

COYOTE VALLEY WATER RESOURCE INVESTMENT STRATEGY

Restoration Design Concept Evaluation

Prepared for
Santa Clara Valley Open Space Authority

June 2021



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EXECUTIVE SUMMARY

The Coyote Valley Water Resource Investment Strategy is an initiative spearheaded by the Santa Clara Valley Open Space Authority (Authority), in partnership with the Santa Clara Valley Water District (Valley Water), to identify opportunities for investment in water resource protection and enhancement in Coyote Valley. This report is a product of that initiative and provides an overview of water resources in Coyote Valley, how they function, how they have changed, and how large-scale floodplain restoration and ecological enhancement activities in Coyote Valley can provide integrated water resource benefits like water quality protection, habitat enhancement, and reduced flood risk. This work aligns with the California Water Resilience Portfolio and the “30x30” Executive Order N-82-20 by exploring the benefits of nature-based solutions that retire obsolete infrastructure and restore natural landscape processes to support green infrastructure in the form of restored creeks, expanded floodplains, wetlands, and riparian forests. It highlights that investments in the restoration and enhancement of natural and working lands in Coyote Valley can provide measurable water resource benefits while also supporting the recovery and resilience of a landscape of statewide importance.

This technical report is conceptual in nature and is intended for use by land conservation practitioners, land use planners, and water and natural resource planners to support multi-benefit water resource and habitat restoration planning. It includes an initial set of stream and floodplain restoration concepts that were rapidly evaluated using one-dimensional/two-dimensional (1D/2D) hydrodynamic flood models to estimate how they could support large-scale ecosystem restoration and provide a suite of water resource benefits.

Key findings from this report include:

- Retiring or retrofitting non-critical flood control infrastructure and agricultural drainages that were built since the early 1900’s can enhance landscape processes that promote large-scale expansion of historic habitat areas, particularly within the Fisher Creek floodplain and the Laguna Seca wetland complex.
- Removing or retrofitting this infrastructure could increase the stormwater holding capacity of the low-lying Laguna Seca wetland basin, thereby reducing peak flows into Coyote Creek and buffering downstream areas during flood events.
- Realigning the mainstem of Fisher Creek to the westerly low-lying area of the valley floor and restoring it to a wide and shallow channel form would support large-scale wetland and riparian forest expansion that would be more resilient to the effects of climate change.
- Modifying barriers between the Fisher Creek and Coyote Creek floodplains could allow floodwater from Coyote Creek to be attenuated in the lower-lying Fisher Creek floodplain during large flood flows, while also creating opportunities for safe wildlife passage across the Monterey Road transportation corridor.

- These nature-based solutions can provide significant integrated water resource benefits that complement, though do not replace the need for, additional flood and water management approaches elsewhere in the Coyote Creek watershed.
- Of the restoration concepts that were evaluated as a part of this effort, the Integrated Restoration Design Concept (see chapter 5) provided the greatest benefits, including:
 - Creation of 5,000 feet of additional channel within a ~5 mile long restored wetland and riparian forest corridor that connects the Santa Cruz Mountains to the Coyote Creek Parkway
 - Increased Fisher Creek floodplain inundation during the 2.33-yr (estimated bankfull) event by 48% (69 acres) supporting a larger active riparian corridor.
 - Reduced shallow flooding over lands actively used for agriculture (depths less than 1-foot) by about 16% (40 acres) protecting water quality by reducing the potential for water contamination from agricultural and urban runoff.
 - Increased flood depths in lands proposed for restoration (depths above 5 feet) by 670% (80 acres), increasing the potential to support substantially deeper wetland areas, including perennial wetlands.
 - Downstream Coyote Creek flood peaks are estimated to be reduced by up to 2-9% for storms centered on Fisher Creek and Anderson Dam area, with up to a 0.6 feet reduction of inundation depth in channel, and estimated flooding is delayed by 0-3 hours, potentially allowing greater time for evacuation of flooded areas.

This work is preliminary and requires more study and coordination with willing landowners, local tribes, local and state agencies, and land conservation partners to better understand the feasibility, costs, and tradeoffs of this work. Efforts like the soon-to-launch Coyote Valley Conservation Areas Master Plan (CVCAMP) and related work will determine where investments in Coyote Valley's water resources are focused, primarily on the growing network of protected lands, and optimized in coordination with ongoing land conservation activities, local planning efforts, and land management activities within Coyote Valley.

CHAPTER 1

Background and Study Overview

Background

The Coyote Valley Water Resource Investment Strategy is an initiative spearheaded by the Santa Clara Valley Open Space Authority (Authority), in partnership with the Santa Clara Valley Water District (Valley Water), to identify important areas for water resource protection and enhancement in Coyote Valley. This initiative was developed by the Authority shortly after the completion of the Authority’s Santa Clara Valley Greenprint, which identified Coyote Valley as one of the Authority’s conservation focus areas for the next several decades due to its rich conservation values which are “...myriad and unparalleled – perhaps greater than they are anywhere else within the Open Space Authority’s jurisdiction” (Authority 2014). This finding was partially supported by the Coyote Creek Historical Ecology Study, a report funded by Valley Water which documented that ecological restoration work in Coyote Valley “...could provide significant off-site flood peak attenuation as well as wetland habitat for a range of native species” (Grossinger et al., 2006).

In 2015, the Authority and Valley Water entered a formal partnership and began looking at where conservation and restoration work in Coyote Valley could help the agencies achieve their shared integrated resource goals, and inform their long-term strategic planning work, including Valley Water’s One Water planning process, and implementation of the Authority’s Santa Clara Valley Greenprint. In 2016, the Authority completed an initial screening-level hydrological modelling assessment of the benefits associated with conserving and restoring areas in Coyote Valley to improve site conditions and reduce peak flows downstream. These findings were presented during a joint Authority/District Board meeting in January 2017, where the Agencies’ Boards directed staff to initiate a second phase of work to look at the benefits associated with specific green infrastructure project investments in Coyote Valley and engage partners in this work. In November of 2018, the voters of San Jose passed Measure T – Disaster Preparedness, Public Safety, and Infrastructure Bond that set aside up to \$50 million dollars to conserve land in Coyote Valley with willing landowners for the purposes of natural flood control and preventing water quality contamination. This money was leveraged along with funding from the Authority and Peninsula Open Space Trust (POST) in 2019 to secure a landmark \$96 million dollar land acquisition consisting of 937-acres in northern Coyote Valley, permanently protecting the majority of land designated for campus industrial development in the heart of the Laguna Seca wetland and Fisher Creek floodplain. These lands and other subsequent land acquisitions in Coyote Valley will be held and/or managed by the Authority and will be the focus of the Coyote Valley Conservation Areas Master Plan (CVCAMP)- a comprehensive master planning process

that is expected to begin in summer 2021. In addition to this, the Coyote Valley Conservation Program Area was created under Assembly Bill 948 in 2019, which established Coyote Valley as an area of statewide significance and authorized the Authority to oversee the Coyote Valley Conservation Program to address resource and recreational goals of Coyote Valley. Future water resources investigations that are led by the Authority are expected to support the Coyote Valley Conservation Program and the restoration and management of conserved lands in Coyote Valley.

Study Overview

This report summarizes the results of the second phase of the Coyote Valley Water Resource Investment Strategy and was used to inform priority actions that were identified as a part of Valley Water's One Water: Coyote Watershed report. It includes an evaluation of existing conditions, past modifications, general opportunities for water resource restoration and enhancement, and an assessment of specific restoration design alternatives. The goal of this report was to begin to evaluate the feasibility and benefits of large-scale floodplain restoration and ecological enhancement activities in Coyote Valley and how they can provide integrated water resource benefits. Restoration design alternatives were primarily developed for areas within the Fisher Creek Watershed portion of Coyote Valley which includes the foothills that drain the Santa Cruz Mountains extending downstream to Fisher Creek's confluence with Coyote Creek. Coyote Creek is primarily considered in the context of how it influences surface water and groundwater characteristics in the Fisher Creek Watershed and how habitat and floodplain enhancements in the Fisher Creek Watershed may result in improved downstream conditions in Coyote Creek.

Detailed two-dimensional flood models were used to assess how different restoration concepts could change surface water movement under a wide range of storm events, ranging from small storm events that support aquatic habitats and riparian areas, to large storm events that could result in widespread flooding in Coyote Valley and in urban areas downstream. The results from this assessment were used to develop an initial set of restoration design concepts for Fisher Creek and its floodplain that support large-scale ecological restoration across the valley floor, most notably in the Laguna Seca wetland complex. These restoration concepts were then evaluated for their ability to reduce flows in Coyote Creek, to estimate how conservation and restoration of Coyote Valley could help buffer downstream areas from stormflows and flood events.

It is important to note that the restoration concepts included in this report should be reevaluated as site-level opportunities arise and additional studies are completed. One notable example includes work in support of CVCAMP, where the Authority will begin a master planning process largely centered around the restoration of the Fisher Creek, its floodplain, and the Laguna Seca wetland.

CHAPTER 2

Current Physical Conditions

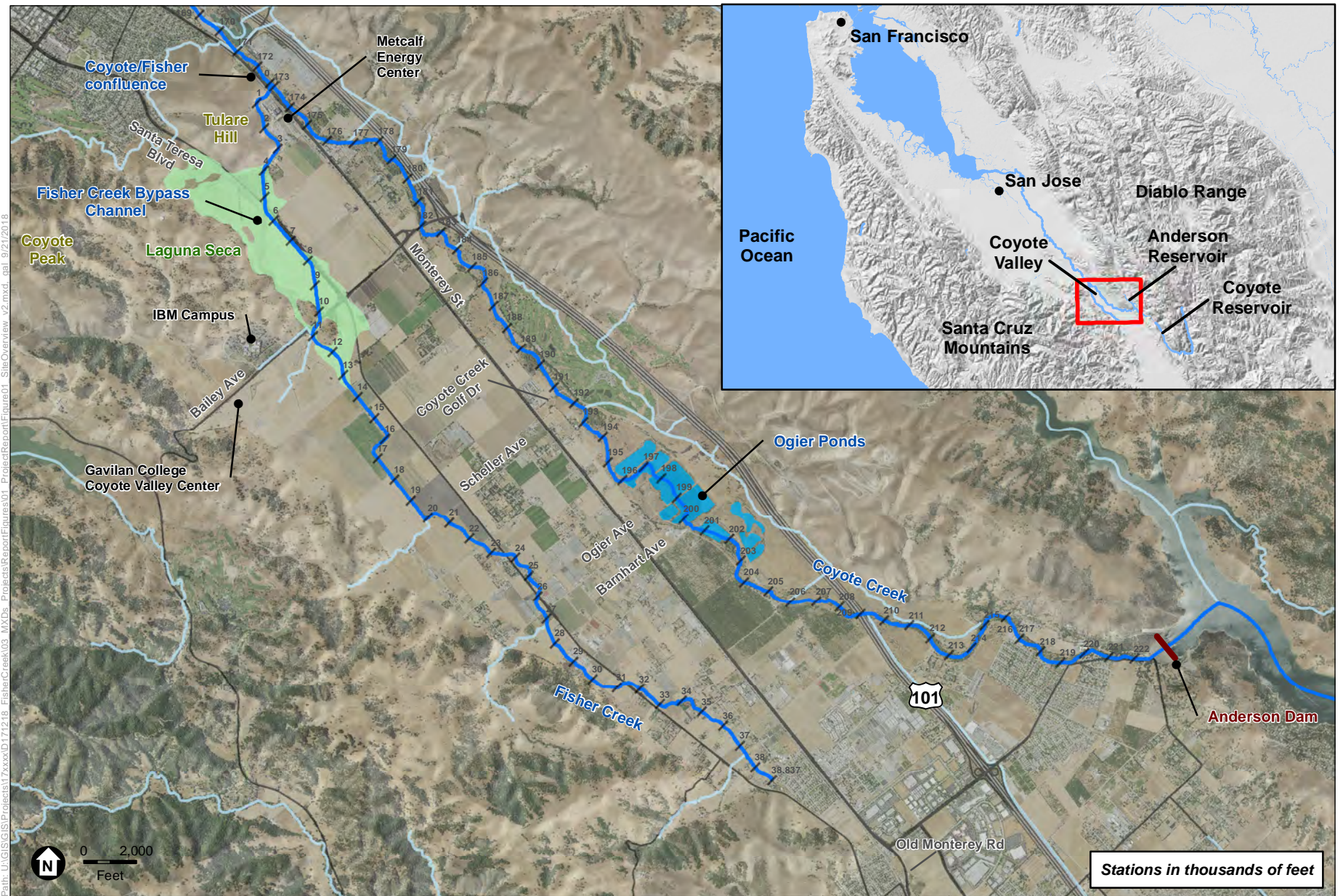
Coyote Valley is an 18,500-acre sub-watershed of Coyote Creek in Santa Clara County, California. Its approximately 7,400-acre valley floor extends from the City of Morgan Hill to the City of San Jose and is defined by the Santa Cruz Mountains to the west, and the Diablo Mountain Range to the east. An overview of Coyote Valley and key landscape features is presented in **Figure 1**.

