

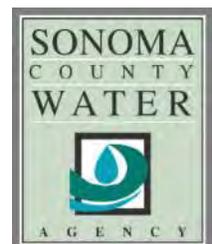
# DRY CREEK FISH HABITAT ENHANCEMENT: CONCEPTUAL DESIGN REPORT

Final Report • July 2012

**DRY CREEK:  
WARM SPRINGS DAM  
TO THE RUSSIAN RIVER  
SONOMA COUNTY, CA**



**PREPARED FOR**  
SONOMA COUNTY WATER AGENCY  
404 AVIATION BOULEVARD  
SANTA ROSA, CA 95403



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**FINAL**

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CONCEPTUAL DESIGN REPORT  
SONOMA COUNTY, CA**

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# DRY CREEK FISH HABITAT ENHANCEMENT FEASIBILITY STUDY: CONCEPTUAL DESIGN REPORT

## EXECUTIVE SUMMARY

### Introduction

Dry Creek is home to native threatened and endangered fish, including coho salmon, Chinook salmon, and steelhead trout. The National Marine Fisheries Service has determined that the operation of Warm Springs Dam could threaten the survival of coho salmon and steelhead trout in Dry Creek, and in 2008 issued a Biological Opinion requiring improvements to their habitat. In particular, key goals identified for habitat enhancement in Dry Creek include development of rearing and refugia habitat for Central California Coast (CCC) coho salmon (*Onchorhynchus kisutch*) and CCC steelhead trout (*O. mykiss*).

Habitat enhancement in Dry Creek is seen as a significant opportunity for the recovery of coho and steelhead in the region due to the relative abundance of cool water in the late summer months which is atypical of streams in the region. Late summer rearing conditions are considered a critical bottleneck for species recovery. Minimum habitat restoration goals are detailed more specifically in the Biological Opinion for Water Supply, Flood Control and Channel Maintenance Activities (RRBO: NMFS 2008).

The RRBO requires six miles of fish habitat enhancements to be implemented over the 13.9 mile long study reach. Generally, Dry Creek currently lacks high quality main channel and off-channel habitats which are critical for juvenile coho and steelhead rearing. The proposed habitat enhancements aim to directly address these deficiencies. The RRBO lays out a timeline for the habitat work, which will ultimately result in over six miles of habitat enhancement in Dry Creek implemented through three phases by 2020.

The Dry Creek Conceptual Design Report has been prepared to facilitate the implementation of fish habitat enhancement in Dry Creek in order to meet the requirements of the RRBO. Following the Feasibility Study Report (Inter-Fluve 2011a), this document presents conceptual designs for groups of off-channel and main-stem habitat enhancements throughout the study reach, and provides information to enable project evaluation, prioritization, selection, and planning for implementation of enhancements.

### Summary of Conceptual Designs

Conceptual designs were developed based on the current understanding of geomorphic processes in Dry Creek, as described in the Dry Creek Feasibility Study Report (Inter-Fluve 2012).

Main-channel enhancements include riffle construction, pool enhancement, main channel remeandering, and logjam installation. Off-channel enhancements include backwater channel construction, side channel construction, and the creation of winter refuge habitat. The main channel and off-channel habitat enhancements prescribed for each enhancement subreach are presented in the subreach-scale concept design booklets (Appendices A – N), which include corresponding cost estimate information.

### Spatial Organization

Dry Creek was stratified into three process-delineated segments in the feasibility study report (Inter-Fluve 2012). These include the upper segment (Warm Springs Dam to Pena Creek), the middle segment (Pena Creek to River Mile 3), and the lower segment (River Mile 3 to Russian River confluence). Within these three segments, the conceptual designs developed for lower Dry Creek include main channel and off-channel enhancements organized by the 16 habitat inventory reaches first delineated in the Dry Creek Current Conditions Report (Inter-Fluve 2010). These reaches were used to organize the field and analytical work accomplished in the current conditions and feasibility analysis phase. Within the 16 reaches are nested 25 'enhancement' subreaches, which are logical groupings of the off-channel and main-channel enhancement opportunities. In some cases, only one enhancement subreach fits into an inventory reach. In these cases, it is typically because the inventory reach was relatively short to begin with, or there was relatively limited enhancement potential. In other cases, the inventory reaches may be split into 2 or 3 enhancement subreaches. Each subreach may contain multiple off-channel and main-channel enhancements

### Project Evaluation and Prioritization

Prioritization of enhancement subreaches for implementation includes two main phases: project ranking and project selection. In order to summarize potential habitat benefits to assist with project ranking, three evaluation metrics were assessed for each of the 25 enhancement subreaches. These metrics are based on 1) potential summer coho rearing habitat, 2) incremental winter rearing and refugia habitat, and 3) total potential enhanced habitat. Following application of the metrics, the enhancement subreaches were further organized into Tier 1 and Tier 2 within each study reach segment (lower, middle and upper). Over the three study reach segments, the ranking phase resulted in a total of sixteen Tier 1 enhancement subreaches (out of twenty-five total).

Project selection represents the second phase of project prioritization. In this phase, the results of the ranking phase will be evaluated alongside other critical factors such as access, cost, and overall distribution along Dry Creek. Project selection will be ongoing over the next several years as the Water Agency and its partners identify opportunities to implement habitat enhancement to meet the requirements of the RRBO.

### Planning-level Conceptual Design Cost Opinions

Planning-level conceptual design cost opinions were prepared for comparison between alternative enhancement subreaches and for planning purposes. In the report, these estimates are summarized in terms of total costs and in terms of cost per unit habitat area.

## **ACKNOWLEDGEMENTS**

We would like to acknowledge the following groups for their respective contributions to this study:

Sonoma County Water Agency Staff

Dry Creek Property Owners

Dry Creek Advisory Group Members

National Marine Fisheries Service Staff

California Department of Fish and Game Staff

U.S. Army Corps of Engineers Staff

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## 1. INTRODUCTION

Dry Creek, a major tributary to the Russian River, flows 32 miles from its source at Snow Mountain near Hopland, CA to its mouth near Healdsburg in Sonoma County, California (Figure 1). Warm Springs Dam (WSD) at river mile (RM) 13.9 divides the rugged terrain and steeper channel of the upper watershed from the relatively flat agricultural valley and lower gradient channel that is present below the dam. Since 1984, WSD is operated by the Army Corps of Engineers to control floods, and by the Sonoma County Water Agency (Water Agency) to supply potable water to 600,000 consumers in Sonoma and northern Marin Counties. The dam is one of multiple facilities that comprise the Russian River Water Supply and Flood Control Project (RRWSFC).

The current geomorphology of lower Dry Creek is a result of the interaction between watershed characteristics, including local geology, hydrology, and vegetation; the legacy of channel evolution and response to land management changes; and the ongoing influence of flow management. 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. Following base-level lowering, widespread systemic incision occurred which 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. Modern hydrology in Dry Creek is characterized by greatly reduced flood peak magnitudes and elevated summer base-flows. Regulated hydrology has resulted in the establishment of dense riparian forest vegetation on bar features, and a reduced ability of the channel to erode vegetated floodplain surfaces due to a reduction of flood peak magnitudes by several hundred percent.

Dry Creek is home to ESA-listed native fish, including Central California Coast (CCC) coho salmon (*Onchorhynchus kisutch*; endangered) and steelhead trout (*O. mykiss*; threatened), and California Coastal (CC) Chinook salmon (*O. tshawytscha*; threatened). The National Marine Fisheries Service (NMFS) has 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 Biological Opinion for Water Supply, Flood Control and Channel Maintenance Activities for the Russian River Watershed (RRBO; NMFS 2008), which requires improvements to existing fish habitat in Dry Creek. In particular, key requirements focus on rearing and refugia habitat for coho and steelhead. Generally, Dry Creek currently lacks high quality main channel and off-channel habitats which are critical for juvenile coho and steelhead rearing. The proposed habitat enhancements aim to directly address these deficiencies.

Dry Creek is seen as 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 which is atypical of streams in the region. Late summer rearing conditions are considered a critical bottleneck for species recovery. Habitat enhancement goals for Dry Creek are discussed later in this document and detailed more specifically in the RRBO (NMFS 2008). The RRBO lays out a timeline for the habitat work, which will ultimately result in six miles of habitat enhancement in Dry Creek by 2020. This Conceptual Design Report presents conceptual designs for over 4,000,000 ft<sup>2</sup> of enhancements spaced over the 13.9 mile project reach between WSD and the Russian River (hereafter referred to as 'lower Dry Creek'). The conceptual designs were developed specifically to meet the goals laid out by the RRBO.

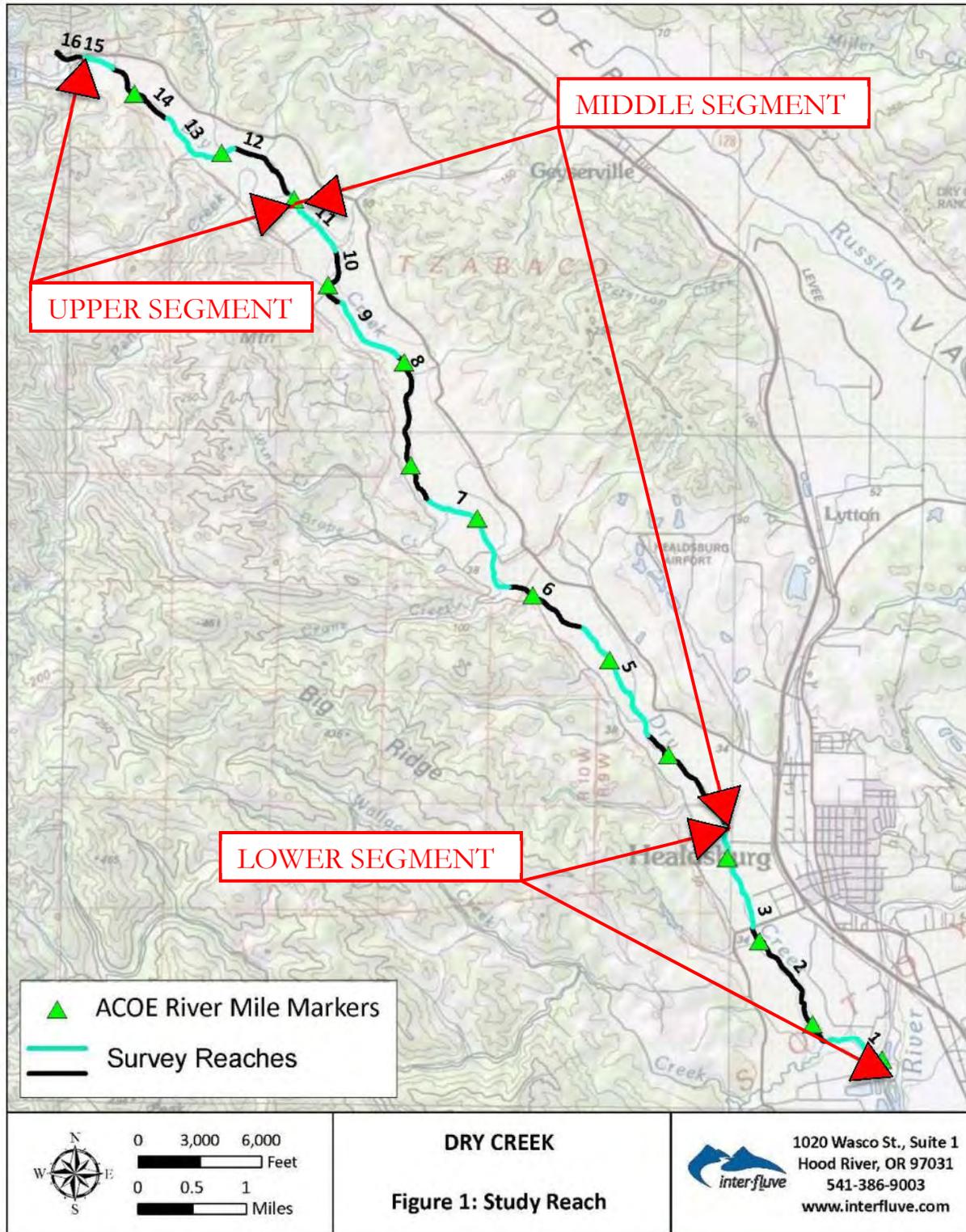


Figure 1. Map of Lower Dry Creek between Warm Springs Dam and the Russian River.

## 2. SCOPE OF WORK

The feasibility study is being conducted in three phases. Phase 1 included inventory and assessment of current conditions along Dry Creek between Warm Springs Dam and the confluence with the Russian River. Completed between the summer of 2009 and the spring of 2010, the final version of the Dry Creek Current Conditions Report was issued in December 2010 (Inter-Fluve 2010). Conducted between the summer of 2010 to the winter of 2011, Phase 2 included detailed feasibility assessment of habitat enhancement approaches. The Draft Feasibility Study Report was issued in April 2011 and finalized in July 2012.

The third phase of the feasibility study (the subject of this draft report), involved development of conceptual designs for habitat enhancement approaches deemed feasible as a result of the feasibility assessment. The conceptual design phase has included the following tasks:

- Development of conceptual designs for the study reach, based on the results of the feasibility assessment (Inter-Fluve 2012),
- Development of planning level cost estimates for the conceptual designs,
- Development and application of evaluation metrics to enable comparative review of project opportunities for which conceptual designs have been prepared, and
- Summarize the results of application of the evaluation metrics.

## 3. PREVIOUS STUDIES BY INTER-FLUVE

As noted above, the feasibility study has resulted in two reports which provide a foundation for the conceptual designs. These reports are summarized below:

- *Final Current Conditions Report, Dry Creek from Warm Springs Dam to the Confluence with the Russian River* (Inter-Fluve 2010): This report includes a summary of watershed context and hydrology, an assessment of stream geomorphology based on available data and field observations, and a detailed summary of the fish habitat inventory completed in summer 2009.
- *Final Habitat Enhancement Feasibility Study Report, Dry Creek from Warm Springs Dam to the Confluence with the Russian River* (Inter-Fluve 2012): This report includes additional quantitative assessment of stream geomorphology and trajectory, and assessment of the feasibility of fish habitat enhancement to meet the habitat goals of the RRBO on Dry Creek.

The reader is referred to the above reports for more detailed discussions of the results of the current conditions and feasibility assessments.

## 4. ENHANCEMENT GOALS, OBJECTIVES AND DESIGN CRITERIA

The following section describes the goals, objectives and assumed design criteria for the Dry Creek Habitat Enhancement Project which guided the development of the conceptual designs.

### 4.1 PROJECT GOAL

In the broadest sense, the goal of the Dry Creek Habitat Enhancement Project is to:

- Enhance channel and riparian conditions on lower Dry Creek to benefit juvenile life stages of ESA-listed coho salmon and steelhead trout, which will aid in their recovery within the region.

### 4.2 ATTENDANT OBJECTIVES

Attendant to the project goal, the following are the primary objectives for the Dry Creek Habitat Enhancement Project:

- Enhance summer rearing habitat for coho salmon and steelhead to ‘near-ideal’ conditions,
- Enhance summer rearing habitat for steelhead to ‘near-ideal’ conditions,
- Create refugia from winter high-flow releases for both coho salmon and steelhead,
- Enhance habitat, and to the extent feasible, minimize impacts on private property and infrastructure.
- Enhance habitat without adversely affecting Chinook salmon.

### 4.3 DESIGN CRITERIA

The RRBO lays out criteria which define high quality rearing habitat conditions for coho salmon and steelhead trout. These criteria were combined with additional considerations to constitute the preliminary design criteria for the project, summarized in Table 1. Although the RRBO is a 15-year guiding document, NMFS and CDFG will likely require the Water Agency to maintain functioning coho and steelhead habitat beyond this time frame. It is anticipated that the habitat enhancements will continue to provide habitat benefits and be maintained in approximately similar quantities for 25 years. The Water Agency, NMFS, and CDFG are engaged in an adaptive management planning process that will specify goals, objectives, and monitoring methods to verify the effectiveness and longevity of habitat enhancements (Porter et al. 2011).

Table 1. Dry Creek Fish Habitat Enhancement Design Criteria

Feature/Issue	Criteria	Remarks/Reference
Fish Habitat Design Criteria		
a. Target flow range	<ul style="list-style-type: none"> <li>• 110 to 175 cfs</li> </ul>	<ul style="list-style-type: none"> <li>• Flow range outlined in RRBO</li> </ul>
b. Pool Abundance	<ul style="list-style-type: none"> <li>• 33% to 67% of all habitats</li> </ul>	<ul style="list-style-type: none"> <li>• RRBO</li> </ul>
c. Pool : riffle ratio	<ul style="list-style-type: none"> <li>• 1:2 to 2:1</li> </ul>	<ul style="list-style-type: none"> <li>• RRBO</li> </ul>
d. Water depth	<ul style="list-style-type: none"> <li>• 2 to 4 feet in pools</li> </ul>	<ul style="list-style-type: none"> <li>• RRBO</li> </ul>
e. Velocity in rearing habitat	<ul style="list-style-type: none"> <li>• &lt; 0.2 ft/s</li> <li>• Reduced from present conditions to extent practicable</li> </ul>	<ul style="list-style-type: none"> <li>• RRBO</li> <li>• Primarily able to be met in off-channel habitats and shelter habitats associated with large woody debris</li> <li>• Local velocities in mainstem pool habitat</li> </ul>
f. Cover	<ul style="list-style-type: none"> <li>• &gt;30% of habitat bottom obscured by cover</li> </ul>	<ul style="list-style-type: none"> <li>• RRBO</li> <li>• due to depth, surface turbulence, or presence of structures such as logs, debris piles, boulders, or overhanging banks and vegetation</li> </ul>
g. Refugia habitat	<ul style="list-style-type: none"> <li>• Should provide high quality shelter during high flow releases</li> </ul>	<ul style="list-style-type: none"> <li>• RRBO</li> </ul>
h. Longevity of habitat	<ul style="list-style-type: none"> <li>• 25 years in approximately similar quantities though adjustments will occur</li> </ul>	<ul style="list-style-type: none"> <li>• Water Agency</li> </ul>
Large Woody Debris Stability		
i. Mobility of LWD	<ul style="list-style-type: none"> <li>• 25 year event</li> </ul>	<ul style="list-style-type: none"> <li>• In most cases, stability requirements similar between Q2 and Q100-year events.</li> </ul>
j. LWD Decay	<ul style="list-style-type: none"> <li>• 15-25 year period</li> </ul>	<ul style="list-style-type: none"> <li>• Typical decay rates for coniferous species</li> </ul>
Vertical Stability		
k. Design stability for riffles	<ul style="list-style-type: none"> <li>• 25 year event</li> </ul>	<ul style="list-style-type: none"> <li>• In most cases, design substrate sizing is similar between Q2 and Q100 events</li> </ul>
Lateral Stability		
l. Stream boundaries constructed inside the channel corridor	<ul style="list-style-type: none"> <li>• 5 year event</li> </ul>	<ul style="list-style-type: none"> <li>• Relatively deformable boundary construction</li> </ul>
m. Stream boundaries constructed along margin of the channel corridor	<ul style="list-style-type: none"> <li>• 50-year event</li> </ul>	<ul style="list-style-type: none"> <li>• Less deformable boundary construction</li> </ul>
n. Stream boundary construction techniques	<ul style="list-style-type: none"> <li>• Employ techniques that also provide margin shelter and riparian habitat</li> </ul>	<ul style="list-style-type: none"> <li>• Biotechnical techniques</li> </ul>

Table 1. Dry Creek Fish Habitat Enhancement Design Criteria

Feature/Issue	Criteria	Remarks/Reference
<b>Planform Stability</b>		
o. Avulsion into off-channel habitat	<ul style="list-style-type: none"> <li>• None within first 5 years following construction, notwithstanding extraordinary hydrologic events</li> <li>• Future avulsion is acceptable provided habitat criteria continue to be met</li> </ul>	<ul style="list-style-type: none"> <li>• Address risk of avulsion through design overbank roughness created with LWD</li> </ul>
<b>Riparian Vegetation</b>		
p. Invasive species	<ul style="list-style-type: none"> <li>• Endeavor to eliminate invasive vegetation</li> </ul>	
q. Native revegetation	<ul style="list-style-type: none"> <li>• Encourage diverse, less dense native community</li> </ul>	
<b>Construction Period</b>		
r. Impacts to existing resources	<ul style="list-style-type: none"> <li>• Minimal</li> </ul>	
s. Impacts to adjacent operations	<ul style="list-style-type: none"> <li>• Minimal</li> </ul>	
t. Impacts to infrastructure	<ul style="list-style-type: none"> <li>• None</li> </ul>	

## 5. GENERAL ENHANCEMENT APPROACHES

Fish habitat enhancements will emphasize natural stream characteristics, or those which evolve through a given stream's geomorphology. By using enhancement practices that emulate 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 the project reach, and the planned adaptive management approach will assist with this. Design concepts have been developed based on our understanding of physical processes in each segment of Dry Creek. The Dry Creek Feasibility Report laid out the different processes occurring in the upper, middle and lower 'segments' of Dry Creek, each of which contain several of the 'inventory reaches' first delineated in the Current Conditions Report (Figure 1; Inter-Fluve 2010).

Channel processes and dynamics vary along the length of Dry Creek, which suggest tailoring the enhancement approach in each segment to match the prevailing fluvial processes at each location. In general, the approaches may fall in a range defined by strongly process-reliant at one end, and direct habitat construction at the other end. Accordingly, Lower Dry Creek has been split into three segments based on dominant physical processes and other shared characteristics: 1) upstream of Pena Creek (RM 11 to 13.7), 2) Pena Creek to the grade control sills (RM 3 to 11), and 3) from the grade control sills to the Russian River confluence (RM 0 to 3); see Figure 1. Generally, enhancement projects will be identified to include a series of main channel and off-channel enhancements which will provide continuity of juvenile coho and steelhead habitats through a given project reach.

The prevailing physical functions and implications for developing fish habitat of the desired character within each Dry Creek segment (upper, middle, lower) include the following:

- *Upper Segment:* Upstream of Pena Creek, construction of late-successional habitat was assessed to be feasible with low risk of the constructed habitat being compromised due to nuisance sediment deposition or other factors. Conversely, relying on channel processes to create the habitat was deemed to have low feasibility due to the lack of sediment supply and highly regulated hydrology. Generally, enhancement through direct habitat construction can be considered as having low risk of failure in this segment relative to other segments.
- *Middle Segment:* The middle segment stretching from RM 3 - 11 has greater sediment supply than the upstream reach due to the unregulated tributaries which enter Dry Creek below WSD. This increases the risk for nuisance sedimentation impacts to potential directly-constructed off-channel habitat. This risk can be mitigated through appropriate site selection and other considerations. In this segment, off-channel enhancements may shift in character due to channel processes, again dependent on the characteristics of each site. Conversely, several large off-channel opportunities may lend themselves to a more dynamic, process-focused approach, or combined approach. In summary, the preferred enhancement approach to each site is more variable in this segment than the other two segments, and careful consideration of the attributes of each proposed location will determine the corresponding advisable enhancement strategy.
- *Lower Segment:* In the downstream segment (RM 0-3), there is high risk that a direct habitat construction approach would be compromised by sedimentation due to the backwater influence of

the Russian River (Figure 2). Conversely, enhancement that relies on a modified process-driven approach likely provides 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.

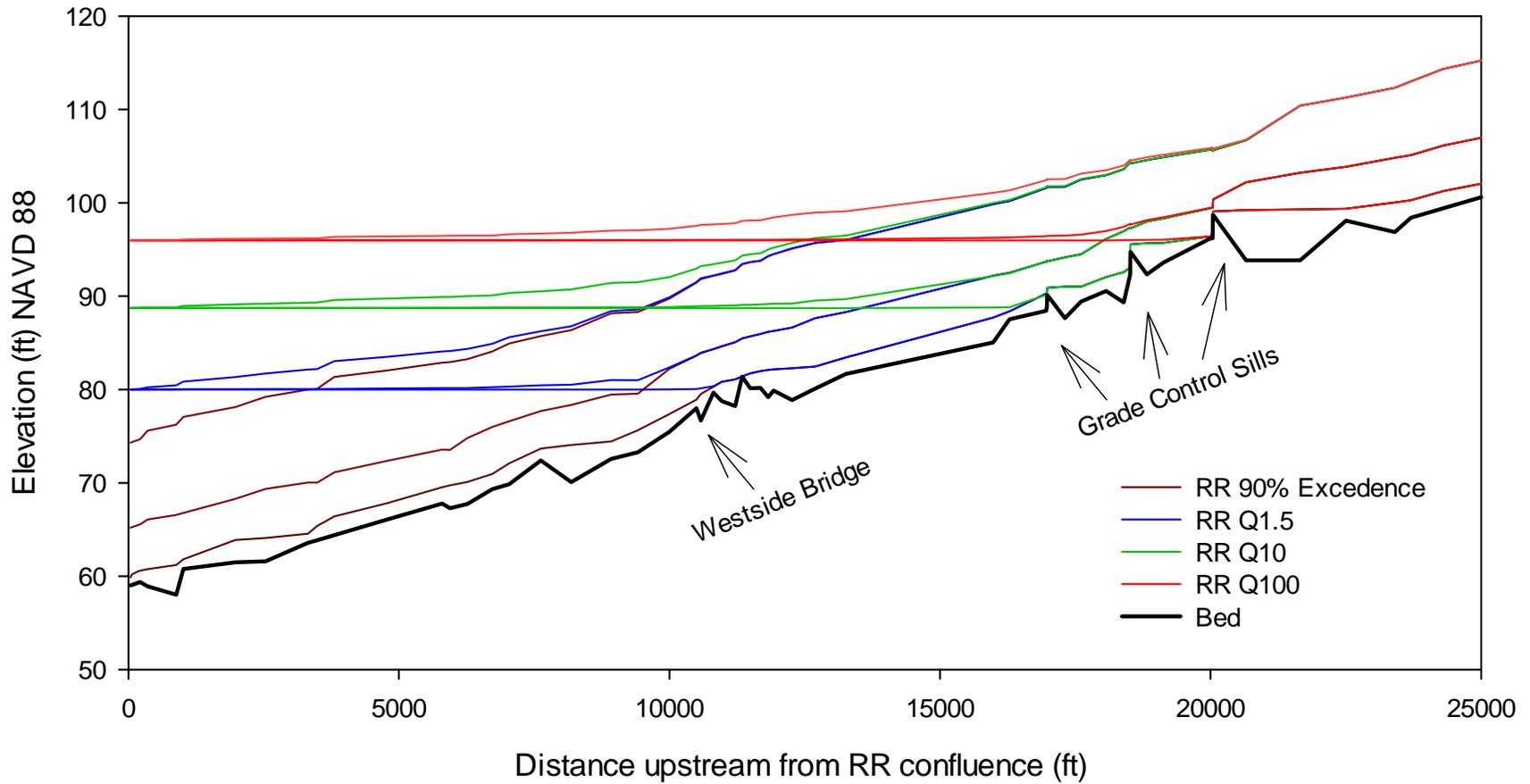


Figure 2. Model results predicting Dry Creek water surface elevations at 110 cfs, Q1 and Q10 in Dry Creek for 4 different flow levels in the Russian River, from Inter-Fluve 2012.

## 6. THE ENHANCEMENT TOOLBOX

Conceptual designs created for the enhancement subreaches emphasize natural stream characteristics, or those which evolve through a given stream's geomorphology. By using enhancement practices that emulate 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 the project reach, and the planned adaptive management approach will assist with this. The following paragraphs describe the primary enhancement approaches applied to the conceptual designs included in Appendices A through N. See the Feasibility Study Report (Inter-Fluve 2012) for more detail on these approaches.

### 6.1 BACKWATER CHANNELS AND ALCOVES



Backwater channels, alcoves and ponds (Figure 3 and Figure 4) are areas off to the side of the stream that in summer connect to the main stream only at their downstream end. During this time, water backs into these areas, and has very low or no current. In addition to still water, logs that protrude into or float on the water, floating and submerged vegetation, and surrounding tall vegetation make these areas very attractive to juvenile fish. They use these areas to search for food, rest and to avoid predators. During winter periods, these areas will continue to have quiet water despite occasional high flows moving through them. In Dry Creek, this type of habitat will be primarily constructed in wider areas of the creek. This type of habitat provides the greatest opportunity to meet the target velocity criteria specified in the RRBO (Inter-Fluve 2012). Construction of these areas will include excavation to achieve desired grades relative to the summer water surface elevation and include placement of logs at appropriate locations, planting of aquatic vegetation and management of surrounding vegetation. The bottom grades for these areas have been set at 4 feet below the summer water surface elevations.

Based on repeat observations of backwater habitats in Dry Creek and assessment of the response of these habitats to high flow events, and monitoring of constructed side channels on other streams, Inter-Fluve (2012) developed guidelines to inform design of this habitat type on Dry Creek (Table 2). The primary challenges to the longevity of constructed backwater habitats are nuisance sedimentation and downstream changes in the main channel affecting the hydraulic control for the backwater habitat. Of the backwater channels reviewed on Dry Creek to date, those whose upstream ends were located a moderate distance from the active channel, and/or with a section of hydraulically rough floodplain between the upstream channel and the habitat were substantially less affected. These considerations will promote the longevity of the constructed habitat. Nevertheless, some degree of sedimentation in these areas will be unavoidable, and this issue should be tracked through the adaptive management program. Over the length of Dry Creek, there will be variability between the constructed backwater channels in terms of sedimentation and adjustment to flood flow. These responses can be expected to varying degrees over the 25-year horizon assigned to the project.



*Figure 3. Conceptual depiction of backwater channel and alcove.*



*Figure 4. Conceptual depiction of backwater pond feature.*

Table 2. Considerations for design of backwater channels on Dry Creek, based on field observations of similar habitats on Dry Creek, and observations of constructed side channel evolution on other project sites.

Consideration	Relevant Failure Mode
Outlets should not be located in depositional zones (e.g., riffles)	Nuisance sedimentation
Moderate distance from the active channel at the upstream end, and/or	Nuisance sedimentation
Hydraulically rough zone between active channel and upstream end	Nuisance sedimentation
A robust control on channel grade should be located downstream of the outlet (e.g., riffle)	Abandonment by loss of hydraulic control.

Substantial volumes of large woody debris will be installed in the backwater habitats. These installations will be overtopped by the full range of flood flows. In order to remain in the enhancement areas over a prolonged period to continue to provide habitat value, the large woody debris must either be large enough that it cannot be transported by the stream, or be ballasted to prevent its mobilization. Because it is not realistic to supply the size of large woody debris that would be self-stable in the reach (i.e., old growth logs), the large woody debris installed in Dry Creek will be ballasted to emulate the stability characteristics of much larger logs. Large woody debris will be ballasted through a range of techniques which will include partial burial, and cabling to other logs, existing mature trees, timber piles, snags, and/or boulders.

## 6.2 SIDE CHANNELS



Side channels run parallel to the main stream and connect at both ends, including during the summer (Figure 5). The flow of the stream is split between the two channels. This serves to reduce the stream current, which in combination with pools and logs in the water, make these areas attractive to coho salmon and steelhead trout. The fish use these areas to search for food, to rest and to avoid predators. In Dry Creek, this type of habitat will also be primarily constructed in wider areas of the creek. In some of these areas, old abandoned channels may be excavated to provide enhanced side channels. Construction of these areas will entail excavation to form the channel, riffles and pools; placement of logs at appropriate locations, and management of the surrounding vegetation.

Based on repeat observations of backwater habitats in Dry Creek and assessment of the response of these habitats to high flow events, and monitoring of constructed side channels on other streams, Inter-Fluve (2012) developed guidelines to inform design of this habitat type on Dry Creek (Table 3).



Figure 5. Conceptual depiction of side channel.

Table 3. Consideration for design of side channels on Dry Creek, based on observations of similar habitats on Dry Creek following a high water event, and observations of constructed side channel evolution on other project sites.

Consideration	Relevant Failure Mode
Inlets and Outlets should not be located in depositional zones (e.g., riffles)	Nuisance sedimentation
Side channel inlet alignment should be oblique to upstream main channel alignment	Nuisance sedimentation, debris blockage
Sediment competency should be balanced with the main channel	Nuisance sedimentation
A robust control on channel grade should be located downstream of the outlet (e.g., riffle)	Abandonment by loss of hydraulic control.

### 6.3 LOG JAMS



A log jam is an accumulation of logs that may be constructed in an area where it would be beneficial to initiate or stabilize a turn or fork in the channel (Figure 6). The log jam serves to anchor the stream's location by being an immobile object along one or both banks, acting similar to a bridge abutment or a natural bedrock outcrop. Deep pools may form next to log jams through the interaction of the logs and flowing water, creating excellent fish habitat. To create a log jam, an area is excavated and then logs are stacked and knit together with boulders and “snags” (trunks of dead trees that remain standing vertical to the horizon). This combination stabilizes the log jam during floods. Similar to the descriptions above for large woody debris in backwater and pool habitats, large woody debris in log jams will be ballasted through a range of techniques to enhance its longevity in the reach.

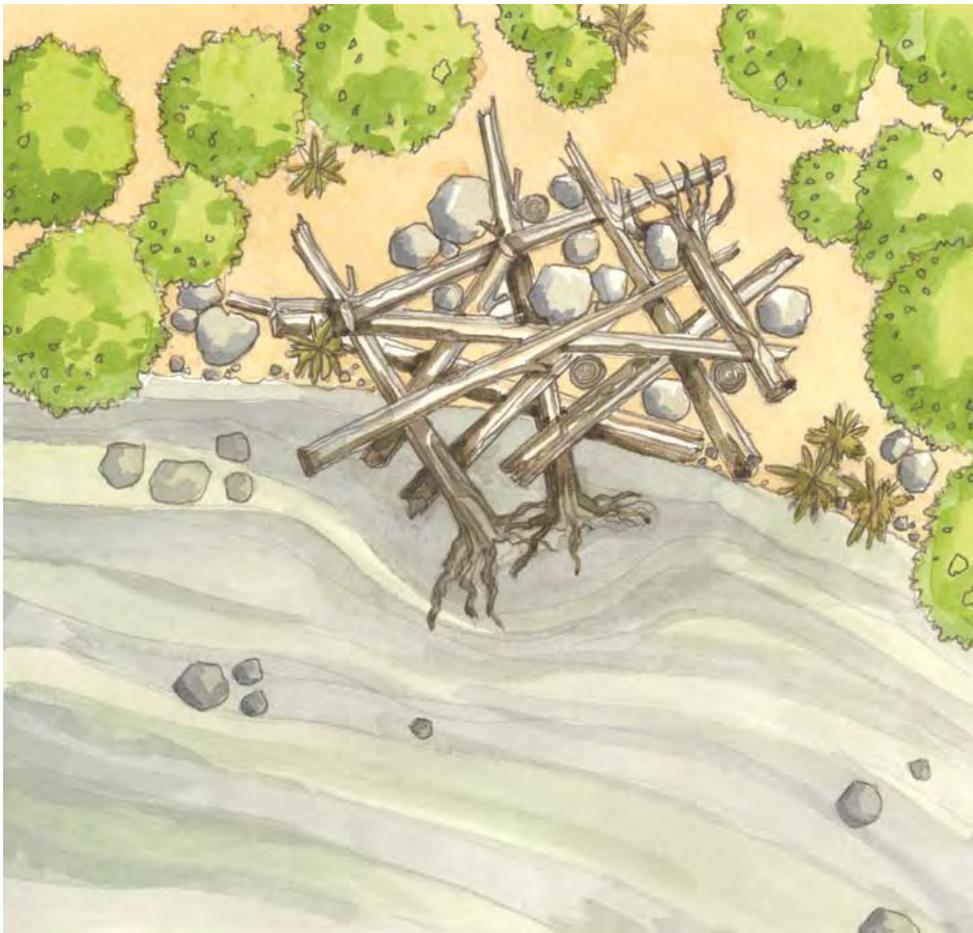


Figure 6. Conceptual depiction of a log jam.

## 6.4 RIFFLE CONSTRUCTION AND POOL ENHANCEMENT



Riffles are areas where the streambed is steeper and the current is swift (Figure 7). Riffles play a key role in controlling the elevation of the streambed and releasing the stream's energy so that the current flowing through adjoining pools is slower during the summer period. They are also important for food production. Riffle habitat was found to be relatively lacking during the 2009 habitat inventory, which leads to long flatwater and pool habitat units with swifter than desired velocities and that lack complexity (Inter-Fluve 2010). Riffle habitat is lacking because Dry Creek has evolved to a condition where it is very efficient at transporting the sediment that is supplied to the stream downstream of WSD (Inter-Fluve 2012).

Pools are deeper areas of the stream which in a healthy stream provide key habitat for young fish because currents are slow, the flow patterns are diverse, and fish can hide beneath logs that project into the water (Figure 8). Proposed pool enhancement in the enhancement areas will act to increase the complexity and diversity of habitat for young fish, and create areas that have sheltered currents that young fish prefer. This will be accomplished with selected grading of existing pool features and the installation of large woody debris along the pool margins. Additionally, as described above, pool velocities will be reduced due to riffle construction.

Construction of riffles is proposed to provide key grade control for backwater habitats and to improve the quality of the adjoining pools for fish. The riffles are designed to backwater the adjacent upstream pool in the summer operational discharge range, which will flatten the water surface through the pool and lead to reduced stream velocity. Although the riffles will reduce stream velocity through the existing pools, the primary locations in these habitats where the target velocity criteria specified in the RRBO will be met will be in shelter habitats associated with large woody debris and along the channel margins. Riffles are constructed with a well-mixed layer of small boulders, cobbles, gravel and sand across the stream, and entail excavation of portions of the existing streambed to prepare suitable subgrade conditions.

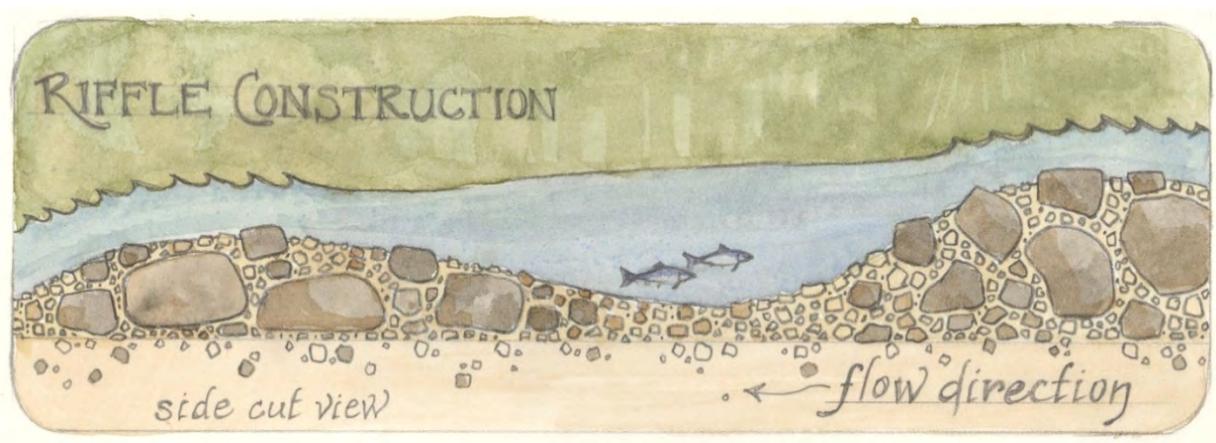


Figure 7. Conceptual depiction of riffle construction.

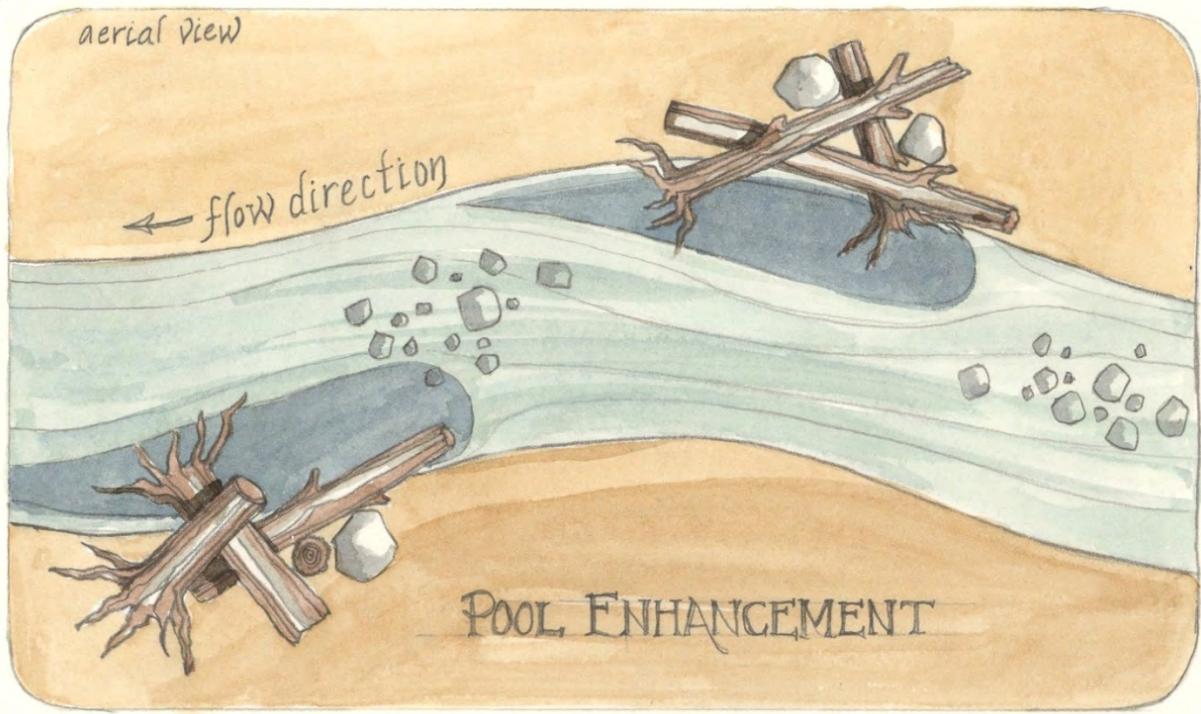


Figure 8. Conceptual depiction of pool enhancement.

## 6.5 WINTER REFUGE HABITAT



Winter refuge zones are areas where fish can escape high velocities in the main stream channel during elevated winter flows (Figure 9). Winter refuge habitats are floodplain areas that become inundated during frequent 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, and terrestrial vegetation. Winter refuge habitats are created by lowering certain portions of the floodplain in order to increase the frequency of inundation. LWD will be placed in winter refuge habitats in order to provide additional cover, and enhance the flood refuge for juvenile salmonids. In addition to lowering floodplain areas to create winter refuge habitat, constructed backwater channels will provide winter refuge over a large range of flows.

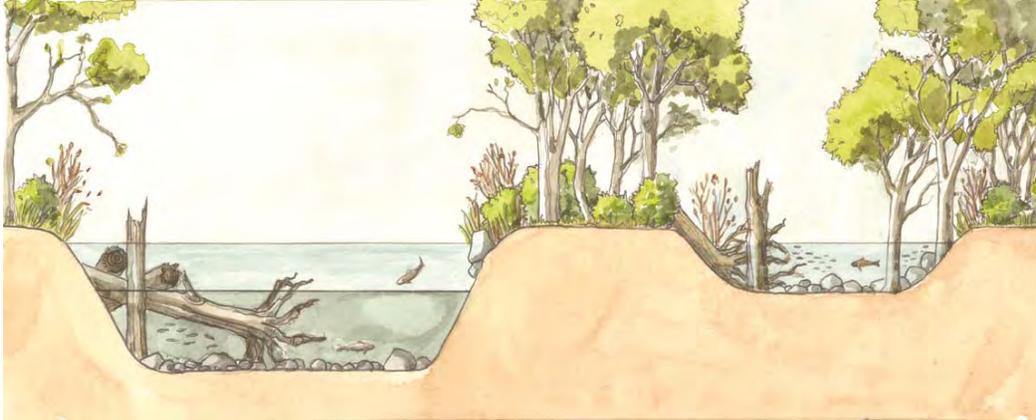


Figure 9. Conceptual depiction of winter refuge habitat.

## 6.6 VEGETATION MANAGEMENT



Dry Creek has extensive vegetative growth along the channel, which includes many non-native or invasive weed species. In some areas, overly dense stands of vegetation impair stream function by channelizing the flow of the creek and acting like a levee, which forces energy into the creek bed, and results in pools that are too long, with water that moves too swiftly (Figure 10).

In general, the vegetation within the project area does not display the range of different successional classes indicative of a dynamic, properly functioning riparian system. Plant communities within intact riparian systems typically consist of a variety of vegetation communities that represent a range of different age classes and structural types. This pattern is largely a function of active floodplain evolution which is currently suppressed in the project reach.

Riparian vegetation management will include selective thinning of existing vegetation, removal of invasive weeds, and in some cases, replanting of native vegetation (Figure 11). A palette of native plants to be used in revegetation activities would be developed in consultation with the Sonoma County Stream Maintenance Program Manual (Horizon Water and Environment 2009).



*Figure 10. Conceptual depiction of riparian vegetation before treatment.*



*Figure 11. Conceptual depiction of riparian vegetation after treatment.*

## 6.7 STREAMBANK CONSTRUCTION



Streambank construction techniques may be applied at select locations to prevent the creek from migrating into high terraces, where graded slopes are steeper than 3 horizontal to 1 vertical, or where the main channel planform is adjusted. The technique used in a given location will depend on shear stresses acting on the bank, substrate, slope, and other factors. Potential streambank construction areas will be evaluated in greater detail once project reaches are selected.

## 6.8 DYNAMIC PROCESS-BASED FLOODPLAIN ENHANCEMENT



In the lower segment of Dry Creek, highly dynamic channel processes are present due to the supply of water and sediment from unregulated tributaries, and the influence of the Russian River which creates a backwater profile upstream into Dry Creek during floods. In this section of Dry Creek, the construction of late-successional habitats will not provide lasting habitat benefits due to the risk for sedimentation or other impacts on enhancements. A different approach was developed to utilize construction techniques designed to set the stage for the enhancement to be dynamic and continue to provide habitat benefits over time. In the lower two miles of Dry Creek, lateral floodplain surfaces and bars are perched high above the main channel. This approach would reconnect floodplain processes by shaving down lateral bars and excavating terraces to “reset” the connectivity between the channel and its floodplain which are not currently accessed frequently during storm events. Excavation, grading, and construction of logjams in strategic locations set the stage for a diverse suite of habitats to evolve and change over time (Figure 12).

This approach relies on both heavy construction techniques and natural processes to drive the evolution of habitats over time. This approach is based on the function of natural floodplain systems. In naturally-functioning channels, lateral, or off-channel, habitats may be short lived habitat types in floodplain systems. Alcoves and backwater channels may be destroyed and recreated as channels migrate across their floodplains, but the quantities or availability of off-channel and main channel habitat remains relatively stable. Although these habitats are constantly being created and destroyed over time, they typically offer high quality habitat and are responsible for a significant portion of juvenile coho productivity in many river systems. Juvenile coho utilize these lateral habitats to seek out terrestrial and aquatic food sources, to find refuge from the main channel, and avoid predators.

Dynamic process-based floodplain restoration in the lower segment will utilize a combination of floodplain grading, logjam construction, and excavation of off-channel habitats. Substantial excavation of the floodplain will serve to increase the frequency of inundation and create large areas of “Pilot Winter Refuge Habitat.” Additionally, the excavation of “Pilot Off-Channel Habitat” will provide immediate summer habitat function, but this habitat is expected to change over time and potentially soon after construction. Logjams will be installed in strategic locations in order to encourage planform development in response to flood flows and sediment supply. Over time, pilot off-channel habitat will be become main channel habitat, and vice-versa.

Reconnecting the channel to its floodplain will allow for main channel and floodplain habitats to be dynamic over time.

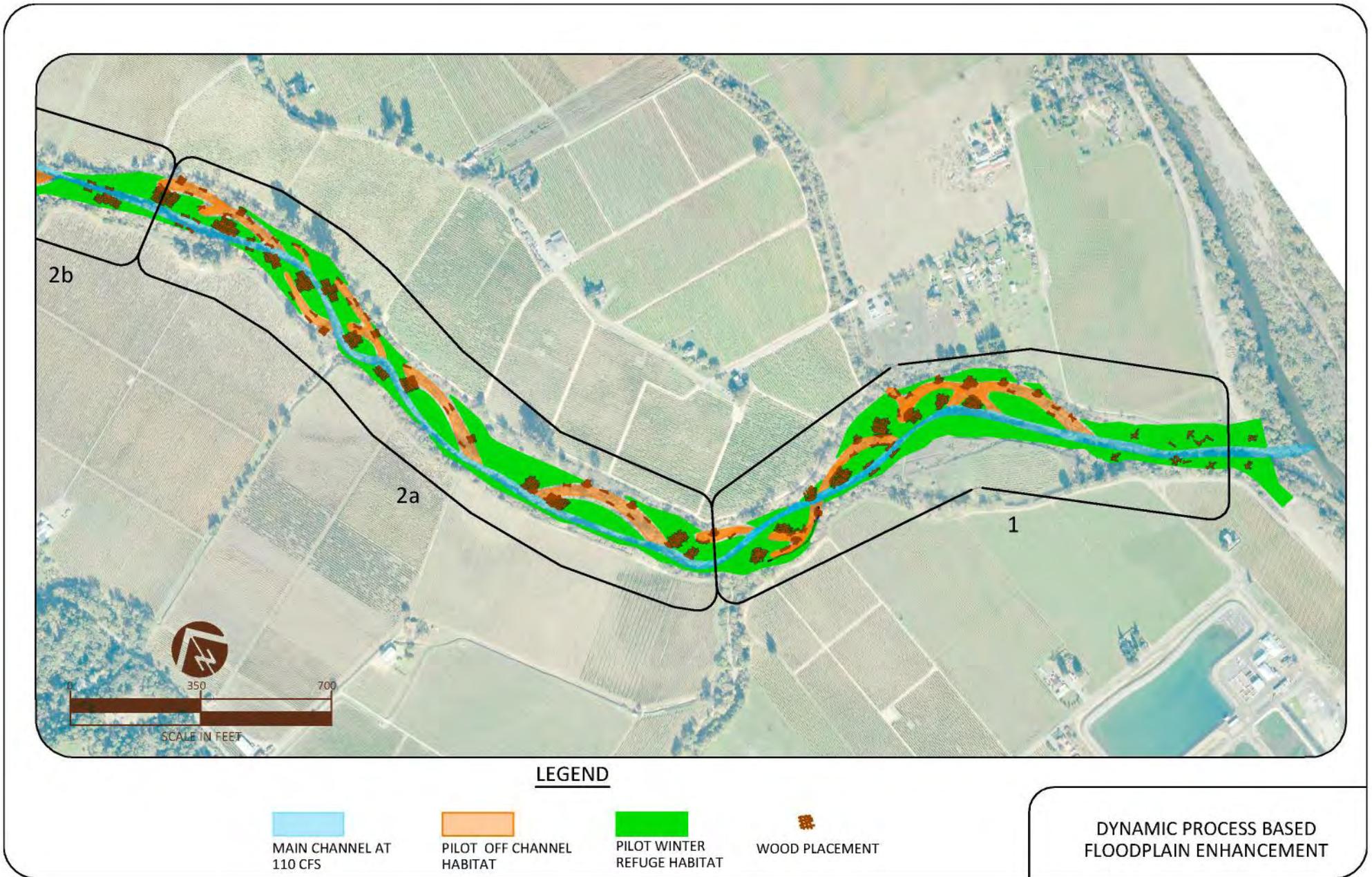


Figure 12. Depiction of dynamic, process-based enhancement in enhancement subreaches 1 and 2.

## 7. SPATIAL ORGANIZATION OF CONCEPTUAL DESIGNS

Habitat enhancements described in this report are organized based on the sixteen ‘inventory reaches’ first established in the Dry Creek Current Conditions Report (Figure 1, Table 4 : Inter-Fluve 2010). In order to organize the conceptual designs and to facilitate the project evaluation and prioritization process, the 16 inventory reaches have been further sub-divided into 25 ‘enhancement subreaches’ (Figure 13). Each enhancement subreach contains multiple ‘enhancement sites’, which refer to groupings of individual habitat features such as backwater channels, pools, riffles, log jams, etc<sup>1</sup>. This organization approach was implemented in order to result in a manageable number of potential alternate conceptual designs, which are at the scale that enhancements would be advanced towards implementation.

Within this report, the conceptual designs are presented in the form of conceptual design booklets, found in Appendices A-N. Each of these appendices describes the conceptual designs contained within a single inventory reach. The general outline for these design briefs includes a general overview of the inventory reach, and then one or more subsections that are dedicated to each enhancement subreach found within the inventory reach. The treatment of each enhancement subreach includes narrative description, conceptual plans, estimation of habitat benefits, and planning-level cost estimate.

It should be noted that inventory reaches 15, 11, 6, and 1 were not divided into enhancement subreaches due to either limited reach length, or lack of enhancement opportunities, within the reach. Additionally, conceptual designs are not presented for inventory reach 7, as this constitutes the one-mile demonstration reach that has been advanced towards implementation on an accelerated timeline. See the Demonstration Reach design report (Inter-Fluve 2011) for further detail on the enhancement approach in the Dry Creek demonstration reach.

In some cases the inventory reach boundaries did not match up perfectly with the enhancement concept locations for a given enhancement subreach. For example, the backwater channel at the lower end of reach 8 would necessarily be constructed paired with a riffle that is actually located at the upstream end of reach 7. In a case such as this, the grouping of the backwater channel and riffle into the same subreach was maintained, even though technically one of the features would fall into the adjacent inventory reach. In this way, in a few cases habitat units from outside of a given inventory reach or enhancement subreach were grouped with projects in an adjacent reach/subreach in order to employ a consistent methodology for grouping enhancement sites.

It is recognized that the exact groupings of enhancement sites selected for implementation may not precisely match the groupings of the concept designs as presented in this report. Appendix O provides a summary table of cost information at the individual site scale. This may facilitate contemplation of alternate groupings of projects during the evaluation and prioritization phase.

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<sup>1</sup> For example, 0.5 mile long Sub-Reach X may consist of a series of riffle/pool enhancements, one backwater channel, and one side channel. Cost estimates are developed to represent the cost associated with all of the enhancement “features” in Sub-Reach X. Predicted habitat benefits are reported assuming that all enhancement sites in Sub-Reach X are constructed together.

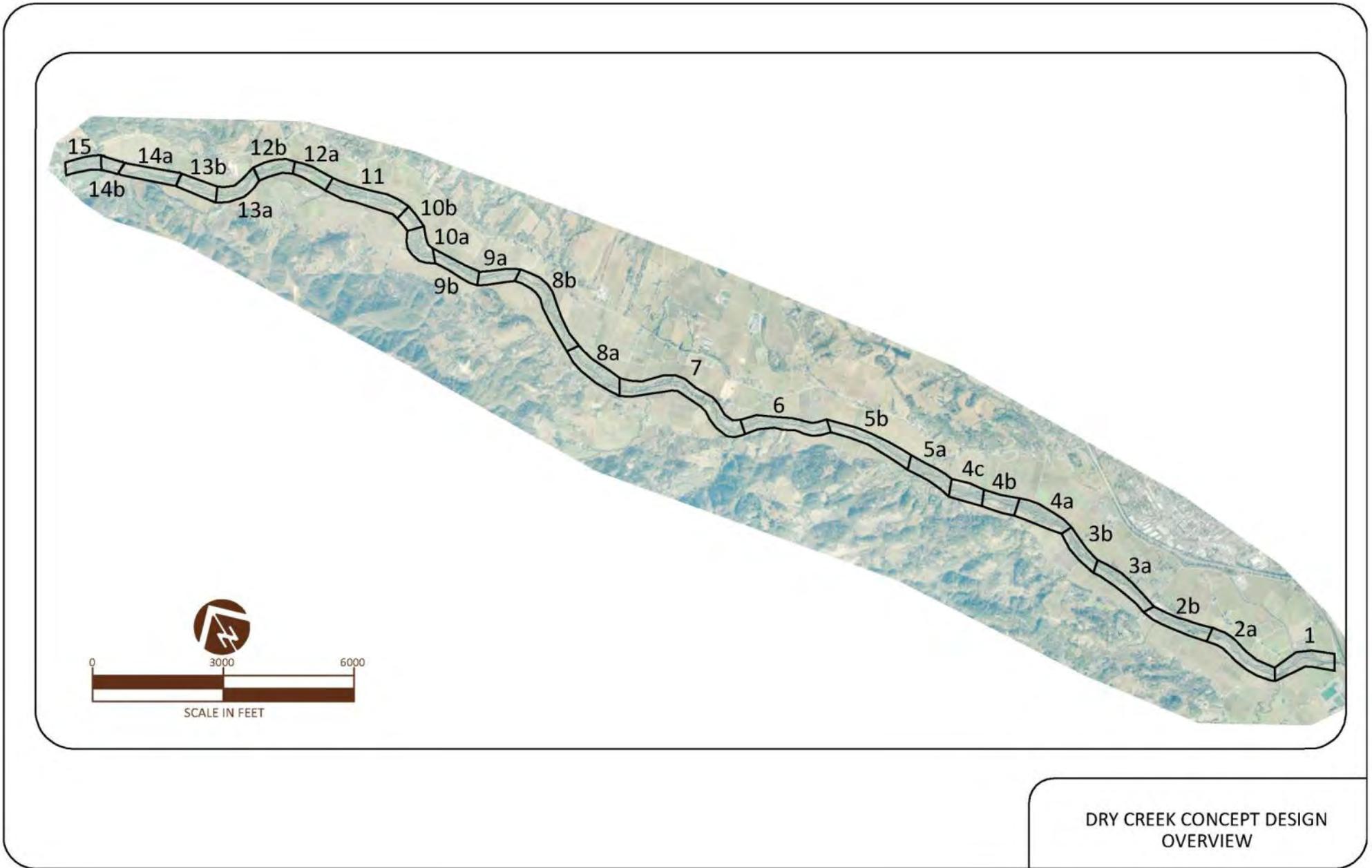


Figure 13. Overview of the 25 reaches and sub-reach for the conceptual design report. Note: Reach 7 is the demonstration reach, and is not included in the conceptual design report.

Table 4: Inventory reach and enhancement subreaches for lower Dry Creek.

Inventory Reach	Enhancement Subreach	DS end (RM)	DS end (landmark)	US end (RM)	US end (landmark)	Length (ft)
1	1	0.0	Dry Creek Mouth	0.7	Mill Creek	3550
2	2a, 2b	0.7	Mill Creek	2.0	Westside Road	7000
3	3a, 3b	2.0	Westside Road	3.0	Fault lineament 1150' DS Sill 1	5500
4	4a, 4b, 4c	3.0	Fault lineament 1150' DS Sill 1	4.1	1600' US Sill 3, US end check dam impoundment	5460
5	5a, 5b	4.1	1600' US Sill 3, US end check dam impoundment	5.3	Fault lineament, 150' DS Kelley Ck	6850
6	6	5.3	Fault lineament, 150' DS Kelley Ck	6.1	Bedrock outcrop, 475' DS Crane Ck	4150
7 <i>Demonstration Reach</i>	7	6.1	Bedrock outcrop, 475' DS Crane Ck	7.4	Bedrock outcrop, 950' US Grape Ck	6940
8	8a, 8b	7.4	Bedrock outcrop, 950' US Grape Ck	8.9	Change in relative confinement	7630
9	9a, 9b	8.9	Change in relative confinement	9.7	Change in relative confinement, and fault lineament	4190
10	10a, 10b	9.7	Change in relative confinement, and fault lineament	10.3	Tributary location	3390
11	11	10.3	Tributary location	11.0	Pena Ck	3755
12	12a, 12b	11.0	Pena Ck	11.7	Gradient shift, 700' DS Dutcher Ck	3670
13	13a, 13b	11.7	Gradient shift, 700' DS Dutcher Ck	12.4	Steep riffle	3930
14	14a, 14b	12.4	Steep riffle	13.3	Schoolhouse Creek confluence	4021
15	15	13.2	Schoolhouse Creek confluence	13.6	Bord Bridge	1980
16	16	13.6	Bord Bridge	13.9	Dam Outlet	1340

\*Conceptual designs for the "Demonstration Reach", reach 7 are not included in this report.

\*\*It is not feasible to enhance Reach 16, as it is the dam tailwater channel. Therefore conceptual designs were not created for this reach.

## 8. ASSUMPTIONS

The Conceptual Design Report and associated design development is based on ongoing planning-level and detailed hydraulic modeling and analysis of Dry Creek, as described in Inter-Fluve 2010, 2011, 2012. The conceptual designs that are presented reflect the best available information about the reaches and subreaches discussed in this report. The current versions of the planning-level and detailed hydraulic models have been developed from a combination of ground survey and LiDAR<sup>2</sup> data (Inter-Fluve 2011, 2012). The same data are implicit in the development of the design concepts and associated cost estimates, which reflect excavation volumes based on the same combination of data. Due to the nature of LiDAR data collected in the forested riparian zone along Dry Creek, it is likely that earthwork estimates contained in the cost estimates are conservative. As individual groupings of projects are prioritized and selected, future site-specific ground surveys will improve the precision and enable refinement of enhancement designs, and associated hydraulic modeling and cost estimates.

The earthwork associated with each off-channel enhancement site was estimated based on preliminary grading plans developed at each site with the data sets described above. The criteria that were used to develop the preliminary grading plans are summarized in Table 5.

*Table 5. Criteria assumed for development of grading plans in off-channel enhancement areas.*

<b>Design Criteria Description</b>	<b>Design Criteria Utilized</b>
Distance between project footprint and active channel	50 - 60 ft, minimum
Target wetted width for backwater channel grading	20 ft minimum
Target width for side channel grading	40 ft minimum
Side-slope assumptions	3 horizontal : 1 vertical, or flatter
Target invert elevation for off-channel habitat	4 ft below 110 cfs WSE
Target invert elevation for winter refuge	WSE @ 1000 cfs
Target invert elevation for pilot off-channel habitat (reaches 1 and 2)	4 ft below 110 cfs WSE
Target invert elevation for pilot winter refuge (reaches 1 and 2)	WSE @ 500 cfs

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<sup>2</sup> LiDAR, also known as Light Detection And Ranging, is derived from data collected using a specialized aircraft-mounted instrument which can collect high precision topographic data over large areas. In some cases, densely vegetated areas can produce topographic data which over-estimates ground elevations. Furthermore, current LiDAR surveys are unable to obtain elevations covered by water.

## 9. PROJECT EVALUATION

In total, conceptual designs were created along more than 12.5 miles of lower Dry Creek. Twenty-five separate groupings of projects (enhancement subreaches) were developed and are detailed in Appendices A through O. The conceptual designs include a variety of off-channel and main channel enhancements aimed at meeting habitat enhancement objectives laid out in the RRBO. In order to facilitate evaluation of the relative benefits and enable prioritization of alternate enhancement subreaches, the following section describes the methodology used to estimate associated habitat benefits, and describes development and application of three project evaluation metrics to each subreach. It is anticipated that these metrics will support the project prioritization process as depicted in Figure 14.

### 9.1 ANALYSIS OF PROPOSED HABITAT BENEFITS

The habitat benefits resulting from the proposed enhancements are reported in Appendices A through N for each enhancement subreach. The estimated benefits are summarized and organized by anticipated seasonal utilization (i.e. summer coho rearing), and overall fish habitat benefit. Table 6 summarizes the methodology used to estimate the additional habitat benefits resulting from the enhancement work.

It should be noted that alcove/backwater habitats will provide winter rearing and refuge areas in addition to summer rearing, as they continue to offer low velocity off-channel habitat during typical winter flow conditions and during flood events. Additionally, most main channel LWD placements will provide winter rearing and refuge over a portion of the typical flow range, depending on their location in the channel. However, to avoid double-counting of habitat benefits, the habitat areas included in the Incremental Winter Refuge category include only winter refuge specific projects (which consist of lowering overbank areas – see Section 6.5), plus the additional area of alcove/backwater channel projects that are inundated between 110 and 1000 cfs. Both incremental winter refuge and summer rearing habitats are incorporated into the Total Enhanced Habitat calculation and score (see Section 9.3).

Although off-channel LWD-margin habitat is proposed, only main channel LWD-margin habitat areas are reported in the habitat metrics to prevent double-counting of habitat improvements. Aside from LWD-margin habitat, main channel habitat enhancements included in the Total Enhanced Habitat calculation and score are largely conversions of one habitat type to another (i.e. flatwater to pool resulting from riffle construction). Main channel re-meander projects are exceptions where total main channel habitat area would change based on the conceptual design (i.e., a net increase in total main channel habitat area due to newly created habitat area in the main channel).

Table 6. Methodology used to calculate enhanced habitat benefits.

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 extension of hydraulic influence into the channel
	Side Channel	2/3 of habitat inundated at 110 cfs.
	Pilot off-channel	<ul style="list-style-type: none"> <li>• 100% of pilot backwater habitats inundated at 110 cfs</li> <li>• 2/3 of pilot side channel habitats inundated at 110 cfs</li> </ul>
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 extension of hydraulic influence into the 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

## 9.2 EVALUATION METRICS

Four evaluation metrics were developed for application to each enhancement subreach. The first and second metrics address the inherent summer and incremental winter refuge habitat development potential, while the third metric addresses the total habitat development potential, and the fourth metric addresses the predicted continuity of habitat benefits, for each enhancement subreach.

The habitat-based metric scores were derived from the quantity of additional summer coho rearing, incremental winter refuge, and total enhanced habitat area created by the proposed enhancements in each subreach. Scoring criteria for the habitat metrics are summarized in Table 7. The “continuity” score is largely based on the current understanding of fluvial processes in different locations along Dry Creek, as described in the Feasibility Study Report (Inter-Fluve 2012), in addition to subreach-specific channel and floodplain characteristics.

Table 7. Habitat enhancement scoring criteria used to evaluate reaches and sub-reaches in Dry Creek.

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

\*Includes low water areas of backwater channels, LWD-margin habitat, side-channels and pilot off-channel habitat based (see Table 6)

\*\*Includes high flow area of backwater channels, winter refuge habitat, and pilot winter refuge habitat (see Table 6)

\*\*\*Includes all habitat enhancements, including backwater channels, LWD-margin habitat, side channels, pilot off-channel habitat, riffles, enhanced pool area, winter refuge habitat (see Table 6)

## 9.3 EVALUATION RESULTS

Table 8 summarizes the scores resulting from application of the evaluation metrics to each enhancement subreach. Detailed summaries of conceptual designs can be found in Appendices A through N, which provide a synthesis of proposed habitat and cost estimates for conceptual designs created for the lower 13 miles of Dry Creek.

The results for the continuity metric for reaches 1 and 2 should be taken within the context of the different philosophical approach applied in this area. The final scoring will have to take into account the dynamic nature of the approach devised for these two reaches. It has not yet been decided how habitats that change over time will be treated in the evaluation of enhancements (Porter et al 2011).

Table 8. Summary of enhancement subreach scoring and associated additional habitat enhancement areas based on the conceptual designs created for the lower 13 miles of Dry Creek.

Enhancement Subreach	Summer Coho Rearing Habitat Potential	Incremental Winter Refuge Habitat	Total Habitat Potential Score	Enhancement Continuity Score	Enhanced Summer Coho Habitat (ft <sup>2</sup> )	Incremental Winter Refuge Habitat (ft <sup>2</sup> )	Total Habitat Enhancements (ft <sup>2</sup> )
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

## 9.4 ENHANCEMENT SUBREACH RANKING AND PROJECT SELECTION

Results of the project evaluation will support prioritization of enhancement subreaches in lower Dry Creek. Represented conceptually by Figure 14, the prioritization process includes two primary phases: 1) Project Ranking, and 2) Project Selection. In the ranking phase (represented by the left half of Figure 14), the enhancement subreaches were ranked within the upper, middle and lower segments of the study reach based on their summer coho rearing, incremental winter rearing and refuge, and total habitat scores.

Within each study reach segment, the enhancement subreaches were further classified into Tier I and Tier II groups to help summarize their relative potential for habitat enhancement (Table 9). The results show that there are a total of 16 Tier I subreaches distributed across the upper, middle and lower segments of Dry Creek. Table 9 also shows the enhancement continuity score for each enhancement subreach for reference, although this score was not taken into account in the ranking process. This factor will be considered in the project selection phase, discussed below.

Project selection represents the second phase of project prioritization, depicted as the right half of Figure 14. In this phase, the results of the ranking phase will be evaluated alongside other factors that are critical considerations for implementation of habitat enhancement in lower Dry Creek. These implementation considerations include critical factors such as access, cost, and overall distribution along Dry Creek, among other factors. Project selection will be ongoing over the next several years as the Water Agency and its partners identify opportunities to implement habitat enhancement to meet the requirements of the RRBO.

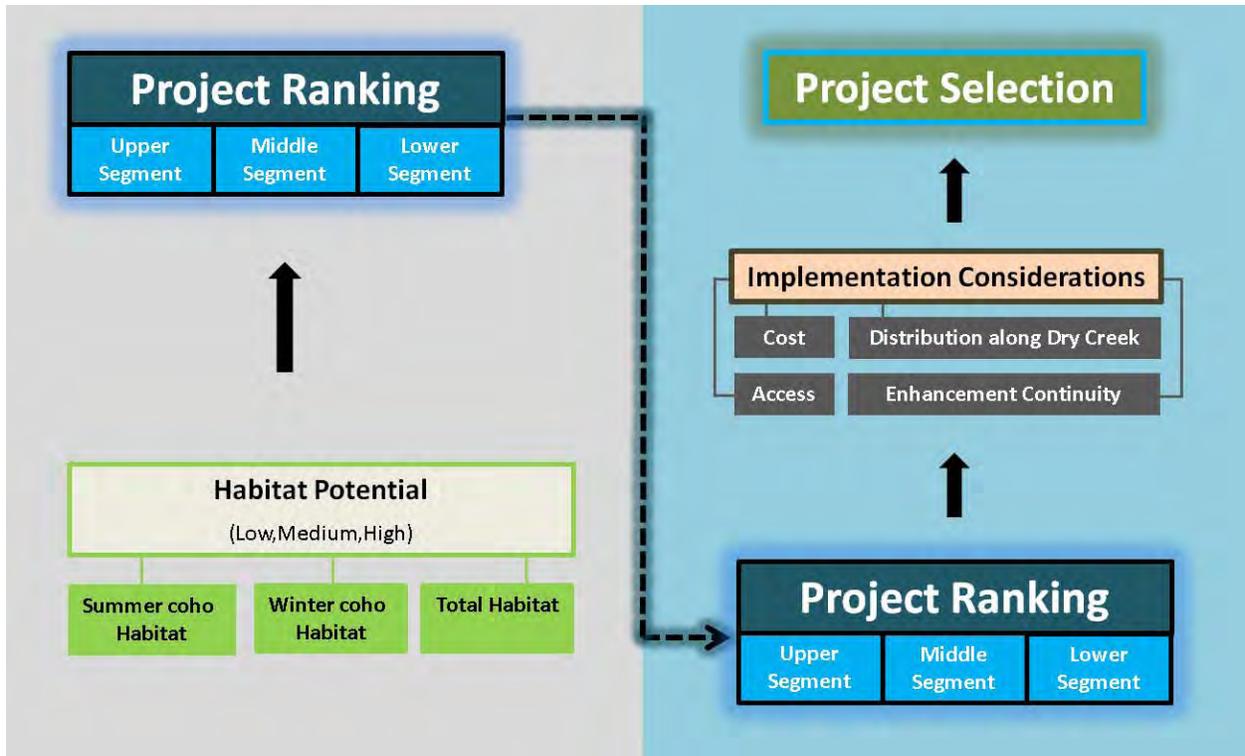


Figure 14. Conceptual depiction of project prioritization approach. The left side of the figure represents the first phase of the prioritization process, which includes ranking of the enhancement subreaches based solely on their inherent potential for habitat enhancement. The second phase, project selection, will factor in implementation considerations such as access, distribution, and cost to result in selection of the enhancement subreaches that are advanced to design and implementation.

Table 9. Ranking of enhancement subreaches in Dry Creek organized by Upper, Middle and Lower segments.

Segment	Ranking Tier	(Sub) Reach	Coho Potential Coho Rearing Habitat Score	Winter Refuge & Rearing Habitat Score	Total Potential Habitat Score	Predicted Continuity Score
Upper	Tier I	14a	High	Medium	High	High
		13b	Medium	Medium	Medium	High
		15	Medium	Low	Low	High
		14b	Medium	Low	Low	High
	Tier II	12b	Low	High	Medium	High
		13a	Low	Low	Low	High
		12a	Low	Low	Low	High
Middle	Tier I	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 II	6	Low	High	High	Medium
		11	Low	Medium	High	Medium
		9b	Low	Medium	Low	Medium
		9a	Low	Low	Low	Medium
Lower	Tier I	2b	High	High	High	Low
		2a	High	High	High	Low
		1	High	High	High	Low
	Tier II					
		3b	Medium	Low	Medium	Medium
		3a	Medium	Low	Medium	Medium

## 10. CONCEPTUAL DESIGN COST OPINIONS

Planning-level conceptual design cost opinions were prepared for comparison between alternative enhancement subreaches and for planning purposes. These estimates are summarized in Table 10 in terms of total costs and various factors describing cost per unit habitat area. The cost opinions are detailed in the individual reach-scale conceptual enhancement design booklets (Appendices A-N) for each enhancement subreach. The cost opinions are presented in 2011 dollars.

These should be considered order-of-magnitude cost opinions assuming design-bid-build public works procurement, and given the current level of design development concept-level cost contingencies have been included. The cost opinions would be considered Class 4 (study or feasibility level) according to standards established by the Association for the Advancement of Cost Engineering. As these are planning estimates, project delivery costs (permitting, engineering design, contract administration) have also been included. Detailed quantity takeoffs made for the excavation work items were computer-generated (and independently checked) using the surfaces described in Section 7 and represent neat-line quantities. In preparation of the concept-level cost opinions, several global factors or criteria were applied across all enhancement subreaches. These factors are summarized in Table 11.

Additional cost estimate information has been provided in Appendix O in order to provide flexibility in creating groups of projects for future implementation of habitat enhancement in Dry Creek, which may vary from the groupings assumed in this report for the 25 enhancement subreaches detailed in Appendices A-N. To do so, each enhancement subreach was split into its component enhancement sites, and associated costs were broken out for these smaller groupings. For example, a smaller scale grouping of enhancement sites would include a backwater channel with the associated downstream riffle that would be constructed together.

The opinions of estimated construction cost presented are based on information developed for this report and market conditions at the time of preparation (December 2011) of the estimates. Construction cost was estimated with the use of a combination of unit prices from published, internally-developed and maintained historical databases, vendor quotes, and other consultations, factored for location and other project specific criteria.

Lastly, various limitations should be considered in the use of the cost opinions contained herein. These limitations include the potential for changes in technology, methods and construction applications, the impact of short-term economic cycles and other market fluctuations, the time-lag of reporting databases, and other factors. Any estimate of unit prices is not intended to predict the actual outcome of hard dollar results from open and competitive bidding. The cost estimation efforts described herein were conducted in a manner consistent with the standard of care ordinarily applied as the state of practice in the profession, given the amount of design information presently available.

Table 10. Cost estimate and cost metrics based on the conceptual designs created for the lower 13 miles of Dry Creek. Cost/ft<sup>2</sup> of summer coho rearing habitat includes backwater channels, qualifying portions of side channels and pilot off-channel habitat, and LWD-margin habitat. Cost/ft<sup>2</sup> of winter refuge and rearing habitat includes summer habitats plus winter refuge, pilot winter refuge, and area of backwater/alcove inundated between 110 and 1000 cfs. Cost/ft<sup>2</sup> of all habitat enhancements includes winter habitat plus enhanced pool habitat, and riffle habitat.

(Sub) Reach	Total cost	Summer Coho Rearing (\$/ft <sup>2</sup> )	Cumulative Winter Rearing & Refuge* (\$/ft <sup>2</sup> )	All Habitat Enhancements (\$/ft <sup>2</sup> )
15	\$4,624,000	120	96	72
14b	\$3,790,000	67	53	49
14a	\$7,614,000	85	63	45
13b	\$8,640,000	144	90	66
13a	\$1,700,000	155	N/A	57
12b	\$5,596,000	799	54	46
12a	\$692,000	173	N/A	42
11	\$4,063,000	508	56	25
10b	\$6,390,000	133	N/A	77
10a	\$10,897,000	145	120	78
9b	\$5,457,000	910	96	79
9a	\$681,000	43	N/A	25
8b	\$12,224,000	140	92	58
8a	\$13,693,000	232	57	54
6	\$7,007,000	876	68	44
5b	\$9,964,000	269	119	59
5a	\$8,402,000	90	71	55
4c	\$3,904,000	68	59	56
4b	\$6,456,000	60	52	48
4a	\$8,656,000	80	65	47
3b	\$4,866,000	74	56	40
3a	\$4,060,000	92	64	43
2b	\$9,123,000	88	25	21
2a	\$11,934,000	79	27	26
1	\$11,526,000	102	24	23

\*Cumulative winter rearing and refuge habitat area includes summer coho rearing and incremental winter rearing and refuge areas.

Table 11. Global assumptions applied for preparation of conceptual cost opinions.

Cost Item	Assumptions
Vegetation Management	<ul style="list-style-type: none"> <li>• Area calculated based on the channel corridor width from vineyard grade to vineyard grade, with channel and off-channel enhancement areas excluded from calculation</li> <li>• Estimated based on the 10-yr flood inundation extent</li> </ul>
Clear and Grub	<ul style="list-style-type: none"> <li>• Calculated area includes off-channel enhancement impact areas plus a multiplier (5% of impact area) for development of temporary access.</li> </ul>
Floodplain Roughness Logs	<ul style="list-style-type: none"> <li>• Number estimated at 130 pieces/acre</li> <li>• 30% with rootwads</li> </ul>
Backwater Habitat Logs	<ul style="list-style-type: none"> <li>• Number estimated at 130 pieces/acre</li> <li>• 30% with rootwads</li> </ul>
Pool Enhancement Logs	<ul style="list-style-type: none"> <li>• Number estimated at 8 pieces per individual pool enhancement location</li> <li>• 30% with rootwads</li> </ul>
Log Jams – Reaches 15-3	<ul style="list-style-type: none"> <li>• Number estimated at 40 pieces/each log jam</li> <li>• 30% with rootwads</li> </ul>
Log Jams – Reaches 1-2	<ul style="list-style-type: none"> <li>• Individual log jams: number estimated at 50 pieces/individual jam</li> <li>• Clustered log jams; number estimated at 0.03 pieces/ft<sup>2</sup> of area of coverage</li> <li>• 30% with rootwads</li> </ul>
Riffles	<ul style="list-style-type: none"> <li>• Riffles assumed to be 100' in length.</li> <li>• For riffle enhancements, assume 1.5' of depth.</li> <li>• For riffle construction, assume 3' of depth.</li> <li>• Assume width of riffle to be 1.2 * average channel width of 50 ft</li> </ul>
Appendix O Costs	<ul style="list-style-type: none"> <li>• 'Earthwork' lumps clearing and grubbing with common excavation.</li> <li>• Direct costs each grouped set of sites is based on a ratio of the indirect costs and total direct costs</li> </ul>

## 11. BIBLIOGRAPHY

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Porter, M., D. Pickard, and D. Marmorek. 2011. Draft - Dry Creek Adaptive Management Framework (AMF). Report prepared by ESSA Technologies Ltd., Vancouver, BC. for Sonoma Water County Agency, Santa Rosa CA.

## 11. APPENDICES

## APPENDIX A

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### A.1 Reach 15 Description

Reach 15 is a short (1600 ft) reach which is located immediately downstream of WSD. Dry Creek follows a single-thread channel geometry consisting of one riffle and one very long pool in this reach. Dry Creek has very low sinuosity in reach 15, and the air photo record suggests that the channel has generally narrowed over time due to incision, post-dam vegetation establishment and channelization.



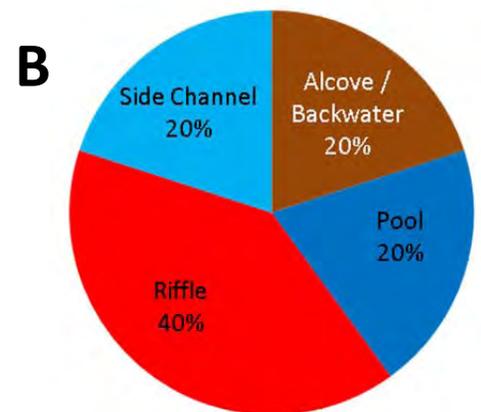
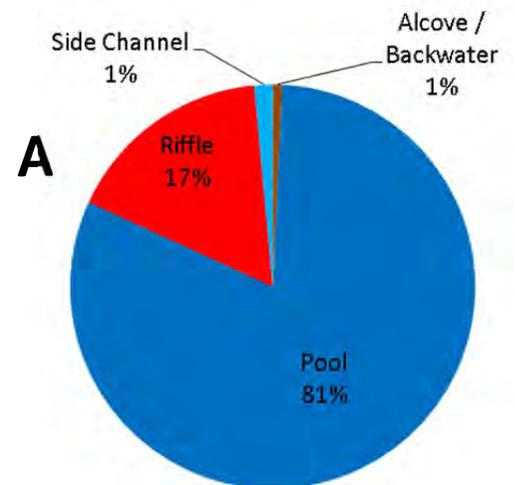
At the Bord Bridge (the upstream boundary of Reach 15) a boulder revetment associated with the bridge armors the right bank. Higher on this bank there is evidence of an older wood revetment. The high canopy cover is provided by California bay, willow, alder and cottonwood. Himalayan blackberries and other exotics are present on both banks. Current channel characteristics have been dictated by channel evolution following base level lowering in Dry Creek, a lack of sediment supply caused by WSD, and post-dam vegetation patterns which has locked up floodplain surfaces. Due to the small size of this reach, it was not divided into sub-reach units for concept development. See the Dry Creek Current Conditions Report (Inter-Fluve 2010) for more detail.

#### Current Habitat Conditions

Table A1. Habitat units based on current conditions.

Habitat	Existing Habitat	
	Area (ft <sup>2</sup> )	#
Alcove / Backwater	750	1
Flatwater	0	0
Pool	80450	1
Riffle	16550	2
Side Channel	1450	1

Figure A1. Habitat Units in reach 15 based on area (A) and frequency (B).



### A.2 Reach 15 Enhancement Approach

Reach 15 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 coho and steelhead rearing habitat. The focus of the restoration approach will be to construct late successional habitats given the limited risk of future sedimentation and channel migration. Channel processes are limited in this reach which precludes the feasibility of process-based restoration approaches. Primary habitat types proposed for this reach are backwater channels, LWD-driven main channel habitat, constructed riffles and enhanced main channel pools. Backwater channels will provide low velocity habitat with cover for coho juveniles.

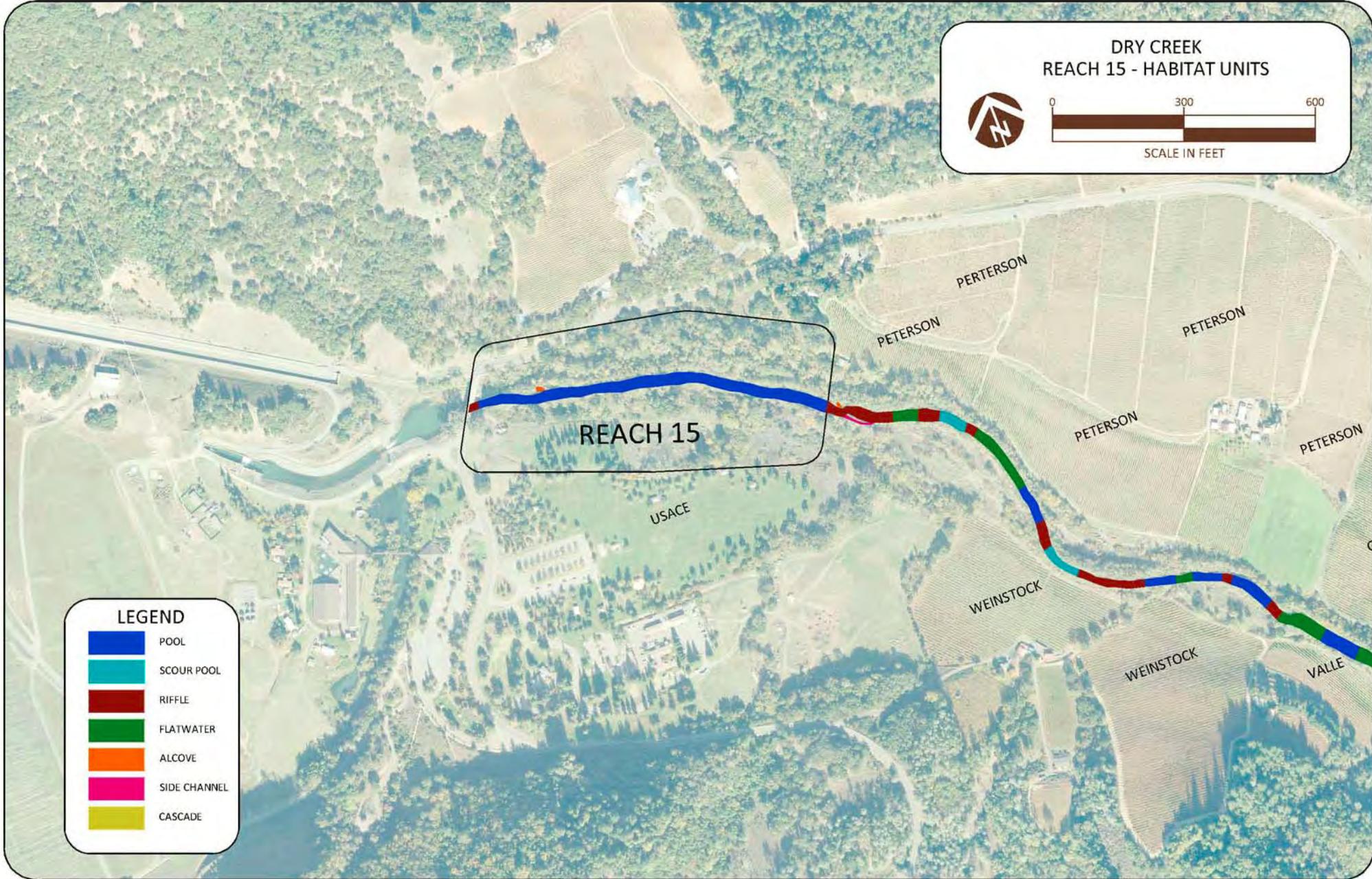


Figure A2. Habitat units based on current conditions in Dry Creek. Reach boundary shown by the black line.

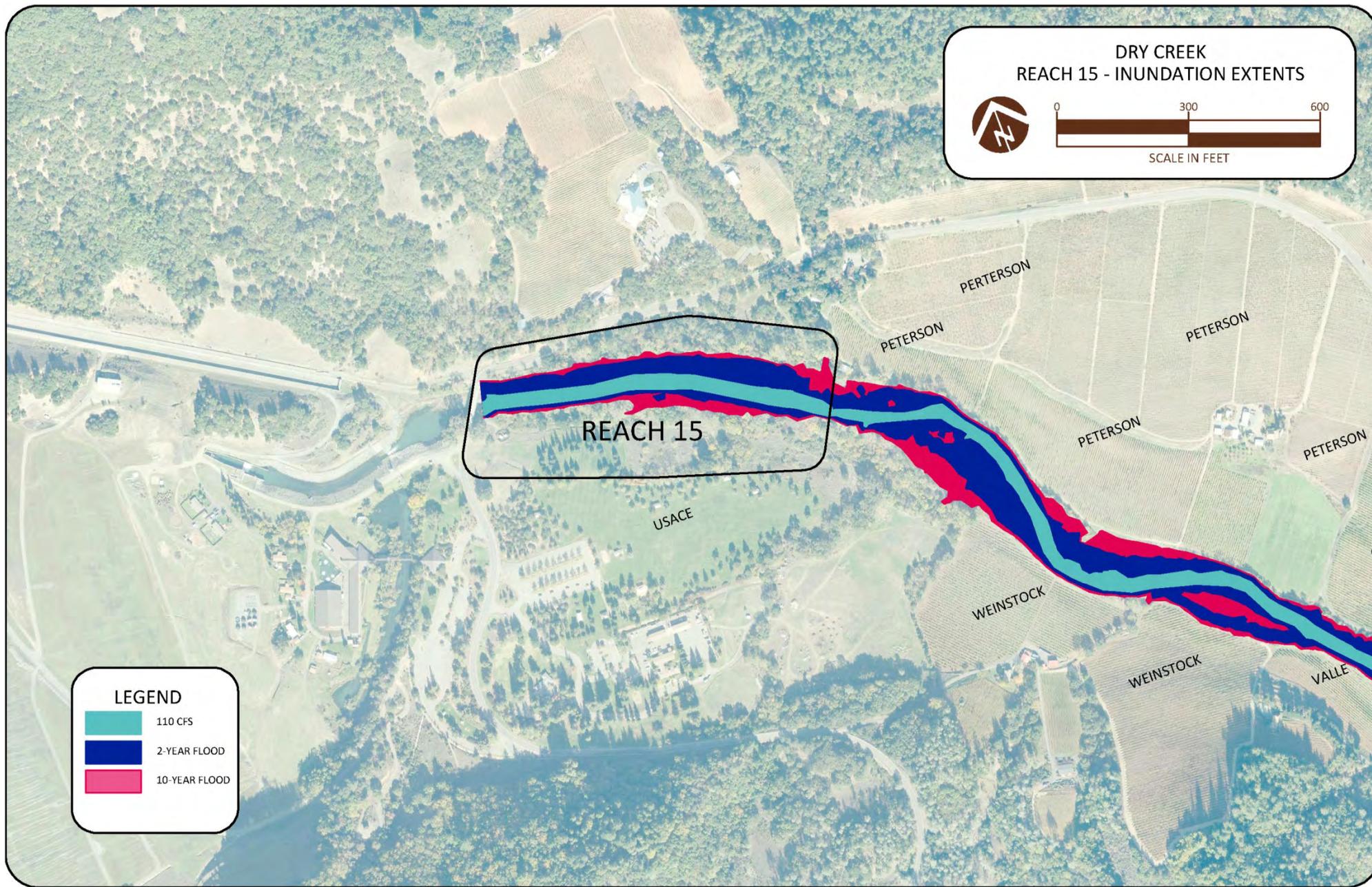


Figure A3. Modeled inundations in reach 15 based on the planning level hydraulic model developed for lower Dry Creek. The steady-state operation discharge of 105 cfs, the 2-year and 10-year floods are shown.

**A.3 Reach 15 Conceptual Design**

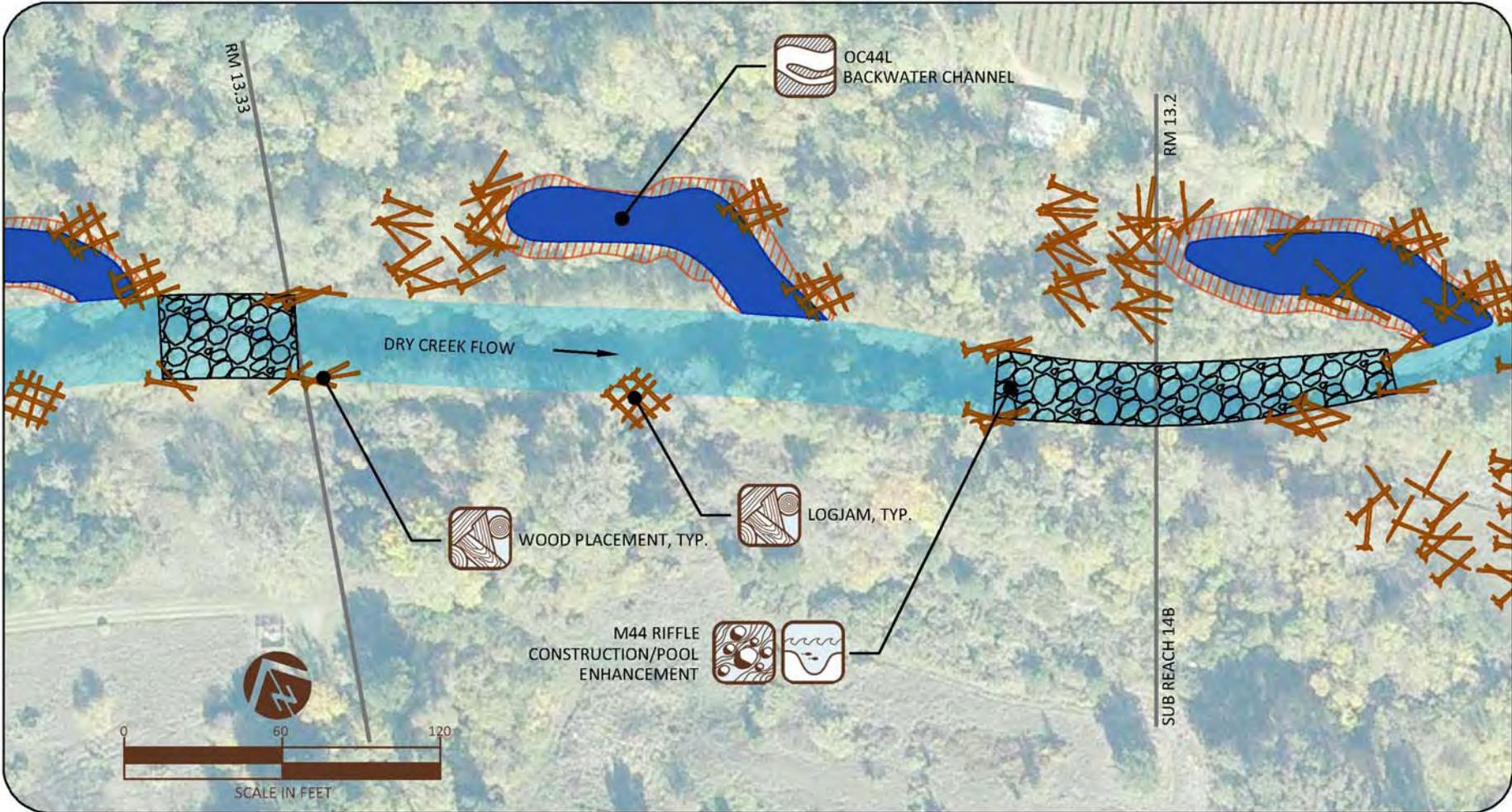
Reach 15 is characterized by a relatively narrow active floodplain, and a channel geometry that lacks sinuosity due to the history of incision in Dry Creek. In order to improve the quality and quantity of juvenile salmonid rearing habitat, a combination of both off-channel and main channel habitat enhancements are proposed. Off-channel enhancements include the creation of backwater channels, side channels, and placement of LWD. Main channel habitat enhancements include pool enhancements, riffle construction, and log jams. The following table and accompanying figures provide an overview of the design concepts developed for reach 15.

Project Code	Backwater Channel	Side Channel	Pool Enhancement	Riffle Enhancement	LWD	Winter Refuge Habitat*	Bank Stabilization	Vegetation Management	Comments
M 44				X	X			X	Riffle & Pool Enhancement
OC 44L	X				X		X	X	Backwater Channel Construction
M 45.1			X	X	X			X	Riffle Construction & Pool Enhancement
OC 45L	X				X		X	X	Backwater Channel Construction
M 45.2			X	X	X			X	Riffle Construction & Pool Enhancement
M 45.3			X	X	X			X	Riffle Construction & Pool Enhancement

Table A2. Inventory of individual projects identified for reach 15.

\*Although there are no winter refuge habitats proposed in reach 15, backwater channel habitats will provide winter refuge, and available off-channel habitat for juvenile salmonids will become large as flows increase during winter storms.





**LEGEND**

MAIN CHANNEL AT 110 CFS

OFF CHANNEL HABITAT

GRADING LIMIT

RIFFLE CONSTRUCTION/ ENHANCEMENT

REACH 15  
CONCEPT DESIGN  
1 OF 2

Figure A5. Reach 15 conceptual design detail sheet 1 of 2.

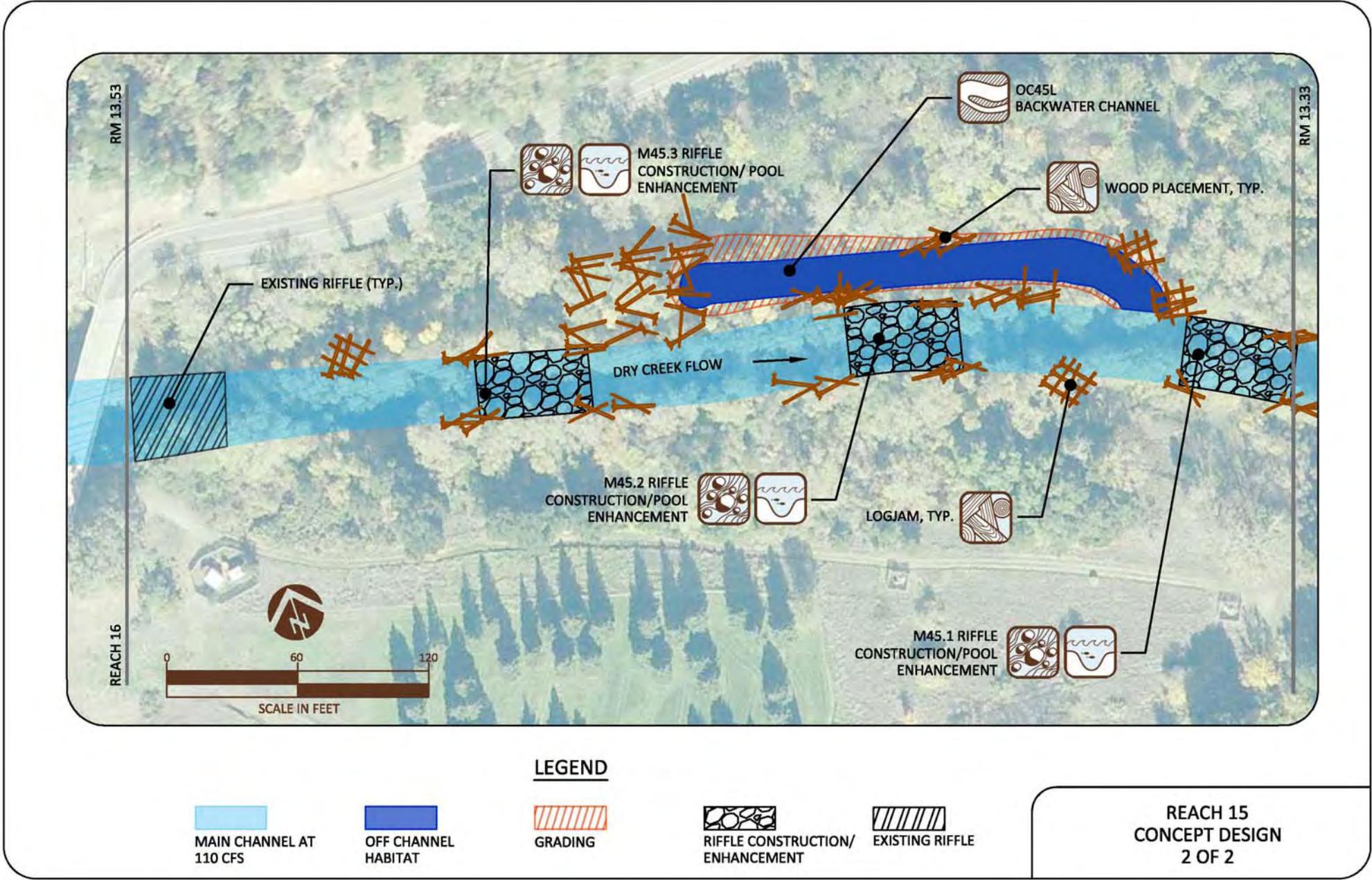


Figure A6. Reach 15 conceptual design detail sheet 2 of 2. Dry Creek Conceptual Design Report

Reach 15 Analysis of Proposed Enhancements

Proposed enhancements in reach 15 would result in more than 63,000 ft<sup>2</sup> of habitat enhancements, including 38,000 ft<sup>2</sup> of summer coho rearing habitat. The relatively homogenous reach 15, currently composed of one pool bounded by two riffles, would be converted into a series of pool-riffle sequences with two additional off-channel habitats. The following tables summarize proposed conditions based on frequency and area (Table A3), additional habitat to be created by the enhancements (Table A4) and cost-based metrics (Table A5). Table A6 presents habitat enhancement areas normalized by main channel reach length. Table A7 summarizes the planning level cost estimate developed for reach 15.

Table A3 Habitat area by unit type for existing and proposed conditions in sub-reach 15.

Habitat	Existing Habitat		Proposed Habitat	
	Area (ft <sup>2</sup> )	#	Area (ft <sup>2</sup> )	#
Alcove / Backwater	750	1	27350	3
Flatwater	0	0	0	0
Pool	80450	1	64800	4
Riffle	16550	2	32350	5
Side Channel	1450	1	1450	1

Table A4. Additional coho rearing habitat provided by new alcoves and LWD placements in sub-reach 15.

Habitat Type	(ft <sup>2</sup> )	(m <sup>2</sup> )
Alcove/Backwater <sup>+</sup> (summer coho rearing)	26600	2470
LWD-Margin Habitat (summer coho rearing)	12000	1110
Winter Refuge Habitat (winter coho rearing)	9550	890
Riffles	15800	1470
<b>Total</b>	<b>63950</b>	<b>5940</b>

<sup>+</sup> Alcove/Backwater habitats also provide winter refuge habitat during flood events.

Table A5. Cost –benefit table for design concepts created for reach 15.

Cost - Benefit Metric	Cost / ft <sup>2</sup>
Cost / ft <sup>2</sup> of summer coho rearing*	120
Cost / ft <sup>2</sup> of winter rearing habitat**	96
Cost / ft <sup>2</sup> of total enhanced habitat***	72

\*includes backwater and LWD-margin habitats

\*\*includes alcove/backwater, LWD-margin, and winter refuge

\*\*\*includes alcove/backwater, LWD-margin, riffles

Table A6. Length metrics showing habitat enhancement area divided by main channel reach length for summer coho rearing and total enhanced habitats.

Length Metric	area (ft <sup>2</sup> )/ length (ft)
Summer coho rearing habitat	20
Winter coho rearing habitat	24
Total enhanced habitat	32

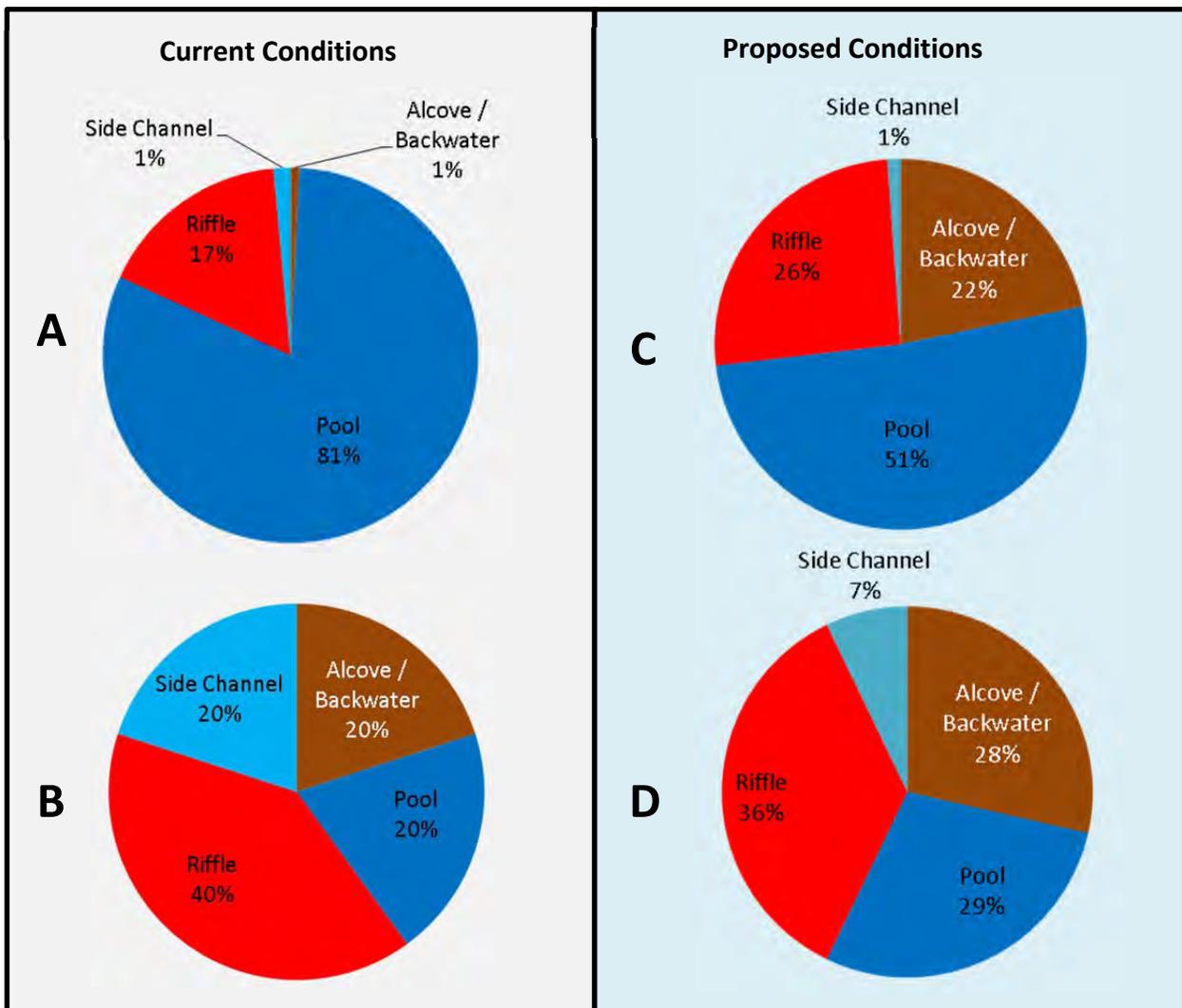


Figure A7. Existing reach 15 habitats shown by area (A), frequency (B) and proposed habitat units based on area (C) and frequency (D).

**Reach 15 Alternatives Discussion**

An alternative to the creation of backwater habitats in the valley left side of the floodplain could be the construction of winter flood refuge habitat. This alternative would provide juvenile rearing habitat only during winter flood flows. Furthermore, the water flowing out of WSD into reach 15 is generally very cold and thought to limit productivity of the aquatic organisms, such as macroinvertebrates and other prey for juvenile fishes. In order to address the temperature issue in the upstream reach, acclimation ponds could be constructed on the valley right side of Dry Creek which would increase water temperature and feed off-channel habitats. Additional studies may be warranted in order to determine whether or not the system is temperature limited in reach 15 before proposing this type of a treatment.

Table A7. Reach 15 Planning Level Cost Estimate

Note: This is a preliminary cost estimate for planning purposes. Actual costs for design and construction activities may vary substantially from these estimates. Assumptions for time requirements and material quantities have been made based on limited information that is available for the site. Additional information obtained during site investigations will be needed to determine actual quantities and costs. Estimates based on 2011 costs.

