, as amended. The authorized cost share is 75% Federal and 25% non-Federal for Design and Implementation costs. The Corps has agreed to support this CAP Section 1135 project's monitoring and data collection needs as outlined in Attachement 1,

U.S. Fish and Wildlife Service. The USFWS will provide a CAR for this project after reviewing the Draft DPR/EA. The CAR will be included in Appendix L of this document once received.

Non-Federal Sponsor. The SCWA has provided technical and other advisory assistance during all phases of the project and will continue to provide assistance during project implementation. The non-Federal sponsor has agreed to support this CAP Section 1135 project's monitoring and data collection needs as outlined in attachment 1.

14. COORDINATION, PUBLIC VIEWS, AND COMMENTS*

Coordination has been made throughout the planning and design process with a number of state and federal resource agencies including the USFWS, NMFS, CDFW, and North Coast RWQCB. These agencies have expressed their support of the project.

Pursuant to 33 C.F.R. § 230.11 (b) U.S. Army Corps of Engineers – Procedures for Implementing NEPA, notice of the availability of this DPR/ EA and draft FONSI for the Dry Creek Ecosystem Restoration Section 1135 Project has been provided to agencies, organizations, and the interested public for a 30-day comment period. Any comments received will be considered and incorporated into this DPR/EA prior to deciding whether to prepare a FONSI under NEPA.

The following federal, state, and local agencies, as well as various interested local individuals have been notified of the availability of this DPR/EA for review and comment.

A. Federal agencies:
1) U.S. Environmental Protection Agency (Region 9)
2) U.S. Fish and Wildlife Service (Sacramento Office)
3) National Marine Fisheries Service (North Coast Branch)
4) Advisory Council – Historic Preservation

B. State and local agencies:
1) California Department of Fish and Wildlife (Bay Delta Region Office)
2) California State Historic Preservation Officer
3) North Coast Regional Water Quality Control Board
4) Northern Sonoma County Air Pollution Contorl District
5) Sonoma County Permit and Resource Management Department

C. Other organizations
1) Dry Creek Rancheria Band of Pomo Indians
2) Healdsburg Regional Library

15. CONCLUSIONS

Implementation of the proposed plan at the Dry Creek project would result in positive benefits by creating complex instream and floodplain habitats, improving fish passage over an existing Corps sill, and improving the diversity and complexity of riparian vegetation while removing and management invasive plant species. The project is consistent with and fully supports the overall goals and objectives of the Continuing Authorities Program Section 1135. For proposed recommendations, see Recommendations section below.

16. **REFERENCES***

The Corps has prepared the following studies and reports on Dry Creek:

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17. RECOMMENDATION

I recommend Alternative 2 as the analysis included in this feasibility reports supports that Alternative 2 is the most effective alternative for meeeting project objectives and is the most cost effecient. I have weighed the outputs to be obtained from the full implementation of this aquatic ecosystem restoration project against its estimated cost and have considered the various alternatives proposed, impacts identified, and overall scope. In my judgment, this project, as proposed, justifies expenditure of Federal funds. I recommend that the South PAcific Division Engineer approve the proposed project to restore the quality, complexity, and diversity of habitat along lower Dry Creek by restoring instream and floodplain and channel habitat complexity, riparian vegetation diversity, and productive backwater habitat by reconnecting Dry Creek to available floodplain.

The fully funded cost for the tentatively selected plan, including inflation, is $7,605,546. The total project cost would be cost-shared 75/25, Federal/non-Federal and in accordance with Section 1135, 1986 Water Resources Development Act, as amended, Federal project costs are limited to $10,000,000. Any amounts in excess of the Federal cost share will be borne by the non-Federal sponsor. The Federal share is $5,354,160. The non-Federal share is $2,251,387. Of the total cost, the lands, easements and right-of-ways (LERRDS) costs are approximately $830,546, of which $755,546 is a non-Federal responsobilty and $75,000 is a Federal administration cost. Operation, maintenance, repair, replacement and rehabilitation costs (O&&MRRR) are approximately $662,000, or 25,100 per year, and total monitoring cost are estimated to be $1,560, with monitoring occurring on a 2-year cycle. The total area of available habitat created over the life of the project is 6.1 acres. The total annual NER (average annual habitat unit) are 2.48 at a cost of $96,900 per year per habitat unit.

Date:

John C. Morrow
Lieutenant Colonel, US Army
District Engineer

Appendix A:

Civil Engineering Report

US Army Corps of Engineers ®
San Francisco District

CAP SECTION 1135
DRY CREEK

ECOSYSTEM RESTORATION PROJECT

APPENDIX A

CIVIL ENGINEERING REPORT

JANUARY 2017

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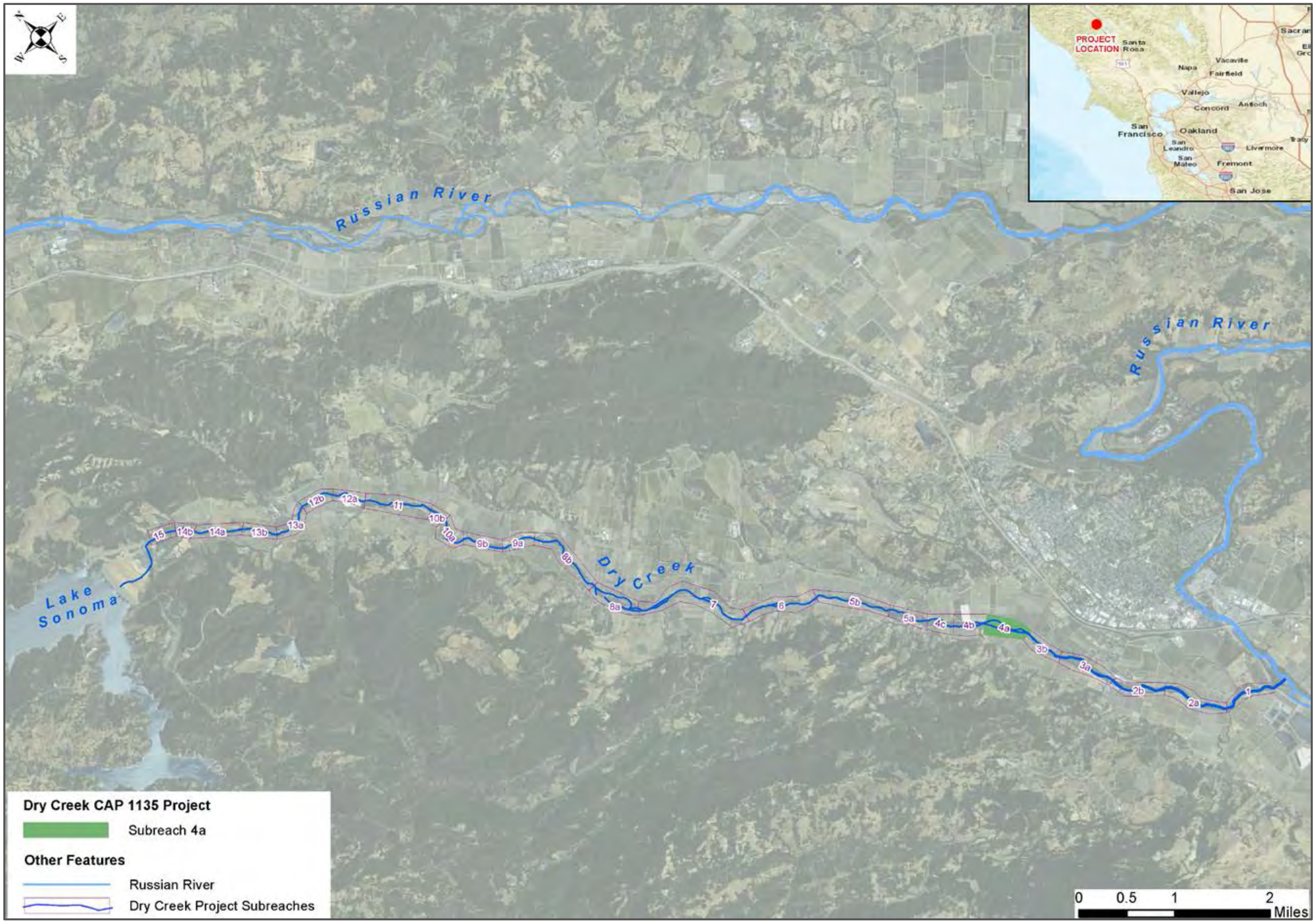


Figure 1: Project Location and Vicinity Map

PART 1 CIVIL

1.1 General

This appendix documents the Civil Design portion of the engineering analysis and follows the format of Engineer Regulation1110-2-1150. It covers the alternative that will be part of the Miles three of the total 6 miles habitat enhancement recommendation laid out by the Russian River Biological Opinion (RRBO). Mile three includes reaches 2, 4 and 5. The reaches area further sub-divided into smaller subreaches labeled alphabetically. Both the Reach number and the Subreach alphabets are assigned from downstream to an upstream viewing perspective (Figure 1).

1.2 Abbreviation and Names

AMD – Adaptive Management Plan
CDFG – California Department of Fish and Games
CE/ICA – Cost Effectiveness and Incremental Cost Analysis
CY – Cubic Yard
EA – Each
ESA - Environmental Science Associates
HSI – Habitat Suitability Index
H:V – Horizontal: Vertical
LS – Lump Sum
LWD – Large Woody Debris
LWS – Large Wood Structure
NMFS – National Marine Fisheries Service
PED – Pre-construction Engineering and Design
QTY – Quantity
RRBO – Russian River Biological Opinion
SF – Square Foot
TSP – Tentatively Selected Plan
USACE – US Army Corps of Engineers

1.3 Project-Specific References

1. ESA 2015. Draft 60% Complete Design Drawings, Dry Creek Habitat Enhancement Projects: Mile III. Prepared for Sonoma County Water Agency. September.
2. ESA 2015. Draft 60% Complete Design Report, Dry Creek Habitat Enhancement Projects: Mile III. Prepared for Sonoma County Water Agency. September.

1.4 Project Alternative Selection

Including the no-action plan, multiple alternatives were developed during the initial alternative formulation process. The initial alternatives were then screened down to a final six arrays of alternatives by using the four main qualitative and quantitative screening criteria such as acceptability, completeness, effectiveness, and efficiency. The six final arrays of alternatives include; Alternative 1 or the no action plan, Alternative 2 consisting of Subreach 4a, Alternative

3 consisting of Subreach 14a, Alternative 4 consisting of Subreach 14b, Alternative 5 comprised of Subreaches 4a and 14a, and Alternative 6 comprised of Subreaches 14a and 14b. The six alternatives were then compared based on mainly their efficiency to provide the highest benefit and opportunities, their cost effectiveness, as well as their complexity to fulfil the objectives and solve the problems of the project. The benefits of these six alternatives were evaluated using the Habitat Suitability Index (HSI) model for coho salmon and the Habitat Evaluation Procedure (HEP) for habitat assessment methodology. The cost effectiveness and incremental cost analysis (CE/ICA) was used to identify the best buy alternatives using the Corps Institute of Water Resources Plan software. The Tentatively Selected Plan (TSP) is the best fit alternative of all the six final arrays of alternatives selected based on the above comparison criteria. For the detailed analysis, evaluation, and processes utilized for the comparison of the alternatives that resulted in the selection of the TSP, refer to Section 6 of the main report (Detailed Project Report with Integrated Environmental Assessment) and Appendix D.

1.5 Tentatively Selected Plan (TSP) / Recommended Plan

Out of the six final arrays of alternatives that were evaluated, Alternative 2 is selected as the TSP. The TSP exhibited the highest number of annual habitat units and lower average annual cost compared to the other alternatives based on the outcome of the environmental benefit analysis and CE/ICA analysis, consecutively. Alternative 2 consists only Subreach 4a (Sites 4A and 4B). Included with this appendix are detailed project drawings, layouts of the proposed construction access routes, and the location of the proposed staging area for the selected alternative.

1.5.1 Subreach 4a (Sites 4A and 4B)

This Subreach is part of the Mile three to be completed out of the 6 miles habitat enhancement recommendation laid out by the RRBO. Design of this Subreach is carried out by the Sponsor's (Sonoma County Water Agency) consultant ESA. Subreach 4a is part of Reach 4 that extends from Project Station 160+00 to 176+50 (Attachment 1). Enhancement features included in Subreach 4a are shown in Table 1 below and in Attachment 4.

A total of three secondary channels, two in Sites 4A and one in Site 4B are proposed. The first one is a 500 ft long channel in Site 4A planned to the right of the main channel between Stations 164+50 and 168+00. The depth of the channel design grade varies from 8 to 2 ft from existing ground. The channel side slopes vary approximately from 1:1 to 2.5:1 (H:V). One Alcove will be added to the right of this secondary channel near the upstream section. Another 1,100 ft long secondary channel is planned in Site 4A to the left of the main channel between Stations 160+00 and 170+00. The depth of the channel design grade varies from 9 to 4 ft from existing ground. The channel side slopes vary approximately from 1:1 to 8:1(H:V). One small Alcove will be added to the left upstream section of this secondary channel. This left channel will also be connected to the main channel by means of two traverse channels. The third 650 ft long secondary channel is planned in Site 4B to the left of the main channel between Stations 171+00 and 176+50. The side slopes of the channel vary approximately from 1:1 to 3.5:1(H:V). The depth of channel's design grade varies from 9 to 5 ft from existing ground.

The elevation of all the secondary channels' bed is designed to closely match the main channel grade. Construction of the secondary channels will require excavation and grading of current topographic low points and abandoned or higher flow channels and lateral connection to the main channel through existing berms or bars (*ESA*[2] p61). Hydraulic modeling with all the proposed measures (features) in subreach 4a (Sites 4A and 4B) were developed using SRH-2D model by ESA. The determination of the depth for all the side channels, alcoves and backwaters as well as the flow velocities are based on the output obtained from the model. For further discussion and details regarding the Hydrology and Hydraulics (H&H) modeling, refer to Appendix B. Biotechnical and Geotechnical / Biotechnical Bank stabilization structures will also be included in the form of Brush Mat on both the main and secondary channel slopes at bends and at erosion prone areas. Further design refinements will be made to all the restoration features and Geotechnical / Biotechnical Bank stabilization structures during the future design stages. For additional geotechnical information, see the Geotechnical Report (Appendix C). For description of all the features included in Subreach 4a (Sites 4A and 4B), see Table 1. For detailed plans, profiles, cross-section and grading of all the features, see the plans prepared by ESA in Attachment 3 & 4.

1.5.2 Existing Fish Ladder and Grouted Riprap Sill

Site 4A and 4B are disconnected by one of the many post-dam erosion control sills constructed by Corps of Engineers in 1981. The sill separating the two restoration sites is approximately up to 380 ft long by 62 ft wide and is made up of a one foot thick quarry spall base topped with a ¼ ton (18 inch) sized stone grouted with concrete. The thickness of the grouted riprap varies along the creek cross section. Along the channel bottom section, the grouted riprap layer is up to 4 ft thick while along the channel slopes the layer is up to 2 ft thick. At the center of the sill, there are two 2.3 ft wide concrete fish ladders near the thalweg of the channel at a distance of 4 ft (end-to-end) from each other. Future modification are proposed to notch the sill at two locations. One area is to the left of the fish ladders in order to provide a continuity to the proposed new secondary channels in Site 4A and 4B. The additional modification proposed is to remove the fish ladders and replacing it with a much better form of transitional structure that will enhance fish passage and provide additional benefits by increasing longitudinal connectivity. Further discussion and detailed designs of the proposed modifications would likely take place during the Pre-construction Engineering and Design (PED) phase of the project. For the location of the sill structure, refer to Attachments 3 and 4.

1.6 Quantity Computation

The quantity computations were performed by ESA. The quantities provided have been reviewed to ensure that they are in agreement with the project design drawings and the units of measurements and cost breakdown are in conformance with the format required by Cost Engineering. For the selected alternative (TSP), the table below summarizes the quantities of the major features that are planned to be employed for the restoration effort. The table also provides a brief description and purpose of all the features. Detailed Plans (prepared by ESA) showing placement of the different features listed in the tables below are provided in Attachment 4. For additional detail lists of items and construction costs associated with the items in Table 1 and all the other alternatives evaluated under this study, refer to the Cost Engineering Report (Appendix E).

Table 1. Quantities for Subreach 4a (Sites 4A & 4B)

Feature	QTY, Unit	Description
Earthwork	20,500 CY	Removal of earthen material for construction of side channels, riffles and pools.
Large Wood Structure	8 EA	Are used to provide cover and create complex habitat structure that will reduced flow volumes and velocities in the main channel.
Habitat Wood Structure – Type 1	36 EA	Consist of a single horizontally embedded log installed to provide instream and margin habitat for fish and other aquatic species as well as add roughness to the channel and floodplain. The habitat logs provide cover, velocity refuge, shade, and are a location for foraging perennially in the main or secondary channels, and seasonally, on the floodplain under high flow conditions. Both dead and live wood will be used for the habitat log structures.
Habitat Wood Structure – Type 2	20 EA	Is composed of a one horizontal log and one vertically embedded log serving similar purpose as Type 1.
Live Wood Structure	3 EA	Are used as a Habitat wood structure with the only difference that Live wood structures are used to create an opportunity for the structure to anchor itself in place with root growth and regenerate via new shoots.
Apex Log Structure	4 EA	Are a complex form of Large Wood Structure that are intended to affect the channel hydraulics by modifying flow paths in the mainstem, forcing water to divert into secondary channels or as larger scale bank stabilization measures.
Topple Logs	7 EA	Trees toppled into the mainstem channel intended to create pools in combination with other woody debris.
Pool Wood Structure	39 EA	Are installed in the pools of the secondary channels in groupings of three units to create a more complex structure made up of a total of two horizontal logs and one vertically embedded log.
Boulder Cluster	3 EA	Are installed to provide velocity refugia and habitat for juvenile steelhead and coho salmon.
Main Channel New Riffle	223 CY	Are well mixed layers of small boulders, cobbles, gravel and sand across the main or side channel. They are placed at areas where stream
Side Channel New Riffle	2,004 CY	

		bed is steep to control the elevation and stream velocity.
Live Poles (Live willow stakes)	4,082 EA	Are live willows used to anchor and staple live and dead logs. Willows are also used in combination with biodegradable erosion control fabrics for bank stabilization.
Brush Mat	8,164 SF	Baffles are used to effectively and economically restore washed out streambanks and flood terraces.
Revegetate Disturbed Areas (year 1)	6 ACRE	Seeding of native species after providing of stream bank and slope stabilization.
Plant Establishment & Maintenance (Years 1-3)	1 LS	Performing active vegetation management including both selective tree removal and establishment of new native plantings.
Irrigation	1 LS	For use during new native vegetation establishment

Source: ESA[1&2]

1.7 Relocations

No features that require relocation were identified within the limits of the project.

1.8 Utilities

No major structures or utilities have been identified within the project footprints. If any additional utilities are discovered during the next phases of the project, they will be included on the next preliminary design stages.

1.9 Design Criteria Standards

The enhancement effort utilizes the design approach laid out by RRBO (*ESA* [2], p46). An Adaptive Management Plan (AMP) was later developed with participation of Sonoma Water Agency, NMFS, and DDFG to meet the specific project goals, objectives, and monitoring methods for effective and long term habitat enhancement in order to specifically refine the essential habitat criteria within Dry Creek. The AMP includes the design criteria recommended by the RRBO. The table below summarizes the design criteria used for all the Subreaches.

Table 2. Design Criteria for the Mile 3 Enhancement Projects

Feature/Issue	Criteria	Remarks/Reference
Fish Habitat Design Criteria		
A. Target flow range	• 110 to 175 cfs	• Flow range outlined in RRBO
B. Pool Abundance	• 33% to 67% of all habitats	• RRBO
C. Pool : riffle ratio	• 1:2 to 2:1	• RRBO
D. Water depth	• 2 to 4 ft in pools, with locally deeper areas	• AMP
E. Velocity in rearing habitat	• 0 to 0.5 ft/s • Reduced from present conditions to extent practicable	• AMP • Primarily able to be met in off-channel habitats and shelter habitats associated with large woody debris • Local velocities in mainstem pool habitat
F. Cover	• >30% of habitat bottom obscured by cover	• RRBO • due to depth, surface turbulence, or presence of structures such as logs, debris piles, boulders, or overhanging banks and vegetation
G. Refugia habitat	• Should provide high quality shelter during high flow releases	• RRBO
H. Longevity of habitat	• 25 years in approximately similar quantities though adjustments will occur	• Water Agency
Large Woody Debris Stability		
I. Mobility of LWD	• 25 year event	• In most cases, stability requirements similar between Q2 and Q100-year events.
J. LWD Decay	• 15-25 year period	• Typical decay rates for coniferous species
Vertical Stability		

K. Design stability for riffles Lateral Stability	• 25 year event	• In most cases, design substrate sizing is similar between Q2 and Q100 events
L. Stream boundaries constructed inside the channel corridor	• 5 year event	• Relatively deformable boundary construction
M. Stream boundaries constructed along margin of the channel corridor	• 50-year event	• Less deformable boundary construction
N. Stream boundary construction techniques	• Employ techniques that also provide margin shelter and riparian habitat	• Biotechnical techniques
Planform Stability		
O. Avulsion into off-channel habitat	• None within first 5 years following construction, notwithstanding extraordinary hydrologic events • Future avulsion is acceptable provided habitat criteria continue to be met	• Address risk of avulsion through design overbank roughness created with LWD
Riparian Vegetation		
P. Invasive species	• Endeavor to eliminate invasive vegetation	
Q. Native revegetation	• Encourage diverse, less dense native community	
Construction Period		
R. Impacts to existing resources	• Minimal	
S. Impacts to adjacent operations	• Minimal	
T. Impacts to infrastructure	• None	

Source: ESA[2]

1.10 Borrow Site and Disposal Area

It is anticipated that majority of the wood retrieved from clearing during construction can be reused for habitat structures. As identified in Table 1, majority of the streambank and flood terrace areas that are washed out are restored using a Brush Mat made out of existing vegetation available at the project site. Excavated earthen material from the project site will be stored near the project site to be used as a bank stabilization and treatment fill. Future design stages of the project would provide a better detail if the excavated material is in excess or if additional earthen material is required. No hazardous material requiring special handling or disposal is anticipated on the project sites. It is anticipated that miscellaneous debris including concrete rubble, car bodies, rubber tires, piping may be encountered during construction. These materials will become the property of the contractor. It will be the responsibility of the contractor to identify appropriate landfill or other waste receiving agencies for excessive waste that can't be reused or recycled.

1.11 Flow Diversion

Design elements and approaches have been selected with the intent of minimizing the needs for dewatering and/or channel diversion (*ESA*[2], p89). Based on previously constructed demonstration reaches, partial flow diversion will be required at multiple locations in Sites 4A and 4B to allow installation of log jams, and during excavation of secondary channel and/or alcove connections along the main stem. This tasks are accomplished using coffer dams to isolate the work area from the main channel. Dewatering will also be required when embedded log structures are anchored to ballast boulders. Though the chance of bypassing the entire project site is very slim, the contractor may put together a redundancy plan in case the site constraints diminish the opportunity of partial diversion. Further detail information related to water control plan can be found in ESA's draft design report. Additional refinement to the detailed flow diversion plan will be done during the future design phases of the project.

1.12 Construction Access, Haul Routes and Staging Area

The organization of the project Reaches were developed with the intention that each Reach could be implemented in a single construction season and that each project site could be implemented individually, if necessary (*ESA*[2], p89). Majority of the lands along the creek banks near the projects site are privately owned. Getting access to the project sites require travelling though roads that are within privately owned vineyard. As a result, the proposed construction access routes and staging areas should be reviewed by the Sponsor (Sonoma County Water Agency) and vetted for use before construction. It is also important that the landowners understand the impacts of the construction activities to verify consistency with vineyard operations. The construction activity is anticipated to have minimal impacts to other resources and infrastructures. All existing paved roads used during construction of the project will be protected from damage. All ramps connecting to the main streets will be improved to accommodate heavy construction vehicular traffic. Any damage resulting from the use of the roads will be repaired and restored to its original condition at the completion of the projects.

1.12.1 Subreach 4a (Sites 4A and 4B)

Proposed haul routes and construction staging areas for Sites 4A and 4B are shown on Attachment 2. From east, an existing paved road connects to Kinley Drive to provide access to the project site. A short term staging area, approximately 150,000 SF, is provided adjacent to the project covering more than half of the left bank extent. The owner of this abandoned vineyard have provided temporarily permit to the sponsor in exchange for removal of all the old vine trees from the land and clearing of the site. Proposed ingress/egress to the different project sites within the Creek and access to the project staging area are shown along the Creek left bank. Further coordination and discussion to refine the extents of the access routes and the staging areas will be made with the owners of the land providing the temporary access as the project progresses towards its final design stages.

PART 2 STRUCTURAL

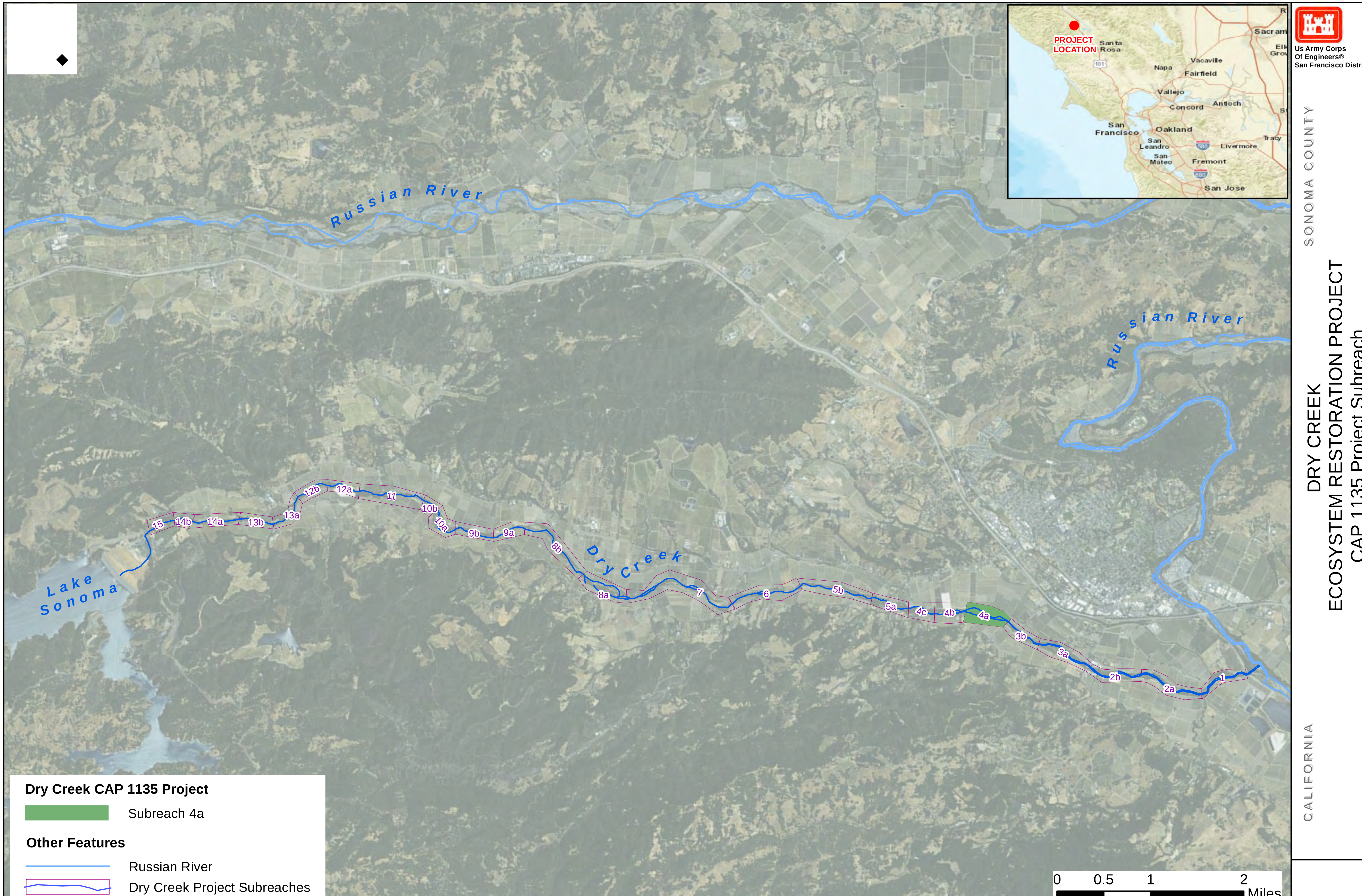
2.1 Large Wood Structures

Different forms of large wood structures are proposed as part of the selected alternative (Table 1). Most of these large wood structures are immobile live and /or dead logs of different sizes assembled together in different technique to serve various purposes in the restoration effort. One of their main purposes is to create different types of non-structural covers for the habitats. When used for this purpose, the log structures are simple log installations that provide instream and margin habitat for fish and other aquatic species as well as add roughness to the channel and floodplain. The techniques used to create the large wood structures for this purposed include simple partial embedment into the channel bed, interlocking individual dead and live logs, and cabling or pinning to other logs, existing live mature trees or timber piles.

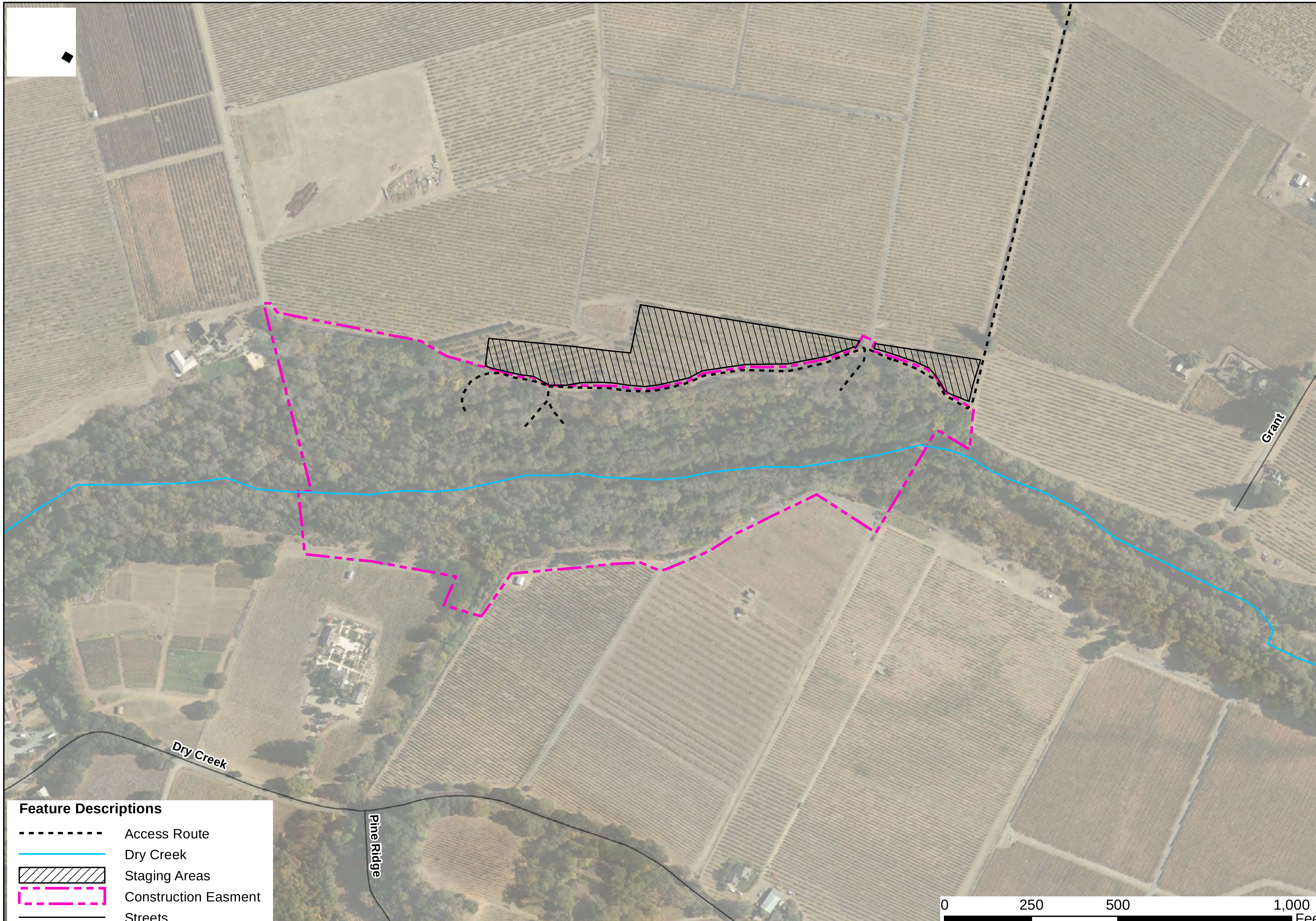
The second purpose of the large wood structures is to serve as structurally rigid element in forcing flows and influencing the hydraulics and the geomorphologic conditions of the creek. Apex log structures are specifically designed to serve this purpose. For the selected alternative, there are four proposed locations for Apex Log Structures. Within Site 4A, two are provided at the two instream connection locations of the left proposed side channel and one is located at the splitting point of the right proposed side channel (Attachment 4). Within Site 4B, one Apex Log Structure is situated at the upstream end serving as a flow splitting structure for the new left secondary channel. When serving this purpose, the large wood structures (Apex Log Structures) are placed in areas where it would be beneficial to initiate or stabilize the bedform of the channel. They are placed at the inlet of a proposed secondary channel for splitting the flow from the main channel towards the side channels. They also maintain interface between main and lateral habitats, limit flanking around the installations, and prevent bank erosions. To create the Apex Log Structures, a group of large logs will be attached together and ballasted with a vertical snag or boulder to act as a single unit. Some of the techniques used to stabilize the Apex Log Structures include partial deep vertical embedment in to the bank & bed, interlocking individual logs, and cabling or pinning to, large boulders, and other logs. The foundation condition of the locations where deep log embedment is required should be confirmed to avoid encountering shallow bedrock. This and similar foundation soil information can be found in the Geotechnical Report (Appendix C).

Further refinement to the stability design criteria (Table 2) of the large wood structures is anticipated in the future design stages of the project. Typical sections and details showing the placement of the different types of large wood structures, side channels, instream connection and other proposed restoration features for the selected alternative are included in Attachments 3 and 4. The configuration (placement) and typical approaches proposed on the drawings may possibly be refined on upcoming designs or depending on site condition during construction. For details of the non-structural large wood structures and the structural Apex Log Structure, see the plans prepared by ESA in Attachment 5.

Dry Creek CAP 1135 Project Location


Russian River
Russian River
Dry Creek
Lake Sonoma
15
14b
14a
13b
13a
12b
12a
11
10b
10a
9b
9a
8b
8a
7
6
5b
5a
4c
4b
4a
3b
3a
2b
2a
1
PROJECT LOCATION
Santa Rosa
Napa
Vacaville
Fairfield
Vallejo
Antioch
Concord
San Francisco
Oakland
San Leandro
Livermore
Tracy
San Mateo
Fremont
San Jose
Us Army Corps Of Engineers®
San Francisco District
SONOMA COUNTY
DRY CREEK
ECOSYSTEM RESTORATION PROJECT
CAP 1135 Project Subreach
CALIFORNIA
Dry Creek CAP 1135 Project
Subreach 4a
Other Features
Russian River
Dry Creek Project Subreaches
0
0.5
1
2
Miles

Subreach 4a (Sites 4A and 4B) Proposed Access Route, Staging Area Locations and Construction Easement Limits



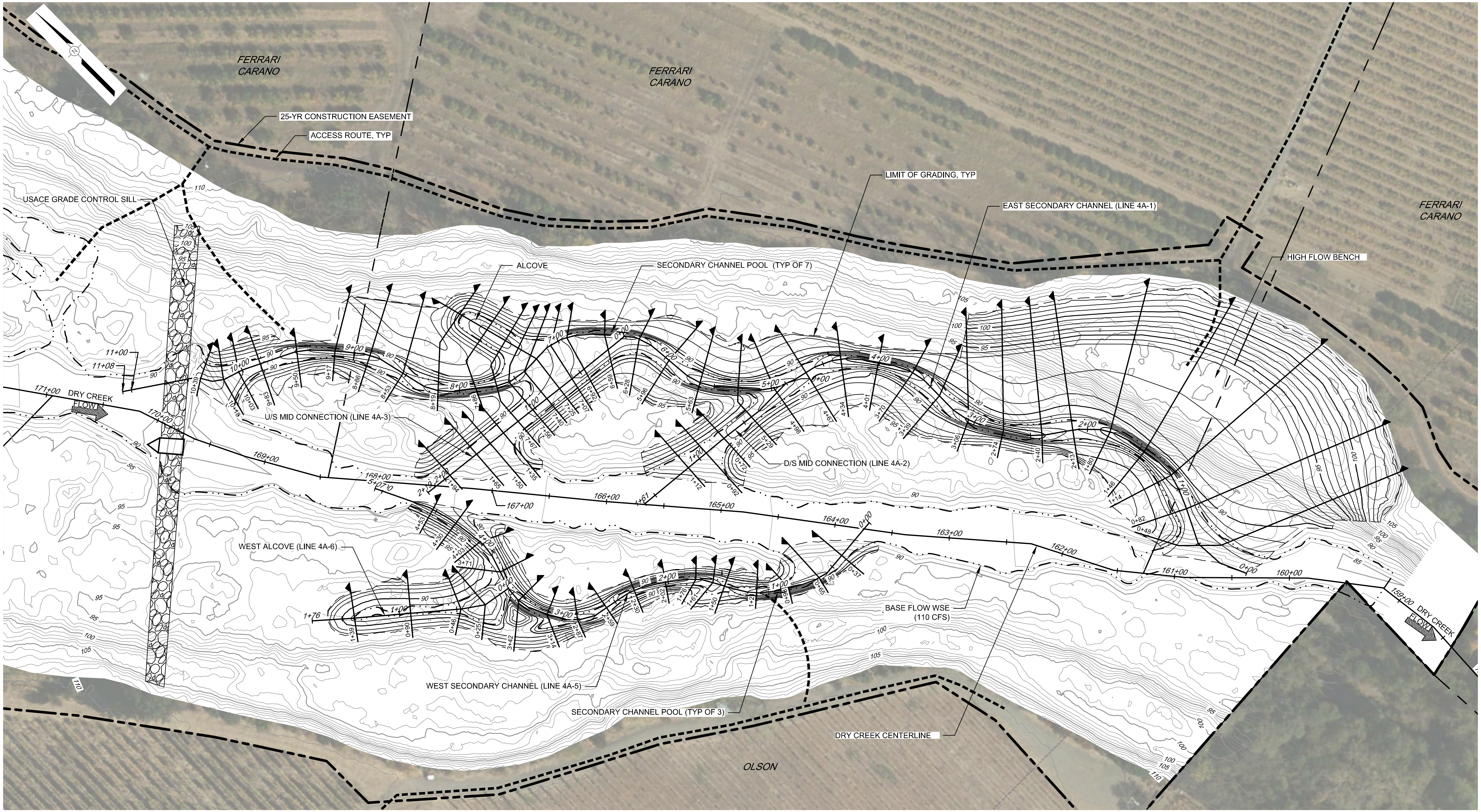
Us Army Corps
Of Engineers®
San Francisco District

SONOMA COUNTY

DRY CREEK
ECOSYSTEM RESTORATION PROJECT
Project Access Routes, Easements, and Staging Areas

CALIFORNIA

Subreach 4a (Sites 4A and 4B) Preliminary Grading Plan, Profile and Cross-sections



PLAN

SCALE: 1"= 40'

NOTES

1. GRADING SECTIONS ARE ORIENTED LOOKING UPSTREAM.
2. SEE DRAWING C-02 FOR GRADING PROFILES.
3. SEE DRAWINGS C-03 TO C-10 FOR GRADING SECTIONS.

0 15' 1" = 30' 60'

HORIZONTAL SCALE

BAR LENGTH ON ORIGINAL DRAWING EQUALS ONE INCH. ADJUST SCALE ACCORDINGLY

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SCALE: 1" =40'
DATE: 09/18/2015
DRAWN: JW, AF
REVIEWED:

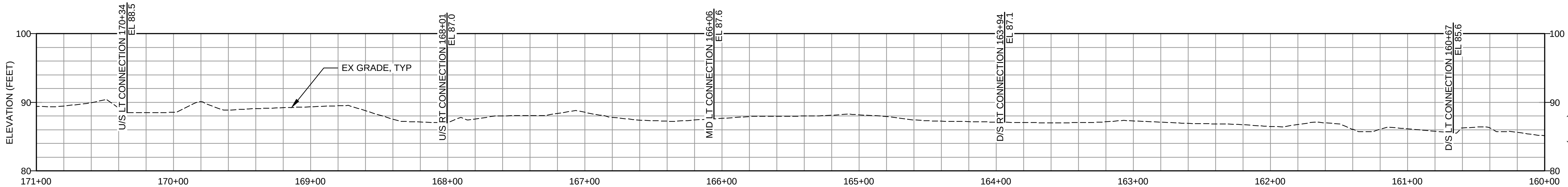
DRY CREEK HABITAT ENHANCEMENT PHASE III, MILE THREE - REACH 4 & 5

SITE 4A GRADING PLAN

FILE NAME: 7351-DRY-CREEK-REACH-4A-GRADING.dwg
CONTRACT NUMBER: 7351

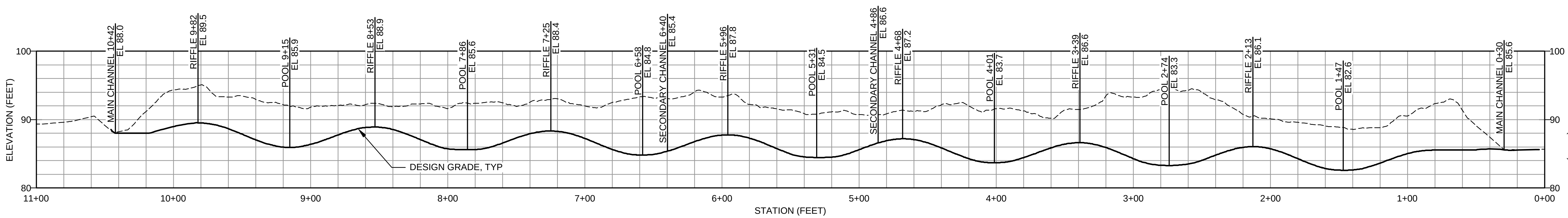
DRAWING NUMBER: C-01

SHEET 15 OF 56



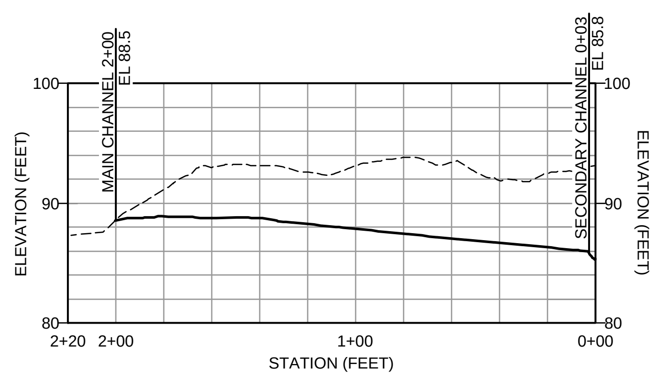
PROFILE - DRY CREEK THALWEG

HORIZONTAL SCALE: 1"= 40'
VERTICAL SCALE: 1"=8' (5X EXAGGERATION)



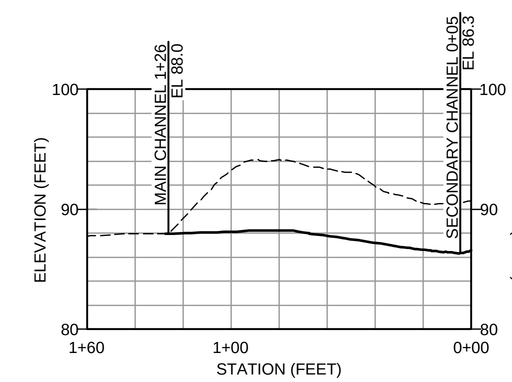
PROFILE - EAST SECONDARY CHANNEL (LINE 4A-1)

HORIZONTAL SCALE: 1"= 40'
VERTICAL SCALE: 1"=8' (5X EXAGGERATION)



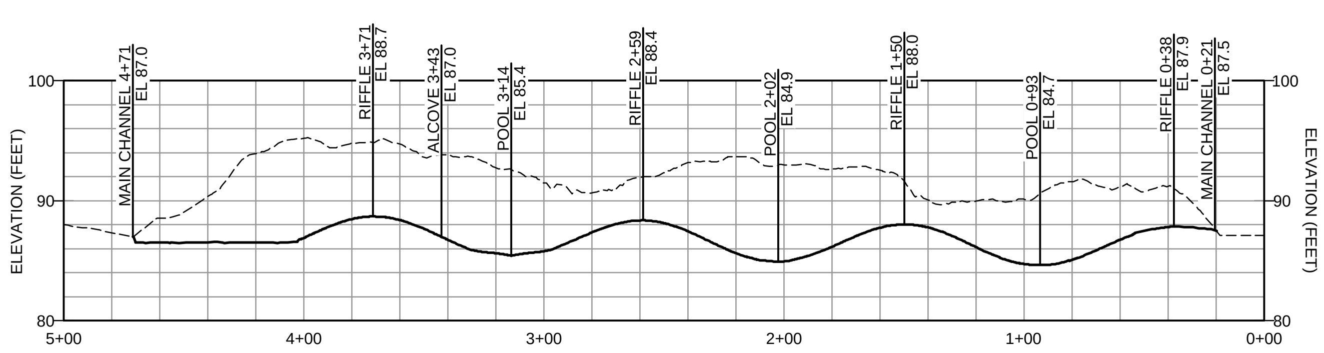
PROFILE - U/S MID CONNECTION (LINE 4A-3)

HORIZONTAL SCALE: 1"= 40'
VERTICAL SCALE: 1"=8' (5X EXAGGERATION)



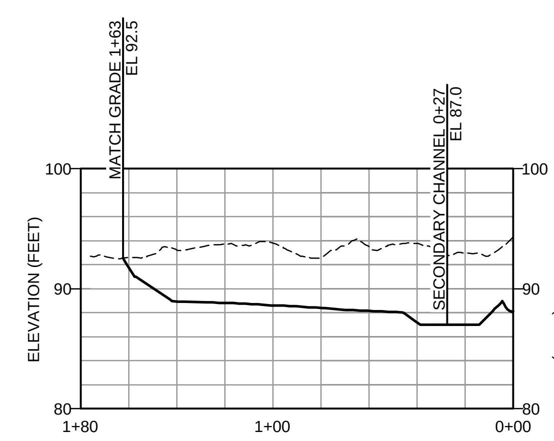
PROFILE - D/S MID CONNECTION (LINE 4A-2)

HORIZONTAL SCALE: 1"= 40'
VERTICAL SCALE: 1"=8' (5X EXAGGERATION)



PROFILE - WEST SECONDARY CHANNEL (LINE 4A-5)

HORIZONTAL SCALE: 1"= 40'
VERTICAL SCALE: 1"=8' (5X EXAGGERATION)



PROFILE - WEST SECONDARY CHANNEL ALCOVE (LINE 4A-6)

HORIZONTAL SCALE: 1"= 40'
VERTICAL SCALE: 1"=8' (5X EXAGGERATION)

NOTES

1. SEE DWGS G-10 AND G-11 FOR ALIGNMENT LAYOUT.

0 4' 1" = 8' 16'
VERTICAL SCALE

0 20' 1" = 40' 80'
HORIZONTAL SCALE

BAR LENGTH ON ORIGINAL DRAWING EQUALS ONE INCH. ADJUST SCALE ACCORDINGLY

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SCALE: AS SHOWN
DATE: 09/18/2015
DRAWN: JW, AF
REVIEWED:

DRY CREEK HABITAT ENHANCEMENT PHASE III, MILE THREE - REACH 4 & 5

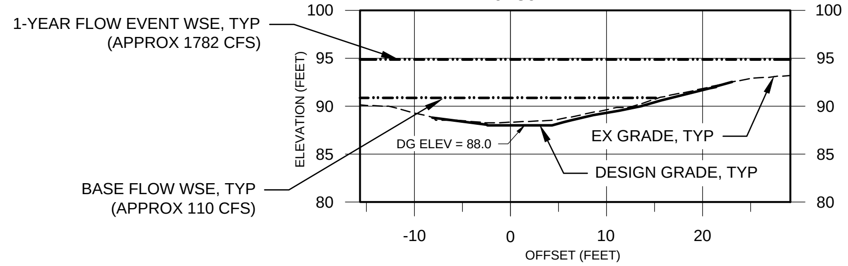
SITE 4A GRADING ROFILES

FILE NAME: 7351-DRY-CREEK-REACH-4A-GRADING.dwg
CONTRACT NUMBER: 7351

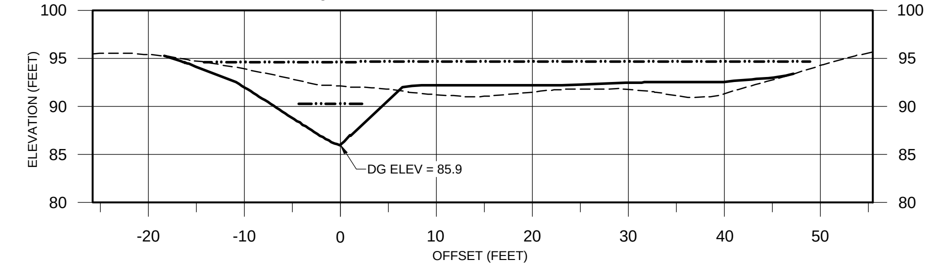
DRAWING NUMBER: C-02

SHEET 16 OF 56

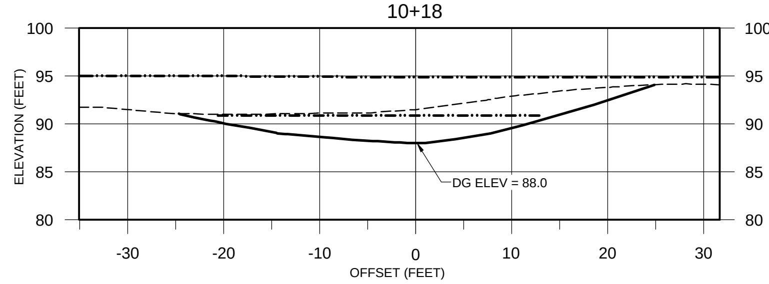
10+39



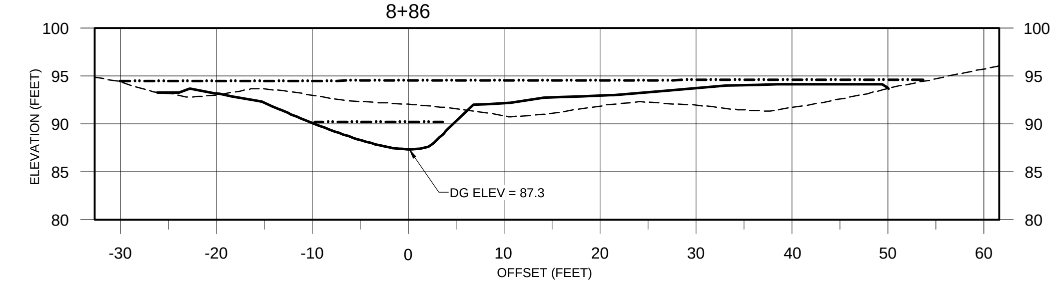
9+17



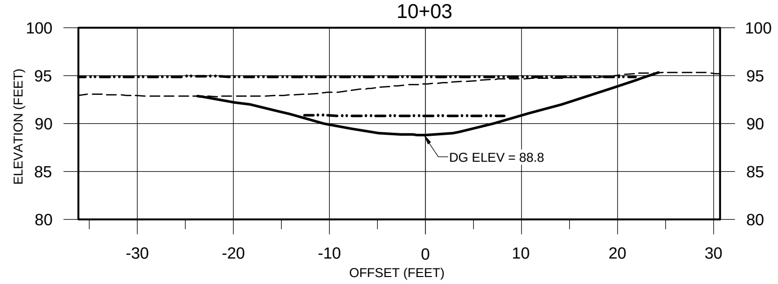
10+18



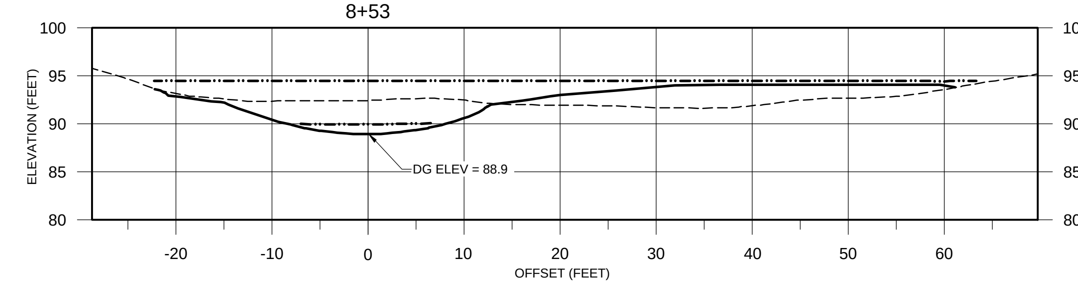
8+86



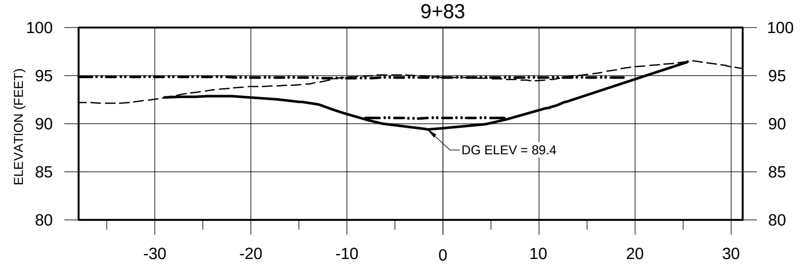
10+03



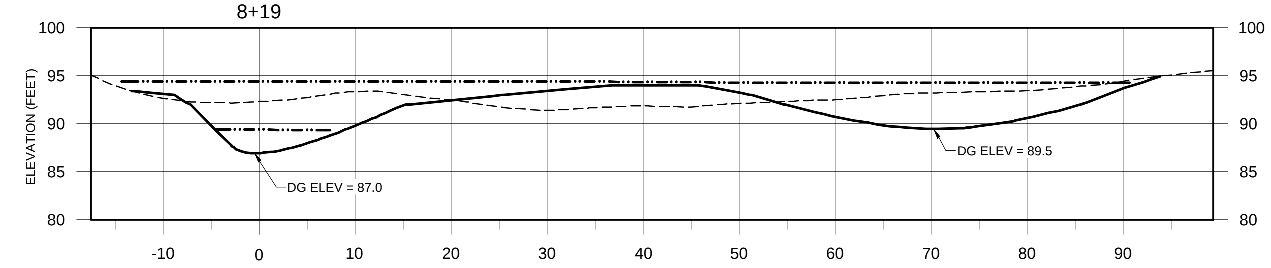
8+53



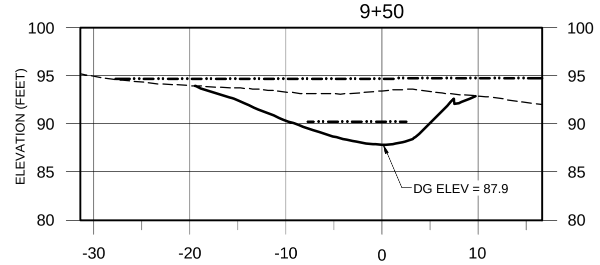
9+83



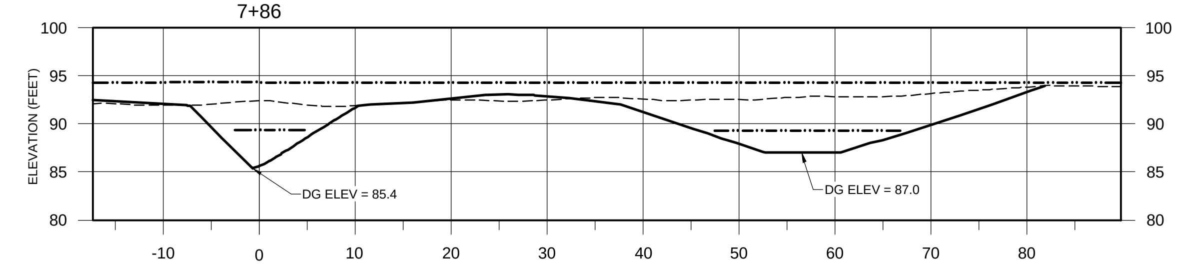
8+19



9+50



7+86



SECTIONS - EAST SECONDARY CHANNEL (LINE 4A-1) - STA 7+86 TO 10+39

HORIZONTAL SCALE: 1"= 10'
VERTICAL SCALE: 1"=10'

0 5' 1" = 10' 20'
HORIZONTAL SCALE

0 5' 1" = 10' 20'
VERTICAL SCALE

BAR LENGTH ON ORIGINAL DRAWING EQUALS ONE INCH. ADJUST SCALE ACCORDINGLY

NOTES

1. GRADING SECTIONS ARE ORIENTED UPSTREAM.
2. BLEND TO CONFORM TO EXISTING GRADE AT LIMIT OF GRADING.

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SONOMA COUNTY WATER AGENCY

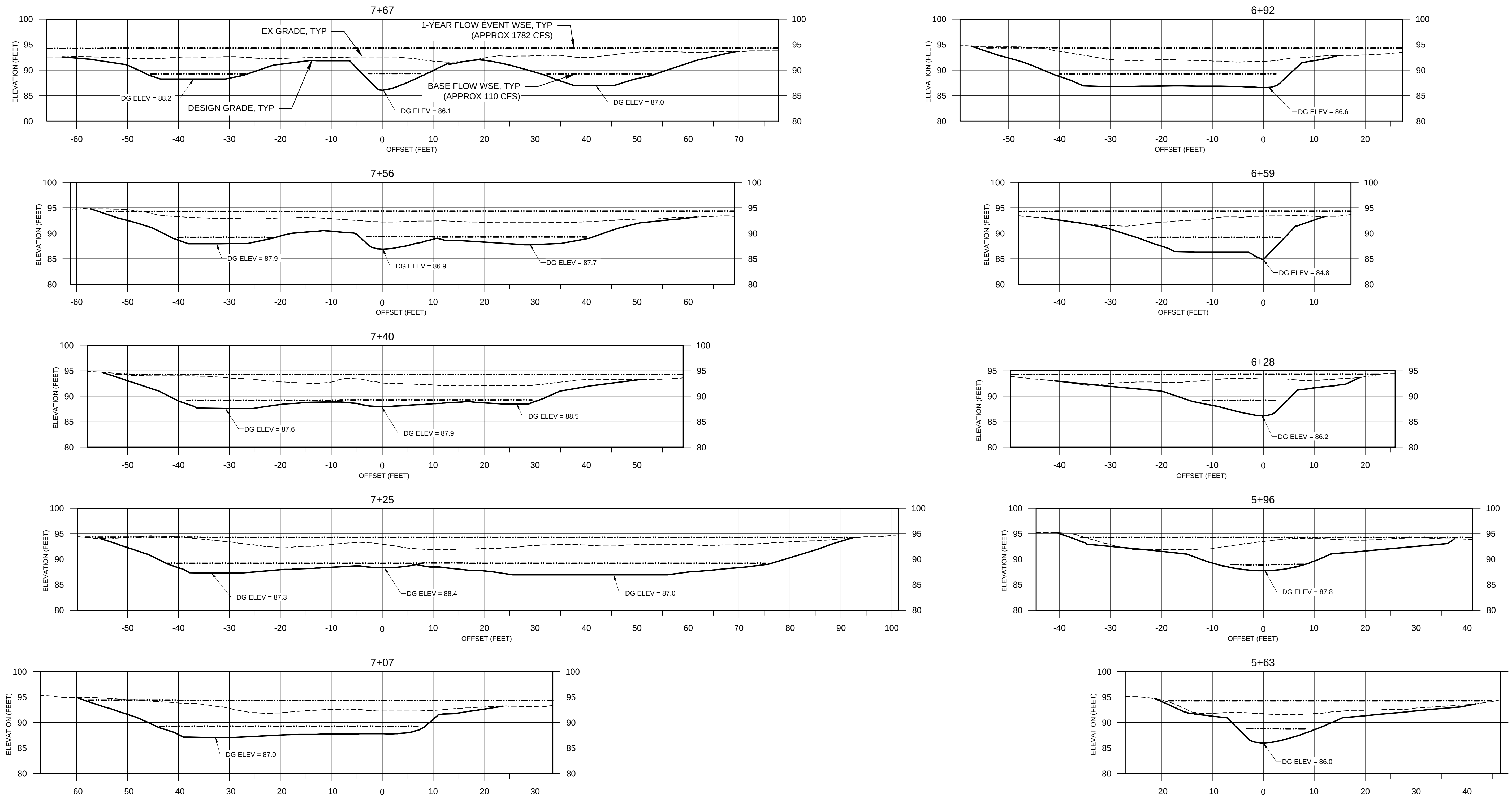
SCALE: 1" = 10'
DATE: 09/18/2015
DRAWN: JW, AF
REVIEWED:

DRY CREEK HABITAT ENHANCEMENT PHASE III, MILE THREE - REACH 4 & 5

SITE 4A GRADING SECTIONS-1

FILE NAME: 7351-DRY-CREEK-REACH-4A-GRADING.dwg
CONTRACT NUMBER: 7351

DRAWING NUMBER: C-03



SECTIONS - EAST SECONDARY CHANNEL (LINE 4A-1) - STA 5+63 TO 7+67

HORIZONTAL SCALE: 1"= 10'
VERTICAL SCALE: 1"=10'

0 5' 1" = 10' 20'
HORIZONTAL SCALE

0 5' 1" = 10' 20'
VERTICAL SCALE

BAR LENGTH ON ORIGINAL DRAWING EQUALS ONE INCH. ADJUST SCALE ACCORDINGLY

NOTES

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SCALE: 1" = 10'
DATE: 09/18/2015
DRAWN: JW, AF
REVIEWED:

DRY CREEK HABITAT ENHANCEMENT PHASE III, MILE THREE - REACH 4 & 5

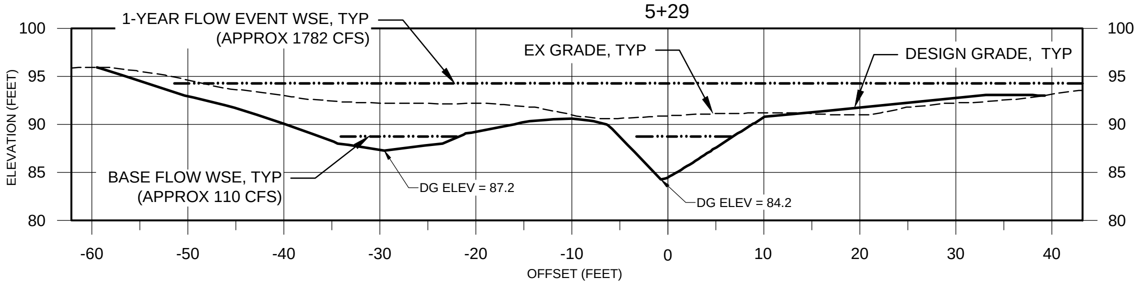
SITE 4A GRADING SECTIONS-2

FILE NAME: 7351-DRY-CREEK-REACH-4A-GRADING.dwg
CONTRACT NUMBER: 7351

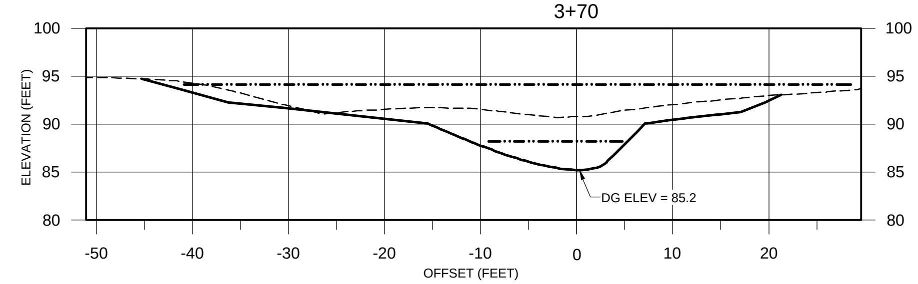
DRAWING NUMBER: C-04

SHEET 18 OF 56

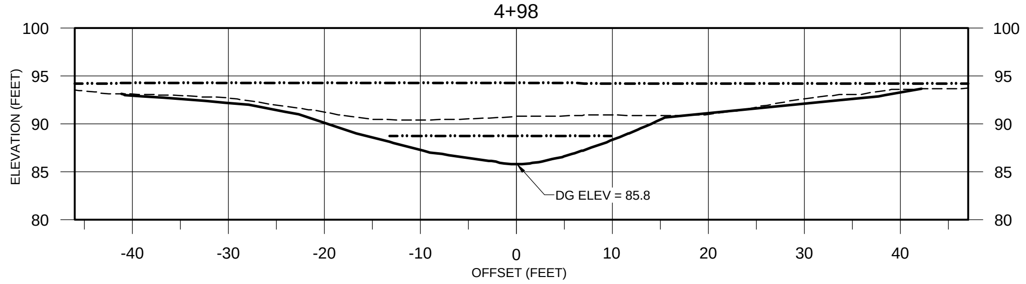
5+29



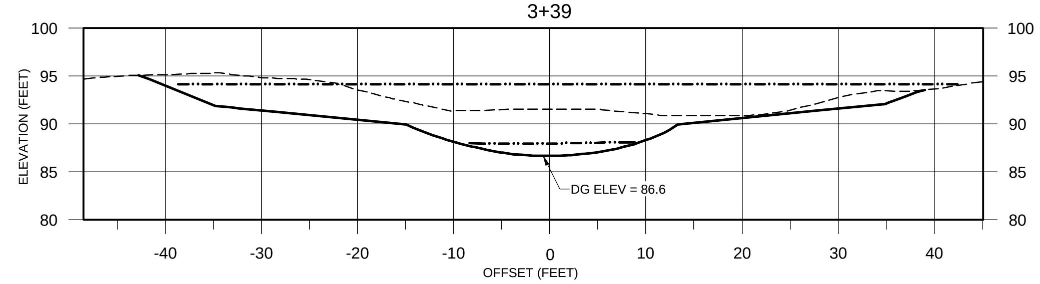
3+70



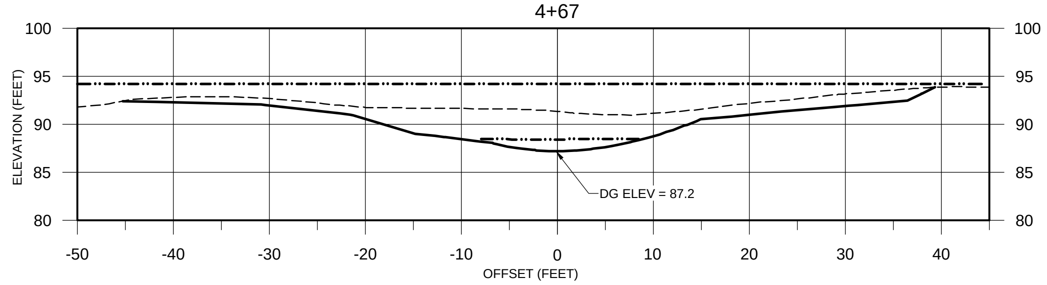
4+98



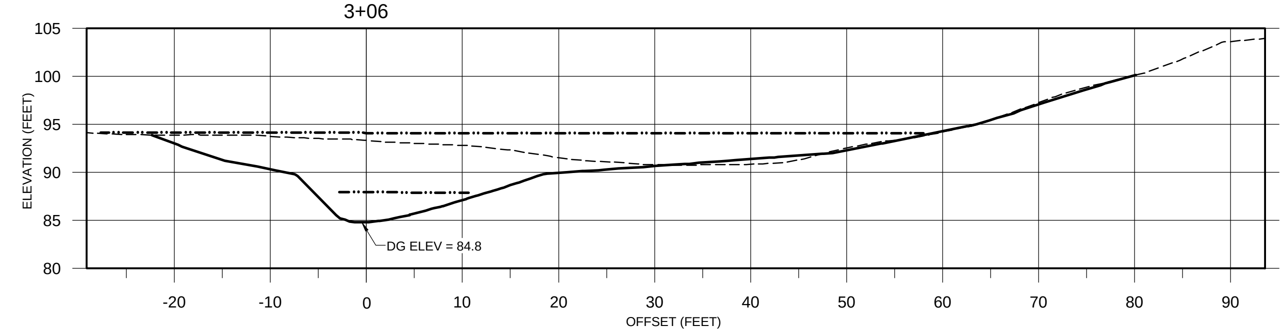
3+39



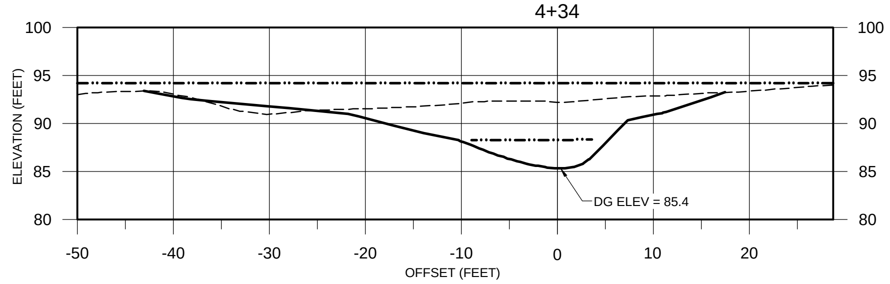
4+67



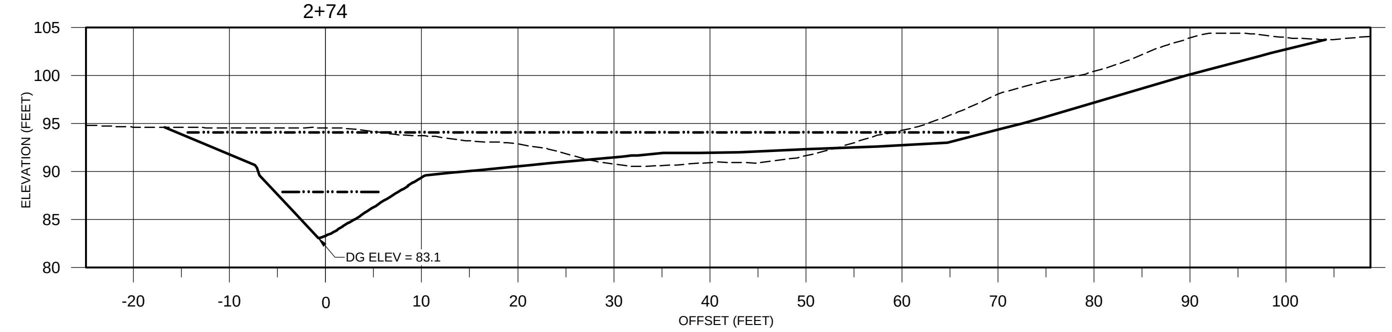
3+06



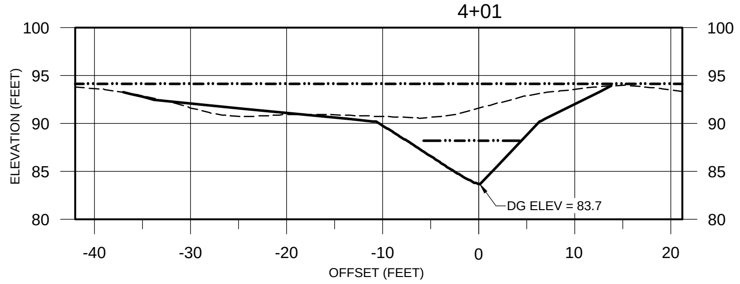
4+34



2+74



4+01



SECTIONS - EAST SECONDARY CHANNEL (LINE 4A-1) - STA 2+74 TO 5+29

HORIZONTAL SCALE: 1"= 10'
VERTICAL SCALE: 1"=10'

0 5' 1" = 10' 20'
HORIZONTAL SCALE

0 5' 1" = 10' 20'
VERTICAL SCALE

BAR LENGTH ON ORIGINAL DRAWING EQUALS ONE INCH. ADJUST SCALE ACCORDINGLY

NOTES

1. GRADING SECTIONS ARE ORIENTED UPSTREAM.
2. BLEND TO CONFORM TO EXISTING GRADE AT LIMIT OF GRADING.

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SONOMA COUNTY WATER AGENCY

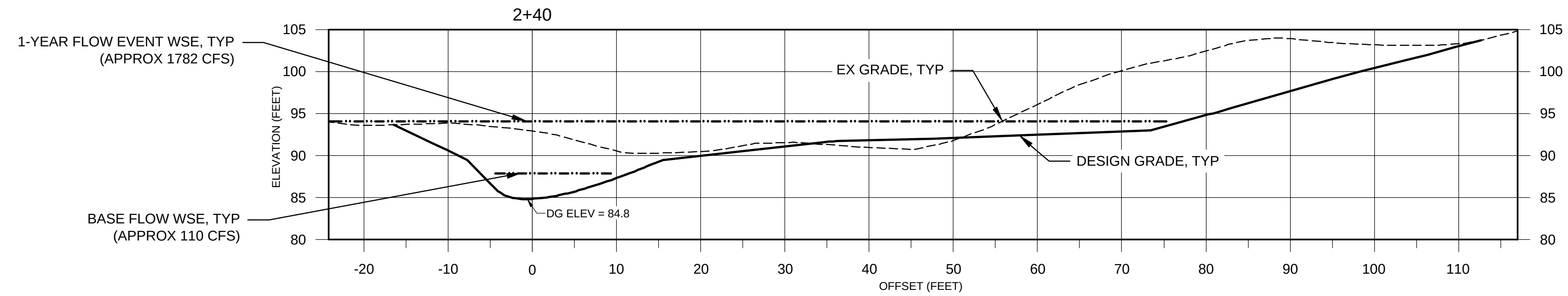
SCALE: 1" = 10'
DATE: 09/18/2015
DRAWN: JW, AF
REVIEWED:

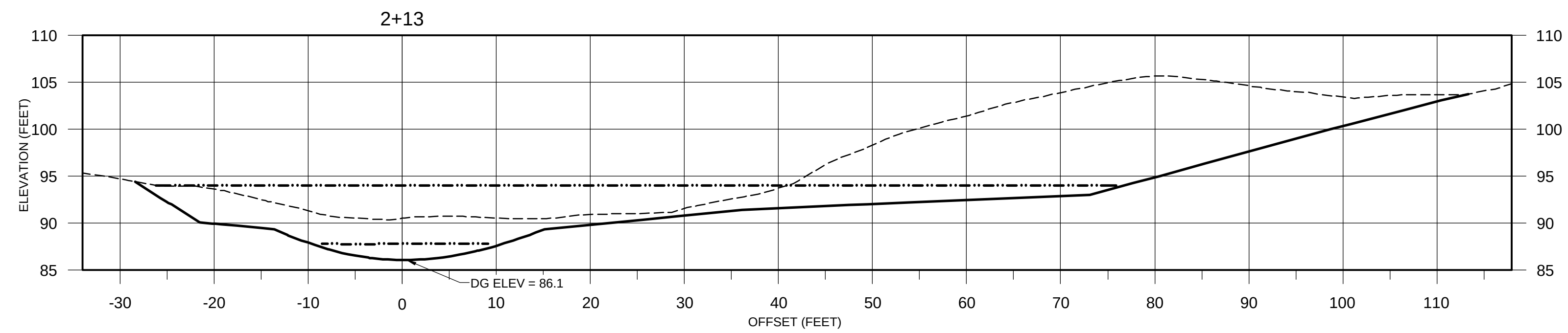
DRY CREEK HABITAT ENHANCEMENT PHASE III, MILE THREE - REACH 4 & 5
SITE 4A GRADING SECTIONS-3

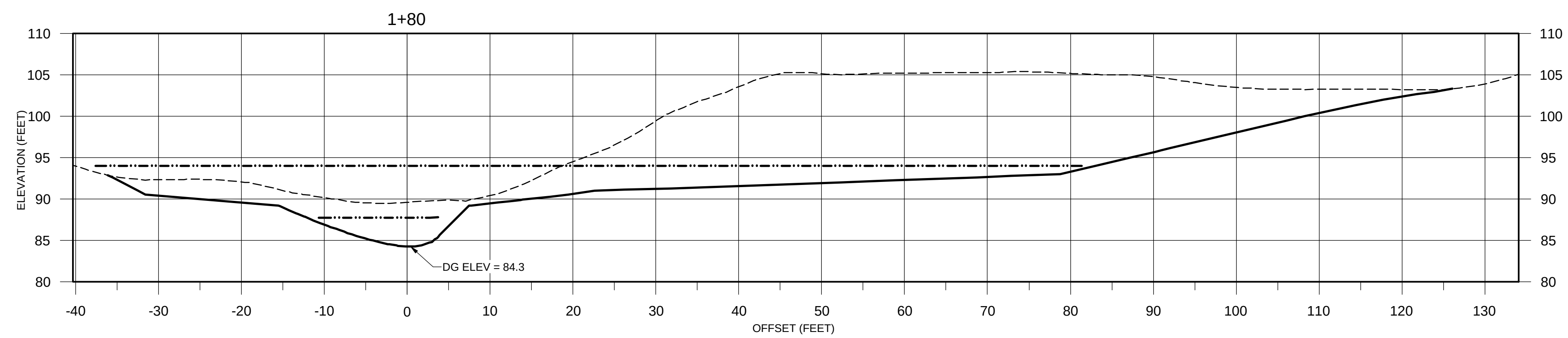
FILE NAME: 7351-DRY-CREEK-REACH-4A-GRADING.dwg
CONTRACT NUMBER: 7351

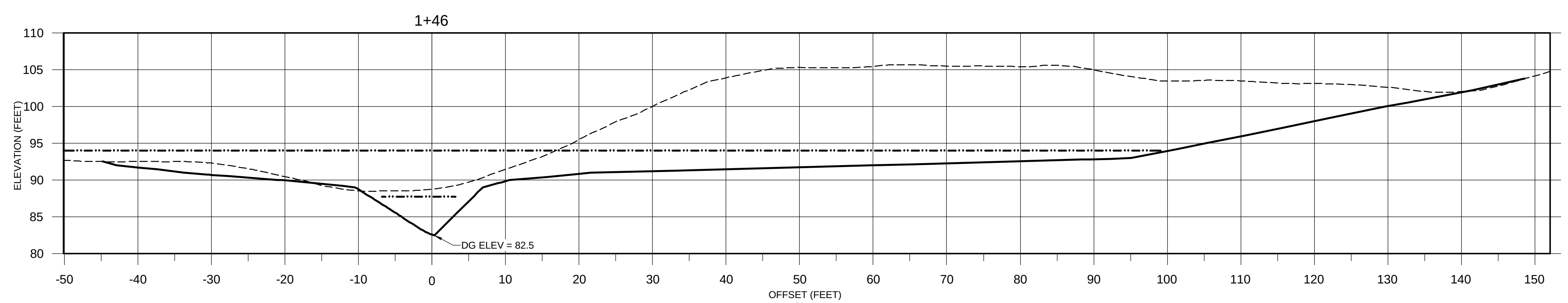
DRAWING NUMBER: C-05

SHEET 19 OF 56









SECTIONS - EAST SECONDARY CHANNEL (LINE 4A-1) STA 1+46 TO 2+40

HORIZONTAL SCALE: 1"= 10'
VERTICAL SCALE: 1"=10'

0 5' 1" = 10' 20'
HORIZONTAL SCALE

0 5' 1" = 10' 20'
VERTICAL SCALE

BAR LENGTH ON ORIGINAL DRAWING EQUALS ONE INCH. ADJUST SCALE ACCORDINGLY

NOTES

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2. BLEND TO CONFORM TO EXISTING GRADE AT LIMIT OF GRADING.