The two primary streams in Coyote Valley are Coyote Creek and its tributary Fisher Creek. Coyote Creek flows into Coyote Valley from the Diablo Range and Fisher Creek from the Santa Cruz Mountains. The creeks meet east of Tulare Hill at a location known as “Coyote Narrows”, where Coyote Creek then continues to flow north through urban San Jose and into the San Francisco Bay. Fisher Creek’s watershed is separated from Coyote Creek by a subtle raised topographic divide on the valley floor that generally runs from north to south along the Monterey Road corridor. Western areas of the valley in the Fisher Creek subwatershed are approximately 20 feet lower than the stream bed of Coyote Creek. A transect across the valley is shown in **Figure 2**. Watershed subbasins are shown for Fisher Creek and Coyote Creek along with other key hydrologic features in **Figure 3**.

Land Use / Land Cover

The existing land use classes surrounding the current alignment of Fisher Creek within Coyote Valley are a mix of cultivated crops, hay/pasture, developed open space, and low intensity developed areas. The predominant land uses are open space preservation and agriculture with cultivated crops making up most of the surrounding land cover. Landuse/landcover categories from the National Landcover Dataset of 2011 published by the Multi-resolution Landcover Consortium (MRLC, 2011) are shown in **Figure 4**.

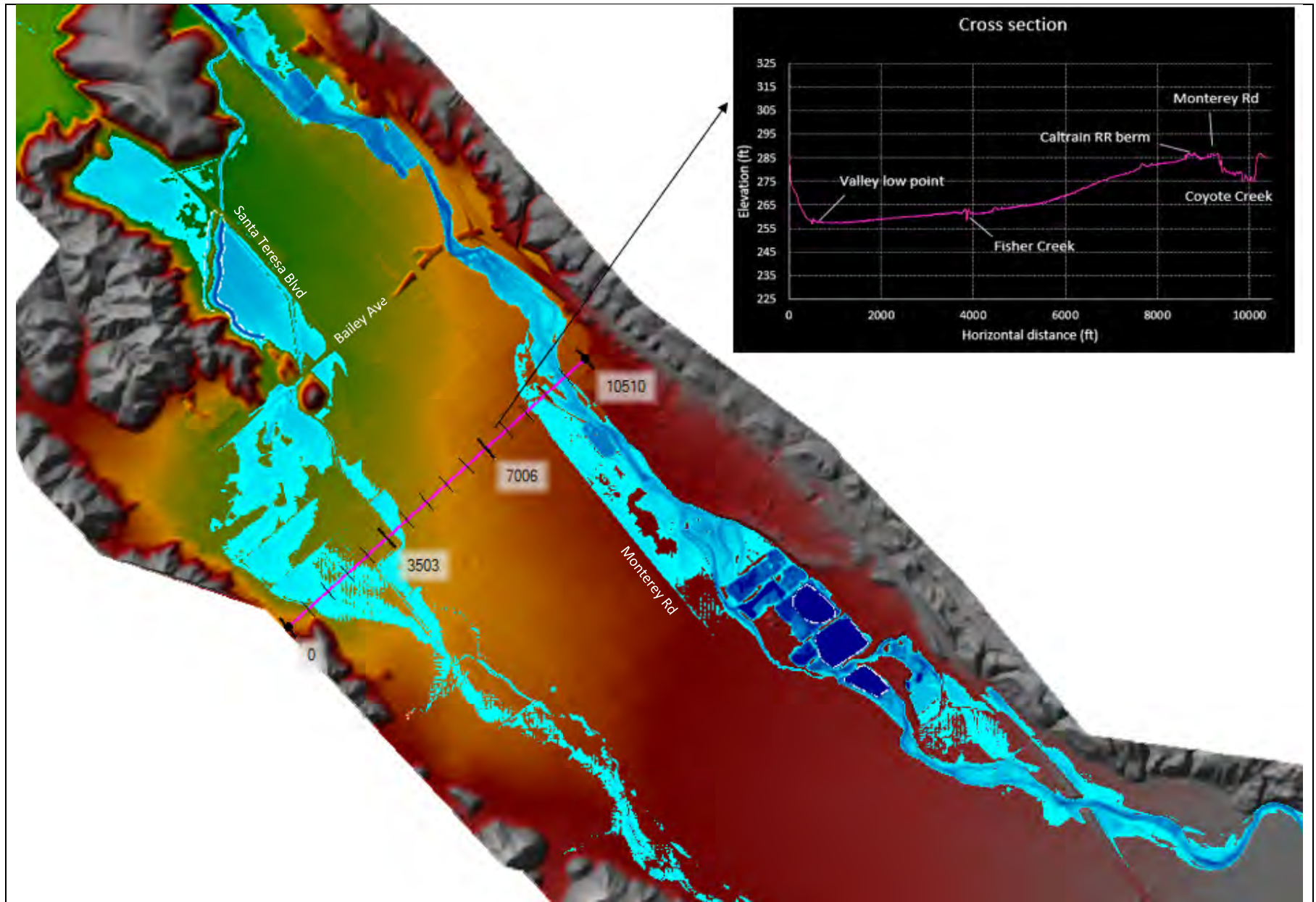
Protected lands shown in **Figure 5** highlights the growing network of conserved lands within the Coyote Valley Conservation Program Area, created under Assembly Bill 948, which establishes Coyote Valley as an area of statewide significance and authorizes the Authority to oversee the Coyote Valley Conservation Program to address resource and recreational goals of Coyote Valley.



SOURCE: SFEI (2010), NHD (2016), NAIP (2014)

Coyote Valley Restoration

Figure 1
Overview of Study Area and Key Landscape Features

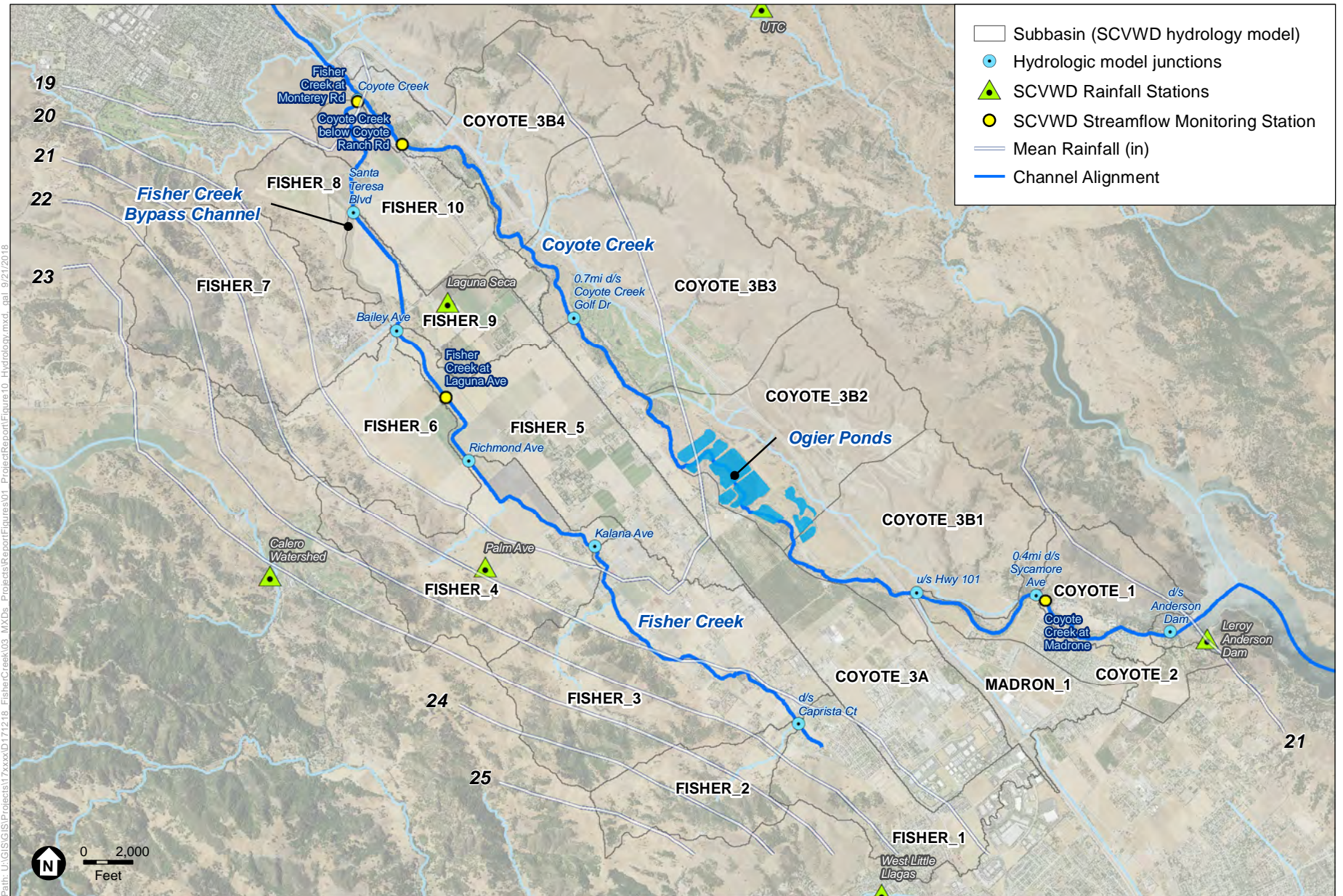


SOURCE: SCVWD (2006 LiDAR), ESA (2018 HEC-RAS model inundation results)