No.	Description	Unit	Quantity	Unit Cost	Total Cost	Design and Quantity Assumptions
1	Mobilization and Demobilization	LS	1	\$140,000	\$140,000	Calculated at 5% of construction sub-total.
2	Site Access Measures	LS	1	\$210,000	\$210,000	Includes access road improvements, traffic control, dust control, and site restoration.
3	Environmental Protection Measures	LS	1	\$690,000	\$690,000	Includes stream diversion/dewatering, fish relocation, and erosion control BMPs.
4	Clearing and Grubbing	AC	1	\$2,000	\$2,000	
5	Common Excavation					
a.	OC 44	CY	3,380	\$20	\$67,600	Final design criteria and analysis will likely alter these estimates up or down.
b.	OC 45	CY	2,080	\$20	\$41,600	
6	Large Woody Debris Installation					
a.	Floodplain Roughness Logs	EA	80	\$1,150	\$92,000	Assumes 30% delivered with root wads attached.
b.	Backwater Habitat Logs	EA	120	\$1,150	\$138,000	
c.	Pool Enhancement Logs	EA	130	\$1,150	\$149,500	
d.	Log Jams	EA	360	\$1,150	\$414,000	
7	Boulder Ballast (purchased, delivered, installed)	TN	690	\$100	\$69,000	Estimated 1 ton per log.
8	Bank Stabilization	LF	580	\$1,000	\$580,000	Bank stabilization methods will vary but will include one or more of the following components: large woody debris, earthwork, riprap scour protection, granular backfill, aggregate filter material, geotextile fabric, and/or fabric encapsulated soil lifts. Assumes 30% delivered with root wads attached.
9	Riffle Installation (purchased, delivered, installed)	CY	2,330	\$120	\$279,600	Assume average of 3 feet of depth per riffle for riffle construction. Assume average of 1.5 feet of depth per riffle for riffle enhancement.
9	Vegetation Management	AC	5	\$20,000	\$100,000	Assumes area of floodplain from vineyard grade to vineyard grade minus the base flow inundation area of the main channel and of the proposed backwater habitat areas.
<b>Construction Sub-Total</b>					<b>\$2,973,300</b>	<div style="display: flex; justify-content: space-between;"> <div style="border: 1px solid black; padding: 5px;"> <p><b>Key</b>                      LS = Lump Sum                      CY = Cubic Yard                      LF = Lineal Foot                      AC = Acre                      EA = Each</p> </div> <div style="border: 1px solid black; padding: 5px;"> <p><b>Project Delivery Items are calculated as a percent of the construction sub-total</b>  <b>General Notes:</b>                      -Cost includes a 30% design and construction contingency                      -Costs assume all materials (wood and rock) are purchased and hauled to the site from a nearby source                      -Boulder ballast requirements may be able to be reduced depending on hydraulics analysis</p> </div> </div>
Concept Level Design & Construction Contingency (30%)					\$891,990	
<b>Construction Total</b>					<b>\$3,865,300</b>	
<b>Project Delivery</b>						
Permitting (4%)					\$118,932	
Detailed Engineering Design (15%)					\$445,995	
Contract Administration (5%)					\$148,665	
Construction Oversight (1.5%)					\$44,600	
<b>Project Delivery Sub-Total</b>					<b>\$758,200</b>	
<b>TOTAL ESTIMATE</b>					<b>\$4,624,000</b>	

## APPENDIX B

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**B.1 Reach 14 Description**

Reach 14 is located in between WSD and Dry Creek’s confluence with Pena Creek. In Reach 14, Dry Creek follows a single-thread channel geometry extending upstream to the Schoolhouse Creek confluence. The channel is slightly less entrenched than Reach 13 and has migrated laterally slightly prior to, and since, dam construction. The air photo record suggests that the channel has generally narrowed over time with incision and post-dam vegetation establishment.



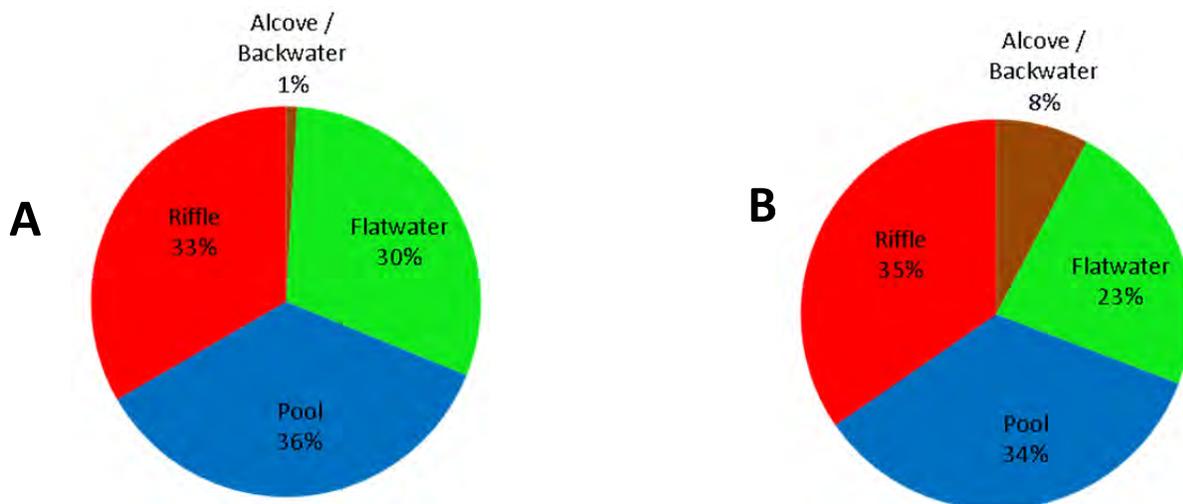
Board fence bank protection was constructed along the lower 500 feet of the right bank of Reach 14. Riprap boulder bank armor was installed along the banks near the upstream end of the reach for about 1,200 feet. Some litter was observed in Reach 14, including a ¾” black pipe on the left bank that disappears into the floodplain forest at river mile 12.9, and tires in the center of a flatwater at river mile 13.3 at the top of the reach. Current channel characteristics have been dictated by channel evolution following base level lowering in Dry Creek, a lack of sediment supply caused by WSD, and post-dam vegetation patterns which have locked up floodplain surfaces. See the Dry Creek Current Conditions Report (Inter-Fluve 2010), Appendix A, for more detail.

**Reach 14 Current Habitat Conditions**

Table B1. Reach 14 habitat units based on current conditions

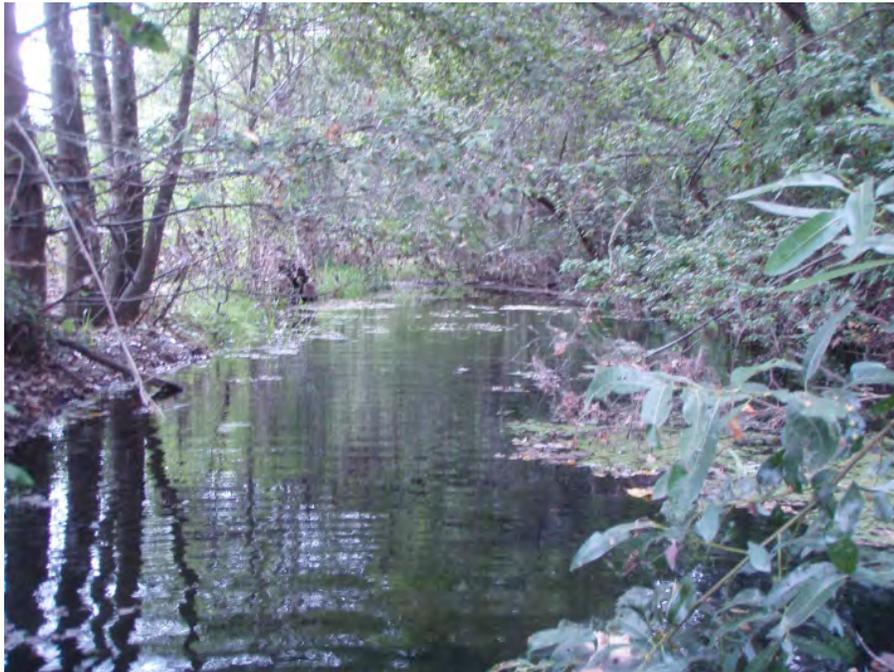
Habitat	Existing Habitat	
	Area (ft <sup>2</sup> )	#
Alcove / Backwater	1850	2
Flatwater	59950	6
Pool	70450	9
Riffle	30300	9
Side Channel	0	0

Figure B1. Habitat units in reach 14 based on area (A) and frequency (B).



## B.2 Reach 14 Enhancement Approach

Reach 14 is located in the “upper segment<sup>1</sup>” 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 coho and steelhead rearing habitat. The focus of the restoration approach will be to construct late successional habitats given the limited risk of future sedimentation and channel migration. There is one exception to this approach, in the vicinity of OC 42, 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 habitat in this location. Primary habitat types are to include off channel habitats such as side channels and backwater channels, LWD-driven main channel habitat, and main channel pools. Side channel and backwaters will provide low velocity habitat with cover for coho juveniles. For purposes of enhancement planning, reach 14 has been split into 2 enhancement sub-reaches (h). Sub-reach 14a (RM 12.5 to RM 13) is described in section B.3, and sub-reach 14b (RM 13 to 13.2) is described in section B.4.



*Figure B2 Existing off-channel ponds on the valley left side of the evidence of former surface water connection seen upstream of off-channel ponds*

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<sup>1</sup> Additional detail of process-based delineation of lower Dry Creek into upper, middle and lower segments can be found in the Fish Habitat Enhancement Feasibility Study, Section 5.3, IFI 2011



*Figure B3. 500 feet of board fence limits lateral migration of the main channel in Reach 14.*

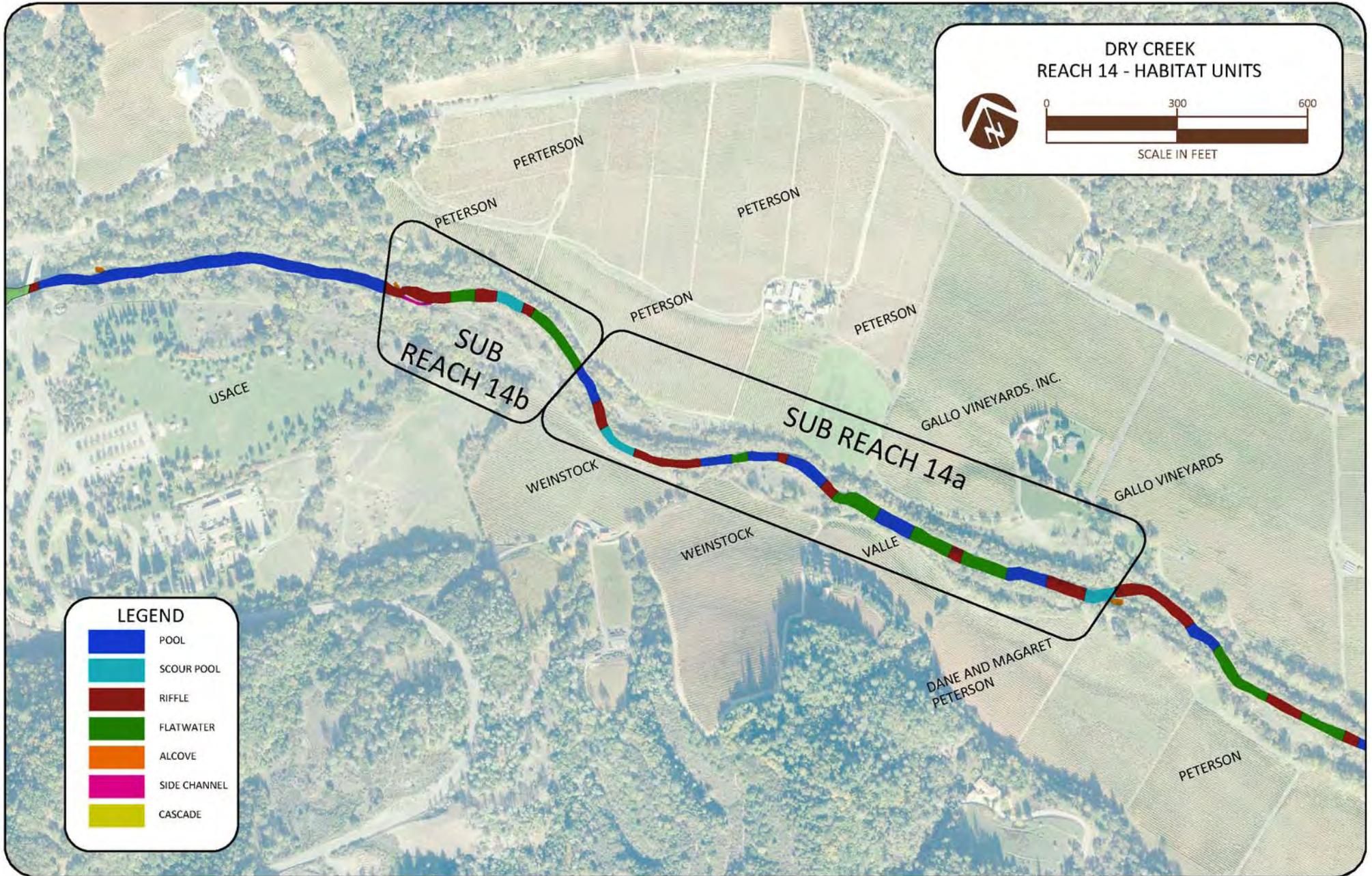


Figure B4. Reach 14b habitat units and sub-reach boundaries.

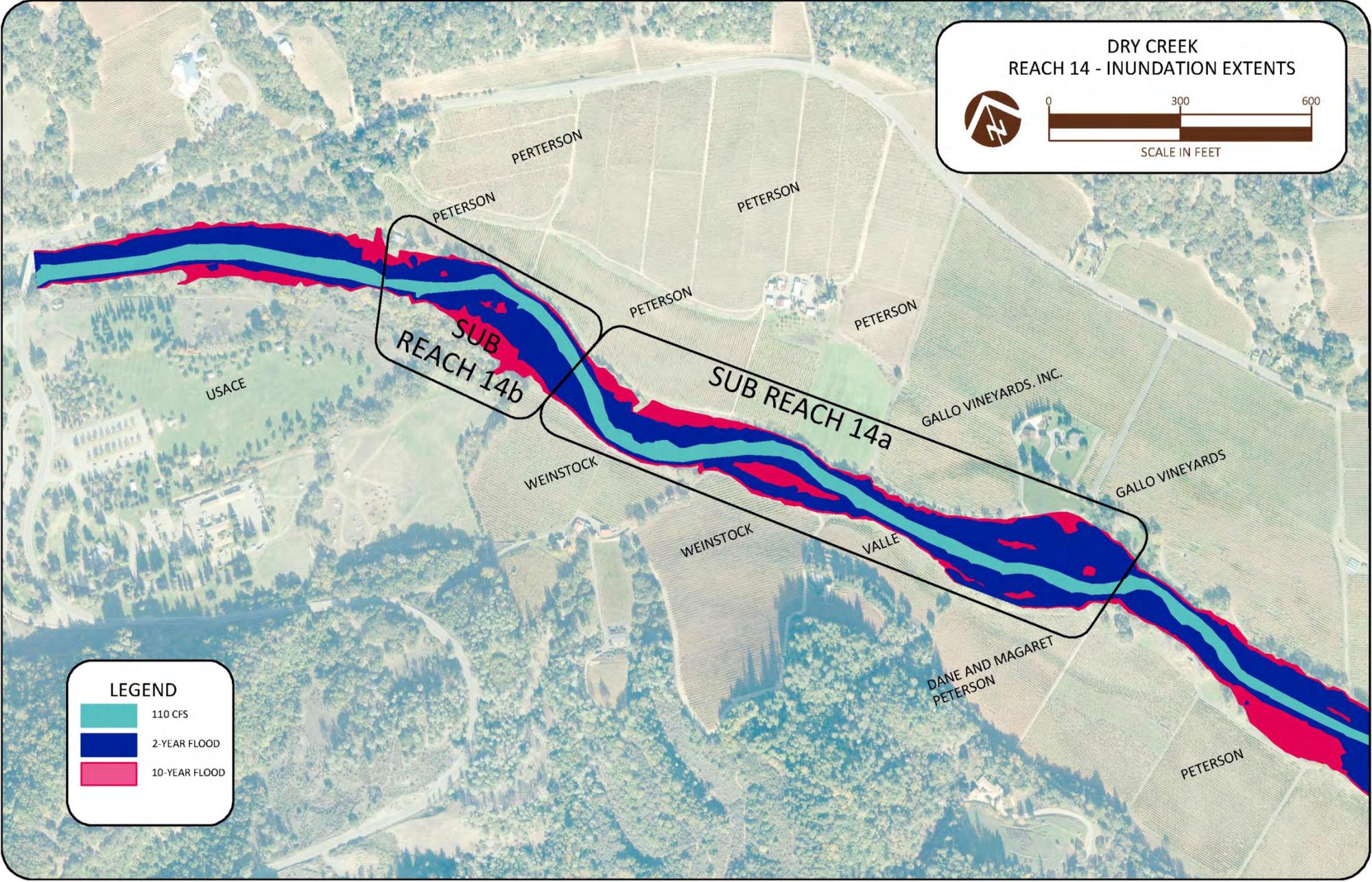


Figure B5. Modeled inundations in reach 14 based on three specific discharge levels: 110 cfs, the 2-year and 10-year flood events.

**B.3 Sub-Reach 14a Conceptual Designs**

Sub-Reach 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. In order to improve the quality and quantity of juvenile salmonid rearing habitat, a combination of both off-channel and main channel habitat enhancements are proposed. Off-channel enhancements include the creation of backwater channels, side channels, and placement of LWD. Main channel habitat enhancements include pool enhancements, riffle construction, and log jams. The following table and figures provide a summary of design concepts created for Sub-Reach 14a. The following table and accompanying figures summarize the design concepts developed for sub-reach 14a.

Project Code	Backwater Channel	Side Channel	Pool Enhancement	Riffle Enhancement	LWD	Winter Refuge Habitat*	Bank Stabilization	Vegetation Management	Comments
M 38/39			X	X	X			X	Riffle & Pool Enhancement
OC 38 L	X				X			X	Backwater Channel Construction
OC 39 R	X				X		X	X	Backwater Channel Construction
M 40			X	X	X			X	Riffle Construction & Pool Enhancement
OC 40 R	X				X		X	X	Backwater Channel Construction
M 41			X	X	X			X	Pool & Riffle Enhancement
OC 41 L	X				X			X	Backwater Channel Construction

Table B2. Inventory of projects identified in sub-reach 14a.

\*Although there are no winter refuge habitats proposed in reach 14, backwater channel habitats will provide winter refuge, and available off-channel habitat for juvenile salmonids will become large as flows increase during winter storms.

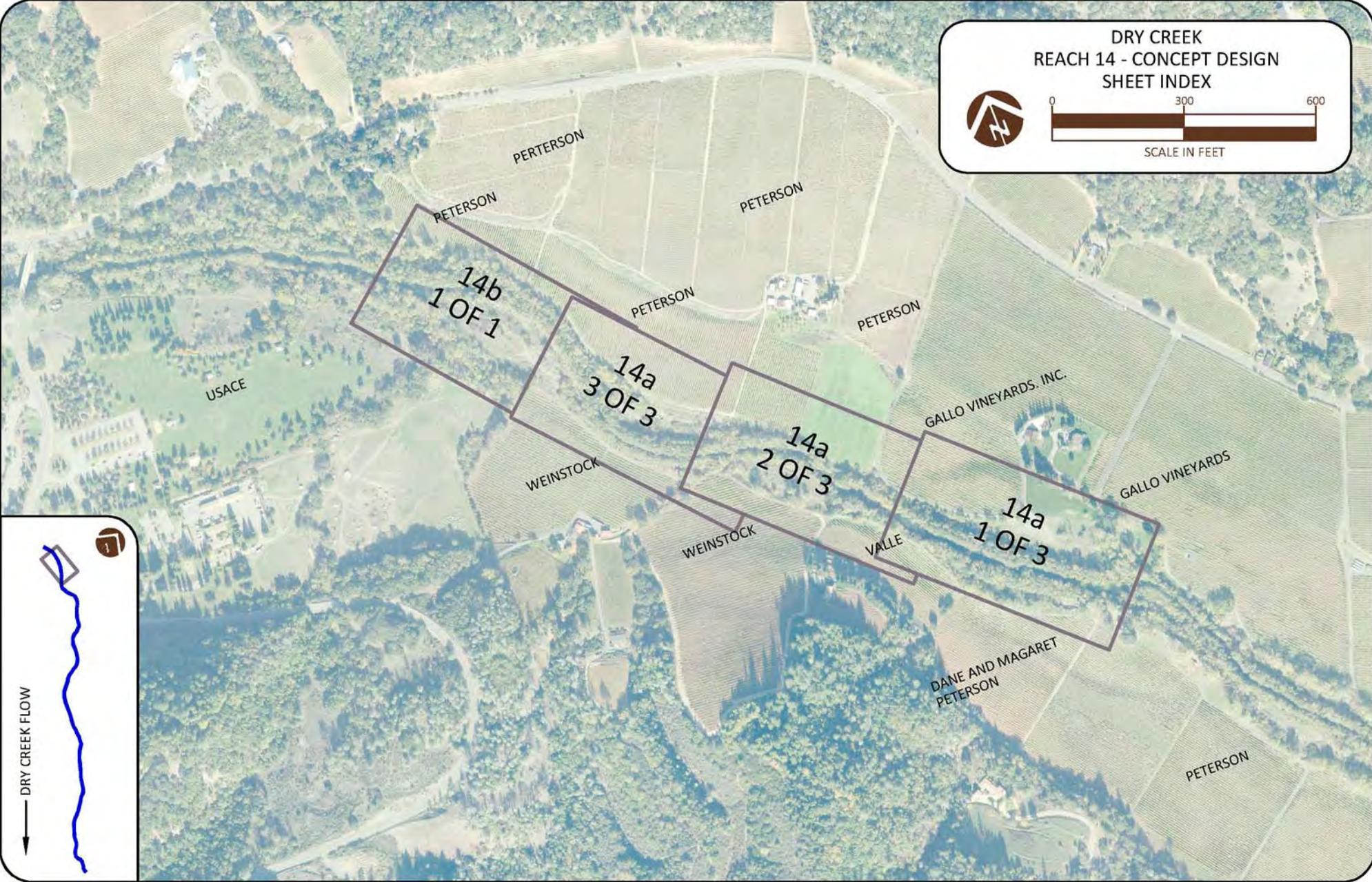


Figure B6. Reach 14 sheet index for conceptual design detail sheets.

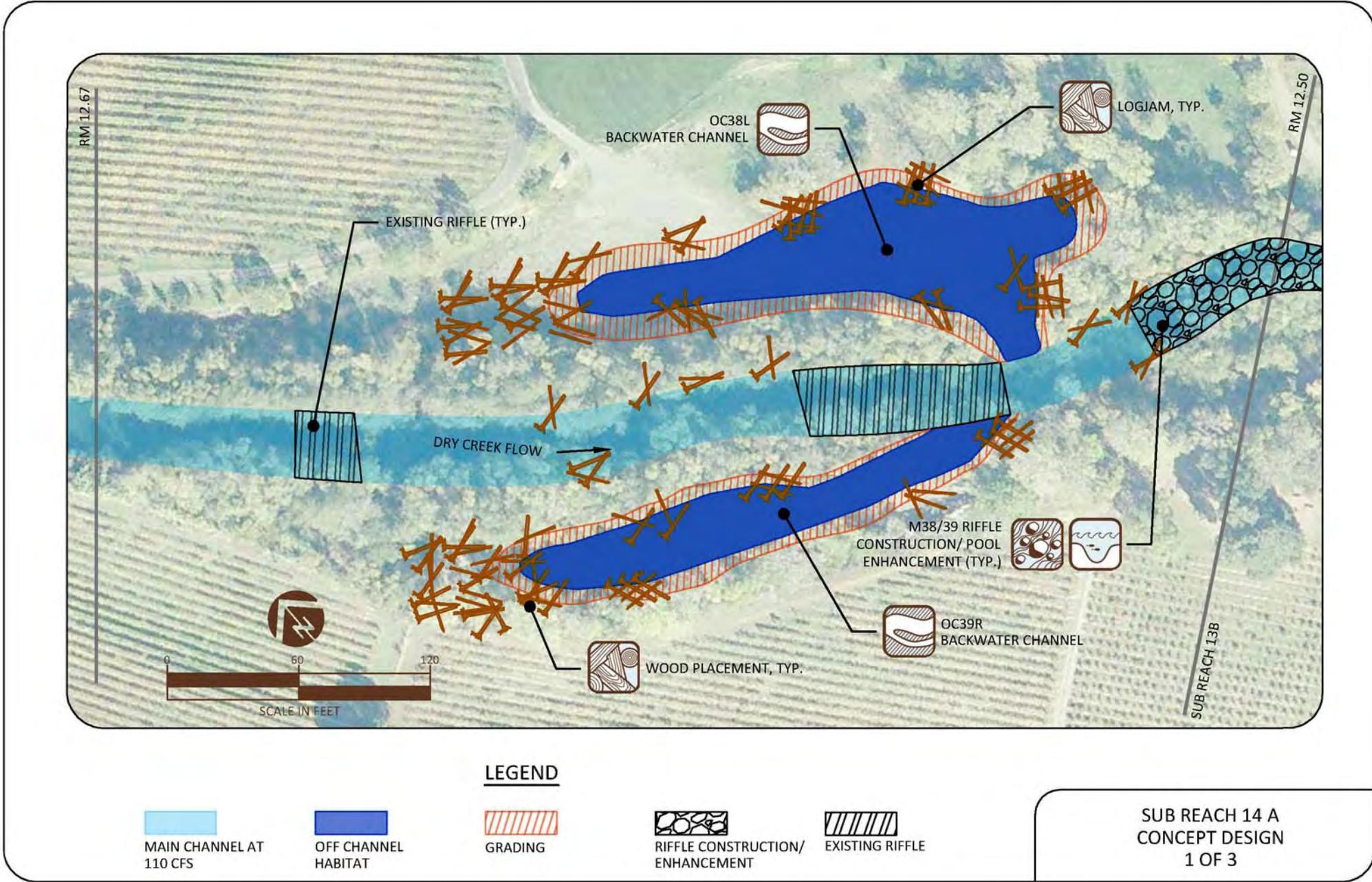


Figure B7. Sub-reach 14a conceptual design detail sheet 1 of 3.

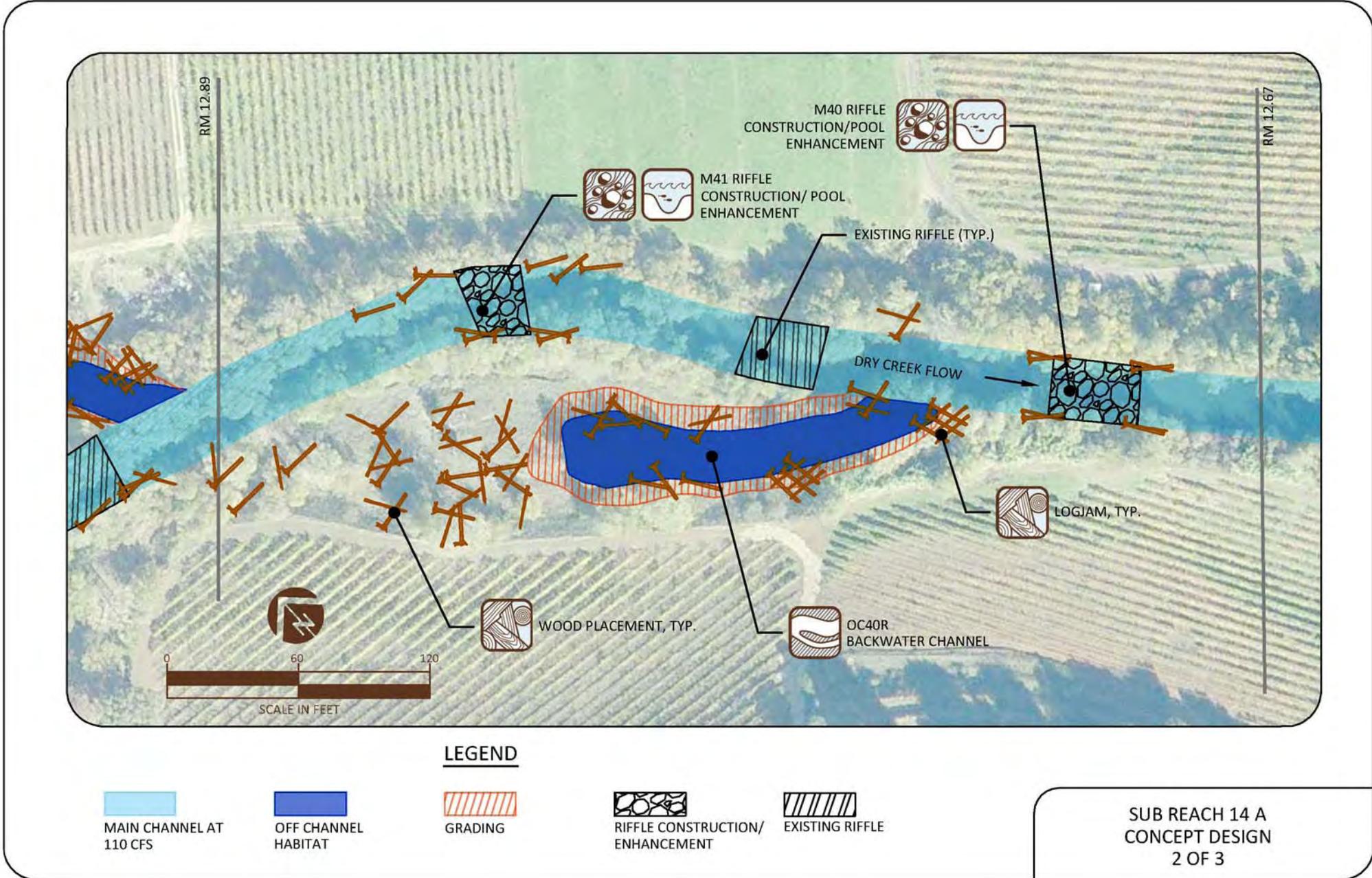


Figure B8. Sub-reach 14a conceptual design detail sheet 2 of 3.

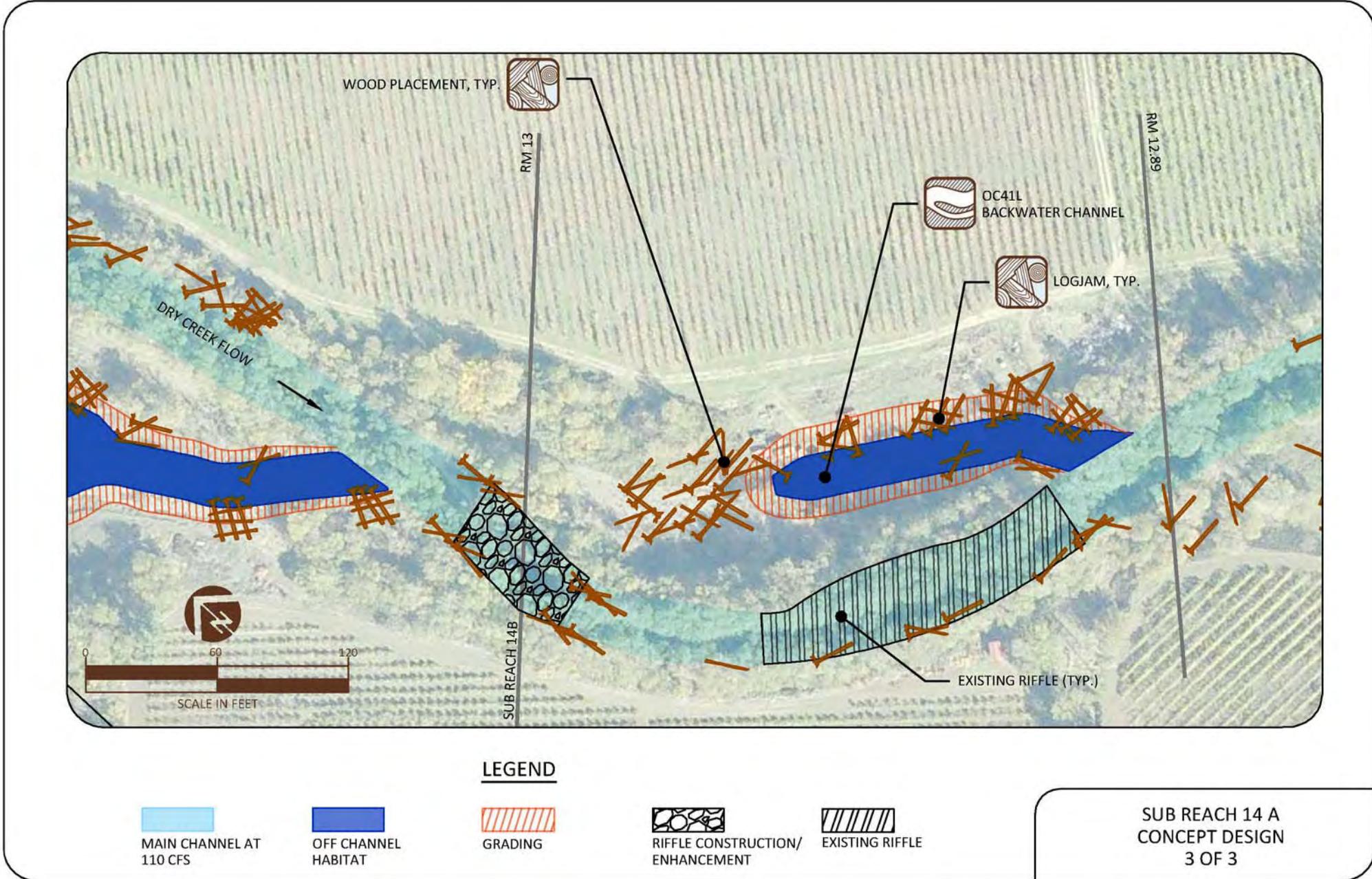


Figure B9. Sub-reach 14a conceptual design detail sheet 3 of 3.

Sub-Reach 14a Analysis of Proposed Enhancements

Proposed enhancements will create nearly 90,000 ft<sup>2</sup> of summer coho rearing habitat in sub-reach 14a. Long sections of flatwaters and pools will be converted into pool-riffle sequences rich with LWD-margin habitat, providing habitat benefits to juvenile steelhead and coho. The proposed enhancements will provide increased habitat diversity in sub-reach 14a. The following tables summarize the frequency and areas of existing vs. proposed habitat (Table B3), additional habitat to be created by enhancements (Table B4) and cost-based metrics (

Table B5). Table B6 presents habitat enhancement areas normalized by sub-reach main channel length. Table B7 summarizes the planning level cost estimate developed for sub-reach 14a.

Table B3: Habitat area by unit type for existing and proposed conditions in sub-reach 14a.

Habitat	Existing Habitat		Proposed Habitat	
	Area (ft <sup>2</sup> )	#	Area (ft <sup>2</sup> )	#
Alcove / Backwater	1450	1	70160	4
Flatwater	39600	4	23900	2
Pool	56750	7	67300	9
Riffle	16800	6	54550	7
Side Channel	0	0	0	0

Table B4. Additional habitat benefits provided by backwater habitat, LWD-margin habitat, and riffles in Sub-reach 14a.

Habitat Type	(ft <sup>2</sup> )	(m <sup>2</sup> )
Alcove/Backwater <sup>+</sup> (summer coho rearing)	81800	7600
LWD-Margin Habitat (summer coho rearing)	8000	740
Winter Refuge Habitat (winter coho rearing)	31050	2890
Pools	10550	980
Riffles	37750	3510
<b>Total</b>	<b>169150</b>	<b>15710</b>

<sup>+</sup>Alcove/Backwater habitats also provide winter refuge habitat during flood events.

Table B5. Cost-benefit table for design concepts presented for sub-reach 14.

Cost - Benefit Metric	Cost / ft <sup>2</sup>
Cost / ft <sup>2</sup> of summer coho rearing*	85
Cost / ft <sup>2</sup> of winter coho rearing**	63
Cost / ft <sup>2</sup> of total enhanced habitat***	45

\*includes backwater and LWD-margin habitats

\*\* includes alcove/backwater, high flow backwater, LWD-margin, and winter refuge

\*\*\*includes alcove/backwater, LWD-margin, and riffles

Table B6. Length metrics showing habitat enhancement area divided by sub-reach main channel length for summer coho rearing and total enhanced habitat.

Length Metric	area (ft <sup>2</sup> )/ length (ft)
Summer coho rearing habitat	30
Winter coho rearing habitat	41
Total enhanced habitat	57

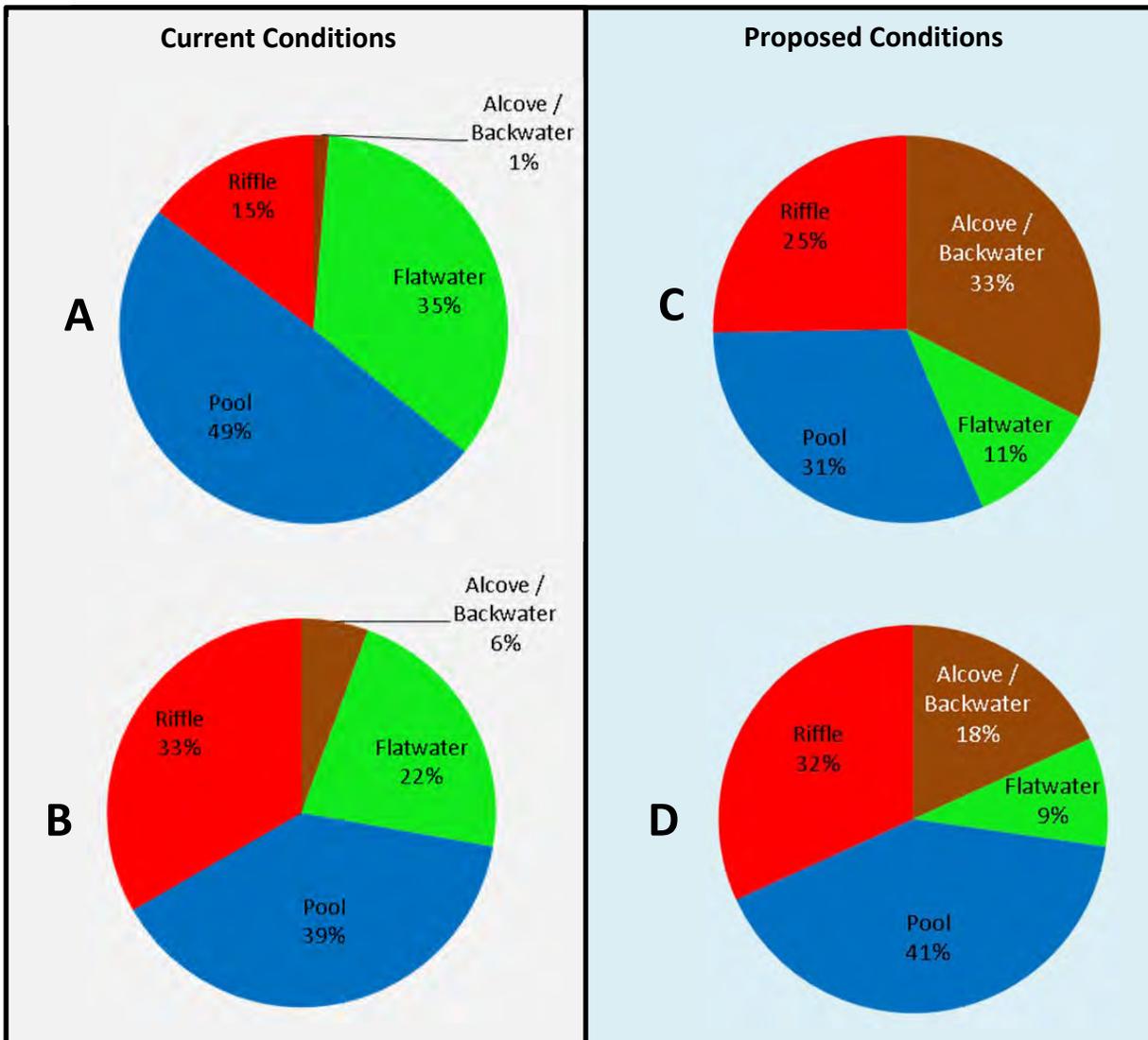


Figure B10. Existing habitats shown by area (A), frequency (B) and proposed habitat units based on area (C) and frequency (D).

**Sub-reach 14a Alternatives Discussion**

Two alternatives were identified for off-channel and main channel enhancement sites in the downstream end of sub-reach 14a. Side channel enhancements could be constructed in OC 38L and OC 39R. Additionally, the board fence main channel could be re-meandered to the valley right side of the floodplain, which would be accompanied by removal of the board fence which is aligned with the right bank of the current main channel.

Table B7. Sub-Reach 14a Planning Level Cost Estimate

Note: This is a preliminary cost estimate for planning purposes. Actual costs for design and construction activities may vary substantially from these estimates. Assumptions for time requirements and material quantities have been made based on limited information that is available for the site. Additional information obtained during site investigations will be needed to determine actual quantities and costs. Estimates based on 2011 costs.

No.	Description	Unit	Quantity	Unit Cost	Total Cost	Design and Quantity Assumptions
1	Mobilization and Demobilization	LS	1	\$230,000	\$230,000	Calculated at 5% of construction sub-total.
2	Site Access Measures	LS	1	\$350,000	\$350,000	Includes access road improvements, traffic control, dust control, and site restoration.
3	Environmental Protection Measures	LS	1	\$1,130,000	\$1,130,000	Includes stream diversion/dewatering, fish relocation, and erosion control BMPs.
4	Clearing and Grubbing	AC	3	\$2,000	\$6,000	
5	Common Excavation					
a.	OC 38	CY	14,400	\$20	\$288,000	Final design criteria and analysis will likely alter these estimates up or down.
b.	OC 39	CY	6,630	\$20	\$132,600	
c.	OC 40	CY	6,420	\$20	\$128,400	
d.	OC 41	CY	4,580	\$20	\$91,600	
6	Large Woody Debris (purchased, delivered, installed)					
a.	Floodplain Roughness Logs	EA	190	\$1,150	\$218,500	Assumes 30% delivered with root wads attached.
b.	Backwater Habitat Logs	EA	390	\$1,150	\$448,500	
c.	Pool Enhancement Logs	EA	100	\$1,150	\$115,000	
d.	Log Jams	EA	400	\$1,150	\$460,000	
7	Boulder Ballast (purchased, delivered, installed)	TN	1,080	\$100	\$108,000	Estimated 1 ton per log.
8	Bank Stabilization	LF	810	\$1,000	\$810,000	Bank stabilization methods will vary but will include one or more of the following components: large woody debris, earthwork, riprap scour protection, granular backfill, aggregate filter material, geotextile fabric, and/or fabric encapsulated soil lifts. Assumes 30% delivered with root wads attached.
9	Riffle Installation (purchased, delivered, installed)	CY	1,330	\$120	\$159,600	Assume average of 3 feet of depth per riffle for riffle construction. Assume average of 1.5 feet of depth per riffle for riffle enhancement.
10	Vegetation Management	AC	11	\$20,000	\$220,000	Assumes area of floodplain from vineyard grade to vineyard grade minus the base flow inundation area of the main channel and of the proposed backwater habitat areas.
<b>Construction Sub-Total</b>					<b>\$4,896,200</b>	<div style="display: flex; justify-content: space-between;"> <div style="border: 1px solid black; padding: 5px;"> <p><b>Key</b>                      LS = Lump Sum                      CY = Cubic Yard                      LF = Lineal Foot                      AC = Acre                      EA = Each</p> </div> <div style="border: 1px solid black; padding: 5px;"> <p><b>Project Delivery Items are calculated as a percent of the construction sub-total</b>  <b>General Notes:</b>                      -Cost includes a 30% design and construction contingency                      -Costs assume all materials (wood and rock) are purchased and hauled to the site from a nearby source                      -Boulder ballast requirements may be able to be reduced depending on hydraulics analysis</p> </div> </div>
Concept Level Design & Construction Contingency (30%)					\$1,468,860	
<b>Construction Total</b>					<b>\$6,365,100</b>	
<b>Project Delivery</b>						
Permitting (4%)					\$195,848	
Detailed Engineering Design (15%)					\$734,430	
Contract Administration (5%)					\$244,810	
Construction Oversight (1.5%)					\$73,443	
<b>Project Delivery Sub-Total</b>					<b>\$1,248,500</b>	
<b>TOTAL ESTIMATE</b>					<b>\$7,614,000</b>	

rounded to nearest \$1,000

**B.4 Sub-Reach 14b Conceptual Designs**

Sub-reach 14b is a 1000 foot sub-reach characterized by a flow expansion in the upstream end, and a flow contraction in the downstream end. The wider floodplain area in the middle of this sub-reach provides two off-channel habitat enhancement opportunities which include two backwater channels in addition to riffle and pool enhancements in the main channel. The tributary drainage, Schoolhouse Creek, enters Dry Creek at the top of sub-reach 14b, and appears to provide sediment in a segment of Dry Creek which has minimal sediment supply. The following table and accompanying figures summarize the design concepts developed for sub-reach 14b.

Project Code	Backwater Channel	Side Channel	Pool Enhancement	Riffle Enhancement	LWD	Winter Refuge Habitat*	Bank Stabilization	Vegetation Management	Comments
M 42			X	X	X			X	Riffle & Pool Enhancement
OC 42	X				X			X	Backwater Channel Construction
M 43	X				X			X	Riffle & Pool Enhancement
OC 43 L	X				X		X	X	Backwater Channel Construction

Table B8. Inventory of projects identified in sub-reach 14b.

\*Although there are no winter refuge habitats proposed in reach 14, backwater channel habitats will provide winter refuge, and available off-channel habitat for juvenile salmonids will become large as flows increase during winter storms.

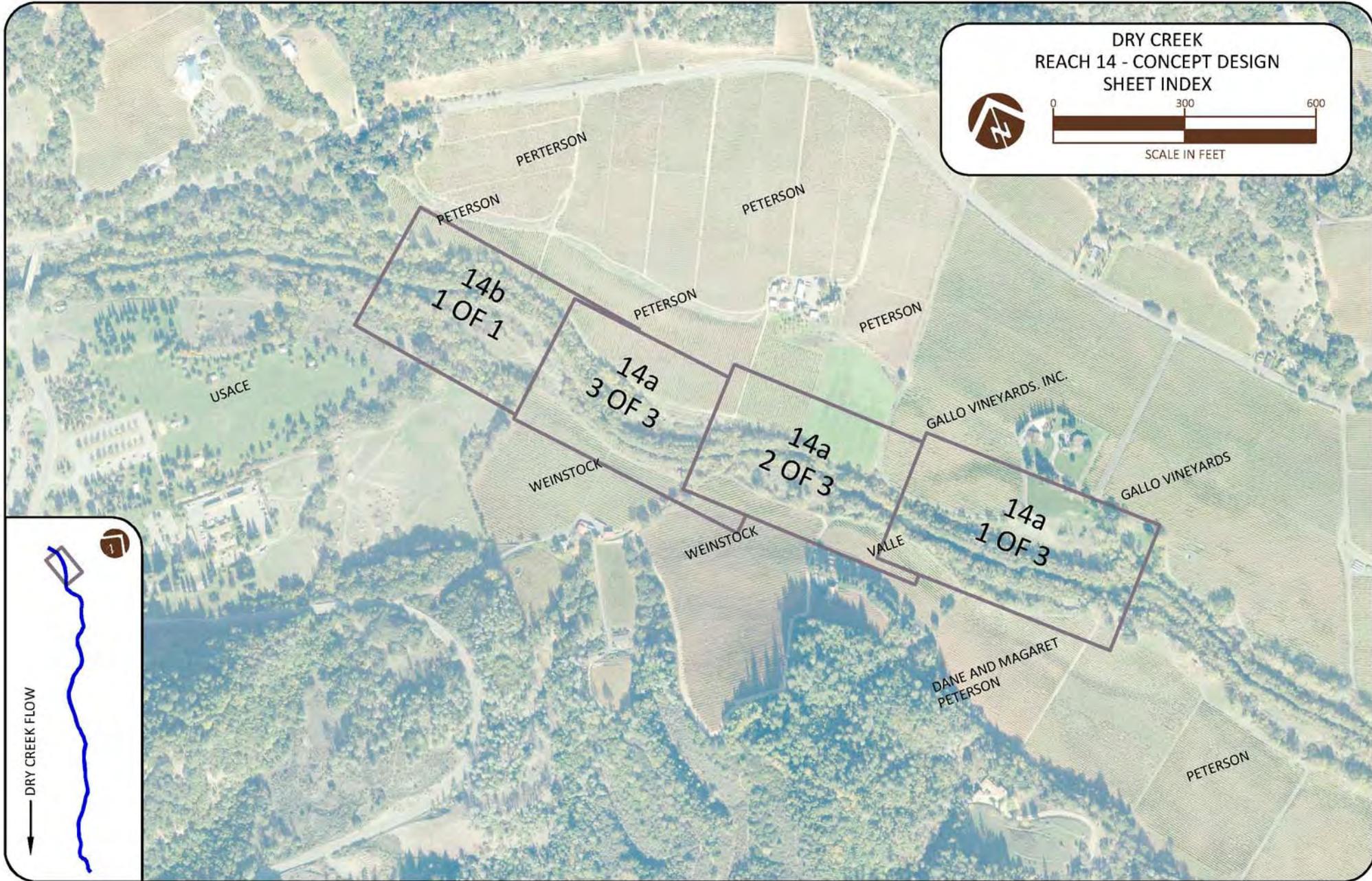


Figure B11. Reach 14 sheet index for conceptual design detail sheets.

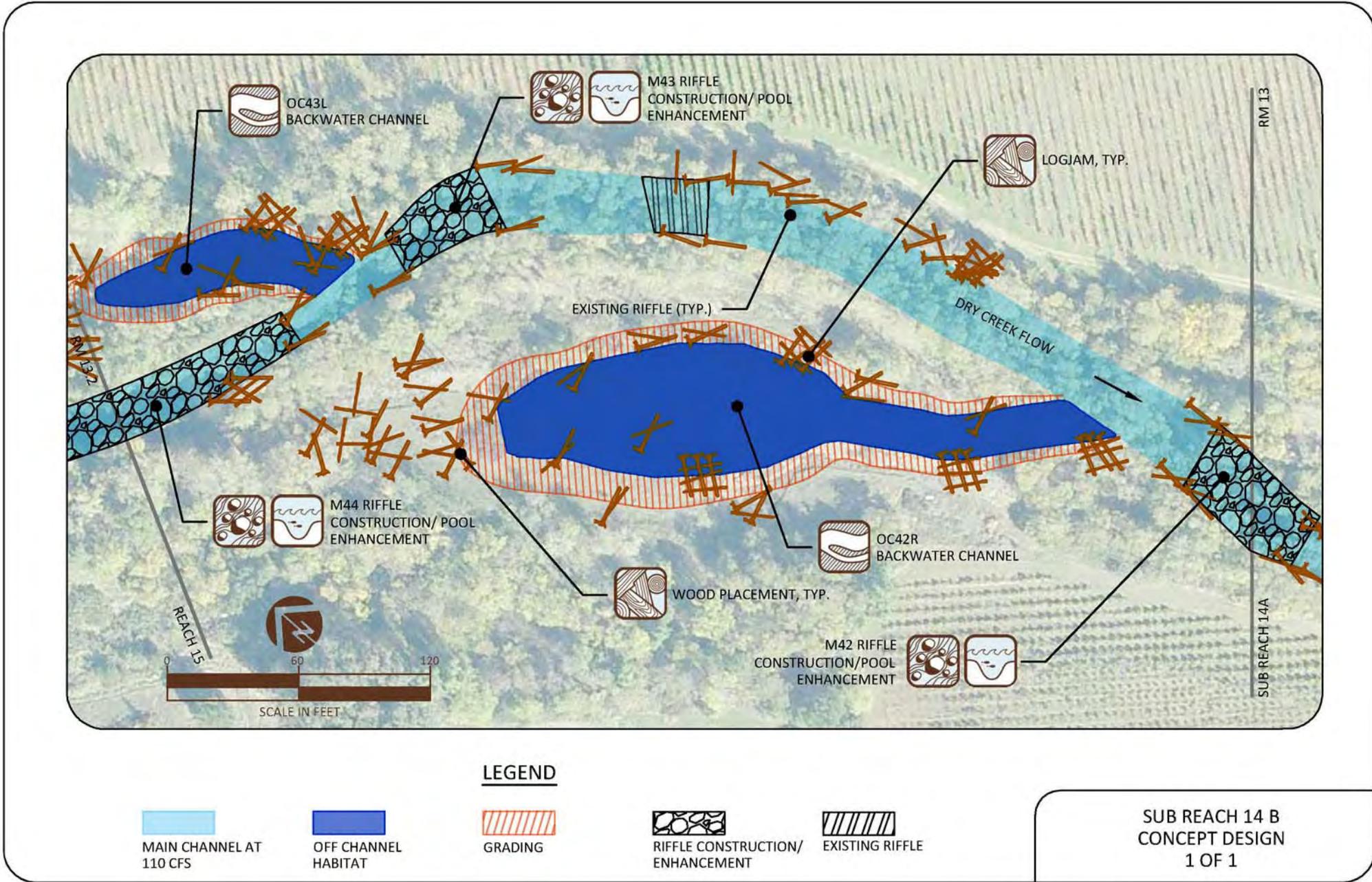


Figure B12. Sub-reach 14b conceptual design detail.  
Dry Creek Conceptual Design Report

**Sub-Reach 14b Analysis of Proposed Enhancements**

Proposed enhancements would provide a significant increase in the quantity and quality of available juvenile rearing habitat to a sub-reach with minimal off-channel habitat and main-stem quality pool habitat. The creation of over 50,000 ft<sup>2</sup> of off-channel habitat in addition to enhancing pools to provide near-optimal rearing habitat will improve the ecological function of sub-reach 14b. The following tables summarize the frequency and areas of existing vs. proposed habitat (Table B9), additional habitat to be created by enhancements (Table B10) and cost-based metrics (Table B11). Table B12 presents habitat enhancement areas normalized by sub-reach main channel length. Table B13 summarizes the planning level cost estimate developed for sub-reach 14b.

*Table B9. Habitat areas and frequencies based on existing and proposed habitats for sub-reach 14b.*

Habitat	Existing Habitat		Proposed Habitat	
	Area (ft <sup>2</sup> )	#	Area (ft <sup>2</sup> )	#
Alcove/ Backwater	400	1	50550	3
Flatwater	20350	2	14400	1
Pool	13700	2	19600	3
Riffle	13500	3	13500	3
Side Channel	0	0	0	0

*Table B10. Additional habitat benefits provided by backwater habitat, LWD-margin habitat, and riffles.*

Habitat Type	(ft <sup>2</sup> )	(m <sup>2</sup> )
Alcove/Backwater <sup>+</sup> (summer coho rearing)	50150	4660
LWD-Margin Habitat (summer coho rearing)	8000	560
Winter Refuge Habitat (winter coho rearing)	15350	1420
Pools	5900	550
<b>Total</b>	<b>77400</b>	<b>7190</b>

<sup>+</sup>Alcove/Backwater habitats also provide winter refuge habitat during flood events.

*Table B11. Cost – benefit table for design concepts presented for sub-reach 14b.*

Cost - Benefit Metric	Cost (\$)
Cost / ft <sup>2</sup> of summer coho rearing*	67
Cost / ft <sup>2</sup> of winter coho rearing**	53
Cost / ft <sup>2</sup> of total enhanced habitat***	49

\*includes backwater and LWD-margin habitats

\*\*includes alcove/backwater, high flow backwater habitat, LWD-margin, and winter refuge habitat

\*\*\*includes alcove/backwater, LWD-margin, and riffles

Table B12. Length metrics showing habitat enhancement area divided by sub-reach main channel length for summer coho rearing and total enhanced habitat.

Length Metric	area (ft <sup>2</sup> )/ length (ft)
Summer coho rearing habitat	54
Winter coho rearing habitat	69
Total enhanced habitat	74

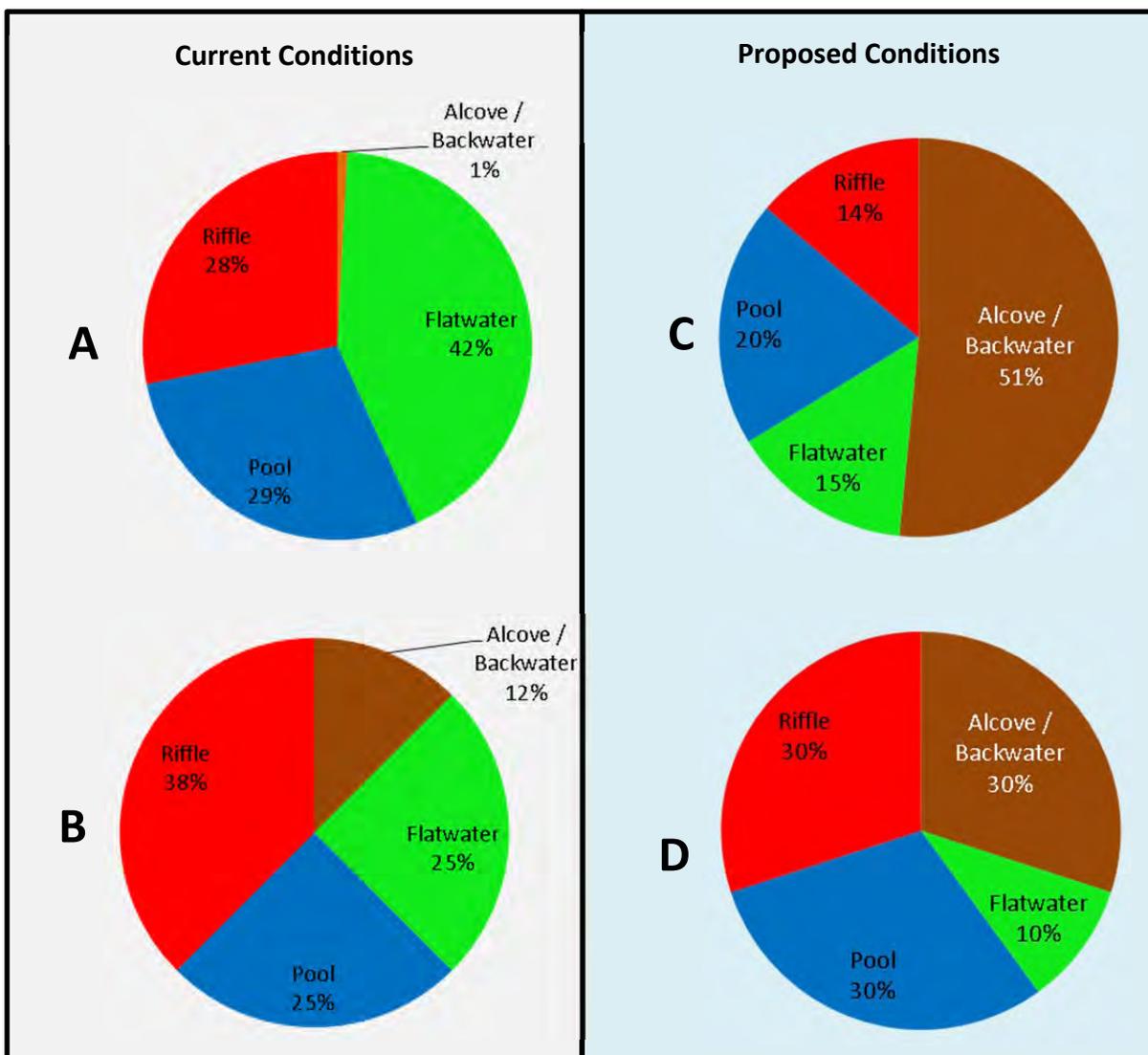


Figure B13. Existing sub-reach 14b habitats shown by area (A), frequency (B) and proposed habitat units based on area (C) and frequency (D).

**Sub-reach 14b Alternatives Discussion**

The floodplain surface in the vicinity of OC 42R is frequently inundated and appears to be suitable for a side channel enhancement designed to be dynamic over time. It appears as though sediment delivered by Schoolhouse Creek and additional local drainage deposits in this area will facilitate a dynamic floodplain enhancement approach. Existing high flow channels could be utilized in creating an alignment of the side channel alternative at this location.

Table B13. Sub-reach 14b Planning Level Cost Estimate

Note: This is a preliminary cost estimate for planning purposes. Actual costs for design and construction activities may vary substantially from these estimates. Assumptions for time requirements and material quantities have been made based on limited information that is available for the site. Additional information obtained during site investigations will be needed to determine actual quantities and costs. Estimates based on 2011 costs.

No.	Description	Unit	Quantity	Unit Cost	Total Cost	Design and Quantity Assumptions
1	Mobilization and Demobilization	LS	1	\$120,000	\$120,000	Calculated at 5% of construction sub-total.
2	Site Access Measures	LS	1	\$170,000	\$170,000	Includes access road improvements, traffic control, dust control, and site restoration.
3	Environmental Protection Measures	LS	1	\$560,000	\$560,000	Includes stream diversion/dewatering, fish relocation, and erosion control BMPs.
4	Clearing and Grubbing	AC	2	\$2,000	\$4,000	
5	Common Excavation					
a.	OC 42	CY	15,460	\$20	\$309,200	Final design criteria and analysis will likely alter these estimates up or down.
b.	OC 43	CY	2,810	\$20	\$56,200	
6	Large Woody Debris (purchased, delivered, installed)					
a.	Floodplain Roughness Logs	EA	100	\$1,150	\$115,000	Assumes 30% delivered with root wads attached.
b.	Backwater Habitat Logs	EA	230	\$1,150	\$264,500	
c.	Pool Enhancement Logs	EA	60	\$1,150	\$69,000	
d.	Log Jams	EA	320	\$1,150	\$368,000	
7	Boulder Ballast (purchased, delivered, installed)	TN	710	\$100	\$71,000	Estimated 1 ton per log.
8	Bank Stabilization	LF	150	\$1,000	\$150,000	Bank stabilization methods will vary but will include one or more of the following components: large woody debris, earthwork, riprap scour protection, granular backfill, aggregate filter material, geotextile fabric, and/or fabric encapsulated soil lifts. Assumes 30% delivered with root wads attached.
9	Riffle Installation (purchased, delivered, installed)	CY	670	\$120	\$80,400	Assume average of 3 feet of depth per riffle for riffle construction. Assume average of 1.5 feet of depth per riffle for riffle enhancement.
10	Vegetation Management	AC	5	\$20,000	\$100,000	Assumes area of floodplain from vineyard grade to vineyard grade minus the base flow inundation area of the main channel and of the proposed backwater habitat areas.
<b>Construction Sub-Total</b>					<b>\$2,437,300</b>	<div style="display: flex; justify-content: space-between;"> <div style="border: 1px solid black; padding: 5px;"> <p><b>Key</b>                      LS = Lump Sum                      CY = Cubic Yard                      LF = Lineal Foot                      AC = Acre                      EA = Each</p> </div> <div style="border: 1px solid black; padding: 5px;"> <p><b>Project Delivery Items are calculated as a percent of the construction sub-total</b>  <b>General Notes:</b>                      -Cost includes a 30% design and construction contingency                      -Costs assume all materials (wood and rock) are purchased and hauled to the site from a nearby source                      -Boulder ballast requirements may be able to be reduced depending on hydraulics analysis</p> </div> </div>
Concept Level Design & Construction Contingency (30%)					\$731,190	
<b>Construction Total</b>					<b>\$3,168,500</b>	
<b>Project Delivery</b>						
Permitting (4%)					\$97,492	
Detailed Engineering Design (15%)					\$365,595	
Contract Administration (5%)					\$121,865	
Construction Oversight (1.5%)					\$36,560	
<b>Project Delivery Sub-Total</b>					<b>\$621,500</b>	
<b>TOTAL ESTIMATE</b>					<b>\$3,790,000</b>	

rounded to nearest \$1,000

## APPENDIX C

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**C.1 Reach 13 Description**

Reach 13 extends from river mile 12.6 downstream to the junction of Dry Creek with Dutcher Creek. Downstream of river mile 12, there is evidence of channel migration since the construction of WSD. In the upper portion of the reach, planform has remained relatively stable since the construction of WSD. At the upstream extent of the reach, trees near previous channel boundaries are about 26 years old, which corresponds to the approximate date of dam construction. Trees close to the current channel are about 14 years old, indicating that narrowing and vegetation encroachment along the active channel margins has occurred. See the Dry Creek Current Conditions Report (Inter-Fluve 2010), Appendix A, for more detail.

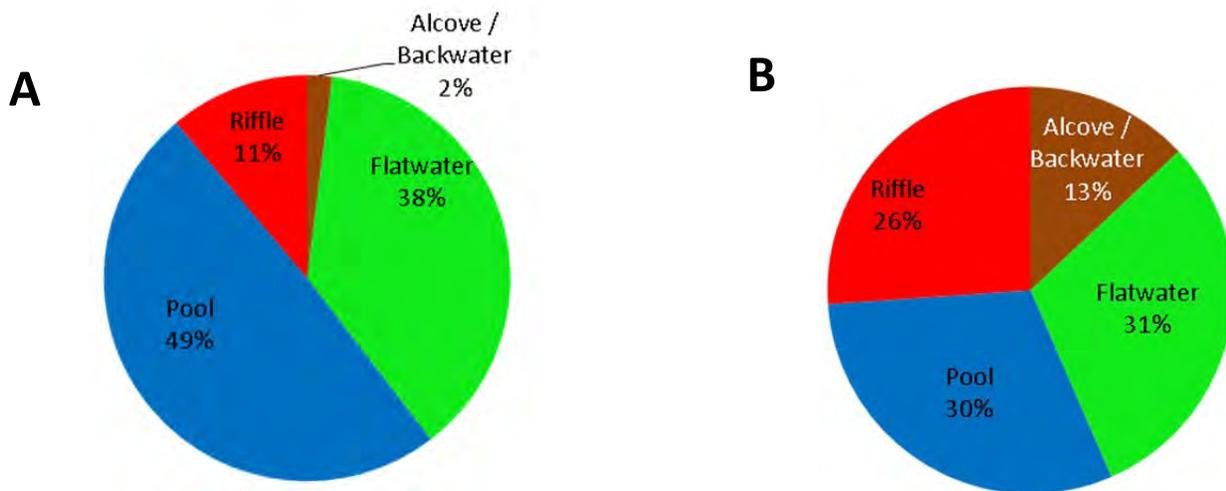


**Reach 13 Current Habitat Conditions**

Table C1. Reach 13 habitat units based on current conditions.

Habitat	Existing Habitat	
	Area (ft <sup>2</sup> )	#
Alcove / Backwater	3650	3
Flatwater	69100	7
Pool	90550	7
Riffle	20450	6
Side Channel	0	0

Figure C1. Habitat units in reach 14 based on area (A) and frequency (B).



## C.2 Reach 13 Enhancement Approach

Reach 13 is located in the “upper segment<sup>1</sup>” of Dry Creek and receives little sediment from upstream due to the lack of significant 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 coho and steelhead rearing habitat. The focus of the enhancement approach will be to construct late successional habitats given the limited risk of future sedimentation and channel migration. Primary habitat types are to include off channel habitats such as side channels and backwater channels, pools, and LWD-driven habitat in 13b, while the focus will be on main channel habitats (riffles, pools and LWD placements) in sub-reach 13a. For purposes of enhancement planning, reach 13 has been split into two enhancement sub-reaches (see Figure C2). Sub-reach 13a (RM 11.66 to 12.08) is described in section C.3 and sub-reach 13b (RM 12.08 to 12.5) is described in section C.4.

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<sup>1</sup> Additional detail of process-based delineation of lower Dry Creek into upper, middle and lower segments can be found in the Fish Habitat Enhancement Feasibility Study, Section 5.3, IFI 2011

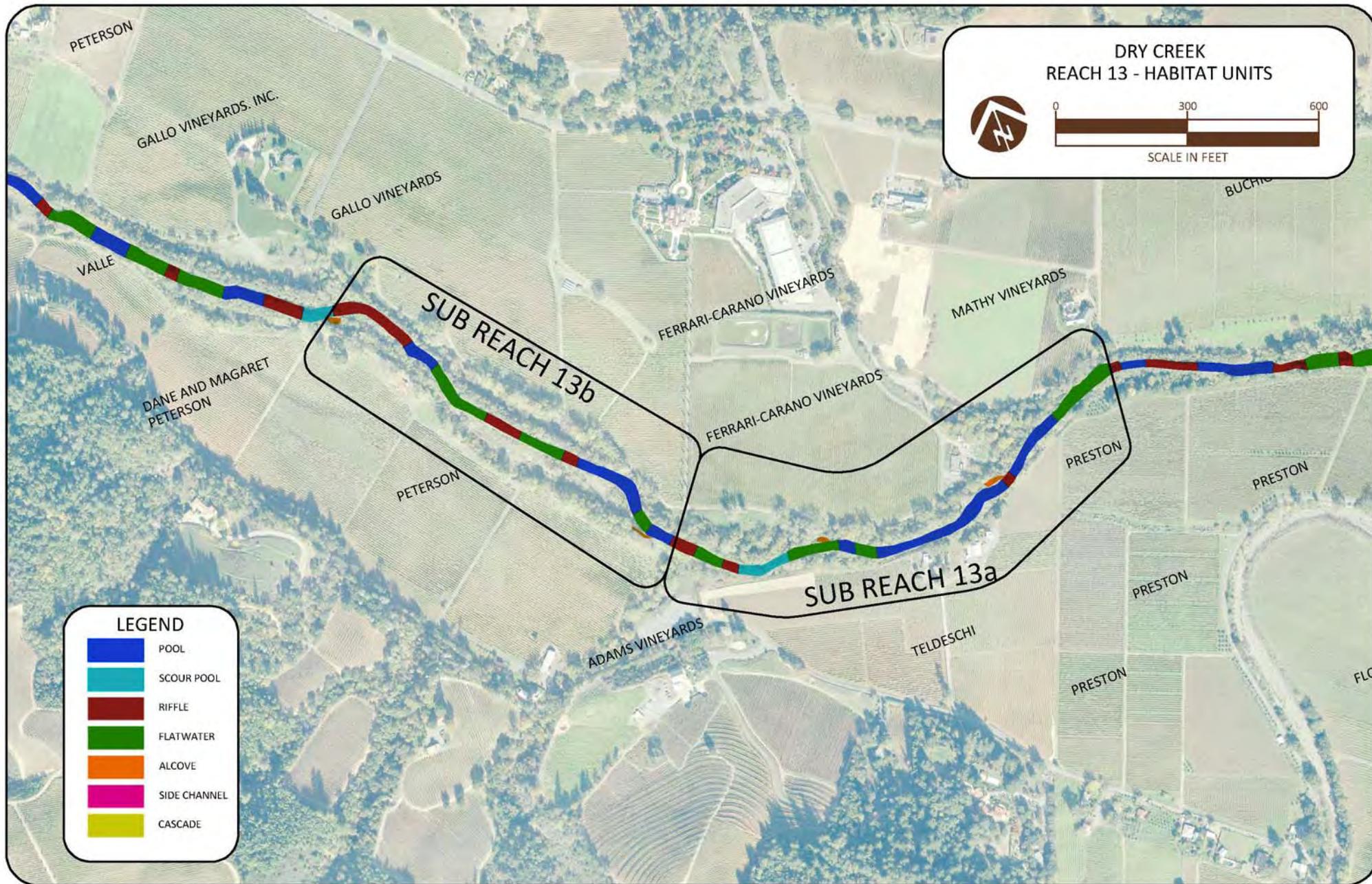


Figure C2. Reach 13 habitat units and sub-reach boundaries.

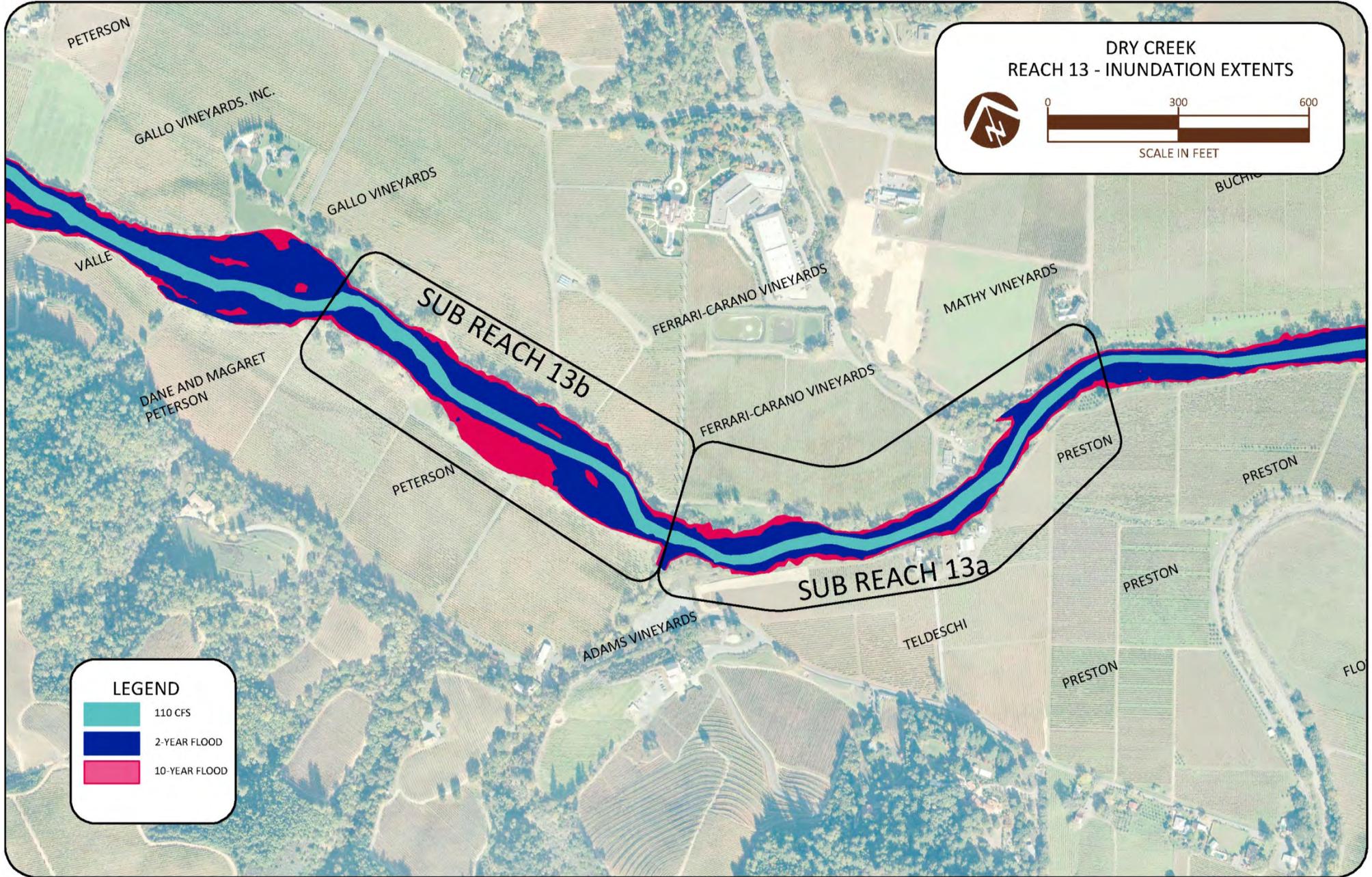


Figure C3. Modeled inundations in reach 13 based on three specific discharge levels: 110 cfs, the 2-year and 10-year flood events.

**C.3 Sub-Reach 13a Conceptual Designs**

Sub-Reach 13a is characterized by a relatively narrow active floodplain, and a channel geometry that lacks sinuosity due to the history of incision in Dry Creek. In order to improve the quality and quantity of juvenile salmonid rearing habitat, enhancement efforts will focus on main channel projects including the construction of riffles, enhancement of pools, and placement of LWD. Due to the small floodplain areas present in this sub-reach, there are no viable locations for the creation of off-channel habitats. The following table and accompanying figures summarize the design concepts created for sub-reach 13a.

Project Code	Backwater Channel	Side Channel	Pool Enhancement	Riffle Enhancement	LWD	Winter Refuge Habitat*	Bank Stabilization	Vegetation Management	Comments
M 35.1			X	X	X			X	Riffle Construction & Pool Enhancement
M 35.2					X			X	LWD Enhancement
M 35.3			X	X	X			X	Riffle Construction & Pool Enhancement
M 35.4			X	X	X			X	Riffle Construction & Pool Enhancement
M 35.5			X	X	X			X	Riffle Construction & Pool Enhancement

Table C2. Inventory of individual projects identified in sub-reach 13a.

\*Although there are no winter refuge habitats proposed in sub-reach 13a, backwater channel habitats will provide winter refuge, and available off-channel habitat for juvenile salmonids will become large as flows increase during winter storms.

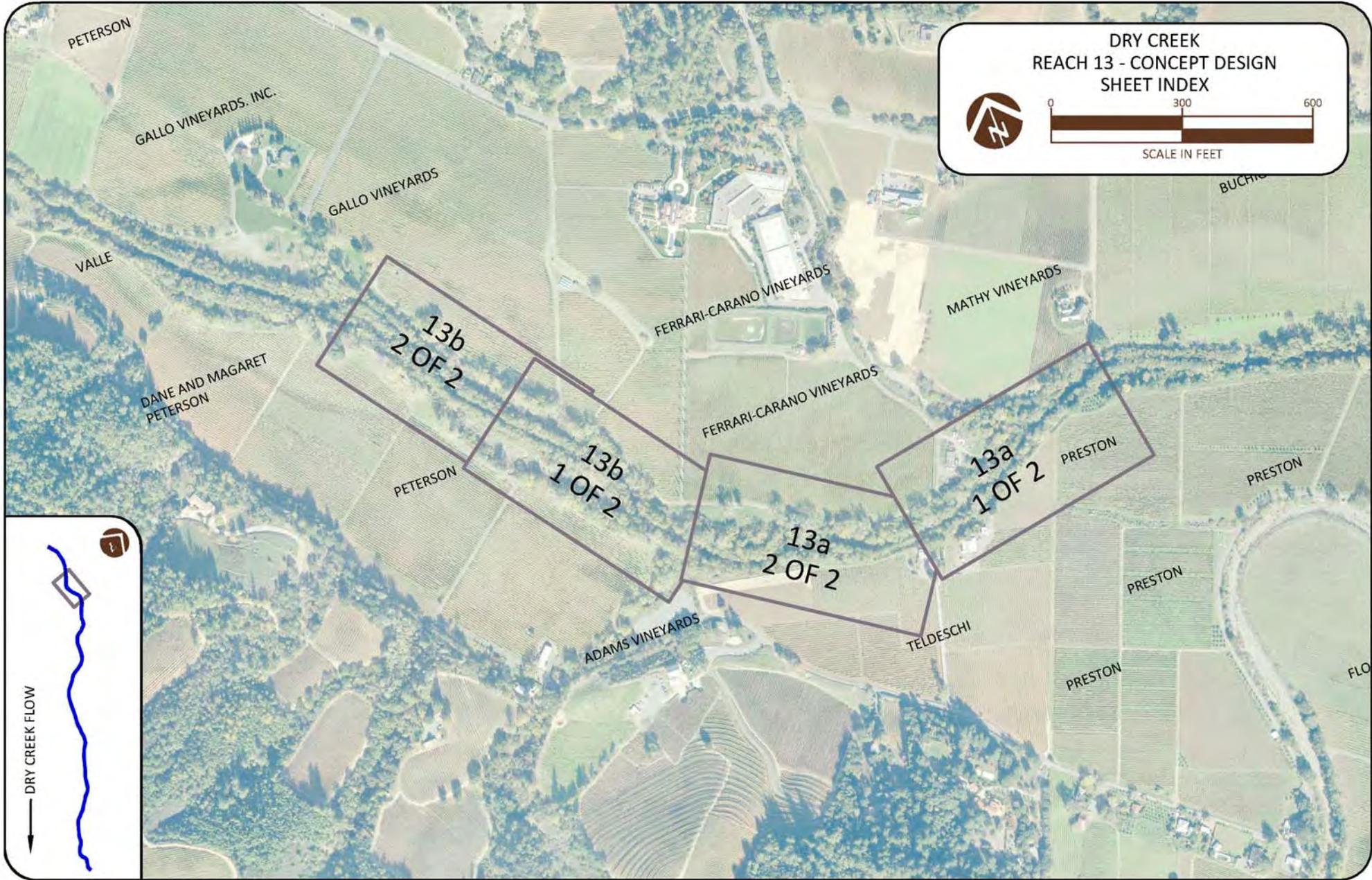
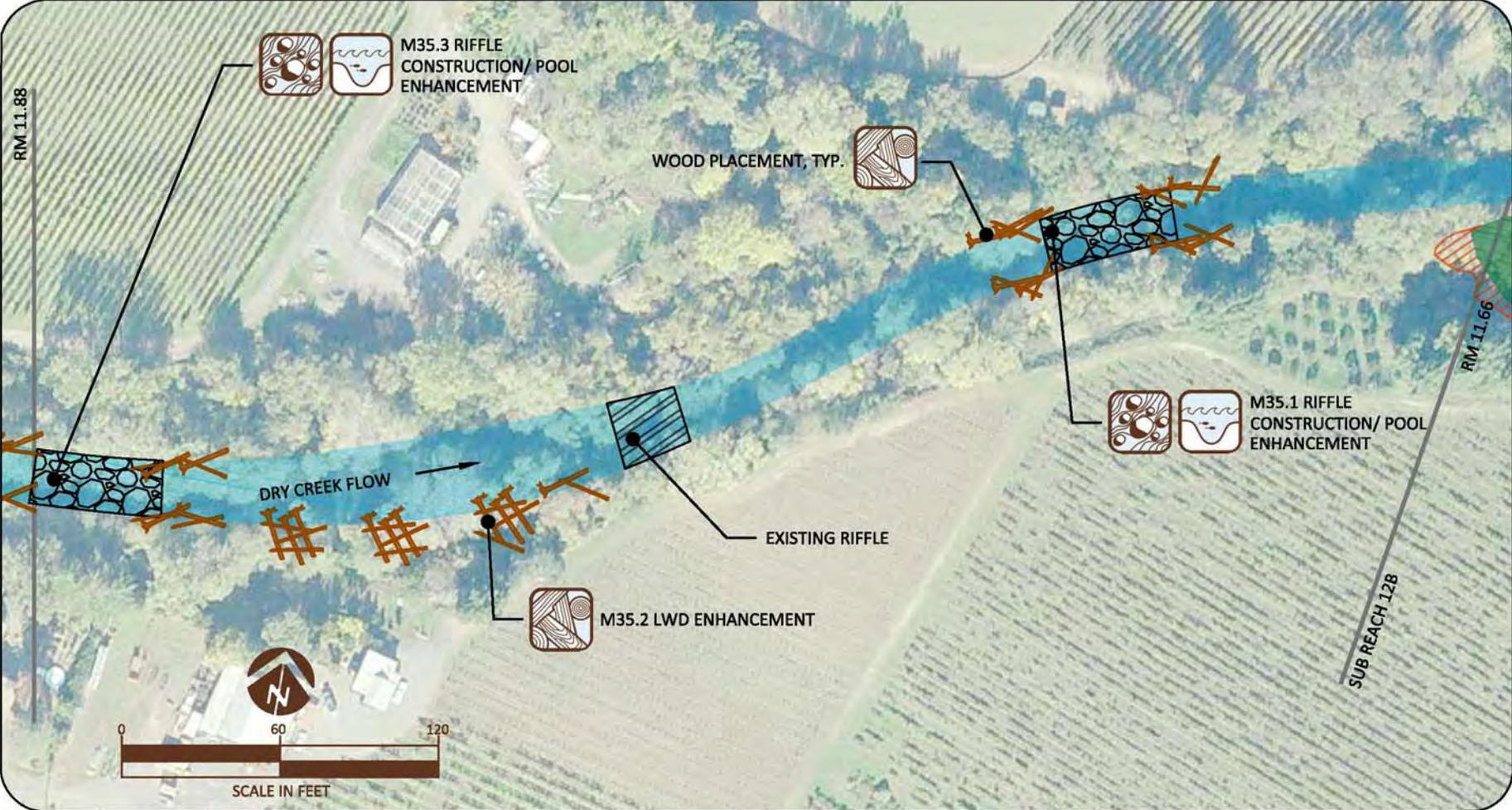


Figure C4. Reach 13 sheet index for conceptual design detail sheets.



**LEGEND**

-   
 MAIN CHANNEL AT  
110 CFS
-   
 GRADING
-   
 RIFFLE CONSTRUCTION/  
ENHANCEMENT
-   
 EXISTING RIFFLE

SUB REACH 13 A  
CONCEPT DESIGN  
1 OF 2

Figure C5. Sub-reach 13a conceptual design detail sheet 1 of 2.

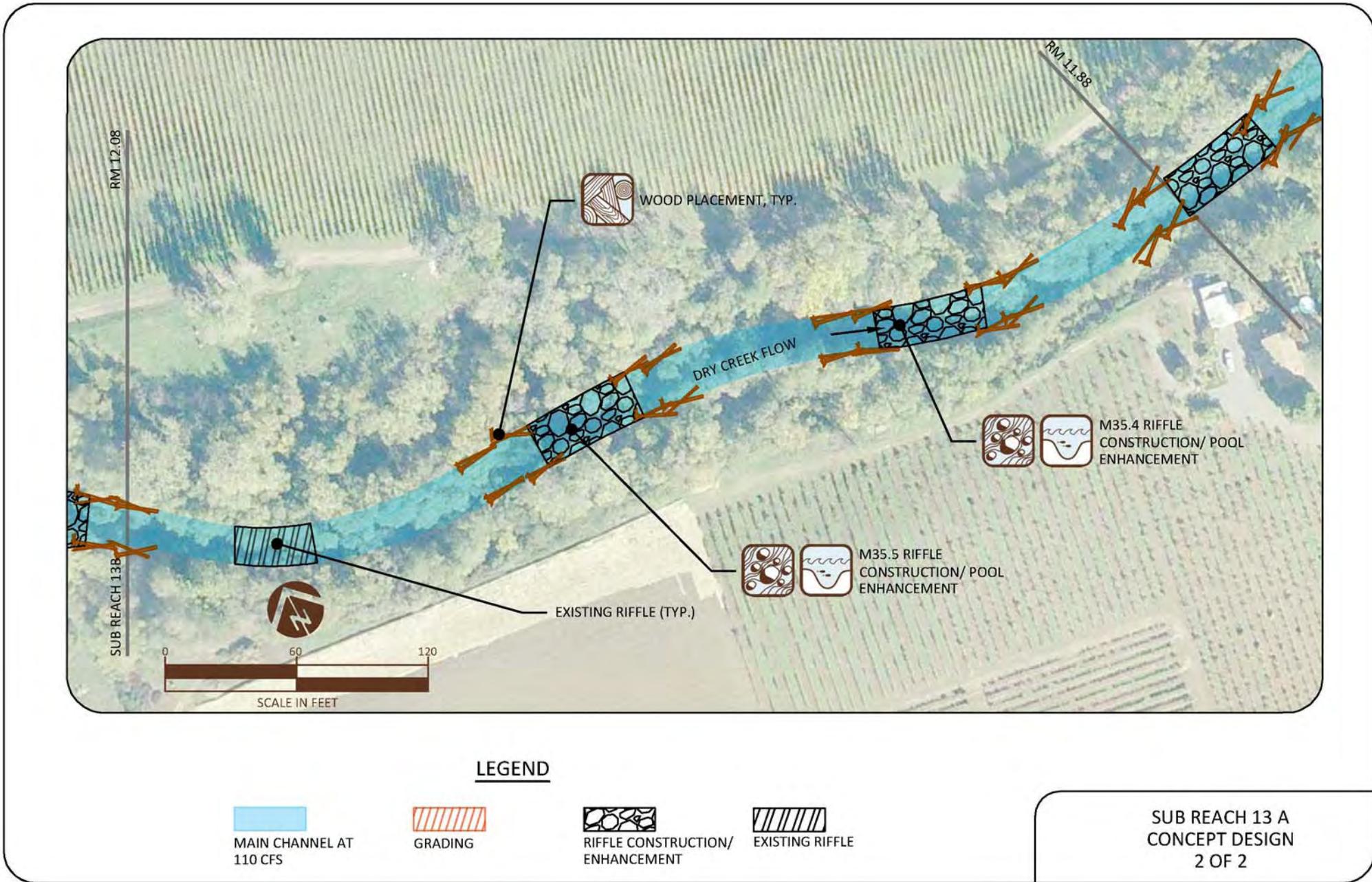


Figure C6. Sub-reach 13a conceptual design detail sheet 2 of 2.

**Sub-Reach 13a Analysis of Proposed Enhancements**

Proposed habitat enhancements in sub-reach 13a are focused on the main channel, due to the lack of significant floodplain areas for off-channel habitat development. More than 11,000 ft<sup>2</sup> of LWD-margin habitat will be created as a result of the proposed design concepts in addition to increased pool and riffle habitat. The following tables summarize the frequency and areas of existing vs. proposed habitat (Table C3), additional habitat to be created by enhancements (Table C4) and cost-based metrics (Table C5). Table C6 presents habitat enhancement areas normalized by sub-reach main channel length. Table C7 summarizes the planning level cost estimate developed for sub-reach 13a.

Table C3. Habitat area by unit type for existing and proposed conditions in sub-reach 13a.

Habitat	Existing Habitat		Proposed Habitat	
	Area (ft <sup>2</sup> )	#	Area (ft <sup>2</sup> )	#
Alcove / Backwater	2750	2	2750	2
Flatwater	40450	4	21600	2
Pool	58100	4	60650	7
Riffle	5500	2	21800	6
Side Channel	0	0	0	0

Table C4. Additional coho rearing habitat provided by new alcoves and LWD placements.

Habitat Type	(ft <sup>2</sup> )	(m <sup>2</sup> )
LWD-Margin Habitat (summer coho rearing)	11000	1020
Pools	2550	240
Riffles	16300	1510
<b>Total</b>	<b>29850</b>	<b>2770</b>

\*Alcove/Backwater habitats also provide winter refuge habitat during flood events.

Table C5. Cost-benefit table for design concepts presented for sub-reach 13a.

Cost - Benefit Metric	Cost / ft <sup>2</sup>
Cost / ft <sup>2</sup> of summer coho rearing*	155
Cost / ft <sup>2</sup> of total enhanced habitat**	57

\*includes backwater and LWD-margin habitats

\*\*includes alcove/backwater, LWD-margin, and riffles

Table C6. Length metric table showing habitat enhancement area divided by sub-reach main channel length for summer coho rearing and total enhanced habitats.

Length Metric	area (ft <sup>2</sup> )/ length (ft)
Summer coho rearing habitat	5
Total enhanced habitat	13

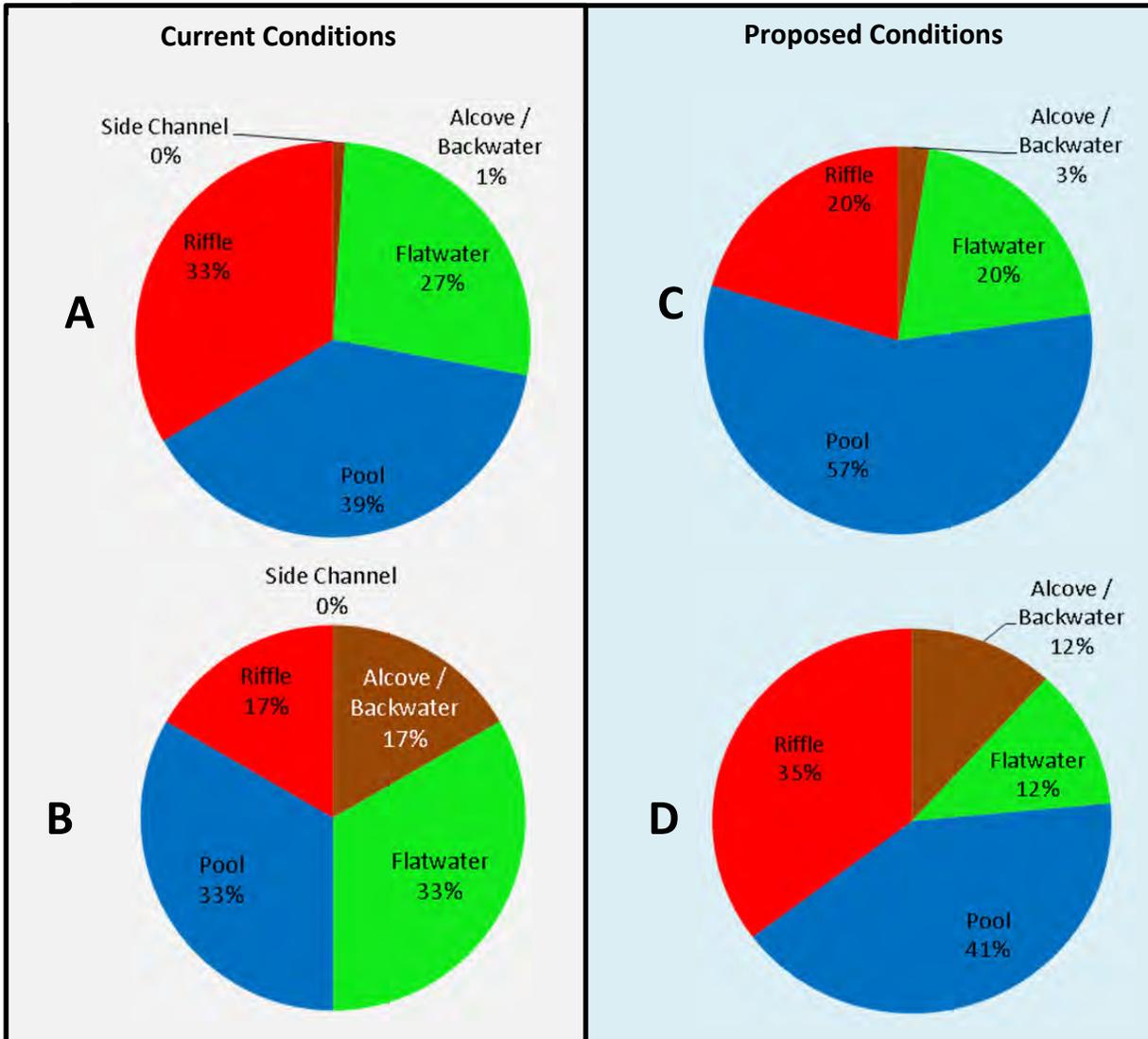


Figure C7. Existing habitat units shown by area (A), frequency (B) and proposed habitat units based on area (C) and frequency (D).

Table C7. Sub-Reach 13a Planning Level Cost Estimate

Note: This is a preliminary cost estimate for planning purposes. Actual costs for design and construction activities may vary substantially from these estimates. Assumptions for time requirements and material quantities have been made based on limited information that is available for the site. Additional information obtained during site investigations will be needed to determine actual quantities and costs. Estimates based on 2011 costs.

No.	Description	Unit	Quantity	Unit Cost	Total Cost	Design and Quantity Assumptions												
1	Mobilization and Demobilization	LS	1	\$50,000	\$50,000	Calculated at 5% of construction sub-total.												
2	Site Access Measures	LS	1	\$50,000	\$50,000	Includes access road improvements, traffic control, dust control, and site restoration.												
3	Environmental Protection Measures	LS	1	\$260,000	\$260,000	Includes stream diversion/dewatering, fish relocation, and erosion control BMPs.												
4	Large Woody Debris (purchased, delivered, installed)																	
a.	Pool Enhancement Logs	EA	130	\$1,150	\$149,500	Assumes 30% delivered with root wads attached.												
b.	Log Jams	EA	120	\$1,150	\$138,000													
5	Boulder Ballast (purchased, delivered, installed)	TN	250	\$100	\$25,000	Estimated 1 ton per log.												
6	Riffle Installation (purchased, delivered, installed)	CY	2,670	\$120	\$320,400	Assume average of 3 feet of depth per riffle for riffle construction. Assume average of 1.5 feet of depth per riffle for riffle enhancement.												
7	Vegetation Management	AC	5	\$20,000	\$100,000	Assumes area of floodplain from vineyard grade to vineyard grade minus the base flow inundation area of the main channel and of the proposed backwater habitat areas.												
<b>Construction Sub-Total</b>					<b>\$1,092,900</b>	<table border="1"> <tr> <td colspan="2"><b>Key</b></td> </tr> <tr> <td>LS = Lump Sum</td> <td></td> </tr> <tr> <td>CY = Cubic Yard</td> <td></td> </tr> <tr> <td>LF = Lineal Foot</td> <td></td> </tr> <tr> <td>AC = Acre</td> <td></td> </tr> <tr> <td>EA = Each</td> <td></td> </tr> </table>	<b>Key</b>		LS = Lump Sum		CY = Cubic Yard		LF = Lineal Foot		AC = Acre		EA = Each	
<b>Key</b>																		
LS = Lump Sum																		
CY = Cubic Yard																		
LF = Lineal Foot																		
AC = Acre																		
EA = Each																		
Concept Level Design & Construction Contingency (30%)					\$327,870													
<b>Construction Total</b>					<b>\$1,420,800</b>													
<b>Project Delivery</b>																		
Permitting (4%)					\$43,716													
Detailed Engineering Design (15%)					\$163,935													
Contract Administration (5%)					\$54,645													
Construction Oversight (1.5%)					\$16,394													
<b>Project Delivery Sub-Total</b>					<b>\$278,700</b>													
<b>TOTAL ESTIMATE</b>					<b>\$1,700,000</b>	rounded to nearest \$1,000												

**Project Delivery Items are calculated as a percent of the construction sub-total**  
**General Notes:**  
 -Cost includes a 30% design and construction contingency  
 -Costs assume all materials (wood and rock) are purchased and hauled to the site from a nearby source  
 -Boulder ballast requirements may be able to be reduced depending on hydraulics analysis

**C.4 Sub-Reach 13b Conceptual Designs**

Sub-reach 13b is a 2000 foot sub-reach characterized by a flow contraction moving downstream from sub-reach 14a as the channel passes through a straight, long riffle flanked by a riprap bank on the valley left side. Mid-way downstream through the sub-reach the floodplain has increased width and provides for off-channel habitat enhancement opportunities. As the main channel alignment follows the center of the floodplain and lacks sinuosity, re-meandering the main channel in order to create improved main channel habitat conditions and increase opportunities for off-channel habitat enhancement is proposed for sub-reach 13b. A combination of backwater channel construction, wood placements, riffle construction and pool enhancements are included in the list of design concepts for 13b. The following table and accompanying figures summarize the design concepts created for sub-reach 13b.

Project Code	Backwater Channel	Side Channel	Pool Enhancement	Riffle Enhancement	LWD	Winter Refuge Habitat*	Bank Stabilization	Vegetation Management	Comments
M 36.1			X	X	X			X	Riffle & Pool Enhancement
OC 36.1 R	X				X		X	X	Backwater Channel Construction
M 36.2			X	X	X		X	X	Main Channel Re-meander, Riffle Construction, Pool Enhancement
OC 36.21L					X	X		X	Winter Refuge Habitat
OC 36.2 L	X				X		X	X	Backwater Channel Construction
OC 36.3 L	X				X			X	Backwater Channel Construction
OC 36.22L					X	X		X	Winter Refuge Habitat

Table C8. Inventory of projects identified in sub-reach 13b. \*Backwater channel habitats will also provide winter refuge, and available off-channel habitat for juvenile salmonids will become larger as flows increase during winter storms.

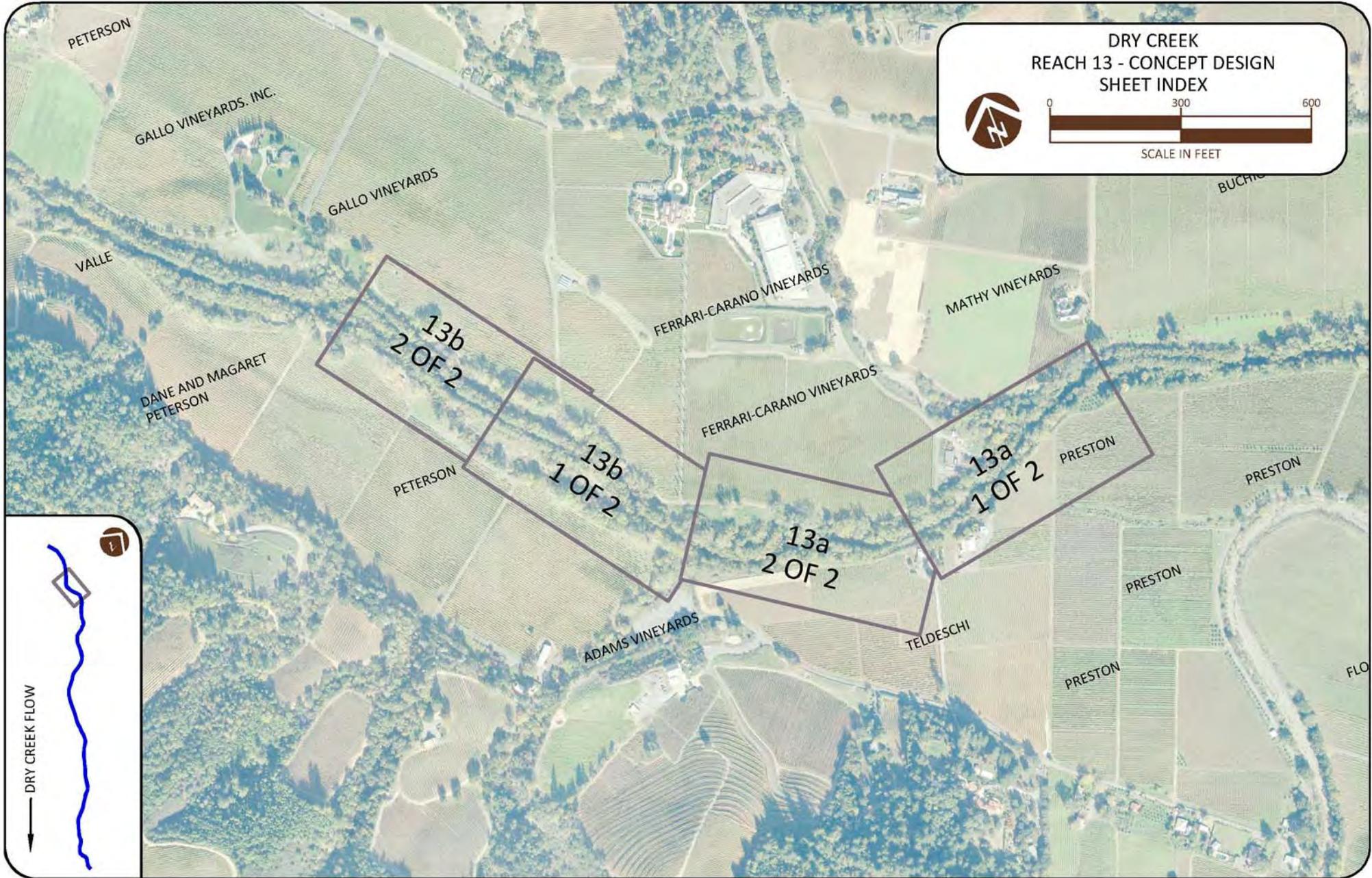
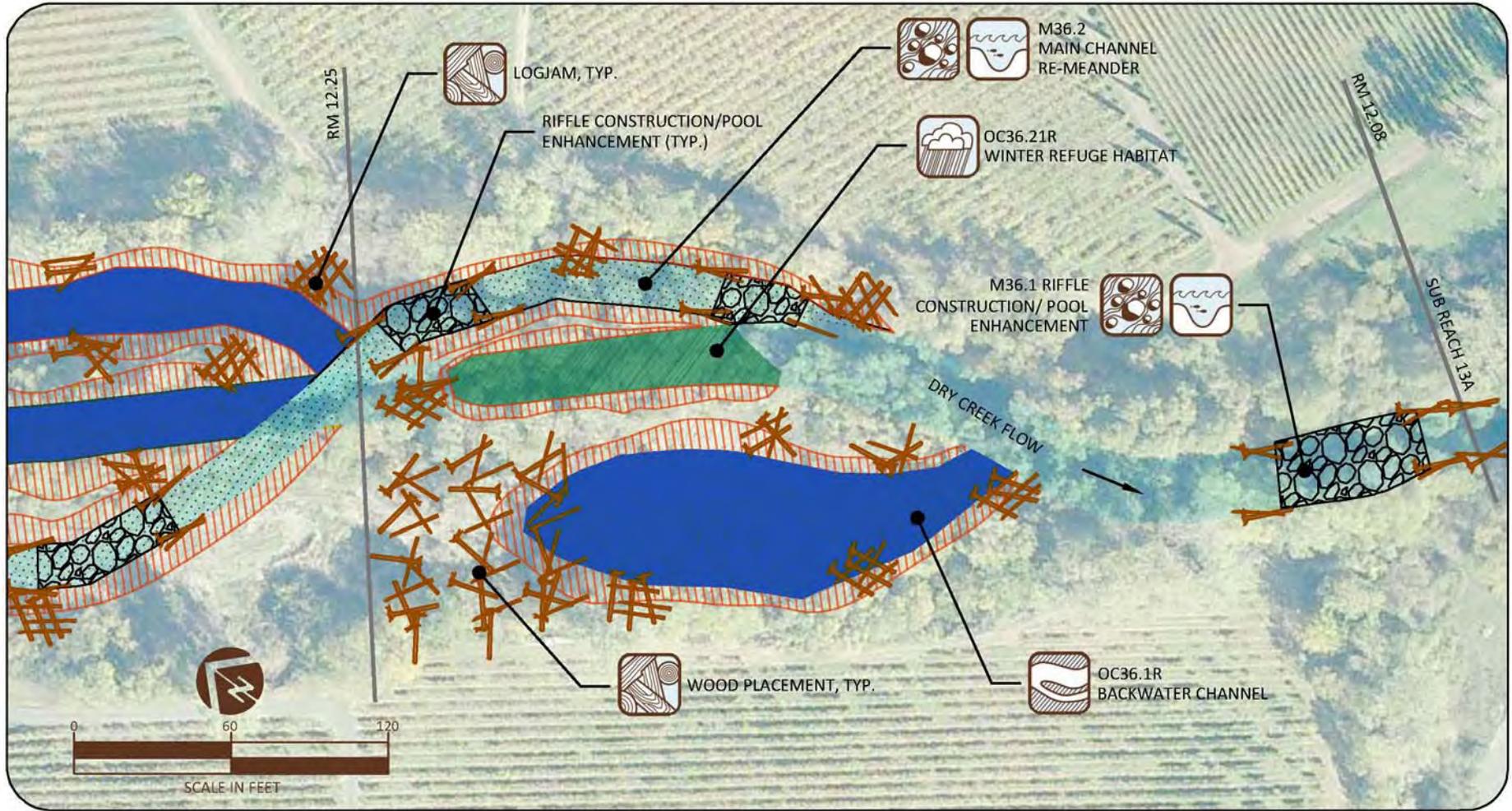


Figure C8. Reach 13 sheet index for conceptual design detail sheets.



**LEGEND**

-   
 MAIN CHANNEL AT  
110 CFS
-   
 OFF CHANNEL  
HABITAT
-   
 GRADING LIMIT
-   
 RIFFLE CONSTRUCTION/  
ENHANCEMENT
-   
 EXISTING RIFFLE
-   
 WINTER REFUGE

SUB REACH 13 B  
CONCEPT DESIGN  
1 OF 2

Figure C9. Sub-reach 13b conceptual design detail sheet 1 of 2.