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SCALE: 1" = 10'
DATE: 09/18/2015
DRAWN: JW, AF
REVIEWED:

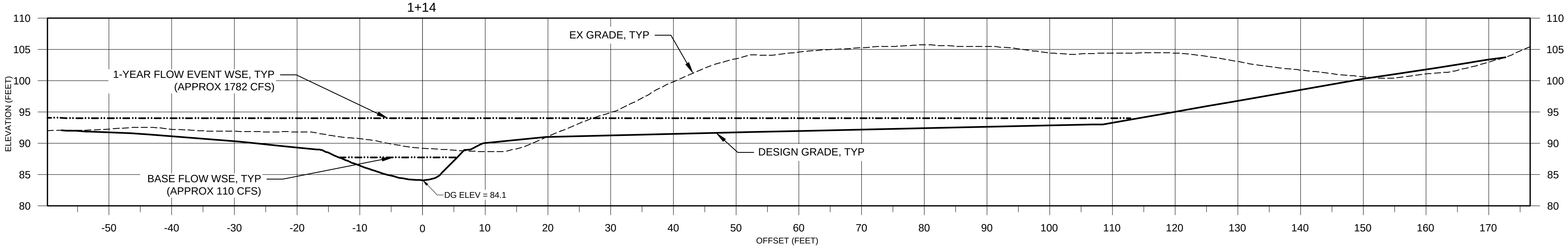
DRY CREEK HABITAT ENHANCEMENT PHASE III, MILE THREE - REACH 4 & 5

SITE 4A GRADING SECTIONS-4

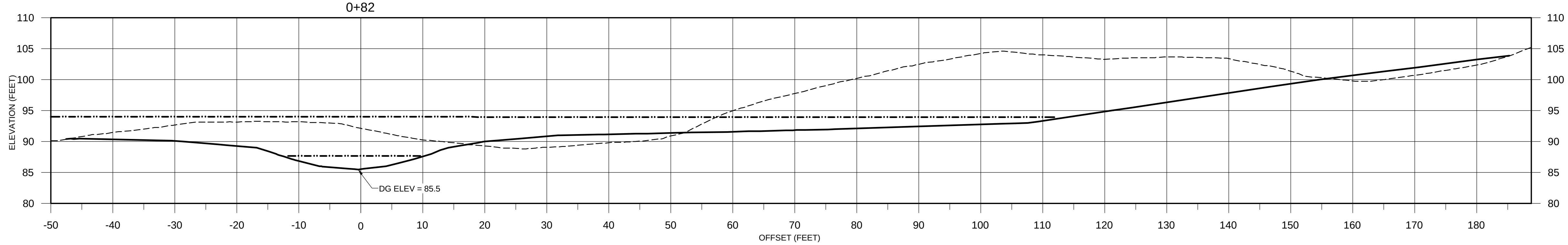
FILE NAME: 7351-DRY-CREEK-REACH-4A-GRADING.dwg
CONTRACT NUMBER: 7351

DRAWING NUMBER: C-06

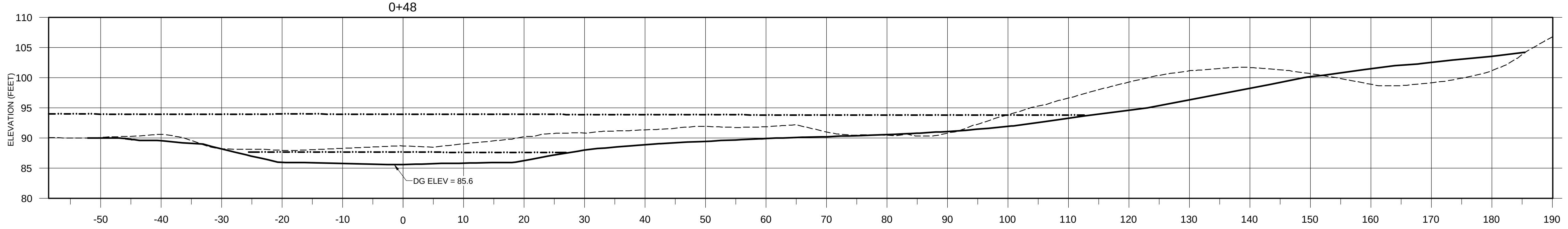
1+14



0+82



0+48



SECTIONS - EAST SECONDARY CHANNEL (LINE 4A-1) STA 0+48 TO 1+14

HORIZONTAL SCALE: 1"= 10'
VERTICAL SCALE: 1"=10'

0 5' 1" = 10' 20'
HORIZONTAL SCALE

0 5' 1" = 10' 20'
VERTICAL SCALE

BAR LENGTH ON ORIGINAL DRAWING EQUALS ONE INCH. ADJUST SCALE ACCORDINGLY

NOTES

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SONOMA COUNTY WATER AGENCY

SCALE: 1" = 10'
DATE: 09/18/2015
DRAWN: JW, AF
REVIEWED:

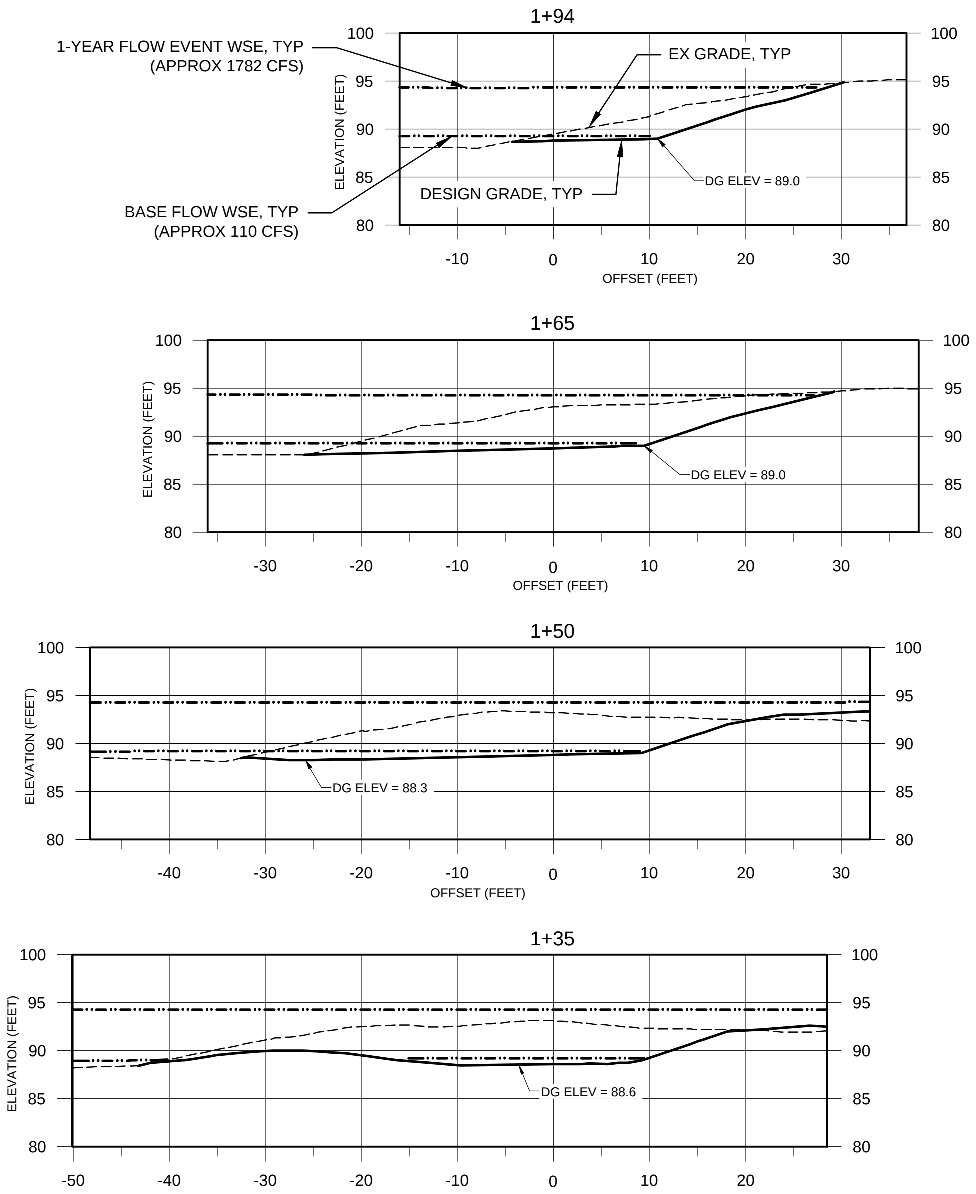
DRY CREEK HABITAT ENHANCEMENT PHASE III, MILE THREE - REACH 4 & 5

SITE 4A GRADING SECTIONS-5

FILE NAME: 7351-DRY-CREEK-REACH-4A-GRADING.dwg
CONTRACT NUMBER: 7351

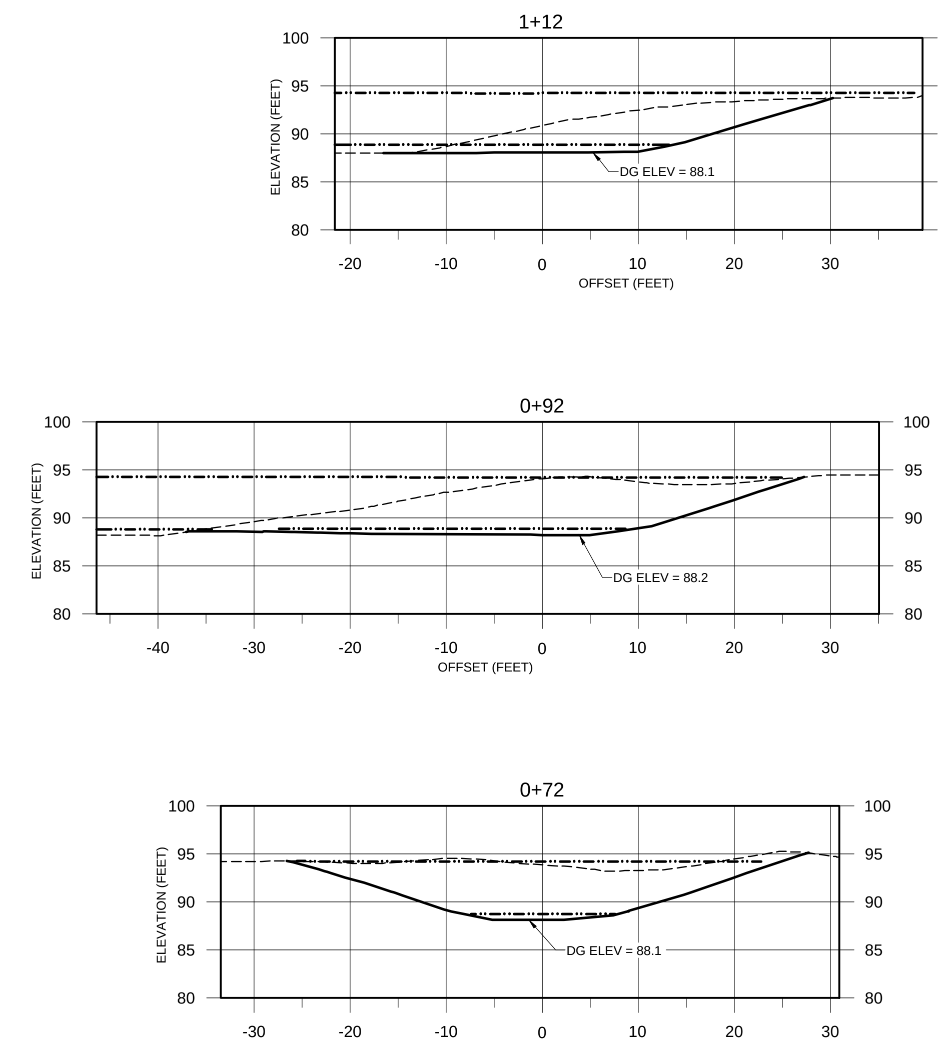
DRAWING NUMBER: C-07

SHEET 21 OF 56



SECTIONS - U/S MID CONNECTION (LINE 4A-3)

HORIZONTAL SCALE: 1"= 10'
VERTICAL SCALE: 1"=10'



SECTIONS - D/S MID CONNECTION (LINE 4A-2)

HORIZONTAL SCALE: 1"= 10'
VERTICAL SCALE: 1"=10'

0 5' 1" = 10' 20'
HORIZONTAL SCALE

0 5' 1" = 10' 20'
VERTICAL SCALE

BAR LENGTH ON ORIGINAL DRAWING EQUALS ONE INCH. ADJUST SCALE ACCORDINGLY

NOTES

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2. BLEND TO CONFORM TO EXISTING GRADE AT LIMIT OF GRADING.

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SONOMA COUNTY WATER AGENCY

SCALE: 1" = 10'
DATE: 09/18/2015
DRAWN: JW, AF
REVIEWED:

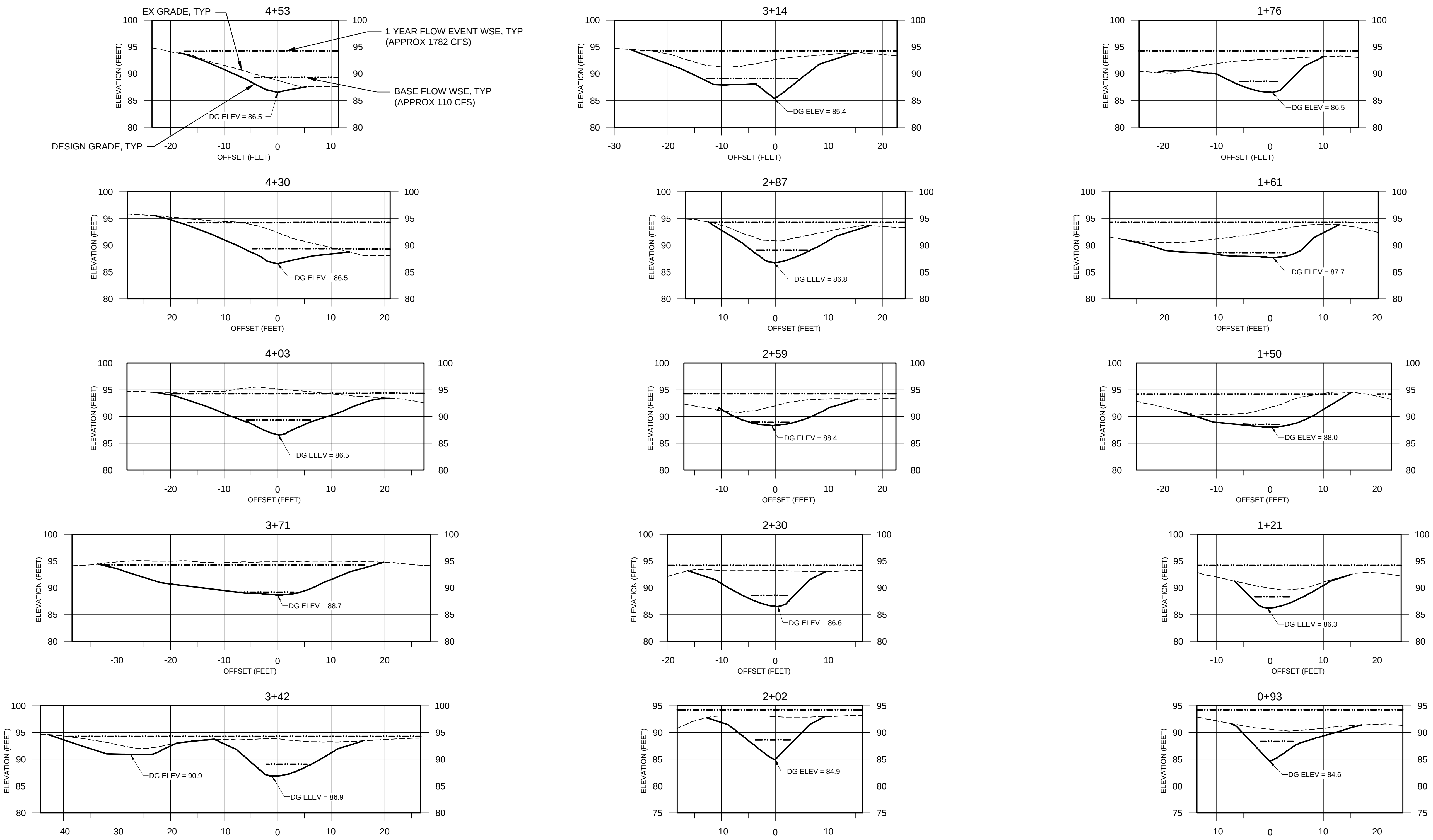
DRY CREEK HABITAT ENHANCEMENT PHASE III, MILE THREE - REACH 4 & 5

SITE 4A GRADING SECTIONS-6

FILE NAME: 7351-DRY-CREEK-REACH-4A-GRADING.dwg
CONTRACT NUMBER: 7351

DRAWING NUMBER: C-08

SHEET 22 OF 56



SECTIONS - WEST SECONDARY CHANNEL (LINE 4A-5) - STA 0+93 TO 4+53

HORIZONTAL SCALE: 1"= 10'
VERTICAL SCALE: 1"=10'

0 5' 1" = 10' 20'
HORIZONTAL SCALE

0 5' 1" = 10' 20'
VERTICAL SCALE

BAR LENGTH ON ORIGINAL DRAWING EQUALS ONE INCH. ADJUST SCALE ACCORDINGLY

NOTES

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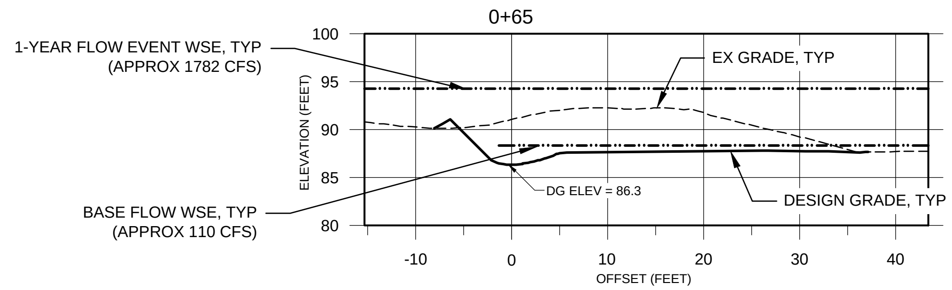
SONOMA COUNTY WATER AGENCY

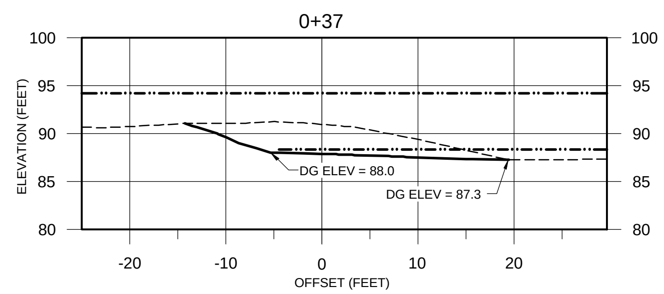
SCALE: 1" = 10'
DATE: 09/18/2015
DRAWN: JW, AF
REVIEWED:

DRY CREEK HABITAT ENHANCEMENT PHASE III, MILE THREE - REACH 4 & 5
SITE 4A GRADING SECTIONS-7

FILE NAME: 7351-DRY-CREEK-REACH-4A-GRADING.dwg
CONTRACT NUMBER: 7351
DRAWING NUMBER: C-09
SHEET 23 OF 56

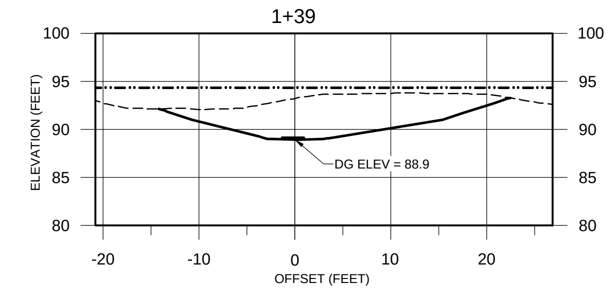
SECTIONS - WEST SECONDARY CHANNEL (LINE 4A-5) - STA 0+65 TO 0+37

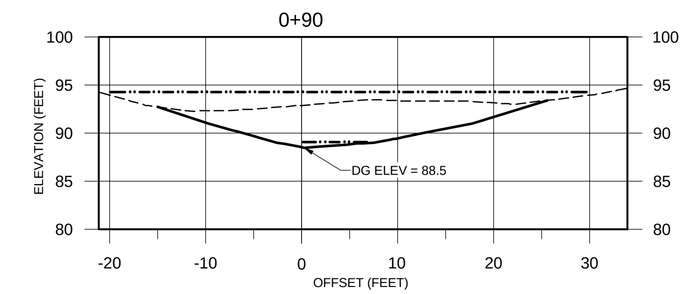


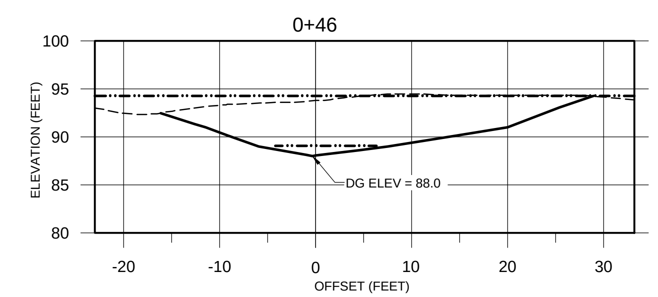


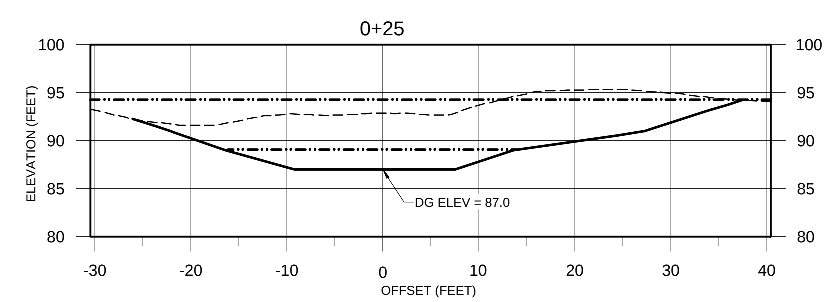
SECTIONS - WEST SECONDARY CHANNEL (LINE 4A-5) - STA 0+65 TO 0+37

HORIZONTAL SCALE: 1"= 10'
VERTICAL SCALE: 1"=10'









SECTIONS - WEST SECONDARY CHANNEL ALCOVE (LINE 4A-6)

HORIZONTAL SCALE: 1"= 10'
VERTICAL SCALE: 1"=10'

0 5' 1" = 10' 20'
HORIZONTAL SCALE

0 5' 1" = 10' 20'
VERTICAL SCALE

BAR LENGTH ON ORIGINAL DRAWING EQUALS ONE INCH. ADJUST SCALE ACCORDINGLY

NOTES

1. GRADING SECTIONS ARE ORIENTED UPSTREAM.
2. BLEND TO CONFORM TO EXISTING GRADE AT LIMIT OF GRADING.

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SONOMA COUNTY WATER AGENCY

SCALE: 1" = 10'
DATE: 09/18/2015
DRAWN: JW, AF
REVIEWED:

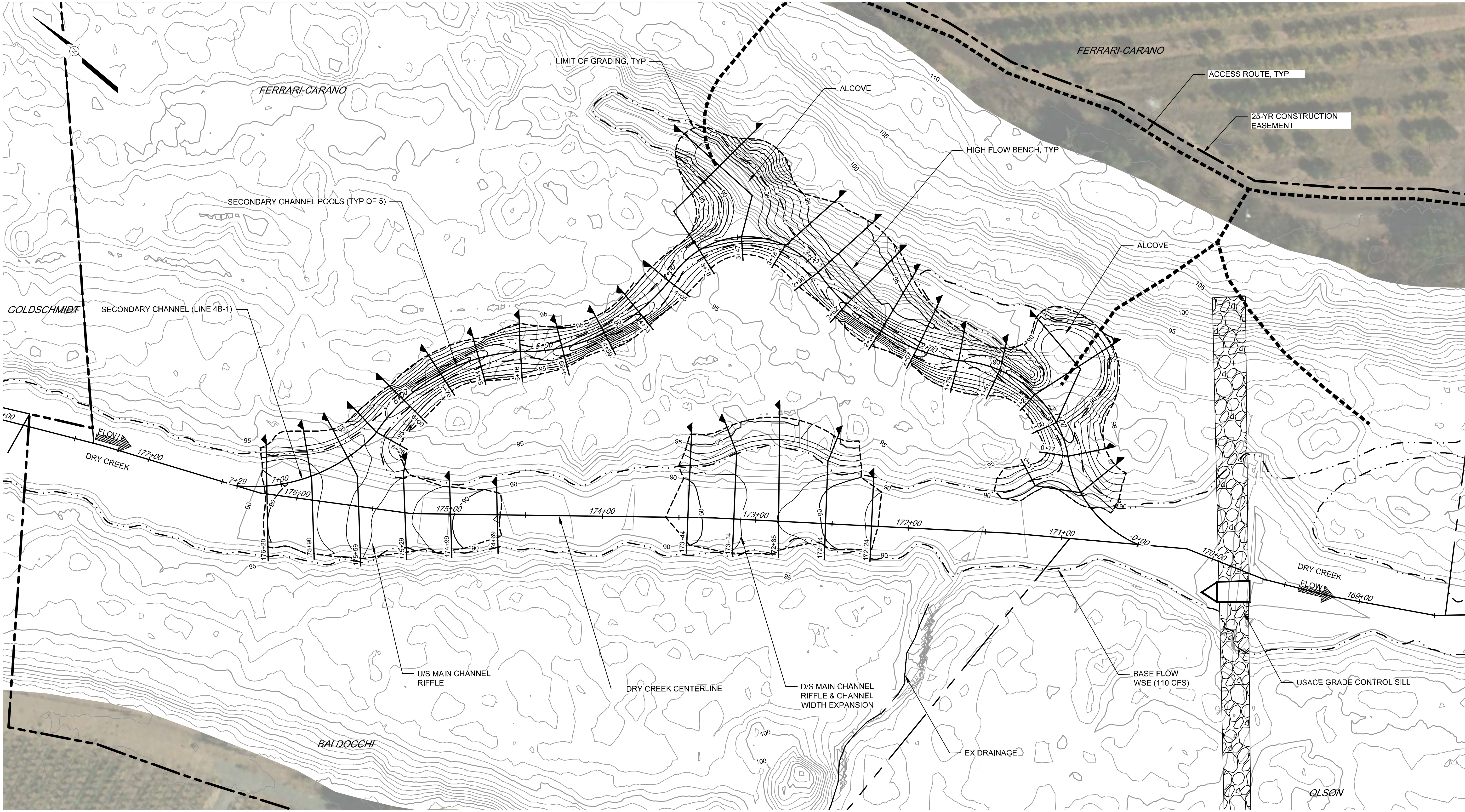
DRY CREEK HABITAT ENHANCEMENT PHASE III, MILE THREE - REACH 4 & 5

SITE 4A GRADING SECTIONS-8

FILE NAME: 7351-DRY-CREEK-REACH-4A-GRADING.dwg
CONTRACT NUMBER: 7351

DRAWING NUMBER: C-10

SHEET 24 OF 56



PLAN

SCALE: 1"= 30'

NOTES

1. GRADING SECTIONS ARE ORIENTED LOOKING UPSTREAM.
2. SEE DRAWING C-13 FOR GRADING PROFILES.
3. SEE DRAWINGS C-14 TO C-16 FOR GRADING SECTIONS.

0 15' 1" = 30' 60'

HORIZONTAL SCALE

BAR LENGTH ON ORIGINAL DRAWING EQUALS ONE INCH. ADJUST SCALE ACCORDINGLY

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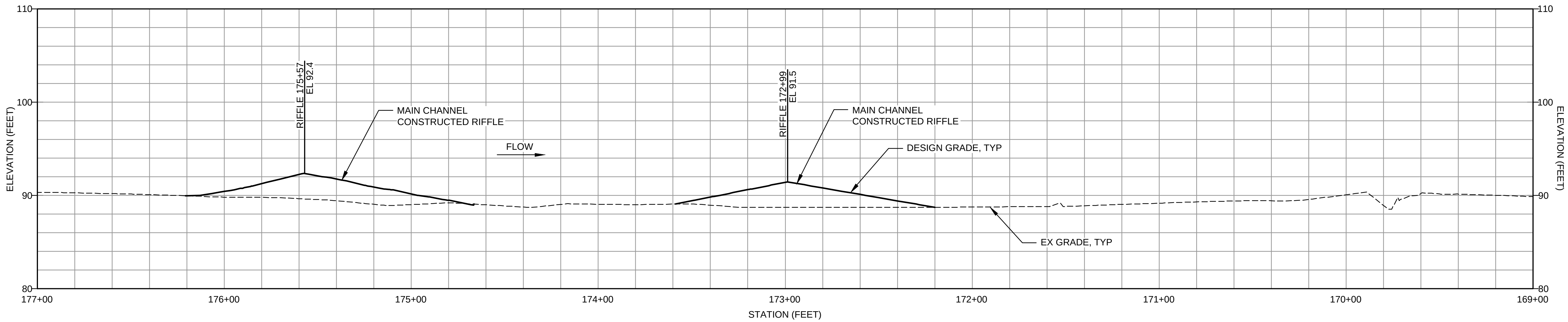
SCALE: 1" = 30'	DATE: 09/18/2015
DRAWN: AF, JW	
REVIEWED:	

DRY CREEK HABITAT ENHANCEMENT PHASE III, MILE THREE - REACH 4 & 5

SITE 4B GRADING PLAN

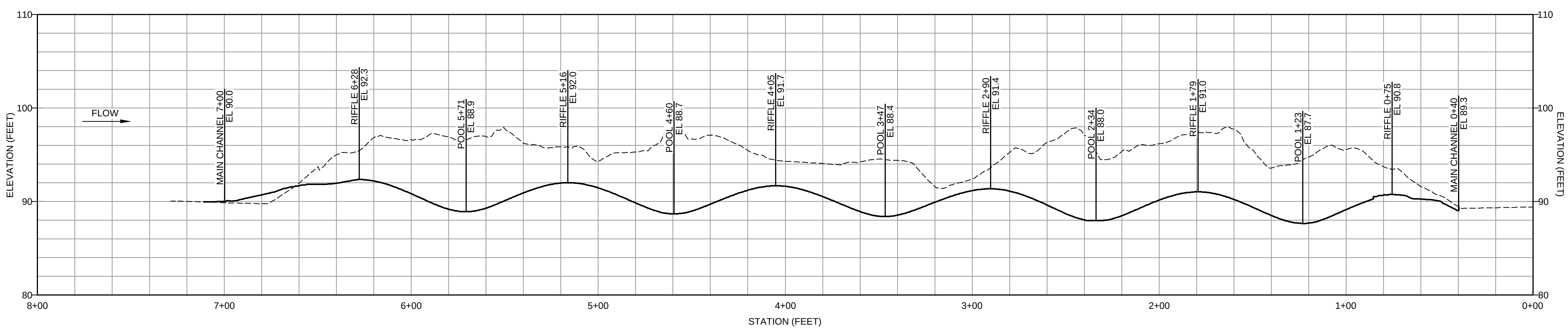
FILE NAME: 7351-DRY-CREEK-REACH-4B-GRADING.dwg
CONTRACT NUMBER: 7351

DRAWING NUMBER: C-12



PROFILE - MAIN CHANNEL (DRY CREEK CENTERLINE)

HORIZONTAL SCALE: 1"= 30'
VERTICAL SCALE: 1"=6' (5X EXAGGERATION)



PROFILE - SECONDARY CHANNEL (LINE 4B-1)

HORIZONTAL SCALE: 1"= 30'
VERTICAL SCALE: 1"=6' (5X EXAGGERATION)

0 15' 1" = 30' 60'
HORIZONTAL SCALE

0 3' 1" = 6' 12'
VERTICAL SCALE

BAR LENGTH ON ORIGINAL DRAWING EQUALS ONE INCH. ADJUST SCALE ACCORDINGLY

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NOTES

1. SEE DRAWING G-12 FOR ALIGNMENT LAYOUT.

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SONOMA COUNTY WATER AGENCY

SCALE: AS SHOWN
DATE: 09/18/2015
DRAWN: AF, JW
REVIEWED:

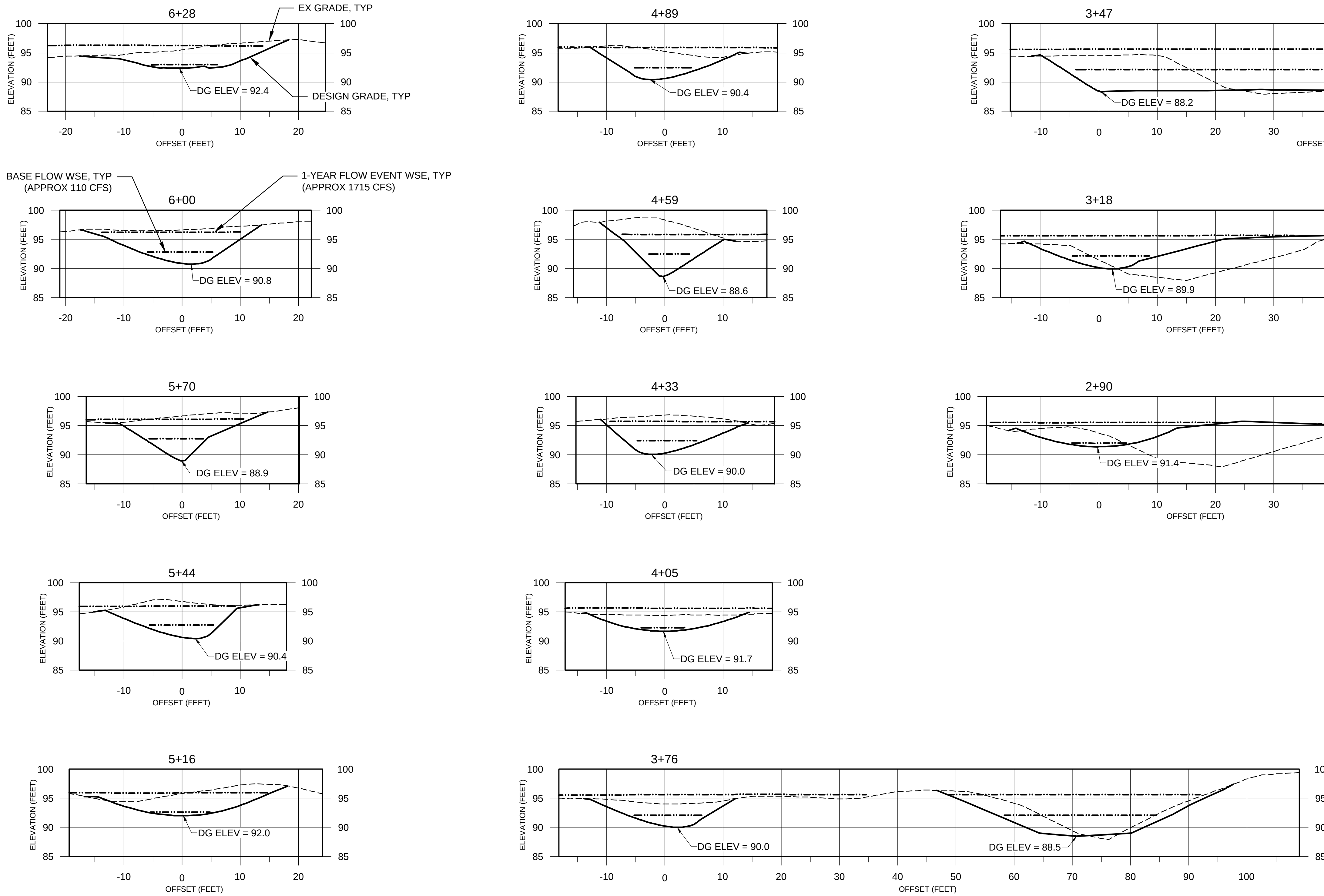
DRY CREEK HABITAT ENHANCEMENT PHASE III, MILE THREE - REACH 4 & 5

SITE 4B GRADING PROFILES

FILE NAME: 7351-DRY-CREEK-REACH-4B-GRADING.dwg
CONTRACT NUMBER: 7351

DRAWING NUMBER: C-13

SHEET 27 OF 56



SECTIONS - SECONDARY CHANNEL (LINE 4B-1) - STA 2+90 TO 6+28

HORIZONTAL SCALE: 1"= 10'
VERTICAL SCALE: 1"=10'

0 5' 1" = 10' 20'
HORIZONTAL SCALE

0 5' 1" = 10' 20'
VERTICAL SCALE

BAR LENGTH ON ORIGINAL DRAWING EQUALS ONE INCH. ADJUST SCALE ACCORDINGLY

NOTES

1. GRADING SECTIONS ARE ORIENTED LOOKING UPSTREAM.
2. BLEND TO CONFORM TO EXISTING GRADE AT LIMIT OF GRADING.

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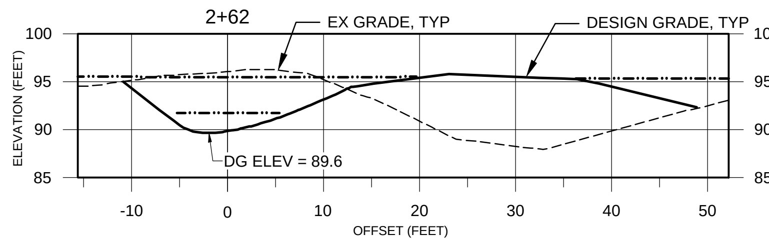
SCALE: 1" = 10'
DATE: 09/18/2015
DRAWN: AF, JW
REVIEWED:

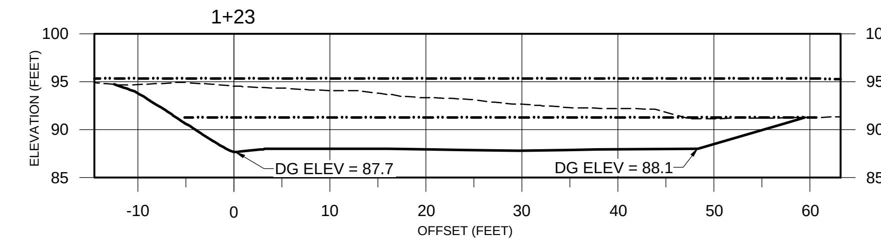
DRY CREEK HABITAT ENHANCEMENT PHASE III, MILE THREE - REACH 4 & 5

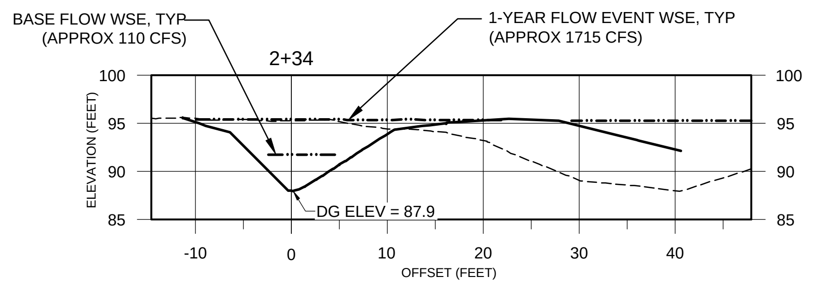
SITE 4B GRADING SECTIONS-1

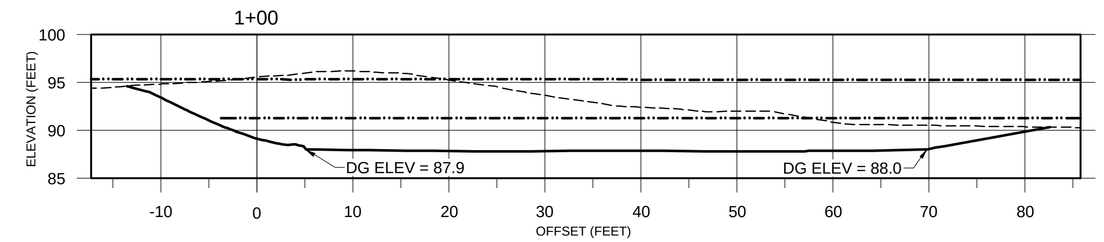
FILE NAME: 7351-DRY-CREEK-REACH-4B-GRADING.dwg
CONTRACT NUMBER: 7351

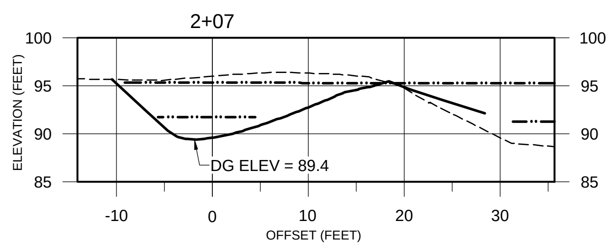
DRAWING NUMBER: C-14

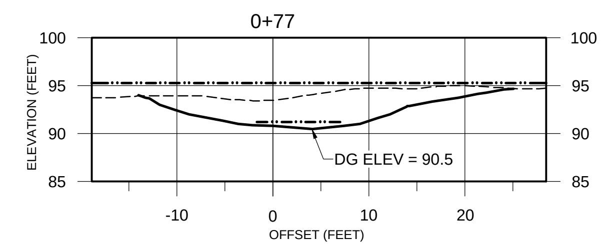


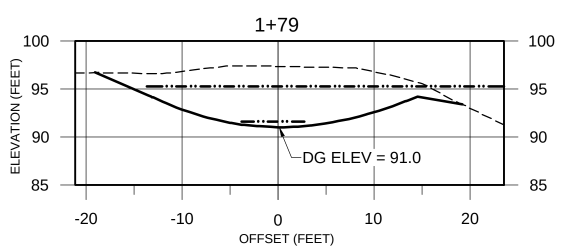


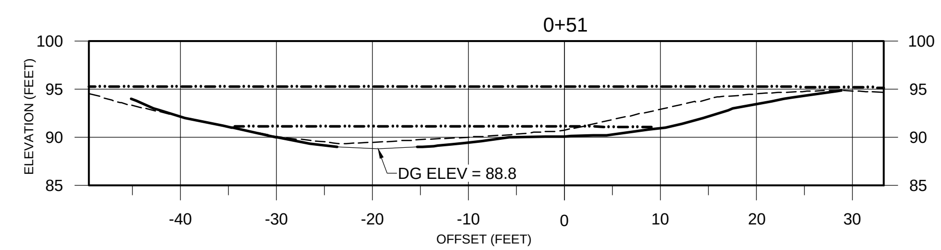


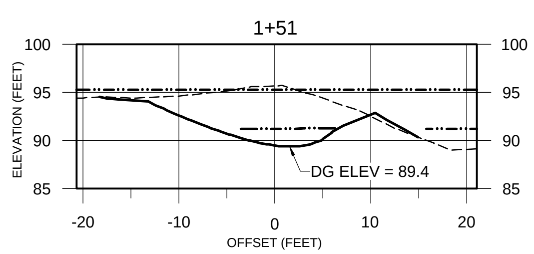












SECTIONS - SECONDARY CHANNEL (LINE 4B-1) - STA 0+51 TO 2+62

HORIZONTAL SCALE: 1"= 10'
VERTICAL SCALE: 1"=10'

0 5' 1" = 10' 20'
HORIZONTAL SCALE

0 5' 1" = 10' 20'
VERTICAL SCALE

BAR LENGTH ON ORIGINAL DRAWING EQUALS ONE INCH. ADJUST SCALE ACCORDINGLY

NOTES

1. GRADING SECTIONS ARE ORIENTED LOOKING UPSTREAM.
2. BLEND TO CONFORM TO EXISTING GRADE AT LIMIT OF GRADING.

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NO.	DATE	REVISION	BY

SONOMA COUNTY WATER AGENCY

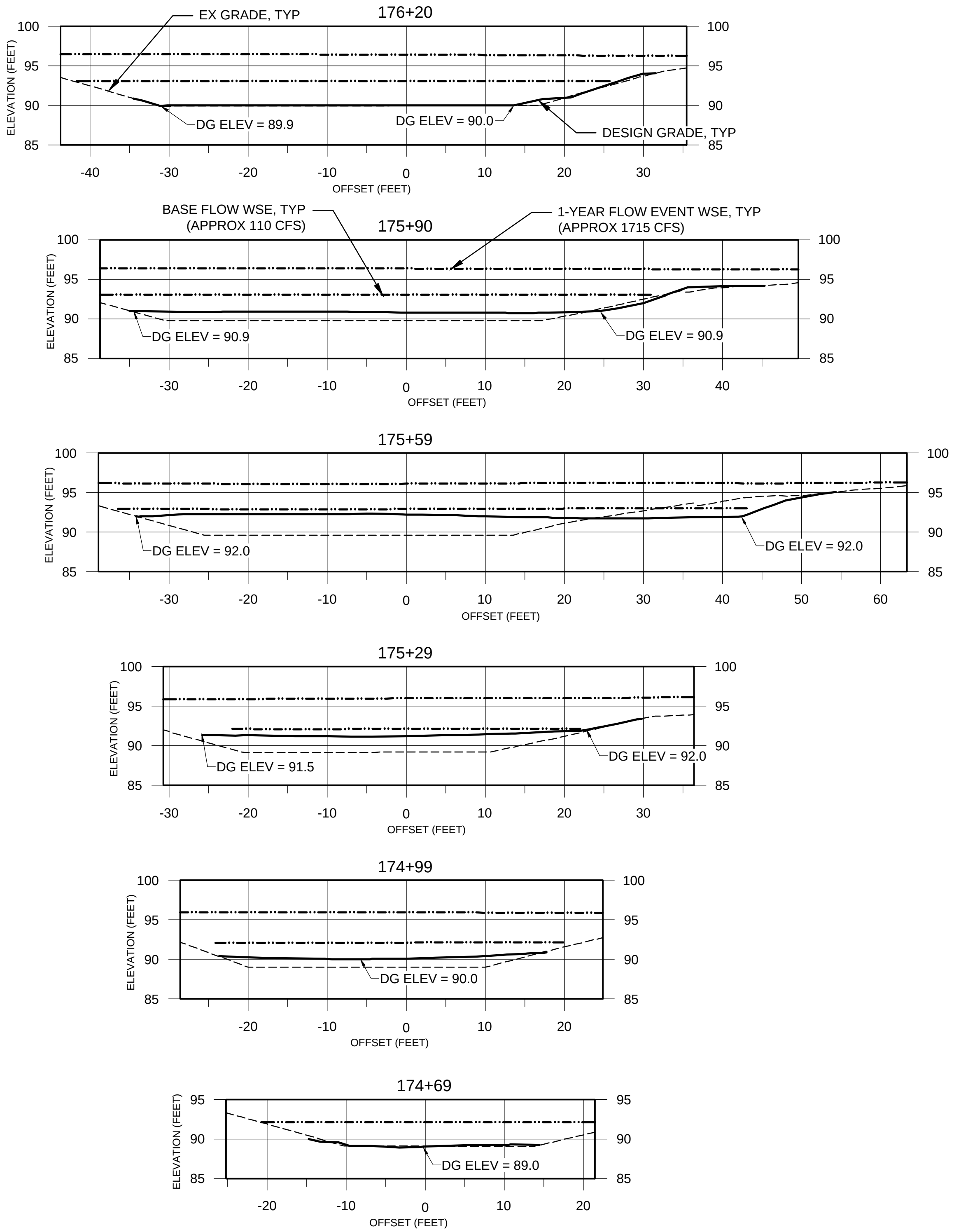
SCALE: 1" = 10'	DATE: 09/18/2015
DRAWN: AF, JW	
REVIEWED:	

DRY CREEK HABITAT ENHANCEMENT PHASE III, MILE THREE - REACH 4 & 5

SITE 4B GRADING SECTIONS-2

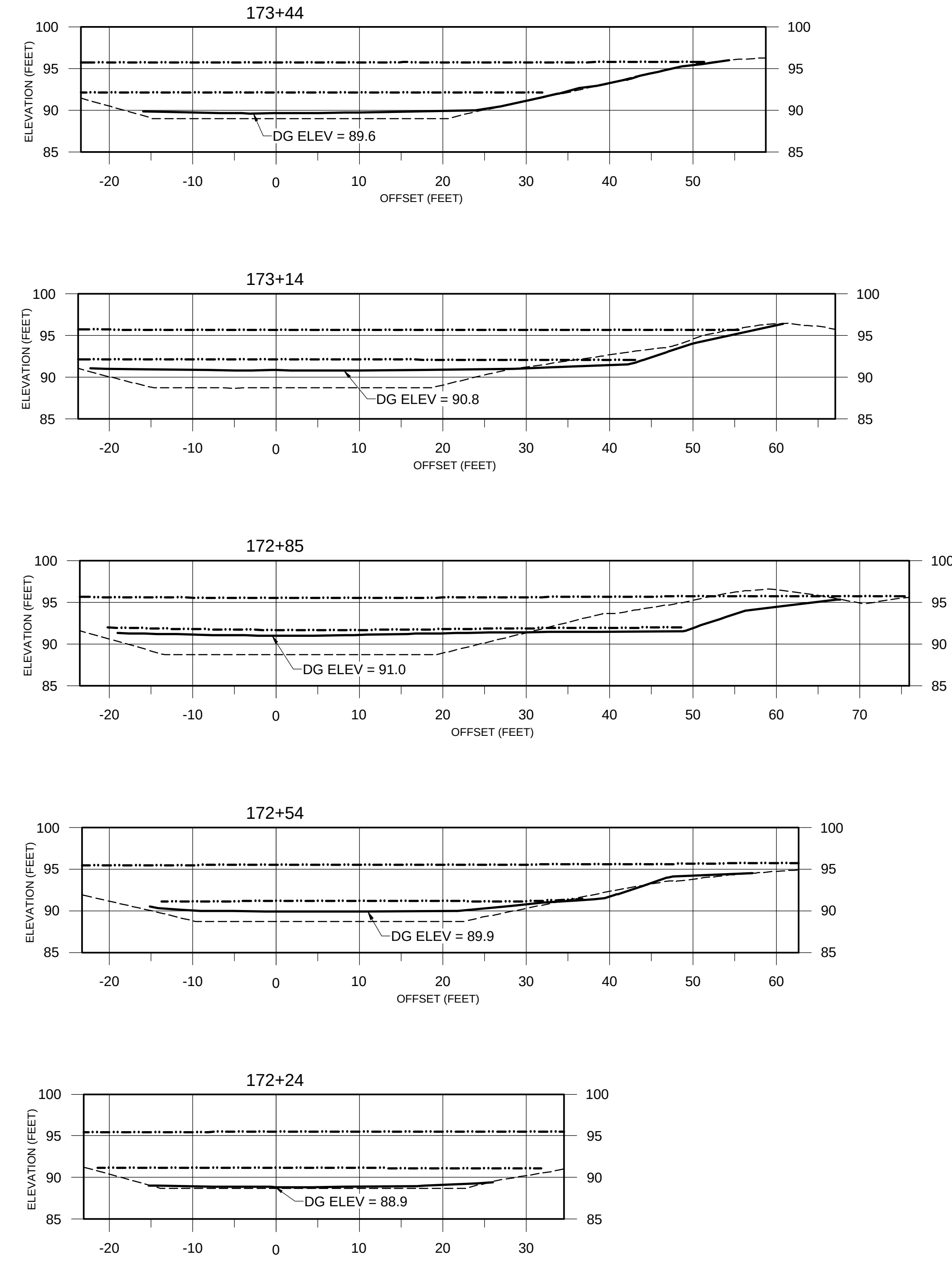
FILE NAME: 7351-DRY-CREEK-REACH-4B-GRADING.dwg
CONTRACT NUMBER: 7351

DRAWING NUMBER: C-15



SECTIONS - U/S MAIN CHANNEL CONSTRUCTED RIFFLE

HORIZONTAL SCALE: 1"= 10'
VERTICAL SCALE: 1"=10'



SECTIONS - D/S MAIN CHANNEL CONSTRUCTED RIFFLE

HORIZONTAL SCALE: 1"= 10'
VERTICAL SCALE: 1"=10'

NOTES

1. GRADING SECTIONS ARE ORIENTED LOOKING UPSTREAM.
2. BLEND TO CONFORM TO EXISTING GRADE AT LIMIT OF GRADING.

0 5' 1" = 10' 20'
HORIZONTAL SCALE

0 5' 1" = 10' 20'
VERTICAL SCALE

BAR LENGTH ON ORIGINAL DRAWING EQUALS ONE INCH. ADJUST SCALE ACCORDINGLY

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NO.	DATE	REVISION	BY

SONOMA COUNTY WATER AGENCY

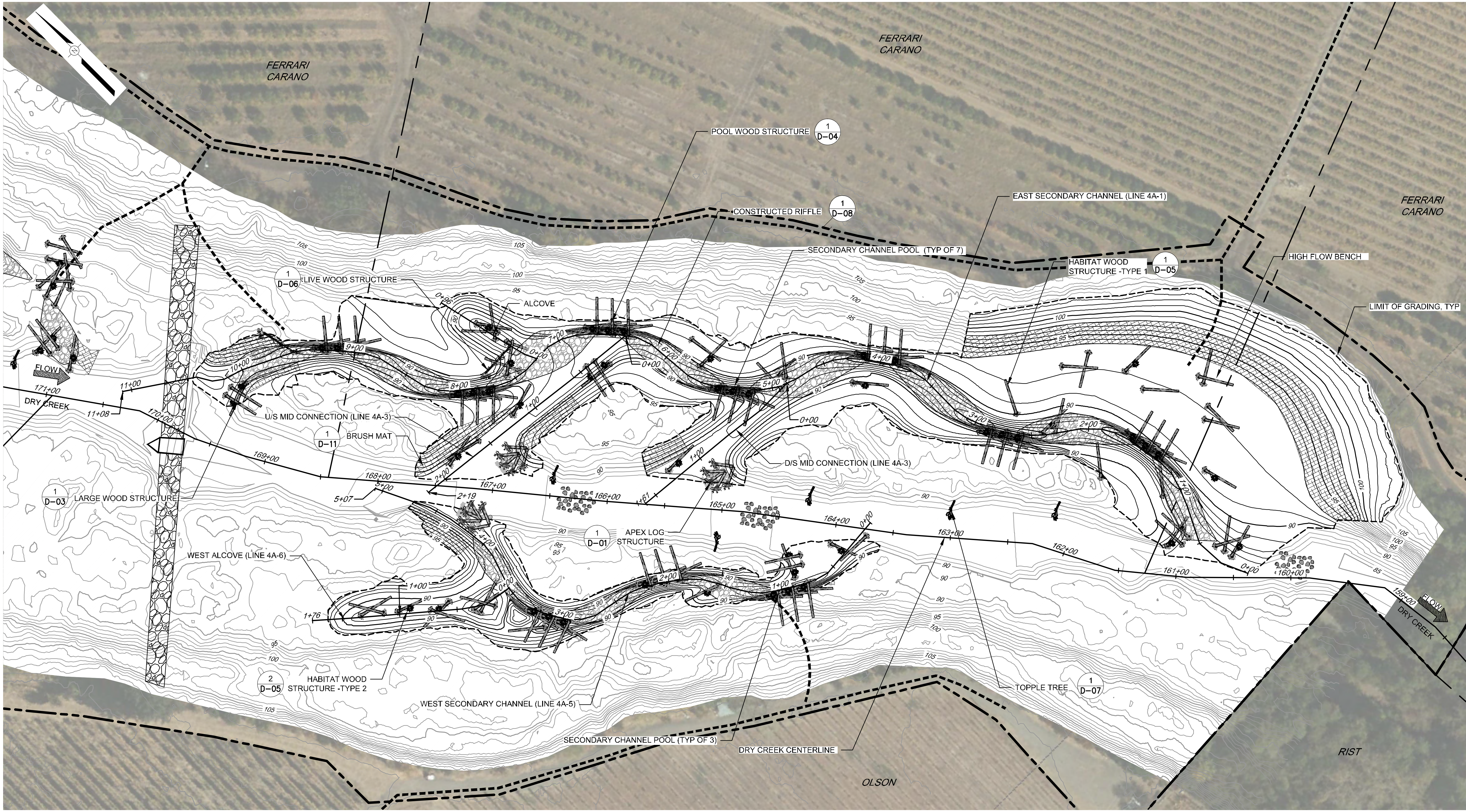
SCALE: 1" = 10'
DATE: 09/18/2015
DRAWN: AF, JW
REVIEWED:

DRY CREEK HABITAT ENHANCEMENT PHASE III, MILE THREE - REACH 4 & 5

SITE 4B GRADING SECTIONS-3

FILE NAME: 7351-DRY-CREEK-REACH-4B-GRADING.dwg
CONTRACT NUMBER: 7351
DRAWING NUMBER: C-16
SHEET 30 OF 56

Subreach 4a (Sites 4A and 4B) Preliminary Enhancement Plans



PLAN

SCALE: 1"= 40'

NOTES

1. THE LOCATION AND ORIENTATION OF SOME ENHANCEMENT FEATURES MAY REQUIRE MINOR FIELD ADJUSTMENTS DURING CONSTRUCTION.

0 20' 1" = 40' 80'

HORIZONTAL SCALE

BAR LENGTH ON ORIGINAL DRAWING EQUALS ONE INCH. ADJUST SCALE ACCORDINGLY

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SONOMA COUNTY WATER AGENCY

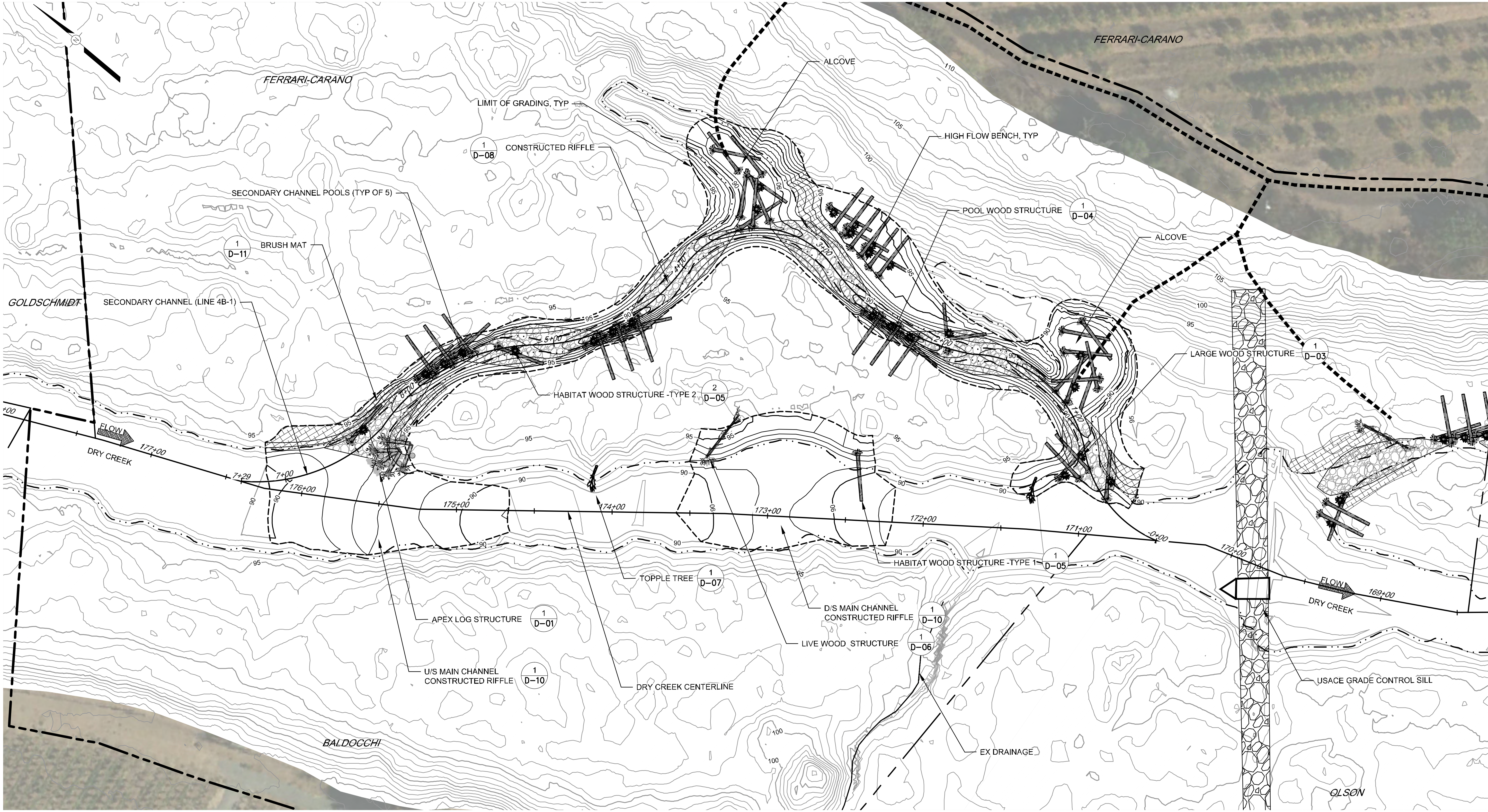
SCALE: 1" = 40' | DATE: 09/18/2015
DRAWN: PL, JW, AF
REVIEWED:

DRY CREEK HABITAT ENHANCEMENT PHASE III, MILE THREE - REACH 4 & 5

SITE 4A ENHANCEMENT PLAN

FILE NAME: 7351-DRY-CREEK-REACH-4A-FEATURES.dwg
CONTRACT NUMBER: 7351

DRAWING NUMBER: C-11



PLAN

SCALE: 1"= 30'

0 15' 1" = 30' 60'

HORIZONTAL SCALE

BAR LENGTH ON ORIGINAL DRAWING EQUALS ONE INCH. ADJUST SCALE ACCORDINGLY

NOTES

1. GRADING SECTIONS ARE ORIENTED LOOKING UPSTREAM.
2. SEE DRAWING C-13 FOR GRADING PROFILES.
3. SEE DRAWINGS C-14 TO C-16 FOR GRADING SECTIONS.

REGISTERED PROFESSIONAL ENGINEER PHILIP L. LUECKING 66113 CIVIL STATE OF CALIFORNIA

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SONOMA COUNTY WATER AGENCY

SCALE: 1" = 30'
DATE: 09/18/2015
DRAWN: PL, JW, AF
REVIEWED:

DRY CREEK HABITAT ENHANCEMENT PHASE III, MILE THREE - REACH 4 & 5

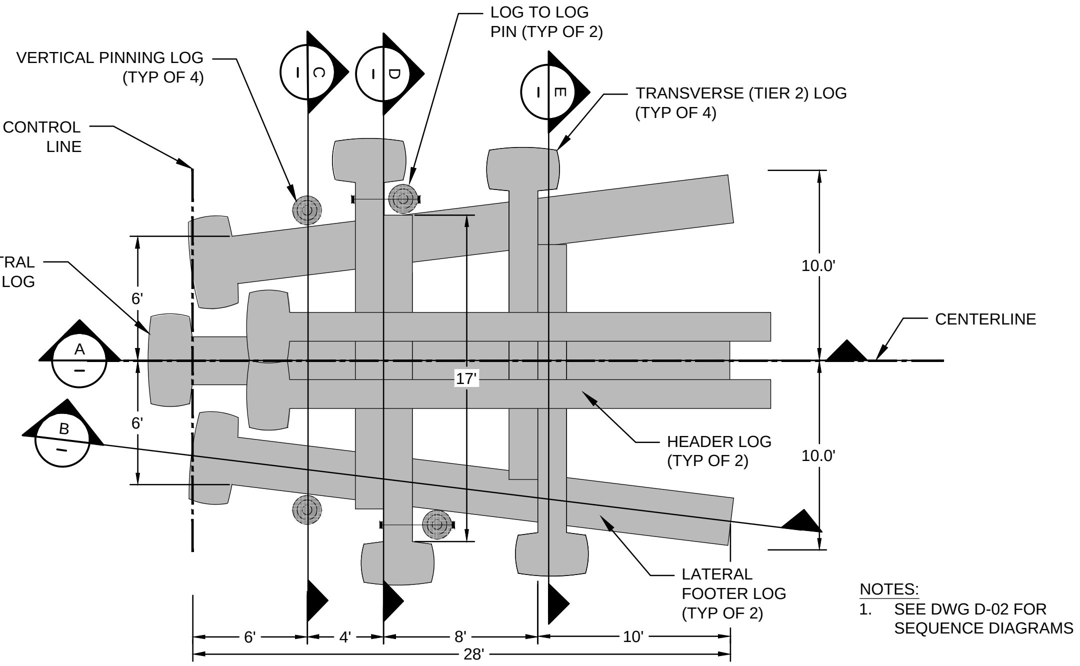
SITE 4B ENHANCEMENT PLAN

FILE NAME: 7351-DRY-CREEK-REACH-4B-FEATURES.dwg
CONTRACT NUMBER: 7351

DRAWING NUMBER: C-17

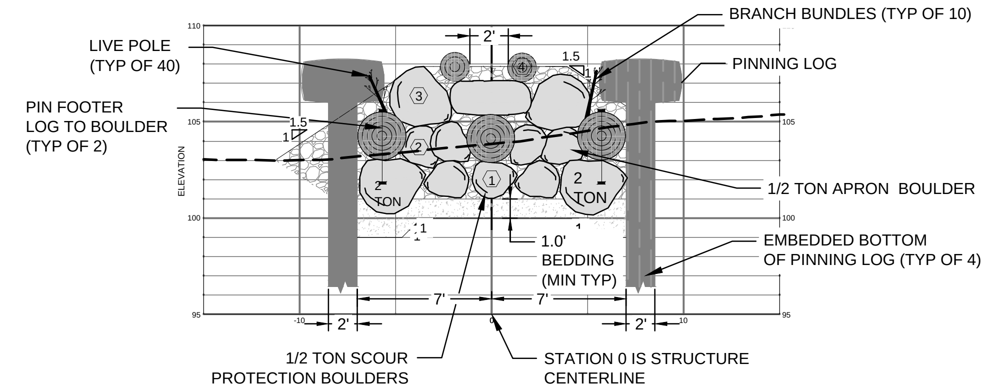
SHEET 31 OF 56

Details of Large Wood Structures

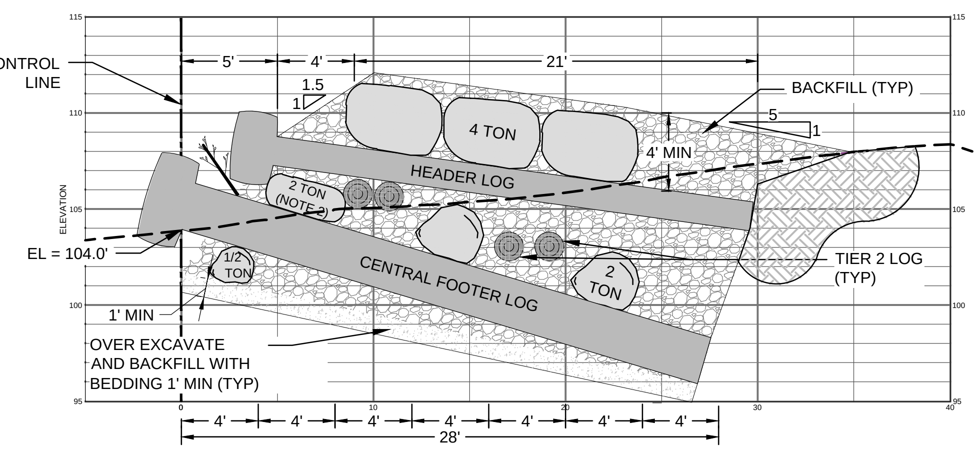


NOTES:
1. SEE DWG D-02 FOR SEQUENCE DIAGRAMS

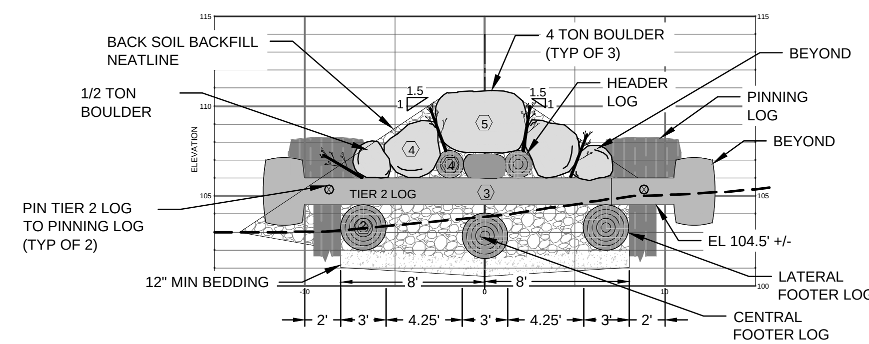
APEX LOG STRUCTURE
PLAN VIEW SCALE: 1"= 5' 1 VAR



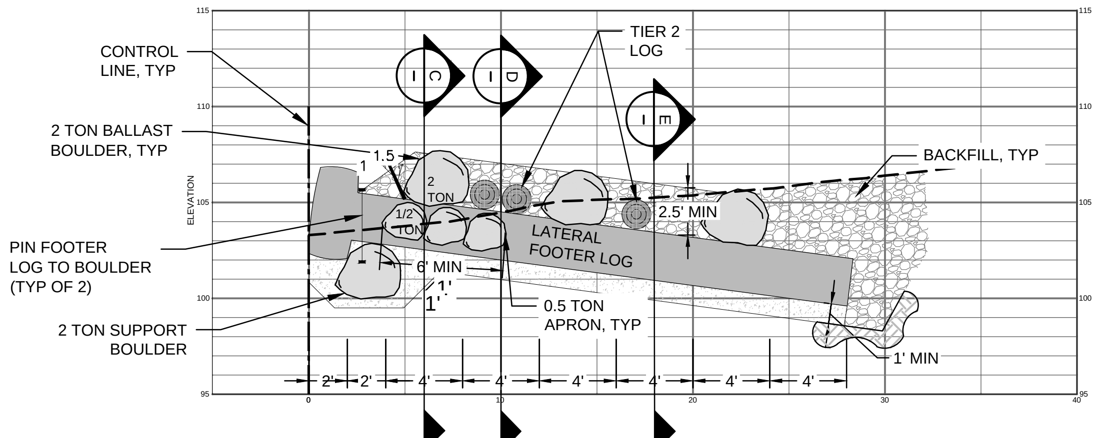
SECTION D
SCALE: 1"= 5' C VAR



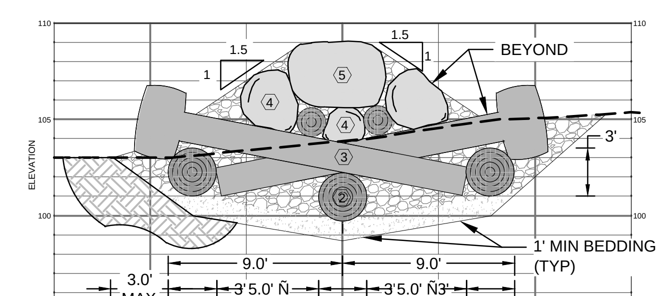
SECTION A
ALONG CENTERLINE SCALE: 1"= 5' A VAR



SECTION C
SCALE: 1"= 5' D VAR



PROFILE B
THOUGH LATERAL FOOTER LOG SCALE: 1"= 5' B VAR



SECTION E
SCALE: 1"= 5' E VAR

SHEET NOTES
1. PLACE LIVE STAKES AND BRANCH BUNDLES IN ALL CAVITIES. BACK FILL WITH SELECT NATIVE COBBLE, GRAVELS, AND SOIL.
2. ADDITIONAL SELECT FILL MAY BE REQUIRED TO PROVIDE A STABLE FOUNDATION FOR PLACEMENT OF BALLAST BOULDERS.
3. LOGS MAY BE SELECTIVELY NOTCHED TO ACHIEVE ORIENTATION AND EMBEDMENT AS SOWN OR TO PROVIDE A SUITABLE BASE FOR BALLAST BOULDER PLACEMENT. PROVIDE A FLAT BASE FOR BALLAST BOULDER PLACEMENT (3" MAX CUT).
4. ELEVATIONS ARE SHOWN IN ARBITRARY DATUM.