Coyote Valley Restoration

Figure 2

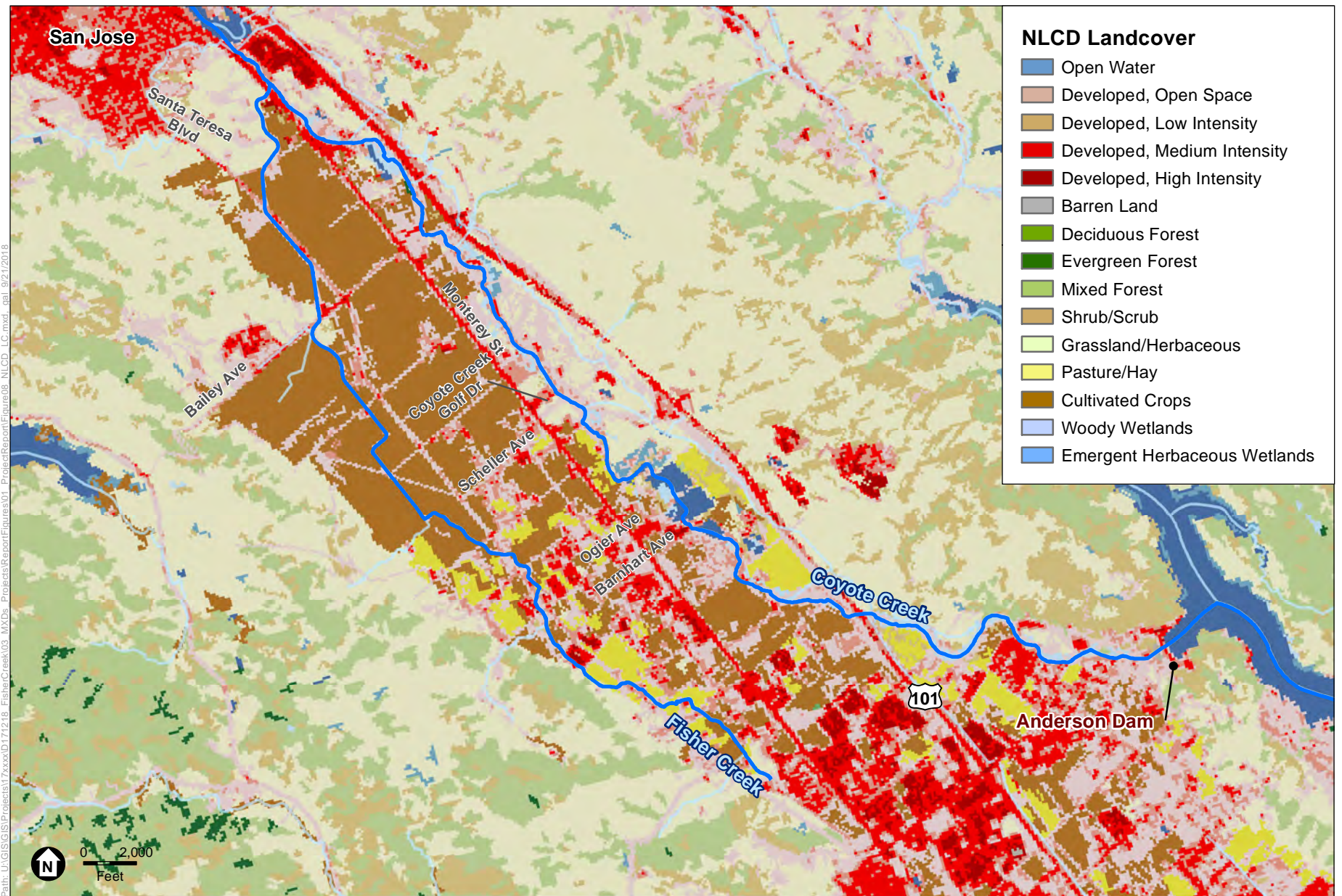
Topographic transect of Coyote Valley through Fisher Creek and Coyote Creek with modeled 100-year inundation (72-hr, Anderson storm center)



SOURCE: SCVWD (2018 HEC-HMS model)

Coyote Valley Restoration

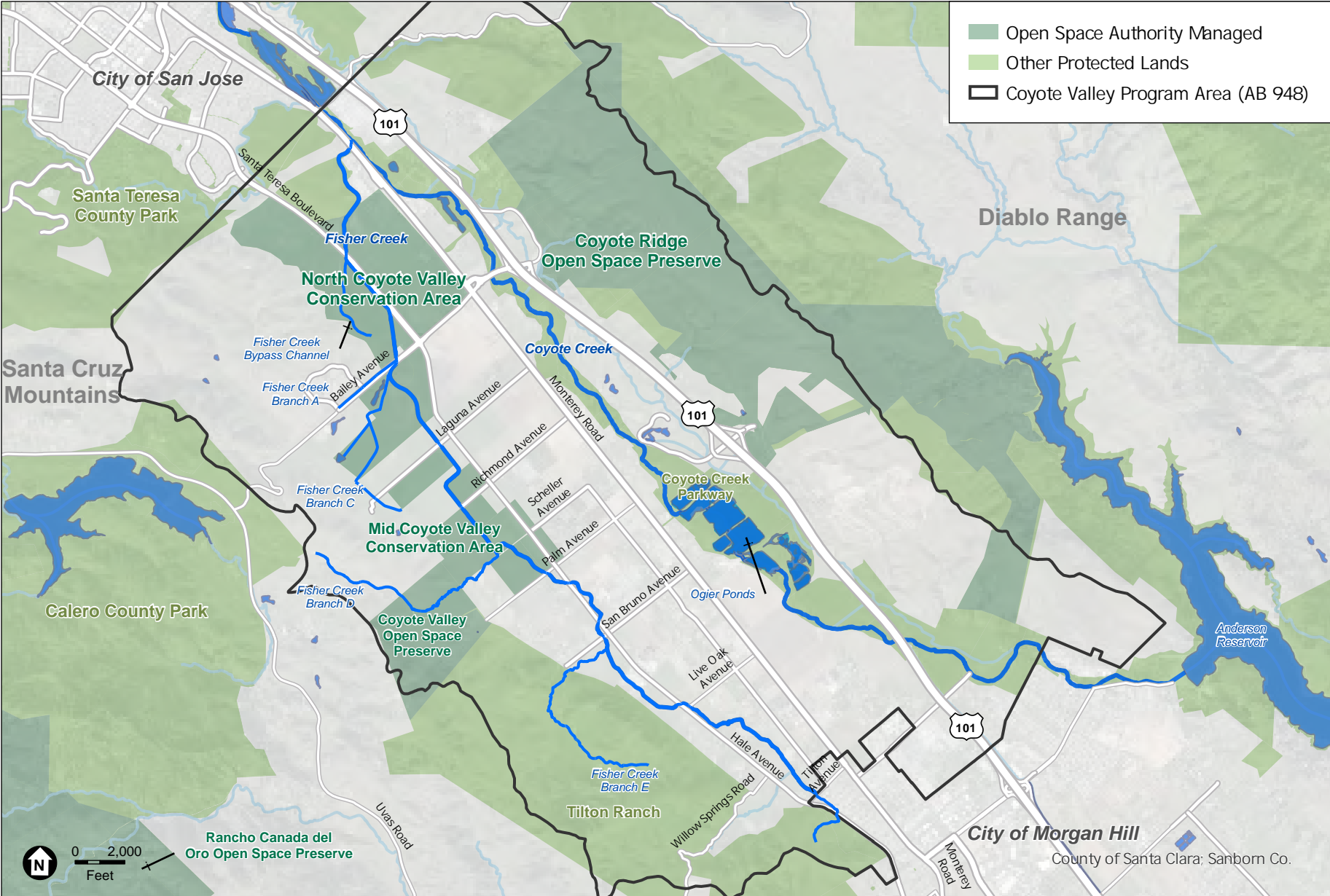
Figure 3
Site Hydrology



SOURCE: NLCD (2011)

Coyote Valley Restoration

Figure 4
Present Day Landcover/Landuse in the Coyote Valley



SOURCE: SCVWD, CPAD 2021, CCED 2021, SCVOSA

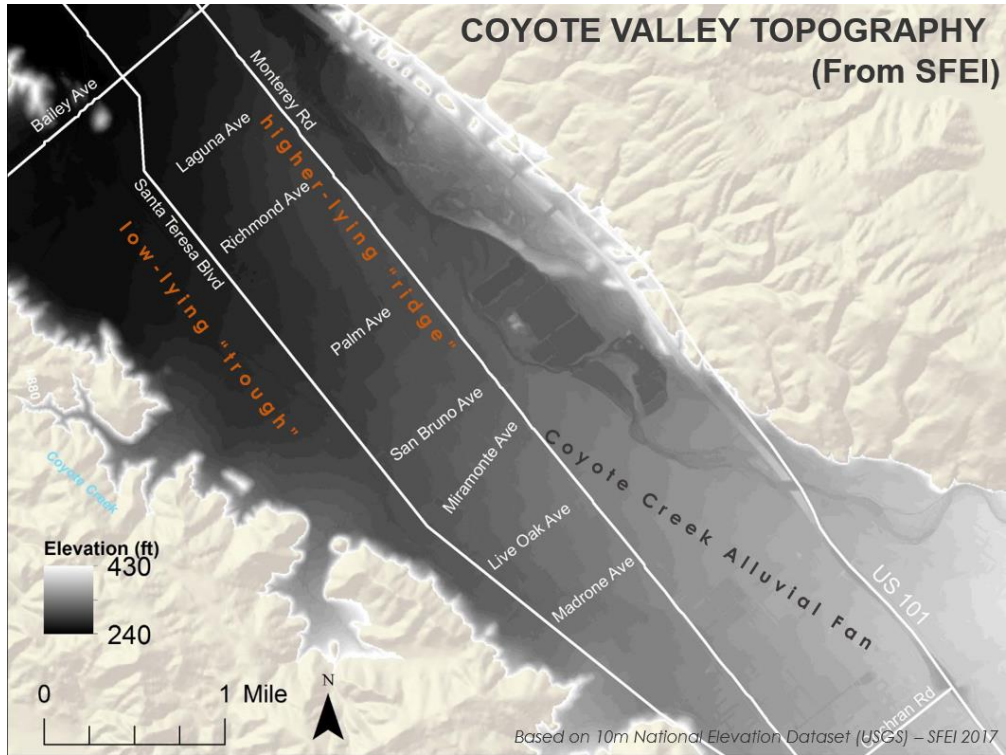
Coyote Valley Restoration
Figure 5
 Protected Lands



Topography & Soils

Coyote Valley lies in an intermountain structural depression between the Santa Cruz Mountains and the Diablo Range, caused by block faulting associated with the Calaveras fault (Imamura, 1999). Over time, as Coyote Creek flowed from the steep, confined reaches in the eastern Diablo Range it flooded across the valley floor, creating an alluvial fan as its flood waters deposited sediment (**Figure 6**). This alluvial fan development caused soils in the valley floor to be elevated in the southeast, sloping downward toward the north-west from Coyote Creek to the lowest point in the valley at a location known as the Laguna Seca—the largest remaining freshwater wetland in Santa Clara County. Sediments, and therefore soils, generally become finer as you travel across the valley floor from south-east (Coyote Creek) to north-west (Fisher Creek), generally resulting in well-drained silt loam and sandy loam soils in the east and poorer-drained clay loam and clay adobe soil in the west (**Figure 7**). Due to its large watershed, Coyote Creek, played the dominant role in creating the soil profile in the valley as its flood waters dropped sediment over the valley floor. At a smaller scale, Fisher Creek’s drainages also created alluvial fans at the base of the Santa Cruz Mountains, depositing coarser soils at the base of the foothills and continuously finer soils toward the fringes. While the majority of high percolation soils associated with Coyote Creek generally diminish moving across the valley from east to west, pockets of gravelly loam soils along the base of the Santa Cruz Mountains provide relatively high percolation capacity relative to the Valley floor resulting in elevated deposits of coarser gravelly loam soils along the slope breaks between the western foothills.