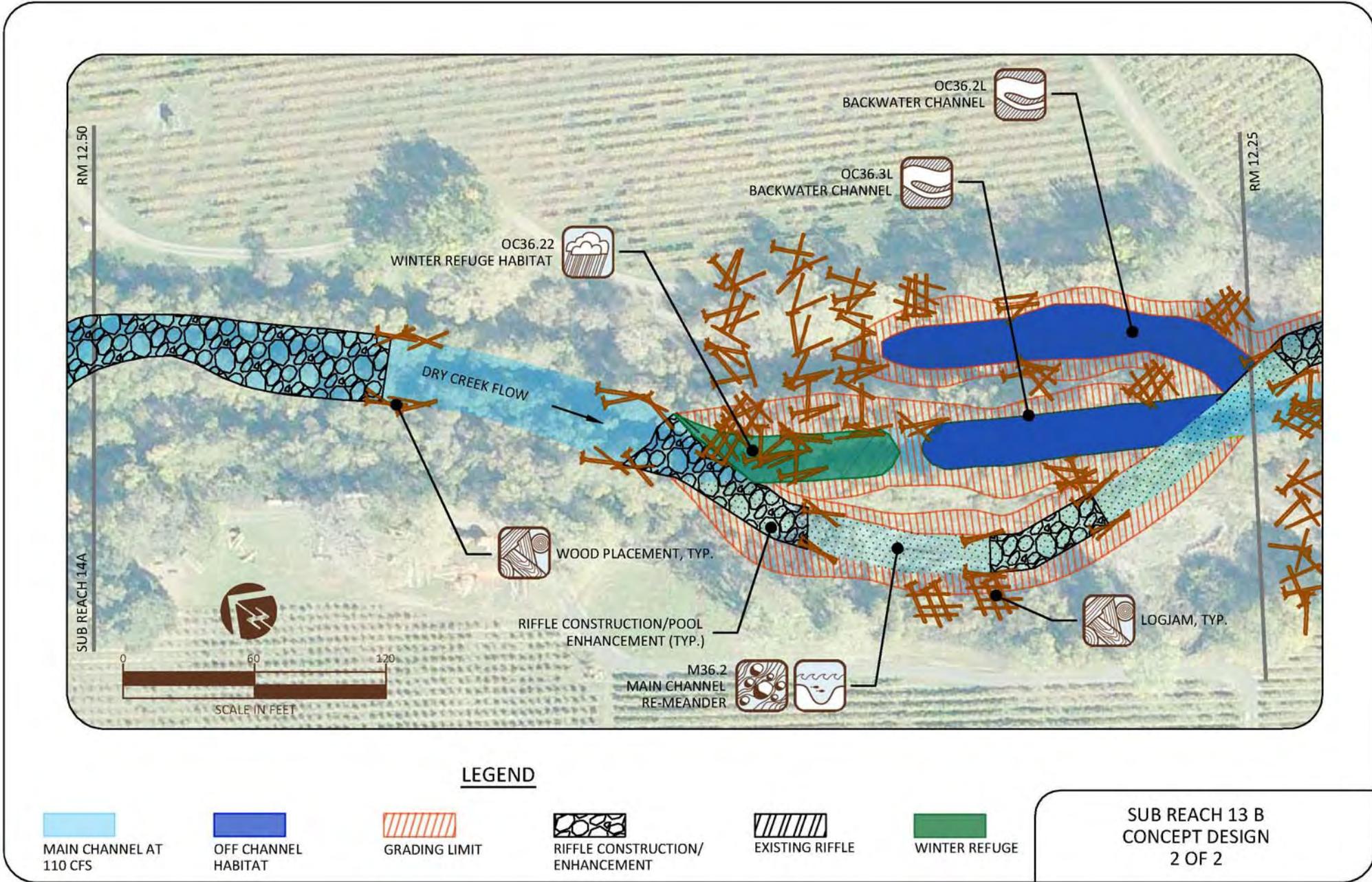


Figure C10. Sub-reach 13b conceptual design detail, sheet 2 of 2.  
Dry Creek Conceptual Design Report

**Sub-Reach 13b Analysis of Proposed Enhancements**

Proposed enhancements would provide a significant increase in the quantity and quality of available juvenile rearing habitat to a sub-reach with minimal off-channel habitat and main-stem quality pool habitat. The creation of nearly 50,000 ft<sup>2</sup> of off-channel habitat in addition to enhancing pools to provide near-optimal rearing habitat will greatly improve the ecological function of sub-reach 13b. Adding length to the main channel through M 36.2, the re-meander project, provides the opportunity to create multiple backwater channels in addition to winter refuge habitats. The following tables summarize the frequency and areas of existing vs. proposed habitat (Table C9), additional habitat to be created by enhancements (Table C10) and cost-based metrics (Table C11). Table C12 presents enhancement habitat areas normalized by sub-reach main channel length. Table C13 summarizes the planning level cost estimate developed for sub-reach 13b.

Table C9. Habitat units based on existing and proposed conditions.

Habitat	Existing Habitat		Proposed Habitat	
	Area (ft <sup>2</sup> )	#	Area (ft <sup>2</sup> )	#
Alcove / Backwater	900	1	49800	4
Flatwater	28650	3	0	0
Pool	32450	3	57600	9
Riffle	16800	4	23750	5
Side Channel	0	0	0	0
Winter Refuge	0	0	17250	2

Table C10. Additional habitat provided by backwater , LWD-margin, and riffle habitat.

Habitat Type	(ft <sup>2</sup> )	(m <sup>2</sup> )
Alcove/Backwater (summer coho rearing)	48900	4540
LWD-Margin Habitat (summer coho rearing)	11000	1020
Winter Refuge (winter coho rearing)	36200	3360
Pools	25150	2340
Riffles	8800	820
<b>Total</b>	<b>130050</b>	<b>12080</b>

Table C11. Cost – benefit table for design concepts presented for sub-reach 13b

Cost - Benefit Metric	Cost (\$)
Cost / ft <sup>2</sup> of summer coho rearing*	144
Cost / ft <sup>2</sup> of winter coho rearing**	90
Cost / ft <sup>2</sup> of total enhanced habitat**	66

\*includes backwater and LWD-margin habitats

\*\*includes alcove/backwater, LWD-margin, and winter refuge habitats

\*\*\*includes alcove/backwater, LWD-margin, winter refuge, pools and riffles

Table C12. Length metrics showing habitat enhancement area divided by sub-reach main channel length for summer coho rearing, winter coho rearing and total enhanced habitats.

Length Metric	area (ft <sup>2</sup> )/ length (ft)
Summer coho rearing habitat	36
Winter coho rearing habitat	58
Total enhanced habitat	78

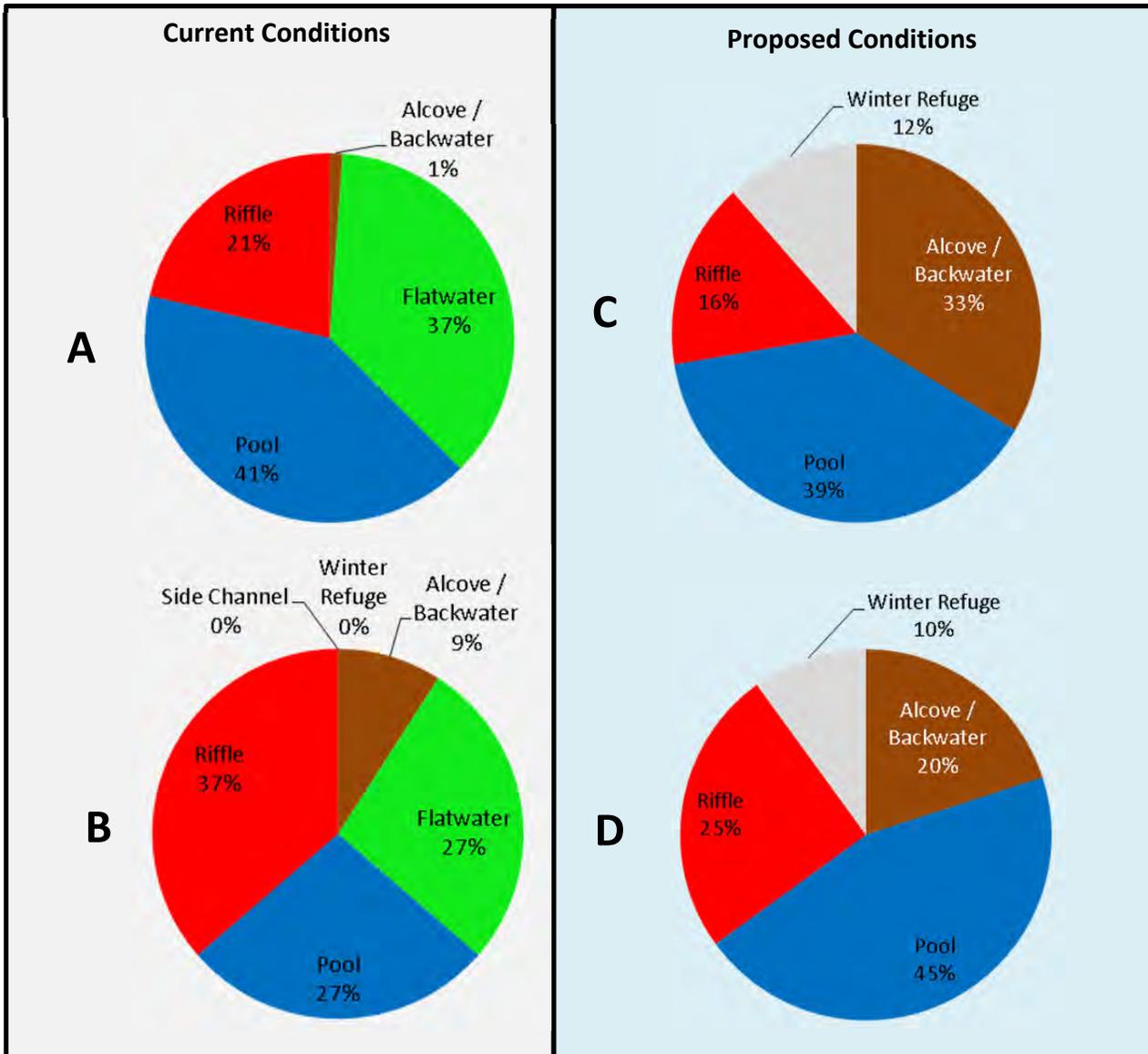


Figure C11. Existing sub-reach 13b habitats shown by area (A), frequency (B) and proposed habitat units based on area (C) and frequency (D).

**Sub-Reach 13b Alternatives Discussion**

The floodplain in sub-reach 13b ranges from 100 to 250 feet wide and presents opportunities for off-channel habitat development. Multiple alternatives were identified. One alternative is to leave the main channel alignment in place and create backwater channels in floodplain areas. A second alternative is to create a complex of side channels and alcoves like those found in the vicinity of Westside Bridge.

Table C13. Sub-reach 13b Planning Level Cost Estimate

Note: This is a preliminary cost estimate for planning purposes. Actual costs for design and construction activities may vary substantially from these estimates. Assumptions for time requirements and material quantities have been made based on limited information that is available for the site. Additional information obtained during site investigations will be needed to determine actual quantities and costs. Estimates based on 2011 costs.

No.	Description	Unit	Quantity	Unit Cost	Total Cost	Design and Quantity Assumptions							
1	Mobilization and Demobilization	LS	1	\$270,000	\$270,000	Calculated at 5% of construction sub-total.							
2	Site Access Measures	LS	1	\$260,000	\$260,000	Includes access road improvements, traffic control, dust control, and site restoration.							
3	Environmental Protection Measures	LS	1	\$1,320,000	\$1,320,000	Includes stream diversion/dewatering, fish relocation, and erosion control BMPs.							
4	Clearing and Grubbing	AC	3	\$2,000	\$6,000								
5	Common Excavation												
a.	OC 36.1	CY	9,090	\$20	\$181,800	Final design criteria and analysis will likely alter these estimates up or down.							
b.	OC 36.2	CY	5,120	\$20	\$102,400								
c.	M 36.2	CY	11,240	\$20	\$224,800								
d.	OC 36.3	CY	1,430	\$20	\$28,600								
6	Large Woody Debris (purchased, delivered, installed)												
a.	Floodplain Roughness Logs	EA	160	\$1,150	\$184,000	Assumes 30% delivered with root wads attached.							
b.	Backwater Habitat Logs	EA	410	\$1,150	\$471,500								
c.	Pool Enhancement Logs	EA	160	\$1,150	\$184,000								
d.	Log Jams	EA	560	\$1,150	\$644,000								
7	Boulder Ballast (purchased, delivered, installed)	TN	1,290	\$100	\$129,000	Estimated 1 ton per log.							
8	Bank Stabilization	LF	1,070	\$1,000	\$1,070,000	Bank stabilization methods will vary but will include one or more of the following components: large woody debris, earthwork, riprap scour protection, granular backfill, aggregate filter material, geotextile fabric, and/or fabric encapsulated soil lifts. Assumes 30% delivered with root wads attached.							
9	Riffle Installation (purchased, delivered, installed)	CY	3,000	\$120	\$360,000	Assume average of 3 feet of depth per riffle for riffle construction. Assume average of 1.5 feet of depth per riffle for riffle enhancement.							
9	Vegetation Management	AC	6	\$20,000	\$120,000	Assumes area of floodplain from vineyard grade to vineyard grade minus the base flow inundation area of the main channel and of the proposed backwater habitat areas.							
<b>Construction Sub-Total</b>					<b>\$5,556,100</b>	<table border="1"> <tr> <td><b>Key</b></td> <td>LS = Lump Sum CY = Cubic Yard LF = Lineal Foot AC = Acre EA = Each</td> </tr> </table> <table border="1"> <tr> <td><b>Project Delivery Items are calculated as a percent of the construction sub-total</b></td> </tr> <tr> <td><b>General Notes:</b></td> </tr> <tr> <td>-Cost includes a 30% design and construction contingency</td> </tr> <tr> <td>-Costs assume all materials (wood and rock) are purchased and hauled to the site from a nearby source</td> </tr> <tr> <td>-Boulder ballast requirements may be able to be reduced depending on hydraulics analysis</td> </tr> </table>	<b>Key</b>	LS = Lump Sum CY = Cubic Yard LF = Lineal Foot AC = Acre EA = Each	<b>Project Delivery Items are calculated as a percent of the construction sub-total</b>	<b>General Notes:</b>	-Cost includes a 30% design and construction contingency	-Costs assume all materials (wood and rock) are purchased and hauled to the site from a nearby source	-Boulder ballast requirements may be able to be reduced depending on hydraulics analysis
<b>Key</b>	LS = Lump Sum CY = Cubic Yard LF = Lineal Foot AC = Acre EA = Each												
<b>Project Delivery Items are calculated as a percent of the construction sub-total</b>													
<b>General Notes:</b>													
-Cost includes a 30% design and construction contingency													
-Costs assume all materials (wood and rock) are purchased and hauled to the site from a nearby source													
-Boulder ballast requirements may be able to be reduced depending on hydraulics analysis													
Concept Level Design & Construction Contingency (30%)					\$1,666,830								
<b>Construction Total</b>					<b>\$7,222,900</b>								
<b>Project Delivery</b>													
Permitting (4%)					\$222,244								
Detailed Engineering Design (15%)					\$833,415								
Contract Administration (5%)					\$277,805								
Construction Oversight (1.5%)					\$83,342								
<b>Project Delivery Sub-Total</b>					<b>\$1,416,800</b>								
<b>TOTAL ESTIMATE</b>					<b>\$8,640,000</b>	rounded to nearest \$1,000							

## APPENDIX D

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**D.1 Reach 12 Description**

Reach 12 begins at the Pena Creek confluence and extends downstream of where Dutcher Creek joins with Dry Creek. In addition to Dutcher and Pena, an unnamed tributary flows into Dry Creek from the valley left side half way through the reach at river mile 11.6. The active channel has narrowed substantially over the available aerial photo record, consistent with the incision and vegetation encroachment observed throughout lower Dry Creek. Riprap bank stabilization covers approximately 800 feet of Reach 12. See the Dry Creek Current Conditions Report (Inter-Fluve 2010), Appendix A, for more detail.

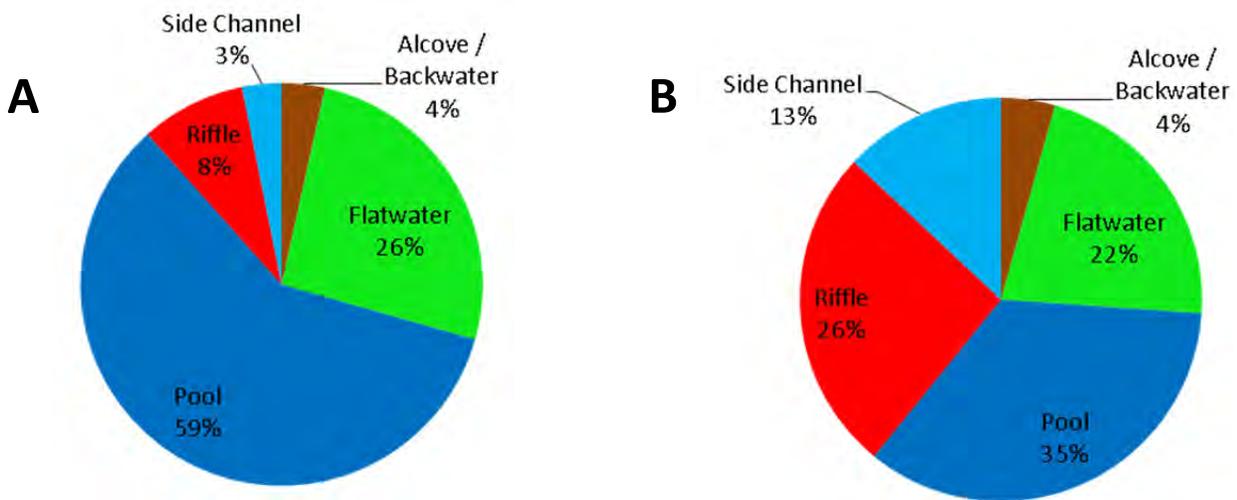


**Reach 12 Current Habitat Conditions**

Table D1. Reach 12 habitat units based on current conditions.

Habitat	Existing Habitat	
	Area (ft <sup>2</sup> )	#
Alcove / Backwater	6200	1
Flatwater	46300	5
Pool	105350	8
Riffle	15050	6
Side Channel	5650	3

Figure D1. Habitat units in reach 14 based on area (A) and frequency (B).



## D.2 Reach 12 Enhancement Approach

Reach 12 is the first reach of the “middle segment<sup>1</sup>” of Dry Creek, characterized by the increased sediment and surface water contributed by tributaries. Moving downstream from the Pena Creek confluence, Dry Creek begins to have a more significant sediment supply due to the influence of unregulated tributaries. Enhancements in Reach 12 will have to consider potential consequences of the larger sediment supplied by Pena Creek. The focus of the enhancement approach will be to improve main channel conditions by constructing riffles, enhancing pools, and installing LWD. Off-channel habitat will be increased by creating winter refuge habitats in the floodplain areas on the valley right side of the main channel. For purposes of enhancement planning, reach 12 has been split into 2 enhancement sub-reaches (see Figure D2). Sub-reach 12a (RM 10.96 to 11.2) is described in section D.3, and sub-reach 12b (RM 11.2 to 11.66) is described in section D.4.

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<sup>1</sup>Additional detail of process-based delineation of lower Dry Creek into upper, middle and lower segments can be found in the Fish Habitat Enhancement Feasibility Study, Section 5.3, IFI 2011

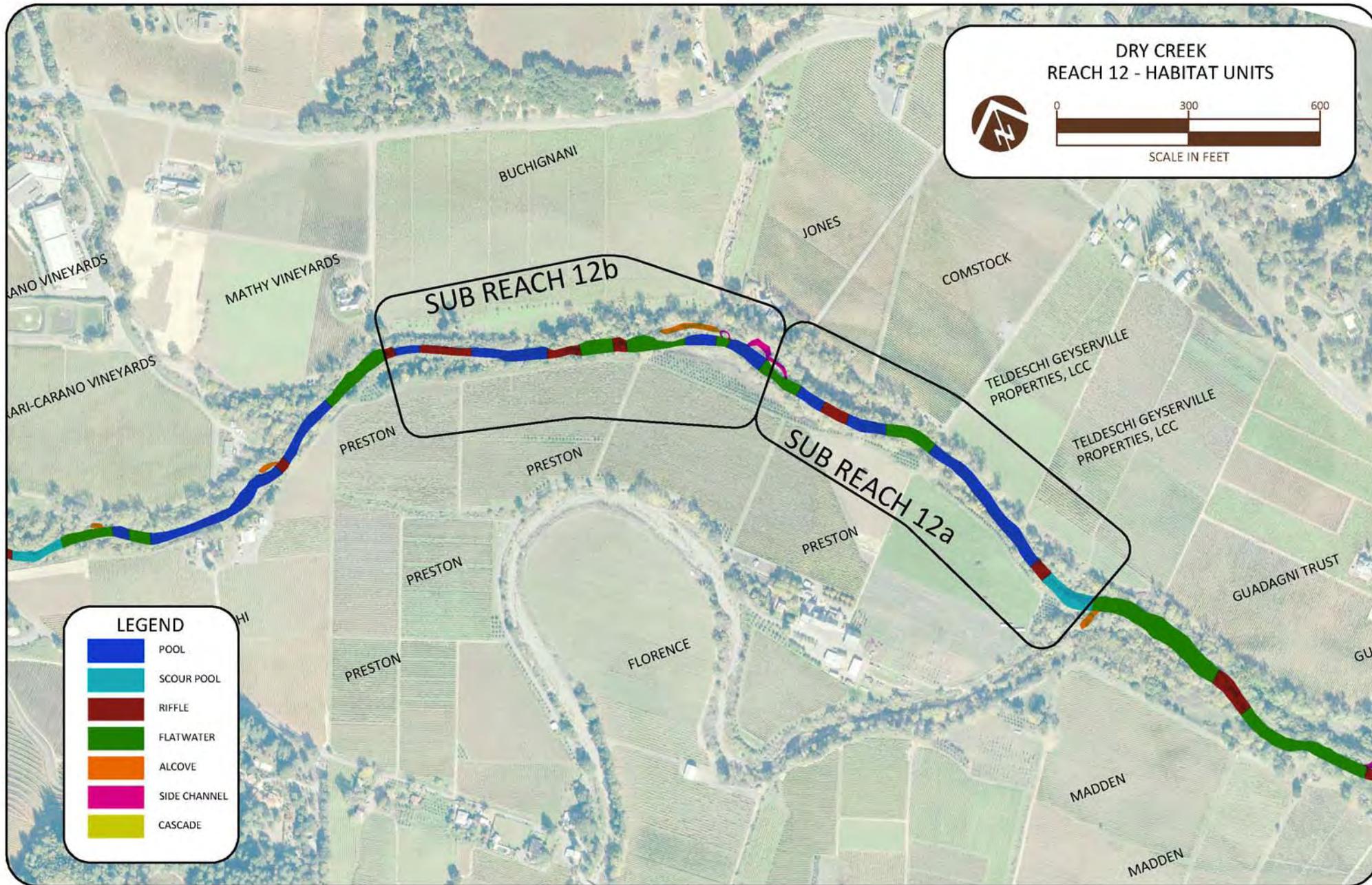


Figure D2. Reach 12 habitat units and sub-reach boundaries.

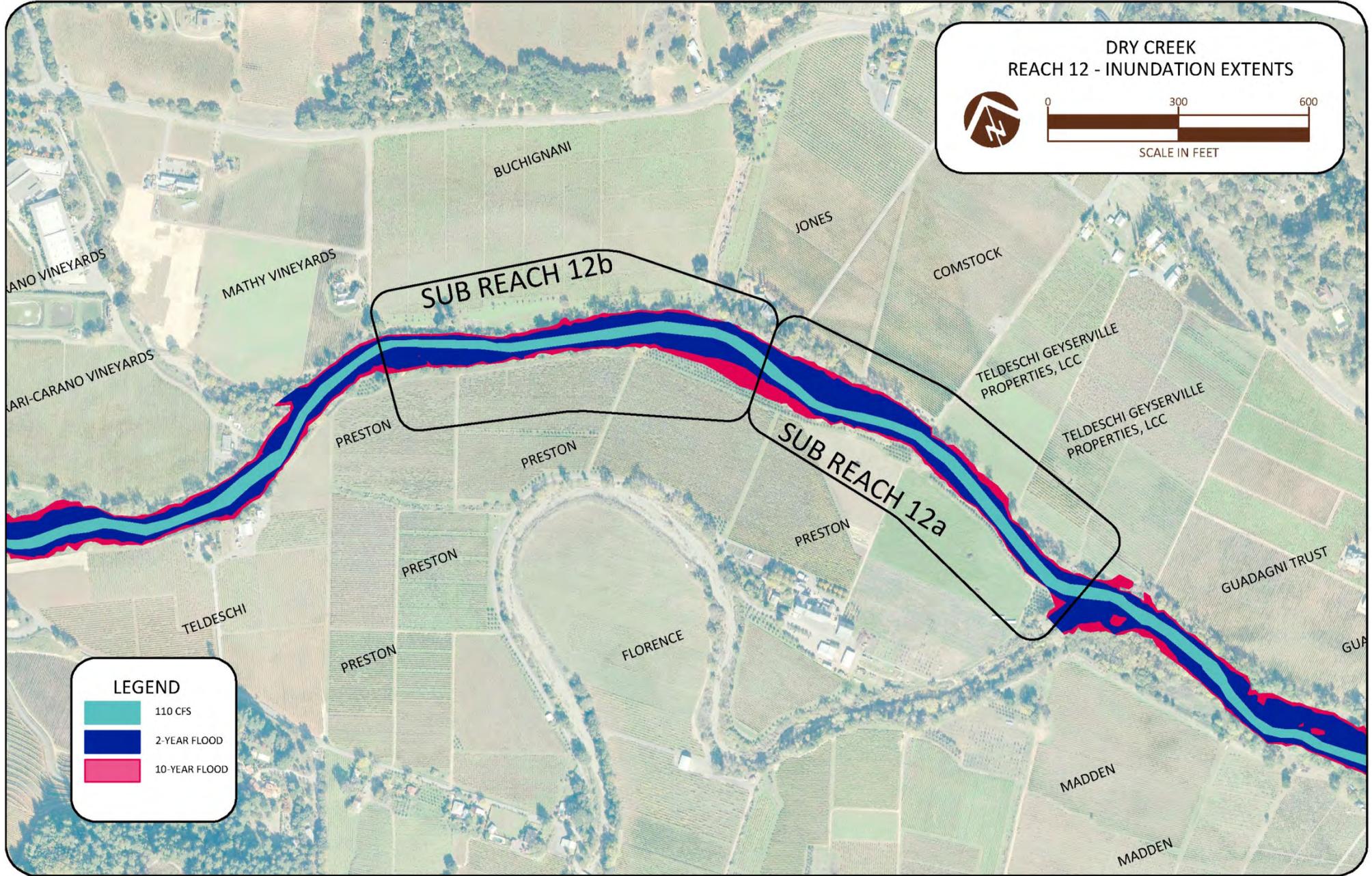


Figure D3. Modeled inundations in reach 12 based on three specific discharge levels: 110 cfs, the 2-year and 10-year flood events.

**D.3 Sub-Reach 12a Conceptual Designs**

Sub-Reach 12a is characterized by a relatively narrow active floodplain and a channel geometry that lacks sinuosity due to the history of incision in Dry Creek. In order to improve the quality and quantity of juvenile salmonid rearing habitat, enhancement efforts will focus on main channel projects including the construction of riffles, enhancement of pools, and placement of LWD. Due to the small floodplain areas present in this sub-reach, there are no viable locations for the creation of off-channel habitats. The following table and accompanying figures summarize the design concepts developed for sub-reach 12a.

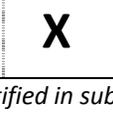
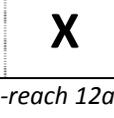
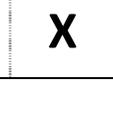
Project Code	Backwater Channel	Side Channel	Pool Enhancement	Riffle Enhancement	LWD	Winter Refuge Habitat	Bank Stabilization	Vegetation Management	Comments
M 33.8									Pool & Riffle Enhancement
M 33.9									Riffle Construction & Pool Enhancement

Table D2. Inventory of individual projects identified in sub-reach 12a.

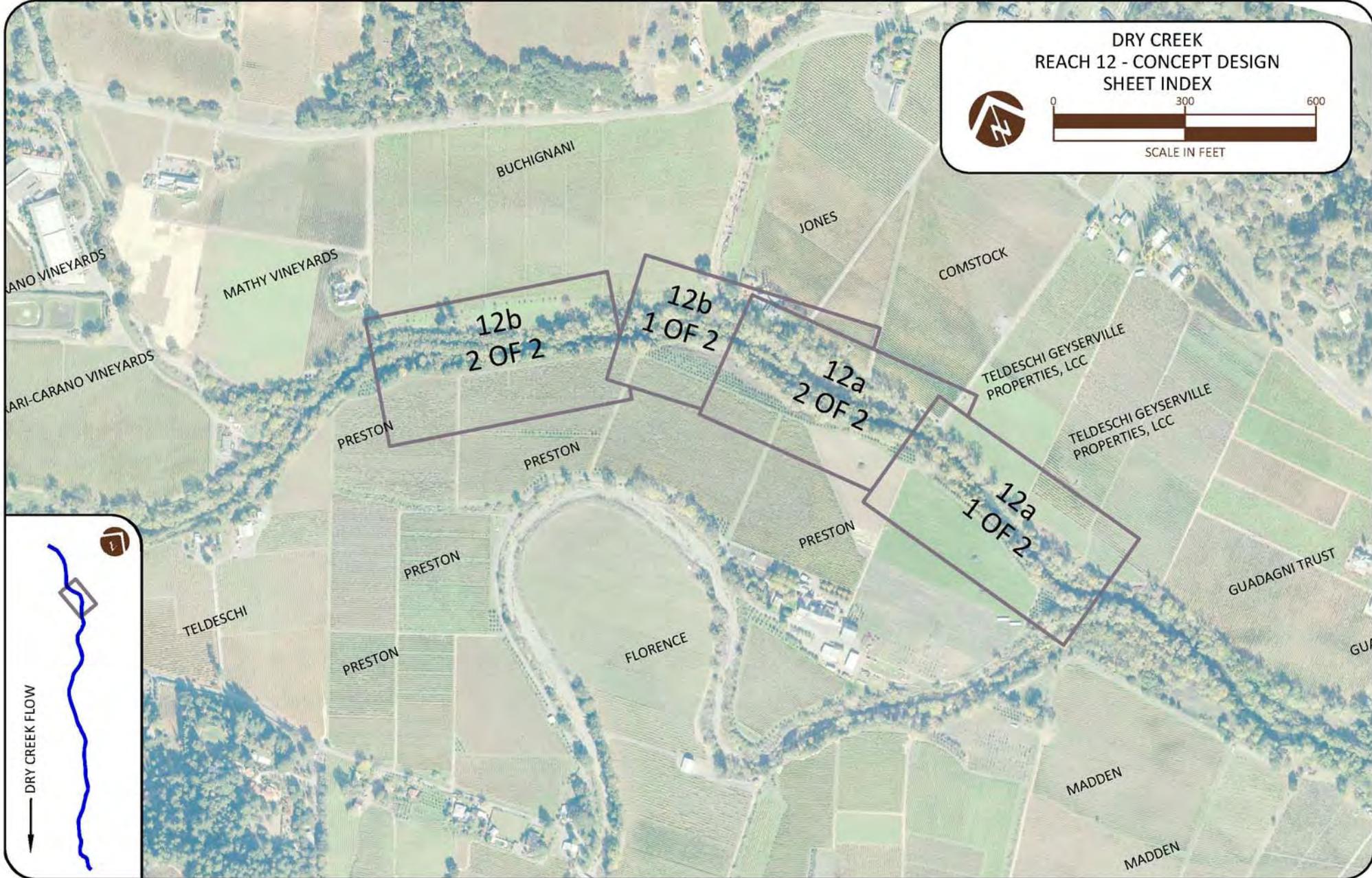


Figure D4. Reach 12 sheet index for conceptual design detail sheets.

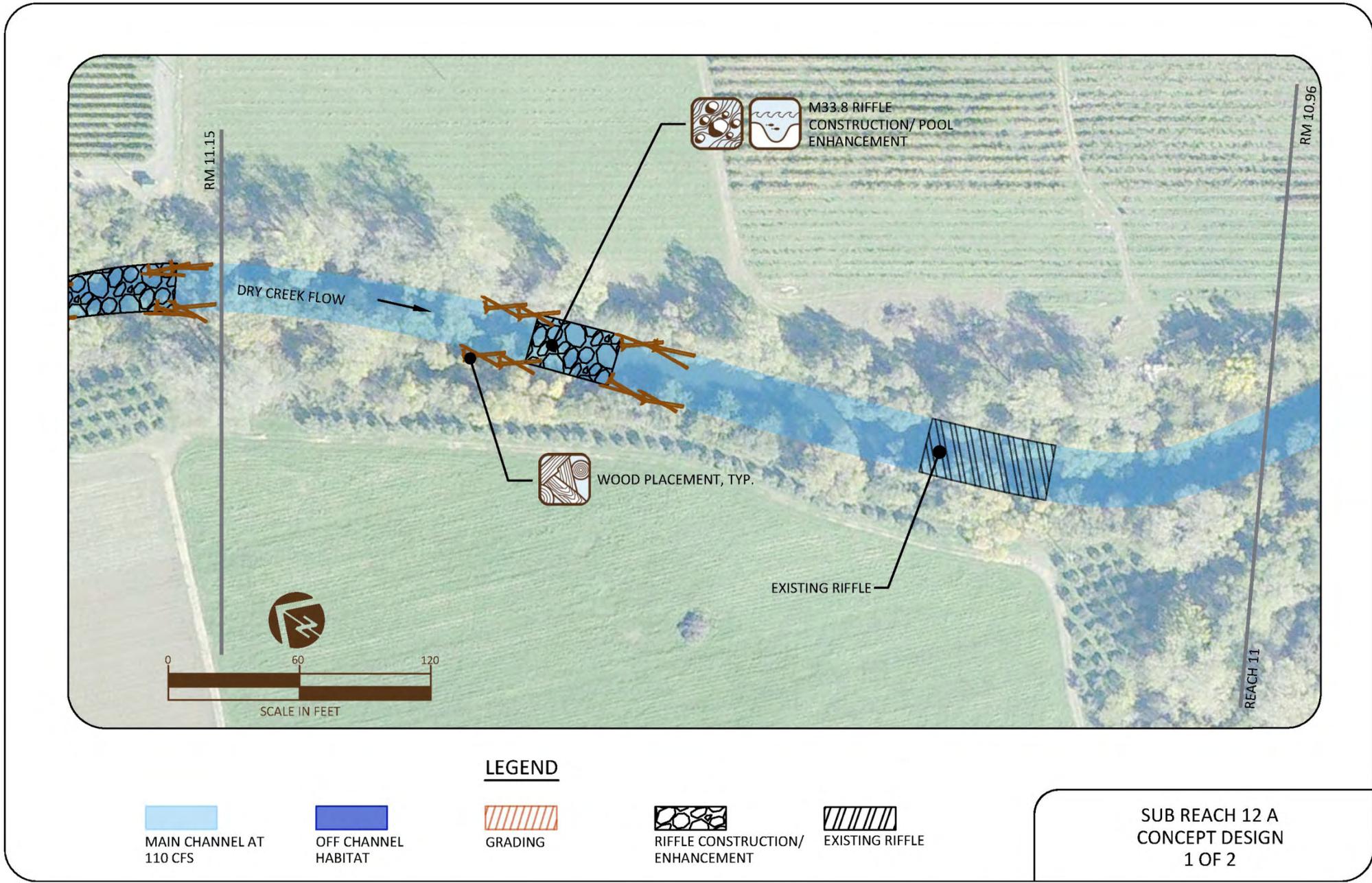


Figure D5. Sub-reach 12a conceptual design detail sheet 1 of 2.



Figure D6. Sub-reach 12a conceptual design detail sheet 2 of 2.

Sub-Reach 12a Analysis of Proposed Enhancements

Proposed enhancements in sub-reach 12a will improve conditions in main channel habitats. Riffle construction and pool enhancement will create series of high-quality riffle and pool habitats including LWD-margin habitat, which provides summer rearing areas to juvenile coho. The construction of riffles will serve to reduce flatwater habitat and increase residual depth of main channel habitats. The following tables summarize the frequency and areas of existing vs. proposed habitat (Table D3), additional habitat to be created by enhancements (Table D4) and cost-based metrics (Table D5). Table D6 presents enhancement habitat areas normalized by main channel sub-reach length. Table D7 summarizes the planning level cost estimate developed for sub-reach 12a.

Table D3. Habitat area by unit type for existing and proposed conditions in sub-reach 12a.

Habitat	Existing Habitat		Proposed Habitat	
	Area (ft <sup>2</sup> )	#	Area (ft <sup>2</sup> )	#
Alcove / Backwater	0	0	0	0
Flatwater	22100	2	0	0
Pool	62600	4	65350	4
Riffle	4400	1	14250	3
Side Channel	0	0	0	0

Table D4. Additional coho rearing habitat provided by new alcoves and LWD placements.

Habitat Type	(ft <sup>2</sup> )	(m <sup>2</sup> )
LWD-Margin Habitat (summer coho rearing)	4000	370
Pools	2750	260
Riffles	9850	920
<b>Total</b>	<b>1660</b>	<b>1540</b>

Table D5. Cost-benefit table for design concepts presented for sub-reach 12a.

Cost - Benefit Metric	Cost / ft <sup>2</sup>
Cost / ft <sup>2</sup> of summer coho rearing*	173
Cost / ft <sup>2</sup> of total enhanced habitat**	42

\*includes backwater and LWD-margin habitats

\*\*includes alcove/backwater, LWD-margin, and riffles

Table D6. Length metrics showing habitat enhancement area divided by sub-reach main channel length for summer coho rearing and total enhanced habitats.

Length Metric	area (ft <sup>2</sup> ) / length (ft)
Summer coho rearing habitat	2
Total enhanced habitat	9

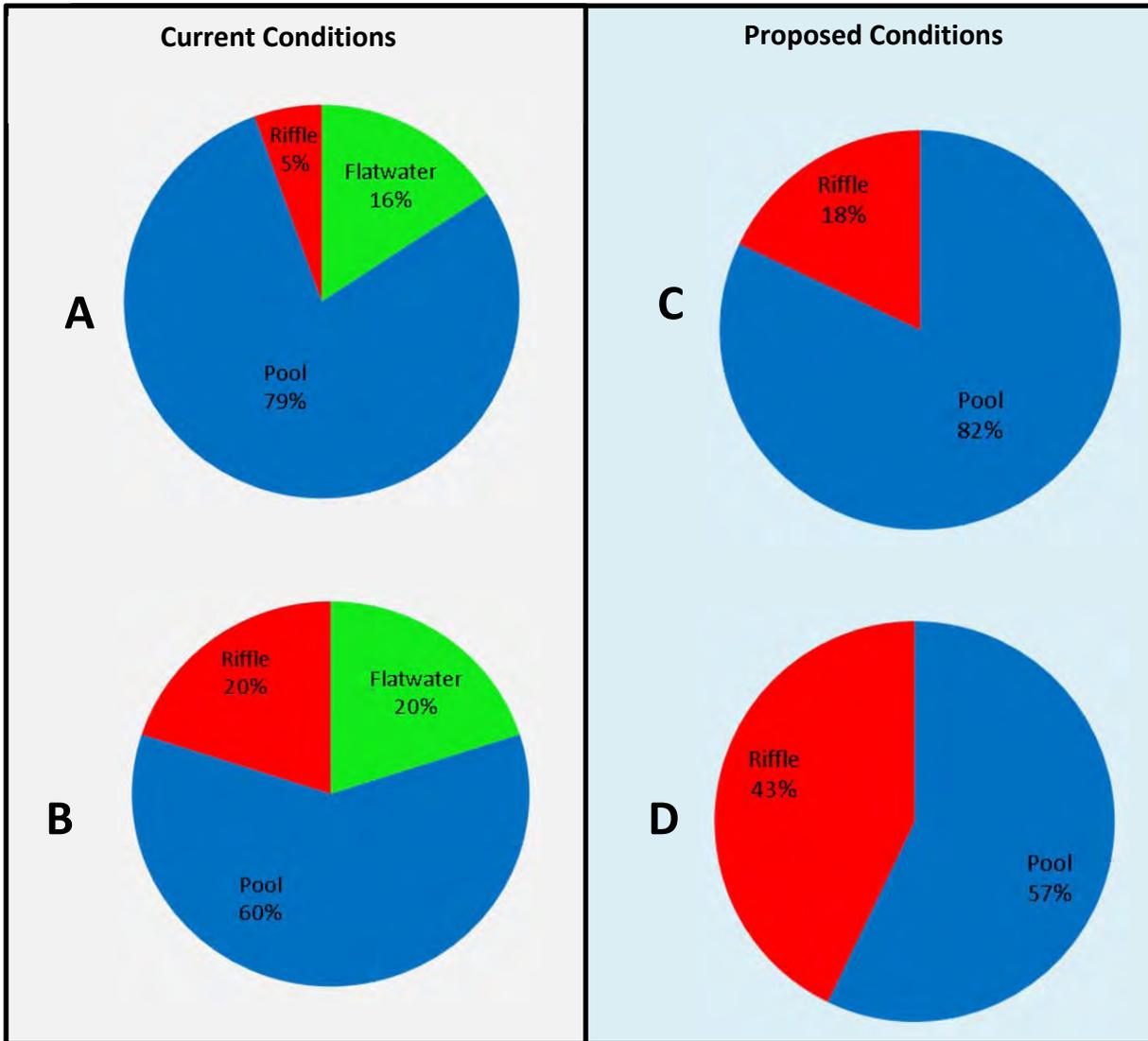


Figure D7. Existing habitats shown by area (A), frequency (B) and proposed habitat units based on area (C) and frequency (D).

Table D7. Sub-Reach 12a Planning Level Cost Estimate

Note: This is a preliminary cost estimate for planning purposes. Actual costs for design and construction activities may vary substantially from these estimates. Assumptions for time requirements and material quantities have been made based on limited information that is available for the site. Additional information obtained during site investigations will be needed to determine actual quantities and costs. Estimates based on 2011 costs.

No.	Description	Unit	Quantity	Unit Cost	Total Cost	Design and Quantity Assumptions
1	Mobilization and Demobilization	LS	1	\$20,000	\$20,000	Calculated at 5% of construction sub-total.
2	Site Access Measures	LS	1	\$20,000	\$20,000	Includes access road improvements, traffic control, dust control, and site restoration.
3	Environmental Protection Measures	LS	1	\$110,000	\$110,000	Includes stream diversion/dewatering, fish relocation, and erosion control BMPs.
4	Large Woody Debris (purchased, delivered, installed)					
a.	Pool Enhancement Logs	EA	60	\$1,150	\$69,000	Assumes 30% delivered with root wads attached.
5	Boulder Ballast (purchased, delivered, installed)	TN	60	\$100	\$6,000	Estimate 1 ton per log.
6	Riffle Installation (purchased, delivered, installed)	CY	1,000	\$120	\$120,000	Assume average of 3 feet of depth per riffle for riffle construction. Assume average of 1.5 feet of depth per riffle for riffle enhancement.
7	Vegetation Management	AC	5	\$20,000	\$100,000	Assumes area of floodplain from vineyard grade to vineyard grade minus the base flow inundation area of the main channel and of the proposed backwater habitat areas.
				<b>Construction Sub-Total</b>	<b>\$445,000</b>	<div style="border: 1px solid black; padding: 5px;"> <p><b>Key</b>                      LS = Lump Sum                      CY = Cubic Yard                      LF = Lineal Foot                      AC = Acre                      EA = Each</p> </div> <div style="border: 1px solid black; padding: 5px; margin-top: 5px;"> <p><b>Project Delivery Items are calculated as a percent of the construction sub-total</b>  <b>General Notes:</b>                      -Cost includes a 30% design and construction contingency                      -Costs assume all materials (wood and rock) are purchased and hauled to the site from a nearby source                      -Boulder ballast requirements may be able to be reduced depending on hydraulics analysis</p> </div>
				Concept Level Design & Construction Contingency (30%)	\$133,500	
				<b>Construction Total</b>	<b>\$578,500</b>	
				<b>Project Delivery</b>		
				Permitting (4%)	\$17,800	
				Detailed Engineering Design (15%)	\$66,750	
				Contract Administration (5%)	\$22,250	
				Construction Oversight (1.5%)	\$6,675	
				<b>Project Delivery Sub-Total</b>	<b>\$113,500</b>	
				<b>TOTAL ESTIMATE</b>	<b>\$692,000</b>	

rounded to nearest \$1,000

**D.4 Sub-Reach 12b Conceptual Designs**

Reach 12b is characterized by a relatively narrow active floodplain and a channel geometry that lacks sinuosity due to the history of incision in Dry Creek. Due to the absence of wide floodplain areas in Reach 12, the construction of side channels, backwater channels, or alcoves was found to be infeasible. The relatively small floodplain areas appear to be suitable locations for the creation of winter flood refuge habitats which are thought to help improve the quality and quantity of juvenile salmonid rearing habitat specifically during winter flood events. In sub-reach 12b channel enhancements include the creation of winter flood refuge habitat, and LWD placements. Main channel habitat enhancements include pool enhancements, riffle construction, and log jams. The following table and accompanying figures summarize the design concepts developed for sub-reach 12b.

Project Code	Backwater Channel	Side Channel	Pool Enhancement	Riffle Enhancement	LWD	Winter Refuge Habitat	Bank Stabilization	Vegetation Management	Comments
M 34.1			X	X	X			X	Riffle & Pool Enhancement
OC 34.1 R					X	X	X	X	Winter Refuge Habitat
M 34.2			X	X	X			X	Riffle Construction & Pool Enhancement
M 34.3			X	X	X			X	Riffle Construction & Pool Enhancement
OC 34.2 R					X	X	X	X	Winter Refuge Habitat

Table D8. Inventory of projects identified in sub-reach 12b.

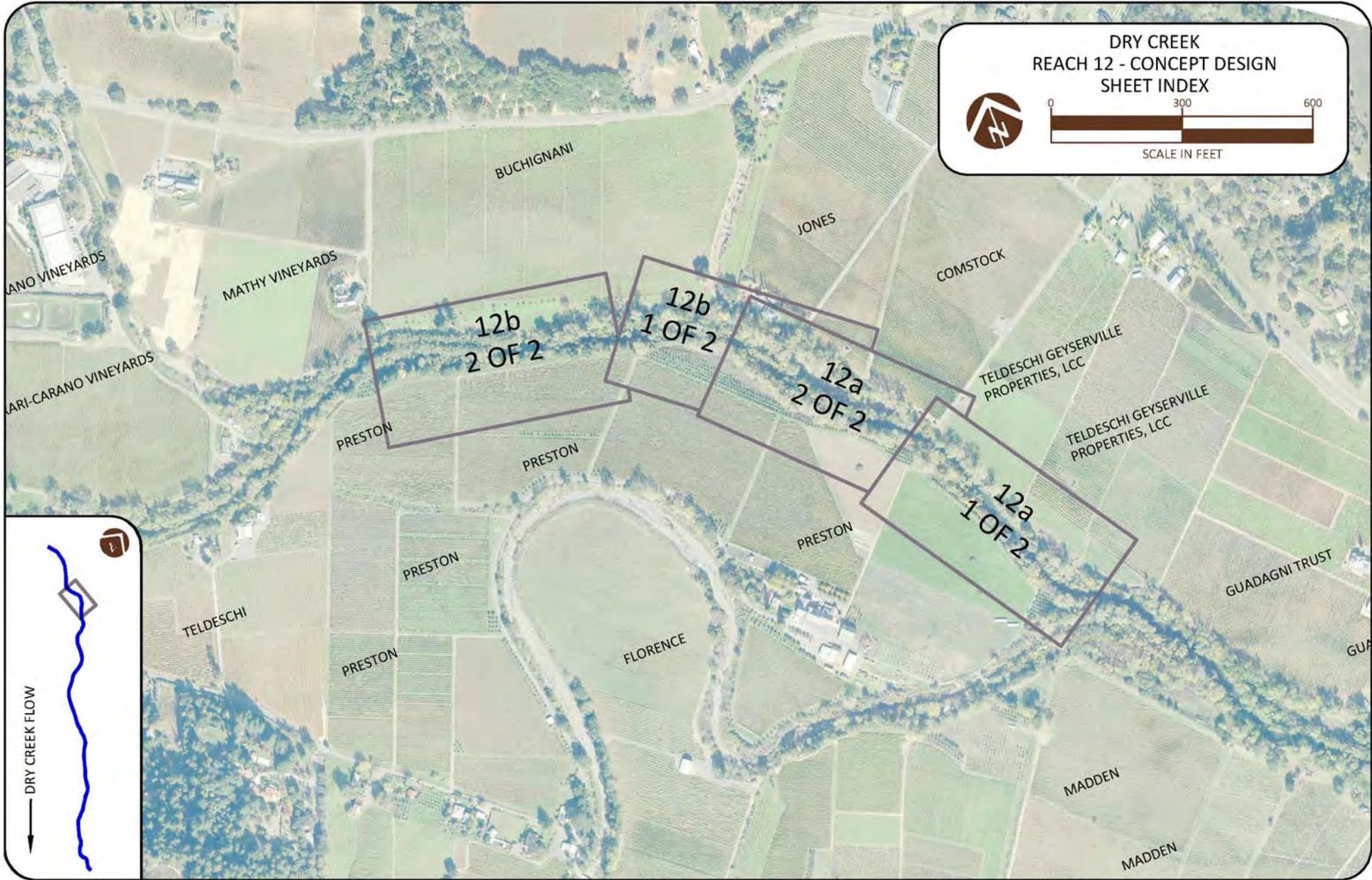
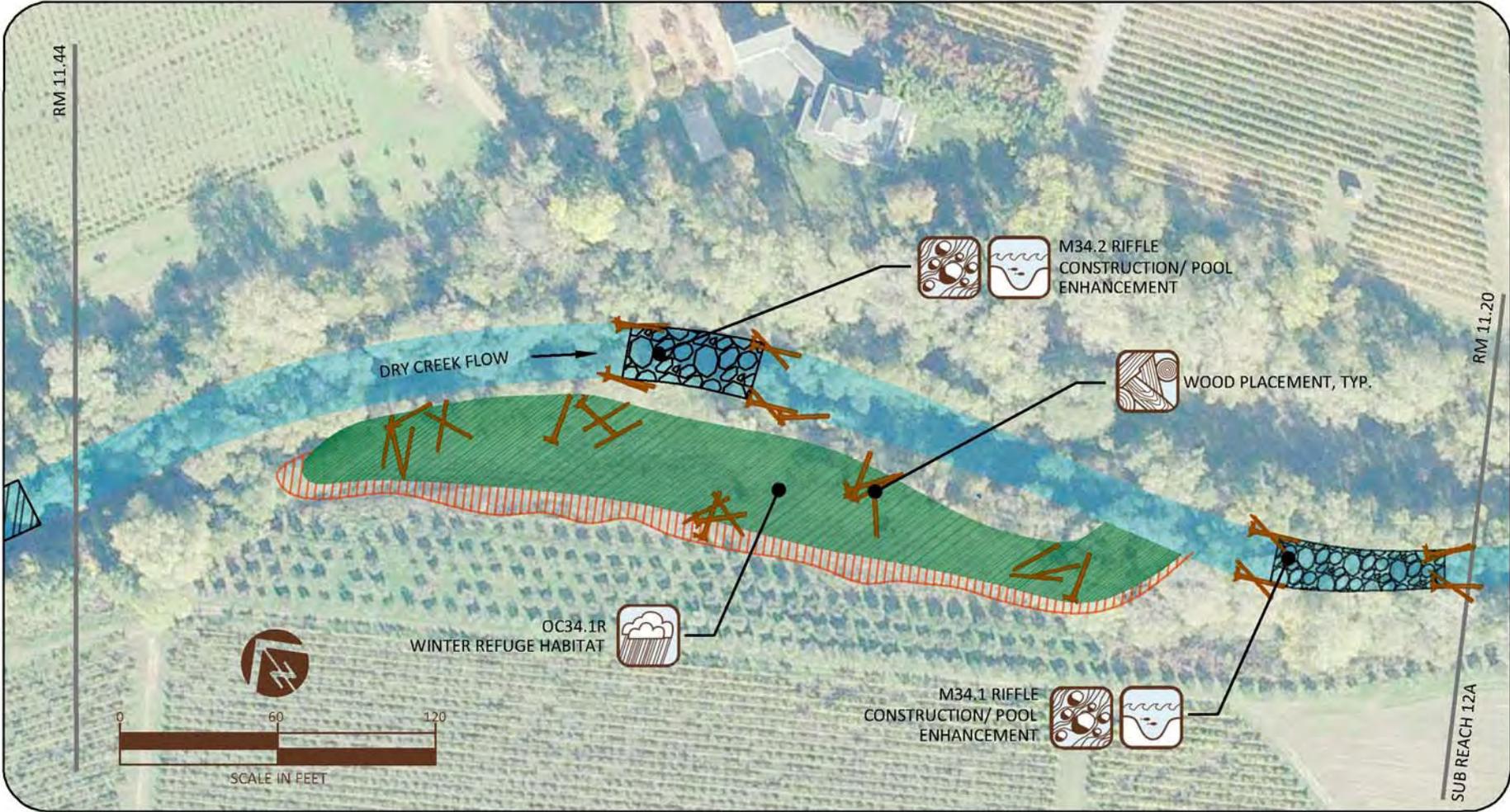


Figure D8. Reach 12 sheet index for conceptual design detail sheets.



**LEGEND**

MAIN CHANNEL AT 110 CFS

GRADING LIMIT

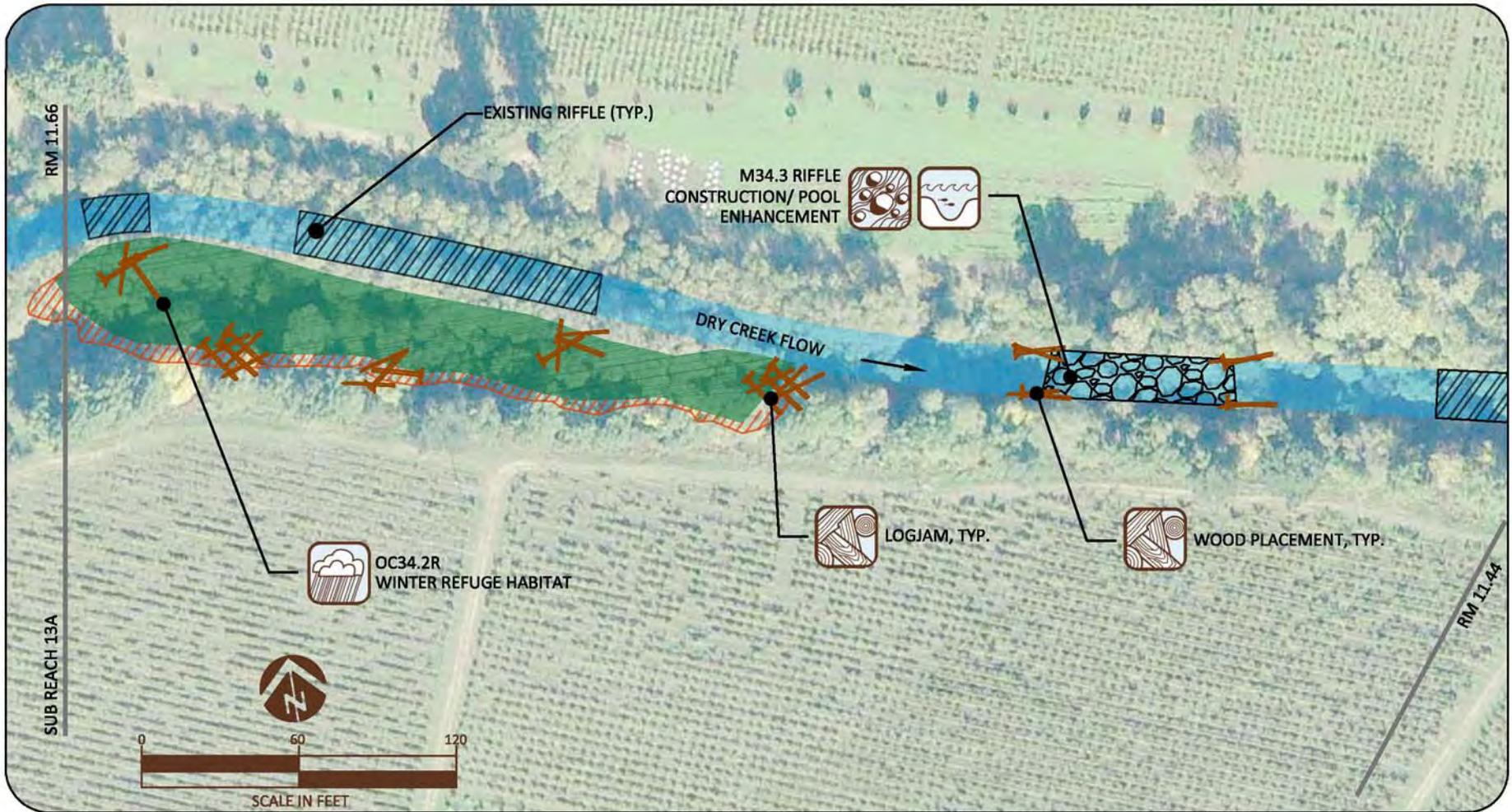
RIFFLE CONSTRUCTION/ ENHANCEMENT

EXISTING RIFFLE

WINTER REFUGE

SUB REACH 12 B  
CONCEPT DESIGN  
1 OF 2

Figure D9. Sub-reach 12b conceptual design detail sheet 1 of 2.



**LEGEND**

-   
**MAIN CHANNEL AT 110 CFS**
-   
**GRADING LIMIT**
-   
**RIFFLE CONSTRUCTION/ ENHANCEMENT**
-   
**EXISTING RIFFLE**
-   
**WINTER REFUGE**

**SUB REACH 12 B  
CONCEPT DESIGN  
2 OF 2**

Figure D10. Sub-reach 12b conceptual design detail sheet 2 of 2.  
Dry Creek Conceptual Design Report

**Sub-Reach 12b Analysis of Proposed Enhancements**

Design concepts developed for sub-reach 12b will create over 140,000 ft<sup>2</sup> of enhanced habitat. 7,000 ft<sup>2</sup> of the enhancements will provide summer coho rearing habitat, while over 100,000 ft<sup>2</sup> will provide coho rearing habitat during the winter. Nearly 40,000 ft<sup>2</sup> of pool and riffle habitat will be created by constructing riffles and enhancing main channel habitat. The following tables summarize the frequency and areas of existing vs. proposed habitat (Table D9), additional habitat to be created by enhancements (Table D10) and cost-based metrics (Table D11). Table D12 presents enhancement habitat areas normalized by main channel sub-reach length. Table D13 summarizes the planning level cost estimate developed for sub-reach 12b.

Table D9. Habitat units based on existing and proposed conditions.

Habitat	Existing Habitat		Proposed Habitat	
	Area (ft <sup>2</sup> )	#	Area (ft <sup>2</sup> )	#
Alcove / Backwater	6200	1	6200	1
Flatwater	33750	4	31350	3
Pool	42750	5	51150	8
Riffle	10650	5	30450	6
Side Channel	5650	3	5650	3
Winter Refuge	0	0	96150	2

Table D10. Additional habitat provided by backwater, LWD-margin, and riffle habitat

Habitat Type	(ft <sup>2</sup> )	(m <sup>2</sup> )
LWD-Margin Habitat (summer coho rearing)	7000	650
Winter Refuge (winter coho rearing)	96150	8930
Pools	8400	780
Riffles	19800	1840
<b>Total</b>	<b>131350</b>	<b>12200</b>

Table D11. Cost – benefit table for design concepts presented for sub-reach 12b

Cost - Benefit Metric	Cost (\$)
Cost / ft <sup>2</sup> of summer coho rearing*	799
Cost / ft <sup>2</sup> of winter coho rearing**	54
Cost / ft <sup>2</sup> of total enhanced habitat***	43

\*includes alcove/backwater and LWD-margin habitats

\*\*includes alcove/backwater, LWD-margin, and winter refuge habitats

\*\*\*includes alcove/backwater, LWD-margin, winter refuge, pools and riffles

Table D12. Length metric table showing enhancement habitat area divided by sub-reach main channel length for summer coho rearing, winter refuge, and total enhanced habitats.

Length Metric	area (ft <sup>2</sup> )/ length (ft)
Summer coho rearing habitat	4
Winter coho rearing habitat	57
Total enhanced habitat	72

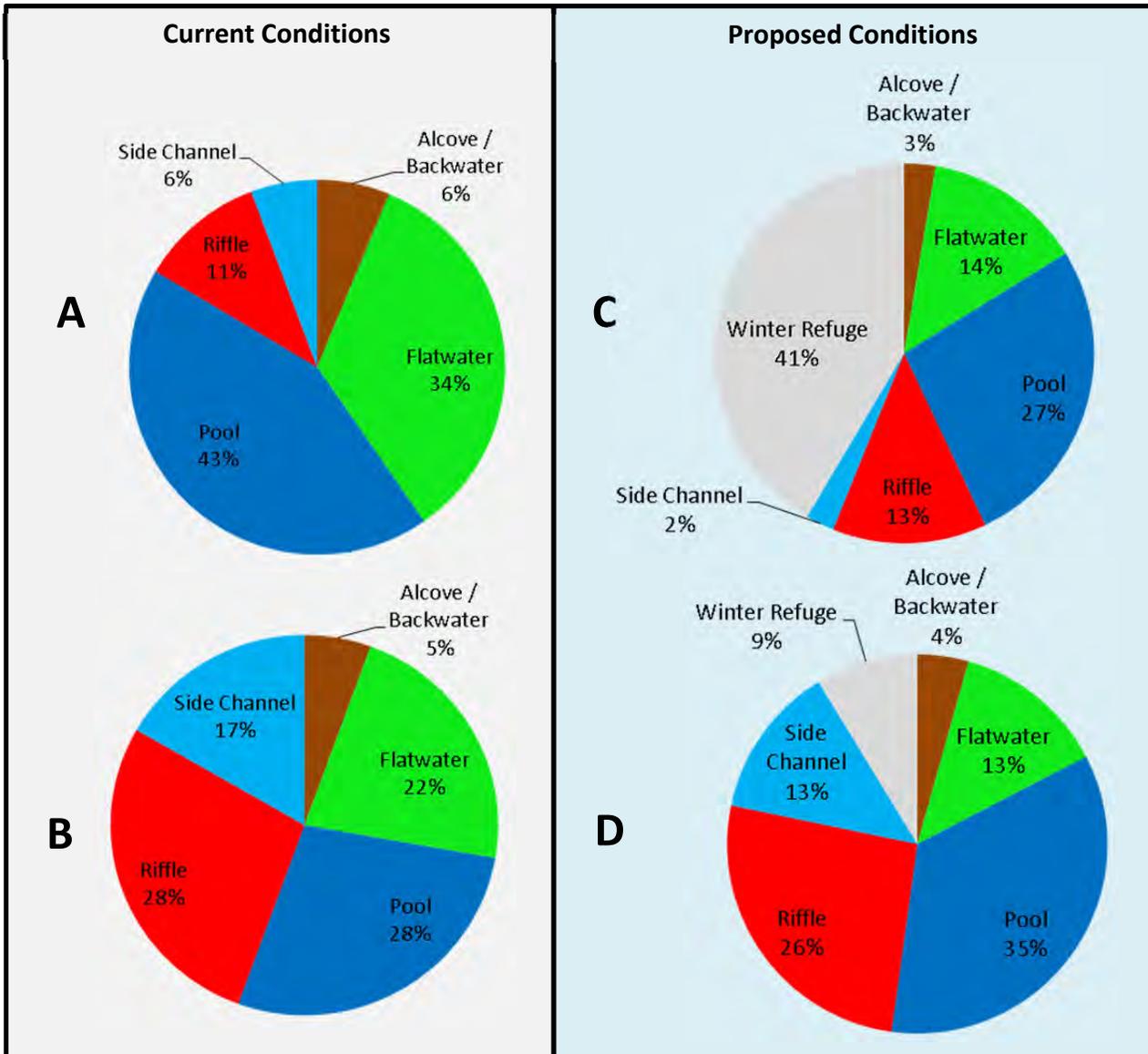


Figure D11. Existing sub-reach 12b habitats shown by area (A), frequency (B) and proposed habitat units based on area (C) and frequency (D).

Table D13. Sub-reach 12b Planning Level Cost Estimate

Note: This is a preliminary cost estimate for planning purposes. Actual costs for design and construction activities may vary substantially from these estimates. Assumptions for time requirements and material quantities have been made based on limited information that is available for the site. Additional information obtained during site investigations will be needed to determine actual quantities and costs. Estimates based on 2011 costs.

No.	Description	Unit	Quantity	Unit Cost	Total Cost	Design and Quantity Assumptions						
1	Mobilization and Demobilization	LS	1	\$180,000	\$180,000	Calculated at 5% of construction sub-total.						
2	Site Access Measures	LS	1	\$170,000	\$170,000	Includes access road improvements, traffic control, dust control, and site restoration.						
3	Environmental Protection Measures	LS	1	\$850,000	\$850,000	Includes stream diversion/dewatering, fish relocation, and erosion control BMPs.						
4	Clearing and Grubbing	AC	2	\$2,000	\$4,000							
5	Common Excavation											
a.		OC 34.3	CY	2,620	\$20	Final design criteria and analysis will likely alter these estimates up or down.						
b.		OC 34	CY	7,370	\$20							
6	Large Woody Debris (purchased, delivered, installed)											
a.	Backwater Habitat Logs	EA	280	\$1,150	\$322,000							
b.	Pool Enhancement Logs	EA	100	\$1,150	\$115,000							
c.	Log Jams	EA	80	\$1,150	\$92,000							
7	Boulder Ballast (purchased, delivered, installed)	TN	460	\$100	\$46,000	Estimate 1 ton per log.						
8	Bank Stabilization	LF	1,360	\$1,000	\$1,360,000	Bank stabilization methods will vary but will include one or more of the following components: large woody debris, earthwork, riprap scour protection, granular backfill, aggregate filter material, geotextile fabric, and/or fabric encapsulated soil lifts. Assumes 30% delivered with root wads attached.						
9	Riffle Installation (purchased, delivered, installed)	CY	1,330	\$120	\$159,600	Assume average of 3 feet of depth per riffle for riffle construction. Assume average of 1.5 feet of depth per riffle for riffle enhancement.						
9	Vegetation Management	AC	5	\$20,000	\$100,000	Assumes area of floodplain from vineyard grade to vineyard grade minus the base flow inundation area of the main channel and of the proposed backwater habitat areas.						
<b>Construction Sub-Total</b>					<b>\$3,598,400</b>	<table border="1"> <tr> <td><b>Key</b></td> <td>LS = Lump Sum CY = Cubic Yard LF = Lineal Foot AC = Acre EA = Each</td> </tr> <tr> <td><b>Project Delivery Items are calculated as a percent of the construction sub-total</b></td> <td></td> </tr> <tr> <td><b>General Notes:</b></td> <td>-Cost includes a 30% design and construction contingency -Costs assume all materials (wood and rock) are purchased and hauled to the site from a nearby source -Boulder ballast requirements may be able to be reduced depending on hydraulics analysis</td> </tr> </table>	<b>Key</b>	LS = Lump Sum CY = Cubic Yard LF = Lineal Foot AC = Acre EA = Each	<b>Project Delivery Items are calculated as a percent of the construction sub-total</b>		<b>General Notes:</b>	-Cost includes a 30% design and construction contingency -Costs assume all materials (wood and rock) are purchased and hauled to the site from a nearby source -Boulder ballast requirements may be able to be reduced depending on hydraulics analysis
<b>Key</b>	LS = Lump Sum CY = Cubic Yard LF = Lineal Foot AC = Acre EA = Each											
<b>Project Delivery Items are calculated as a percent of the construction sub-total</b>												
<b>General Notes:</b>	-Cost includes a 30% design and construction contingency -Costs assume all materials (wood and rock) are purchased and hauled to the site from a nearby source -Boulder ballast requirements may be able to be reduced depending on hydraulics analysis											
Concept Level Design & Construction Contingency (30%)					\$1,079,520							
<b>Construction Total</b>					<b>\$4,677,900</b>							
<b>Project Delivery</b>												
Permitting (4%)					\$143,936							
Detailed Engineering Design (15%)					\$539,760							
Contract Administration (5%)					\$179,920							
Construction Oversight (1.5%)					\$53,976							
<b>Project Delivery Sub-Total</b>					<b>\$917,600</b>							
<b>TOTAL ESTIMATE</b>					<b>\$5,596,000</b>	rounded to nearest \$1,000						

## APPENDIX E

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**E.1 Reach 11 Description**

Reach 11 starts at the Pena Creek (Dry Creek’s largest tributary) confluence and flows past Yoakim bridge to its end at an unnamed tributary confluence. There is a relatively narrow channel corridor through Reach 11, exhibiting simplified planform that has very little sinuosity. Concrete and concrete chunks 200 ft downstream of Yoakim Bridge along the left bank and across the channel cause a small cascade in the mainstem. Based on the air photo record, there have been little changes in this reach other than those caused by activities around Yoakim Bridge. See the Dry Creek Current Conditions Report (Inter-Fluve 2010), Appendix A, for more detail.



**Reach 11 Current Habitat Conditions**

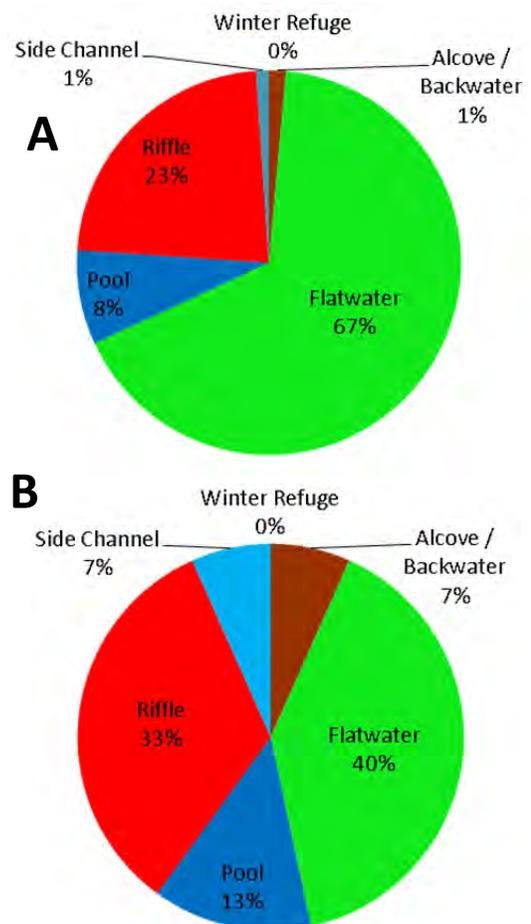
Table E1. Reach 12 habitat units based on current conditions.

Habitat	Existing Habitat	
	Area (ft <sup>2</sup> )	#
Alcove / Backwater	2750	1
Flatwater	129950	6
Pool	15450	6
Riffle	44600	5
Side Channel	2100	1

**E.2 Reach 11 Enhancement Approach**

Reach 11 (RM 10.4 to 10.96) falls in the “middle segment<sup>1</sup>” of Dry Creek, characterized by the increased sediment and surface water contributed by tributaries. Moving downstream from the Pena Creek confluence, Dry Creek begins to have a more significant sediment supply due to the influence of unregulated tributaries. Enhancements in Reach 11 will have to consider potential consequences of the larger sediment supplied by Pena Creek. The focus of habitat enhancement will be on improving conditions in the main channel, and creating winter rearing habitat for juvenile salmonids. Proposed enhancements include riffle construction, pool enhancement, and LWD to improve main channel conditions. Off-channel habitat development potential is limited, and includes the creation of winter refuge habitat.

Figure E1. Habitat units in reach 14 based on area (A) and frequency (B).



<sup>1</sup>Additional detail of process-based delineation of lower Dry Creek into upper, middle and lower segments can be found in the Fish Habitat Enhancement Feasibility Study, Section 5.3, IFI 2011



Figure E2. Reach 11 habitat units and reach boundaries.



Figure E3. Modeled inundations in Reach 11 based on three specific discharge levels: 110 cfs, the 2-year and 10-year flood events.

**E.3 Reach 11 Conceptual Designs**

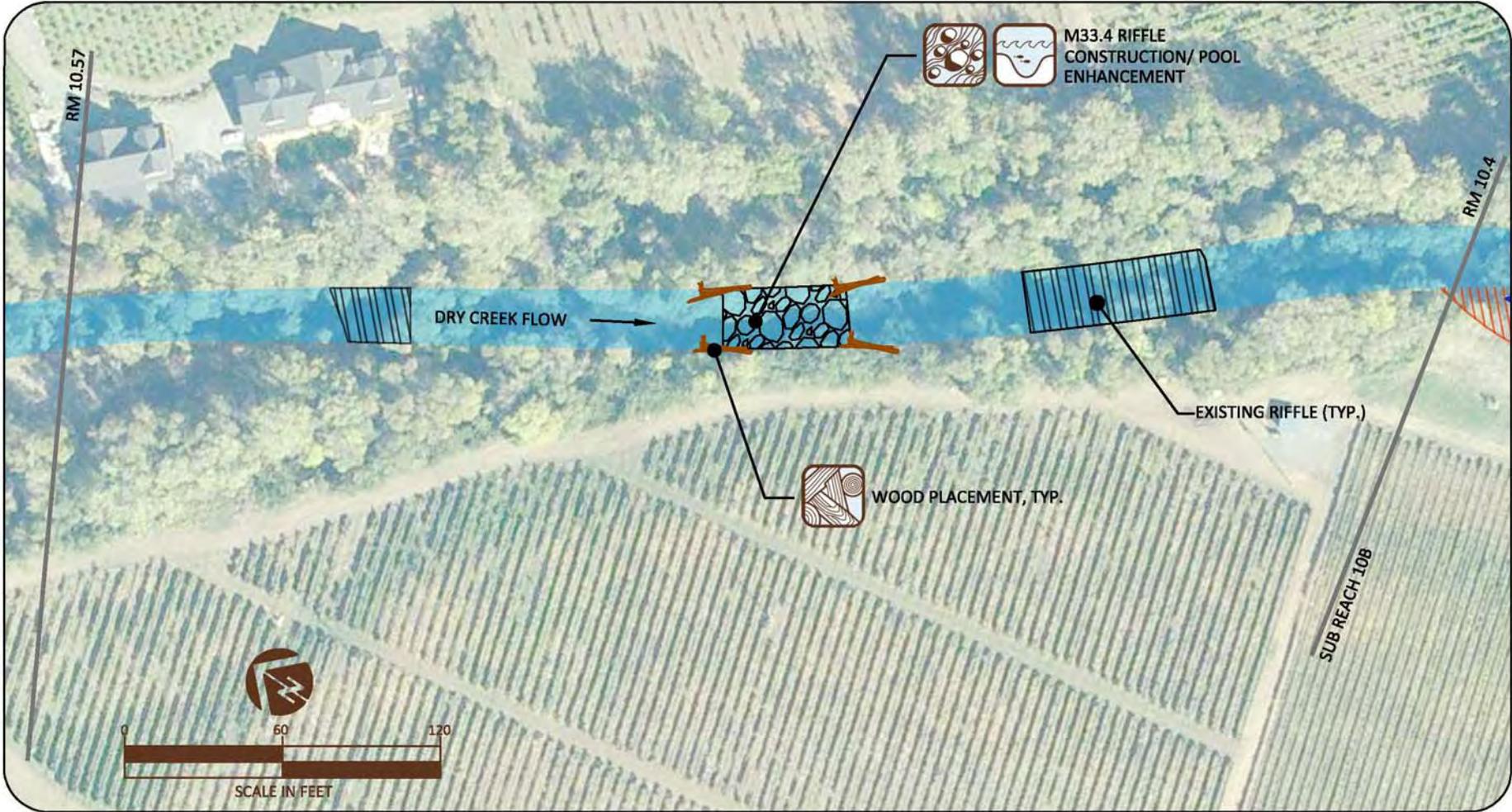
Reach 11 is characterized by a relatively narrow active floodplain, which limits the potential development of off-channel habitat designed to function at 110 cfs. The focus of design concepts developed is on breaking up the flatwater habitats (which represent 2/3 of habitat area). Riffle construction and enhancement of pools upstream will create a network of juvenile habitats as they migrate through this reach. A proposed winter refuge habitat on valley left floodplain will provide additional rearing habitat during winter flood flows. The following table and accompanying figures summarize the design concepts developed for reach 11.

Project Code	Backwater Channel	Side Channel	Pool Enhancement	Riffle Enhancement	LWD	Winter Refuge Habitat	Bank Stabilization	Vegetation Management	Comments
M 33.4			X	X	X			X	Riffle Construction & Pool Enhancement
OC 33.3 L					X	X	X	X	Winter Refuge Habitat
M 33.5			X	X	X			X	Riffle & Pool Enhancement
M 33.6			X	X	X			X	Riffle Construction & Pool Enhancement
M 33.7			X	X	X			X	Riffle Construction & Pool Enhancement

Table E2. Inventory of individual projects identified in reach 11.



Figure E4. Reach 11 sheet index for conceptual design detail sheets.

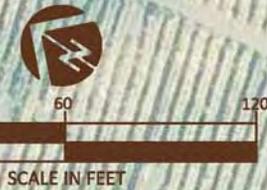


M33.4 RIFFLE  
CONSTRUCTION/ POOL  
ENHANCEMENT

DRY CREEK FLOW

EXISTING RIFFLE (TYP.)

WOOD PLACEMENT, TYP.



**LEGEND**

MAIN CHANNEL AT  
110 CFS

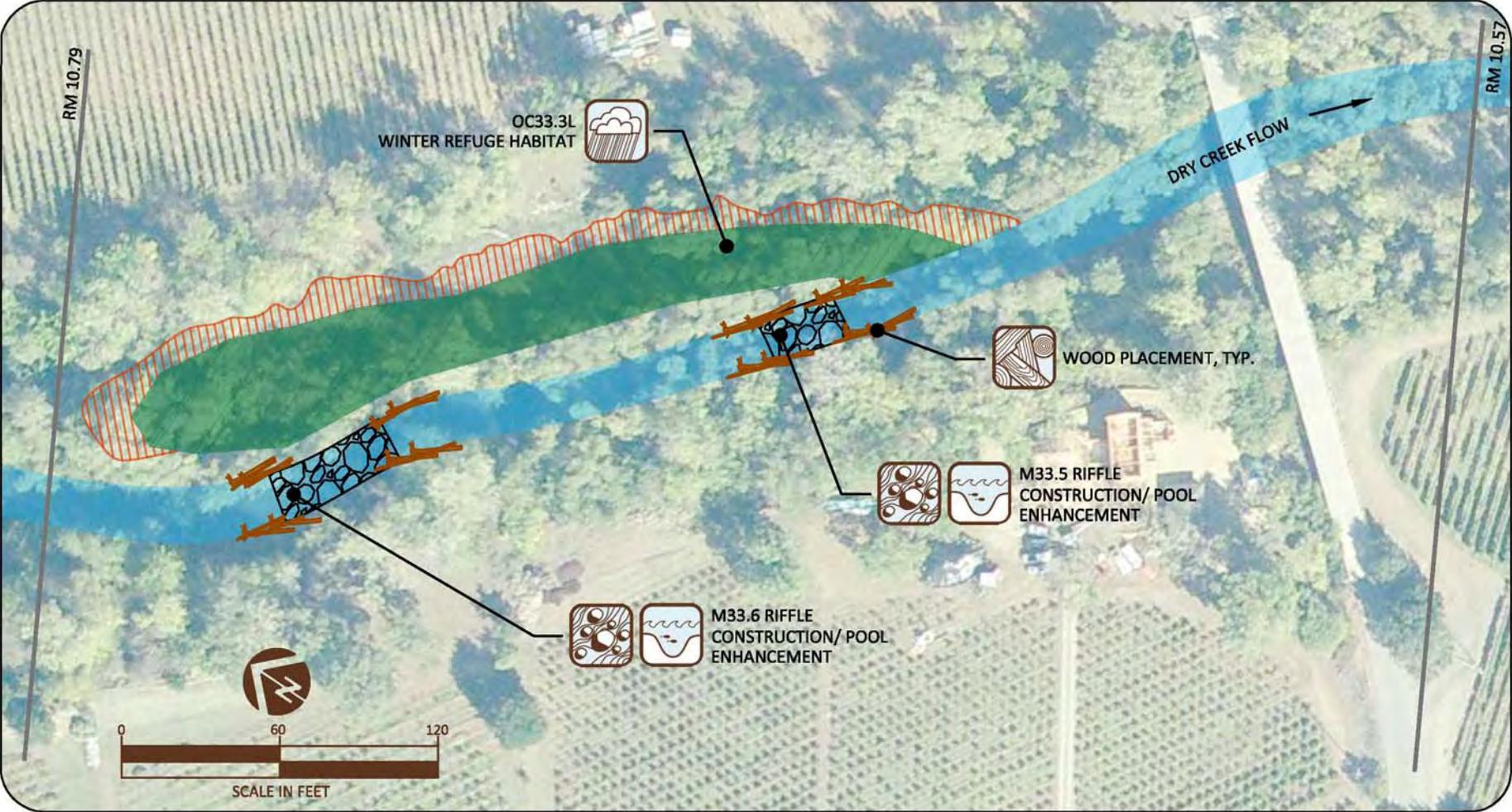
GRADING

RIFFLE CONSTRUCTION/  
ENHANCEMENT

EXISTING RIFFLE

REACH 11  
CONCEPT DESIGN  
1 OF 3

Figure E5. Reach 11 conceptual design detail sheet 1 of 3.



**LEGEND**

MAIN CHANNEL AT 110 CFS

GRADING LIMIT

RIFFLE CONSTRUCTION/ ENHANCEMENT

REACH 11  
CONCEPT DESIGN  
2 OF 3

Figure E6. Reach 11 conceptual design detail sheet 2 of 3.

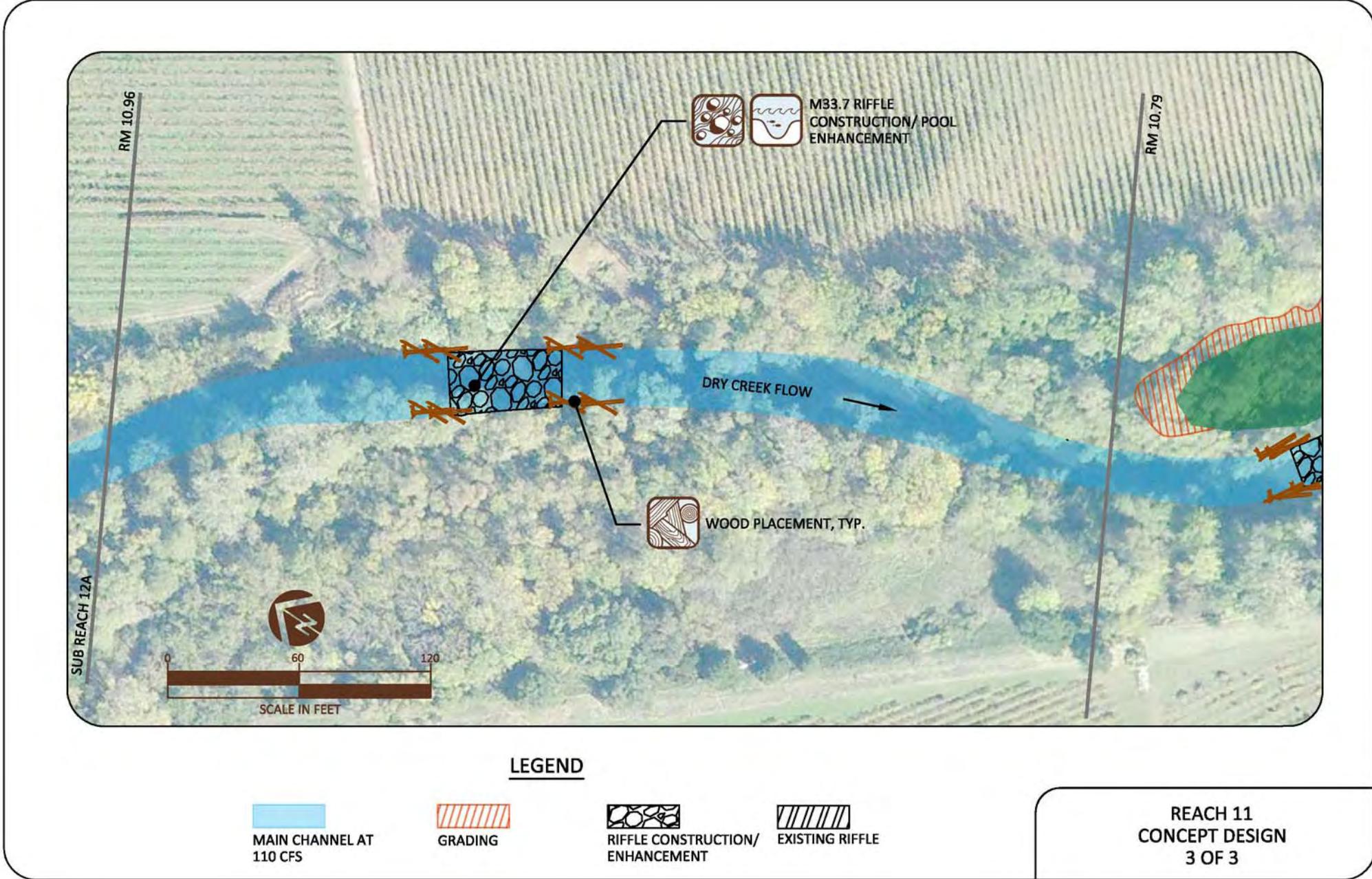


Figure E7. Reach 11 conceptual design detail sheet 3 of 3.

**Reach 11 Analysis of Proposed Enhancements**

Proposed enhancements for reach 11 would increase the quality of main channel summer rearing habitat through the construction of pool – riffle sequences and creation of LWD-margin habitats. Winter coho rearing habitat would be increased by more than 64,000 ft<sup>2</sup> as a result of the proposed winter refuge habitat. The following tables summarize the frequency and areas of existing vs. proposed habitat (Table E3), additional habitat to be created by enhancements (Table E4) and cost-based metrics (Table E5). Table E6 presents enhancement habitat areas normalized by main channel reach length. Table E7 summarizes the planning level cost estimate developed for reach 11.

Table E3. Habitat area by unit type for existing and proposed conditions in reach 11.

Habitat	Existing Habitat		Proposed Habitat	
	Area (ft <sup>2</sup> )	#	Area (ft <sup>2</sup> )	#
Alcove / Backwater	2750	1	2750	1
Flatwater	129950	6	45450	4
Pool	15450	2	89900	7
Riffle	44600	5	64050	8
Side Channel	2100	1	2100	1
Winter Refuge	0	0	64100	1

Table E4. Additional coho rearing habitat provided by new alcoves and LWD placements.

Habitat Type	(ft <sup>2</sup> )	(m <sup>2</sup> )
LWD-Margin Habitat (summer coho rearing)	8000	740
Winter Refuge (summer coho rearing)	64100	5960
Pools	72300	6720
Riffles	19450	1810
<b>Total</b>	<b>163850</b>	<b>15220</b>

Table E5. Cost-benefit table for design concepts presented for reach 11.

Cost - Benefit Metric	Cost / ft <sup>2</sup>
Cost / ft <sup>2</sup> of summer coho rearing*	508
Cost / ft <sup>2</sup> of winter coho rearing**	56
Cost / ft <sup>2</sup> of total enhanced habitat***	25

\*includes backwater and LWD-margin habitats

\*\*includes alcove/backwater, LWD-margin, and winter refuge habitats

\*\*\*includes alcove/backwater, LWD-margin, pools, and riffles

Table E6. Length metric table showing enhancement habitat area divided by sub-reach main channel length.

Length Metric	area (ft <sup>2</sup> )/ length (ft)
Summer coho rearing habitat	2
Winter coho rearing habitat	19
Total enhanced habitat	44

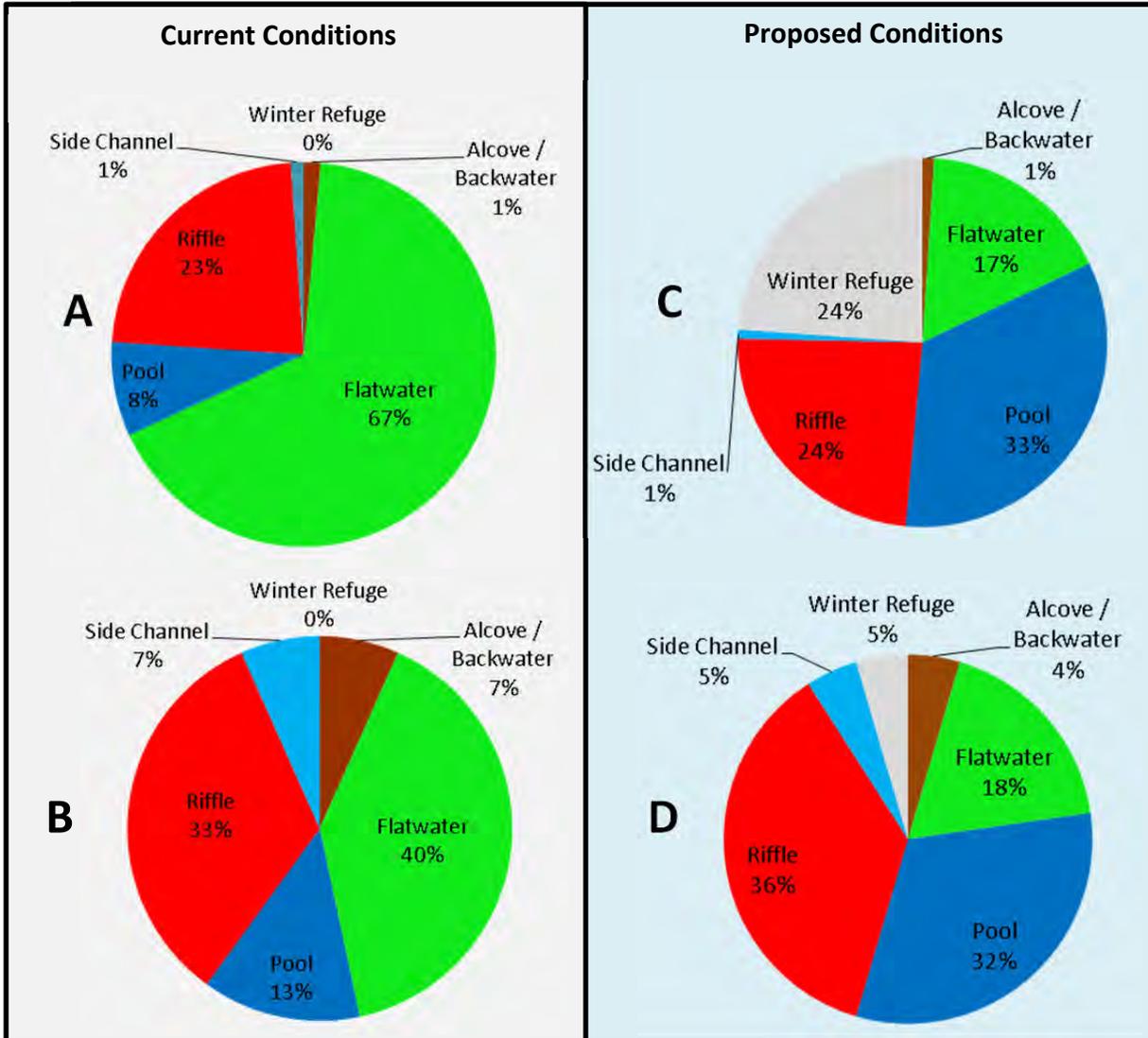


Figure E8. Existing habitats shown by area (A), frequency (B) and proposed habitat units based on area (C) and frequency (D).

Table E7. Reach 11 Planning Level Cost Estimate

Note: This is a preliminary cost estimate for planning purposes. Actual costs for design and construction activities may vary substantially from these estimates. Assumptions for time requirements and material quantities have been made based on limited information that is available for the site. Additional information obtained during site investigations will be needed to determine actual quantities and costs. Estimates based on 2011 costs.

No.	Description	Unit	Quantity	Unit Cost	Total Cost	Design and Quantity Assumptions
1	Mobilization and Demobilization	LS	1	\$130,000	\$130,000	Calculated at 5% of construction sub-total.
2	Site Access Measures	LS	1	\$110,000	\$110,000	Includes access road improvements, traffic control, dust control, and site restoration.
3	Environmental Protection Measures	LS	1	\$580,000	\$580,000	Includes stream diversion/dewatering, fish relocation, and erosion control BMPs.
4	Clearing and Grubbing	AC	2	\$2,000	\$4,000	
5	Common Excavation					
a.	OC 33.3	CY	7,920	\$20	\$158,400	Final design criteria and analysis will likely alter these estimates up or down.
5	Large Woody Debris (purchased, delivered, installed)					
a.	Backwater Habitat Logs	EA	190	\$1,150	\$218,500	
b.	Pool Enhancement Logs	EA	130	\$1,150	\$149,500	
6	Boulder Ballast (purchased, delivered, installed)	TN	320	\$100	\$32,000	Estimate 1 ton per log.
7	Bank Stabilization	LF	690	\$1,000	\$690,000	Bank stabilization methods will vary but will include one or more of the following components: large woody debris, earthwork, riprap scour protection, granular backfill, aggregate filter material, geotextile fabric, and/or fabric encapsulated soil lifts. Assumes 30% delivered with root wads attached.
8	Riffle Installation (purchased, delivered, installed)	CY	2,670	\$120	\$320,400	Assume average of 3 feet of depth per riffle for riffle construction. Assume average of 1.5 feet of depth per riffle for riffle enhancement.
8	Vegetation Management	AC	11	\$20,000	\$220,000	Assumes area of floodplain from vineyard grade to vineyard grade minus the base flow inundation area of the main channel and of the proposed backwater habitat areas.
<b>Construction Sub-Total</b>					<b>\$2,612,800</b>	<div style="display: flex; justify-content: space-between;"> <div style="border: 1px solid black; padding: 5px;"> <p><b>Key</b>                      LS = Lump Sum                      CY = Cubic Yard                      LF = Lineal Foot                      AC = Acre                      EA = Each</p> </div> <div style="border: 1px solid black; padding: 5px;"> <p><b>Project Delivery Items are calculated as a percent of the construction sub-total</b>  <b>General Notes:</b>                      -Cost includes a 30% design and construction contingency                      -Costs assume all materials (wood and rock) are purchased and hauled to the site from a nearby source                      -Boulder ballast requirements may be able to be reduced depending on hydraulics analysis</p> </div> </div>
Concept Level Design & Construction Contingency (30%)					\$783,840	
<b>Construction Total</b>					<b>\$3,396,600</b>	
<b>Project Delivery</b>						
Permitting (4%)					\$104,512	
Detailed Engineering Design (15%)					\$391,920	
Contract Administration (5%)					\$130,640	
Construction Oversight (1.5%)					\$39,192	
<b>Project Delivery Sub-Total</b>					<b>\$666,300</b>	
<b>TOTAL ESTIMATE</b>					<b>\$4,063,000</b>	

## APPENDIX F

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**F.1 Reach 10 Description**

Reach 10 is a single-thread channel that extends upstream to where the east lineament intersects Dry Creek about 150 ft downstream of the inflow from an unnamed tributary. This is a short reach (3390 ft long), with an active floodplain width ranging from 200 – 500 ft. Reach 10 contains significant length of stabilized streambank in the form of riprap, and dead grapevines, I-beam and chain-link fence structures. Since the construction of WSD, the channel has narrowed substantially and the main meander bend has migrated or avulsed to the opposite side of the riparian corridor. Despite efforts to harden banks and arrest bank erosion, the channel has continued to migrate southward in the last 25 years. The channel change that has occurred has resulted in a large elevated bar on the right bank that is 400 x 500 ft, as well as off-channel ponds and backwater channels. Numerous juvenile salmonids were observed in the off-channel habitats. See the Dry Creek Current Conditions Report (Inter-Fluve 2010), Appendix A, for more detail.

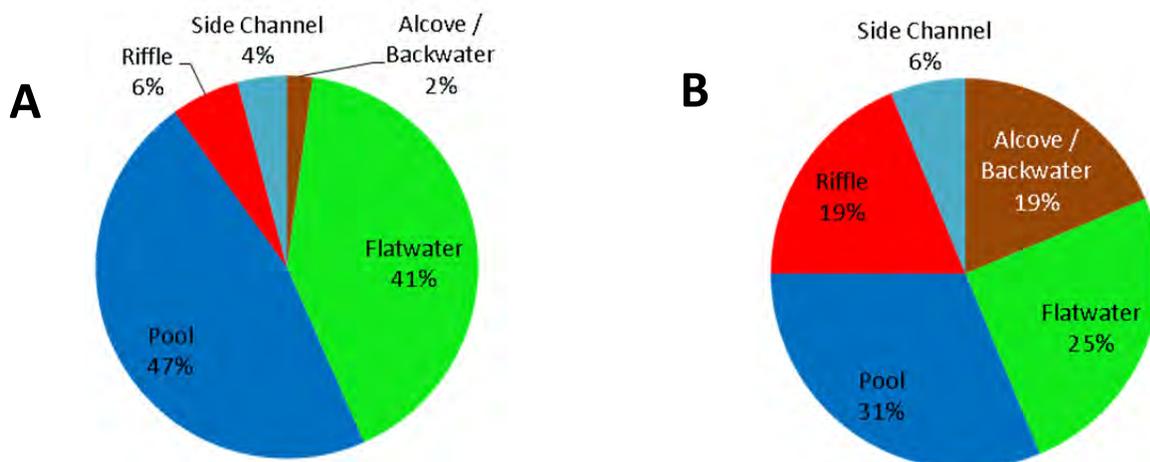


**Reach 10 Current Habitat Conditions**

Table F1. Reach 10 habitat units based on current conditions.

Habitat	Existing Habitat	
	Area (ft <sup>2</sup> )	#
Alcove / Backwater	4450	3
Flatwater	84800	4
Pool	95900	5
Riffle	11950	3
Side Channel	8550	1

Figure F1. Habitat units in reach 14 based on area (A) and frequency (B).



## F.2 Reach 10 Enhancement Approach

Reach 10 falls in the “middle segment<sup>1</sup>” of Dry Creek, characterized by the increased sediment and surface water contributed by tributaries. Moving downstream from the Pena Creek confluence, Dry Creek begins to have a more significant sediment supply due to the influence of unregulated tributaries. Enhancements in reach 10 will have to consider potential consequences of the larger sediment supplied by Pena Creek and more natural hydrology due to the influence of tributaries. The focus of enhancement efforts in reach 10 will be to construct late successional habitats in a way that takes into account the moderate risk of future sedimentation and channel migration. Primary habitat types are to include off channel habitats such as side channels and backwater channels, pools, and LWD-driven habitat, in addition to main channel habitats (riffles, pools and LWD placements). For purposes of enhancement planning, reach 10 has been split into two sub-reaches (see Figure F2). Sub-reach 10a (RM 9.65 to 10.07) is described in section F.3, and sub-reach 10b (RM 10.07 to 10.4) is described in section F.4.

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<sup>1</sup>Additional detail of process-based delineation of lower Dry Creek into upper, middle and lower segments can be found in the Fish Habitat Enhancement Feasibility Study, Section 5.3, IFI 2011

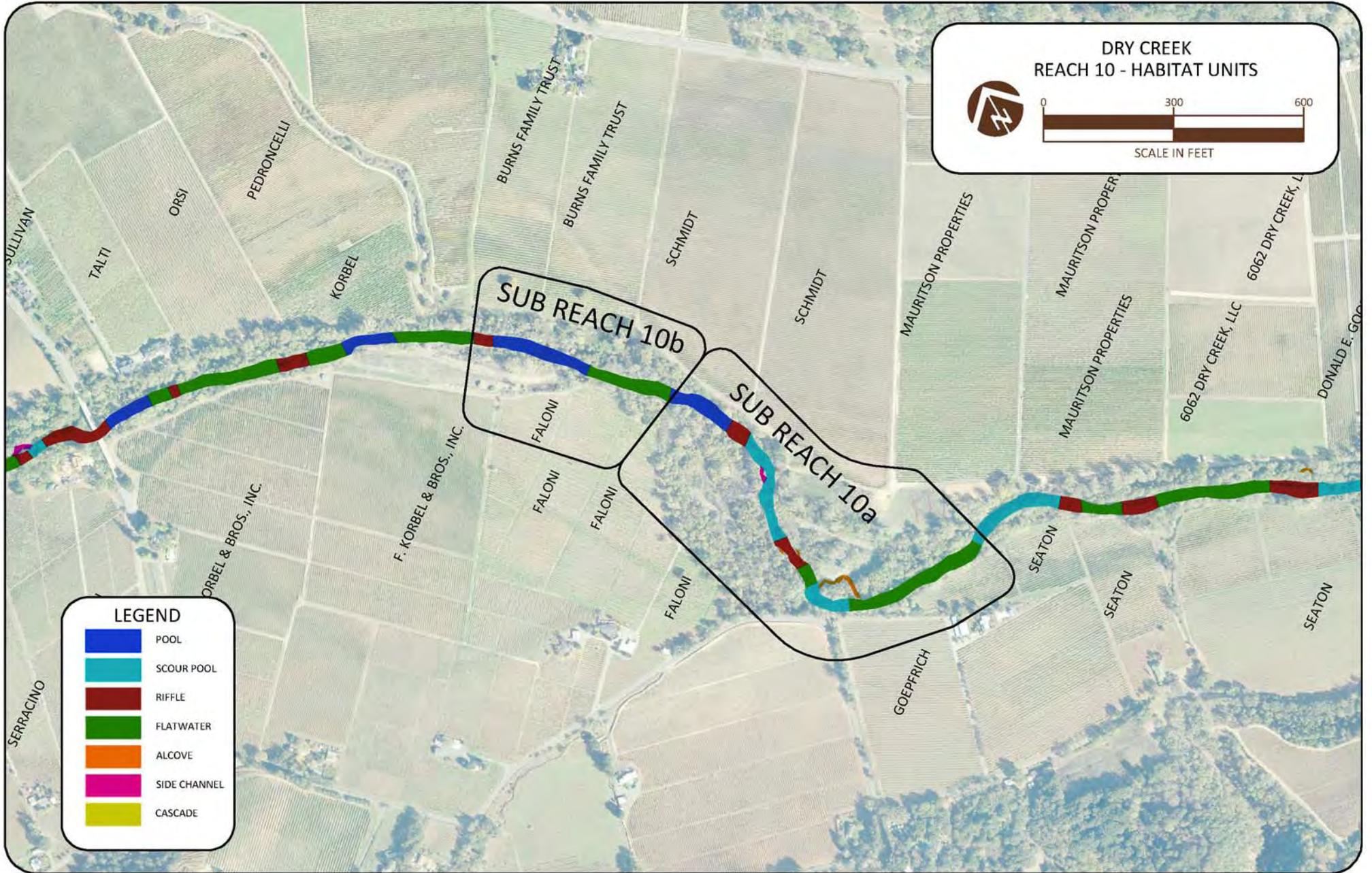


Figure F2. Reach 10 habitat units and sub-reach boundaries.

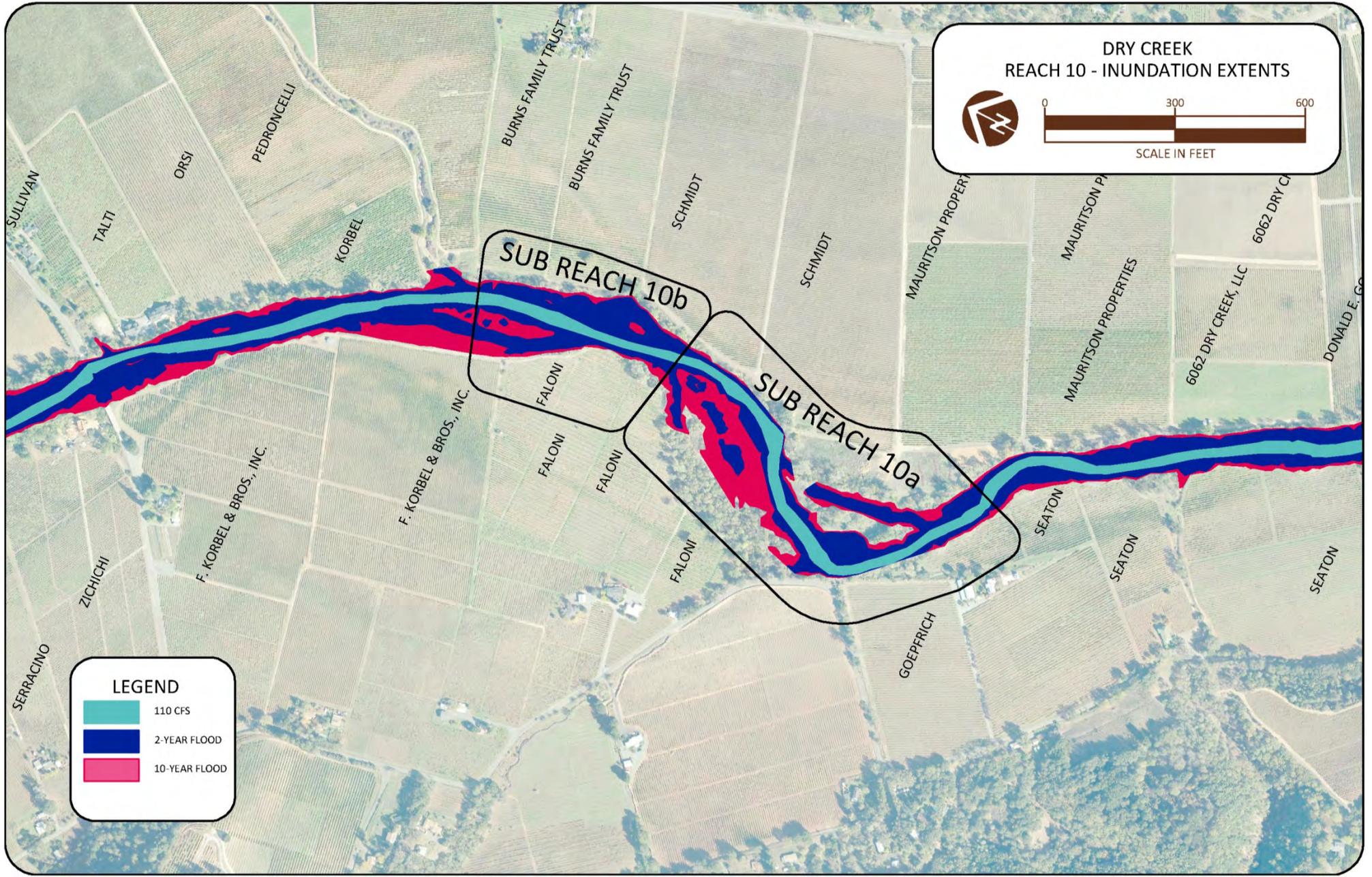


Figure F3. Modeled inundations in reach 10 based on three specific discharge levels: 110 cfs, the 2-year and 10-year flood events.

**F.3 Sub-Reach 10a Conceptual Designs**

Sub-reach 10a is characterized by a relatively wide active floodplain that provides significant areas for off-channel habitat creation. Off-channel enhancements include backwater channels and side-channel habitats. Main channel projects include pool enhancements, riffle construction, and LWD placements. The following table and accompanying figures summarize the design concepts created for sub-reach 10a.