0 2.5' 1" = 5' 10'
SCALE
BAR LENGTH ON ORIGINAL DRAWING EQUALS ONE INCH. ADJUST SCALE ACCORDINGLY

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NO.	DATE	REVISION	BY

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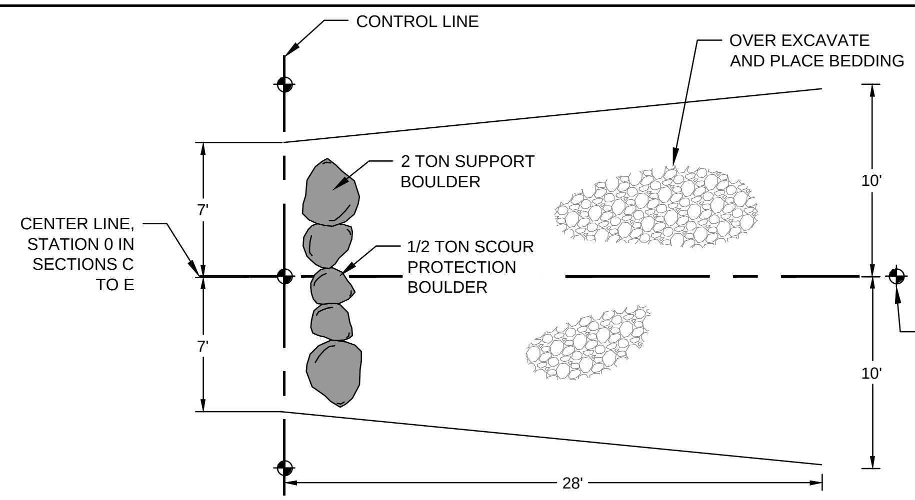
SONOMA COUNTY WATER AGENCY

SCALE: 1" = 5'
DATE: 09/18/2015
DRAWN: BT
REVIEWED:

DRY CREEK HABITAT ENHANCEMENT PHASE III, MILE THREE - REACH 4 & 5

APEX LOG STRUCTURE DETAILS (1 OF 2)

FILE NAME: 7351-DETAIL-APEX-LOG-STRUCTURE.dwg
CONTRACT NUMBER: 7351
DRAWING NUMBER: D-01
SHEET 44 OF 56

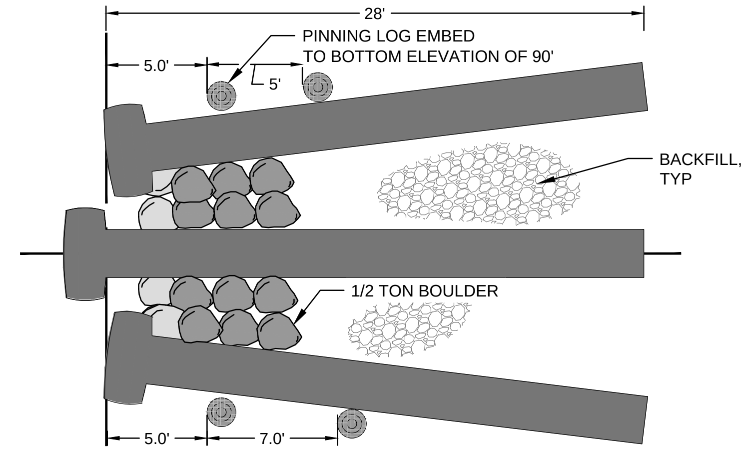


STEP 1

PLAN VIEW SCALE: 1" = 5'

NOTES:

1. EXCAVATE SUBGRADE TO DIMENSIONS SHOWN AND BACKFILL WITH BEDDING.
2. PLACE 2-TON FOOTER BOULDER AND ì -TON BOULDER FOR SCOUR PROTECTION.

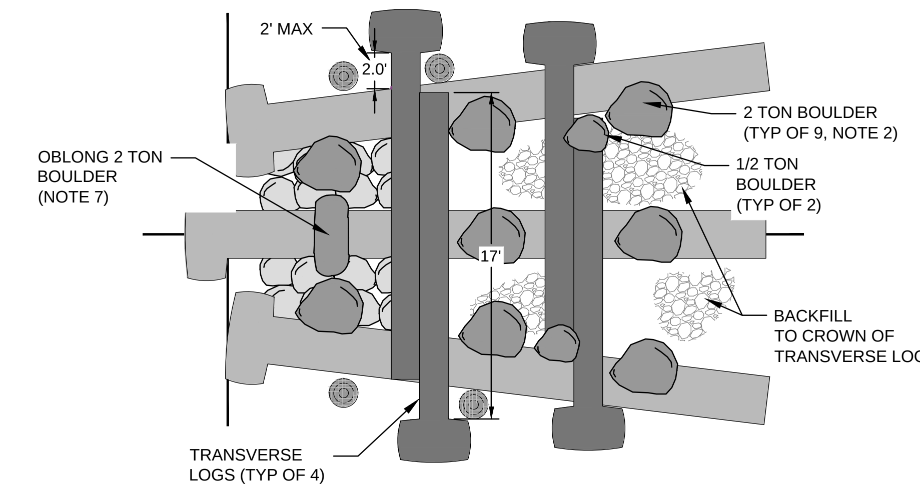


STEP 2

PLAN VIEW SCALE: 1" = 5'

NOTES:

1. EMBED VERTICAL LOGS.
2. PLACE FOOTER LOGS.
3. PLACE ì -TON BOULDER APRON BETWEEN FOOTER LOGS.
4. BACKFILL BETWEEN LOGS WITH ROCK-SOIL MIX.

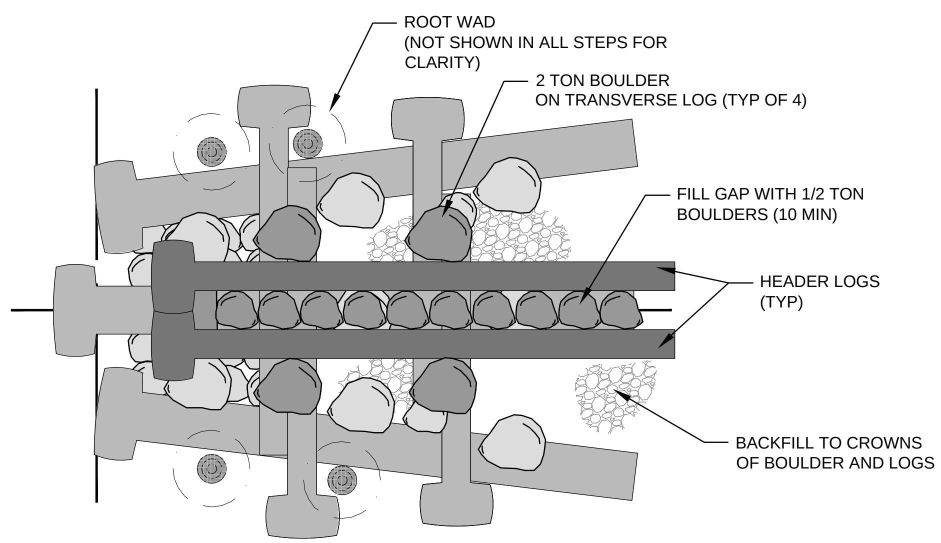


STEP 3

PLAN VIEW SCALE: 1" = 5'

NOTES:

1. PLACE TRANSVERSE LOGS.
2. PLACE 2-TON ANCHOR BOULDERS ON FOOTER LOGS (9 TOTAL, INCLUDING OBLONG BOULDER, GENERAL NOTE 7).
3. UPSTREAM TRANSVERSE LOGS: DRIVE ADJACENT VERTICAL LOG SO ROOT WAD IS IN CONTACT TRANSVERSE LOG.
4. DOWNSTREAM TRANSVERSE LOGS: PLACE ì -TON ANCHOR BOULDER ON BURIED END.
5. BACKFILL VOIDS WITH ROCK-SOIL MIX.

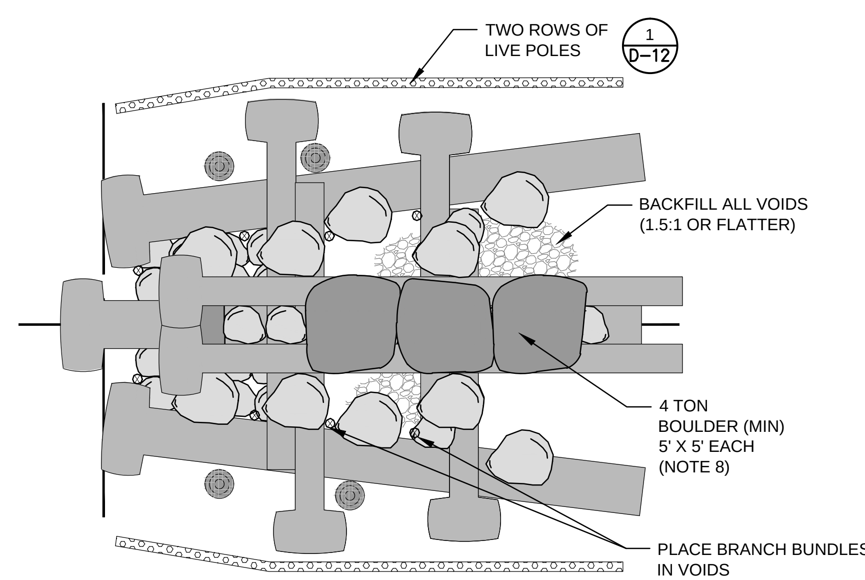


STEP 4

PLAN VIEW SCALE: 1" = 5'

NOTES:

1. PLACE HEADER LOGS.
2. PLACE ì -TON BOULDER BETWEEN HEADER LOGS.
3. PLACE 2-TON ANCHOR BOULDERS ON TRANSVERSE LOGS (4 TOTAL).
4. BACKFILL VOIDS WITH ROCK-SOIL MIX.



STEP 5

PLAN VIEW SCALE: 1" = 5'

NOTES:

1. PLACE 4-TON ANCHOR BOULDERS.
2. PIN LOGS PER LOCATIONS INDICATED IN PROFILES AND SECTIONS
3. BACKFILL WITH ROCK-SOIL MIX AND SHAPE TO PRODUCE 1.5:1 OR FLATTER SIDE SLOPES.
4. EMBED LIVE WILLOW STEMS AND BRANCH BUNDLES. (MAY BE PLACED IN EARLIER STEPS PROVIDED STEMS/BRANCHES ARE NOT DAMAGED.)
5. PIN LATERAL FOOTER LOG TO BURIED SUPPORT STONE (2 TOTAL).
6. PIN UPSTREAM TRANSVERSE LOG TO VERTICAL LOG (2 TOTAL).

SCHEDULE OF LOGS

STEP	LOGS	#	DIA (FT)	LENGTH (FT)
2	FOOTER LOGS (LATERAL)	2	2.5	26
2	FOOTER LOGS (CENTRAL)	1	2.5	28
2	VERTICAL LOGS	4	1.5	17
3	TRANSVERSE LOGS (UPSTREAM)	2	1.5	17
3	TRANSVERSE LOGS (DOWNSTREAM)	2	1.5	15
4	HEADER LOGS	2	1.5	25

NOTES:

1. DESIGN INTENT IS ACHIEVE LOG-TO-LOG AND LOG-TO-BOULDER CONTACT.
2. LOGS ARE SHOWN AT MINIMUM DIMENSIONS (DIAMETER AND LENGTH). GAPS SHOWN BETWEEN LOGS AND BOULDERS TO ALLOW FOR VARIABLE LOG DIMENSIONS (E.G., GREATER DIAMETER THAN MINIMUM).
3. FOR CLARITY, BOULDERS ARE SHOWN WITH UNIFORM, ROUND DIMENSIONS (EXCEPT AS NOTED OTHERWISE). SELECT BOULDERS TO MEET WEIGHT CLASS AND ALLOWABLE DIMENSIONS.
4. ORIENT BOULDERS TO MAXIMIZE STABILITY. IN GENERAL SMALLEST DIMENSION OF BOULDER SHOULD BE VERTICAL. PLACE FLATTEST SIDE OF BOULDERS IN CONTACT WITH LOGS.
5. BACKFILL OVER-EXCAVATED SUBGRADE WITH BEDDING TO ELEVATIONS AND DIMENSIONS SHOWN.
6. FILL ALL VOIDS IN STRUCTURE WITH ROCK-SOIL MIX PER SPECIFICATIONS.
7. OBLONG BOULDER SHALL BE APPROXIMATELY 4' X 4' X 2' HIGH. SELECT AND PLACE TO MAXIMIZE HORIZONTAL DIMENSION AND ACHIEVE DESIGN ELEVATION OF OVERLYING LOGS.
8. BOULDERS SHALL BE 4-TON MINIMUM. ORIENT BOULDER WITH SMALLEST DIMENSION VERTICAL. BOULDERS SHOWN WITH APPROXIMATE DIMENSIONS OF 5' X 5' X 4' HIGH.

BAR LENGTH ON ORIGINAL DRAWING EQUALS ONE INCH, ADJUST SCALE ACCORDINGLY

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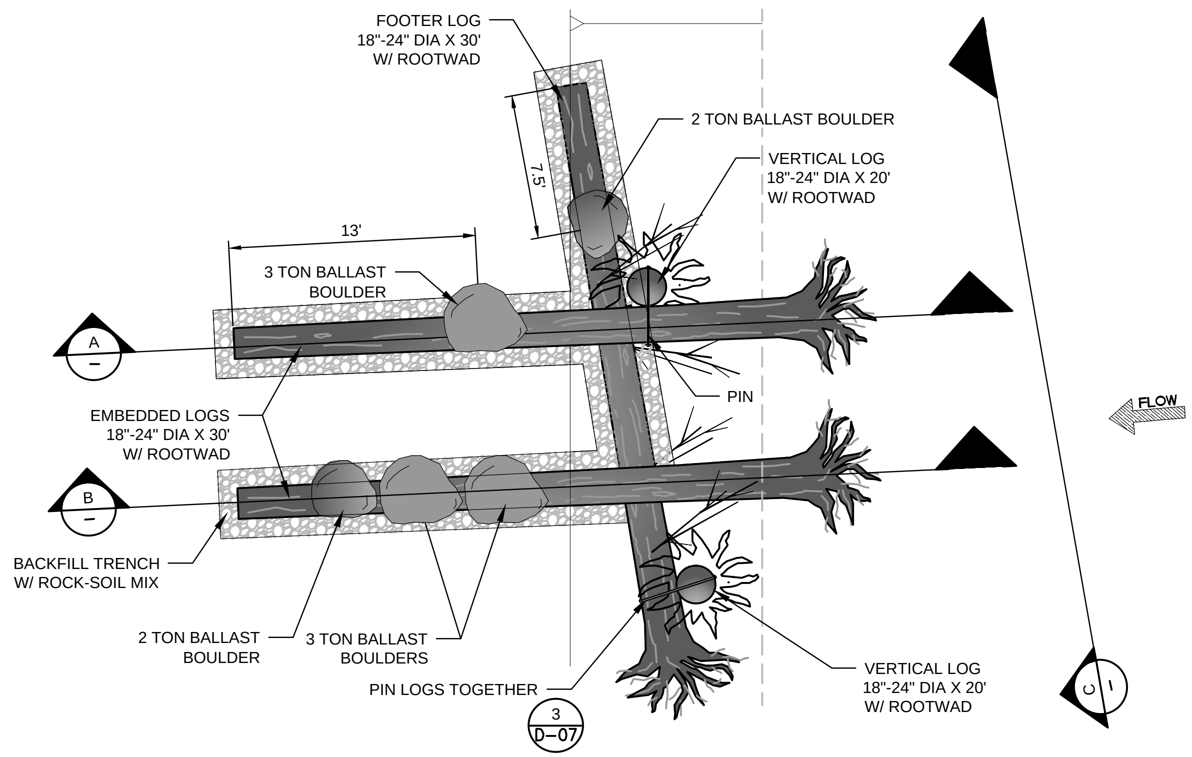
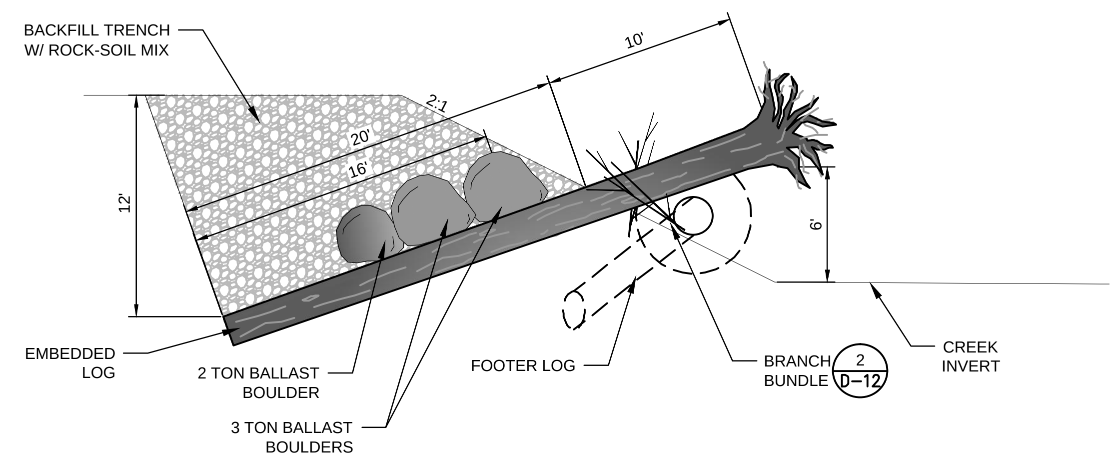
SCALE: 1" = 5' DATE: 09/18/2015
DRAWN: BT
REVIEWED:

DRY CREEK HABITAT ENHANCEMENT PHASE III, MILE THREE - REACH 4 & 5
APEX LOG STRUCTURE DETAILS (2 OF 2)

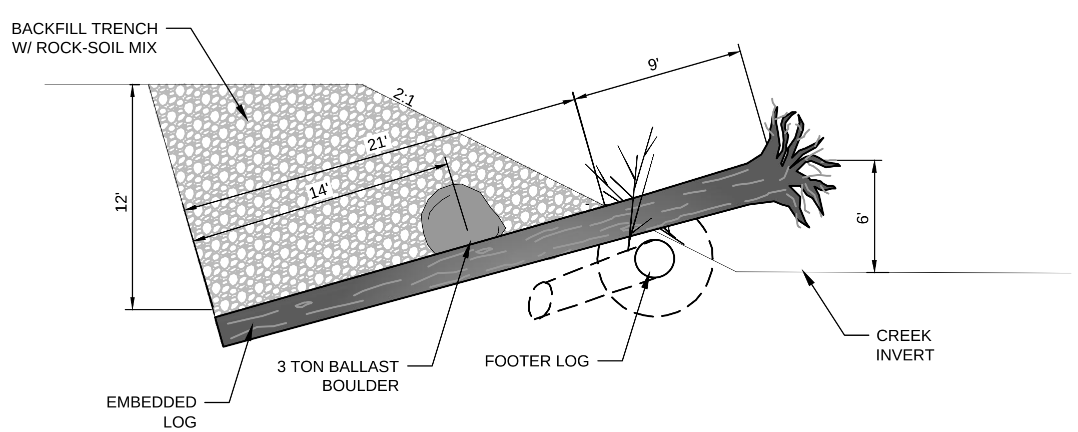
FILE NAME: 7351-DETAIL-APEX-LOG-STRUCTURE.dwg
CONTRACT NUMBER: 7351
DRAWING NUMBER: D-02
SHEET 45 OF 56



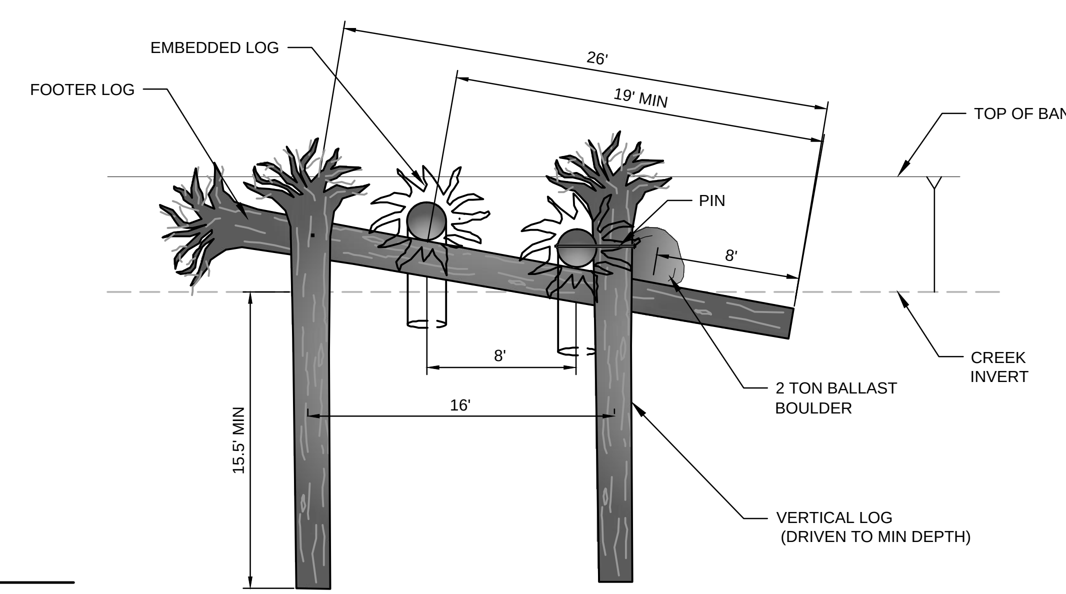
LARGE WOOD STRUCTURE 1 VAR
PLAN VIEW SCALE: 1"= 5'



LARGE WOOD STRUCTURE B
SECTION VIEW SCALE: 1"= 5'



LARGE WOOD STRUCTURE A
SECTION VIEW SCALE: 1"= 5'



LARGE WOOD STRUCTURE C
SECTION VIEW SCALE: 1"= 5'

NOTES

1. LOG SHALL BE PLACED IN THE PRESENCE OF THE OWNER'S REPRESENTATIVE. FIELD FIT AND ADJUST AS NEEDED TO CONFORM IRREGULAR LOGS TO NEAT DIMENSIONS SHOWN.
2. DETAIL SHOWS EMBEDMENT DEPTH ASSUMING THE LOG IS THE MINIMUM LENGTH SPECIFIED. IF LONGER LOG IS USED, INCREASE EMBEDMENT LENGTH AND DEPTH AS NEEDED TO MEET REQUIREMENTS SHOWN. DETAIL SHOWS MAXIMUM EXPOSED LOG LENGTH, LENGTH MAY BE INCREASED IF LONGER LOG IS USED. CONFIRM WITH ENGINEER.
3. LOGS MAY BE NOTCHED (3" MAX) TO ACHIEVE ORIENTATION AND EMBEDMENT AS SHOWN.
4. BALLAST BOULDER MUST BEAR DIRECTLY ON LOG.
5. BACKFILL TRENCH WITH ROCK-SOIL MIX.
6. ORIENT BRANCH BUNDLES TO MAXIMIZE VOLUME AND EXTENT.

0 2.5' 1" = 5' 10'
SCALE

BAR LENGTH ON ORIGINAL DRAWING EQUALS ONE INCH. ADJUST SCALE ACCORDINGLY

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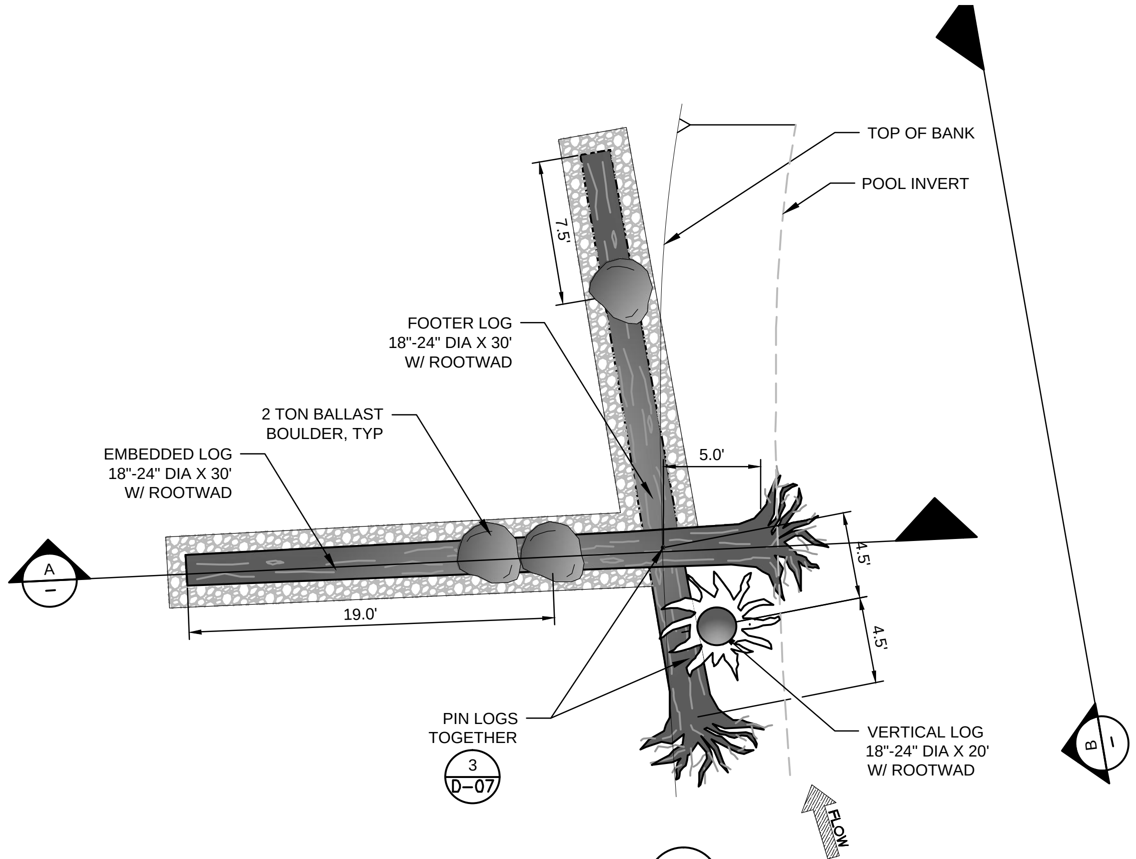
SCALE: 1" = 5'
DATE: 09/18/2015
DRAWN: PL
REVIEWED:

DRY CREEK HABITAT ENHANCEMENT PHASE III, MILE THREE - REACH 4 & 5
LARGE WOOD STRUCTURE DETAILS

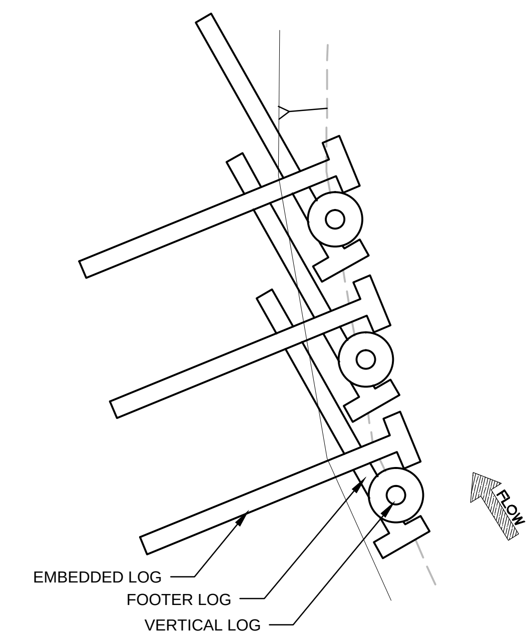
FILE NAME: 7351-DETAIL-LARGE-WOOD-STRUCTURE.dwg
CONTRACT NUMBER: 7351
DRAWING NUMBER: D-03
SHEET 46 OF 56

NOTES

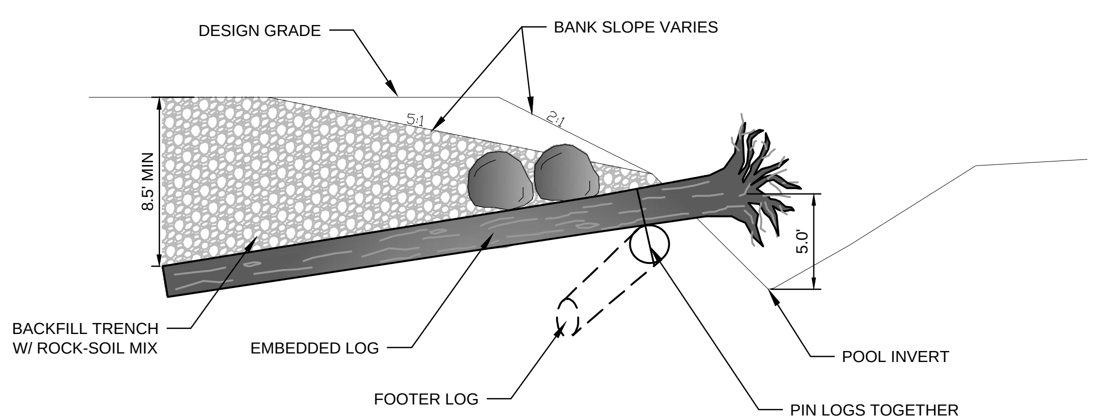
1. LOG SHALL BE PLACED IN THE PRESENCE OF THE OWNER'S REPRESENTATIVE. FIELD FIT AND ADJUST AS NEEDED TO CONFORM IRREGULAR LOGS TO NEAT DIMENSIONS SHOWN.
2. DETAIL SHOWS EMBEDMENT DEPTH ASSUMING THE LOG IS THE MINIMUM LENGTH SPECIFIED. IF LONGER LOG IS USED, INCREASE EMBEDMENT LENGTH AND DEPTH AS NEEDED TO MEET REQUIREMENTS SHOWN. DETAIL SHOWS MAXIMUM EXPOSED LOG LENGTH, LENGTH MAY BE INCREASED IF LONGER LOG IS USED. CONFIRM WITH ENGINEER.
3. BALLAST BOULDER MUST BEAR DIRECTLY ON LOG.
4. BACKFILL TRENCH WITH ROCK-SOIL MIX.
5. EACH SECONDARY CHANNEL POOL WILL INCLUDE A POOL WOOD STRUCTURE COMPLEX CONSISTING OF THREE (3) POOL WOOD STRUCTURES. SEE ENHANCEMENT PLANS.



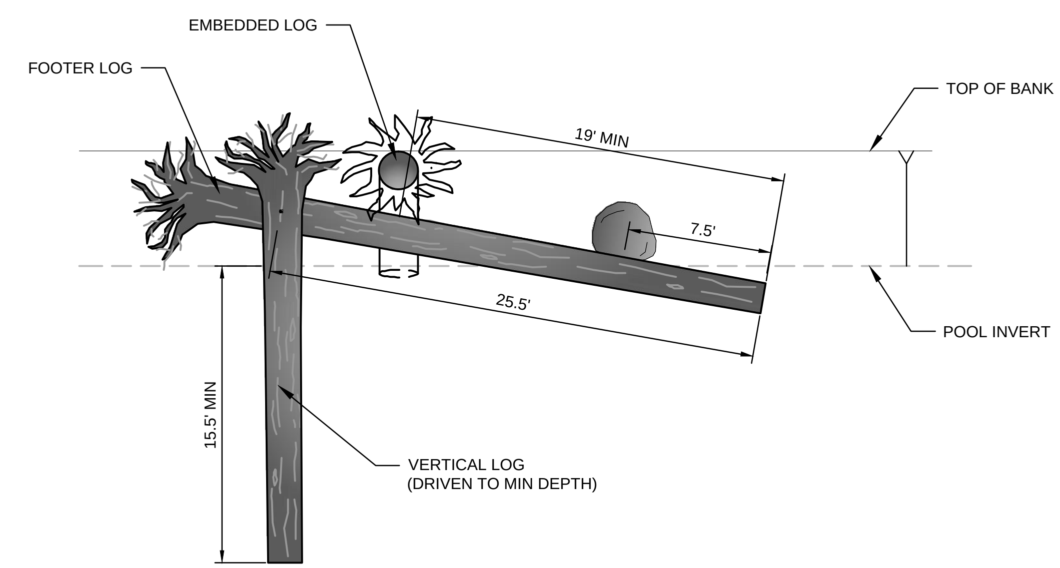
POOL WOOD STRUCTURE
PLAN VIEW SCALE: 1"= 5'
1
VAR



POOL WOOD STRUCTURE- COMPLEX (NOTE 5)
SCHEMATIC PLAN VIEW SCALE: NTS



POOL WOOD STRUCTURE
SECTION VIEW SCALE: 1"= 5'
A
–



POOL WOOD STRUCTURE
ELEVATION VIEW SCALE: 1"= 5'
B
–

0 2.5' 1" = 5' 10'
SCALE

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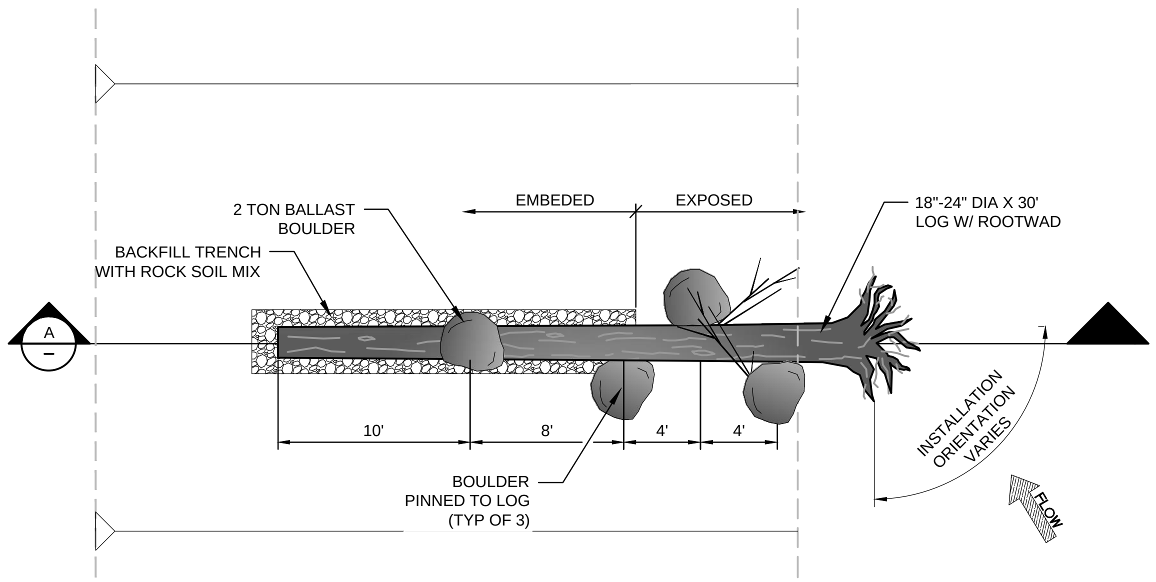
SCALE: AS SHOWN	DATE: 09/18/2015
DRAWN: PL	
REVIEWED:	

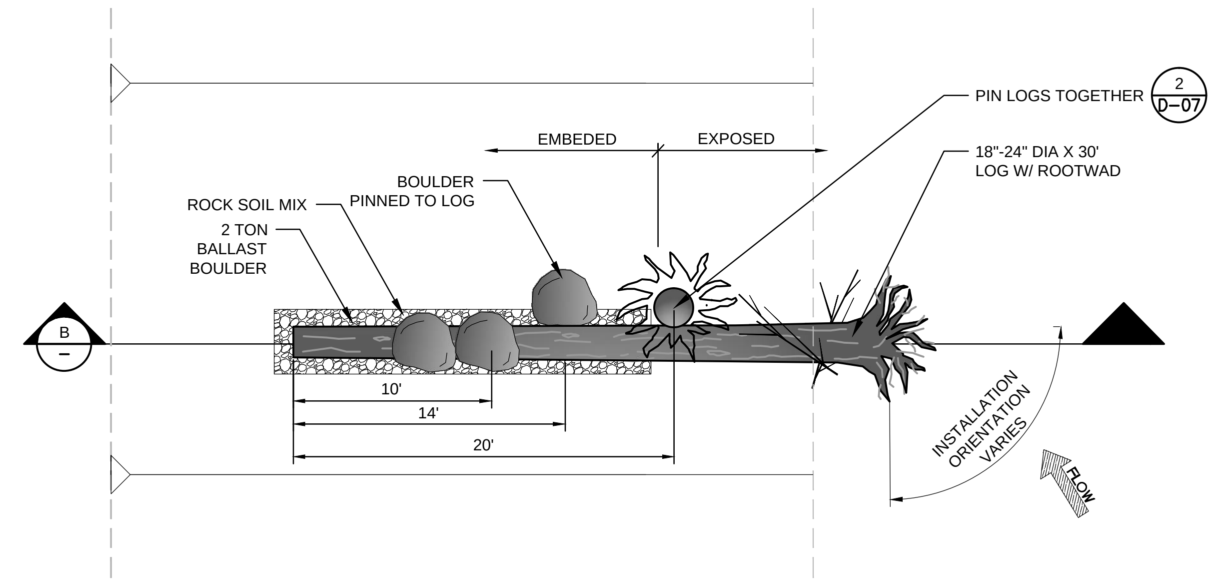
DRY CREEK HABITAT ENHANCEMENT PHASE III, MILE THREE - REACH 4 & 5
POOL WOOD STRUCTURE DETAILS

FILE NAME: 7351-DETAIL-POOL-WOOD-STRUCTURE.dwg
CONTRACT NUMBER: 7351
DRAWING NUMBER: D-04
SHEET 47 OF 56



HABITAT WOOD STRUCTURE - TYPE 1 (1 / VAR)

PLAN VIEW SCALE: 1"= 5'



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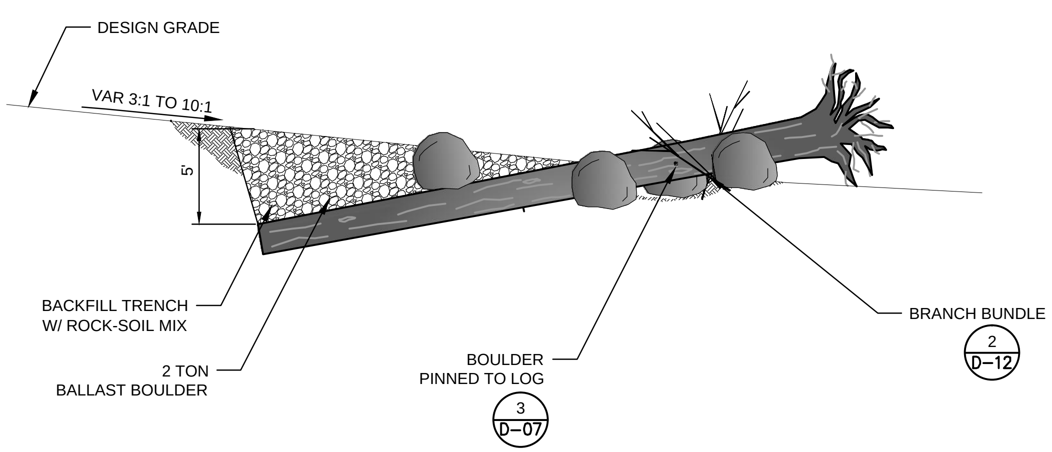
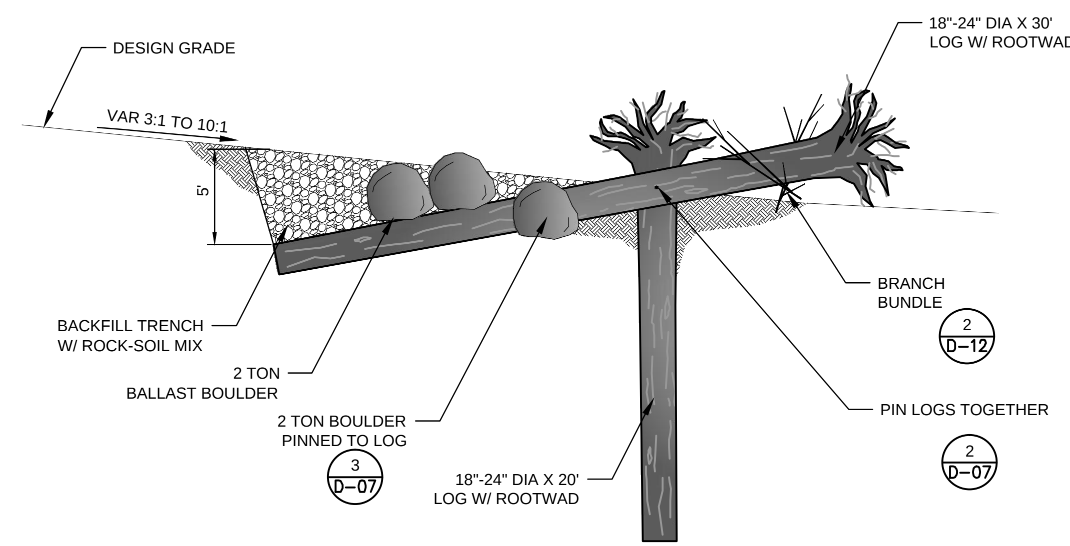


HABITAT WOOD STRUCTURE - TYPE 1 (A / –)

SECTION VIEW SCALE: 1"= 5'



HABITAT WOOD STRUCTURE - TYPE 2 (B / –)

SECTION VIEW SCALE: 1"= 5'

NOTES

1. LOG SHALL BE PLACED IN THE PRESENCE OF THE OWNER'S REPRESENTATIVE. FIELD FIT AND ADJUST AS NEEDED TO CONFORM IRREGULAR LOGS TO NEAT DIMENSIONS SHOWN.
2. DETAIL SHOWS EMBEDMENT DEPTH ASSUMING THE LOG IS THE MINIMUM LENGTH SPECIFIED. IF LONGER LOG IS USED, INCREASE EMBEDMENT LENGTH AND DEPTH AS NEEDED TO MEET REQUIREMENTS SHOWN. DETAIL SHOWS MAXIMUM EXPOSED LOG LENGTH, LENGTH MAY BE INCREASED IF LONGER LOG IS USED. CONFIRM WITH ENGINEER.
3. HABITAT WOOD STRUCTURES WILL BE INSTALLED OVER A RANGE OF ORIENTATION AND A RANGE OF BANK SLOPES. SEE ENHANCEMENT PLANS FOR ORIENTATION.
4. BALLAST BOULDER MUST BEAR DIRECTLY ON LOG.
5. BACKFILL TRENCH WITH ROCK-SOIL MIX.
6. ORIENT BRANCH BUNDLES TO MAXIMIZE VOLUME AND EXTENT.
7. HABITAT WOOD STRUCTURES MAY INCLUDE ANCHORING AND INTERLOCKING WITH LIVE TREES. LOCATIONS TO BE DETERMINED IN SUBSEQUENT DESIGN PHASES.

0 2.5' 1" = 5' 10'
SCALE

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SCALE: 1" = 5' DATE: 09/18/2015
DRAWN: PL
REVIEWED:

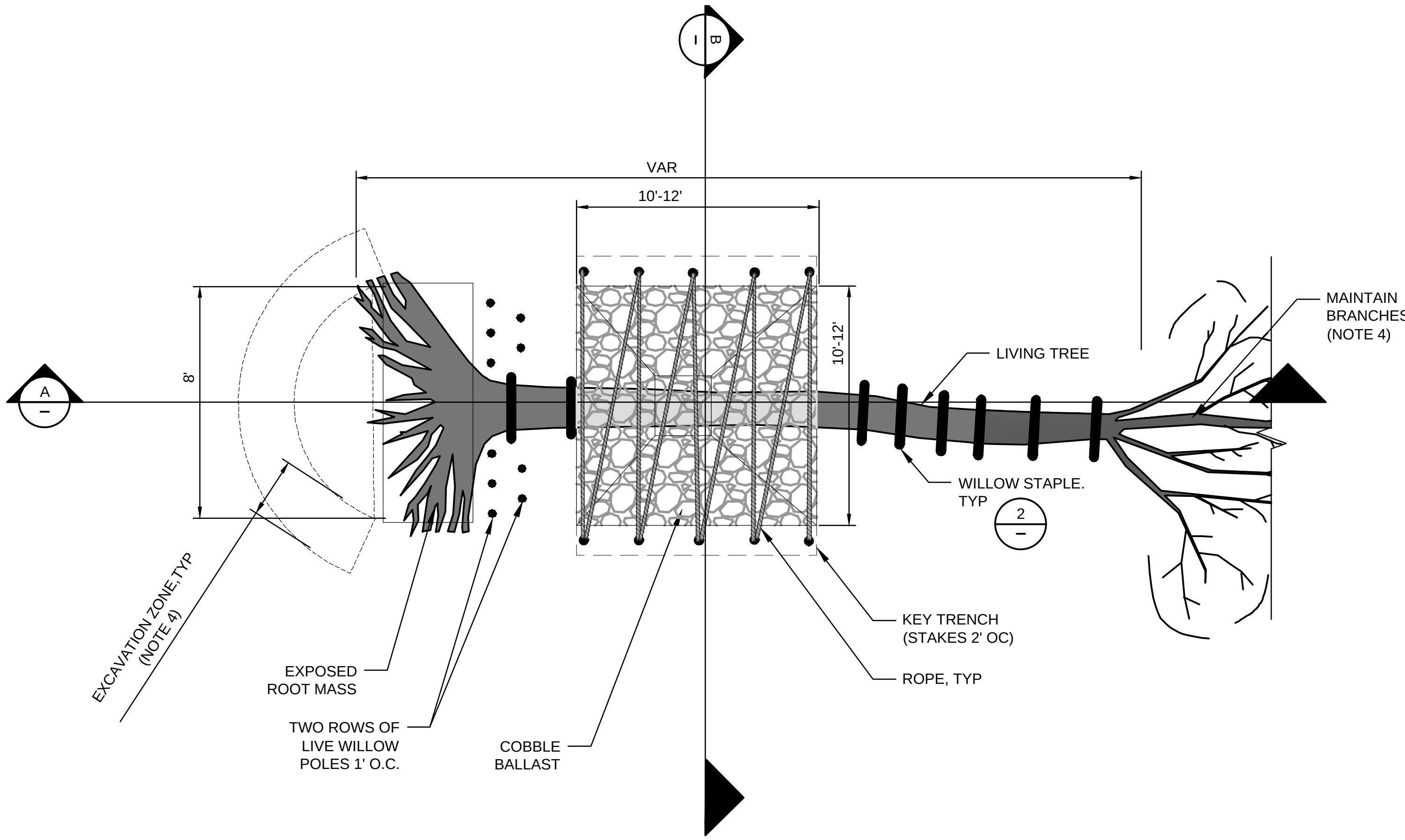
DRY CREEK HABITAT ENHANCEMENT PHASE III, MILE THREE - REACH 4 & 5

HABITAT WOOD STRUCTURE DETAILS

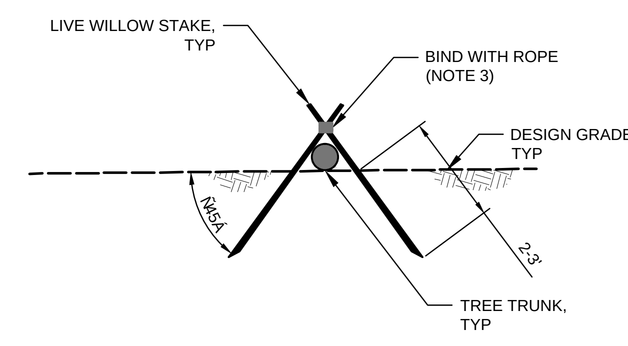
FILE NAME: 7351-DETAIL-HABITAT-WOOD-STRUCTURE.dwg
CONTRACT NUMBER: 7351
DRAWING NUMBER: D-05

NOTES

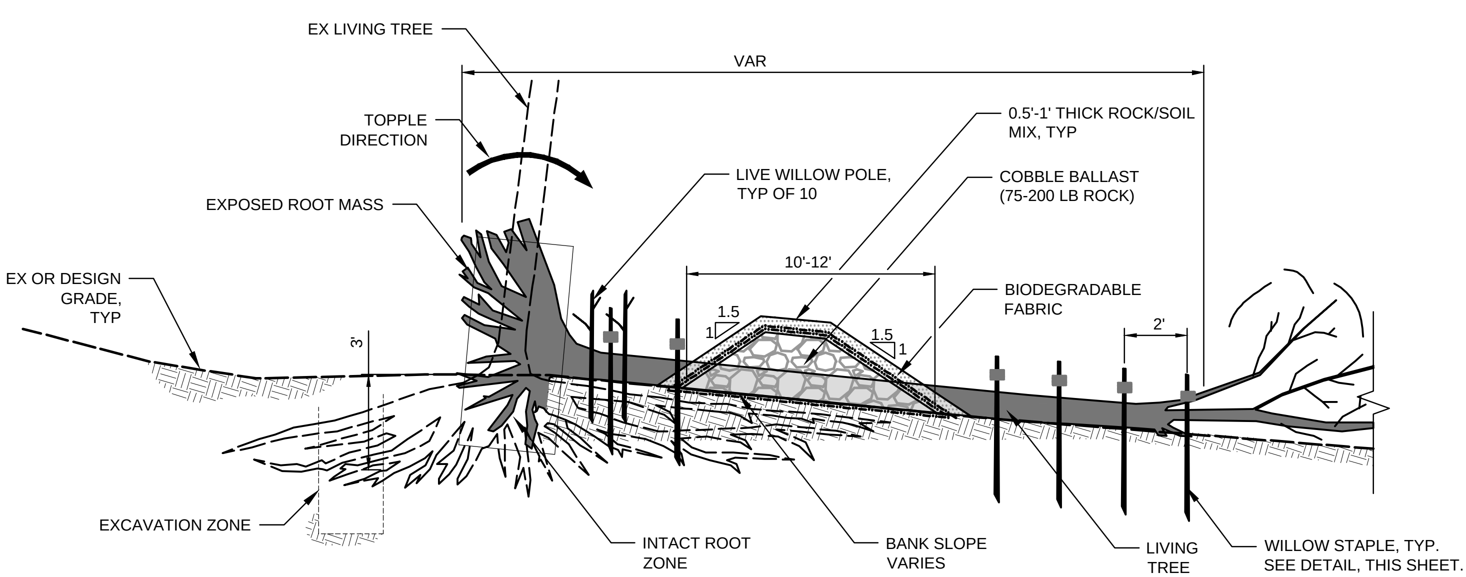
1. TOPPLE TREE IN SAFE MANNER. MAINTAIN ROOT MASS AS SHOWN AND RETAIN APPROX. 35% OF THE ROOTS INTACT IN PLACE. BACKFILL EXCAVATED TRENCH WITH ROCK/SOIL MIX TO APPROX. DESIGN GRADE ELEVATION AND COMPACT TO 85% RC.
2. WILLOW STAPLES SHALL BEAR DIRECTLY UPON TREE TRUNK.
3. BIND STAKES WITH ¾" MANILA ROPE, MINIMUM OF 5 WRAPS.
4. MAINTAIN BRANCHES AND CANOPY STRUCTURE, ENGINEER MAY PROVIDE GUIDANCE REGARDING REMOVAL OF SELECT BRANCHS TO FACILITATE INSTALLATION.
5. INSTALL WOODEN STAKE PER DETAIL 3 DWG D-11.



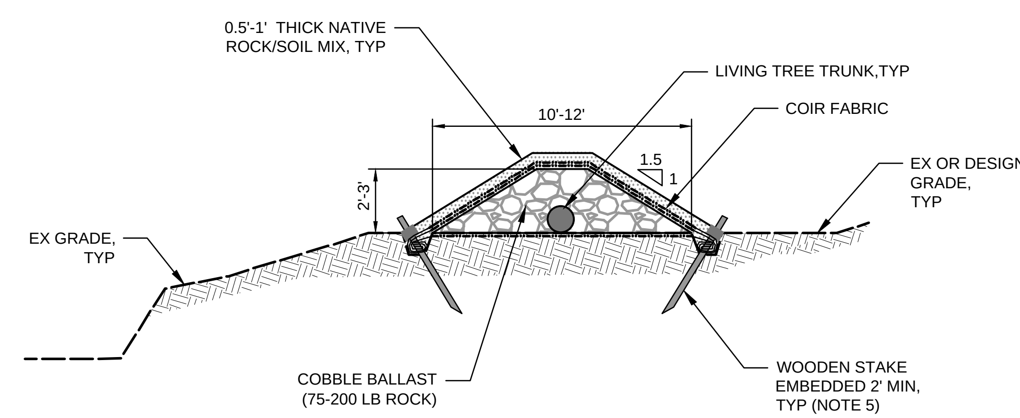
LIVE WOOD STRUCTURE — PLAN VIEW — SCALE: 1"= 3' — 1 / VAR



WILLOW STAPLE — SECTION VIEW — SCALE: 1"= 3' — 2



LIVE WOOD STRUCTURE — PROFILE VIEW — SCALE: 1"= 3' — A



COBBLE BALLAST — SECTION VIEW — SCALE: 1"= 3' — B

0 1.5' 1" = 3' 6'
SCALE

BAR LENGTH ON ORIGINAL DRAWING EQUALS ONE INCH. ADJUST SCALE ACCORDINGLY

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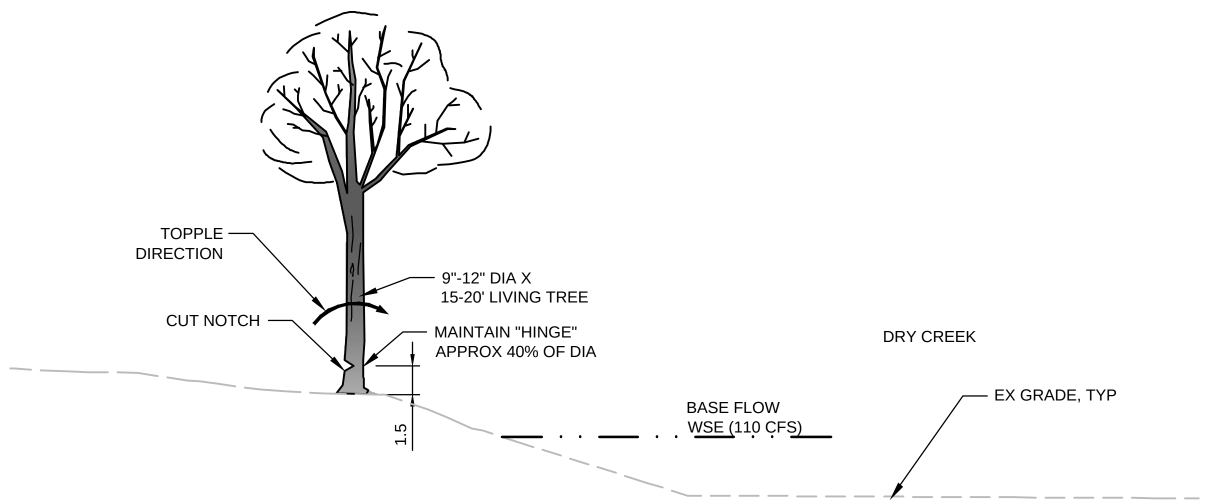
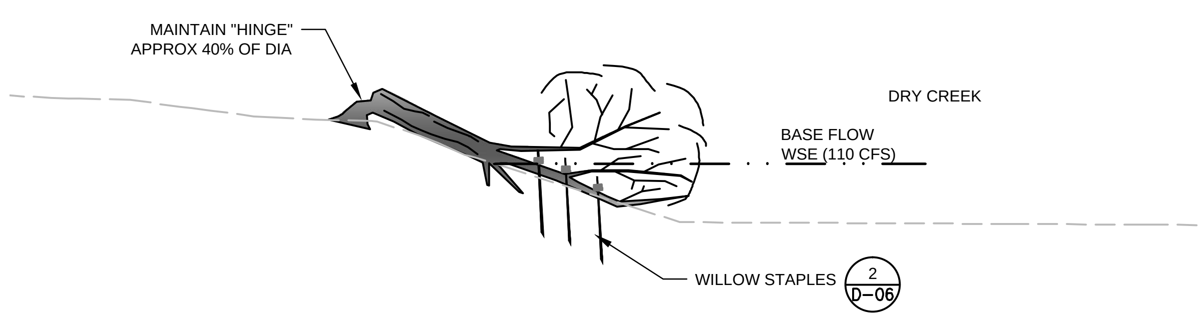
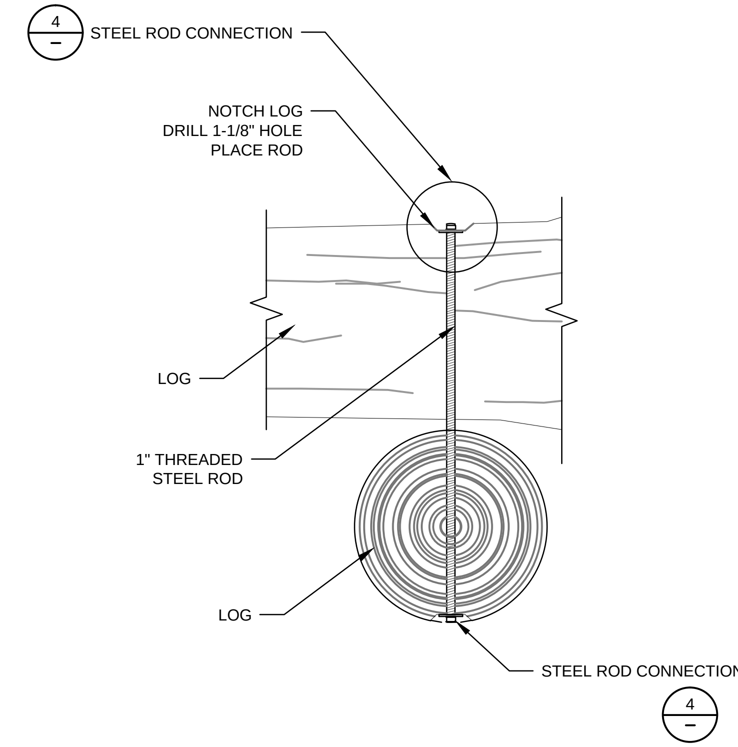
SONOMA COUNTY WATER AGENCY

SCALE: AS SHOWN	DATE: 09/18/2015	DRY CREEK HABITAT ENHANCEMENT PHASE III, MILE THREE - REACH 4 & 5
DRAWN: JW		LIVE WOOD STRUCTURE DETAILS
REVIEWED:		FILE NAME: 7351-DETAIL-LIVE-WOOD-STRUCTURE.dwg; CONTRACT NUMBER: 7351
DRAWING NUMBER: D-06		SHEET 49 OF 56

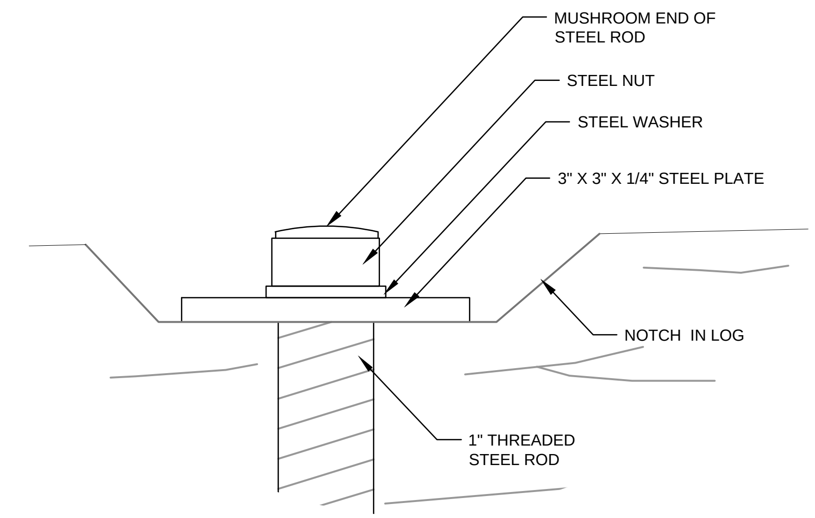




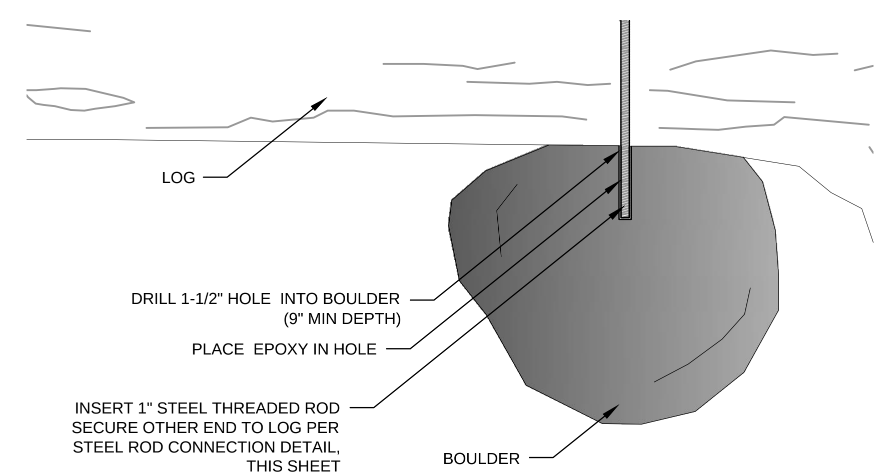
TOPPLE TREE
TYPICAL DETAIL SCALE: 1"= 5' 1 VAR



LOG TO LOG ANCHORING
TYPICAL DETAIL SCALE: 1"= 1' 2 VAR



STEEL ROD CONNECTION
TYPICAL DETAIL SCALE: 1"= 1" 4 –



LOG TO BOULDER ANCHORING
TYPICAL DETAIL SCALE: 1"= 1' 3 VAR

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DRY CREEK HABITAT ENHANCEMENT PHASE III, MILE THREE - REACH 4 & 5

TOPPLE TREE & ANCHORING DETAILS

FILE NAME: 7351-DETAIL-TOPPLE TREE & ANCHORING.dwg
CONTRACT NUMBER: 7351
DRAWING NUMBER: D-07
SHEET 50 OF 56

Appendix B:

Hydrology and Hydraulics

US Army Corps of Engineers ®
San Francisco District

Dry Creek Ecosystem Restoration Project

Continuing Authorities Program (CAP) Section 1135

Hydrology and Hydraulics (H&H) Appendix

Originally Prepared: June 30, 2016

Last Revision: January 19, 2017

1. Introduction and Background

This hydrologic and hydraulic appendix has been prepared under the authority of the Section 1135 of the Water Resource Development Act (WRDA) of 1986, in response to a request for Federal assistance from the Sonoma County Water Agency (SCWA) to the US Army Corps of Engineers (the Corps) for an ecosystem restoration project (the “project” hereafter).

The project is located in the Dry Creek watershed in the interior coast range of northern Sonoma County, approximately 30 miles from the Pacific Ocean and 60 miles north of San Francisco Bay. Dry Creek is 32 miles long and drains 217 square miles of rugged terrain in the southwestern portion of the Russian River Basin. The project is focused along the approximately 14 miles of Dry Creek that meanders downstream of Warm Springs Dam (WSD) to its confluence with the Russian River near the City of Healdsburg (this area is referred to as Lower Dry Creek). Outflows from the dam are regulated by the Corps and SCWA for flood risk reduction and water supply.

Flow regulation in Lower Dry Creek has resulted in higher summer base flows and reduced winter peak flows. These changes in watershed hydrology have altered fluvial processes and riparian vegetation patterns, resulting in a loss of complex channel and floodplain habitats. Dam operations and land use changes have resulted in a loss of spawning and rearing habitats for salmonids in the Russian River. Habitats such as alcoves, side channels, and pool-riffle complexes are important for all life stages of salmonids, in addition to other native species that are dependent on aquatic and riparian communities.

Between 1995 and 1999, three species of salmonids native to the Russian River were listed as threatened or endangered under the Endangered Species Act:

1. Central California Coast (CCC) Coho salmon - endangered
2. California Coast Chinook salmon – threatened
3. Central California Coast steelhead trout - threatened

In response, the National Marine Fisheries Service (NMFS) issued a Biological Opinion (BO) in 2008 that mandates that the Corps and SCWA perform various “Reasonable and Prudent Measures” to save threatened and endangered salmonid species in the Russian River watershed. Measures include the enhancement of six linear miles of Lower Dry Creek to provide near ideal summer rearing conditions. A small proportion of reach-scale enhancements have already been implemented by the Corps and SCWA as part of other projects.

This Section 1135 project aims to select and implement additional reach-scale enhancements using the Corps’ SMART planning process, which screens project alternatives based on habitat suitability and incremental cost-benefit analysis. The project will look at enhancement options consistent with the BO findings, which seek to restore channel and floodplain connectivity, create high quality instream and floodplain habitats, and increase the proportion and complexity of native riparian vegetation.

This appendix documents the with and without project alternatives developed and analyzed by SCWA and their engineering consultants – Environmental Science Associates (ESA) and Inter-

Fluve, Inc. (Inter-Fluve) – and the process for evaluating alternatives and selecting the Recommended Plan for ecosystem restoration.

1.1. Project Area and Reach Delineations

Inter-Fluve conducted an assessment of the project area as part of the *Current Conditions Inventory Report* (Inter-Fluve, 2010) and the *Fish Habitat Enhancement Feasibility Study* (Inter-Fluve, 2013). The project area was divided into 15 reaches based on geomorphic parameters, land ownership, and hydrologic and hydraulic conditions. These reaches were further divided into 25 subreaches based on fish habitat enhancement opportunities and constraints (Figure 1). Additional information on the subreach delineations and enhancement options is compiled in the *Fish Habitat Enhancement: Conceptual Design Report* (Inter-Fluve, 2012).

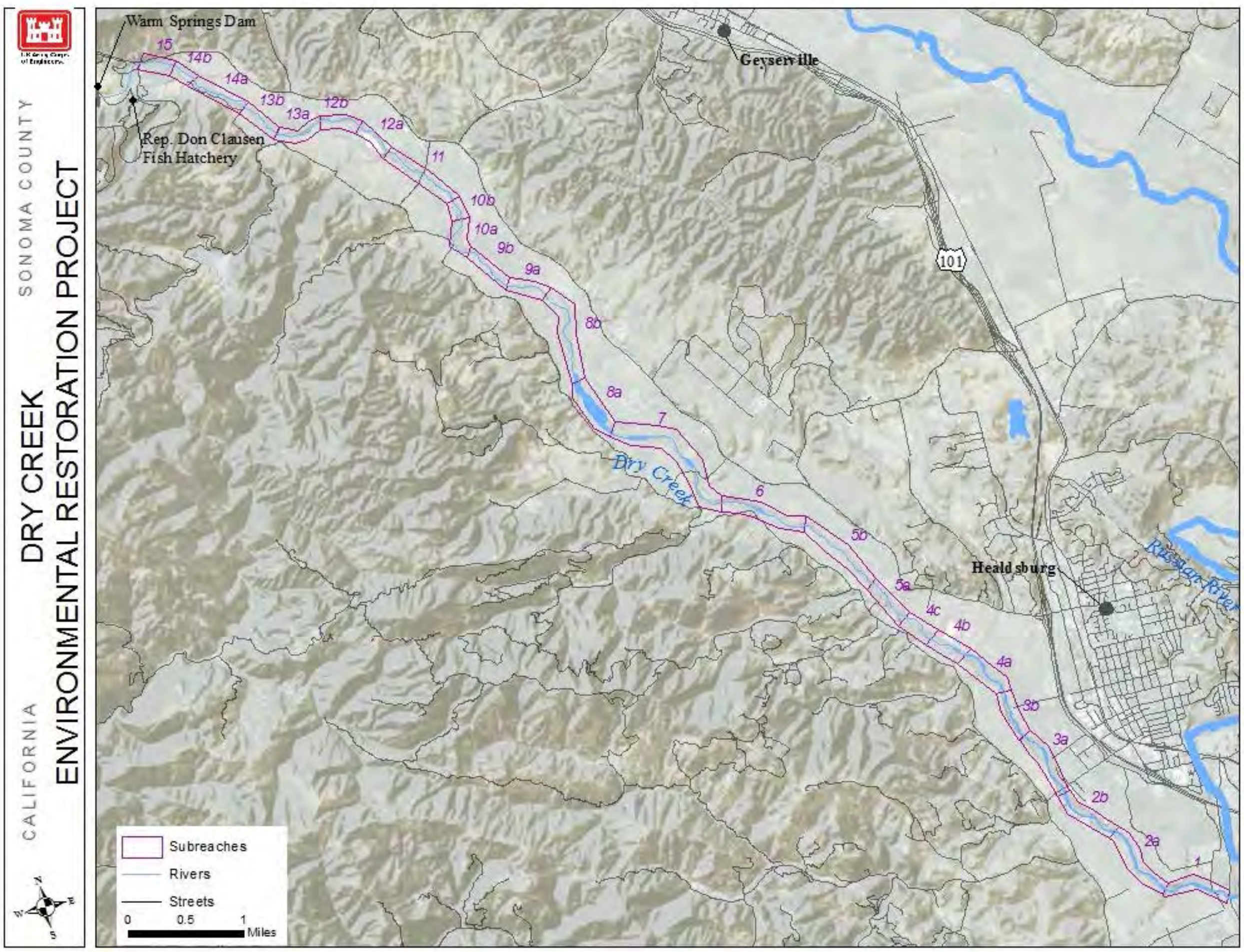

Figure 1. Subreaches of the Dry Creek Ecosystem Restoration Project.

2. Surface Water Hydrology Under Existing Conditions

The existing hydrologic conditions of Lower Dry Creek are the result of regulated flows being released from Warm Springs Dam. Prior to the construction of the dam, the river experienced ephemeral conditions: high flows during the months of January - March and low flows during the rest of the year. After completion of the dam, the river has a more perennial flow regime: muted peak flows during the months of January – March, and higher base flow during the rest of the year. Data from the U.S. Geological Survey (USGS) stream gage at the Yoakim Bridge (Gage No. 11465200, "Dry Creek near Geyserville, CA") is presented in Figure 2 to illustrate the change in hydrologic conditions in Lower Dry Creek.

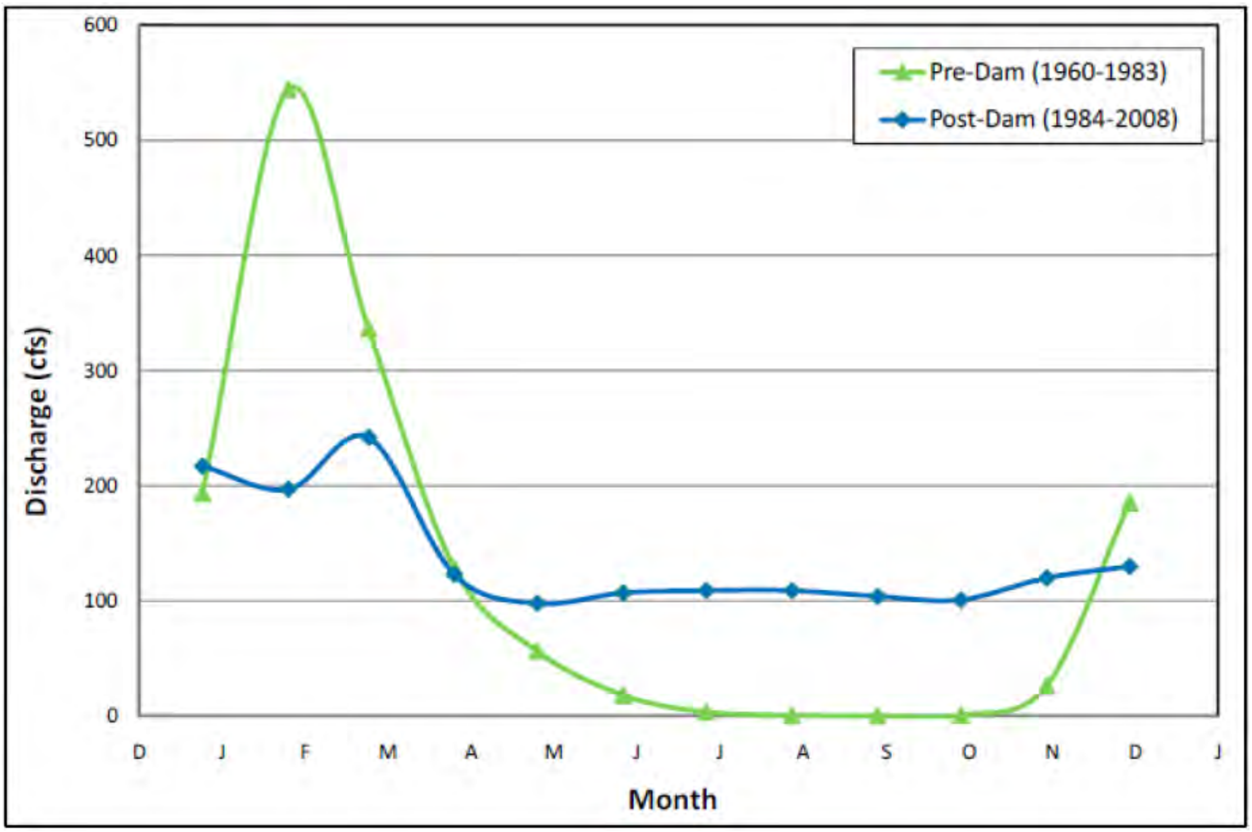

Figure 2. Monthly median discharges at Yoakim Bridge on Lower Dry Creek before and after construction of Warm Springs Dam (Inter-Fluve, 2010).

