Upper Sonoma Creek
RESTORATION VISION


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**Introduction**

Historically, Upper Sonoma Creek was a vibrant river corridor bordered by many seasonal and perennial wetlands that supported significant runs of Steelhead, and Chinook and Coho salmon. Today, there are only small runs of Steelhead and Chinook salmon. Investigations into the decline of the salmonid runs led to Sonoma Creek being listed as impaired due to excessive fine sediment in 1996, and the 2006 Limiting Factors Analysis (LFA) identified channel erosion as the main source of fine sediment. Channel erosion was also found to be degrading the in-channel habitat for salmonid spawning and rearing, while fish migration barriers and lack of cold water during the summer were found to be impacting summer rearing by Steelhead. The LFA identified the need to counter hydrologic effects of settlement and to restore degraded summer and winter rearing habitat by re-developing channel complexity and instream shelter.

**The Upper Sonoma Creek Habitat Restoration Project** is the planning phase of a project to protect and restore habitat for Steelhead and Chinook salmon.

This project is funded by The California Department of Fish and Wildlife Watershed Restoration Grant Program, which was developed in response to the Water Quality, Supply, and Infrastructure Improvement Act of 2014 (Proposition 1). Sonoma Ecology Center (SEC) is leading the project with support from Environmental Science Associates (ESA).

**Project Goals**

The primary goal of the project is to improve spawning conditions for adult Steelhead along with winter and summer rearing habitat for juvenile Steelhead. While this may appear to be a narrow goal, Steelhead can be thought of as an "umbrella" species: restoring spawning and rearing habitat for juvenile Steelhead would entail restoring a wide range of inter-related species and habitats, from the gravel-dwelling invertebrates on which Steelhead and other aquatic animals feed to the trees that shade them.

Several secondary objectives will help us meet the primary goal. These include:

- **Slow Water**: create places where runoff can be retained before entering Sonoma Creek, to reduce flooding, increase groundwater infiltration in the winter and create more sustained summer baseflows in the creek
- **Improve Water Quality**: take measures to reduce water temperature, contaminants, pathogens, and fine sediment
- **Reduce Bank Erosion**: restore natural sediment dynamics that promote the deposition of coarse sediment (for spawning and supporting the invertebrates that salmonids eat) while reducing erosion that generates fine sediment, burying spawning gravel
- **Improve Riparian Habitat**: restore native vegetation, expand the riparian corridor, restore seasonal wetlands

**Project Approach**

While many restoration projects have been driven by specific opportunities or requirements to restore an individual site, the overall Upper Sonoma Creek project is taking a more holistic view of the watershed, building on the successful model of the Napa River Rutherford and Oakville-to-Oak Knoll Projects.

Using previous studies of the watershed, we have prioritized potential locations for restoration actions that will address both the causes and the symptoms of salmonid decline. The project team has taken a system-wide approach to locating potential restoration reaches and worked with landowners who are willing to consider restoration on their property. The project has identified 20 sites with restoration potential and developed conceptual plans for 16 sites based on landowner input and interest. At one demonstration site, the restoration concepts will be more fully developed to 65% engineering plans to support applications for implementation funding and permits.

This Restoration Vision represents the project team’s synthesis of previous studies, historic and existing conditions, and restoration opportunities. Here, we summarize project work and lay out a vision for a restored Upper Sonoma Creek.
Based on geographic and physical conditions, the 9.5-mile length of Sonoma Creek was split into six reaches. Then, we examined available topographic data to identify opportunities to increase the amount of area and potential actions to make use of such opportunities. Using various metrics, the desktop analysis generally found the creek corridor area to be extremely tall and narrow. A closer examination found that at certain locations within the creek corridor, an inset floodplain of varying elevations has established. This process helped identify a set of six restoration actions: widen creek corridor, lower inset floodplain, expand high flow floodplain, restore seasonal wetland, restore confluence, and improve fish passage. We found several sites where these restoration actions can be applied in combination.

Field reconnaissance was then performed to verify each restoration opportunity and their associated actions. Observations from the field were used to refine the recommended restoration actions and to provide further detail.

The results of the desktop analysis and field reconnaissance were used to develop one-page “action sheets” describing the existing condition and proposed restoration actions. These were used to introduce landowners to the opportunities on their property and to guide discussion.
The Restoration Vision for Upper Sonoma Creek has been formed through numerous formal and informal conversations with the community that lives and works in the watershed. A key component of SEC’s work has been landowner outreach to define the issues of concern for landowners and to develop interest in a communal solution to the challenges created by development of the Sonoma Creek watershed.

In January 2019, SEC mailed a postcard survey to the 280 creekside property owners that live, work, and farm most of the land in the 9.5-mile project area stretch of Upper Sonoma Creek. Response rate to the survey was 21%, showing that many property owners care about the creek and would like to engage in a process to restore habitat and improve water resource management. The top two concerns reported by this survey were bank erosion (chosen 41 times) and Steelhead habitat (chosen 34 times). Summer flows (25), flooding (23), and debris (22) were all closely ranked. The concerns about bank erosion and Steelhead habitat are both related to changes to the historical hydrology and development of the watershed. The channelization of the upper watershed has concentrated flows so that the creek has degraded, lowering the water level and steepening banks.

In the spring and summer of 2019, SEC and ESA staff held four public meetings: two at Kenwood Depot, one at a private home in Glen Ellen, and one at a private home along Warm Springs Road. More than 70 Sonoma Creek landowners joined us at these community meetings to share their stories, their love for Sonoma Creek, and their concerns regarding the future of the creek as a resource for habitat and for their grandchildren to be able to enjoy. At these public meetings landowners shared with us their observations of changes in the creek over the last 40 years including the eroding of banks, lowering of the level of the creek to bedrock in some places, and reduction of numbers of Steelhead observed in the creek by fishermen. At these meetings, landowners acknowledged that no single landowner can reverse these trends on their own, but working together towards a shared vision we may be able to mitigate the systemic losses that are currently underway.

Following the public meetings, SEC met with landowners that expressed interest in hosting restoration projects, or who had land that was particularly well situated to host restoration projects, to discuss restoration ideas. The restoration concepts in this document arose from these individual landowner meetings.

What are your top concerns on Sonoma Creek?

The survey was sent to 280 property owners and had a 21% response rate. Respondents could select more than one answer.
The land that we now know as the Sonoma Creek watershed is the ancestral territory of the Pomo, Coast Miwok, and Wappo peoples, who have occupied the area for at least the last 12,000 years and who continue to reside in the area. Historically, salmon were once bountiful in this watershed, along with creeks, ponds, springs, and wetlands that persisted into the summer months. With settlement and development in the past few centuries, the watershed has been changed by the forces of nature and man. As the SEC, its partners, and watershed residents begin to prepare for restoration, it is helpful to first understand the historical ecology of Sonoma Creek.

This section of the report draws heavily from An Introduction to the Historical Ecology of the Sonoma Creek Watershed (SFEI, 2008) and Sonoma Valley Historical Hydrology Mapping Project (Baseline Consulting, Sonoma Ecology Center and Rebecca Lawton Consulting, 2016), which synthesized several previous studies on the historical ecology of the Sonoma Creek watershed.

The Sonoma Creek watershed has undergone changes common to most Bay Area watersheds since European settlement in the 19th century. Prior to European settlement the landscape was relatively sponge-like, with permeable land cover and tributaries that dissipated flow across alluvial fans. Much of the winter rainfall infiltrated to groundwater that slowly re-emerged downslope to feed wetlands and then flow into Sonoma Creek.

Some of the key findings of the Historical Hydrology Mapping Project relevant to this project include:

- More than 20 of Sonoma Creek’s tributaries were disconnected when first mapped around the mid-18th century, but were mostly connected artificially by the late 19th century.
- Sections of Sonoma Creek in the alluvial fan reaches were dynamic and migrated laterally in response to large flood events and the associated erosion and deposition.
- Unmodified tributary confluentes often approached Sonoma Creek via circuitous paths. Many of these connections were subsequently shortened by settlers, steepening tributaries and speeding flow to the mainstem.
- Perennial wetlands covered about 1% of the valley floor, mostly in the upper watershed and especially focused on Kenwood Marsh.
- Seasonal wetlands covered approximately 20% of the valley floor, mostly in the middle and lower reaches of the valley. We estimate that only about 11% of historic wetlands in the study reach are still present today.
Prior to Euroamerican contact in the 19th century, indigenous peoples relied heavily on the acorn for food, but steelhead and other fishes, elk, deer, birds, jackrabbit, and other animals and plants were also important sources of food and tool materials. Obsidian from nearby Annadel was also very important to these groups for tool production and trade with neighboring peoples. Euroamerican settlement dramatically affected these indigenous peoples, as ranching and farming became popular, resulting in conflict and a drastic decline in population from skirmishes, vigilante raids, and introduced diseases. Despite the previous massive decline in population, the Pomo, Coast Miwok, and Wappo continue to reside in the area, practice and share their cultural traditions, and are interested in the health of the Sonoma Creek watershed.