Project Code	Backwater Channel	Side Channel	Pool Enhancement	Riffle Enhancement	LWD	Winter Refuge Habitat*	Bank Stabilization	Vegetation Management	Comments
M 31			X	X	X			X	Riffle Construction & Pool Enhancement
OC 31 L	X				X		X	X	Backwater Channel Construction
M 32.1			X	X	X			X	Riffle Construction & Pool Enhancement
OC 32.1 R	X				X			X	Backwater Channel Construction
M 32.2			X	X	X			X	Riffle & Pool Enhancement
OC 32.2		X	X	X	X			X	Side Channel Construction
M 32.3			X	X	X			X	Riffle Construction & Pool Enhancement

Table F2. Inventory of individual projects identified in sub-reach 10a.

\*Although no winter refuge projects are proposed for sub-reach 10a, enhancements will increase the amount of winter refuge habitat as backwater channels will provide low velocity habitat during winter flood events.



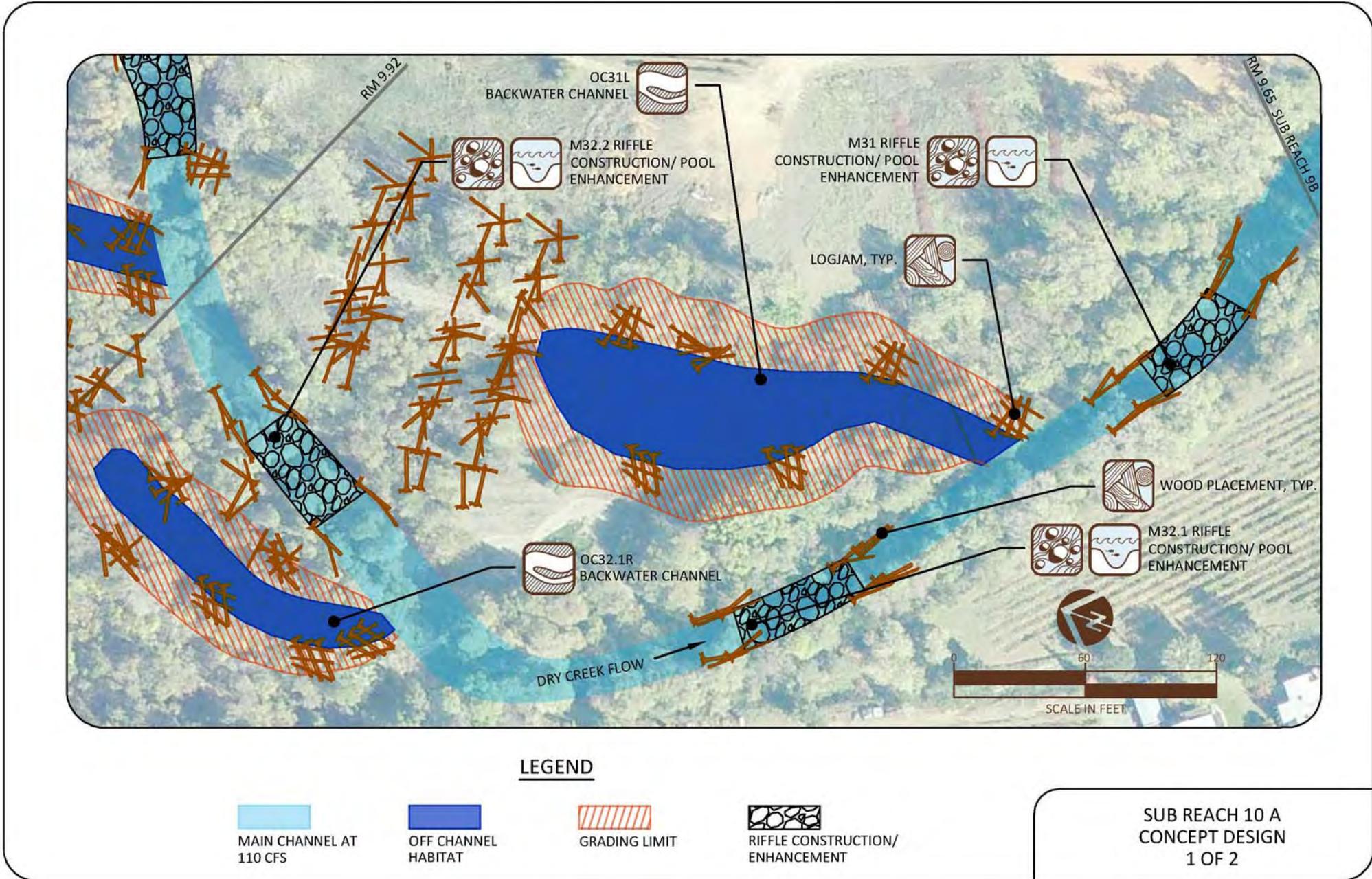


Figure F5. Sub-reach 10a conceptual design detail sheet 1 of 2.

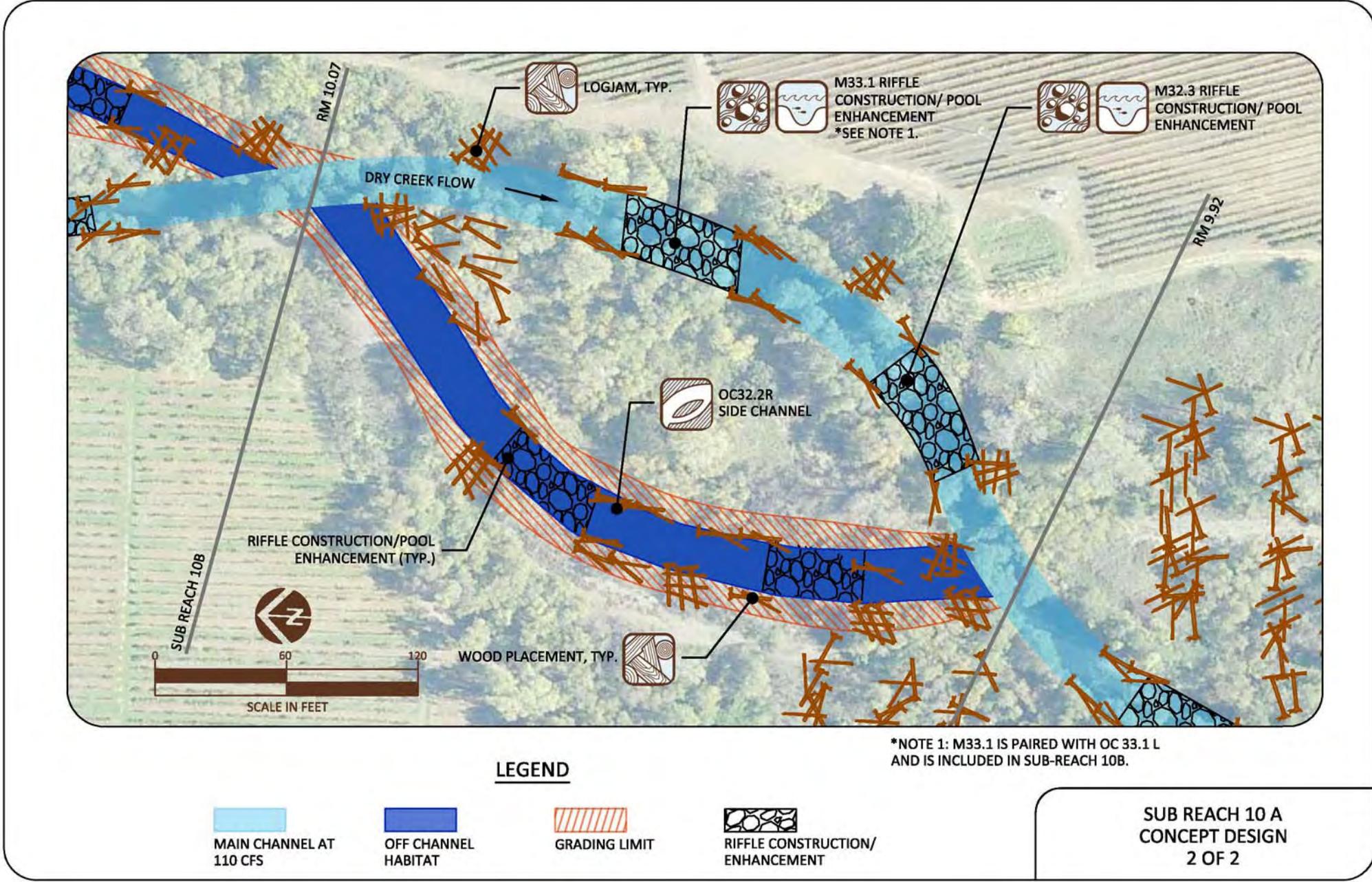


Figure F6. Sub-reach 10a conceptual design detail sheet 2 of 2.

Sub-Reach 10a Analysis of Proposed Enhancements

Proposed enhancements in sub-reach 10a include over 145,000 ft<sup>2</sup> of improved or new habitat. More than 70,000 ft<sup>2</sup> of the proposed enhancements have been designed to provide summer coho rearing habitat. The proposed backwater and side channel habitats will increase diversity, quality and quantity of juvenile coho habitat. Additionally, proposed enhancements for sub-reach 10a will increase the amount of winter refuge habitat during winter flood events. The following tables summarize the frequency and areas of existing vs. proposed habitat (Table F3), additional habitat to be created by enhancements (Table F4) and cost-based metrics (Table F5). Table F6 presents the habitat enhancement areas normalized by sub-reach main channel length. Table F7 summarizes the planning level cost estimate developed for sub-reach 10a.

Table F3. Habitat area by unit type for existing and proposed conditions in sub-reach 10a.

Habitat	Existing Habitat		Proposed Habitat	
	Area (ft <sup>2</sup> )	#	Area (ft <sup>2</sup> )	#
Alcove / Backwater	4450	3	48450	6
Flatwater	44150	2	5450	1
Pool	58200	3	79700	6
Riffle	7500	2	32750	5
Side Channel	8550	1	35450	2

Table F4. Additional coho rearing habitat provided by new alcoves and LWD placements.

Habitat Type	(ft <sup>2</sup> )	(m <sup>2</sup> )
Alcove/Backwater <sup>+</sup> (summer coho rearing)	44000	4090
LWD-Margin Habitat (summer coho rearing)	13000	1210
Side Channels (summer coho rearing)	17950	1670
Winter Refuge (coho rearing)	15650	1450
Pools	21500	2000
Riffles	25250	2350
<b>Total</b>	<b>146300</b>	<b>13590</b>

<sup>+</sup>Alcove/Backwater habitats also provide winter refuge habitat during flood events.

Table F5. Cost-benefit table for design concepts presented for sub-reach 10a.

Cost - Benefit Metric	Cost / ft <sup>2</sup>
Cost / ft <sup>2</sup> of summer coho rearing*	145
Cost / ft <sup>2</sup> of winter coho rearing**	120
Cost / ft <sup>2</sup> of total enhanced habitat***	74

\*includes backwater and LWD-margin habitats

\*\*includes alcove/backwater, high flow backwater habitat, side channels, and LWD-margin

\*\*\*includes alcove/backwater, high flow backwater habitat, side channels, LWD-margin, pools and riffles

Table F6. Length metric table showing habitat area divided by main-channel sub-reach length.

Length Metric	area (ft <sup>2</sup> )/ length (ft)
Summer coho rearing habitat	35
Winter coho rearing habitat	42
Total enhanced habitat	68

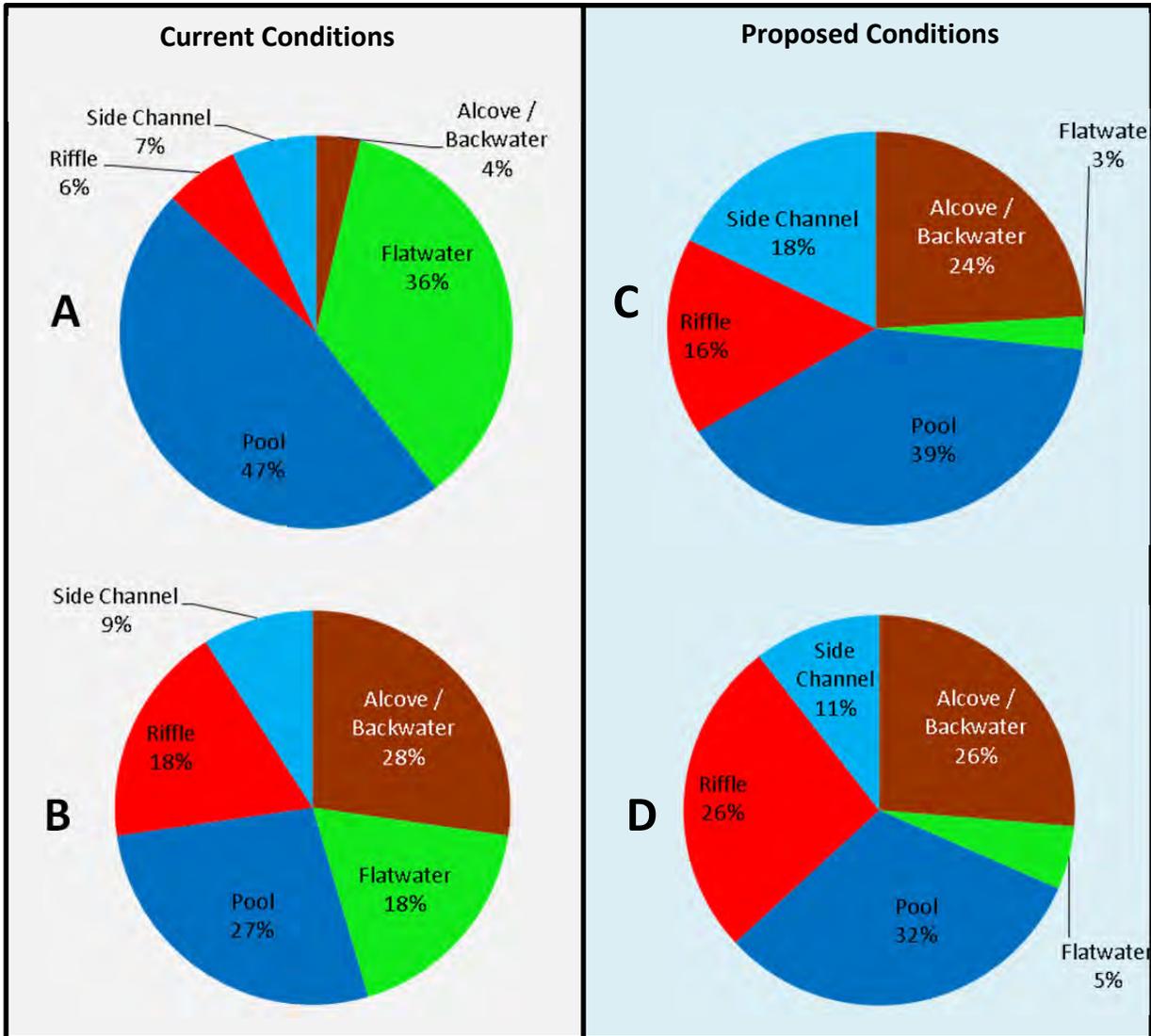


Figure F7. Existing habitats shown by area (A), frequency (B) and proposed habitat units based on area (C) and frequency (D).

Table F7. Sub-Reach 10a Planning Level Cost Estimate

Note: This is a preliminary cost estimate for planning purposes. Actual costs for design and construction activities may vary substantially from these estimates. Assumptions for time requirements and material quantities have been made based on limited information that is available for the site. Additional information obtained during site investigations will be needed to determine actual quantities and costs. Estimates based on 2011 costs.

No.	Description	Unit	Quantity	Unit Cost	Total Cost	Design and Quantity Assumptions						
1	Mobilization and Demobilization	LS	1	\$340,000	\$340,000	Calculated at 5% of construction sub-total.						
2	Site Access Measures	LS	1	\$330,000	\$330,000	Includes access road improvements, traffic control, dust control, and site restoration.						
3	Environmental Protection Measures	LS	1	\$1,660,000	\$1,660,000	Includes stream diversion/dewatering, fish relocation, and erosion control BMPs.						
4	Clearing and Grubbing	AC	4	\$2,000	\$8,000							
5	Common Excavation											
a.	OC 32.2	CY	13,900	\$20	\$278,000	Final design criteria and analysis will likely alter these estimates up or down.						
b.	OC 32.1	CY	9,950	\$20	\$199,000							
c.	OC 31	CY	24,260	\$20	\$485,200							
6	Large Woody Debris (purchased, delivered, installed)											
a.	Floodplain Roughness Logs	EA	250	\$1,150	\$287,500	Assumes 30% delivered with root wads attached.						
b.	Backwater Habitat Logs	EA	480	\$1,150	\$552,000							
c.	Pool Enhancement Logs	EA	130	\$1,150	\$149,500							
d.	Log Jams	EA	640	\$1,150	\$736,000							
7	Boulder Ballast (purchased, delivered, installed)	TN	1,500	\$100	\$150,000	Estimate 1 ton per log.						
8	Bank Stabilization	LF	1,100	\$1,000	\$1,100,000	Bank stabilization methods will vary but will include one or more of the following components: large woody debris, earthwork, riprap scour protection, granular backfill, aggregate filter material, geotextile fabric, and/or fabric encapsulated soil lifts. Assumes 30% delivered with root wads attached.						
9	Riffle Installation (purchased, delivered, installed)	CY	4,440	\$120	\$532,800	Assume average of 3 feet of depth per riffle for riffle construction. Assume average of 1.5 feet of depth per riffle for riffle enhancement.						
9	Vegetation Management	AC	10	\$20,000	\$200,000	Assumes area of floodplain from vineyard grade to vineyard grade minus the base flow inundation area of the main channel and of the proposed backwater habitat areas.						
<b>Construction Sub-Total</b>					<b>\$7,008,000</b>	<table border="1"> <tr> <td><b>Key</b></td> <td>LS = Lump Sum CY = Cubic Yard LF = Lineal Foot AC = Acre EA = Each</td> </tr> <tr> <td><b>Project Delivery Items are calculated as a percent of the construction sub-total</b></td> <td></td> </tr> <tr> <td><b>General Notes:</b></td> <td>-Cost includes a 30% design and construction contingency -Costs assume all materials (wood and rock) are purchased and hauled to the site from a nearby source -Boulder ballast requirements may be able to be reduced depending on hydraulics analysis</td> </tr> </table>	<b>Key</b>	LS = Lump Sum CY = Cubic Yard LF = Lineal Foot AC = Acre EA = Each	<b>Project Delivery Items are calculated as a percent of the construction sub-total</b>		<b>General Notes:</b>	-Cost includes a 30% design and construction contingency -Costs assume all materials (wood and rock) are purchased and hauled to the site from a nearby source -Boulder ballast requirements may be able to be reduced depending on hydraulics analysis
<b>Key</b>	LS = Lump Sum CY = Cubic Yard LF = Lineal Foot AC = Acre EA = Each											
<b>Project Delivery Items are calculated as a percent of the construction sub-total</b>												
<b>General Notes:</b>	-Cost includes a 30% design and construction contingency -Costs assume all materials (wood and rock) are purchased and hauled to the site from a nearby source -Boulder ballast requirements may be able to be reduced depending on hydraulics analysis											
Concept Level Design & Construction Contingency (30%)					\$2,102,400							
<b>Construction Total</b>					<b>\$9,110,400</b>							
<b>Project Delivery</b>												
Permitting (4%)					\$280,320							
Detailed Engineering Design (15%)					\$1,051,200							
Contract Administration (5%)					\$350,400							
Construction Oversight (1.5%)					\$105,120							
<b>Project Delivery Sub-Total</b>					<b>\$1,787,000</b>							
<b>TOTAL ESTIMATE</b>					<b>\$10,897,000</b>	rounded to nearest \$1,000						

**F.4 Sub-Reach 10b Conceptual Designs**

Sub-reach 10b is short (<1000 ft) and is characterized by a relatively narrow active floodplain, and a channel geometry that lacks sinuosity due to the history of incision in Dry Creek. Floodplain areas on both sides of the channel provide sufficient space to create side channels. Enhancements proposed for the sub-reach include side channel construction, riffle construction, pool enhancement and LWD placements. The following table and accompanying figures summarize design concepts created for sub-reach 10b.

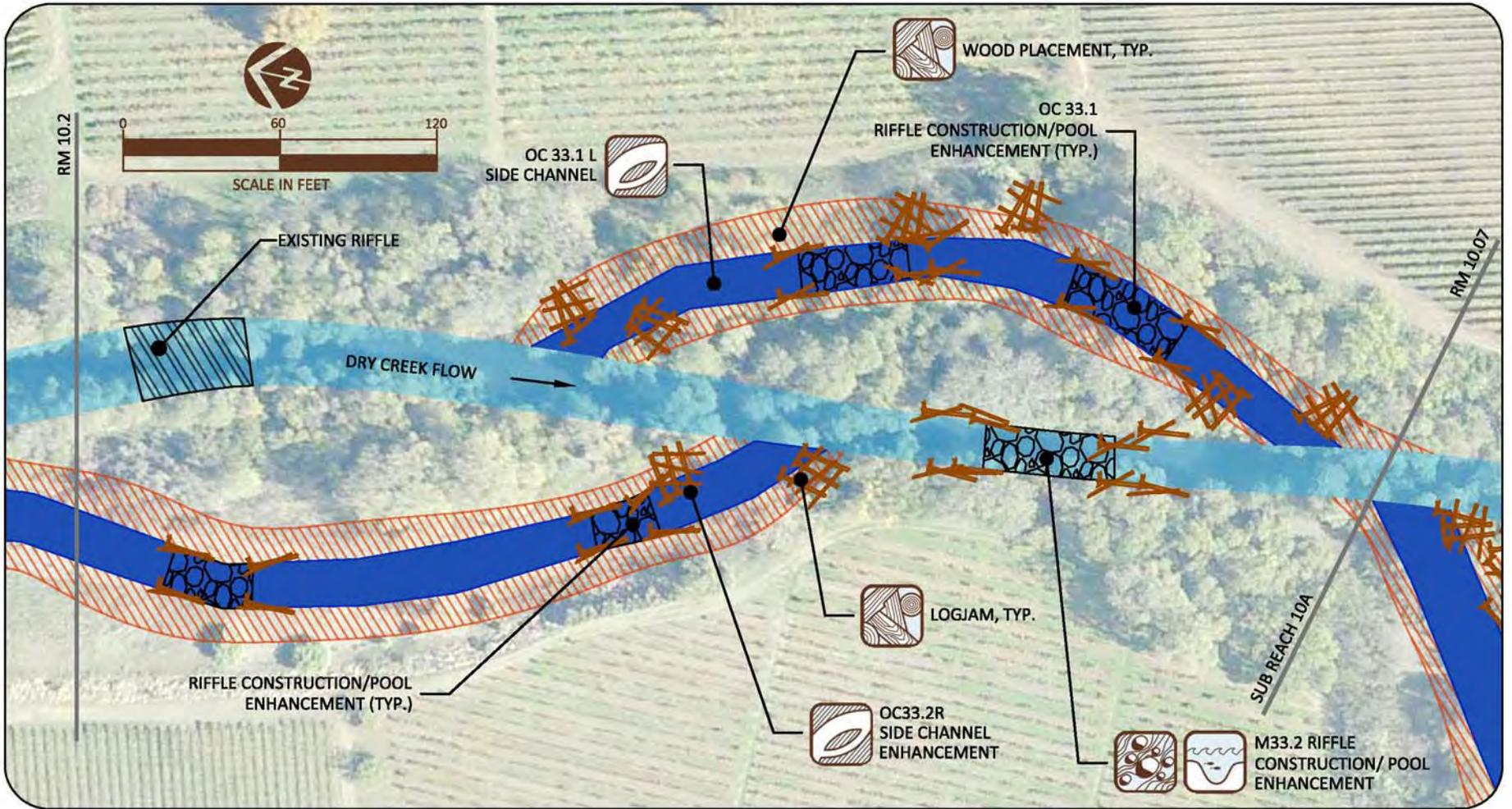
Project Code	Backwater Channel	Side Channel	Pool Enhancement	Riffle Enhancement	LWD	Winter Refuge Habitat*	Bank Stabilization	Vegetation Management	Comments
M 33.1			X	X	X			X	Riffle & Pool Enhancement <i>(Shown in Figure F6, Sub –Reach 10B 2 of 2)</i>
OC 33.1 L		X			X		X	X	Side Channel Construction
M 33.2			X	X	X			X	Riffle Construction & Pool Enhancement
OC 33.2 R		X			X		X	X	Side Channel Construction
M 33.3			X	X	X			X	Riffle Construction & Pool Enhancement

Table F8. Inventory of projects identified in sub-reach 10b.

\*Although no winter refuge projects are proposed for sub-reach 10a, enhancements will increase the amount of winter refuge habitat as backwater channels will provide low velocity habitat during winter flood events.



Figure F8. Reach 10 sheet index for conceptual design detail sheets.



**LEGEND**

MAIN CHANNEL AT 110 CFS

OFF CHANNEL HABITAT

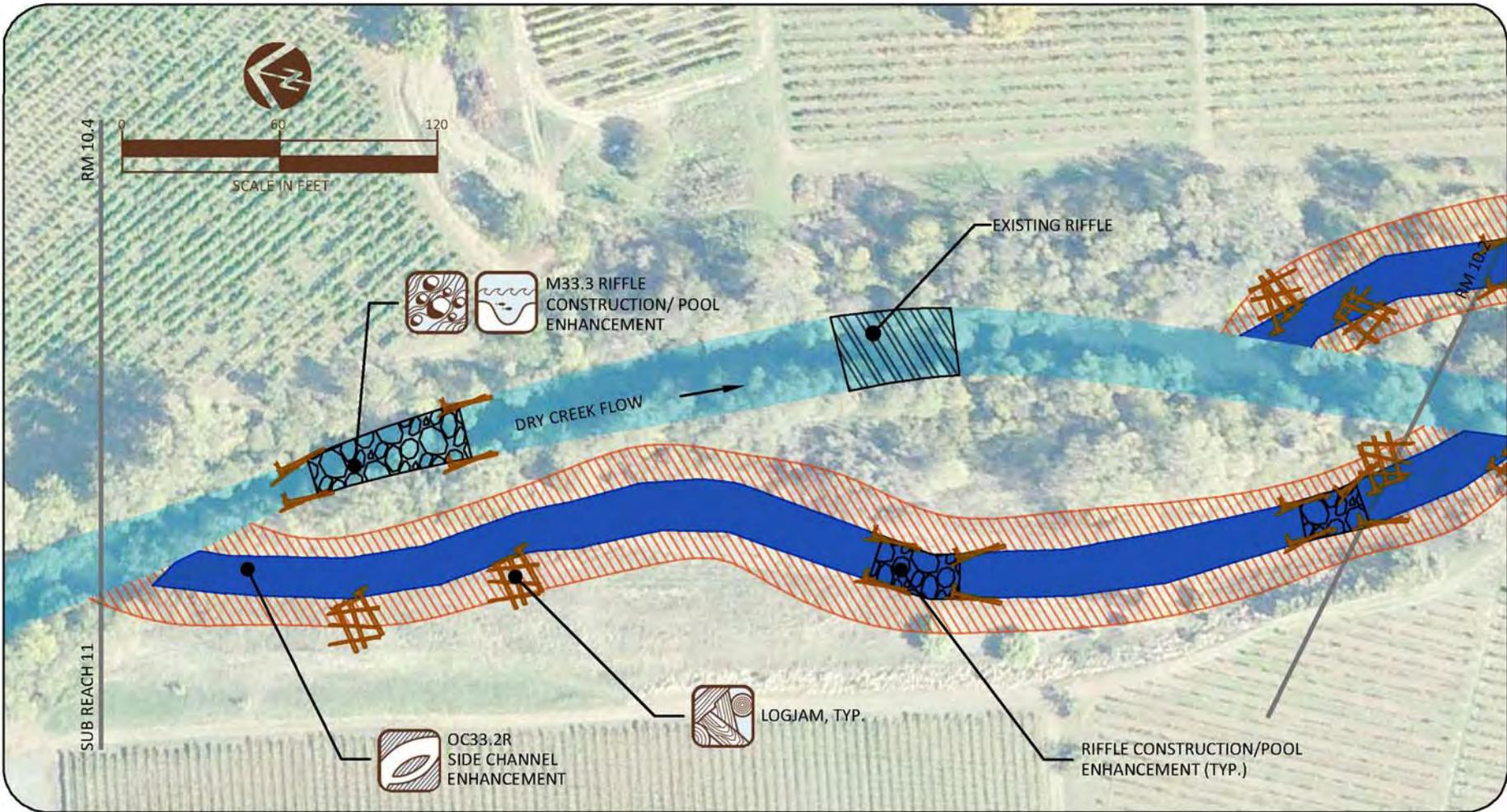
GRADING

RIFFLE CONSTRUCTION/ ENHANCEMENT

EXISTING RIFFLE

SUB REACH 10 B  
CONCEPT DESIGN  
1 OF 2

Figure F9. Sub-reach 10b conceptual design detail sheet 1 of 2.  
Dry Creek Conceptual Design Report



**LEGEND**

				
MAIN CHANNEL AT 110 CFS	OFF CHANNEL HABITAT	GRADING	RIFFLE CONSTRUCTION/ ENHANCEMENT	EXISTING RIFFLE

SUB REACH 10 B  
 CONCEPT DESIGN  
 2 OF 2

Figure F10. Sub-reach 10b conceptual design detail sheet 2 of 2.

**Sub-Reach 10b Analysis of Proposed Enhancements**

The enhancements proposed for sub-reach 10b include more than 80,000 ft<sup>2</sup> of side channel habitat – in a sub-reach that currently has no off-channel habitats. Additionally, 4,000 ft<sup>2</sup> of LWD-margin habitat will increase the quantity of coho rearing habitat in the main channel. Pool enhancement and riffle construction will improve over 13,000 ft<sup>2</sup> of the main channel. The following tables summarize the frequency and areas of existing vs. proposed habitat (Table F9), additional habitat to be created by enhancements (Table F10) and cost-based metrics (Table F11). Table F12 presents the enhancement habitat areas normalized by sub-reach main channel length. Table F13 summarizes the planning level cost estimate developed for sub-reach 10b.

Table F9. Habitat units based on existing and proposed conditions.

Habitat	Existing Habitat		Proposed Habitat	
	Area (ft <sup>2</sup> )	#	Area (ft <sup>2</sup> )	#
Alcove / Backwater	0	0	0	0
Flatwater	40650	2	27200	2
Pool	37700	2	40250	3
Riffle	4450	1	15350	3
Side Channel	0	0	65850	2

Table F10. Additional habitat provided by backwater, LWD-margin, side channels and riffle habitat.

Habitat Type	(ft <sup>2</sup> )	(m <sup>2</sup> )
LWD-Margin Habitat (summer coho rearing)	4000	370
Side Channels (summer coho rearing)	43900	4080
Pools	2550	240
Riffles	10900	1010
<b>Total</b>	<b>83300</b>	<b>7740</b>

<sup>+</sup>Alcove/Backwater habitats also provide winter refuge habitat during flood events.

Table F11. Cost – benefit table for design concepts presented for sub-reach 10b.

Cost - Benefit Metric	Cost (\$/ft <sup>2</sup> )
Cost / ft <sup>2</sup> of coho rearing*	133
Cost / ft <sup>2</sup> of total enhanced habitat**	77

\*includes backwater and LWD-margin habitats

\*\*Side channels LWD-margin, pools, and riffles

Table F12. Length metric table showing habitat area divided by main-channel sub-reach length.

Length Metric	area (ft <sup>2</sup> )/ length (ft)
Summer coho rearing habitat	38
Total enhanced habitat	67

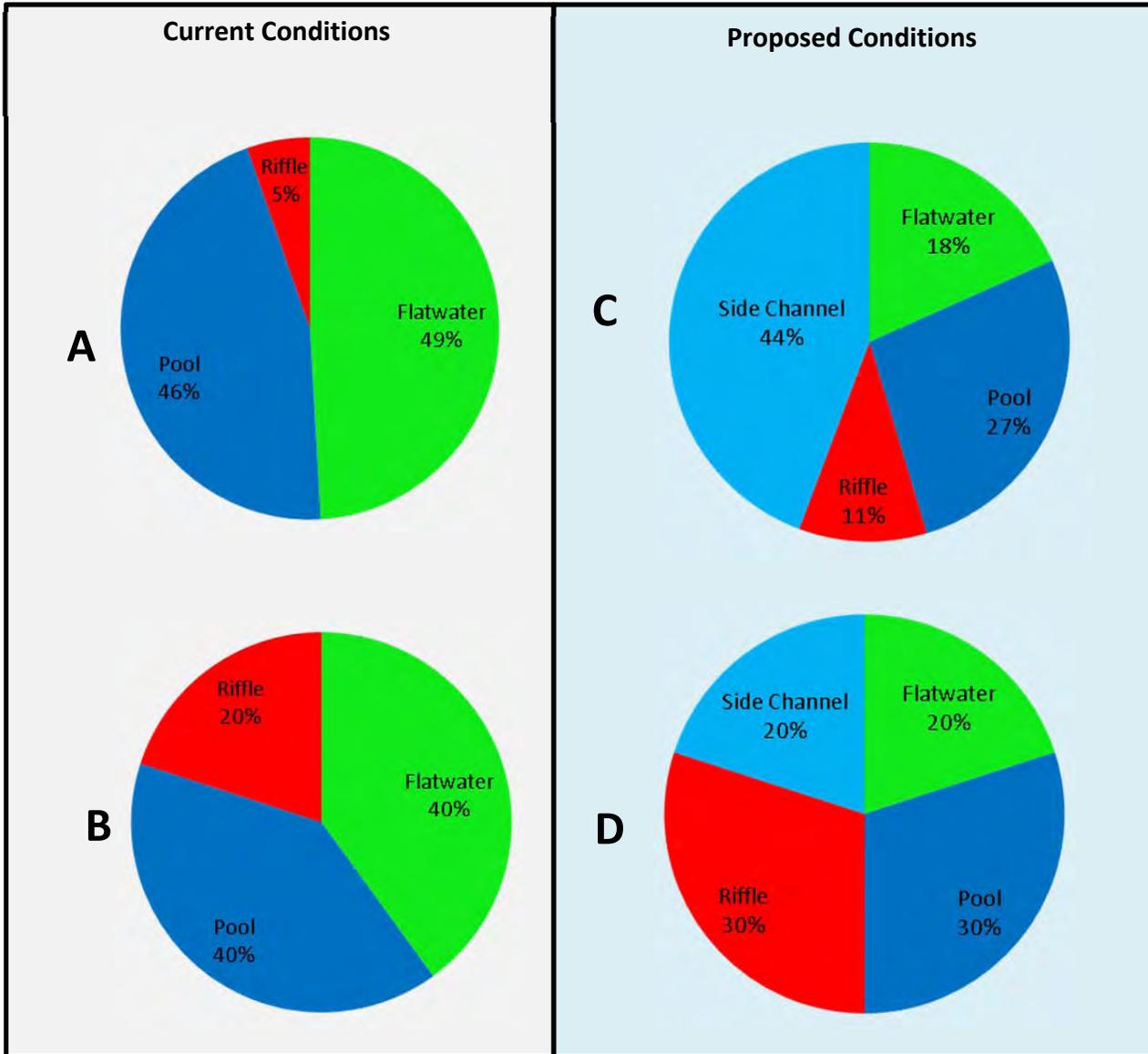


Figure F11. Existing sub-reach 10b habitats shown by area (A), frequency (B) and proposed habitat units based on area (C) and frequency (D).

Table F13. Sub-reach 10b Planning Level Cost Estimate

Note: This is a preliminary cost estimate for planning purposes. Actual costs for design and construction activities may vary substantially from these estimates. Assumptions for time requirements and material quantities have been made based on limited information that is available for the site. Additional information obtained during site investigations will be needed to determine actual quantities and costs. Estimates based on 2011 costs.

No.	Description	Unit	Quantity	Unit Cost	Total Cost	Design and Quantity Assumptions						
1	Mobilization and Demobilization	LS	1	\$200,000	\$200,000	Calculated at 5% of construction sub-total.						
2	Site Access Measures	LS	1	\$190,000	\$190,000	Includes access road improvements, traffic control, dust control, and site restoration.						
3	Environmental Protection Measures	LS	1	\$980,000	\$980,000	Includes stream diversion/dewatering, fish relocation, and erosion control BMPs.						
4	Clearing and Grubbing	AC	3	\$2,000	\$6,000							
5	Common Excavation											
a.	OC 33.2	CY	18,960	\$20	\$379,200	Final design criteria and analysis will likely alter these estimates up or down.						
b.	OC 33.1	CY	7,050	\$20	\$141,000							
6	Large Woody Debris (purchased, delivered, installed)											
a.	Backwater Habitat Logs	EA	390	\$1,150	\$448,500							
b.	Pool Enhancement Logs	EA	60	\$1,150	\$69,000							
c.	Log Jams	EA	400	\$1,150	\$460,000							
7	Boulder Ballast (purchased, delivered, installed)	TN	860	\$100	\$86,000	Estimate 1 ton per log.						
8	Bank Stabilization	LF	870	\$1,000	\$870,000	Bank stabilization methods will vary but will include one or more of the following components: large woody debris, earthwork, riprap scour protection, granular backfill, aggregate filter material, geotextile fabric, and/or fabric encapsulated soil lifts. Assumes 30% delivered with root wads attached.						
9	Riffle Installation (purchased, delivered, installed)	CY	1,330	\$120	\$159,600	Assume average of 3 feet of depth per riffle for riffle construction. Assume average of 1.5 feet of depth per riffle for riffle enhancement.						
9	Vegetation Management	AC	6	\$20,000	\$120,000	Assumes area of floodplain from vineyard grade to vineyard grade minus the base flow inundation area of the main channel and of the proposed backwater habitat areas.						
<b>Construction Sub-Total</b>					<b>\$4,109,300</b>	<table border="1"> <tr> <td><b>Key</b></td> <td>LS = Lump Sum CY = Cubic Yard LF = Lineal Foot AC = Acre EA = Each</td> </tr> <tr> <td><b>Project Delivery Items are calculated as a percent of the construction sub-total</b></td> <td></td> </tr> <tr> <td><b>General Notes:</b></td> <td>-Cost includes a 30% design and construction contingency -Costs assume all materials (wood and rock) are purchased and hauled to the site from a nearby source -Boulder ballast requirements may be able to be reduced depending on hydraulics analysis</td> </tr> </table>	<b>Key</b>	LS = Lump Sum CY = Cubic Yard LF = Lineal Foot AC = Acre EA = Each	<b>Project Delivery Items are calculated as a percent of the construction sub-total</b>		<b>General Notes:</b>	-Cost includes a 30% design and construction contingency -Costs assume all materials (wood and rock) are purchased and hauled to the site from a nearby source -Boulder ballast requirements may be able to be reduced depending on hydraulics analysis
<b>Key</b>	LS = Lump Sum CY = Cubic Yard LF = Lineal Foot AC = Acre EA = Each											
<b>Project Delivery Items are calculated as a percent of the construction sub-total</b>												
<b>General Notes:</b>	-Cost includes a 30% design and construction contingency -Costs assume all materials (wood and rock) are purchased and hauled to the site from a nearby source -Boulder ballast requirements may be able to be reduced depending on hydraulics analysis											
Concept Level Design & Construction Contingency (30%)					\$1,232,790							
<b>Construction Total</b>					<b>\$5,342,100</b>							
<b>Project Delivery</b>												
Permitting (4%)					\$164,372							
Detailed Engineering Design (15%)					\$616,395							
Contract Administration (5%)					\$205,465							
Construction Oversight (1.5%)					\$61,640							
<b>Project Delivery Sub-Total</b>					<b>\$1,047,900</b>							
<b>TOTAL ESTIMATE</b>					<b>\$6,390,000</b>	rounded to nearest \$1,000						

## **APPENDIX G**

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**G.1 Reach 9 Description**

Reach 9 is characterized by a single-thread section of Dry Creek. A new section of riprap bank stabilization has been installed on the right bank. Little channel change has occurred since the 1940's, other than the narrowing resulting from incision and vegetation encroachment. In the few areas where abandoned channel alignments are present, a dense stand of alders has developed effectively protecting the floodplain. Reach 9 is composed largely of flatwater – riffle sequences with little existing off-channel habitat and a few pools. See the Dry Creek Current Conditions Report (Inter-Fluve 2010), Appendix A, for more detail.

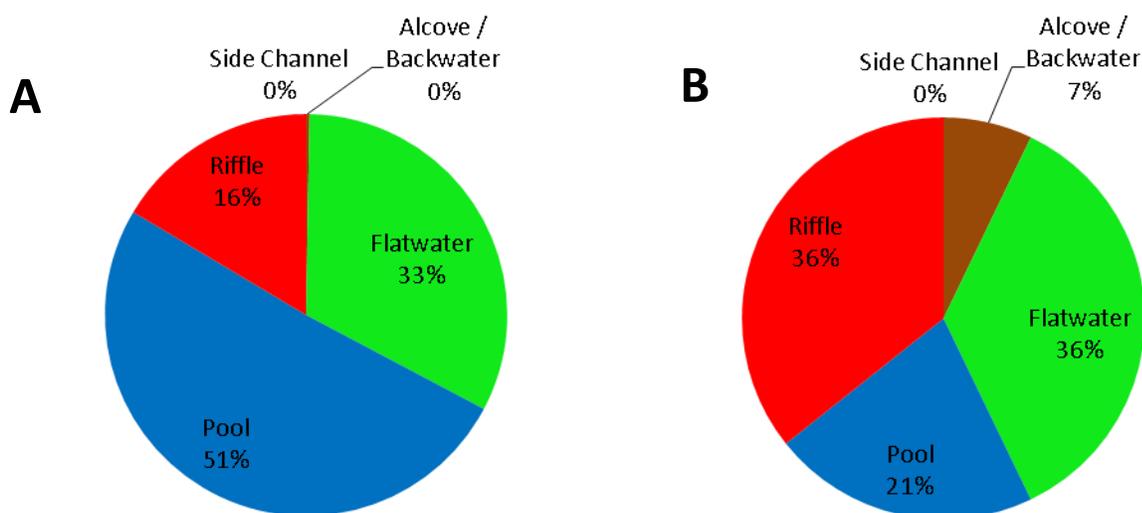


**Reach 9 Current Habitat Conditions**

Table G1. Reach 9 habitat units based on current conditions.

Habitat	Existing Habitat	
	Area (ft <sup>2</sup> )	#
Alcove / Backwater	650	1
Flatwater	75500	5
Pool	118150	3
Riffle	38250	5
Side Channel	0	0

Figure G1. Habitat units in reach 9 based on area (A) and frequency (B).



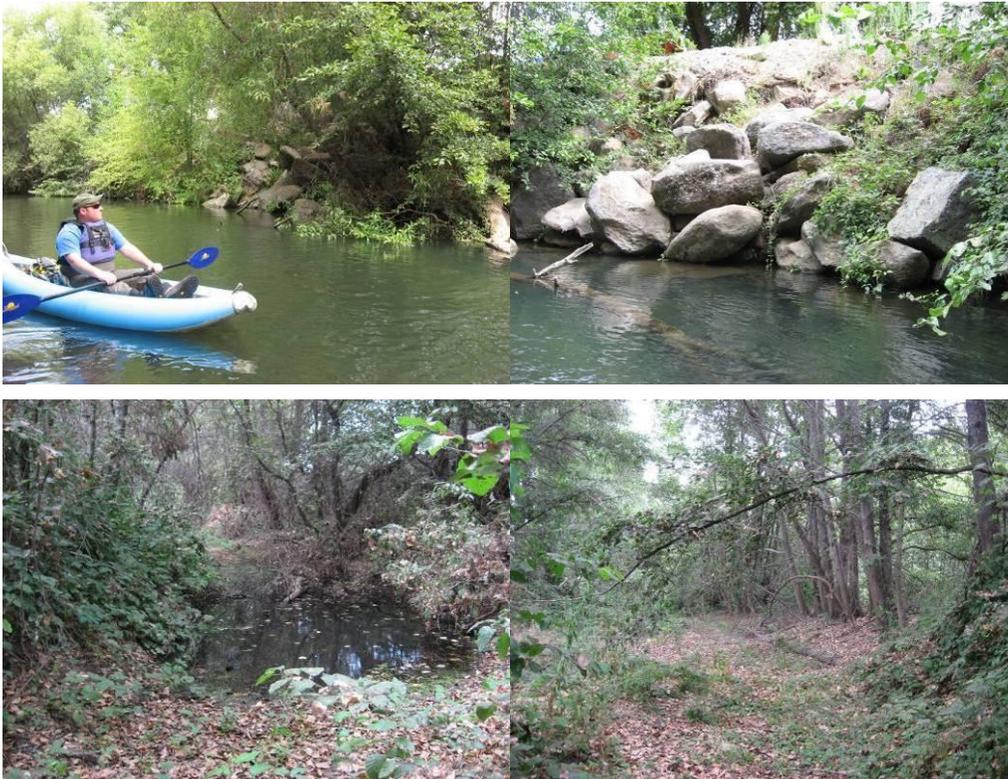


Figure G2. (Upper row) pool habitat with riprap bank protection, (lower left) alcove habitat, (lower right) former channel along left bank, protected by a long, straight berm vegetated by even-aged alders.

## G.2 Reach 9 Enhancement Approach

Reach 9 falls in the “middle segment<sup>1</sup>” of Dry Creek, characterized by the increased sediment and surface water contributed by tributaries. In this segment, Dry Creek begins to have a more significant sediment supply due to the influence of unregulated tributaries. Enhancements in Reach 9 will have to consider potential consequences of the larger sediment supplied by Pena Creek. Process-based approaches are unlikely to be implemented in reach 9 due to the confined and straight nature of the reach. Off-channel habitat development in reach 9 is limited to winter refuge projects, due to the limited active floodplain width. Main channel enhancements including riffle construction, pool enhancement and creation of LWD-margin habitat is proposed for the reach. For purposes of enhancement planning, reach 9 has been split into 2 enhancement sub-reaches (Figure G3). Sub-reach 9a (RM 8.86 to 9.25) is described in section G.3, and sub-reach 9b (RM 9.25 to 9.66) is described in section G.4.

<sup>1</sup>Additional detail of process-based delineation of lower Dry Creek into upper, middle and lower segments can be found in the Fish Habitat Enhancement Feasibility Study, Section 5.3, IFI 2011

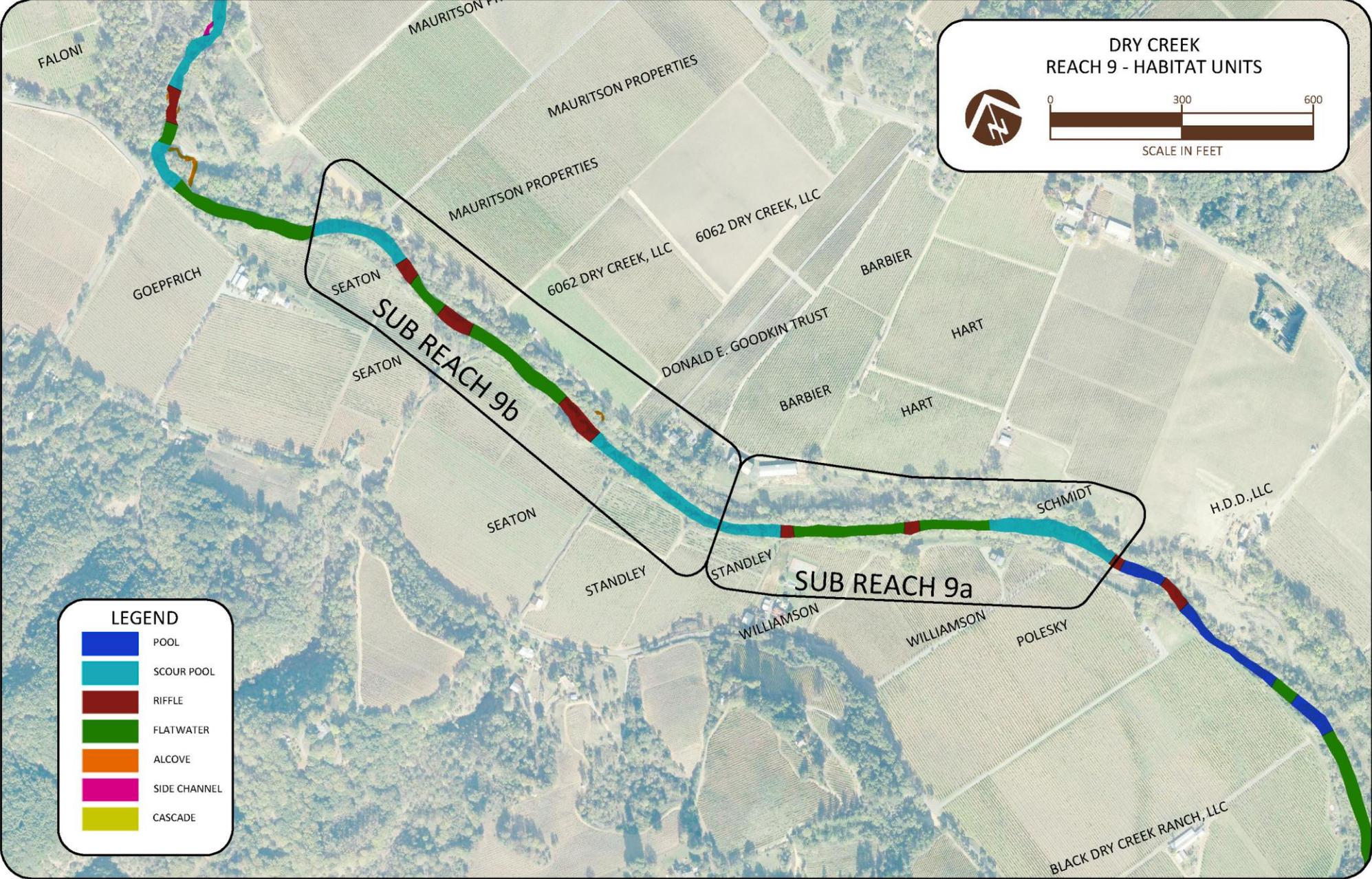


Figure G3. Reach 9 habitat units and sub-reach boundaries.

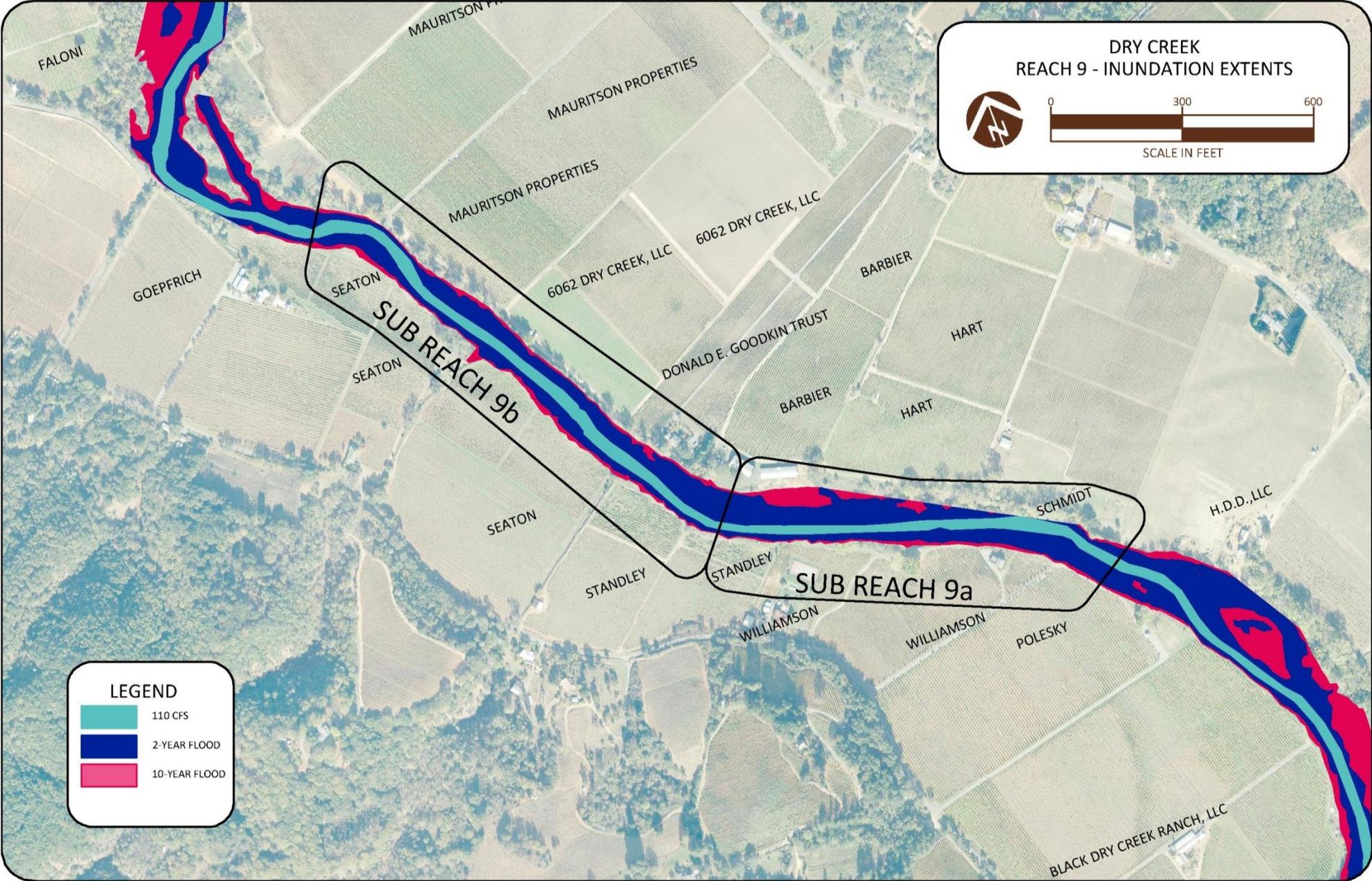


Figure G4. Modeled inundations in reach 9 based on three specific discharge levels: 110 cfs, the 2-year and 10-year flood events.

**G.3 Sub-reach 9a Conceptual Designs**

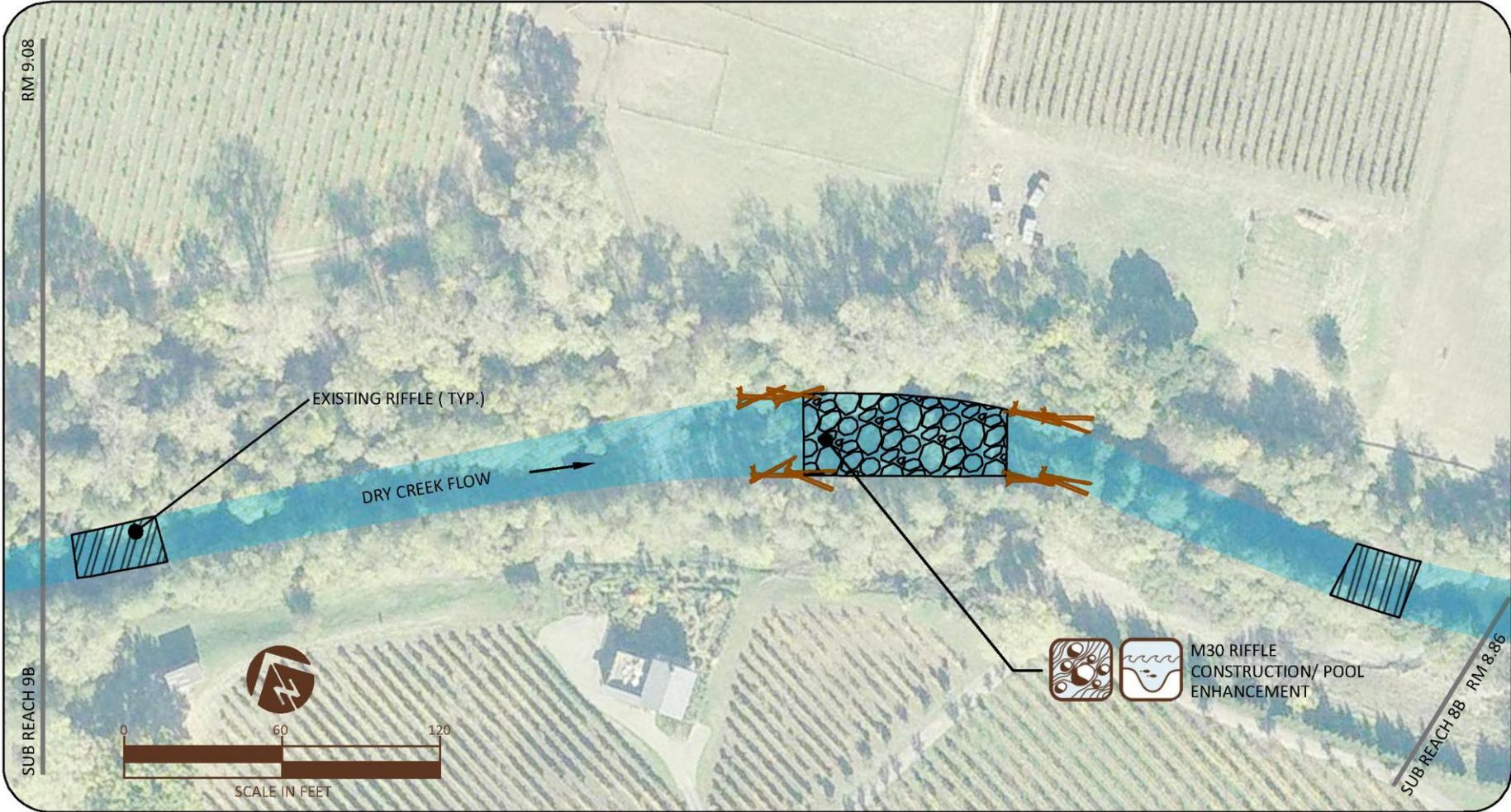
Sub-reach 9a is characterized by a straight section of Dry Creek with a very narrow active floodplain. Due to the lack of wide floodplain areas, it is not feasible to construct side channel or backwater channel habitats, and enhancement opportunities are generally quite limited. Main channel riffle construction, pool enhancement and LWD placements are proposed for this sub-reach. The following table and accompanying figures summarize design concepts developed for sub-reach 9a.

Project Code	Backwater Channel	Side Channel	Pool Enhancement	Riffle Enhancement	LWD	Winter Refuge Habitat	Bank Stabilization	Vegetation Management	Comments
M 30									Riffle Construction & Pool Enhancement

Table G2. Inventory of individual projects identified in sub-reach 9a.



Figure G5. Reach 9 sheet index for conceptual design detail sheets.



**LEGEND**

 MAIN CHANNEL AT 110 CFS

 GRADING

 RIFFLE CONSTRUCTION/ ENHANCEMENT

 EXISTING RIFFLE

SUB REACH 9 A  
CONCEPT DESIGN  
1 OF 1

Figure G6. Sub-reach 9a conceptual design detail sheet 1 of 1.

**Sub-Reach 9a Analysis of Proposed Enhancements**

Modest habitat enhancements will result from proposed conditions in sub-reach 9a. The construction of a riffle will create improved riffle and pool habitat in the main channel, including 3000 ft<sup>2</sup> of LWD-margin habitat for summer juvenile coho rearing. The following tables summarize the frequency and areas of existing vs. proposed habitat (Table G3), additional habitat to be created by enhancements (Table G4) and cost-based metrics (Table G5). Table G6 presents habitat enhancement areas normalized by sub-reach main channel length. Table G7 summarizes the planning level cost estimate developed for sub-reach 9a.

*Table G3. Habitat area by unit type for existing and proposed conditions in sub-reach 9a.*

Habitat	Existing Habitat		Proposed Habitat	
	Area (ft <sup>2</sup> )	#	Area (ft <sup>2</sup> )	#
Alcove / Backwater	0	0	0	0
Flatwater	36800	2	36800	2
Pool	39050	1	59350	4
Riffle	6950	2	18200	3
Side Channel	0	0	0	0

*Table G4. Additional coho rearing habitat provided by new alcoves and LWD placements.*

Habitat Type	(ft <sup>2</sup> )	(m <sup>2</sup> )
LWD-Margin Habitat (summer coho rearing)	3000	280
Pools	20300	1890
Riffles	11250	1050
<b>Total</b>	<b>34550</b>	<b>3210</b>

*Table G5. Cost-benefit table for design concepts presented for sub-reach 9a.*

Cost - Benefit Metric	Cost / ft <sup>2</sup>
Cost / ft <sup>2</sup> of summer coho rearing*	29
Cost / ft <sup>2</sup> of total enhanced habitat**	20

\*includes LWD-margin habitats

\*\*includes alcove/backwater, LWD-margin, pools and riffles

*Table G6. Length metrics showing habitat enhancement area divided by sub-reach main channel length for summer coho rearing and total enhanced habitats.*

Length Metric	area (ft <sup>2</sup> ) / length (ft)
Summer coho rearing habitat	2
Total enhanced habitat	19

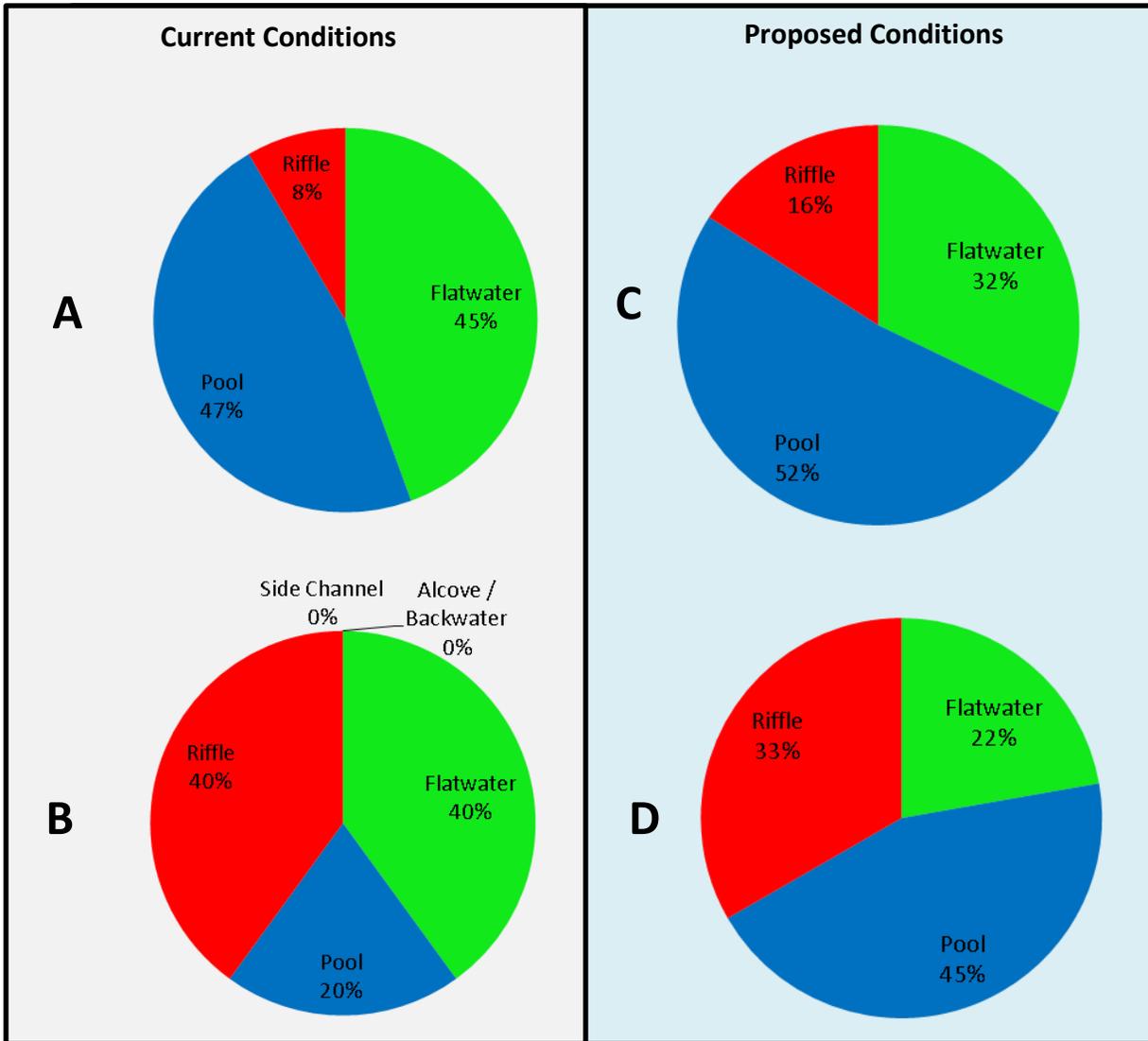


Figure G7. Existing habitats shown by area (A), frequency (B) and proposed habitat units based on area (C) and frequency (D).

Table G7. Sub-Reach 9a Planning Level Cost Estimate

Note: This is a preliminary cost estimate for planning purposes. Actual costs for design and construction activities may vary substantially from these estimates. Assumptions for time requirements and material quantities have been made based on limited information that is available for the site. Additional information obtained during site investigations will be needed to determine actual quantities and costs. Estimates based on 2011 costs.

No.	Description	Unit	Quantity	Unit Cost	Total Cost	Design and Quantity Assumptions						
1	Mobilization and Demobilization	LS	1	\$20,000	\$20,000	Calculated at 5% of construction sub-total.						
2	Site Access Measures	LS	1	\$20,000	\$20,000	Includes access road improvements, traffic control, dust control, and site restoration.						
3	Environmental Protection Measures	LS	1	\$110,000	\$110,000	Includes stream diversion/dewatering, fish relocation, and erosion control BMPs.						
4	Large Woody Debris (purchased, delivered, installed)											
a.	Pool Enhancement Logs	EA	30	\$1,150	\$34,500							
b.	Log Jams	EA	40	\$1,150	\$46,000							
5	Boulder Ballast (purchased, delivered, installed)	TN	70	\$100	\$7,000	Estimate 1 ton per log.						
6	Riffle Installation (purchased, delivered, installed)	CY	670	\$120	\$80,400	Assume average of 3 feet of depth per riffle for riffle construction. Assume average of 1.5 feet of depth per riffle for riffle enhancement.						
7	Vegetation Management	AC	6	\$20,000	\$120,000	Assumes area of floodplain from vineyard grade to vineyard grade minus the base flow inundation area of the main channel and of the proposed backwater habitat areas.						
<b>Construction Sub-Total</b>					<b>\$437,900</b>	<table border="1"> <tr> <td><b>Key</b></td> <td>LS = Lump Sum CY = Cubic Yard LF = Lineal Foot AC = Acre EA = Each</td> </tr> <tr> <td><b>Project Delivery Items are calculated as a percent of the construction sub-total</b></td> <td></td> </tr> <tr> <td><b>General Notes:</b></td> <td>-Cost includes a 30% design and construction contingency -Costs assume all materials (wood and rock) are purchased and hauled to the site from a nearby source -Boulder ballast requirements may be able to be reduced depending on hydraulics analysis</td> </tr> </table>	<b>Key</b>	LS = Lump Sum CY = Cubic Yard LF = Lineal Foot AC = Acre EA = Each	<b>Project Delivery Items are calculated as a percent of the construction sub-total</b>		<b>General Notes:</b>	-Cost includes a 30% design and construction contingency -Costs assume all materials (wood and rock) are purchased and hauled to the site from a nearby source -Boulder ballast requirements may be able to be reduced depending on hydraulics analysis
<b>Key</b>	LS = Lump Sum CY = Cubic Yard LF = Lineal Foot AC = Acre EA = Each											
<b>Project Delivery Items are calculated as a percent of the construction sub-total</b>												
<b>General Notes:</b>	-Cost includes a 30% design and construction contingency -Costs assume all materials (wood and rock) are purchased and hauled to the site from a nearby source -Boulder ballast requirements may be able to be reduced depending on hydraulics analysis											
Concept Level Design & Construction Contingency (30%)					\$131,370							
<b>Construction Total</b>					<b>\$569,300</b>							
<b>Project Delivery</b>												
Permitting (4%)					\$17,516							
Detailed Engineering Design (15%)					\$65,685							
Contract Administration (5%)					\$21,895							
Construction Oversight (1.5%)					\$6,569							
<b>Project Delivery Sub-Total</b>					<b>\$111,700</b>							
<b>TOTAL ESTIMATE</b>					<b>\$681,000</b>	rounded to nearest \$1,000						

**G.4 Sub-Reach 9b Conceptual Designs**

Reach 9b is relatively straight with a narrow floodplain, which makes the construction of summer off-channel habitat infeasible. There is enough floodplain area on the valley left side of the main channel to construct winter refuge habitat, to provide benefits to juvenile salmonids during frequently occurring winter flood flows. Main channel enhancements proposed include riffle construction, pool enhancement, and LWD placements. The following table summarizes design concepts created for sub-reach 9b. The following table and accompanying figures summarize the design concepts created for sub-reach 9b.

Project Code	Backwater Channel	Side Channel	Pool Enhancement	Riffle Enhancement	LWD	Winter Refuge Habitat	Bank Stabilization	Vegetation Management	Comments
M 30.1			X	X	X			X	Riffle Construction & Pool Enhancement
OC 30.1 L					X	X	X	X	Winter Refuge Habitat
M 30.2			X	X	X			X	Riffle & Pool Enhancement
OC 30.2 L					X	X	X	X	Winter Refuge Habitat
M 30.3			X	X	X			X	Riffle Construction & Pool Enhancement

Table G8. Inventory of projects identified in sub-reach 9b.

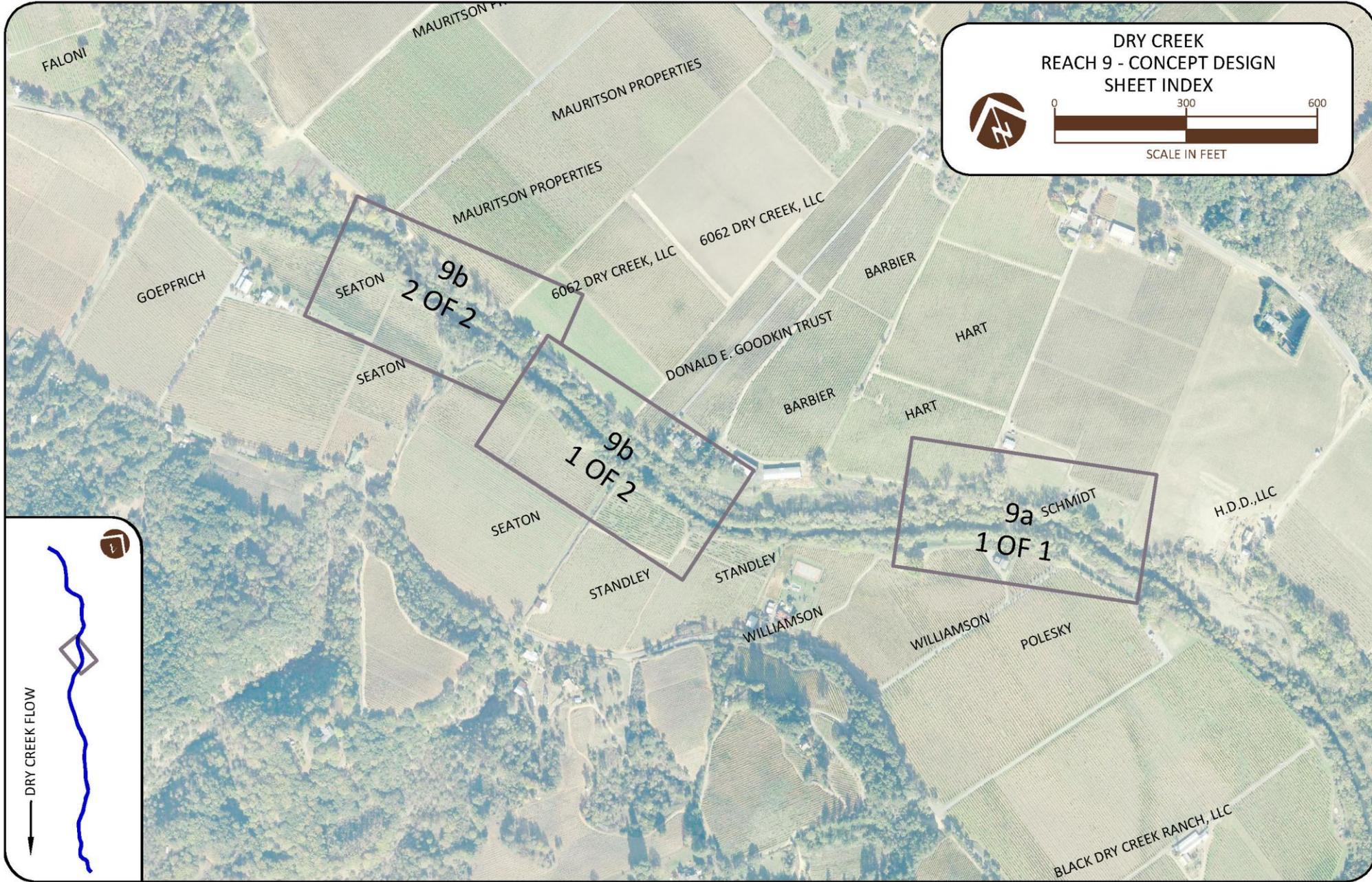
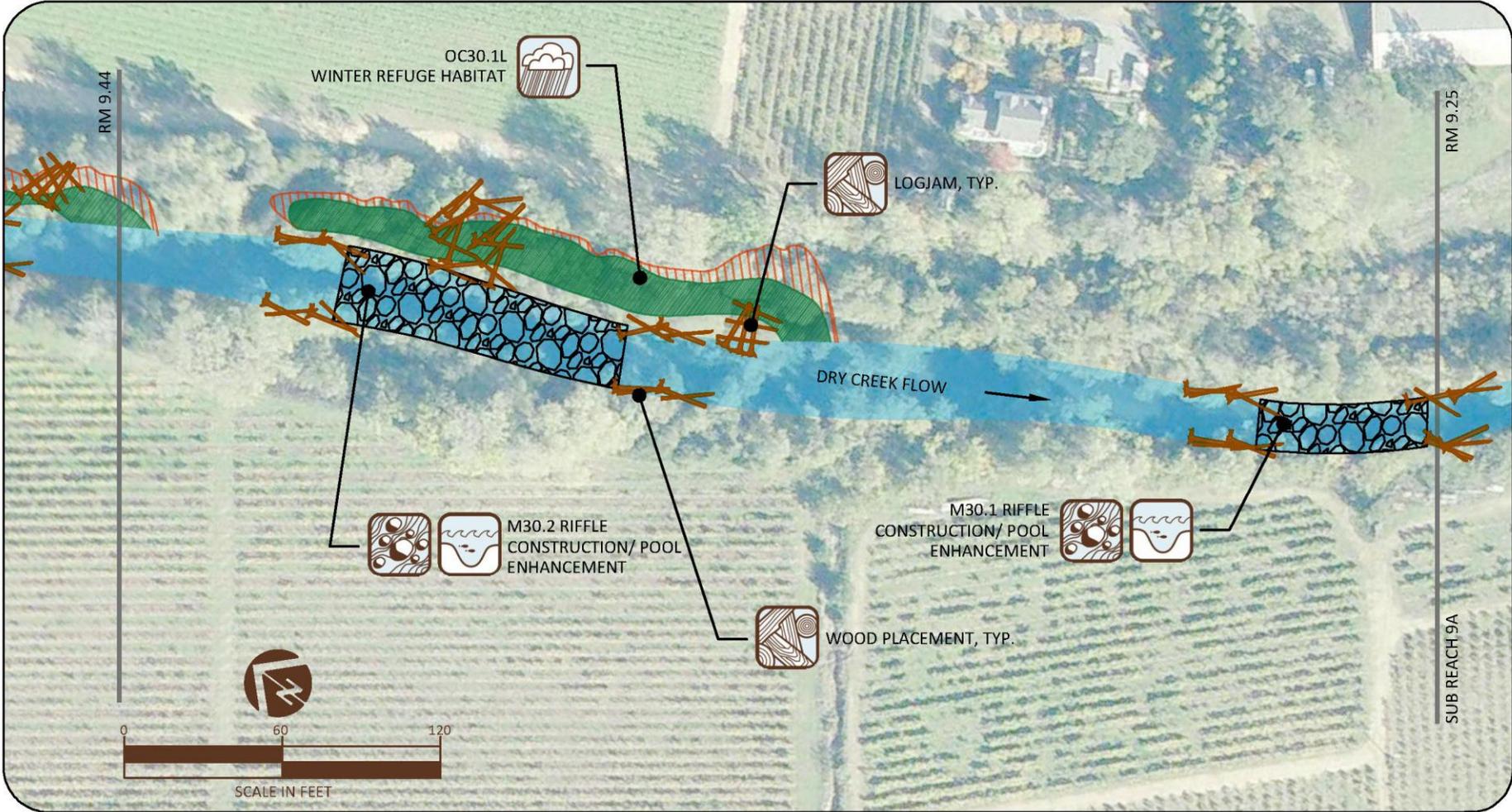


Figure G8. Reach 9 sheet index for conceptual design detail sheets.



**LEGEND**

MAIN CHANNEL AT 110 CFS

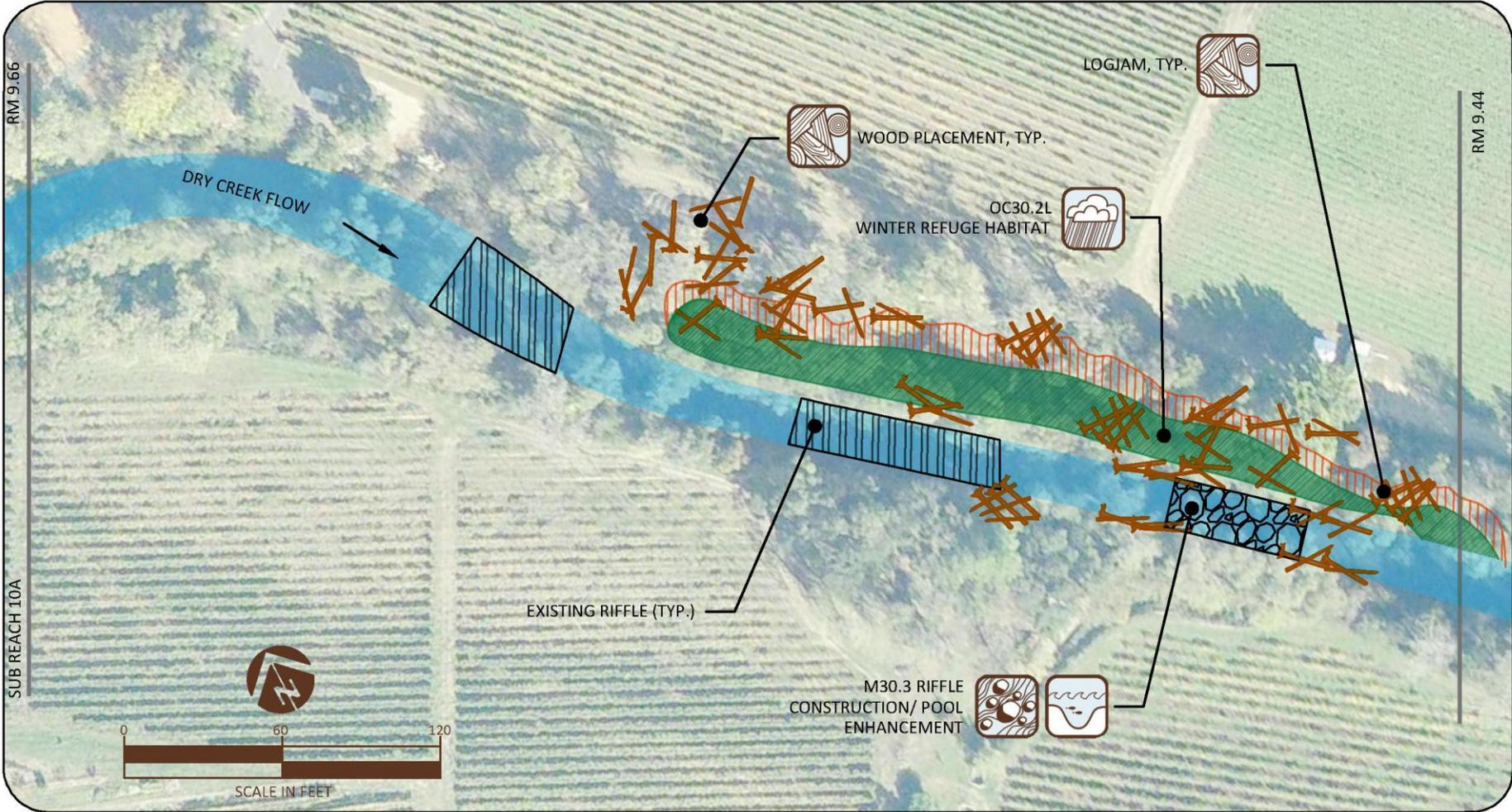
GRADING LIMIT

RIFFLE CONSTRUCTION/ ENHANCEMENT

WINTER REFUGE

SUB REACH 9 B  
CONCEPT DESIGN  
1 OF 2

Figure G9. Sub-reach 9b conceptual design detail 1 of 2.  
Dry Creek Conceptual Design Report



**LEGEND**

-   
 MAIN CHANNEL AT  
110 CFS
-   
 GRADING LIMIT
-   
 RIFFLE CONSTRUCTION/  
ENHANCEMENT
-   
 EXISTING RIFFLE
-   
 WINTER REFUGE

SUB REACH 9 B  
CONCEPT DESIGN  
2 OF 2

Figure G10. Sub-reach 9b conceptual design detail 2 of 2.

**Sub-Reach 9b Analysis of Proposed Enhancements**

Proposed enhancements will create nearly 70,000 ft<sup>2</sup> of additional habitat in sub-reach 9b. The majority of this habitat will serve as high quality juvenile rearing habitat during winter flood events – over 50,000 ft<sup>2</sup> of winter refuge. Additionally, riffle construction and LWD placements in the main channel will provide habitat benefits to the target species. The following tables summarize the frequency and areas of existing vs. proposed habitat (Table G9), additional habitat to be created by enhancements (Table G10) and cost-based metrics (Table G11). Table G12 presents habitat enhancement areas normalized by sub-reach main channel length. Table G13 summarizes the planning level cost estimate developed for sub-reach 9b.

Table G9. Habitat units based on existing and proposed conditions.

Habitat	Existing Habitat		Proposed Habitat	
	Area (ft <sup>2</sup> )	#	Area (ft <sup>2</sup> )	#
Alcove / Backwater	650	1	650	1
Flatwater	38700	3	8750	1
Pool	79100	2	77950	4
Riffle	31300	3	43650	5
Side Channel	0	0	0	0
Winter Refuge	0	0	50950	2

Table G10. Additional habitat provided by backwater, LWD-margin, side channels and riffle habitat

Habitat Type	(ft <sup>2</sup> )	(m <sup>2</sup> )
LWD-Margin Habitat (summer coho rearing)	6000	560
Winter Refuge (winter coho rearing)	50950	4730
Riffles	12350	1150
<b>Total</b>	<b>69300</b>	<b>6440</b>

Table G11. Cost – benefit table for design concepts presented for sub-reach 9b

Cost - Benefit Metric	Cost/ft <sup>2</sup>
Cost / ft <sup>2</sup> of summer coho rearing*	910
Cost / ft <sup>2</sup> of winter coho rearing**	96
Cost / ft <sup>2</sup> of total enhanced habitat***	79

\*includes LWD-margin habitats

\*\*includes alcove/backwater, LWD-margin, and winter refuge habitats

\*\*\*includes alcove/backwater, LWD-margin, pools and riffles

Table G12. Length metrics showing habitat enhancement area divided by sub-reach main channel length for summer coho rearing, winter coho rearing and total enhanced habitats.

Length Metric	area (ft <sup>2</sup> )/ length (ft)
Summer coho rearing habitat	3
Winter coho rearing habitat	24
Total enhanced habitat	30

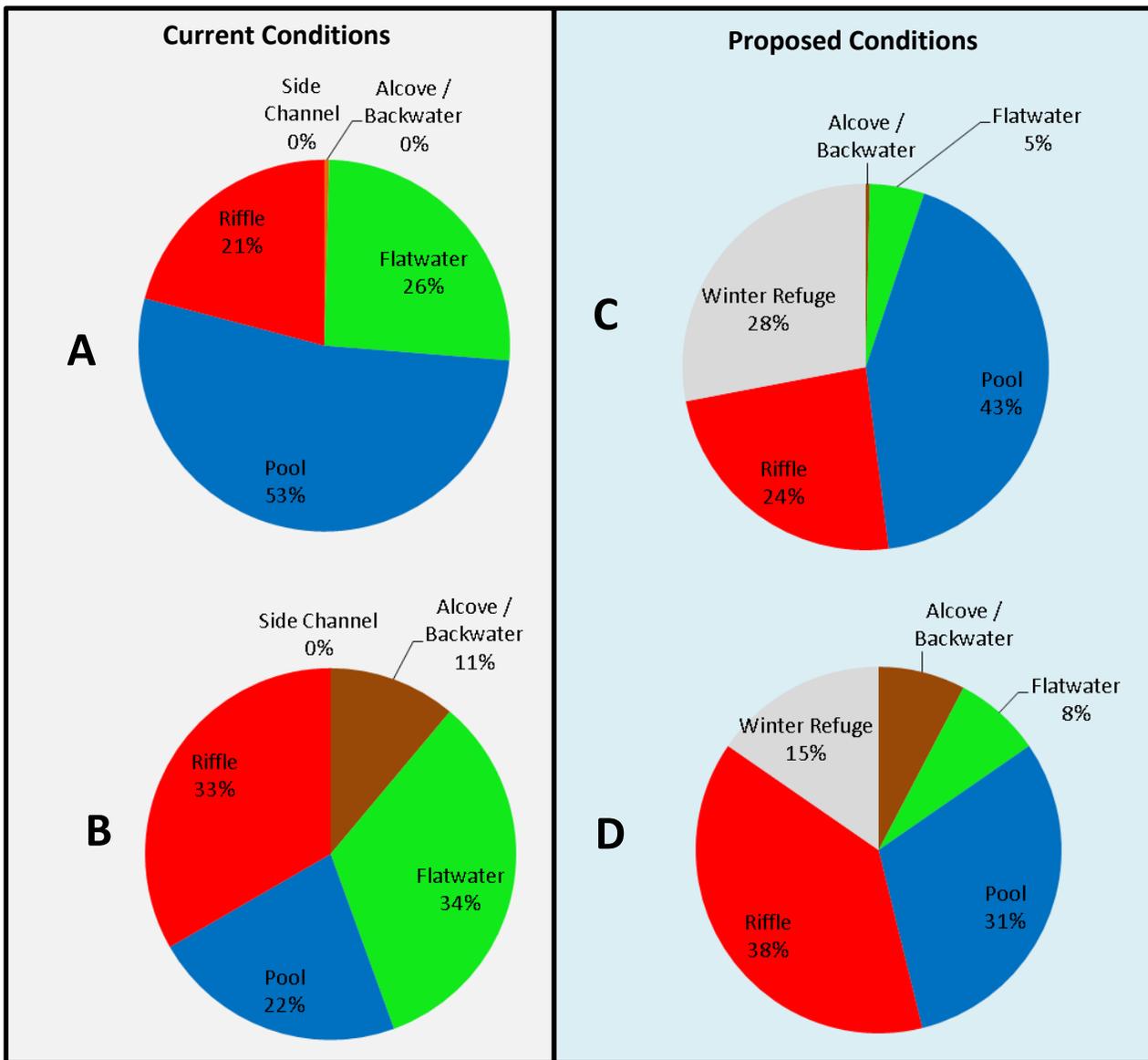


Figure G11. Existing sub-reach 9b habitats shown by area (A), frequency (B) and proposed habitat units based on area (C) and frequency (D).

Table G13. Sub-reach 9b Planning Level Cost Estimate

Note: This is a preliminary cost estimate for planning purposes. Actual costs for design and construction activities may vary substantially from these estimates. Assumptions for time requirements and material quantities have been made based on limited information that is available for the site. Additional information obtained during site investigations will be needed to determine actual quantities and costs. Estimates based on 2011 costs.

No.	Description	Unit	Quantity	Unit Cost	Total Cost	Design and Quantity Assumptions
1	Mobilization and Demobilization	LS	1	\$170,000	\$170,000	Calculated at 5% of construction sub-total.
2	Site Access Measures	LS	1	\$160,000	\$160,000	Includes access road improvements, traffic control, dust control, and site restoration.
3	Environmental Protection Measures	LS	1	\$830,000	\$830,000	Includes stream diversion/dewatering, fish relocation, and erosion control BMPs.
4	Clearing and Grubbing	AC	1	\$2,000	\$2,000	
5	Common Excavation					
a.	OC 30.2	CY	3,850	\$20	\$77,000	Final design criteria and analysis will likely alter these estimates up or down.
b.	OC 30.1	CY	480	\$20	\$9,600	
6	Large Woody Debris (purchased, delivered, installed)					
a.	Floodplain Roughness Logs	EA	20	\$1,150	\$23,000	Assumes 30% delivered with root wads attached.
b.	Backwater Habitat Logs	EA	160	\$1,150	\$184,000	
c.	Pool Enhancement Logs	EA	96	\$1,150	\$110,400	
d.	Log Jams	EA	200	\$1,150	\$230,000	
7	Boulder Ballast (purchased, delivered, installed)	TN	476	\$100	\$47,600	Estimate 1 ton per log.
8	Bank Stabilization	LF	1,286	\$1,000	\$1,286,000	Bank stabilization methods will vary but will include one or more of the following components: large woody debris, earthwork, riprap scour protection, granular backfill, aggregate filter material, geotextile fabric, and/or fabric encapsulated soil lifts. Assumes 30% delivered with root wads attached.
9	Riffle Installation (purchased, delivered, installed)	CY	2,000	\$120	\$240,000	Assume average of 3 feet of depth per riffle for riffle construction. Assume average of 1.5 feet of depth per riffle for riffle enhancement.
9	Vegetation Management	AC	7	\$20,000	\$140,000	Assumes area of floodplain from vineyard grade to vineyard grade minus the base flow inundation area of the main channel and of the proposed backwater habitat areas.
<b>Construction Sub-Total</b>					<b>\$3,509,600</b>	<div style="display: flex; justify-content: space-between;"> <div style="border: 1px solid black; padding: 5px;"> <p><b>Key</b>                      LS = Lump Sum                      CY = Cubic Yard                      LF = Lineal Foot                      AC = Acre                      EA = Each</p> </div> <div style="border: 1px solid black; padding: 5px;"> <p><b>Project Delivery Items are calculated as a percent of the construction sub-total</b>  <b>General Notes:</b>                      -Cost includes a 30% design and construction contingency                      -Costs assume all materials (wood and rock) are purchased and hauled to the site from a nearby source                      -Boulder ballast requirements may be able to be reduced depending on hydraulics analysis</p> </div> </div>
Concept Level Design & Construction Contingency (30%)					\$1,052,880	
<b>Construction Total</b>					<b>\$4,562,500</b>	
<b>Project Delivery</b>						
Permitting (4%)					\$140,384	
Detailed Engineering Design (15%)					\$526,440	
Contract Administration (5%)					\$175,480	
Construction Oversight (1.5%)					\$52,644	
<b>Project Delivery Sub-Total</b>					<b>\$894,900</b>	
<b>TOTAL ESTIMATE</b>					<b>\$5,457,000</b>	

## APPENDIX H

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**H.1 Reach 8 Description**

Reach 8 is a single-thread section of Dry Creek extending 1.5 miles upstream from the Grape Creek confluence to river mile 9. The channel has incised and narrowed since 1940 but has remained largely stable for about half of the reach. Near the upstream reach boundary, where an unnamed tributary enters, moderate channel migration has occurred since the 1940s. Planform has remained constant throughout the reach since the construction of WSD. Significant bank protection installation has occurred in reach 8 over the years. Approximately 2500 ft of banks have been armored using riprap and old vehicle parts, and board fence has been installed over 750 ft. See the Dry Creek Current Conditions Report (Inter-Fluve 2010), Appendix A, for additional detail.

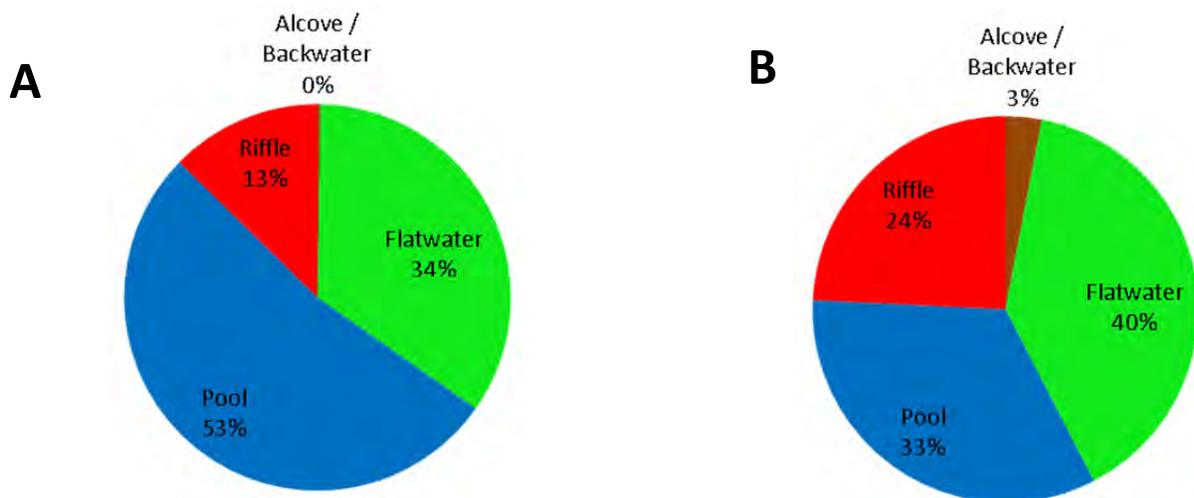


**Reach 8 Current Habitat Conditions**

Table H1. Reach 8 habitat units based on current conditions.

Habitat	Existing Habitat	
	Area (ft <sup>2</sup> )	#
Alcove / Backwater	1150	1
Flatwater	142200	13
Pool	216950	10
Riffle	52200	8
Side Channel	0	0

Figure H1. Habitat units in reach 8 based on area (A) and frequency (B).



## H.2 Reach 8 Restoration Approach

Reach 8 falls in the “middle segment<sup>1</sup>” of Dry Creek, characterized by the increased sediment and surface water contributed by tributaries. In this segment, Dry Creek begins to have a more significant sediment supply due to the influence of unregulated tributaries. Enhancements in reach 8 will have to consider potential consequences of the larger sediment supplied by tributaries. The relatively large floodplain areas lend themselves to off-channel habitat development in reach 8. The main channel is straight, with plenty of floodplain on either side. Re-meandering a 1000 ft section of the main channel will allow for increased off-channel habitat enhancement. Off-channel habitat enhancement will include backwater channels and winter refuge habitat, providing both summer and winter coho rearing habitat. Main channel enhancements include riffle construction, pool enhancement, LWD-margin habitat, and a main channel re-meander project. For purposes of enhancement planning, reach 8 has been split into 2 enhancement sub-reaches (Figure H4). Sub-reach 8a (RM 7.42 to 7.99) is described in section H.3, and sub-reach 8b (RM 7.99 to 8.86) is described in section H.4.

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<sup>1</sup>Additional detail of process-based delineation of lower Dry Creek into upper, middle and lower segments can be found in the Fish Habitat Enhancement Feasibility Study, Section 5.3, IFI 2011



Figure H2. Reach 8 habitat units and sub-reach boundaries.

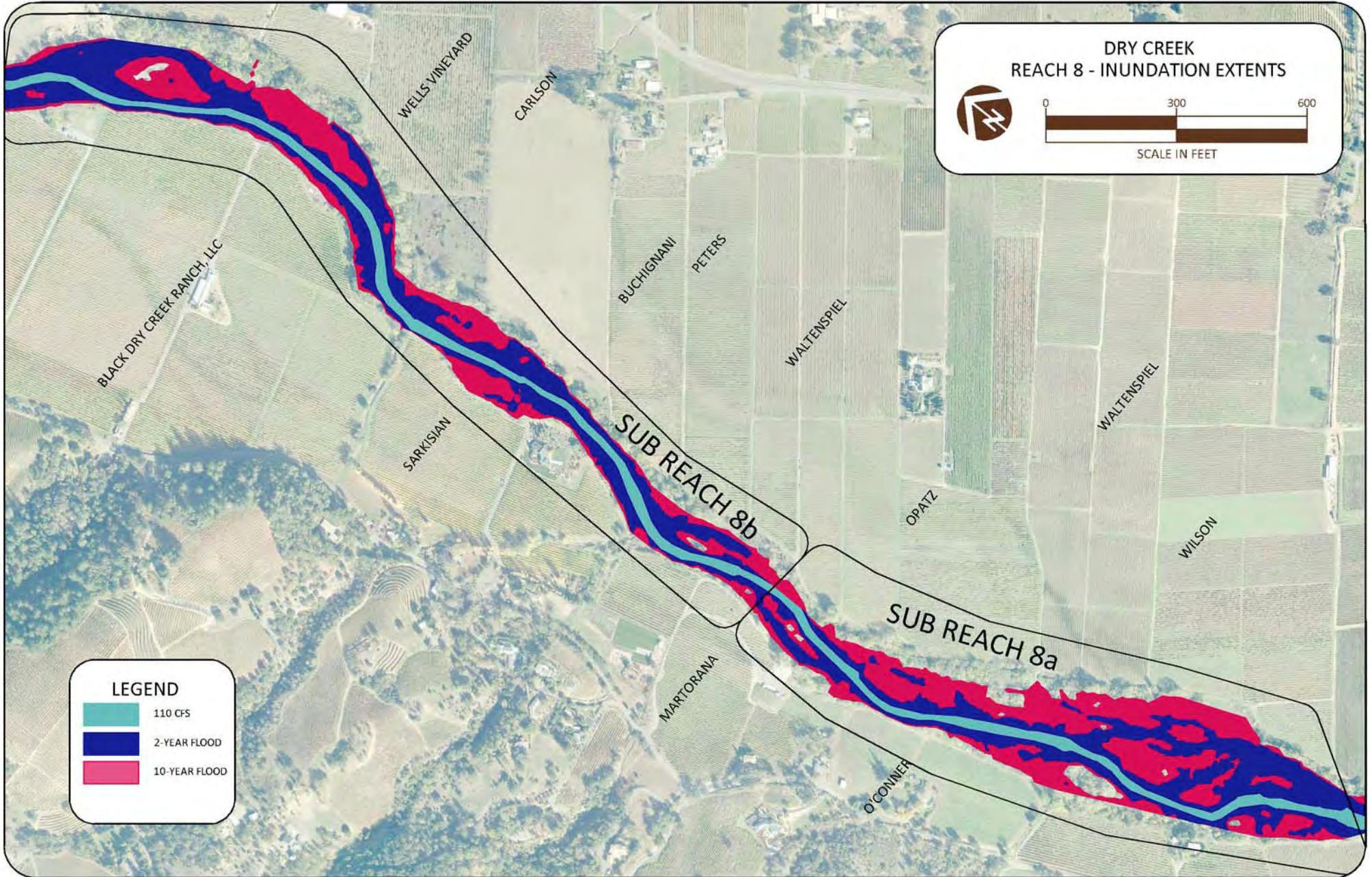


Figure H3. Modeled inundations in reach 8 based on three specific discharge levels: 110 cfs, the 2-year and 10-year flood events.

**H.3 Sub-Reach 8a Conceptual Designs**

Sub-reach 8a is characterized by relatively wide sections of floodplain, providing opportunities for off-channel habitat enhancements. In order to maximize off-channel habitat development, a main channel re-meander project is proposed in sub-reach 8a. The main channel re-meander project will increase channel length, create more habitat diversity, and allow multiple off-channel habitats to link up to the new main channel alignment. Re-aligning the main channel will both improve main-stem habitat while setting up the planform of the channel in a way that maximizes off-channel habitat development. The upstream portion of sub-reach 8a has a large floodplain area where a winter refuge habitat enhancement is proposed, in addition to a small backwater channel. The following table and accompanying figures summarize the design concepts developed for sub-reach 8a.

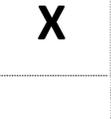
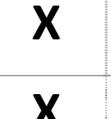
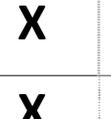
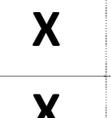
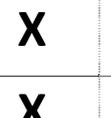
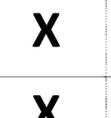
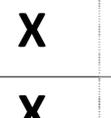
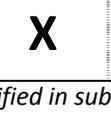
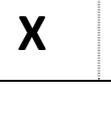
Project Code	Backwater Channel	Side Channel	Pool Enhancement	Riffle Enhancement	LWD	Winter Refuge Habitat*	Bank Stabilization	Vegetation Management	Comments
M 24.1									Riffle & Pool Enhancement
M 24									Re-meander Main Channel, Riffle Construction, pool Enhancements
OC 24.1 R									Backwater Channel Construction
OC 24.11R									Winter Refuge Habitat
OC 24.2L									Backwater Channel Construction
M 24.2									Riffle Construction & Pool Enhancement
OC 24.3L									Winter Refuge Habitat
M 24.3									Riffle Construction & Pool Enhancement

Table H2. Inventory of individual projects identified in sub-reach 8a.

Project Code	Backwater Channel	Side Channel	Pool Enhancement	Riffle Enhancement	LWD	Winter Refuge Habitat*	Bank Stabilization	Vegetation Management	Comments
M 25			X	X	X			X	Riffle & Pool Enhancement
OC 25R	X				X		X	X	Backwater Channel Construction

Table H2 (continued). Inventory of individual projects identified in sub-reach 8a.

\* Backwater channel habitats will also provide winter refuge, and available off-channel habitat for juvenile salmonids will become large as flows increase during winter storms.



Figure H4. Reach 8 sheet index for conceptual design detail sheets.

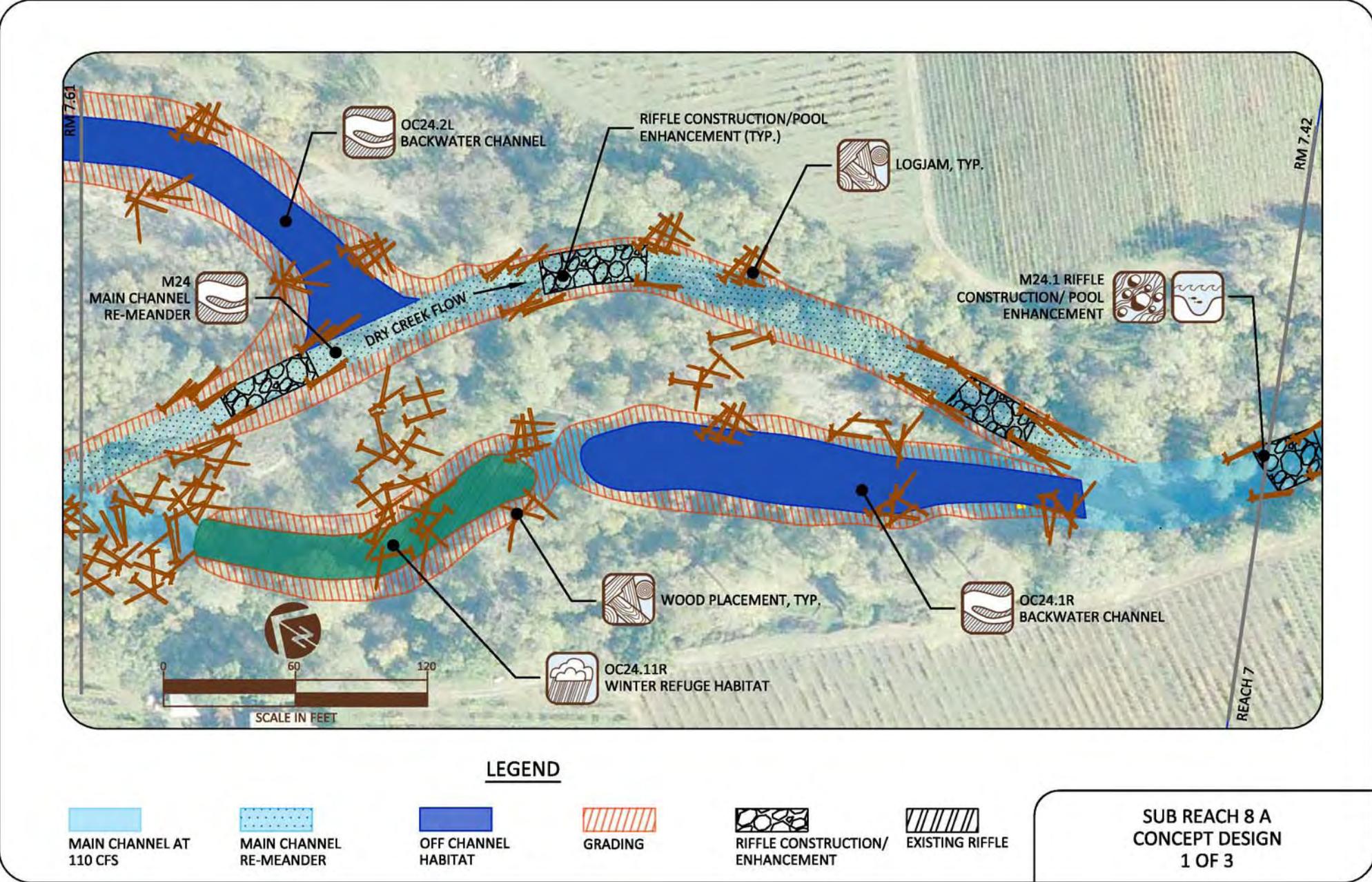


Figure H5. Sub-reach 8a conceptual design detail sheet 1 of 3.