2.1. Summary of Available Data

Multiple hydrology studies have been conducted on Lower Dry Creek. Drainage areas and river mile locations of WSD, USGS gaging stations, bridges, and tributaries of Lower Dry Creek are shown in Table 1. A summary of the USGS gaging stations located on the Lower Dry Creek between WSD and the Russian River are shown in Table 2. The USGS stream gage near the confluence with the Russian River (Gage No.11465350, "Dry Creek near mouth near Healdsburg, CA") was not used in the hydrologic considerations for this Project. That location is subject to backwater affects from the Russian River, and as such, the gaging station only provides reasonable measurements for low flow conditions.

Table 1. Drainage areas and river miles along Lower Dry Creek (USACE, 1987).

USGS Stations, Bridges, Sub-Watersheds (and Associated Tributaries)	Tributary Drainage Area (square miles)[1]	Sub-Watershed Drainage Area (sq. miles)[1]	Dry Creek Drainage Area (sq. miles)[1]	River Mile
Outlet of Warm Springs Dam – USGS Gage No. 11465000	-	-	130.0	13.9
Dutcher Creek Sub-Watershed		8.8	138.8	
Schoolhouse Creek	0.6			
Fall Creek	2.0			
Dutcher Creek	3.0			
Local Drainage	3.2			
Pena Creek Sub-Watershed		22.9	161.7	11.0
Vince's Creek	0.9			
Pena Creek	22.0			
Yoakim Bridge – USGS Gage No. 11465200			162.0	10.7
Lambert Bridge Sub-Watershed		13.7	175.7	6.6
Canyon Road Creek	2.1			
Grape Creek	3.3			
Local Drainage	8.3			
Pine Ridge Canyon Creek Sub-Watershed		10.3	186.0	
Crane Creek	2.4			
Kelly Creek	1.6			
Pine Ridge Canyon	1.2			
Local Drainage	5.1			
Westside Bridge				2.0
Confluence Sub-Watershed		31.0	217.0	0.0
Mill Creek	22.0			
Local Drainage	9.0			

Table 2. USGS gaging stations located along Lower Dry Creek (Inter-Fluve, 2010).

Station Description	USGS No.	Location	Available Observed Discharge Values
Upstream of reservoir near Yorkville, CA	11464400	38°47'21'' 123°09'16'' NAD27	10/01/73 – 09/30/83
In reservoir near Cloverdale, CA	11464500	38°44'59'' 123°05'28'' NAD27	10/01/41 – 09/30/80
Below Warm Springs Dam near Geyserville, CA	11465000	38°43'11'' 122°59'58'' NAD27	10/1/39 – 09/30/42; and 10/01/81 – present
Yoakim Bridge below Pena Creek near Geyserville, CA	11465200	38°41'55'' 122°57'25'' NAD27	10/01/59 – present
Mouth of Dry Creek at the confluence with the Russian River near Healdsburg, CA	11465350	38°35'15'' 122°51'40'' NAD27	10/01/81 - present

2.2. Flood Frequency Analysis

A hydrologic analysis to determine flood frequency estimates for the Lower Dry Creek watershed was conducted by Inter-Fluve and is described in detail in Section 4.4 of *Fish Habitat Enhancement Feasibility Study* (Inter-Fluve, 2013). This H&H appendix will only summarize key points of the hydrologic analysis.

Flood frequency estimates were made at the outlet of Warm Springs Dam and at several tributary confluences within the study area (Figure 3). Data sources included USGS stream gages within the Lower Dry Creek watershed and peak flow estimates from the Water Control Manual for Warms Springs Dam (USACE, 1984).

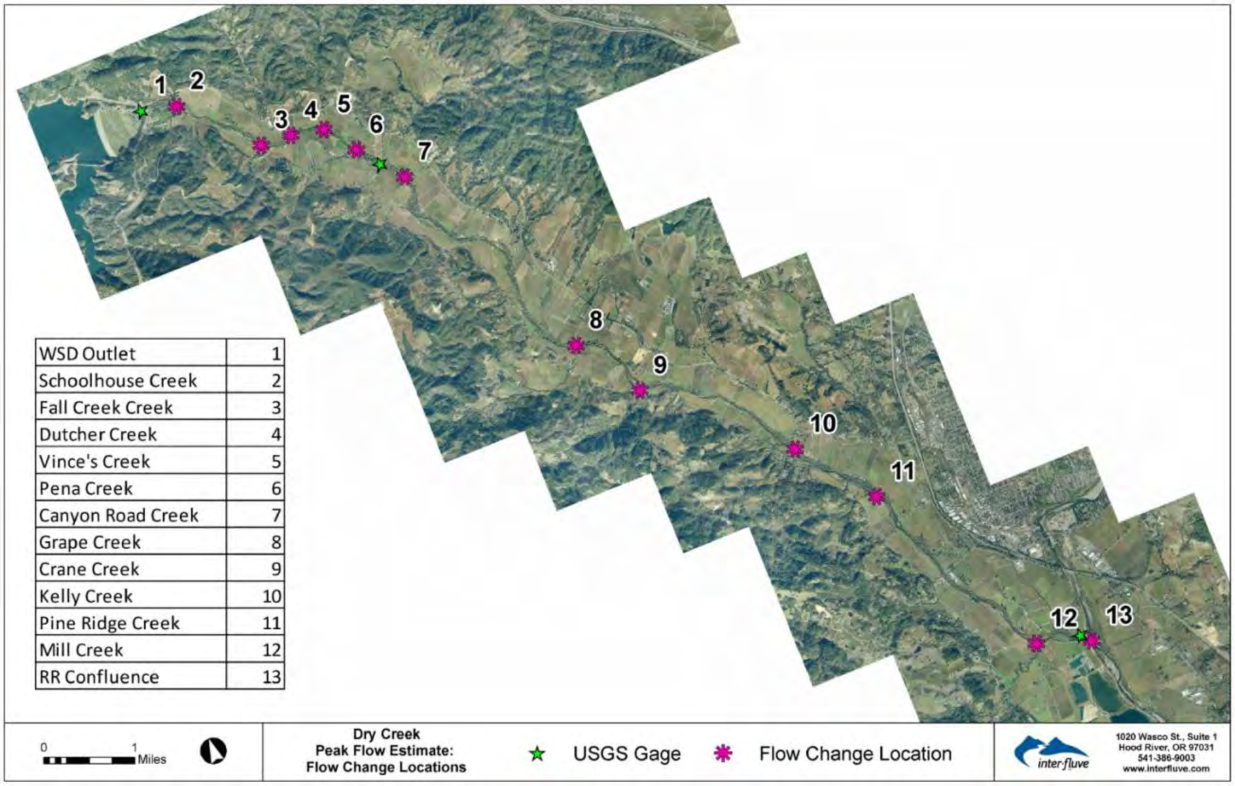

Figure 3. Locations for the flood frequency estimates (Inter-Fluve, 2013).

Peak flow estimates of gaged areas were developed using the standard Log Pearson Type III method. Extrapolation of peak flow estimates to ungaged areas within the study area occurred by using the following regional regression equation:

$$Q_i = Q_j = DA_i^y / DA_j^y$$

where:

- Q is discharge in cubic feet per second
- DA is drainage area in square miles
- i denotes the watershed for which a peak flow estimate is known
- j denotes the watershed for which the extrapolated peak flow estimate is desired
- y is a coefficient determined empirically through regression of many sets of peak flow data across the region

The values of coefficient y were adopted from USGS regional regression equations for the North Coast region of California. Further information about the above can be found in Section 4.4.2.2 of *Fish Habitat Enhancement Feasibility Study.*

The Corps conducted peak flow estimates on Lower Dry Creek for the development of the Water Control Manual for Warm Springs Dam (USACE, 1984). These estimates can be found on the six sheets contained within Plate 15 of the Water Control Manual (Figure 4). Peak flow estimates were developed for the 10-year, 50-year, 100-year, and 500-year events. Based on least-squares regression of these values, peak flow estimates were then extrapolated for other return period events. Finally, peak flow estimates were distributed to additional locations that were not covered in the 1984 estimate based on ratios of the relative drainage areas between the locations were flow estimates were available and the locations where flow estimates were desired.

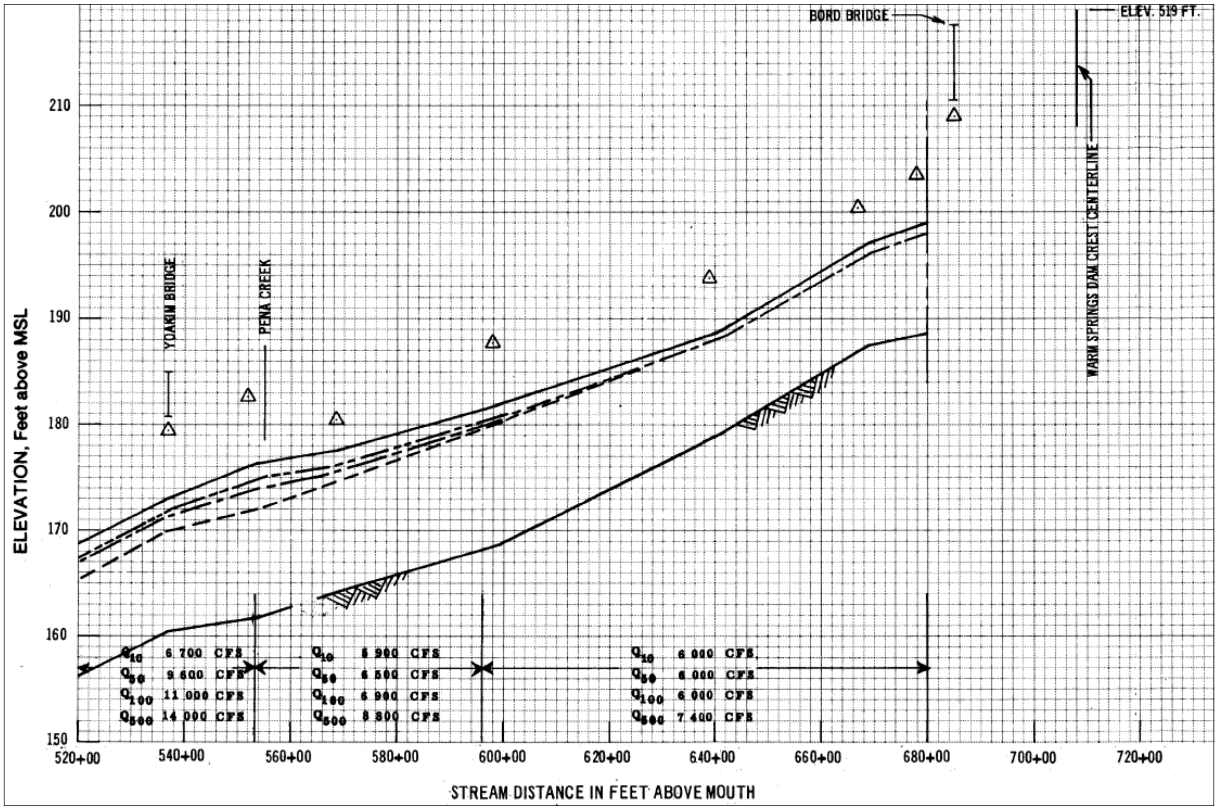

Figure 4. Example of peak flow estimates from the Water Control Manual (USACE, 1984).

A comparison of peak flow estimates obtained from USGS stream gage data and the Water Control Manual was conducted (Table 3). In general, the estimates compared well. Peak flow estimates based on available USGS stream gage data were adopted for use in the hydraulic analyses of the study area by ESA and Inter-Fluve, rather than the estimates based on the Water Control Manual. Note that “Q1” is the 1-year event, “Q2” is the 2-year event, and so forth.

Table 3. Comparison of peak flow estimates derived from the Water Control Manual and USGS stream gage data (adapted from Inter-Fluve, 2013).

Location / Tributary Confluence	Q1		Q2		Q5		Q10		Q25		Q50		Q100	
	WCM[1] (cfs)	Gage Data (cfs)	WCM[1] (cfs)	Gage Data (cfs)	WCM[1] (cfs)	Gage Data (cfs)	WCM[1] (cfs)	Gage Data (cfs)	WCM[1] (cfs)	Gage Data (cfs)	WCM[1] (cfs)	Gage Data (cfs)	WCM[1] (cfs)	Gage Data (cfs)
Outlet of Warm Springs Dam	1500	400	2500	2450	4000	4300	**6000**	5500	6000	6000	**6000**	6000	**6000**	6000
Schoolhouse Creek	1511	431	2522	2500	4033	4436	6022	5668	6039	6270	6056	6297	6100	6300
Fall Creek	1551	529	2603	2550	4154	4867	6103	6192	6180	6500	6257	6500	6463	7000
Dutcher Creek	1600	644	2700	2600	4300	5366	**6200**	6797	6350	6800	**6500**	7000	**6900**	7500
Vince's Creek	1629	676	2737	2650	4341	5508	6219	6971	6428	7000	6619	7500	7058	8000
Pena Creek	2358	1059	3655	2790	5369	7000	**6700**	7000	8380	7400	**9600**	8100	**11000**	8600
Canyon Road Creek	2434	1137	3758	3025	5507	7339	6846	7412	8580	8056	9833	8821	11291	9223
Grape Creek	2707	1392	4127	3795	6004	8444	7371	8743	9302	10152	10673	11127	12342	11214
Crane Creek	2878	1559	4359	4301	6316	9174	**7700**	9626	9754	11550	**11200**	12500	**13000**	12700
Kelly Creek	3107	1715	4697	4770	6799	9850	**8200**	10445	10490	12846	**12100**	13700	**14100**	14100
Pine Ridge Canyon	3485	1782	5144	4974	7336	10147	**8700**	10808	11187	13426	**13000**	14300	**15000**	14700
Mill Creek	5371	2222	7610	7092	10569	13682	**12500**	15374	15767	18948	**18000**	20500	**21000**	21103
RR Confluence		2442		7757		14631		16510		20726		22000		22792

3. Geomorphic Setting and Existing Fish Habitat

Lower Dry Creek is an entrenched gravel bed channel that has responded to significant human-induced changes in watershed drivers over the past 150 years. The long-term gradient of the creek is controlled by bedrock outcrops or resistant depositional units, discharge and sediment supplied from the watershed, and the base level at the confluence of the creek with the Russian River. Widespread, systematic incision and head-cutting of the channel bed occurred prior to dam, in response to base level lowering from historic grazing, agricultural production, stream channelization, gravel mining, water regulation and wildland fire (Harvey and Schumm, 1985; Simons and Li, 1980). Channel degradation had ceased by the early 1980's the channel began to evolve a new quasi-equilibrium condition within the inset floodplain.

After completion of Warm Springs Dam in 1982, outflows to the creek were regulated, and bed sediments from the upper watershed were trapped in Lake Sonoma. The regulated flow regime, reduced sediment supply, and channel incision has resulted in a more uniform single-thread channel, disconnected from the previously flood-prone areas and off-channel habitats. Consistent summer base flows have allowed vegetation to establish on previously active gravel bars, and reduced winter peak flows have reduced fluvial erosion and sedimentation responsible for creating and maintaining complex in-channel habitats. The channel has become more efficient at transporting the limited sediment supply, resulting in an overall loss of active gravel bars and riffle-pool complexes in the upper half of the project area. Significant tributary inputs of sediment helps to promote, at least partially, more natural fluvial processes in the lower portion of the project area.

A channel conditions inventory (Inter-Fluve, 2010) showed that contemporary Dry Creek is comprised of 26% riffles, 30% pools, and 44% flatwater (glides and runs) based on the relative frequency of mainstem habitats. There is far more flatwater than riffle habitat due to the watershed conditions described above. Pebble counts show that riffle sediment grain size was appropriate for Coho and steelhead spawning requirements. Gravels were the dominant grain size class in the mainstem, while off-channel areas such as alcoves and side channels contained a range of size classes including fines, sands and gravels. A total of 44 alcoves and 27 side channels were measured during the inventory, with a greater proportion of off-channel habitats in the lower half of the project area.

Riparian vegetation plays a critical role in fluvial systems by providing bank stability, habitat structure, and shade. Consistent base flows have allowed riparian vegetation to flourish and channel banks are generally well established. Erosion along the toe of banks has created overhanging banks with exposed roots – a desirable habitat for salmonids. Bank erosion was more significant in Reaches 1 and 7, and a variety of past stabilization measures were observed. Riparian trees provide a moderate amount of cover and shade for aquatic habitats, ranged from 14% cover for riffles to 27% for pools. Less frequently activated, off-channel habitats typically had higher percent cover than in-channel habitat. Finally, fallen wood counts (all sizes) totaled an average of 183 pieces per mile, with the lowest density (63 pieces) observed in Reach 14 and the highest density (362 pieces) observed in Reach 10. Anecdotal accounts explain that adjacent landowners have actively maintained portions of the creek when log jams presented a perceived flood risk.

The channel conditions inventory note that overall quantity of pool habitats falls below the desired range for native species and that the pools may lack sufficient cover and structure. In addition, hydraulic models of Lower Dry Creek indicate that channel velocities in pools under base flow conditions range from 0.2 to 1.3 feet/sec with an average of 0.6 feet/sec. Juvenile salmonids are placed under excess physical stress when velocities exceed 0.2 feet/sec. Pools both in-channel and off-channel are the primary summer rearing habitat and high flow refugia for salmonids.

4. Hydraulic Analysis of Existing Conditions

Ecosystem restoration projects for rivers and streams typically include objectives for improving channel to floodplain connectivity, using a range of channel forms that are competent to pass supplied sediment loads, allowing acceptable levels of erosion and sedimentation responsible for creating and maintaining a diversity of habitats, and promoting favorable hydraulic conditions for the occupation and passage of fishes and other aquatic species. As such, hydraulic analysis is a critical component of the restoration design. Stream restoration practitioners use hydraulic parameters metrics such as depth, velocity, and inundation extent in order to assess and prioritize restoration objectives and design elements. Existing conditions parameters provide the baseline that alternatives are compared and evaluated.

A hydraulic analysis for existing conditions was conducted by Inter-Fluve using the HEC-RAS modeling software. HEC-RAS is a one and two-dimensional hydraulic model that solves the energy and momentum equations for open channel flow. HEC-RAS is developed by the Corps and used widely by Corps water resource staff, as well as other local, state, and national agencies and engineering consulting firms. Details regarding model development and results from this particular hydraulic analysis can be found in Section 4.5.3 of the *Fish Habitat Enhancement Feasibility Study* (Inter-Fluve, 2013).

Channel and floodplain geometry from the existing conditions model was developed using channel cross section surveys from the summer of 2010, and LiDAR-based digital elevation models from 2008. The original model was divided into two separate models for the purposes of evaluating restoration alternatives for Reaches 1-6 (lower reaches), and Reaches 7-15 (upper reaches). Geometry for the lower reaches was updated by ESA in 2014 to account for more recent ground and bathymetry surveys (2013-2015) and LiDAR coverage (2013). Similar updates were made by Inter-Fluve in 2015 for the upper reaches.

Manning's roughness coefficients for both models were determined from field observations and aerial photography. Typical roughness values ranged from 0.03 to 0.045 in-channel, and 0.06 to 0.12 for out-of-bank and floodplain areas.

A total of eight steady flow profiles from the *Fish Habitat Enhancement Feasibility Study* (Inter-Fluve, 2013) were used to define the flow released from Warm Springs and internal flow change locations (Figure 3). Flow events ranging from the 1-year event to the 100-year event were modeled (Table 4). Base flows were also modeled using information on steady state operational discharge from Warm Springs Dam during the spring, summer, and fall. Base flows at the outlet of the dam and Yoakim Bridge (below the confluence with Pena Creek) were assumed to be 105 cfs and 110 cfs, respectively. Upstream and downstream boundary conditions were set to either normal depth or a known water surface elevation depending on the flow profile being modeled (e.g. 95.8 feet using the North American Vertical Datum of 1988 (NAVD88) for the 100-year event).

Table 4. Steady flow profiles used for hydraulic modeling (Inter-Fluve, 2013).

Flow Change Location	Q1 (cfs)	Q2 (cfs)	Q5 (cfs)	Q10 (cfs)	Q25 (cfs)	Q50 (cfs)	Q100 (cfs)
1. Outlet of Warm Springs Dam	400	2450	4300	5500	6000	6000	6000
2. Schoolhouse Creek	431	2500	4436	5668	6270	6297	6300
3. Fall Creek	529	2550	4867	6192	6500	6500	7000
4. Dutcher Creek	644	2600	5366	6797	6800	7000	7500
5. Vince's Creek	676	2650	5508	6971	7000	7500	8000
6. Pena Creek	1059	2790	7000	7000	7400	8100	8600
7. Canyon Road Creek	1137	3025	7339	7412	8056	8821	9223
8. Grape Creek	1392	3795	8444	8743	10152	11127	11214
9. Crane Creek	1559	4301	9174	9626	11550	12500	12700
10. Kelly Creek	1715	4770	9850	10445	12846	13700	14100
11. Pine Ridge Canyon	1782	4974	10147	10808	13426	14300	14700
12. Mill Creek	2222	7092	13682	15374	18948	20500	21103
13. RR Confluence	2442	7757	14631	16510	20726	22000	22792

5. Formulation of Restoration Alternatives

Initial restoration concepts for the 25 subreaches were developed, compared, and prioritized as part of the *Fish Habitat Enhancement Feasibility Study: Conceptual Design Report* (Inter-Fluve, 2012). Subreaches were prioritized based on potential improvements to summer rearing and winter refuge habitats, total habitat area, and process continuity (i.e. self-sustaining geomorphic processes and forms). Analyses were conducted for the subreaches with relatively high potential:

- ESA performed analyses on subreaches 2a, 2b, 4a, 4b, and 5a
- Inter-Fluve performed analyses on – subreaches 8b, 13a, 13b, 14a and 14b

This project used rankings from the *Conceptual Design Report* as a starting point for the subreach screening and alternatives formulation process. Several formulation strategies for were developed for assembling alternatives that meet, fully or partially, the identified planning objectives. Formulation strategies include:

- Maximize ecosystem restoration benefits in places with cooperating landowners
- Focus on subreaches located on Federal Land
- Focus on subreaches where Corps structures exist (e.g. riprap, grade control, etc.)
- Focus on subreaches with connectivity to adjacent restored reaches

Federal land ownership and/or existing Corps structures became more of an alternative requirement because site access is a major constraint in the largely privately owned creek corridor.

5.1. Focused Array of Alternatives

As a result of the subreach screening and alternatives formulation process, subreaches 4A, 14A, and 14B were selected for use in the “focused array” of alternatives. These subreaches are wide enough to provide significant opportunities for off channel features such as alcoves and side channels. In addition all three subreaches have existing Corps structures, and therefore, present opportunities to address prior impacts of these structures. Finally, subreaches 14A and 14B are adjacent to constructed subreach 15.

The three subreaches were used to generate a total of six restoration alternatives, including a “no action” alternative:

- Alternative 1: no action
- Alternative 2: subreach 4A
- Alternative 3: subreach 14A
- Alternative 4: subreach 14B
- Alternative 5: subreaches 4A and 14A
- Alternative 6: subreaches 14A and 14B

Alternatives 2-6 are comprised of one or two subreach restoration designs. The differences among the alternatives are based on watershed location (upper, middle, lower) and not design strategy. The objectives of all alternatives are to decrease baseline flow velocity, increase off channel habitats, and establish pool-riffle channel areas.

5.2. Common Restoration Elements

All of the restoration action alternatives include in-channel and off-channel elements configured to meet project objectives. A summary of the elements are discussed below for the purposes of orienting the reader and discussing how the elements will affect channel geomorphology and hydraulics. More details can be found in the *Dry Creek Habitat Enhancement Project – Phase III, Draft Mile Three 60% Design Report* (ESA, 2015).

Riffle & Pool Enhancements – The high proportion of flatwater habitat in Lower Dry Creek lowers the proportion of riffle and pool habitats, and results in lower than ideal pool-riffle ratios (NMFS, 2008). Creation or enhancement of existing habitats will allow restoration alternatives to meet pool-riffle ratios identified in the BO and subsequent design criteria. Such enhancements will include grading at the channel margin to create areas of widening and constriction. Variation in channel width promotes natural geomorphic processes including high-flow velocity reversal, and sediment accumulation (riffles) and scour (pools). Large wood structures will also be used to force flow constrictions to scour and maintain pools.

Modifications to Existing Sills – Three grouted rock grade control “sills” span Lower Dry Creek at river miles 3.5, 3.7, and 4.0. These features prevent bed incision and maintain existing bed slopes in the lower reach. While protective, the features also create relatively still backwater conditions upstream of sill which encourage deposition of fine sediments and uniform channel conditions – a general reduction in habitat. Advanced restoration designs will include options to notch or lower the sill to improve habitat conditions, while maintaining grade.

Secondary Channels – Secondary side channels carry flow away from the mainstem of the creek through the adjacent floodplain, sometimes connect with other side channels, and reconnect with the mainstem downstream. These channels may be engaged frequently or during higher flow events depending on invert elevations relative to those in the mainstem. Secondary channels reduce mainstem velocities by spreading flow across a larger wetted perimeter, and provide valuable rearing habitat and refugia for salmonids. These features are common to all restoration alternatives, because they are appropriate given the watershed context and meet several project objectives. Location and design of secondary channels is based on existing topographic depressions and historic secondary channel alignments (prior to systemic incision).

Alcoves or Backwater Channels – These features are a form of side channels that are typically connected to the mainstem at only one location. Flows from the mainstem backup into these depressional features creating low velocity refugia. These features have high potential for cover and habitat complexity. Design of alcove features are typically focused on more frequent flow events to promote favorable water quality conditions (less stagnant water) and flush out fine sediments. Alcoves are selected over secondary channels in areas that would require excessive grading to create a secondary channel.

Large Wood Elements – Large wood - both dead and alive - is a key component of rivers and streams because it creates hydraulic and geomorphic controls (e.g. log jams, backwater, scour pools) and provides complex microhabitats through stem and root exposure. Large wood habitats vary in form and include log jams, large wood structures, pool wood structures, and habitat log structures. Log jams are complex large wood structures comprised of several to many dead logs that are intended to divert flow paths, provide bank stabilization, and promote large scour pools, and extensive cover and habitat complexity. Logs are typically driven into excavated streambanks and stabilized using large boulders, embedment, and connections with adjacent logs. Large wood structures can also be comprised of smaller clusters of 3-5 logs driven into the banks and bed with root wads exposed. These smaller log structures or pool wood structures are typically included as stabilizing and habitat enhancing features of secondary channels. Finally, habitat log structures are simple one or two log, dead or alive, installations intended to provide instream and margin habitat, and increased channel roughness. Although driven into the bed or banks, habitat logs are not heavily ballasted or embedded like other large wood elements, and are subject to movement during higher flow events. These elements are preferred in sensitive areas where less disturbance is required.

Boulder Elements – Boulder elements are installations of large boulders in the active channel, that are intended to break up high velocity fields, encourage local sediment sorting (through varied velocity), and provide small resting areas for migrating adult salmonids. Boulder elements can be categorized into boulder “clusters” and boulder “fields”. Clusters typically consist of three to four 1 to 3-ton boulders. They can be placed in the channel without the need for flow diversion during construction. Boulder fields are larger boulder installations comprised of several boulder clusters with additional boulders placed at random in between the clusters. These fields typically span 30 to 100 linear feet of channel. Boulder fields can be used to develop riffles in flatwater areas by trapping gravel and cobble in between boulders, and to force backwater into side channels and alcoves.

Biotechnical Bank Stabilization – Excessive bank erosion contributes fine sediments to the channel, filling in voids between spawning gravels. Excess fines also lowers visibility for aquatic species and can contribute to nutrient loading and reduced levels of dissolved oxygen. Historic instability in Lower Dry Creek led to bed incision and bank retreat. In response, several “hard” bank stabilization measures including riprap, board fences, tires, and car bodies were installed along constrictions and channel banks to prevent further erosion. The hard structures are in varied condition and offer limited levels of bank protection and geomorphic and ecological benefit. Restoration alternative consider replaced hard bank protection measures with biotechnical measures that by definition utilize natural materials and vegetation to stabilize banks and provide ecological lift.

Tributary Enhancement – Tributaries to Lower Dry Creek act as important sediment sources and off-channel refuge and upstream rearing and spawning habitats for salmonids. Tributary connections can be modified to provide year-round access, migratory passage, and instream cover. Large wood structures will be utilized as needed to maintain tributary openings and provide additional cover and habitat complexity. Boulder step-pool structures may also be considered to provide grade control and passage, though these are not included as part of the current engineering designs (subject to change in advanced design).

Riparian Vegetation Management – The final restoration element – management of riparian vegetation is universal to all restoration alternatives. The existing mosaic of vegetation along Dry Creek has been heavily influenced by historic land use, channel evolution, and dam operation. Riparian vegetation has colonized previously active gravel bars due to perennial base flows and a relative lack of channel scouring high-flow events. Existing vegetation will be actively managed to promote diversity in channel form, cover and shade, sediment filtering, food sources, structural diversity, and to control invasive species including insects. Enhanced riparian vegetation will also provide long-term sources of wood and organic debris to the channel, and promote natural food webs between riparian and aquatic habitats. Management actions include selective tree and understory removal, grading to control inundation frequency and duration, biotechnical treatments, and native planting. Individual trees and stand with high existing geomorphic and ecological value will be preserved.

6. Hydraulic Analysis of Restoration Alternatives

Hydraulic models for the six proposed or "with-project" alternatives were developed using a combination of modeling software including:

- Hydrologic Engineering Center-River Analysis System (HEC-RAS)
- Sedimentation and River Hydraulics - Two-Dimensional (SRH-2D), and
- Two-dimensional Unsteady Flow (TUFLOW) flood and coastal simulation software

SRH-2D is a two-dimensional hydraulic model developed by the U.S. Bureau of Reclamation that is available for public use. The model solves the dynamic wave equations, is numerically stable even with wetting and drying, and utilizes a flexible mesh that may contain arbitrary shaped cells. ESA selected SRH-2D to model project alternatives because of the above mentioned characteristics and because of their familiarity with this model from their past experience on other ecosystem restoration studies. Details regarding the hydraulic analysis are presented in Section 3.9, Section 5.5, Section 5.7, Appendix B, and Appendix C of *Dry Creek Habitat Enhancement Project - Phase III, Mile Three 60% Design Report* (ESA, 2015).

TUFLOW is a two-dimensional hydraulic model that is privately developed by BMT WBM. The model solves the full set of shallow water equations, is numerically stable even with wetting and drying, uses a combination of multiple grids of varying resolution and one-dimensional channels, and has integration with ArcGIS for inputs and outputs. Inter-Fluve selected TUFLOW to model project alternatives because of the above mentioned characteristics and because of their familiarity with this model from past experience on other ecosystem restoration studies. Details regarding the hydraulic analysis are presented in Section 3.8, Section 4.2, Appendix A, and Appendix B of *60% Design Report, Dry Creek Habitat Enhancement Projects: Mile II*.

Both SRH-2D and TUFLOW are allowed for use per the approved software list provided by the Hydrology, Hydraulics, and Coastal Community of Practice.

6.1. Hydraulic Analysis of Subreach 4A

ESA conducted a hydraulic analysis of subreach 4A using both HEC-RAS and SRH-2D. The HEC-RAS model for subreach 4A utilized geometry from the 2013 existing conditions HEC-RAS model, additional survey data that was collected in 2013 and 2014 by ESA, and topographic data obtained from Sonoma County Vegetation Mapping and LiDAR Program. The HEC-RAS model was used to develop stable channel dimensions and conceptual grading configurations for proposed secondary channels (side and backwater channels).

Manning's roughness coefficient values for in-channel and overbank areas for the subreach 4A model were based on the discrete roughness values used in the existing conditions HEC-RAS model. Grading and revegetation plans were used to determine with-project roughness values. Mature riparian vegetation was assumed. Typical roughness values ranged from 0.03 to 0.045 for in-channel areas, and 0.06 to 0.12 for overbank and floodplain areas. Large wood structures were modeled using a roughness value of 0.1.

For secondary channel sizing, three flow events were simulated: base flow of 105 cfs, an annual high flow event equivalent to the 1-year event, and a semi-annual high flow event equivalent to the 2-year event. The 1-year event was the target for sizing the secondary channels. It was assumed that once flows span the width of the incised stream corridor at a depth of approximately five feet, the benefits from any graded features would not exist. A typical secondary channel cross section that was developed from the modeling effort is shown below in Figure 5.

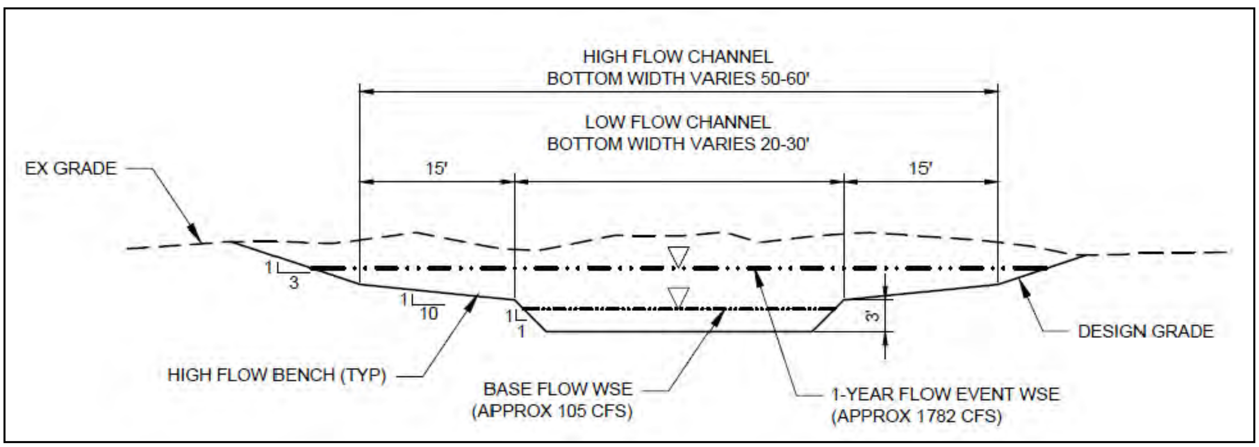

Figure 5. Typical cross section for a secondary channel (ESA, 2015).

ESA developed a SRH-2D model of subreach 4A to evaluate the depth and velocities of the main channel and proposed secondary channels. The model grid system representing the main channel and overbank areas was created from a digital terrain model that was developed from terrestrial topography data collected by the Sonoma County Vegetation Mapping and LiDAR Program. The low flow channel section of the main channel had to be entered manually since LiDAR cannot penetrate water surfaces. Proposed measures for with-project conditions, such as the development of secondary channels and riffles, were manually input into the model grid system. A sample output of predicted inundation depths and velocities within the main channel and secondary channels is shown in Figure 6. A full set of outputs are included in Appendix C of *Dry Creek Habitat Enhancement Project - Phase III, Mile Three 60% Design Report*. Outputs from Appendix C were utilized in the selection of the Recommended Plan for the project.

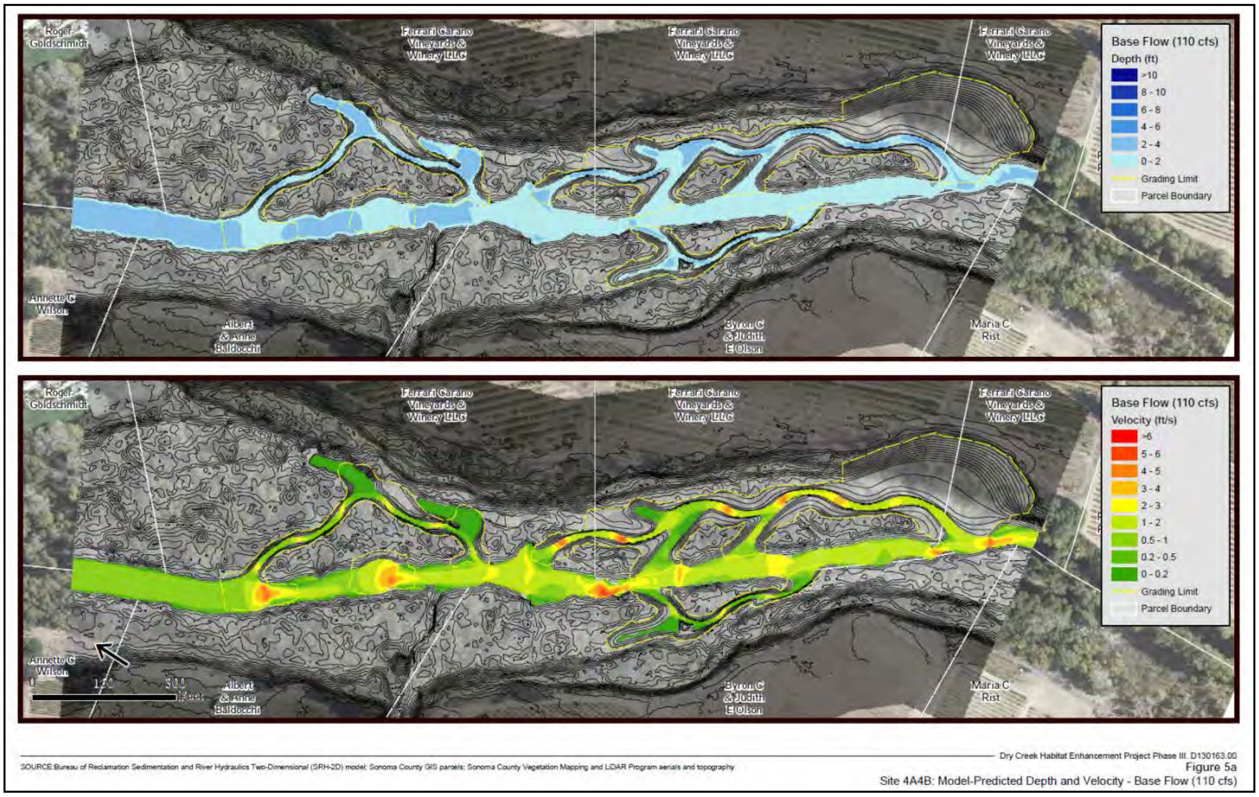

Figure 6. Base flow outputs from the SRH-2D model of subreach 4A showing flow depth (top panel) and velocity (bottom panel) for potential with-project conditions (ESA, 2015).

6.2. Hydraulic Analysis of Subreaches 14A and 14B

Inter-Fluve conducted a hydraulic analysis of subreaches 14A and 14B using HEC-RAS and TUFLOW. Geometry from the 2013 existing conditions HEC-RAS model was used as a basis for the development of the TUFLOW model for subreaches 14A and 14B. The TUFLOW model was updated to include more recent elevation data, consisting of a digital elevation model produced by SCWA covering the overbank areas, as-built drawings from the Corps for the demonstration project that was constructed in reach 15, and a digital elevation model from a 2014 survey covering reaches 8, 13, and 14.

Manning's roughness coefficient values for the channel and overbank areas were developed for the TUFLOW model by using the original values from the HEC-RAS model, but updated based on recent vegetation inventory mapping and based on refinements during model calibration. Proposed measures such as the development of side channels, backwater channels, riffles and large wood structures were modeled. Typical roughness values ranged from 0.03 to 0.045 in-channel, and 0.06 to 0.12 for out-of-bank and floodplain areas. The proposed large wood elements were represented by modifications to roughness values based on an empirical equation developed by Shields & Gippel (1995). A unit roughness value of 0.1 was used to represent areas with large wood structures and similar design elements.

A sample output of the TUFLOW model is shown in Figure 7. This particular output depicts the predicted inundation extents for various flow events under with-project conditions. A full set of outputs can be found in Section 3.8 (without-project conditions), Section 4.14 (with-project conditions), and Appendix B (modeling methods and expanded results) of *60% Design Report, Dry Creek Habitat Enhancement Projects: Mile II* (Inter-Fluve, 2015). These outputs were utilized in the selection of the Recommended Plan for the Project.

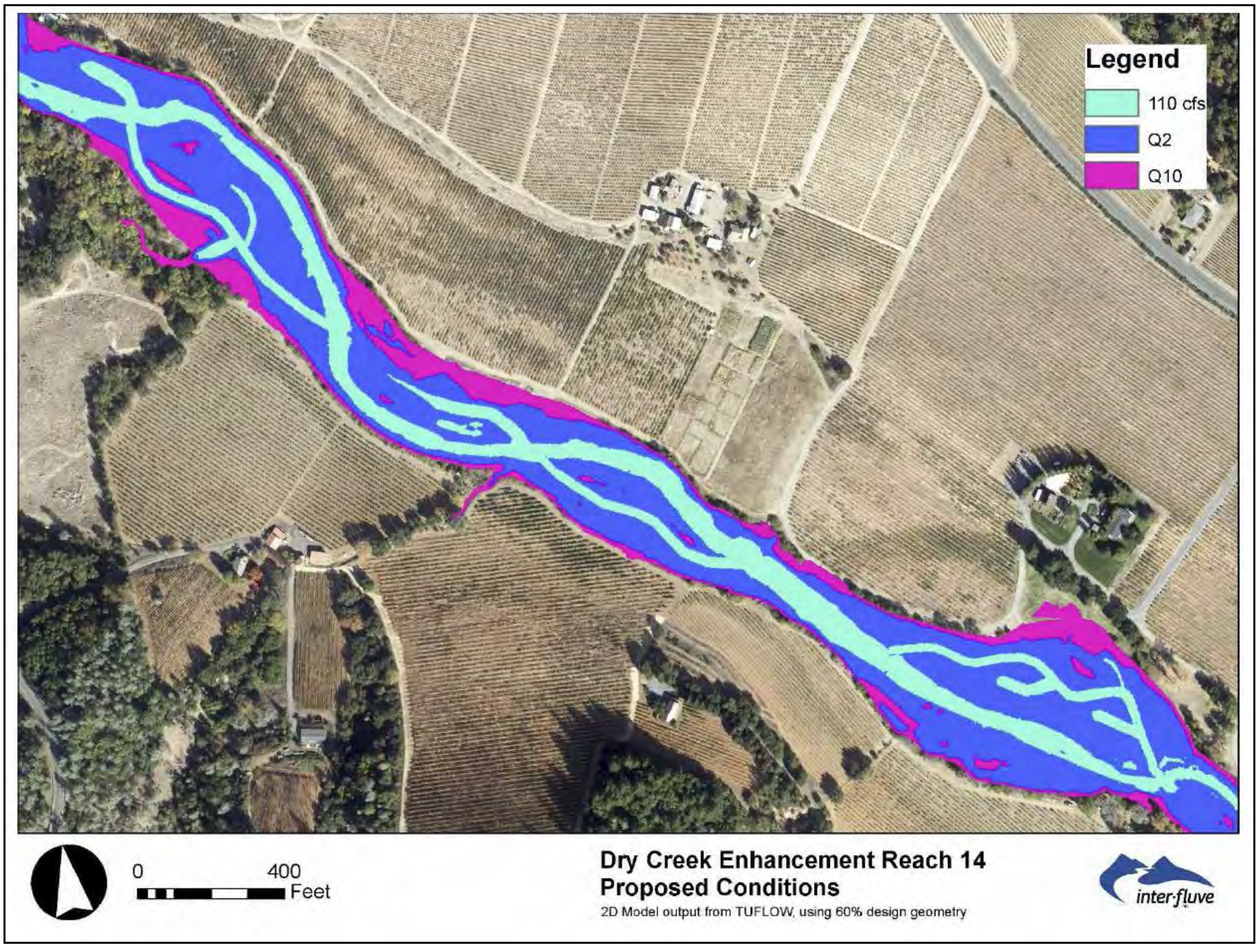

Figure 7. Sample output from TUFLOW model of Reach 14 showing inundation extents for potential with-project conditions (Inter-Fluve, 2015).

7. Evaluation of Restoration Alternatives

A multi-phase, cost-benefit analysis was conducted to determine the restoration alternative that is the most efficient in terms of project costs and ecological benefit, and competitively priced amongst federal-funded CAP projects – referred to as the Recommended Plan. The cost-benefit analysis used design plans and hydraulic outputs for the subreaches included in the focused array of alternatives (ESA, 2015; Inter-Fluve, 2010, 2013, and 2015).

Each restoration alternative and associated restoration elements were analyzed using a Habitat Suitability Index (HSI) model developed for CCC Coho salmon. HSI models are mathematical expressions designed to represent the suitability of an area for a single species or assemblage of species. Model variables include measures of habitat requirements such as percent cover and water depth. Combined the model variables generate a habitat index score between zero and one - a value of 0 corresponding to no suitable habitat, a value of 1 suggesting ideal habitat conditions for the species or assemblage of interest. The HSI model for Coho uses parameters that describe habitat suitability for adult spawning, egg incubation, and free embryo habitats. HSI models were developed using existing data and restoration alternative dimensions and specifications.

HSI model results were used to conduct a Cost Effectiveness and Incremental Cost Analysis (CE/ICA) using the Corps' Institute for Water Resources (IWR) Planning Suite, a water resources investment decision support software built for the formulation and evaluation of ecosystem restoration alternatives. Alternatives 1, 2 and 5 were identified as "best buy" plans, which provide the greatest incremental increase in benefits for the lowest incremental increase in cost. Alternative 5 (subreaches 14A and 14B) resulted in the most benefits; however, those benefits were generated at the greatest overall cost.

The focused array of alternatives were also evaluated and rated using a suite of qualitative and quantitative metrics based on planning principles and guidelines (P&G) - project completeness, effectiveness, efficiency, and acceptability. The P&G metrics were selected to describe habitat features and qualities beyond those included in the Coho HSI model - habitat complexity, channel connectivity, high quality fish and wildlife habitat, and improvements to riparian vegetation complexity and biodiversity. Each metric was weighted based on the perceived level of importance. For instance, floodplain features and side channels received a higher weight than large wood and boulder field elements. Metric scores were normalized by the stream length of each alternative. Alternative 2 (subreach 4A) resulted in the highest normalized score.

Finally, Engineering Regulation 1105-2-100 states that Corps ecosystem restoration projects should contribute to National Ecosystem Restoration (NER). A suitable NER plan will maximize ecosystem restoration benefits relative to costs, and consider cost effectiveness and incremental cost of implementation relative to other restoration alternatives. Alternative 2 was selected as the NER Plan.

Based on the results of the alternatives evaluation, Alternative 2 was selected as the Recommended Plan. The alternative best meets the project objectives and has the approval of the non-federal sponsor. As highlighted by the evaluation process, the Recommended Plan significantly increases habitat complexity and connectivity, decreases invasive plan species, and creates self-sustaining summer rearing and winter refuge habitats for threatened and endangered salmonids.

8. Hydraulic Analysis of the Recommended Plan

The Corps conducted an independent hydraulic analysis of the Recommended Plan in order to evaluate potential impacts of the restoration alternative on adjacent reaches and land parcels such as changes in flood depths and inundation extents, hydraulic parameters, and boundary conditions. The analysis required an update of the existing conditions model to reflect Future Without Project (FWOP) conditions, and clipping and merging the hydraulic model for subreach 4A into the FWOP model to create a full-length model representing Lower Dry Creek under "with-project" conditions.

8.1. Future Without Project Conditions

A full-length hydraulic model (from Warm Springs Dam to the Russian River) was developed by Corps to reflect Future Without Project conditions. The model was developed using the latest version (at the time of reporting) of the HEC-RAS hydraulic modeling software (version 5.0.3).

The existing conditions models from ESA and Interfluve (focused on the lower and upper halves of the creek, respectively) were combined to form the base model. Channel geometry and underlying terrain models were updated using bare earth LiDAR data from Sonoma County (2013) and channel topography and bathymetric surveys collected by ESA and Inter-Fluve (2014, 2015). In addition, recent restoration projects implemented in subreaches 7A and 15 were merged into the channel geometry and underlying terrain model.

Additional modifications were required to better reflect existing conditions downstream of subreach 4A. The exiting conditions model did not contain any cross-sections in subreach 3B. A total of five cross sections were interpolated and cut from the terrain model to provide hydraulic calculations downstream of the project. Channel inverts for subreach 3B were lowered 2-3 feet based on observed differences between the bare earth LiDAR and surveyed channel geometry upstream of the subreach, and professional judgment on relative cross section capacity (i.e. wider cross sections tend to be shallow, narrow cross sections tend to be deep). The adjusted cross sections were then merged into the underlying terrain so that the geometry and terrain represented the same topographic surface.

Boundary conditions from the Inter-Fluve existing conditions model were maintained for the FWOP model (appendix Section 4).

8.2. With-project Conditions

The hydraulic model for with-project conditions was based on the FWOP model, but updated with design geometry developed by ESA for subreach 4A. Cross sections from the subreach 4A model were imported into the FWOP model using the import geometry tool in HEC-RAS. The FWOP terrain model was merged with surfaces exported from AutoCAD design drawings for subreach 4A to develop the terrain model for with-project conditions (Figure 8). Figure 8 shows the terrain models used for FWOP and with-project hydraulic analysis. Two-foot contours are shown. FWOP cross-sections are shown in green. Cross-sections shown in yellow were added to the with-project model to better capture hydraulic conditions through with-project design elements (e.g. side channels).

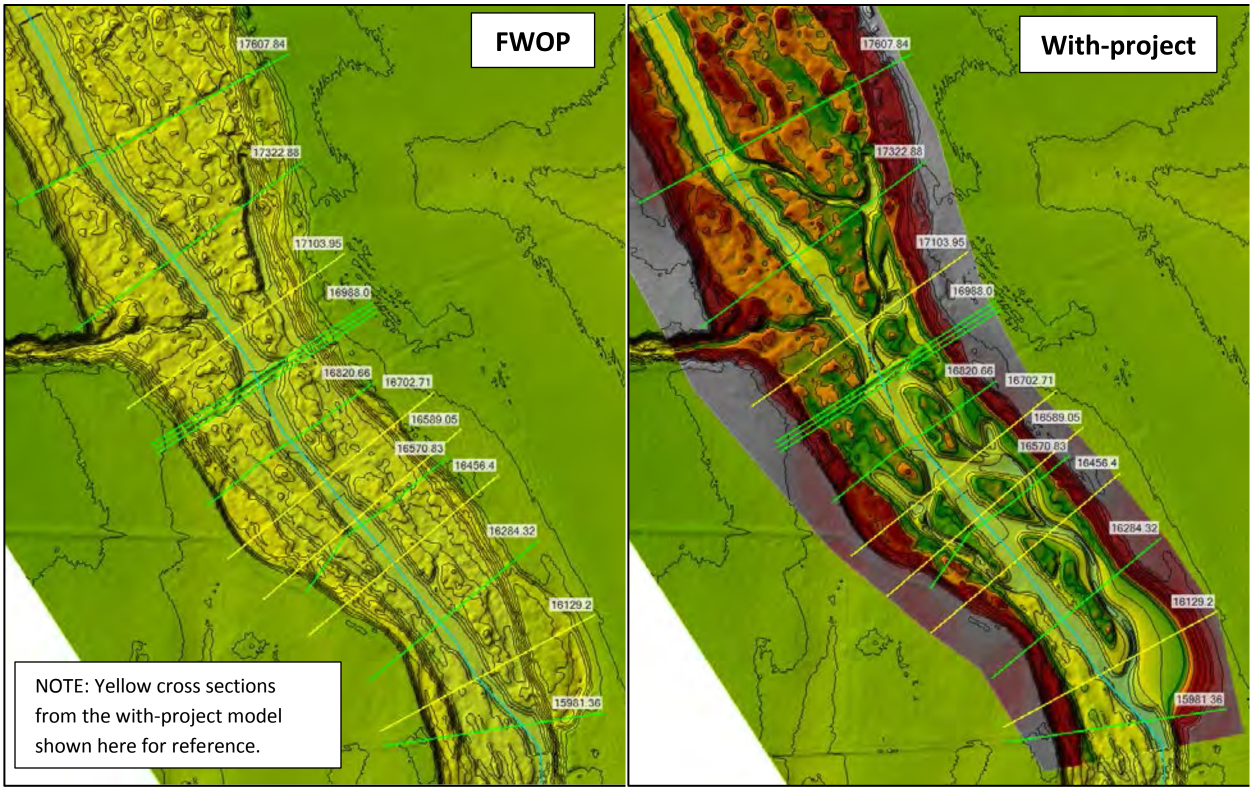

Figure 8. Comparison of HEC-RAS terrains used for hydraulic analysis of subreach 4A – the Recommended Plan.

Boundary conditions for the with-project model remain the same as those described in previous sections of the appendix. Steady flow profiles from the *Fish Habitat Enhancement Feasibility Study* (Inter-Fluve, 2013) were used to define the upstream boundary condition and internal flow change locations (Figure 3). Downstream boundary conditions were set to either normal depth or a known water surface elevation depending on the flow profile (e.g. 95.8 feet-NAVD88 for the 100-year event). Grading and revegetation plans were used to determine with-project roughness values. Mature riparian vegetation was assumed. Typical roughness values ranged from 0.03 to 0.045 for in-channel areas to represent riffle and pool bed forms comprised of gravel and cobble, and 0.06 to 0.12 was used for overbank and floodplain areas, which range in composition from grasses and shrubs to dense riparian woodlands. A roughness value of 0.1 was used to simulate areas where large wood elements are proposed (Shields and Gippel, 1995).

8.3. Potential Impacts

The SRH-2D model developed by ESA provides two-dimensional hydraulic outputs of depth, velocity, and shear for flow events ranging from the 100 cfs base flow to 50-year flood event for subreach 4A and other subreach restoration designs discussed above. The outputs show that in-channel depth and velocity are lowered relative to existing conditions, and that off-channel habitats (side channels and alcoves) provide low velocity refuge during higher flow events. The changes in hydraulic parameters meet project objectives. Additional details of the model and outputs can be found in Appendix C of the *Draft Mile Three 60% Design Report* (ESA, 2015).

Hydraulic analysis of the 100-year flow event has been conducted by the Corps in order to assess potential impacts of the project on large event flood depths, inundations extents, and in-channel hydraulics; and to supplement the hydraulic outputs provided by ESA. The analysis was conducted using the FWOP and with-project conditions hydraulic models developed in HEC-RAS. Outputs from the models were generated using the RAS Mapper geospatial visualization tool, in addition to standard results summary tables and plots. All geospatial outputs are projected in California State Plane Zone II and use the North American Datum of 1983 (NAD83) for horizontal coordinates and NAVD88 for vertical elevations. Horizontal and vertical units are provided in US Survey Feet. No projection or datum conversion was required (e.g. National Geodetic Vertical Datum of 1929 (NGVD29) to NAVD88). Upstream and downstream impacts are also considered. Subreach 4B is upstream of the Recommended Plan, while subreach 3B is downstream.

The addition of side channels and large wood elements in subreach 4A, increases form roughness and reduces hydraulic forces acting on the boundary of the mainstem channel (Figure 9). Under the with-project condition, average channel velocity is reduced from 7.2 to 5.4 feet per second, and average boundary shear stress is reduced from 0.8 to 0.5 pounds per square foot (Table 5). There are small variations in water surface elevations between the FWOP and with-project models, but average values remain the same (Figure 10).

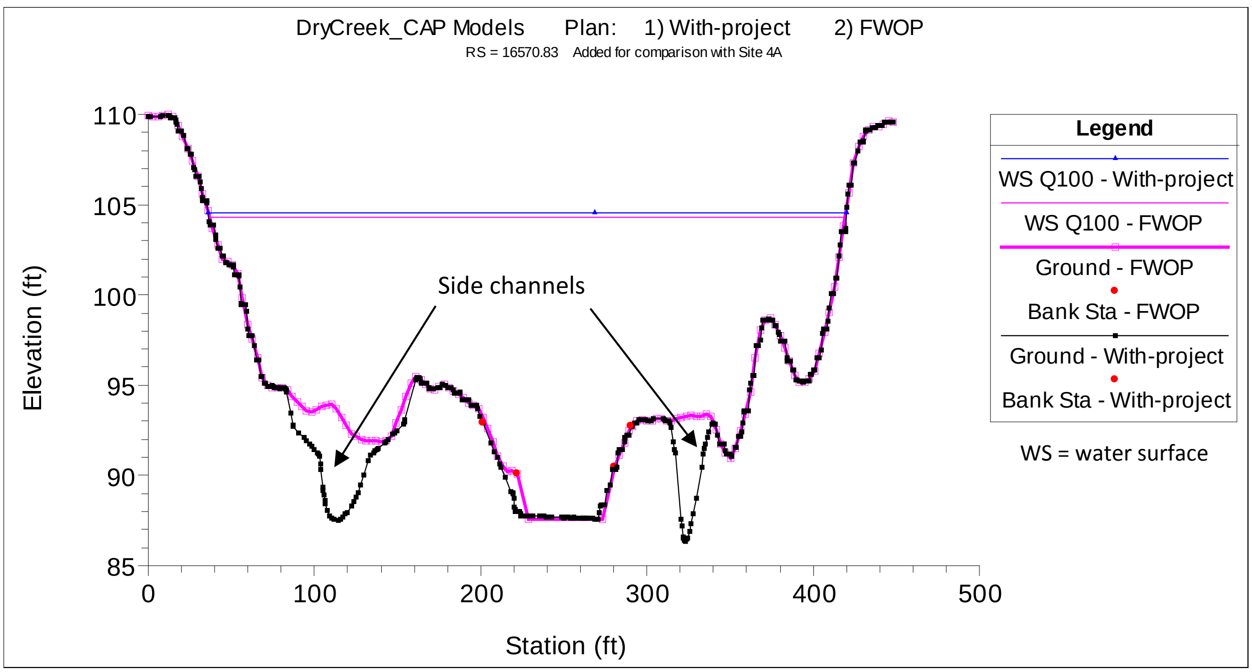

Figure 9. An example of FWOP and with-project cross sections in subreach 4A.

Table 5. Summary of hydraulics along the project reach for the 100-year flow event.

Subreach Averaged Values	FWOP			With-project			Percent Change		
	Velocity (fps)	Shear (psf)	WS Elev (ft)	Velocity (fps)	Shear (psf)	WS Elev (ft)	Velocity (fps)	Shear (psf)	WS Elev (ft)
4B (upstream)	7.4	1.2	107.3	7.7	1.3	107.0	4%	9%	-0.3%
4A (project)	7.2	0.8	105.0	5.4	0.5	104.9	-25%	-40%	-0.1%
3B (downstream)	8.5	1.1	102.1	8.5	1.1	102.1	0%	0%	0.0%

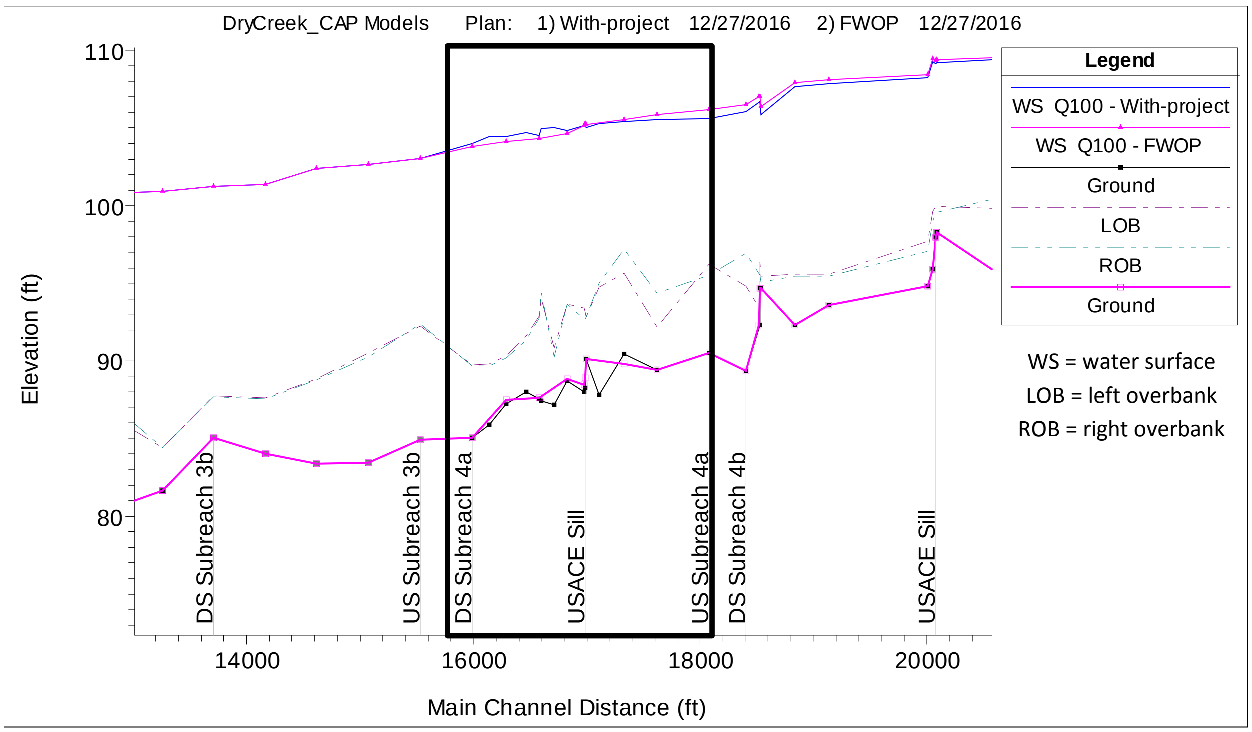

Figure 10. Comparison of water surface elevations near the project area (outlined in black).

The with-project model suggests that the Recommended Plan may have minor, but non-concerning impacts outside of the project area. Increased channel capacity through the grading of side channels within the project area results in a small draw down of the water surface upstream of the project area in subreach 4B. Average water surface elevations in subreach 4B are reduced by 0.3 feet, but average channel velocity and shear stress are increased relative to FWOP conditions (4% and 9%, respectively). The addition of cross-sections in subreach 4A to represent changes in channel form under with-project conditions (e.g. side channels, constructed riffles, etc.) reduced the reach length between cross sections used for one-dimensional hydraulic calculations. Changes in cross-sectional spacing for natural channels can introduce small variations in hydraulic parameter values, and actual changes in channel velocity and shear in subreach 4B are expected to be negligible. No changes in hydraulic conditions are projected downstream of the project in subreach 3B (Table 5).

Flood inundation extents for the 100-year event remain the same under with-project conditions except for a location where a terrace is graded to provide high-flow refugia along the active channel margin (Figure 11).

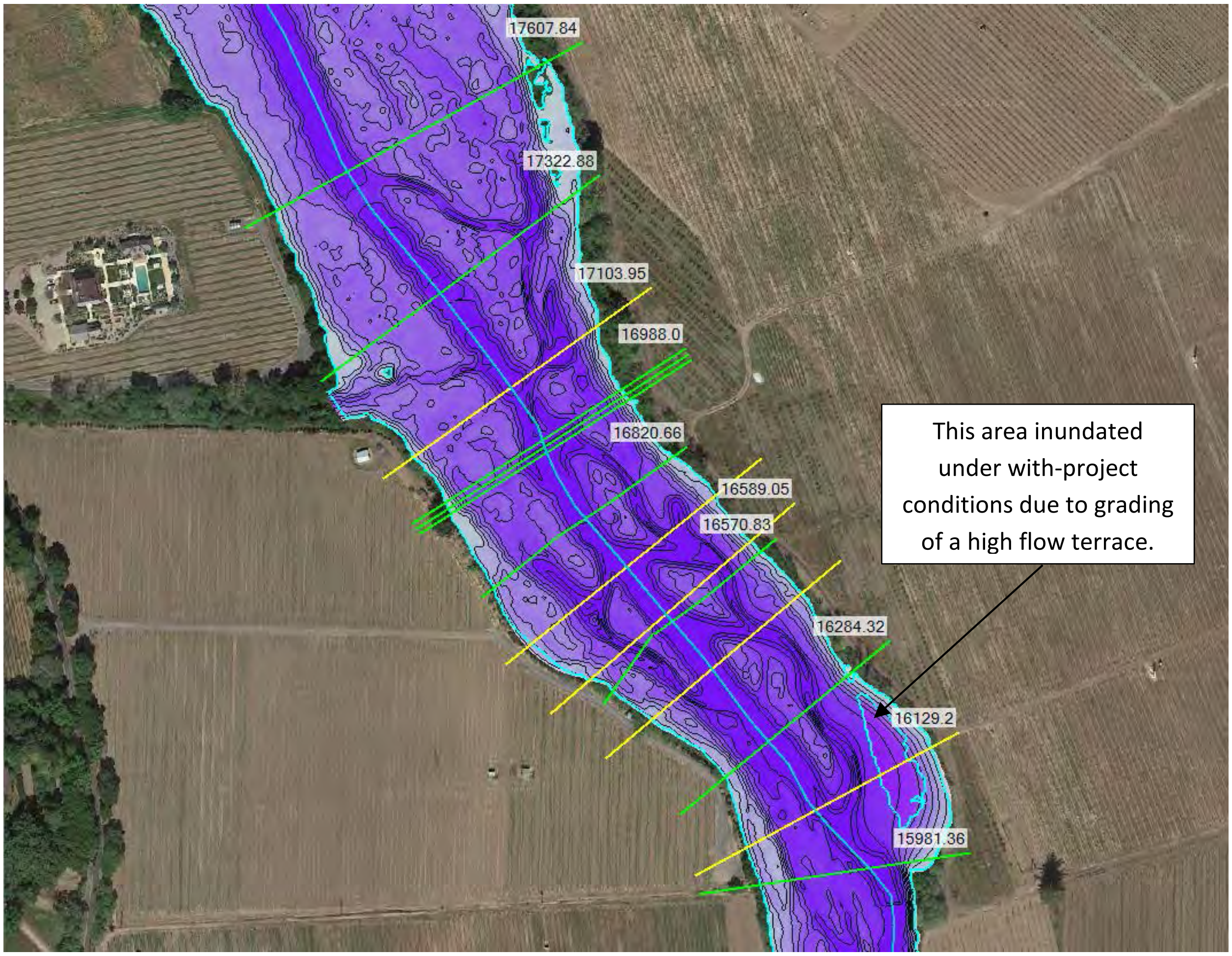

Figure 11. Water depths and flood inundation extents for the 100-year event along subreach 4A. Legend – Light Blue Outline = FWOP conditions, Deep Purple Fill = With-project conditions.

9. Conclusions and Recommendations

The Recommended Plan appears to have met the hydraulic objectives set for the project. The *Draft Mile Three 60% Design Report* (ESA, 2015) shows that design plans for subreach 4A introduce several secondary channels, large wood structures and boulder clusters to improve in-channel habitat and create off channel habitat. In-channel velocities are reduced during base flows, and Habitat Suitability Indexes show that habitat conditions for salmonids (velocity and depth-based metrics) are improved under the with-project condition. Variations in design channel width promote velocity reversal and riffle-pool maintenance during moderate flow events. Revegetation plans are designed to provide shaded riparian area cover for new side channels and alcoves

Modeling by Corps shows that the hydraulic benefits of the ESA design elements extend to higher flow events as well. Velocity and shear are reduced within the project area during the 100-year event and no significant changes in water surface elevations or inundation extents are observed upstream or downstream of the project.

As the project enters the Design and Implementation Phase, additional model revisions should be made to account for final design modifications by ESA and any new hydrologic and topographic data collected and provided by the ESA, Inter-Fluve, or SCWA. Potential modifications include notching or removal of grade control sills. FWOP conditions should be reviewed before final modeling to include any additional stream restoration or channel modification activities that may occur before implementation of subreach 4A. In addition, considerations should be made for the potential impacts of climate change on inland hydrology and water control operations of Warm Springs Dam.

The final hydraulic models for the project will become the base models for FWOP conditions for the Dry Creek Ecosystem Restoration Project - General Investigation. It is important that models from the CAP are properly documented and quality controlled before transfer to the General Investigation.

10. References

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Appendix C:

Geotechnical

US Army Corps of Engineers ®
San Francisco District

Geotechnical Appendix

Dry Creek 1135 CAP Project
Healdsburg and Geyserville, California

January 2017

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LIST OF ABBREVIATIONS AND ACRONYMS

CAP	Continuing Authorities Program
CGS	California Geological Survey
ESA	Environmental Science Associates
ft	Feet or foot
in.	Inch or inches
MASW	Multichannel analysis of surface waves
mm	Millimeter or millimeters
NAVD	North American Vertical Datum
NGVD	National Geodetic Vertical Datum
NMFS	National Marine Fisheries Service
SAGE	Sanders & Associates Geostructural Engineering
SR	Seismic Refraction
USACE	US Army Corps of Engineers
USGS	US Geologic Survey

1.0 INTRODUCTION

1.1 Study Area

This geotechnical appendix provides of summary of project conditions and geotechnical engineering considerations for the Dry Creek 1135 Continuing Authorities Program (CAP) Project between USACE San Francisco District and Sonoma County Water Agency (SCWA). The 1135 CAP Project goals are to restore the quality, complexity, and diversity of habitat along lower Dry Creek by restoring floodplain and channel habitat complexity, riparian vegetation diversity, and productive backwater habitat by reconnecting the Dry Creek floodplain. The 1135 CAP Project will evaluate Subreaches 4a, 14a, and 14b.

To facilitate environmental enhancements over 13.9 miles of lower Dry Creek, the creek was separated into 15 Reaches and 25 Subreaches (Reaches are shown on Plate 1). To date, the USACE San Francisco District constructed Reach 15 in 2013 and the SCWA constructed Reach 7 (commonly referred to as the Demonstration Project) in 2014. Once a recommended plan was identified in the 1135 CAP Project, all unmodified Subreaches will be incorporated into a separate General Investigation Study. Vertical elevations stated in this document are referenced in North American Vertical Datum 88 unless specifically noted otherwise.

1.2 Recommended Plan

The recommended plan for the 1135 CAP Project is the National Ecosystem Restoration (NER) plan for Subreach 4a (Also known as Site 4a and 4b). Subreach 4a is approximately 1,700 ft long between Station 160+00 and 177+00. Proposed measures include side channel both sides of the main channel, backwater alcoves, and reconnections to the main channel, large woody debris structures, pool enhancements, riffles, bank stabilization, and boulder fields.

1.3 Scope of Geotechnical Appendix

This geotechnical appendix is limited to Subreach 4a and measures proposed in the recommended plan. Geotechnical engineering considerations did not influence the selection of the recommended plan.

2.0 AVAILABLE INFORMATION

Geologic and geotechnical information related to the Dry Creek 1135 CAP Project were sourced from publications by the California Geological Survey (CGS), Environmental Science Associates (ESA), Inter-Fluve, Sanders & Associates Geostructural Engineering (SAGE), and USACE. Descriptions of existing structures were summarized from publications completed by Horizon. Seismic refraction (SR) and multichannel analysis of subsurface waves (MASW) sounding results to evaluate subsurface conditions and estimate the depth of bedrock were conducted by A3GEO.

3.0 GEOLOGIC CONDITIONS

3.1 Regional and Local Geology

Dry Creek is located in the drainage valley within the Coast Ranges geomorphic province of California. The Coast Ranges province is generally characterized by northwest-trending mountain ranges and intervening valleys that are controlled by right-lateral strike-slip faulting along the San Andreas fault system. Dry Creek lies on the boundary between sedimentary units of the Great Valley Complex to the east and various fault bounded lenses of the Coast Range ophiolite and metamorphic rock units of the Franciscan Complex to the west. However, sandstone, siltstone, and shale units belonging to the Great Valley Complex are also mapped along the western margin of the valley. The valley is filled with stream channel and floodplain deposits associated with Dry Creek and include up to three terrace deposits, the oldest of which appears to be approximately 1,000 years old (Sanders & Associates Geostructural Engineering [SAGE] 2011). The 2010 California Geological Survey (CGS) Geologic Map depicts two synclinal folds located to the eastern flank of the valley (Jennings & Bryant 2010).

The valley floor is comprised of Late Holocene alluvial deposits. Near Dry Creek channel and outer banks, the alluvium is mapped as Holocene. Pleistocene-age alluvium and sediments are mapped near the base of the hill east of Reaches 4 and 5; Pleistocene-age soils may also underlie Holocene alluvium (ESA 2015). The Dry Creek geologic map is shown on Plate 2.

Harvey and Schumm identified exposed bedrock along Grape Creek that consisted of two depositional units (cemented sand and gravel unit and a very tight, consolidated unit of laminated silts and clays) which lay directly on an erosional unconformity above exposed sedimentary bedrock. They also observed similar cemented depositional units at several other points along the 1985 channel bed of lower Dry Creek (Reaches 5 through 8), and inferred that bedrock was approximately 8 to 10 ft below the channel bed. However, Harvey and Schumm noted that the resistant bedrock and/or the cemented sediments were exclusively located on the western side of the valley and considered any estimated of the suballuvial location of bedrock to be highly speculative eastward of these bedrock and resistant alluvial controls (Inter-Fluve 2010).

Five seismic refraction (SR) lines and one multichannel analysis of surface waves (MASW) sounding were conducted in Subreach 4a to evaluate subsurface conditions and estimate the depth of bedrock (A3GEO 2016). The interpreted seismic refraction data and the estimated bedrock depths are summarized in Table 3.1. Based on the seismic refraction results, bedrock was estimated relatively shallow in Subreach 4a between 69 ft and 84 ft. Comparing the interpreted elevation of bedrock to the finish grade of the channel may expose remnants of bedrock or shallow pinnacles below the ground surface (reference Table 3.1 for interpreted elevations and depths below finish grade). Line SR 4b-1 was measured over the existing grade control sill and sections of the grade control sill crest and downstream apron could be registering shallower bedrock depths. The A3GEO Seismic Refraction Report is attached at the end of this appendix.