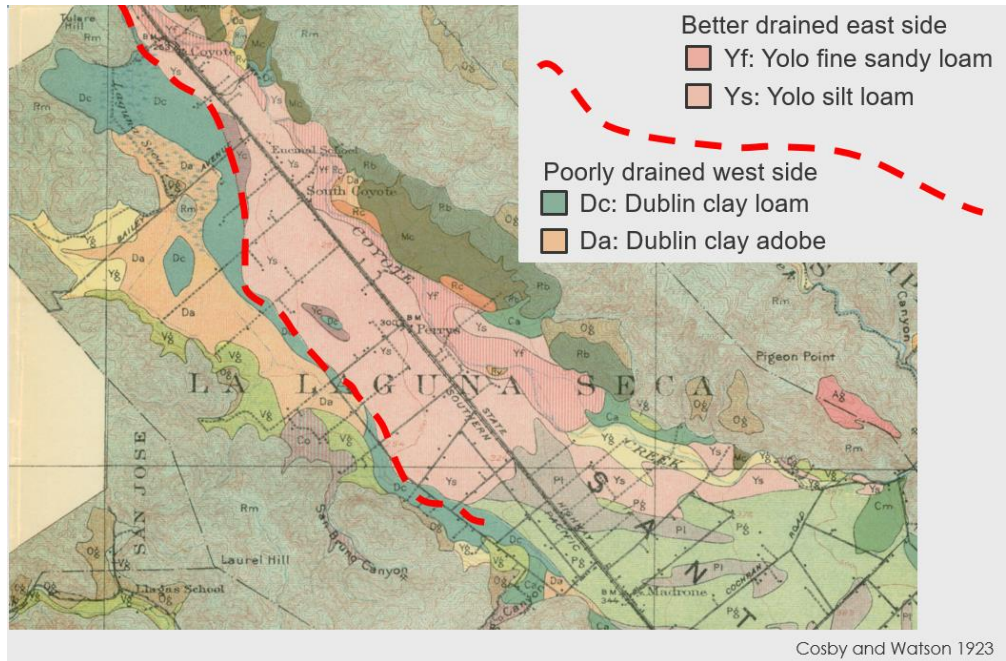
Soils data from the National Resources Conservation Service (NRCS) supports these patterns and reveals that the soils in the valley are dominated by coarser type B (Hydrologic Soils Group) soils adjacent to the Coyote Creek corridor trending towards finer clay dominated type C and D soils along Fisher Creek with some Class B soils at alluvial fans at the base of drainages from the Santa Cruz Mountains (**Figure 8**). These data are helpful for understanding both the spatial pattern of connectivity and infiltration rates between surface water and groundwater throughout the valley as well as the restoration potential for various habitat types. Depending on soil moisture conditions, oak woodlands, oak savannahs, and grasslands are generally supported in higher, better-drained soils and wetlands and willow riparian woodlands in the lower poorer-drained soils.



SOURCE: SFEI 2017

Coyote Valley Restoration

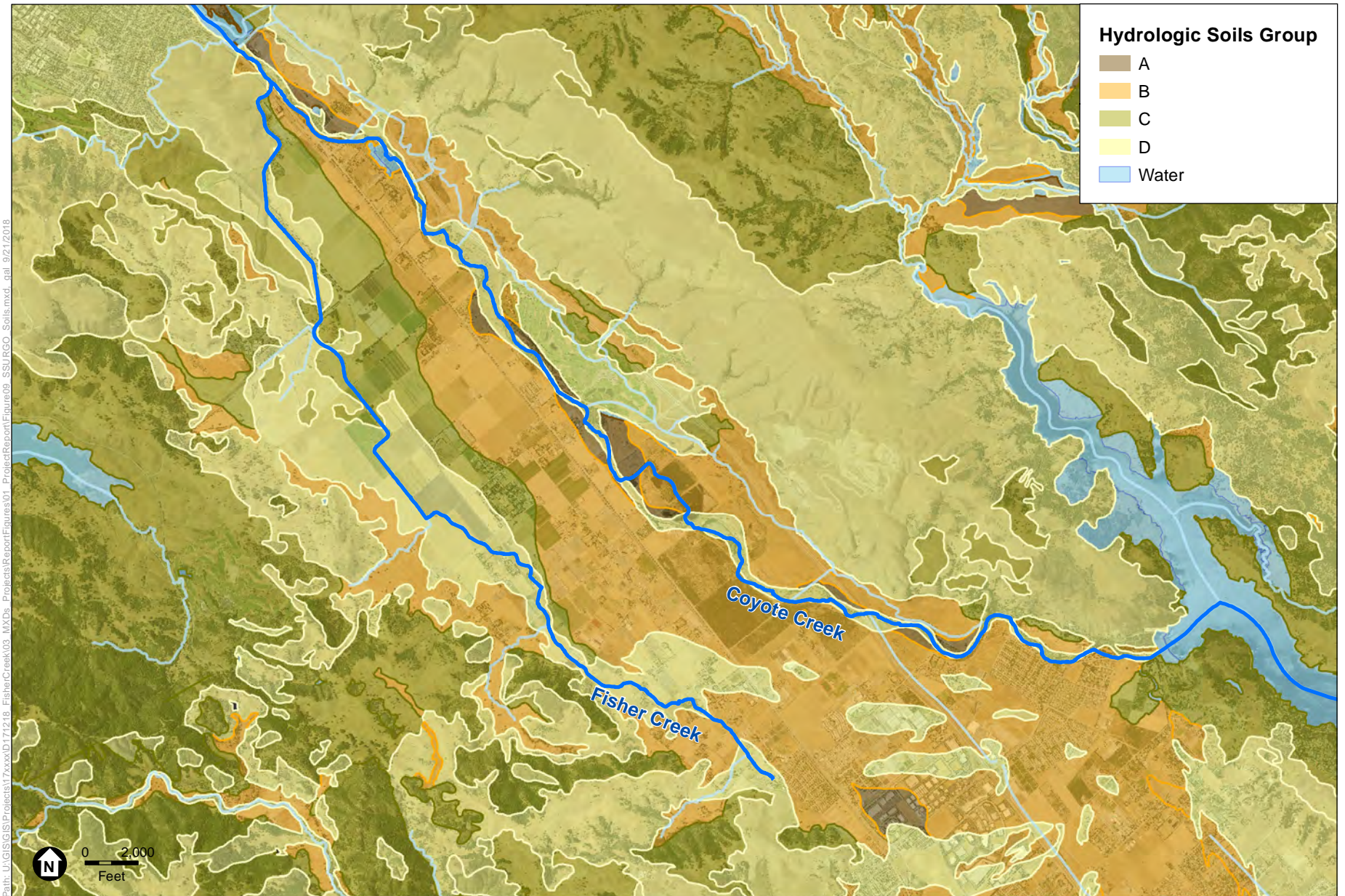
Figure 6
Topography of Coyote Valley



SOURCE: SFEI 2017, modified by ESA

Coyote Valley Restoration

Figure 7
Historic Soil Types



SOURCE: SSURGO (2003), NAIP (2014)

Coyote Valley Restoration

Figure 8
Present Day Soil Type by Hydrologic Soil Group in the Coyote Valley

Surface Water Hydrology

The two primary streams in Coyote Valley are Coyote Creek and its tributary Fisher Creek. Coyote Creek flows into Coyote Valley from the Diablo Range and Fisher Creek from the Santa Cruz Mountains. Fisher Creek is approximately 8 miles in length, flowing from the Santa Cruz Mountains, across the valley floor through the Laguna Seca basin before it crosses under Monterey Road and enters Coyote Creek. It drains approximately 15 square-miles of primarily open hillsides, farmland, and rural ranchettes with a mean annual rainfall of 19-25 inches/year (NOAA, 2011). Fisher Creek is fed by five subwatersheds including (from upstream to downstream) Willow Springs Creek (1.2 sq-mi), Fisher Creek Branch E (2.8 sq-mi), Fisher Creek Branch D (1.9 sq-mi), Fisher Creek Branch C (1.5 sq-mi), and Fisher Creek Branch A (2.0 sq-mi).

Flows on Coyote Creek are managed by Anderson Dam, which captures runoff from the 190 sq. mile Upper Coyote Creek Watershed, and then releases water downstream into Coyote Creek. Although historically an intermittent creek with reaches on the alluvial fan that likely dried up in the summer (SFEI, 2006), under current California Department of Fish and Wildlife permits, Valley Water is required to deliver at least 2.5 cfs of flow to the Coyote Creek at Edenvale gauge, resulting in perennial flow conditions. Valley Water releases additional water for groundwater recharge at the Coyote Percolation Pond just downstream of the Fisher Creek confluence, as well as along Coyote Creek itself. Excluding releases from Anderson Dam and the San Felipe pipeline, the 9-mile reach of Coyote Creek in Coyote Valley drains runoff from approximately 11 square miles of the Coyote Valley floor and western foothills of the Diablo Range before it receives flows from Fisher Creek and then exits the valley after it crosses under Metcalf Road. During large events, where peak flow on Coyote Creek is driven by overtopping from Anderson Dam's emergency spillway, peak flow timing is not coincident between Coyote and Fisher Creeks. In this type of event, Fisher Creek's peak enters Coyote Creek and flows downstream well before the second, larger peak passes through Coyote Creek in Coyote Valley. Peak flow rates for Fisher and Coyote Creeks for a range of flow scenarios are summarized in **Table 1**.

Measured Streamflow

Fisher Creek contains two primary gages that record continuous stream stage measurements (1) Fisher Creek at Laguna Avenue upstream of Bailey Ave and (2) Fisher Creek at Monterey Road, just upstream of the confluence with Coyote Creek. From October 2011 to April 2018, overlapping data were available at both gages, allowing comparison between them, with the caveat that the Laguna Avenue stage-discharge relationship is believed to be less accurate than the Bailey Avenue gauge, and the former gauge is used primarily for stage measurements. Data from the Monterey Road gage which extends back to 1939 were also reviewed. As **Figure 9** shows (and longer-term records confirm), flow at Monterey Road is relatively perennial, though it became ephemeral during the severe drought in 2014-15. By comparison, flow upstream at Laguna Avenue was very 'flashy' and short-lived, with only the flows of winter 2017 (which included a flow that is believed to be approximately a 10 to 15-year event) generating prolonged baseflow after the rainfall event. Within the October 2011 to April 2018 period of record (which includes the 2014-15 drought), Fisher Creek had no flow 71% of the time at Laguna Avenue and 28% of the time further downstream at Monterey Road. Additionally, at Monterey Road, flow

was below 2 cfs 50% of the time between 2011 and 2018 (5% for the complete period of record). Flow exceedance curves which represent the percent of the total flow record for which a given flow is exceeded is shown at the two gages in **Figure 9**, recognizing that the Laguna Avenue flows may be less accurate than the Bailey Avenue values.