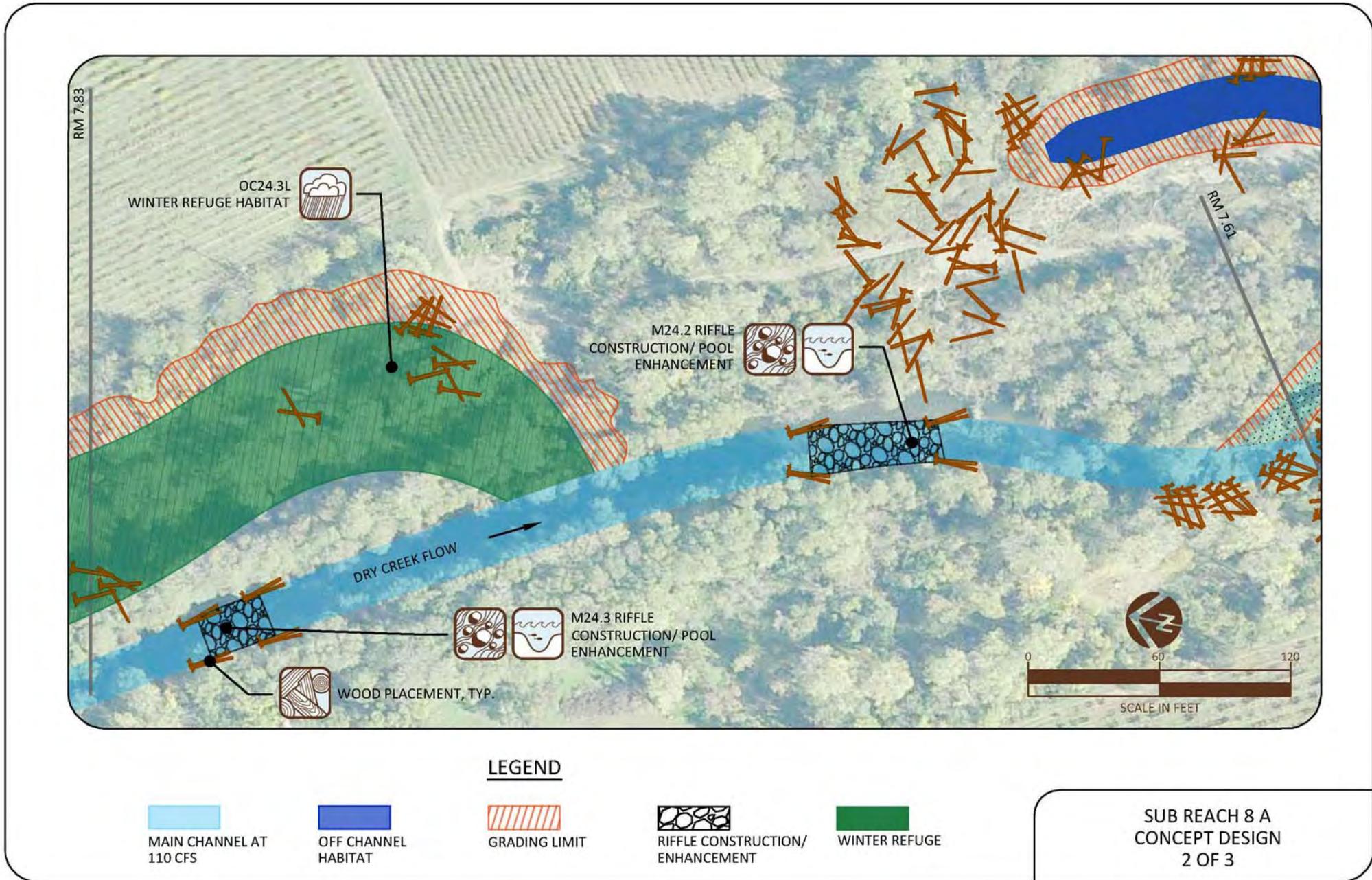


Figure H6. Sub-reach 8a conceptual design detail sheet 2 of 3.

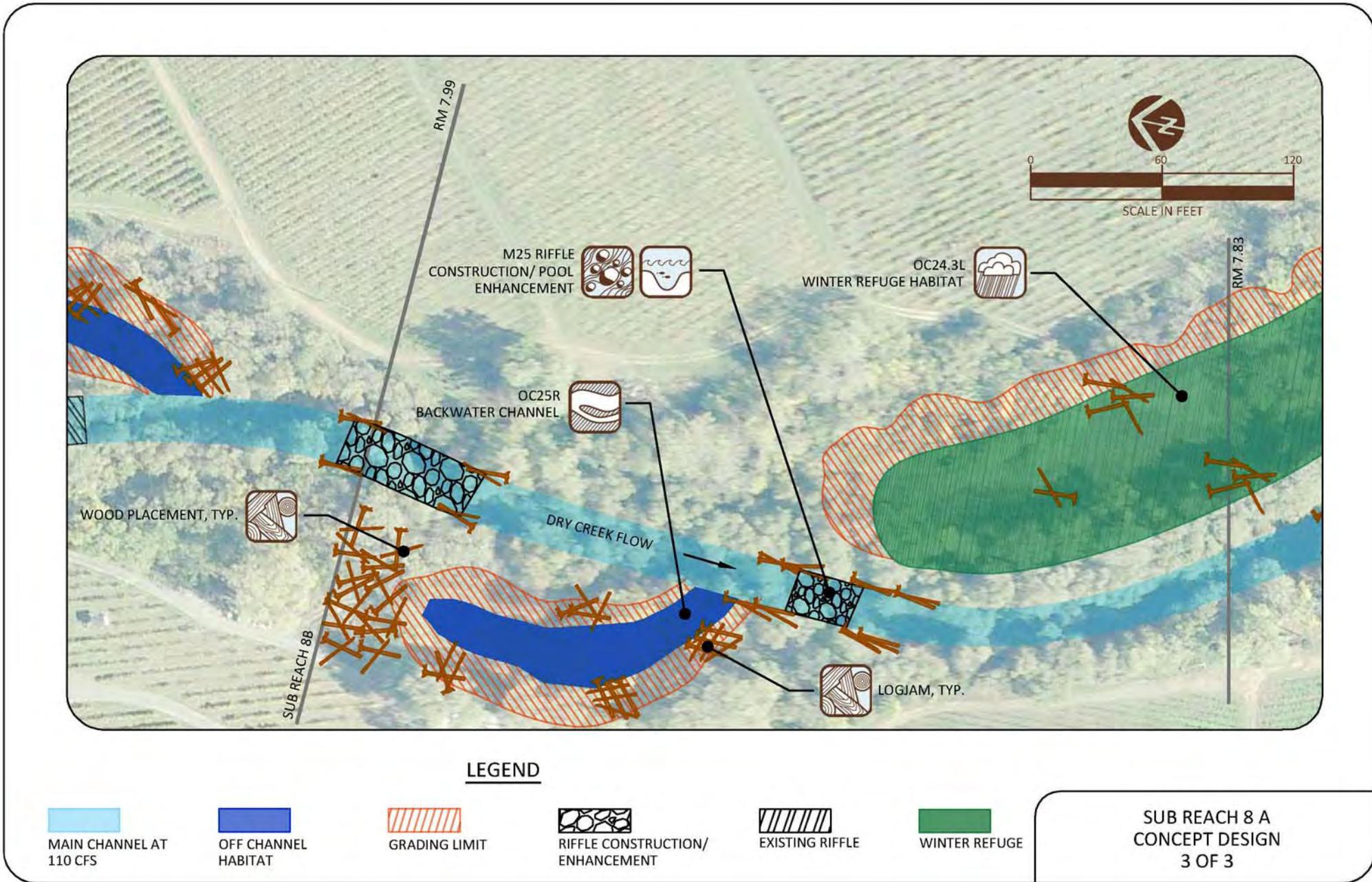


Figure H7. Sub-reach 8a conceptual design detail sheet 3 of 3.

**Sub-Reach 8a Analysis of Proposed Enhancements**

Proposed enhancements in sub-reach 8a will create 59,000 ft<sup>2</sup> of additional summer coho rearing habitat. Two winter refuge habitat enhancements will create an additional 180,000 ft<sup>2</sup> of winter coho rearing habitat. Main channel enhancements will create an additional 12,500 ft<sup>2</sup> of riffle habitat in sub-reach 8a. Main channel and off-channel habitat diversity will be greatly increased based on proposed conditions in sub-reach 8a. The following tables summarize the frequency and areas of existing vs. proposed habitat (Table H3), additional habitat to be created by enhancements (Table H4) cost-based metrics (Table H5). Table H6 present the habitat enhancements normalized by main channel sub-reach length. Table H7 summarizes the planning level cost estimate developed for sub-reach 8a.

Table H3. Habitat area by unit type for existing and proposed conditions in sub-reach 8a.

Habitat	Existing Habitat		Proposed Habitat	
	Area (ft <sup>2</sup> )	#	Area (ft <sup>2</sup> )	#
Alcove / Backwater	1150	1	46150	4
Flatwater	51800	4	0	0
Pool	92850	5	119300	10
Riffle	15050	2	27550	6
Side Channel	0	0	0	0
Winter Refuge	0	0	168150	2

Table H4. Additional coho rearing habitat provided by new alcoves and LWD placements.

Habitat Type	(ft <sup>2</sup> )	(m <sup>2</sup> )
Alcove/Backwater (summer coho rearing)	45000	4180
LWD-Margin Habitat (summer coho rearing)	14000	1300
Winter Refuge (winter coho rearing)	181900	16900
Riffles	12500	1160
<b>Total</b>	<b>253400</b>	<b>23540</b>

Table H5. Cost-benefit table for design concepts presented for sub-reach 8a.

Cost - Benefit Metric	Cost / ft <sup>2</sup>
Cost / ft <sup>2</sup> of summer coho rearing*	232
Cost / ft <sup>2</sup> of winter coho rearing**	57
Cost / ft <sup>2</sup> of total enhanced habitat***	54

\*includes backwater and LWD-margin habitats

\*\*includes alcove/backwater, LWD-margin, and winter refuge habitats

\*\*\*includes alcove/backwater, LWD-margin, and riffles

Table H6. Length metric table showing habitat area divided by main channel sub-reach length.

Length Metric	area (ft <sup>2</sup> )/ length (ft)
Summer coho rearing habitat	19
Winter coho rearing habitat	78
Total enhanced habitat	82

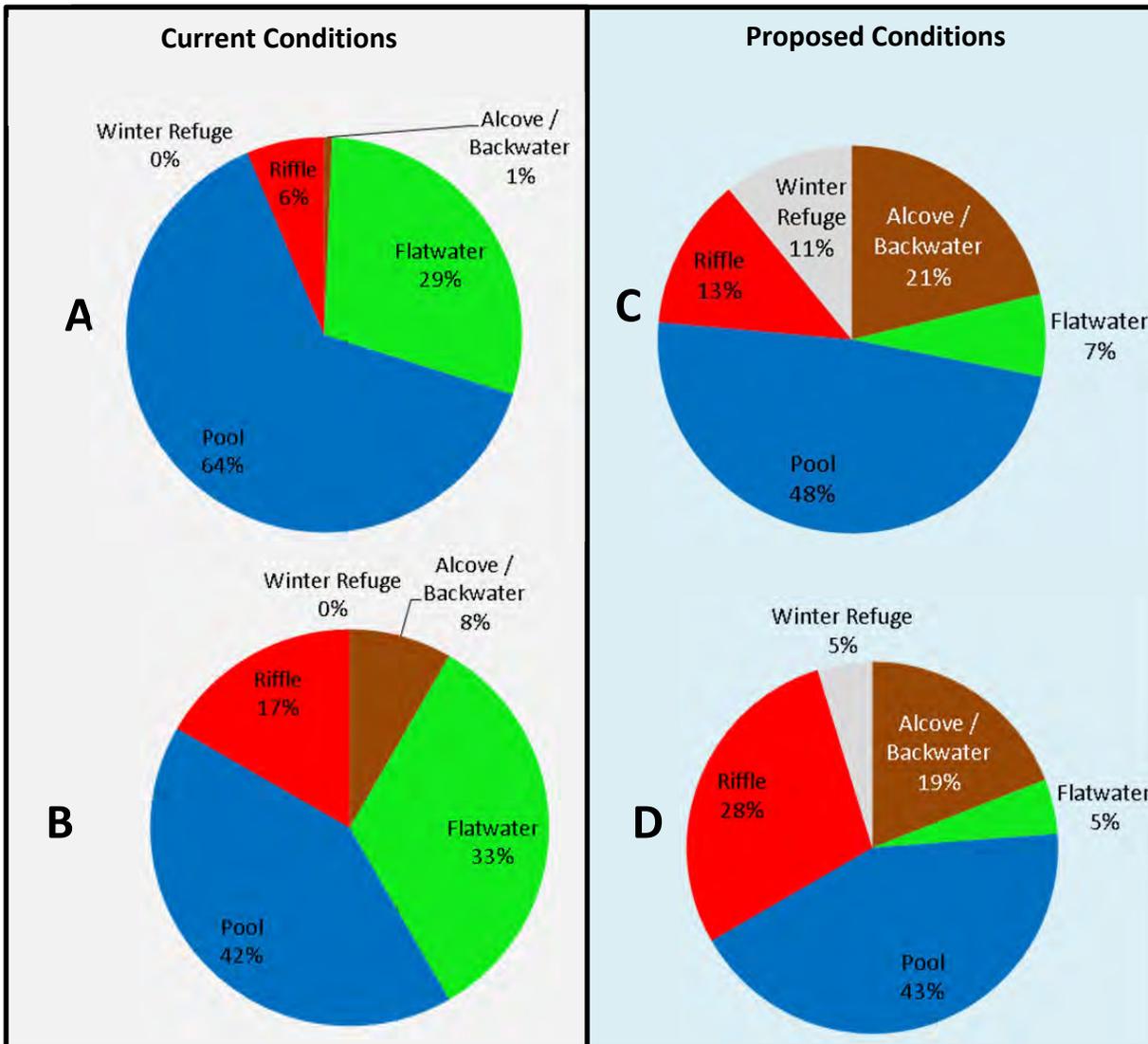


Figure H8. Existing habitats shown by area (A), frequency (B) and proposed habitat units based on area (C) and frequency (D).

**Sub-Reach 8a Alternatives Discussion**

The group of enhancements for sub-reach 8a was chosen to maximize habitat benefits. Alternatives should be considered, but may provide fewer habitat benefits. As an alternative to re-meandering the main channel (M24), a side channel could be constructed in the valley left floodplain area with a backwater channel connecting to the sidechannel. As a second alternative, a complex of smaller alcoves could be constructed in the valley left floodplain, connecting to the current main channel alignment.

Table H7. Sub-Reach 8a Planning Level Cost Estimate.

Note: This is a preliminary cost estimate for planning purposes. Actual costs for design and construction activities may vary substantially from these estimates. Assumptions for time requirements and material quantities have been made based on limited information that is available for the site. Additional information obtained during site investigations will be needed to determine actual quantities and costs. Estimates based on 2011 costs.

No.	Description	Unit	Quantity	Unit Cost	Total Cost	Design and Quantity Assumptions
1	Mobilization and Demobilization	LS	1	\$430,000	\$430,000	Calculated at 5% of construction sub-total.
2	Site Access Measures	LS	1	\$410,000	\$410,000	Includes access road improvements, traffic control, dust control, and site restoration.
3	Environmental Protection Measures	LS	1	\$2,090,000	\$2,090,000	Includes stream diversion/dewatering, fish relocation, and erosion control BMPs.
4	Clearing and Grubbing	AC	9	\$2,000	\$18,000	
5	Common Excavation					
a.	OC 25	CY	6,950	\$20	\$139,000	Final design criteria and analysis will likely alter these estimates up or down.
b.	OC 24.3	CY	33,280	\$20	\$665,600	
c.	OC 24.2	CY	13,630	\$20	\$272,600	
d.	OC 24.1	CY	10,080	\$20	\$201,600	
e.	M 24	CY	7,440	\$20	\$148,800	
6	Large Woody Debris (purchased, delivered, installed)					
a.	Floodplain Roughness Logs	EA	270	\$1,150	\$310,500	Assumes 30% delivered with root wads attached.
b.	Backwater Habitat Logs	EA	1,100	\$1,150	\$1,265,000	
c.	Pool Enhancement Logs	EA	190	\$1,150	\$218,500	
d.	Log Jams	EA	560	\$1,150	\$644,000	
7	Boulder Ballast (purchased, delivered, installed)	TN	2,120	\$100	\$212,000	Estimate 1 ton per log.
8	Bank Stabilization	LF	940	\$1,000	\$940,000	Bank stabilization methods will vary but will include one or more of the following components: large woody debris, earthwork, riprap scour protection, granular backfill, aggregate filter material, geotextile fabric, and/or fabric encapsulated soil lifts. Assumes 30% delivered with root wads attached.
9	Riffle Installation (purchased, delivered, installed)	CY	3,670	\$120	\$440,400	Assume average of 3 feet of depth per riffle for riffle construction. Assume average of 1.5 feet of depth per riffle for riffle enhancement.
10	Vegetation Management	AC	20	\$20,000	\$400,000	Assumes area of floodplain from vineyard grade to vineyard grade minus the base flow inundation area of the main channel and of the proposed backwater habitat areas.
<b>Construction Sub-Total</b>					<b>\$8,806,000</b>	<div style="display: flex; justify-content: space-between;"> <div style="border: 1px solid black; padding: 5px;"> <p><b>Key</b>                      LS = Lump Sum                      CY = Cubic Yard                      LF = Lineal Foot                      AC = Acre                      EA = Each</p> </div> <div style="border: 1px solid black; padding: 5px;"> <p><b>Project Delivery Items are calculated as a percent of the construction sub-total</b>  <b>General Notes:</b>                      -Cost includes a 30% design and construction contingency                      -Costs assume all materials (wood and rock) are purchased and hauled to the site from a nearby source                      -Boulder ballast requirements may be able to be reduced depending on hydraulics analysis</p> </div> </div>
Concept Level Design & Construction Contingency (30%)					\$2,641,800	
<b>Construction Total</b>					<b>\$11,447,800</b>	
<b>Project Delivery</b>						
Permitting (4%)					\$352,240	
Detailed Engineering Design (15%)					\$1,320,900	
Contract Administration (5%)					\$440,300	
Construction Oversight (1.5%)					\$132,090	
<b>Project Delivery Sub-Total</b>					<b>\$2,245,500</b>	
<b>TOTAL ESTIMATE</b>					<b>\$13,693,000</b>	

rounded to nearest \$1,000

**H.4 Sub-Reach 8b Conceptual Designs**

Sub-reach 8b is a 4500 foot sub-reach with moderate sinuosity of the main channel. Relatively large floodplain areas are available for off-channel habitat development. Backwater channels are proposed on wide floodplain surfaces found on the inside of meander bends. A combination of main channel and off-channel enhancements are proposed to increase the quantity and quality of habitat in sub-reach 8b. The following table and accompanying figures summarize the design concepts developed for sub-reach 8b.

Project Code	Backwater Channel	Side Channel	Pool Enhancement	Riffle Enhancement	LWD	Winter Refuge Habitat*	Bank Stabilization	Vegetation Management	Comments
M 26.1			X	X	X			X	Riffle Construction & Pool Enhancement
OC 26.1 L	X				X		X	X	Backwater Channel Construction
M 26.2			X	X	X			X	Riffle Construction & Pool Enhancement
M 27			X	X	X			X	Riffle & Pool Enhancement
OC 27.1L	X				X		X	X	Backwater Channel Construction
OC 27.2R	X				X		X	X	Backwater Channel Enhancement
M 28.1			X	X	X			X	Riffle & Pool Enhancement
OC 28L	X				X		X	X	Backwater Channel Construction

Table H8. Inventory of projects identified in sub-reach 8b.

Project Code	Backwater Channel	Side Channel	Pool Enhancement	Riffle Enhancement	LWD	Winter Refuge Habitat*	Bank Stabilization	Vegetation Management	Comments
M 28.2			X	X	X			X	Riffle Construction & Pool Enhancement
M 29.1			X	X	X			X	Riffle Construction & Pool Enhancement
OC 29L	X				X		X	X	Backwater Channel Construction
M 29.2			X	X	X			X	Riffle Construction & Pool Enhancement

Table H8 (continued). Inventory of projects identified in sub-reach 8b.

\* Backwater channel habitats will also provide winter refuge, and available off-channel habitat for juvenile salmonids will become large as flows increase during winter storms.



Figure H9. Reach 8 sheet index for conceptual design detail sheets.

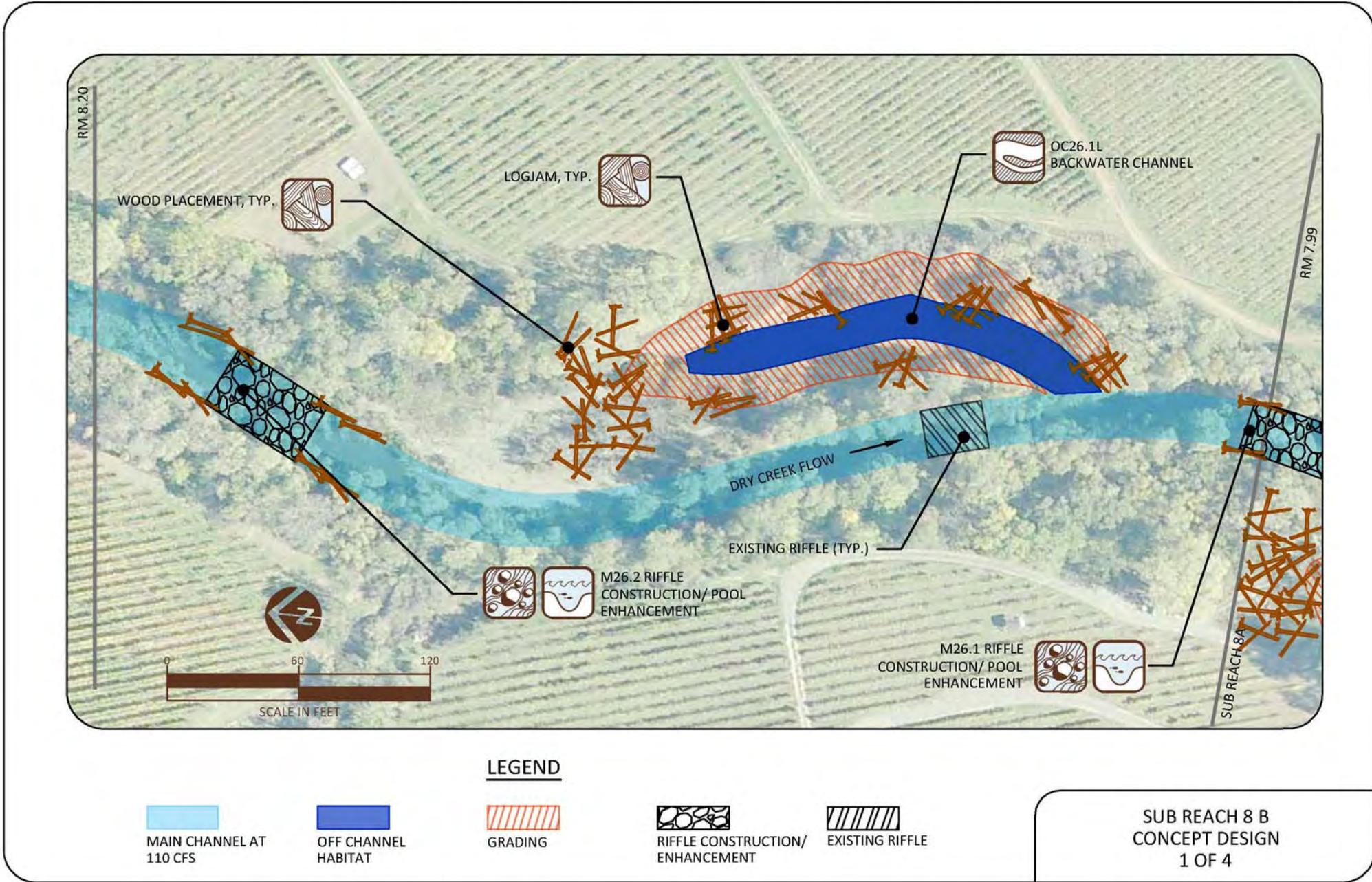
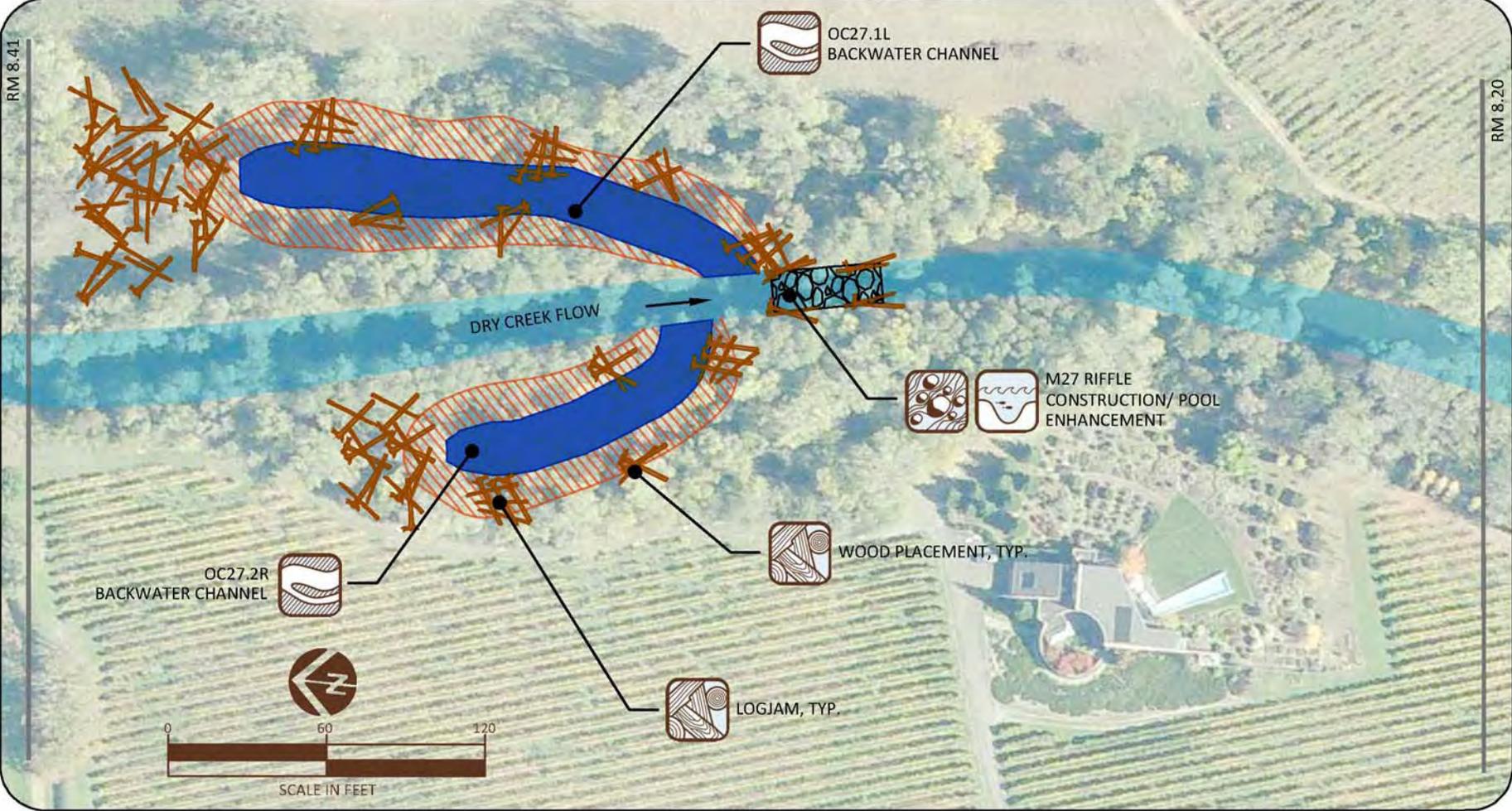
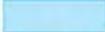


Figure H10. Sub-reach 8b concept design detail sheet 1 of 4.



LEGEND

-   
 MAIN CHANNEL AT  
110 CFS
-   
 OFF CHANNEL  
HABITAT
-   
 GRADING LIMIT
-   
 RIFFLE CONSTRUCTION/  
ENHANCEMENT

SUB REACH 8 B  
CONCEPT DESIGN  
2 OF 4

Figure H11. Sub-reach 8b conceptual design detail sheet 2 of 4.  
 Dry Creek Conceptual Design Report

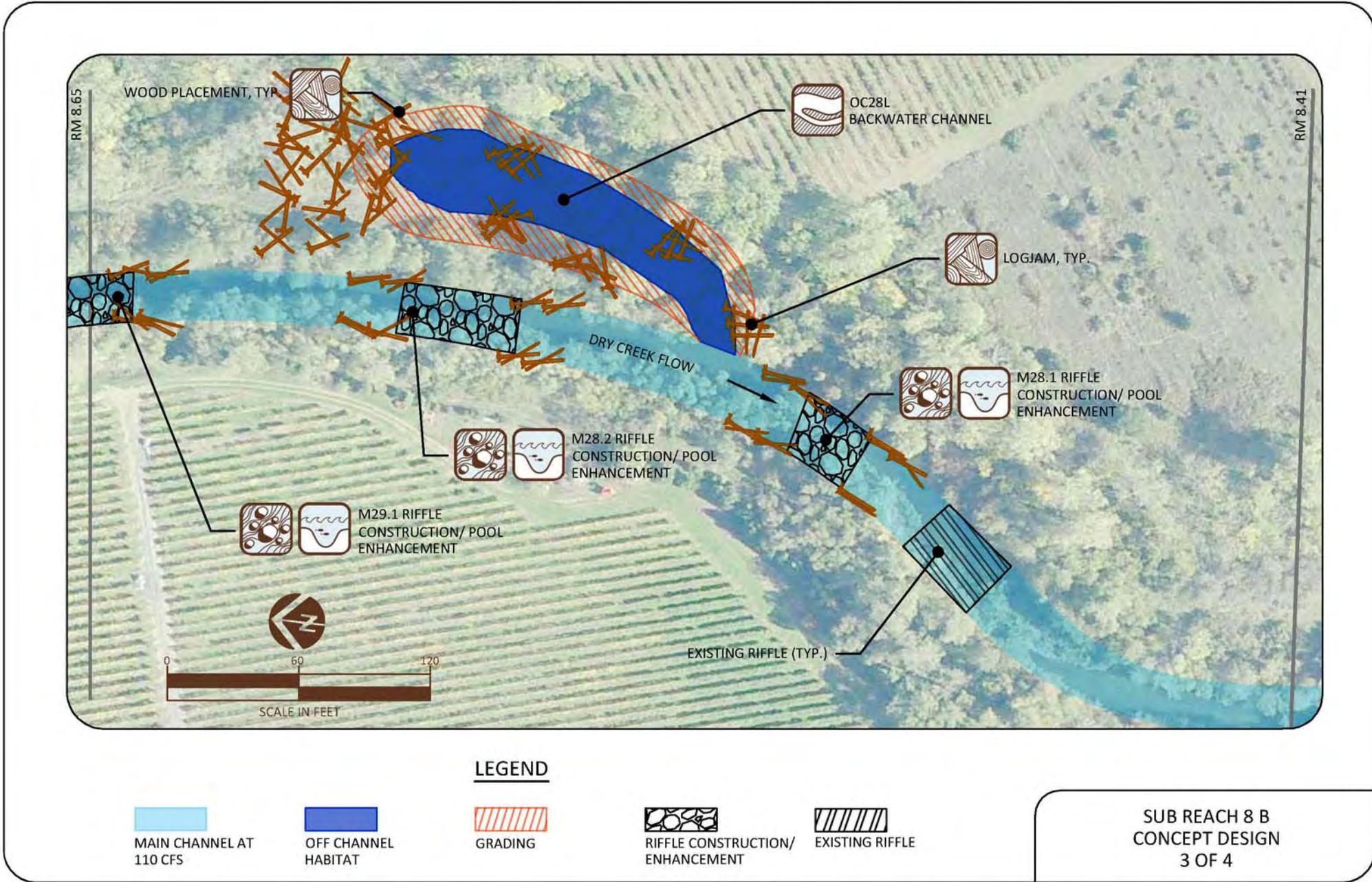
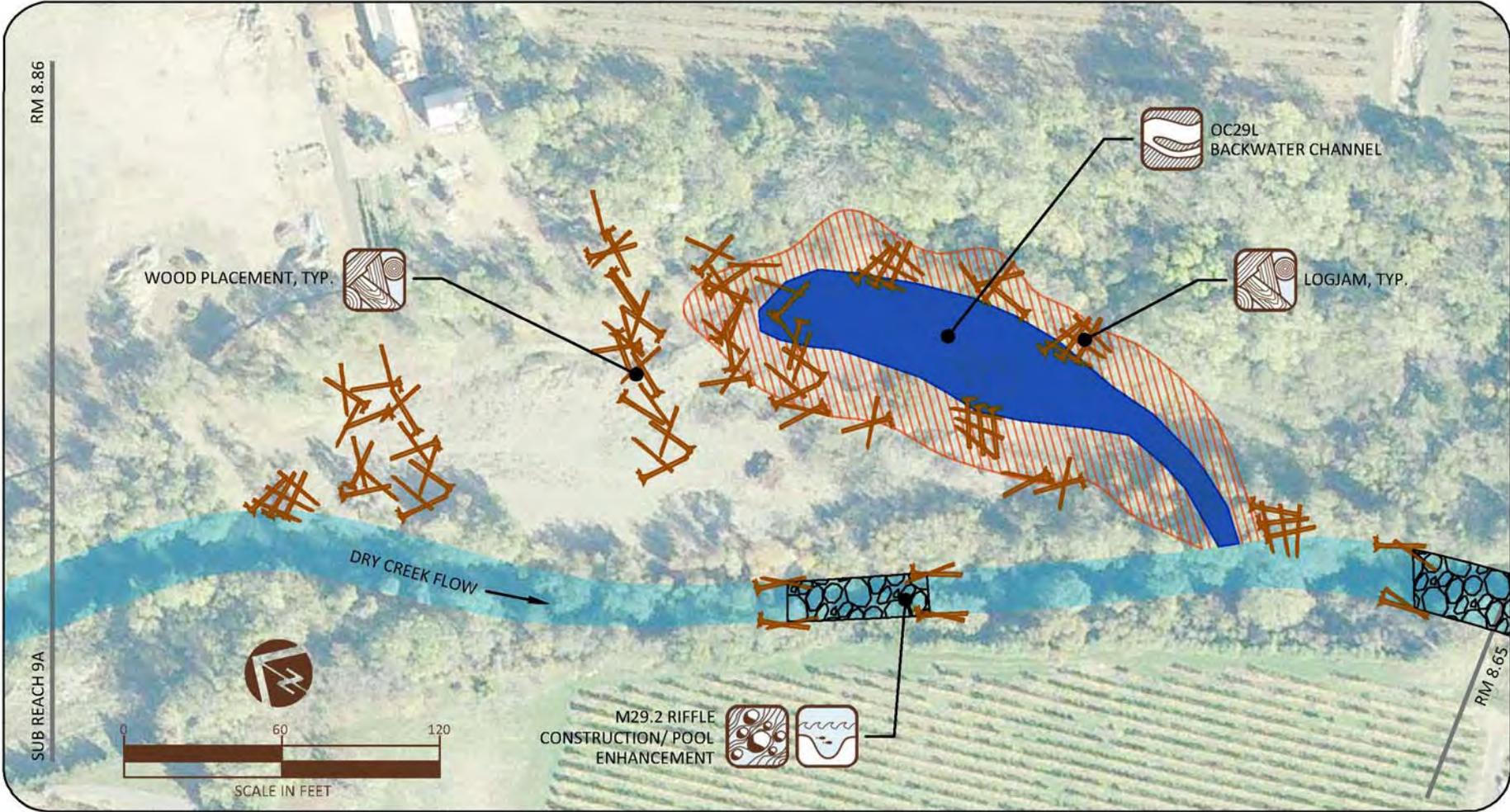


Figure H12. Sub-reach 8b conceptual design detail sheet 3 of 4.  
Dry Creek Conceptual Design Report



**LEGEND**

-   
 MAIN CHANNEL AT 110 CFS
-   
 OFF CHANNEL HABITAT
-   
 GRADING LIMIT
-   
 RIFFLE CONSTRUCTION/ ENHANCEMENT

SUB REACH 8 B  
 CONCEPT DESIGN  
 4 OF 4

Figure H13. Sub-reach 8b conceptual design detail sheet 4 of 4.  
 Dry Creek Conceptual Design Report

**Sub-Reach 8b Analysis of Proposed Enhancements**

Proposed enhancements would provide a significant increase in the quantity and quality of available juvenile rearing habitat to a sub-reach with minimal off-channel habitat and main-stem quality pool habitat. The creation of more than 75,000 ft<sup>2</sup> of off-channel habitat in addition to enhancing pools to provide near-optimal rearing habitat will greatly improve the ecological function of sub-reach 8b. The following tables summarize the frequency and areas of existing vs. proposed habitat (Table H9), additional habitat to be created by enhancements (Table H10) and cost-based metrics (Table H11). Table H13 summarizes the planning level cost estimate developed for sub-reach 8b.

Table H9. Habitat units based on existing and proposed conditions.

Habitat	Existing Habitat		Proposed Habitat	
	Area (ft <sup>2</sup> )	#	Area (ft <sup>2</sup> )	#
Alcove / Backwater	0	0	76800	5
Flatwater	90400	9	31200	8
Pool	124100	6	182550	14
Riffle	37150	6	64650	11
Side Channel	0	0	0	0

Table H10. Additional habitat provided by backwater , LWD-margin, and riffle habitat

Habitat Type	(ft <sup>2</sup> )	(m <sup>2</sup> )
Alcove/Backwater <sup>+</sup> (summer coho rearing)	76800	7130
LWD-Margin Habitat (summer coho rearing)	10500	980
Winter Refuge (coho rearing)	45900	4260
Pools	58450	5430
Riffles	27500	2550
<b>Total</b>	<b>211600</b>	<b>19660</b>

<sup>+</sup>Alcove/Backwater habitats also provide winter refuge habitat during flood events.

Table H11. Cost – benefit table for design concepts presented for sub-reach 8b.

Cost - Benefit Metric	Cost (\$)
Cost / ft <sup>2</sup> of summer coho rearing*	140
Cost / ft <sup>2</sup> of winter coho rearing**	92
Cost / ft <sup>2</sup> of additional habitat***	58

\*includes backwater and LWD-margin habitats

\*\*includes alcove/backwater, high flow backwater, LWD-margin, winter refuge

\*\*\*includes alcove/backwater, LWD-margin, winter refuge, pools and riffles

Table H12. Length metric table showing habitat area divided by main channel sub-reach length for summer coho rearing and total enhanced habitats.

Length Metric	area (ft <sup>2</sup> )/ length (ft)
Summer coho rearing habitat	19
Winter coho rearing habitat	29
Total enhanced habitat	46

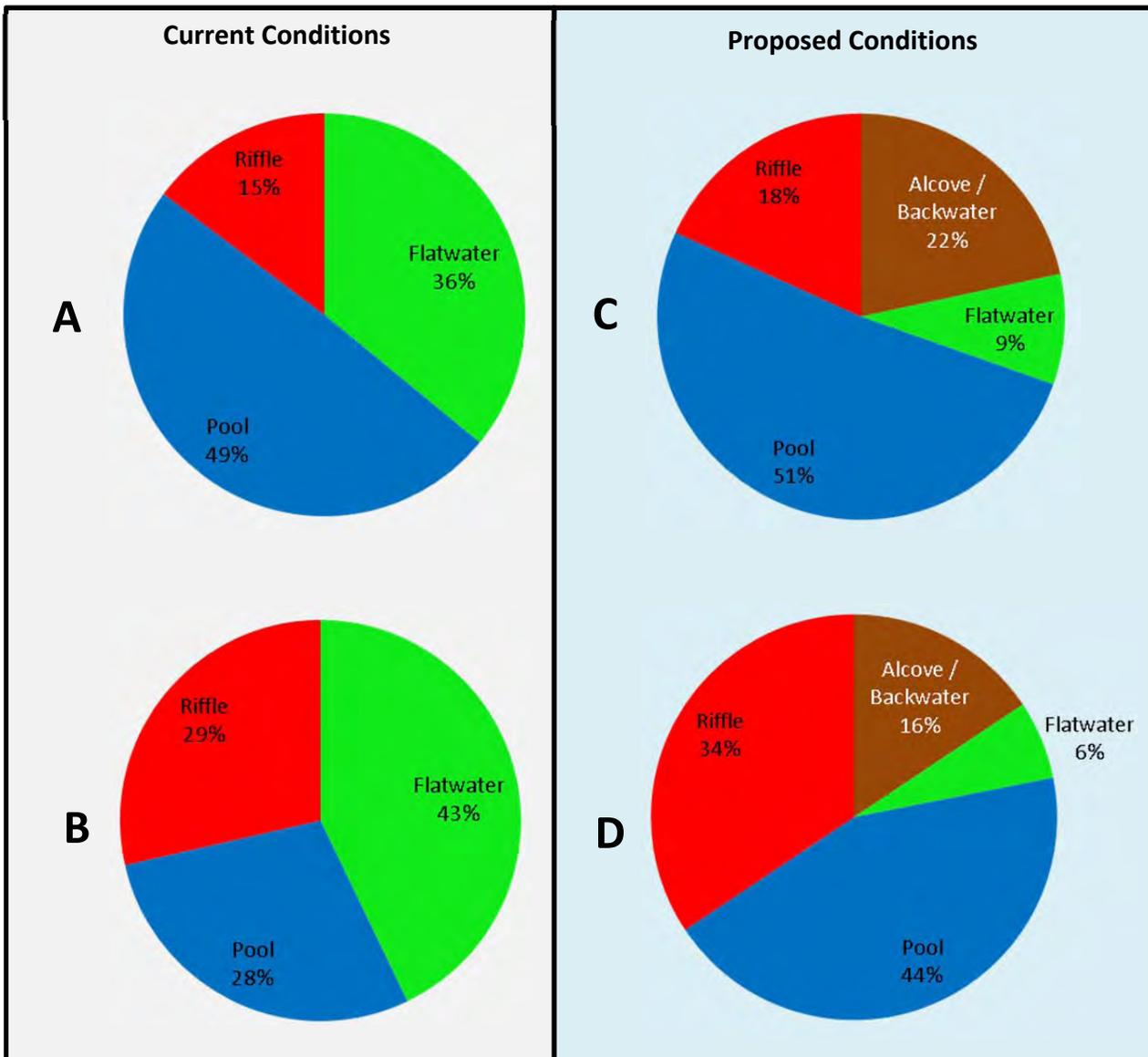


Figure H14. Existing sub-reach 9b habitats shown by area (A), frequency (B) and proposed habitat units based on area (C) and frequency (D).

**Sub-Reach 8b Alternatives Discussion**

The floodplain in sub-reach 13b ranges from 100 to 250 feet wide and presents opportunities for off-channel habitat development. Multiple alternatives were identified. One alternative is to leave the main channel alignment in place and create backwater channels in floodplain areas. A second alternative is to create a complex of side channels and alcoves like those found in the vicinity of Westside Bridge.

Table H13. Sub-reach 8b Planning Level Cost Estimate

Note: This is a preliminary cost estimate for planning purposes. Actual costs for design and construction activities may vary substantially from these estimates. Assumptions for time requirements and material quantities have been made based on limited information that is available for the site. Additional information obtained during site investigations will be needed to determine actual quantities and costs. Estimates based on 2011 costs.

No.	Description	Unit	Quantity	Unit Cost	Total Cost	Design and Quantity Assumptions
1	Mobilization and Demobilization	LS	1	\$380,000	\$380,000	Calculated at 5% of construction sub-total.
2	Site Access Measures	LS	1	\$370,000	\$370,000	Includes access road improvements, traffic control, dust control, and site restoration.
3	Environmental Protection Measures	LS	1	\$1,860,000	\$1,860,000	Includes stream diversion/dewatering, fish relocation, and erosion control BMPs.
4	Clearing and Grubbing	AC	4	\$2,000	\$8,000	
5	Common Excavation					
a.	OC 29	CY	14,480	\$20	\$289,600	Final design criteria and analysis will likely alter these estimates up or down.
b.	OC 28	CY	11,030	\$20	\$220,600	
c.	OC 27.2	CY	5,730	\$20	\$114,600	
d.	OC 27.1	CY	8,860	\$20	\$177,200	
e.	OC 26.1	CY	8,310	\$20	\$166,200	
6	Large Woody Debris (purchased, delivered, installed)					
a.	Floodplain Roughness Logs	EA	280	\$1,150	\$322,000	Assumes 30% delivered with root wads attached.
b.	Backwater Habitat Logs	EA	550	\$1,150	\$632,500	
c.	Pool Enhancement Logs	EA	190	\$1,150	\$218,500	
d.	Log Jams	EA	600	\$1,150	\$690,000	
7	Boulder Ballast (purchased, delivered, installed)	TN	1,620	\$100	\$162,000	Estimate 1 ton per log.
8	Bank Stabilization	LF	1,390	\$1,000	\$1,390,000	Bank stabilization methods will vary but will include one or more of the following components: large woody debris, earthwork, riprap scour protection, granular backfill, aggregate filter material, geotextile fabric, and/or fabric encapsulated soil lifts. Assumes 30% delivered with root wads attached.
9	Riffle Installation (purchased, delivered, installed)	CY	4,000	\$120	\$480,000	Assume average of 3 feet of depth per riffle for riffle construction. Assume average of 1.5 feet of depth per riffle for riffle enhancement.
10	Vegetation Management	AC	19	\$20,000	\$380,000	Assumes area of floodplain from vineyard grade to vineyard grade minus the base flow inundation area of the main channel and of the proposed backwater habitat areas.
<b>Construction Sub-Total</b>					<b>\$7,861,200</b>	<div style="display: flex; justify-content: space-between;"> <div style="border: 1px solid black; padding: 5px;"> <p><b>Key</b>                      LS = Lump Sum                      CY = Cubic Yard                      LF = Lineal Foot                      AC = Acre                      EA = Each</p> </div> <div style="border: 1px solid black; padding: 5px;"> <p><b>Project Delivery Items are calculated as a percent of the construction sub-total</b>  <b>General Notes:</b>                      -Cost includes a 30% design and construction contingency                      -Costs assume all materials (wood and rock) are purchased and hauled to the site from a nearby source                      -Boulder ballast requirements may be able to be reduced depending on hydraulics analysis</p> </div> </div>
Concept Level Design & Construction Contingency (30%)					\$2,358,360	
<b>Construction Total</b>					<b>\$10,219,600</b>	
<b>Project Delivery</b>						
Permitting (4%)					\$314,448	
Detailed Engineering Design (15%)					\$1,179,180	
Contract Administration (5%)					\$393,060	
Construction Oversight (1.5%)					\$117,918	
<b>Project Delivery Sub-Total</b>					<b>\$2,004,600</b>	
<b>TOTAL ESTIMATE</b>					<b>\$12,224,000</b>	

rounded to nearest \$1,000

## APPENDIX I

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**I.1 Reach Description**

Reach 6 is located 600 ft downstream of the Crane Creek confluence and extends downstream to river mile 6.2. No tributaries flow into Dry Creek in this reach. Reach 6 has narrowed over time but has not had significant changes to the planform. A PIT tag antenna station was located in the middle of the reach at the time of the habitat survey. Car bodies and riprap have been installed to armor the bank in the lower 500 ft of reach 6. Dry Creek has exposed bedrock in the upstream end of the reach. See the Dry Creek Current Conditions Report (Inter-Fluve 2010), Appendix A, for more detail.

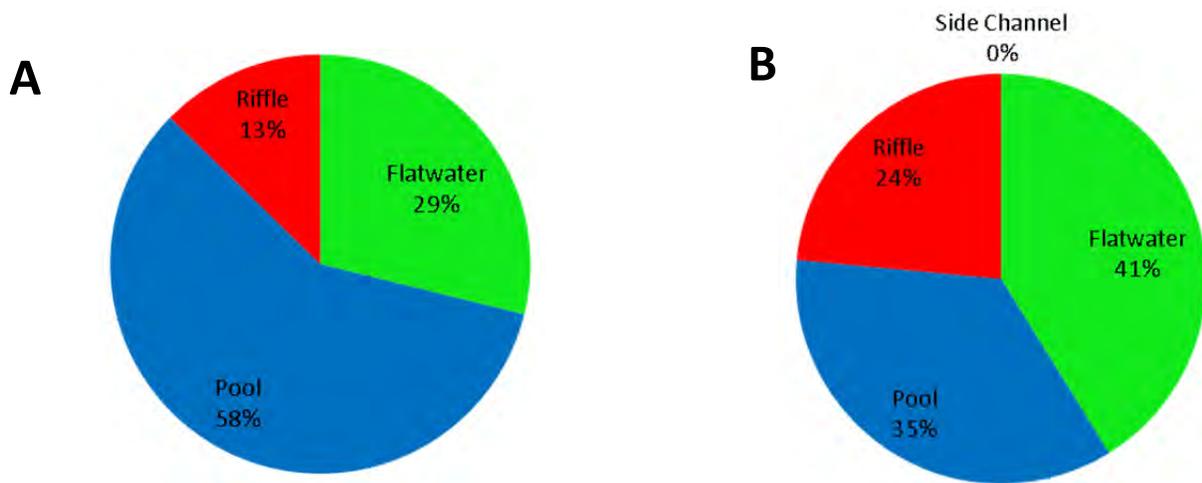


**Reach 6 Current Habitat Conditions**

Table I1. Reach 6 habitat units based on current conditions.

Habitat	Existing Habitat	
	Area (ft <sup>2</sup> )	#
Alcove / Backwater	0	0
Flatwater	59600	7
Pool	120750	6
Riffle	26150	4
Side Channel	0	0

Figure I1. Habitat units in reach 6 based on area (A) and frequency (B).



## I.2 Reach 6 Enhancement Approach

Reach 6 falls in the “middle segment<sup>1</sup>” of Dry Creek, characterized by the increased sediment and surface water contributed by tributaries. In this segment, Dry Creek begins to have a more significant sediment supply due to the influence of unregulated tributaries. Enhancements in reach 6 will have to consider potential consequences of the larger sediment supplied by tributaries. Process-based approaches are unlikely to be implemented in reach 8 due to the confined and straight nature of the reach. The development of summer off-channel habitat is not possible in reach 6, due to the narrow active floodplain width. The enhancement approach in reach 6 will include the creation of winter refuge habitat, and improvement of conditions in the main channel through riffle construction, pool enhancement, and LWD installation. Design concepts are presented in full detail in section I.3.

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<sup>1</sup>Additional detail of process-based delineation of lower Dry Creek into upper, middle and lower segments can be found in the Fish Habitat Enhancement Feasibility Study, Section 5.3, IFI 2011

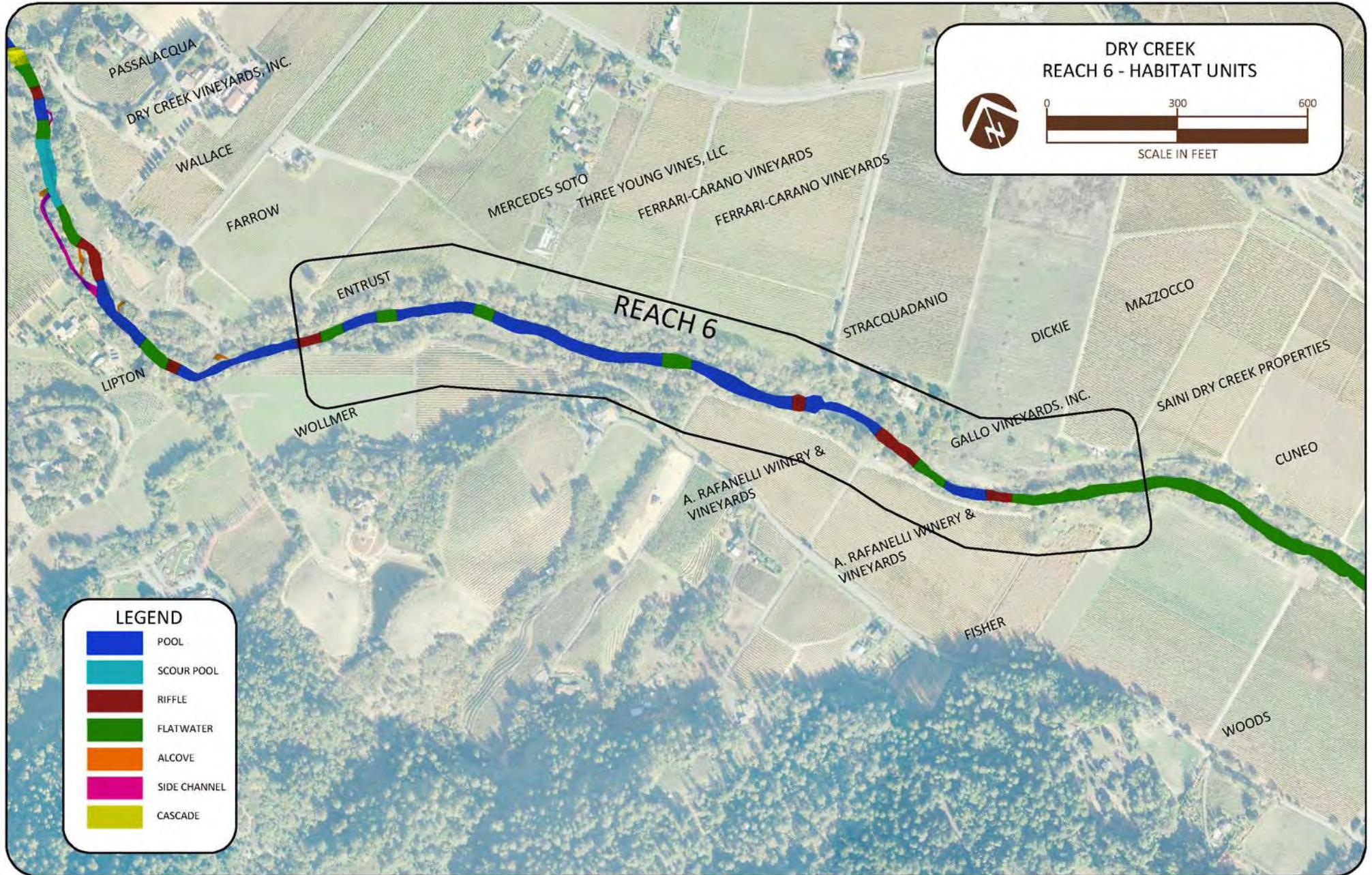


Figure 12. Reach 6 habitat units based on current conditions in Dry Creek.

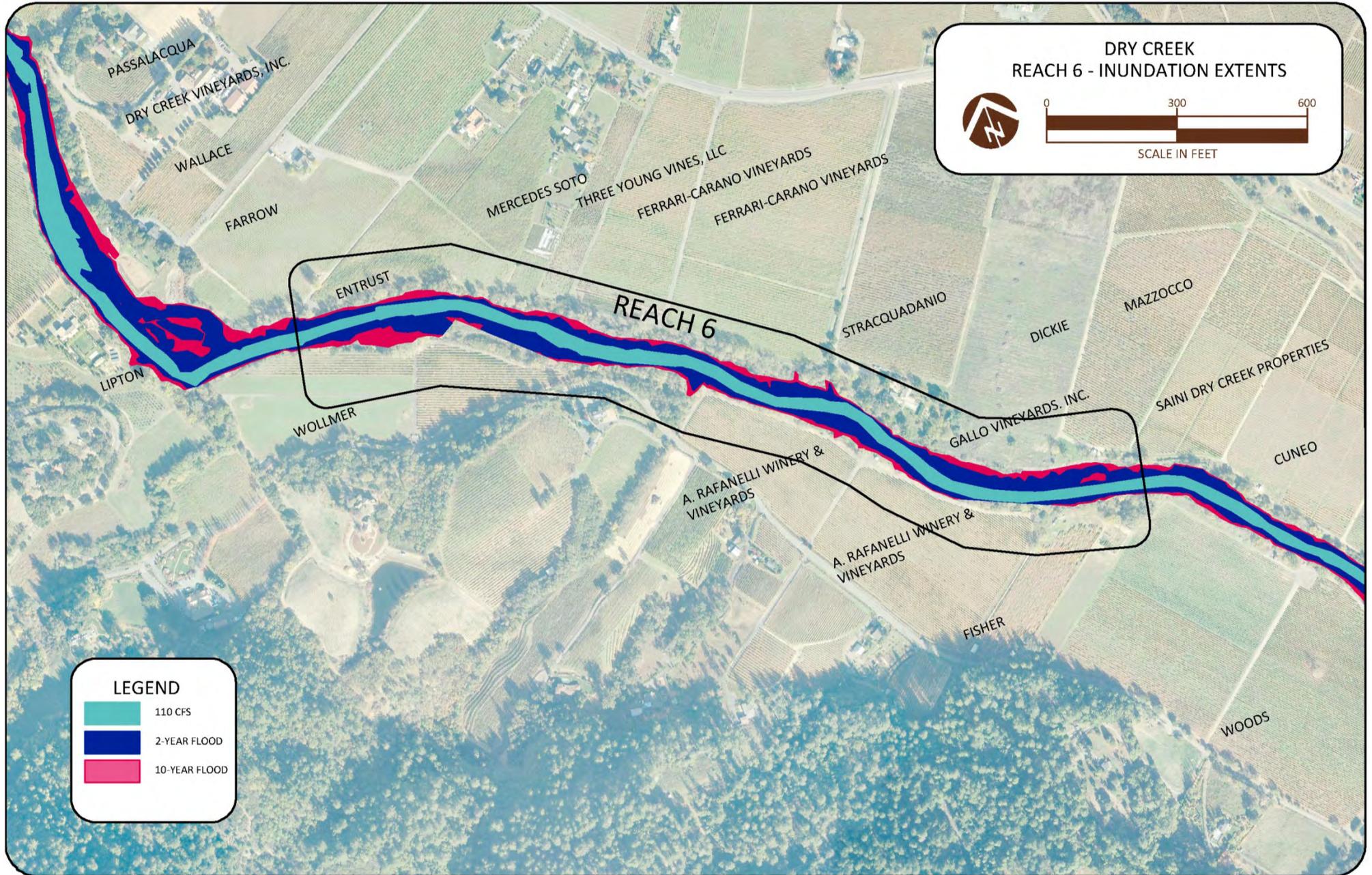


Figure 13. Modeled inundations in reach 6 based on three specific discharge levels: 110 cfs, the 2-year and 10-year flood events.

**I.3 Reach 6 Conceptual Designs**

Reach 6 is a relatively straight and narrow reach with modest floodplain areas for the development of off-channel habitat. Floodplain areas on both sides of the channel are wide enough to create winter refuge habitats, which will increase off channel juvenile rearing habitat during frequently occurring winter flows. Main channel enhancements will include riffle construction, pool enhancement, and LWD placements, improving the quantity and quality of main channel coho habitat. The following table and corresponding figures summarize design concepts developed for reach 6.

Project Code	Backwater Channel	Side Channel	Pool Enhancement	Riffle Enhancement	LWD	Winter Refuge Habitat	Bank Stabilization	Vegetation Management	Comments
M 20.6			X	X	X			X	Riffle Construction & Pool Enhancement
OC 20.6L					X	X		X	Winter Refuge Habitat
M 20.7			X	X	X			X	Riffle Construction & Pool Enhancement
M 20.8			X	X	X			X	Riffle Construction & Pool Enhancement
OC 20.9R					X	X		X	Winter Refuge Habitat
M 20.9					X			X	LWD Placement

Table I2. Inventory of individual projects identified in reach 6.

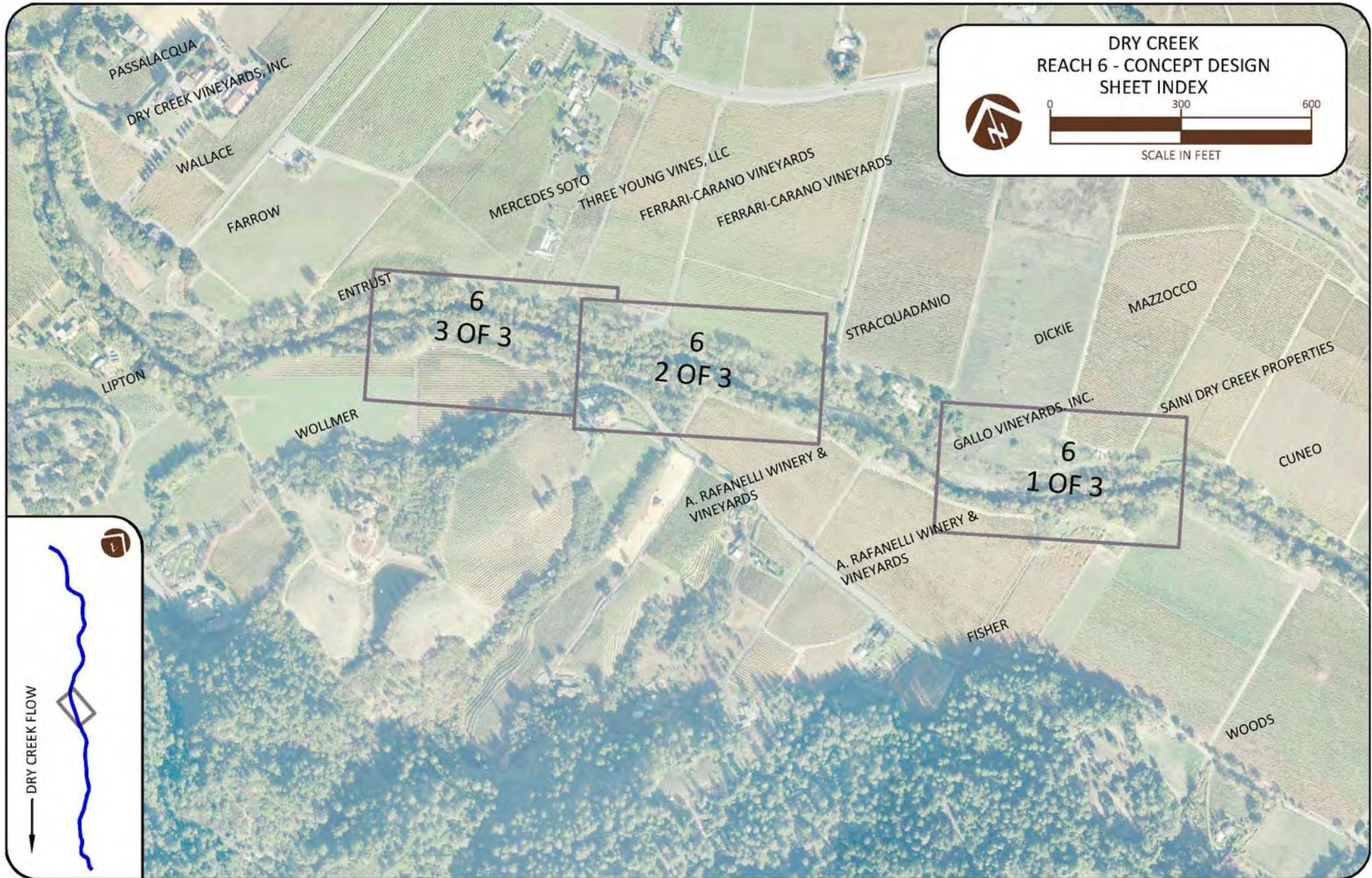
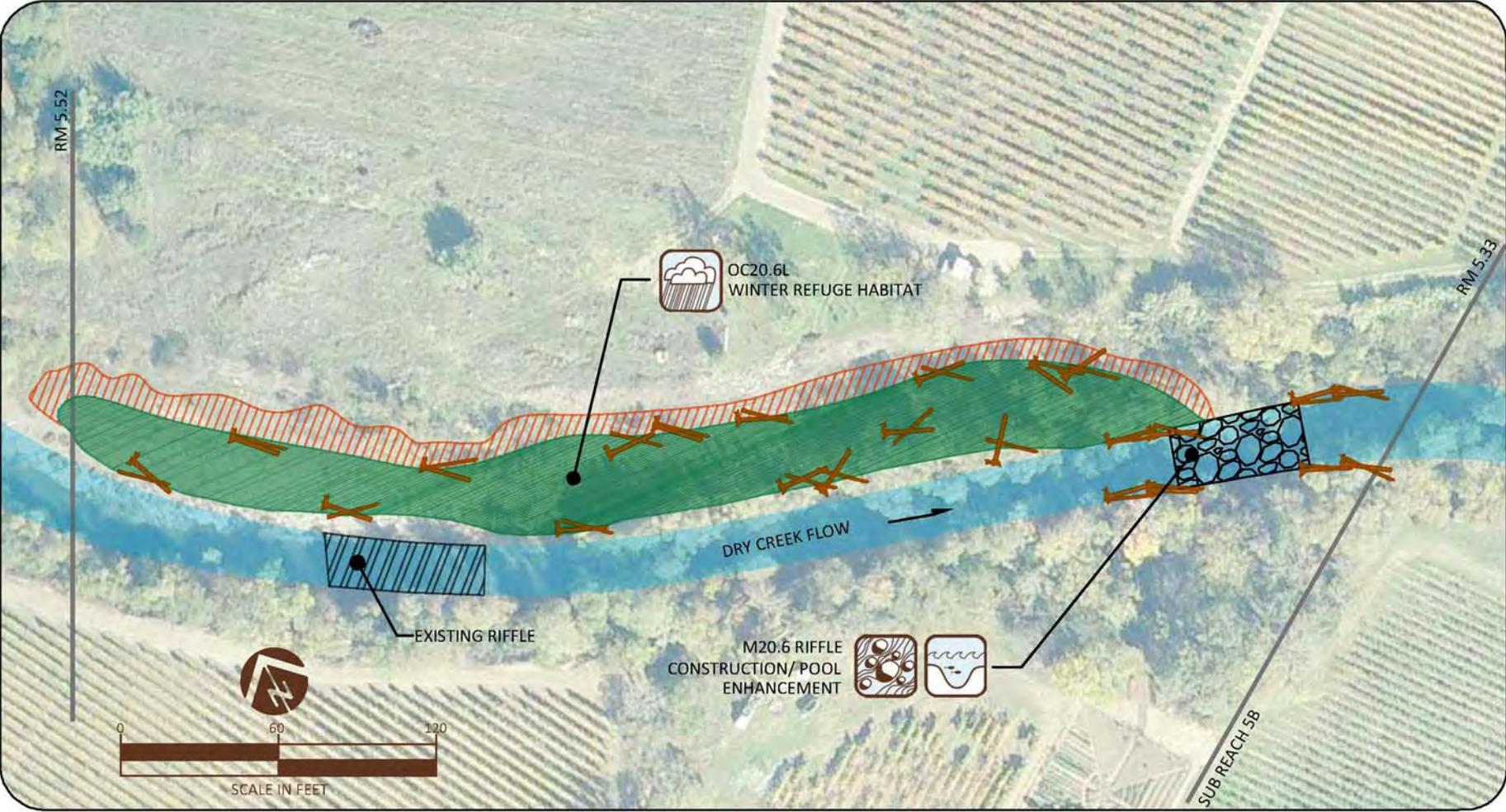


Figure 14. Reach 6 sheet index for conceptual design detail sheets.

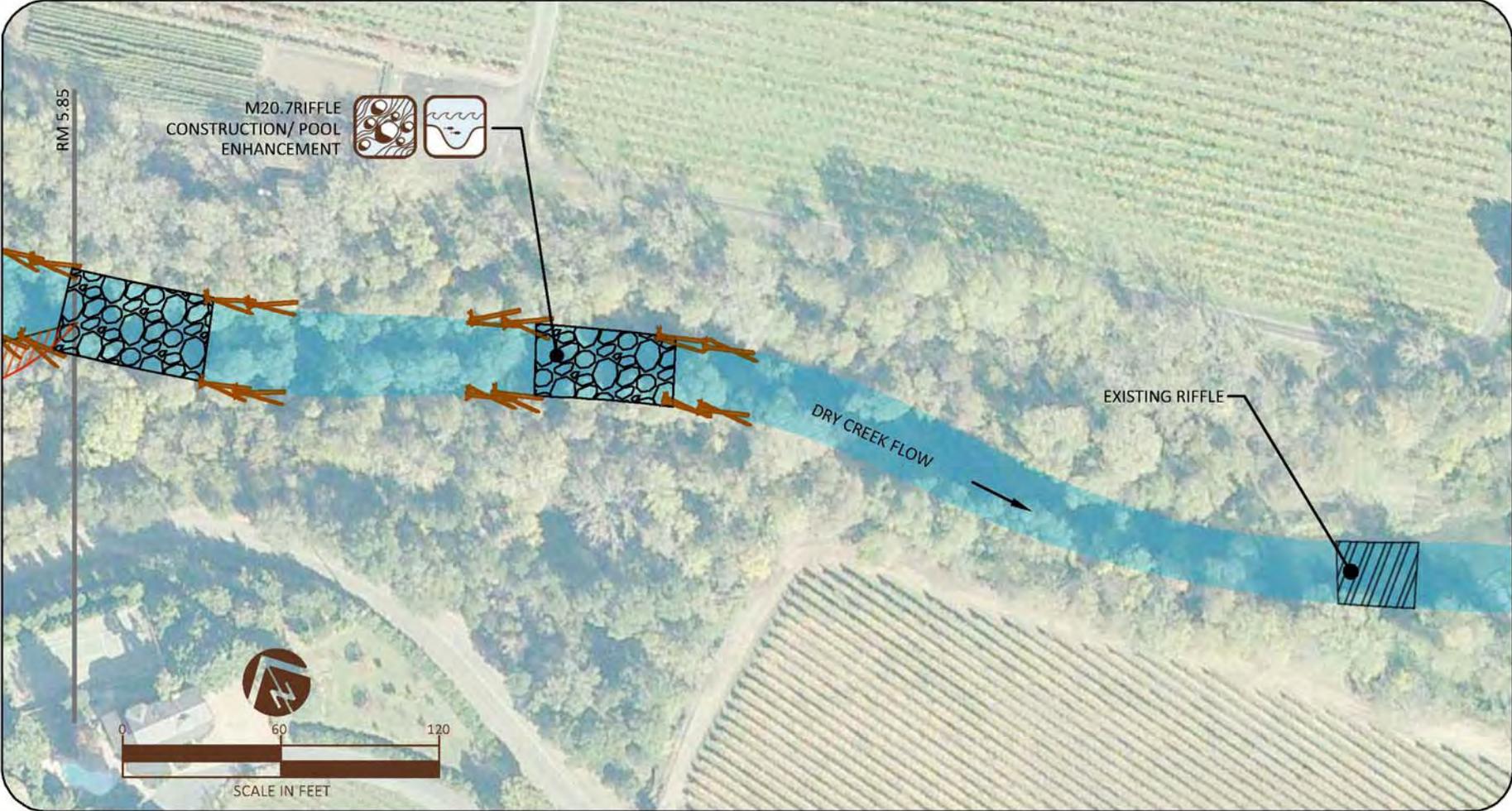


LEGEND

-   
 MAIN CHANNEL AT 110 CFS
-   
 GRADING LIMIT
-   
 RIFFLE CONSTRUCTION/ ENHANCEMENT
-   
 EXISTING RIFFLE
-   
 WINTER REFUGE

REACH 6  
 CONCEPT DESIGN  
 1 OF 3

Figure 15. Reach 6 conceptual design detail sheet 1 of 3.



**LEGEND**



MAIN CHANNEL AT 110 CFS



GRADING LIMIT



RIFFLE CONSTRUCTION/ ENHANCEMENT



EXISTING RIFFLE



WINTER REFUGE

REACH 6  
CONCEPT DESIGN  
2 OF 3

Figure 16. Reach 6 conceptual design detail sheet 2 of 3.

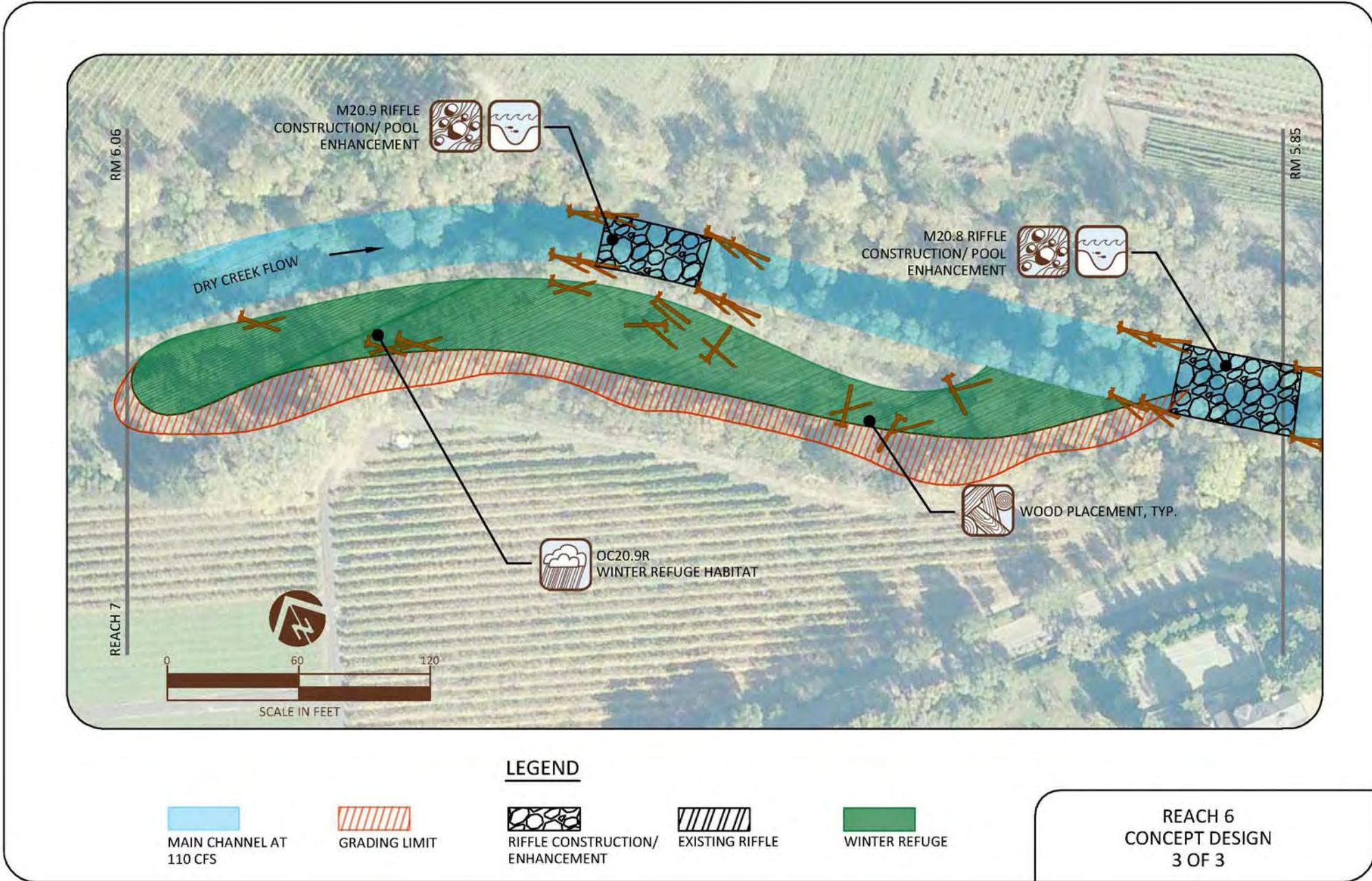


Figure 17. Reach 6 conceptual design detail sheet 3 of 3.

**Reach 6 Analysis of Proposed Enhancements**

Proposed enhancements in reach 6 include more than 158,000 ft<sup>2</sup> of improved or newly created habitat. 8,000 ft<sup>2</sup> of the enhancements will provide summer coho rearing habitat, and an additional 95,000 ft<sup>2</sup> of enhancements will provide winter coho rearing habitat. Additional main channel enhancements, totaling 55,000 ft<sup>2</sup>, will improve the quality and quantity of main-channel juvenile habitat. The following tables summarize the frequency and areas of existing vs. proposed habitat (Table I3), additional habitat to be created by enhancements (Table I4) cost-based metrics (Table I5). Table I6 presents habitat enhancement areas normalized by main channel length. Table I7 summarizes the planning level cost estimate developed for reach 6.

Table I3. Habitat area by unit type for existing and proposed conditions in reach 6.

Habitat	Existing Habitat		Proposed Habitat	
	Area (ft <sup>2</sup> )	#	Area (ft <sup>2</sup> )	#
Alcove / Backwater	0	0	0	0
Flatwater	59600	7	34100	5
Pool	120750	6	153450	13
Riffle	26150	4	49250	8
Side Channel	0	0	0	0
Winter Refuge	0	0	95100	2

Table I4. Additional coho rearing habitat provided by new alcoves and LWD placements.

Habitat Type	(ft <sup>2</sup> )	(m <sup>2</sup> )
LWD-Margin Habitat (summer coho rearing)	8000	740
Winter Refuge (winter coho rearing)	95100	8840
Pools	32700	3040
Riffles	23100	2150
<b>Total</b>	<b>158900</b>	<b>14760</b>

Table I5. Cost-benefit table for design concepts presented for reach 6.

Cost - Benefit Metric	Cost / ft <sup>2</sup>
Cost / ft <sup>2</sup> of summer coho rearing*	876
Cost / ft <sup>2</sup> of winter coho rearing	68
Cost / ft <sup>2</sup> of total enhanced habitat**	44

\*includes LWD-margin habitats

\*\*includes winter refuge, LWD-margin, pools and riffles

Table 16. Length metric table showing habitat area divided by main channel length.

Length Metric	area (ft <sup>2</sup> )/ length (ft)
Summer coho rearing habitat	2
Winter coho rearing habitat	25
Total enhanced habitat	38

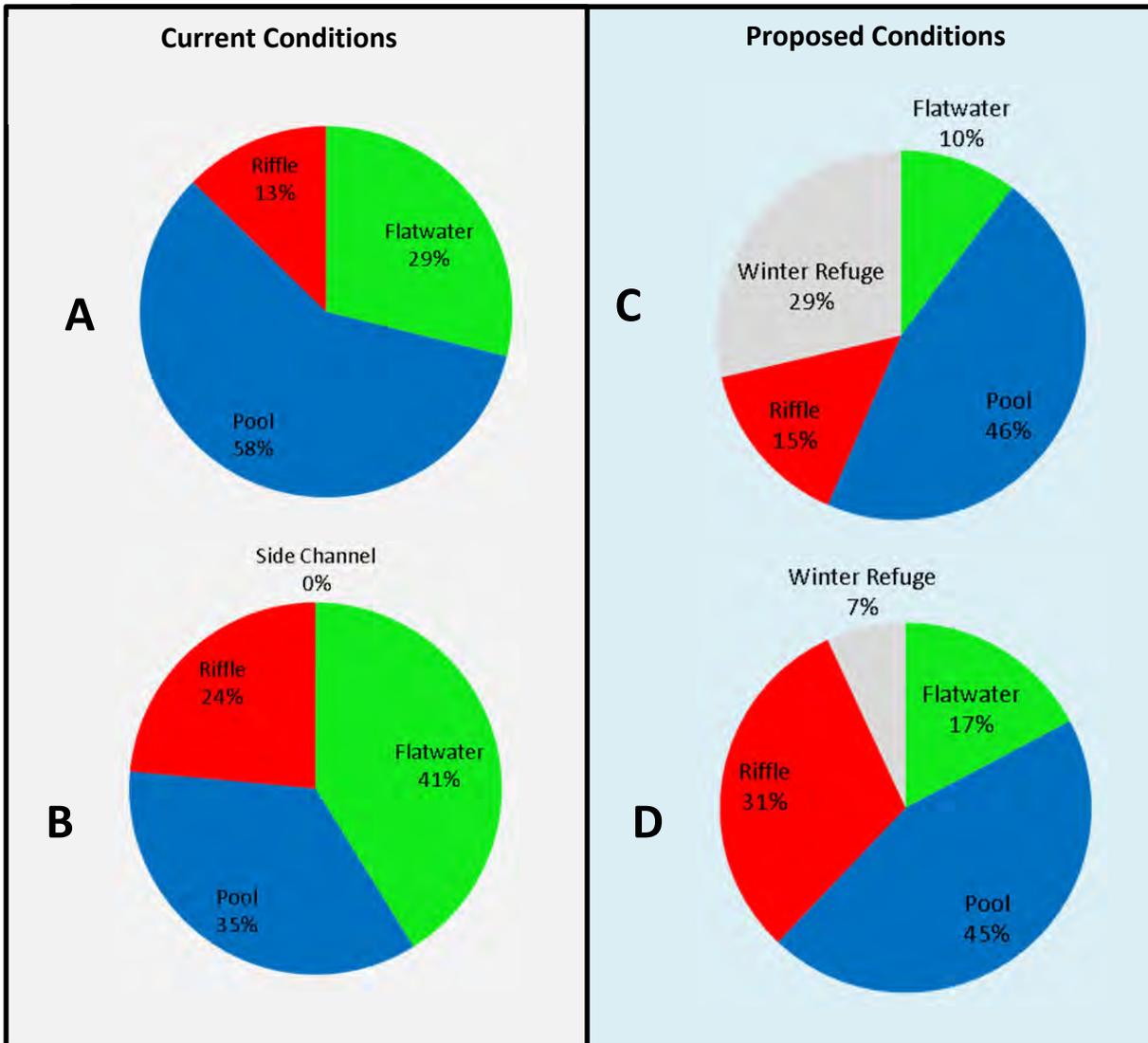


Figure 18. Existing habitats shown by area (A), frequency (B) and proposed habitat units based on area (C) and frequency (D).

Table 17. Reach 6 Planning Level Cost Estimate

Note: This is a preliminary cost estimate for planning purposes. Actual costs for design and construction activities may vary substantially from these estimates. Assumptions for time requirements and material quantities have been made based on limited information that is available for the site. Additional information obtained during site investigations will be needed to determine actual quantities and costs. Estimates based on 2011 costs.

No.	Description	Unit	Quantity	Unit Cost	Total Cost	Design and Quantity Assumptions						
1	Mobilization and Demobilization	LS	1	\$220,000	\$220,000	Calculated at 5% of construction sub-total.						
2	Site Access Measures	LS	1	\$210,000	\$210,000	Includes access road improvements, traffic control, dust control, and site restoration						
3	Environmental Protection Measures	LS	1	\$1,070,000	\$1,070,000	Includes stream diversion/dewatering, fish relocation, and erosion control BMPs						
4	Clearing and Grubbing	AC	5	\$2,000	\$10,000							
5	Common Excavation											
a.	OC 20.6	CY	9,980	\$20	\$199,600	Final design criteria and analysis will likely alter these estimates up or down. Assume haul will be less than 1,500 feet. Haul distances greater than 1,500 feet off site on road will substantially increase haul costs.						
b.	OC 20.9	CY	17,020	\$20	\$340,400							
6	Large Woody Debris Installation											
a.	Floodplain Roughness Logs	EA	0	\$1,150	\$0	Assumes 30% delivered with root wads attached.						
b.	Backwater Habitat Logs	EA	560	\$1,150	\$644,000							
c.	Pool Enhancement Logs	EA	128	\$1,150	\$147,200							
d.	Log Jams	EA	0	\$1,150	\$0							
7	Boulder Ballast (purchased, delivered, installed)	TN	688	\$100	\$68,800	Estimate 1 ton per log.						
8	Bank Stabilization	LF	1,076	\$1,000	\$1,076,000	Bank stabilization methods will vary but will include one or more of the following components: large woody debris, earthwork, riprap scour protection, granular backfill, aggregate filter material, geotextile fabric, and/or fabric encapsulated soil lifts. Assumes 30% delivered with root wads attached.						
9	Riffle Installation (purchased, delivered, installed)	CY	2,667	\$120	\$320,000	Assume average of 3 feet of depth per riffle for riffle construction. Assume average of 1.5 feet of depth per riffle for riffle enhancement.						
10	Vegetation Management	AC	10	\$20,000	\$200,000	Assumes area of floodplain from vineyard grade to vineyard grade minus the base flow inundation area of the main channel and of the proposed backwater habitat areas.						
<b>Construction Sub-Total</b>					<b>\$4,506,000</b>	<table border="1"> <tr> <td><b>Key</b></td> <td>LS = Lump Sum CY = Cubic Yard LF = Lineal Foot AC = Acre EA = Each</td> </tr> <tr> <td><b>Project Delivery Items are calculated as a percent of the construction sub-total</b></td> <td></td> </tr> <tr> <td><b>General Notes:</b></td> <td>-Cost includes a 30% design and construction contingency -Costs assume all materials (wood and rock) are purchased and hauled to the site from a nearby source -Boulder ballast requirements may be able to be reduced depending on hydraulics analysis</td> </tr> </table>	<b>Key</b>	LS = Lump Sum CY = Cubic Yard LF = Lineal Foot AC = Acre EA = Each	<b>Project Delivery Items are calculated as a percent of the construction sub-total</b>		<b>General Notes:</b>	-Cost includes a 30% design and construction contingency -Costs assume all materials (wood and rock) are purchased and hauled to the site from a nearby source -Boulder ballast requirements may be able to be reduced depending on hydraulics analysis
<b>Key</b>	LS = Lump Sum CY = Cubic Yard LF = Lineal Foot AC = Acre EA = Each											
<b>Project Delivery Items are calculated as a percent of the construction sub-total</b>												
<b>General Notes:</b>	-Cost includes a 30% design and construction contingency -Costs assume all materials (wood and rock) are purchased and hauled to the site from a nearby source -Boulder ballast requirements may be able to be reduced depending on hydraulics analysis											
Concept Level Design & Construction Contingency (30%)					\$1,351,800							
<b>Construction Total</b>					<b>\$5,857,800</b>							
<b>Project Delivery</b>												
Permitting (4%)					\$180,240							
Detailed Engineering Design (15%)					\$675,900							
Contract Administration (5%)					\$225,300							
Construction Oversight (1.5%)					\$67,590							
<b>Project Delivery Sub-Total</b>					<b>\$1,149,000</b>							
<b>TOTAL ESTIMATE</b>					<b>\$7,007,000</b>	rounded to nearest \$1,000						

## APPENDIX J

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**J.1 Reach 5 Description**

Reach 5 is a long and straight section of Dry Creek that is largely composed of long flatwater habitats. The upper half of the reach has been armored with concrete slabs and some riprap and car bodies. The active floodplain is narrow in this reach, with the 15 foot slopes up to the terrace located very close to the main channel. The air photo record indicates channel narrowing as a result of historic incision and the subsequent encroachment of vegetation. Sediment inputs from Kelley Creek and an unnamed tributary have contributed to the limited channel migration over the past several decades. See the Dry Creek Current Conditions Report (Inter-Fluve 2010), Appendix A, for more detail.

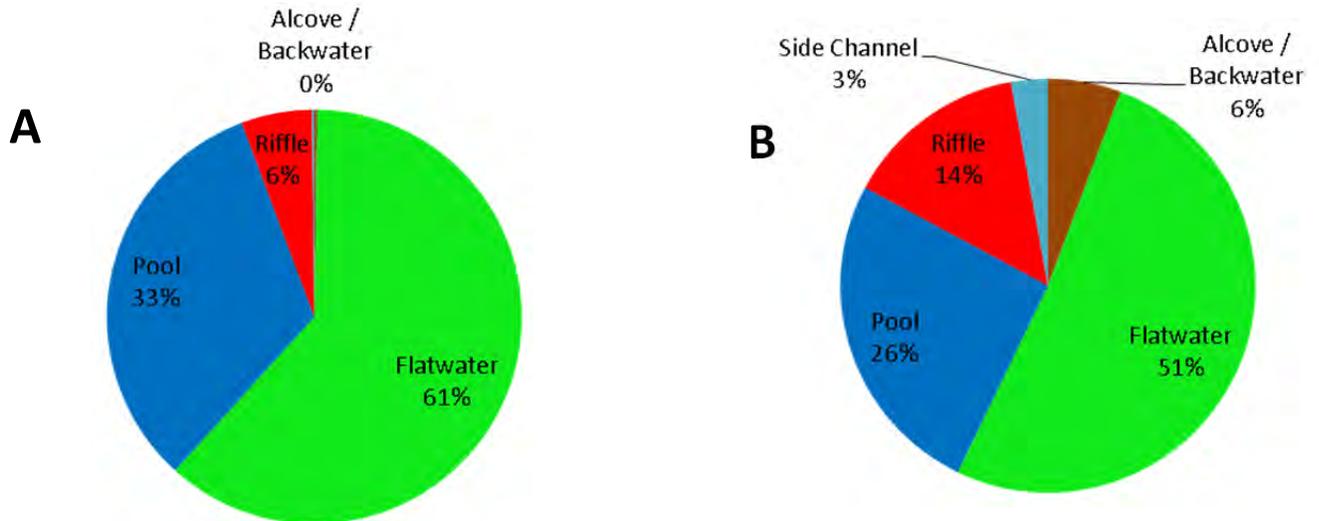


**Reach 5 Current Habitat Conditions**

Table J1. Reach 5 habitat units based on current conditions.

Habitat	Existing Habitat	
	Area (ft <sup>2</sup> )	#
Alcove / Backwater	800	2
Flatwater	223450	18
Pool	118450	8
Riffle	20100	5
Side Channel	650	1

Figure J1. Habitat units in reach 5 based on area (A) and frequency (B).



## J.2 Reach 5 Restoration Approach

Reach 5 is located in the “middle segment<sup>1</sup>” of Dry Creek, which has sediment supplied by tributary inputs in addition to hydrologic influence of unregulated tributaries. Enhancements will have to consider increased sediment supply and natural hydrology driven by unregulated tributaries. Habitat enhancement efforts in reach 5 will focus on creating high quality off-channel summer coho rearing habitat, in addition to main channel enhancements to improve conditions in the main-stem. The upper portion of the reach contains smaller floodplain areas, while the lower half has more sinuosity, and larger floodplain areas for off-channel habitat development. For purposes of enhancement planning, reach 5 has been split into two enhancement sub-reaches (Figure J2). Sub-reach 5a (RM 4.04 to 4.52) is described in section J.3, and sub-reach 5b (RM 4.52 to 5.33) is described in section H.4.

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<sup>1</sup> Additional detail of process-based delineation of lower Dry Creek into upper, middle and lower segments can be found in the Fish Habitat Enhancement Feasibility Study, Section 5.3, IFI 2011.

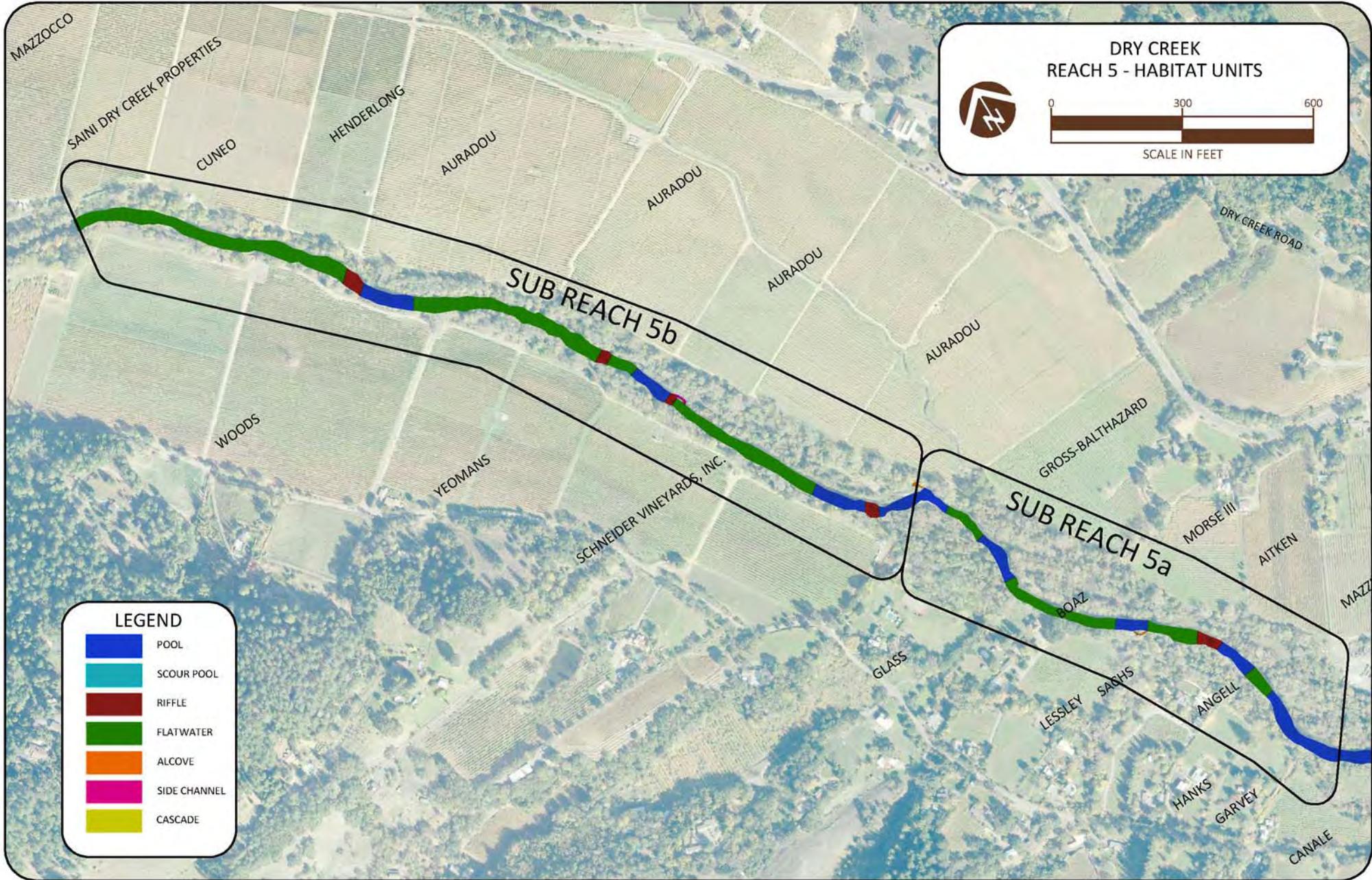


Figure J2. Reach 5 habitat units and sub-reach boundaries.

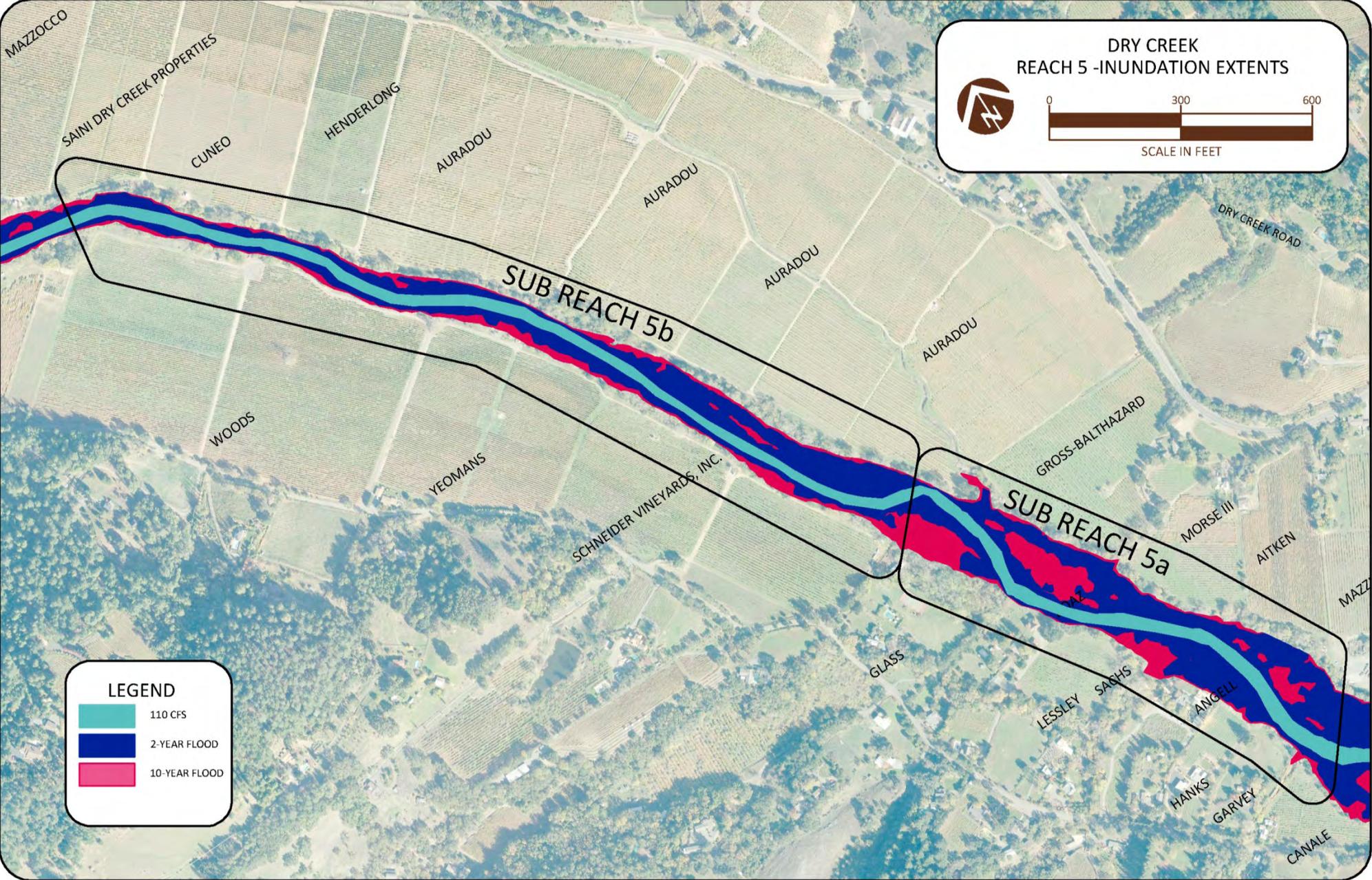


Figure J3. Modeled inundations in Reach 5 based on three specific discharge levels: 110 cfs, the 2-year and 10-year flood events.

**J.3 Sub-Reach 5a Conceptual Designs**

Sub-Reach 5a has relatively high level of sinuosity compared to other sections of Dry Creek, likely due to the wider active floodplain. The over-bank area in-between the main channel and the slope up to the terrace provide significant opportunity for off-channel habitat enhancement. Off-channel enhancements include the creation of backwater channels and placement of LWD. Main channel habitat enhancements are to include pool enhancements, riffle construction, and log jams. The following table and figures provide a summary of design concepts created for sub-reach 5a. The following table and accompanying figures summarize the design concepts developed for sub-reach 5a.

Project Code	Backwater Channel	Side Channel	Pool Enhancement	Riffle Enhancement	LWD	Winter Refuge Habitat*	Bank Stabilization	Vegetation Management	Comments
M 17.3			X	X	X			X	Riffle Construction & Pool Enhancement
OC 17.3L	X				X			X	Backwater Channel Construction
M 19			X	X	X			X	Riffle & Pool Enhancement
OC 19L	X				X			X	Backwater Channel Construction
M 19.4			X	X	X			X	Riffle Construction & Pool Enhancement
M 19.5			X	X	X			X	Riffle Construction & Pool Enhancement
OC 19.5R	X				X			X	Backwater Channel Construction

Table J2. Inventory of projects identified in sub-reach 5a.

\*Backwater channels serve as winter refuge habitat during winter flood events, as the areas of low-velocity off-channel habitat increases as discharge increases during winter storms.

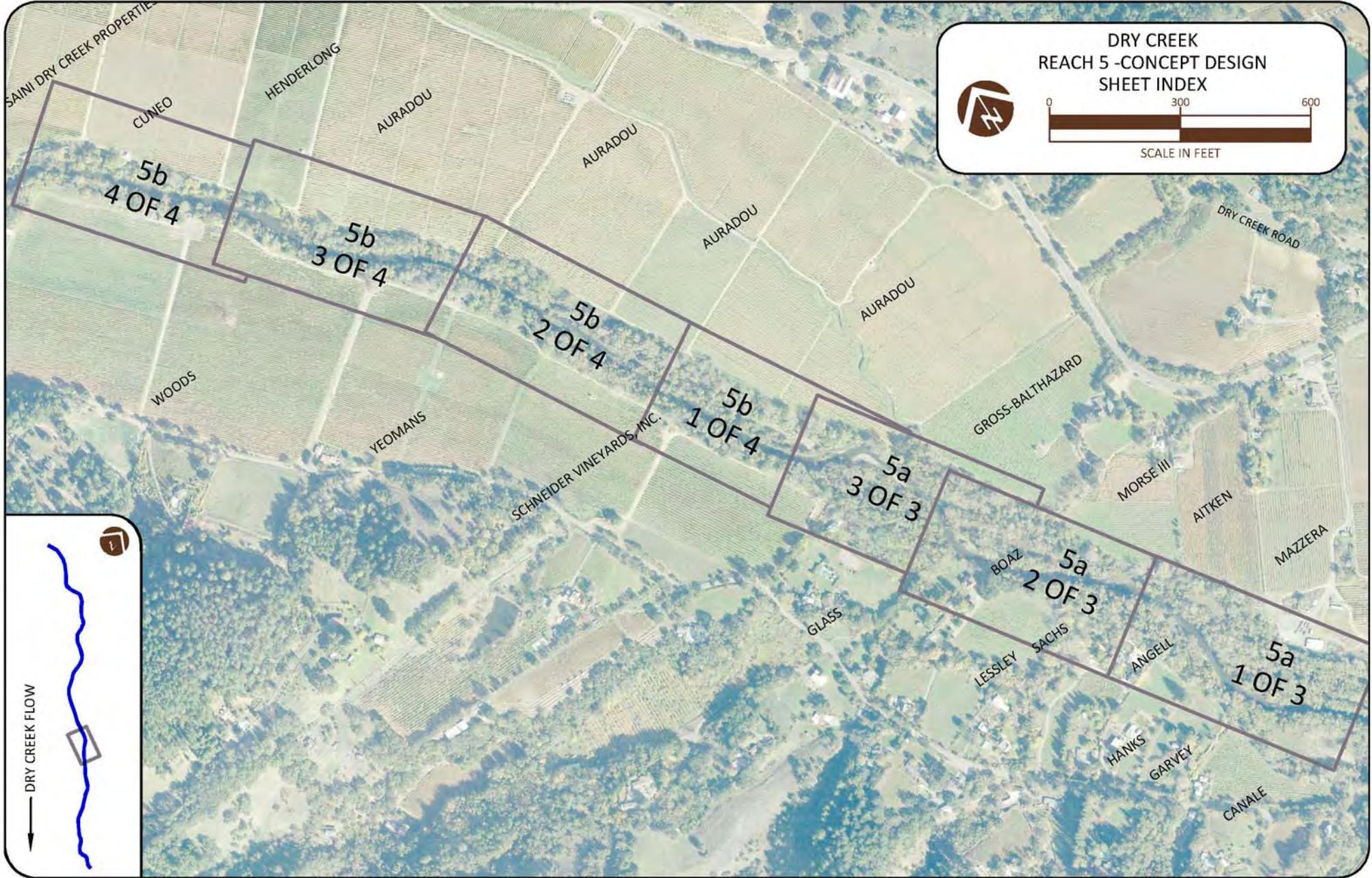


Figure J4. Reach 5 sheet index for conceptual design detail sheets.

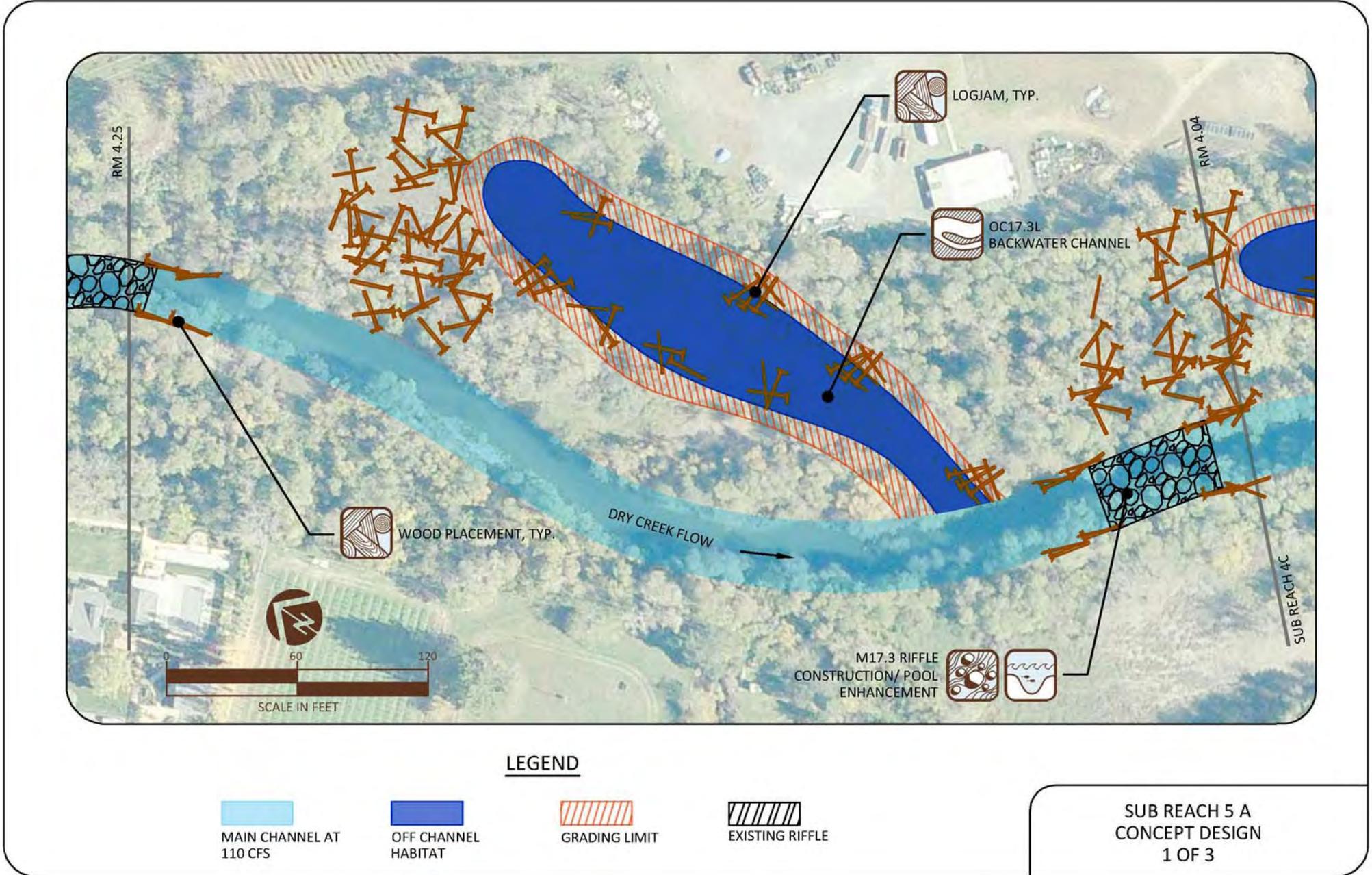
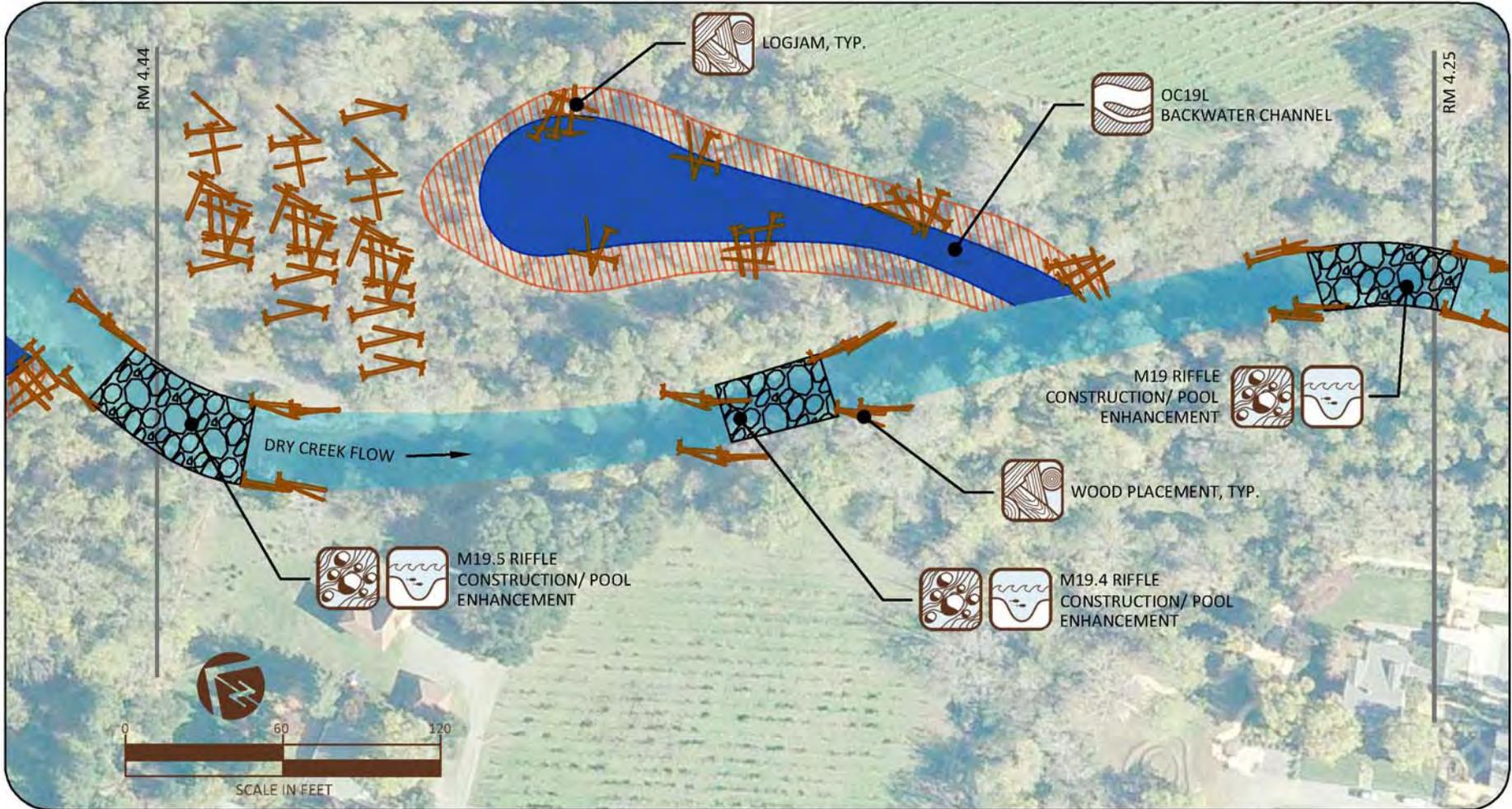


Figure J5. Sub-reach 5a conceptual design detail sheet 1 of 3.