Table 3.1: Refraction Survey Results

Site	Survey ID	Interpreted Depth to Bedrock (feet below the ground surface)	Interpreted Elevation of Bedrock (feet)	Interpreted depth of bedrock compared to the finish elevation grade (feet)
4a	SR 4a-1	9-15	75-83	0-11
	SR 4a-2*	14-27	76-84	0-12
	SR 4a-3	Not encountered (> 20)	< 75	11-14.5
	MASW 4a	26	69	17
4b	SR 4b-1	10-20	74-84	2-12
	SR 4b-2*	Not encountered (> 25)	<76	12-14

*Surveys performed at elevations above planned restoration areas due to site inaccessibility (i.e. dense vegetation). Bedrock surface likely dips down toward the creek; therefore, elevations of bedrock at actual restoration sites are likely lower than the elevations shown in the table.

3.2 Seismicity

Dry Creek is within close proximity to nine active or potentially active faults in northern California (Table 3.2 and Plate 3). The CGS defines an active fault as one that has had surface displacement within Holocene time (about the last 11,000 years), and a sufficiently active fault as one that has evidence of Holocene surface displacement along one or more of its segments or branches. Faults with movement within the past 1.6 million years (i.e., Quaternary) and no known Holocene displacement are considered moderately capable of rupture and are categorized as “potentially active.”

Table 3.2: List of Faults near Dry Creek (Jennings and Bryant, 2010)

Fault	Reference Number	Age
Healdsburg Fault Zone	142	Quaternary
Maacama Fault Zone	141	Late Quaternary
Rodgers Creek Fault Zone	149	Holocene
San Andreas Fault Zone (Fort Ross to Manchester)	119	Historic
San Andreas Fault Zone (Offshore)	145	Late Quaternary
Bennett Valley Fault Zone	143	Quaternary
Unnamed Faults Northwest of Santa Rose Near Trentor	144	Late Quaternary

Fault	Reference Number	Age
Collayomi Fault	120	Late Quaternary
Adobe Creek Fault	113	Late Quaternary

4.0 SITE CONDITIONS

4.1 Surface Conditions

4.1.1 Topography

Dry Creek is defined as predominately open channel, flanked by riparian vegetation in the overbank areas. Dry Creek has an active channel width between 40 ft (upstream of Dutcher Creek) to 86 ft. Dry Creek flows southeast through a valley floor about 0.5 miles wide at Warm Springs Dam (Reach 15) and widening to about 2 miles wide approaching Reach 5. Downstream of Reach 5, the valley containing Dry Creek merges with the valley containing the Russian River. The City of Healdsburg occupies the widened valley flood upstream of the Dry Creek-Russian River confluence, which is roughly 6 to 7 miles wide. The 1997 U.S. Geological Survey (USGS) topographic map of the Geyserville, California Quadrangle shows the top of the creek banks at the Warm Springs Dam near elevation +200 ft National Geodetic Vertical Datum (NGVD) 29. The 1993 USGS map of the Healdsburg Quadrangle shows the top of the creek banks near +90 ft NGVD 29. The direct-line distance between these two points is about 12 aerial miles (as opposed to 13.9 river miles); an elevation change of 110 ft over this distance represents an average valley floor gradient of about 0.17%. The hills along the east side of the valley rise to elevation +600 ft NGVD 29 and the mountains to the west are higher with peaks rising above elevation +1,000 ft NGVD 29 (ESA 2015).

4.1.2 Existing Structures

Channel improvements were constructed along Dry Creek and adjacent tributaries in 1981, 1983, and 1988 (Horizon 2012) by the USACE and include stone protection, board fences, concrete weirs, and grouted riprap sills. Relative to Subreach 4a, a grouted riprap grade control sill, documented as Sill #1, was constructed at River Mile 3.54 (USACE 1981 and Plate 4).

4.2 Subsurface Conditions

Dry Creek is composed of sandy silt and variable mixtures of silts, sands, and gravel (USACE 1981 and 1987). Soils along Dry Creek banks are erosive and porous, often comprised of layered gravels, and sands, resulting in an extremely xeric (i.e. dry) condition by the summer. Prior to construction of Warm Springs Dam, Dry Creek would typically run nearly dry each year in the summer and early fall. As Warm Springs Dam began operations, the flow regime changed to a perennial stream due to minimum discharge requirements, which essentially eliminated any dry conditions during the summer.

Recent investigation of Dry Creek characterized the alluvial bed primarily composed of coarse gravel, ranging from sand to boulders and bedrock. The sand is generally concentrated in the pool bottoms and other backwatered areas, whereas the flat waters and riffles are dominated by gravel and cobbles (Inter-Fluve 2010). Inter-Fluve analyzed the sediment grain size of observed riffles in each reach and summarized the D16, D50, and D84 percentile of grain sizes. Overall, the surficial grain sizes found in riffles does vary throughout Dry Creek and the median grain size ranges between 20 to 30 millimeters (mm). One riffle was sampled in Subreach 4a with the results summarized in Table 4.1. The sediment grain size analysis for Unit # D256 is summarized in Plate 5 along with a summary of Subreach 4a existing conditions in Plate 6.

Table 4.1: Grain sizes for three percentiles of the surficial bed materials in riffles from Subreach 4a

Reach	Unit #	D16*	D50*	D84*
4	D256	14.4	31.4	59.8

* Grain sizes shown in mm.

5.0 GEOTECHNICAL ENGINEERING CONSIDERATIONS

A 60% Design Report was developed by ESA (2015). The 1135 CAP Project can be successfully implemented based on engineering recommendations by ESA. Select criteria related to geotechnical engineering are summarized below.

5.1 Excavation of Side Channels and Coves

Site grading and channel footprints should follow recommendations described by the hydraulic and hydrology analysis. Excavation of side channel and cove criteria includes:

- Avulsion into off-channel habitat should not occur within the first 5 years following construction, notwithstanding extraordinary hydrologic events. Future avulsion is acceptable provided habitat criteria continue to be met.

During construction, maximum side slope angles should be maintained to 1:1 H:V and work sites near the center of the creek may require dewatering techniques to maintain the work site and to construction large woody debris structures. Near the grade control sill, the structure should be maintained during construction and excavation should not occur unless specific plans are in place to modify portions of the structure.

5.2 Erosion Control for the Main Channel, Side Channels, and Coves

From the ESA 60% plans (ESA 2015), biotechnical stabilization will use live cuttings (e.g. willow, dogwood, and cottonwood), biodegradable erosion control fabrics, and seeding in combination with traditional grading. Biotechnical stabilization methods including brush matting, pole planting, vegetated soil lifts and live wood installations. Brush mat installation is proposed at the limits of grading at the secondary channel connections to the main channel and in several locations along the channel banks. Temporary access roads are necessary to access areas inside the channel. Excavated slopes from secondary channel construction and reconstructed slopes shall incorporate erosion protection measures documented in the project plans.

5.3 Wood Pile Installation

The proposed wood pile installations typically require no more than 10 ft embedment. Preliminary geophysical investigations show several specific locations where bedrock can be within 10 ft of the final grade elevation. It should be anticipated that conflicts with bedrock will be encountered on a regular basis during construction. During design, intrusive or non-intrusive investigations can be advanced to verify the extent of shallow (i.e less than 10 ft) bedrock below the final grade elevations.

The primary considerations for wood installation were the mobility and longevity of placed wood. The Dry Creek Adaptive Management Plan specifies mobility and decay criteria as:

- Large woody debris stability criteria for mobility is designed for a 100 year event. Decay criteria is greater than a 25 year period.

The greater concern is the mobility of larger diameter pilings becoming mobile during higher flow events. Several structures may require anchoring to ballast boulders using rebar secured by epoxy resin (reference 60% project plans).

The longevity of woody structures primarily considers the frequency and period of seasonal inundation of placed wood and the decay resistance of placed wood. Wood materials continuously saturated have slow decay rates as does wood placed in very arid conditions that see little seasonal wetting. Locations that see frequent wet and dry cycling are subject to the most rapid decay rates, hence location domains (wet, wet/dry, and dry) are recommended for this project.

5.4 Grade Control Sills

All components of the grade control sills (upstream section, grouted center, downstream apron, and side slopes) shall be maintained during construction. It is recommended all construction activity should be restricted to at least 5 ft away from the structure and any excavation or damage occurred during construction should be replaced in-kind. Planned modifications to the grade control sills should be coordinated through USACE prior to construction.

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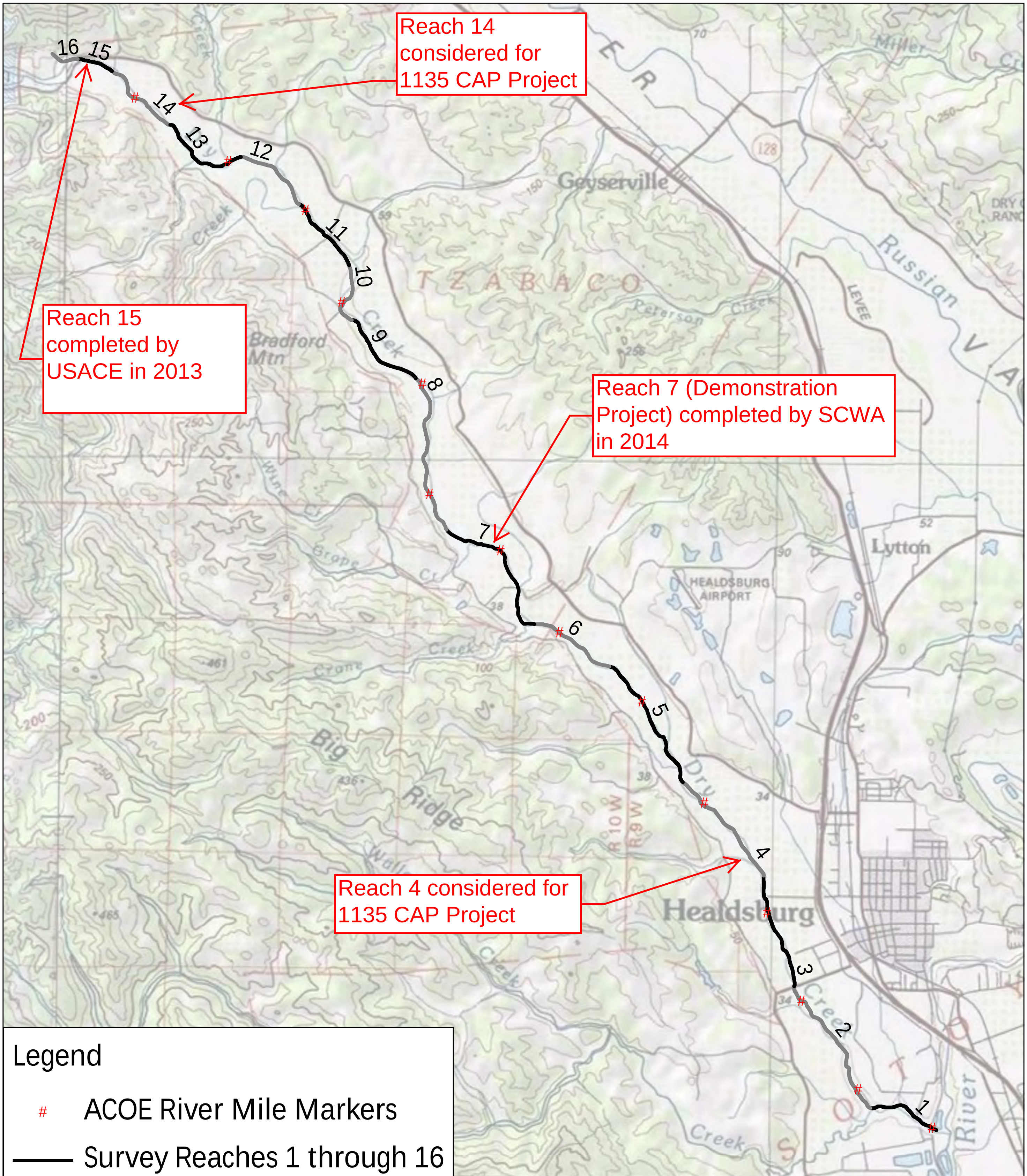
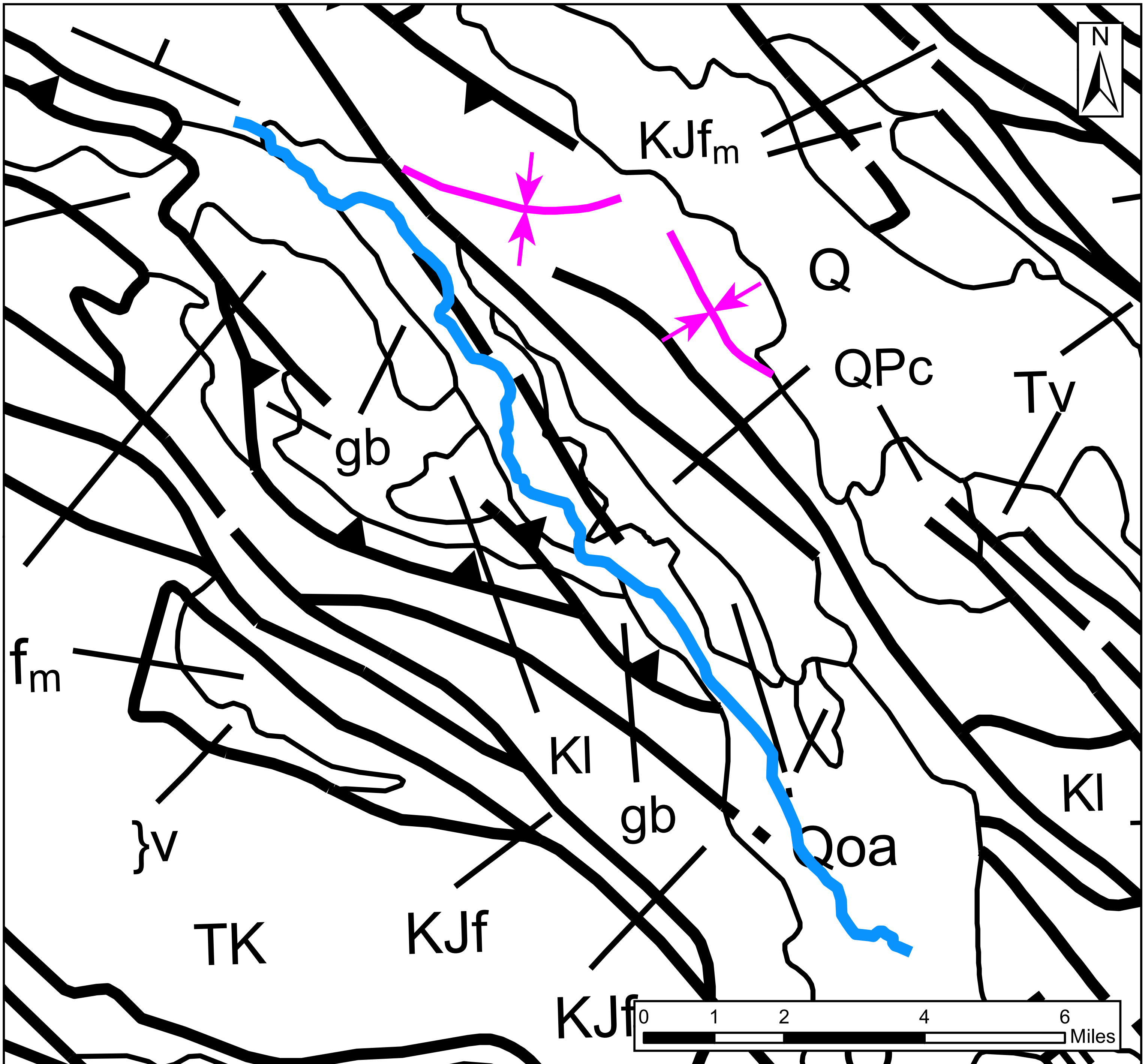


0 3,000 6,000 Feet
0 0.5 1 Miles

DRY CREEK
Current Conditions Inventory
Figure 1: Study Reach

inter-fluve
1020 Wasco St., Suite 1
Hood River, OR 97031
541-386-9003
www.interfluve.com

Plate 1 - Location and Vicinity Map

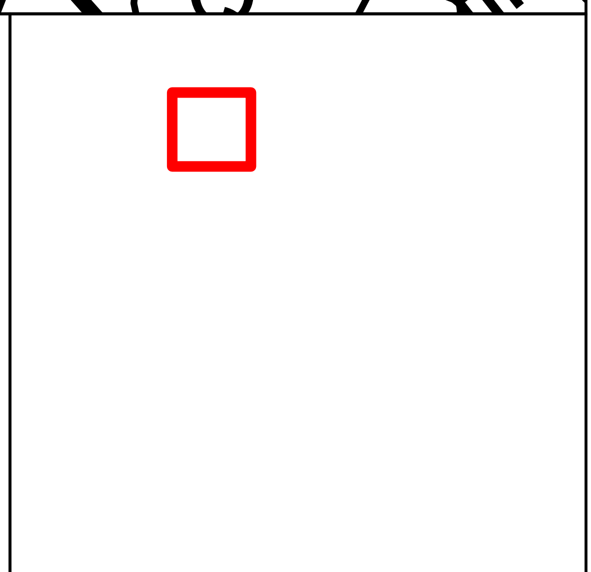


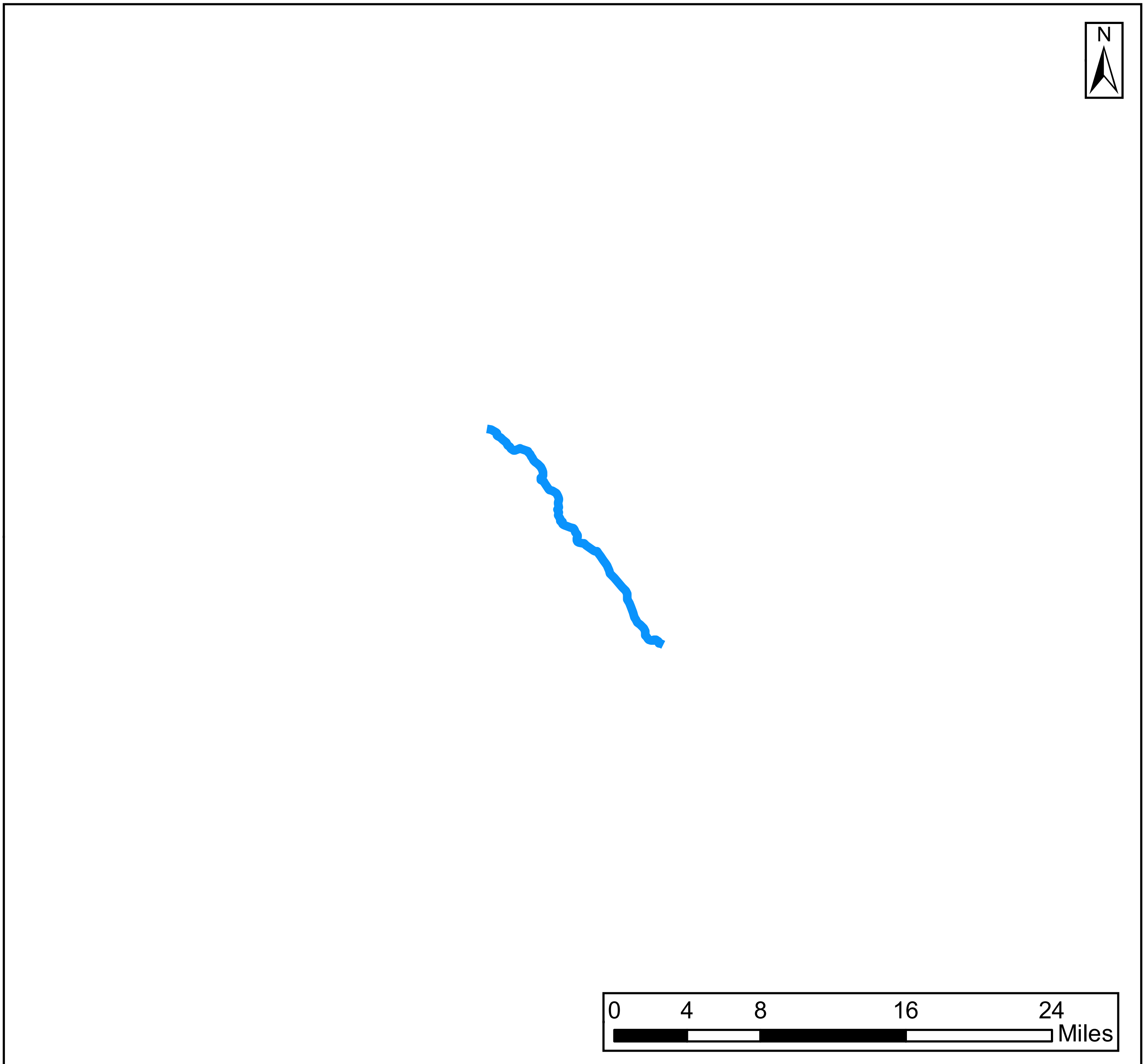
Legend

Q	Alluvium
Qoa	Older Alluvium
QPc	Pliocene/Pleistocene sandstone, shale, and gravel deposits
Tv	Tertiary volcanic flow rocks
TK	Tertiary-Cretaceous sandstone & shale (Franciscan Complex)
Kl; Kl?	Lower cretaceous sandstone, shale, and conglomerate
KJf	Franciscan Complex Cretaceous and Jurrassic sandstone
KJfm	Melange of fragmented and sheared Franciscan Complex rocks
KJfs	Blueschist and semi-schist of Franciscan Complex
Mzv	Mesozoic volcanic and metavolcanic rocks
um	Serpentine
gb	Mesozoic Gabbro

syncline, certain
Dry Creek Centerline

Plate 2 - Geologic Map





Legend

- Historic
- Holocene
- Late Quaternary
- Quaternary
- Dry Creek Centerline

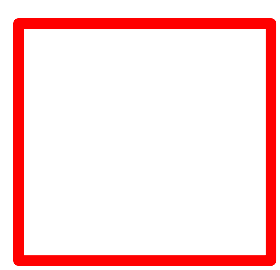
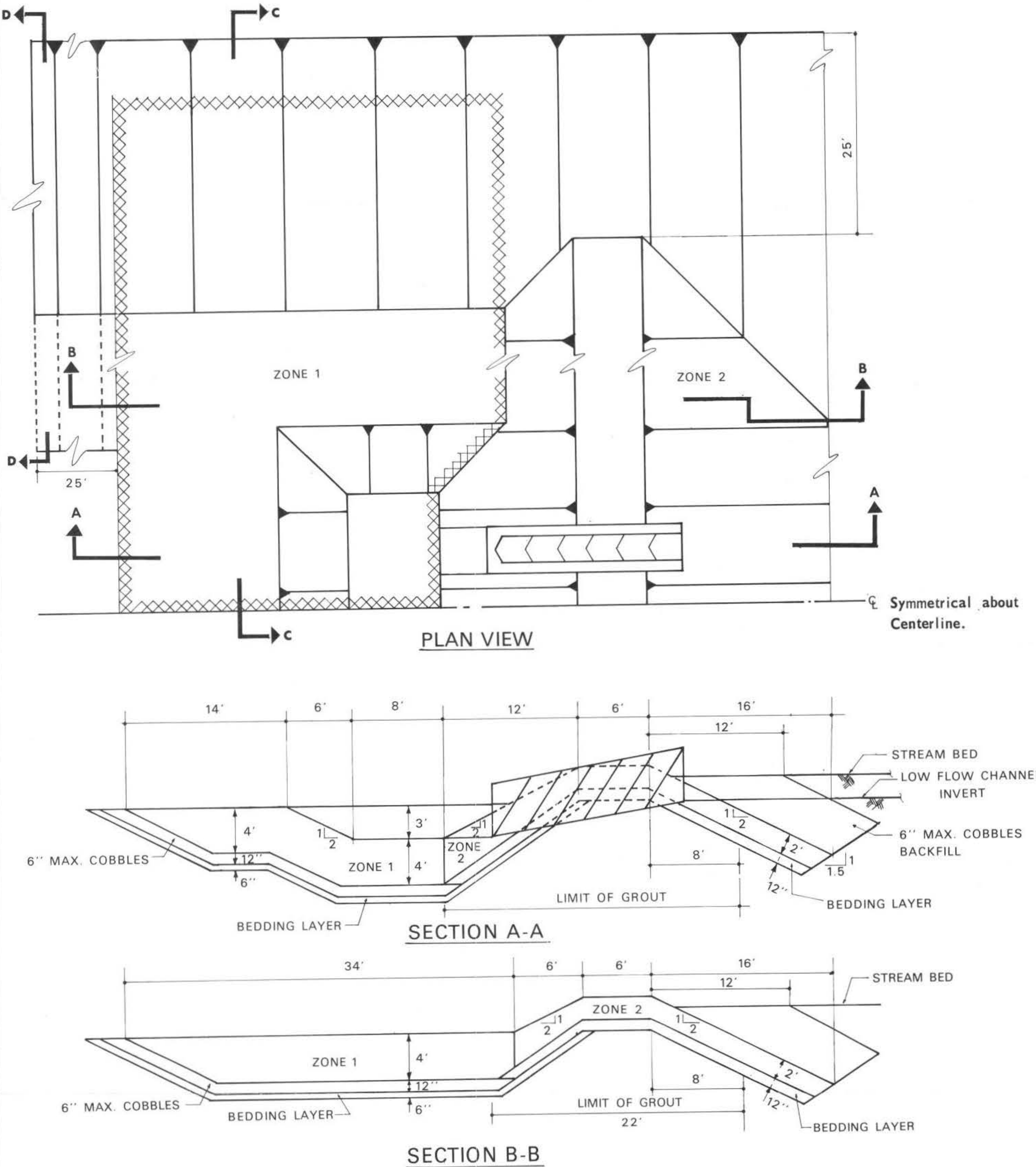


Plate 3 - Fault Map



STONE	% LIGHTER BY WEIGHT	WEIGHT (LBS) MAX	WEIGHT (LBS) MIN
ZONE 1	100	1600	900
	50	750	450
	15	350	150
ZONE 2	100	525	300
	50	350	150
	15	100	40

NOTE: SEE PLATE 19 FOR SECTIONS C-C AND D-D.

SONOMA COUNTY CALIFORNIA
DESIGN MEMORANDUM NO. 18
WARM SPRINGS DAM & LAKE SONOMA
DRY CREEK
CHANNEL IMPROVEMENTS
EROSION CONTROL SILL
PLAN AND SECTIONS
IN SHEET SHEET NO.
U.S. ARMY ENGINEER DIST., SAN FRANCISCO, C. OF E.
DRAWN
TRACED
CHECKED
TO ACCOMPANY REPORT
DATED
FILE NO.

PLATE 19

Plate 4 - Grade Control Sill Plan and Profile

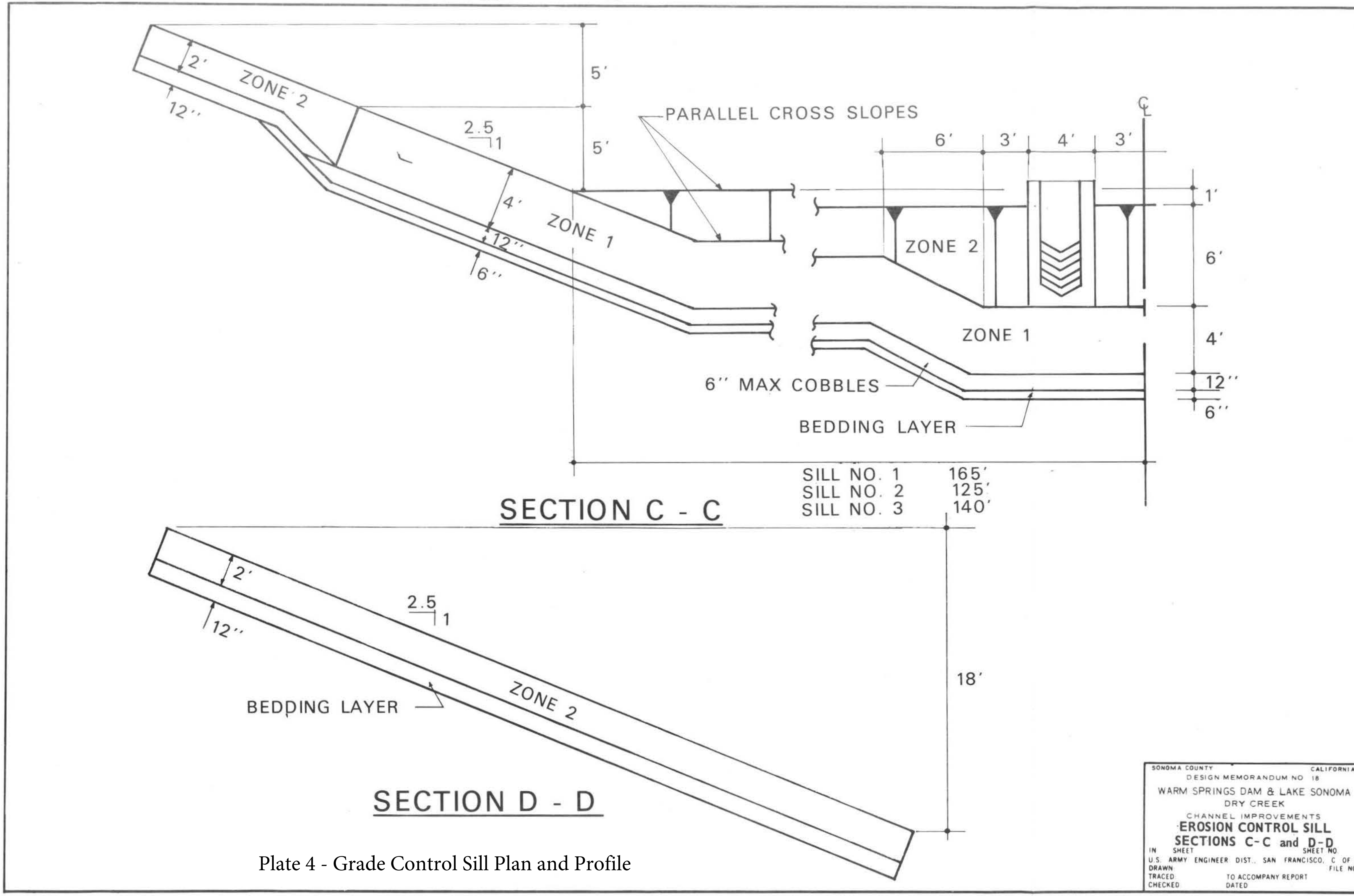


Plate 4 - Grade Control Sill Plan and Profile

Location (Stream, Reach, Description)

Sediment Grain Size Analysis

Dry	Stream	Dry Creek	**8/31/2009**	Date
4	Reach	5	N. Nelson & J. Mullen	Personnel
	Location			Latitude
256	Identifier / Unit			Longitude
Riffle	Longitudinal Description (Pool, Riffle, Bend, Crossing)			Northing
Surficial	Sample Type: Armor Layer or Subarmor			Easting
	Approximate Depth of Flow at Thalweg (ft)			Waypoint

Notes:

Pebble Count Data

Class (Wentworth)	*Size Class mm*	*Frequency*	*Cumulative %*
Sand	<2	1	1.0%
Very Fine Gravel	2.1-4	1	1.9%
Fine Gravel	4.1-5.7	1	2.9%
Fine Gravel	5.8-8	5	7.7%
Medium Gravel	8.1-11.3	3	10.6%
Medium Gravel	11.4-16	8	18.3%
Coarse Gravel	16.1-22.6	15	32.7%
Coarse Gravel	22.7-32	19	51.0%
Very Coarse Gravel	32.1-45	19	69.2%
Very Coarse Gravel	45.1-64	19	87.5%
Small Cobble	64.1-90	11	98.1%
Small Cobble	90.1-128	2	100.0%
Large Cobble	128.1-256	0	100.0%
Small Boulders	>256	0	100.0%
Bedrock	Bedrock	0	100.0%
	Total	104	

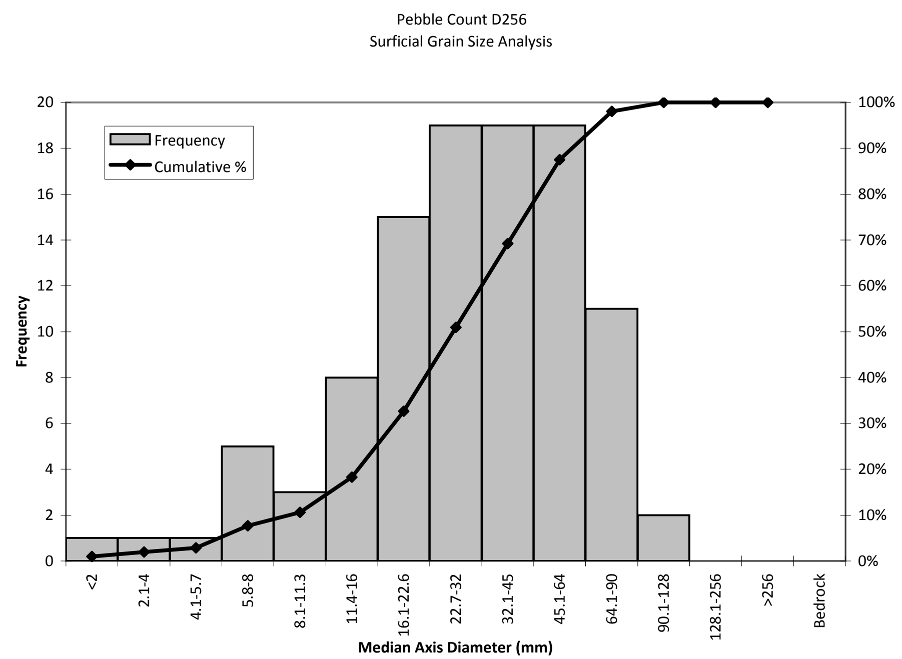


Plate 5 - Unit # D256 Sediment Grain Size Analysis

REACH 4 (RM 3.0 to RM 4.1) **Three Constructed Gradient Sills with a fault running alongside, to the top of the upper backwatered pool**

Three gradient sills were constructed in 1983 by the ACOE to slow migrating nick points and associated channel incision in lower Dry Creek. This reach is vertically stable due to the check dams. The backwatered pools created by each sill extended several hundred feet upstream, forming a pool-dominated reach. The upper sill (RM 3.8) consisted of a cascade down two sets of boulder falls, 2’ and 1’ in height. The middle sill (RM 3.5) was 200’ long, 10’ wide, and 3’ in height. The lower sill (RM 3.3) was 100’ long, 10’ wide, and 1 foot tall. Each sill has a fish ladder to provide passage through the short cascades. Rock riprap covers than right bank between the upper and middle sill, and short sections of boulder riprap cover both banks upstream and downstream of each sill. An unnamed tributary enters Dry Creek just downstream of the lower sill at river mile 3.25.

Through Reach 4, the channel has become less sinuous since the dam was built, though minor channel migration has continued. Three side channels and eight alcoves were identified in this reach, and these are located primarily along previous channel paths.

Figure 18: (upper left) lower sill, (upper right) upper sill,
(lower left) ladder on middle sill, (lower right) middle sill.

Habitat Classification

This reach is primarily composed of flatwaters (50%) pools (25%) backwatered behind check dams, and riffles (20%) at and just downstream of the dams. Four riffles were identified ranging in length from 50 to 80 ft and comprise 6% of the 1.1 mile mainstem length for the reach on a length basis. At each sill, a short cascade of water pours over the structure.

The channel in this reach has steep banks as the average wetted width and active channel widths are the same at 52 ft. The active channel depth was 2.7 feet. The average flood prone width is more than double at 112 ft. The floodplain in Reach 4 is approximately 3 to 4 ft above the bed and adjacent terraces are 10 to 15 ft above the channel bed.

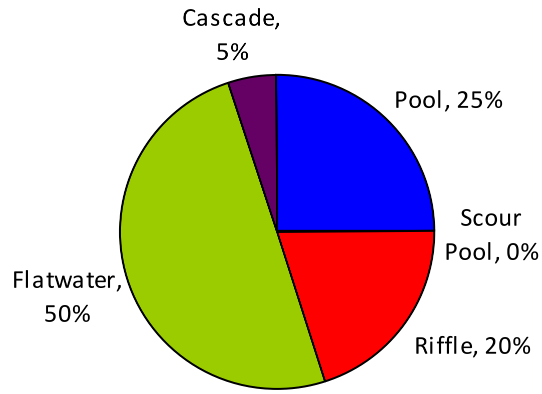
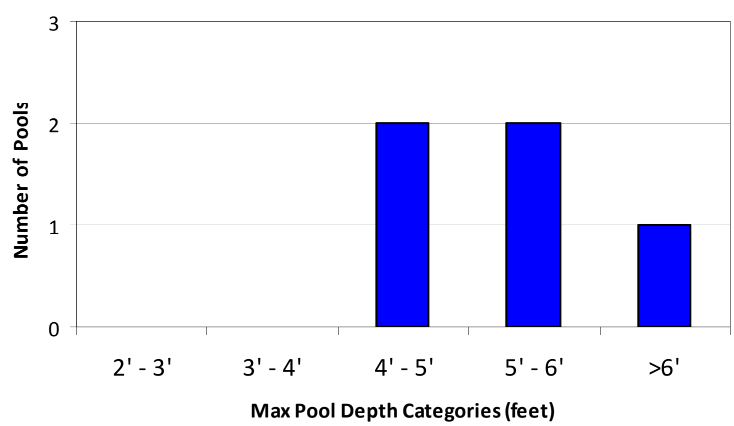


Figure 19: Proportion of Habitat Types by Relative Frequency in Reach 4

Pools

All five pools in Reach 4 were greater than 3 feet deep (Figure 20). The average maximum pool depth was 5.3 feet (st.dev. 0.6). The average residual pool depth was 3.8 feet, and the average pool tail crest depth was 1.6 feet. Substrate observed in pools was gravel with sand.

Figure 20: Maximum Pool Depths in Reach 4.



Riffles, Flatwaters & Cascades

In Reach 4, the average depth of riffles was 1.2 feet, 1.3 feet in flatwaters, and 0.9 feet in cascades. The bed material in Reach 4 ranges from sand to small cobbles, but is primarily composed of coarse to very coarse gravel. Gravel and some sand make up the majority of the channel bed in the pools and flatwaters and the riffles are composed primarily of gravel with a few small cobbles. In cascades, most of the substrate was boulders with large cobbles. The dimensions of the riffle downstream of the upper check dam, where the pebble count was conducted (D256), partly resembled a flatwater. The median grain size of the riffle below the most upstream check dam was 31 mm, coarse gravel (Figure 21). The frequency of fine sediment was 1%. 89% percent of the surface substrate was within ideal spawning sizes for coho and steelhead (11.4 to 128 mm), and 49% was within ideal juvenile rearing clast sizes (32 to 128 mm).

Figure 21: Grain size distribution for riffle below the most upstream check dam (habitat unit #256).

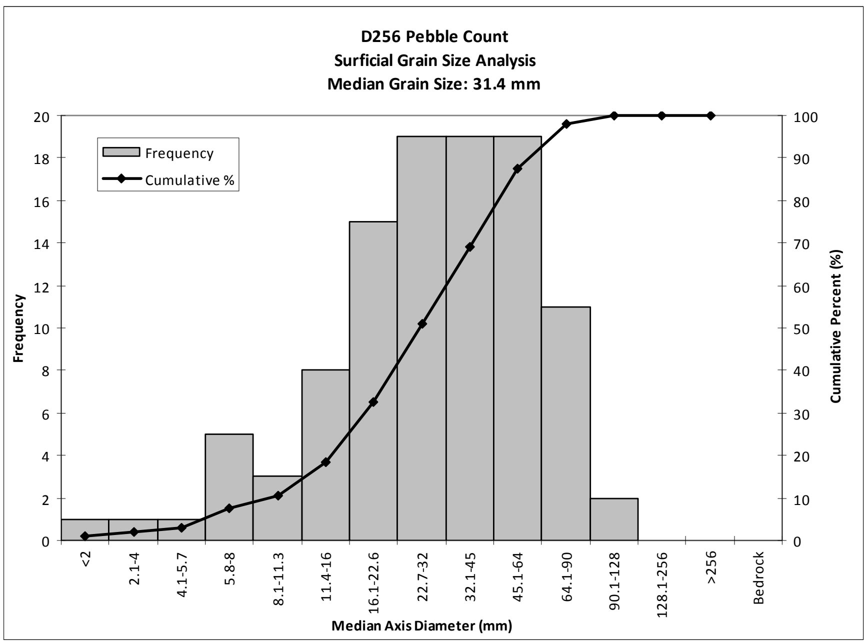


Figure 22: (upper left) long pool above upper sill, (upper right) alcove off upper sill, (lower left) side-channel habitat, (lower right) aquatic vegetation in alcove near middle sill.

Side-Channels

In Reach 4, three side channels were observed. Two of the side-channels were on the right side between the upper and middle sills, each with a pool in the middle and riffles and their entrances and exits. Their average depths were 0.5 and 0.7 feet. The third size-channel occurred where the creek split around an island downstream of the middle sill. The left channel, which was primarily flatwater habitat, was slightly smaller than the main channel to the right, with an average depth of 1.5. Substrates observed in side channels were classified as gravel with small cobbles and sand.

Alcoves

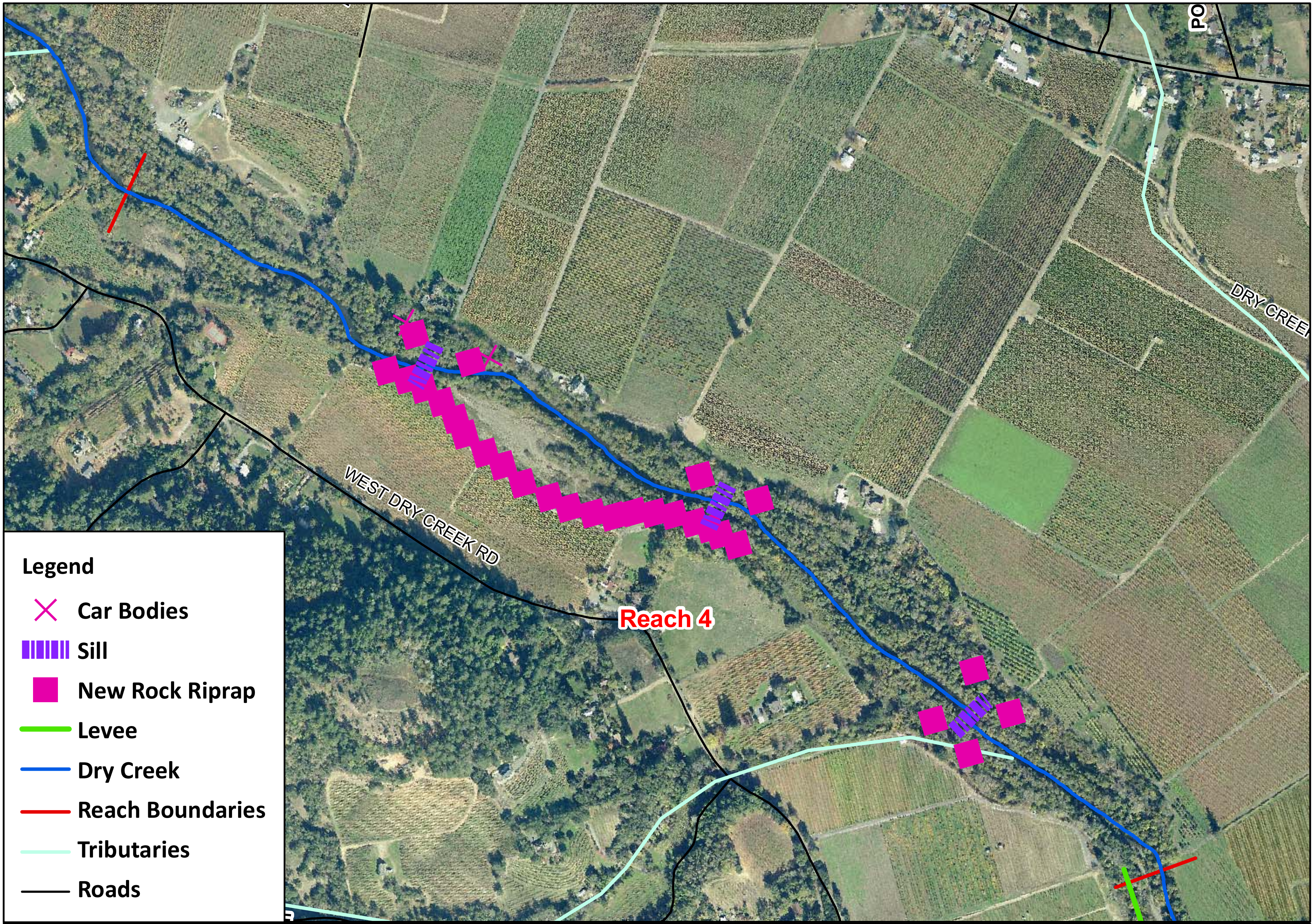
There were eight alcoves in Reach 4. Several were associated with the areas around the sills. There were two alcove pools on the right side of channel near the middle sill, with one upstream and the other downstream of the structure. The average maximum depth of the alcoves was 1.7 (st.dev. 0.9), with only one over three feet deep. Substrate in the alcoves was fine sediment and gravels with sand.

Instream Cover & Woody Debris

Overall, Reach 4 contained 185 pieces of wood per mile, with the greatest densities in pools, riffles, and side channels. Eight of the fifteen large pieces of wood were found in pools. The cascade and alcove habitats had more instream shelter and cover than ,riffles, and flatwaters. The side-channels in Reach 4 offered lower than ideal instream cover. Cover was provided in pools by terrestrial vegetation and small woody debris. In riffles, most cover was provided by woody debris, and secondarily by root masses and overhanging vegetation. In flatwaters, overhanging vegetation and root masses provided cover, along with some small woody debris. In cascades, cover was provided by boulders, with some overhanging terrestrial vegetation. Cover in alcoves was mainly provided by aquatic vegetation, with root masses, terrestrial vegetation, and some small woody debris. In side-channels the limited cover was mainly provided by small woody debris and root masses. Edge habitat was present in 5 pools, 5 flatwaters, and the majority of side-channels and alcoves.

Table 4: Instream woody debris, cover, and edge habitat frequency for Reach 4.

	wood pieces/mile				instream cover		
	small 6" - 12"	med 12" - 20"	large >20"	total	% cover	shelter rating	% units with edge habitat
Pools	145.3	66.6	10.6	222.5	38%	114	60%
Riffles	168.8	61.4	15.3	245.6	12%	26	0%
Flatwaters	88.8	15.7	7.8	112.3	16%	37	70%
Cascade	0	0	0	0.0	50%	100	0%
Side Channels	196.1	90.5	30.2	316.8	12%	23	67%
Alcoves	138.8	36.2	12.1	187.1	43%	101	75%
	mainstem wood pieces/mile			184.9			



0 500 1,000 Feet

DRY CREEK
Reach 4 Features

inter·fluve

1020 Wasco St., Suite 1
Hood River, OR 97031
541-386-9003
www.interfluve.com

Plate 6 - Reach 4 Current Conditions Summary

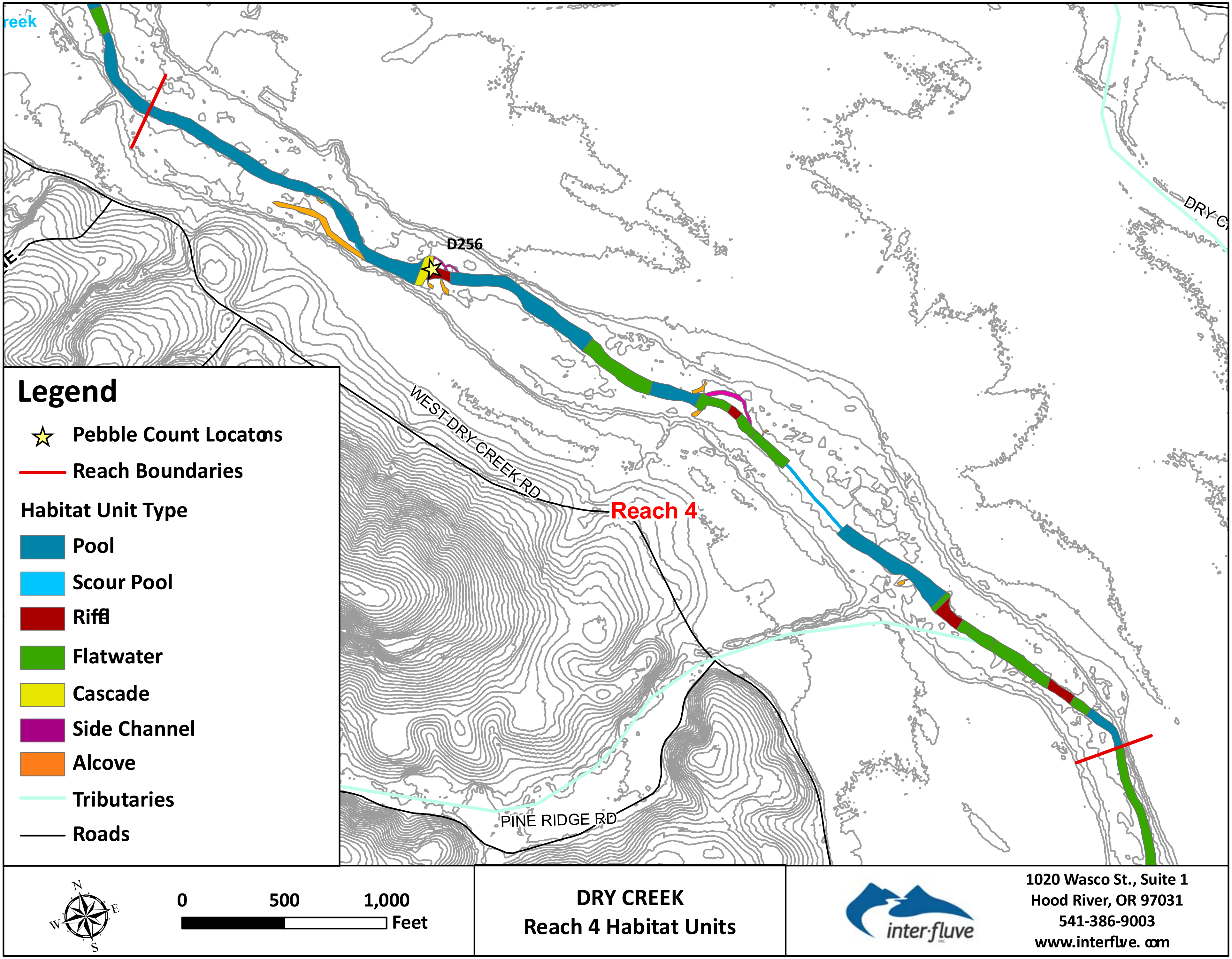
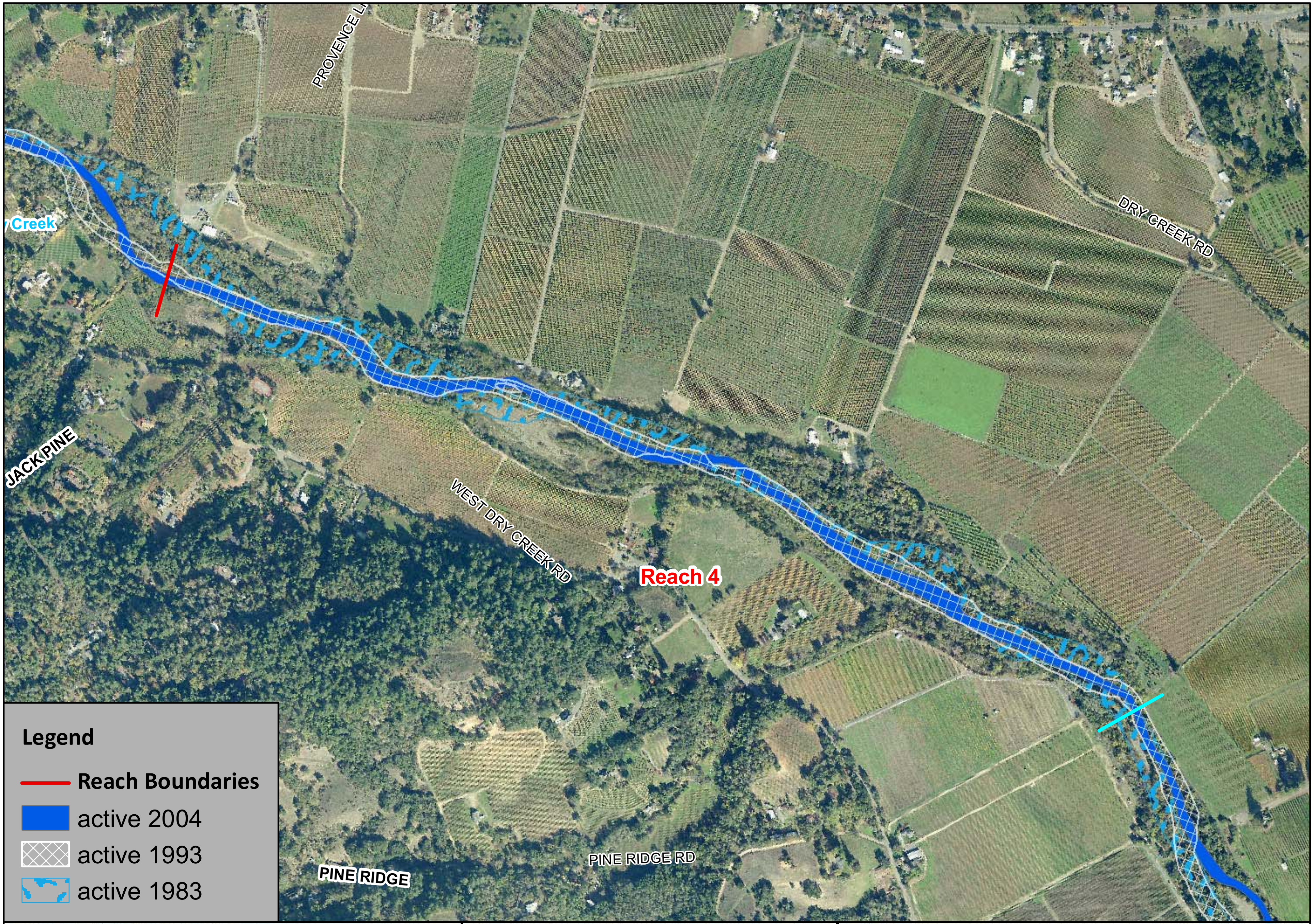


Plate 6 - Reach 4 Current Conditions Summary



N E S W

0 500 1,000 Feet

DRY CREEK
Reach 4 - Channel Positon M p

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1020 Wasco St., Suite 1
Hood River, OR 97031
541-386-9003
www.interflve. com

Supplemental Geotechnical Reports

(Available Upon Request)

Appendix D:
Cost Engineering Report

US Army Corps of Engineers ®
San Francisco District

CAP SECTION 1135
DRY CREEK

ECOSYSTEM RESTORATION PROJECT

APPENDIX D

COST ENGINEERING REPORT

January 2017

Introduction:

The initial cost estimate for the Tentatively Selected Plan (TSP) Alternative 2 (Subreach 4A, sites A&B), was developed using the Micro-Computer Aided Cost Estimating System (MII). It was mainly based on the unit prices provided by Environmental Science Associates (ESA); the consultant that is developing the project designs.

Tentatively Selected Plan Subreach 4A (Sites A&B):

The cost estimate for the TSP includes clearing and grubbing, removal of debris, excavation to grade the channel, Temporary Access Improvements, installation of erosion control, seeding, log structures, landscaping and irrigation. Costs are included for Revegetation and Irrigation are included for reference only as it is understood that the Sonoma County Water Agency (SCWA) will be implementing those components. The costs will be refined in subsequent phases of design and with additional coordination with SCWA.

Costs are presented in 2016 dollars and will need to be adjusted to account for price escalation for implementation in future years.

A contingency of 21% was applied to the construction costs to account for unknowns related to actual costs at the time of construction including but not limited to potential delays, availability of construction equipment and crews, construction materials, and fluctuation of supply prices at the time the work is bid.

Preconstruction Engineering and Design (PED) of 9% was applied to construction costs because the project currently is moving towards the 90% design.

No permit and environmental costs have been included.

The initial Cost Estimate is based on the following:

1- Quantities provided by the civil design section
2- MII Cost Estimating System
3- 2014 Region 7 Equipment Database.
4- Local Davis Bacon wage rates
5- Past estimates from similar projects specifically the first two phases of the Dry Creek Habitat Enhancement Project.

Detailed Cost Breakdown
For
Tentatively Selected Plan (TSP)
Subreach 4A (Sites A&B)

PROJECT: DRY CREEK HABITAT ENHANCEMENT PROJECT

LOCATION: SONOMA COUNTY, CALIFORNIA

Estimated by San Francisco District

Designed by Environment Science Associate (ESA) and Sonoma Cou

Prepared by Ali Hajali

Preparation Date 12/28/2016

Effective Date of Pricing 12/28/2016

Estimated Construction Time 90 Days

Description	Quantity	UOM	CostToPrime	JOOH_PRM	HOOH_PRM	Profit_PRM	Bond_PRM	ContractCost
Summary of Costs			**1,938,694.91**	**387,738.98**	**348,965.08**	**240,785.91**	**87,485.55**	**3,291,063.43**
			1,938,694.91					*3,291,063.43*
1 06 Fish and Wildlife	**1.00**	**EA**	**1,938,694.91**	**387,738.98**	**348,965.08**	**240,785.91**	**87,485.55**	**3,291,063.43**

Currency in US dollars

Abbreviated Risk Analysis

Project (less than $40M): **Dry Creek CAP 1135** — **Alternative: Alt 2**

Project Development Stage/Alternative: **Feasibility (Alternatives)**

Risk Category: **Low Risk: Typical Construction, Simple** — **Meeting Date: 1/26/2017**

Total Estimated Construction Contract Cost = **$ 3,291,063**

	CWWBS	Feature of Work	Contract Cost		% Contingency	$ Contingency	Total
	01 LANDS AND DAMAGES	Real Estate	**$ 615,000**		**35.00%**	$ 215,250	$ 830,250
1	**32 01 MOB, DEMOB & PREPARATORY WORK**	**Mobilization**	**$ 92,960**		16.14%	$ 15,001	$ 107,961
2	**09 CHANNELS AND CANALS (Except Navigation Ports and Harbors)**	**Earthwork and Grading**	**$ 1,085,901**		16.24%	$ 176,328	$ 1,262,228
3	**09 CHANNELS AND CANALS (Except Navigation Ports and Harbors)**	**Channels and Wood Structures**	**$ 1,615,776**		27.10%	$ 437,944	$ 2,053,720
4	**09 CHANNELS AND CANALS (Except Navigation Ports and Harbors)**	**Biotechnical and Geotechnical Structures**	**$ 123,845**		14.69%	$ 18,190	$ 142,035
5	**09 CHANNELS AND CANALS (Except Navigation Ports and Harbors)**	**Revegetation**	**$ 235,663**		13.90%	$ 32,754	$ 268,417
6	**09 CHANNELS AND CANALS (Except Navigation Ports and Harbors)**	**Irrigation**	**$ 33,398**		10.62%	$ 3,548	$ 36,946
7					0.00%	$ -	$ -
8			$ -		0.00%	$ -	$ -
9			$ -		0.00%	$ -	$ -
10			$ -		0.00%	$ -	$ -
11			$ -		0.00%	$ -	$ -
12	All Other	**Remaining Construction Items**	**$ 103,522**	*3.2%*	7.00%	$ 7,247	$ 110,768
13	30 PLANNING, ENGINEERING, AND DESIGN	**Planning, Engineering, & Design**	**$ 610,000**		8.97%	$ 54,744	$ 664,744
14	31 CONSTRUCTION MANAGEMENT	**Construction Management**	**$ 477,000**		10.79%	$ 51,492	$ 528,492

Totals				
Real Estate	$ 615,000	35.00%	$ 215,250	$ 830,250.00
Total Construction Estimate	$ 3,291,063	21.00%	$ 691,012	$ 3,982,075
Total Planning, Engineering & Design	$ 610,000	8.97%	$ 54,744	$ 664,744
Total Construction Management	$ 477,000	10.79%	$ 51,492	$ 528,492
Total Excluding Real Estate	**$ 4,378,063**	**18%**	**$ 797,247**	**$ 5,175,311**

	Base	50%	80%
Confidence Level Range Estimate ($000's)	$4,378k	$4,856k	$5,175k

* 50% based on base is at 5% CL.

Fixed Dollar Risk Add: (Allows for additional risk to be added to the risk analsyis. Must include justification. Does not allocate to Real Estate.	

**** TOTAL PROJECT COST SUMMARY ****

PROJECT: **DRY CREEK HABITAT ENHANCEMENT PROJECT** DISTRICT: **SPN San Francisco** PREPARED: **1/27/2017**
PROJECT NO:
LOCATION: **Sonoma County, California** POC: **CHIEF, COST ENGINEERING, xxx**

This Estimate reflects the scope and schedule in report; CAP Feasibility STUDY - DRY CREEK

Civil Works Work Breakdown Structure		ESTIMATED COST				PROJECT FIRST COST (Constant Dollar Basis)						TOTAL PROJECT COST (FULLY FUNDED)			
								Program Year (Budget EC):		2017					
								Effective Price Level Date:		1-Oct- 16					
WBS NUMBER	Civil Works Feature & Sub-Feature Description	COST ($K)	CNTG ($K)	CNTG (%)	TOTAL ($K)	ESC (%)	COST ($K)	CNTG ($K)	REMAINING COST ($K)	Spent Thru: 9/6/2016 ($K)	TOTAL FIRST COST ($K)	ESC (%)	COST ($K)	CNTG ($K)	FULL ($K)
09	CHANNELS & CANALS	$3,291	$691	21%	$3,982	-	$3,291	$691	$3,982		$3,982	1.1%	$3,328	$699	$4,027
	CONSTRUCTION ESTIMATE TOTALS:	$3,291	$691		$3,982		$3,291	$691	$3,982		$3,982	1.1%	$3,328	$699	$4,027
01	LANDS AND DAMAGES	$615	$215	35%	$830		$615	$215	$830		$830	0.7%	$619	$217	$836
30	PLANNING, ENGINEERING & DESIGN	$610	$55	9%	$665		$610	$55	$665		$665	0.9%	$616	$55	$671
31	CONSTRUCTION MANAGEMENT	$477	$51	11%	$528		$477	$51	$528		$528	1.6%	$485	$52	$537
	PROJECT COST TOTALS:	$4,993	$1,013	20%	$6,006		$4,993	$1,013	$6,006		**$6,006**	1.1%	$5,047	$1,023	$6,070

CHIEF, COST ENGINEERING, xxx

PROJECT MANAGER, xxx

CHIEF, REAL ESTATE, xxx

CHIEF, PLANNING, xxx

CHIEF, ENGINEERING, xxx

CHIEF, OPERATIONS, xxx

CHIEF, CONSTRUCTION, xxx

CHIEF, CONTRACTING, xxx

CHIEF, PM-PB, xxxx

CHIEF, DPM, xxx

ESTIMATED TOTAL PROJECT COST:		**$6,070**
ESTIMATED FEDERAL COST:	75%	$4,553
ESTIMATED NON-FEDERAL COST:	25%	$1,518
22 - FEASIBILITY STUDY (CAP studies):		**$15,000**
ESTIMATED FEDERAL COST:		$800
ESTIMATED NON-FEDERAL COST:		$700
ESTIMATED FEDERAL COST OF PROJECT		**$5,353**

**** TOTAL PROJECT COST SUMMARY ****

**** CONTRACT COST SUMMARY ****

PROJECT: DRY CREEK HABITAT ENHANCEMENT PROJECT
LOCATION: Sonoma County, California
This Estimate reflects the scope and schedule in report; CAP Feasibility STUDY - DRY CREEK

DISTRICT: SPN San Francisco
POC: CHIEF, COST ENGINEERING, xxx

PREPARED: 1/27/2017

WBS Structure		ESTIMATED COST				PROJECT FIRST COST (Constant Dollar Basis)				TOTAL PROJECT COST (FULLY FUNDED)				
		Estimate Prepared:			8/23/2016	Program Year (Budget EC):			2017					
		Estimate Price Level:			42644	Effective Price Level Date:			1 -Oct-16					
WBS NUMBER	Civil Works Feature & Sub-Feature Description	COST ($K)	CNTG ($K)	RISK BASED CNTG (%)	TOTAL ($K)	ESC (%)	COST ($K)	CNTG ($K)	TOTAL ($K)	Mid-Point Date	ESC (%)	COST ($K)	CNTG ($K)	FULL ($K)
A	*B*	*C*	*D*	*E*	*F*	*G*	*H*	*I*	*J*	*P*	*L*	*M*	*N*	*O*
	PHASE 1 or CONTRACT 1													
06	FISH & WILDLIFE FACILITIES	$3,291	$691	21.0%	$3,982		$3,291	$691	$3,982	2017Q3	1.1%	$3,328	$699	$4,027
16														
	CONSTRUCTION ESTIMATE TOTALS:	$3,291	$691	21.0%	**$3,982**		$3,291	$691	$3,982			$3,328	$699	$4,027
01	LANDS AND DAMAGES	$615	$215	35.0%	$830		$615	$215	$830	2017Q2	0.7%	$619	$217	$836
30	PLANNING, ENGINEERING & DESIGN													
0.025	Project Management	$82	$7	9.0%	$89		$82	$7	$89	2017Q2	0.7%	$83	$7	$90
0.02	Planning & Environmental Compliance	$66	$6	9.0%	$72		$66	$6	$72	2017Q2	0.7%	$66	$6	$72
0.05	Engineering & Design	$165	$15	9.0%	$180		$165	$15	$180	2017Q2	0.7%	$166	$15	$181
0.01	Engineering Tech Review ITR & VE	$33	$3	9.0%	$36		$33	$3	$36	2017Q2	0.7%	$33	$3	$36
0.01	Contracting & Reprographics	$33	$3	9.0%	$36		$33	$3	$36	2017Q2	0.7%	$33	$3	$36
0.03	Engineering During Construction	$99	$9	9.0%	$108		$99	$9	$108	2017Q3	1.6%	$101	$9	$110
0.02	Planning During Construction	$66	$6	9.0%	$72		$66	$6	$72	2017Q3	1.6%	$67	$6	$73
0.02	Project Operations	$66	$6	9.0%	$72		$66	$6	$72	2017Q2	0.7%	$66	$6	$72
31	CONSTRUCTION MANAGEMENT													
0.1	Construction Management	$329	$35	10.8%	$364		$329	$35	$364	2017Q3	1.6%	$334	$36	$370
0.02	Project Operation:	$66	$7	10.8%	$73		$66	$7	$73	2017Q3	1.6%	$67	$7	$74
0.025	Project Management	$82	$9	10.8%	$91		$82	$9	$91	2017Q3	1.6%	$83	$9	$92
	CONTRACT COST TOTALS:	$4,993	$1,013		**$6,006**		$4,993	$1,013	$6,006			$5,047	$1,023	**$6,070**

Appendix E:

Real Estate Plan

QUALITY CONTROL CERTIFICATE
Real Estate Division, Acquisition and Management Branch

PROJECT NAME: DRY CREEK CAP
PRODUCT: REAL ESTATE APPENDIX FOR TSP MILESTONE
ACTUAL COMPLETION DATE: JULY 2016

PROJECT MANAGER: KATHERINE REYES

The Real Estate Appendix is intended to inform the reader of the major Real Estate factors which were considered in the investigation and influenced decisions documented in the main report. It also presents a summary of the real estate costs, inventory, and analysis and assumptions associated with the lands, easements, right of way, relocations and disposal required for the tentatively selected plan. This DQC effort has verified that the Real Estate analysis is compliant with clearly established U.S Army Corps of Engineers policies, regulations, and that the assumptions, methods, data and tools used are appropriate for purposes of a real estate plan and that the level of detail and scope are reasonable and consistent within the context of the Real Estate Appendix.

REAL ESTATE LEAD
I have ensured that the above products were prepared in accordance with standard quality control practices. I have also incorporated or resolved issues identified during District Quality Control (DQC) Review.

Lead Realty Specialist Name　　Title: Realty Specialist

BONIEVEE DELAPAZ　　[signature]　　July 2016
Print Name　　Signature　　Date

REVIEWER
I have reviewed the products noted above and find them to be in accordance with project requirements, standards of the profession, and USACE policies and standards.

DQC Reviewer: Name　　Title: Chief, Civil Works Section

Paul Zianno　　ZIANNO.PAUL.VINCENT.1231886059 Digitally signed by ZIANNO.PAUL.VINCENT.1231886059 DN: c=US, o=U.S. Government, ou=DoD, ou=PKI, ou=USA, cn=ZIANNO.PAUL.VINCENT.1231886059 Date: 2016.10.05 14:05:54 -07'00'　　July 2016
Print Name　　Signature　　Date

APPENDIX E

REAL ESTATE PLAN

Dry Creek Ecosystem Restoration Project
Continuing Authorities Program Section 1135
Sonoma County, California

PREPARED FOR THE
SAN FRANCISCO DISTRICT
SOUTH PACIFIC DIVISION, U.S. ARMY CORPS OF ENGINEERS

October 28, 2016

PREPARED
BY THE
SACRAMENTO DISTRICT
REAL ESTATE DIVISION
SOUTH PACIFIC DIVISION, U.S. ARMY CORPS OF ENGINEERS

TABLE OF CONTENTS

Dry Creek Ecosystem Restoration Project
Continuing Authorities Program Section 1135, Sonoma County, California
REAL ESTATE PLAN

1. Introduction

This Ecosystem Restoration Report Synopsis is prepared under the authority of Section 1135 of the Water Resources Development Act (WRDA) of 1986, as amended, in response to a request for Federal assistance from the Sonoma County Water Agency (SCWA) for an ecosystem restoration project. The Real Estate Plan is an appendix to the Ecosystem Restoration Report Synopsis.

This Real Estate Plan is tentative in nature, focuses on the Recommended Plan, and is to be used for planning purposes only. There may be modifications to the plans that occur during Pre-construction, Engineering and Design (PED) phase, thus changing the final acquisition area(s) and/or administrative and land costs.

The U.S. Army Corps of Engineers (the Corps) constructed the Warm Springs Dam (WSD) in 1983 to provide flood control, water storage, and outdoor recreation. Dry Creek also serves as a conduit for water that is released from Lake Sonoma by the Corps for flood risk management purposes and by the SCWA for water supply. As a result, Dry Creek presently represents a highly modified system with timing of releases providing higher and colder water levels in summer versus natural conditions. Flood risk management operations reduce channel forming flows in winter, resulting in a decrease of channel complexity. The altered hydrology resulting from WSD regulation of stream flow on Dry Creek has created ideal conditions for riparian vegetation growth while failing to provide large enough flood events to erode vegetated bars and expose bare surfaces for primary vegetation succession. The combination of altered hydrology caused by the dam's regulation of the stream and vegetation growth patterns has curtailed the fluvial processes which erode and deposit bars in the active channel. Without these fluvial processes, the creation lateral habitats such as alcoves, backwaters, and side channels important for all life stages of salmonids has been severely limited below the dam (Inter-Fluve 2011). The construction and operation of the dam directly resulted of the loss of upstream spawning and rearing habitat for the Russian River salmonids. Between 1995 and 1999, the three species of salmonids native to the Russian River were listed under the Endangered Species Act (ESA) as threatened or endangered, including: endangered Central California Coast (CCC) coho salmon, threatened California Coastal (CC) Chinook salmon, and threatened CCC steelhead. Since this time, the Corps has been become involved in many programs and partnerships aimed at restoring salmonid populations.

A September 24, 2008 Biological Opinion issued by the National Oceanic and Atmospheric Administration (NOAA) requires that the Corps and SCWA perform various actions to save threatened salmonid species on Dry Creek. Corps actions are predicated upon the Corps' authority to carry out the necessary actions. While the Biological Opinion outlines a number of Reasonable and Prudent Alternatives, such as the enhancement of six miles of lower Dry Creek to provide near ideal summer rearing conditions for coho and steelhead, the scope and scale of the Dry Creek Ecosystem Restoration Feasibility Study (the Study) will not be limited by the specific actions or requirements included in the Biological Opinion. The Corps and the SCWA have already completed a small percentage of the Dry Creek restoration required by the Biological Opinion. Based on the requirements of the Biological Opinion, the Corps utilized Operations and Maintenance (environmental stewardship) funds to complete an ecosystem restoration project (1,600-feet long) on the Corp's property immediately below the WSD. In addition to the Corps restoration effort, the SCWA worked closely with a group of willing landowners to complete approximately one mile of additional habitat enhancements. The SCWA continues to work with supportive landowners to further their Dry Creek restoration goals and requirements, and is currently in the process of designing the second and third miles of habitat restoration.

2. Project Authority

This study is being conducted under the authority of section 1135 of the Water Resources Development Act (WRDA) of 1986 (Public Law 99-662) as amended. Section 1135 provides authority to review and modify the structures and operations of water resources projects constructed by the Corps for the purpose of improving the quality of the environment when it is determined that such modifications are feasible, are consistent with the authorized project purposes, and will improve the quality of the environment in the public interest. The Federal share of implementation costs for any one project under Section 1135 may not exceed $5 million, including construction.

> SEC. 1135. PROJECT MODIFICATIONS FOR IMPROVEMENT OF [THE] ENVIRONMENT.
> *(a) The Secretary is authorized to review the operation of water resources projects constructed by the Secretary before the date of enactment of this Act to determine the need for modifications in the structures and operations of such projects for the purpose of improving the quality of the environment in the public interest.*
> *(b) The Secretary is authorized to carry out a demonstration program in the two-year period beginning on the date of enactment of this Act for the purpose of making such modifications in the structures and operations of water resources projects constructed by the Secretary before the date of enactment of this Act which the Secretary determines (1) are feasible and consistent with the authorized project purposes, and (2) will improve the quality of the environment in the public interest. The non-Federal share of the cost of any modifications carried out under this section shall be 25 percent.*
> *(c) The Secretary shall coordinate any actions taken pursuant to this section with appropriate Federal, State, and local agencies.*
> *(d) Not later than two years after the date of enactment of this Act, the Secretary shall transmit to Congress a report on the results of the review conducted under subsection (a) and on the demonstration program conducted under subsection (b). Such report shall contain any recommendations of the Secretary concerning modification and extension of such program.*
> *(e) There is authorized to be appropriated not to exceed $25,000,000 to carry out this section.*

3. Project Description

The project is located in the lower Dry Creek watershed in the interior coast range of northern Sonoma County, approximately 30 miles from the Pacific Ocean and 60 miles north of San Francisco Bay. Dry Creek is 32 miles long and drains 217 square miles of rugged terrain in the southwestern portion of the Russian River Basin. The Section 1135 Ecosystem Restoration Project is located along the approximately 14 miles of Dry Creek that meanders downstream of WSD to its confluence with the Russian River near the City of Healdsburg.