Hydrologic conditions were historically more ecologically benign than conditions today: peak flows during the rainy season would have been lower and less erosive, baseflows would have been higher and persisted longer into the dry season, more of the channel would have been perennially wet than today, and the subsurface flow paths taken by much of the water in Sonoma Creek would have improved water quality and lowered water temperatures compared to today’s overground paths. The regional ecology was adapted to this hydrologic regime, with Steelhead spawning in the mainstem creek and the connected tributaries, and able to rear during the dry season in reaches fed by cold groundwater. As it was less eroded than its present condition, the mainstem likely had more extensive gravel spawning beds and complex riffle-pool morphology that provided better summer rearing habitat. That channel morphology and bed composition, combined with colder and more persistent summer baseflows, would likely have supported a rich benthic macroinvertebrate community, a foundational part of the aquatic food web.

Within weeks of the Sonoma Mission’s founding in 1823, settlers began modifying the watershed by constructing drainage and water supply ditches. This continued at an accelerating pace through the middle and late 19th century, with maps from the 1870s showing extensive evidence of artificial or improved drainage—for example: straightened channels, or the extension of previously disconnected tributaries to connect permanently to the mainstem of Sonoma Creek. The drainage network expanded in part to drain wetlands and make them more suitable for farming or settlement, and in places may also have been an unintended consequence of overgrazing (Baseline Consulting et al., 2016). Additionally, runoff increased due to forest clearance, grazing, and urbanization.

All of these changes resulted in hydromodification; that is, the bypassing and drying out the watershed’s natural “sponge” with an efficient engineered drainage system that rapidly drains the watershed directly into Sonoma Creek. This led to several changes in Sonoma Creek’s hydrology, geomorphology and ecology that have shaped the watershed to this day.
Building on an understanding of the watershed’s historical ecology, the project team prepared an existing conditions synthesis from literature review, GIS analysis, hydraulic modeling, and fieldwork.

In short, we found ample evidence of the ways historical hydromodification has shaped the watershed into its present state. The confluences of Sonoma Creek and its tributaries have been shortened and steepened to promote more efficient drainage throughout the watershed, with the unintended consequence of making flows more erosive. At the same time, the drainage network has been lengthened and expanded in some areas such as the Kenwood reach, draining wetland areas and directing more flow to the river during the winter while drying the system out during the summer. Construction of berms cut off some distributary channels and floodplains, forcing more water into the mainstem channel. Urbanization has led to more runoff and less percolation.

As a consequence of increased winter flow, the mainstem of Sonoma Creek has eroded in many places. Erosion has scoured spawning gravel out of some reaches, leaving behind bedrock or cohesive substrate that is not suitable for spawning or as habitat for the benthic macro invertebrates that fish feed on. Channel downcutting concentrates winter flows that would historically spread out over a wider floodplain, trapping fish in faster moving water that forces them to expend more energy. Finally, channel and bank erosion degrade the diverse riffle-pool habitat that provides a range of spawning, feeding and sheltering habitats for fish, replacing it with more uniform glides that support fewer ecological functions. For people living near the creek, these changes manifest themselves through increased bank erosion and flood risk, along with the loss of riparian trees, gravel bars and easy access to the water.

During the summer, these geomorphic processes reduce the available habitat for Steelhead to rear, for example by reducing the number of deep pools shaded by overhanging trees. At the same time, the changes in hydrology further stress aquatic life. Whereas historically Sonoma Creek received cool groundwater and seepage from wetlands through much of the year, now flows drop earlier in the year due to channel incision and groundwater pumping. Lower summer baseflows, combined with in-channel structures such as bridge aprons, create barriers to fish movement. For example, as reaches dry out during the summer, even small barriers may prevent juvenile Steelhead from moving upstream to seek more persistent pools.

These myriad challenges also present opportunities to restore and enhance the hydrology, ecology, and ecosystem services of the Sonoma Creek watershed.
The menu of restoration actions identified during the desktop analysis phase offers varied ways to improve habitat and geomorphic function, many of which are synergistic. Creating high flow swales, lowering inset floodplains, widening riparian corridors, and restoring seasonal wetlands all help to slow the speed at which water moves during winter flows, reduce erosion, etc. Removing fish passage barriers and restoring confluences both help fish migrate to upstream spawning grounds.

Historical ecology provides a valuable window into how watersheds have functioned in the past, their present trajectory, and the potential for restoration. However, restoration can rarely completely “turn back the clock” on a watershed. Some changes may be irreversible for practical purposes—for example, increases in runoff from older urban developments where there is not room to retrofit stormwater retention facilities. Restoration in the mainstem of Sonoma Creek must account for some permanent changes in watershed hydrology—for instance, extensive urbanization and reduced groundwater inputs to the creek. However, outside of these unrecoverable changes, there is a wide spectrum of restoration potential that may or may not be constrained by land ownership, funding opportunities, socioeconomic and scientific choices, as illustrated in the figure below.
This action will be used in areas where the channel is deeply incised and the riparian corridor is narrow.

Presently, there is an existing mid-level floodplain that has been disconnected from the creek by downcutting.

Over the years as Sonoma Creek downcut, it left its floodplain tributaries “hanging” and disconnected.

Grading the tributaries down to the creek allows fish to migrate upstream while the restored confluences are nodes of high value habitat.

The result is a densely-vegetated riparian corridor that is both wider and more connected to creek flows.

While the width of the riparian corridor remains the same, it is lower and more connected to the creek at high flows.
The existing condition is an incised channel with an opportunity to cut into the bank and provide high flow refugia for Steelhead.

Sonoma Creek has downcut below hardened structures such as bridge aprons and weirs. The hard point creates a step in the creek profile that juvenile Steelhead and other fish cannot pass over, trapping them in creek sections that may dry out in summer.

Building an armored riffle below the hard point builds up the water level, allowing fish to migrate upstream.

The result is a well-shaded riparian corridor with a floodplain activated during high winter flows.

Grading subtle depressions allows runoff to be slowed down, providing wetland habitat and filtering water before it reaches the creek.
Landowner stewardship

Property owners and land managers in the Sonoma Creek watershed have many opportunities to improve the health of Sonoma Creek by taking care of riparian areas. Good land management practices can prevent excess erosion of the creek’s banks, slow down rain and runoff as it flows over the land, and clean runoff before it reaches the creek. More guidance on stormwater best management practices can be found online in the Permit Sonoma Best Management Practices Guide.

Due to the sensitivity and importance of riparian areas, many management and restoration efforts within the riparian corridor are regulated by various local, state, and federal agencies. In Sonoma County, the riparian corridor is defined as extending at least 50 feet from the top-of-bank and includes the width of the dripline of trees and vegetation on either side of the creek, and the vegetated channel banks below the top-of-bank. Removal of vegetation along creek banks requires permits, and any manipulation of the stream bank including adding riprap or fill material will require permits also. For example, permits would be required to reinforce a failing bank or to move a downed tree in the creek corridor, or to place any fill (rock or soil) on the stream bank or floodplain area. If you are interested in undertaking such a project, or just need advice about whether activities may require a permit, SEC or Sonoma RCD can help.

SEC regularly conducts small-scale habitat enhancement and management actions on public and private land within the Sonoma Creek corridor. SEC’s main activity types include:

- Vegetation management: trimming and removing flow-constricting vegetation, removing invasive weed plants, and reforesting streambanks with native riparian plants.
- Debris management: removing debris or downed trees that reduce flood conveyance capacity or threaten channel stability; in fact, most downed trees beneficially increase channel complexity and habitat diversity, so SEC particularly targets removing debris around infrastructure such as bridges or culverts.
- Bank stabilization and erosion control: targets weak, unstable, or eroding banks that increase flood risk, sediment pollution, and erosion, or otherwise pose a risk to property, infrastructure or public safety. Activities that move earth would require agency approval.

While landowners can independently secure approvals, working with SEC can facilitate the permitting process. Depending on the complexity and impact of a project, permit approvals—if required—can take months to years. SEC can also help landowners secure grant funding, though this process does not enter creeks.