MAIN CHANNEL AT  
110 CFS

OFF CHANNEL  
HABITAT

GRADING

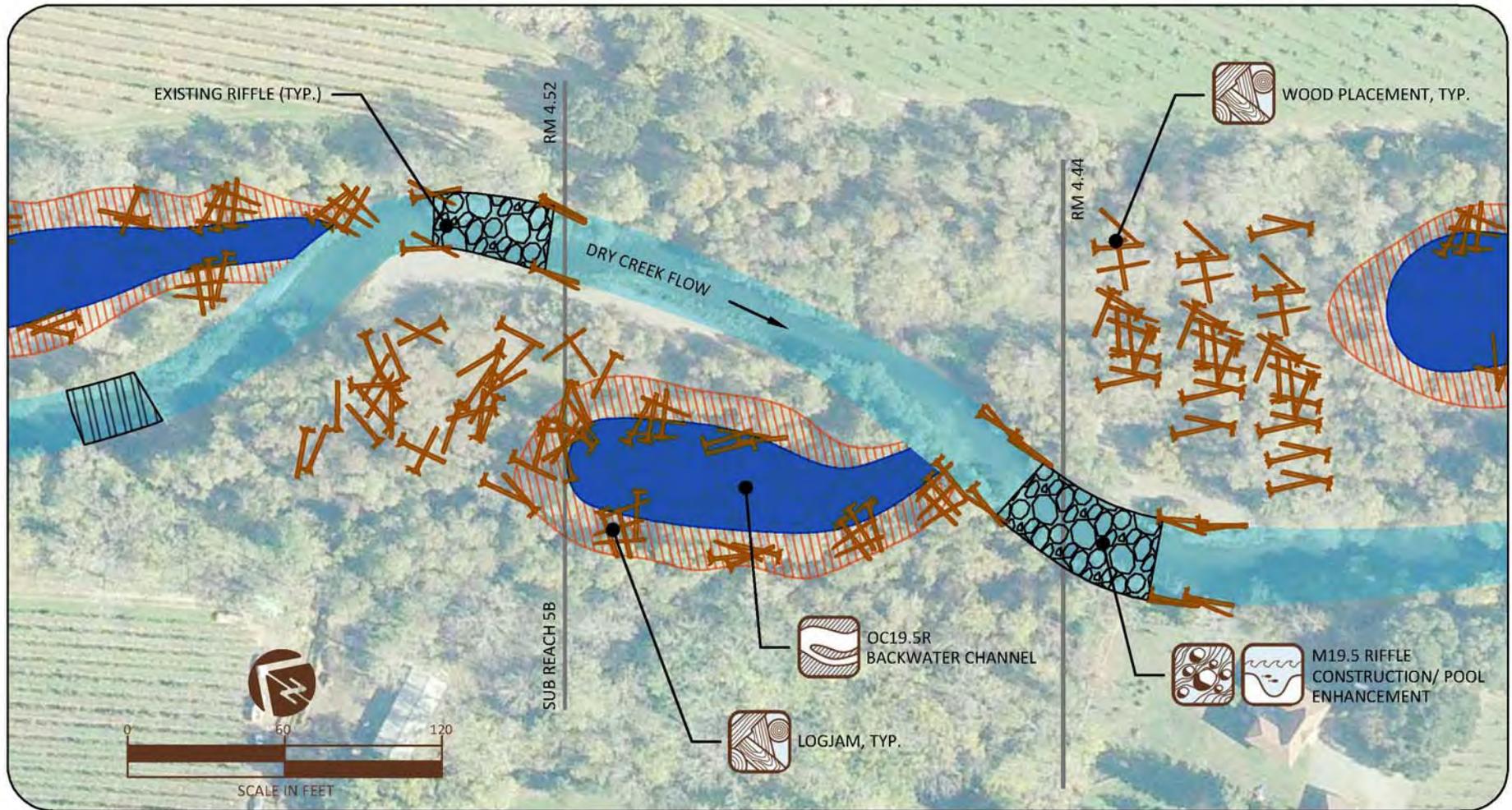
RIFFLE CONSTRUCTION/  
ENHANCEMENT

EXISTING RIFFLE

**LEGEND**

SUB REACH 5 A  
CONCEPT DESIGN  
2 OF 3

Figure J6. Sub-reach 5a conceptual design detail sheet 2 of 3.



**LEGEND**



MAIN CHANNEL AT  
110 CFS



OFF CHANNEL  
HABITAT



GRADING



RIFFLE CONSTRUCTION/  
ENHANCEMENT



EXISTING RIFFLE

SUB REACH 5 A  
CONCEPT DESIGN  
3 OF 3

Figure J7. Sub-reach 5a conceptual design detail sheet 3 of 3.  
Dry Creek Conceptual Design Report

**Sub-Reach 5a Analysis of Proposed Enhancements**

Proposed enhancements will create over 150,000 ft<sup>2</sup> of additional habitat. More than 90,000 ft<sup>2</sup> of the enhancements proposed will benefit target juvenile fish species during typical summer flows. Additionally, proposed enhancements would create higher quality main channel habitat conditions for juvenile coho and steelhead. The following tables summarize the frequency and areas of existing vs. proposed habitat (Table J3), additional habitat to be created by enhancements (Table J4), and cost-based metrics (Table J5). Table J6 present the habitat enhancements normalized by main channel sub-reach length. Table J6 presents habitat enhancement areas normalized by sub-reach main channel length. Table J7 summarizes the planning level cost estimate developed for sub-reach 5a.

*Table J3: Habitat area by unit type for existing and proposed conditions in sub-reach 5a.*

Habitat	Existing Habitat		Proposed Habitat	
	Area (ft <sup>2</sup> )	#	Area (ft <sup>2</sup> )	#
Alcove / Backwater	350	1	83000	4
Flatwater	50800	6	30400	5
Pool	67150	5	82850	7
Riffle	5050	1	21700	4
Side Channel	0	0	0	0

*Table J4. Additional habitat benefits provided by backwater habitat, LWD-margin habitat, and riffles in Sub-reach 5a.*

Habitat Type	(ft <sup>2</sup> )	(m <sup>2</sup> )
Alcove/Backwater <sup>+</sup> (summer coho rearing)	82650	7680
LWD-Margin Habitat (summer coho rearing)	11000	1020
Winter Refuge (coho rearing)	24500	2280
Pools	16850	1570
Riffles	16650	1550
<b>Total</b>	<b>151650</b>	<b>14090</b>

<sup>+</sup>Alcove/Backwater habitats also provide winter refuge habitat during flood events.

*Table J5. Cost-benefit table for design concepts presented for sub-reach 5a.*

Cost - Benefit Metric	Cost / ft <sup>2</sup>
Cost / ft <sup>2</sup> of summer coho rearing*	90
Cost / ft <sup>2</sup> of winter coho rearing**	71
Cost / ft <sup>2</sup> of total enhanced habitat***	55

\*includes backwater and LWD-margin habitats

\*\* includes alcove/backwater, high flow backwater habitat, LWD-margin, pool and riffle habitats.

\*\*\* includes alcove/backwater, LWD-margin, high flow backwater habitat, pool and riffle habitats.

Table J6. Length metric table showing habitat area divided by main channel sub-reach length for summer coho rearing habitat, and total enhanced habitat.

Length Metric	area (ft <sup>2</sup> ) / length (ft)
Summer coho rearing habitat	37
Winter coho rearing habitat	47
Total enhanced habitat	60

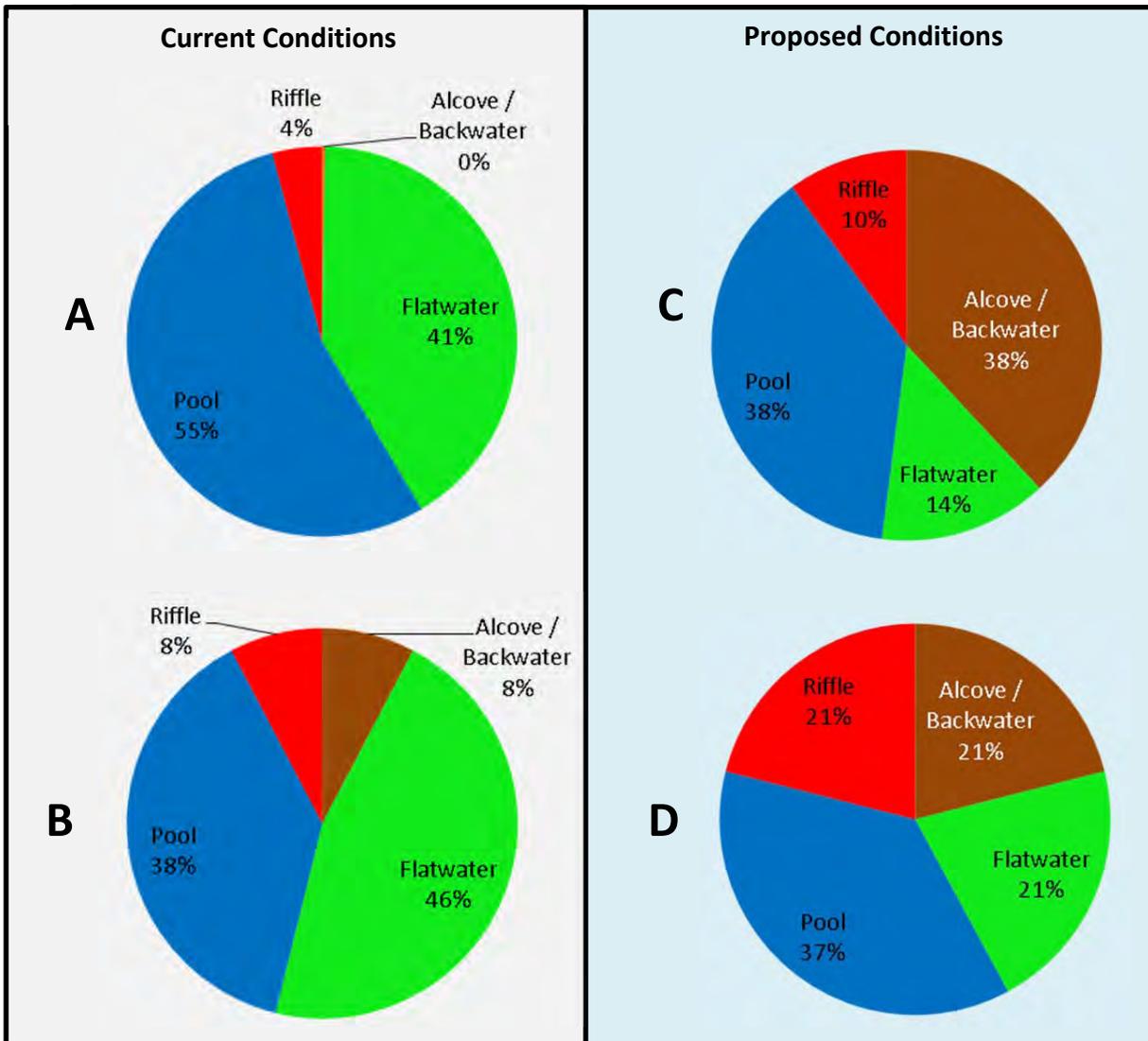


Figure J8. Existing habitats shown by area (A), frequency (B) and proposed habitat units based on area (C) and frequency (D).

Table J7. Sub-Reach 5a Planning Level Cost Estimate

Note: This is a preliminary cost estimate for planning purposes. Actual costs for design and construction activities may vary substantially from these estimates. Assumptions for time requirements and material quantities have been made based on limited information that is available for the site. Additional information obtained during site investigations will be needed to determine actual quantities and costs. Estimates based on 2011 costs.

No.	Description	Unit	Quantity	Unit Cost	Total Cost	Design and Quantity Assumptions							
1	Mobilization and Demobilization	LS	1	\$260,000	\$260,000	Calculated at 5% of construction sub-total.							
2	Site Access Measures	LS	1	\$250,000	\$250,000	Includes access road improvements, traffic control, dust control, and site restoration.							
3	Environmental Protection Measures	LS	1	\$1,280,000	\$1,280,000	Includes stream diversion/dewatering, fish relocation, and erosion control BMPs.							
4	Clearing and Grubbing	AC	3	\$2,000	\$6,000								
5	Common Excavation												
a.	OC 19.5	CY	10,170	\$20	\$203,400	Final design criteria and analysis will likely alter these estimates up or down.							
b.	OC 19	CY	12,400	\$20	\$248,000								
c.	OC 17.3	CY	15,810	\$20	\$316,200								
6	Large Woody Debris (purchased, delivered, installed)												
a.	Floodplain Roughness Logs	EA	280	\$1,150	\$322,000	Assumes 30% delivered with root wads attached.							
b.	Backwater Habitat Logs	EA	430	\$1,150	\$494,500								
c.	Pool Enhancement Logs	EA	130	\$1,150	\$149,500								
d.	Log Jams	EA	400	\$1,150	\$460,000								
7	Boulder Ballast (purchased, delivered, installed)	TN	1,240	\$100	\$124,000	Estimate 1 ton per log.							
8	Bank Stabilization	LF	750	\$1,000	\$750,000	Bank stabilization methods will vary but will include one or more of the following components: large woody debris, earthwork, riprap scour protection, granular backfill, aggregate filter material, geotextile fabric, and/or fabric encapsulated soil lifts. Assumes 30% delivered with root wads attached.							
9	Riffle Installation (purchased, delivered, installed)	CY	2,330	\$120	\$279,600	Assume average of 3 feet of depth per riffle for riffle construction. Assume average of 1.5 feet of depth per riffle for riffle enhancement.							
10	Vegetation Management	AC	13	\$20,000	\$260,000	Assumes area of floodplain from vineyard grade to vineyard grade minus the base flow inundation area of the main channel and of the proposed backwater habitat areas.							
<b>Construction Sub-Total</b>					<b>\$5,403,200</b>	<table border="1"> <tr> <td><b>Key</b></td> <td>LS = Lump Sum CY = Cubic Yard LF = Lineal Foot AC = Acre EA = Each</td> </tr> </table> <table border="1"> <tr> <td><b>Project Delivery Items are calculated as a percent of the construction sub-total</b></td> </tr> <tr> <td><b>General Notes:</b></td> </tr> <tr> <td>-Cost includes a 30% design and construction contingency</td> </tr> <tr> <td>-Costs assume all materials (wood and rock) are purchased and hauled to the site from a nearby source</td> </tr> <tr> <td>-Boulder ballast requirements may be able to be reduced depending on hydraulics analysis</td> </tr> </table>	<b>Key</b>	LS = Lump Sum CY = Cubic Yard LF = Lineal Foot AC = Acre EA = Each	<b>Project Delivery Items are calculated as a percent of the construction sub-total</b>	<b>General Notes:</b>	-Cost includes a 30% design and construction contingency	-Costs assume all materials (wood and rock) are purchased and hauled to the site from a nearby source	-Boulder ballast requirements may be able to be reduced depending on hydraulics analysis
<b>Key</b>	LS = Lump Sum CY = Cubic Yard LF = Lineal Foot AC = Acre EA = Each												
<b>Project Delivery Items are calculated as a percent of the construction sub-total</b>													
<b>General Notes:</b>													
-Cost includes a 30% design and construction contingency													
-Costs assume all materials (wood and rock) are purchased and hauled to the site from a nearby source													
-Boulder ballast requirements may be able to be reduced depending on hydraulics analysis													
Concept Level Design & Construction Contingency (30%)					\$1,620,960								
<b>Construction Total</b>					<b>\$7,024,200</b>								
<b>Project Delivery</b>													
Permitting (4%)					\$216,128								
Detailed Engineering Design (15%)					\$810,480								
Contract Administration (5%)					\$270,160								
Construction Oversight (1.5%)					\$81,048								
<b>Project Delivery Sub-Total</b>					<b>\$1,377,800</b>								
<b>TOTAL ESTIMATE</b>					<b>\$8,402,000</b>	rounded to nearest \$1,000							

J.4 Sub-Reach 5b Conceptual Designs

Sub-reach 5b is a straight and narrow 4300 ft section of Dry Creek with modest areas of floodplain for potential off-channel habitat development. Proposed off-channel enhancements include relatively small backwater channels and winter refuge habitats. Main channel enhancements include riffle construction, pool enhancement, and logjams. The following table and corresponding tables summarize the design concepts developed for sub-reach 5b.

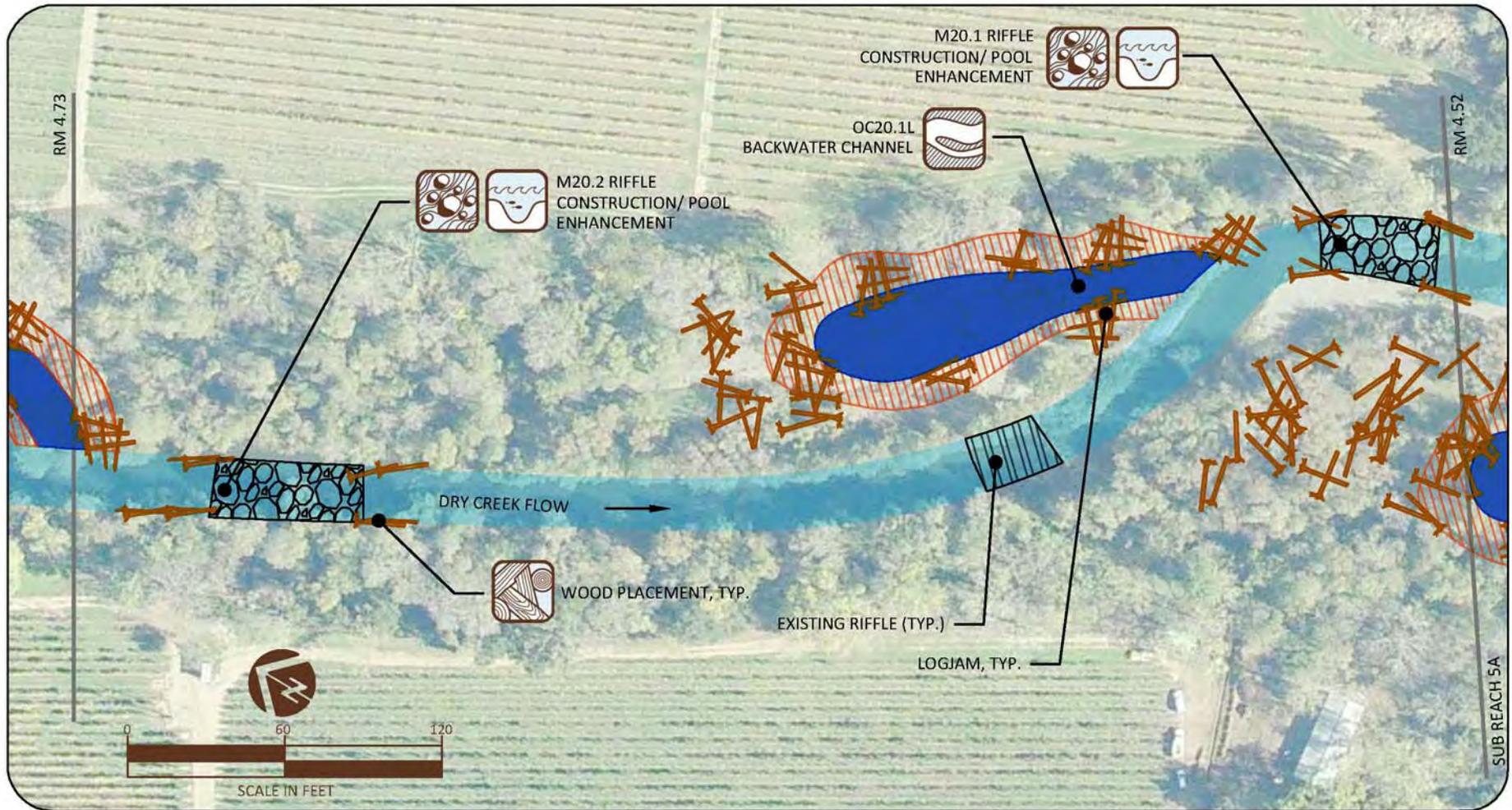
Project Code	Backwater Channel	Side Channel	Pool Enhancement	Riffle Enhancement	LWD	Winter Refuge Habitat	Bank Stabilization	Vegetation Management	Comments
M 20.1	X				X			X	Riffle Construction & Pool Enhancement
OC 20.1L			X	X	X			X	Backwater Channel Construction
M 20.2			X	X	X			X	Riffle Construction & Pool Enhancement
OC 20.2L	X				X			X	Alcove Enhancement
M 20.3			X	X	X			X	Riffle Construction & Pool Enhancement
OC 20.3R					X	X		X	Winter Refuge Habitat
M 20.4			X	X	X			X	Riffle Construction & Pool Enhancement
OC 20.4L					X	X		X	Winter Refuge Habitat
M 20.5			X	X	X			X	Riffle Construction & Pool Enhancement

Table J8. Inventory of projects identified in sub-reach 5b.

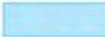
\*Backwater channels provide serve as winter refuge habitat during frequently occurring winter flood events. Off-channel, low-velocity habitat area increases with discharge in backwater channels during winter storms.



Figure J9. Reach 5 sheet index for conceptual design detail sheets.

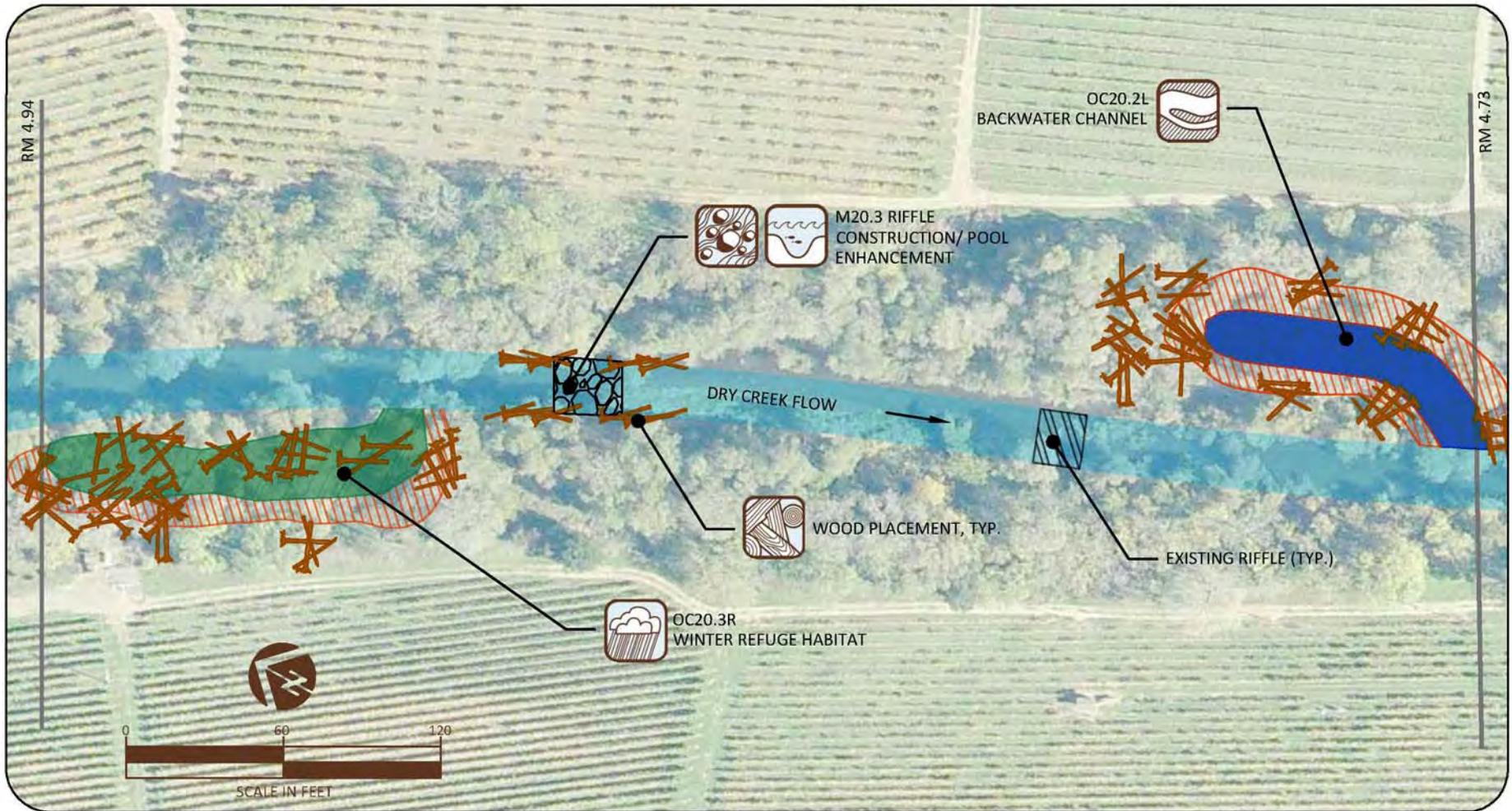


**LEGEND**

- |   |   |   |  |   |
|---|---|---|--|---|
|  |  |  |  |  |
| MAIN CHANNEL AT 110 CFS   | OFF CHANNEL HABITAT   | GRADING   | RIFFLE CONSTRUCTION/ ENHANCEMENT   | EXISTING RIFFLE   |

SUB REACH 5 B  
CONCEPT DESIGN  
1 OF 4

Figure J10. Sub-reach 5b conceptual design detail 1 of 4.



**LEGEND**

-   
 MAIN CHANNEL AT  
110 CFS
-   
 OFF CHANNEL  
HABITAT
-   
 GRADING LIMIT
-   
 RIFFLE CONSTRUCTION/  
ENHANCEMENT
-   
 EXISTING RIFFLE
-   
 WINTER REFUGE

SUB REACH 5 B  
CONCEPT DESIGN  
2 OF 4

Figure J11. Sub-reach 5b conceptual design detail 2 of 4.



Figure J12. Sub-reach 5b conceptual design detail 3 of 4.



MAIN CHANNEL AT  
110 CFS

**LEGEND**

GRADING LIMIT

RIFFLE CONSTRUCTION/  
ENHANCEMENT

SUB REACH 5 B  
CONCEPT DESIGN  
4 OF 4

Figure J13. Sub-reach 5b conceptual design detail 4 of 4.

**Sub-Reach 5b Analysis of Proposed Enhancements**

Proposed enhancements would create over 168,000 ft<sup>2</sup> of additional habitat in sub-reach 5b. More than 80,000 ft<sup>2</sup> of the enhancements would specifically benefit juvenile coho in the form of summer and winter off-channel habitat (backwater channel and winter refuge), and addition to the enhanced main channel margin habitat. The following tables summarize the frequency and areas of existing vs. proposed habitat (Table J9), additional habitat to be created by enhancements (Table J10) cost-based metrics (Table J11). Table J12 present the habitat enhancements normalized by main channel sub-reach length. Table J13 summarizes the planning level cost estimate developed for sub-reach 5b.

Table J9. Habitat areas and frequencies based on existing and proposed habitats for sub-reach 5b.

Habitat	Existing Habitat		Proposed Habitat	
	Area (ft <sup>2</sup> )	#	Area (ft <sup>2</sup> )	#
Alcove / Backwater	450	1	24450	2
Flatwater	172650	12	92950	9
Pool	51300	4	145750	11
Riffle	15050	4	37900	8
Side Channel	650	1	650	1
Winter Refuge	0	0	33000	2

Table J10. Additional habitat benefits provided by backwater habitat, LWD-margin habitat, and riffles.

Habitat Type	(ft <sup>2</sup> )	(m <sup>2</sup> )
Alcove/Backwater (summer coho rearing)	24000	2230
LWD-Margin Habitat (summer coho rearing)	13000	1210
Winter Refuge (winter coho rearing)	46450	4320
Pools	94450	8770
Riffles	22850	2120
<b>Total</b>	<b>168950</b>	<b>15700</b>

\*Alcove/Backwater habitats also provide winter refuge habitat during flood events.

Table J11. Cost – benefit table for design concepts presented for sub-reach 5b

Cost - Benefit Metric	Cost (\$)
Cost / ft <sup>2</sup> of summer coho rearing*	269
Cost / ft <sup>2</sup> of winter coho rearing**	119
Cost / ft <sup>2</sup> of total enhanced habitat***	59

\*includes backwater and LWD-margin habitats

\*\*includes alcove/backwater, LWD-margin, and winter refuge habitats

\*\*\*includes alcove/backwater, LWD-margin, winter refuge, and riffles

Table J12. Length metric table showing habitat area divided by main channel sub-reach length for summer coho rearing, winter coho rearing, and total enhanced habitat.

Length Metric	area (ft <sup>2</sup> )/ length (ft)
Summer coho rearing habitat	9
Winter coho rearing habitat	19
Total enhanced habitat	39

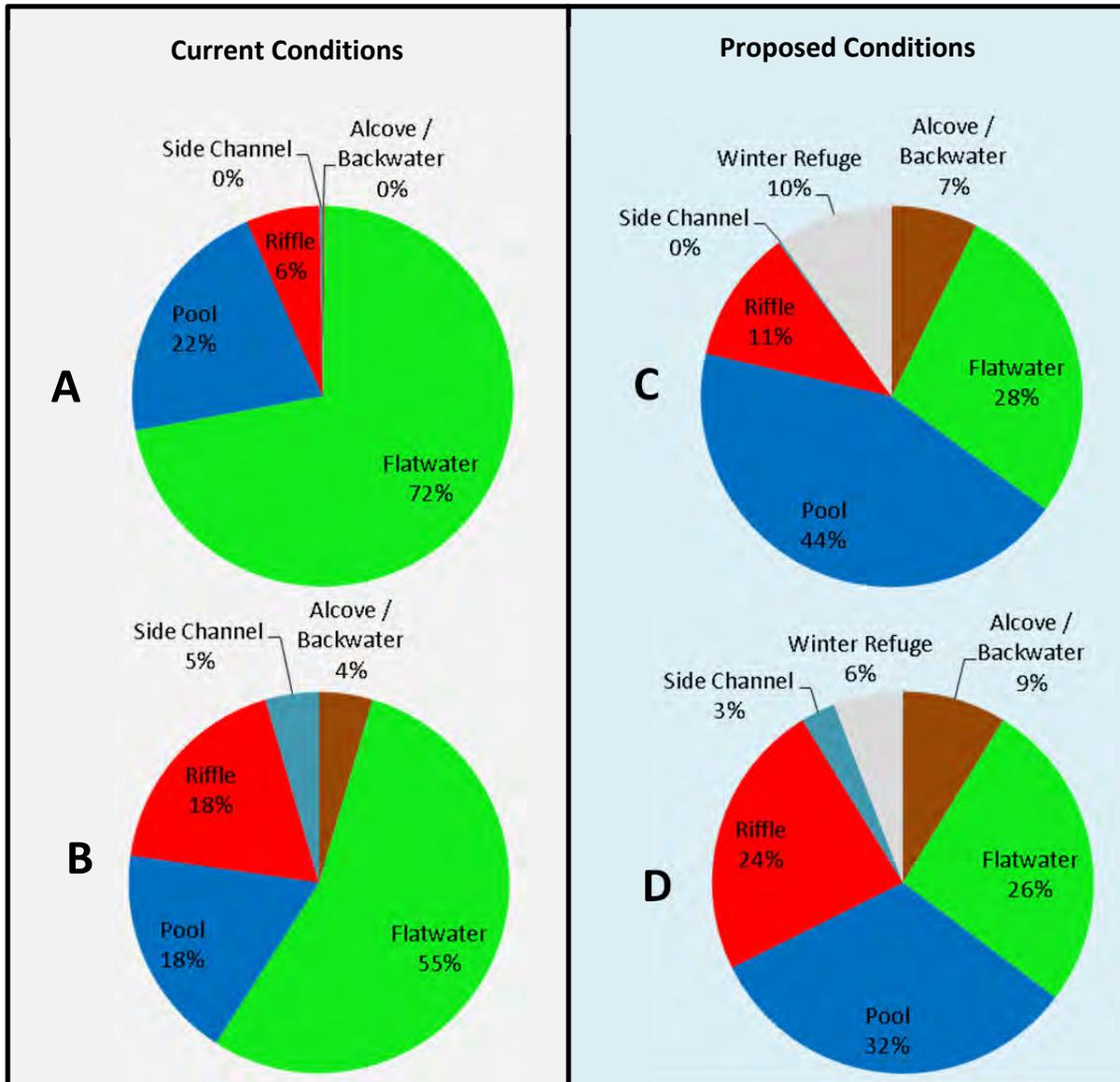


Figure J14. Existing sub-reach 5b habitats shown by area (A), frequency (B) and proposed habitat units based on area (C) and frequency (D).

**Sub-Reach 5b Alternatives Discussion**

The floodplain surface, in the vicinity of OC 42R, is frequently inundated and appears to be suitable for a side channel enhancement designed to be dynamic over time. It appears as though sediment delivered by Schoolhouse Creek and additional local drainage deposits in this area will facilitate a dynamic floodplain enhancement approach. Existing high flow channels could be utilized in creating an alignment of the side channel alternative at this location.

Table J13. Sub-reach 5b Planning Level Cost Estimate

Note: This is a preliminary cost estimate for planning purposes. Actual costs for design and construction activities may vary substantially from these estimates. Assumptions for time requirements and material quantities have been made based on limited information that is available for the site. Additional information obtained during site investigations will be needed to determine actual quantities and costs. Estimates based on 2011 costs.

No.	Description	Unit	Quantity	Unit Cost	Total Cost	Design and Quantity Assumptions						
1	Mobilization and Demobilization	LS	1	\$310,000	\$310,000	Calculated at 5% of construction sub-total.						
2	Temporary Access Road Improvements	LS	1	\$300,000	\$300,000	Includes access road improvements, traffic control, dust control, and site restoration.						
3	Temporary Traffic Control & Flagging	LS	1	\$1,520,000	\$1,520,000	Includes stream diversion/dewatering, fish relocation, and erosion control BMPs.						
4	Clearing and Grubbing	AC	2	\$2,000	\$4,000							
5	Common Excavation											
a.	OC 20.4	CY	33,280	\$20	\$665,600	Final design criteria and analysis will likely alter these estimates up or down.						
b.	OC 20.3	CY	4,166	\$20	\$83,320							
c.	OC 20.2	CY	4,655	\$20	\$93,100							
d.	OC 20.1	CY	5,660	\$20	\$113,200							
6	Large Woody Debris (purchased, delivered, installed)											
a.	Floodplain Roughness Logs	EA	127	\$1,150	\$146,050	Assumes 30% delivered with root wads attached.						
b.	Backwater Habitat Logs	EA	291	\$1,150	\$334,650							
c.	Pool Enhancement Logs	EA	160	\$1,150	\$184,000							
d.	Log Jams	EA	600	\$1,150	\$690,000							
7	Boulder Ballast (purchased, delivered, installed)	TN	1,178	\$100	\$117,800	Estimate 1 ton per log.						
8	Bank Stabilization	LF	1,206	\$1,000	\$1,206,000	Bank stabilization methods will vary but will include one or more of the following components: large woody debris, earthwork, riprap scour protection, granular backfill, aggregate filter material, geotextile fabric, and/or fabric encapsulated soil lifts. Assumes 30% delivered with root wads attached.						
9	Riffle Installation (purchased, delivered, installed)	CY	3,333	\$120	\$399,960	Assume average of 3 feet of depth per riffle for riffle construction. Assume average of 1.5 feet of depth per riffle for riffle enhancement.						
10	Vegetation Management	AC	12	\$20,000	\$240,000	Assumes area of floodplain from vineyard grade to vineyard grade minus the base flow inundation area of the main channel and of the proposed backwater habitat areas.						
<b>Construction Sub-Total</b>					<b>\$6,407,680</b>	<table border="1"> <tr> <td><b>Key</b></td> <td>LS = Lump Sum CY = Cubic Yard LF = Lineal Foot AC = Acre EA = Each</td> </tr> <tr> <td><b>Project Delivery Items are calculated as a percent of the construction sub-total</b></td> <td></td> </tr> <tr> <td><b>General Notes:</b></td> <td>-Cost includes a 30% design and construction contingency -Costs assume all materials (wood and rock) are purchased and hauled to the site from a nearby source -Boulder ballast requirements may be able to be reduced depending on hydraulics analysis</td> </tr> </table>	<b>Key</b>	LS = Lump Sum CY = Cubic Yard LF = Lineal Foot AC = Acre EA = Each	<b>Project Delivery Items are calculated as a percent of the construction sub-total</b>		<b>General Notes:</b>	-Cost includes a 30% design and construction contingency -Costs assume all materials (wood and rock) are purchased and hauled to the site from a nearby source -Boulder ballast requirements may be able to be reduced depending on hydraulics analysis
<b>Key</b>	LS = Lump Sum CY = Cubic Yard LF = Lineal Foot AC = Acre EA = Each											
<b>Project Delivery Items are calculated as a percent of the construction sub-total</b>												
<b>General Notes:</b>	-Cost includes a 30% design and construction contingency -Costs assume all materials (wood and rock) are purchased and hauled to the site from a nearby source -Boulder ballast requirements may be able to be reduced depending on hydraulics analysis											
Concept Level Design & Construction Contingency (30%)					\$1,922,304							
<b>Construction Total</b>					<b>\$8,330,000</b>							
<b>Project Delivery</b>												
Permitting (4%)					\$256,307							
Detailed Engineering Design (15%)					\$961,152							
Contract Administration (5%)					\$320,384							
Construction Oversight (1.5%)					\$96,115							
<b>Project Delivery Sub-Total</b>					<b>\$1,634,000</b>							
<b>TOTAL ESTIMATE</b>					<b>\$9,964,000</b>	rounded to nearest \$1,000						

## APPENDIX K

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**K.1 Reach 4 Description**

Reach 4 is influenced greatly by three grade control sills constructed by USACE in 1983. The concrete sills were installed to limit the migrating knickpoint’s ability to continue the widespread incision in Dry Creek. The upper sill (RM 3.8) consists of a cascade down two sets of boulder falls, 2’ and 1’ in height. The middle sill (RM 3.5) is 200’ long, 10’ wide, and 3’ in height. The lower sill (RM 3.3) is 100’ long, 10’ wide, and 1 foot tall. Each sill has a fish ladder to provide passage through the short cascades. Rock riprap covers the 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. After the construction of WSD, reach 4 has become less sinuous although some channel migration has occurred. A series of floodplain contractions and expansions are found in reach 4, with active floodplain width varying from 300 – 600 ft. See the Dry Creek Current Conditions Report (Inter-Fluve 2010), Appendix A, for more detail.



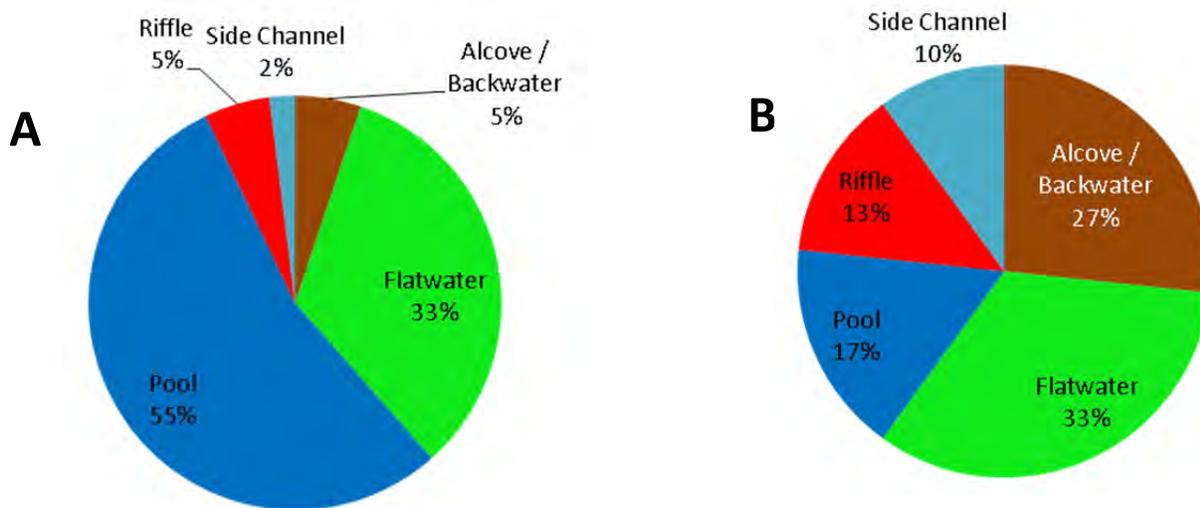
Figure K1. (upper left) lower sill, (upper right) upper sill, (lower left) ladder on middle sill, (lower right) middle sill.

Reach 4 Current Habitat Conditions

Table K1. Reach 4 habitat units based on current conditions

Habitat	Existing Habitat	
	Area (ft <sup>2</sup> )	#
Alcove / Backwater	18750	8
Flatwater	120800	10
Pool	197300	5
Riffle	18600	4
Side Channel	7200	3

Figure K2. Habitat units in reach 5 based on area (A) and frequency (B).



K.2 Reach 4 Enhancement Approach

Reach 4 is located in the “middle segment<sup>1</sup>” of Dry Creek, characterized by the increased sediment and surface water contributed by tributaries. In this segment, Dry Creek begins to have a more significant sediment supply due to the influence of unregulated tributaries. Enhancements in reach 4 will have to consider potential consequences of the larger sediment supplied by tributaries. The focus of enhancements in reach 4 will be to utilize relatively large floodplain areas for off-channel habitat development. For purposes of enhancement planning, reach 4 has been split into 3 enhancement sub-reaches (Figure K3). Sub-reach 4a (RM 3.01 to 3.46) is described in section K.3, sub-reach 4b (RM 3.46 to 3.78) is described in section K.4, and sub-reach 4c (RM 3.78 to 4.04) is described in K.5.

<sup>1</sup> Additional detail of process-based delineation of lower Dry Creek into upper, middle and lower segments can be found in the Fish Habitat Enhancement Feasibility Study, Section 5.3, IFI 2011.



Figure K3. Reach 4 habitat units and sub-reach boundaries.

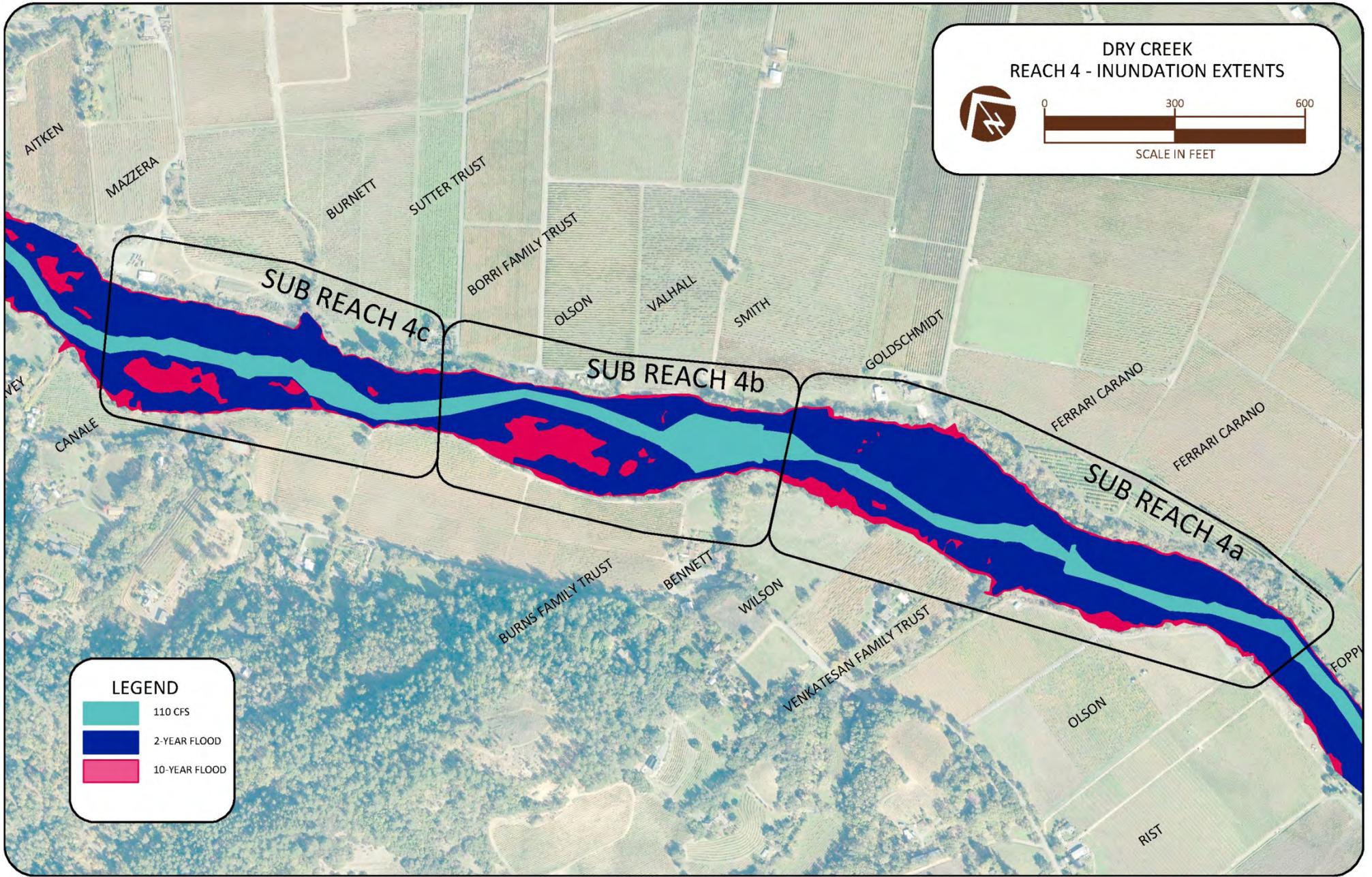


Figure K4. Modeled inundations in Reach 4 based on three specific discharge levels: 110 cfs, the 2-year and 10-year flood events.

**K.3 Sub-Reach 4a Conceptual Designs**

Sub-Reach 4a has a relatively low level of sinuosity compared to other sections of Dry Creek, and the channel is influenced by the grade control sills constructed by the USACE. The over-bank area in between the main channel and the slope up to the terrace provides significant opportunity for off-channel habitat enhancement. The floodplain ranges from 200 to 500 ft wide in sub-reach 4a. Off-channel enhancements include the creation of backwater channels and placement of LWD. Main channel habitat enhancements are to include pool enhancements, riffle construction, and log jams. The lower-most grade control sill is located 1100 ft upstream from the boundary of the sub-reach, and provides stable water surface elevation for a backwater channel proposed in the valley left floodplain. The following table and accompanying figures summarize the design concepts developed for sub-reach 4a.

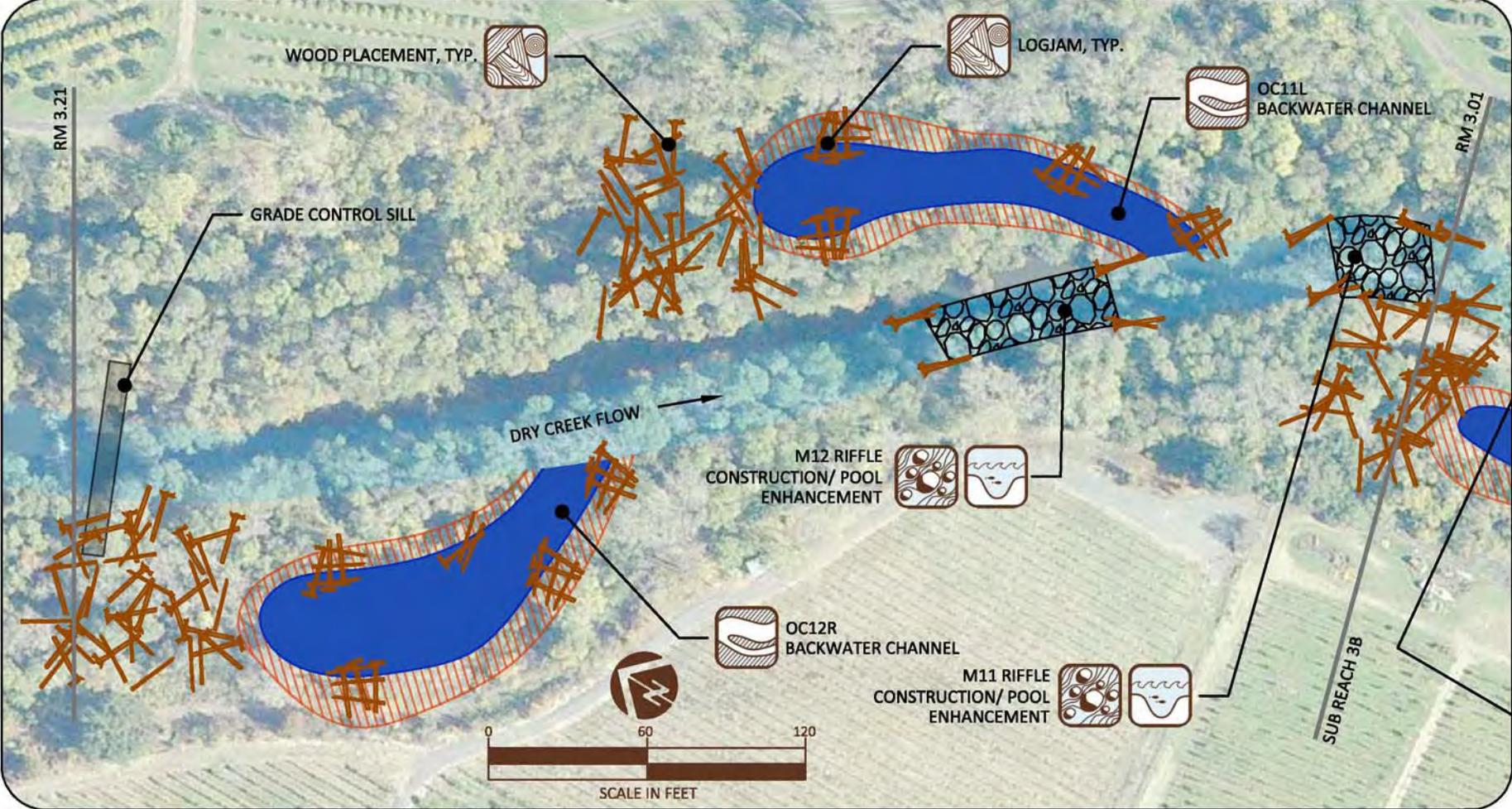
Project Code	Backwater Channel	Side Channel	Pool Enhancement	Riffle Enhancement	LWD	Winter Refuge Habitat*	Bank Stabilization	Vegetation Management	Comments
M 11			X	X	X			X	Riffle Construction & Pool Enhancement
OC 11L	X				X			X	Backwater Channel Construction
M 12			X	X	X			X	Riffle & Pool Enhancement
OC 12R	X				X			X	Backwater Channel Construction
OC 13L	X				X			X	Backwater Channel Construction
M 14			X	X	X			X	Riffle Construction & Pool Enhancement
OC 14	X				X			X	Alcove Enhancement

Table K2. Inventory of projects identified in sub-reach 4a.

\* Backwater channel habitats will also provide winter refuge, and available off-channel habitat for juvenile salmonids will become large as flows increase during winter storms.



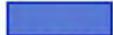
Figure K5. Reach 4 index sheet for conceptual design detail sheets.



**LEGEND**



MAIN CHANNEL AT 110 CFS



OFF CHANNEL HABITAT



GRADING



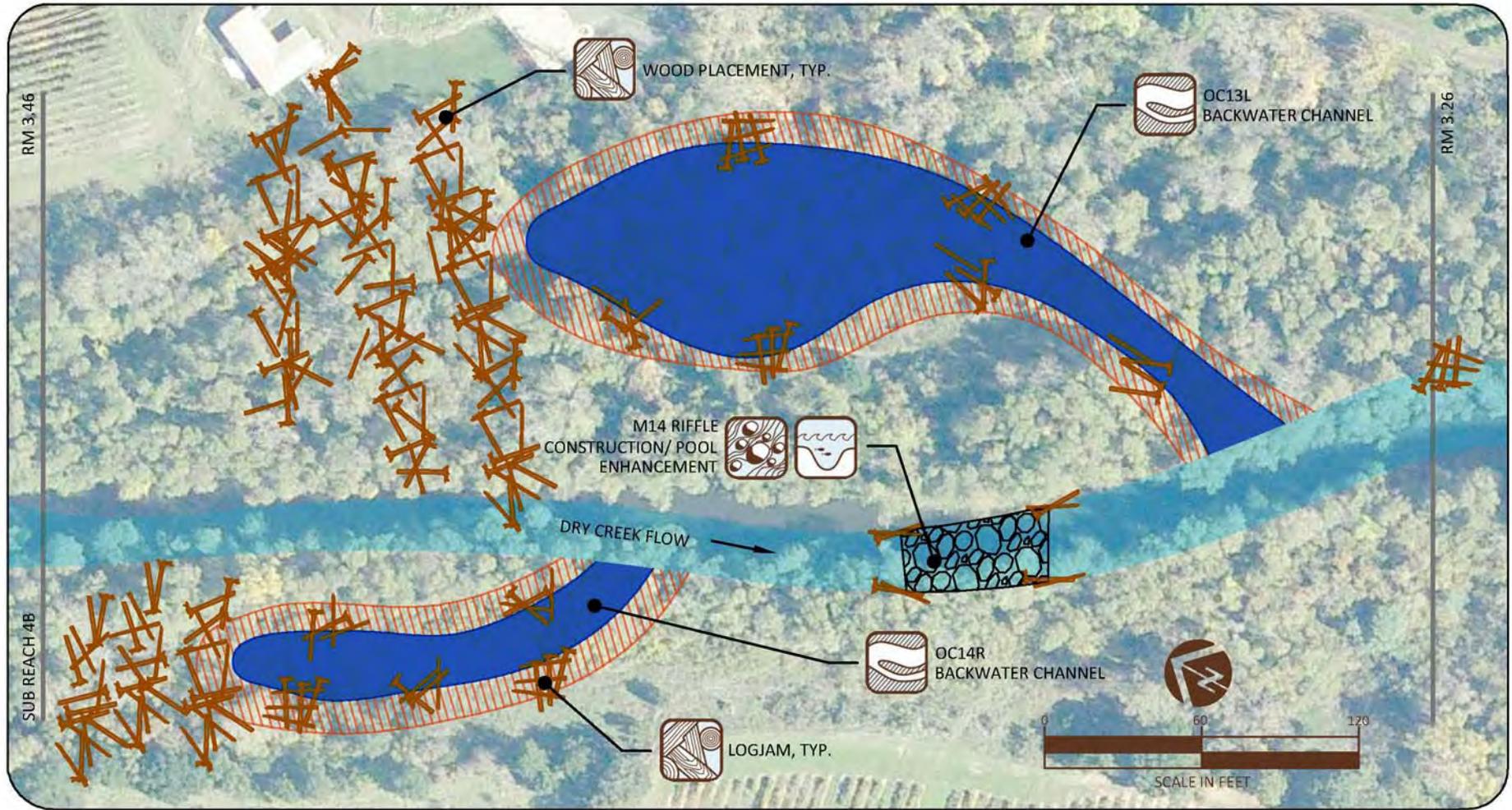
RIFFLE CONSTRUCTION/ ENHANCEMENT



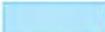
EXISTING RIFFLE

SUB REACH 4 A  
CONCEPT DESIGN  
1 OF 2

Figure K6. Sub-reach 4a conceptual design detail sheet 1 of 2.



**LEGEND**

-  MAIN CHANNEL AT 110 CFS
-  OFF CHANNEL HABITAT

SUB REACH 4 A  
CONCEPT DESIGN  
2 OF 2

Figure K7. Sub-reach 4a conceptual design detail sheet 2 of 2.

Sub-Reach 4a Analysis of Proposed Enhancements

Proposed enhancements will create over 180,000 ft<sup>2</sup> of additional habitat. More than 107,000 ft<sup>2</sup> of the enhancements will provide summer coho rearing habitat. Additionally, more than 50,000 ft<sup>2</sup> of main channel enhancements will improve the function of sub-reach 4a, and the quality of juvenile coho and steelhead habitat. The following tables summarize the frequency and areas of existing vs. proposed habitat (Table K3), additional habitat to be created by enhancements (Table K4) cost-based metrics (Table K5). Table K6 presents the habitat enhancement areas normalized by sub-reach main channel length. Table K7 summarizes the planning level cost estimate developed for sub-reach 4a.

Table K3: Habitat area by unit type for existing and proposed conditions in sub-reach 4a.

Habitat	Existing Habitat		Proposed Habitat	
	Area (ft <sup>2</sup> )	#	Area (ft <sup>2</sup> )	#
Alcove / Backwater	1000	2	106850	6
Flatwater	85850	8	53800	6
Pool	52850	2	93000	6
Riffle	14050	3	26150	5
Side Channel	0	0	0	0

Table K4. Additional habitat benefits provided by backwater habitat, LWD-margin habitat, and riffles in Sub-reach 4a.

Habitat Type	(ft <sup>2</sup> )	(m <sup>2</sup> )
Alcove/Backwater <sup>+</sup> (summer coho rearing)	105850	9830
LWD-Margin Habitat (summer coho rearing)	2000	190
Winter Refuge (coho rearing)	24450	2270
Pools	38100	3540
Riffles	12100	1120
<b>Total</b>	<b>182500</b>	<b>16950</b>

<sup>+</sup>Alcove/Backwater habitats also provide winter refuge habitat during flood events.

Table K5. Cost-benefit table for design concepts presented for sub-reach 4a.

Cost - Benefit Metric	Cost / ft <sup>2</sup>
Cost / ft <sup>2</sup> of summer coho rearing*	80
Cost / ft <sup>2</sup> of winter coho rearing**	65
Cost / ft <sup>2</sup> of total enhanced habitat***	47

\*includes backwater and LWD-margin habitats

\*\* includes alcove/backwater, high flow backwater habitat, LWD-margin, pool and riffle habitats.

\*\*\* includes alcove/backwater, LWD-margin, high flow backwater habitat, pool and riffle habitats.

Table K6. Length metric table showing habitat area divided by main channel sub-reach length for summer coho rearing and total enhanced habitat.

Length Metric	area (ft <sup>2</sup> ) / length (ft)
Summer coho rearing habitat	45
Winter coho rearing habitat	55
Total enhanced habitat	76

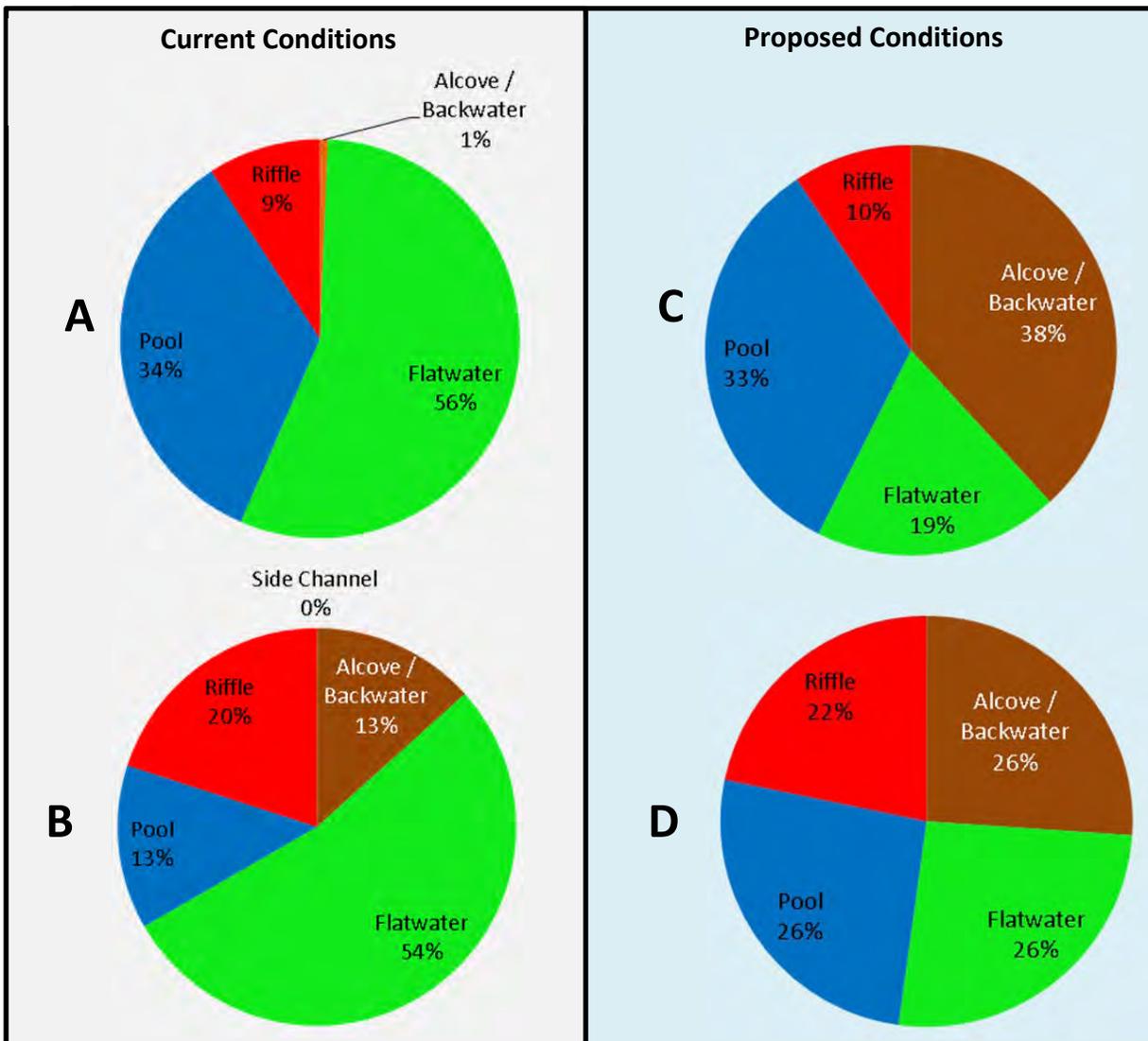


Figure K8. Existing habitats shown by area (A), frequency (B) and proposed habitat units based on area (C) and frequency (D).

Table K7. Sub-Reach 4a Planning Level Cost Estimate

Note: This is a preliminary cost estimate for planning purposes. Actual costs for design and construction activities may vary substantially from these estimates. Assumptions for time requirements and material quantities have been made based on limited information that is available for the site. Additional information obtained during site investigations will be needed to determine actual quantities and costs. Estimates based on 2011 costs.

No.	Description	Unit	Quantity	Unit Cost	Total Cost	Design and Quantity Assumptions
1	Mobilization and Demobilization	LS	1	\$270,000	\$270,000	Calculated at 5% of construction sub-total.
2	Site Access Measures	LS	1	\$260,000	\$260,000	Includes access road improvements, traffic control, dust control, and site restoration.
3	Environmental Protection Measures	LS	1	\$1,320,000	\$1,320,000	Includes stream diversion/dewatering, fish relocation, and erosion control BMPs.
4	Clearing and Grubbing	AC	4	\$2,000	\$8,000	
5	Common Excavation					
a.	OC 14, M 14	CY	7,590	\$20	\$151,800	Final design criteria and analysis will likely alter these estimates up or down.
b.	OC 13	CY	16,580	\$20	\$331,600	
c.	OC 12	CY	7,010	\$20	\$140,200	
d.	OC 11	CY	4,490	\$20	\$89,800	
6	Large Woody Debris (purchased, delivered, installed)					
a.	Floodplain Roughness Logs	EA	380	\$1,150	\$437,000	Assumes 30% delivered with root wads attached.
b.	Backwater Habitat Logs	EA	380	\$1,150	\$437,000	
c.	Pool Enhancement Logs	EA	100	\$1,150	\$115,000	
d.	Log Jams	EA	520	\$1,150	\$598,000	
7	Boulder Ballast (purchased, delivered, installed)	TN	1,380	\$100	\$138,000	Estimate 1 ton per log.
8	Bank Stabilization	LF	770	\$1,000	\$770,000	Bank stabilization methods will vary but will include one or more of the following components: large woody debris, earthwork, riprap scour protection, granular backfill, aggregate filter material, geotextile fabric, and/or fabric encapsulated soil lifts. Assumes 30% delivered with root wads attached.
9	Riffle Installation (purchased, delivered, installed)	CY	1,670	\$120	\$200,400	Assume average of 3 feet of depth per riffle for riffle construction. Assume average of 1.5 feet of depth per riffle for riffle enhancement.
10	Vegetation Management	AC	15	\$20,000	\$300,000	Assumes area of floodplain from vineyard grade to vineyard grade minus the base flow inundation area of the main channel and of the proposed backwater habitat areas.
<b>Construction Sub-Total</b>					<b>\$5,566,800</b>	<div style="display: flex; justify-content: space-between;"> <div style="border: 1px solid black; padding: 5px;"> <p><b>Key</b>                      LS = Lump Sum                      CY = Cubic Yard                      LF = Lineal Foot                      AC = Acre                      EA = Each</p> </div> <div style="border: 1px solid black; padding: 5px;"> <p><b>Project Delivery Items are calculated as a percent of the construction sub-total</b>  <b>General Notes:</b>                      -Cost includes a 30% design and construction contingency                      -Costs assume all materials (wood and rock) are purchased and hauled to the site from a nearby source                      -Boulder ballast requirements may be able to be reduced depending on hydraulics analysis</p> </div> </div>
Concept Level Design & Construction Contingency (30%)					\$1,670,040	
<b>Construction Total</b>					<b>\$7,236,800</b>	
<b>Project Delivery</b>						
Permitting (4%)					\$222,672	
Detailed Engineering Design (15%)					\$835,020	
Contract Administration (5%)					\$278,340	
Construction Oversight (1.5%)					\$83,502	
<b>Project Delivery Sub-Total</b>					<b>\$1,419,500</b>	
<b>TOTAL ESTIMATE</b>					<b>\$8,656,000</b>	

rounded to nearest \$1,000

**K.4 Sub-Reach 4b Conceptual Designs**

Sub-reach 4b also has a relatively low level of sinuosity compared to other sections of Dry Creek, and the sub-reach is bounded by the middle and upper grade control sills. There are significant floodplain areas suitable for off-channel habitat enhancement. Off-channel enhancements include the creation of alcoves/backwater channels and placement of LWD features. Main channel habitat enhancements are to include pool enhancements, riffle construction, and log jams. The lower-most grade control sill is located 1100 ft upstream from the boundary of the sub-reach, and provides stable water surface elevation for a backwater channel proposed in the valley left floodplain. The following table and accompanying figures summarize the design concepts developed for sub-reach 4b.

Project Code	Backwater Channel	Side Channel	Pool Enhancement	Riffle Enhancement	LWD	Winter Refuge Habitat*	Bank Stabilization	Vegetation Management	Comments
OC 15L	X				X			X	Alcove Enhancement
OC 16.1R	X				X			X	Backwater Channel Construction
M 16.2			X	X	X			X	Riffle Construction & Pool Enhancement
OC 16.2R	X				X			X	Backwater Channel Construction

Table K8. Inventory of projects identified in sub-reach 4b.

\* Backwater channel habitats will also provide winter refuge, and available off-channel habitat for juvenile salmonids will become large as flows increase during winter storms.



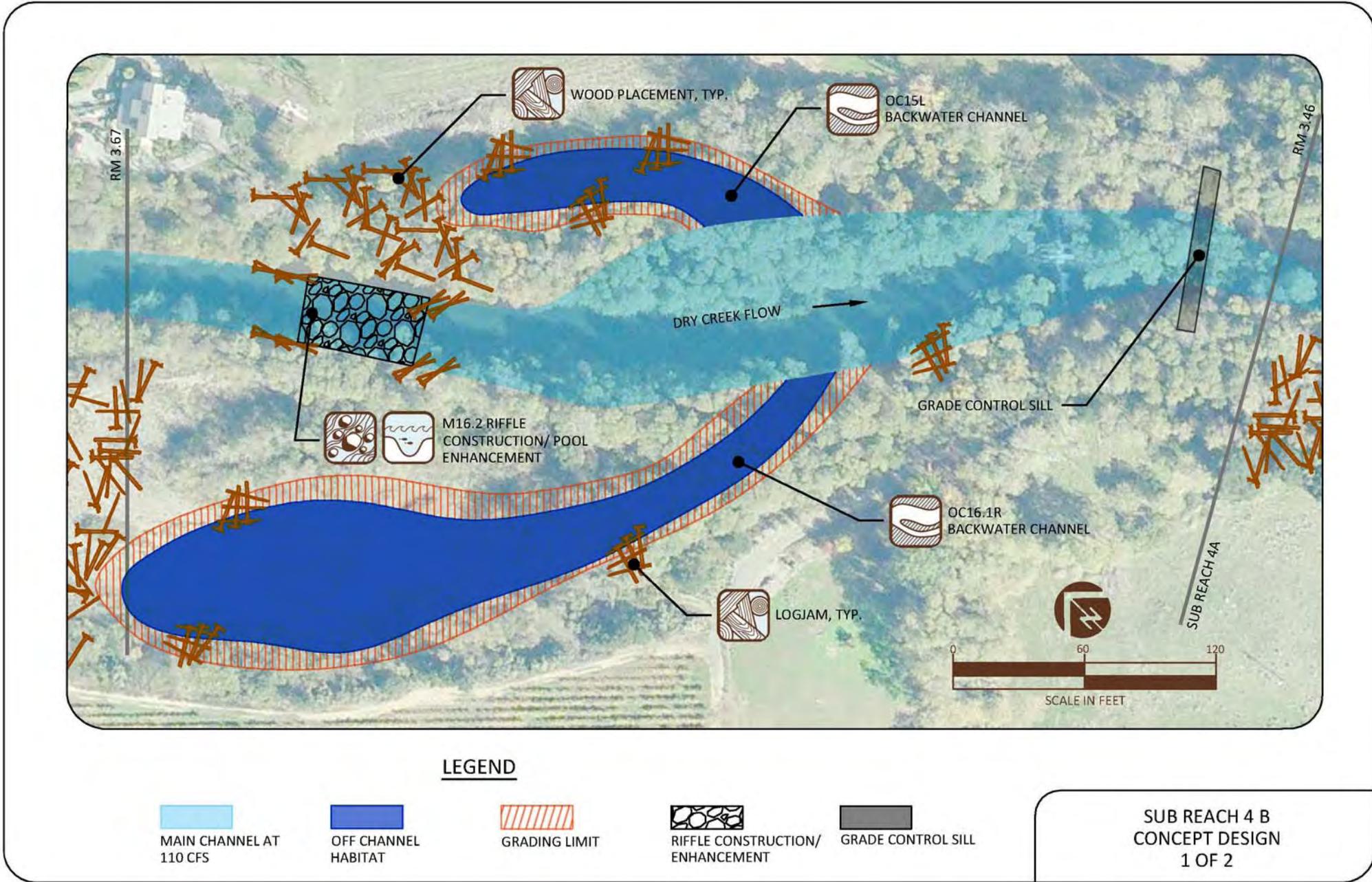
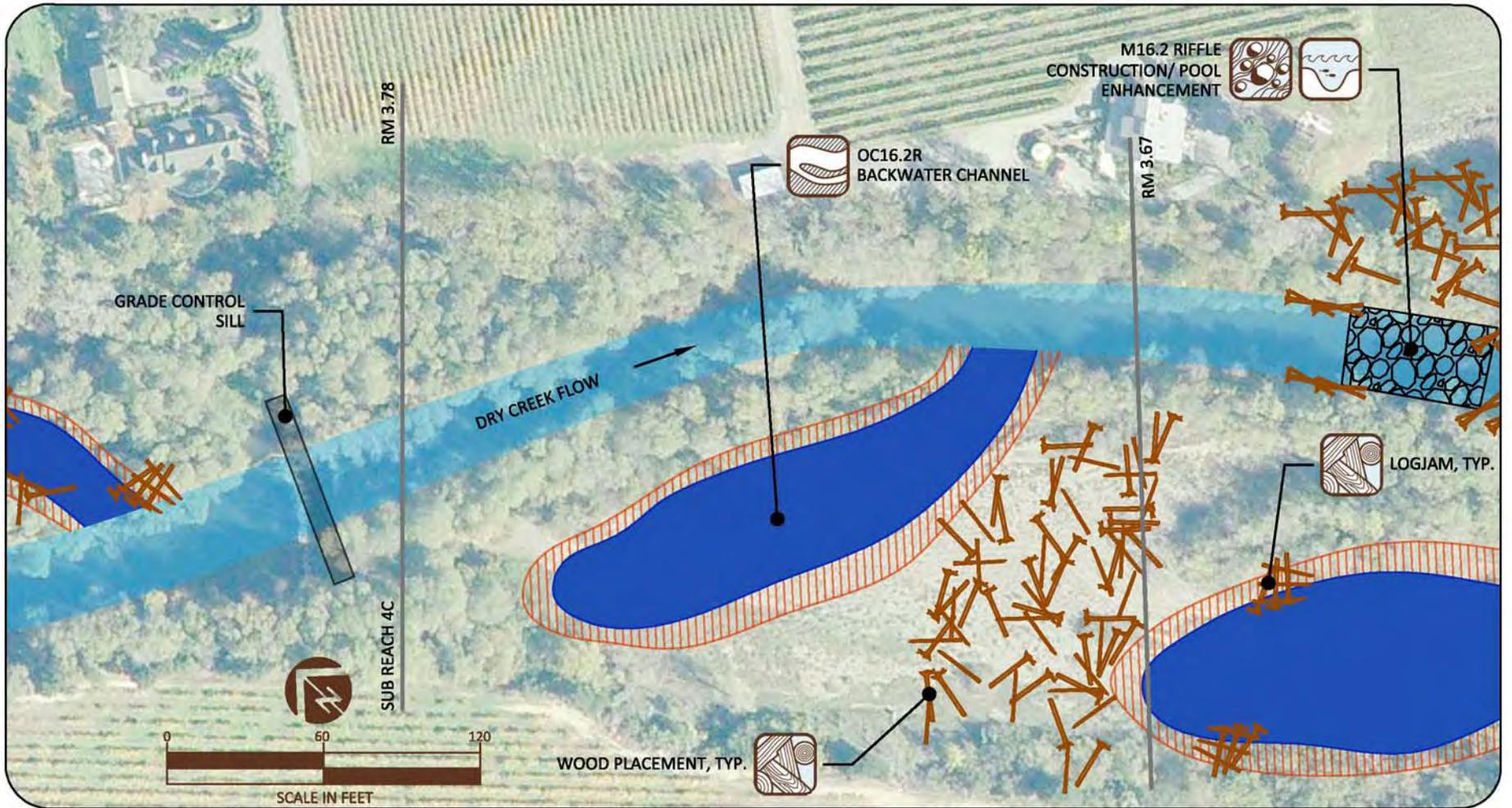


Figure K10. Sub-reach 4b conceptual design detail sheet 1 of 2.



**LEGEND**

-   
 MAIN CHANNEL AT 110 CFS
-   
 OFF CHANNEL HABITAT
-   
 GRADING LIMIT
-   
 RIFFLE CONSTRUCTION/ ENHANCEMENT
-   
 GRADE CONTROL SILL

**SUB REACH 4 B  
CONCEPT DESIGN  
2 OF 2**

Figure K11. Sub-reach 4b conceptual design detail sheet 2 of 2.

**Sub-Reach 4b Analysis of Proposed Enhancements**

Proposed enhancements would provide nearly 130,000 ft<sup>2</sup> of improved or new habitat in sub-reach 4b. More than 108,000 ft<sup>2</sup> of enhancements will provide summer coho rearing habitat, while an additional 10,000 ft<sup>2</sup> of enhancements will improve main channel habitat. The following tables summarize the frequency and areas of existing vs. proposed habitat (Table K9), additional habitat to be created by enhancements (Table K10) and cost-based metrics (Table K11). Table K12 presents the habitat enhancement areas normalized by sub-reach main channel length. Table K13 summarizes the planning level cost estimate developed for sub-reach 4b.

Table K9. Habitat areas and frequencies based on existing and proposed habitats for sub-reach 4b.

Habitat	Existing Habitat		Proposed Habitat	
	Area (ft <sup>2</sup> )	#	Area (ft <sup>2</sup> )	#
Alcove / Backwater	4200	1	107700	7
Flatwater	34950	2	34950	2
Pool	6700	2	56150	2
Riffle	4550	4	15450	2
Side Channel	7200	3	7200	3

Table K10. Additional habitat benefits provided by backwater habitat, LWD-margin habitat, and riffles.

Habitat Type	(ft <sup>2</sup> )	(m <sup>2</sup> )
Alcove/Backwater (summer coho rearing)	103500	9620
LWD-Margin Habitat (summer coho rearing)	5000	460
Winter Refuge (coho rearing)	15050	1400
Riffles	10900	1010
<b>Total</b>	<b>134450</b>	<b>12490</b>

<sup>+</sup>Alcove/Backwater habitats also provide winter refuge habitat during flood events.

Table K11. Cost – benefit table for design concepts presented for sub-reach 4b

Cost - Benefit Metric	Cost (\$)
Cost / ft <sup>2</sup> of summer coho rearing*	60
Cost / ft <sup>2</sup> of winter coho rearing**	52
Cost / ft <sup>2</sup> of total enhanced habitat***	48

\*includes backwater and LWD-margin habitats

\*\*includes alcove/backwater, high flow backwater habitat, LWD-margin, and winter refuge

\*\*\*includes alcove/backwater, high flow backwater habitat, LWD-margin, winter refuge, and riffles

Table K12. Length metric table showing habitat area divided by main channel sub-reach length for summer coho rearing and total enhanced habitat.

Length Metric	area (ft <sup>2</sup> ) / length (ft)
Summer coho rearing habitat	62
Winter coho rearing habitat	71
Total enhanced habitat	77

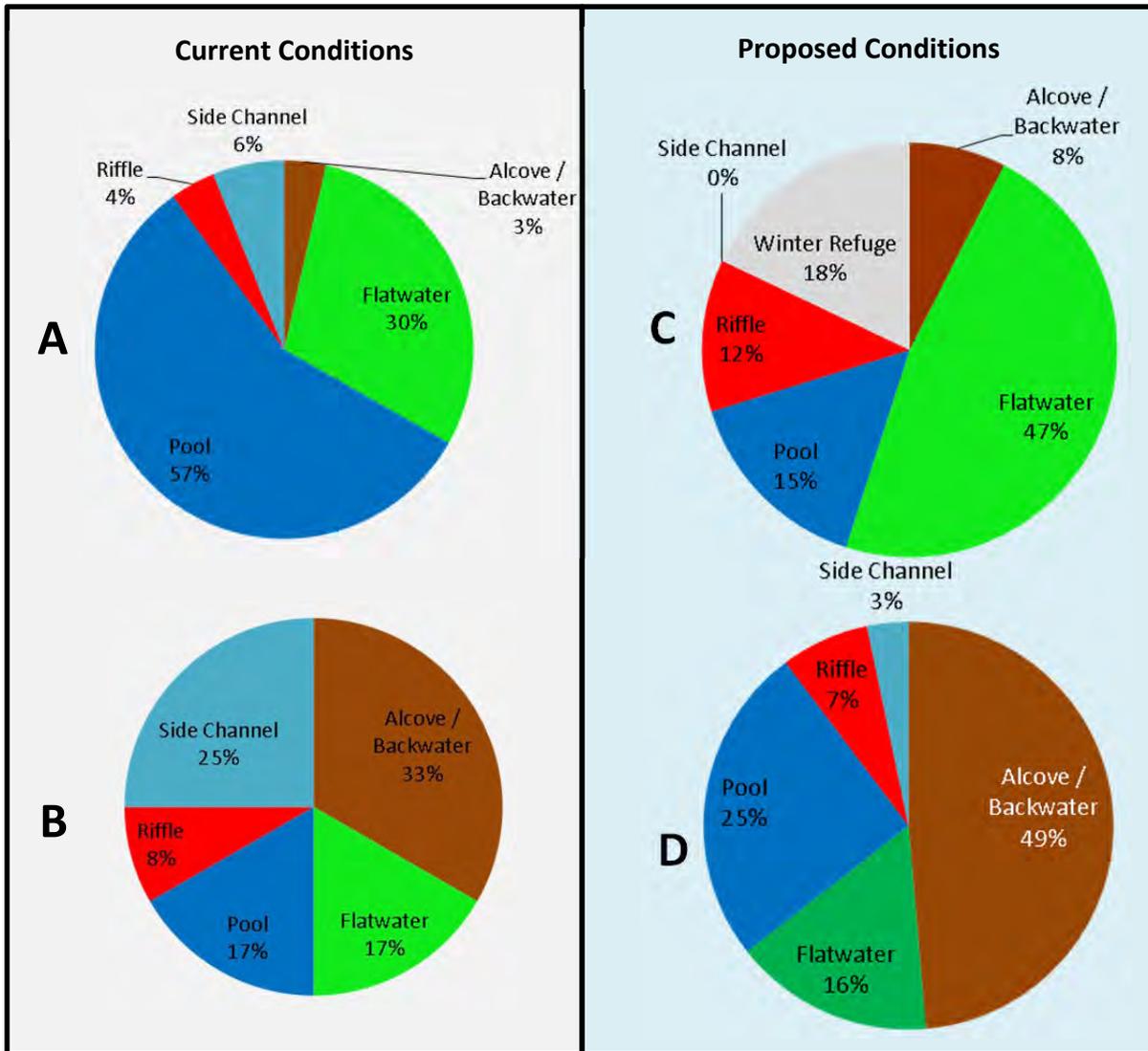


Figure K12. Existing sub-reach 4b habitats shown by area (A), frequency (B) and proposed habitat units based on area (C) and frequency (D).

Table K13. Sub-reach 4b Planning Level Cost Estimate

Note: This is a preliminary cost estimate for planning purposes. Actual costs for design and construction activities may vary substantially from these estimates. Assumptions for time requirements and material quantities have been made based on limited information that is available for the site. Additional information obtained during site investigations will be needed to determine actual quantities and costs. Estimates based on 2011 costs.

No.	Description	Unit	Quantity	Unit Cost	Total Cost	Design and Quantity Assumptions
1	Mobilization and Demobilization	LS	1	\$200,000	\$200,000	Calculated at 5% of construction sub-total.
2	Site Access Measures	LS	1	\$190,000	\$190,000	Includes access road improvements, traffic control, dust control, and site restoration.
3	Environmental Protection Measures	LS	1	\$990,000	\$990,000	Includes stream diversion/dewatering, fish relocation, and erosion control BMPs.
4	Clearing and Grubbing	AC	3	\$2,000	\$6,000	
5	Common Excavation					
a.	OC 16.2	CY	10,840	\$20	\$216,800	Final design criteria and analysis will likely alter these estimates up or down.
b.	OC 16.1	CY	15,710	\$20	\$314,200	
c.	OC 15	CY	3,230	\$20	\$64,600	
6	Large Woody Debris (purchased, delivered, installed)					
a.	Floodplain Roughness Logs	EA	210	\$1,150	\$241,500	Assumes 30% delivered with root wads attached.
b.	Backwater Habitat Logs	EA	410	\$1,150	\$471,500	
c.	Pool Enhancement Logs	EA	60	\$1,150	\$69,000	
d.	Log Jams	EA	200	\$1,150	\$230,000	
7	Boulder Ballast (purchased, delivered, installed)	TN	880	\$100	\$88,000	Estimate 1 ton per log.
8	Bank Stabilization	LF	790	\$1,000	\$790,000	Bank stabilization methods will vary but will include one or more of the following components: large woody debris, earthwork, riprap scour protection, granular backfill, aggregate filter material, geotextile fabric, and/or fabric encapsulated soil lifts. Assumes 30% delivered with root wads attached.
9	Riffle Installation (purchased, delivered, installed)	CY	1,000	\$120	\$120,000	Assume average of 3 feet of depth per riffle for riffle construction. Assume average of 1.5 feet of depth per riffle for riffle enhancement.
10	Vegetation Management	AC	8	\$20,000	\$160,000	Assumes area of floodplain from vineyard grade to vineyard grade minus the base flow inundation area of the main channel and of the proposed backwater habitat areas.
<b>Construction Sub-Total</b>					<b>\$4,151,600</b>	<div style="border: 1px solid black; padding: 5px; display: inline-block;"> <b>Key</b>                      LS = Lump Sum                      CY = Cubic Yard                      LF = Lineal Foot                      AC = Acre                      EA = Each                 </div> <div style="border: 1px solid black; padding: 5px; display: inline-block; margin-left: 20px;"> <b>Project Delivery Items are calculated as a percent of the construction sub-total</b>  <b>General Notes:</b>                      -Cost includes a 30% design and construction contingency                      -Costs assume all materials (wood and rock) are purchased and hauled to the site from a nearby source                      -Boulder ballast requirements may be able to be reduced depending on hydraulics analysis                 </div>
Concept Level Design & Construction Contingency (30%)					\$1,245,480	
<b>Construction Total</b>					<b>\$5,397,100</b>	
<b>Project Delivery</b>						
Permitting (4%)					\$166,064	
Detailed Engineering Design (15%)					\$622,740	
Contract Administration (5%)					\$207,580	
Construction Oversight (1.5%)					\$62,274	
<b>Project Delivery Sub-Total</b>					<b>\$1,058,700</b>	
<b>TOTAL ESTIMATE</b>					<b>\$6,456,000</b>	

rounded to nearest \$1,000

**K.5 Sub-Reach 4c Conceptual Designs**

Sub-reach 4c is located immediately upstream of the upper-most grade control structure. The channel has a moderate level of sinuosity, and is flanked by relatively wide floodplain areas. There are significant areas suitable for off-channel habitat creation. Off-channel enhancements include the construction of an alcove, a backwater channel, and placement of LWD features. Main channel enhancements include riffle construction, pool enhancement, and installation of logjams. The following table and corresponding figures summarize the concepts developed for sub-reach 4c.

Project Code	Backwater Channel	Side Channel	Pool Enhancement	Riffle Enhancement	LWD	Winter Refuge Habitat*	Bank Stabilization	Vegetation Management	Comments
OC 17.1L	X				X			X	Alcove Enhancement
M 17.2			X	X	X			X	Riffle Construction & Pool Enhancement
OC 17.2L	X				X			X	Backwater Channel Construction

Table K14. Inventory of projects identified in sub-reach 4c.

\* Backwater channel habitats will also provide winter refuge, and available off-channel habitat for juvenile salmonids will become large as flows increase during winter storms.

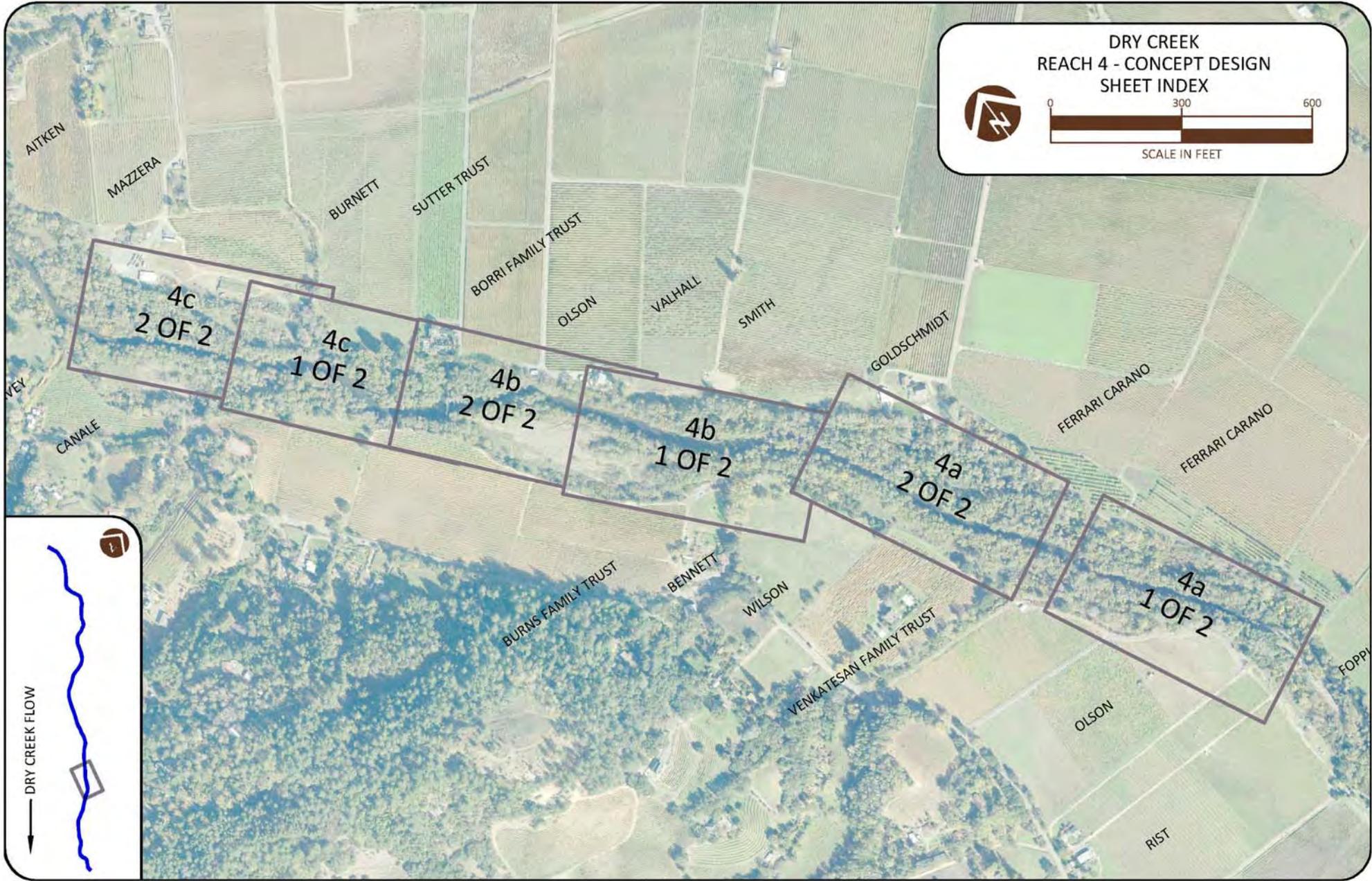
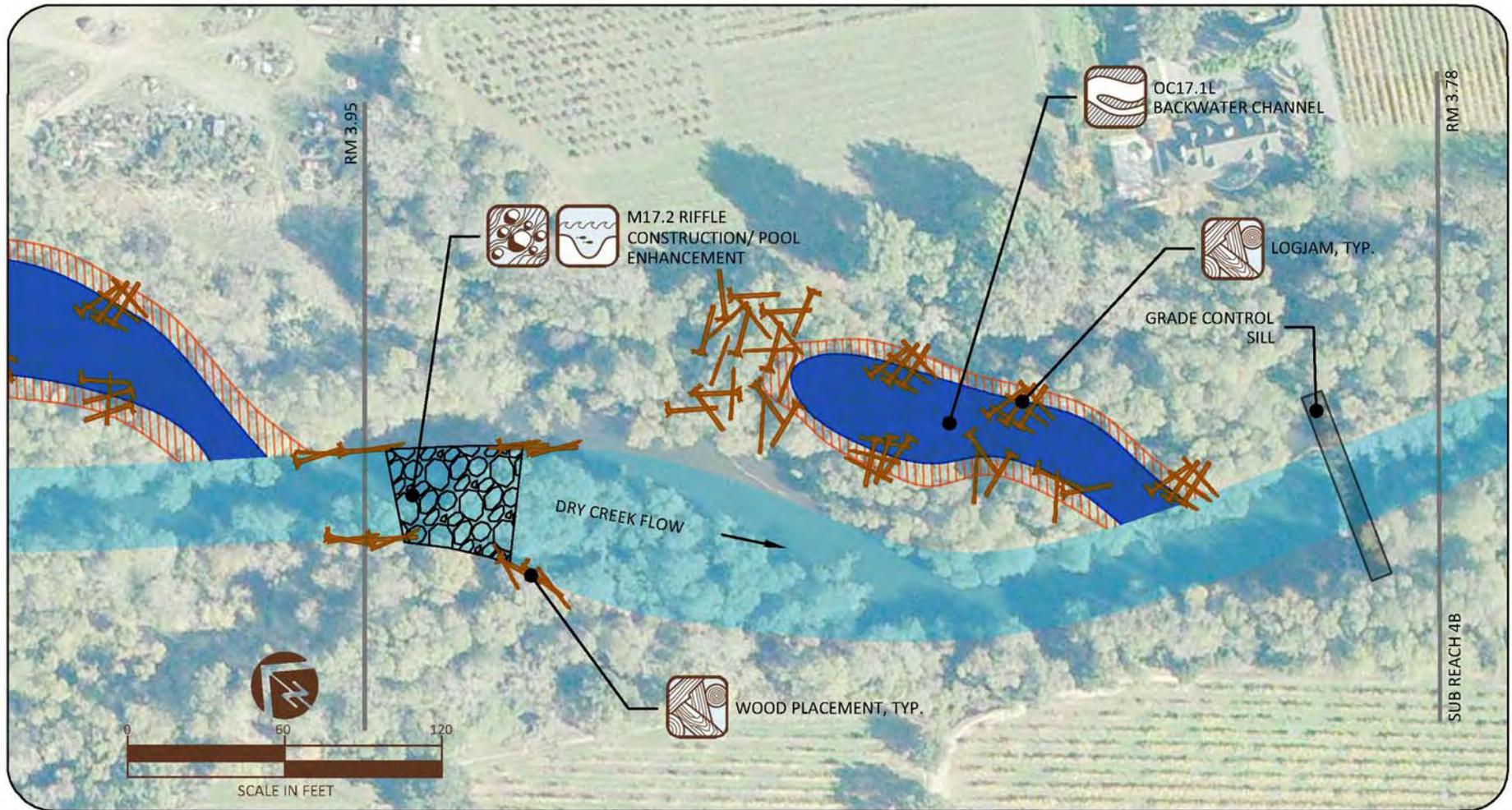


Figure K13 . Reach 4 sheet index for conceptual design detail sheets.



**LEGEND**

MAIN CHANNEL AT 110 CFS

OFF CHANNEL HABITAT

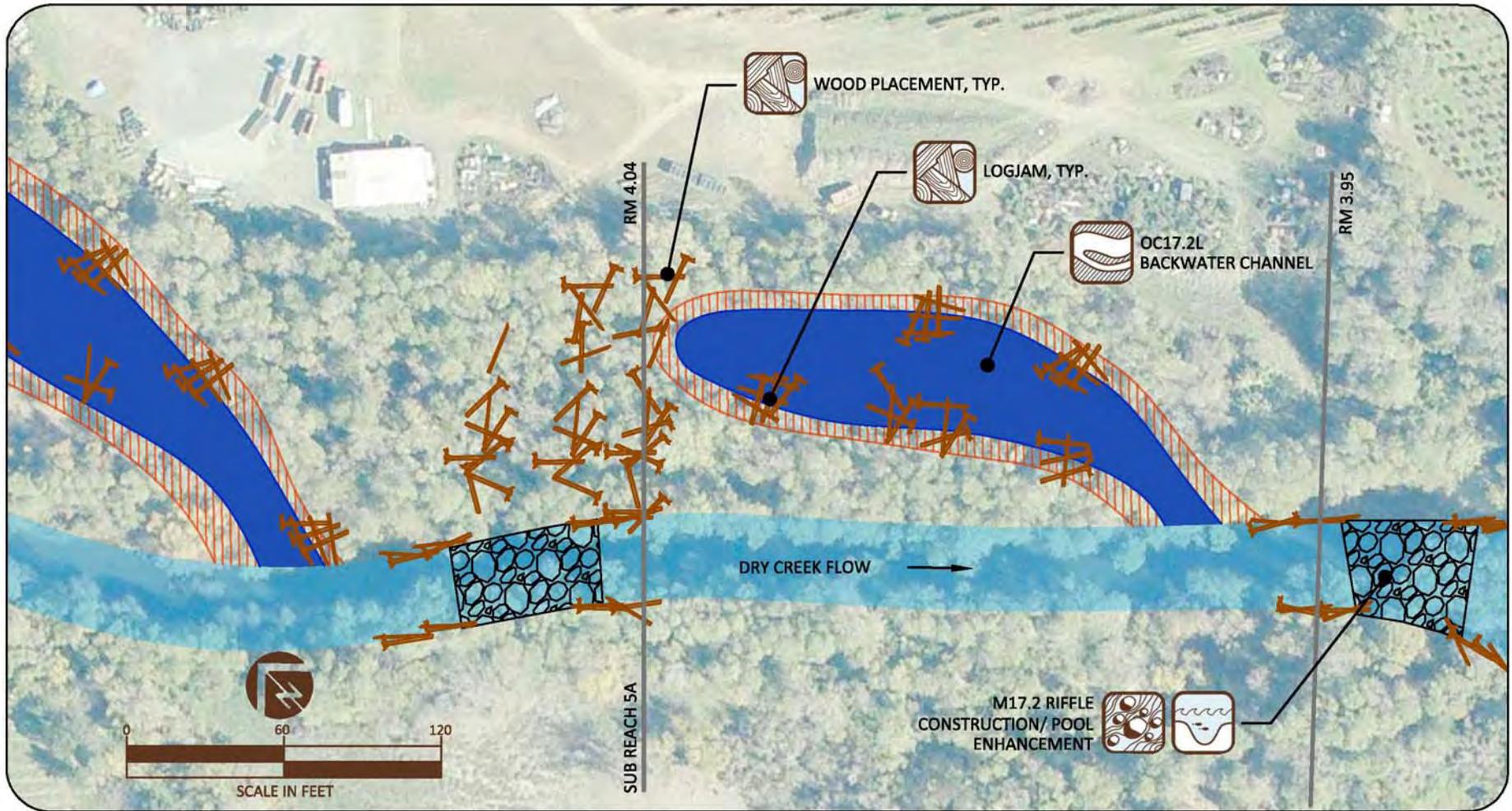
GRADING LIMIT

RIFFLE CONSTRUCTION/ ENHANCEMENT

GRADE CONTROL SILL

SUB REACH 4 C  
CONCEPT DESIGN  
1 OF 2

Figure K14. Sub-reach 4c conceptual design detail sheet 1 of 2.



**LEGEND**

- MAIN CHANNEL AT 110 CFS
- OFF CHANNEL HABITAT
- GRADING LIMIT
- EXISTING RIFFLE

SUB REACH 4 C  
CONCEPT DESIGN  
2 OF 2

Figure K15. Sub-reach 4c conceptual design detail sheet 2 of 2.

**Sub-Reach 4c Analysis of Proposed Enhancements**

Proposed enhancements would provide nearly 70,000 ft<sup>2</sup> of new or improved habitat in sub-reach 4c. More than 57,000 ft<sup>2</sup> of the enhancements will provide summer coho rearing habitat. Additionally, 3,850 ft<sup>2</sup> of main channel habitat will be enhanced through riffle construction and pool enhancement. The following tables summarize the frequency and areas of existing vs. proposed habitat (Table K15), additional habitat to be created by enhancements (Table K16) cost-based metrics (Table K17). Table K18 presents the habitat enhancement areas normalized by sub-reach main channel length. Table K19 summarizes the planning level cost estimate developed for sub-reach 4c.

Table K15. Habitat areas and frequencies based on existing and proposed habitats for sub-reach 4c.

Habitat	Existing Habitat		Proposed Habitat	
	Area (ft <sup>2</sup> )	#	Area (ft <sup>2</sup> )	#
Alcove / Backwater	13550	2	62200	4
Flatwater	0	0	0	0
Pool	77450	1	73650	2
Riffle	0	0	3850	1
Side Channel	650	1	0	0
Cascade	3550	1	3550	1

Table K16. Additional habitat benefits provided by backwater habitat, LWD-margin habitat, and riffles.

Habitat Type	(ft <sup>2</sup> )	(m <sup>2</sup> )
Alcove/Backwater (summer coho rearing)	48650	4520
LWD-Margin Habitat (summer coho rearing)	9000	840
Winter Refuge (coho rearing)	8050	750
Riffles	3850	360
<b>Total</b>	<b>69550</b>	<b>6460</b>

<sup>+</sup>Alcove/Backwater habitats also provide winter refuge habitat during flood events.

Table K17. Cost – benefit table for design concepts presented for sub-reach 4c

Cost - Benefit Metric	Cost (\$)
Cost / ft <sup>2</sup> of summer coho rearing*	68
Cost / ft <sup>2</sup> of winter coho rearing**	59
Cost / ft <sup>2</sup> of total enhanced habitat***	56

\*includes backwater and LWD-margin habitats

\*\*includes alcove/backwater, LWD-margin, high flow backwater habitat, and winter refuge

\*\*\*includes alcove/backwater, LWD-margin, winter refuge, and riffles

Table K18. Length metric table showing habitat area divided by main channel sub-reach length for summer coho rearing and total enhanced habitat.

Length Metric	area (ft <sup>2</sup> )/ length (ft)
Summer coho rearing habitat	43
Winter coho rearing habitat	50
Total enhanced habitat	52

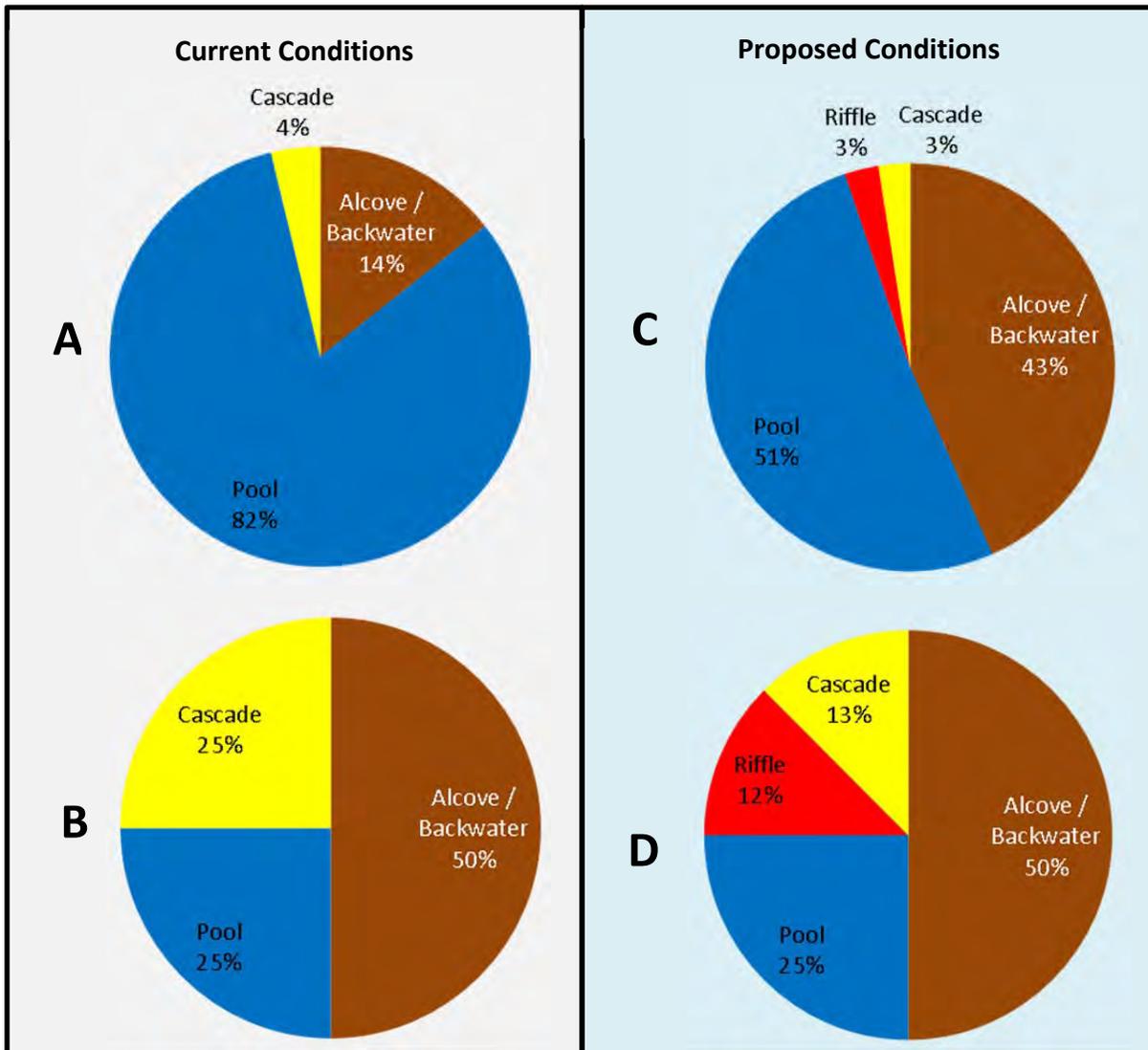


Figure K16. Existing sub-reach 4c habitats shown by area (A), frequency (B) and proposed habitat units based on area (C) and frequency (D).

Table K19. Sub-reach 4c Planning Level Cost Estimate

Note: This is a preliminary cost estimate for planning purposes. Actual costs for design and construction activities may vary substantially from these estimates. Assumptions for time requirements and material quantities have been made based on limited information that is available for the site. Additional information obtained during site investigations will be needed to determine actual quantities and costs. Estimates based on 2011 costs.