The overall projects goals are to restore the quality and diversity of habitat along lower Dry Creek by restoring instream and floodplain habitat complexity, riparian vegetation diversity, and productive backwater habitat by reconnecting the floodplain to Dry Creek. These goals would be achieved by the following objectives:

- Restoring and enhancing stream channel and floodplain complexity to benefit aquatic species along Dry Creek's mainstem.
- Restoring lateral instream-floodplain connectivity through side channels, backwaters, and lowered floodplain terraces along Dry Creek's mainstem
- Restoring high quality instream and floodplain habitat conditions along areas of Dry Creek's mainstem to benefit listed salmonid species throughout their life cycle
- Reducing non-native vegetation and increasing native riparian vegetation successional complexity in order to promote habitat diversity for riparian wildlife, to provide food and cover for aquatic wildlife, and to shade the river along Dry Creek's mainstem.

Besides the no-action alternative, five (5) alternatives were considered in detail to meet the project goals and objectives. The considered action alternatives all address reconnecting the floodplain and increasing channel complexity within various subreaches along the approximately 14 mile length of lower Dry Creek below WSD.

The Tentatively Selected Plan is Alternative 2, Reach 4a only. The Recommended Plan consists of the construction of a combination of both off-channel and main channel habitat enhancements in subreach 4a. Alternative 2 was selected as the recommended plan. This alternative meets the project objectives and has the approval of the non-Federal sponsor. The plan increases habitat complexity and connectivity, decreases invasive plant species, and creates essential endangered and threatened salmonid habitat. It improves aquatic habitat and restores riparian vegetation diversity and complexity as well as creates floodplain habitat on the site while considerably increasing the chances for the survival of these habitats.

Implementation of the Section 1135 Ecosystem Restoration Project proposed at the Dry Creek project would result in positive benefits to the environment by restoring ecosystem structure and function through 1) increasing instream and floodplain habitat complexity, 2) increasing floodplain connectivity between Dry Creek and its floodplain; and 3) increasing riparian species and age class diversity.

4. <u>Description of Land, Easements, Rights-Of-Way, Relocation, and Disposal Areas (LERRDs)</u>

The project is situated within the wine growing region of central California. Land use in Dry Creek consists primarily of large vineyards with parcels typically ranging in size from 15-60 acres. Lands for the proposed project consists primarily of tributary watersheds and areas draining directly to Dry Creek from agricultural area. The Recommended Plan consists of the construction of a combination of both off-channel and main channel habitat enhancements within the creek in subreach 4a. The creek channel and riparian zones are heavily regulated by California Department of Fish and Wildlife, Regional Water Quality Board, State Water Board and the National Marine Fisheries Service (due to the severely declining salmonid populations).

The standard estate for ecosystem restoration is Fee Estate acquisition. Currently, Real Estate is seeking a non-standard estate for a perpetual easement, (see Section 6 of this report for details).

Alternative 2 requires an estimated total of 27.929 acres from six parcels, based on the project cadastral maps and tract register dated 2 September 2016 (Exhibit A).

An estimated 3.257 acres is required for staging.

An estimated 2.078 acres is required for permanent road easement.

An estimated 22.594 acres is required for ecosystem restoration.

The non-Federal sponsors will acquire the minimum interests in real estate to support the construction and subsequent operation and maintenance of the future USACE project.

Once the project partnership agreement (PPA) process is complete, the San Francisco District Engineering Branch will prepare the final design for advertisement and construction. During this process the tract register and tract maps will be updated to reflect any modifications to include final staging areas, access requirements, construction haul routes, and recreation features. This information will be used for future crediting purposes.

5. <u>LERRDs Owned by the Non-Federal Sponsor and Crediting</u>

The Project proposes to alter a portion of the Federal Bank Stabilization (the Sill) within the creek, which is between the two main construction areas. In 1983, the sponsor acquired an easement for an estimated 1 acre for the portion of the Sill, therefore the SCWA shall not receive credit for the value of any LER for this project that have been provided as an item of cooperation for another Federal project.

Credit will only be applied to LERRDs owned and/or held by the sponsors that fall within the "project footprint," namely the LERRDs required for the TSP. Lands outside of the project requirements and that may be acquired for the sponsor's own purposes which do not support the minimum interests necessary to construct, operate and maintain the Project would not be creditable LERRDs. Only land deemed necessary to construct, operate and maintain the plan would be creditable. The value of potentially creditable lands owned by the sponsors is included in the TSP's cost estimate.

6. <u>Standard Federal Estates and Non-Standard Estates</u>

The non-Federal sponsor will be required to acquire the minimum interest in real estate that will support the construction and subsequent operation and maintenance of the proposed USACE project.

The following standard estates (with definitions) are identified as required for the project:

Temporary Work Area Easement (TWAE): A temporary easement and right-of-way in, on, over and across (the land described in Schedule A) (Tracts Nos. ____, ____ and ____), for a period not to exceed ________________, beginning with date possession of the land is granted to the United States, Sonoma County Water Agency, for use by the United States, State Coastal Conservancy and/or Santa Clara Valley Water District, its representatives, non-Federal sponsors, agents, and contractors as a (borrow area) (work area), including the right to (borrow and/or deposit fill, spoil and waste material thereon) (move, store and remove equipment and supplies, and erect and remove temporary structures on the land and to perform any other work necessary and incident to the construction of the __________________ Project, together with the right to trim, cut, fell and remove therefrom all trees, underbrush, obstructions, and any other vegetation, structures, or obstacles within the limits of the right-of-way; reserving, however, to the landowners, their heirs and assigns, all such rights and privileges as may be used without interfering with or abridging the rights and easement hereby acquired; subject, however, to existing easements for public roads and highways, public utilities, railroads and pipelines.

A (perpetual [exclusive] [non-exclusive]and assignable) (temporary) easement and right-of-way in, on, over and across (the land described in Schedule A) (Tracts Nos. ____, ____ and ____) for the location, construction, operation, maintenance, alteration replacement of (a) road(s) and appurtenances thereto; together with the right to trim, cut, fell and remove therefrom all trees, underbrush, obstructions and other vegetation, structures, or obstacles within the limits of the right-of-way; (reserving, however, to the owners, their heirs and assigns, the right to cross over or under the right-of-way as access to their adjoining land at the locations indicated in Schedule B); [1] subject, however, to existing easements for public roads and highways, public utilities, railroads and pipelines.

In addition, the PDT received an approved non-standard estate, which is a perpetual easement. It was coordinated between the Sacramento District Office and South Pacific Division. A copy of the SPD approved non-standard estate can be found in Exhibit C.

Non-standard estate for a perpetual easement in lieu of Fee Estate.

The standard estate for ecosystem restoration projects is Fee simple in accordance with ER 405-1-12, 12-9 b(6)) However, for CAP 1135 projects, exceptions to this estate are provided in planning regulations ER 1109-2-100, Appendix F, Section F-20, 31 January 2007. It also provides, “the MSC may approve use of a permanent easement instead of fee for the implementation of the CAP ecosystem restoration project where use of such easement will satisfy project requirements and protect the project benefits.”

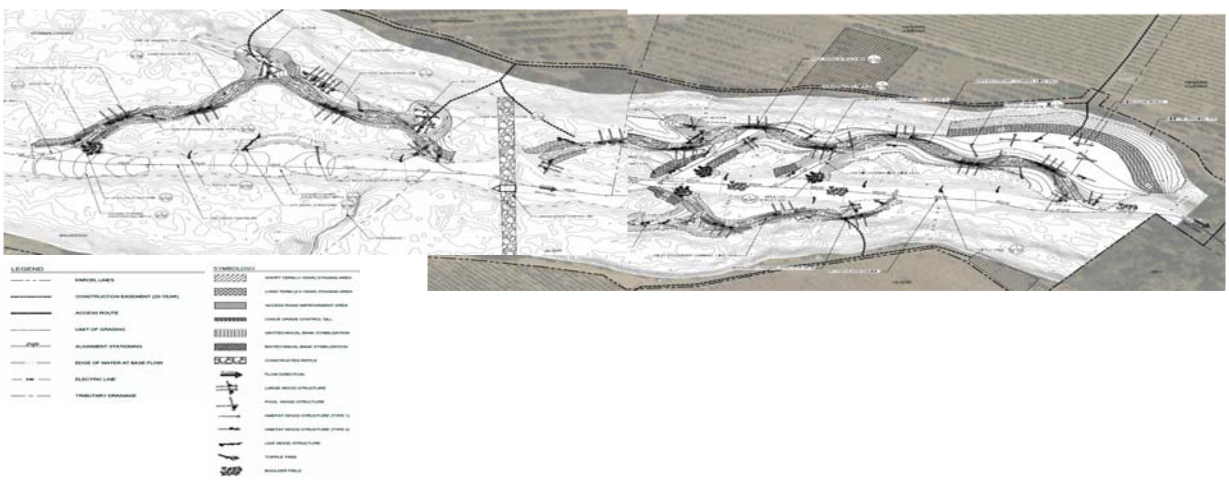
The Sonoma County Water Agency has been actively engaging landowners along Dry Creek to implement the project as landowners were not willing to provide fee title for project required lands. Acquiring project lands in fee would sever the remainder by eliminating connection to the creek. The loss of the parcel size would potentially impact subdivision rights, thereby creating an additional loss of value to the remainder. However through demonstrated project successes and ongoing public outreach, the sponsors have received an increase in landowner participation to accept an easement in perpetuity. Therefore, in order to avoid and minimize impact to the parcel, the proposed interest is the non-standard estate, Ecosystem Restoration Easement, a less than fee interest and in perpetuity. This situation is not adverse. There is no loss of value to the remaining parcel.

Surveys and coordination of the proposed project and real estate requirements were conducted by San Francisco District and South Pacific Division Realty Specialists with the PDT and NFS Realty Specialist. Due consideration was given to the overall project scope, the types of project features to be constructed, and the long term O&M requirements. It was determined that a perpetual easement in lieu of fee simple would convey sufficient rights to successfully construct and maintain the project and protect the Federal investment.

7. <u>Description of any Existing Federal Projects in or Partially in the Proposed Project</u>

One of the three grade control sills constructed by the Corps in 1983 is an existing Federal project that influences the channel in this subreach. The concrete sills were installed to arrest headcutting from continuing the widespread upstream incision in Dry Creek at the time of WSD's construction. The lower sill, the furthest downstream sill, is commonly referenced as Sill #1 and is located in the middle of subreach 4a (river mile 3.3). Sill #1 is 380 ft long, 62 ft wide, and 8.5 ft thick within the downstream apron and has a Denil fish ladder and trash rack to provide passage through the short cascades. The Project may propose to alter a short section of the Sill to improve fish passage as the fish ladder and trash racks are currently in various states of degraded function due to debris accumulation, sediment deposition, and general degradation of the metal structures (Figure 1).

Figure 1: Dry Creek Ecosystem Restoration Project recommended plan features



8. <u>Description of any Federally owned Land Needed for the Project</u>

No Federal lands will be required.

9. <u>Application of Navigational Servitude to the LERRDs Requirement</u>

Navigational servitude is not necessary for this project.

10. <u>Project Maps</u>

See Exhibit A.

11. Anticipated Increased Flooding and Impacts

Based on hydraulic modeling results, there will be no increased flooding from the proposed project, from either the flood risk management or ecosystem restoration actions. Additionally, projects which have been built which are very similar to what we will be proposing have already demonstrated that they do not increase flooding impacts and in some cases reduce flooding.

12. Cost Estimate

The abbreviated gross appraisal below was provided by an appraiser dated September 23, 2016. The effective date of value is September 9, 2016.

Land	Acres	Cost
USACE Recommended Plan Lands and Damages rounded (01 Account) 6 parcels/3 landowners	27.929 ac	$426,330
Incremental RE Costs rounded (35% contingency of lands & damages) (01 Account)		$149,216
Non Federal Administrative Costs rounded (includes 5% contingency) (01 Account)		$180,000
Federal Administrative Costs rounded (includes 5% contingency) (including crediting) (01 Account)		$75,000
Total LERRDs plus Administrative Costs rounded (01 Account)		**$830,546**
Cost Estimate for Utility/Facility Relocations rounded		$0
Relocation Cost Contigency (27%) (02 Account) rounded		$0
Relocation Escalation costs rounded (1.5%) (02 Account)		
Total LERRDs (rounded)		**$830,546**

13. Relocation Assistance Benefits.

The non-Federal sponsors must comply with the Uniform Relocation Assistance and Real Properties Acquisition Policies Act of 1970, as amended, 42 U.S.C. 4601 *et seq.* (P.L. 91-646, "the Uniform Act") and provide relocation assistance to qualifying residences and businesses within the project area that are displaced, as defined in the Uniform Act, as a consequence of USACE project implementation. No displacements will be required for the Alternatives.

The sponsor has also been advised of PL 91-646 requirements to pay Fair Market Value for property as part of the acquisition necessary for the project and the requirements for documenting expenses for credit purposes.

14. Mineral / Timber Activity.

There are no valuable minerals impacted by this project. There was no enhancement for mineral deposits included in the cost estimate.

15. Non-Federal Sponsor's Ability to Acquire.
The non-Federal Sponsor, the Sonoma County Water Agency (Water Agency) right to acquire and hold property is found in Deering's California Water Code Uncodified Act 1260 § 3(e). As a public agency, the Water Agency, formerly known as the Sonoma County Flood Control and Water Conservation District, derives its power of eminent domain from Deering's California Water Code Uncodified Act 1260 § 3(f). The Water Agency has the right under California eminent domain law to obtain an "Order of Immediate Possession" (quick-take).

16. Zoning Anticipated in Lieu of Acquisition.

There is no zoning in lieu of acquisition planned in connection with the project.

17. Real Estate Acquisition Schedule.

REAL ESTATE ACQUISITION SCHEDULE				
Project Name: Dry Creek CAP	**USACE Start**	**USACE Finish**	**NFS Start**	**NFS Finish**
Receipt of preliminary drawings from Engineering/PM (Conceptual, 10%, 30% Designs)	30% 11/15 60% 7/16	May 2017	March 2014	March 2015
Receipt of final drawings from Engineering/PM (60%, 90%, 99%, 100%)	Nov 2016	Oct 2017	July 2015	July 2016
Execution of PPA	Dec 2016	Jun 2017	Dec 2016	Jun 2017
Formal transmittal of final drawings & instruction to acquire LERRDS ("Take Letter")	Oct 2017	Nov 2017 *sponsor notified of risks associated with acq ahead of PPA and formal agreement	Nov 2017	Nov 20117
Conduct landowner meetings (if applicable, NFS responsibility)			December 2016	February 2017
Prepare/review mapping & legal descriptions			November 2016	Sep 2017
Obtain/review title evidence			February 2016	Sep 2017
Obtain/review tract appraisals			September 2016	Sep 2017
Conduct negotiations			November 2016	Sep 2017
Perform closing			Oct 2017	Oct 2017
Prepare/review condemnations				
Perform condemnations				
Obtain Possession				
Complete/review PL 91-646 benefit assistance				
Conduct/review facility and utility relocations.				
Certify all necessary LERRDS are available for construction	Nov 2017	Nov 2017	Nov 2017	Nov 2017
Prepare and submit credit requests (3 months)	Jan 2018	Jan 2018	Jan 2018	Jan 2018
Review/approve or deny credit requests (2 months)	Feb 2018	Feb 2018	Feb 2018	Feb 2018
Establish value for creditable LERRDS in F&A cost accounting system	Mar 2018	Mar 2018	Mar 2018	Mar 2018

COE – Corps of Engineers
NFS – Non-Federal Sponsor

18. Description of Facility and Utility Relocations.

There are no impacted utilities/facilities for the Dry Creek CAP Project.

19. STATEMENT NON-FEDERAL SPONSOR NOTIFICATION

The non-Federal sponsors were notified in writing about the risks associated with acquiring land for the proposed project on October 5, 2015; see Exhibit C.

20. Hazardous, Toxic, and Radiological Waste (HTRW).

No sites with HTRW conditions that could impact construction activities at Reach 4a have been identified.

21. Attitude of Landowners.

The Sonoma County Water Agency has been actively engaging landowners along Dry Creek to implement the project. In discussions with landowners, there is still resentment expressed regarding the impacts from Warm Springs Dam to the Dry Creek system. Notwithstanding, there is support throughout the community for the ecosystem restoration efforts. And through demonstrated project successes and ongoing public outreach, the sponsors have received an increase in landowner participation to accept an easement in perpetuity, (see Section 6 for non-Standard estate discussion).

EXHIBIT A
PROJECT MAPS

CORPS OF ENGINEERS

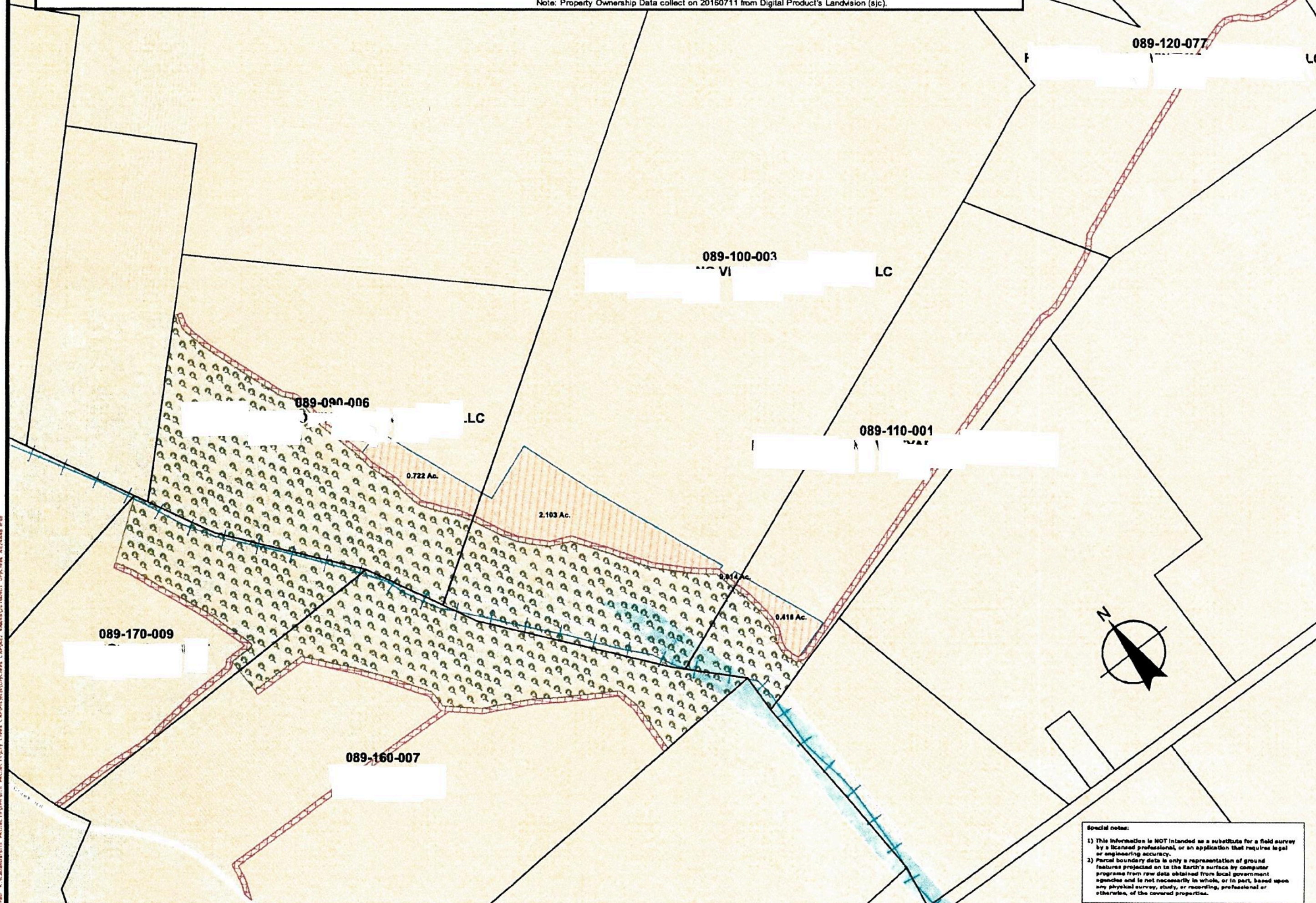
U.S. ARMY

TRACT ACQUISITION REGISTER: Dry Creek CAP -Alternative 2 - September 01, 2016

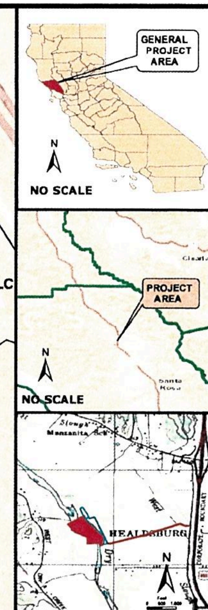
APN	OWNER	CA RE	ADDRESS (Mail)	SITE ADDRESS (Physcial)	PARCEL AREA ACRES	T.W.A.E. Staging ACRES	P.R.E. ACRES	Ecosys. Restor. ACRES	APN Sub Totals ACRES
089-090-006			PO BOX 1549, HEALDSBURG, CA, 95448-1549		18.32	0.722	0.360	7.719	8.801
089-100-003			PO BOX 1549, HEALDSBURG, CA, 95448-1549		45.92	2.117	0.272	4.552	6.941
089-110-001			PO BOX 1549, HEALDSBURG, CA, 95448-1549		12.54	0.418	0.592	1.201	2.211
089-120-077			PO BOX 1549, HEALDSBURG, CA, 95448-1549		16.21		0.346		0.346
089-160-007			1430 TROTTING HORSE LN, MISSOULA, MT 59804-5806		37.05		0.290	5.844	6.134
089-170-009			1083 VINE ST # 211, HEALDSBURG, CA, 95448-4830		15.75		0.218	3.278	3.496
				TOTAL ACRES =	145.80	3.257	2.078	22.594	27.929

LEGEND
Ecosys. Restor. = Ecosysem Restoration

Note: Property Ownership Data collect on 20160711 from Digital Product's Landvision (sjc).



Special notes:
1) This information is NOT intended as a substitute for a field survey by a licensed professional, or an application that requires legal or engineering accuracy.
2) Parcel boundary data is only a representation of ground features projected on to the Earth's surface by computer programs from raw data obtained from local government agencies and is not necessarily in whole, or in part, based upon any physical survey, study, or recording, professional or otherwise, of the covered properties.



MARGINALIA

1 inch = 150 feet

1:1,800

Meters: 0 12.5 25 50 75 100
Feet: 0 45 90 180 270 360

Coordinate System: NAD 1983 2011 StatePlane California II FIPS 0402 Ft US
Projection: Lambert Conformal Conic
Datum: NAD 1983 2011
Units: Foot US

ACQUISITION AUTHORIZATION

FINAL
As Applicable

PROJECT MAP

DEPARTMENT OF THE ARMY
USING SERVICE

LOCATION OF PROJECT

STATE CALIFORNIA
COUNTY SONOMA
DIVISION SACRAMENTO (SPK)
DISTRICT SOUTH PACIFIC (SPD)
ARMY AREA
~25.0 MILES N.E. OF SANTA ROSA
~28.0 MILES S.W. OF CLEAR LAKE

TRANSPORTATION FACILITIES

RAILROADS
STATE ROADS CA 126 (HWY 101)
FEDERAL ROADS
AIRPORTS

ACQUISITION

TOTAL ACRES ACQUIRED N/A
FEE
PUBLIC DOMAIN (WITHDRAWN / USE PERMIT)
USE PERMIT (Other than P.D.)
TRANSFER (WITHDRAWN / USE PERMIT)
LEASE N/A
EASEMENT RESERVED IN FEE DISPOSAL
LESSER INTERESTS (EASEMENT / PERMIT / LICENSE)

DISPOSAL

TOTAL ACRES DISPOSED N/A
SOLD
PUBLIC DOMAIN (WITHDRAWN / USE PERMIT)
USE PERMIT (Other than P.D.)
TRANSFERRED (FEE)
LEASES TERMINATED
LESSER INTERESTS TERM
REASSIGNED
ACRES TO

LEGEND

EXCEPT FOR SPECIAL SYMBOLS SHOWN BELOW, MAP SYMBOLS ARE STANDARD IN U.S. ARMY FIELD MANUAL, FM 21-31, TOPOGRAPHIC SYMBOLS, DEC. 1968.

- Parcel Boundary
- Ecosystem Restoration
- Road Easement (Perm.)
- Staging Area (Temp.)
- Creek Centerline

Estates created using SPN's Engineering Design Drawing: 2016-08-28_Easements_Access_Site_4A_4B.dwg dated 31 AUG 2016.

REAL ESTATE ESTATE MAP

DEPARTMENT OF THE ARMY
OFFICE OF THE SACRAMENTO DISTRICT ENGINEER
SOUTH PACIFIC DIVISION

CARTOGRAPHER STEVE J CAREY
CARTO TECH
CHECKED BY
SUBMITTED BY STEVE J. CAREY, TEAM LEAD, CADASTRAL UNIT
RECOMMENDED BY LISA NG, CHIEF, ACQ. & MGMT. BRANCH

SONOMA COUNTY — CALIFORNIA

REAL ESTATE DIVISION

DRY CREEK CAP
Alternative 2 Subreach 4A

APPROVED BY DIANE SIMPSON, CHIEF, REAL ESTATE DIVISION — DATE

OFFICE, CHIEF OF ENGINEERS, WASHINGTON 25, D.C.
REMIS CODE:
REMIS UNIQUE ID:
INSTALLATION OR PROJECT #

Date Saved: 9/2/2016 10:39:34 AM
This sheet originally formatted to ANSI D 22"X34"
SHEET 1 OF 1 — DRAWING NO.

ER 405-1-200 Eng_Form 1456A, Oct 81

EXHIBIT B

NFS Notification of Risks prior to notification & P.L. 91-646

DEPARTMENT OF THE ARMY
U. S.ARMY ENGINEER DISTRICT, SACRAMENTO
CORPS OF ENGINEERS
1325 J STREET
SACRAMENTO, CALIFORNIA 95814-2922

REPLY TO
ATTENTION OF

May 26, 2014

Real Estate Division

Mr. Grant Davis, General Manager
Attention: Mr. David Manning
Sonoma County Water Agency
404 Aviation Boulevard
Santa Rosa, CA 95403-9019

Re: Real Estate Risk Letter - Dry Creek Continuing Authorities Program (CAP) Section 1135 Ecosystem Restoration

Dear Mr. Manning:

It is our understanding that the Sonoma County Water Agency (SCWA) is undertaking real estate activities/acquisition management, and acquisition of land it anticipates will be required for the proposed Dry Creek CAP 1135. This is prior to execution of the Project Partnership Agreement (PPA), and prior to the Government's formal notice to proceed with its acquisition after PPA execution.

We caution you that there are many risks associated with acquisition under such circumstances and that, as the non-Federal sponsor, your agency assumes full and sole responsibility for any and all costs, or liability arising out of the acquisition effort. Generally, these risks include, but may not be limited to the following:

a. The Congress of the United States may not appropriate funds to construct the proposed project.

b. A PPA mutually agreeable to the SCWA and the Federal Government may not be executed and implemented.

c. SCWA may incur liability and expense by virtue of its ownership of contaminated lands, or interests therein, whether such liability should arise out of local, state, or Federal laws or regulations including liability arising out of the Comprehensive Environmental Response, Compensation and Liability Act (CERCLA), 42, U.S.C. 9601-9675.

d. SCWA may acquire interests or estates in real property that are later determined by the Government to be inappropriate, insufficient, or otherwise not required for the project.

e. SCWA may initially acquire insufficient or excessive real property acreage that may result in additional negotiations, payment of Public Law 91-646 (as amended) benefits, or payments of fair market value to affected landowners that could have been avoided by delaying acquisition until after PCA execution and the said formal notice by the Corps to commence acquisition of land and right of way.

f. SCWA may incur costs or expenses in connection with its decision to acquire or perform acquisition activities in advance of the executed PCA and the Government's notice to proceed which may not be creditable under the provisions of Public Law 99-662, The Water Resources Development Act of 1986, or the PCA.

Should you have any questions, contact Realty Specialist, Bonievee Delapaz at (415) 503-6745.

Sincerely,

Sharon Caine

SHARON CAINE
Chief, Real Estate Division

Copy Furnished:

Irene Lee - USACE Project Manager (VIA EMAIL ONLY)

Delapaz____

Wallin____

Caine____

EXHIBIT C
SPD APPROVED NON STANDARD ESTATE

RECORDED AT NO FEE PER GOVERNMENT CODE § 6103
RECORDING REQUESTED BY AND WHEN RECORDED RETURN TO:

Sonoma County Water Agency
404 Aviation Boulevard
Santa Rosa, CA 95403

Portion of APN: Deed to Public Agency

AGREEMENT AND GRANT OF EASEMENT

Grantors Name and Capacity from Vesting Deed (hereinafter referred to as "Grantor") and the **Sonoma County Water Agency**, a body corporate and politic, organized and existing under and by virtue of the laws of the State of California (hereinafter referred to as "Agency") hereby agree as follows:

RECITALS

WHEREAS, Grantor is the owner of certain real property in Sonoma County, California, more particularly described as follows:

> The lands of **Grantors Name and Capacity from Vesting Document** as described in that certain Insert Title of Vesting Document recorded on Insert Recording Date under Document Number Insert Grantor's Vesting Document Number (or in Book Insert Book Number at Page Insert Page Number) of Official Records of the County of Sonoma (hereafter referred to as the "Grantor's Property").

WHEREAS, Agency requires an easement over portions of the Grantor's Property (the "Easement Area") for purposes and uses related to the construction, maintenance, inspection, repair, alteration and reconstruction of the Dry Creek Habitat Enhancement Project (the "Project"). Grantor's Property is described more particularly in Exhibit "A" and the Easement Area is shown for reference in Exhibit "A-1" attached hereto and by this reference hereby made a part of this Agreement.

NOW, THEREFORE, for good and valuable consideration Grantor covenants and agrees as follows:

1. **GRANT OF NON-EXCLUSIVE EASEMENT TO AGENCY:** Grantor does hereby grant to the Agency a non-exclusive easement over the Easement Area for the following purposes: to excavate, install, construct, repair, replace, remove, re-construct, operate, and maintain the Project in the Easement Area, together with a right of ingress to and egress for such purposes from the Easement Area over and across roads and lanes thereon, if such there be, or otherwise by such route or routes over, across and through Grantor's Property as shall occasion the least practicable damage and inconvenience to Grantor.

Grantor further grants to Agency:

A. The right to excavate or fill within the Easement Area as necessary to carry out the Project, and to temporarily place excavated material for such work into land owned by Grantor along and outside the Easement Area to such extent as Agency's Engineer may find reasonably necessary;

B. The right to grade, construct, maintain, and use such roads on and across the Easement Area as Agency's engineer may deem necessary in the exercise of said right of ingress and egress or to provide access to lands adjacent to said Area;

C. The right from time to time to trim and to cut down and clear away any and all trees and brush now or hereafter in the Easement Area and to trim and to cut down and clear away any brush or trees in the vicinity of the Easement Area which now or hereafter in the opinion of Agency's Engineer may interfere with the Project, and which may interfere with the exercise of Agency's rights hereunder. Agency shall not be required to compensate Grantor for any such removal of trees and brush; provided, however, that all trees which Agency is hereby authorized to cut and remove, if valuable for timber or wood, shall continue to be the property of Grantor, but all trimmings, brush and refuse shall be removed by Agency;

D. The right to plant vegetation now or hereafter in the Easement Area that supports and benefits the Project together with the right to install irrigation and/or water systems required to support plantings placed in connection with the Project.

2. **AGENCY'S RESPONSIBILITIES**:

A. Except as specifically provided otherwise in this Agreement, Agency agrees to backfill or restore any temporary excavation made by it within the Easement Area or adjacent area, and to repair all damage on Grantor's Property resulting from Agency's activities under this Agreement, including damage to Grantor's private roads or lanes; provided, that Agency shall not be required to fully replace such roads or lanes but only to repair such damage, and Agency shall not be required to repair damage caused from routine maintenance activities due to Grantor's failure to properly maintain such roads or lanes, or due to improper construction of such roads or lanes.

B. Agency shall maintain the Project during the Term of the Easement at its sole cost and expense.

C. Agency shall be responsible for the cost of recording this Agreement.

3. **GRANTOR'S RIGHTS AND RESPONSIBILITIES**: Grantor reserves the right to use the Easement Area for purposes which will not interfere with Agency's full enjoyment of the rights hereby granted; provided that Grantor shall not take any action on the Easement Area that will interfere with or diminish the efficacy of the Project, or erect or construct any building, reservoir, or other structure within the Easement Area, or disturb or diminish or substantially add to the earth cover over the Easement Area.

4. **TERM:** The Easement granted herein shall commence upon the execution of this Agreement and Grant of Easement and shall remain in perpetuity.

5. **HAZARDOUS MATERIALS:** (a) Grantor represents that Grantor is not aware of any Hazardous Materials in, on or near the Easement Area or Property. Grantor agrees that Agency shall have no obligation to remove or remediate any Hazardous Materials discovered by Agency within the Easement Area. Notwithstanding the foregoing, if the Agency discovers Hazardous Materials within the Easement Area during construction of the Project, the Agency shall immediately contact and confer with Grantor about the discovery, and if Agency determines to continue with construction of the Project, then Agency shall take reasonable steps to remove and remediate the Hazardous Materials; *provided, however*, that Agency's obligation to pay the costs of such removal and remediation shall be limited to $25,000, and that any costs above that amount shall be paid by Grantor. If after consultation with Grantor, Agency determines, in its sole discretion that it will not continue with construction of the Project then Agency shall have no obligation to remove or remediate the Hazardous Materials.

(b) Neither Agency nor Grantor shall cause or permit any Hazardous Materials (as hereinafter defined) to be brought upon, kept or used in or about the Easement Area. As used herein, "Hazardous Materials" includes, without limitation, any flammable explosives, radioactive materials, hazardous materials, hazardous wastes, hazardous or toxic substances, or related materials defined in the Comprehensive Environmental Response, Compensation and Liability Act of 1980, as amended (42 U.S.C. § 9601 et seq.), the Hazardous Materials Transportation Act, as amended (49 U.S.C. § 1801 et seq.), the Resource Conservation and Recovery Act of 1976, as amended (42 U.S.C. § 6901 et seq.), Section 25117 of the California Health & Safety Code, Section 25316 of the California Health & Safety Code, and in the regulations adopted and publications promulgated pursuant to them, or any other federal, state, or local environmental laws, ordinances, rules, or regulations concerning the environment, industrial hygiene or public health or safety now in effect or enacted after this date.

6. **INDEMNITY:** Each party to this Agreement (the "Indemnifying Party") agrees to accept all responsibility for loss or damage to any person or entity, and to defend, indemnify, hold harmless and release the other party (the "Indemnified Party"), and the Indemnified Party's supervisors, officers, agents, and employees, from and against any and all liabilities, actions, claims, damages, disabilities, or expenses that may be asserted by any person or entity, including the Indemnifying Party, to the extent resulting from the Indemnifying Party's breach of any material term of or representation make

in this Agreement and Grant of Easement, or Indemnifying Party's negligence or willful misconduct in connection with this Agreement and Grant of Easement, but excluding liabilities, actions, claims, damages, disabilities, or expenses to the extent arising from Indemnified Party's breach of any material term of this Agreement, or Indemnified Party's negligence or willful misconduct in connection with the performance of this Agreement. The Indemnified Party shall have the right to select its legal counsel at the Indemnifying Party's expense, subject to the Indemnifying Party's approval, which shall not be unreasonably withheld.

7. **SUCCESSORS:** This Agreement and Grant of Easement shall be binding on and shall inure to the benefit of the parties hereto and their respective successor, heirs, assigns and transferees, and all covenants shall apply to and run with the land.

8. **NOTIFICATION:** In the event Grantor sells, conveys, or assigns any property interests encumbered by this Agreement, Grantor shall notify the successor or assignee of the rights and obligations of both parties as included herein.

9. **SURVIVAL OF AGREEMENT:** This Agreement and Grant of Easement, including all representations, warranties, covenants, agreements, releases and other obligations contained herein shall survive the closing of this transaction and the recordation of this easement agreement.

10. **ENTIRE UNDERSTANDING:** This writing is intended both as the final expression of the agreement between the parties hereto with respect to the included terms and as a complete and exclusive statement of the terms of the agreement, pursuant to California Code of Civil Procedure §1856. No modification of this Agreement and Grant of Easement shall be effective unless and until such modification is evidenced by a writing signed by both parties.

11. **SIGNATURES OF GRANTORS:** Grantor represents and warrants that (a) Grantor is the sole legal and lawful owners of the Property, (b) Grantor has the requisite authority to execute this agreement on behalf of the interest they represent herein, and to grant the easement conveyed herein to the Agency, and (c) no other party has any legal or equitable claim to or interest in the Property.

12. **SUBORDINATION AGREEMENT:** Grantor warrants that Grantor is the owner in fee simple of the Property, and that on the date it executed this Agreement the Grantor's Property was not subject to any deeds of trust or other encumbrance other than the deeds of trust or encumbrances identified in Exhibit B, attached hereto and incorporated herein by this reference, whose trust deed beneficiaries have therein consented to this Agreement and Grant of Easement, agreed to subordinate their respective interests in the Grantor's Property to this Agreement and Grant of Easement, and covenanted that any sale made under the provisions of the respective deeds of trust or encumbrances shall be subject to this Agreement and Grant of Easement, pursuant to the executed Consent forms included in Exhibit B. No breach of or default of this Agreement and Grant of Easement shall affect the validity of the lien of any deed of trust or mortgage given in good faith and for value and encumbering any portion of the Grantor's Property.

IN WITNESS WHEREOF, the parties hereto have caused this Agreement to be executed.

Grantor:

By: ______________________________ Date: ______________________________
Grantor's Name

By: ______________________________ Date: ______________________________
Grantor's Name

Sonoma County Water Agency:

By: ______________________________ Date: ______________________________
Grant Davis
General Manager

Approved as to Form for Sonoma County Water Agency:

By: ______________________________
Deputy County Counsel

EXHIBIT "A"

Insert Legal Description, signed and stamped by a Licensed Land Surveyor

EXHIBIT “A-1”

Insert Plat of Easement

<u>EXHIBIT "B"</u>

To

Grant of Easement Agreement between the Sonoma County Water Agency and [Insert **Owner(s) Name**, From Owner(s) Vesting Documents] dated **______________________**.

<u>B.1 EXISTING DEEDS OF TRUST</u>

Deeds of Trust encumbering Grantor's Property as of the Effective Date of this Agreement:

[List all of the Deeds of Trust/Encumbrances that exist as of effective date of Agreement, e.g.:

1. **Deed of Trust dated as of _______________, executed by ______________, as Trustee under Trust No. ______________, a [Delaware] limited liability company, in favor of ___________________, and recorded on December ___, 2004, as Instrument No. _____________, Sonoma County, California Official Records**.

B.2 EXECUTED CONSENT FORMS OF LIENHOLDERS SPECIFIED IN B.1

CONSENT OF LIENHOLDER
AND SUBORDINATION OF DEED OF TRUST

NOTICE: This Subordination Agreement results in your security interest in the property becoming subject to and of lower priority than the Easement described below.

For valuable consideration, the undersigned, **<Insert Name of Beneficiary>**, the beneficiary/lienholder under that certain deed of Trust dated as of <Insert Date of Trust Deed>, executed by <Insert Name of Trustee>, as Trustee, in favor of the undersigned, and recorded <Insert Trust Recording Date>, as Document Number <Insert Trust Document Number>, Official Records of County of Sonoma ("Deed of Trust") and encumbering the real property described in the Grant of Easement identified above to which this Consent form is attached as Exhibit B ("Easement"), hereby consents to the Easement, and intentionally and unconditionally subordinates the lien or charge of the Deed of Trust in favor of the Easement, and understands that in reliance upon and in consideration of this subordination, specific obligations are being undertaken by the Sonoma County Water Agency, and as part and parcel thereof, specific monetary and other obligations are being and will be entered into by the Sonoma County Water Agency which would not be made or entered into but for said reliance on this subordination. In addition, the undersigned covenants that any sale or transfer made under the provisions of said Deed of Trust shall be subject to the Easement.

Date: _________________, 20___

<Insert Name of Beneficiary>

By:_________________________________

Printed Name:________________________

Title: ___________________________

****

CERTIFICATE OF ACCEPTANCE

This is to certify that the interest in real property conveyed Grant of Easement dated ___________________________, from **Grantor's Names and capacity from vesting deed** to the **Sonoma County Water Agency,** a body corporate and politic, organized and existing under and by virtue of the laws of the State of California, and the terms specified therein are hereby accepted pursuant to authority by Resolution No. 10-0140a of the Board of Directors of the Sonoma County Water Agency on February 24, 2010.

Sonoma County Water Agency

Dated:___________________________ ____

Grant Davis
General Manager

****

EXHIBIT D
ASSESSMENT OF NON-FEDERAL SPONSOR'S
REAL ESTATE ACQUISITION CAPABILITY
Dry Creek CAP Study

I. Legal Authority:

a. Does the sponsor have legal authority to acquire and hold title to real property for project purposes?

Yes. The Sonoma County Water Agency (Water Agency) right to acquire and hold property is found in Deering's California Water Code Uncodified Act 1260 § 3(e).

b. Does the sponsor have the power of eminent domain for this project?

Yes. As a public agency, the Water Agency, formerly known as the Sonoma County Flood Control and Water Conservation District, derives its power of eminent domain from Deering's California Water Code Uncodified Act 1260 § 3(f).

c. Does the sponsor have "quick-take" authority for this project?

Yes, the Water Agency has the right under California eminent domain law to obtain an "Order of Immediate Possession" (quick-take).

d. Are any of the lands/interests in land required for the project located outside of the sponsor's political boundary?

No

e. Are any of the lands/interests in land required for the project owned by an entity whose property the sponsor cannot condemn?

No

II. Human Resource Requirements:

a. Will the sponsor's in-house staff require training to become familiar with the real estate requirements of Federal projects including PL 91-646, as amended?

No

b. If the answer to II. A. is "yes", has a reasonable plan been developed to provide such training?

N/A

c. Does the sponsor's in-house staff have sufficient real estate acquisition experience to meet its responsibilities for the project?

Yes

d. Is the sponsor's projected in-house staffing level sufficient considering its other workload, if any, and the project schedule?

Yes

e. Can the sponsor obtain contractor support, if required, in a timely fashion

Yes

f. Will the sponsor likely request USACE assistance in acquiring real estate?

No

III. Other Project Variables:

a. Will the sponsor's staff be located within reasonable proximity to the project site?

Yes. Water Agency's office is located 8 miles from Dry Creek Valley.

b. Has the sponsor approved the project/real estate schedule/milestones?

RE schedule/milestones have yet to be defined in the Feasibility Study.

IV. Overall Assessment:

a. Has the sponsor performed satisfactorily on other USACE projects?

Yes. Warm Springs Dam, Lake Sonoma & Flood Control features within Dry Creek on private property.

b. With regard to this project, the sponsor is anticipated to be: (Capable – Highly Capable – Not capable, etc.)

Highly

V. Coordination:

a. Has this assessment been coordinated with the sponsor?

Assessment completed by Sponsor.

b. Does the sponsor concur with this assessment?

Yes

Prepared by:

Bonievee Delapaz

BONIEVEE A. DELAPAZ
Real Estate Specialist

Reviewed and Approved by:

for DIANE SIMPSON
Chief, Real Estate Division

Appendix F:

Habitat Benefit Analysis

1. CONCEPTUAL HABITAT MODEL FRAMEWORK AND ENVIRONMENTAL BENEFITS EVALUATION METHODOLOGY

According to USACE Engineering Regulation (ER) 1165-2-501 (Civil Works Ecosystem Restoration Policy), plans to address ecosystem restoration should be formulated and recommended based on their monetary and non-monetary benefits. These measures do not need to exhibit net national economic development (NED) benefits and should be viewed on the basis of non-monetary outputs compatible with the USACE ER 1105-2-100 (Planning Guidance Notebook) evaluation criteria. The USACE ER 1105-2-100 states that ecosystem restoration outputs (benefits) must be clearly identified and quantified in units that measure an increase in "ecosystem" value and productivity.

The overall purpose of the Dry Creek Ecosystem Restoration CAP 1135 project is to identify and implement ecosystem-based habitat restoration measures that would provide the attributes necessary to support the project objectives including habitat complexity, habitat connectivity, riparian vegetation diversity and complexity, and salmonid specific restoration. To facilitate the selection of a preferred alternative and to ensure that the federal government is investing funds in the most cost-effective plans, ER 1105-2-100 requires that the ecosystem restoration benefits be identified and quantified so that relative levels of habitat benefit can be compared to the costs. Models and analysis must be compliant with Corps policy, theoretically sound, computationally accurate, and transparent.

In conformance with Corps guidance, the purpose of the Environmental Benefits Evaluation described here is to provide quantification of the potential ecological improvement of proposed restoration alternatives so that the actions can be compared to each other, and to compare alternative suites of actions in the cost effectiveness and incremental cost analysis. Each habitat restoration measure was analyzed using the Habitat Evaluation Procedures (HEP) habitat assessment methodology (USFWS 1980) and the Habitat Suitability Index (HSI) model for coho salmon (McMahon 1983). The Corps National Ecosystem Planning Center of Expertise and Headquarters have approved both of the aforementioned ecosystem restoration planning models.

2. COHO SALMON HABITAT SUITABILITY INDEX (HSI) MODEL OVERVIEW AND APPLICABILITY

HSI models provide numeric scores for existing conditions at a project site, potential future without-project conditions, and various future with-project action alternatives for a species or assemblage of species in a particular geographic area. A suitable HSI model must include habitat variables for which data collection is possible or data are already available. Variables must also show a change in score between the existing and proposed condition. If the project does not affect the suitability index score for a species, it will not be possible to quantify an effect.

The best HSI model to capture the ecosystem restoration benefits of each Dry Creek CAP 1135 project alternative is the coho salmon model. Coho salmon habitat quality in this model is based on parameters assumed to affect habitat suitability for each of four life stages of coho salmon during residence in freshwater including: adult, smolt, parr, and spawning/embryo/alevin (McMahon 1983).

Dry Creek historically supported populations of coho and steelhead, although it only provided marginal salmon habitat when compared to other Russian River tributaries closer to the coast due to very low summer flow (Hopkirk and Northen 1980). Today, endangered CCC coho salmon (*Oncorhynchus kisutch*) and threatened CC steelhead (*Oncorhynchus mykiss*) are present in Dry Creek year-round. Adult coho and steelhead enter Dry Creek to spawn in the late fall and winter. Eggs deposited in gravel nests called redds incubate through the winter and early spring, and fry emerge in the spring. Juvenile coho and steelhead rear in Dry Creek for a minimum of one year before migrating to the sea the following late winter or spring. Furthermore, it should be noted that Dry Creek currently supports a robust population of threatened Chinook salmon (*O. tshawytscha*) (Inter-Fluve 2011).

While it is difficult and costly to measure all parameters that could change with restoration work, this model captures a few key indicators that can serve as a proxy for the host of environmental restoration benefits that could be expected. The parameters selected to characterize baseline habitat quality in the coho salmon HSI model are not intended to fully describe conditions in the study area, but rather to represent critical elements of habitat structure and dynamics. Additionally, these metrics are ecosystem components that can be affected directly by management measures implementable by the Corps. The assumption is that the condition of those critical elements will reflect overall ecosystem structure and function, and that they serve as reasonable surrogates for a broad suite of possible habitat measurements, many of which would be beyond the scope of a planning-level environmental benefits evaluation.

There are common basic requirements limiting the availability and condition of habitat for all species in the Salmonidae family that are present in Dry Creek (endangered CCC coho -*,* threatened CC steelhead - *Oncorhynchus mykiss,* and threatened Chinook salmon - *O. tshawytscha*) including but not limited to stable spawning gravels, canopy cover, pools, instream cover, a functional riparian zone, and appropriate flow rates. The coho salmon HSI model and HEP habitat assessment methodology take each of these parameters into account either through the HSI (index) scoring process or the habitat type area designation process. The measured environmental benefits of each alternative apply to all species in the Salmonidae family in Dry Creek, while the measures within each alternative are aimed at holistic ecosystem restoration at Dry Creek.

The coho salmon HSI mathematical model was derived from a review of literature concerning the coho salmon habitat requirements and preferences, which was then synthesized into a subjective set of habitat variables and corresponding curves. This set of variables that represent the habitat requirements for the coho salmon species (e.g. percent canopy cover over rearing stream, substrate composition in riffle areas, percent pools during summer low flow period) are measured in the field or predicted (planned) in the project design. The measured or planned values of each habitat variable are inserted into the HSI curves to produce a suitability index (HSI) score between 0 (unsuitable habitat) and 1 (optimal habitat) for each habitat variable. The suitability indices for various habitat parameters for the species are combined per the guidance in the coho salmon HSI model to yield an overall HSI score for the species to describe existing or future habitat quality. The HSI score for available habitat is a function of the suitability of all habitat types used by the evaluation species (coho salmon). The overall HSI score for available habitat is calculated in one of several ways; the method depends on the structure of the model.

Table 1 summarizes the HSI model proposed for use in the evaluation of project measures by subreach, where each of 15 HSI scores that incorporate temperature, dissolved oxygen, substrate composition, vegetative canopy, vegetation type, instream cover, and pools are utilized. The result of the equation shown in the table is a score between 0 and 1. The final overall HSI score for each subreach is based on the lowest limiting parameter score of the 15 total parameters (McMahon 1983).

Table 1. HSI Model and Equation for Coho Salmon

HSI Model	Variables		Final HSI Score Equation for Each Subreach
Coho Salmon	V_1 =	Maximum temperature during upstream migration	HSI = Lowest value of $V_1 - V_{15}$
	V_2 =	Minimum dissolved oxygen concentration during upstream migration	
	V_3 =	Maximum temperature from spawning to emergence of fry	
	V_4 =	Minimum dissolved oxygen concentration from spawning to emergence of fry	
	V_5 =	Substrate composition in riffle/run areas	
	V_6 =	Maximum temperature during rearing (parr)	
	V_7 =	Minimum dissolved oxygen concentration during rearing (parr)	
	V_8 =	Percent vegetative canopy over rearing stream	
	V_9 =	Vegetation index of riparian zone during summer	
	V_{10} =	Percent pools during summer low flow period	
	V_{11} =	Proportion of pools during summer low flow period that are in size and have sufficient riparian canopy to provide shade	
	V_{12} =	Percent instream and bank cover present during summer low flow period.	
	V_{13} =	Percent of total area consisting of quiet backwaters and deep (≥ 45 cm) pools with dense cover of roots, logs, debris, jams, flooded brush, or deeply undercut banks during winter.	
	V_{14} =	Maximum temperature during (A) winter (November-March) in rearing streams and (B) spring-early summer (April-July) in streams were seaward migration of smolt occurs.	
	V_{15} =	Minimum dissolved oxygen concentration during April-July in streams were seaward migration occurs.	

3. HABITAT EVALUATION PROCEDURES (HEP) HABITAT ASSESSMENT – NET IMPACTS OF THE SUBREACHES

The Habitat Evaluation Procedures (HEP) include a habitat assessment methodology that was developed by USFWS to facilitate the identification of net impacts of various federal actions on fish and wildlife habitat. The ultimate output of the HEP habitat assessment methodology is the determination of the net impact of the action.

The HEP habitat assessment methodology quantifies wildlife habitat by calculating habitat units (HUs) for the evaluation species in the study area. The number of HUs is based on two primary variables, HSI and the total area of available habitat. The HSI model is a set of mathematical relationships designed to represent the habitat suitability (quality) of an area for a single species or assemblage of species as well as different life stages of a species or assemblage of species as described above. The total area of available habitat for an evaluation species includes all areas that can be expected to provide some support to the evaluation species. Total area of available habitat is calculated by summing the areas of all cover types likely to be used by the evaluation species. The HSI score is multiplied by the total area of available habitat at various target years to determine the number of HUs throughout the life of the project.

Habitat assessments involve measurement and description of habitat conditions for baseline (present) assessments and impact (future with-project and without-project) assessments (USFWS 1980). This process includes predicting total available habitat and HSI for each evaluation species, using the same HSI models that were used for the baseline year. The HEP habitat assessment can be simplified by selecting target years (TYs) for which habitat conditions can be reasonably defined. The HU-time analysis must begin at a baseline year (TY-0). A baseline year is defined as a point in time before proposed changes in land and water use result in habitat alterations in the study area. In most cases and for the subreaches in this assessment, the baseline year will be existing or current year conditions (USFWS 1980).

The existing subreach conditions data were used to establish the coho salmon HSI score and total area of available habitat for each subreach at target year 0, the baseline assessment year. The existing subreach conditions data are presented in the 2010 Current Conditions Inventory Report (Inter-Fluve 2010). The baseline subreach conditions were measured in the field using the methods described in the California Salmonid Stream Habitat Restoration Manual and the U.S. Forest Service Stream Inventory Handbook (Flosi et al. 2010; USFS 2006). The baseline condition information and projections of future conditions form the basis of the future without-project condition. The future without-project condition is compared to proposed actions in each subreach to determine if they could have a measurable change to the environment.

For each proposed subreach, the area of available habitat must be estimated for future years. The period of analysis for this project (i.e. the project life) is 50 years following construction completion. The ending target year is the end of the period of analysis for this project (target year 50). The HEP manual states that some habitat types will increase in total area, others will decrease, and in some cases new habitat types will be created or existing ones totally lost under projected future conditions. The recommended method for determining the future area of each habitat type is the use of habitat type maps (USFWS 1980), which were used for this assessment. The planned project HSI and total area of available habitat under the future with-project conditions at target year 50 within each subreach were determined using the 60% designs for each subreach and associated hydraulic modeling (Inter-Fluve 2015).

The coho salmon HSI model includes criteria and methods to determine a value for each variable that includes the appropriate size, depth, stream flow, habitat type, and more (McMahon 1983). Once the appropriate value is determined based on the criteria, the value is then input into the corresponding HSI curves. If the HSI model criterion for a variable differed from the criterion established in the Biological Opinion (NMFS 2008), the Biological Opinion criterion was used for this HEP habitat assessment.

The calculation of the baseline and future values for each of the 15 HSI variables in the coho salmon model and the total area of available habitat rely on the aforementioned guidance, Biological Opinion (NMFS 2008), USFWS HSI model application guidelines (Terrell et al. 1982), 2010 Current Conditions Habitat Inventory (Inter-Fluve 2011), project designs and hydraulic modeling (ESA 2015; Inter-Fluve 2015), and professional judgment.

The calculated HSI scores and total area of available habitat by habitat type for each subreach are provided in Table 16 below. Please note that the final overall HSI scores for each subreach in Table 2 are based on the lowest limiting variable score of the 15 total variables (see Table 3) per the HSI model guidance (McMahon 1983).

Table 2. Habitat Evaluation Procedures – Calculated Baseline and Future With-Project Overall HSI Scores and Total Areas of Available Habitat

Subreach and Habitat Type	Baseline/Without-Project Condition (Target Year 0)		Future With-Project Condition (Target Year 50)	
	Area (ft^2)	Overall HSI score	Area (ft^2)	Overall HSI score
Subreach 4A				
Backwater/Alcove	990	0.25	10,844	0.37
Flatwater	85,841		65,447	
Pool	52,862		20,096	
Riffle/Boulder Field	14,054		28,208	
Side Channel[1]	0		22,687	
Winter	0		297,579	
TOTAL	153,747		444,861	
Subreach 14A				
Backwater/Alcove	1,458	0.20	10,365	0.37
Flatwater	39,601		24,957	
Pool	64,008		57,864	
Riffle/Boulder Field	55,073		51,394	
Side Channel[1]	0		39,497	
Winter	0		41,724	
TOTAL	160,140		225,800	
Subreach 14B				
Backwater/Alcove	396	0.20	14,350	0.35
Flatwater	20,331		13,395	
Pool	6,436		16,495	
Riffle/Boulder Field	22,489		19,767	
Side Channel[1]	1,441		15,647	
Winter	0		3,658	
TOTAL	51,093		83,312	
Note: [1] Some side channel habitats include pools. These areas were included in when calculating values for HSI variables related to pools.				

In addition to a baseline year and ending target year, there must always be a target year 1. Target year 1 is the first year land and water use conditions are expected to deviate from baseline conditions and is the first year after construction in this assessment. The habitat conditions (HSI and area of available habitat) described for each target year are the expected conditions at the end of that year. At a minimum, target years should be selected for points in time when the rates of loss or gain in HSI or area are predicted to change.

The HSI and total area of available habitat at target year 0 for each subreach are based on current year conditions. The HSI and total area of available habitat in target year 0 are assumed to remain constant through the entire period of analysis under without-project conditions. These conditions are assumed to remain the same under without-project conditions in target year 50 because the single incised channel will likely remain largely stable and continue to produce hydraulic conditions unsuitable to the sheltering of juvenile fish, as described in the future without-project condition section of the Detailed Project Report. Aquatic/riparian habitat in Dry Creek will likely be maintained at the current conditions due to the consistent flow from Lake Sonoma and the hatchery. All the tributary confluences to Dry Creek are expected to become intermittent in the summers, especially under a changing climate (Inter-Fluve 2011).

Future projections of HSI scores and total area of available habitat were made for target years 1, 5, 10, and 50 under with-project conditions for each subreach. Habitat-forming processes occur during two-year to 10-year flood events (Knighton 1998). Therefore, for all variables, it is assumed that the planned project HSI score and total area of available habitat determined using the 60% designs will be reached in target year 10.

Each future with-project HSI score and total area of available habitat takes into consideration how long a given habitat feature will take to achieve benefits, with a continuous linear function of habitat gain/loss from one notable point in time to the next (i.e. habitat quality is interpolated between these noted points). According to the USFWS HEP manual, rates of loss or gain in HSI or area of available habitat are assumed to occur linearly between target years.

For the total area of available habitat under future with-project conditions, it was assumed that each subreach would have approximately 10% of the planned total area of available habitat (expected at target year 50) immediately after construction in target year 1. Between target years 1 and 5, the total area of available habitat escalates linearly to around 75% of the planned total area of available habitat (expected at target year 50) by five years after construction (at target year 5). Between target years 5 and 10, again, the total area of available habitat escalates linearly to 100% of the planned total area of available habitat (expected at target year 50) by ten years after construction (at target year 10). Lastly, it is assumed that benefits of new habitat will be consistent and stable for the remainder of the period of analysis from target years 10 through 50, assuming moderate effort at post-project maintenance and adaptive management. A summary of the projection of each HSI variable with the potential to change under restoration activities is given in Table 3. More detailed description of the assumptions underlying the projection of each HSI variable is available upon request.

Table 3. Habitat Evaluation Procedures – Summary of Future Without Project (FWOP) and Future With Project (FWP) HSI Variable Scores by Subreach and Target Year.

Subreach		**Target Year**	**Winter Affected Areas**	**V5 Riffle Comp.**	**V8 Canopy over Stream**	**V9 Veg Index**	**V10 %Pools Summer**	**V11 Prop. Sized Pools Summer**	**V12 %Instream Cover Summer**	**V13 %Quiet Backwater Winter**	**Final HSI Score (Minimum)**
4A	*FWOP HSI Score*	0	153,747	1.00	1.00	1.00	0.6	0.31	0.93	0.25	0.25
		50	153,747	1.00	1.00	1.00	0.6	0.31	0.93	0.25	0.25
	FWP HSI Score	1	44,486	1.00	0.24	1.00	0.518	0.36	0.22	0.4	0.22
		5	333,646	1.00	0.99	1.00	0.19	0.56	0.7	1	0.19
		10	444,861	1.00	1.00	1.00	0.37	0.82	0.93	1.00	0.37
		50	444,861	1.00	1.00	1.00	0.37	0.82	0.93	1.00	0.37
14A	*FWOP HSI Score*	0	160,140	0.98	0.96	1.00	0.99	0.2	0.4	0.24	0.2
		50	160,140	0.98	0.96	1.00	0.99	0.2	0.4	0.24	0.2
	FWP HSI Score	1	22,580	1	0.25	1.00	0.898	0.216	0.22	0.276	0.216
		5	169,351	1	1	1.00	0.53	0.28	0.62	0.42	0.28
		10	225,801	1	0.96	1.00	0.92	0.37	0.88	0.74	0.37
		50	225,801	1	0.96	1.00	0.92	0.37	0.88	0.74	0.37
14B	*FWOP HSI Score*	0	51,093	0.64	0.85	1.00	0.65	0.2	0.4	0.2	0.2
		50	51,093	0.64	0.85	1.00	0.65	0.2	0.4	0.2	0.2
	FWP HSI Score	1	8,331	1	0.25	1.00	0.704	0.212	0.22	0.236	0.212
		5	62,484	1	1	1.00	0.92	0.26	0.62	0.38	0.26
		10	83,312	1	0.85	1.00	1.00	0.35	0.88	0.68	0.35
		50	83,312	1	0.85	1.00	1	0.35	0.88	0.68	0.35

Habitat unit gains or losses must be annualized in order to determine the net impact of the action. The net impact of the action is defined as the difference between the average annual habitat units under with-project conditions and the average annual habitat units under without-project conditions (USFWS 1980). Habitat units are annualized by adding the HUs across all target years in the period of analysis (cumulative HUs) and dividing the total (cumulative HUs) by the number of years in the project period of analysis.

The formula to determine the cumulative HUs is defined in the HEP manual. The formula was developed to precisely calculate cumulative HUs when either the overall HSI score or total area of available habitat or both change over a time interval. The formula will calculate cumulative

HUs whether the rate of change of HUs is linear, either the overall HSI score or total area of available habitat is constant over the time interval, or curvilinear, both the overall HSI score and total area of available habitat change over the time interval (USFWS 1980).

$$Cumulative\ HUs = (T_2 - T_1)\left(\frac{A_1H_1 + A_2H_2}{3} + \frac{A_2H_1 + A_1H_2}{6}\right)$$

where T_1 = First target year of the time interval

T_2 = Last target year of the time interval

A_1 = Area of available habitat at beginning of time interval

A_2 = Area of available habitat at end of time interval

H_1 = HSI at beginning of time interval

H_2 = HSI at end of time interval

3 and 6 = Constants derived from integration

Gains (or losses) in habitat units must be calculated under both with-project and without-project conditions for the project period of analysis, which are called the Average Annual Habitat Units (AAHUs). AAHUs are the sum of the cumulative HUs at all target years divided by the project period of analysis.

$$Average\ Annual\ Habitat\ Units\ (AAHUs), With - Project\ Condition = \frac{(Cumulative\ HUs_{Baseline\ to\ TY1} + Cumulative\ HUs_{TY1\ to\ TY5} + Cumulative\ HUs_{TY5\ to\ TY10} + Cumulative\ HUs_{TY10\ to\ TY50})}{50}$$

where *Baseline* = Target year 0

TY_X = Target year evaluated (Target years 1, 5, 10, and 50)

50 = Project period of analysis

$$Average\ Annual\ Habitat\ Units\ (AAHUs), Without - Project\ Condition = \frac{(Cumulative\ HUs_{Baseline\ to\ TY50})}{50}$$

where *Baseline* = Target year 0

TY_{50} = Target year evaluated (Target year 50)

50 = Project period of analysis

The net annual impact of the proposed action is calculated using the following formula.

$$Net\ Impact = AAHUs_{with\ project} - AAHUs_{without\ project}$$

Table 4 below shows the results of the HEP habitat assessment expressed as the net annual impact for each subreach.

Table 4. Habitat Evaluation Procedures – Impact Assessment – Habitat Unit Analysis for 50 Year Time Period

Subreach		Target Year	Area of Available Habitat at the Target Year	Final HSI Score	Cumulative Habitat Units	Average Annual Habitat Units (AAHUs)
4A	Future Without-Project (FWOP) Condition	0	153,747	0.25	N/A	38,437
		50	153,747	0.25	1,921,838	
	Future With-Project (FWP) Condition	1	44,486	0.22	23,566	146,259
		5	333,646	0.19	152,142	
		10	444,861	0.37	553,296	
		50	444,861	0.37	6,583,943	
	Net Annual Impact (With-Without Project)			0.12		107,822
14A	Future Without-Project (FWOP) Condition	0	160,140	0.2		32,028
		50	160,140	0.2	1,601,400	
	Future With-Project (FWP) Condition	1	22,580	0.216	18,819	75,664
		5	169,351	0.28	98,329	
		10	225,801	0.37	323,178	
		50	225,801	0.37	3,341,855	
	Net Annual Impact (With-Without Project)			0.17		43,616
14B	Future Without-Project (FWOP) Condition	0	51,093	0.2		10,219
		50	51,093	0.2	510,930	
	Future With-Project (FWP) Condition	1	8,331	0.212	6,078	26,374
		5	62,484	0.26	34,291	
		10	83,312	0.35	111,951	
		50	83,312	0.35	1,166,368	
	Net Annual Impact (With-Without Project)			0.15		16,155

As a result of the HEP habitat assessment, subreach 4A exhibits the highest number of average annual habitat units and, therefore, has the greatest net annual impact out of the subreaches included in the assessment. Subreach 4A also has the largest difference in area of available habitat between the future with-project and without-project conditions. The driving factor of this outcome is the addition of a large amount of winter refuge habitat in the future with-project condition at subreach 4A. The project team chose to keep winter habitat in the total area of available habitat calculation because a primary objective of the Reasonable and Prudent Alternatives for Dry Creek in the Biological Opinion is to restore winter rearing habitat to address the displacement of over-wintering coho by high flows associated with flood control releases (NMFS 2008).

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Appendix G:

Draft Finding of No Significant Impact

DRAFT
FINDING OF NO SIGNIFICANT IMPACT (FONSI)

(33 CFR Part 230-325)

Dry Creek Ecosystem Restoration 1135 Project
Northern Sonoma County, California

1. **Action:** construction of a combination of both off and main channel aquatic habitat restoration features along approximately 1700 feet in subreach 4a of Dry Creek in Northern Sonoma County (between stations 160+00 to 176+50). Off-channel restoration features include the creation of side channels and backwater alcoves on both sides of Dry Creek. Restoration features also include large woody debris structures of varying sizes and complexities in the off channel features and the main channel, as well as pool restoration, constructed riffles, and bolder fields in the main channel. Invasive species removal and native revegetation within the subreach will also be conducted. The existing grade control sill in the subreach may be notched and the existing fish ladder may be replaced. Proposed alcove and secondary channel features are anticipated to generally persist naturally in their constructed condition for years to decades, however some maintenance activates will likely be performed.

2. **Factors Considered:** Factors considered for this FONSI were direct, indirect, and cumulative impacts to hydrology; air and water quality; aquatic and terrestrial habitat; fish and wildlife; endangered and threatened species and critical habitats; special aquatic sites; noise; transportation and traffic; recreation; aesthetics; farmland; cultural, archeological and historic resources; public health and safety; hazardous and toxic materials; conflicts with other plans, policies, or controls; irreversible changes or irretrievable resource commitments; and cumulative impacts.

3. **Conclusion:** Based on a review of the information incorporated in the Environmental Assessment, including views of the United States Army Corps of Engineers (USACE), the general public, and resource agencies having special expertise or jurisdiction by law, as well as the stated avoidance, minimization, and best management measures, USACE concludes the proposed activity would not significantly affect the quality of the physical, biological, or human environment. Pursuant to the provisions of the National Environmental Policy Act of 1969, the preparation of an Environmental Impact Statement (EIS) will therefore, not be required.

   Approved by:

   ____________________________   __________________

   John C. Morrow   Date
   Lieutenant Colonel, US Army
   District Engineer

Appendix H:

Special Status Species Tables

NOTE: Federally threatened or endangered plants are outlined in blue. Species with moderate or high potential to occur in Dry Creek are outlined in dashed yellow.