**Ways to protect or repair creek banks and riparian areas that do not typically require permits**

- Leave native plants on the banks. If pruning must occur, leave as much vegetation as possible, and plant bare areas with native plants. Removal of any trees in the riparian corridor requires a permit from CDFW.
- Leave rocks in the creek. These are homes for creek critters. Don’t remove rocks for landscaping projects.
- Divert water only if it is legal for you to do so. Water diversions have many legal requirements. Contact the State Water Resources Control Board, Division of Water Rights and CDFW for information.
- Avoid building structures such as sheds, barns, or decks near creeks. Check with Permit Sonoma for setback requirements.
- Avoid building livestock corrals and feeding and watering areas near creeks.
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- Avoid building livestock corrals and feeding and watering areas near creeks.

For larger projects, what kinds of permits may be involved?

Several federal, state, county, local, and tribal agencies may require permits depending on the planned action:

- Clean Water Act Section 404: required for projects involving dredging or filling (including riprap) for any in-channel or wetlands work up to the ordinary high water mark. Jurisdiction of the US Army Corps of Engineers (USACE)
- Rivers and Harbors Act Section 10: required for structures and work in, above, or below navigable creeks. Jurisdiction of the USACE
- Regional Water Quality Control Boards and/or California Department of Fish and Wildlife permits: required for activities in the channel and along the banks, including the riparian corridor
- Federal Endangered Species Act, Migratory Bird Treaty Act, Magnuson-Stevens Act, National Historic Preservation Act: handled by US Fish and Wildlife Service (USFWS), National Marine Fisheries Service (NMFS), and the

State Historic Preservation Offices (SHPO) in coordination with the USACE process. Any work with a federal action (federal permit, federal grant, etc.) requires federal consultation with USFWS and/or NMFS if the project may affect federal listed species and with SHPO if the project may affect historic resources.

- California Environmental Quality Act: compliance required for any action when a project requires discretionary approval by a state or local governmental body, such as state agency and County grading permits.
- Sonoma County Riparian Corridor Combining Zone: zoning set-back of 50 feet from top-of-bank prohibiting certain activities without a permit. Examples include County grading permits, tree protection ordinances, and riparian corridor use permits. More details in Section 26-65 of County code.

Questions? Interested in partnering with SEC?
Contact us at creek@sonomaeccologycenter.org or (707) 996-0712
Reaches & sites

The six geomorphically distinct reaches along these 9.5 miles of Sonoma Creek offered many opportunities to implement the restoration actions described in the previous section. The following concepts came out of a process to identify potential sites for restoration, but moving forward with them was and is subject to discussions with landowners.
Reach 1

Madrone Creek to Sonoma Valley Regional Park

Reach 1 sits at the downstream end of the 9.5 miles of Sonoma Creek studied for this project. Beginning just upstream of Madrone Creek, Reach 1 follows the western margin of Sonoma Valley before ending at Sonoma Valley Regional Park. Throughout this reach, the creek corridor is much wider than in any of the other reaches. As a result, the creek corridor contains a number of inset floodplains, particularly along the Sonoma Developmental Center Property. The condition of the banks, channel bed, and riparian cover ranges considerably across this reach. Some portions of the reach have intact banks, gravel that is well-sized for Steelhead spawning, and good shade, whereas other portions contain high eroding banks, exposed clay hardpan or excessive fine sediment, and poor riparian shade cover resulting in excessive algal growth.

A stretch of Reach 1 featuring a wide creek corridor but with a severely eroded bank.
Site Description
Site 1 sits on the left bank of Sonoma Creek and features a relatively wide riparian corridor and an existing inset floodplain. However, the opposite bank is high, steep, and armored with riprap. The channel bed at this site is a mix of gravel, cobble, and exposed clay hardpan. A potential fish passage barrier exists on the upstream end of the site, where concrete covers a wastewater line crossing beneath the Madrone Road bridge.

Site Goals
The primary goal at this site is to create Steelhead rearing habitat and high-flow refugia. Other goals include slowing water, improving water quality, reducing bank erosion, and improving riparian habitat.

Restoration Actions
The recommended actions at this site will improve fish habitat by lowering the inset floodplain to create rearing habitat and high-flow refugia, and by addressing the fish passage barrier at the northern end of the site.

Site Description
Site 2 encompasses a relatively wide riparian zone on the left bank of Sonoma Creek. However, its high, steep bank also shows signs of active erosion, which has undermined tree roots to the point that they are at risk of falling into the creek. The channel bed at this site is a mix of gravel, cobble, fine sediment, and exposed clay hardpan. There is an existing inset floodplain at this site. A lack of shade from fallen trees along this site appears to have contributed to excess algae on the channel bed.

Site Goals
The primary goal at this site is to create Steelhead rearing and high-flow refugia habitat. Other goals include slowing water, improving water quality, reducing bank erosion, and improving riparian habitat.

Restoration Actions
The recommended action at this site is to expand the riparian corridor by utilizing the space beyond the top of bank to widen and lay back banks, thus creating Steelhead rearing habitat and high-flow refugia. The gentler bank slopes will reduce bank erosion, improving water quality. This will also slow water, promoting sediment deposition and improving rearing conditions in the existing channel. Finally, removing invasive non-native species and revegetating the site will improve overall riparian habitat.

Site Constraints
Restoration at this site is constrained by the existing mature riparian trees.
Site Description
Site 3 sits in a relatively wide riparian zone on the left bank of Sonoma Creek. Here, active erosion has carved out a high, steep bank and undermined tree roots such that the trees are now falling into the creek. The channel bed is a mix of gravel, cobbles, fine sediment, and exposed clay hardpan.

This site encompasses the confluence of an unnamed tributary with Sonoma Creek. The confluence sits atop clay hardpan several feet above the bed of Sonoma Creek. Just upstream of the confluence, the tributary flows through a terrace and riparian zone that are both lower than the adjacent vineyard.

Site Goals
The primary goal for Site 3 is to create Steelhead rearing habitat and high-flow refugia. Other goals include slowing water, improving water quality, reducing bank erosion, and improving riparian habitat.

Restoration Actions
The confluence of the unnamed tributary with Sonoma Creek offers an opportunity to create rearing habitat and high-flow refugia by realigning the tributary’s channel or by augmenting it with additional channels or floodplain benches. This will also improve access to potential upstream rearing habitat and expand the riparian corridor. Reducing bank steepness will create additional refugia, slow water, and improve overall riparian habitat. It will also mitigate the existing bank erosion problem, thus improving water quality.

Finally, removing invasive non-native species and revegetating will improve the overall riparian habitat.

Site Constraints
Known Site 3 constraints include the homes on the opposite bank.

Site 4: Sonoma Developmental Center
Conceptual Design: p. 35

Site Description
Site 4 extends the length of the Sonoma Developmental Center’s (SDC) large facility for nearly a mile of Sonoma Creek. Across the length of the site there are numerous existing inset floodplain features. While much of the parcel contains SDC buildings and infrastructure, there are some relatively wide riparian zones surrounded by open or undeveloped space. Active erosion primarily near the development has carved out a high, steep bank and undermined tree roots such that they are starting to fall into the creek.

The channel bed is a mix of gravel, cobbles, and exposed clay hardpan. Sonoma Creek is fed by four tributaries in this area: two unnamed tributaries on the right bank upstream of the site, one unnamed tributary on the left bank in the middle of the site, and Mill Creek on the site’s downstream right bank.

Site Goals
The primary goal for Site 4 is to create Steelhead rearing habitat and high-flow refugia. Other goals include slowing water, improving water quality, reducing bank erosion, and improving riparian habitat.

Restoration Actions
A complex of integrated restoration actions—lowering the existing floodplain, widening the corridor, and enhancing the tributaries—will create rearing habitat and refugia while providing a suite of other benefits. Lowering the inset floodplain to an elevation that will be underwater during winter flows will provide winter rearing habitat and expand the riparian corridor. It will also slow the flow of water, promoting sediment deposition and improving rearing conditions in the existing channel.

The riparian corridor can be further expanded by utilizing the open space beyond the top of bank on both sides to widen and lay back the banks. This will reduce bank steepness, reducing erosion and improving water quality. Like the lowered floodplain, this will slow water and promote sediment deposition.