No.	Description	Unit	Quantity	Unit Cost	Total Cost	Design and Quantity Assumptions						
1	Mobilization and Demobilization	LS	1	\$120,000	\$120,000	Calculated at 5% of construction sub-total.						
2	Site Access Measures	LS	1	\$120,000	\$120,000	Includes access road improvements, traffic control, dust control, and site restoration.						
3	Environmental Protection Measures	LS	1	\$600,000	\$600,000	Includes stream diversion/dewatering, fish relocation, and erosion control BMPs.						
4	Clearing and Grubbing	AC	2	\$2,000	\$4,000							
5	Common Excavation											
a.	OC 17.2	CY	8,930	\$20	\$178,600	Final design criteria and analysis will likely alter these estimates up or down.						
b.	OC 17.1	CY	3,510	\$20	\$70,200							
6	Large Woody Debris (purchased, delivered, installed)											
a.	Floodplain Roughness Logs	EA	130	\$1,150	\$149,500	Assumes 30% delivered with root wads attached.						
b.	Backwater Habitat Logs	EA	190	\$1,150	\$218,500							
c.	Pool Enhancement Logs	EA	30	\$1,150	\$34,500							
d.	Log Jams	EA	280	\$1,150	\$322,000							
7	Boulder Ballast (purchased, delivered, installed)	TN	630	\$100	\$63,000	Estimate 1 ton per log.						
8	Bank Stabilization	LF	370	\$1,000	\$370,000	Bank stabilization methods will vary but will include one or more of the following components: large woody debris, earthwork, riprap scour protection, granular backfill, aggregate filter material, geotextile fabric, and/or fabric encapsulated soil lifts. Assumes 30% delivered with root wads attached.						
9	Riffle Installation (purchased, delivered, installed)	CY	670	\$120	\$80,400	Assume average of 3 feet of depth per riffle for riffle construction. Assume average of 1.5 feet of depth per riffle for riffle enhancement.						
10	Vegetation Management	AC	9	\$20,000	\$180,000	Assumes area of floodplain from vineyard grade to vineyard grade minus the base flow inundation area of the main channel and of the proposed backwater habitat areas.						
<b>Construction Sub-Total</b>					<b>\$2,510,700</b>	<table border="1"> <tr> <td><b>Key</b></td> <td>LS = Lump Sum CY = Cubic Yard LF = Lineal Foot AC = Acre EA = Each</td> </tr> <tr> <td><b>Project Delivery Items are calculated as a percent of the construction sub-total</b></td> <td></td> </tr> <tr> <td><b>General Notes:</b></td> <td>-Cost includes a 30% design and construction contingency -Costs assume all materials (wood and rock) are purchased and hauled to the site from a nearby source -Boulder ballast requirements may be able to be reduced depending on hydraulics analysis</td> </tr> </table>	<b>Key</b>	LS = Lump Sum CY = Cubic Yard LF = Lineal Foot AC = Acre EA = Each	<b>Project Delivery Items are calculated as a percent of the construction sub-total</b>		<b>General Notes:</b>	-Cost includes a 30% design and construction contingency -Costs assume all materials (wood and rock) are purchased and hauled to the site from a nearby source -Boulder ballast requirements may be able to be reduced depending on hydraulics analysis
<b>Key</b>	LS = Lump Sum CY = Cubic Yard LF = Lineal Foot AC = Acre EA = Each											
<b>Project Delivery Items are calculated as a percent of the construction sub-total</b>												
<b>General Notes:</b>	-Cost includes a 30% design and construction contingency -Costs assume all materials (wood and rock) are purchased and hauled to the site from a nearby source -Boulder ballast requirements may be able to be reduced depending on hydraulics analysis											
Concept Level Design & Construction Contingency (30%)					\$753,210							
<b>Construction Total</b>					<b>\$3,263,900</b>							
<b>Project Delivery</b>												
Permitting (4%)					\$100,428							
Detailed Engineering Design (15%)					\$376,605							
Contract Administration (5%)					\$125,535							
Construction Oversight (1.5%)					\$37,661							
<b>Project Delivery Sub-Total</b>					<b>\$640,200</b>							
<b>TOTAL ESTIMATE</b>					<b>\$3,904,000</b>	rounded to nearest \$1,000						

## APPENDIX L

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**L.1 Reach 3 Description**

Reach 3 extends from the Westside Road bridge upstream to a fault lineament immediately downstream of the grade control sills. There are eight side channels with over 100 ft in length and four alcove habitats. A levee runs along the right bank for 1300 ft in the upper end of the reach. The channel is active in reach 3 and has been migrating frequently since the construction of WSD. Relic channels are now productive side channels flowing through dense riparian vegetation. Degradation has likely not occurred in reach 3 since the construction of WSD, however some aggradation may have occurred. The evidence of channel migration is likely due to the deposition of sediment supplied by upstream tributaries and channel processes, causing lateral instability. See the Dry Creek Current Conditions Report (Inter-Fluve 2010), Appendix A, for more detail.

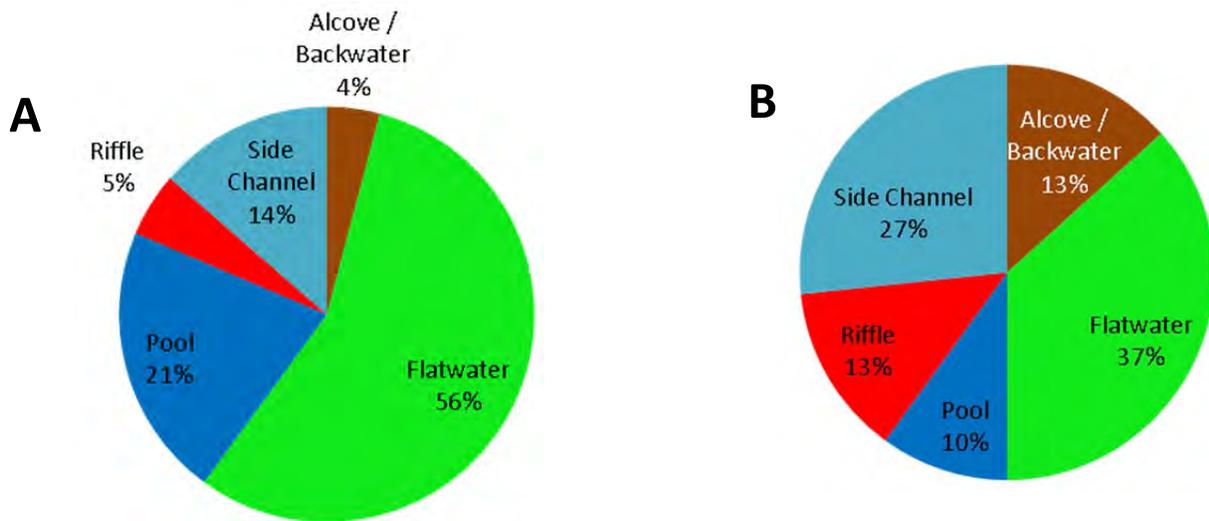


**Reach 3 Current Habitat Conditions**

Table L1. Reach 3 habitat units based on current conditions.

Habitat	Existing Habitat	
	Area (ft <sup>2</sup> )	#
Alcove / Backwater	14650	4
Flatwater	198400	11
Pool	75700	3
Riffle	17700	4
Side Channel	48300	8

Figure L1. Habitat units in reach 3 based on area (A) and frequency (B).



## L.2 Reach 3 Enhancement Approach

Reach 3 is located in the “lower segment<sup>1</sup>” where the influence of the Russian River backwater controls the routing of sediment and fluvial processes in Dry Creek. Construction of late-successional habitats in this segment would be associated with a higher level of risk for sedimentation. The focus of habitat enhancement in reach 3 will be to increase the quantity and quality of available off channel juvenile rearing habitat, while improving conditions in the main channel. For purposes of enhancement planning, reach 3 has been split into 2 enhancement sub-reaches (Figure L2). Sub-reach 3a (RM 2.33 to 2.53) is described in section L.3, and sub-reach 3b (RM 2.53 to 3.01) is described in section L.4.

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<sup>1</sup> Additional detail of process-based delineation of lower Dry Creek into upper, middle and lower segments can be found in the Fish Habitat Enhancement Feasibility Study, Section 5.3, IFI 2011.

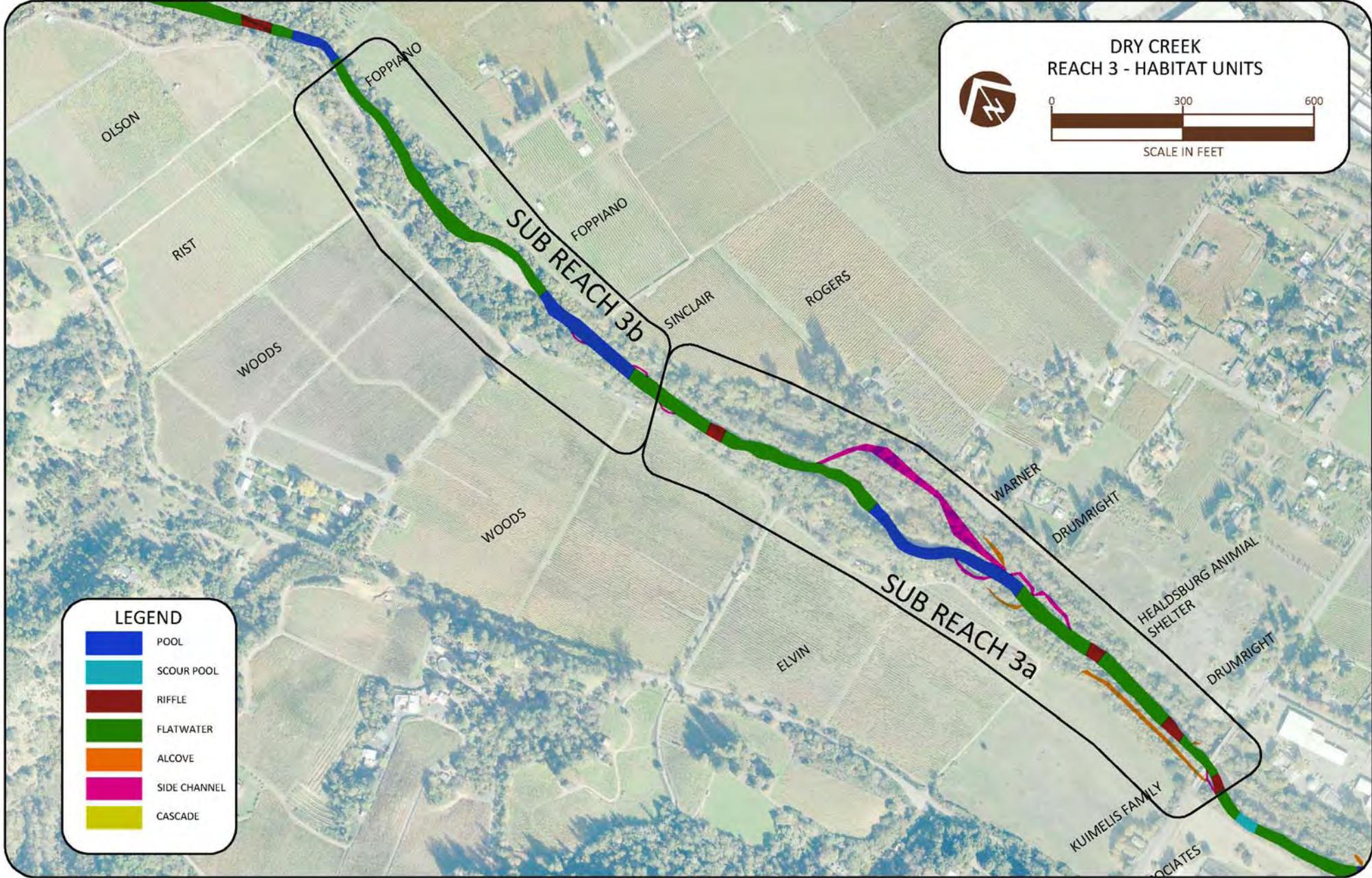


Figure L2. Reach 3 habitat units and sub-reach boundaries.

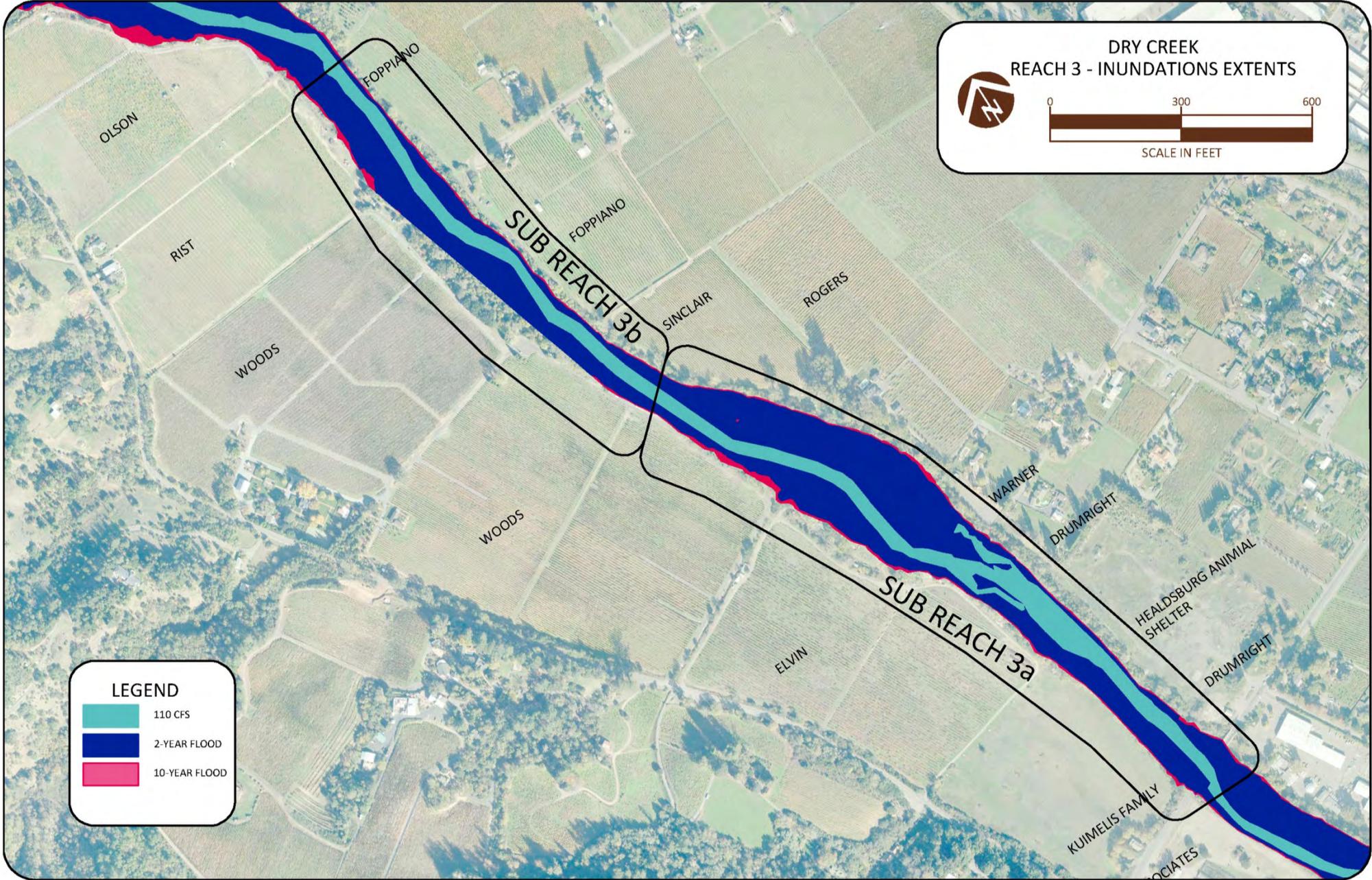


Figure L3. Modeled inundations in reach 3 based on three specific discharge levels: 110 cfs, the 2-year and 10-year flood events.

**L.3 Sub-Reach 3a Conceptual Designs**

Sub-Reach 3a is the combination of a straight and narrow section in the lower half, and a slightly sinuous section with a wider active floodplain in the upper half. Due to the presence of a wider floodplain in the upper half, off-channel enhancements paired with work in the main channel are proposed for this upper portion of the sub-reach. Enhancements include the construction of backwater channels, LWD placements and logjams, in addition to the enhancement of pool – riffle sequences to improve conditions in the main-stem. The following table and corresponding figures summarize the design concepts developed for sub-reach 3a.

Project Code	Backwater Channel	Side Channel	Pool Enhancement	Riffle Enhancement	LWD	Winter Refuge Habitat*	Bank Stabilization	Vegetation Management	Comments
M 8.1			X	X	X			X	Riffle Construction & Pool Enhancement
OC 8.1R	X				X			X	Backwater Channel Construction
M 8.2			X	X	X			X	Riffle Construction & Pool Enhancement
OC 8.2L	X				X			X	Backwater Channel Construction

Table L2. Inventory of projects identified in sub-reach 3a.

\* Backwater channel habitats will also provide winter refuge, and available off-channel habitat for juvenile salmonids will become large as flows increase during winter storms.



Figure L4. Reach 3 sheet index for conceptual design detail sheets.

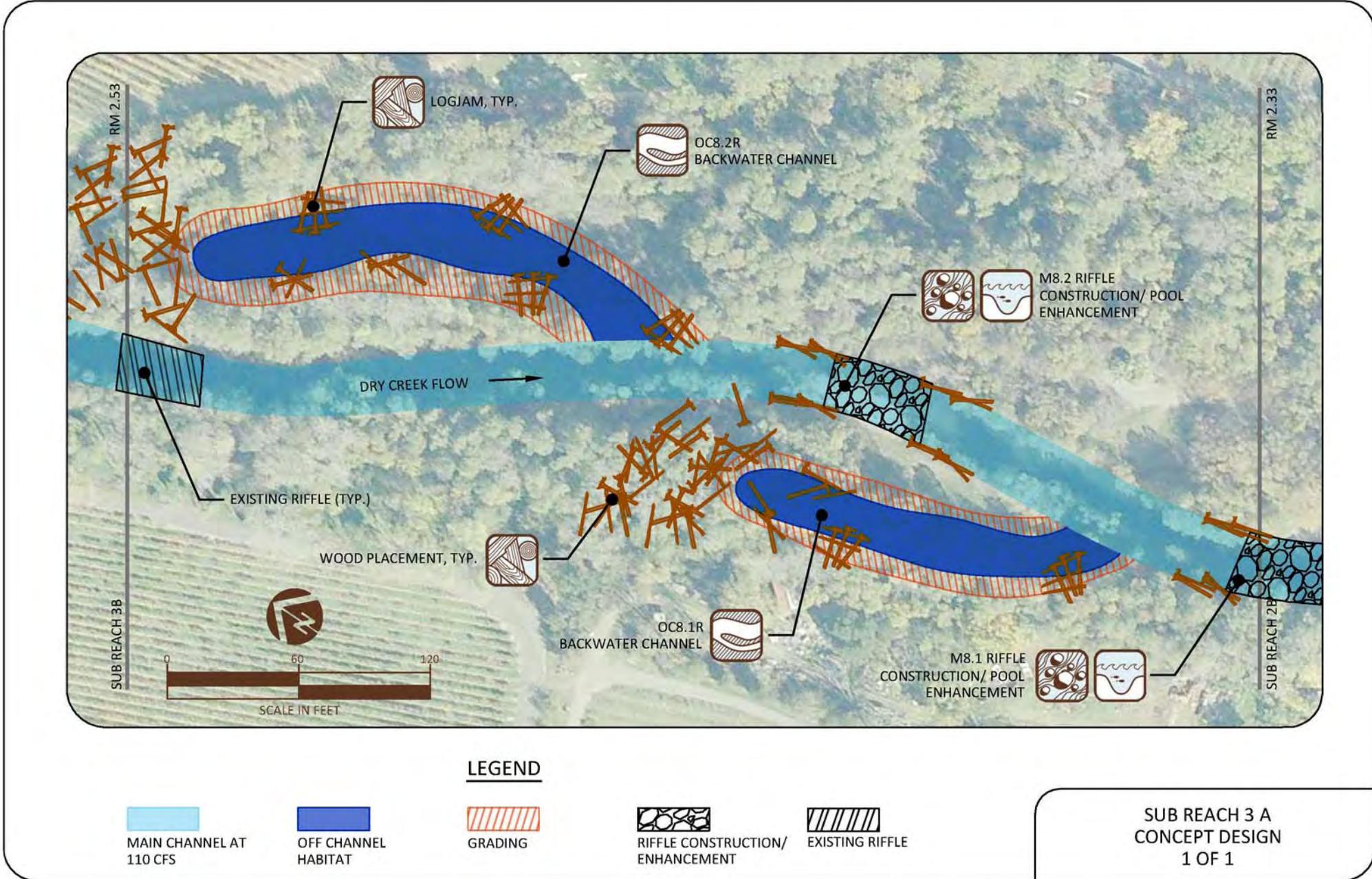


Figure L5. Sub-reach 3a conceptual design detail sheet 1 of 1.

Sub-Reach 3a Analysis of Proposed Enhancements

Proposed enhancements will create over 95,000 ft<sup>2</sup> of new or improved habitat. Nearly 45,000 ft<sup>2</sup> of new habitat will be off-channel and LWD-margin coho rearing habitat. Additionally, main channel enhancements will improve conditions for juvenile coho and steelhead in the main-stem. The following tables summarize the frequency and areas of existing vs. proposed habitat (Table L3), additional habitat to be created by enhancements (Table L4) cost-based metrics (Table L5). Table L6 presents the habitat enhancement areas normalized by sub-reach main channel length. Table L7 summarizes the planning level cost estimate developed for sub-reach 3a.

Table L3: Habitat area by unit type for existing and proposed conditions in sub-reach 3a.

Habitat	Existing Habitat		Proposed Habitat	
	Area (ft <sup>2</sup> )	#	Area (ft <sup>2</sup> )	#
Alcove / Backwater	14650	4	52900	6
Flatwater	129400	8	119000	8
Pool	42650	2	58300	4
Riffle	17700	4	28000	6
Side Channel	47150	6	47150	6

Table L4. Additional habitat benefits provided by backwater habitat, LWD-margin habitat, and riffles in Sub-reach 5a.

Habitat Type	(ft <sup>2</sup> )	(m <sup>2</sup> )
Alcove/Backwater (summer coho rearing)	38250	3550
LWD-Margin Habitat (summer coho rearing)	6000	560
Winter Refuge (coho rearing)	18850	1750
Pools	21650	2010
Riffles	10300	960
<b>Total</b>	<b>95050</b>	<b>8830</b>

\*Alcove/Backwater habitats also provide winter refuge habitat during flood events.

Table L5. Cost-benefit table for design concepts presented for sub-reach 5a.

Cost - Benefit Metric	Cost / ft <sup>2</sup>
Cost / ft <sup>2</sup> of summer coho rearing*	92
Cost / ft <sup>2</sup> of winter rearing**	64
Cost / ft <sup>2</sup> of total enhanced habitat***	43

\*includes backwater and LWD-margin habitats

\*\*includes high flow backwater habitat and LWD-margin habitat

\*\*\*includes alcove/backwater, LWD-margin, pools and riffles

Table L6. Length metric table showing enhanced habitat area divided by main channel sub-reach length for summer coho rearing and total enhanced habitats.

Length Metric	area (ft <sup>2</sup> )/ length (ft)
Summer coho rearing habitat	14
Winter coho rearing habitat	19
Total enhanced habitat	29

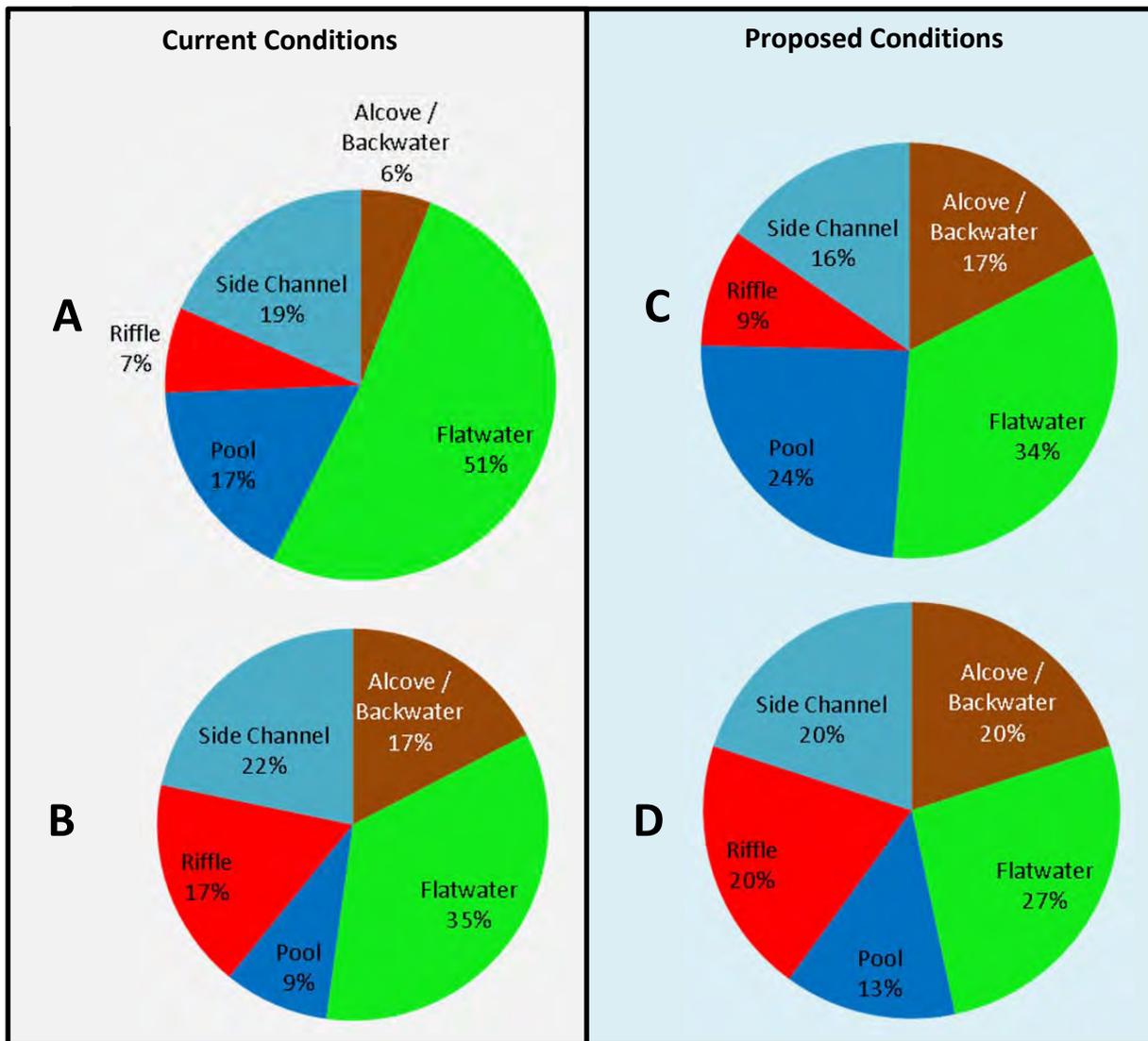


Figure L6. Existing habitats shown by area (A), frequency (B) and proposed habitat units based on area (C) and frequency (D).

Table L7. Sub-Reach 3a Planning Level Cost Estimate

Note: This is a preliminary cost estimate for planning purposes. Actual costs for design and construction activities may vary substantially from these estimates. Assumptions for time requirements and material quantities have been made based on limited information that is available for the site. Additional information obtained during site investigations will be needed to determine actual quantities and costs. Estimates based on 2011 costs.

No.	Description	Unit	Quantity	Unit Cost	Total Cost	Design and Quantity Assumptions
1	Mobilization and Demobilization	LS	1	\$130,000	\$130,000	Calculated at 5% of construction sub-total.
2	Site Access Measures	LS	1	\$120,000	\$120,000	Includes access road improvements, traffic control, dust control, and site restoration.
3	Environmental Protection Measures	LS	1	\$620,000	\$620,000	Includes stream diversion/dewatering, fish relocation, and erosion control BMPs.
4	Clearing and Grubbing	AC	2	\$2,000	\$4,000	
5	Common Excavation					
a.	OC 8.2	CY	9,010	\$20	\$180,200	Final design criteria and analysis will likely alter these estimates up or down.
b.	OC 8.1	CY	3,990	\$20	\$79,800	
6	Large Woody Debris (purchased, delivered, installed)					
a.	Floodplain Roughness Logs	EA	140	\$1,150	\$161,000	Assumes 30% delivered with root wads attached.
b.	Backwater Habitat Logs	EA	190	\$1,150	\$218,500	
c.	Pool Enhancement Logs	EA	60	\$1,150	\$69,000	
d.	Log Jams	EA	320	\$1,150	\$368,000	
7	Boulder Ballast (purchased, delivered, installed)	TN	710	\$100	\$71,000	Estimated 1 ton per log.
8	Bank Stabilization	LF	130	\$1,000	\$130,000	Bank stabilization methods will vary but will include one or more of the following components: large woody debris, earthwork, riprap scour protection, granular backfill, aggregate filter material, geotextile fabric, and/or fabric encapsulated soil lifts. Assumes 30% delivered with root wads attached.
9	Riffle Installation (purchased, delivered, installed)	CY	1,330	\$120	\$159,600	Assume average of 3 feet of depth per riffle for riffle construction. Assume average of 1.5 feet of depth per riffle for riffle enhancement.
10	Vegetation Management	AC	15	\$20,000	\$300,000	Assumes area of floodplain from vineyard grade to vineyard grade minus the base flow inundation area of the main channel and of the proposed backwater habitat areas.
<b>Construction Sub-Total</b>					<b>\$2,611,100</b>	<div style="border: 1px solid black; padding: 5px; display: inline-block;"> <b>Key</b>                      LS = Lump Sum                      CY = Cubic Yard                      LF = Lineal Foot                      AC = Acre                      EA = Each                 </div> <div style="border: 1px solid black; padding: 5px; display: inline-block; margin-left: 20px;"> <b>Project Delivery Items are calculated as a percent of the construction sub-total</b>  <b>General Notes:</b>                      -Cost includes a 30% design and construction contingency                      -Costs assume all materials (wood and rock) are purchased and hauled to the site from a nearby source                      -Boulder ballast requirements may be able to be reduced depending on hydraulics analysis                 </div>
Concept Level Design & Construction Contingency (30%)					\$783,330	
<b>Construction Total</b>					<b>\$3,394,400</b>	
<b>Project Delivery</b>						
Permitting (4%)					\$104,444	
Detailed Engineering Design (15%)					\$391,665	
Contract Administration (5%)					\$130,555	
Construction Oversight (1.5%)					\$39,167	
<b>Project Delivery Sub-Total</b>					<b>\$665,800</b>	
<b>TOTAL ESTIMATE</b>					<b>\$4,060,000</b>	

**L.4 Sub-Reach 3b Conceptual Designs**

Sub-reach 3b is 2200 feet long with moderate active floodplain width (200 to 400 feet). Two wider floodplain areas were found to be suitable for off-channel habitat development. Enhancements in this sub-reach include backwater channel construction, LWD placements, riffle construction and pool enhancement. The following table and corresponding figures summarize the design concepts created for sub-reach 3b.

Project Code	Backwater Channel	Side Channel	Pool Enhancement	Riffle Enhancement	LWD	Winter Refuge Habitat*	Bank Stabilization	Vegetation Management	Comments
M 9			X	X	X			X	Riffle Construction & Pool Enhancement
OC 9R	X				X			X	Backwater Channel Construction
M 10			X	X	X			X	Riffle Construction & Pool Enhancement
OC 10R	X				X			X	Backwater Channel Construction

Table L8. Inventory of projects identified in sub-reach 3b.

\*Backwater channel habitats will also provide winter refuge, and available off-channel habitat for juvenile salmonids will become larger as flows increase during winter storms.

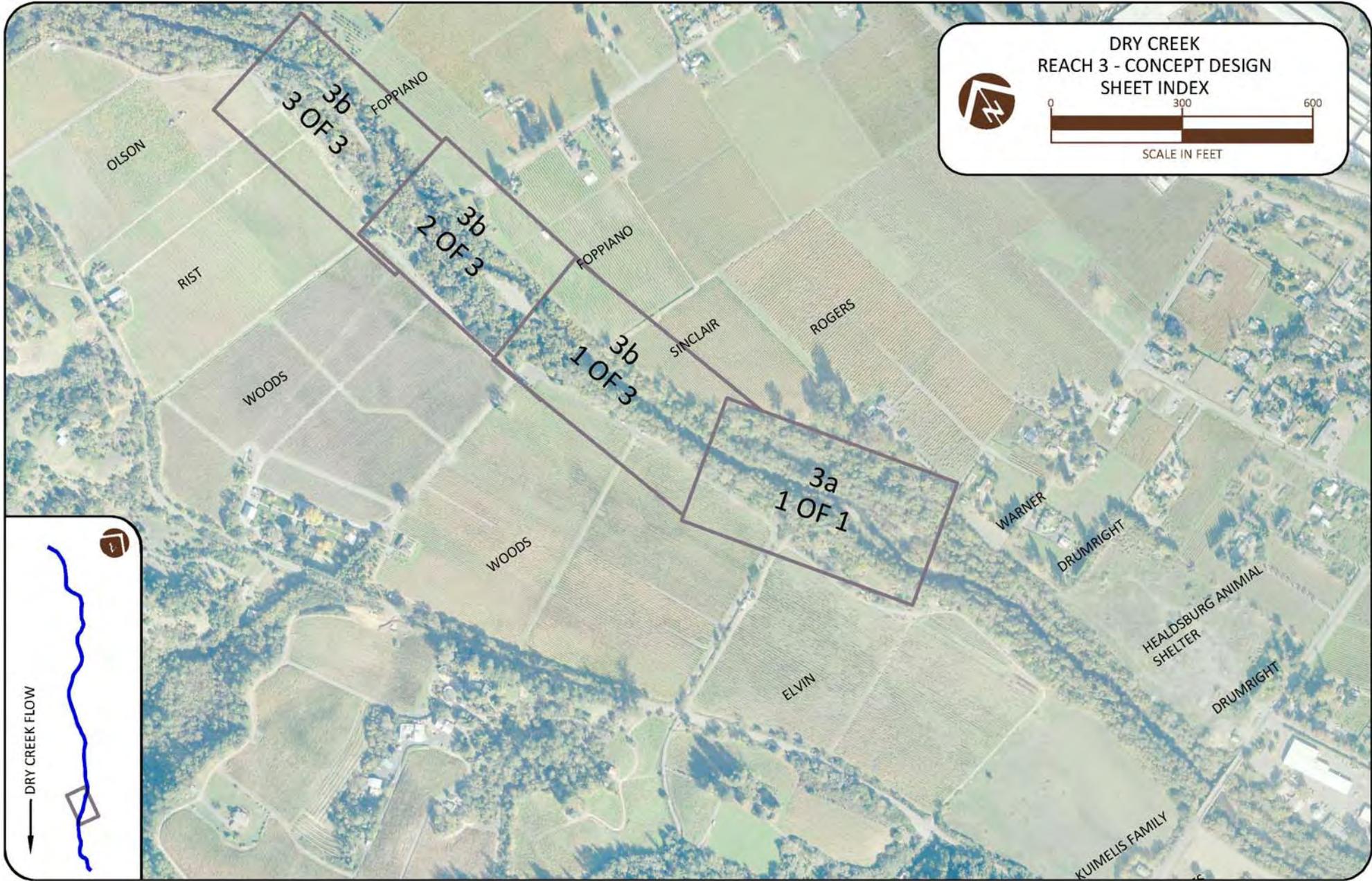


Figure L7. Reach 3 sheet index for conceptual design detail sheets.

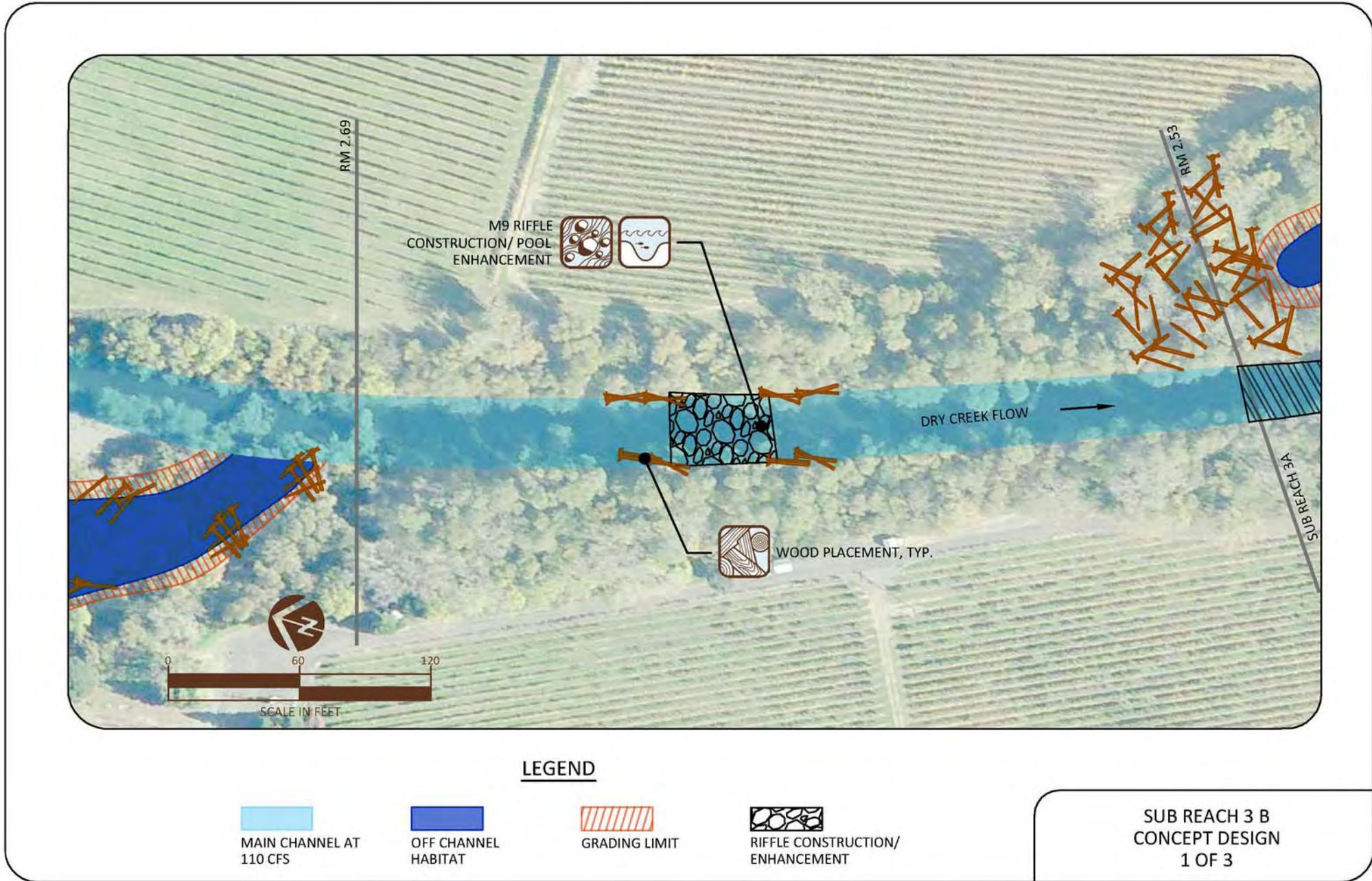
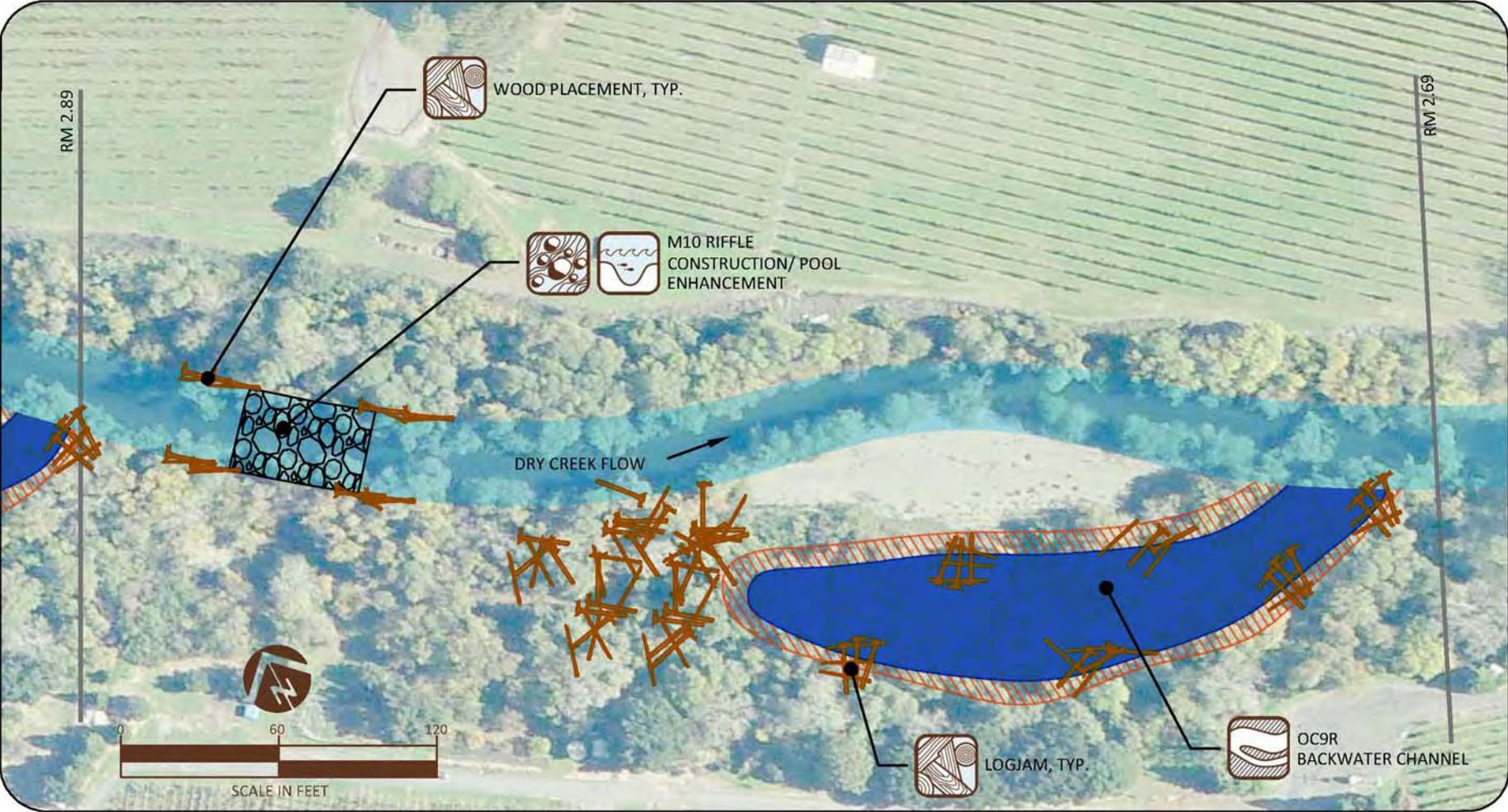


Figure L8. Sub-reach 3b conceptual design detail sheet 1 of 3.  
 Dry Creek Conceptual Design Report



**LEGEND**

MAIN CHANNEL AT 110 CFS

OFF CHANNEL HABITAT

GRADING LIMIT

RIFFLE CONSTRUCTION/ ENHANCEMENT

SUB REACH 3 B  
CONCEPT DESIGN  
2 OF 3

Figure L9. Sub-reach 3b conceptual design detail sheet 2 of 3.

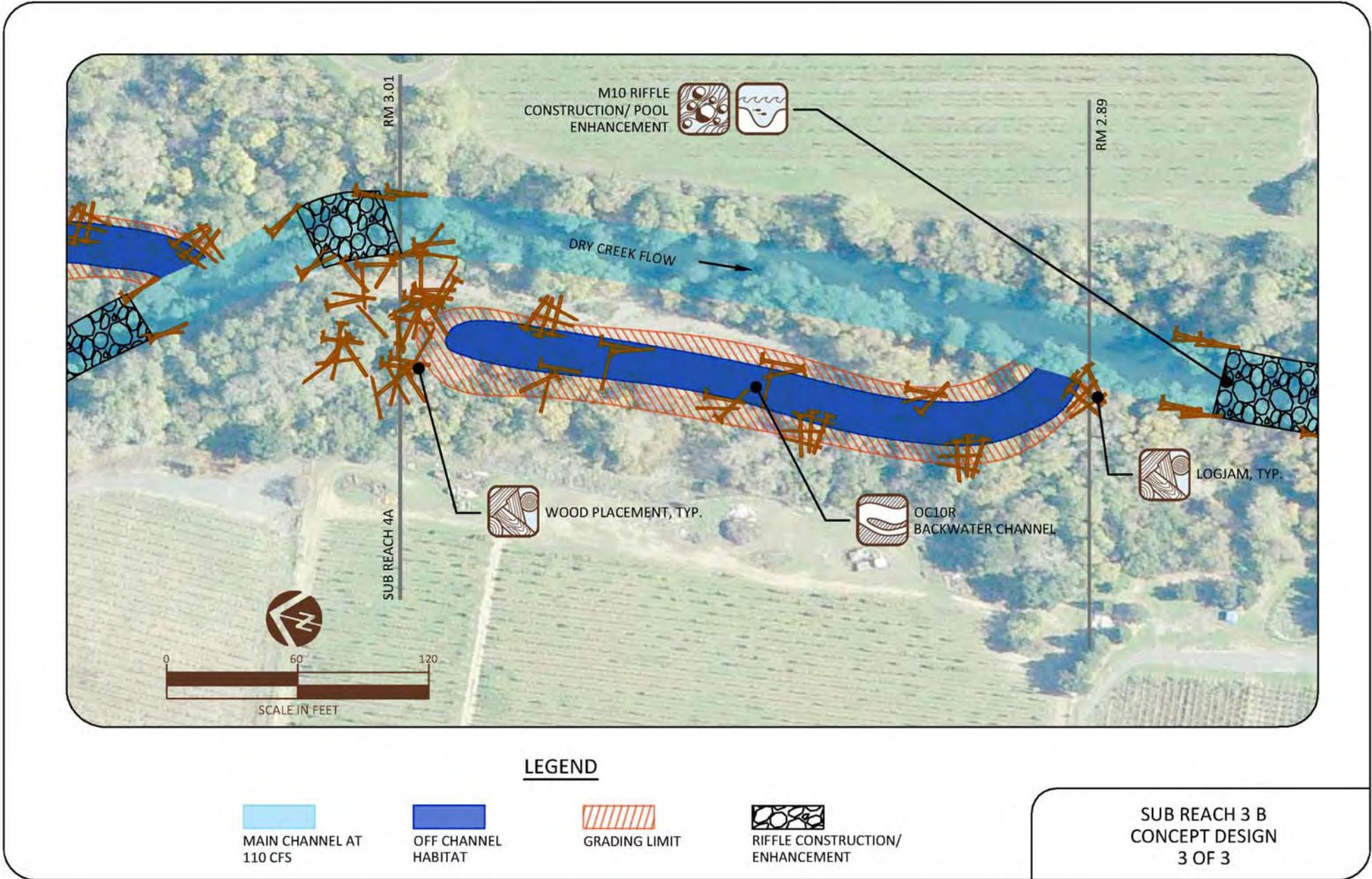


Figure L10. Sub-reach 3b conceptual design detail sheet 3 of 3.

**Sub-Reach 3b Analysis of Proposed Enhancements**

Proposed enhancements would provide over 121,000 ft<sup>2</sup> of additional habitat in sub-reach 3b. New backwater channel and LWD-margin habitats would specifically benefit juvenile coho – totaling more than 65,000 ft<sup>2</sup>. Additionally, enhanced main channel habitats would provide improved conditions in the main-stem for juvenile coho and steelhead. The following tables summarize the frequency and areas of existing vs. proposed habitat (Table L9), additional habitat to be created by enhancements (Table L10) and cost-based metrics (Table L11). Table L12 presents habitat enhancement areas normalized by sub-reach main channel length. Table L13 summarizes the planning level cost estimate developed for sub-reach 3b.

Table L9. Habitat areas and frequencies based on existing and proposed habitats for sub-reach 3b.

Habitat	Existing Habitat		Proposed Habitat	
	Area (ft <sup>2</sup> )	#	Area (ft <sup>2</sup> )	#
Alcove / Backwater	0	0	59950	2
Flatwater	69000	3	64250	4
Pool	33050	1	59250	2
Riffle	0	0	10400	2
Side Channel	1150	2	1150	2

Table L10. Additional habitat benefits provided by backwater habitat, LWD-margin habitat, and riffles.

Habitat Type	(ft <sup>2</sup> )	(m <sup>2</sup> )
Alcove/Backwater (coho rearing)	59950	5570
LWD-Margin Habitat (coho rearing)	6000	560
Winter Refuge (coho rearing)	20350	1890
Pools	24800	2300
Riffles	10400	970
<b>Total</b>	<b>121500</b>	<b>11290</b>

<sup>†</sup>Alcove/Backwater habitats also provide winter refuge habitat during flood events.

Table L11. Cost – benefit table for design concepts presented for sub-reach 3b

Cost - Benefit Metric	Cost (\$)
Cost / ft <sup>2</sup> of summer coho rearing*	74
Cost / ft <sup>2</sup> of winter refuge habitat**	56
Cost / ft <sup>2</sup> of additional habitat***	40

\*includes alcove/backwater and LWD-margin habitats

\*\*includes alcove/backwater, high flow backwater habitat, LWD-margin

\*\*\*includes alcove/backwater, LWD-margin, pools and riffles

Table L12. Length metric table showing habitat area divided by main channel sub-reach length for summer coho rearing and total enhanced habitats.

Length Metric	area (ft <sup>2</sup> )/ length (ft)
Summer coho rearing habitat	29
Winter coho rearing habitat	38
Total enhanced habitat	54

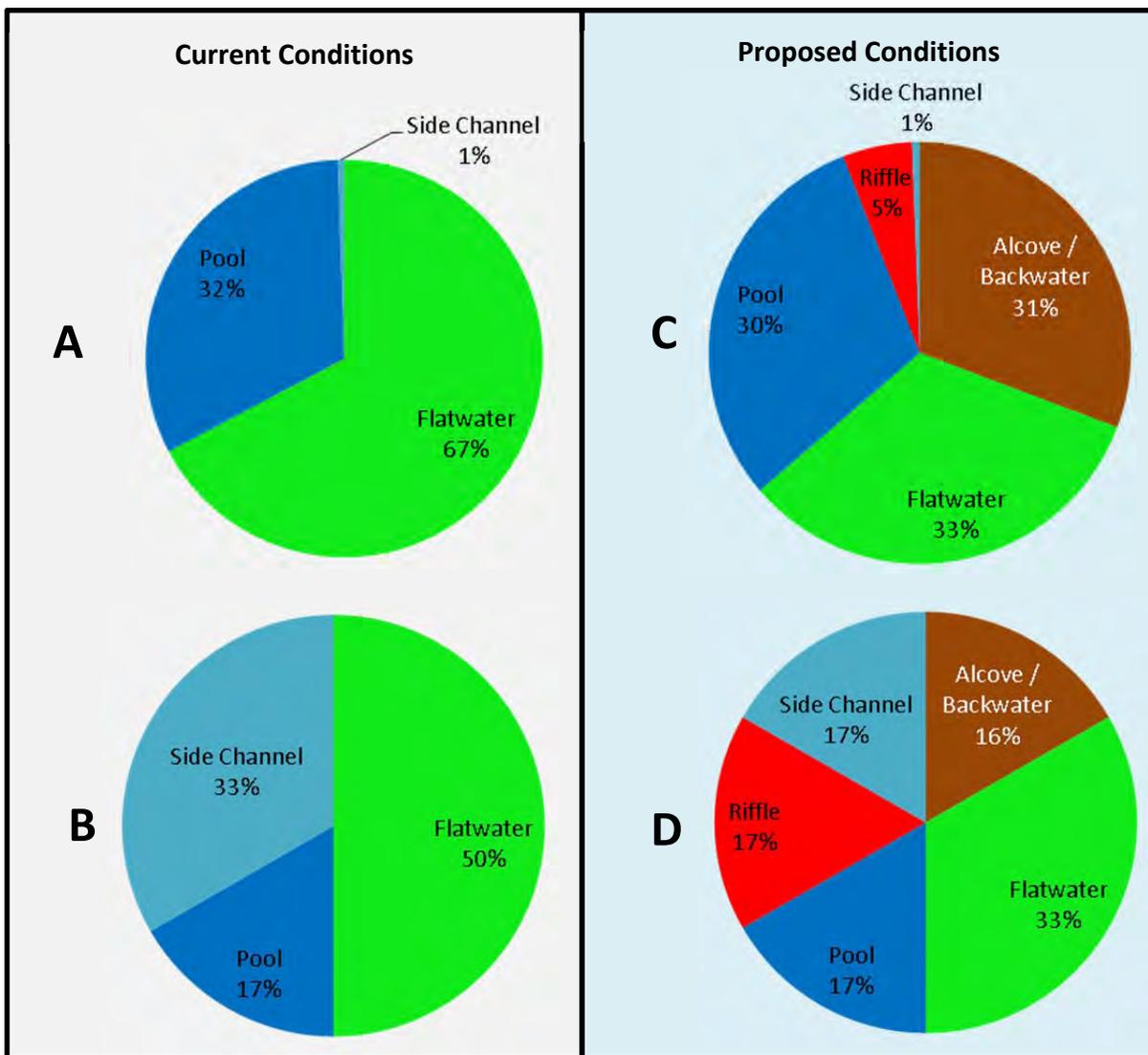


Figure L11. Existing sub-reach 3b habitats shown by area (A), frequency (B) and proposed habitat units based on area (C) and frequency (D).

**Sub-Reach 3b Alternatives Discussion**

The floodplain surface in the vicinity of OC 42R is frequently inundated and appears to be suitable for a side channel enhancement designed to be dynamic over time. It appears as though sediment delivered by Schoolhouse Creek and additional local drainage deposits in this area will facilitate a dynamic floodplain enhancement approach. Existing high flow channels could be utilized in creating an alignment of the side channel alternative at this location.

Table L13. Sub-reach 3b Planning Level Cost Estimate

Note: This is a preliminary cost estimate for planning purposes. Actual costs for design and construction activities may vary substantially from these estimates. Assumptions for time requirements and material quantities have been made based on limited information that is available for the site. Additional information obtained during site investigations will be needed to determine actual quantities and costs. Estimates based on 2011 costs.

No.	Description	Unit	Quantity	Unit Cost	Total Cost	Design and Quantity Assumptions						
1	Mobilization and Demobilization	LS	1	\$150,000	\$150,000	Calculated at 5% of construction sub-total.						
2	Site Access Measures	LS	1	\$150,000	\$150,000	Includes access road improvements, traffic control, dust control, and site restoration.						
3	Environmental Protection Measures	LS	1	\$740,000	\$740,000	Includes stream diversion/dewatering, fish relocation, and erosion control BMPs.						
4	Clearing and Grubbing	AC	2	\$2,000	\$4,000							
5	Common Excavation											
a.	OC 10	CY	7,940	\$20	\$158,800	Final design criteria and analysis will likely alter these estimates up or down.						
b.	OC 9	CY	10,730	\$20	\$214,600							
6	Large Woody Debris (purchased, delivered, installed)											
a.	Floodplain Roughness Logs	EA	120	\$1,150	\$138,000	Assumes 30% delivered with root wads attached.						
b.	Backwater Habitat Logs	EA	270	\$1,150	\$310,500							
c.	Pool Enhancement Logs	EA	60	\$1,150	\$69,000							
d.	Log Jams	EA	320	\$1,150	\$368,000							
7	Boulder Ballast (purchased, delivered, installed)	TN	770	\$100	\$77,000	Estimated 1 ton per log.						
8	Bank Stabilization	LF	450	\$1,000	\$450,000	Bank stabilization methods will vary but will include one or more of the following components: large woody debris, earthwork, riprap scour protection, granular backfill, aggregate filter material, geotextile fabric, and/or fabric encapsulated soil lifts. Assumes 30% delivered with root wads attached.						
9	Riffle Installation (purchased, delivered, installed)	CY	1,330	\$120	\$159,600	Assume average of 3 feet of depth per riffle for riffle construction. Assume average of 1.5 feet of depth per riffle for riffle enhancement.						
10	Vegetation Management	AC	7	\$20,000	\$140,000	Assumes area of floodplain from vineyard grade to vineyard grade minus the base flow inundation area of the main channel and of the proposed backwater habitat areas.						
<b>Construction Sub-Total</b>					<b>\$3,129,500</b>	<table border="1"> <tr> <td><b>Key</b></td> <td>LS = Lump Sum CY = Cubic Yard LF = Lineal Foot AC = Acre EA = Each</td> </tr> <tr> <td><b>Project Delivery Items are calculated as a percent of the construction sub-total</b></td> <td></td> </tr> <tr> <td><b>General Notes:</b></td> <td>-Cost includes a 30% design and construction contingency -Costs assume all materials (wood and rock) are purchased and hauled to the site from a nearby source -Boulder ballast requirements may be able to be reduced depending on hydraulics analysis</td> </tr> </table>	<b>Key</b>	LS = Lump Sum CY = Cubic Yard LF = Lineal Foot AC = Acre EA = Each	<b>Project Delivery Items are calculated as a percent of the construction sub-total</b>		<b>General Notes:</b>	-Cost includes a 30% design and construction contingency -Costs assume all materials (wood and rock) are purchased and hauled to the site from a nearby source -Boulder ballast requirements may be able to be reduced depending on hydraulics analysis
<b>Key</b>	LS = Lump Sum CY = Cubic Yard LF = Lineal Foot AC = Acre EA = Each											
<b>Project Delivery Items are calculated as a percent of the construction sub-total</b>												
<b>General Notes:</b>	-Cost includes a 30% design and construction contingency -Costs assume all materials (wood and rock) are purchased and hauled to the site from a nearby source -Boulder ballast requirements may be able to be reduced depending on hydraulics analysis											
Concept Level Design & Construction Contingency (30%)					\$938,850							
<b>Construction Total</b>					<b>\$4,068,400</b>							
<b>Project Delivery</b>												
Permitting (4%)					\$125,180							
Detailed Engineering Design (15%)					\$469,425							
Contract Administration (5%)					\$156,475							
Construction Oversight (1.5%)					\$46,943							
<b>Project Delivery Sub-Total</b>					<b>\$798,000</b>							
<b>TOTAL ESTIMATE</b>					<b>\$4,866,000</b>	rounded to nearest \$1,000						

## APPENDIX M

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**M.1 Reach 2 Description**

Reach 2 extends from the Mill Creek confluence upstream to about 100 ft below the Westside Road Bridge. Reach 2 is relatively straight with many riprap installations observed. This reach is unique due to the high density of off-channel habitats. Several side channels and alcoves of relatively significant size are present in this reach. Over the last century, the channel has become narrower, but there has been little channel migration. In between river mile 1.5 and 2, the main channel has migrated laterally since the 1980's, and the former 1983 channel is now in the floodplain. Main channel habitats are dominated by flatwaters. See the Dry Creek Current Conditions Report (Inter-Fluve 2010), Appendix A, for more detail.

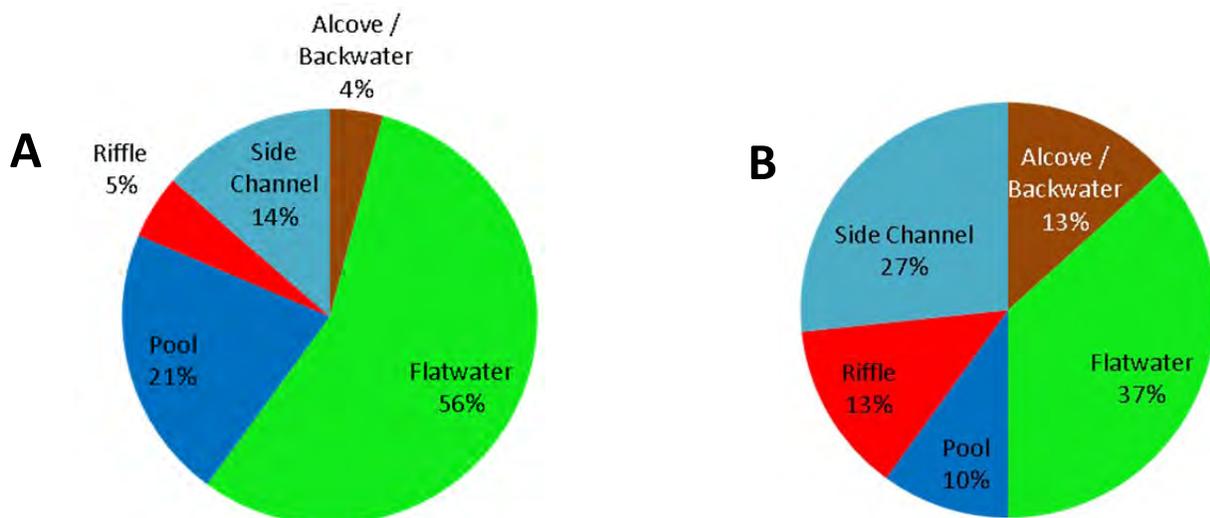


**Reach 2 Current Habitat Conditions**

Table M1. Reach 2 habitat units based on current conditions

Habitat	Existing Habitat	
	Area (ft <sup>2</sup> )	#
Alcove / Backwater	7750	6
Flatwater	237800	23
Pool	65700	9
Riffle	20950	5
Side Channel	4550	3

Figure M1. Habitat units in reach 2 based on area (A) and frequency (B).



## M.2 Reach 2 Enhancement Approach

Reach 2 is located in the “lower segment<sup>1</sup>” of Dry Creek, where the influence of the Russian River backwater controls the routing of sediment and fluvial processes in Dry Creek. Construction of late-successional habitats in this segment would be associated with a high level of risk for sedimentation and other issues that would limit the longevity and function of such enhancements. The best approach to habitat enhancement in reach 2 would be to utilize project elements that are designed to evolve with natural processes. Due to the presence of terraces and high bar features which are not accessed by the main channel at high flow, the best approach to reconnect floodplain processes is to shave down lateral bars and terraces to “reset” the connectivity between the main channel and the floodplain. For purposes of enhancement planning, reach 2 has been split into 2 enhancement sub-reaches (Figure M2). Sub-reach 2a (RM 0.64 to 1.39) is described in section M.3, and sub-reach 2b (RM 1.39 to 1.99) is described in section M.4.

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<sup>1</sup> Additional detail of process-based delineation of lower Dry Creek into upper, middle and lower segments can be found in the Fish Habitat Enhancement Feasibility Study, Section 5.3, IFI 2011.

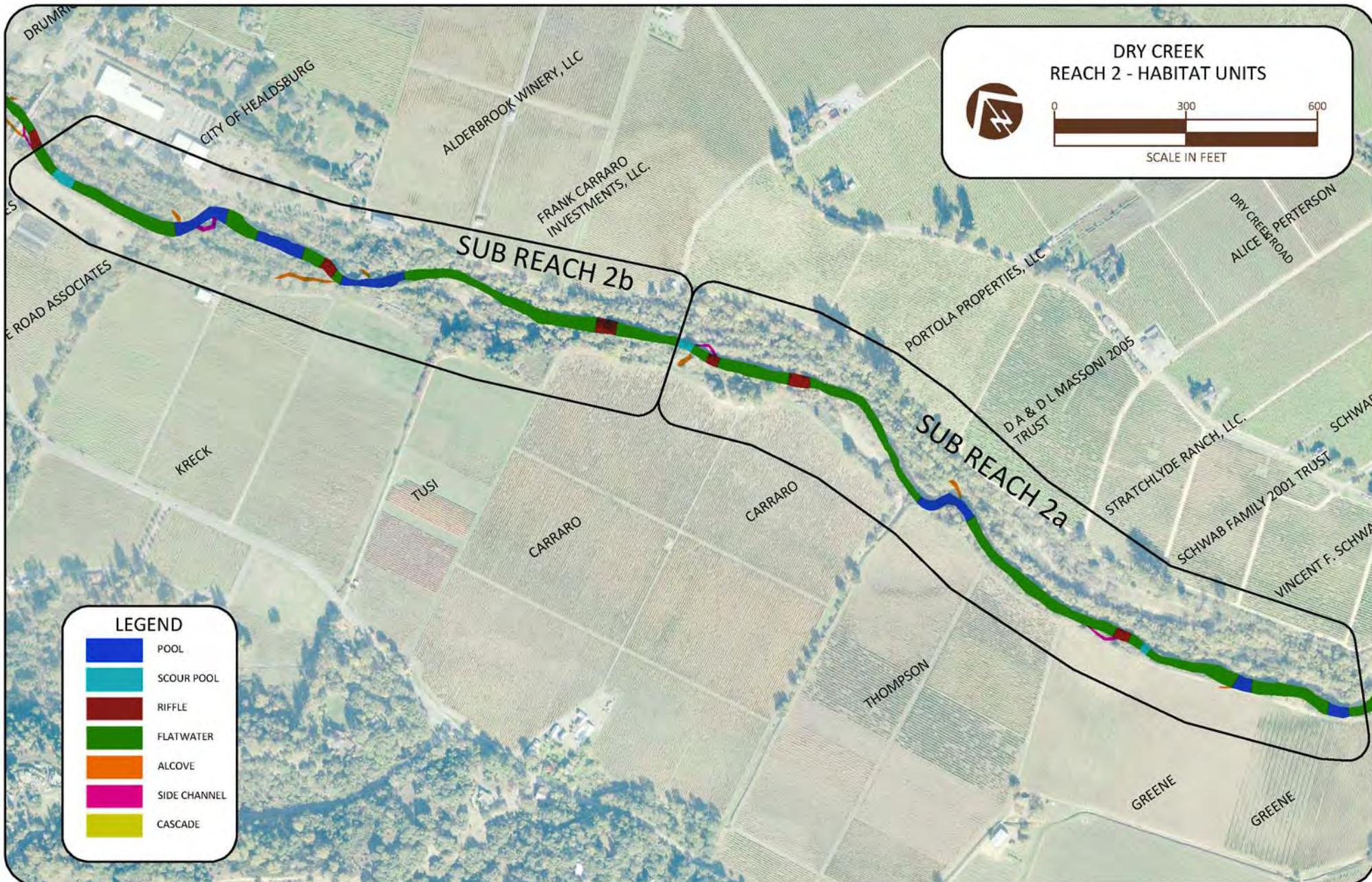


Figure M2. Reach 2 habitat units and sub-reach boundaries.

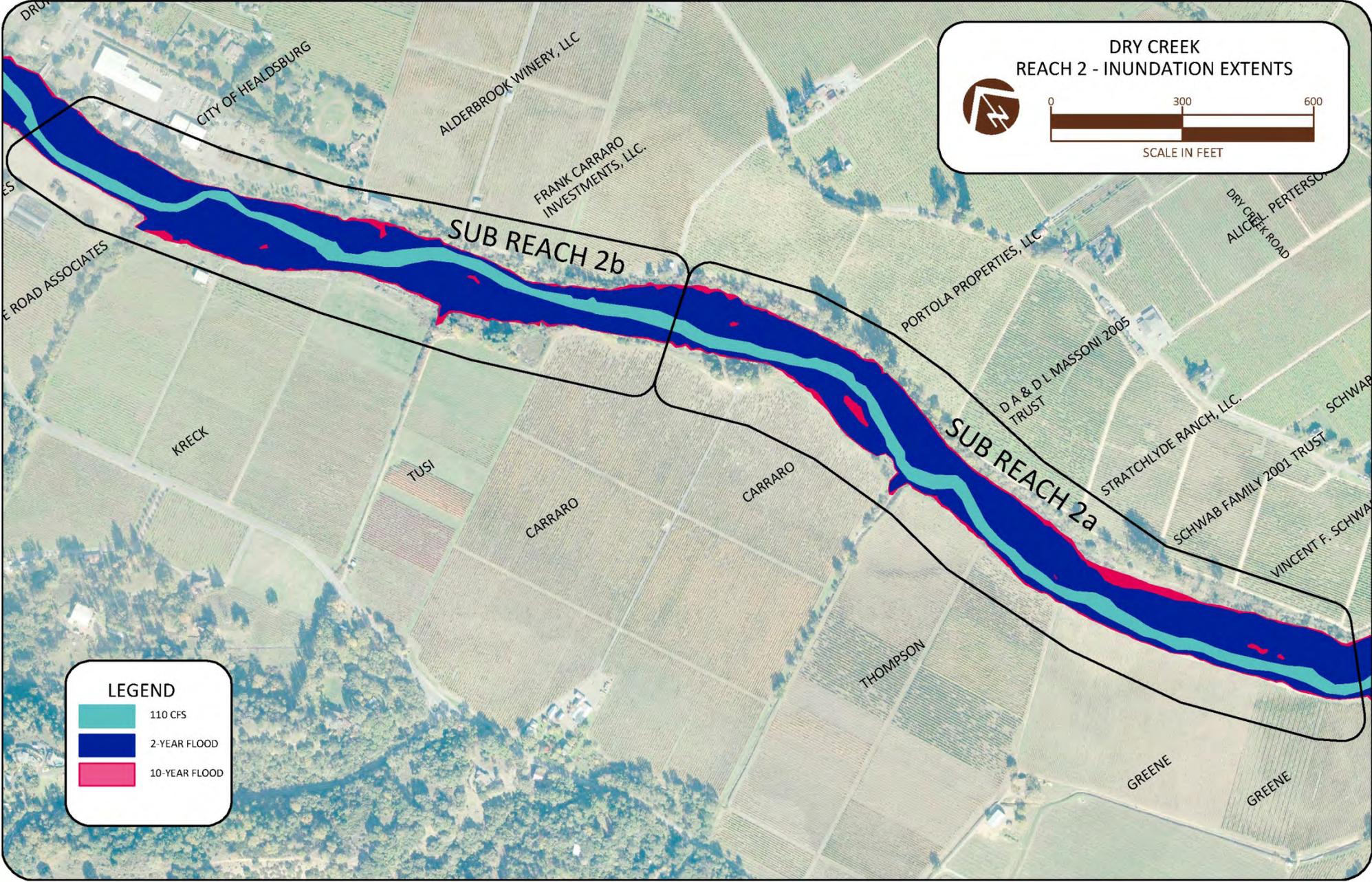


Figure M3. Modeled inundations in reach 2 based on three specific discharge levels: 110 cfs, the 2-year and 10-year flood events.

**M.3 Sub-Reach 2a Conceptual Designs**

Due to the greater presence of geomorphic processes occurring in the lower segment of Dry Creek, a “Dynamic, Process-Based Floodplain Enhancement” is proposed. This project involves creating a suite of diverse habitat types that are setup in a way that they will evolve over time and function similarly to dynamic, natural floodplain systems. Due to the presence of terraces and high bar features which are not accessed by the main channel at high flow, the best approach to reconnect floodplain processes is to shave down lateral bars and terraces to “reset” the connectivity between the main channel and the floodplain. Enhancement efforts will utilize a combination of floodplain grading, logjam construction, and excavation of off-channel habitats. Grading of the floodplain will serve to increase the frequency of inundation and create large areas of “Pilot Winter Refuge Habitat.” Logjams will be installed in strategic locations in order to encourage planform development as the reach becomes dynamic over time. The following table and corresponding figures summarizes the design concepts created for sub-reach 2a.

Project Code	Backwater Channel	Side Channel	Pool Enhancement	Riffle Enhancement	LWD	Winter Refuge Habitat	Bank Stabilization	Vegetation Management	Comments
M 2a	X	X			X	X	X	X	Dynamic Process-Based Floodplain Enhancement

Table M2. Inventory of projects identified in sub-reach 2a.

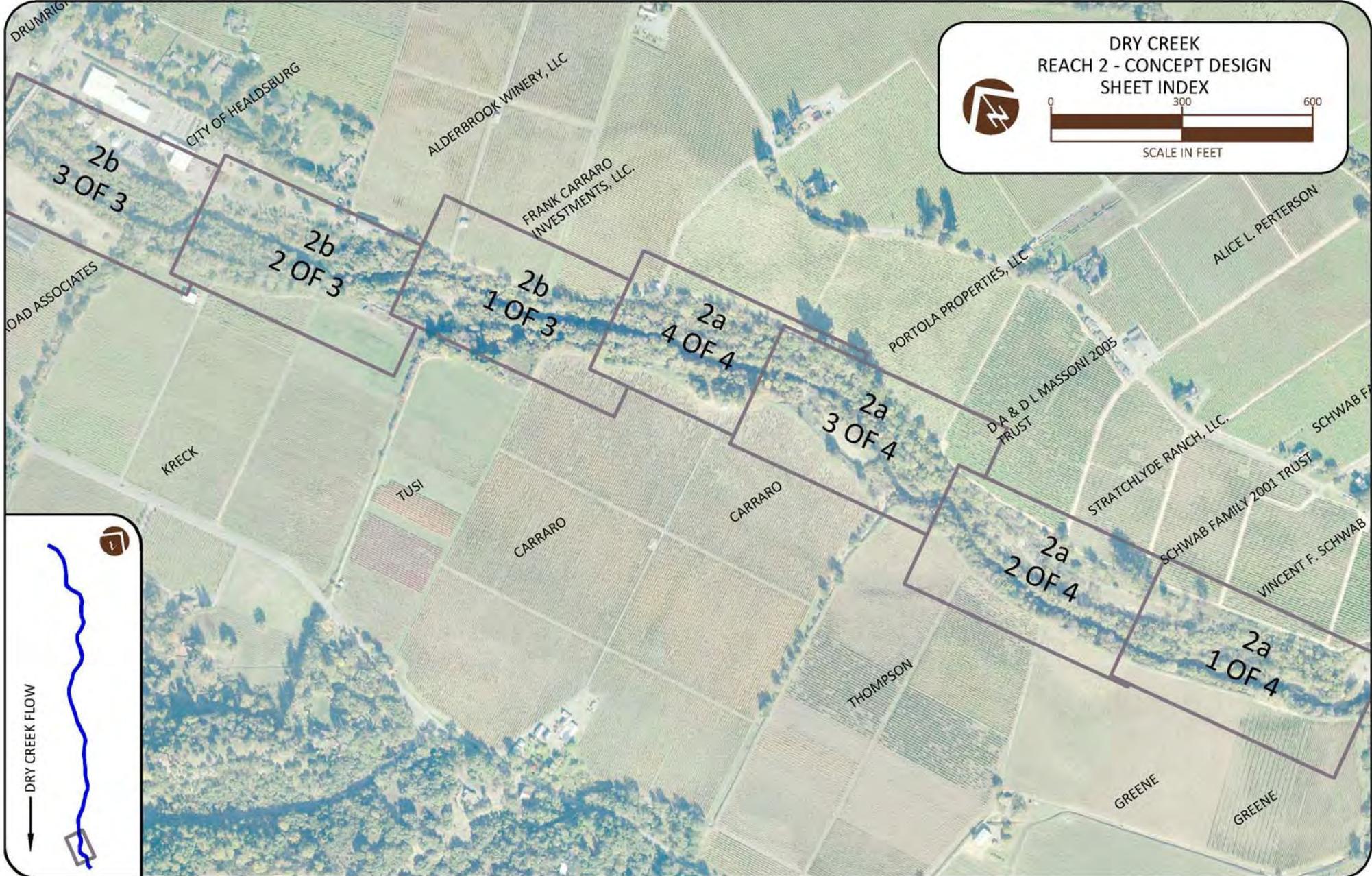
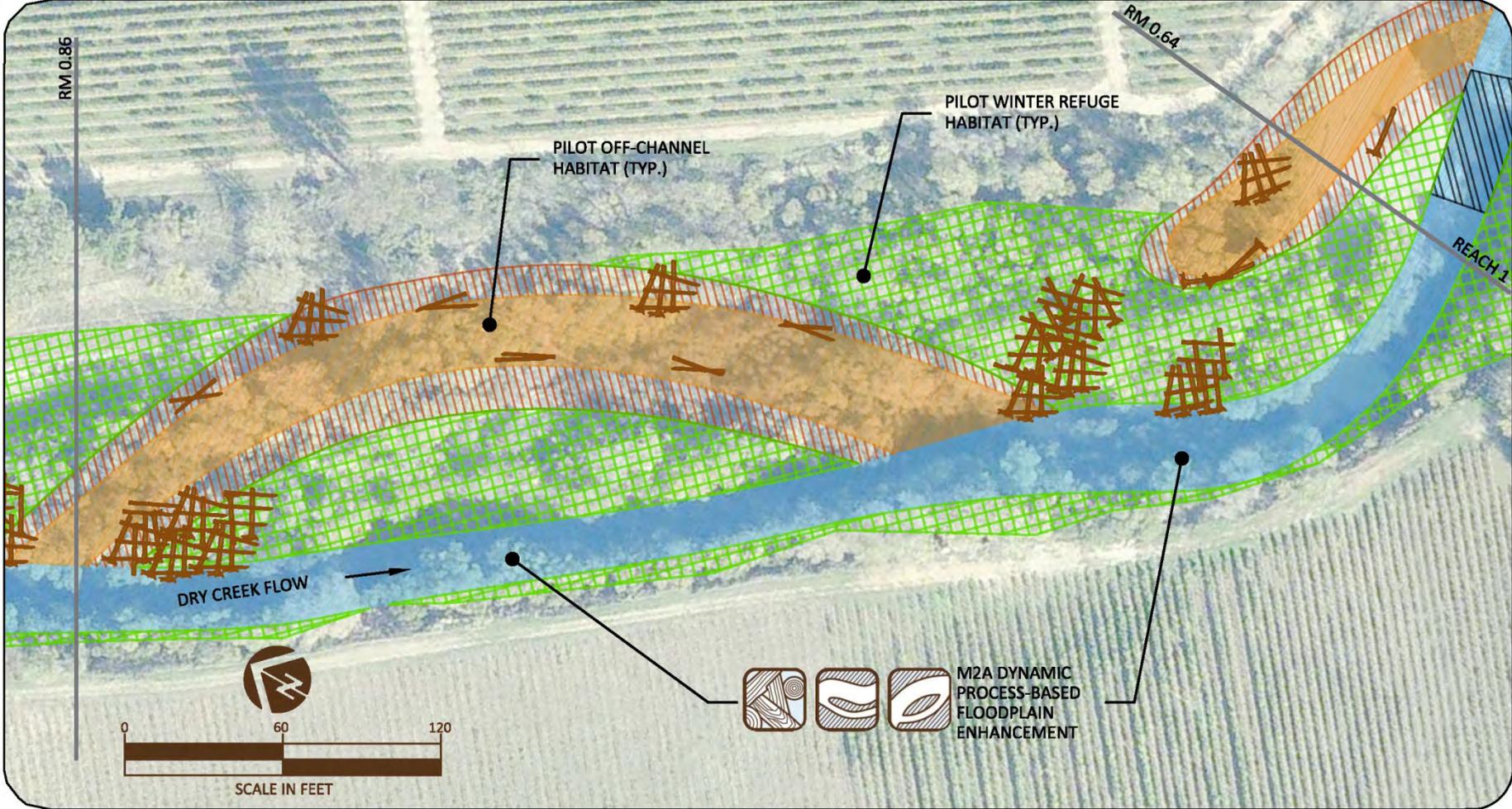


Figure M4. Reach 2 sheet index for conceptual design details.

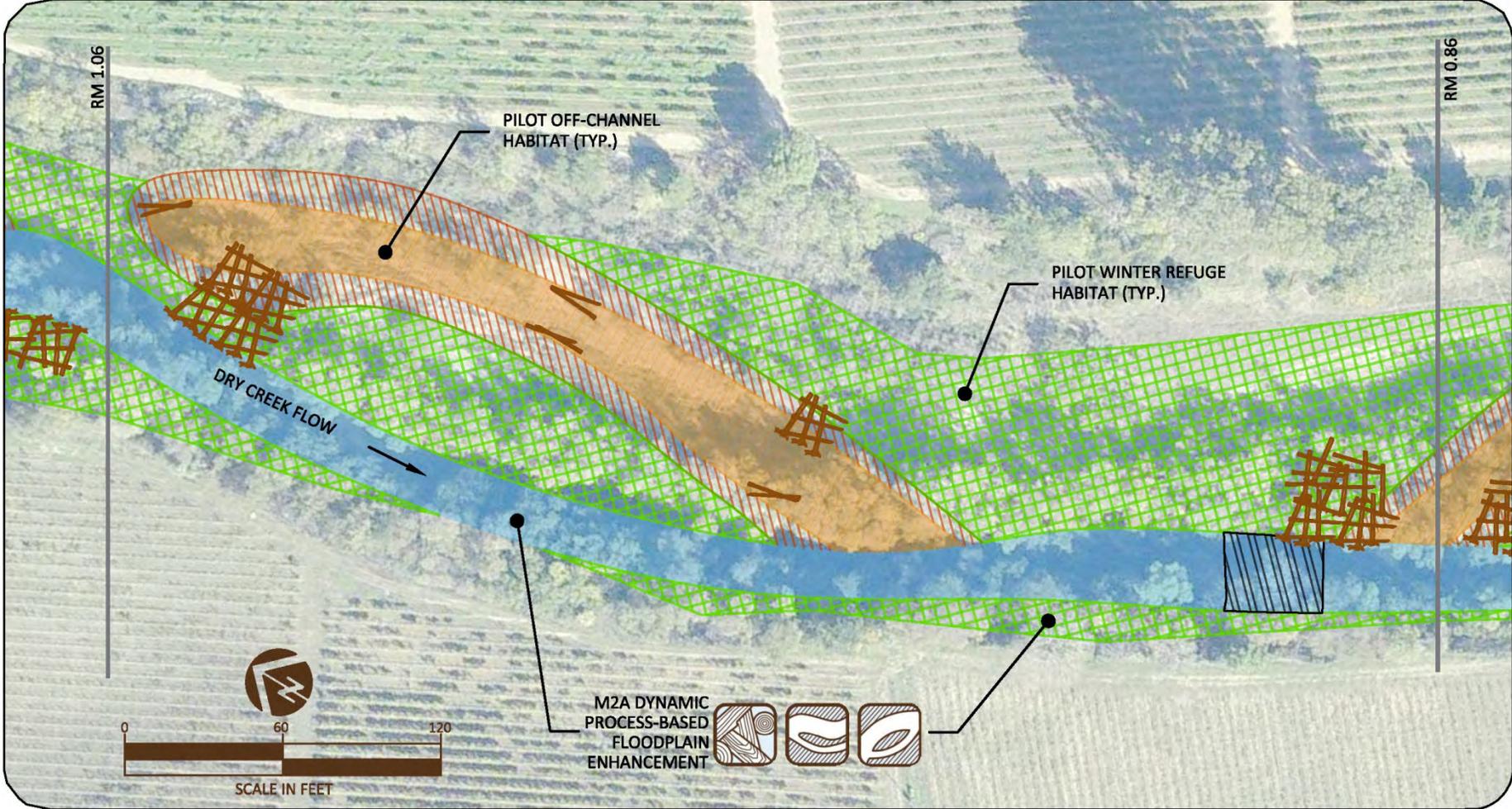


**LEGEND**

- MAIN CHANNEL AT 110 CFS
- PILOT OFF CHANNEL HABITAT
- GRADING
- PILOT WINTER REFUGE HABITAT

SUB REACH 2 A  
CONCEPT DESIGN  
1 OF 4

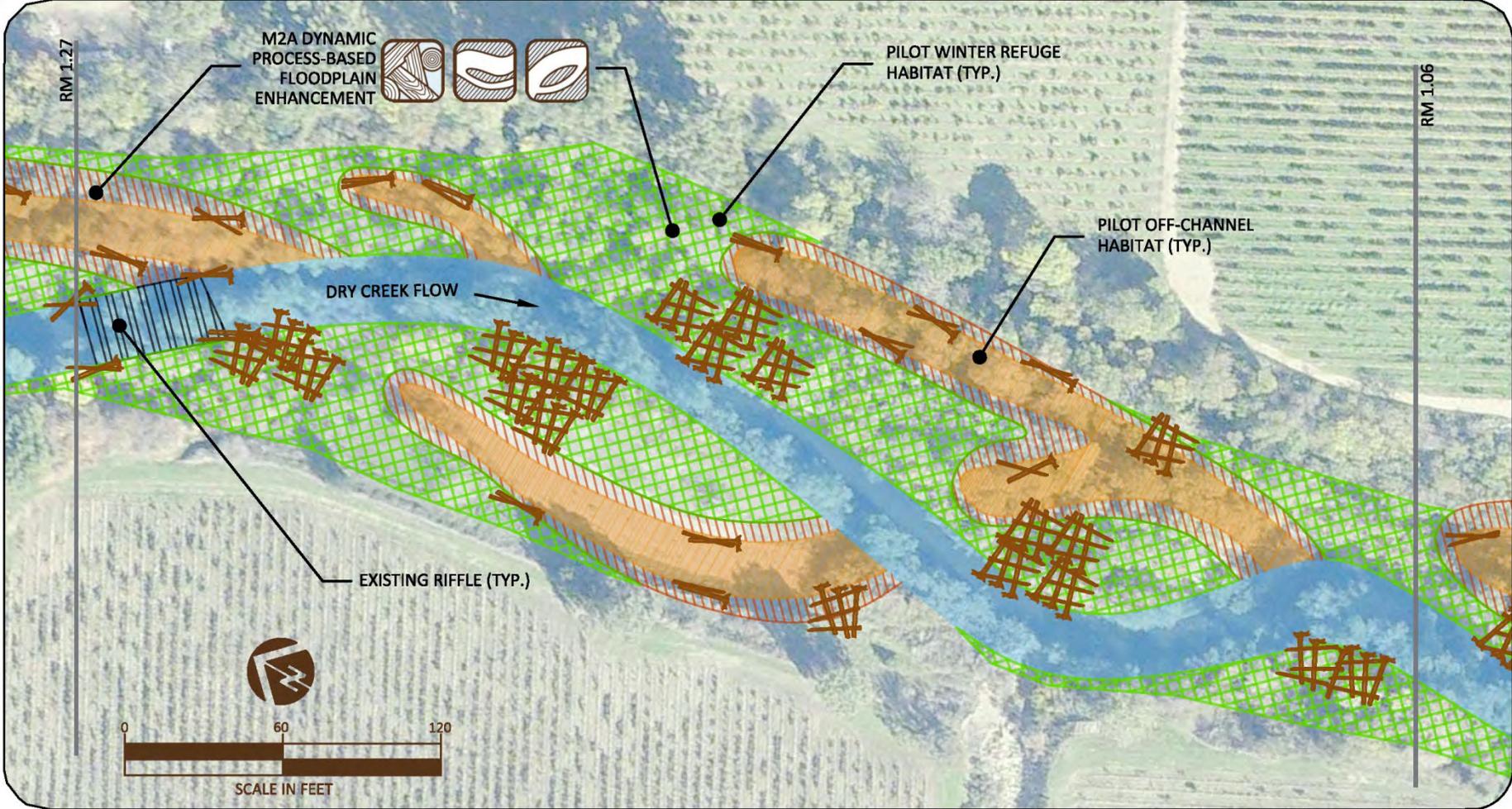
Figure M5. Sub-reach 2a conceptual design detail sheet 1 of 4.



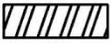
- LEGEND**
-   
 MAIN CHANNEL AT 110 CFS
  -   
 PILOT OFF CHANNEL HABITAT
  -   
 GRADING
  -   
 EXISTING RIFFLE
  -   
 PILOT WINTER REFUGE HABITAT

SUB REACH 2 A  
CONCEPT DESIGN  
2 OF 4

Figure M6. Sub-reach 2a conceptual design detail sheet 2 of 4.

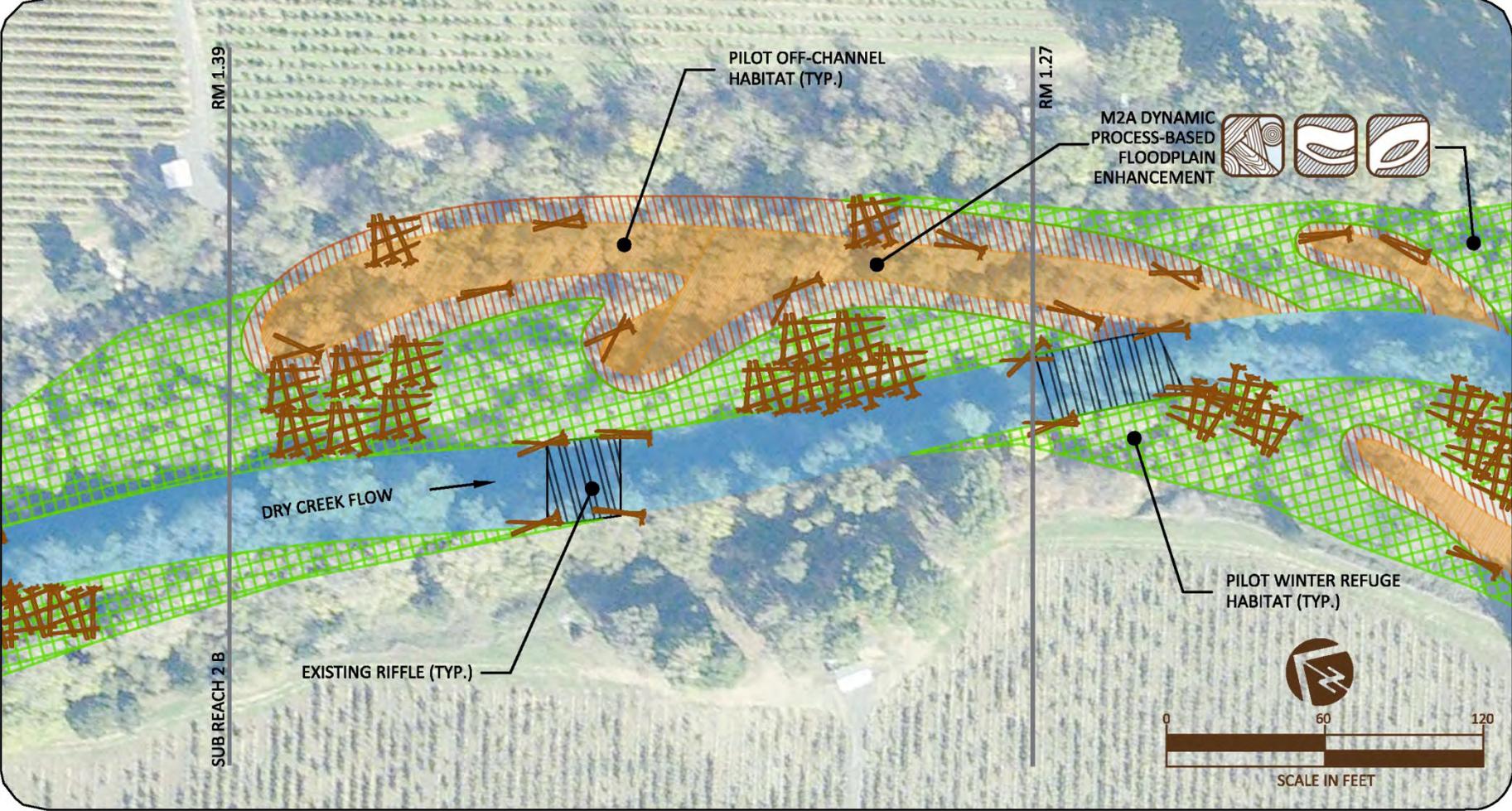


**LEGEND**

 MAIN CHANNEL AT 110 CFS	 PILOT OFF CHANNEL HABITAT	 GRADING	 EXISTING RIFFLE	 PILOT WINTER REFUGE HABITAT
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SUB REACH 2 A  
CONCEPT DESIGN  
3 OF 4

Figure M7. Sub-reach 2a conceptual design detail sheet 3 of 4.



**LEGEND**

- MAIN CHANNEL AT 110 CFS
- PILOT OFF CHANNEL HABITAT
- GRADING
- EXISTING RIFFLE
- PILOT WINTER REFUGE HABITAT

SUB REACH 2A  
CONCEPT DESIGN  
4 OF 4

Figure M8. Sub-reach 2a conceptual design detail sheet 4 of 4.

Sub-Reach 2a Analysis of Proposed Enhancements

Proposed enhancements will create more than 460,000 ft<sup>2</sup> of habitat in sub-reach 2a. More than 140,000 ft<sup>2</sup> of the proposed enhancements would be summer coho rearing habitat and the remaining 371,000 ft<sup>2</sup> would provide coho habitat during winter flows. Because the “dynamic process-based floodplain enhancement” approach greatly increases the frequency of floodplain inundation, pilot winter refuge habitat would provide coho rearing habitat during a large range of winter flows. This dynamic, process-based approach would fundamentally alter sub-reach 2a, and re-start geomorphic processes which have been locked up for several decades. The following tables summarize the frequency and areas of existing vs. proposed habitat (Table M3), additional habitat to be created by enhancements (Table M4) cost-based metrics (Table M5). Table M6 presents the habitat enhancement areas normalized by sub-reach main channel length. Table M7 summarizes the planning level cost estimate developed for sub-reach 2a.

Table M3. Habitat area by unit type for existing and proposed conditions in sub-reach 2a.

Habitat	Existing Habitat		Proposed Habitat	
	Area (ft <sup>2</sup> )	#	Area (ft <sup>2</sup> )	#
Alcove / Backwater	2900	3	2900	3
Flatwater	130450	16	13045	16
Pool	25550	5	25550	5
Riffle	11200	3	11200	3
Side Channel	2550	2	2550	2
Pilot Off-Channel Habitat	0	0	147700	6
Pilot Winter Refuge Habitat	0	0	371150	6

Table M4. Additional habitat benefits provided by backwater habitat, LWD-margin habitat, and riffles in sub-reach 2a.

Habitat Type	(ft <sup>2</sup> )	(m <sup>2</sup> )
Pilot Off-Channel Habitat (summer coho rearing)	133400	12390
LWD-Margin Habitat (summer coho rearing)	18400	1710
Pilot Winter Refuge Habitat (winter coho rearing)	296900	27580
Total	463000	43010

Table M5. Cost-benefit table for design concepts presented for sub-reach 2a.

Cost - Benefit Metric	Cost / ft <sup>2</sup>
Cost / ft <sup>2</sup> of summer coho rearing*	79
Cost / ft <sup>2</sup> of winter coho rearing **	27
Cost / ft <sup>2</sup> of total enhanced habitat***	26

\*includes pilot off-channel and LWD-margin habitats

\*\*includes pilot off-channel, LWD-margin, and winter refuge habitats

\*\*\*includes total pilot off-channel, LWD-margin, and winter refuge habitats

Table M6. Length metrics showing habitat area divided by main channel sub-reach length for summer coho rearing and total enhanced habitat.

Length Metric	area (ft <sup>2</sup> )/ length (ft)
Summer coho rearing habitat	40
Winter coho rearing habitat	118
Total enhanced habitat	122

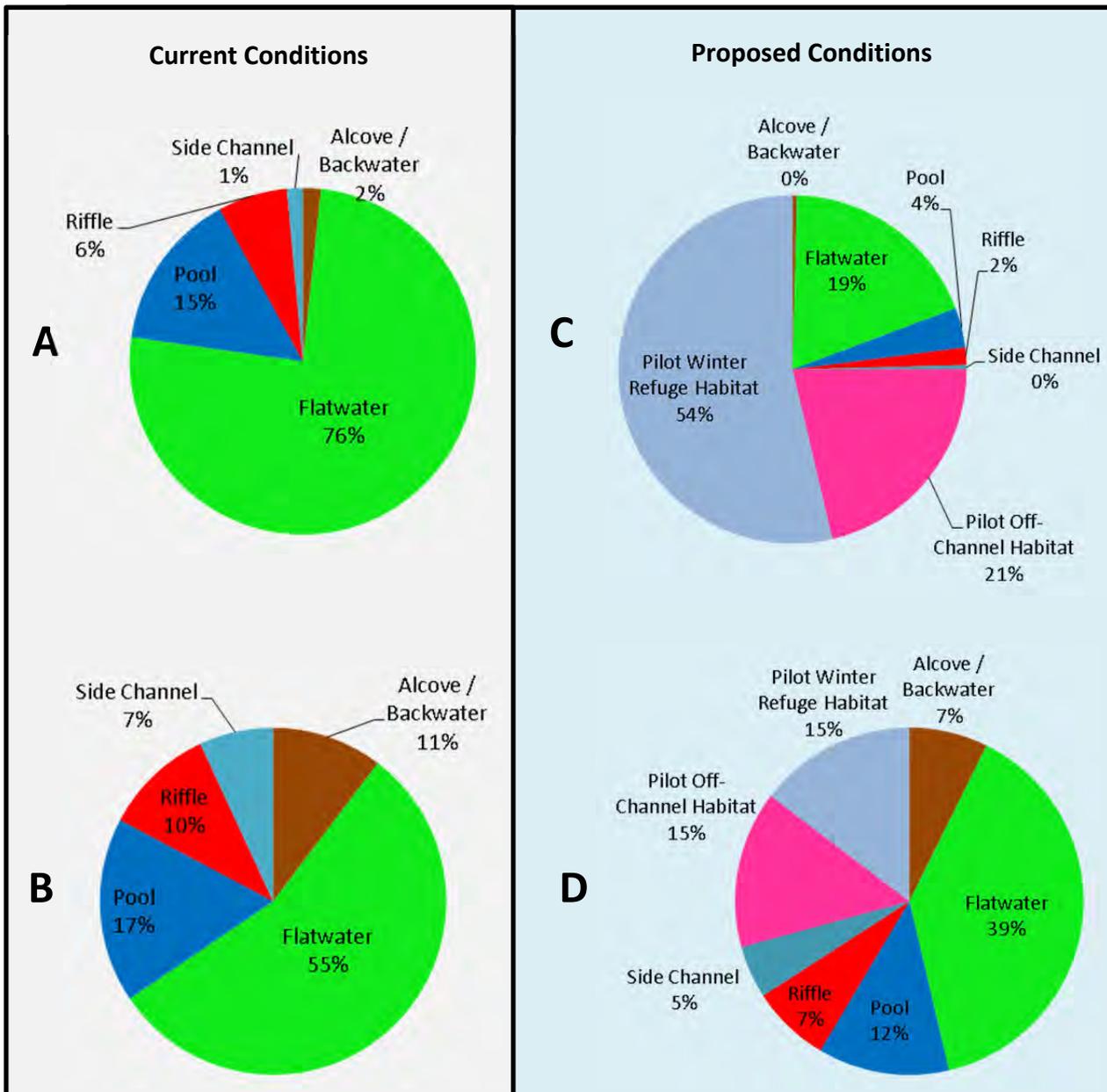


Figure M9. Existing habitats shown by area (A), frequency (B) and proposed habitat units based on area (C) and frequency (D).

**Sub-Reach 2a Alternatives Discussion**

Construction of late-successional habitats could be considered as an alternative to the process-based approach proposed for sub-reach 2b. Due to the dynamic nature of Dry Creek in this reach, there would be a high level of risk associated with constructing backwater channels and side channels in order to enhance habitat for coho and steelhead.

Table M7. Sub-Reach 2a Planning Level Cost Estimate

Note: This is a preliminary cost estimate for planning purposes. Actual costs for design and construction activities may vary substantially from these estimates. Assumptions for time requirements and material quantities have been made based on limited information that is available for the site. Additional information obtained during site investigations will be needed to determine actual quantities and costs. Estimates based on 2011 costs.

No.	Description	Unit	Quantity	Unit Cost	Total Cost	Design and Quantity Assumptions
1	Mobilization and Demobilization	LS	1	\$380,000	\$380,000	Calculated at 5% of construction sub-total.
2	Site Access Measures	LS	1	\$360,000	\$360,000	Includes access road improvements, traffic control, dust control, and site restoration.
3	Environmental Protection Measures	LS	1	\$1,820,000	\$1,820,000	Includes stream diversion/dewatering, fish relocation, and erosion control BMPs.
4	Clearing and Grubbing	AC	4	\$2,000	\$8,000	
5	Common Excavation	CY	96,570	\$20	\$1,931,400	Final design criteria and analysis will likely alter these estimates up or down.
6	Large Woody Debris (purchased, delivered, installed)					
a.	Pilot Off-Channel Margin Logs	EA	440	\$1,150	\$506,000	Assumes 30% delivered with root wads attached.
b.	Pool Enhancement Logs	EA	60	\$1,150	\$69,000	
c.	Log Jams	EA	1,040	\$1,150	\$1,196,000	
7	Boulder Ballast (purchased, delivered, installed)	TN	1,540	\$100	\$154,000	Estimated 1 ton per log.
8	Bank Stabilization	LF	910	\$1,000	\$910,000	Bank stabilization methods will vary but will include one or more of the following components: large woody debris, earthwork, riprap scour protection, granular backfill, aggregate filter material, geotextile fabric, and/or fabric encapsulated soil lifts. Assumes 30% delivered with root wads attached.
9	Vegetation Management	AC	17	\$20,000	\$340,000	Assumes area of floodplain from vineyard grade to vineyard grade minus the base flow inundation area of the main channel and of the proposed backwater habitat areas.
<b>Construction Sub-Total</b>					<b>\$7,674,400</b>	<div style="border: 1px solid black; padding: 5px; display: inline-block;"> <b>Key</b>                      LS = Lump Sum                      CY = Cubic Yard                      LF = Lineal Foot                      AC = Acre                      EA = Each                 </div> <div style="border: 1px solid black; padding: 5px; display: inline-block; margin-left: 20px;"> <b>Project Delivery Items are calculated as a percent of the construction sub-total</b>  <b>General Notes:</b>                      -Cost includes a 30% design and construction contingency                      -Costs assume all materials (wood and rock) are purchased and hauled to the site from a nearby source                      -Boulder ballast requirements may be able to be reduced depending on hydraulics analysis                 </div>
Concept Level Design & Construction Contingency (30%)					\$2,302,320	
<b>Construction Total</b>					<b>\$9,976,700</b>	
<b>Project Delivery</b>						
Permitting (4%)					\$306,976	
Detailed Engineering Design (15%)					\$1,151,160	
Contract Administration (5%)					\$383,720	
Construction Oversight (1.5%)					\$115,116	
<b>Project Delivery Sub-Total</b>					<b>\$1,957,000</b>	
<b>TOTAL ESTIMATE</b>					<b>\$11,934,000</b>	

rounded to nearest \$1,000

**M.4 Sub-Reach 2b Conceptual Designs**

Due to the greater presence of geomorphic processes occurring in the lower segment of Dry Creek, a “Dynamic, Process-Based Floodplain Enhancement” is proposed. This project involves creating a suite of diverse habitat types that are setup in a way that they will evolve over time and function similarly to dynamic, natural floodplain systems. Due to the presence of terraces and high bar features which are not accessed by the main channel at high flow, the best approach to reconnect floodplain processes is to shave down lateral bars and terraces to “reset” the connectivity between the main channel and the floodplain. Enhancement efforts will utilize a combination of floodplain grading, logjam construction, and excavation of off-channel habitats. Grading of the floodplain will serve to increase the frequency of inundation and create large areas of “Pilot Winter Refuge Habitat.” Logjams will be installed in strategic locations in order to encourage planform development as the reach becomes dynamic over time. The following table and accompanying figures summarize the design concepts created for sub-reach 2b.

Project Code	Backwater Channel	Side Channel	Pool Enhancement	Riffle Enhancement	LWD	Winter Refuge Habitat*	Bank Stabilization	Vegetation Management	Comments
M 2b	X	X			X	X	X	X	Riffle Construction & Pool Enhancement

Table M8. Inventory of projects identified in sub-reach 2b.

\*Pilot off channel habitat will also provide winter refuge habitat, as available off-channel habitat for juvenile salmonids will become larger as flows increase during winter storms.

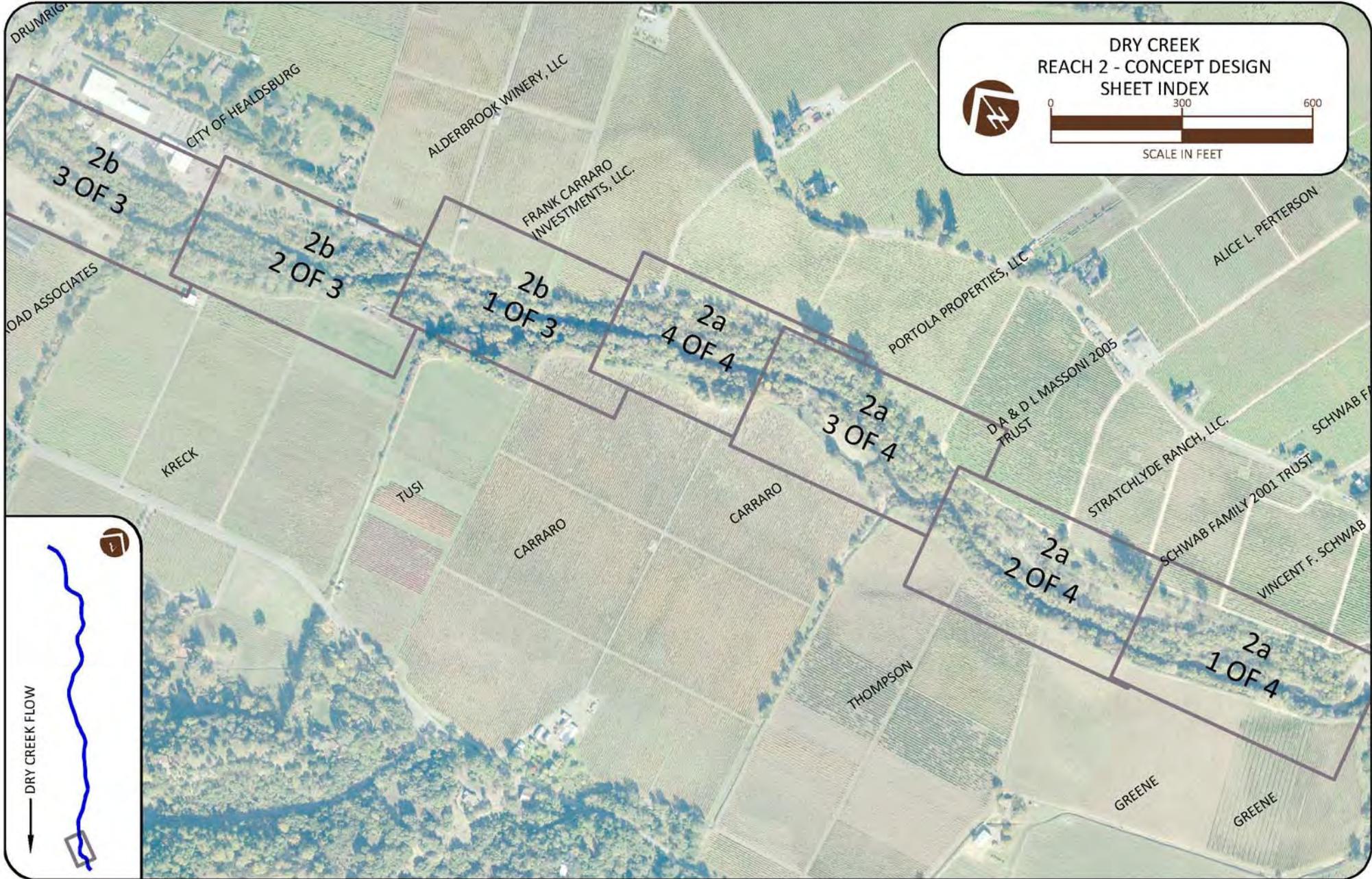
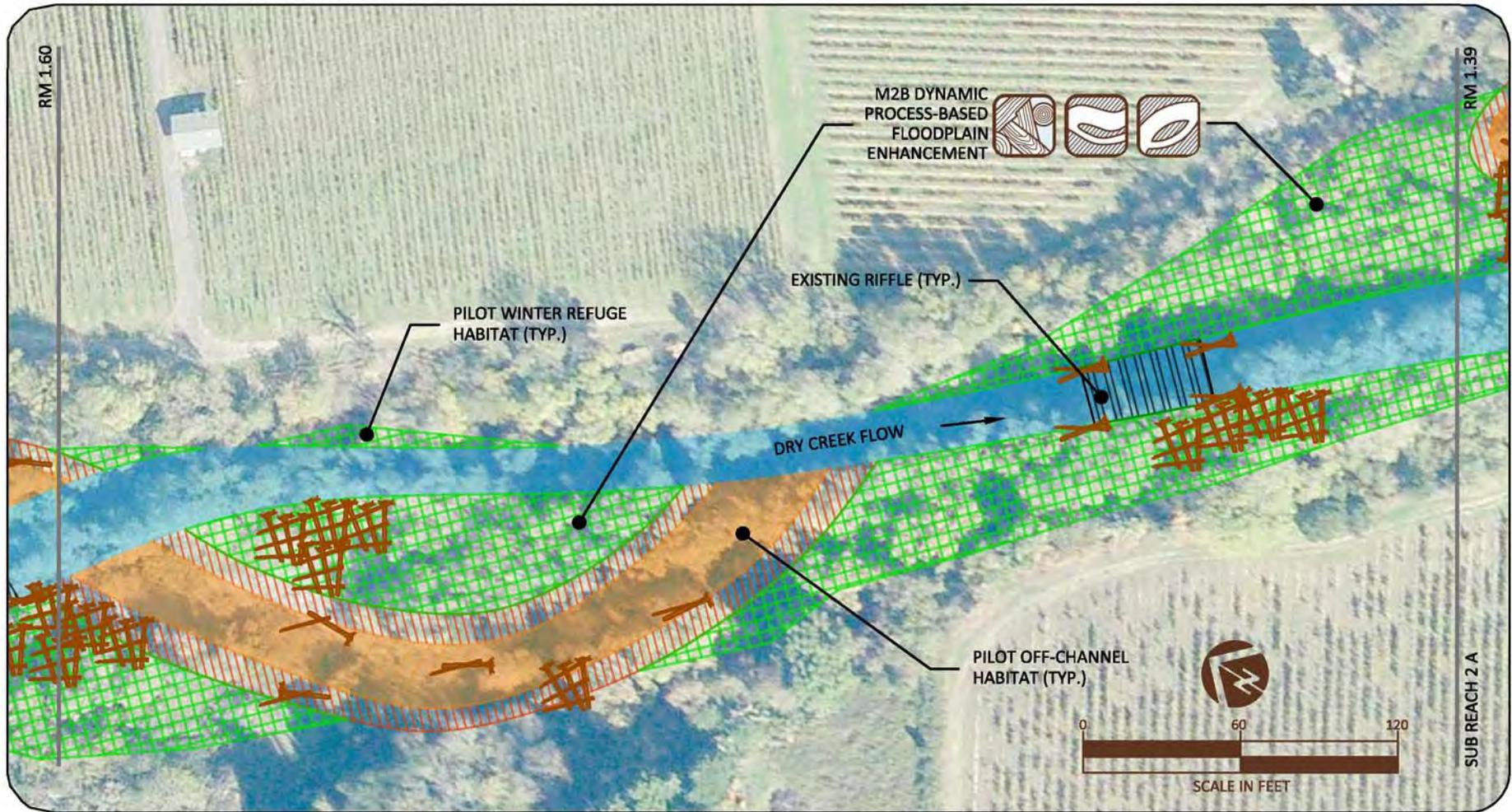


Figure M10. Reach 2 sheet index for conceptual design detail sheets.