Special-Status Plant Species Occurring in Sonoma County and Potential to Occur in Dry Creek

Genus species Common Name	Status	Habitat	Potential to Occur	Phenology	Flowering/ Survey Period
Franciscan onion *Allium peninsulare var. franciscanum*	1.B2	Cismontane woodland, valley and foothill grassland, often on serpentine, ultramafic or clay soils, and dry hillsides between 52-300 meters. Known from MEN, SCL, SMT and, SON counties.	Unlikely. No potential habitat within project area. Known from 21 CNDDB occurrences, 4 from SON County with most recent occurrence in 2006 in Sonoma.	Perennial bulbiferous herb	May - June
Sonoma alopecurus *Alopecurus aequalis* var. *sonomensis*	FE 1B.1	Occurs in freshwater marshes, swamps, and riparian scrub. Known from MRN and SON counties between 5-365 meters.	Unlikely. Known from fewer than 10 occurrences. Suitable habitat may be present within project area but the potential for occurance is highly unlikey.	Perennial herb	May - July
Napa false indigo *Amorpha californica var. napensis*	1B.2	Broadleaved upland forest, chaparral, cismontane woodland. Prefers openings in forest or woodland or in chaparral. 120-2000 meters.	Unlikely. No potential habitat within project area. Known from 45 occurrences with 22 from SON County with most recent occurrence in 2003 in Calistoga.	Perennial deciduous shrub	April - July
twig-like snapdragon *Antirrhinum virga*	4.3	Rocky openings, often on serpentine soils and in chaparral and lower montane coniferous forests between 100-2015 meters. Known from LAK, MEN, NAP, SON, and YOL counties.	Unlikely. No potential habitat within project area. No CNDDB occurrences.	Perennial herb	March - April
The Cedars manzanita *Arctostaphylos bakeri ssp. sublaevis*	1B.2	Serpentine in closed cone coniferous forest and serpentine chaparral, and Sargent cypress woodland, typically in canyons and on slopes. Known only from SON County between 275-600 meters.	Unlikely. No potential habitat within project area. No CNDDB occurrences.	Perennial evergreen shrub	February - May
Howell's manzanita *Arctostaphylos hispidula*	4.2	Serpentinite and sandstone in chaparral between 120-1250 meters. Known from DNT, HUM, SIS, and SON counties.	Unlikely. No potential habitat within project area. No CNDDB occurrences.	Perennial evergreen shrub	March - April

Genus species Common Name	Status	Habitat	Potential to Occur	Phenology	Flowering/ Survey Period
Rincon Ridge manzanita *Arctostaphylos stanfordiana ssp. decumbens*	1B.1	Chaparral and cismontane woodland often on barren red-rhyolites. Known from SON County between 75-370 meters.	Unlikely. No potential habitat within project area. Taxon recorded from 3 upland locations near Bradford Mountain.	Perennial evergreen shrub	February - May
Clara Hunts milk-vetch *Astragalus claranus*	FE CT 1B.1	Chaparral openings and cismontane woodland and valley and foothill grassland on serpentinite or volcanic, rocky or clay substrates. Known from NAP and SON counties between 75-275 meters.	Unlikely. No potential habitat within project area. Known from 6 occurrences, one in NE Santa Rosa on St. Helena Road.	Annual herb	March - May
Sonoma sunshine *Blennosperma bakeri*	FE 1B.1	Mesic valley and foothill grasslands and vernal pools. Known only from SON County between 10-110 meters.	Unlikely. No potential habitat within project area. Taxon recorded from the Laguna de Santa Rosa and Sonoma area.	Annual herb	March - May
narrow-anthered California brodiaea *Brodiaea californica var. leptandra*	1B.2	Broadleaved upland forest, chaparral, lower montane coniferous forest. Known from LAK, NAP and SON counties between 110-915 meters.	Unlikely. No potential habitat within project area. Known from 29 occurrences with 14 occurring in SON County, most recently in 2004 in Sonoma.	Perennial bulbiferous herb	May - June
narrow-anthered California brodiaea *Calamagrostis ophitidis*	4.3	Serpentinite and rocky soils in chaparral, lower montane coniferous forests, valley and foothill grassland, and meadows and seeps between 90-1065 meters. Known from LAK, MEN, MRN, NAP, and SON counties.	Unlikely. No potential habitat within project area. No CNDDB occurrences.	Perennial herb	April - July
Mt. Saint Helena morning-glory *Calystegia collina ssp. oxyphylla*	4.2	Serpentinite and in chaparral, lower montane coniferous forest and valley and foothill grassland between 279-1010 meters. Known from LAK, MEN, MRN, NAP, SBT, and SON counties.	Unlikely. No potential habitat within project area. Known from 9 occurrence with 2 occurring in SON county, most recently in 1988 in Mark West Springs.	Perennial rhizomatous herb	April - June
white sedge *Carex albida*	FE 1B.1	Freshwater wetlands,wetland-riparian, freshwater marsh and bogs/fens.	Low. Suitable habitat may be present within project area. Only recorded occurrences at Lower Pitkin Marsh in 2008.	Perennial rhizomatous herb	No data

Genus species Common Name	Status	Habitat	Potential to Occur	Phenology	Flowering/ Survey Period
California sedge *Carex californica*	2B.3	Bogs and fens, closed-cone coniferous forest, coastal prairie, meadows, marshes and swales. Known from MEN and SON counties between 90-335 meters.	Unlikely. Suitable habitat not present within project area. Only CNDDB occurances known from Mendocino county. Calflora occurrances known from both Mendocino and Sonoma counties.	Perennial rhizomatous herb	May - August
bristly sedge *Carex comosa*	2B.1	Coastal prairie, lake margins of marshes and swamps and valley and foothill grassland. Known from CCA, LAK, MEN, SAC, SHA, SJQ and SON counties between 0-625 meters.	Low. Suitable habitat may be present within project area. Taxon recorded in Guerneville but presumed extirpated. Additonally recorded at Bodega Head in 2011.	Perennial rhizomatous herb	May - September
johnny-nip *Castilleja ambigua var. ambigua*	4.2	Coastal bluff scrub, coastal prairie, coastal scrub, marshes and swamps, valley and foothill grassland and vernal pool margins. Known from ALA, CCA, DNT, HUM, MEN, MRN, NAP, SCR, SFO, SLO, SMT, SON counties between 0-435 meters.	Low. Suitable habitat may be present within project area however, there are no CNDDB occurrences.	Annual hemiparasitic herb	March - August
Rincon Ridge ceanothus *Ceanothus confusus*	1B.1	Closed-cone coniferous forest, chaparral, and cismontane woodland on volcanic or serpentine soils. Known from LAK, MEN, NAP and SON counties between 75-1065 meters.	Unlikely. No potential habitat within project area. Taxon recorded from 3 upland locations near Bradford Mountain, as well as west of Wholer Bridge near the Russian River on Glider Ridge, and west Cloverdale on Red Mountain.	Perennial evergreen shrub	February - April
holly-leaved ceanothus *Ceanothus purpureus*	1B.2	Chaparral and cismontane woodland on volcanic and rocky substrates. Known from NAP, SOL and SON counties between 120-640 meters.	Unlikely. No potential habitat within project area. Only occurrence recorded outside Guerneville in 2002.	Perennial evergreen shrub	February -June
pappose tarplant *Centromadia parryi ssp. parryi*	1B.2	Coastal prairie, meadows and seeps, coastal salt marsh, valley and foothill grassland (vernally mesic, often alkaline sites). Known to occur from BUT, COL, GLE, LAK, NAP, SMT, SOL, and SON counties between 0-420 meters.	Low. Suitable habitat may be present within project area. Known from only one occurrence near the Sonoma Conuty Airport in 2004.	Annual herb	May - November
Sonoma spineflower *Chorizanthe valida*	FE CE 1B.1	Coastal prairie in sandy substrate. Known from MRN and SON counties between 10-305 meters.	Unlikely. No potential habitat within project area. SON occurrences presumed extripated.	Annual herb	July - August

Genus species Common Name	Status	Habitat	Potential to Occur	Phenology	Flowering/ Survey Period
Vine Hill clarkia *Clarkia imbricata*	FE CE 1B.1	Chaparral and valley and foothill grassland on acidic sandy loam. Known from SON county between 50-75 meters.	Unlikely. Known only from Vine Hill area. Last known occurrence in 1997.	Annual herb	June - August
Pennell's bird's-beak *Cordylanthus brunneus ssp. capillaris*	FE 1B.2	Closed-cone coniferous forest, chaparral, cismontane woodland on serpentinite substrates. Known from SON counties between 45 - 305 meters.	Unlikely.No potential habitat within project area. Last known occurrence in Camp Meeker in 2001.	Annual hemiparasitic herb	June-September
soft bird's-beak *Cordylanthus mollis ssp. mollis*	FE CR 1B.2	Coastal salt marshes and swamps. Known from CCA, MRN, NAP, SAC, SOL and SON counties between 0-3 meters.	Unlikely. No potential habitat within project area. No CNDDB occurrences.	Annual hemiparasitic herb	July-November
serpentine bird's-beak *Cordylanthus tenuis ssp. Brunneus*	4.3	Serpentinite, in chaparral and closed-cone coniferous forests and cismontane woodland. Known to occur from LAK, NAP, and SON counties between 475-915 meters.	Unlikely. No potential habitat within project area. No CNDDB occurrences.	Annual hemiparasitic herb	July - August
serpentine cryptantha *Cryptantha dissita*	1B.2	Chaparral on ultramafic and serpentine outcrops. Known from COL, LAK, MEN, NAP, SHA, SIS and SON counties between 395-580 meters.	Unlikely. No potential habitat within project area. Last known occurrence 2 miles N of Redwood Mountain in 1999.	Annual herb	April - June
mountain lady's-slipper *Cypripedium montanum*	4.2	Broadleaved upland forest, cismontane woodland, lower montane coniferous forest and north coast coniferous forest. Known from DNT, HUM, MAD, MEN, MOD, MPA, PLU, SCR, SHA, SIE, SIS, SMT, SON, TEH, TRI, and TUO counties between 185-2225 meters.	Unlikely. No potential habitat within project area. No CNDDB occurrences.	Perennial rhizomatous herb	March - August
Baker's larkspur *Delphinium bakeri*	FE CE 1B.1	Broadleafed upland forest, coastal scrub and valley and foothill grassland on decomposed shale, often mesic sites. Known from MRN and SON counties between 80-305 meters.	Low. Marginally suitable habitat may be present within project area. Known from 3 occurrences, most recent in 2011 in MRN county.	Perennial herb	March - May
golden larkspur *Delphinium luteum*	FE CR 1B.1	Chapparral, coastal prairie, coastal scrub, valley and foothill grassland on rocky substrates. Known from MRN and SON counties between 0-100 meters.	Low. Suitable habitat may be present within project area. Known from 11 occurrences, 2 most recent occurrences in 2011 from Tomales and Bodega Head areas.	Perennial herb	March - May

Genus species Common Name	Status	Habitat	Potential to Occur	Phenology	Flowering/ Survey Period
dwarf downingia *Downingia pusilla*	2B.2	Mesic sites in valley and foothill grassland and vernal pools. Known from MER, MPA, NAP, PLA, SAC, SOL, SON, STA, THE, and YUB counties between 1-445 meters.	Low. Suitable habitat may be present within project area. Known from 3 occurrences on SON county, all of which contain vernal pool and/or swale habitat.	Annual herb	March - May
serpentine daisy *Erigeron serpentinus*	1B.3	Serpentine seeps in chaparral. Known only from SON County between 60- 670 meters.	Unlikely. No potential habitat within project area. Known from 3 occurrences, most recent in 1998 at The Cedars.	Perennial herb	May - August
Loch Lomond button celery *Eryngium constancei*	FE CE 1B.1	Vernal pools. Known only from LAK, NAP and SON counties between 460-855 meters.	Unlikely. No potential habitat within project area. Known from 1 occurrence in SON County in 1996 near Diamond Mountian.	Annual / Perennial herb	April – June
fragrant fritillary *Fritillaria liliacea*	1B.2	Cismontane woodland, coastal prairie, coastal scrub, valley and foothill grassland near the coast, on clay or serpentinite. Known from ALA, CCA, MNT, MRN, SBT, SCL, SFO, SMT, SOL, and SON counties between 3-410 meters.	Unlikely. No potential habitat within project area. Only extant occurrence in SON County in 2013 near Camp Meeker.	Perennial bulbiferous herb	February - April
Roderick's fritillary *Fritillaria roderickii*	CE 1B.1	Coastal bluff scrub, coastal prairie, valley and foothill grasslands. Known from MEN and SON counties between 15-400 meters.	Unlikely. No potential habitat within project area. Only extant occurrence in SON County in 1987 near Gualala.	Perennial bulbiferous herb	March - May
White seaside tarplant *Hemizonia congesta ssp. congesta*	1B.2	Coastal scrub, valley and foothill grassland and in grassy valleys and hills, often in fallow fields. Known to occur from MEN, MRN, SFO, SMT and SON counties between 20-560 meters.	Moderate. Suitable habitat may be present within project area. Known from 3 CNDDB occurrences, 2 most recent occurrences from 1990 in Windsor.	Annual herb	April - Novemeber
thin-lobed horkelia *Horkelia tenuiloba*	1B.2	Broadleaved upland forest and chaparral on mesic openings and sandy substrates. Known from MEN, MRN and SON counties between 50-500 meters.	Unlikely. No potential habitat present within project area. Taxon recorded from 2 upland locations near Bradford Mountain.	Perennial herb	May - July

Genus species Common Name	Status	Habitat	Potential to Occur	Phenology	Flowering/ Survey Period
northern California black walnut *Juglans californica* var. *hindsii*	1B.1	Riparian forests and woodlands, floodplain terraces. Known from CCA, LAK, NAP, SAC, SOL, and YOL counties between 0-440 meters.	Moderate. *Juglans* species detected in several locations within project are for Miles 2-3 during botanical surveys, however, unlikely to be native. Suitable habitat is present within project area. CNPS Rare Plant inventory states closest confirmed location is Napa County. Calflora observation database includes one observation in the Lake Sonoma area and 7 other recorded occurrences in Sonoma County. No CNDDB occurrences in Sonoma County.	Perennial deciduous tree	April - May
Burke's goldfields *Lasthenia burkei*	FE CE 1B.1	Vernal pools, swales, seeps (mesic), and meadows between LAK, MEN, NAP, and SON counties between 15 – 600 meters.	Unlikely. Known from 25 occurrences in SON County. Taxon recorded in 2 locations near Healdsburg in 2007 and 2012. No vernal pools in project area.	Annual herb	April - June
Contra Costa goldfields *Lasthenia conjugens*	FE 1B.1	Cismontane woodland, alkaline playas, valley and foothill grasslands (mesic), vernal pools. Known from ALA, CCA, MEN, MNT, MRN, NAP, SBA, SCL, SOL, and SON counties between 0 – 470 meters.	Unlikely. No potential habitat within project area. Known from 33 occurrences, only 1 from SON County in 2003 near Petaluma.	Annual herb	March - June
Colusa layia *Layia septentrionalis*	1B.2	Chaparral, cismontane woodland, and valley and foothill grasslands on sandy or serpentine soils. Known from COL, GLE, LAK, MEN, NAP, SON, SUT, THE, and YOL counties between 100-1095 meters.	Unlikely. No potential habitat within project area. Known from 46 occurrences, 2 in SON County from 1902 and 1949 near Kenwood and Cloverdale.	Annual herb	April - May
Jepson's leptosiphon *Leptosiphon jepsonii*	1B.2	Volcanic substrates in chaparral and cismontane woodland. Known from LAK, NAP, SON and YOL counties between 100-500 meters.	Unlikely. No potential habitat within project area. 36 occurrences, 17 in SON County.	Annual herb	March - May
Crystal Springs lessingia *Lessingia arachnoidea*	1B.2	Serpentinite, often roadsides and cismontane woodland, coastal scrub, and valley and foothill grassland between 60-200 meters. Known from SMT and SON counties.	Unlikely. No potential habitat within project area. 11 occurrences, 3 in SON county outside Camp Meeker from 1992, 1996 and 2005.	Annual herb	July - October

Genus species Common Name	Status	Habitat	Potential to Occur	Phenology	Flowering/ Survey Period
Pitkin Marsh Lily *Lilium pardalinum ssp. pitkinense*	FE CE 1B.1	Cismontane woodland, meadows and seeps and freshwater marshes and swamps. Known from SON Conuty between 35-65 meters.	Low. Suitable habitat may be present within project area. Known from 4 occurrences near Sebastopol, most recent in 2012 at Pitkin Marsh.	Perennial bulbiferous herb	June - July
Sebastopol meadowfoam *Limnanthes vinculans*	FE CE 1B.1	Vernally mesic sites in meadows and seeps, valley and foothill grassland, vernal pools, wet meadows, marshy areas in Valley Oak savanna and on poorly drained soils of clay and sandy loam. Known from SON County. Possibly occurs in NAP County. Recorded between 15- 305 meters.	Unlikely. Known from 41 occurrences in SON County, most occurrences in the Laguna de Santa Rosa.	Annual herb	April - May
Tidestrom's lupine *Lupinus tidestromii*	FE CE 1B.1	Coastal dunes. Known from MNT, MRN and SON counties between 0-100 meters.	Unlikely. No potential habitat within project area. Known from 21 occurrences, 2 in SON County at Bodega Head, Goat Rock State Beach, and Duncans Mills.	Perennial rhizomatous herb	April - June
Mt. Diablo cottonweed *Micropus amphibolus*	3.2	Rocky areas in broadleaved upland forest, chaparral, cismontane woodland, valley and foothill grassland between 45-825 meters. Known from ALA, CCA, COL, LAK, MNT, MRN, NAP, SBA, SCL, SCR, SJQ, SLO, SOL, and SON counties.	Unlikely. No potential habitat within project area. No CNDDB occurrences.	Annual herb	March - May
marsh microseris *Microseris paludosa*	1B.2	Closed-cone coniferous forest, cismontane woodland, coastal scrub, valley and foothill grassland between 5-300 meters. Known from MEN, MNT, MRN, SBT, SCR, SFO, SLO, SMT, and SON counties.	Low. No potential habitat within project area. Known from 1 occurrence recorded in 1981, 2 miles NW of Windsor.	Perennial herb	April - July
green monardella *Monardella viridis*	4.3	Broadleafed upland forest, chaparral, and cismontane woodland. Known from LAK, NAP, SOL, and SON counties between 100-1010 meters.	Unlikely. No potential habitat within project area. No CNDDB occurrences.	Perennial rhizomatous herb	June - September

Genus species Common Name	Status	Habitat	Potential to Occur	Phenology	Flowering/ Survey Period
Baker's navarretia *Navarretia leucocephala ssp. bakeri*	1B.1	Cismontane woodland, lower montane coniferous forest, meadows and seeps, valley and foothill grassland on mesic sites also on adobe or alkaline soils and vernal pools. Known from COL, LAK, MEN, MRN, NAP, SOL, SON, and THE counties between 5-1740 meters.	Low. Suitable habitat unlikely to be present within project area. Known from 3 occurrences found between 1989-1992 near Windsor.	Annual herb	April - July
many-flowered navarretia *Navarretia leucocephala ssp. plieantha*	FE CE 1B.2	Swales and volcanic ash flow vernal pools. Known from LAK, SON, counties between 30-950 meters.	Unlikely. No potential habitat within project area. Known from 1 occurrence, 2 miles S of Windor.	Annual herb	May - June
Gairdner's yampah *Perideridia gairdneri* ssp. *gairdneri*	4.2	Broadleaf upland forests, chaparral, valley and foothill grasslands at mesic sites, vernal pools. Known from CCA, KRN, LAX, MEN, MNT, MRN, NAP, ORA, SBT, SCL, SCR, SDG, SLO, SMT, SOL and SON counites between 0-610 meters.	Low. Suitable habitat may be present within project area. No CNDDB occurrences.	Perennial herb	June - October
North Coast semaphore grass *Pleuropogon hooverianus*	CT 1B.1	Broadleaf upland forest, meadows, north coast coniferous forest at mesic sites, vernal pools. Known from MEN, MRN and SON counties between 10-671 meters.	Unlikely. No potential habitat within project area. Known from 24 CNDDB occurrences. 2 in SON county of which, 1 extripated and 1 extant occurrence observed in 2003 in Cotati.	Perennial rhizomatous herb	May - August
Hickman's cinquefoil *Potentilla hickmanii*	FE CE 1B.1	Coastal bluff scrub, closed-cone coniferous forest, vernally mesic meadows and seeps, freshwater marshes and swamps. Known from MNT, SMT and SON counties between 10-149 meters.	Unlikely. No potential habitat within project area. No CNDDB occurrences in SON county.	Perennial herb	April - August
Two-fork clover *Trifolium amoenum*	FE 1B.1	Coastal bluff scrub, valley and foothill grassland on sometimes serpentine soil. Known from MRN, NAP, SCL, SMT, SOL and SON counties between 5-415 meters.	Unlikely. No potential habitat within project area. Known from 26 occurrences with 10 from SON county, most recent occurrence in 1993 at Camp Meeker.	Annual herb	April - June
Lobb's aquatic buttercup *Ranunculus lobbii*	4.2	Mesic locations, cismontante woodland, north coast coniferous forest, valley and foothill grassland, and vernal pools. Known from ALA, CCA, MEN, MRN, NAP, SCR, SMT, SOL, and SON conuties between 15-470 meters.	Low. Suitable habitat may be present within project area. No CNDDB occurrences.	Annual herb	February - May

Genus species Common Name	Status	Habitat	Potential to Occur	Phenology	Flowering/ Survey Period
showy rancheria clover *Trifolium amoenum*	FE 1B.1	Coastal bluff scrub, valley and foothill grassland, sometimes serpentine. Known from MRn, NAP, SCL, SMT, SOL, and SON counites between 5-415 meters.	Low. No potential habitat within project area. One plant rediscovered in Marin County in 1993.	Annual herb	April - June
Methuselah's beard lichen *Usnea longissima*	4.2	Broadleaved upland forests, North Coast coniferous forests on tree branches; ussally on old growth hardwoods and conifers. Known from DNT, HUM, MEN, SCR, SMT, and SON counties between 50 and 1460 meters.	Unlikely. No potential habitat within project area. Known from 206 occurrences with 7 occurring in SON county, Most recent occurrence in 2004 at Camp Meeker.	Fruticose epiphytic lichen	Lichen (no blooming period)

List of species based on review of California Department of Fish and Game Natural Diversity Data Base for the Geyserville, Cloverdale, Healdsburg and Guerneville U.S. Geological Survey 7.5 minute quadrangles and species lists provided by the U.S. Fish and Wildlife Service.

Status

FE: Endangered under federal Endangered Species Act (ESA).
FT: Threatened under federal ESA.
FPE: Proposed endangered under federal ESA.
FC: Candidate for listing under federal ESA.
FSC: U. S. Fish and Wildlife Service Species of Concern.
SE: Endangered under California ESA.
ST: Threatened under California ESA.
SR: Listed as rare under the California Native Plant Protection Act.
1A: California Native Plant Society List 1A: Plants presumed extinct in California.
1B: California Native Plant Society List 1B: Plants rare, threatened or endangered in California.
2: California Native Plant Society List 2: Plants rare, threatened, or endangered in California, but more common elsewhere.
.1 Seriously Endangered in California (over 80% of occurrences Threatened/ high degree of immediacy of threat)
.2 Fairly Endangered in California (20-80% occurrences Threatened)
.3 Not very Endangered in California (<20% of occurrences Threatened or no current threats known)

Abbreviations:

ALA Alameda
AMA Amador
BUT Butte
CAL Calaveras
CCA Contra Costa
COL Colusa
DNT Del Norte
ELD El Dorado
FRE Fresno
GLE Glenn
HUM Humboldt
KRN Kern
LAK Lake
LAS Lassen
LAX Los Angeles
LCP Local Coastal Plan
MAD Madera
MOD Modoc
MEN Mendocino
MER Merced
MNT Monterey
MPA Mariposa
MRN Marin
NAP Napa
NEV Nevada
ORA Orange
PLA Placer
PLU Plumas
RIV Riverside
SAC Sacramento
SBA Santa Barbara
SBD San Bernardino
SBT San Benito
SCF Sonoma County Flora
SCL Santa Clara
SCR Santa Cruz
SCT Santa Catalina Island
SCZ Santa Cruz Island
SDG San Diego
SFO San Francisco
SHA Shasta SIE Sierra
SIS Siskiyou
SJQ San Joaquin
SMI San Miguel Island
SMT San Mateo
SNI San Nicolas Island
SDG San Diego
SFO San Francisco
SHA Shasta
SIE Sierra
SIS Siskiyou
SOL Solano
SON Sonoma County
STA Stanislaus
SJQ San Joaquin
SMI San Miguel Island
SMT San Mateo
SNI San Nicolas Island

NOTE: Federally threatened or endangered species are outlined in blue. Species with moderate or high potential to occur in Dry Creek are outlined in dashed yellow.

Special-Status Wildlife Species Potentially Occuring in Sonoma County and thier Potential to Occur in Dry Creek

Genus species **Common Name**	**Status**	**Habitat**	**Potential to Occur**
		Invertebrates	
Conservancy fairy shrimp *Branchinecta conservation*	CE	Endemic to the grasslands of the northern two-thirds of the Central Valley; Inhabits astatic pools located in swales formed by old braided alluvium; filled by winter/spring rains. Known from BUT, GLE, KRN, MER, SOL, STA, TEH, and YOL counties.	Unlikely. No potential habitat within project area. No CNDDB occurrences in SON County.
vernal pool fairy shrimp (including critical habitat) *Branchinecta lynchi*	CT	Endemic to the grasslands of Central Valley, Central coast mountains, and south coast mountains. Inhabits small, clear-water sandstone depression pools and grassed swale, earth slump, or basalt-flow depression pools. Known from ALA, AMA, BUT, CAL, COL, CCA, ELD, FRE, GLE, KRN, KIN, LAX, MAD, MER, MNT, NAP, PLA, RIV, SAC, SBN, SJO, SDI, SLO, SBA, SHA, SOL, STA, SUT, TEH, TUL, TUO, VEN, YOL, and YUB counties.	Unlikely. No potential habitat within project area. No CNDDB occurrences in SON County.
Sonoma artic skipper *Carterocephalus palaemon* ssp.	FSC	Grasses including purple reed grass (*Calamagrostis purpurascens*) host caterpillars. Adults found in glades and openings in heavily forested woods, moist meadows, and streamsides. Known from SON county.	Unlikely. No potential habitat within project area. The only CNDDB occurrence was observed near Salt Point State Park in 1965.
Giuliani's dubiraphian riffle beetle *Dubiraphia giulianii*	NL	Aquatic. Inhabits rocks and vegetation and found in slow parts of the Russian River. Known from SON County.	Unlikely due to the relatively high water velocities in Dry Creek. The only CNDDB occurrence was recorded in 1948 at Rio Nido on the Russian River.
Leech's skyline diving beetle *Hydroporus leechi*	FSC	Shallow water, pond shores. Known from CAL, MAD, MRP, MEN, MNO, PLU, SMA, SHA, SIS, and SON counties.	Low. Potential habitat may be present on project area, but additional information required on distribution data. The only CNDDB occurrence in SON County was located in 1963 at Annadel State Park, in Bennett Mountain Lake, west of Kenwood.
California linderiella *Linderiella occidentalis*	NL	Seasonal pools in unplowed grasslands with old alluvial soils underlain by hardpan or in sandstone depressions. Known from ALA, AMA, BUT, CCO, FRE, GLE, MAD, MER, MNT, PLA, SAC, SBA, SJO, SLO, SCR, SHA, SOL, SON, STA, SUT, TEH, YOL, and YUB counties.	Unlikely. No potential habitat within the project area. Closest CNDDB occurrence in 1993 at vernal pools south-east of Windsor.
Callippe silverspot butterfly *Speyeria callippe callippe*	FE	Restricted to the northern coastal scrub of the San Francisco peninsula. Host plant is *Viola pedunculata*. Most adults found on east facing slopes; males congregate on hilltops in search of females. Known from NAP, SFR, SMA, and SOL counties.	Unlikely. Project area is located outside the normal range for this species; colonies are all restricted to the coastal scrub of the San Francisco peninsula.

Genus species **Common Name**	**Status**	**Habitat**	**Potential to Occur**
Behren's silverspot butterfly *Speyeria zerene behrensii*	FE	Early successional coastal terrace prairie habitat extending along the northern coast of California, from the mouth of the Russian River (north bank) in Sonoma County northward to the vicinity of Point Arena in Mendocino County. May also inhibit coastal sand dune systems. Larval host plant is western dog violet (*Viola adunca*). Known from HUM, MEN, and SON counties.	Unlikely. Project area is located outside the normal range for this species; two CNDDB occurrences in Sonoma County of specimens collected near Jenner, at the mouth of the Russian River are unclear, possibly an intermediate zone with Myrtles' silverspot butterfly (see below).
Myrtle's silverspot *Speyeria zerene myrtleae*	FE	Coastal dunes, coastal scrub, and coastal prairie habitat extending along the northern coast of California, from the mouth of the Russian River (south bank) in Sonoma County southward to Point Ano Nuevo in San Mateo county. Larval host plant is western dog violet (*Viola adunca*). Known from MRN, SMA, and SON counties.	Unlikely. Project area is located outside the normal range for this species; Known from 7 CNDDB occurrences in SON County all of which are coastally located, in Bodega Head, Valley Ford, and Duncans Mills.
California freshwater shrimp *Syncaris pacifica*	FE CE	Endemic to low-elevation and low gradient perennial freshwater streams in MRN, SON, and NAP counties.	Low. Marginally suitable habitat within project area due to current high water velocities. There are 12 CNDDB occurrences in Sonoma County. The closest occurrences to the project location are at Mark West Springs, Sonoma, and Glen Ellen.
Reptiles			
western pond turtle *Actinemys* (=*Emys*) *marmorata*	CSC	Variety of aquatic habitats, both permanent and intermittent, with suitable aerial and aquatic basking sites. Needs upland habitats for nesting, overwintering, and aestivating.	High. Suitable habitat within project area. Known from 3 CNDDB occurrences on Dry Creek and has been observed during fisheries monitoring surveys on the mainstem Russian River near the confluence with Dry Creek.
California horned lizard *Phrynosoma coronatum frontale*	FSC, SSC	Areas with exposed gravelly-sandy substrates with scattered shrubs; clearings in riparian woodlands; dry uniform chamise chaparral; and annual grassland with scattered perennial seepweed (*Suadea fruticosa*) or saltbush (*Atriplex polycarpa*).	Low. Marginally suitable habitat present within project area. Known throughout California, but no confirmed occurrences in Sonoma County.
Amphibians			
California tiger salamander Sonoma County DPS *Ambystoma californiense*	FE, FT, CT	Endemic to CA with isolated populations in Santa Barbara and Sonoma counties. Frequents lowland grassland and oak woodlands. Adults spend most of their live underground in animal burrows. Breeding occurs in vernal pools and ephemeral ponds that form during winter rains and dry out in summer.	Unlikely. No suitable habitat outside the range of this species. 79 CNDDB occurrences in Sonoma County, all of which are located near the Santa Rosa Plain approximately 12-30 miles outside of project area.
tailed frog *Ascaphus truei*	SSC	Clear, cold, rocky streams in humid mixed forests. Grassland, chaparral, or shrub growth may be interspersed. Known from Coast Range and Cascade mountains from Humboldt County and north.	Unlikely. Project area is located outside of species range. No suitable within project area and no CNDDB occurrences in Sonoma County.

Genus species **Common Name**	Status	Habitat	Potential to Occur
northern red-legged frog *Rana aurora aurora*	SSC	Permanent or temporary water bordered by dense, grassy or shrubby vegetation. Requires 4-6 months of permanent water for larval development. Known from Coast Mountains from Humboldt County and north .	Unlikely. Project area is located outside of species range. No CNDDB occurrences in Sonoma County.
foothill yellow-legged frog *Rana boylii*	SSC	Foothill streams with pools and riffles with rocky substrate in a variety of habitats. Known throughout CA and OR.	Moderate. Marginally suitable habitat in project area. Seventy-one CNDDB occurrences in Sonoma County and present in multiple locations within 5 miles of project area; the nearest occurrence recorded at Warm Springs Creek in 1974 prior to dam construction.
California red-legged frog (including critical habitat) *Rana draytonii*	FT, SSC	Lowlands and foothills in or near permanent sources of deep water with dense, shrubby or emergent riparian vegetation. Requires 11-20 weeks of permanent water for larval development; must have access to aestivation habitat. Known from Coast Range Mountains from Sonoma County south.	Moderate. No known occurrences within Dry Creek watershed. Potentially suitable habitat present in project area. Known from 38 occurrences in Sonoma County with the nearest in occurrence in Guerneville at Armstrong Redwoods State Reserve.
Birds			
Allen's hummingbird (nesting) *Selasphorus sasin*	FSC, BCC	Pacific coastal fog belt in meadows, moist canyon bottoms, humid woody or brushy ravines, brushy edges of coniferous forest, coastal chaparral and low riparian woodlands. Known to occur throughout CA and Mexico.	Moderate. Potential to occur in project area. Suitable habitat exists within project area and known to occur in SON during breeding season. No CNDDB occurrences in SON County.
bald eagle (nesting & wintering) *Haliaeetus leucocephalus*	FE-delisted, CE, FP BCC	Found on coasts, rivers, and large lakes in open areas. Nests primarily in coniferous trees and on cliffs. Known from ALA, ALP, BUT CAL, COL, CCO, DNO, ELD, FRE, GLE, HUM, IMP, INY, KER, LAK, LAS, LAN, MAD, MEN, MER, MOD, MNO, MNT, NAP, NEV, ORA, PLA, PLU, RIV, SBN, SBR, SLO, SBA, SHA, SIE, SIS, STA, TEH, TRI, TUO, and YUB counties.	Moderate. No suitable breeding habitat in project area, but a pair is known to have maintained an active nest at Lake Sonoma from 2001 to the present. May occasionally forage in the project area and on the Russian River. No CNDDB occurrences in SON County.
bank swallow (nesting) *Riparia riparia*	CT	Open country near running water. Nests in burrows along the banks of streams, creeks, and rivers. Known from ALA, BUT, COL, EDL, FRE, GLE, HUM, INY, LAS, LAN, MOD, MNO, MNT, NAP, ORA, PLA, PLU, SAC, SBN, SDI, SFR, SJO, SLO, SMT, SBA, SCR, SHA, SIE, SIS, SON, SUT, TEH, VEN, YOL, and YUB counties.	Unlikely. Project area is outside of the known breeding range for this species. Only CNDDB in SON county from 1960 at Duncans Mills approximately 30 miles from project area.
Bell's sage sparrow (nesting) *Artemisiospiza belli belli*	WL, BCC	Found in sage-covered brushlands and arid chaparral-covered hillsides. Known from LAK, LAN, RIV, SRB, and SDI conuties.	Unlikely. No suitable habitat within project area. No CNDDB occurrence in SON County.
Ridgway's clapper rail *Rallus obsoletus*	FE, CE	Wetland habitats and tidal marshes with dense vegetation for foraging and nesting. Known from ALA, CCO, HUM, MRN, MNT, NAP, SFR, SLO, SMA, SCL, SOL, and SON counties.	Unlikely. No suitable habitat within project area. Known occurrences in SON County are in the the marshes and tidal baylands adjacent to San Pablo Bay.

Genus species **Common Name**	**Status**	**Habitat**	**Potential to Occur**
Calfornia horned lark *Eremophila alpestris actia*	WL	Grasslands and other open habitats with low, sparse vegetation. Builds grass-lined nest; cup-shaped in depression on open ground. Known from ALA, CCO, FRE, KER, LAN, MER, MNT, ORA, RIV, SBN, SBR, SDI, SJO, SLO, STA, and VEN counties.	Low. Small patches of marginally suitable habitat adjacent to the project area. Known to occur in SON County year-round, however there are no CNDDB occurrences in SON County.
California least tern (nesting colony) *Sternula antillarum browni*	FE, CE	Often palagic, and found in marine habitats. Colonial nesters prefer open beaches with limited vegetation. Known from ALA, CCO, LAN, ORA, SDI, SLO, SMA, SBA, SCL, SOL, and VEN counties.	Unlikely. Project area is located outside of species range. No ocean or coastal habitat within the project area.
Cooper's hawk (nesting) *Accipiter cooperii*	WL	Riparian, oak woodland, or other forest habitats near water. Occurs in variety of habitats during migration. Known from ALA, COL, CCO, FRE, HUM, IMP, INY, KER, LAN, MEN, MNT, ORA, PLA, RIV, SAC, SBN, SBR, SDI, SLO, SBA, SCL, SCR, SIS, TUL, TUO, and VEN counties.	High. Suitable breeding habitat identified in project area. Known to be a year-round resident of SON County, however, there are no CNDDB occurrences.
ferruginous hawk (wintering) *Buteo regalis*	BCC, WL	Open country, usually prairies and plains. Nests in coniferous trees with expansive view. Prefers open, rolling, grassy hills. Known from ALA, CCO, IMP, KER, LAN, MER, MNT, NAP, ORA, RIV, SAC, SDI, SJO, SLO, SBA, SIS, SOL, and VEN counties.	Unlikely. Uncommon winter resident in SON County. No suitable habitat within project area. No CNDDB in SON County.
golden eagle (nesting & wintering) *Aquila chrysaetos*	WL, FP	Open habitats, particularly hills and mountains. Nests on cliffs or in high tree tops. Known from ALA, COL, CCO, ELD, FRE, HUM, IMP, INY, KER, LAK, LAS, LAN, MAD, MER, MOD, MNO, MNT, NAP, ORA, RIV, SAC, SBR, SDI, SJO, SLO, SCL, SIS, SOL, STA, TRI, TUL, and VEN county.	Low. No suitable breeding habitat within project area but nesting recorded in the hills east of Highway 101 near Geyserville and Healdsburg with possible nesting recorded at Lake Sonoma and elsewhere within the Dry Creek watershed. May occasionally forage in the project area. No CNDDB occurrences in SON County.
grasshopper sparrow (nesting) *Ammodramus savannarum*	SSC	Dense, dry or well-drained grassland with scattered shrubs for perching. Known from LAN, MEN, ORA, PLA, SAC, SDI, SLO, SOL and YUB counties.	Low. Marginally suitable habitat in grasslands adjacent to project area. Known to occur in SON County in the summer months, however, there are no CNDDB occurrences in SON County.
Lewis' woodpecker (nesting) *Melanerpes lewis*	FSC, BCC	Breeds in open forest and woodland with an open canopy and brushy understory. Requires dead trees for nest cavities. Known to occur throughout western North America.	Low. Uncommon, sporadic winter resident of SON county. Project area outside known breeding range for this species. Suitable wintering habitat identified in project area. No CNDDB occurrences in SON County.
little willow flycatcher (nesting) *Empidonax traillii brewsteri*	FSC, CE BCC	Swamps, willow thickets, riparian woodland. Nests in the forks of trees or shrubs, approximately 0.5 to 3 meters above ground. Known throughout California, Oregon and Washington.	Unlikely. Project area outside known breeding range for this species. Only CNDDB occurrence in HUM County.

Genus species **Common Name**	Status	Habitat	Potential to Occur
Loggerhead Shrike (nesting) *Lanius ludovicanus*	BCC, SSC	Open habitats with sparse shrubs and trees, other suitable perches, bare ground, and low or sparse herba ceous cover. Known from ALA, BUT, CCO, FRE, IMP, INY, KER, LAN, RIV, SBR, SDI, SJO, SLO, STA, and TUL counties.	Moderate. Marginally suitable breeding and foraging habitat identified adjacent to project area. Known to nest in Sonoma County but all recorded nesting occurrences are located south of Windsor. A year-round resident, however, no CNDDB occurrences in SON County.
long-billed curlew (nesting) *Numenius americanus*	BCC, WL	Upland shortgrass prairies and wet meadows are used for nesting; coastal estuaries, open grasslands, and croplands are used in winter. Known to occur throughout the US, Canada and Mexico.	Unlikely. Project area outside known breeding range for this species. No CNDDB occurrences in SON County.
long-eared owl (nesting) *Asio otus*	SSC	Dense riparian and live-oak thickets near meadow edges, and nearby woodland and forest habitats. Known from FRE, INY, KER, LAS, MOD, MNO, NEV, ORA, RIV, SBN, SBR, SDI, SLO, and SMA counties.	Unlikely. Project area outside of known breeding range for this species, however, some records indicate that breeding pairs identified in Sonoma County previously along Russian River. No CNDDB occurrences in SON County.
marbled murrelet (nesting and critical habitat) *Brachyramphus marmoratus*	FT, CE	Feeds near-shore; nests in old-growth trees along coast of California, from Eureka to Oregon border and from Half Moon Bay to Santa Cruz. Nests in old-growth forests, characterized by large trees, multiple canopy layers, and moderate to high canopy closure. Forests are located close enough to the marine environment for the birds to fly to and from nest sites.	Unlikely. No suitable habitat in project area. No confirmed nesting in Sonoma County. Sitings occur along coast. Present offshore of Arched Rock Beach, approximately 40 miles from project area. No ocean or coastal habitat within the project area. No CNDDB occurrences in SON County.
merlin (wintering) *Falco columbarius*	SSC	Does not breed in California. Winters on coastlines, open grasslands, savannahs, woodlands, lakes, wetlands, and early successional stages. Known from BUT, FRE, IMP, KER, LAN, MER, RIV, SAC, SBN, SJO, SLO, SMA, and YOL counties.	Moderate. Marginally suitable foraging habitat identified in project area. Individual was observed in Demonstration Project area by Water Agency biologist. No CNDDB occurrences in SON county.
northern harrier (nesting) *Circus cyaneus*	SSC	Prairie, savanna, slough, wet meadow, marshes. Nests on elevated ground or in thick vegetation. Known from ALA, BUT, CCO, FRE, INY, MRN, MER, MNO, MNT, NAP, ORA, RIV, SDI, SJO, SMT, SOL, and YUB counties.	Low. No suitable habitat within project area. This species has been observed in SON county near the Laguna de Santa Rosa approximately 35 miles from the project area, as well as tidal marsh areas near Petaluma, approximately 40 miles from project site. No CNDDB occurrences in SON County.
northern spotted owl (including critical habitat) *Strix occidentalis caurina*	FT, SC	Dense coniferous and deciduous forests. Nests primarily in coniferous trees, occasionally on cliffs in heavily wooded canyons. Known to occur in Northern CA, Oregon, Washington, and Canada.	Unlikely. Potentially suitable nesting habitat in woodlands adjacent to project area. Known to be a year round resident of SON County.
olive-sided flycatcher (nesting) *Contopus cooperi*	BCC, SSC	Summer resident. Breeds in forest and woodland especially where burns or slashing has occurred. Also in eucalyptus trees in foothill canyons.	High. Marginally suitable habitat within project area. This is species has been observed in project area during summer bird surveys. Known to be a summer resident in SON County, however, there are no CNDDB occurrences in SON County.

Genus species **Common Name**	Status	Habitat	Potential to Occur
osprey (nesting) *Pandion haliaetus*	WL	Found along rivers, lakes, and coasts. Nests in deciduous or coniferous trees or standing snags (occasionally power poles) near or over water. Known from BUT, COL, DNO, ELD, FRE, GLE, HUM, INY, LAK, LAS, MRN, MEN, MOD, MNO, NEV, ORA, PLA, PLU, SDI, SJO, SCL, SCR, SHA, SIS, SOL, SON, TEH, TRI, and TUO counties.	Moderate. Suitable foraging and marginal breeding habitat identified in project area. Known to nest at Lake Sonoma as well as throughout the Russian River area. Possible breeding occurrences recorded in Dry Creek Valley. Requires large, open bodies of water for preying on fish. Dry Creek is largely covered by tree canopy and presents hazards due to a swift current, reducing the likelihood that Osprey would forage in the project area.
peregrine falcon (nesting) *Falco peregrinus anatum*	FE/CE delisted FP BCC	In open habitats from tundra, savanna, and coasts to high mountains. Known to occur in urban areas on tall buildings. Usually nests in scrapes on cliff ledges. Known from ALA, AMA, BUT, HUM, LAN, MEN, NAP, SBN, SDI, SMA, SBA, SCL, SCR, SHA, SIS, SOL, TEH, and TUO counties.	Moderate. Water Agency staff observed one individual soaring over Dry Creek Valley in 2014. No suitable breeding habitat exists within the project area, but nesting is known to occur among the mountains and cliffs immediately east of Lake Sonoma, apporximately 3 miles upstream of the dam. May occasionally forage in the project area. No occurrences are listed in the CNDDB in SON County.
red-breasted sapsucker (nesting) *Sphyrapicus ruber*	SAL	Coastal ranges in moist coniferous or mixed forests at low elevations. Known from KER county.	Moderate. Fairly common throughout county in winter. Nesting recorded in extreme northwest SON county. Nesting reported as “possible” in portions of Dry Creek Valley. This species has been observed on Dry Creek during bird surveys. No CNDDB occurrences in SON county.
rufous hummingbird (nesting) *Selasphorus rufus*	BCC	Open arid scrub, brushy slopes, desert vegetation and North Coast coniferous forests. Breeds in transition life zones of northwest coastal area from Oregon border to southern SON County.	Unlikely. Uncommon spring migrant, casual summer and winter visitant in SON county. No known breeding occurrences in SON County.
sharp-shinned hawk (nesting) *Accipiter striatus*	WL	Nests in dense, pole and small-tree stands of conifers, which are cool, moist, well-shaded, with little ground cover, near water. Forages in openings at woodland edges, hedgerows, brushy pastures, and shorelines. Known from ALA, CAL, ELD, HUM, MEN, NAP, SBN, SLO, and TUO counties.	Low. Rare summer resident and nester, fairly common fall migrant along the coast, fairly common in winter. Confirmed nesting at Annadel State Park and location near Windsor. Potentially suitable nesting habitat within project area. No CNDDB occurrences in SON County.
short-eared owl (nesting) *Asio flammeus*	SSC	Found in open, treeless areas and grasslands with elevated sites for perches, and dense vegetation for roosting and nesting. Nests on dry ground in a depression concealed with vegetation, and lined with grasses, forbs, sticks, and feathers; occasionally nests in burrows. Known from CCO, FRE, IMP, LAN, MOD, MNT, SMA, and SOL counties.	Unlikely. Uncommon winter resident, only a few recorded occurrences in summer. Only one possible nest recorded for all of SON County, in Annadel State Park in 1979. CNDDB occurrences in SON County.
summer tanager (nesting) *Piranga rubra*	SSC	Found in cottonwoods and willows, especially older, dense stands along rivers and streams, which provide nesting, feeding, and other cover. Known from IMP, INY, KER, RIV, and SBR counties.	Unlikely. Rare in SON County during all seasons. No breeding occurrences recorded for SON County.

Genus species **Common Name**	**Status**	**Habitat**	**Potential to Occur**
tricolored blackbird (nesting colony) *Agelaius tricolor*	SE, BCC	Nest located over or near fresh water, especially in emergent wetland. Usually nests in dense cattails or tules; also nests in thickets of willow, blackberry, wild rose, tall herbs. Known from ALA, BUT, GLE, CAL, COL, CCO, ELD, FRE, HUM, KER, KIN, LAK, LAS, LAN, MAD, MRN, MEN, MER, MOD, MNT, NAP, ORA, PLA, RIV, SAC, SBN, SBR, SDI, SJO, SLO, SBA, SCL, SCR, SHA, SIS, SOL, SON, STA, SUT, TEH, TUL, TUO, YOL and YUB counties.	Low. Nesting generally occus in emergent tules and cattails associated with freshwater marsh habitat; seldom in willow, blackberry, or edge thickets. Little or no habitat within project area. Closest confirmed breeding location is near the Sonoma County Airport. Two CNDDB occurrences in SON County in Cotati, approximately 30 miles south from project area and Sears Point, approximately 50 miles south/southeast of project area.
Vaux's swift (nesting) *Chaetura vauxi*	SSC	Old-growth coniferous forests, especially in coast redwood, and mixed deciduous/coniferous forests. Nests in hollow or broken top trees, stumps, and chimneys.	Low. No suitable nesting habitat identified in project area. Potentially suitable nesting habitat in adjacent forested areas. Confirmed nesting in Healdsburg and Russian River area. Suitable foraging habitat identified in project area. No CNDDB occurrences in SON County.
western snowy plover (nesting) *Charadrius alexandrines nivosus*	FT, SSC, BCC	Alkaline habitats and sandy or coralline beaches along the coast, roost in flocks on the ground, coastal nesters in dune hollows on sandy beaches. Known from ALA, DNO, HUM, IMP, INY, KER, KIN, LAN, MRN, MEN, MOD, MNT, NAP, ORA, RIV, SBR, SDI, SLO, SMT, SBA, SCR, SIS, SON, TUL, VEN and YOL counties.	Unlikely. No suitable nesting or foraging habitat present in project area. No ocean or coastal habitat within the project area.
western Yellow-billed Cuckoo (nesting) *Coccyzus americanus occidentalis*	FT, CE BCC	Open woodlands, especially with dense undergrowth, riparian woodlands, and thickets. Nests in deciduous trees or shrubs approximately one to two meters from the ground. Known from BUT, COL, FRE, GLE, HUM, IMP, INY, KER, LAK, LAN, RIV, SAC SBN, SBR, SDI, SJO, SLO, SIS, SON, SUT, TEH, and VEN counties.	Unlikely. Suitable nesting or foraging habitat within project area, however project area is located outside known breeding range for this species. No recorded breeding occurrences within SON County since 1940s. Single bird seen briefly on Dry Creek in 1988 but subsequent searches yielded no results. Known from 2 CNDDB occurrences in SON County at Glen Ellen, approximately 34 miles from project area and Valley Ford, approximately 40 miles from project area.
white-tailed Kite (nesting) *Elanus leucurus*	FP	Nests in dense-canopied woodlands adjacent to grasslands, agricultural fields, and wetlands. Known from ALA, COL, CCO, ELD, DNO, KER, LAN, MRN, MEN, MNT, NAP, ORA, PLA, RIV, SAC, SBN, SBR, SDI, SJO, SLO, SMA, SBA, SCL, SCR, SOL, SON, TEH, VEN, YOL and YUB counties.	Moderate. Suitable nesting and foraging habitat within project area. No confirmed nesting reported in Dry Creek Valley but nesting considered confirmed and probable in several locations throughout SON County.
yellow warbler (nesting) *Dendroica petechia brewsteri*	SSC, BCC	Riparian; open to medium-density woodlands and forests with a heavy brush understory. Known from ALA, BUT, FRE, IMP, INY, KER, LAN, MRN, MEN, MNO, MNT, NEV, PLA, RIV, SBR, SDI, SJO, SBA, SIE, TEH, and VEN counties.	High. Suitable breeding and foraging habitat within project area. Nesting confirmed along Dry Creek. Known to breed in Sonoma County but no CNDDB occurrences in Sonoma County.
yellow-breasted chat (nesting) *Icteria virens*	SSC	Dense brushy thickets and tangles near water and thick understory in riparian woodland. Known from IMP, INY, KER, LAN, MEN, MER, ORA, RIV, SBN, SBR, SDI, SJO, SOL, STA, TEH, and VEN counties.	Moderate. Potential to occur on site. Suitable breeding and foraging habitat within project area. Known to breed in Sonoma County but no CNDDB occurrences in SON County.

Genus species Common Name	Status	Habitat	Potential to Occur
Mammals			
American badger *Taxidea taxus*	SSC	Herbaceous, shrub, and open stages of most habitats with dry, friable soils. Known from ALA, BUT, COL, CCO, ELD, FRE, GLE, HUM, IMP, INY, KER, KIN, LAK, LAS, LAN, MAD, MRN, MRP, MEN, MER, MOD, MNO, MNT, NAP, ORA, PLU, RIV, SAC, SBN, SBR, SDI, SFR, SJO, SLO, SMA, SBA, SCL, SCR, SHA, SIE, SIS, SOL, SON, STA, TEH, TRI, TUL, TUO, VEN and YOL counties.	Low. No suitable habitat within project area, however potential habitat occurs in undeveloped portions of the surrounding valley and hills. Seventeen CNDDB occurrences in SON County, most of which are located near the coast. Nearest occurrence is west of Santa Rosa at the Wright Preserve, approximately 12 miles from project area.
fringed myotis bat *Myotis thysanodes*	FSC	Pinyon-juniper, valley foothill hardwood, and hardwood-conifer habitats at 4,000-7,000 feet are optimal, but occurs in a wide variety of habitats. Breeds in caves and old buildings. Known from BUT, DNO, ELD, FRE, HUM, KER, LAK, LAS, LAN, MRP, MNO, NAP, PLU, RIV, SBN, SBR, SDI, SLO, SMA, SHA, SIE, SON, TRI, TUL, TUO and VEN counties.	Low. No suitable roosting habitat within project area. Potential foraging habitat identified in project area. Two extant CNDDB occurrences in SON County, Santa Rosa at Pepperwood Ranch Preserve, 22 miles from project area and Pinnacle Rock, Bodega Bay, approximately 40 miles from project area.
greater western mastiff-bat *Eumops perotis californicus*	FSC, SSC	Extensive open areas with abundant roost locations provided by crevices in rock outcrops and buildings. Known from ALA, BUT, CAL, FRE, IMP, INY, KER, LAN, MAD, MRP, MER, MNO, MNT, ORA, RIV, SBN, SBR, SDI, SJO, SLO, SBA, SIS, STA, THE, TUL, TUO, and VEN counties.	Low. No suitable roosting habitat within project area. Potential foraging habitat identified in project area. No CNDDB occurrences in SON County.
long-eared myotis bat *Myotis evotis*	FSC	Coniferous forests and woodlands preferred, but found in nearly all brush, woodland and forested habitats. Does not roost colonnially. Roosts in buildings, crevices, spaces under bark, and snags. Caves used primarily as night roosts. Known from BUT, FRE, HUM, INY, LAK, LAS, LAN, MAD, MAR, MEN, MON, NAP, PLU, SBN, SBR, SDI, SCL, SHA, SIE, SIS, SON, TEH, TRI, TUL, and TUO counties.	Low. Marginal roosting habitat within project area. Suitable foraging habitat identified in project area. Only CNDDB occurrence in SON County at Pinnacle Rock, Bodega Bay, approximately 40 miles from project area.
long-legged myotis bat *Myotis volans*	FSC	Forages in chaparral, coastal scrub, early successional woodlands and forests. Roosts in trees, buildings, rock crevices, under tree bark, in snags, and crevices in cliffs. Caves and mines used as night roosts. Known from ALP, DNO, ELD, FRE, HUM, INY, KER, LAS, LAN, MAD, MRP, MNO, PLA, PLU, SBR, SDI, SLO, SHA, SIS, TRI, TUL, TUO and VEN counties.	Low. Marginal roosting habitat within project area. Suitable foraging habitat identified in project area. No CNDDB occurrences in SON County.

Genus species **Common Name**	Status	Habitat	Potential to Occur
pallid bat *Antrozous pallidus*	SSC	Forages in variety of habitats. Roosts in caves, crevices, mines, and occasionally hollow trees and buildings. Prefers mesic sites. Known from ALA, AMA, BUT, CAL, CCO, ELD, FRE, HUM, IMP, INY, KER, LAK, LAS, LAN, MAD, MRN, MRP, MEN, MER, MOD, MNO, MNT, NAP, ORA, PLU, RIV, SAC, SBN, SBR, SDI, SJO, SLO, SMA, SBA, SCL, SCR, SHA, SIS, SOL, SON, STA, SUT, TEH, TRI, TUL, TUO, VEN and YOL counties.	Moderate. Marginal roosting habitat within project area. Suitable foraging habitat in project area. Nineteen CNDDB occurrences in SON County. Closest recorded occurrences are located at residential and vineyard buildings in the Lambert Bridge area but three of these four are presumed extirpated.
Point Arena mountain beaver *Aplodontia rufa nigra*	FE SSC	Coastal areas of Point Arena with springs or seepages on north-facing slopes of ridges and gullies with friable soils and thickets of undergrowth. Known from MEN County.	Unlikely. Project area is outside known range for this species. No CNDDB occurrences in SON County.
salt marsh harvest mouse *Reithrodontomys raviventris*	FE, CE	Known only to occur in the saline emergent wetlands of San Francisco Bay and its tributaries. Found almost exclusively in pickleweed habitat, they build loosely organized nests and require higher areas for flood escape. Known ALA, CCO, MRN, NAP, SMA, SCL, SOL, and SON counties.	Unlikely. No suitable habitat within project area (pickleweed or emergent wetland). Project area is outside species' range.
Sonoma tree vole *Arborimus pomo*	SSC	North coast coniferous forests from the Klamath Mountians to Sonoma County. Nest, reproduces and forages high up in coniferous trees. Known from DNO, HUM, MEN, SON and TRI counties.	Unlikely. No suitable habitat within project area. Nearest occurrence is approximately 11 miles west in Austin Creek watershed.
Townsend's big-eared bat *Corynorhinus townsendii*	FSC, SSC	Forages in variety of habitats: cliff, desert, and coniferous, riparian hardwood, and mixed forests, grasslands, savannah, and chaparral. Roosts in caves, mine shafts, and buildings. Known from ALA, AMA, BUT, CAL, COL, CCO, DNO, ELD, FRE, HUM, IMP, INY, KER, LAK, LAN, MRN, MRP, MEN, MOD, MNO, MNT, NAP, PLA, PLU, RIV, SBN, SBR, SDI, SFR, SJO, SLO, SMA, SBA, SCL, SCR, SHA, SIE, SIS, SOL, SON, STA, TEH, TRI, TUL, TUO, VEN and YOL counties.	Low. Potential to occur in project area. Suitable foraging habitat identified in project area. Known from 11 CNDDB occurrences in SON County with the closest occurrence recorded at Healdsburg in 1954. The most recent occurrence was from 1999 at Bodega Head, approximately 50 miles from project area.
Yuma myotis bat *Myotis yumanensis*	FSC	Commonly occurs along wooded canyon botteoms with sources of water to forage over. Roosts in caves and old buildings. Known from ALA, BUT, CAL, COL, DNO, ELD, FRE, HUM, IMP, INY, KER, LAS, LAN, MAD, MRP, MER, MNO, NAP, ORA, PLU, RIV, SBN, SBR, SDI, SLO, SBA, SCL, SHA, SIE, SON, STA, TEH, TRI, TUL, TUO, and YUB counties.	Low. Marginal roosting habitat in project area. Potential foraging habitat identified in project area. One extant occurrence in SON County located at House Creek off Skaggs Springs Road approximately 15 miles west of the project area.

CODES:

FC: Federal Candidate for listing	CD: State of California Delisted	SAL: CDFW Special Animals List
FD: Federal Delisted	CE: Listed as endangered under the California ESA.	SC: Candidate for listing under the California ESA
FE: Federally listed as Endangered	CP: State of California Proposed for listing	WL: California Department of Fish and Wildlife Watch List
FT: Federally listed as Threatened	CT: Listed as threatened under the California ESA.	BCC: U.S. Fish and Wildlife Service Birds of Conservation Concern
FPE: Proposed for listing under the federal ESA.	CSC: California Species of Special Concern	SSC: A California Department of Fish and Wildlife Species of Special Concern.
FP: Fully protected under California Fish and Wildlife Code		SCT: State Candidate for Listing

(Birds §3511; Mammals §4700; Reptiles and Amphibians §5050; Fish §5515).

FSC: Species previously identified as a Species of Concern. *Please note that The U.S. Fish and Wildlife Service Sacramento Office no longer maintains a “Species of Concern” list. Species of Concern is not defined in the federal Endangered Species Act, but the term commonly refers to species that are declining or appear to be in need of conservation.

POTENTIAL TO OCCUR:

Unlikely: Habitat not present in the Dry Creek Project Area and/or species is not known to occur in the Dry Creek Project Area based on CNDDB occurrences, recent field surveys or species distribution information.

Low: Habitat not present in the Dry Creek Project Area and/or few occurrence in the region.

Moderate: Marginal habitat present in the Dry Creek Project Area and/or some occurrences in the region.

High: Good habitat present in the Dry Creek Project Area and nearby occurrences or species is known to occur in the Dry Creek Project Area based on CNDDB occurrences or recent field surveys

SOURCES:

List of species based on review of California Department of Fish and Wildlife, California Natural Diversity Database (CNDDB) for the Cloverdale, Geyserville, Healdsburg and Guerneville U.S. Geological Survey 7.5 minute quadrangles and species lists provided by the U.S. Fish and Wildlife Service.

https://map.dfg.ca.gov/rarefind/view/RareFind.aspx Accessed December 2, 2014
http://www.fws.gov/sacramento/es_species/Lists/es_species_lists-form.cfm Accessed December 18, 2014
http://ecos.fws.gov/ecos/home.action Accessed March 5, 2015
http://www.dfg.ca.gov/biogeodata/cnddb/pdfs/spanimals.pdf Accessed March 5, 2015
http://www.allaboutbirds.org/guide//id The Cornell Lab of Ornithology, Accessed March 31, 2015
http://www.calflora.org/ The Calflora
Burridge, Betty. 1995. *Sonoma County Breeding Bird Atlas.* Santa Rosa: Madrone Audubon Society, Inc.
Bolander, Gordon L. and Benjamin D. Parmeter. Revised and Updated 2000. *Birds of Sonoma County, California: An Annotated Checklist and Birding Gazetteer*. Napa. Redwood Region Ornithological Society.

Abbreviations:

ALA Alameda	LAK Lake	NEV Nevada	SCT Santa Catalina Island	SHA Shasta
AMA Amador	LAS Lassen	ORA Orange	SCZ Santa Cruz Island	SIE Sierra
BUT Butte	LAX Los Angeles	PLA Placer	SDG San Diego	SIS Siskiyou
CAL Calaveras	LCP Local Coastal Plan	PLU Plumas	SFO San Francisco	SOL Solano
CCA Contra Costa	MAD Madera	RIV Riverside	SHA Shasta SIE Sierra	SON Sonoma County
COL Colusa	MOD Modoc	SAC Sacramento	SIS Siskiyou	STA Stanislaus
DNT Del Norte	MEN Mendocino	SBA Santa Barbara	SJQ San Joaquin	SJQ San Joaquin
ELD El Dorado	MER Merced	SBD San Bernardino	SMI San Miguel Island	SMI San Miguel Island
FRE Fresno	MNT Monterey	SBT San Benito	SMT San Mateo	SMT San Mateo
GLE Glenn	MPA Mariposa	SCF Sonoma County Flora	SNI San Nicolas Island	SNI San Nicolas Island
HUM Humboldt	MRN Marin	SCL Santa Clara	SDG San Diego	
KRN Kern	NAP Napa	SCR Santa Cruz	SFO San Francisco	

Appendix I:

SHPO Concurrence Letter

STATE OF CALIFORNIA – THE NATURAL RESOURCES AGENCY

EDMUND G. BROWN, JR., *Governor*

OFFICE OF HISTORIC PRESERVATION
DEPARTMENT OF PARKS AND RECREATION
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SACRAMENTO, CA 95816-7100
(916) 445-7000 Fax: (916) 445-7053
calshpo@parks.ca.gov
www.ohp.parks.ca.gov

February 11, 2016

In reply refer to: NOAA_2015_1228_001

Alecia Van Atta, Assistant Regional Administrator
U.S. Department of Commerce
National Oceanic and Atmospheric Administration
National Marine Fisheries Service
777 Sonoma Avenue, Room 325
Santa Rosa, Ca 95404

Re: Section 106 consultation for NOAA's NMFS Enhancement of Survival Permit #20032 for fisheries habitat restoration along Dry Creek, Sonoma County, California

Dear Ms. Van Atta:

Thank you for your letter of December 24, 2015 initiating consultation for the above referenced undertaking to comply with Section 106 of the National Historic Preservation Act of 1966. The National Oceanic and Atmospheric Administration (NOAA) is requesting, pursuant to 36 CFR § 800.4(d)(1) that I concur with the determination that no historic properties will be affected as a result of the proposed undertaking.

NOOA's National Marine Fisheries Service (NMFS) is consulting under Section 106 for the proposed issuance of an Endangered Species Act (ESA) Enhancement of Survival Permit (undertaking) to Sonoma County Water Agency for fisheries habitat restoration on Dry Creek, Sonoma County. The undertaking would facilitate stream habitat restoration work on six miles of the Dry Creek channel between Warm Springs Dam and the Russian River. Proposed work would enhance or stabilize pools and riffles, side-channels, and stream banks by re-vegetating, grading, installing logs and large boulders, and installing fabric and straw to control erosion. The Area of Potential Effects (APE) includes nine portions of the Dry Creek channel comprising approximately six miles where work is proposed as well as access and staging areas.

Efforts to identify historic properties located within the APE included a review of the sacred lands file with the Native American Heritage Commission, consultation with Indian Tribes, records search, literature review, and pedestrian archaeological field survey.

General support for the project and no concerns for affects to resources were expressed during Tribal consultation. The larger boundaries of the Dry Creek-Warm Springs Archaeological District were found to overlap with the APE, though no archaeological sites that contribute to that district are located within it. In addition, one resource (P-49-000600) had been previously recorded within the APE; field inspection and archaeological testing revealed no evidence of the site and archival research suggests that the site could be located in at least two other locations outside of the APE. No other resources are present in the APE.

In addition to your letter, you have provided the following documentation in support of your findings:

- *An Archaeological Survey for the Dry Creek Habitat Enhancement Demonstration Project Sonoma County, California* (Bondio and Origer, 2010).

- *A Cultural Resources Study for the Dry Creek Habitat Enhancement Project, Miles 2-6 Sonoma County* (Barrow and Caskey, 2015).

My staff has reviewed your letter and supporting evidence and I have the following comments:

- I have no objection to your determination of the APE and agree that your efforts to identify historic properties within it constitute a reasonable and good faith effort pursuant to 36 CFR 800.4.

- I do not concur with your determination pursuant to 36 CFR 800.4(d)(1) that no historic properties will be affected as a result of this undertaking. Rather, as the Dry Creek-Warm Springs Archaeological District is present within the APE but will not be adversely affected, pursuant to 36 CFR 800.5(b), this undertaking will cause no adverse effect to historic properties.

- I recommend a qualified professional archaeologist be present to monitor all construction activities within the mapped site boundaries at archaeological site P-49-000600.

Thank you for considering historic properties in your project planning, Please be advised that NOAA might have additional responsibilities under 36 CFR § 800 in the event of project change or inadvertent discovery.

Sincerely,

Julianne Polanco
State Historic Preservation Officer

Appendix J:

Adaptive Management Plan

Dry Creek Adaptive Management Plan (AMP)

Final

Prepared for

Sonoma County Water Agency

Prepared by

Marc Porter, David Marmorek, Darcy Pickard and Katherine Wieckowski
ESSA Technologies Ltd.
Suite 300, 1765 West 8th Avenue
Vancouver, BC V6J 5C6

May 9, 2014

Citation: Porter, M., D. Marmorek, D. Pickard, and K. Wieckowski. 2014. Dry Creek Adaptive Management Plan (AMP). Prepared by ESSA Technologies Ltd., Vancouver, BC for Sonoma County Water Agency, Santa Rosa CA. 32 pp. + appendices.

Executive Summary

The Russian River Biological Opinion (RRBIOP, NMFS 2008) identifies the operation of Warm Springs Dam as adversely modifying critical habitat in Dry Creek and jeopardizing coho salmon (endangered) and steelhead (threatened). To alleviate these impacts, the RRBIOP compels the Sonoma County Water Agency (Water Agency) and the United States Army Corps of Engineers (USACE) to implement projects along up to six miles of mainstem Dry Creek. Projects will be designed and implemented with the objective of addressing the lack of low water velocity areas with adequate cover and appropriate water depth that limit habitat suitability for juvenile salmonids in general and juvenile coho salmon in particular. Multiple habitat enhancement projects over the 14 mile length will occur in phases during the 15 year time-period covered by the RRBIOP.

A question raised by the RRBIOP is whether Dry Creek habitat enhancements will have the desired benefits. This question is important both for receiving credit toward the total amount of habitat enhancements set forth in the RRBIOP (six miles) and for assessing the relative effectiveness of various habitat enhancements options. For the latter reason, the RRBIOP states that "an adaptive management, monitoring and evaluation plan" will be developed that identifies "project goals, objectives and success criteria". ESSA Technologies Ltd. (an independent consulting firm from Vancouver Canada) facilitated the collaborative development of an adaptive management plan (AMP) for Dry Creek in an iterative process of meetings, discussions and document revision. This document captures the outcomes of that process.

The goal of the Dry Creek AMP is to serve as a guide for monitoring juvenile coho and steelhead populations and the habitats they live in over multiple years to detect change resulting from habitat enhancement. A series of multi-agency workshops were convened to address the following objectives:

1. Identify performance measures;
2. Develop success criteria for each performance measure;
3. Select approaches for evaluating performance measures relative to success criteria;
4. Agree on a set of decision rules for determining credit toward the total amount of habitat enhancement.

Evaluation of performance measures will be based on the results of implementation monitoring to determine if the habitat enhancement was done according to the approved design, effectiveness (habitat) monitoring to determine if the enhancement is having the intended effect on physical habitat quality and validation (fish) monitoring to assess whether the habitat enhancement is achieving the intended biological objective. For each type of monitoring, quantitative data for performance measures will be gathered using specific data collection protocols. These quantitative data will then be used to qualitatively rate whether the habitat enhancement was implemented correctly, whether it is having the desired effect on physical habitat conditions and whether juvenile coho and steelhead are benefiting from the work. Ratings at smaller spatial scales will be combined within or "rolled-up" to larger spatial scales as new habitat enhancement projects are implemented. Results from habitat monitoring will play a central role in determining project success, but results from fish monitoring will influence interpretation of project success, and potentially modify future project design. Information

gained in earlier phases of the project regarding habitat enhancement measures that provide the most benefit will be fed in to the design adaptively to inform the design of future project phases.

In order to arrive at an overall qualitative rating for all habitat enhancements in Dry Creek, qualitative ratings from specific types of monitoring and scales will lead to decisions ranging from no action required (good and excellent ratings) to some remedial action (fair and poor ratings). Finally, qualitative ratings from all types of monitoring will be combined to arrive at an overall decision on how much credit to assign to the entire set of habitat enhancement projects in Dry Creek (Figure 1).

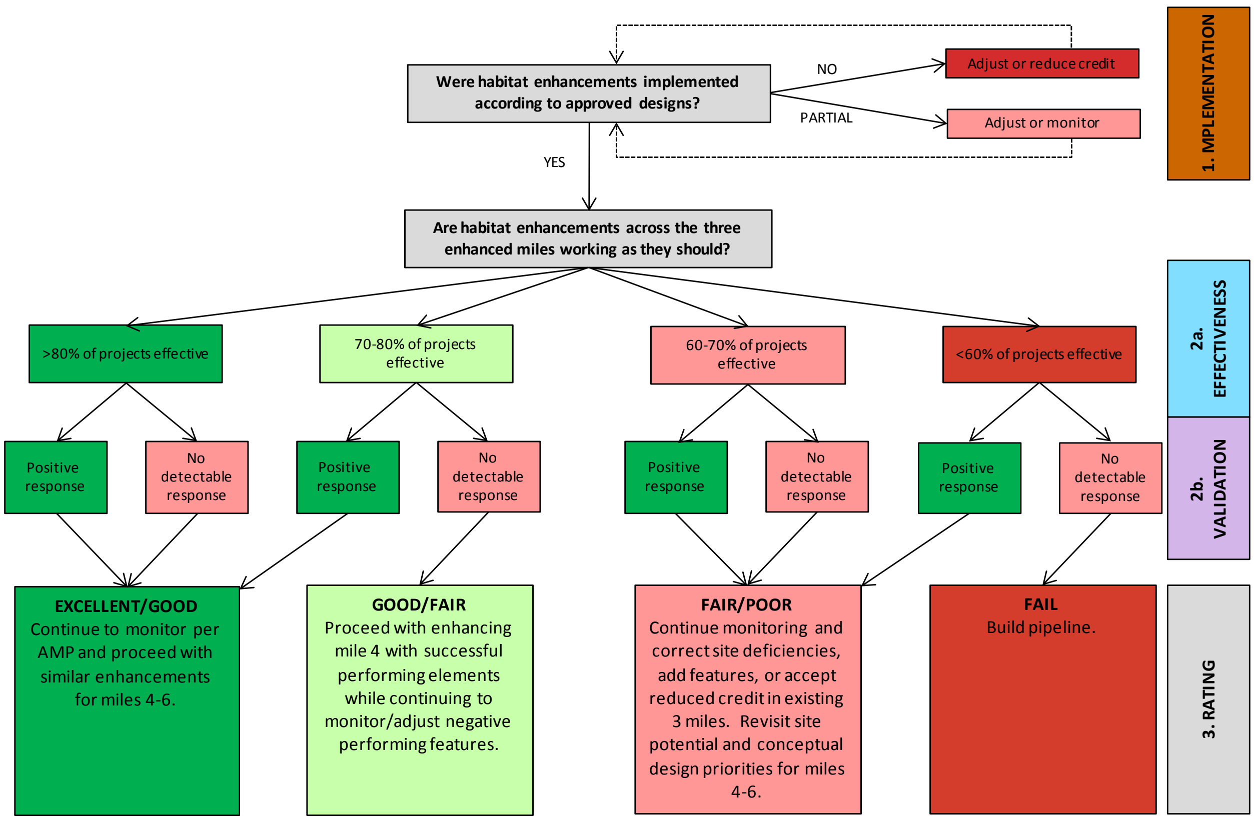

Figure 1. Process for determining course of action in 2018 after the first three miles of Dry Creek have been enhanced.

Acknowledgements

We are very grateful to the participants who have attended multiple workshops (Appendix 5) in support of the development of the Dry Creek AMP. This includes representatives from the Sonoma County Water Agency, the National Marine Fisheries Service, California Department of Fish and Wildlife, United States Army Corps of Engineers, Inter-Fluve, and ESSA Technologies Ltd. Their ideas form the core content of this document.

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Glossary of Terms

Effectiveness monitoring: Monitoring to determine if the enhancement/restoration is having the intended effect on physical habitat quality.

Estimate: A value (i.e., a point estimate) or range of values (i.e., an interval estimate) applied to a parameter of a population on the basis of sampling statistics.

Features: Individually engineered elements (e.g., large woody debris accumulation, riffle, pool, side channel, alcove, boulder cluster, etc.) that will individually or in composite make up a habitat enhancement site (see definition for Site below). Features can in some cases represent complete habitat units (see definition for Habitat Unit below), while in other cases they represent only structural components within a habitat unit (e.g., large wood placement).

Goals[1]: Desired outcomes from Dry Creek enhancement actions as articulated in applicable documents and agency missions / mandates. Goals are distinguished from objectives as follows:

- Goals are broad; objectives are narrow.
- Goals are general intentions; objectives are precise.
- Goals are intangible; objectives are tangible (i.e., measurable).
- Goals are abstract; objectives are concrete.

There are usually tradeoffs among the goals suggested by different stakeholders. *Examples:* ‘supply water to Santa Rosa’, ‘significantly improve juvenile coho production out of Dry Creek’.

Habitat Unit: A designation within a habitat classification system that allows stratification (based on natural patterns of variation) when attempting to quantify biological or physical attributes of a stream. For the purpose of habitat condition assessments (Inter-Fluve 2010) habitat units within Dry Creek have been identified as pools, scour pools, riffles, flatwaters, cascades, alcoves, or side channels. Individual habitat unit definitions are as follows:

> **Main Channel Pool**: Pools are areas with very low velocities and multiple flow vectors, spanning at least 60% of the channel width, with minimum residual depths of 2.0 feet. Water surfaces are flat.
>
> **Scour Pool**: Pools that consist of less than 60% of the channel width and are often associated with large wood, sharp meander bends, or boulders and have residual pool depths of at least 2.0 feet.
>
> **Riffle**: Riffles have obvious surface turbulence and are typically shallow water with low to moderate slopes (<4%). Water velocities are greater than 1 ft/s.
>
> **Flatwater**: Flatwaters have little surface turbulence and lack significant residual depth (less than 2 feet), with water velocities greater than pools. Flatwaters are deeper and velocity is less than in riffles; water surfaces are gently sloping.
>
> **Cascade**: Cascades are steep gradient (>4%) riffles with short falls, plunges or chutes typically dominated by boulders or bedrock.

[1] goal = fundamental objective = what you want; objective and sub-objectives = means objectives = how to get what you want

Alcove/Backwater Pool: Alcove/backwater pools are pools located off the main channel in alcove or backwater areas. These units do not have a downstream flow component at the time of the survey.

Side Channel Pool/Riffle/Flatwater: Side channels split from the main channel and reconnect downstream. Side channels can be categorized as side channel pools, riffles, or flatwaters based on the dominant habitat type in the side channel.

Implementation monitoring: Monitoring to determine if the habitat enhancement/restoration was done according to the approved design.

Large woody debris: A large piece of relatively stable woody material having a diameter greater than 30 cm (12 inches) and a length greater than 2 m (6 feet) that intrudes into the stream channel.

Objectives: The proposed means of achieving goals. Objectives are a disaggregation of goals into a logical hierarchy of desired attributes of the system. Higher level objectives in the objectives hierarchy may reflect a combination of conditions that are not directly measurable with a single metric, but sub-objectives lower in the hierarchy should correspond to performance measures that are directly measurable. (*Example*: 'create and maintain 6 miles of coho habitat').

Performance measure: A method of assessing the attainment of an objective in either quantitative or descriptive terms. More technically, the variable measured during monitoring (or calculated during analysis) and reported as an estimate of the performance of one or more management actions against one or more objectives. Performance measures can also be proxy measures or indicators for something that cannot be measured directly.

Reach: a) Any specified length of stream; b) A relatively homogeneous section of a stream having a repetitious sequence of physical characteristics and habitat types; or c) a regime of hydraulic units whose overall profile is different from another reach. It is often the principal sampling unit for collecting physical, chemical, and biological data.

Enhancement reach: A specified collection of enhancement sites (see definition for site below) that are implemented in close proximity to one another.

Project reach: A specified collection of enhancement reaches (see definition for Enhancement Reach above)

Site: One or more engineered habitat features (see definition for Features above) that have been designed to work in combination to enhance a stream reach.

Suitable habitat: Environments used by a particular species or particular life stages which provide all requirements for survival (e.g., food, shelter) at a level deemed acceptable based on project goals.

Temporal scale: The length of time over which a certain kind of response from management actions can be expected to take, and the logical duration of monitoring to detect that response.

Trend monitoring: Monitoring to detect trends in a particular performance measure (or set of performance measures) over time.

Validation monitoring: Monitoring to assess whether the habitat enhancement/restoration work is achieving the intended objective (i.e., creating habitat that is inhabited by listed salmonids and appreciably improves the production and survival of rearing steelhead and coho salmon in Dry Creek).

1.0 Introduction

1.1 Background

In September 2008, the National Marine Fisheries Service (NMFS) through Section 7 consultation under the federal Endangered Species Act (ESA) issued a Russian River Biological Opinion (RRBIOP) on the water supply, flood control, and channel maintenance operations in the Russian River watershed (NMFS 2008). The California Department of Fish and Wildlife (CDFW) issued a consistency determination on November 9, 2009, finding that the RRBIOP was consistent with the California Endangered Species Act (CESA). The RRBIOP identifies the operation of Warm Springs Dam (WSD) as adversely modifying critical habitat in Dry Creek and jeopardizing coho (endangered) and steelhead (threatened). The RRBIOP includes a Reasonable and Prudent Alternative (RPA) with a 15 year timeline for implementation that minimizes these adverse impacts. More specifically, the RPA compels the Sonoma County Water Agency (Water Agency) and the United States Army Corps of Engineers (USACE) to conduct projects along six miles of Dry Creek to enhance habitat and reduce stream velocities during critical fish-rearing months. Guidance for the types of habitat enhancement projects and target habitat conditions are outlined in the RPA. Many of the site specific details (e.g., location, form, connectivity) are identified in Inter-Fluve's Conceptual Design Report (Inter-Fluve 2012) and depend on the opportunities available in the system, which in turn are affected by both geomorphic characteristics and the cooperation of landowners. The RPA also states that the Water Agency will develop and implement an adaptive management plan to assess the effectiveness of the habitat enhancement projects:

> "Prior to construction of Phase III, IV and V enhancement projects, SCWA [the Water Agency] will develop and submit to NMFS and CDFG [CDFW] for review and approval, a post-construction adaptive management, monitoring and evaluation plan that will identify project goals, objectives and success criteria." (pg. 265; NMFS 2008)

To meet this, the Water Agency asked ESSA Technologies Ltd. (an independent consulting firm from Vancouver Canada) to facilitate the collaborative development of an adaptive management plan (AMP) for Dry Creek, involving all parties to that portion of the RPA, together with other experts, in an iterative process of meetings, discussions and document revision. The current AMP incorporates our best understanding of agreements reached during multi-agency workshops and meetings convened between 2010 and 2012 to define approaches for monitoring Dry Creek habitat enhancements so as to inform RRBIOP crediting toward the total amount of habitat enhancement area outlined in the RRBIOP. The key entities involved in implementing the RPA for Dry Creek (NMFS, CDFW, Water Agency, USACE, and Inter-Fluve) were encouraged to participate in the AMP process so that the final document accurately captures the knowledge, goals and objectives of all parties. Throughout this document we will refer to the entities that participated in this process as the "Dry Creek AMP Working Group". The initial one mile targeted for habitat enhancement of Dry Creek has been selected. This "Demonstration Mile" represents a pilot project that will serve as a guide for habitat enhancement work in later phases. It is a pilot both in regards to the design of the habitat projects themselves as well as to the associated implementation, effectiveness and validation monitoring approaches that will be used to gauge overall project success. It is expected that aspects of the AMP will be adjusted based on results from pilot implementation and analyses in the Demonstration Mile. The initial monitoring and evaluation methods described herein will be evaluated relative to their cost, feasibility and overall utility and may be revised as necessary. The general schedule for developing the Dry Creek AMP is summarized in Appendix 1.