The tributaries flowing into Sonoma Creek at this site present valuable opportunities to create more rearing habitat and refugia. To do so, these tributaries (including Mill Creek) can be modified through channel realignment or by adding multiple channels. In addition to creating rearing habitat and refugia, this will improve access to potential upstream rearing habitat and expand the riparian corridor. Reducing bank steepness in the tributaries will create additional refugia, slow water, and improve overall riparian habitat. It will also mitigate the existing bank erosion problem, thus improving water quality.

Finally, revegetation and the removal of invasive non-native species will improve the quality of habitat.

Site Constraints
Restoration design must consider Sonoma Developmental Center’s building, facilities, and infrastructure. In particular, any structures slated for preservation as part of future development on the property will constrain the project footprint.
Site Description
Site 5 comprises a stretch of the left bank of Sonoma Creek in the Sonoma Valley Regional Park, where there is a relatively wider riparian zone. Currently, the high, steep bank shows signs of active erosion that has undermined tree roots such that the trees are starting to fall into the creek. There is an existing inset floodplain covered in trees along the left bank. The channel bed is a mix of gravel, cobbles, and exposed clay hardpan. A lack of shade from lost trees along this site appears to have contributed to excess algae on the channel bed as well.

Site Goals
The primary goal at this site is to create Steelhead rearing habitat and high-flow refugia. Other goals include slowing water, improving water quality, reducing bank erosion, and improving riparian habitat.

Restoration Actions
The recommended action at this site is to lower the existing inset floodplain so that it will be inundated and provide rearing habitat and high-flow refugia during the winter. The lowered floodplain will also slow water, promoting the deposition of sediment in the existing channel, which will improve rearing conditions. The surrounding open space of the regional park additionally offers the opportunity to lay back banks, thus reducing bank erosion and improving water quality. Finally, removing invasive non-native species and revegetating will improve the quality of riparian habitat.

Site Constraints
Restoration at this site is constrained by the existing mature trees and paved hiking path. Additionally, there is a historic railroad line.
Reach 2
Sonoma Valley Regional Park to Warm Springs Road

Reach 2 begins at Sonoma Valley Regional Park, extends through most of Glen Ellen, and ends where Sonoma Creek flows under Warm Springs Road near the intersection with Sonoma Mountain Road. The creek is confined by the adjacent Sonoma Mountains hillslopes and by Warm Springs Road and creek-adjacent homes. However, in this reach, the adjacent hillslopes form a number of large bends in the channel alignment that have resulted in extremely high and unstable banks. Consequently, landslides are common in this reach, and the creek corridor is wider with a more expansive inset floodplain than upstream reaches. In this reach, the creek bed is a combination of fine sediment, large cobbles, and boulders—all likely a product of the eroding banks. The tops of banks are lined with mature native vegetation primarily where there appears to be less bank erosion, which has resulted in patchy shade.

Due to the constraints outlined above, no restoration opportunities were identified in this reach. However, landowners should continue to contact SEC to consult on bank stability or other issues to see if biotechnical or other solutions might be practical. Further, installations of trees and other vegetative cover in this reach are encouraged to stabilize banks and maintain shade over the creek. Additional creekside landowner stewardship suggestions can be found on p. 10-11 of this document.
Reach 3 follows Warm Springs Road from the intersection with Sonoma Mountain Road to the intersection with Bennett Valley Road. This reach is confined by the hillslopes of the Sonoma Mountains and creek-adjacent homes along the left bank, and by Warm Springs Road along the right bank of this entire reach. Consequently, there are few places where the creek has room to form a floodplain, compared to other reaches. The result is a highly-confined creek corridor with less sediment storage than similarly-confined stretches upstream. An open, level terrace follows nearly the entire length of Reach 3 west of Warm Springs Road. The creek bed throughout this reach has eroded down to clay hardpan and armored cobble sediment, creating poor Steelhead spawning and rearing habitat. This is a well-shaded reach with mature native vegetation lining the tops of banks.

Reach 3 is constrained by a combination of steep hillslopes and creek-adjacent properties.
Site Description
This site spans three properties on the left bank of Sonoma Creek, which features a relatively wide riparian zone at Site 6. However, the high, steep bank also shows signs of active erosion, which has undermined tree roots to the point where they are falling into the creek. The channel bed at this site is a mix of gravel, cobble, and exposed clay hardpan. There is an existing inset floodplain at this site.

Site Goals
The primary goal at this site is to create Steelhead rearing habitat and high-flow refugia. Other goals are to slow water, improve water quality, reduce bank erosion, and improve riparian habitat.

Restoration Actions
The recommended action at Site 6 focuses on lowering the existing inset floodplain so that it will be underwater during the winter months, thus providing Steelhead rearing habitat and high-flow refugia. It will also widen the riparian corridor, slowing water and promoting sediment deposition, which will in turn improve rearing conditions in the existing channel of Sonoma Creek. Laying back the banks will reduce bank erosion and improve water quality. Finally, removing invasive non-natives and revegetating the site will enhance the overall quality of riparian habitat.

Site Constraints
Restoration at this site is constrained by the presence of existing mature trees.

Site Description
Site 7 spans a relatively wide riparian zone on both banks of Sonoma Creek. However, its high, steep bank also shows signs of active erosion, which has undermined tree roots to the point where they are falling into the creek. The channel bed at this site is a mix of gravel, cobble, and exposed clay hardpan. There is an existing inset floodplain.

Site Goals
The primary goal at this site is to create Steelhead rearing habitat and high-flow refugia. Other goals are to slow water, improve water quality, reduce bank erosion, and improve riparian habitat.

Restoration Actions
The recommended action at this site focuses on lowering the existing inset floodplain so that it will be underwater during the winter months, thus providing Steelhead rearing habitat and high-flow refugia. It will also widen the riparian corridor, slowing water and promoting sediment deposition, which will in turn improve rearing conditions in the existing channel of Sonoma Creek. At Site 7, the space beyond the current top of bank provides an opportunity to widen the stream corridor by laying back the banks. This will create additional rearing habitat and high-flow refugia. The reduced gradient of the bank slopes will reduce bank erosion and improve water quality. This will also slow water, thus promoting the deposition of sediment that improves rearing conditions in the existing channel. Finally, removing invasive non-natives and revegetating the site will enhance the overall quality of riparian habitat.

Site Constraints
At Site 7, restoration design is constrained by the existing trees.
Site Description

Site 8 is located in relatively wide riparian zone. However, the high, steep bank also shows signs of active erosion, which has undermined tree roots to the point where they are falling into the creek. The channel bed at this site is a mix of gravel, cobble, and exposed clay hardpan. There is an existing inset floodplain at this site.

Site Goals

The primary goal at this site is to create Steelhead rearing habitat and refugia. Other goals are to slow water, improve water quality, reduce bank erosion, and improve riparian habitat.

Site Constraints

Restoration is constrained by the existing trees.

Restoration Actions

The recommended action at this site focuses on lowering the existing inset floodplain so that it will be underwater during the winter months, thus providing Steelhead rearing habitat and high-flow refugia. It will also widen the riparian corridor, slowing water and promoting sediment deposition, which will in turn improve rearing conditions in the existing channel of Sonoma Creek. Laying back the banks will reduce bank erosion and improve water quality. Finally, removing invasive non-natives and revegetating the site will enhance the overall quality of riparian habitat.

Site Description

Site 9 sits in a relatively narrow riparian corridor between the right bank of Sonoma Creek and Warm Springs Road. The high, steep bank shows signs of active erosion that has undermined tree roots to the point where they are falling into the creek. The channel bed at this site is a mix of gravel, cobble, and exposed clay hardpan. This site begins along the right bank, traverses Warm Springs Road, and continues on the other side of the road onto an existing open field.

Site Goals

The primary goal for this site is to create Steelhead rearing habitat and high-flow refugia. Other goals are to slow water, improve water quality, reduce bank erosion, and improve riparian habitat.

Site Constraints

Warm Springs Road presents the largest constraint to this project, as restoration depends on the road’s realignment. Other constraints include public and private infrastructure and utilities.

Restoration Actions

The recommended action at this site is to expand the riparian corridor by utilizing the open field beyond Warm Springs Road to widen and lay back banks in order to create Steelhead rearing habitat and high-flow refugia. Though this requires realigning the adjacent stretch of Warm Springs Road, doing so creates room for more gently-sloped banks that will mitigate the current erosion problem that may be threatening the road in the long term. This will also improve water quality and slow flows, promoting sediment deposition that will improve rearing conditions in the existing channel. Finally, removing invasive non-native species and revegetating the site will generally enhance the riparian habitat.
Reach 4
Bennett Valley Road to Sonoma Mountain Road

Reach 4 extends along Warm Springs Road between Bennett Valley Road and Sonoma Mountain Road. The creek is naturally confined by the adjacent hillslopes of the Sonoma Mountains along this entire reach, and it is further confined by Warm Springs Road and creek-adjacent homes. Consequently, compared to other reaches, there are fewer places here where the creek has room to form a floodplain.