**LEGEND**

MAIN CHANNEL AT  
110 CFS

PILOT OFF CHANNEL  
HABITAT

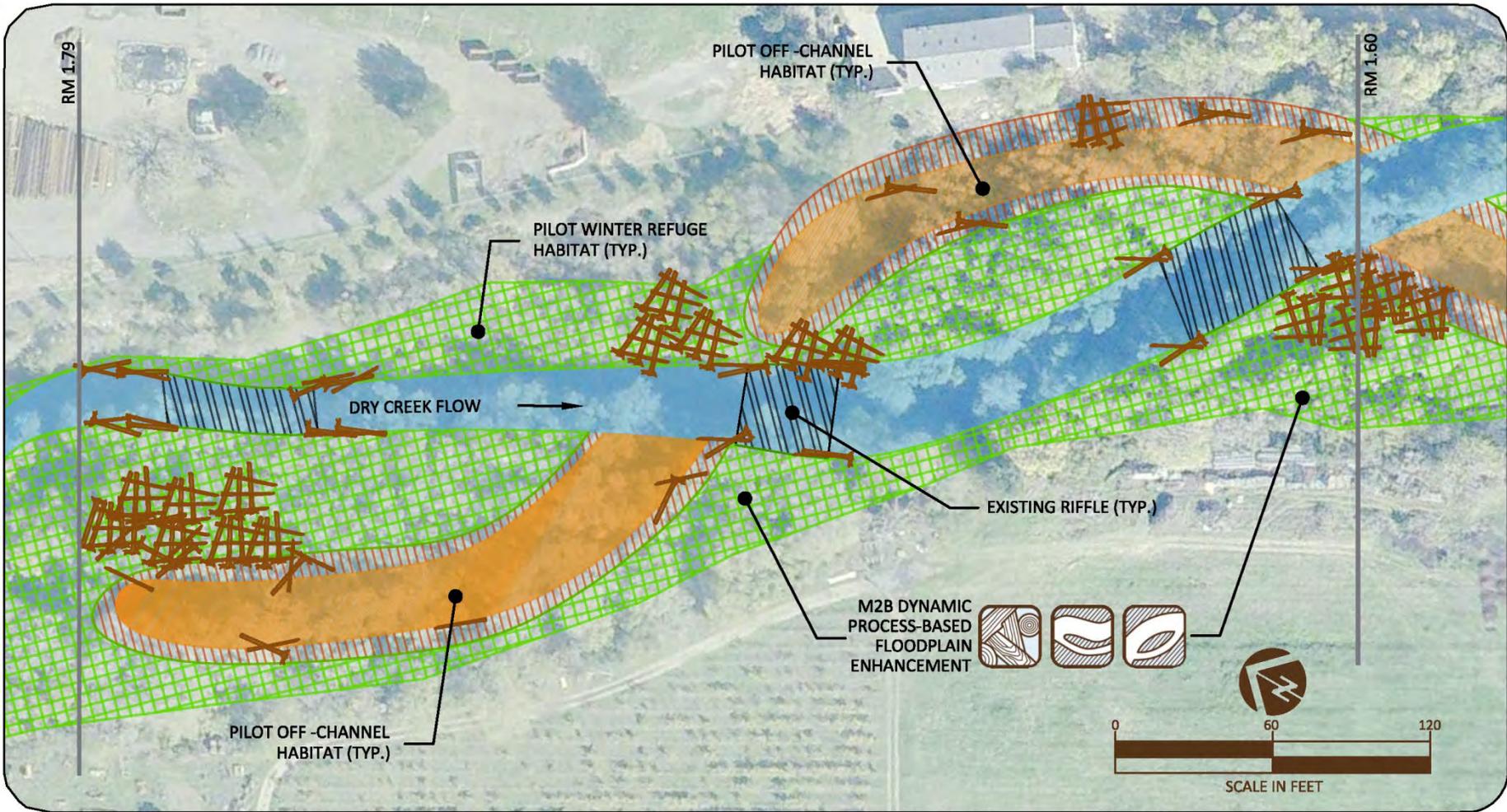
GRADING

EXISTING RIFFLE

PILOT WINTER  
REFUGE HABITAT

SUB REACH 2 B  
CONCEPT DESIGN  
1 OF 3

Figure M11. Sub-reach 2b conceptual design detail sheet 1 of 3.

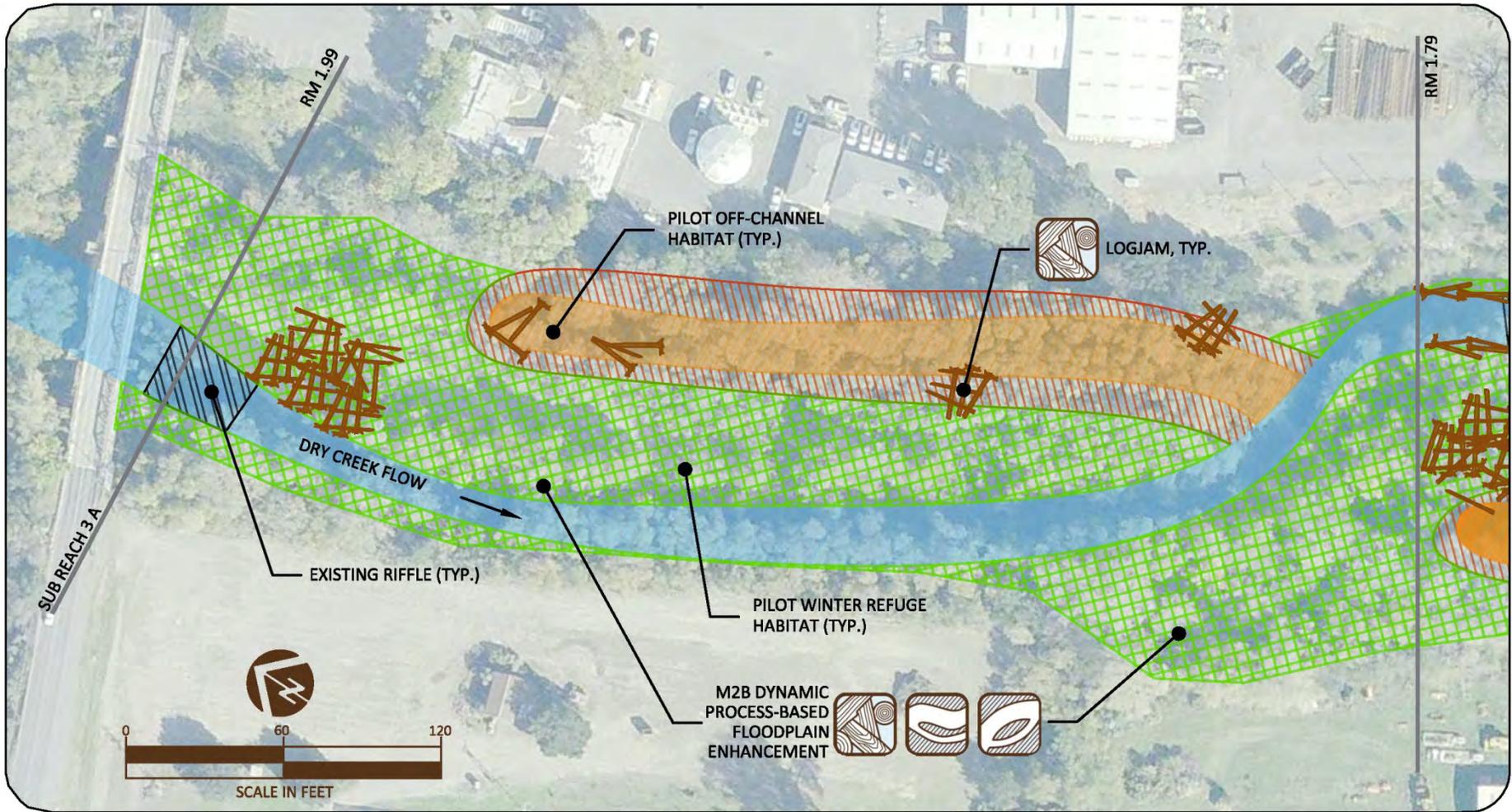


**LEGEND**

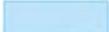
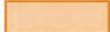
-   
 MAIN CHANNEL AT  
110 CFS
-   
 PILOT OFF CHANNEL  
HABITAT
-   
 GRADING
-   
 EXISTING RIFFLE
-   
 PILOT WINTER  
REFUGE HABITAT

**SUB REACH 2 B  
CONCEPT DESIGN  
2 OF 3**

Figure M12. Sub-reach 2b conceptual design detail sheet 2 of 3



**LEGEND**

-   
 MAIN CHANNEL AT 110 CFS
-   
 PILOT OFF CHANNEL HABITAT
-   
 GRADING
-   
 EXISTING RIFFLE
-   
 PILOT WINTER REFUGE HABITAT

**SUB REACH 2 B  
CONCEPT DESIGN  
3 OF 3**

Figure M13. Sub-reach 2b conceptual design detail sheet 3 of 3.

**Sub-Reach 2b Analysis of Proposed Enhancements**

Proposed enhancements will create more than 430,000 ft<sup>2</sup> of habitat in sub-reach 2b. More than 100,000 ft<sup>2</sup> of the proposed enhancements would be summer coho rearing habitat and the remaining 254,000 ft<sup>2</sup> would provide coho habitat during winter flows. Because the “dynamic process-based floodplain enhancement” approach greatly increases the frequency of floodplain inundation, pilot winter refuge habitat would provide coho rearing habitat during a large range of winter flows. This dynamic, process-based approach would fundamentally alter sub-reach 2b, and re-start geomorphic processes which have been locked up for several decades. The following tables summarize the frequency and areas of existing vs. proposed habitat (Table M9), additional habitat to be created by enhancements (Table M10) and cost-based metrics (Table M11). Table M12 presents habitat enhancement areas normalized by sub-reach main channel length. Table M13 summarizes the planning level cost estimate developed for sub-reach 2b.

Table M9. Habitat areas and frequencies based on existing and proposed habitats for sub-reach 2b.

Habitat	Existing Habitat		Proposed Habitat	
	Area (ft <sup>2</sup> )	#	Area (ft <sup>2</sup> )	#
Alcove / Backwater	4850	3	4850	3
Flatwater	107350	7	107350	7
Pool	40150	4	40150	4
Riffle	9750	2	9750	2
Side Channel	2000	1	2000	1
Pilot Off-Channel Habitat	0	0	97700	4
Pilot Winter Refuge Habitat	0	0	317850	6

Table M10. Additional habitat benefits provided by backwater habitat, LWD-margin habitat, and riffles.

Habitat Type	(ft <sup>2</sup> )	(m <sup>2</sup> )
Pilot Off-Channel Habitat (coho rearing)	88600	8230
LWD-Margin Habitat (coho rearing)	15200	1410
Pilot Winter Refuge Habitat (coho rearing)	254280	23620
Total	367180	34110

Table M11. Cost – benefit table for design concepts presented for sub-reach 2b

Cost - Benefit Metric	Cost/ft <sup>2</sup>
Cost / ft <sup>2</sup> of summer coho rearing*	88
Cost / ft <sup>2</sup> of winter coho rearing **	25
Cost / ft <sup>2</sup> of total enhanced habitat***	25

\*includes pilot off-channel and LWD-margin habitats

\*\*includes pilot off-channel, LWD-margin, pilot winter refuge habitats

\*\*\*includes total pilot off-channel, LWD-margin, pilot winter refuge

Table M12. Length metric table showing habitat area divided by main channel sub-reach length for summer coho rearing and total enhanced habitat.

Length Metric	area (ft <sup>2</sup> )/ length (ft)
Summer coho rearing habitat	32
Winter coho rearing habitat	112
Total enhanced habitat	115

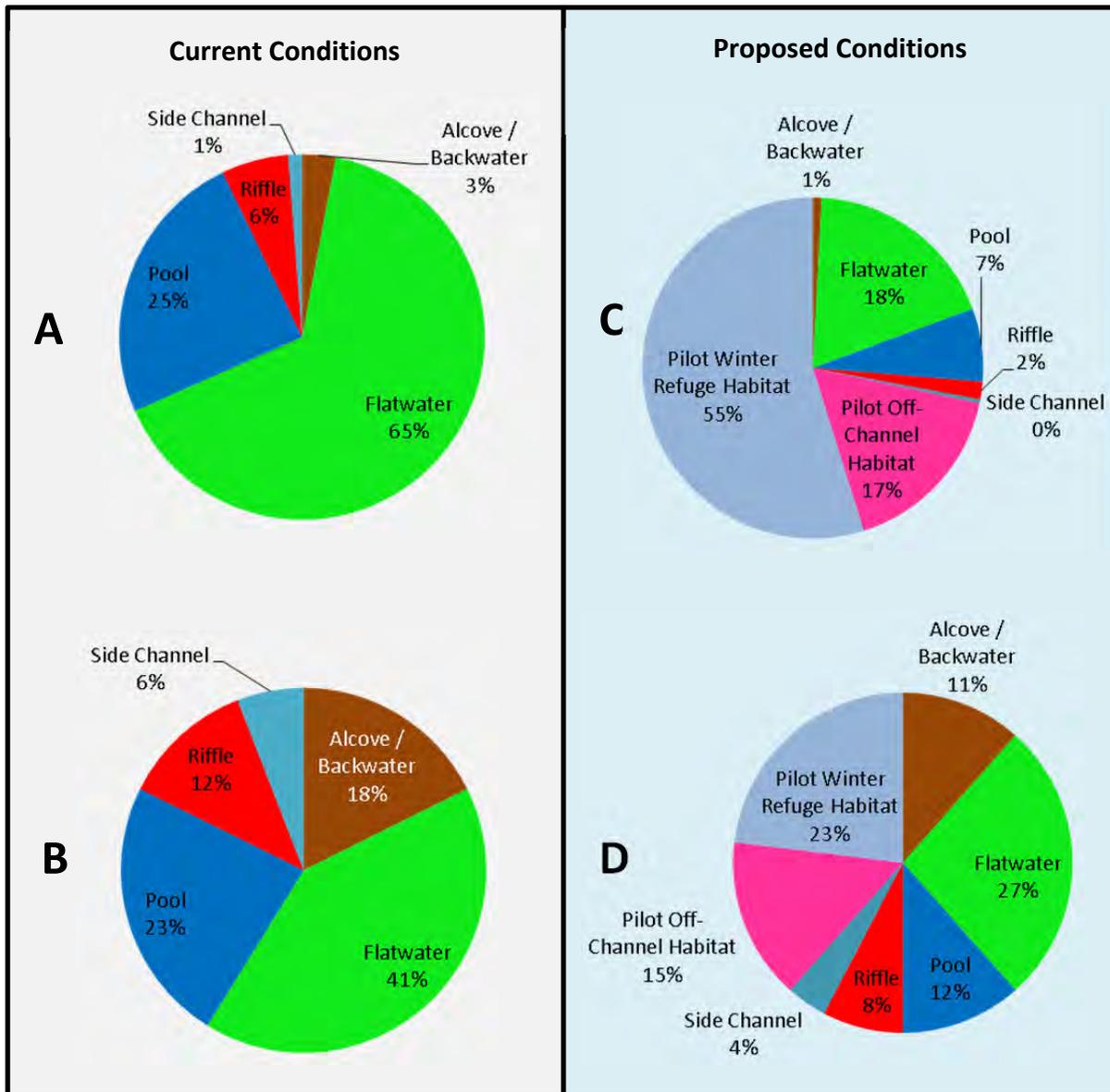


Figure M14. Existing sub-reach 2b habitats shown by area (A), frequency (B) and proposed habitat units based on area (C) and frequency (D).

**Sub-Reach 2b Alternatives Discussion**

Construction of late-successional habitats could be considered as an alternative to the process-based approach proposed for sub-reach 2b. Due to the dynamic nature of Dry Creek in this reach, there would be a high level of risk associated with constructing backwater channels and side channels in order to enhance habitat for coho and steelhead.

Table M13. Sub-reach 2b Planning Level Cost Estimate

Note: This is a preliminary cost estimate for planning purposes. Actual costs for design and construction activities may vary substantially from these estimates. Assumptions for time requirements and material quantities have been made based on limited information that is available for the site. Additional information obtained during site investigations will be needed to determine actual quantities and costs. Estimates based on 2011 costs.

No.	Description	Unit	Quantity	Unit Cost	Total Cost	Design and Quantity Assumptions
1	Mobilization and Demobilization	LS	1	\$290,000	\$290,000	Calculated at 5% of construction sub-total.
2	Site Access Measures	LS	1	\$270,000	\$270,000	Includes access road improvements, traffic control, dust control, and site restoration.
3	Environmental Protection Measures	LS	1	\$1,390,000	\$1,390,000	Includes stream diversion/dewatering, fish relocation, and erosion control BMPs.
4	Clearing and Grubbing	AC	2	\$2,000	\$4,000	
5	Common Excavation	CY	63,130	\$20	\$1,262,600	Final design criteria and analysis will likely alter these estimates up or down.
6	Large Woody Debris (purchased, delivered, installed)					
a.	Pilot Off-Channel Margin Logs	EA	290	\$1,150	\$333,500	Assumes 30% delivered with root wads attached.
b.	Pool Enhancement Logs	EA	130	\$1,150	\$149,500	
c.	Log Jams	EA	700	\$1,150	\$805,000	
7	Boulder Ballast (purchased, delivered, installed)	TN	1,120	\$100	\$112,000	Estimated 1 ton per log.
8	Bank Stabilization	LF	1,030	\$1,000	\$1,030,000	Bank stabilization methods will vary but will include one or more of the following components: large woody debris, earthwork, riprap scour protection, granular backfill, aggregate filter material, geotextile fabric, and/or fabric encapsulated soil lifts. Assumes 30% delivered with root wads attached.
9	Vegetation Management	AC	11	\$20,000	\$220,000	Assumes area of floodplain from vineyard grade to vineyard grade minus the base flow inundation area of the main channel and of the proposed backwater habitat areas.
<b>Construction Sub-Total</b>					<b>\$5,866,600</b>	<div style="display: flex; justify-content: space-between;"> <div style="border: 1px solid black; padding: 5px;"> <p><b>Key</b>                      LS = Lump Sum                      CY = Cubic Yard                      LF = Lineal Foot                      AC = Acre                      EA = Each</p> </div> <div style="border: 1px solid black; padding: 5px;"> <p><b>Project Delivery Items are calculated as a percent of the construction sub-total</b>  <b>General Notes:</b>                      -Cost includes a 30% design and construction contingency                      -Costs assume all materials (wood and rock) are purchased and hauled to the site from a nearby source                      -Boulder ballast requirements may be able to be reduced depending on hydraulics analysis</p> </div> </div>
Concept Level Design & Construction Contingency (30%)					\$1,759,980	
<b>Construction Total</b>					<b>\$7,626,600</b>	
<b>Project Delivery</b>						
Permitting (4%)					\$234,664	
Detailed Engineering Design (15%)					\$879,990	
Contract Administration (5%)					\$293,330	
Construction Oversight (1.5%)					\$87,999	
<b>Project Delivery Sub-Total</b>					<b>\$1,496,000</b>	
<b>TOTAL ESTIMATE</b>					<b>\$9,123,000</b>	

rounded to nearest \$1,000

## APPENDIX N

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**N.1 Reach 1 Description**

Reach 1 is bounded by the Russian River confluence at river mile 0, and the Mill Creek confluence at river mile 0.7. In this reach, Dry Creek is a single thread channel with a few vegetated bars. Terraces along the channel are both indicators of historical incision, and current influence of the Russian River backwater. There is a USGS low-flow gage in reach 1, located at river mile 0.16. See the Dry Creek Current Conditions Report (Inter-Fluve 2010), Appendix A, for more detail.

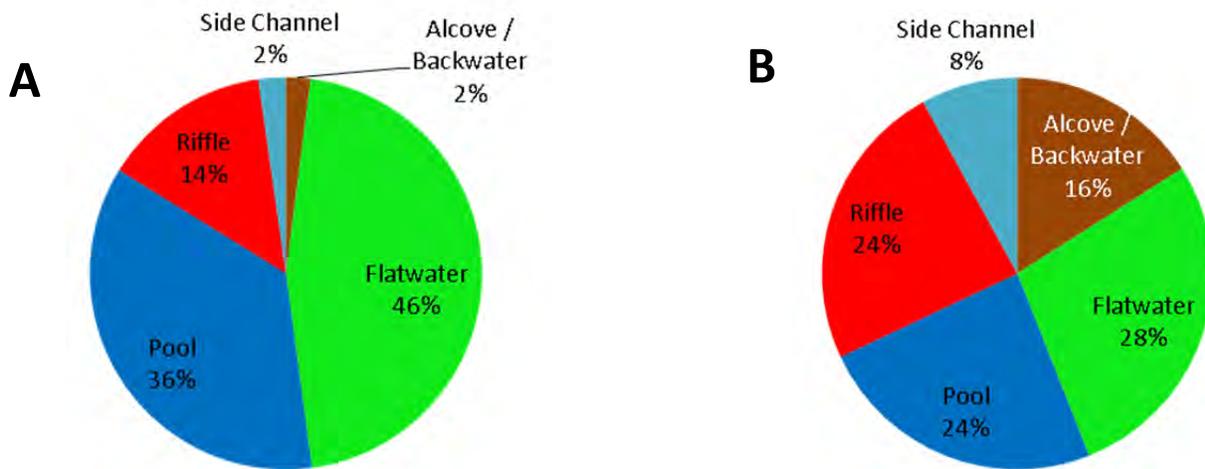


**Reach 1 Current Habitat Conditions**

Table N1. Reach 1 habitat units based on current conditions.

Habitat	Existing Habitat	
	Area (ft <sup>2</sup> )	#
Alcove / Backwater	3600	4
Flatwater	81350	7
Pool	63800	6
Riffle	24700	6
Side Channel	4000	2

Figure N1. Habitat units in reach 3 based on area (A) and frequency (B).



## N.2 Reach 1 Enhancement Approach

Reach 1 (RM 0 to 0.64) is located in the “lower segment<sup>1</sup>” of Dry Creek, where the influence of the Russian River backwater exerts a significant control on the routing of sediment and fluvial processes in Dry Creek. Construction of late-successional habitats in this segment of Dry Creek would be associated with a high level of risk of nuisance sedimentation or other effects that would limit the longevity and function of such enhancements. The most appropriate approach to habitat enhancement in Reach 1 is to utilize project elements that are designed to evolve with natural processes. Details of conceptual designs developed for reach 1 are presented in section N.3.

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<sup>1</sup> Additional detail of process-based delineation of lower Dry Creek into upper, middle and lower segments can be found in the Fish Habitat Enhancement Feasibility Study, Section 5.3, IFI 2011.



Figure N2. Reach 1 habitat units and sub-reach boundaries.



Figure N3. Modeled inundations in reach 1 based on three specific discharge levels: 110 cfs, the 2-year and 10-year flood events.

**N.3 Reach 1 Conceptual Designs**

In order to leverage the presence of highly dynamic channel and sediment processes in this reach, a “Dynamic Process-Based Floodplain Enhancement” is proposed. This project involves creating a suite of diverse habitat types that are setup in a way that they will evolve over time and function similarly to dynamic, natural floodplain systems. Enhancement efforts will utilize a combination of floodplain grading, logjam construction, and excavation of off-channel habitats. Grading of the floodplain will serve to increase the frequency of inundation and create large areas of “Pilot Winter Refuge Habitat.” Logjams will be installed in strategic locations in order to encourage planform development as the reach becomes dynamic over time. The following table and corresponding figures summarize design concepts created for reach 1.

	Backwater Channel	Side Channel	Pool Enhancement	Riffle Enhancement	LWD	Winter Refuge Habitat*	Bank Stabilization	Vegetation Management	
Project Code									Comments
M 1	X	X			X	X	X	X	Dynamic Process-Based Floodplain Enhancement

Table N2. Inventory of projects identified in reach 1.

\*Pilot off channel habitats will also serve as winter refuge habitat during frequently occurring winter flood flows. Available off channel habitat for juvenile salmonids will become larger as flows increase during winter storms.

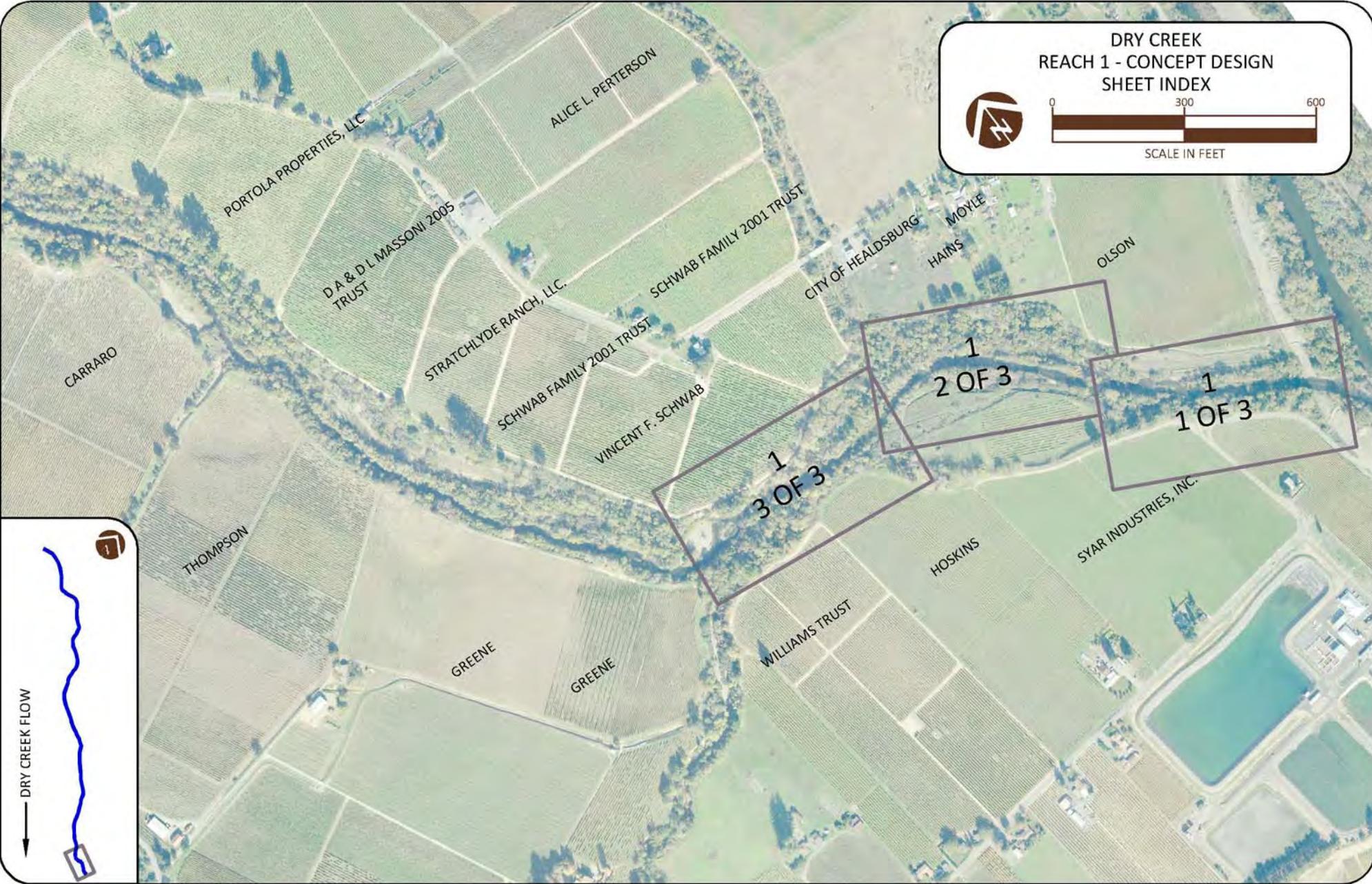
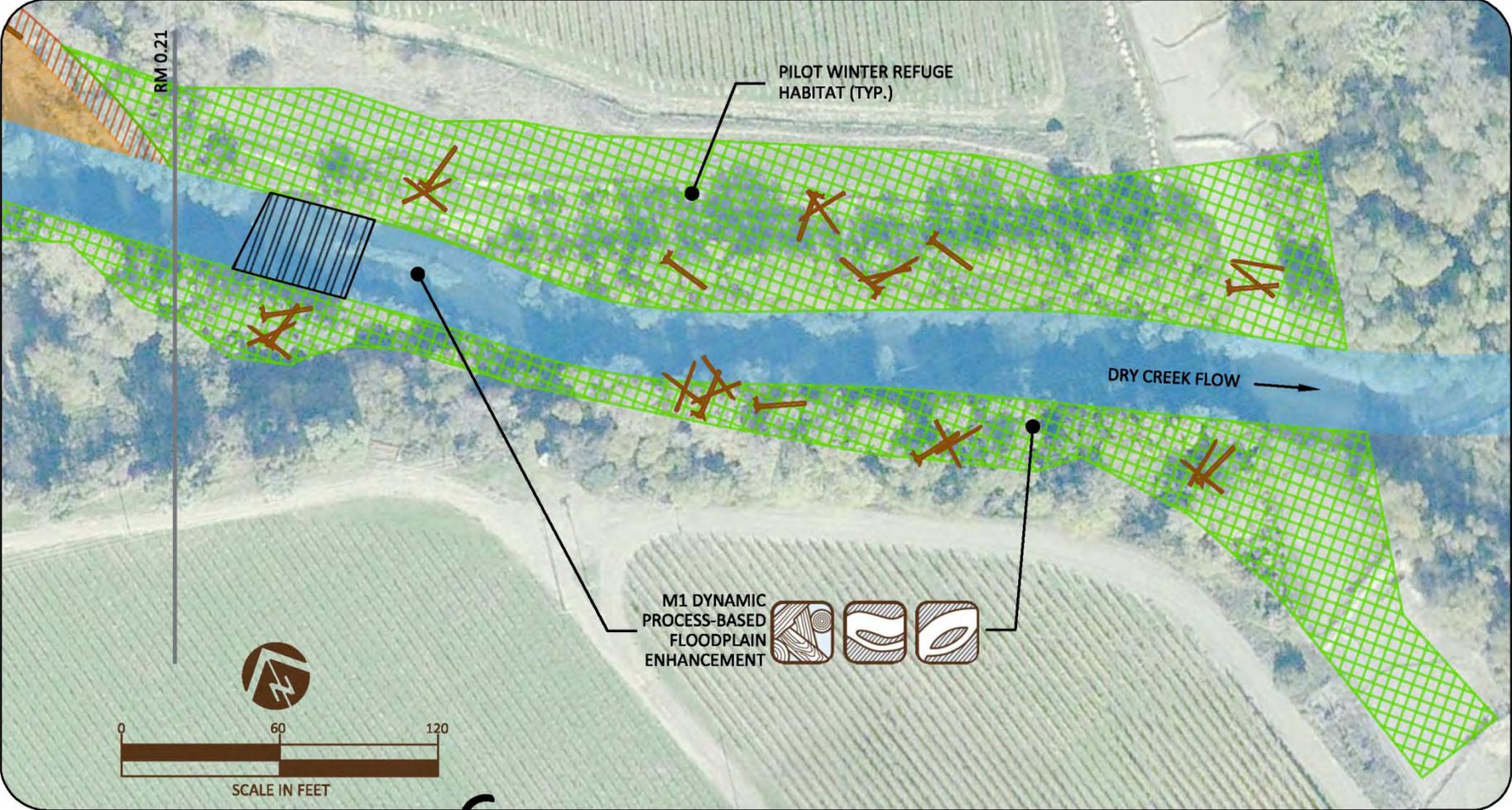


Figure N4. Reach 1 sheet index for conceptual design detail sheets.

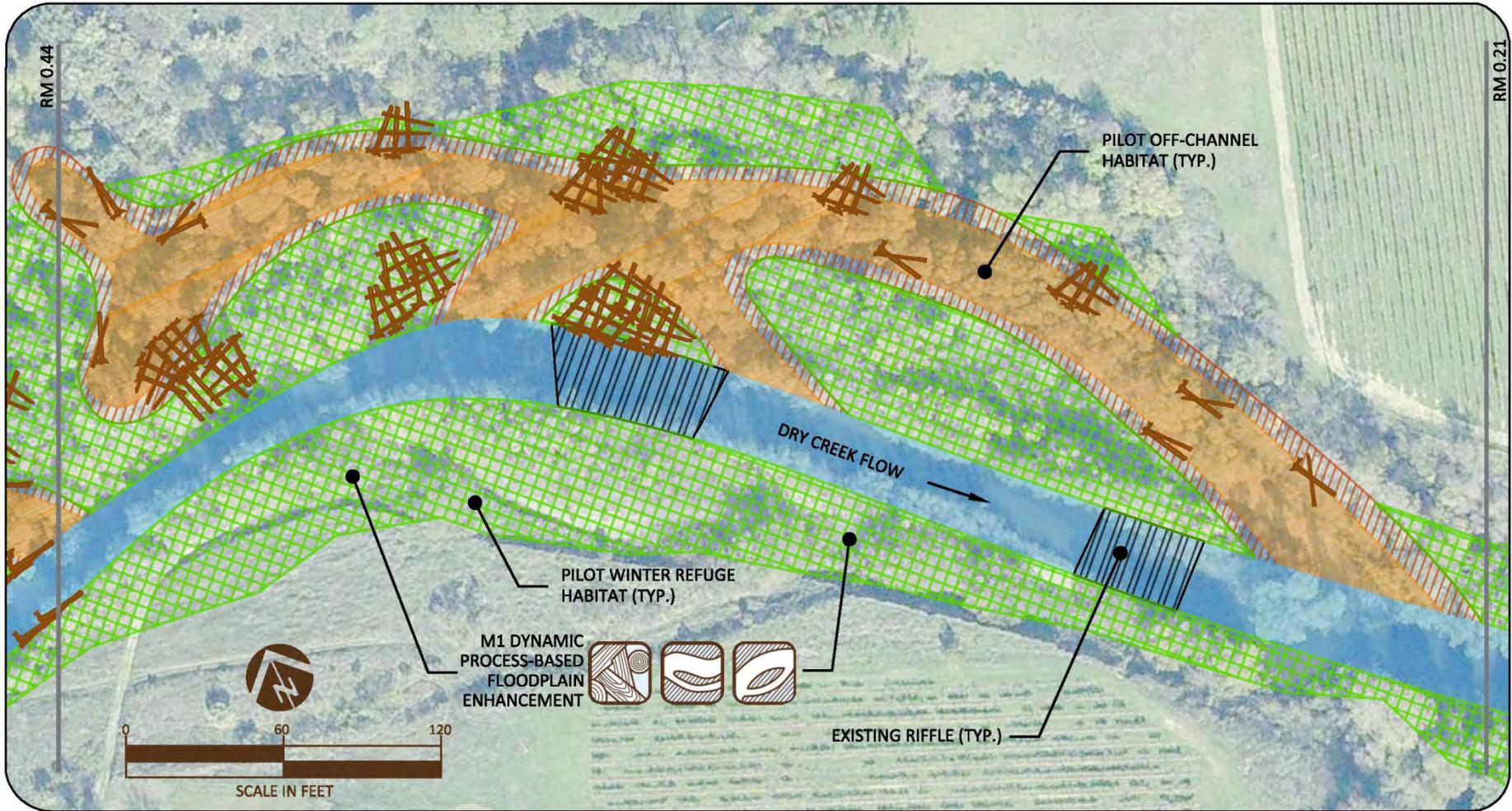


**LEGEND**

- MAIN CHANNEL AT 110 CFS
- PILOT WINTER REFUGE HABITAT

REACH 1  
CONCEPT DESIGN  
1 OF 3

Figure N5. Reach 1 conceptual design detail sheet 1 of 3.



M1 DYNAMIC  
PROCESS-BASED  
FLOODPLAIN  
ENHANCEMENT



EXISTING RIFFLE (TYP.)

**LEGEND**

MAIN CHANNEL AT  
110 CFS

PILOT OFF CHANNEL  
HABITAT

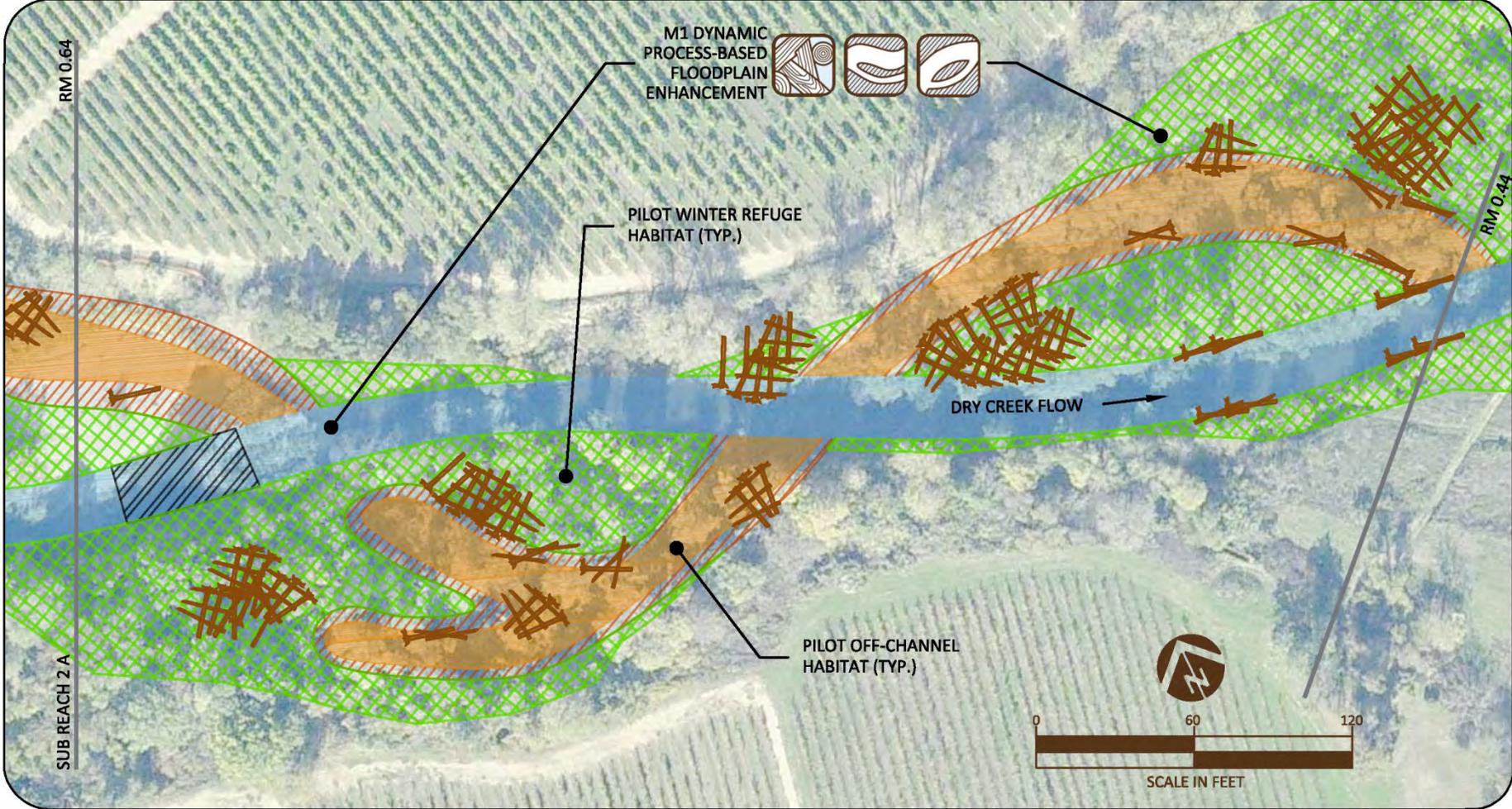
GRADING

EXISTING RIFFLE

PILOT WINTER  
REFUGE HABITAT

REACH 1  
CONCEPT DESIGN  
2 OF 3

Figure N6. Reach 1 conceptual design detail sheet 2 of 3.



**LEGEND**

MAIN CHANNEL AT 110 CFS

PILOT OFF CHANNEL HABITAT

GRADING

EXISTING RIFFLE

PILOT WINTER REFUGE HABITAT

REACH 1  
CONCEPT DESIGN  
3 OF 3

Figure N7. Reach 1 conceptual design detail sheet 3 of 3.

Reach 1 Analysis of Proposed Enhancements

Proposed enhancements will create more than 4500,000 ft<sup>2</sup> of coho rearing habitat in reach 1. Pilot off-channel habitat will provide benefits for juvenile fish at 110 cfs. Due to the lowering of the floodplain, frequently occurring winter flows will provide large areas of winter refuge habitat, allowing juvenile salmonids to seek out areas with near-optimal velocities. The LWD installations and 105,000 ft<sup>2</sup> of pilot off-channel habitat will evolve over time to provide a combination of main channel and off-channel habitats. The metrics used to evaluate habitat benefits in reaches 1 and 2 are not necessarily to be compared directly with upstream reaches where late-successional habitats are proposed. Pilot off-channel and winter refuge habitats will be dynamic over time, and stakeholders will need to decide how to evaluate habitat benefits for this type of an enhancement. The following tables summarize the frequency and areas of existing vs. proposed habitat (Table N3), additional habitat to be created by enhancements (Table N4) cost-based metrics (Table N5). Table N6 presents the habitat enhancements normalized by main channel sub-reach length. Table N7 summarizes the planning level cost estimate developed for reach 1.

Table N3: Habitat area by unit type for existing and proposed conditions in reach 1.

Habitat	Existing Habitat		Proposed Habitat	
	Area (ft <sup>2</sup> )	#	Area (ft <sup>2</sup> )	#
Alcove / Backwater	3600	4	3600	4
Flatwater	81350	7	81350	8
Pool	63800	6	63800	6
Riffle	24700	6	24700	6
Side Channel	4000	2	47150	2
Pilot Off-Channel Habitat	0	0	130200	7
Pilot Winter Refuge Habitat	0	0	450250	6

Table N4. Additional habitat benefits provided by backwater habitat, LWD-margin habitat, and riffles in reach 1.

Habitat Type	(ft <sup>2</sup> )	(m <sup>2</sup> )
Pilot Off-Channel (coho rearing)	105150	9770
LWD-Margin Habitat (coho rearing)	8000	740
Pilot Winter Refuge Habitat (coho rearing)	360200	33460
<b>Total</b>	<b>498400</b>	<b>46300</b>

Table N5. Cost-benefit table for design concepts presented for reach 1.

Cost - Benefit Metric	Cost / ft <sup>2</sup>
Cost / ft <sup>2</sup> of summer coho rearing*	102
Cost / ft <sup>2</sup> of winter coho rearing*	24
Cost / ft <sup>2</sup> of additional habitat**	23

\*includes pilot off-channel, and LWD-margin habitats

\*\*includes pilot off-channel, incremental winter refuge, pilot winter refuge, and LWD-margin habitats

\*\*\* includes pilot off-channel, pilot winter refuge, and LWD-margin habitats

Table N6. Length metric table showing enhancement habitat area divided by main channel reach length for summer coho rearing and total enhanced habitats.

Length Metric	area (ft <sup>2</sup> )/ length (ft)
Summer coho rearing habitat	32
Winter coho rearing habitat	133
Total enhanced habitat	140

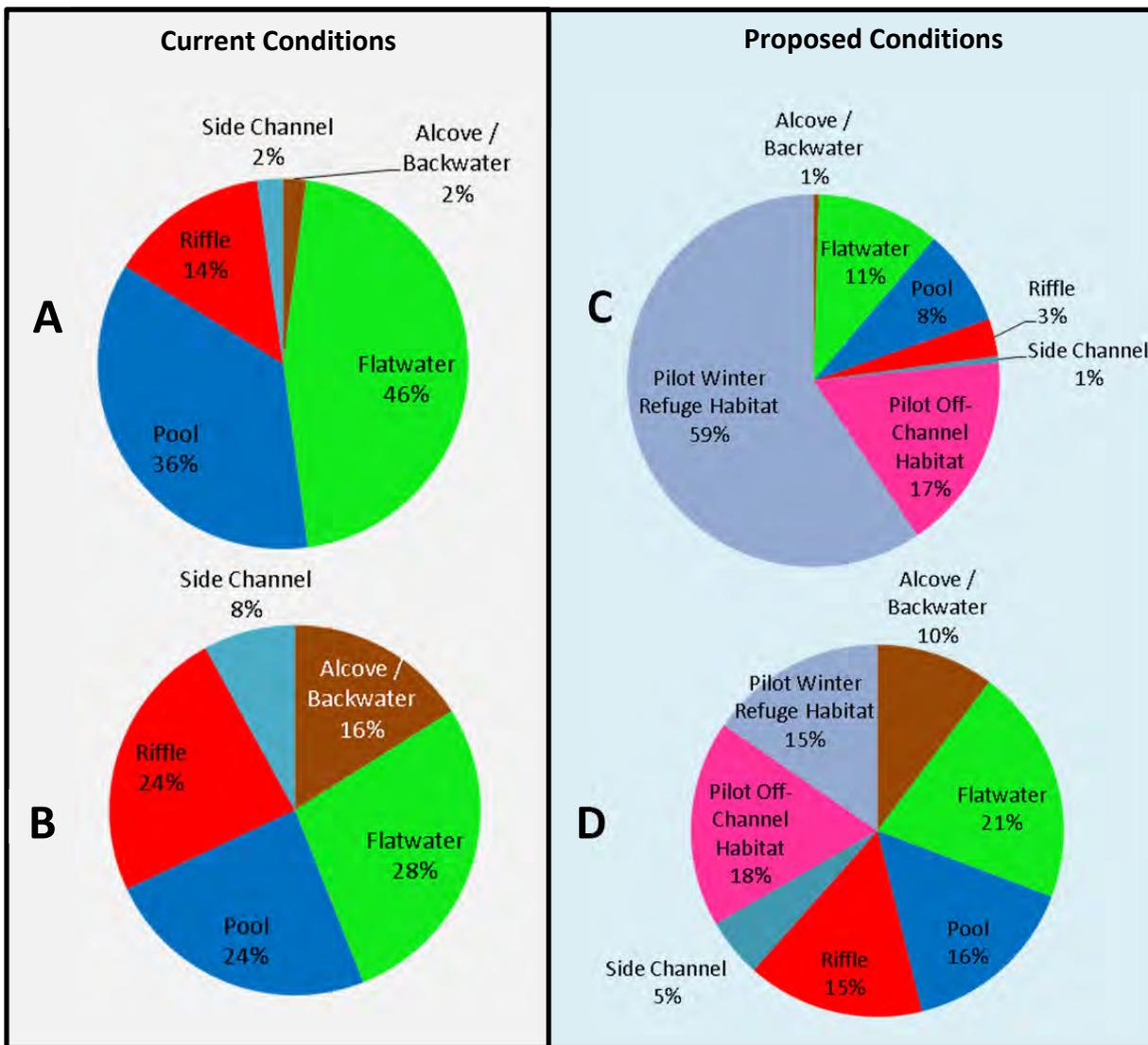


Figure N8. Existing habitats shown by area (A), frequency (B) and proposed habitat units based on area (C) and frequency (D).

**Reach 1 Alternatives Discussion**

Construction of late-successional habitats could be considered as an alternative to the process-based approach proposed for reach 1. Due to the dynamic nature of Dry Creek in this reach, there would be a high level of risk associated with constructing backwater channels and side channels in order to enhance habitat for coho and steelhead.

Table N7. Reach 1 Planning Level Cost Estimate

Note: This is a preliminary cost estimate for planning purposes. Actual costs for design and construction activities may vary substantially from these estimates. Assumptions for time requirements and material quantities have been made based on limited information that is available for the site. Additional information obtained during site investigations will be needed to determine actual quantities and costs. Estimates based on 2011 costs.

No.	Description	Unit	Quantity	Unit Cost	Total Cost	Design and Quantity Assumptions										
1	Mobilization and Demobilization	LS	1	\$360,000	\$360,000	Calculated at 5% of construction sub-total.										
2	Site Access Measures	LS	1	\$340,000	\$340,000	Includes access road improvements, traffic control, dust control, and site restoration.										
3	Environmental Protection Measures	LS	1	\$1,740,000	\$1,740,000	Includes stream diversion/dewatering, fish relocation, and erosion control BMPs.										
4	Clearing and Grubbing	AC	3	\$2,000	\$6,000											
5	Common Excavation	CY	113,570	\$20	\$2,271,400	Final design criteria and analysis will likely alter these estimates up or down.										
6	Large Woody Debris Installation															
a.	Pilot Off-Channel Margin Logs	EA	390	\$1,150	\$448,500	Assumes 30% delivered with root wads attached.										
b.	Pool Enhancement Logs	EA	30	\$1,150	\$34,500											
c.	Log Jams	EA	680	\$1,150	\$782,000											
7	Boulder Ballast (purchased, delivered, installed)	TN	1,100	\$100	\$110,000	Estimated 1 ton per log.										
8	Bank Stabilization	LF	920	\$1,000	\$920,000	Bank stabilization methods will vary but will include one or more of the following components: large woody debris, earthwork, riprap scour protection, granular backfill, aggregate filter material, geotextile fabric, and/or fabric encapsulated soil lifts. Assumes 30% delivered with root wads attached.										
9	Vegetation Management	AC	20	\$20,000	\$400,000	Assumes area of floodplain from vineyard grade to vineyard grade minus the base flow inundation area of the main channel and of the proposed backwater habitat areas.										
<b>Construction Sub-Total</b>					<b>\$7,412,400</b>	<table border="1"> <tr> <td><b>Key</b></td> <td>LS = Lump Sum</td> </tr> <tr> <td></td> <td>CY = Cubic Yard</td> </tr> <tr> <td></td> <td>LF = Lineal Foot</td> </tr> <tr> <td></td> <td>AC = Acre</td> </tr> <tr> <td></td> <td>EA = Each</td> </tr> </table>	<b>Key</b>	LS = Lump Sum		CY = Cubic Yard		LF = Lineal Foot		AC = Acre		EA = Each
<b>Key</b>	LS = Lump Sum															
	CY = Cubic Yard															
	LF = Lineal Foot															
	AC = Acre															
	EA = Each															
Concept Level Design & Construction Contingency (30%)					\$2,223,720											
<b>Construction Total</b>					<b>\$9,636,100</b>											
<b>Project Delivery</b>																
Permitting (4%)					\$296,496											
Detailed Engineering Design (15%)					\$1,111,860											
Contract Administration (5%)					\$370,620											
Construction Oversight (1.5%)					\$111,186											
<b>Project Delivery Sub-Total</b>					<b>\$1,890,200</b>											
<b>TOTAL ESTIMATE</b>					<b>\$11,526,000</b>	rounded to nearest \$1,000										

**Project Delivery Items are calculated as a percent of the construction sub-total**  
**General Notes:**  
 -Cost includes a 30% design and construction contingency  
 -Costs assume all materials (wood and rock) are purchased and hauled to the site from a nearby source  
 -Boulder ballast requirements may be able to be reduced depending on hydraulics analysis

## APPENDIX O

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**O.1 Summary of Additional Cost Estimate Information**

Additional cost estimate information has been provided in Appendix O in order to provide flexibility in creating groups of projects for future implementation of habitat enhancement in Dry Creek. To do so, each enhancement sub-reach was split into its component enhancement sites, and associated costs were broken out for these smaller groupings. For example, a smaller scale grouping of enhancement sites would include a backwater channel with the associated downstream riffle that would be constructed together. Logical small-scale groupings of enhancement sites are presented in the following 25 tables.



**Table O1. Sub-Reach 15 – Project Area Cost Estimate**

Note: The following table provides a breakdown of the planning level cost estimate provided in Appendix A into project areas that make up Sub-Reach 15. This is a preliminary cost estimate for planning purposes. Actual costs for design and construction activities may vary substantially from these estimates. Assumptions for time requirements and material quantities have been made based on limited information that is available for the site. Additional information obtained during site investigations will be needed to determine actual quantities and costs. Estimates based on 2011 costs.

Project Areas	Approximate River Mile Start	Approximate River Mile End	Main Channel Length (ft)	Habitat Area (Acres)	Sub-Reach 15 Project Area Cost Estimates						
					Earthwork <sup>1</sup>	Large Woody Debris & Boulder Ballast	Riffle Installation	Vegetation Management	Bank Stabilization	Direct Costs	Total
M 45.2, M 45.3	13.5	13.4	826	0	\$ -	\$ 180,000	\$ 160,000	\$ 27,779	\$ -	\$ 197,957	\$ 565,736
OC 45, M 45.1	13.4	13.3	301	0.33	\$ 68,766	\$ 389,557	\$ 80,000	\$ 33,281	\$ 393,000	\$ 519,198	\$ 1,483,802
OC 44, M 44	13.3	13.2	850	0.24	\$ 42,290	\$ 288,689	\$ 40,000	\$ 45,375	\$ 184,000	\$ 323,141	\$ 923,496
<b>Construction Sub-Total</b>					\$ 111,056	\$ 858,246	\$ 280,000	\$ 106,435	\$ 577,000	\$ 1,040,296	\$ <b>2,973,033</b>
Concept Level Design & Construction Contingency (30%)										\$ 891,910	
<b>Construction Total</b>										\$ <b>3,864,900</b>	
<b>Project Delivery</b>											
Permitting (4%)										\$ 118,921	
Detailed Engineering Design (15%)										\$ 445,955	
Contract Administration (5%)										\$ 148,652	
Construction Oversight (1.5%)										\$ 44,595	
<b>Project Delivery Sub-Total</b>										\$ <b>758,123</b>	
<b>TOTAL ESTIMATE</b>										\$ <b>4,623,000</b>	

<sup>1</sup> Earthwork includes clearing and grubbing and common excavation.

**Table O2. Sub-Reach 14A – Project Area Cost Estimate**

Note: The following table provides a breakdown of the planning level cost estimate provided in Appendix B into project areas that make up Sub-Reach 14A. This is a preliminary cost estimate for planning purposes. Actual costs for design and construction activities may vary substantially from these estimates. Assumptions for time requirements and material quantities have been made based on limited information that is available for the site. Additional information obtained during site investigations will be needed to determine actual quantities and costs. Estimates based on 2011 costs.

Project Areas	Approximate River Mile Start	Approximate River Mile End	Main Channel Length (ft)	Habitat Area (Acres)	Sub-Reach 14A Project Area Cost Estimates						
					Earthwork <sup>1</sup>	Large Woody Debris & Boulder Ballast	Riffle Installation	Vegetation Management	Bank Stabilization	Direct Costs	Total
OC 38, OC 39, M 38/39	12.7	12.4	1499	1.2	\$ 424,924	\$ 778,363	\$ 40,000	\$ 127,536	\$ 489,000	\$ 1,001,050	\$ 2,860,873
OC 40, M 40	12.8	12.7	586	0.4	\$ 129,782	\$ 341,368	\$ 80,000	\$ 46,551	\$ 317,000	\$ 492,338	\$ 1,407,039
OC 41, M 41	13.0	12.8	896	0.3	\$ 92,737	\$ 232,800	\$ 40,000	\$ 51,136	\$ -	\$ 224,274	\$ 640,946
<b>Construction Sub-Total</b>					\$ 647,444	\$ 1,352,531	\$ 160,000	\$ 225,222	\$ 806,000	\$ 1,717,662	\$ <b>4,908,858</b>
Concept Level Design & Construction Contingency (30%)										\$ 1,472,658	
<b>Construction Total</b>										\$ <b>6,381,500</b>	
<b>Project Delivery</b>											
Permitting (4%)										\$ 196,354	
Detailed Engineering Design (15%)										\$ 736,329	
Contract Administration (5%)										\$ 245,443	
Construction Oversight (1.5%)										\$ 73,633	
<b>Project Delivery Sub-Total</b>										\$ <b>1,251,800</b>	
<b>TOTAL ESTIMATE</b>										\$ <b>7,633,000</b>	

<sup>1</sup> Earthwork includes clearing and grubbing and common excavation.

**Table O3. Sub-Reach 14B – Project Area Cost Estimate**

Note: The following table provides a breakdown of the planning level cost estimate provided in Appendix B into project areas that make up Sub-Reach 14B. This is a preliminary cost estimate for planning purposes. Actual costs for design and construction activities may vary substantially from these estimates. Assumptions for time requirements and material quantities have been made based on limited information that is available for the site. Additional information obtained during site investigations will be needed to determine actual quantities and costs. Estimates based on 2011 costs.

Project Areas	Approximate River Mile Start	Approximate River Mile End	Main Channel Length (ft)	Habitat Area (Acres)	Sub-Reach 14B Project Area Cost Estimates						
					Earthwork <sup>1</sup>	Large Woody Debris & Boulder Ballast	Riffle Installation	Vegetation Management	Bank Stabilization	Direct Costs	Total
OC 42, M 42	13.1	13.0	824	0.9	\$ 312,250	\$ 579,834	\$ 40,000	\$ 75,380	\$ -	\$ 542,200	\$ 1,549,664
OC 43, M 43	13.2	13.1	216	0.2	\$ 56,938	\$ 320,602	\$ 40,000	\$ 19,854	\$ 145,000	\$ 313,435	\$ 895,829
<b>Construction Sub-Total</b>					\$ 369,189	\$ 900,436	\$ 80,000	\$ 95,234	\$ 145,000	\$ 855,635	<b>\$ 2,445,493</b>
Concept Level Design & Construction Contingency (30%)										\$ 733,648	
<b>Construction Total</b>										<b>\$ 3,179,100</b>	
<b>Project Delivery</b>											
Permitting (4%)										\$ 97,812	
Detailed Engineering Design (15%)										\$ 366,794	
Contract Administration (5%)										\$ 122,265	
Construction Oversight (1.5%)										\$ 36,679	
<b>Project Delivery Sub-Total</b>										<b>\$ 623,600</b>	
<b>TOTAL ESTIMATE</b>										<b>\$ 3,803,000</b>	

<sup>1</sup> Earthwork includes clearing and grubbing and common excavation.

**Table O4. Sub-Reach 13A – Project Area Cost Estimate**

Note: The following table provides a breakdown of the planning level cost estimate provided in Appendix C into project areas that make up Sub-Reach 13A. This is a preliminary cost estimate for planning purposes. Actual costs for design and construction activities may vary substantially from these estimates. Assumptions for time requirements and material quantities have been made based on limited information that is available for the site. Additional information obtained during site investigations will be needed to determine actual quantities and costs. Estimates based on 2011 costs.

Project Areas	Approximate River Mile Start	Approximate River Mile End	Main Channel Length (ft)	Habitat Area (Acres)	Sub-Reach 13A Project Area Cost Estimates						
					Earthwork <sup>1</sup>	Large Woody Debris & Boulder Ballast	Riffle Installation	Vegetation Management	Bank Stabilization	Direct Costs	Total
M 35.5	12.1	12.0	527	0	\$ -	\$ 40,000	\$ 80,000	\$ 32,492	\$ -	\$ 81,238	\$ 233,731
M 35.4	12.0	11.9	311	0	\$ -	\$ 40,000	\$ 80,000	\$ 15,252	\$ -	\$ 72,054	\$ 207,306
M 35.2, M 35.3	11.9	11.8	573	0	\$ -	\$ 190,000	\$ 80,000	\$ 23,758	\$ -	\$ 156,496	\$ 450,254
M 35.1	11.8	11.7	850	0	\$ -	\$ 40,000	\$ 80,000	\$ 36,642	\$ -	\$ 83,449	\$ 240,092
<b>Construction Sub-Total</b>					\$ -	\$ 310,000	\$ 320,000	\$ 108,145	\$ -	\$ 393,238	<b>\$ 1,131,383</b>
Concept Level Design & Construction Contingency (30%)										\$ 339,415	
<b>Construction Total</b>										<b>\$ 1,470,800</b>	
<b>Project Delivery</b>											
Permitting (4%)										\$ 45,255	
Detailed Engineering Design (15%)										\$ 169,707	
Contract Administration (5%)										\$ 56,569	
Construction Oversight (1.5%)										\$ 16,971	
<b>Project Delivery Sub-Total</b>										<b>\$ 288,500</b>	
<b>TOTAL ESTIMATE</b>										<b>\$ 1,759,000</b>	

<sup>1</sup> Earthwork includes clearing and grubbing and common excavation.

**Table O5. Sub-Reach 13B – Project Area Cost Estimate**

Note: The following table provides a breakdown of the planning level cost estimate provided in Appendix C into project areas that make up Sub-Reach 13A. This is a preliminary cost estimate for planning purposes. Actual costs for design and construction activities may vary substantially from these estimates. Assumptions for time requirements and material quantities have been made based on limited information that is available for the site. Additional information obtained during site investigations will be needed to determine actual quantities and costs. Estimates based on 2011 costs.

Project Areas	Approximate River Mile Start	Approximate River Mile End	Main Channel Length (ft)	Habitat Area (Acres)	Sub-Reach 13B Project Area Cost Estimates						
					Earthwork <sup>1</sup>	Large Woody Debris & Boulder Ballast	Riffle Installation	Vegetation Management	Bank Stabilization	Direct Costs	Total
OC 36.2, OC 36.21, OC 36.22, OC 36.3, M 36.2	12.4	12.2	1176	1.3	\$ 360,463	\$ 1,182,616	\$ 320,000	\$ 81,729	\$ 836,000	\$ 1,496,770	\$ 4,277,577
OC 36.1, M 36.1	12.2	12.1	489	0.7	\$ 183,659	\$ 435,013	\$ 40,000	\$ 47,906	\$ 235,000	\$ 506,804	\$ 1,448,381
<b>Construction Sub-Total</b>					\$ 544,122	\$ 1,617,628	\$ 360,000	\$ 129,635	\$ 1,071,000	\$ 2,003,574	\$ <b>5,725,958</b>
Concept Level Design & Construction Contingency (30%)										\$ 1,717,788	
<b>Construction Total</b>										\$ <b>7,443,700</b>	
<b>Project Delivery</b>											
Permitting (4%)										\$ 229,038	
Detailed Engineering Design (15%)										\$ 858,894	
Contract Administration (5%)										\$ 286,298	
Construction Oversight (1.5%)										\$ 85,889	
<b>Project Delivery Sub-Total</b>										\$ <b>1,460,100</b>	
<b>TOTAL ESTIMATE</b>										\$ <b>8,904,000</b>	

<sup>1</sup> Earthwork includes clearing and grubbing and common excavation.

**Table O6. Sub-Reach 12A – Project Area Cost Estimate**

Note: The following table provides a breakdown of the planning level cost estimate provided in Appendix D into project areas that make up Sub-Reach 12A. This is a preliminary cost estimate for planning purposes. Actual costs for design and construction activities may vary substantially from these estimates. Assumptions for time requirements and material quantities have been made based on limited information that is available for the site. Additional information obtained during site investigations will be needed to determine actual quantities and costs. Estimates based on 2011 costs.

Project Areas	Approximate River Mile Start	Approximate River Mile End	Main Channel Length (ft)	Habitat Area (Acres)	Sub-Reach 12A Project Area Cost Estimates						
					Earthwork <sup>1</sup>	Large Woody Debris & Boulder Ballast	Riffle Installation	Vegetation Management	Bank Stabilization	Direct Costs	Total
M 33.9	11.3	11.2	829	0	\$ -	\$ 40,000	\$ 80,000	\$ 59,191	\$ -	\$ 96,450	\$ 275,641
M 33.8	11.2	11.0	1029	0	\$ -	\$ 40,000	\$ 40,000	\$ 39,753	\$ -	\$ 64,457	\$ 184,210
<b>Construction Sub-Total</b>					\$ -	\$ 80,000	\$ 120,000	\$ 98,944	\$ -	\$ 160,907	<b>\$ 459,851</b>
Concept Level Design & Construction Contingency (30%)											\$ 137,955
<b>Construction Total</b>											<b>\$ 597,800</b>
<b>Project Delivery</b>											
Permitting (4%)											\$ 18,394
Detailed Engineering Design (15%)											\$ 68,978
Contract Administration (5%)											\$ 22,993
Construction Oversight (1.5%)											\$ 6,898
<b>Project Delivery Sub-Total</b>											<b>\$ 117,300</b>
<b>TOTAL ESTIMATE</b>											<b>\$ 715,000</b>

<sup>1</sup> Earthwork includes clearing and grubbing and common excavation.

**Table 07. Sub-Reach 12B – Project Area Cost Estimate**

Note: The following table provides a breakdown of the planning level cost estimate provided in Appendix D into project areas that make up Sub-Reach 12B. This is a preliminary cost estimate for planning purposes. Actual costs for design and construction activities may vary substantially from these estimates. Assumptions for time requirements and material quantities have been made based on limited information that is available for the site. Additional information obtained during site investigations will be needed to determine actual quantities and costs. Estimates based on 2011 costs.

Project Areas	Approximate River Mile Start	Approximate River Mile End	Main Channel Length (ft)	Habitat Area (Acres)	Sub-Reach 12B Project Area Cost Estimates						
					Earthwork <sup>1</sup>	Large Woody Debris & Boulder Ballast	Riffle Installation	Vegetation Management	Bank Stabilization	Direct Costs	Total
OC 34.2, M 34.3	11.7	11.5	895	0.8	\$ 54,234	\$ 177,110	\$ 40,000	\$ 41,834	\$ 569,000	\$ 474,832	\$ 1,357,011
OC 34.1, M 34.2, M 34.1	11.5	11.3	921	1.3	\$ 150,182	\$ 398,242	\$ 120,000	\$ 59,706	\$ 787,000	\$ 815,519	\$ 2,330,649
<b>Construction Sub-Total</b>					\$ 204,416	\$ 575,352	\$ 160,000	\$ 101,540	\$ 1,356,000	\$ 1,290,351	<b>\$ 3,687,659</b>
Concept Level Design & Construction Contingency (30%)										\$ 1,106,298	
<b>Construction Total</b>										<b>\$ 4,794,000</b>	
<b>Project Delivery</b>											
Permitting (4%)										\$ 147,506	
Detailed Engineering Design (15%)										\$ 553,149	
Contract Administration (5%)										\$ 184,383	
Construction Oversight (1.5%)										\$ 55,315	
<b>Project Delivery Sub-Total</b>										<b>\$ 940,400</b>	
<b>TOTAL ESTIMATE</b>										<b>\$ 5,734,000</b>	

<sup>1</sup> Earthwork includes clearing and grubbing and common excavation.

**Table O8. Sub-Reach 11 – Project Area Cost Estimate**

Note: The following table provides a breakdown of the planning level cost estimate provided in Appendix E into project areas that make up Sub-Reach 11. This is a preliminary cost estimate for planning purposes. Actual costs for design and construction activities may vary substantially from these estimates. Assumptions for time requirements and material quantities have been made based on limited information that is available for the site. Additional information obtained during site investigations will be needed to determine actual quantities and costs. Estimates based on 2011 costs.

Project Areas	Approximate River Mile Start	Approximate River Mile End	Main Channel Length (ft)	Habitat Area (Acres)	Sub-Reach 11 Project Area Cost Estimates						
					Earthwork <sup>1</sup>	Large Woody Debris & Boulder Ballast	Riffle Installation	Vegetation Management	Bank Stabilization	Direct Costs	Total
M 33.4	11.0	10.9	432	0	\$ -	\$ 40,000	\$ 80,000	\$ 32,522	\$ -	\$ 75,369	\$ 227,891
OC 33.3, M 33.3	10.9	10.7	1085	0	\$ 161,514	\$ 281,556	\$ 80,000	\$ 61,552	\$ 685,000	\$ 627,381	\$ 1,897,003
M 33.2	10.7	10.4	1647	0	\$ -	\$ 40,000	\$ 80,000	\$ 109,856	\$ -	\$ 113,583	\$ 343,440
M 33.1	10.5	10.3	749	0	\$ -	\$ 40,000	\$ 80,000	\$ 16,118	\$ -	\$ 67,262	\$ 203,380
<b>Construction Sub-Total</b>					\$ 161,514	\$ 401,556	\$ 320,000	\$ 220,048	\$ 685,000	\$ 883,595	\$ <b>2,671,713</b>
Concept Level Design & Construction Contingency (30%)										\$ 801,514	
<b>Construction Total</b>										\$ <b>3,473,200</b>	
<b>Project Delivery</b>											
Permitting (4%)										\$ 106,869	
Detailed Engineering Design (15%)										\$ 400,757	
Contract Administration (5%)										\$ 133,586	
Construction Oversight (1.5%)										\$ 40,076	
<b>Project Delivery Sub-Total</b>										\$ <b>681,300</b>	
<b>TOTAL ESTIMATE</b>										\$ <b>4,155,000</b>	

<sup>1</sup> Earthwork includes clearing and grubbing and common excavation.

**Table 09. Sub-Reach 10A – Project Area Cost Estimate**

Note: The following table provides a breakdown of the planning level cost estimate provided in Appendix F into project areas that make up Sub-Reach 10A. This is a preliminary cost estimate for planning purposes. Actual costs for design and construction activities may vary substantially from these estimates. Assumptions for time requirements and material quantities have been made based on limited information that is available for the site. Additional information obtained during site investigations will be needed to determine actual quantities and costs. Estimates based on 2011 costs.

Project Areas	Approximate River Mile Start	Approximate River Mile End	Main Channel Length (ft)	Habitat Area (Acres)	Sub-Reach 10A Project Area Cost Estimates						
					Earthwork <sup>1</sup>	Large Woody Debris & Boulder Ballast	Riffle Installation	Vegetation Management	Bank Stabilization	Direct Costs	Total
OC 32.2, M 32.2, M 32.3	10.1	9.9	851	0.7	\$ 280,914	\$ 793,595	\$ 266,667	\$ 63,762	\$ 582,000	\$ 1,069,469	\$ 3,056,407
OC 32.1, M 32.1	9.9	9.8	820	0.3	\$ 200,473	\$ 388,173	\$ 186,667	\$ 31,090	\$ -	\$ 434,046	\$ 1,240,448
OC 31, M 31	9.8	9.7	468	0.7	\$ 488,529	\$ 693,438	\$ 80,000	\$ 95,297	\$ 513,000	\$ 1,006,669	\$ 2,876,933
<b>Construction Sub-Total</b>					\$ 969,915	\$ 1,875,206	\$ 533,333	\$ 190,150	\$ 1,095,000	\$ 2,510,185	<b>\$ 7,173,789</b>
Concept Level Design & Construction Contingency (30%)										\$ 2,152,137	
<b>Construction Total</b>										<b>\$ 9,325,900</b>	
<b>Project Delivery</b>											
Permitting (4%)										\$ 286,952	
Detailed Engineering Design (15%)										\$ 1,076,068	
Contract Administration (5%)										\$ 358,689	
Construction Oversight (1.5%)										\$ 107,607	
<b>Project Delivery Sub-Total</b>										<b>\$ 1,829,300</b>	
<b>TOTAL ESTIMATE</b>										<b>\$ 11,155,000</b>	

<sup>1</sup> Earthwork includes clearing and grubbing and common excavation.

**Table O10. Sub-Reach 10B – Project Area Cost Estimate**

Note: The following table provides a breakdown of the planning level cost estimate provided in Appendix F into project areas that make up Sub-Reach 10B. This is a preliminary cost estimate for planning purposes. Actual costs for design and construction activities may vary substantially from these estimates. Assumptions for time requirements and material quantities have been made based on limited information that is available for the site. Additional information obtained during site investigations will be needed to determine actual quantities and costs. Estimates based on 2011 costs.

Project Areas	Approximate River Mile Start	Approximate River Mile End	Main Channel Length (ft)	Habitat Area (Acres)	Sub-Reach 10B Project Area Cost Estimates						
					Earthwork <sup>1</sup>	Large Woody Debris & Boulder Ballast	Riffle Installation	Vegetation Management	Bank Stabilization	Direct Costs	Total
OC 33.2, M 33.2	10.3	10.2	677	0.8	\$ 383,341	\$ 564,888	\$ 80,000	\$ 78,570	\$ 284,000	\$ 748,598	\$ 2,139,397
OC 33.1, M 33.1	10.2	10.1	574	0.5	\$ 143,116	\$ 506,362	\$ 80,000	\$ 46,744	\$ 589,000	\$ 734,831	\$ 2,100,052
<b>Construction Sub-Total</b>					\$ 526,456	\$ 1,071,251	\$ 160,000	\$ 125,314	\$ 873,000	\$ 1,483,428	\$ 4,239,449
Concept Level Design & Construction Contingency (30%)										\$ 1,271,835	
<b>Construction Total</b>										<b>\$ 5,511,300</b>	
<b>Project Delivery</b>											
Permitting (4%)										\$ 169,578	
Detailed Engineering Design (15%)										\$ 635,917	
Contract Administration (5%)										\$ 211,972	
Construction Oversight (1.5%)										\$ 63,592	
<b>Project Delivery Sub-Total</b>										<b>\$ 1,081,100</b>	
<b>TOTAL ESTIMATE</b>										<b>\$ 6,592,000</b>	

<sup>1</sup> Earthwork includes clearing and grubbing and common excavation.

**Table O11. Sub-Reach 9A – Project Area Cost Estimate**

Note: The following table provides a breakdown of the planning level cost estimate provided in Appendix G into project areas that make up Sub-Reach 9A. This is a preliminary cost estimate for planning purposes. Actual costs for design and construction activities may vary substantially from these estimates. Assumptions for time requirements and material quantities have been made based on limited information that is available for the site. Additional information obtained during site investigations will be needed to determine actual quantities and costs. Estimates based on 2011 costs.

Project Areas	Approximate River Mile Start	Approximate River Mile End	Main Channel Length (ft)	Habitat Area (Acres)	Sub-Reach 9A Project Area Cost Estimates						
					Earthwork <sup>1</sup>	Large Woody Debris & Boulder Ballast	Riffle Installation	Vegetation Management	Bank Stabilization	Direct Costs	Total
M 30	9.2	8.9	1857	0.0	\$ -	\$ 90,000	\$ 80,000	\$ 128,534	\$ -	\$ 160,686	\$ 459,219
<b>Construction Sub-Total</b>					\$ -	\$ 90,000	\$ 80,000	\$ 128,534	\$ -	\$ 160,686	<b>\$ 459,219</b>
Concept Level Design & Construction Contingency (30%)										\$ 137,766	
<b>Construction Total</b>										<b>\$ 597,000</b>	
<b>Project Delivery</b>											
Permitting (4%)										\$ 18,369	
Detailed Engineering Design (15%)										\$ 68,883	
Contract Administration (5%)										\$ 22,961	
Construction Oversight (1.5%)										\$ 6,888	
<b>Project Delivery Sub-Total</b>										<b>\$ 117,100</b>	
<b>TOTAL ESTIMATE</b>										<b>\$ 714,000</b>	

<sup>1</sup> Earthwork includes clearing and grubbing and common excavation.

**Table O12. Sub-Reach 9B – Project Area Cost Estimate**

Note: The following table provides a breakdown of the planning level cost estimate provided in Appendix G into project areas that make up Sub-Reach 9B. This is a preliminary cost estimate for planning purposes. Actual costs for design and construction activities may vary substantially from these estimates. Assumptions for time requirements and material quantities have been made based on limited information that is available for the site. Additional information obtained during site investigations will be needed to determine actual quantities and costs. Estimates based on 2011 costs.

Project Areas	Approximate River Mile Start	Approximate River Mile End	Main Channel Length (ft)	Habitat Area (Acres)	Sub-Reach 9B Project Area Cost Estimates						
					Earthwork <sup>1</sup>	Large Woody Debris & Boulder Ballast	Riffle Installation	Vegetation Management	Bank Stabilization	Direct Costs	Total
M 30.3	9.7	9.5	1113	0.0	\$ -	\$ 90,000	\$ 80,000	\$ 28,741	\$ -	\$ 106,972	\$ 305,713
OC 30.2, M 30.2	9.5	9.4	517	0.9	\$ 78,734	\$ 362,338	\$ 80,000	\$ 14,887	\$ 826,000	\$ 733,075	\$ 2,095,034
OC 30.1, M 30.1	9.4	9.2	699	0.3	\$ 10,400	\$ 145,993	\$ 80,000	\$ 90,268	\$ 460,000	\$ 423,420	\$ 1,210,080
<b>Construction Sub-Total</b>					\$ 89,134	\$ 598,331	\$ 240,000	\$ 133,895	\$ 1,286,000	\$ 1,263,467	<b>\$ 3,610,827</b>
Concept Level Design & Construction Contingency (30%)											\$ 1,083,248
<b>Construction Total</b>											<b>\$ 4,694,100</b>
<b>Project Delivery</b>											
Permitting (4%)											\$ 144,433
Detailed Engineering Design (15%)											\$ 541,624
Contract Administration (5%)											\$ 180,541
Construction Oversight (1.5%)											\$ 54,162
<b>Project Delivery Sub-Total</b>											<b>\$ 920,800</b>
<b>TOTAL ESTIMATE</b>											<b>\$ 5,615,000</b>

<sup>1</sup> Earthwork includes clearing and grubbing and common excavation.

**Table O13. Sub-Reach 8A – Project Area Cost Estimate**

Note: The following table provides a breakdown of the planning level cost estimate provided in Appendix H into project areas that make up Sub-Reach 8A. This is a preliminary cost estimate for planning purposes. Actual costs for design and construction activities may vary substantially from these estimates. Assumptions for time requirements and material quantities have been made based on limited information that is available for the site. Additional information obtained during site investigations will be needed to determine actual quantities and costs. Estimates based on 2011 costs.

Project Areas	Approximate River Mile Start	Approximate River Mile End	Main Channel Length (ft)	Habitat Area (Acres)	Sub-Reach 8A Project Area Cost Estimates						
					Earthwork <sup>1</sup>	Large Woody Debris & Boulder Ballast	Riffle Installation	Vegetation Management	Bank Stabilization	Direct Costs	Total
OC 25, M 25	8.0	7.9	626	0.3	\$ 140,475	\$ 288,162	\$ 40,000	\$ 46,320	\$ 219,000	\$ 395,052	\$ 1,129,009
OC 24.3, M 24.3	7.9	7.7	1018	0.0	\$ 673,841	\$ 727,417.8	\$ 80,000	\$ 116,616	\$ 722,000	\$ 1,248,673	\$ 3,568,549
OC 24.1, OC 24.11, OC 24.2, M 24	7.7	7.4	1432	1.8	\$ 631,102	\$ 1,639,504	\$ 320,000	\$ 234,682	\$ -	\$ 1,520,711	\$ 4,345,999
<b>Construction Sub-Total</b>					\$ 1,445,418	\$ 2,655,083	\$ 440,000	\$ 397,618	\$ 941,000	\$ 3,164,436	\$ <b>9,043,556</b>
Concept Level Design & Construction Contingency (30%)										\$ 2,713,067	
<b>Construction Total</b>										\$ <b>11,756,600</b>	
<b>Project Delivery</b>											
Permitting (4%)										\$ 361,742	
Detailed Engineering Design (15%)										\$ 1,356,533	
Contract Administration (5%)										\$ 452,178	
Construction Oversight (1.5%)										\$ 135,653	
<b>Project Delivery Sub-Total</b>										\$ <b>2,306,100</b>	
<b>TOTAL ESTIMATE</b>										\$ <b>14,063,000</b>	

<sup>1</sup> Earthwork includes clearing and grubbing and common excavation.

**Table O14. Sub-Reach 8B – Project Area Cost Estimate**

Note: The following table provides a breakdown of the planning level cost estimate provided in Appendix H into project areas that make up Sub-Reach 8B. This is a preliminary cost estimate for planning purposes. Actual costs for design and construction activities may vary substantially from these estimates. Assumptions for time requirements and material quantities have been made based on limited information that is available for the site. Additional information obtained during site investigations will be needed to determine actual quantities and costs. Estimates based on 2011 costs.

Project Areas	Approximate River Mile Start	Approximate River Mile End	Main Channel Length (ft)	Habitat Area (Acres)	Sub-Reach 8B Project Area Cost Estimates						
					Earthwork <sup>1</sup>	Large Woody Debris & Boulder Ballast	Riffle Installation	Vegetation Management	Bank Stabilization	Direct Costs	Total
OC 29, M 29.1, M 29.2	8.9	8.6	1265	0.6	\$ 292,086	\$ 612,771	\$ 160,000	\$ 131,239	\$ 291,000	\$ 800,429	\$ 2,287,525
OC 28, M 28.1, M 28.2	8.6	8.5	698	0.5	\$ 222,279	\$ 440,694	\$ 120,000	\$ 58,789	\$ 331,000	\$ 631,239	\$ 1,804,001
OC 27.1, OC 27.2, M 27	8.5	8.3	1313	0.6	\$ 294,425	\$ 598,548	\$ 40,000	\$ 108,334	\$ 421,000	\$ 787,087	\$ 2,249,394
OC 26.1, M 26.1	8.3	8.0	1282	0.3	\$ 168,168	\$ 378,354	\$ 160,000	\$ 74,630	\$ 343,000	\$ 605,075	\$ 1,729,227
<b>Construction Sub-Total</b>					\$ 976,959	\$ 2,030,366	\$ 480,000	\$ 372,993	\$ 1,386,000	\$ 2,823,830	\$ <b>8,070,148</b>
Concept Level Design & Construction Contingency (30%)										\$ 2,421,044	
<b>Construction Total</b>										\$ <b>10,491,200</b>	
<b>Project Delivery</b>											
Permitting (4%)										\$ 322,806	
Detailed Engineering Design (15%)										\$ 1,210,522	
Contract Administration (5%)										\$ 403,507	
Construction Oversight (1.5%)										\$ 121,052	
<b>Project Delivery Sub-Total</b>										\$ <b>2,057,900</b>	
<b>TOTAL ESTIMATE</b>										\$ <b>12,549,000</b>	

<sup>1</sup> Earthwork includes clearing and grubbing and common excavation.

**Table O15. Sub-Reach 6 – Project Area Cost Estimate**

Note: The following table provides a breakdown of the planning level cost estimate provided in Appendix I into project areas that make up Sub-Reach 6. This is a preliminary cost estimate for planning purposes. Actual costs for design and construction activities may vary substantially from these estimates. Assumptions for time requirements and material quantities have been made based on limited information that is available for the site. Additional information obtained during site investigations will be needed to determine actual quantities and costs. Estimates based on 2011 costs.

Project Areas	Approximate River Mile Start	Approximate River Mile End	Main Channel Length (ft)	Habitat Area (Acres)	Sub-Reach 6 Project Area Cost Estimates						
					Earthwork <sup>1</sup>	Large Woody Debris & Boulder Ballast	Riffle Installation	Vegetation Management	Bank Stabilization	Direct Costs	Total
OC 20.9, M 20.9, M 20.8, M 20.7	6.1	5.8	1858	2.6	\$ 345,809	\$ 535,289	\$ 240,000	\$ 89,551	\$ 116,000	\$ 714,069	\$ 2,040,718
OC 20.6, M 20.6	5.8	5.3	2289	1.8	\$ 203,362	\$ 326,022	\$ 80,000	\$ 104,811	\$ 960,000	\$ 901,136	\$ 2,575,332
<b>Construction Sub-Total</b>					\$ 549,171	\$ 861,311	\$ 320,000	\$ 194,362	\$ 1,076,000	\$ 1,615,205	<b>\$ 4,616,049</b>
Concept Level Design & Construction Contingency (30%)										\$ 1,384,815	
<b>Construction Total</b>										<b>\$ 6,000,900</b>	
<b>Project Delivery</b>											
Permitting (4%)										\$ 184,642	
Detailed Engineering Design (15%)										\$ 692,407	
Contract Administration (5%)										\$ 230,802	
Construction Oversight (1.5%)										\$ 69,241	
<b>Project Delivery Sub-Total</b>										<b>\$ 1,177,093</b>	
<b>TOTAL ESTIMATE</b>										<b>\$ 7,178,000</b>	

<sup>1</sup> Earthwork includes clearing and grubbing and common excavation.

**Table O16. Sub-Reach 5A – Project Area Cost Estimate**

Note: The following table provides a breakdown of the planning level cost estimate provided in Appendix J into project areas that make up Sub-Reach 5A. This is a preliminary cost estimate for planning purposes. Actual costs for design and construction activities may vary substantially from these estimates. Assumptions for time requirements and material quantities have been made based on limited information that is available for the site. Additional information obtained during site investigations will be needed to determine actual quantities and costs. Estimates based on 2011 costs.

Project Areas	Approximate River Mile Start	Approximate River Mile End	Main Channel Length (ft)	Habitat Area (Acres)	Sub-Reach 5A Project Area Cost Estimates						
					Earthwork <sup>1</sup>	Large Woody Debris & Boulder Ballast	Riffle Installation	Vegetation Management	Bank Stabilization	Direct Costs	Total
OC 19.5, M 19.5	4.5	4.4	529	0.4	\$ 205,176	\$ 481,479	\$ 80,000	\$ 61,267	\$ 251,000	\$ 580,730	\$ 1,659,652
OC 19, M 19.4, M 19	4.4	4.2	943	0.6	\$ 250,295	\$ 539,007	\$ 120,000	\$ 99,722	\$ 316,000	\$ 713,194	\$ 2,038,218
OC 17.3, M 17.3	4.2	4.0	1050	0.9	\$ 319,228	\$ 524,943	\$ 80,000	\$ 96,781	\$ 178,000	\$ 645,336	\$ 1,844,288
<b>Construction Sub-Total</b>					\$ 774,699	\$ 1,545,429	\$ 280,000	\$ 257,770	\$ 745,000	\$ 1,939,260	<b>\$ 5,542,158</b>
Concept Level Design & Construction Contingency (30%)										\$ 1,662,647	
<b>Construction Total</b>										<b>\$ 7,204,800</b>	
<b>Project Delivery</b>											
Permitting (4%)										\$ 221,686	
Detailed Engineering Design (15%)										\$ 831,324	
Contract Administration (5%)										\$ 277,108	
Construction Oversight (1.5%)										\$ 83,132	
<b>Project Delivery Sub-Total</b>										<b>\$ 1,413,300</b>	
<b>TOTAL ESTIMATE</b>										<b>\$ 8,618,000</b>	

<sup>1</sup> Earthwork includes clearing and grubbing and common excavation.

**Table O17. Sub-Reach 5B – Project Area Cost Estimate**

Note: The following table provides a breakdown of the planning level cost estimate provided in Appendix J into project areas that make up Sub-Reach 5B. This is a preliminary cost estimate for planning purposes. Actual costs for design and construction activities may vary substantially from these estimates. Assumptions for time requirements and material quantities have been made based on limited information that is available for the site. Additional information obtained during site investigations will be needed to determine actual quantities and costs. Estimates based on 2011 costs.

Project Areas	Approximate River Mile Start	Approximate River Mile End	Main Channel Length (ft)	Habitat Area (Acres)	Sub-Reach 5B Project Area Cost Estimates						
					Earthwork <sup>1</sup>	Large Woody Debris & Boulder Ballast	Riffle Installation	Vegetation Management	Bank Stabilization	Direct Costs	Total
OC 20.4, M 20.4, M 20.5	5.3	5.0	2017	0.0	\$ 666,549	\$ 374,590	\$ 160,000	\$ 82,016	\$ 266,000	\$ 833,832	\$ 2,382,987
OC 20.3, M 20.3	5.0	4.9	555	0.0	\$ 84,748	\$ 346,389	\$ 80,000	\$ 29,415	\$ 375,000	\$ 492,796	\$ 1,408,349
OC 20.2, M 20.2	4.9	4.7	878	0.2	\$ 208,633	\$ 346,799	\$ 80,000	\$ 61,869	\$ 189,000	\$ 477,051	\$ 1,363,352
OC 20.1, M 20.1	4.7	4.5	877	0.3	\$ -	\$ 405,124	\$ 80,000	\$ 60,776	\$ 376,000	\$ 496,213	\$ 1,418,113
<b>Construction Sub-Total</b>					\$ 959,930	\$ 1,472,903	\$ 400,000	\$ 234,076	\$ 1,206,000	\$ 2,299,893	\$ <b>6,572,801</b>
Concept Level Design & Construction Contingency (30%)										\$ 1,971,840	
<b>Construction Total</b>										\$ <b>8,544,600</b>	
<b>Project Delivery</b>											
Permitting (4%)										\$ 262,912	
Detailed Engineering Design (15%)										\$ 985,920	
Contract Administration (5%)										\$ 328,640	
Construction Oversight (1.5%)										\$ 98,592	
<b>Project Delivery Sub-Total</b>										\$ <b>1,676,100</b>	
<b>TOTAL ESTIMATE</b>										\$ <b>10,221,000</b>	

<sup>1</sup> Earthwork includes clearing and grubbing and common excavation.

**Table O18. Sub-Reach 4A – Project Area Cost Estimate**

Note: The following table provides a breakdown of the planning level cost estimate provided in Appendix K into project areas that make up Sub-Reach 4A. This is a preliminary cost estimate for planning purposes. Actual costs for design and construction activities may vary substantially from these estimates. Assumptions for time requirements and material quantities have been made based on limited information that is available for the site. Additional information obtained during site investigations will be needed to determine actual quantities and costs. Estimates based on 2011 costs.

Project Areas	Approximate River Mile Start	Approximate River Mile End	Main Channel Length (ft)	Habitat Area (Acres)	Sub-Reach 4A Project Area Cost Estimates						
					Earthwork <sup>1</sup>	Large Woody Debris & Boulder Ballast	Riffle Installation	Vegetation Management	Bank Stabilization	Direct Costs	Total
OC 14, M 14	3.5	3.3	635	0.4	\$ 153,227	\$ 331,074	\$ 80,000	\$ 36,332	\$ 96,000	\$ 374,962	\$ 1,071,594
OC 13	3.3	3.3	428	1.2	\$ 335,199	\$ 661,112	\$ -	\$ 117,087	\$ 331,000	\$ 777,447	\$ 2,221,846
OC 12, M 12	3.3	3.1	1089	0.4	\$ 141,838	\$ 413,814	\$ 40,000	\$ 71,536	\$ 71,000	\$ 397,329	\$ 1,135,517
OC 11, M 11	3.1	3.0	246	0.4	\$ 91,019	\$ 318,658	\$ 80,000	\$ 75,387	\$ 276,000	\$ 452,702	\$ 1,293,766
<b>Construction Sub-Total</b>					\$ 721,282	\$ 1,724,658	\$ 200,000	\$ 300,342	\$ 774,000	\$ 2,002,441	\$ <b>5,722,723</b>
Concept Level Design & Construction Contingency (30%)										\$ 1,716,817	
<b>Construction Total</b>										\$ <b>7,439,500</b>	
<b>Project Delivery</b>											
Permitting (4%)										\$ 228,909	
Detailed Engineering Design (15%)										\$ 858,408	
Contract Administration (5%)										\$ 286,136	
Construction Oversight (1.5%)										\$ 85,841	
<b>Project Delivery Sub-Total</b>										\$ <b>1,459,300</b>	
<b>TOTAL ESTIMATE</b>										\$ <b>8,899,000</b>	

<sup>1</sup> Earthwork includes clearing and grubbing and common excavation.

**Table O19. Sub-Reach 4B – Project Area Cost Estimate**

Note: The following table provides a breakdown of the planning level cost estimate provided in Appendix K into project areas that make up Sub-Reach 4B. This is a preliminary cost estimate for planning purposes. Actual costs for design and construction activities may vary substantially from these estimates. Assumptions for time requirements and material quantities have been made based on limited information that is available for the site. Additional information obtained during site investigations will be needed to determine actual quantities and costs. Estimates based on 2011 costs.

Project Areas	Approximate River Mile Start	Approximate River Mile End	Main Channel Length (ft)	Habitat Area (Acres)	Sub-Reach 4B Project Area Cost Estimates						
					Earthwork <sup>1</sup>	Large Woody Debris & Boulder Ballast	Riffle Installation	Vegetation Management	Bank Stabilization	Direct Costs	Total
OC 16.2, M 16.2	3.8	3.6	895	0.7	\$ 218,991	\$ 205,242	\$ 80,000	\$ 56,950	\$ -	\$ 302,057	\$ 863,239
OC 16.1, OC 15, M 15	3.6	3.5	842	1.4	\$ 383,323	\$ 898,462	\$ 40,000	\$ 105,586	\$ 793,000	\$ 1,195,115	\$ 3,415,487
<b>Construction Sub-Total</b>					\$ 602,314	\$ 1,103,704	\$ 120,000	\$ 162,536	\$ 793,000	\$ 1,497,172	<b>\$ 4,278,726</b>
Concept Level Design & Construction Contingency (30%)										\$ 1,283,618	
<b>Construction Total</b>										<b>\$ 5,562,300</b>	
<b>Project Delivery</b>											
Permitting (4%)										\$ 171,149	
Detailed Engineering Design (15%)										\$ 641,809	
Contract Administration (5%)										\$ 213,936	
Construction Oversight (1.5%)										\$ 64,181	
<b>Project Delivery Sub-Total</b>										<b>\$ 1,091,100</b>	
<b>TOTAL ESTIMATE</b>										<b>\$ 6,653,000</b>	

<sup>1</sup> Earthwork includes clearing and grubbing and common excavation.

**Table O20. Sub-Reach 4C – Project Area Cost Estimate**

Note: The following table provides a breakdown of the planning level cost estimate provided in Appendix K into project areas that make up Sub-Reach 4C. This is a preliminary cost estimate for planning purposes. Actual costs for design and construction activities may vary substantially from these estimates. Assumptions for time requirements and material quantities have been made based on limited information that is available for the site. Additional information obtained during site investigations will be needed to determine actual quantities and costs. Estimates based on 2011 costs.

Project Areas	Approximate River Mile Start	Approximate River Mile End	Main Channel Length (ft)	Habitat Area (Acres)	Sub-Reach 4C Project Area Cost Estimates						
					Earthwork <sup>1</sup>	Large Woody Debris & Boulder Ballast	Riffle Installation	Vegetation Management	Bank Stabilization	Direct Costs	Total
OC 17.2, M 17.2	4.0	3.9	674	0.7	\$ 180,616	\$ 508,913	\$ 80,000	\$ 144,704	\$ 269,000	\$ 636,876	\$ 1,820,109
OC 17.1	3.9	3.8	653	0.4	\$ 71,374	\$ 281,367	\$ -	\$ 43,368	\$ 99,000	\$ 266,493	\$ 761,603
<b>Construction Sub-Total</b>					\$ 251,990	\$ 790,281	\$ 80,000	\$ 188,073	\$ 368,000	\$ 903,368	\$ <b>2,581,712</b>
Concept Level Design & Construction Contingency (30%)										\$ 774,514	
<b>Construction Total</b>										\$ <b>3,356,200</b>	
<b>Project Delivery</b>											
Permitting (4%)										\$ 103,268	
Detailed Engineering Design (15%)										\$ 387,257	
Contract Administration (5%)										\$ 129,086	
Construction Oversight (1.5%)										\$ 38,726	
<b>Project Delivery Sub-Total</b>										\$ <b>658,300</b>	
<b>TOTAL ESTIMATE</b>										\$ <b>4,015,000</b>	

<sup>1</sup> Earthwork includes clearing and grubbing and common excavation.

**Table O21. Sub-Reach 3A – Project Area Cost Estimate**

Note: The following table provides a breakdown of the planning level cost estimate provided in Appendix L into project areas that make up Sub-Reach 3A. This is a preliminary cost estimate for planning purposes. Actual costs for design and construction activities may vary substantially from these estimates. Assumptions for time requirements and material quantities have been made based on limited information that is available for the site. Additional information obtained during site investigations will be needed to determine actual quantities and costs. Estimates based on 2011 costs.

Project Areas	Approximate River Mile Start	Approximate River Mile End	Main Channel Length (ft)	Habitat Area (Acres)	Sub-Reach 3A Project Area Cost Estimates						
					Earthwork <sup>1</sup>	Large Woody Debris & Boulder Ballast	Riffle Installation	Vegetation Management	Bank Stabilization	Direct Costs	Total
OC 8.2, M 8.2	2.6	2.4	968	0.5	\$ 182,045	\$ 483,342	\$ 80,000	\$ 179,107	\$ -	\$ 497,609	\$ 1,422,102
OC 8.1, M 8.1	2.4	2.0	2283	0.3	\$ 80,993	\$ 401,784	\$ 80,000	\$ 127,683	\$ 126,000	\$ 439,459	\$ 1,255,918
<b>Construction Sub-Total</b>					\$ 263,037	\$ 885,126	\$ 160,000	\$ 306,790	\$ 126,000	\$ 937,068	<b>\$ 2,678,020</b>
Concept Level Design & Construction Contingency (30%)											\$ 803,406
<b>Construction Total</b>											<b>\$ 3,481,400</b>
<b>Project Delivery</b>											
Permitting (4%)											\$ 107,121
Detailed Engineering Design (15%)											\$ 401,703
Contract Administration (5%)											\$ 133,901
Construction Oversight (1.5%)											\$ 40,170
<b>Project Delivery Sub-Total</b>											<b>\$ 682,900</b>
<b>TOTAL ESTIMATE</b>											<b>\$ 4,164,000</b>

<sup>1</sup> Earthwork includes clearing and grubbing and common excavation.

**Table O22. Sub-Reach 3B – Project Area Cost Estimate**

Note: The following table provides a breakdown of the planning level cost estimate provided in Appendix L into project areas that make up Sub-Reach 3B. This is a preliminary cost estimate for planning purposes. Actual costs for design and construction activities may vary substantially from these estimates. Assumptions for time requirements and material quantities have been made based on limited information that is available for the site. Additional information obtained during site investigations will be needed to determine actual quantities and costs. Estimates based on 2011 costs.

Project Areas	Approximate River Mile Start	Approximate River Mile End	Main Channel Length (ft)	Habitat Area (Acres)	Sub-Reach 3B Project Area Cost Estimates						
					Earthwork <sup>1</sup>	Large Woody Debris & Boulder Ballast	Riffle Installation	Vegetation Management	Bank Stabilization	Direct Costs	Total
OC 10, M 10	3.0	2.8	890	0.5	\$ 160,753	\$ 463,903	\$ 80,000	\$ 67,062	\$ 327,000	\$ 591,385	\$ 1,690,102
OC 9, M 9	2.8	2.6	1359	0.8	\$ 216,952	\$ 501,033	\$ 80,000	\$ 67,836	\$ 126,000	\$ 533,848	\$ 1,525,669
<b>Construction Sub-Total</b>					\$ 377,705	\$ 964,936	\$ 160,000	\$ 134,898	\$ 453,000	\$ 1,125,233	\$ <b>3,215,771</b>
Concept Level Design & Construction Contingency (30%)										\$ 964,731	
<b>Construction Total</b>											\$ <b>4,180,500</b>
<b>Project Delivery</b>											
Permitting (4%)										\$ 128,631	
Detailed Engineering Design (15%)										\$ 482,366	
Contract Administration (5%)										\$ 160,789	
Construction Oversight (1.5%)										\$ 48,237	
<b>Project Delivery Sub-Total</b>										\$ <b>820,000</b>	
<b>TOTAL ESTIMATE</b>											\$ <b>5,001,000</b>

<sup>1</sup> Earthwork includes clearing and grubbing and common excavation.

**Table O23. Sub-Reach 2A – Project Area Cost Estimate**

Note: The following table provides a breakdown of the planning level cost estimate provided in Appendix M into project areas that make up Sub-Reach 2A. This is a preliminary cost estimate for planning purposes. Actual costs for design and construction activities may vary substantially from these estimates. Assumptions for time requirements and material quantities have been made based on limited information that is available for the site. Additional information obtained during site investigations will be needed to determine actual quantities and costs. Estimates based on 2011 costs.

Project Areas	Approximate River Mile Start	Approximate River Mile End	Main Channel Length (ft)	Habitat Area (Acres)	Sub-Reach 2A Project Area Cost Estimates						
					Earthwork <sup>1</sup>	Large Woody Debris & Boulder Ballast	Riffle Installation	Vegetation Management	Bank Stabilization	Direct Costs	Total
Sub-Reach 2A	1.4	0.7	3750	0.5	\$ 1,938,511	\$ 1,930,993	\$ -	\$ 340,358	\$ 910,276	\$ 2,755,914	\$ 7,876,052
<b>Construction Sub-Total</b>					\$ 1,938,511	\$ 1,930,993	\$ -	\$ 340,358	\$ 910,276	\$ 2,755,914	<b>\$ 7,876,052</b>
Concept Level Design & Construction Contingency (30%)										\$ 2,362,816	
<b>Construction Total</b>										<b>\$ 10,238,900</b>	
<b>Project Delivery</b>											
Permitting (4%)										\$ 315,042	
Detailed Engineering Design (15%)										\$ 1,181,408	
Contract Administration (5%)										\$ 393,803	
Construction Oversight (1.5%)										\$ 118,141	
<b>Project Delivery Sub-Total</b>										<b>\$ 2,008,400</b>	
<b>TOTAL ESTIMATE</b>										<b>\$ 12,247,000</b>	

<sup>1</sup> Earthwork includes clearing and grubbing and common excavation.

**Table O24. Sub-Reach 2B – Project Area Cost Estimate**

Note: The following table provides a breakdown of the planning level cost estimate provided in Appendix M into project areas that make up Sub-Reach 2B. This is a preliminary cost estimate for planning purposes. Actual costs for design and construction activities may vary substantially from these estimates. Assumptions for time requirements and material quantities have been made based on limited information that is available for the site. Additional information obtained during site investigations will be needed to determine actual quantities and costs. Estimates based on 2011 costs.

Project Areas	Approximate River Mile Start	Approximate River Mile End	Main Channel Length (ft)	Habitat Area (Acres)	Sub-Reach 2B Project Area Cost Estimates						
					Earthwork <sup>1</sup>	Large Woody Debris & Boulder Ballast	Riffle Installation	Vegetation Management	Bank Stabilization	Direct Costs	Total
Sub-Reach 2B	2.0	1.4	3175	0.6	\$ 1,267,350	\$ 1,398,219	\$ -	\$ 221,037	\$ 1,033,182	\$ 2,109,826	\$ 6,029,613
<b>Construction Sub-Total</b>					\$ 1,267,350	\$ 1,398,219	\$ -	\$ 221,037	\$ 1,033,182	\$ 2,109,826	<b>\$ 6,029,613</b>
Concept Level Design & Construction Contingency (30%)										\$ 1,808,884	
<b>Construction Total</b>										<b>\$ 7,838,500</b>	
<b>Project Delivery</b>											
Permitting (4%)										\$ 241,185	
Detailed Engineering Design (15%)										\$ 904,442	
Contract Administration (5%)										\$ 301,481	
Construction Oversight (1.5%)										\$ 90,444	
<b>Project Delivery Sub-Total</b>										<b>\$ 1,537,600</b>	
<b>TOTAL ESTIMATE</b>										<b>\$ 9,376,000</b>	

<sup>1</sup> Earthwork includes clearing and grubbing and common excavation.

**Table O25. Sub-Reach 1 – Project Area Cost Estimate**

Note: The following table provides a breakdown of the planning level cost estimate provided in Appendix N into project areas that make up Sub-Reach 1. This is a preliminary cost estimate for planning purposes. Actual costs for design and construction activities may vary substantially from these estimates. Assumptions for time requirements and material quantities have been made based on limited information that is available for the site. Additional information obtained during site investigations will be needed to determine actual quantities and costs. Estimates based on 2011 costs.

Project Areas	Approximate River Mile Start	Approximate River Mile End	Main Channel Length (ft)	Habitat Area (Acres)	Sub-Reach 1 Project Area Cost Estimates						
					Earthwork <sup>1</sup>	Large Woody Debris & Boulder Ballast	Riffle Installation	Vegetation Management	Bank Stabilization	Direct Costs	Total
Sub-Reach 1	0.7	0.0	3492	3.0	\$ 2,277,592	\$ 1,373,209	\$ -	\$ 326,623	\$ 918,708	\$ 2,635,343	\$ 7,531,475
<b>Construction Sub-Total</b>					\$ 2,277,592	\$ 1,373,209	\$ -	\$ 326,623	\$ 918,708	\$ 2,635,343	<b>\$ 7,531,475</b>
Concept Level Design & Construction Contingency (30%)										\$ 2,259,442	
<b>Construction Total</b>										<b>\$ 9,790,900</b>	
<b>Project Delivery</b>											
Permitting (4%)										\$ 301,259	
Detailed Engineering Design (15%)										\$ 1,129,721	
Contract Administration (5%)										\$ 376,574	
Construction Oversight (1.5%)										\$ 112,972	
<b>Project Delivery Sub-Total</b>										<b>\$ 1,920,500</b>	
<b>TOTAL ESTIMATE</b>										<b>\$ 11,711,000</b>	

<sup>1</sup> Earthwork includes clearing and grubbing and common excavation.