The flow data indicate that upstream of Bailey Ave the flows are lower (average flow of 1.3 cfs) and the channel is significantly more ephemeral than downstream. Downstream of Bailey Ave the flows are generally higher (average flow of 6.3 cfs at Monterey Road) and the drainage is more perennial.

TABLE 1
EXISTING CONDITIONS DESIGN FLOW RATES ON FISHER AND COYOTE CREEKS

Watershed	Location	24-hour Peak flow (cfs)*					
		Annual chance					
		43%	20%	10%	4%	2%	1%
		Representative return period (years)					
		2.33	5	10	25	50	100
Fisher Creek	400 feet downstream of Caprista Court	50	100	150	220	280	340
	Kalana Ave	120	230	330	480	600	710
	Richmond Ave	150	300	440	640	790	950
	Bailey Ave	290	550	810	1,160	1,430	1,710
	Santa Teresa Blvd	330	630	920	1,320	1,630	1,940
	At Coyote Creek	310	610	900	1,310	1,630	1,960
		24-hour peak flow (cfs)*					
Coyote Creek	Immediately downstream of Anderson Dam	0	0	0	0	0	0
	2,000 feet downstream of Sycamore Ave (USGS gage 11170000)	30	60	80	120	140	170
	Immediately upstream of Highway 101	90	190	270	400	500	600
	3,500 feet downstream of Coyote Creek Golf Drive	250	490	720	1,040	1,290	1,550
	At Fisher Creek	220	430	640	930	1,160	1,390
	Downstream of Fisher Creek	790	1,370	1,880	2,550	3,050	3,540
		72-hour peak flow (cfs)**					
Coyote Creek	Immediately downstream of Anderson Dam	1,770	3,580	5,400	7,990	10,040	12,150
	2,000 feet downstream of Sycamore Ave (USGS gage 11170000)	1,780	3,600	5,420	8,010	10,060	12,170
	Immediately upstream of Highway 101	1,800	3,640	5,480	8,090	10,160	12,280
	3,500 feet downstream of Coyote Creek Golf Drive	1,860	3,730	5,600	8,260	10,350	12,500
	At Fisher Creek	1,930	3,850	5,750	8,450	10,580	12,750
	Downstream of Fisher Creek	2,030	4,010	5,980	8,740	10,910	13,120

* Storm centered on Fisher Creek

** Storm centered on Coyote Creek/Anderson reservoir

SOURCE: Valley Water HEC-HMS model (SCVWD, 2017)



SOURCE: Valley Water gage data

Coyote Valley Restoration

Figure 9
Average daily flow (top) and flow exceedance curves (bottom) for Fisher Creek at Laguna Avenue and Monterey Road, October 2011-April 2018

Existing Channels and Conveyance System

Fisher Creek

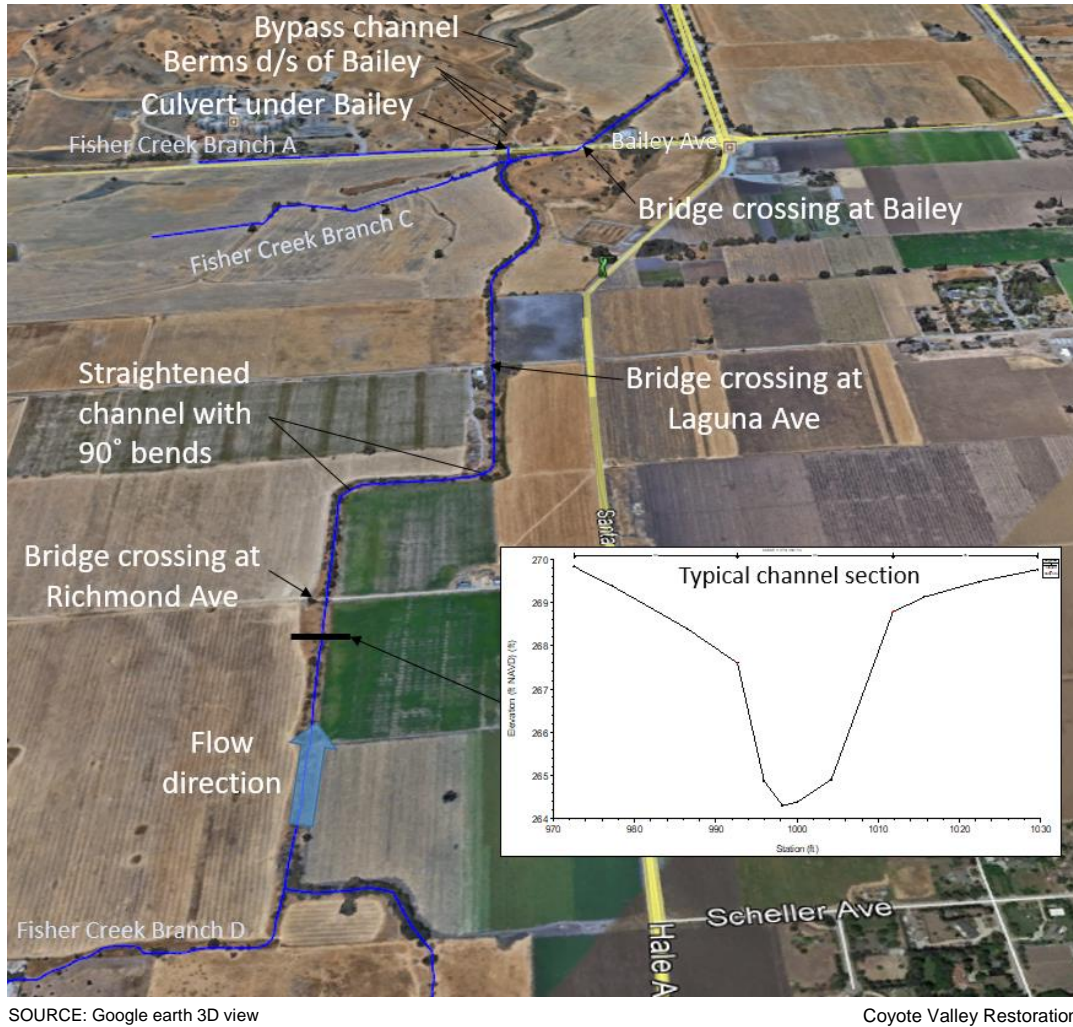
Upstream limit to Scheller Avenue

Fisher Creek upstream of Scheller Avenue to its upper limit at Old Monterey Road (~5.5 miles) is a shallow sparsely vegetated channel with an average depth of 4 feet and a profile slope of 0.3%. The channel has been modified and straightened along its course which runs through a mix of developed and undeveloped reaches. Bed material is silt and sand dominated. Hillside drainages from Willow Springs Creek and Fisher Creek Branch E join Fisher Creek in this reach.

Scheller Avenue to Bailey Ave

Fisher Creek between Scheller Avenue and Bailey Ave (~2 miles) ranges from 10-18 feet wide, featuring a moderately incised channel with a depth of 4-6 feet, and a bed slope of 0.3%. The upper extent of this reach marks the beginning of the artificial extension of Fisher Creek that was excavated downstream to Coyote Creek during the reclamation of Laguna Seca in 1916-1917, evidenced by the channel's transition from a relatively sinuous to a straight and incised form fed by artificial agricultural drainages (notably Fisher Creek branches D, and C). Bed material in this reach is sand and silt dominated. The channel is vegetated throughout most of this reach with a narrow corridor of riparian trees ranging in total width from 50-100 feet. The main channel of Fisher Creek passes under bridges at Laguna Avenue, Richmond Avenue, and then through a free span bridge on two piers at Bailey Avenue. Fisher Creek Branch C and D join the main stem in this reach. Drainage from Fisher Creek Branch A flows from the large meadow north of Bailey Avenue and west of the IBM campus into the straightened and beamed drainage ditch parallel to Bailey, where flow is routed south through a culvert under Bailey and into main stem Fisher Creek.

Banks for this reach of Fisher Creek are elevated approximately 6 feet above the westerly valley low point, where floodwater water collects into Fisher Creek Branch C before it flows back into Fisher Creek near Bailey Avenue. There are no defined levees along this reach, but there are minor agricultural berms along some sections which can both limit sections of the creek from flooding as frequently and inadvertently capture and hold stormwater on farm fields preventing them from draining back to the Creek. In addition, Laguna Avenue, and an old farm road approximately 0.2 miles north of Laguna Avenue are raised, creating east-west berms in the low-lying floodplain west of Fisher Creek. These roads cause floodwater to accumulate and backwater against these barriers during storm events before slowly draining through Fisher Creek Branch C. This likely provides some level of floodwater attenuation as flows drain back into Fisher Creek. Depending on groundwater conditions, this reach can be groundwater fed, where the likelihood of groundwater fed baseflows increases in proximity to Bailey Avenue. Key features for this reach are shown in **Figure 10**.



SOURCE: Google earth 3D view

Coyote Valley Restoration

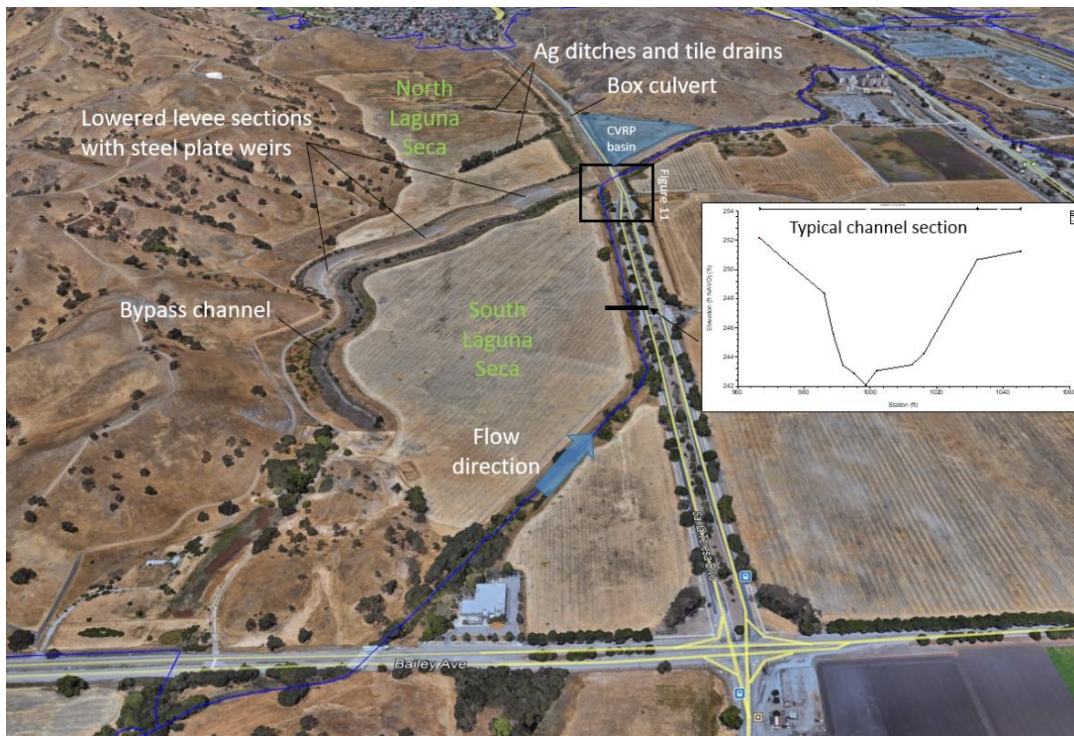
Figure 10
Key Features on Fisher Creek from Scheller Avenue to Bailey Ave