The result is a highly-confined creek corridor with less sediment storage than the similarly-confined stretches upstream. Throughout Reach 4, the creek bed has eroded down to volcanic bedrock and clay hardpan, creating poor Steelhead spawning and rearing habitat. However, it also boasts largely cool, clean perennial flows that may be responsible for the existence of Steelhead in the watershed today. Additionally, it is a well-shaded reach with mature native vegetation lining the tops of banks.
Site Description
Site 10 runs along the left bank of Sonoma Creek. At this site, there is a relatively thin riparian corridor. The high, steep bank shows signs of active erosion, which has undermined tree roots to the point where trees are falling into the creek. The channel bed is characterized by exposed bedrock. Open agricultural space lies beyond the riparian corridor at the top of bank.

Site Goals
The primary goal at this site is to create Steelhead rearing habitat and high-flow refugia. Other goals include slowing water, improving water quality, reducing bank erosion, and improving habitat.

Restoration Actions
The recommended action at this site focuses on expanding and widening the stream corridor to create rearing habitat and high-flow refugia by utilizing the space beyond the current top of bank to widen the channel corridor and lay back the banks. The reduced gradient of the bank slopes will in turn reduce bank erosion and improve water quality. This action will also slow water, thus promoting sediment deposition that in turn improves rearing conditions in the existing channel.

Finally, removing invasive non-native species and revegetating will improve general riparian habitat.

Site Constraints
Known site constraints include the neighboring vineyard and its related infrastructure. Additionally, the excessive height of the terrace poses challenges for restoration. This site was not selected to continue to the conceptual design process.

Site Description
Site 11 follows the right bank of Sonoma Creek in a property that provides an area of floodplain adjacent to Sonoma Creek, which is rare in this confined reach. There is also an existing inset floodplain. The banks on both sides of the creek at this site show signs of minor erosion resulting in fine sediment input and a loss of mature vegetation. The riparian corridor’s trees extend beyond the top of bank at this site. Portions of the bank are covered in invasive non-native vegetation. Upstream of the site, a private bridge crosses the creek.

Site Goals
The primary goals for Site 11 are to improve Steelhead rearing habitat and refugia as well as to provide upstream migration. Secondary goals include slowing water, improving water quality, reducing bank erosion, and improving riparian habitat.

Restoration Actions
The recommended restoration actions at Site 11 will enhance the riparian corridor by widening it toward the downstream end of the site and by lowering the inset floodplain within the already-expanded corridor downstream of the private bridge. The widened corridor may be further improved with a high-flow depression and seasonal wetland. These actions will expand and improve the condition of Steelhead rearing habitat and will provide high-velocity refugia across a range of flows. Slower flow velocities will allow gravels to naturally deposit on the creek bed in the future, making the restoration sustainable. New gently-sloped banks will reduce bank erosion and fine sediment input into Sonoma Creek, improving the quality of spawning gravels downstream.

The transitional habitat from corridor widening through the high flow depression and seasonal wetland will improve riparian habitat through native plant revegetation. The high-flow depression and seasonal wetland will also capture, retain, treat, and infiltrate excess runoff. Finally, large wood will be added to provide refugia in the floodplain and to restore natural channel function in the channel.

Site Constraints
Known Site 11 constraints include a private bridge, existing picnic area, and restroom facilities.
Site Description
Site 12 is located along the right bank of Sonoma Creek. Here, there is a relatively thin riparian zone and a high, steep bank showing signs of the active erosion that has undermined tree roots to the point where they are falling into the creek. The channel bed is characterized by exposed bedrock, and a flashboard weir in the channel may present a fish passage barrier under some flow conditions. Open agricultural space and a small wetland lie beyond the top of bank.

Site Goals
The primary goal at this site is to create Steelhead rearing habitat and high flow refugia. Other goals include slowing water, improving water quality, reducing bank erosion, and improving riparian habitat.

Restoration Actions
The primary recommended action is to expand the riparian corridor by utilizing the open space beyond the top of bank to widen and lay back the banks. This will reduce bank erosion, thus improving water quality. The widened corridor will create Steelhead rearing habitat and high flow refugia, while slowing flows should lead to sediment deposition that helps build up the bed to bury the potential upstream fish passage barrier. Removing invasive non-native species and revegetating the site will further improve habitat. The space surrounding the existing wetland patch offers an opportunity to integrate a seasonal wetland into the newly-widened channel. This will create refugia, slow water, and improve water quality.

Site Constraints
Water diversion infrastructure presents the only known constraint at this site.
Reach 5 begins at the Lawndale Ditch confluence, follows the historic Kenwood alluvial fan, and then cuts through the town of Kenwood to its upstream end at Highway 12. Near Kenwood, the alluvial fan from the east side of the valley has forced the creek up against the hillslope on the west side. The upstream portion of the creek within the alluvial fan experiences excess sediment deposition, which in turn causes the channel to migrate laterally and erode its banks. Deposition has reduced the capacity of the channel along the Lawndale community, increasing the potential for flooding during extreme winter storms. During the later summer months, water flows subsurface along this portion of the reach, drying out the channel bed. Downstream of the Lawndale Ditch confluence, the channel has eroded into its bed, exposing a wide range of materials such as bedrock and clay hardpan that do not support salmonid spawning and rearing, though there are pockets of gravel ideal for steelhead habitat. For most of Reach 5, the tops of banks are lined with mature native vegetation, with some areas of invasive vegetation or no mature vegetation due to bank erosion. Historically, this reach was part of an alluvial fan wetland complex that provided complex habitat, flood attenuation and groundwater recharge in the winter, and the slow release of flows in the summer time.
Site Description
Site 13 crosses fields on several properties just upstream of the confluence of Fisher Creek’s north and south branches, which is in turn about 1000 feet upstream of the confluence of Fisher Creek and Sonoma Creek. This area was historically part of the Kenwood alluvial fan and wetland complex, and today patches of existing wetland and riparian habitat are found within the large open field. Fisher Creek’s south branch flows across this area. There is also an existing drainage channel.

Site Goals
The primary goal at this site is to create Steelhead rearing habitat and refugia. Secondary goals include slowing water, improving water quality, and improving riparian habitat.

Restoration Actions
This site offers an opportunity to restore 32 acres of lost Kenwood wetland habitat and capture winter storm flow from all of Fisher Creek, which drains a 3-square-mile watershed. This new seasonal wetland will create rearing habitat and refugia while also improving access to potential upstream rearing habitat. This expanded riparian habitat will be further enhanced by revegetation and the removal of invasive non-native species. Revegetation will include efforts to support the preservation and reestablishment of the endangered Kenwood Marsh Checkerbloom. Furthermore, capturing winter storm flow will slow and reduce downstream flows while generally improving the water quality of runoff from the adjacent roads and agricultural lands.

Site Constraints
The new wetland’s footprint is constrained by the existing pond, vines, and vineyard infrastructure as well as by Warm Springs Road to the west.

Historic land grant plats like the one shown above for Rancho Los Guílicos provide insight into the original extent and alignment of various water bodies. Kenwood Marsh once covered much of the area between Sonoma and Calabazas Creeks. Today, only pockets of the former wetland exist. The dissolution and hydromodification of Kenwood Marsh over the last two centuries has also had implications for ecology. In particular, the Kenwood Marsh checkerbloom is now a listed species under the California Endangered Species Act, its numbers depressed by historic grazing and by present competition with invasive species. During the course of this project, SEC was made aware of a small occurrence of the checkerbloom at Site 13. Restoring a larger swath of historic Kenwood Marsh may help the checkerbloom’s numbers rebound.
Site Description

Site 14 follows the left bank of Sonoma Creek, comprising the bank and a strip of open space between the top of bank and the edge of existing vineyards and orchards. At this site, there is a relatively thin riparian corridor where the high, steep bank shows signs of active erosion. The erosion has undermined tree roots to where trees are falling into the creek. In the channel bed, there are good quality streambed gravels suitable for Steelhead spawning.

Site Goals
The primary goal of this site is to create Steelhead rearing habitat and high-flow refugia. Other goals include slowing water, improving water quality, reducing bank erosion, and improving habitat.

Site Constraints
The width of the new riparian corridor is constrained by the location of the vineyard and orchard.