1.2 Adaptive management – the concept

Adaptive management (AM) is a formal process for continually improving management policies and practices by learning from their outcomes (Taylor et al. 1997). The fundamental principles of AM include:

- learning to reduce critical management uncertainties;
- using what is learned to change management policy and practice (i.e., “closing the loop”; ensuring what is learned informs decisions); and
- following a formal, structured, and systematic process (i.e., not ad-hoc, trail-and-error, or simply reactionary adaptation).

AM involves synthesizing existing knowledge, exploring alternative actions, making explicit predictions of their outcomes, selecting one or more actions to implement, monitoring to see if the actual outcomes match those predicted, and then using these results to learn and adjust future management plans and policy (Walters 1986, Taylor et. al 1997, Murray and Marmorek 2003, Williams et al. 2007). This sequence can be summarized by the following 6-step process (Figure 2).

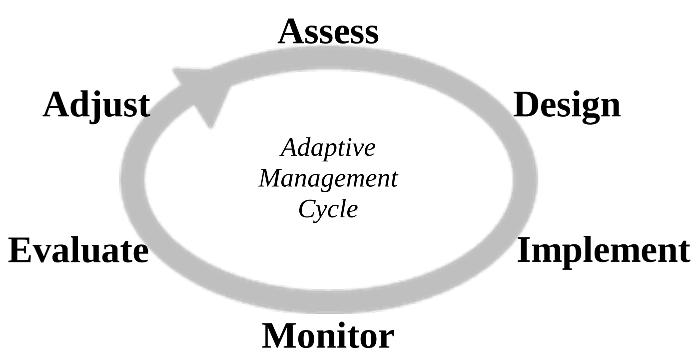

Figure 2 The adaptive management cycle (Murray and Marmorek 2003; Williams et al. 2007).

The AM process for the Dry Creek Project is intended to be iterative. After management treatments are completed and assessed, the knowledge gained will be applied to improve the next round of management, recognizing that pressures from external ecosystem drivers should be expected to change over time and these changes may influence the effectiveness of management strategies.

1.3 Purpose of the Dry Creek AMP

The goal of this Dry Creek AMP is to serve as a guide for monitoring juvenile coho and steelhead populations and the habitats they live in over multiple years (pre- and post-enhancement) to detect change resulting from the treatment conditions and distinguish between background noise or non-treatment variables (NMFS 2008). Describing rigorous methods to be employed for implementation, effectiveness and validation monitoring are the objectives of the AMP, as outlined below:

1) Defining the spatial extent and temporal horizon of the project and the alternative management actions under consideration;
2) Describing the context for Dry Creek monitoring so as to highlight the linkages between management actions and habitat attributes and fish response;
3) Describing the performance measures / indicators associated with each objective as outlined by the RRBIOP; and
4) Identifying decision rules for assessing the success of current and/or future management actions.

The key performance measures (PMs) that will be used to evaluate the implementation and effectiveness of Dry Creek enhancement projects are outlined in the RPA. Monitoring of project effectiveness will rely principally on an adaptation of procedures outlined in Harris (2004), with use of associated pre- and post-treatment checklists developed by CDFW. Standard CDFW checklists described by Harris (2004) for evaluating performance of constructed features (i.e., instream habitat, off-channel habitat and bank stabilization), have been expanded and modified by NMFS, ESSA, and the Water Agency in order to incorporate the additional quantitative metrics in the Dry Creek RPA while allowing rollup of project performance evaluations to larger spatial scales of interest (i.e., site and reach).

2.0 Project Description

2.1 RPA for coho, steelhead and Chinook in Dry Creek

Within the Russian River BiOp, the RPA can be broadly described as (NMFS 2008, pg. xvii):

1) Avoid the likelihood of jeopardizing the continued existence of endangered Central California (CCC) coho, threatened CCC steelhead and threatened California Coast (CC) Chinook;
2) Avoid the destruction or adverse modification of these species' critical habitats;
3) Implement actions that are consistent with the legal authority and jurisdictions of the Water Agency and USACE; and
4) Implement actions that are economically and technologically feasible.

2.2 Spatial extent and temporal horizon of the project

The spatial extent of management actions covered by the AMP includes the 14 mile length of Dry Creek, from WSD to the confluence with the Russian River (see Figure 1 in Inter-Fluve 2012). While the tributaries are of interest and the RPA specifies certain actions be taken by the Water Agency in tributaries (NMFS 2008, pg. xvii), they are explicitly not part of the study area and are therefore beyond the scope of the Dry Creek AMP.

The temporal horizon for undertaking and evaluating current actions is described in the RPA (Table 33, pg. 264, NMFS 2008, reproduced in Table 1 below). The timeline indicates when various habitats should be enhanced, and identifies key decision points that would occur within 15 years of project initiation (i.e., 2009 – 2023). These mandated decision points are incorporated into the AMP; however, a longer time horizon may ultimately be required to determine whether statistically and biologically significant changes occur in freshwater production. There is likely to be an inherent time lag between creation of enhanced freshwater habitat and the ramping up of coho populations, and detection of a response is made more difficult by the high variability in estuarine and marine survival rates (Bradford et al. 2005).

Table 1 Timeline of Dry Creek habitat project design, construction, implementation, monitoring, and evaluation over the next 15 years. Source: Table 33 in NMFS (2008), pg. 264.

Years	2009-10	2011-12	2013-15	2016-18	2019-20	2021-23+
Phase	I	II	III	IV	V	VI
Engineering Design	Conceptual Design	Permitting & final design: mile 1	Permitting and final design: miles 2 & 3	Permitting and final design: miles 4-6		
Engineering Construction			Construct mile 1	Construct miles 2 & 3	Construct miles 4, 5 and 6	
Design evaluation & AM			Evaluate mile 1 & boulder clusters	Evaluate miles 2, 3 & boulder clusters	Evaluate miles 4, 5 and 6	
Monitoring	Pre-monitoring		Pre and post-monitoring			

2.3 Key Decision Points

Several decision points over the next ten years will be important for directing the development of habitat enhancement projects in Dry Creek (Figure 3). An inventory of current conditions in Dry Creek and associated feasibility assessment (Inter-Fluve 2010a) has informed the conceptual design for the demonstration project in Mile 1 (Phases I & II in Table 1; see Inter-Fluve 2010b, 2011a, 2011c). Inter-Fluve's design documents (and reviews by NMFS and CDFW) have moved the project considerably closer to actual construction of habitat enhancement projects (Phase III in Table 1 and Figure 3). Decision points following the completion of habitat enhancement within the first mile and the second and third miles (Phases III and IV, respectively; blue arrows in Figure 3) represent logical places to pause, evaluate the physical habitat response to habitat enhancement projects, and adapt/modify subsequent habitat enhancement projects based on the learning that has taken place through rigorous effectiveness monitoring. Validation (biological response) monitoring will also take place for all phases of the project. However, because of population drivers that are external to habitat conditions in Dry Creek, data from validation monitoring will be supportive to the main data gained through implementation and effectiveness monitoring as described in section 3.3.3 Validation monitoring.

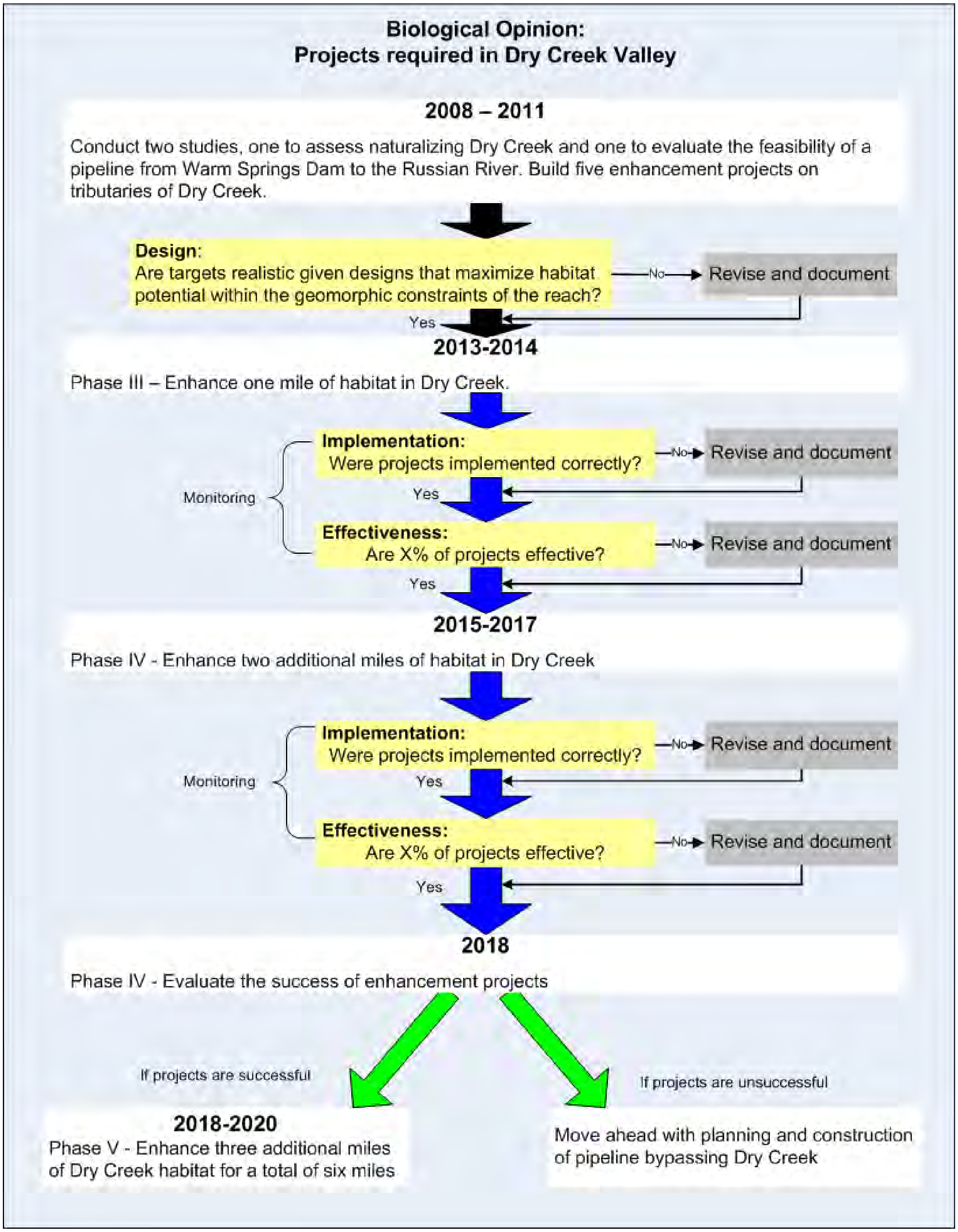

Figure 3 Straw decision process for Dry Creek habitat enhancement. The results of effectiveness and validation monitoring undertaken throughout the 5 years of project implementation from 2013-2017 will be evaluated in 2018 in order to further inform the decision of whether to design and implement future habitat enhancements.

At a higher level is a decision regarding the Water Agency's and USACE's level of compliance with the RPA for Dry Creek. This will involve examination of data from implementation, effectiveness and, to a lesser extent, validation monitoring, as well as comparisons against timelines and targets stipulated in the RPA.

2.4 Actions under consideration for enhancing fish habitat

According to the RPA (NMFS 2008, Section 3.1.1), habitat enhancement activities will focus on converting sections of stream containing marginal or poor quality habitat to near optimal quality habitats that can accommodate a range of flow releases from WSD. Habitat enhancement will create both winter and summer rearing habitat for juvenile steelhead and coho; with an emphasis on improving habitats for the survival of juvenile coho (NMFS 2008). The RPA outlines specific criteria for desired rearing habitat characteristics (see Table 13 in Inter-Fluve 2010a for summary). In considering alternative actions for enhancing fish habitat it will be important to bear in mind that Dry Creek is a fluvial system with particular physical and biological processes operating longitudinally, vertically, laterally, and temporally (Inter-Fluve 2010a). Consequently, all actions will need to be assessed individually and within the context of the system as a whole (WSD to confluence) in order to affirm the feasibility and sustainability of the enhancement work that is implemented at a project scale. Planned fish habitat enhancements (Inter-Fluve 2012) are intended to emphasize natural stream characteristics, or those which evolve through the geomorphology of a given stream reach. By using enhancement practices that emulate outcomes from natural geomorphic effects, the benefits provided to juvenile coho and steelhead will be optimized by increasing the amount of high quality rearing habitat. Because these approaches occur within a dynamic system, they should not be expected to be static through time. However, they should provide approximately similar quantities of habitat through time within an enhancement reach (Inter-Fluve 2012); the planned adaptive management approach outlined in the current document will guide the process of assessing whether this is indeed the case.

2.5 Conceptual model for Dry Creek

A conceptual model for the Dry Creek habitat enhancement is shown in
Figure 5. The conceptual model indicates the expected salmonid habitat and population response as a result of management actions (yellow row, second from bottom) implemented in Dry Creek. Implementation of listed management actions will result in various fluvial geomorphologic processes (darker blue row, third from bottom) taking place which will in turn result in fish habitat creation (light blue row, third from top) and an eventual fish response (juveniles – grey row, second from top, and adults – top tan row). Habitat creation and fish response relate most clearly to the objectives outlined in the RPA. Therefore, progress towards these objectives will need to be monitored and evaluated to determine if the implemented management actions are working as intended.

The brown bottom row of
Figure 5 shows factors currently outside the control of Dry Creek management actions, but which could have significant effects on the rate of recovery of habitat, fish populations and other ecosystem components. These factors operate concurrently with management actions, potentially generating cumulative effects that could make it difficult to tease out their relative importance. The AM monitoring design will attempt to account for and/or control for these factors by

creating contrasts (to the extent possible) in time and space (e.g., reference sites subjected to the same external factors but not enhanced).

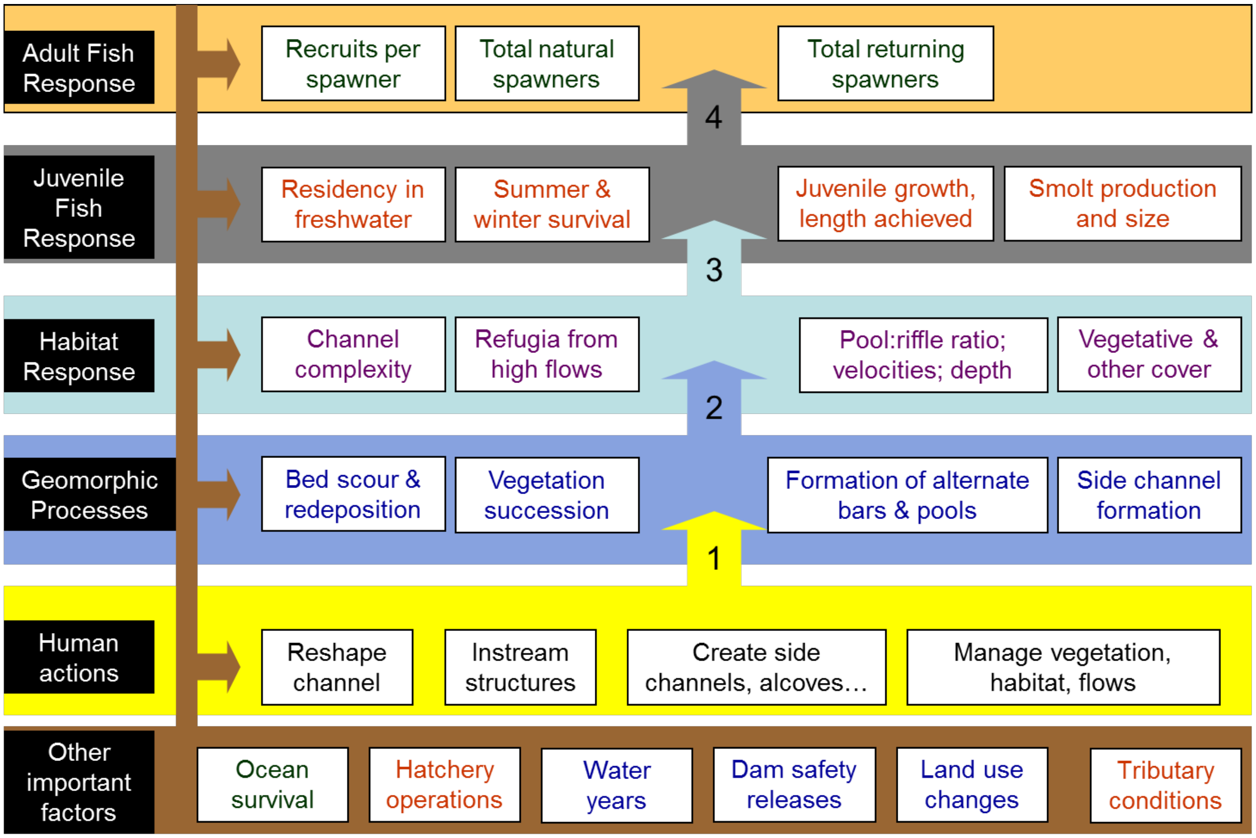

Figure 4 Conceptual model for the Dry Creek habitat enhancement activities. Color coding indicates the different types of monitoring that will be required to determine whether particular objectives are being met. The brown row at the bottom reflects important factors outside of the control of the Water Agency/USACE but that can nevertheless significantly affect each of the other rows.

2.6 Objectives

The objectives hierarchy for Dry Creek (Figure 5) provides a structured way of displaying multiple levels of objectives within the project and the relationships between these objectives. All objectives (at some level of the hierarchy) are measurable by one or more performance measures (PMs).

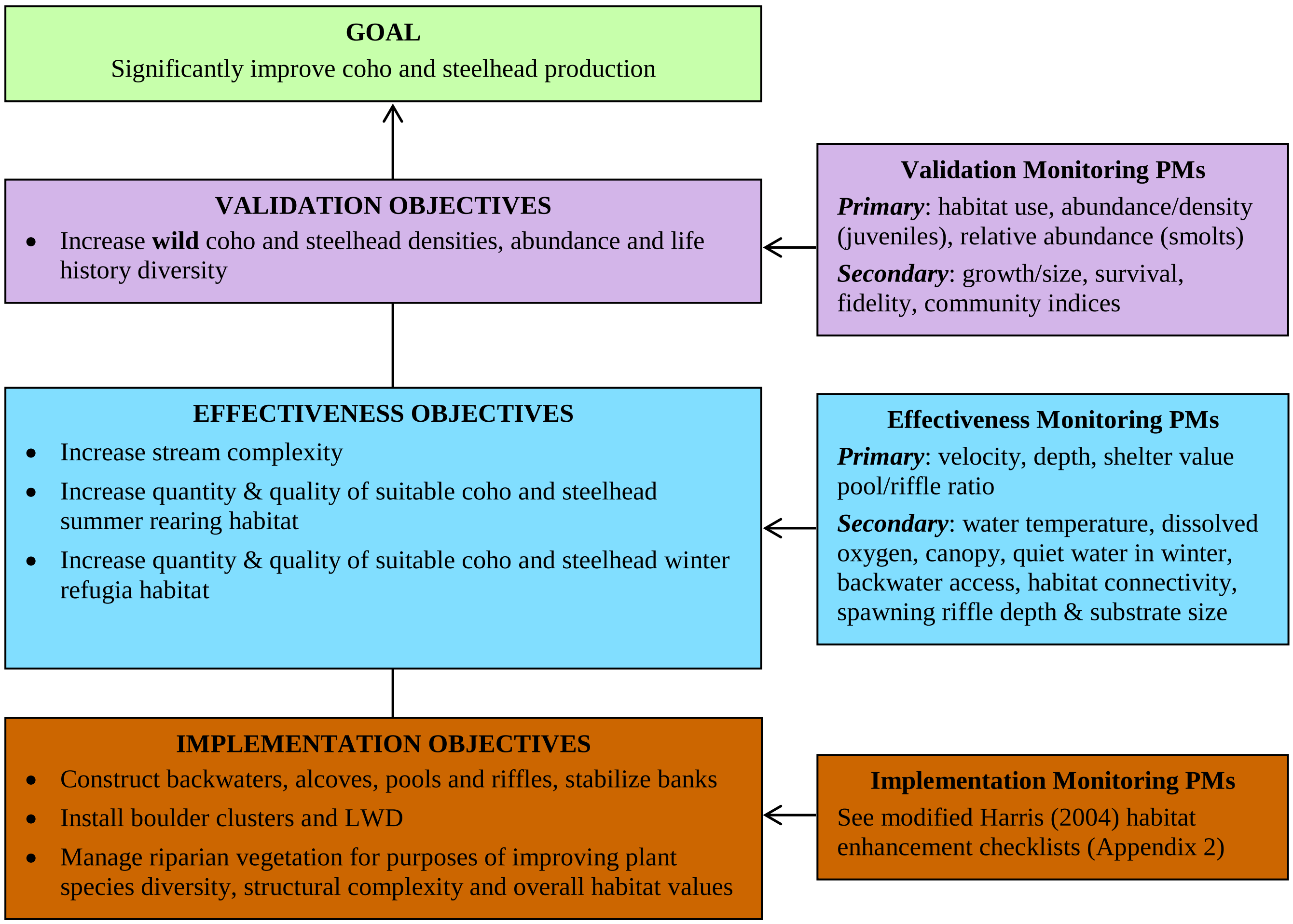

Figure 5 Objectives hierarchy for Dry Creek enhancements (organized by the causal relationships depicted in the Dry Creek conceptual model – Figure 4) with associated performance measures (PMs) to be monitored at each level of the hierarchy.

The RPA has directed the Water Agency and USACE to implement enhancements that will improve the quality of rearing habitat and appreciably increase the survival of juvenile salmonids in Dry Creek in both summer and winter months (NMFS 2008, pg. xvii). At the next level of objective specificity, the RPA lists the expected quantified habitat benefits of the RPA on Dry Creek:

- 96,500 m^2 of habitat created for steelhead (pg. 281 in RRBIOP), assuming that the 6 miles of enhanced pool-riffle habitat averages 10 m in width (i.e., 6 mi * 5280 ft/mi * 0.3048 ft/m * 10 m width) distributed over 8+ sites of Dry Creek (upper, middle, lower),
- 96,500 m^2 of high quality habitat created for coho (pg. 289 in RRBIOP, same assumptions as for steelhead) distributed over 8+ sites of Dry Creek (upper, middle, lower),
- An additional 3,000 to 6,000 m^2 of coho rearing habitat from boulder clusters (pg. 289 in RRBIOP), plus 5,000 to 10,000 m^2 of steelhead habitat from boulder clusters (pg. 282 in RRBIOP) located between enhanced reaches,

- No negative impact on Chinook.

The RPA also translates these expected habitat improvements into specific expected biological responses, while recognizing that the timing of those responses will be delayed (i.e., will not occur immediately after the habitat enhancement activities). RPA estimates of benefits to the population from fish habitat enhancements are based on assumptions outlined for juvenile steelhead and coho (pp. 281 and 289). A broader suite of detailed, measurable objectives and associated PMs have been defined that relate to successful achievement of Dry Creek RPA enhancements across different spatial (e.g. features, sites, reaches) and temporal scales.

3.0 Key questions, information and decisions

The decision that will be made in 2018 to answer the key question of whether to enhance the remaining three miles of Dry Creek will depend on the information collected and associated decisions made relative to the performance of the first three miles of habitat construction until then. For example, if the three miles enhanced by 2018 were functioning well then the decision could be made to similarly enhance additional miles. However, alternative decisions might be made (e.g., undertake additional work, re-evaluate or eliminate poorly performing enhancement techniques/reaches, build pipeline, etc.) if considerably less than a desirable amount of habitat enhancement projects were considered to be effective or a much smaller amount of enhanced coho habitat was considered near-optimal than is listed in the RPA.

This AMP incorporates the performance measures (PMs), target criteria for those PMs and the broad decision rules that will govern future actions and decisions over the 15 years encompassed by the RRBIOP (2009-2023). Decision rules adopted by the agencies will drive the design of pre- and post-construction habitat monitoring. It is expected that feedback from monitoring with regards to how the Dry Creek ecosystem actually responds to habitat enhancements, which techniques are ultimately effective, and which factors (illustrated in the conceptual model – Figure 4) are outside of management control (e.g., extreme climatic events) will allow for continued learning and innovation as well as adaptations of monitoring protocols as appropriate. In short, the results of the monitoring will answer the key questions which inform the decision process. A Joint Monitoring Team consisting of representatives from NMFS, CDFW, USACE and the Water Agency will be responsible for collecting and evaluating monitoring data.

This Adaptive Management Plan is intended to inform the subsequent phases of monitoring by incorporating feedback about the design, implementation and performance of the various techniques and features through decision rules that incorporate information collected from monitoring. Some decision rules are binary and fairly straightforward (e.g., yes or no response). For example, under implementation monitoring, the Joint Monitoring Team will evaluate whether habitat enhancement projects (e.g., pool-riffle sequencing) have been built according to their respective design plans. If the answer is yes, no action is required. If the answer is partially, the Joint Monitoring Team documents deviations from the approved designs (i.e., modifications, additions or omissions) and a course of remediating actions and/or additional monitoring is determined.

Decision rules for effectiveness monitoring are more nuanced, and require a mix of quantitative and qualitative information that involve decision rules at multiple scales to determine a suitable course of action. For example, there are decision rules which involve several possible action alternatives on a response continuum ranging from perfectly functioning habitat enhancements to habitat enhancements that do not function at all. Such a continuum necessitates management actions ranging from no action to no or reduced credit (Figure 6). Although Figure 6 pertains specifically to the first three miles enhanced between now and 2018, it could be extended (with or without modification) for additional miles of habitat enhancement after the 2018 decision point. No feature or site can receive a failed rating – in this case, some action is required to either repair, replace or accept reduced credit.

The feedback portion of the AMP comes into play through the phased approach of tracking project performance from the conceptual design and approved construction design to the overall implementation rating and effectiveness rating through time. For example, if techniques, features or sites do not perform as expected, this could be explained by a poor design, or a good design but poor implementation. The latter instance would be addressed at the implementation monitoring phase. Alternatively, if the design plans were jointly approved by NMFS and CDFW and the overall implementation rating was favorable yet the overall effectiveness rating was poor, the Joint Monitoring Team may decide to eliminate poorly performing techniques in future phases of construction. The Joint Management Team would then determine how much credit would be applied depending upon the relevant information contained in the design feasibility analysis, and the outcome of previous monitoring phases and/or future monitoring phases (eg. validation).

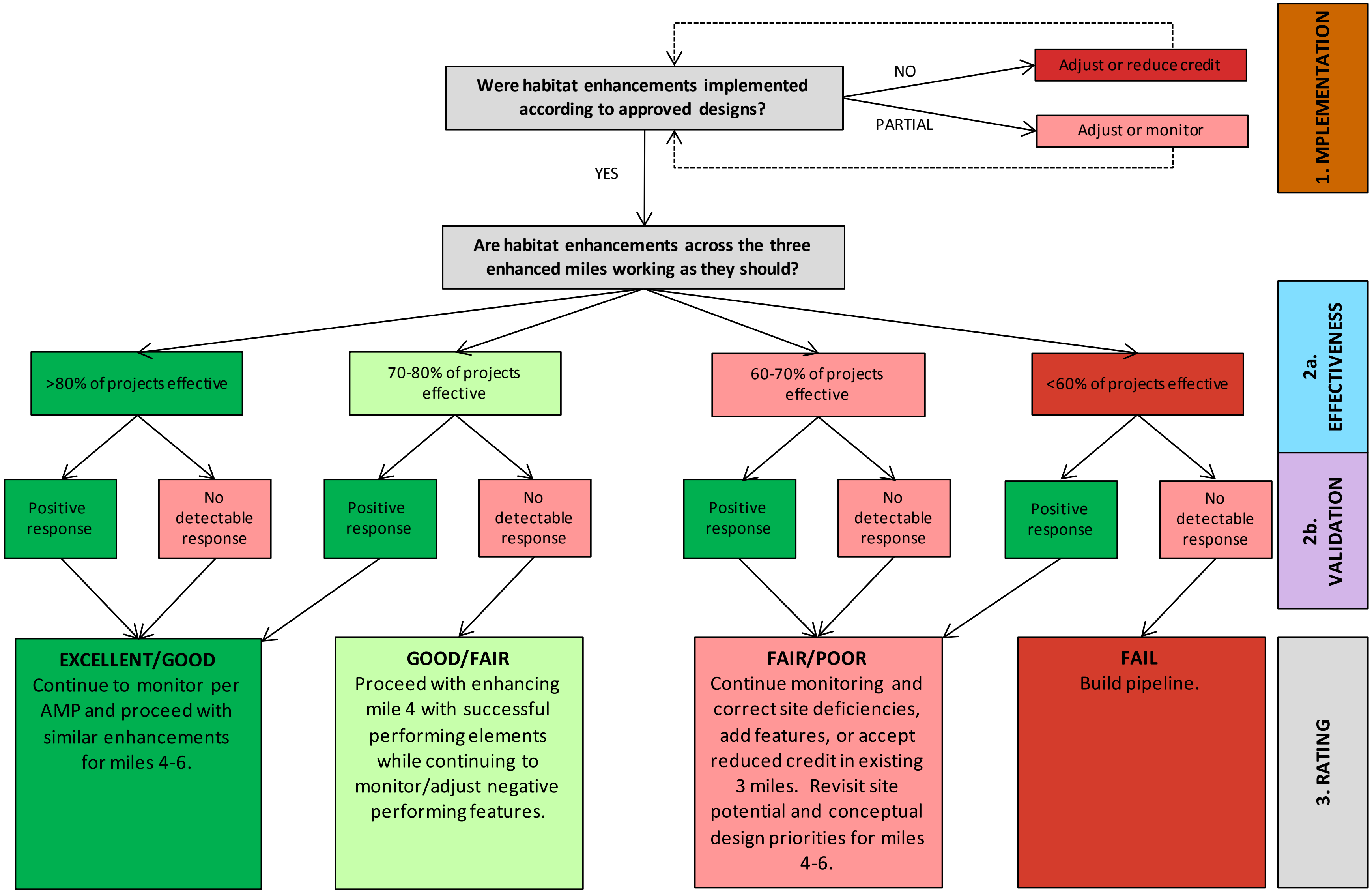

Figure 6 Process for determining course of action in 2018 after the first three miles of Dry Creek have been enhanced. Ratings will be based on an objective evaluation by the Joint Monitoring Team in a step-wise phased monitoring approach which includes phyiscal and biological quantitative measurements which lead to qualitative ratings.

3.1 Types of monitoring

Three types of monitoring (implementation, effectiveness and validation) as defined in the RPA (NMFS 2008, pg. 266) will be conducted in order to inform the decisions in Figure 6. Physical habitat responses (e.g., changes in depth, velocity, shelter) can be more directly linked to habitat enhancement actions than can biological responses which may be subject to complex factors outside of human control (e.g., seasonal rainfall patterns, ocean conditions, etc.) that will affect salmon and steelhead survival and abundance on an annual basis. Additionally, it may take a considerable length of time and a considerable amount of habitat enhancement to produce and detect a measurable biological response (Bradford et al. 2005; Roni et al 2010). For these reasons once project conditions have been documented and approved via implementation monitoring, effectiveness monitoring of improvements in physical habitat will be the primary means whereby the results of fish habitat enhancements in mainstem Dry Creek will be credited.

<u>Implementation monitoring</u> is “monitoring to determine if the habitat enhancement was done according to the approved design” (NMFS 2008, pg. 266). In other words, did the contractor/builder do what they said they were going to do? Implementation monitoring will occur immediately post-construction and will serve as a check-in point to determine if all the essential elements were placed according to the design as approved by NMFS/CDFW. Based on the results of post-construction implementation monitoring, The Water Agency’s, USACE’s or other engineering techniques and approaches will be re-visited as deemed necessary.

<u>Effectiveness monitoring</u> is “monitoring to determine whether habitat enhancement is having the intended effect on physical habitat quality” (NMFS 2008, pg. 266). This definition implies that protocols should facilitate a detailed comparison between baseline habitat quantity and quality data collected prior to any enhancement actions (pre-enhancement monitoring) and the habitat amounts/condition as measured over time after each implementation phase (post-enhancement monitoring). For example, pre-enhancement monitoring will occur prior to each enhancement phase, and post-enhancement monitoring will occur after the first geomorphically-effective flow (i.e., flow that deposits substantial sediment on the flood plain), or within 3 years following each enhancement phase, and then at minimum every 3 years until 2023, to assess the long term sustainability of all implemented habitat enhancement actions. Proposed timing and location of effectiveness monitoring across the 6 enhanced miles is described in Table 7.

<u>Validation monitoring</u> is “monitoring to determine whether habitat enhancement work is achieving the intended objective (i.e., creating habitat that is inhabited by listed salmonids and appreciably improves the production and survival of rearing steelhead and coho salmon in Dry Creek”; NMFS 2008, pg. 266). As discussed elsewhere in this document, establishing the temporal component for validation monitoring (i.e., when should validation monitoring start and for how long) will be challenging because of the inherent time lag between the physical habitat response and the expected biological response. Statistical power to detect changes in freshwater fish production depends strongly on the number of years of pre-enhancement baseline monitoring (Bradford et al. 2005; Parnell et al. 2003) and may require an extensive amount of habitat to be enhanced in order for there to be a measurable response (Roni et al. 2010). Due to serious sampling challenges given the current channel form in Dry Creek (i.e., water depths, velocities and water clarity common in Dry Creek limit efficacy of juvenile sampling techniques)

there is the added complexity of how much baseline population monitoring can be effectively conducted in the time frame prior to scheduled habitat enhancements (Water Agency 2009). Proposed timing and location of validation monitoring across the 6 enhanced miles is described in Table 7.

3.2 Spatial scale and data rollup

In addition to the temporal scale (discussed above) the spatial scale at which data to evaluate PMs are collected will include four progressively broader scales: feature, site, enhancement reach, project reach (see Glossary of Terms section for definitions). Assessments at a smaller spatial scale can be viewed as the fundamental elements of habitat enhancement at a broader scale. For example, a collection of individual features can be considered the building blocks for habitat enhancement within a given site if they work together to achieve desired target conditions (Figure 7).

Depending on the type of monitoring (implementation, effectiveness or validation) and the monitoring objective, data will be used to assess the degree of success in meeting stated objectives as follows. With a few exceptions (see 3.3 Performance measures and monitoring protocols below), quantitative data collected at the feature scale will be used to inform qualitative assessments of individual features for all types of monitoring. The set of qualitative assessments for all features in a given site will then be combined in a data “rollup” to arrive at a qualitative rating (ranging from excellent to fail) for the site. For effectiveness and validation monitoring, this data rollup concept will be similarly extended to the enhancement reach and project reach scales (Figure 8).

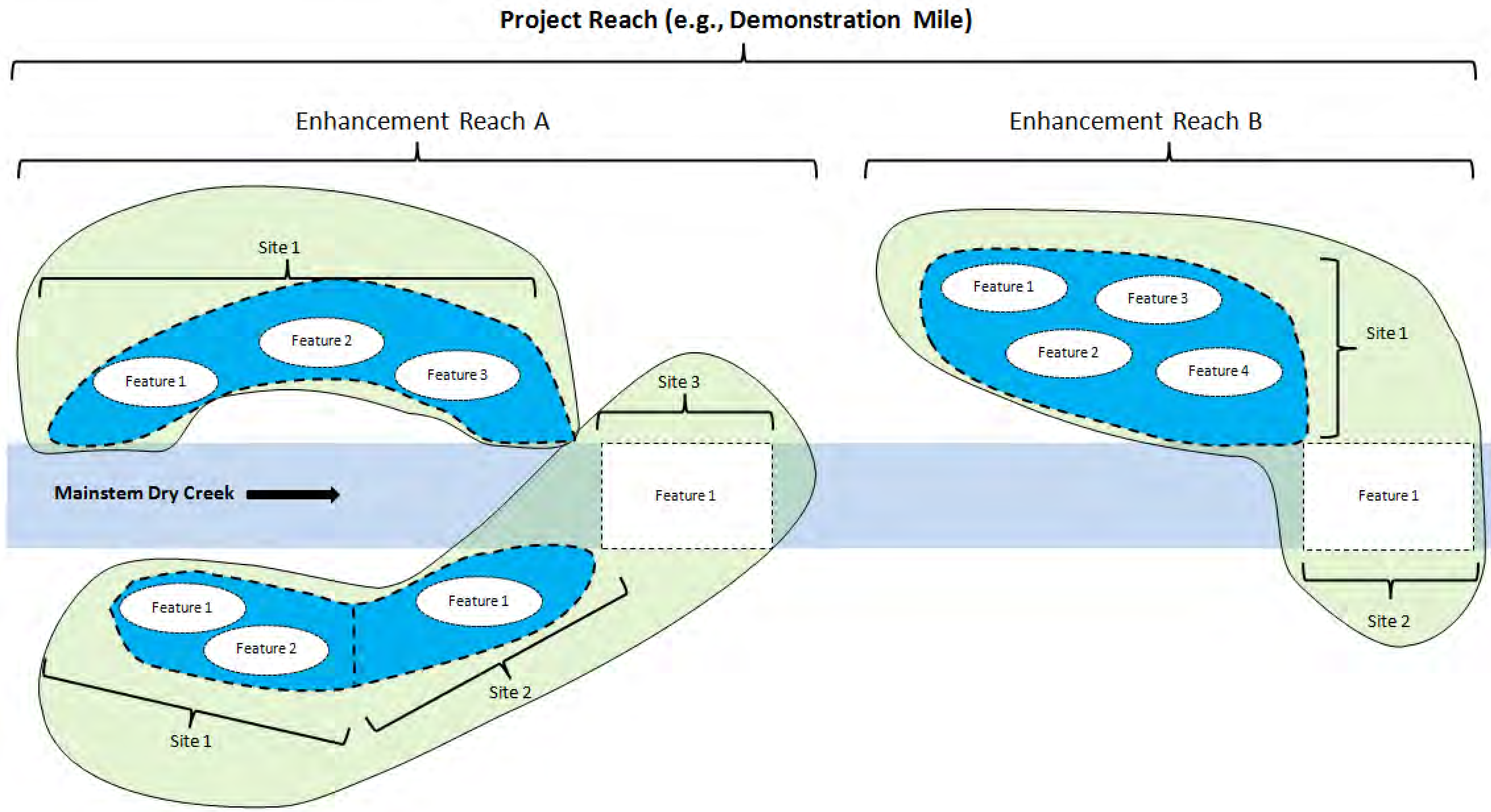

Figure 7 Hypothetical example of an enhancement reach illustrating the relationship between features, sites, enhancement reaches and project reaches. The collection of all project reaches treated represent the length of stream in Dry Creek ultimately treated and evaluated.

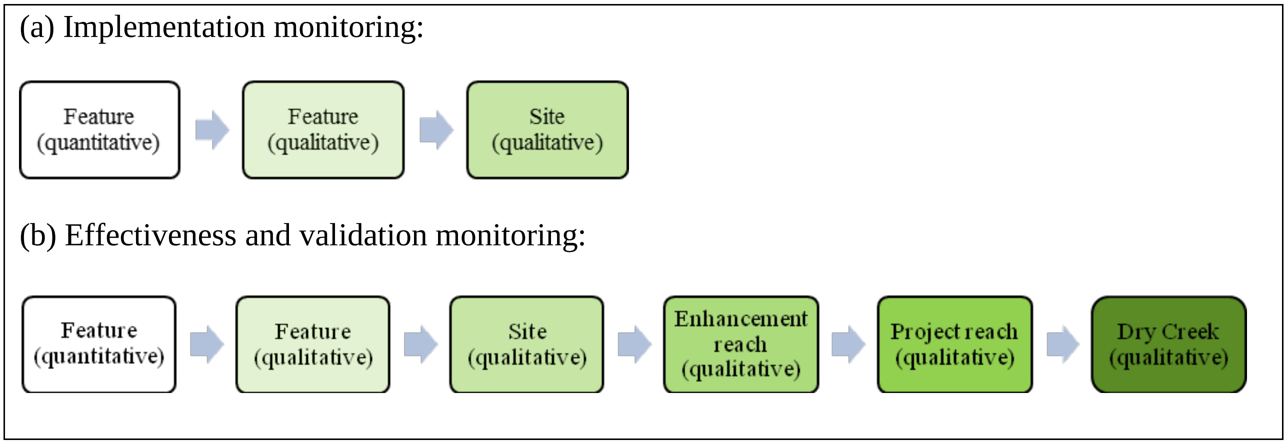

Figure 8 Illustration of the rollup concept for (a) implentation and (b) effectiveness and validation monitoring.

Because of the spatial rollup approach to monitoring described here, an important initial step prior to the commencement of post-construction effectiveness monitoring within a given enhancement reach will be an agreed-on definition of what constitutes a feature and a site within that reach. For features that will be enhanced (e.g., existing pools, placement of boulder clusters) this step could occur prior to the commencement of construction so that the degree of improvement in meeting target habitat conditions can be assessed for a given site. However, in cases where no habitat currently exists (e.g., construction of new off-channel habitat) features and sites will be defined immediately following construction (i.e., during implementation monitoring).

For purposes of the Dry Creek AMP, a site is defined as one or more engineered habitat features that have been designed to work in combination within a stream reach. The degree of hydrologic connectivity between features over a range of flows will be used as the primary criterion for determining which features comprise a given site. While hydrologic connectivity is an important consideration during the design phase, it will be necessary to confirm that all features were implemented according to the approved design (see 3.3.1 Implementation monitoring below) so that, if necessary, adjustments to which features constitute a given site can be documented.

An enhancement reach is defined as a specified collection of enhancement sites that are implemented in close proximity to one another. Most often, an enhancement reach will represent a well-defined area from which to stage construction for a particular group of features/sites. The project reach is a collection of enhancement reaches. In 2018, sufficiency of progress toward habitat enhancement in Dry Creek will be made based on how well the project reach is functioning from both a physical habitat perspective (via effectiveness monitoring) as well as a biological perspective (via validation monitoring).

3.3 Performance measures and monitoring protocols

The basis for monitoring will be performance measures (PMs) and associated protocols to assess habitat enhancement measures relative to these measures. PMs are quantitative and qualitative criteria for measuring or assessing the success of project activities that are intended to support agency management objectives. PMs will provide information on how well the Dry Creek habitat enhancements have achieved their intended benefits (in aggregate, and where appropriate and feasible, their independent benefits or unintended impacts). Consequently, PMs include explicit, pertinent and objectively verifiable results achieved at lower levels of the objectives hierarchy, leading towards the achievement of higher level project objectives and goals.

PMs are based on the expected physical and biological responses under each objective (e.g., improved rearing habitat is an example objective in the RRBIOP). Associated elements include post-project treatment mitigations which would be initiated if the expected target criteria are not met. The summary of PMs and their associated monitoring protocols in the sections that follow describe the habitat and fish response indicators, and the types of decisions they will inform. Given the nature of the AMP, the list of PMs and associated targets (i.e., success criteria) may be revised depending upon data feedback from the initial monitoring of implemented enhancement projects.

3.3.1. Implementation monitoring design and ratings

The focus of implementation monitoring is simply to determine whether actions have/have not been undertaken as intended/planned. As a matter of course, NMFS/CDFW will approve the construction plans for each phase of project construction (phases of overall project construction for habitat enhancement on mainstem Dry Creek are listed in Table 1). This approval is based on several factors including whether habitat enhancement in selected reaches is being designed in such a way to maximize the benefit to juvenile salmonids given the geomorphic opportunities and other constraints in the immediate vicinity of the enhancement reach.

The implementation monitoring design can be envisioned as a way to ensure that each feature has been constructed when, where and how intended and without any structural changes or omissions that would compromise integrity. Monitoring protocols outlined in Harris (2004) and associated implementation monitoring checklists (customized as necessary for RPA assessment) provide a useful, consistent template that will be used within the AMP for describing/documenting the implementation status of engineered enhancements in Dry Creek reaches. There is a separate checklist with respect to the three relative locations within the stream channel where habitat enhancement is being contemplated: 1) instream, 2) off-channel, 3) channel reconstruction and bank stabilization. Enhanced features will be assessed using modified Harris (2004) implementation checklists (Appendix 2). Suites of feature-level assessments will then be rolled-up into a final composite site rating (Table 2) that will be used to determine whether enhancements at a particular site are considered successful or whether further remediation will be necessary. The final overall qualitative site-scale rollup assessments of habitat enhancement implementation (i.e., excellent, good, fair, poor, fail) will be undertaken by a Joint Monitoring Team consisting of representatives from NMFS, CDFW and either the Water Agency or USACE (as appropriate). In the event that implementation was insufficient, remedial action may be recommended by the Joint Monitoring Team (Table 2).

Table 2 Qualitative rating for site-level implementation. The qualitative rating is based on a combination of qualitative and quantitative data collected using protocols as modified from Harris (2004) for each feature within the site.

Rating	Implementation Status	Action
Excellent	Exceeds all specifications and all expectations.	No action required.
Good	Meets all specifications and expectations.	No action required.
Fair	Does not meet some specifications and expectations due to site capacity or conditions beyond control, but implemented adequately.	If non-compliance is significant enough to jeopardize performance, require remedial action.
Poor	Does not meet most specifications and expectations, implemented inadequately.	Serious enough to require remedial action.
Fail	Fails to meet specifications, implemented incorrectly. Or, not implemented.	Reduce total project habitat benefit unless remedial actions are implemented.

Summary of implementation monitoring steps

- Every attempt will be made to implement habitat enhancement measures in a manner that is consistent with designs approved by NMFS and CDFW.
- Upon completion of implementation, a Joint Monitoring Team consisting of representatives from NMFS, CDFW and either the Water Agency or USACE (as appropriate) will conduct a walk-through of newly-implemented enhancement reaches in order to evaluate whether the features were implemented according to the approved designs. The outcome of this step will be a site-scale rollup (see Figure 8a and Table 2).
- Modifications to the approved designs will be documented and determination made as to whether modifications were beneficial to performance or otherwise
- If implementation did not sufficiently follow the approved design, the Joint Monitoring Team will recommend what adjustments (if any) should be made.

3.3.2. Effectiveness monitoring design and ratings

The RPA highlights high stream current velocities, inappropriate water depths, minimal instream cover, and lack of habitat complexity as serious juvenile salmonid habitat deficiencies in mainstem Dry Creek. Because of this, habitat enhancement designs are focused on improving these specific conditions. Likewise, efforts will be focused on developing performance measures that capture how those habitat conditions change as a result of habitat enhancements. Pre-treatment monitoring will occur prior to habitat enhancement implementation while post-treatment monitoring will occur after the first geomorphically-effective flow (i.e., flow that deposits substantial sediment on the flood plain), or within 3 years of completion. For some features, pre-construction monitoring may not be possible or necessary (e.g., for surfaces that are not wet prior to implementation) though as built designs/documentation is necessary for further monitoring phases.

Primary and secondary PM’s have been identified and agreed to by the Joint Monitoring Team. Primary PMs (Table 3) are those metrics which: 1) will be utilized to inform enhancement effectiveness across feature/habitat unit, site and reach scales; and 2) will determine whether reach and project criteria are being met which will, in turn, influence the amount of RRBIOP habitat credit assigned as well as the future decision on whether or not to continue with an additional three miles of habitat enhancement in 2018. Secondary PMs (Table 3) will assist in determining the effectiveness of various enhancement techniques in changing non-target conditions. Secondary PMs, will not directly relate to RRBIOP crediting. Reference sources for PM targets are provided in Appendix 3.

Accounting for variation in seasonal utilization of habitat via PM’s
An issue that was not explicit in the RPA but one that was recognized by the Dry Creek AMP Working Group is that juvenile coho during the spring, when they are small, tend to prefer shallower water and slower water velocities than their larger counter-parts in late summer. Coupled with the importance the RPA places on creating “near-optimal” conditions with respect to the four primary PMs listed in Table 3, the Dry Creek AMP Working Group tailored the primary PM thresholds and the associated effectiveness monitoring approach in the following ways. First, there was agreement to adjust the target velocity from a range of 0-0.2 ft/s (listed in the RPA) to a range of 0-0.5 ft/s in order to encompass the range of velocity preferences of juvenile coho when the entire size range of juveniles in freshwater is considered (see discussion in Appendix 4 and associated references in Appendix 3). Second, to the extent safe and practical we will repeat quantitative data collection for velocity, depth and shelter value at stream discharges that represent the seasonal variation critical to each life stage. Because flows in mainstem Dry Creek during the non-winter season are largely controlled by releases from Warm Springs Dam, there was agreement that stream discharge would be a good proxy for season. Therefore, Table 3 lists three PMs for each of three approximate stream discharges to reflect these differences by season: 105 cfs (currently the typical summer discharge), 200 cfs (typical spring discharge), and 1,000 cfs (typical winter discharge).

Table 3 Primary and secondary habitat performance measures and their associated "near-optimal" quantitative ranges (targets) for coho salmon at feature/habitat unit, site, enhancement reach, and project reach scales that will be directly evaluated at three different flows (spring, summer, winter) during Dry Creek effectiveness monitoring. Reference sources used to inform targeted ranges are provided in Apppendix 6.

Type of Performance Measure	Per-formance Measure	Life Stage	Biologic Function	Spatial Scale	Habitat Type	Evaluation Method	Near-Optimal Ranges (Targets)		
							Spring Flow[1]	Summer Flow[2]	Winter Flow[3]
PRIMARY	Velocity	fry	Rearing	Feature/HU/Site	Margins	Quant. & Qual.	0-0.5 ft/s	n/a	n/a
	Depth	fry	Rearing	Feature/HU/Site	Margins	Quant. & Qual.	0.5-2.0 ft	n/a	n/a
	Velocity	Summer/ winter parr	Rearing	Feature/HU/Site	Pools, off-channel	Quant. & Qual.	0-0.5 ft/s	0-0.5 ft/s	0-0.5ft/s
	Depth	Summer/ winter parr	Rearing	Feature/HU/Site	Pools, off-channel	Quant. & Qual.	2-4 ft	2-4 ft	2-4 ft
	Shelter value[4]	Juvenile	Rearing	Feature/HU	Pools, margins, off-channel	Quant. & Qual.	≥80	≥80	≥80
	Pool:Riffle ratio	Juvenile	Rearing	Project reach	Pools, riffles	Quant. & Qual.	1:2 to 2:1		
SECONDARY	Temperature	Juvenile	Rearing	Site	Off-channel	Quantitative	n/a	8-16^{o} C	n/a
	Diss. oxygen	Juvenile	Rearing	Site	Off-channel	Quantitative	n/a	6-10 mg/l	n/a
	Canopy	Juvenile	Rearing	Site	Off-channel	Quantitative	80 %		
	Quiet water (< 0.5 ft/s)	Juvenile	Rearing	Enhancement reach	Pools off-channel/ backwaters (in winter)	Quant. & Qual.	n/a	n/a	≥ 25%
	Off-channel access	Juvenile	Rearing	Project reach	Off-channel/ backwaters	Quant. & Qual.	Approx. 0.05 – 0.06 ft/s (ucrit); Approx. 3.3 ft/s (burst speed)		
	Connectivity of habitats	Juvenile	Rearing	Project reach	Pools, riffles, margins, off-channel	Qual. & GIS & Inter-Fluve modeling	Undefined		
	Substrate particle size	Adult	Spawning	Feature/Site	Riffles	Quant. & Qual.	n/a	n/a	0.25-2.5 in
	Depth	Adult	Spawning	Feature/Site	Riffles	Quant. & Qual.	n/a	n/a	0.5-1.6 ft

[1] Target coho life stage during spring is newly-emerged feeding fry which use shallower depths than would be preferred later in the summer and winter when fish would be larger. Target spring flow (discharge within the enhancement reach) is 200 cfs (approximately double the summer "base" flow).
[2] Target summer flow is 105 cfs
[3] Target winter flow is 1000 cfs
[4] See Flosi et al. (2003) for a description of how data for shelter value is collected and how shelter values are calculated.

Harris (2004) provides effectiveness monitoring protocols and associated monitoring checklists which will provide the foundation for many of the effectiveness evaluations to be utilized in Dry Creek. The standard Harris (2004) effectiveness monitoring checklists have been modified and supplemented with the addition of more quantitative PMs specific to the RPA as it pertains to Dry Creek, as well as to allow rollup of habitat feature effectiveness ratings to the site and reach scale. These include a pre-treatment and a post-treatment checklist for each of the three relative locations within the stream channel where habitat enhancement is being contemplated: 1) instream, 2) off-channel, 3) channel reconstruction and bank stabilization for a total of six checklists, see Appendix 2).

Quantitative data

As previously discussed (section 3.2 Spatial scale and data rollup), the collection of quantitative data for PMs will form the basis for evaluating overall effectiveness of habitat enhancement measures in Dry Creek (Figure 8b). Collection of quantitative data on velocity, depth and shelter (the three primary PMs that can be measured at the feature/habitat unit scale; Table 3) will take place in locations where habitat enhancement will occur (pre-treatment) or has occurred (post-treatment).

Water velocity and depth data will be collected in either of two ways depending on the type of habitat enhancement being evaluated:

- In constructed backwaters and in main channel portions of Dry Creek where constructed riffles will be placed, water depth and average water column velocity will be measured along evenly-spaced cross-sectional transects. The sampling intensity (i.e., measurement interval along each transect as well as the distance between individual transects) will be decided by the Joint Monitoring Team. To help inform that decision, various levels of sampling intensity will be evaluated in an effort to optimize the trade-off between effort and accuracy so as to inform planning for future effectiveness monitoring.
- In main channel (instream) portions of Dry Creek near selected large woody debris structures (log jams, etc.) and boulder placements, water depth and velocity gradients will be measured and mapped in relation to installed features. This “habitat feature mapping” will result in spatial (two-dimensional) depictions of various habitat features showing the area of newly created habitat meeting depth and velocity criteria (Table 3). Specific approaches and instruments for habitat feature mapping will be evaluated and decided on by the Joint Monitoring Team.

Shelter value (Flosi et al. 2003) is a primary PM that will be measured at the habitat unit-scale for both enhanced existing habitat units as well as newly-created habitat units (e.g. constructed backwaters, pools).

Pool:riffle ratio is the fourth and final primary PM. Pool:riffle ratio will be measured at the project reach scale.

In all cases, the quantitative data will be used to develop qualitative ratings for evaluation at the appropriate scale (feature, habitat unit, project reach). Qualitative ratings for features / habitat units within a site will then be rolled-up to arrive at a composite site rating (Table 4). Qualitative ratings for sites within an enhancement reach will be further rolled-up into a composite enhancement reach rating and, finally, enhancement reach ratings within a project reach will be rolled-up into a final project reach rating. For both the enhancement reach and project reach rollups, the same criteria listed in Table 5 will be used. Monitoring of secondary PMs at the appropriate scale will also occur as a way to document changes that may arise as unintended benefits or detriments due to habitat enhancements which are largely targeted at the primary PMs; however, secondary PMs will only be used as a way to guide future enhancement efforts. The final overall qualitative rollup assessments of habitat enhancement effectiveness (i.e., excellent-good, fair-poor, fail) will be undertaken by a Joint Monitoring Team consisting of representatives from NMFS, CDFW and either the Water Agency or USACE (as appropriate). In the event that effectiveness monitoring reveals less than a "good" rating for a feature, site or an enhancement reach, remedial action may be recommended by the Joint Monitoring Team (Table 4 and Table 5) depending on the circumstances. The Joint Monitoring Team will use the adaptive management feedback loop (Figure 2) as a mechanism to incorporate information regarding primary and secondary PMs when developing/reviewing plans for future habitat enhancements.

Table 4 Post treatment site-level effectiveness rating. Standard CDFW habitat ratings based on Harris (2004) have been modified to incorporate Dry Creek RPA-specific quantitative enhancement objectives.

Rating	Objectives	Criteria	Unintended Effects	Structural Condition	Future Outcome
Excellent-Good	Achieved all or most stated site design objectives.	All to most features/ habitat units achieve desired habitat response and meet targeted values for primary PMs (where relevant) **(>80% of features rated Good or Excellent)**	None or minimal negative unintended effects. Unintended positive effects may outweigh failure to achieve a targeted value.	Excellent to Good. Has the intended functional value.	Continue to monitor according to adaptive management plan.
Fair-poor	Some to many site design objectives not achieved, or objectives not achieved were beyond site capacity	Some to many features/ habitat units do not achieve desired habitat response and do not meet targeted values for primary PMs (where relevant) **(60-80% of features rated Good or Excellent)**	May have minor or major unintended negative effects that partially offset objectives or negates a targeted gain.	Poor to fair. Has some functional value	Step up monitoring on features exhibiting negative performance. Correct site or feature deficiencies as appropriate, including the option of adding sites/features or reducing total project habitat credit.
Fail	No site design objectives achieved at site due to the fault of the features; sites/feature may be completely gone.	Many features/ habitat units did not achieve desired habitat response and did not meet targeted values for primary PMs (where relevant) **(<60% of features rated Good or Excellent).**	Few positive effects and/or unintended negative effects may be degrading the habitat and outweigh achieved objectives.	Fail. Has no functional value.	Reduce site contribution from total project habitat credit. Revisit site potential and feature level design priorities. Redesign or add more sites/features. Alternatively reduce total project habitat credit.

Table 5 Post treatment enhancement reach- and project reach-level effectiveness rating.

Rating	Objectives	Criteria	Unintended Effects	Future Outcome
Excellent-Good	Achieved all or most stated reach design objectives.	All or most sites/ enhancement reaches meet or exceed targeted values.**(>80% of sites rated Good or Excellent)**	None or minimal negative unintended effects. Unintended positive effects may outweigh failure to achieve a targeted value.	Continue to monitor according to adaptive management plan.
Fair-Poor	Partially achieved most reach design objectives, or objectives not achieved were beyond reach capacity	Some sites / enhancement reaches did not meet targeted values **(60-80% of sites/ enhancement reaches rated Good or Excellent)**	May have minor or major unintended negative effects that partially offset objectives or negates a targeted gain.	Develop and implement plans to correct site or metric deficiencies, add sites/features or reduce total project habitat credit. Step up monitoring on sites and features exhibiting negative performance.
Fail	Many sites achieved no goals; objectives not achieved were the fault of the feature; sites/feature may be completely gone.	Many sites/ enhancement reaches did not meet targeted values **(<60% of sites/ enhancement reaches rated Good or Excellent).**	Few positive effects and/or unintended negative effects may be degrading the habitat and outweigh achieved objectives.	Reduce total project habitat credit, and abandon use of failed features. Revisit site potential and conceptual design priorities.

Potential use of reference sites to supplement effectiveness monitoring

As recommended in the RPA, a clearer interpretation of the benefits from habitat enhancement in Dry Creek could be gained through the use of reference/control sites (NMFS 2008). The goal of control-impact survey approaches is to assess the impact of some change, in this case the suite of Dry Creek habitat enhancement projects. A variety of impact designs with degrees of inference that increase with the level of effort (summaries in Underwood 1994 and Schwarz 2006). Mellina and Hinch (1995) provide a summary of different impact designs and describe how each might be used to assess watershed restoration. The simplest impact studies look at a single location before and after some event. Obtaining multiple observations before and after an event improves the ability to determine if an observed change is ‘real’ by taking into account the natural year to year variability. Because obtaining ‘before’ samples is often difficult, some have suggested that randomly sampling from similar but undisturbed habitats may be a suitable way to estimate variance (Underwood 1994). This approach can be considerably improved by adding a control site, where the control site is similar to the treatment site with respect to general characteristics (e.g., region, annual precipitation, size, etc.). These Before-After-Control-Impact (BACI) designs are intended to address the question of whether a particular action has resulted in a change at the treatment/impact site relative to the control site, while simultaneously adjusting for extraneous co-variables that might be similarly affecting both impact and control areas. Our ability to incorporate any of these comparative approaches in our effectiveness monitoring design will depend in large part on whether or not areas of Dry Creek currently exist that represent target conditions. Evaluations of potential reference sites are ongoing but it may be difficult to find reference conditions given dam operations and the legacy of land use in the watershed.

Summary of effectiveness monitoring steps

- Prior to implementing habitat enhancement measures (pre-construction), quantitative data on velocity, depth, shelter value and pool:riffle ratio (primary metrics) will be collected. These data will be collected in the same areas where habitat enhancement will be implemented; quantitative data will be qualitatively rated.
- Following habitat implementation (post-construction) and the first geomorphically-effective flow (i.e., flow that deposits substantial sediment on the flood plain) or within 3 years, quantitative data on velocity, depth, shelter value and pool:riffle ratio (primary metrics) will be collected at the appropriate scale (feature, habitat unit or project reach).
- Qualitative ratings of velocity, depth and shelter value at the feature- or habitat unit-scale will be developed and rolled-up to the site (Table 4) and enhancement reach (Table 5) scales in order to evaluate the project reach (Table 5). Pool:riffle ratio will be directly measured and evaluated at the project reach scale.
- Data for secondary PMs will be used as an aid in understanding unintended detriments (e.g., degraded water quality) or benefits (e.g., spawning gravel aggradation) from habitat enhancements which are primarily targeted at addressing primary PMs.
- If effectiveness monitoring reveals insufficiency (less than ‘good’ rating in either Table 4 or Table 5) in meeting primary PM targets (Table 3), the Joint Monitoring Team may recommend additional monitoring, feature or site remediation, and/or reductions in habitat crediting (Table 4 and Table 5).

3.3.3. Validation monitoring design and ratings

While biological response (validation) monitoring in mainstem Dry Creek will represent a significant effort in Dry Creek over the next several years, the utility of these data for validating the benefits of habitat enhancement is uncertain for a number of reasons inherent to the complexities of monitoring fish in open systems, and due to prevailing conditions in Dry Creek. Validation monitoring in general is often difficult to implement in a meaningful way (see Roni 2005 and references therein) and certain fisheries monitoring methods are particularly difficult to apply in Dry Creek where velocities are high (Water Agency 2009). It is also expected that a significant biological response will not occur until after appreciable suitable habitat has been created (Bradford et al. 2005; Parnell et al. 2003). As such, when crediting the amount of habitat enhanced in Dry Creek, results from validation monitoring will not be weighted as heavily as results from effectiveness monitoring. In cases where effectiveness monitoring alone leads to ambiguous results, validation monitoring will be incorporated as a modifier to aid in the final assessment of whether habitat enhancements in miles 1-3 are working as intended (this concept is reflected in the conceptual model (Figure 4) and ratings process (Figure 6)).

Validation monitoring will consist of methods to gather fish demographic/behavioral data for both primary and secondary PMs with greater emphasis placed on data that facilitate the evaluation of primary PM’s (Table 6). Habitat utilization and abundance (density) will be based on snorkeling observations augmented with data from electrofishing surveys and stationary PIT antennas for juveniles. In 2012-2014 the Water Agency used continuously-operated PIT antennas to successfully document use by PIT-tagged juvenile coho and steelhead of newly-created off-channel winter habitat in the Demonstration Mile. This same approach should prove useful for other sites and, possibly, some features or reaches. Each spring since 2009 a downstream migrant trap on the lower portion of Dry Creek has been operated in order to detect changes in relative smolt abundance over time (a primary PM). Baseline (pre-habitat enhancement) growth and survival (secondary PMs) of juvenile steelhead at the reach scale have been successfully estimated with the use of PIT tags, backpack electrofishing and continuously-operated PIT antennas.

Accounting for variation due to spatial scale via PM’s

Responses to habitat enhancement via validation PM’s may be difficult to detect or interpret at some spatial scales given the necessary assumptions, which may be impossible or prohibitive to test. For example, each summer from 2010-2012 the Water Agency has been conducting repeated electrofishing sampling in conjunction with continuous-operation of PIT antennas to allow decoupled reach-specific survival and fidelity estimates for juvenile steelhead (Manning and Martini Lamb 2012). An important assumption when interpreting these estimates is that all individuals in the population of inference (juvenile steelhead in the reach) experience the same probability of survival regardless of habitat type, body size, behavior, etc. The consequences of violating this assumption could perhaps be partially alleviated by sampling at a small spatial scale (i.e., less habitat variability); however, that may not possible given the tradeoff between the numbers of individuals (sample size, which may be exacerbated by movement out of the reach), and available resources (the equipment and personnel needed to sample). All approaches that could be used for estimating validation PMs listed in Table 6 will require some basic assumptions that may be difficult to satisfy. Such considerations provide yet further reason to exercise caution when interpreting and applying results from validation monitoring.

Table 6 Primary and secondary biological response performance measures and their associated target ranges at feature, site, and enhancement reach scales that will be evaluated during Dry Creek validation monitoring.

Type of Performance Measure	Performance Measure	Life Stage/ Species	Spatial Scale	Evaluation Method	Target Ranges
PRIMARY	Habitat utilization	Juvenile salmonid	Feature/ Site	PIT antennas/ Snorkeling	Evidence of use (presence/absence)
	Abundance/ Density[1]	Juvenile salmonid	Site/ Enhancement reach	Electrofishing	Coho: 0.3/m^2 Steelhead: 0.5-1.5/m^2
	Relative Abundance	Smolt salmonid	Enhancement reach	Downstream migrant trap	Increasing trend
SECONDARY	Growth/ Size	Smolt salmonid	Enhancement reach	Downstream migrant trap/ PIT tags	Comparable to other Russian River coho tributaries
	Growth/ Size	Juvenile salmonid	Enhancement reach	Electrofishing/ PIT tags & antenna	Comparable to other Russian River coho tributaries
	Survival	Juvenile salmonid	Enhancement reach	Electrofishing/ PIT tags & antenna	Comparable to seasonal survival from other Russian River coho tributaries
	Fidelity	Juvenile salmonid	Enhancement reach	Electrofishing/ PIT tags & antenna	Comparable to reference sites
	Community indices	Aquatic macro-invertebrate	Site	To be determined	Comparable to reference sites

Summary of validation monitoring steps

- As with effectiveness monitoring, the focus of validation monitoring will be on evaluating primary PMs (habitat utilization, abundance/density). The methods for gathering data to evaluate primary PMs will include snorkeling observations (juveniles) and downstream migrant trapping (trend monitoring for smolts) augmented with data from electrofishing surveys and stationary PIT antennas.
- It is expected that a significant biological response will not occur until after appreciable suitable habitat has been created and that separating the effects of habitat enhancement from natural variability will be difficult.
- For these reasons, results from validation monitoring will not be weighted as heavily as results from effectiveness monitoring. In cases where effectiveness monitoring alone leads to ambiguous results, however, validation monitoring will be incorporated as a

[1] Target juvenile densities listed for juvenile coho and steelhead are from the RPA.

modifier to aid in the final assessment of whether habitat enhancements in miles 1-3 are working as they should.

3.4 Monitoring timeline

The Water Agency and NMFS have developed an initial timeline (Table 7) for comprehensive monitoring (involving spatial and temporal contrasts within a proposed BACI-based design) of fish habitat and fish population response to Dry Creek enhancements over the duration of the project (commencing with baseline and Mile 1 Demonstration Project monitoring). While the proposed monitoring timeline and crediting strategy for Dry Creek is expected to be adaptively revised based on feedback from monitoring results over time (e.g., appropriate performance metrics to apply for the different types of monitoring, adequate sample sizes, ability to carry out a full BACI-based design, etc.), Table 7 is expected to provide the initial foundation for implementation and effectiveness evaluations of Dry Creek habitat enhancements for the Mile 1 Demonstration Project and will guide at least the first 3 years of monitoring.

3.5 Reporting schedule

Results from implementation monitoring will be reported to NMFS and CDFW during the first six months following the completion of implementation monitoring for all enhancement reaches within a given project reach. Results from effectiveness and validation monitoring will be reported during the first six months following completion of effectiveness monitoring for all enhancement reaches within a given project reach.

Table 7 Initial design and timeline for implementation, effectiveness and validation monitoring in Dry Creek. The proposed BACI component of the design will be dependent on establishing concurrently monitored reference sites for comparison.

Mile	Year	Implementation	Effectiveness		Validation		
			Feature	Reach	Feature/Site	Enhancement Reach	Watershed
pilot / baseline monitoring	2009	N/A	N/A	Yes (baseline)	Yes	Yes	Yes
	2010				Yes	Yes	Yes
Reference[1]	2011	N/A	N/A	N/A	Yes	Yes	Yes
	2012				Yes	Yes	Yes
	2013			BACI for mile 1	Yes	Yes	Yes
	2014				Yes	Yes	Yes
	2015				Yes	Yes	Yes
	2016				Yes	Yes	Yes
	2017			BACI for miles 2-3	Yes	Yes	Yes
	2018				Yes	Yes	Yes
	2019				Yes	Yes	Yes
	2020			BACI for miles 4-6	Yes	Yes	Yes
	2021				Yes	Yes	Yes
	2022				Yes	Yes	Yes
	2023				Yes	Yes	Yes
pilot / baseline monitoring	2009	N/A	N/A	Yes (baseline)	N/A	Yes	Yes
	2010					Yes	Yes
1	2011	N/A	N/A	N/A	N/A	Yes (pre-project)	Yes
	2012					Yes (pre-project)	Yes
	2013-14 (year 0)	Yes	Yes (baseline)	No	Yes (pre-project)	Yes (pre-project)	Yes
	2014-15	N/A	Yes (1x within 1-3 years depending on mobility flow)	Yes (1x within 1-3 years depending on mobility flow)[2]	Yes (post-project)	Yes (post-project)	Yes
	2015-16				Yes (post-project)	Yes (post-project)	Yes
	2016-17				Yes (post-project)	Yes (post-project)	Yes
	2017-18					Yes (post-project)	Yes
	2018-19					Yes (post-project)	Yes
	2019-20					Yes (post-project)	Yes
	2020-21					Yes (post-project)	Yes
	2021-22					Yes (post-project)	Yes
	2022-23		Yes (post-project)	Yes (post-project)[3]	Yes (post-project)	Yes (post-project)	Yes
pilot / baseline monitoring	2009	N/A	N/A	Yes (baseline)	N/A	N/A	Yes
	2010						Yes
2-3	2011	N/A	N/A	N/A	N/A	As soon as reach is identified	Yes
	2012						Yes
	2013			Repeat baseline if necessary (e.g. major changes)			Yes
	2014					Yes (pre-project)	Yes
	2015					Yes (pre-project)	Yes
	2016-17 (year 0)	Yes	Yes (baseline)		Yes (pre-project)	Yes (pre-project)	Yes
	2017-18		Yes (1x within 1-3 years depending on mobility flow)	Yes (1x within 1-3 years depending on mobility flow)[2]	Yes (post-project)	Yes (post-project)	Yes
	2018-19				Yes (post-project)	Yes (post-project)	Yes
	2019-20				Yes (post-project)	Yes (post-project)	Yes
	2020-21					Yes (post-project)	Yes
	2021-22					Yes (post-project)	Yes
	2022-23					Yes (post-project)	Yes
pilot / baseline monitoring	2009	N/A	N/A	Yes (baseline)	N/A	N/A	Yes
	2010						Yes
4-6	2011	N/A	N/A	N/A	N/A	As soon as reach is identified	Yes
	2012						Yes
	2013						Yes
	2014						Yes
	2015						Yes
	2016			Repeat baseline if necessary (e.g. major changes)			Yes
	2017					Yes (pre-project)	Yes
	2018					Yes (pre-project)	Yes
	2019-20 (year 0)	Yes	Yes (baseline)		Yes (pre-project)	Yes (pre-project)	Yes
	2020-21	N/A	Yes (1x within 1-3 years depending on mobility flow)	Yes (1x within 1-3 years depending on mobility flow)	Yes (post-project)	Yes (post-project)	Yes
	2021-22				Yes (post-project)	Yes (post-project)	Yes
	2022-23				Yes (post-project)	Yes (post-project)	Yes

[1] Section of Dry Creek a few hundred meters upstream of Westside Road Bridge. On a site visit on 6/23/10, participants agreed this section of stream probably represents best example of desired habitat conditions for juvenile coho in mainstem Dry Creek. Purpose of monitoring this reference section is to compare effectiveness and validation metrics with metrics in treatment reaches

[2] Level 2 habitat survey (use modified Harris (2004) effectiveness monitoring protocols)

[3] Repeat baseline habitat survey (use protocols in Inter-Fluve's 2010 "Current Conditions" report).

4.0 Implementing an adaptive management strategy

Implementation of the adaptive management plan for Dry Creek habitat enhancements as outlined in this document will follow the adaptive management cycle shown in Figure 2 and decisions (Figure 6) will be made on the basis of relevant sources (Figure 9).

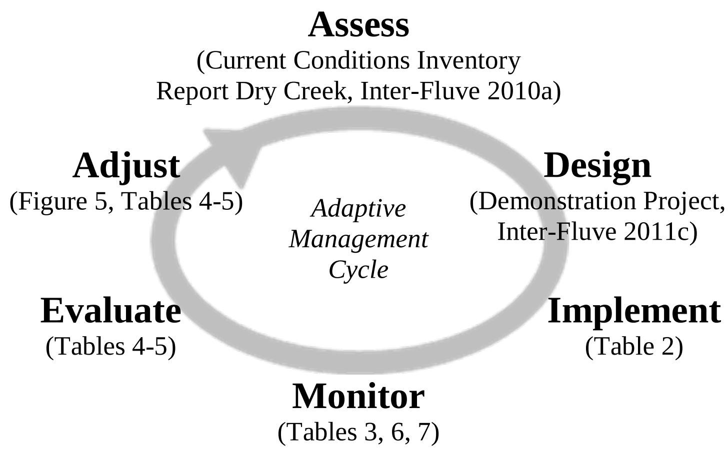

Figure 9 The adaptive management cycle (Murray and Marmorek 2003; Williams et al. 2007) including the releveant sources of information necessary to implement the AMP on Dry Creek.

Because of the period covered by this project (2009-2023), there is opportunity to learn which habitat measures are providing the greatest benefit in terms of physical habitat change to enhanced areas of Dry Creek and the associated biological responses. We will use this opportunity to learn which monitoring and sampling intensities provide the greatest benefit in terms of what we learn and can apply to later project phases.

In the spirit of adaptive monitoring and management, effectiveness monitoring in the AMP must reflect the need to understand the intended functioning of habitat enhancements of a dynamic, process-based nature (e.g., side channel location moving from time to time as dictated by geomorphologic changes) vs. enhancements that are static and fixed permanently to a specific location (e.g., boulder cluster). Questions that will guide effectiveness evaluations and allow incorporation of information learned into future designs and monitoring include:

- Did the project affect the physical, chemical and biological attributes at the appropriate scale (e.g., feature, site, or reach scale) as intended by the action?
- Has sufficient time passed for the project to be fully effective (e.g., riparian vegetation planting on newly constructed side channels would require multiple years to create shade depending on the species and local conditions)?
- Are there non-project activities in the Dry Creek watershed that are influencing the response of habitat to the enhancement projects, either positively or negatively?
- Is the extent/intensity of monitoring sufficient to assess habitat response to the project actions?

Similar to effectiveness monitoring, example questions that may guide future validation monitoring include:

- What biological response PMs are most appropriate to monitor at site, reach and watershed scales, and what are their associated targets?
- How should monitoring be conducted over space and time to assess the cause-effect linkages between habitat projects and associated fish population responses?

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Appendices

(Available Upon Request)