Bailey Ave to Santa Teresa Boulevard

Fisher Creek between Bailey Avenue and Santa Teresa Boulevard (~0.9 miles) ranges from 70-90 feet wide from top of bank to top of bank, with a heavily incised depth of 10.5 feet, and a low slope of 0.1%. The bed material is dominated by fine materials such as silt and sand. This reach of Fisher Creek was constructed as a part of the reclamation of Laguna Seca in 1916-1917 and consists of a straightened channel with levees on either side before flows pass through a dual box culvert under Santa Teresa Boulevard. This channel was excavated below the groundwater table, sending groundwater fed baseflows into Coyote Creek and lowering the local groundwater table. The levees along mainstem Fisher Creek were constructed to prevent small-event flooding of crops grown in the Laguna Seca wetland. However, a section of the Fisher Creek levee that was originally constructed ~1917 was breached in 2007 near the Santa Teresa Boulevard dual box culvert to allow a partially constructed bypass channel to enter Fisher Creek. The bypass channel is approximately 0.7 miles in length and is not directly connected to any drainage at the upstream extent. Immediately north of the bypass channel is the Laguna Seca Dam (also referred to by the California

Division of Safety of Dams as Fisher Creek Dam), which was constructed at the same time as the bypass channel, and divides the low-lying Laguna Seca into northern and southern portions acting as a barrier preventing Fisher Creek floodwater from flowing north into the lowest areas of the basin.

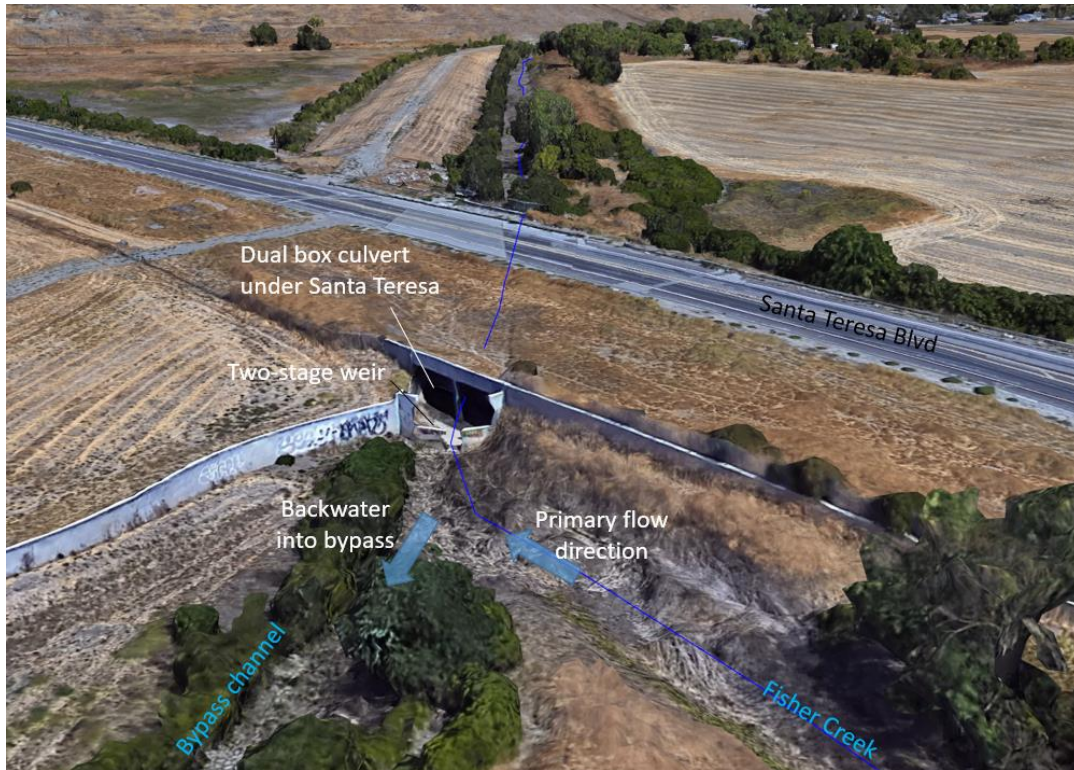
The Laguna Seca Dam was intended to maintain storage capacity to allow large-event flooding to overtop steel-plate weirs at three locations into the northern Laguna Seca Basin. This was designed to help mitigate increases in flooding that would occur if the Valley floor was raised out of the floodplain and developed. In their partially constructed form, the bypass channel and dam are increasing frequency of flooding in southern Laguna Seca and reducing frequency of flooding in the low-lying Northern Laguna Seca. During typical flow conditions, Fisher Creek flows through the lower stage of the weir located at the inlet of the culvert under Santa Teresa Blvd, into the main channel downstream. During intermediate sized flow events (i.e. 2-5 year), flow backwaters into the bypass channel and the floodplain that occupies the southern portion of Laguna Seca. During large flow events, such as the 100-year event, floodwater backwatering into Southern Laguna Seca becomes high enough to spill over the levee and into the northern portion of Laguna Seca. The northern portion of Laguna Seca contains several agricultural ditches which drain surface flows into a small box culvert under Santa Teresa Boulevard into another triangular flood detention basin. In addition to these ditches, there are a series of subsurface tile drains that were installed during the reclamation efforts that may also suppress shallow groundwater. Key features for this reach are shown in **Figures 11** and **12**.



SOURCE: Google Earth 3D view

Coyote Valley Restoration

Figure 11
Key Features on Fisher Creek from Bailey Ave to
Santa Teresa Blvd



SOURCE: Google Earth 3D view

Coyote Valley Restoration

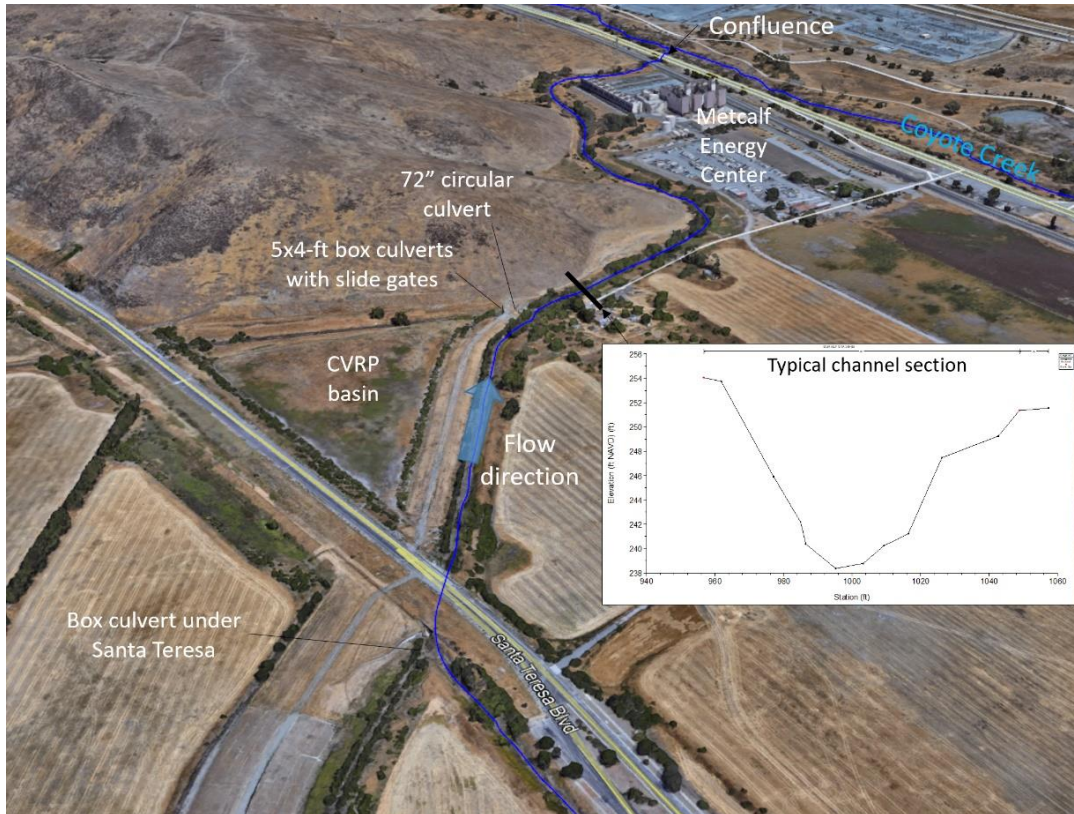
Figure 12
Oblique View of Weir and Culvert Structures on Fisher Creek
Immediately Upstream of Santa Teresa Boulevard

Santa Teresa Boulevard to Coyote Creek

Fisher Creek downstream of Santa Teresa Boulevard to its confluence with Coyote Creek (~0.9 miles) is approximately 100 feet wide from top of bank to top of bank, with a heavily incised depth of 9 to 12 feet, and a low slope of 0.03% from Santa Teresa to the top of the culvert drop structure under Monterey Road which is perched approximately 8 feet above Coyote Creek. The reach is dominated by fine materials such as silt and sand. Most of the channel bottom in this reach is dominated by tule rush vegetation surrounded by sections with a narrow, but dense riparian canopy and leveed areas that support less riparian vegetation.

As with reaches further upstream, this reach of Fisher Creek was constructed as a part of the reclamation of Laguna Seca in 1916-1917. This reach follows along the base of Tulare Hill generally along the same alignment as a 19th century irrigation canal, which was turned into Fisher Creek when it was excavated down and connected to the historic terminus of Fisher Creek to route water directly into Coyote Creek through culverts under the Union Pacific Railroad and Monterey Road. Both banks of this reach are bounded by either levees or the base of Tulare Hill, preventing the creek from flooding across surrounding areas during most storms. This reach also receives water from Northern Laguna Seca Basin via culverts under Santa Teresa Boulevard into a small triangular basin bounded by Tulare Hill, Santa Teresa Boulevard, and Fisher Creek's left bank levee. Water from this basin enters Fisher Creek through a dual slide gate structure over two 5-foot by 4-foot culverts, which then flows through a single 6-foot (72-inch) culvert into Fisher Creek approximately 1000 feet downstream

of Santa Teresa Boulevard. The slide gates can be moved and are currently opened on one of the culverts by 1 foot and closed on the other culvert. A flap gate prevents water from backwatering through this structure and into the northern Laguna Seca basin. Key features for this reach are shown in **Figure 13**.