Restoration Actions
The recommended action is to utilize the space between the top of bank and the adjacent vineyard and orchard to expand the riparian corridor. This swath of land provides room to widen and lay back banks, which will create Steelhead rearing habitat and high flow refugia. The reduced bank slope gradient will reduce bank erosion and improve water quality. It will also slow the flow of water. Finally, removing invasive non-native species and revegetating the site will improve general riparian habitat quality.

Site Description

Site 15 sits along Warm Springs West, a tributary flowing across an open agricultural field to its confluence with Sonoma Creek. The habitat in the channel of Warm Springs West is currently compromised by incision and bank erosion, which have limited Steelhead access to high-flow refugia and deposited fine sediment into the bed. Furthermore, bank erosion has caused a loss of mature vegetation, leaving the tributary without a riparian canopy.

Site Goals
The primary goal for Site 15 is to infiltrate water and restore the alluvial fan. Secondarily, this restoration aims to create high flow refugia for fish at the confluence. Other goals include slowing water, improving water quality, reducing bank erosion, and improving habitat.

Site Constraints
The primary goal for Site 15 is to infiltrate water and restore the alluvial fan. Secondarily, this restoration aims to create high flow refugia for fish at the confluence. Other goals include slowing water, improving water quality, reducing bank erosion, and improving habitat.

Restoration Actions
Site 15 presents an opportunity to restore the confluence along Warm Springs West. The recommended restoration actions thus include channel realignment, bank regrading, and revegetation. Realigning Warm Springs West or adding more channels along it will create rearing habitat and refugia while also improving access to potential upstream rearing habitat and expanding the riparian corridor.

To address the problems associated with channel incision and bank erosion, the banks will be regraded to reduce their steepness. This will create refugia, slow water, improve water quality, and improve overall riparian habitat. Finally, removing invasive non-native species and revegetating the site will also improve habitat quality.

Site Constraints
This site is constrained by the home along the targeted stretch of Warm Springs West and by the need to maintain pasture land use. This site will be advanced under a different project.
**Site Description**

Site 16 encompasses an area on both sides of Sonoma Creek near the Kenilworth Avenue crossing. Kenwood Creek flows through the north end of the site and forms a confluence with Sonoma Creek. The channel of Sonoma Creek is deeply incised at this site, though the channel bed consists of ideal-sized gravel for Steelhead. The incised channel corridor provides limited access to high flow refugia for Steelhead. The banks on both sides of the creek show signs of minor erosion that have resulted in fine sediment input and a loss of mature vegetation. Portions of the bank are covered in invasive non-native vegetation.

**Site Goals**

The primary goals are to improve Steelhead rearing habitat, refugia, and migration access. Other goals include slowing water, improving water quality, reducing bank erosion, and improving habitat.

**Site Constraints**

Restoration is constrained by the Cypress Avenue storm drain and by Kenilworth Avenue and its accompanying bridge.

**Restoration Actions**

- Expanded High Flow Floodplain
- Restored Seasonal Wetland
- Restored Confluence
- Widened Corridor

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**Site Description**

Site 17 spans two properties along a deeply incised stretch of creek. The channel bed has eroded to underlying clay hardpan, which provides poor spawning and rearing habitat for Steelhead. The incised corridor also provides limited access to high flow refugia for Steelhead, but there is an existing inset floodplain. The bank on both sides of the creek is actively eroding, resulting in fine sediment input and a lack of mature vegetation. Channel incision has created a head cut (vertical step in the creek bed) at the USGS gage weir that appears to be a partial barrier to upstream salmonid migration, limiting access to high quality Steelhead habitat in the canyon above Reach 5.

**Site Goals**

The primary goals for Site 17 are to improve Steelhead rearing habitat and refugia as well as improve migration access. Secondary goals include slowing water, improving water quality, reducing bank erosion, and improving riparian habitat.

**Site Constraints**

Known Site 17 constraints include the access road; the municipal water line; the USGS gage; and the vineyard, including its pond and infrastructure, on the opposing property.

**Restoration Actions**

- Fish Passage Barrier Remediation
- Lowered Inset Floodplain
- Widened Corridor

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**Site Description**

Site 17 spans two properties along a deeply incised stretch of creek. The channel bed has eroded to underlying clay hardpan, which provides poor spawning and rearing habitat for Steelhead. The incised corridor also provides limited access to high flow refugia for Steelhead, but there is an existing inset floodplain. The bank on both sides of the creek is actively eroding, resulting in fine sediment input and a lack of mature vegetation. Channel incision has created a head cut (vertical step in the creek bed) at the USGS gage weir that appears to be a partial barrier to upstream salmonid migration, limiting access to high quality Steelhead habitat in the canyon above Reach 5.

**Site Goals**

The primary goals for Site 17 are to improve Steelhead rearing habitat and refugia as well as improve migration access. Secondary goals include slowing water, improving water quality, reducing bank erosion, and improving riparian habitat.

**Site Constraints**

Known Site 17 constraints include the access road; the municipal water line; the USGS gage; and the vineyard, including its pond and infrastructure, on the opposing property.

**Restoration Actions**

- Fish Passage Barrier Remediation
- Lowered Inset Floodplain
- Widened Corridor

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**Site Description**

Site 17 spans two properties along a deeply incised stretch of creek. The channel bed has eroded to underlying clay hardpan, which provides poor spawning and rearing habitat for Steelhead. The incised corridor also provides limited access to high flow refugia for Steelhead, but there is an existing inset floodplain. The bank on both sides of the creek is actively eroding, resulting in fine sediment input and a lack of mature vegetation. Channel incision has created a head cut (vertical step in the creek bed) at the USGS gage weir that appears to be a partial barrier to upstream salmonid migration, limiting access to high quality Steelhead habitat in the canyon above Reach 5.

**Site Goals**

The primary goals for Site 17 are to improve Steelhead rearing habitat and refugia as well as improve migration access. Secondary goals include slowing water, improving water quality, reducing bank erosion, and improving riparian habitat.

**Site Constraints**

Known Site 17 constraints include the access road; the municipal water line; the USGS gage; and the vineyard, including its pond and infrastructure, on the opposing property.

**Restoration Actions**

- Fish Passage Barrier Remediation
- Lowered Inset Floodplain
- Widened Corridor

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**Site Description**

Site 17 spans two properties along a deeply incised stretch of creek. The channel bed has eroded to underlying clay hardpan, which provides poor spawning and rearing habitat for Steelhead. The incised corridor also provides limited access to high flow refugia for Steelhead, but there is an existing inset floodplain. The bank on both sides of the creek is actively eroding, resulting in fine sediment input and a lack of mature vegetation. Channel incision has created a head cut (vertical step in the creek bed) at the USGS gage weir that appears to be a partial barrier to upstream salmonid migration, limiting access to high quality Steelhead habitat in the canyon above Reach 5.

**Site Goals**

The primary goals for Site 17 are to improve Steelhead rearing habitat and refugia as well as improve migration access. Secondary goals include slowing water, improving water quality, reducing bank erosion, and improving riparian habitat.

**Site Constraints**

Known Site 17 constraints include the access road; the municipal water line; the USGS gage; and the vineyard, including its pond and infrastructure, on the opposing property.
Site Description
Site 18 is characterized primarily by a constructed drainage channel spanning several properties that confluences with Sonoma Creek at the site. Several tributaries—Frey Creek, Felton Creek, Pythian Creek, and an unnamed creek—feed into this drainage channel. The low-gradient drainage channel is lined with high, steep banks. A residential development sits on the left overbank and dense, young riparian vegetation covers the right overbank. Currently, the channel’s muddy bed provides poor salmonid rearing habitat.

Site Goals
The primary goal for Site 18 is to create Steelhead rearing habitat, as well as high-flow refugia where juveniles and returning adults can shelter when water in Sonoma Creek is fast-flowing. Other goals include slowing water, improving water quality, reducing bank erosion, and improving riparian habitat.

Restoration Actions
The recommended action at Site 18 is to restore the tributary area and constructed drainage channel leading to Sonoma Creek. Reducing the bed and bank gradients of the unnamed tributary will improve upstream migration potential for Steelhead and create better rearing habitat and high-flow refugia. In the drainage channel, lowering select areas of the dense young riparian zone on the right overbank and reducing the steepness of the left bank will slow water and create low-velocity refugia for Steelhead. The gently-sloped left bank will also reduce bank erosion, improve bank stability, and improve riparian habitat overall. Finally, removing invasive non-native species and revegetating this site with natives will improve the overall riparian habitat.