SOURCE: Google Earth 3D view

Coyote Valley Restoration

Figure 13
Key Features on Fisher Creek from Santa Teresa Blvd to Coyote Creek Confluence

Coyote Creek

Anderson Dam to Fisher Creek Confluence

The reach of Coyote Creek within Coyote Valley extends ~9 miles downstream from Anderson Dam to Metcalf Road and is generally located between Highway 101 and Monterey Road. Within these confines, Coyote Creek supports a broad, relatively natural channel geometry, with a high degree of sinuosity, an average channel depth of 18 feet and a channel corridor averaging 400 feet wide. The channel slope upstream of the Fisher Creek confluence is approximately 0.3-0.4% and alternates between patches of well-established riparian vegetation and actively eroding and aggrading gravel bars with little vegetation. The sand and gravel dominated bed material is much coarser than Fisher Creek, where flows in Coyote Creek provides a high degree of in-stream recharge to the groundwater aquifer. From the Ogier Ponds downstream to Koyanagi Avenue (~1.5 miles), the left bank floodplain of Coyote Creek is lower where sufficiently high flows (~4000 cfs) escape from the channel. These waters flow west before backwatering against

Monterey Road and Union Pacific Railroad, which act as levees, causing this floodwater to then flow north along Monterey Road before entering directly in Coyote Creek near Koyanagi Avenue. Approximately 2,000 feet downstream of Koyanagi Avenue the channel is deeper and does not overtop in the 100-year storm event. Coyote Creek is joined by Fisher Creek approximately 1.5 miles downstream of Bailey Avenue and continues to pick up tributary flows as it heads downstream through San Jose before entering San Francisco Bay approximately 20 miles to the north. Key features for Coyote Creek upstream of Fisher Creek are shown in **Figure 1**.

Groundwater Hydrology

Coyote Valley's aquifer (Aquifer) is a management area within the Santa Clara groundwater subbasin (DWR Basin # 2-9.02)—the primary groundwater subbasin for the majority of businesses and households in Santa Clara County. The Aquifer is approximately 10,888 acres and has an estimated operational storage capacity of 23,000 to 33,000 ac-ft of water. Groundwater is relatively shallow under much of Coyote Valley where depth to groundwater ranges from 0 to 10 feet below ground surface in the northern part and 20 to 50 feet below ground surface in the southern portion of the Valley (SCVWD 2016). It supports 514 domestic, agricultural, and Municipal/Industrial wells, which accounted for 2%, 26%, and 72% of the 11,100 acre-feet of groundwater that was extracted in 2019 (SCVWD 2019). Valley Water serves as the County's Groundwater Sustainability Agency and has been able to keep the Aquifer in balance during much of the past 50+ years through an effective managed recharge program, where releases water from Anderson Dam into Coyote Creek percolates down through the Coyote Creek streambed into groundwater. Groundwater in the Aquifer generally moves to the northwest toward the Santa Teresa Hills and the Laguna Seca wetland, where a downward sloping land surface and rising bedrock surface force water to become shallower and, in places, reach the ground surface (Iwamura 1999). Due to its generally high permeability, unconfined groundwater conditions, and shallow depths to groundwater, this northern portion of the Aquifer is also vulnerable to contamination (SCVWD 2010). Under normal conditions, shallow groundwater support baseflows in Fisher Creek and wetland conditions in the Laguna Seca basin before flowing back into Coyote Creek or into more northern portions of the Santa Clara Plain subbasin (SCVWD 2011).

Groundwater conditions in Coyote Valley are heavily influenced by Valley Water's managed recharge program. Valley Water conducted a groundwater analysis to examine how changes in groundwater recharge operations in Coyote Valley could change groundwater conditions in the Laguna Seca basin (SCVWD 2011 & 2012). The analysis concluded that lack of control over groundwater extraction in the Coyote sub-basin and possible operational changes to water management in the Coyote sub-basin increase uncertainty around future groundwater conditions in Laguna Seca (SCVWD 2012). However, the hydrograph at the Laguna Seca well (08S02E28H002) that Valley Water monitors indicates that groundwater levels in the Laguna Seca area have been consistently between 2 to 5 feet below land surface since the mid-1990s because of the 1991 drought. The only major exception was during the recent drought from about 2014-2016, but water levels have since recovered to between 2-5 ft bls because of Valley Water's aggressive groundwater recharge program. Valley Water is currently in the process of mapping groundwater dependent ecosystems (e.g. ecological communities of species that depend on

groundwater emerging from aquifers or on groundwater occurring near the ground surface) as a part of its Groundwater Sustainability Plan (GSP) Alternative update to help identify the location of beneficial users of groundwater. In addition to this, the Authority and POST are currently installing nine groundwater monitoring wells in mid and north Coyote Valley to measure groundwater depths in the Fisher Creek floodplain and the Laguna Seca wetland.

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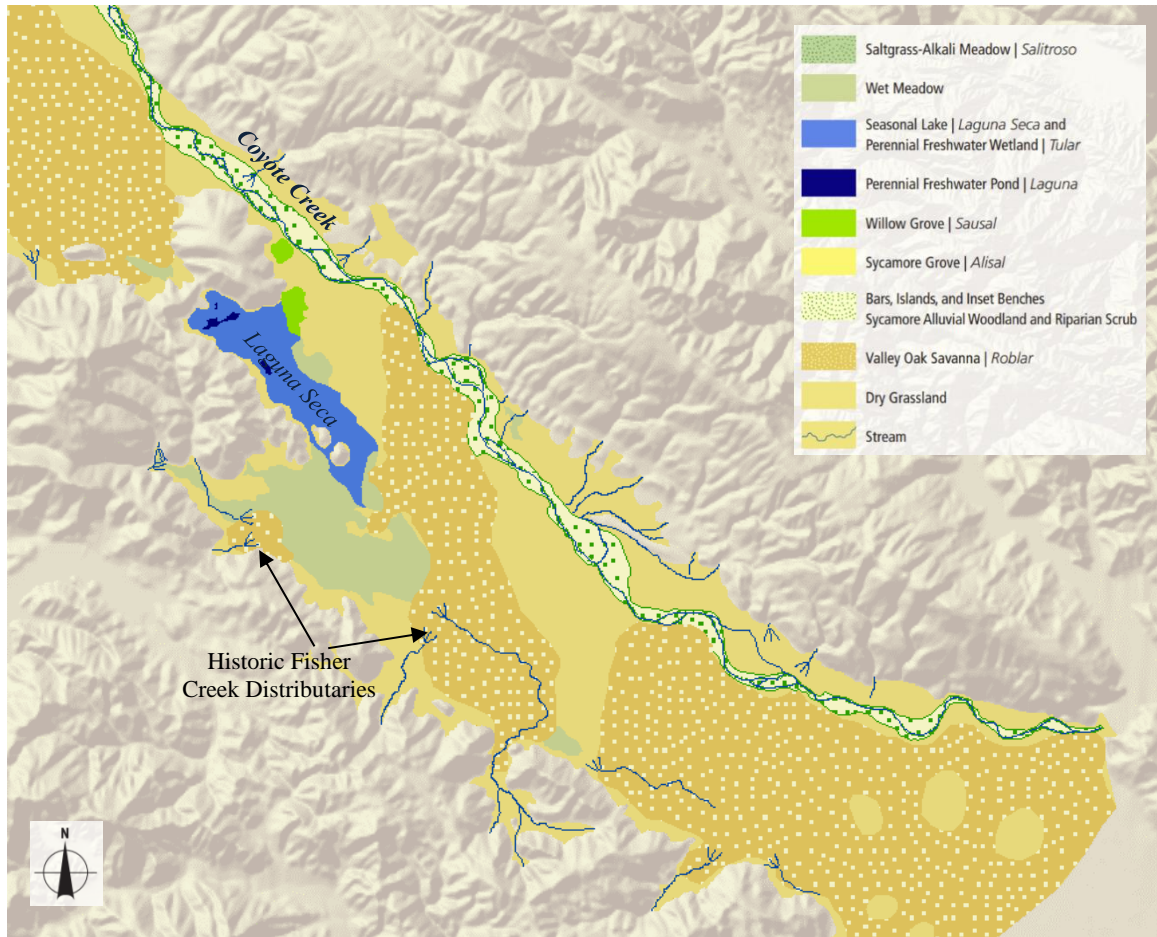
CHAPTER 3

Historical Conditions and Modifications

Coyote Valley’s historical condition provides a valuable picture of past ecology and hydrology. It illustrates a potential “reference condition”: an undisturbed, natural condition towards which creek and wetland restoration might strive. This understanding of historic conditions reveals trends of landscape change, and, when combined with an understanding of man-made modifications, can highlight the trajectory of local hydrology and ecology, and some of the key drivers that could be targeted to restore or enhance conditions.

Historical Ecology and Hydrology

Historically, Coyote Valley was characterized by a vast mosaic of wetland habitats, including wet meadow, freshwater wetlands, tule marshes, willow groves, perennial ponds, and seasonally flooded open water areas that defined the Laguna Seca wetland complex, which once extended over 1,000 acres (**Figure 14**). The Laguna Seca was supported by water from both shallow groundwater and surrounding distributary creeks and early maps of the Laguna Seca rancho indicate the presence of springs in either the low foothills or on the edge of the valley floor. During floods on Coyote Creek, surface water flooded west across the subtle divide from Coyote Creek into Fisher Creek and collected in Laguna Seca surrounded by the “dead end” formed by Tulare Hill and the Santa Teresa Hills. The wetland complex included perennial ponds with depths of 5 to 12 feet. Yet the Laguna Seca, or dry lake, was called that due to its semi-annual drying, providing room for the low-lying basin to capture and hold runoff and floodwater that flowed into it during the wet season. Higher, better drained soils southeast of Laguna Seca and on the surrounding hillsides supported oak woodlands, oak savannas, and grasslands.



SOURCE: SFEI 2017

Coyote Valley Restoration

Figure 14
Historical Habitats

Major Modifications to Hydrology

Since the late 19th century, man-made modifications for agricultural and urban land uses have significantly altered the Valley, presenting both challenges and opportunities to restore this landscape's resiliency. In 1916 and 1917 major reclamation efforts began to convert the valley into arable land for agriculture by realigning and straightening Fisher Creek into a drained network of agricultural ditches added throughout the Laguna Seca wetland, connecting many of the upland drainages to flow directly into Coyote Creek. Small levees and berms were added to prevent flooding of the valley, and subsurface tile drains were added to agricultural fields to drain high groundwater.

Some key changes include:

- **Construction of Coyote and Anderson Reservoirs upstream of Coyote Valley.** The Coyote and Anderson Reservoirs were constructed in 1936 and 1950, respectively. These reservoirs were constructed to capture and hold Coyote Creek's winter runoff originating from the Diablo Range and release it downstream to recharge the Santa Clara Plain

Groundwater subbasin throughout the year. These reservoirs created the delineation between Upper and Lower Coyote Creek watersheds, where the waters that once flowed from the Diablo Range into Coyote Valley were subject to large winter pulses of flow in the winter and intermittent drying in the summer, are modulated and slowly released by Anderson Dam throughout the year. The annual peak flows recorded at the USGS gauge near Madrone (**Figure 15**) show the effect of the dams on downstream hydrology. The timing and duration of releases from Anderson Dam have a large influence on in-stream recharge in Coyote Valley, keeping the Santa Clara Plain and Coyote Valley groundwater management areas within the Santa Clara subbasin in balance during most years. It also has an influence on shallow groundwater conditions in Laguna Seca and baseflows in reaches of Fisher Creek. In the past Valley Water utilized the Coyote Canal, a constructed channel at the foothills of the Diablo Range, to bypass some releases from Anderson Dam from flowing through Coyote Creek in Coyote Valley to reduce in-stream recharge that causes undesirable conditions in Coyote Valley. The Coyote Canal is currently abandoned in a state of disrepair with multiple breaches in the canal.