Site Constraints
Known Site 18 constraints include homes along the left overbank and a private road.

Site 19
Conceptual Design: p. 60

Site Descriptions
Site 19 is along the creek’s left bank. During extreme winter storm events, flows may overtop the channel at this site. The upstream end has a failing concrete wall. Mature vegetation lines the entire bank along this site.

Site Goals
The primary goal for Site 19 is to improve Steelhead habitat, and the secondary goal is to improve general riparian habitat.

Restoration Actions
The recommended action for Site 19 is to create a lowered high flow bench adjacent to the channel that provides Steelhead refugia during high winter flows and improves conveyance. The site can further be enhanced by removing the concrete wall at the upstream end of the site. It may also be beneficial and feasible to regularly excavate coarse sediment from the channel bed along Site 19 to place in the widened area of Site 17.

Site Constraints
Known Site 19 constraints include the vineyard to the left of the stream and homes to the right.
Reach 6

Reach 6 begins at Highway 12 and follows the historic Kenwood alluvial fan to the study reach’s upstream end at Adobe Canyon. Due to its location on the alluvial fan, this reach experiences excess sediment deposition on the creek bed, which in turn causes the channel to migrate laterally and erode its banks. Deposition has reduced the flow capacity of the channel along this reach, which increases the potential for flooding during extreme winter storms. During the later summer months, water percolates into the channel bed and flows subsurface in the upper reach, eventually drying out. For most of Reach 6, the tops of banks are lined with mature native vegetation, with some areas of invasive vegetation and others where bank erosion has removed all cover. Historically, this reach was part of an alluvial fan wetland complex that provided complex habitat, flood attenuation and groundwater recharge in the winter, and the slow release of flows in the summer time.
Site Description
Site 20 sits along the right bank of Sonoma Creek in a relatively narrow riparian zone with short stream banks. Located where Adobe Canyon enters the Kenwood alluvial fan, the channel bed consists of gravel, cobbles, and boulders.

Site Goals
The primary goal for this site is to create high flow refugia for Steelhead. Other goals include improving water quality and improving riparian habitat.

Restoration Actions
The recommended action at this site is to create a high-flow floodplain to the right of the riparian canopy so that it will receive water from Sonoma Creek and serve as Steelhead refugia during high-flow storm events. Additionally, this swale will act as an expanded vegetated buffer between the vineyard and the creek, helping to improve water quality.

This site can be further enhanced by removing any invasive non-native vegetation from the stream bank and revegetating, which will expand the riparian corridor and improve the general riparian habitat.

Site Constraints
The vineyards on the property constrain the swale's potential footprint. This site was not selected to continue to the conceptual design process.
Conceptual designs

Of the 20 sites identified for their restoration potential, 16 were selected to advance to the conceptual design stage. These were developed from the action sheets and in consultation with individual landowners. The plans and typical sections for these conceptual designs are shown in the following pages and were produced following landowner outreach.
NOTES:
1. ALL DISTURBED AREAS WILL RECEIVE COMPREHENSIVE EROSION CONTROL MEASURES AND NATIVE REVEGETATION.
2. PROPERTY LINES ARE APPROXIMATE AND DO NOT REPRESENT AN OFFICIAL RECORD OF SURVEY.
3. EXISTING GRADE TOPOGRAPHY IS FROM LIDAR: SONOMA VEG MAP, 2013.

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UPPER SONOMA CREEK RESTORATION PROJECT: D170565
FIGURE 1
SITE 1 PLAN
SITE 1 - LOWERED INSET FLOODPLAIN

1A

SECTION VIEW

VERT: 1"=12.5'
HORIZ: 1"=25'
SCALE: 2X VERTICAL EXAGGERATION
HORZ: 1"=25' 
VERT: 1"=12.5'

LARGE WOOD STRUCTURE

LOWERED INSET FLOODPLAIN

STABLE SLOPE (3:1)

LOW FLOODPLAIN BENCH

SITE 1 - IMPROVED FISH PASSAGE DISSIPATION POOL

1B

SECTION VIEW

VERT: 1"=12.5'
HORIZ: 1"=25'
SCALE: 2X VERTICAL EXAGGERATION
HORZ: 1"=25'
VERT: 1"=12.5'

EXISTING GRADE, TYP.

IMPROVED FISH PASSAGE

DESIGN GRADE, TYP.

DISSIPATION POOL

NOTES:
1. GRADING SECTIONS FACE DOWNSTREAM.
2. EXISTING GRADE TOPOGRAPHY IS FROM LIDAR (SONOMA VEG MAP, 2013).

UPPER SONOMA CREEK RESTORATION PROJECT - D170565
FIGURE 2

SITE 1 SECTIONS
NOTES:
1. GRADING SECTIONS FACE DOWNSTREAM.
2. EXISTING GRADE TOPOGRAPHY IS FROM LIDAR (SONOMA VEG MAP, 2013).
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1. ALL DISTURBED AREAS WILL RECEIVE COMPREHENSIVE EROSION CONTROL MEASURES AND NATIVE REVEGETATION.
2. PROPERTY LINES ARE APPROXIMATE AND DO NOT REPRESENT AN OFFICIAL RECORD OF SURVEY.
3. EXISTING GRADE TOPOGRAPHY IS FROM LIDAR: SONOMA VEG MAP, 2013.
SITES 6 & 7 SECTIONS

NOTES:
1. GRADING SECTIONS FACE DOWNSTREAM.
2. EXISTING GRADE TOPOGRAPHY IS FROM LIDAR (SONOMA VEG MAP, 2013).
LOW FLOODPLAIN BENCH
NORTH (LEFT)
SOUTH (RIGHT)

STABLE SLOPE (3:1)
EXISTING GRADE, TYP.

LARGE WOOD STRUCTURE, TYP.

NOTES:
1. GRADING SECTIONS FACE DOWNSTREAM.
2. EXISTING GRADE TOPOGRAPHY IS FROM LIDAR (SONOMA VEG MAP, 2013).
NOTES:
1. ALL DISTURBED AREAS WILL RECEIVE COMPREHENSIVE EROSION CONTROL MEASURES AND NATIVE REVEGETATION.
2. PROPERTY LINES ARE APPROXIMATE AND DO NOT REPRESENT AN OFFICIAL RECORD OF SURVEY.
3. EXISTING GRADE TOPOGRAPHY IS FROM LIDAR: SONOMA VEG MAP, 2013.
SITE 9 - FLOODPLAIN BENCH

NORTEAST (LEFT)

SOUTHWEST (RIGHT)

Scale: 2x VERTICAL EXAGGERATION
HORIZ: 1"=30’
VERT: 1"=15’

SECTION VIEW

EXISTING GRADE, TYP.
WIDEN CORRIDOR

NOTES:
1. GRADING SECTIONS FACE DOWNSTREAM.
2. EXISTING GRADE TOPOGRAPHY IS FROM LIDAR (SONOMA VEG MAP, 2013).

SITE 9 SECTIONS
LOW FLOODPLAIN BENCH
STABLE SLOPE (3:1)
NORTHEAST (LEFT)
SOUTHWEST (RIGHT)
EXISTING GRADE, TYP.

CONSERVATION EASEMENT
WIDEN CORRIDOR
NEW ROAD R.O.W.

SITE 9 - WIDENED FLOODPLAIN

NORTHEAST (LEFT)
EXISTING GRADE, TYP.
LOW FLOODPLAIN BENCH
STABLE SLOPE (3:1)

NOTES:
1. GRADING SECTIONS FACE DOWNSTREAM.
2. EXISTING GRADE TOPOGRAPHY IS FROM LIDAR (SONOMA VEG MAP, 2013).

SITE 9 SECTIONS
NOTES:
1. ALL DISTURBED AREAS WILL RECEIVE COMPREHENSIVE EROSION CONTROL MEASURES AND NATIVE REVEGETATION.
2. PROPERTY LINES ARE APPROXIMATE AND DO NOT REPRESENT AN OFFICIAL RECORD OF SURVEY.
3. EXISTING GRADE TOPOGRAPHY IS FROM LIDAR: SONOMA VEG MAP, 2013.
Notes:
1. Grading sections face downstream.
2. Existing grade topography is from LIDAR (Sonoma Veg Map, 2013).
NOTES:
1. ALL DISTURBED AREAS WILL RECEIVE COMPREHENSIVE EROSION CONTROL MEASURES AND NATIVE REVEGETATION.
2. PROPERTY LINES ARE APPROXIMATE AND DO NOT REPRESENT AN OFFICIAL RECORD OF SURVEY.
3. EXISTING GRADE TOPOGRAPHY IS FROM LIDAR: SONOMA VEG MAP, 2013.
LOW FLOODPLAIN BENCH
STABLE SLOPE (5:1)

IN-CHANNEL ROCK STRUCTURE
LOW FLOODPLAIN BENCH

EAST (LEFT)
WEST (RIGHT)

EXISTING GRADE

SITE 12 - IMPROVED FISH PASSAGE, WIDENED CORRIDOR, AND SEASONAL WETLAND
SECTION VIEW

NOTES:
1. GRADING SECTIONS FACE DOWNSTREAM.
2. EXISTING GRADE TOPOGRAPHY IS FROM LIDAR (SONOMA VEG MAP, 2013).
NOTES:
1. ALL DISTURBED AREAS WILL RECEIVE COMPREHENSIVE EROSION CONTROL MEASURES AND NATIVE REVEGETATION.
2. PROPERTY LINES ARE APPROXIMATE AND DO NOT REPRESENT AN OFFICIAL RECORD OF SURVEY.
3. EXISTING GRADE TOPOGRAPHY IS FROM LIDAR: SONOMA VEG MAP, 2013.
NOTES:
1. GRADING SECTIONS FACE DOWNSTREAM.
2. EXISTING GRADE TOPOGRAPHY IS FROM LIDAR (SONOMA VEG MAP, 2013).
HISTORICAL RAILROAD AND APPROX. WATERLINE ALIGNMENT

NOTES:
1. GRADING SECTIONS FACE DOWNSTREAM.
2. EXISTING GRADE TOPOGRAPHY IS FROM LIDAR (SONOMA VEG MAP, 2013).

SITE 13 - RESTORED SEASONAL WETLAND

SCALE: 2X VERTICAL EXAGGERATION
HORIZ: 1"=40'
VERT: 1"=20'

SITE 13 SECTIONS

FIGURE 24

UPPER SONOMA CREEK RESTORATION PROJECT - D170565

SITE 13 - TYPICAL SECTIONS

MATCHLINE

EXISTING CHANNEL

RESTORED SEASONAL WETLAND

LANDSCAPED FILL PLACEMENT

ECOTONE SLOPE (10:1 TO 20:1)

DEPRESSION

ECOTONE SLOPE (10:1 TO 20:1)

MATCHLINE

VERT: 1"=20'
HORIZ: 1"=40'
SCALE: 2X VERTICAL EXAGGERATION
HORIZ: 1"=40'
VERT: 1"=20'

SITE 13 - RESTORED SEASONAL WETLAND

MATCHLINE

EXISTING CHANNEL

RESTORED SEASONAL WETLAND

LANDSCAPED FILL PLACEMENT

ECOTONE SLOPE (10:1 TO 20:1)

DEPRESSION

ECOTONE SLOPE (10:1 TO 20:1)

MATCHLINE

VERT: 1"=20'
HORIZ: 1"=40'
SCALE: 2X VERTICAL EXAGGERATION
HORIZ: 1"=40'
VERT: 1"=20'
SITE 13 - TYPICAL SECTIONS

NOTES:
1. GRADING SECTIONS FACE DOWNSTREAM.
2. EXISTING GRADE TOPOGRAPHY IS FROM LIDAR (SONOMA VEG MAP, 2013).

EXISTING CHANNEL
SOUTHWEST (RIGHT)

RESTORATED SEASONAL WETLAND

MATCHLINE

ECOTONE SLOPE (10:1 TO 20:1)
DEPRESSION

MATCHLINE

ECOTONE SLOPE (10:1 TO 20:1)
DEPRESSION

MATCHLINE

ECOTONE SLOPE (10:1 TO 20:1)

MATCHLINE

LANDSCAPED FILL PLACEMENT

HISTORICAL RAILROAD AND APPROX. WATERLINE ALIGNMENT

NORTHEAST (LEFT)
NOTES:
1. ALL DISTURBED AREAS WILL RECEIVE COMPREHENSIVE EROSION CONTROL MEASURES AND NATIVE REVEGETATION.
2. PROPERTY LINES ARE APPROXIMATE AND DO NOT REPRESENT AN OFFICIAL RECORD OF SURVEY.
3. EXISTING GRADE TOPOGRAPHY IS FROM LIDAR: SONOMA VEG MAP, 2013.
NOTES:
1. GRADING SECTIONS FACE DOWNSTREAM.
2. EXISTING GRADE TOPOGRAPHY IS FROM LIDAR (SONOMA VEG MAP, 2013).
NOTES:
1. ALL DISTURBED AREAS WILL RECEIVE COMPREHENSIVE EROSION CONTROL MEASURES AND NATIVE REVEGETATION.
2. PROPERTY LINES ARE APPROXIMATE AND DO NOT REPRESENT AN OFFICIAL RECORD OF SURVEY.
3. EXISTING GRADE TOPOGRAPHY IS FROM LIDAR: SONOMA VEG MAP, 2013.
FIGURE 29

SITE 16 - TYPICAL SECTIONS

NOTES:
1. GRADING SECTIONS FACE DOWNSTREAM.
2. EXISTING GRADE TOPOGRAPHY IS FROM LIDAR (SONOMA VEG MAP, 2013).
NOTES:
1. ALL DISTURBED AREAS WILL RECEIVE COMPREHENSIVE EROSION CONTROL MEASURES AND NATIVE REVEGETATION.
2. PROPERTY LINES ARE APPROXIMATE AND DO NOT REPRESENT AN OFFICIAL RECORD OF SURVEY.
3. EXISTING GRADE TOPOGRAPHY IS FROM LIDAR: SONOMA VEG MAP, 2013.

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CONCEPTUAL SEDIMENT Placement

FIGURE 30
SITES 17 & 19 PLAN
NOTES:
1. GRADING SECTIONS FACE DOWNSTREAM.
2. EXISTING GRADE TOPOGRAPHY IS FROM LIDAR (SONOMA VEG MAP, 2013).
NORTH EAST (LEFT)

SWALE

EXISTING GRADE, TYP.

EXPANDED HIGH FLOW FLOODPLAIN

SOUTHWEST (RIGHT)

LOW FLOODPLAIN BENCH

SWALE

EXISTING GRADE, TYP.

CONSTRUCTED RIFFLE

SITES 17 & 19 SECTIONS

NOTES:
1. GRADING SECTIONS FACE DOWNSTREAM.
2. EXISTING GRADE TOPOGRAPHY IS FROM LIDAR (SONOMA VEG MAP, 2013).
1. All disturbed areas will receive comprehensive erosion control measures and native revegetation.
2. Property lines are approximate and do not represent an official record of survey.
3. Existing grade topography is from LIDAR: Sonoma Veg Map, 2013.
ADDED NEW TRIBUTARY CHANNEL

EXISTING GRADE, TYP.

EXISTING TRIBUTARY CHANNEL

STABLE SLOPE (3:1)

ADDED NEW TRIBUTARY CHANNEL

LANDSCAPED FILL PLACEMENT

EXISTING TRIBUTARY CHANNEL

ADDED NEW TRIBUTARY CHANNEL

RESTORED CONFLUENCE

ECOTONE SLOPE (10:1)

NOTES:
1. GRADING SECTIONS FACE DOWNSTREAM.
2. EXISTING GRADE TOPOGRAPHY IS FROM LIDAR (SONOMA VEG MAP, 2013).
The willow stems root and sprout, strengthening and maintaining the streambank. The mattress sits on a rock toe to prevent it from being undercut by the creek. The willows are sandwiched between two layers of biodegradable coir fabric that provide initial resistance to erosion while the willows grow.

Brush mattresses are used as a more environmentally-friendly method of stabilizing eroding banks compared to rock armor.
Log structures are used to create cover and habitat for Steelhead. The rootwad intrudes into flow, causing pool scour and sediment sorting that creates habitat for aquatic life.
Willow baffles are used to prevent erosion on newly-restored floodplains giving vegetation a chance to grow. They also create habitat complexity and trap fine sediment on the floodplain.

Willow stems immediately break up flow, and over time sprout into living trees.
References


GIS data sources include those credited directly on figures as well as ArcGIS Online, Cal-Atlas, ESRI, NAIP, Quantum Spatial, Sonoma County Agricultural Preservation & Open Space District, Sonoma County Information Services, Sonoma County Vegetation and Habitat Mapping Program, Sonoma County Water Agency, Tele Atlas North America, Tukman Geospatial LLC, and USGS StreamStats.