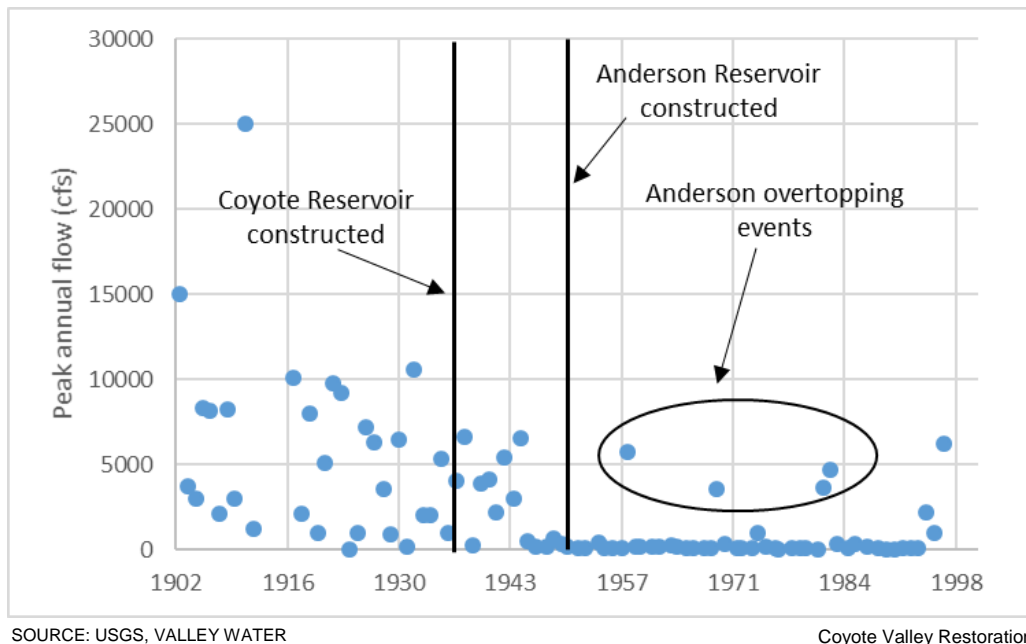
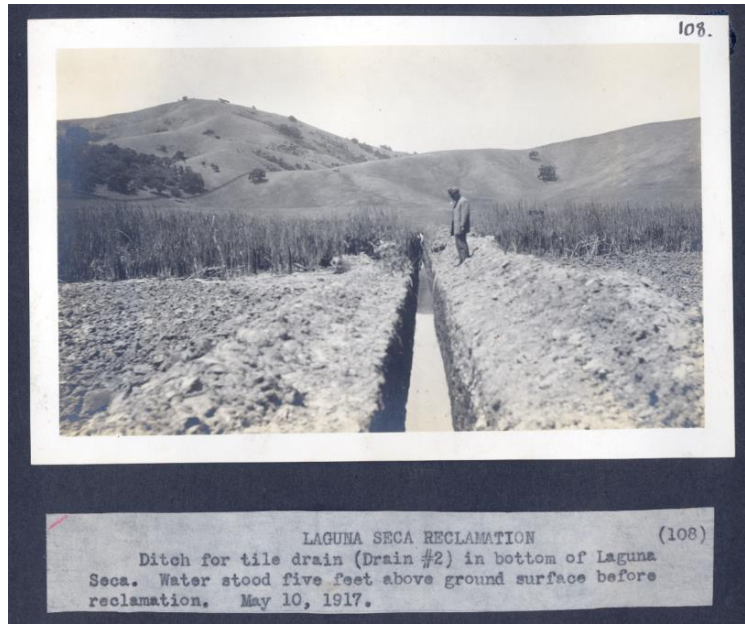


Figure 15

Peak Annual Flows from 1904 to 1997 Downstream of Present-Day Coyote and Anderson Reservoirs

- Drainage of Laguna Seca Wetland.** In 1916-1917 an irrigation canal constructed circa 1830 to route water from Laguna Seca to north of Tulare Hill, was widened and excavated down into the groundwater table an additional 8-12 feet creating a mostly perennial connection from Laguna Seca to Coyote Creek (Grossinger et al. 2006). This canal then was excavated further upstream to the former terminus of historic Fisher Creek, forming a perennial connection from the Fisher Creek distributary system to Coyote Creek. In addition to surface drainage of the Laguna Seca and Fisher Creek, underground tile drains were installed to drain the ground water table, lowering shallow groundwater conditions in the surrounding area and drying wetlands (**Figures 16 and 17**).



SOURCE: SCVWD vault, 1916

Coyote Valley Restoration

Figure 16
Construction of Tile Drains on Laguna Seca



SOURCE: SCVWD vault, 1916 and Authority 2017

Coyote Valley Restoration

Figure 17
Images of the Laguna Seca, past and present

- **Engineering of Fisher Creek and connection of foothill drainage.** Over time, Fisher Creek was lengthened, enlarged, straightened, and leveed from its floodplain to allow for more areas to be used for crop cultivation and lengthen the growing season. Many of sub-watersheds draining from the Santa Cruz Mountains terminated in alluvial fans. Over time these alluvial fan drainages were ditched and directly connected to Fisher Creek, increasing drainage density. Some of the ditched sections are straightened and enlarged sections of earlier natural channels while others were constructed in areas where Fisher Creek had no mapped or documented natural precursor. This work has altered flow paths such that flows are concentrated and routed more efficiently to Coyote Creek. Within Coyote Valley overall, the drainage network is estimated to have increased by almost 40% (Grossinger et al., 2006). Of almost 23,000 feet of Fisher Creek, 16,800 feet follow a new or artificial route (Grossinger et al., 2006). This process is self-perpetuating, as the incising channels will concentrate more flow and incise further over time.
- **Development of Monterey Road and adjacent UPRR track berms.** The Monterey Road median barrier and the Union Pacific Railroad/Caltrain embankment running parallel to Monterey Road are elevated barriers to Coyote Creeks' floodplain, preventing floodwaters from flowing towards the northwestern downward slope of the valley and accumulating in the low-lying Laguna Seca wetland basin. These barriers along Monterey Road make it more difficult for floodwaters to follow their natural flow path into Laguna Seca when Coyote Creek does overtop.
- **Construction of Bypass Channel and the Laguna Seca Dam.** A partial bypass channel (not completed on the upstream end) and earthen dam for Fisher Creek were constructed by a developer in 2007, dividing the low-lying Laguna Seca into a northern and southern portion. The northern portion was designed as flood storage to mitigate runoff and flood impacts associated with future industrial/campus development in northern Coyote Valley that never occurred. Presently, the dam is preventing Fisher Creek floodwater from flowing north into the lowest areas of the Laguna Seca wetland basin, except during significant flood events.
- **Groundwater Extraction.** Coyote Valley's aquifer supports over 514 groundwater supply wells in CY 2019, which extract water for agricultural, residential, and municipal/industrial uses. Each of these wells can result in cones of depression, lowering the groundwater table in the immediate vicinity. In addition to local lowering of the groundwater table, groundwater extraction can result in general declines in Coyote Valley's aquifer during some years, when less water is recharged into the basin than what is extracted, resulting in a basin imbalance. Depending on severity and duration, these basin imbalances tend to be short-term, and often related to drought but can lower the water table, resulting in declining creek baseflows and a decline in shallow groundwater conditions that could support groundwater dependent ecosystems like wetlands and riparian areas around Fisher Creek and Laguna Seca. However, the Coyote Valley groundwater management area is in long-term balance, as indicated in Valley Water's Groundwater Management Plans.
- **Residential and Agricultural Land Uses.** Residential and Agricultural land uses are the most dominant land uses on the Coyote Valley Floor. Depending on Agricultural practices, agricultural land uses can introduce pollutants into surface water and groundwater that can impact water quality. Although Fisher Creek has no listed impairments according to SWRCB 303d listing, there have been observed water quality impacts to Fisher Creek from agricultural operations in Coyote Valley as recently as 2017, where over 400,000 gallons of stormwater polluted with compost leachate were pumped directly into Fisher Creek (RWQCB 2020). In addition, residential land uses added occupied structures primarily

clustered in the Southern and mid portions of the Valley floor in current or historic floodplain areas as well as septic systems that require sufficiently low groundwater conditions to prevent introduction of pollutants to the water table.

Generally, the cumulative effect of these modifications has been converting Coyote Valley's drainage network that was wide, slow, retentive and wet into one that is more narrow, fast, with less water storage capacity, increasing the rate and volume of water which flows downstream. These changes to the network have resulted in:

- Less floodplain connectivity and storage capacity
- Greater outflows from Fisher Creek into downstream Coyote Creek
- Unstable and incising creek channels and drainages
- Less stormwater naturally absorbed by soils and the aquifer
- Less shallow groundwater and ponding that supports aquatic and groundwater dependent habitats
- Less flooding of historical riparian and wetland areas across the valley floor
- Declines in water quality from sedimentation, agricultural and urban pollutant runoff, and loss of wetland areas that capture and treat runoff before it enters Coyote Creek
- Less habitat availability, complexity, and connectivity between surrounding mountain ranges and the valley floor due to the conversion of habitat.

CHAPTER 4

Restoration Concept Development and Rapid Assessment

The project team assessed the site to understand existing and historic conditions, identify restoration opportunities and develop broad objectives to guide the development of restoration design concepts. Restoration objectives were selected to enhance or restore landscape processes that support resilient ecosystems and conserve and enhance water resources. Objectives include:

- Increase floodplain connectivity and capacity for a range of flood events.
- Reduce volume and intensity of storm flows in Fisher Creek and Coyote Creek.
- Stabilize eroding creek channels and drainages and reduce drainage efficiency to mimic historic conditions when possible.
- Increase the amount of uncontaminated storm water absorbed by soils, percolated into the aquifer, and slowly released into creeks and aquatic habitats during the dry season.
- Protect sensitive surface water and groundwater resource areas and promote water quality improvements by establishing habitats and buffer areas that can filter and treat runoff.
- Increase frequency and duration of surface water and groundwater interaction within existing or historic riparian and wetland habitat areas.
- Improve habitat complexity, connectivity and patch size between hillsides, the valley floor, and between the Santa Cruz Mountains and Diablo Range, especially along riparian and wetland areas.

Restoration design concepts were developed for areas that were downstream of Scheller Avenue within Fisher Creek's floodplain and areas within Coyote Creek's floodplain that could potentially route flood flows into these areas during larger events. This area was selected since it encompassed many of the modifications that have significantly altered Coyote Valley's hydrology and consists of a relatively large and undeveloped area that could support large-scale, process-based enhancement and restoration of historic habitats around Fisher Creek and the Laguna Seca wetland complex.

The project team facilitated a design charrette to lay out early restoration concepts and considerations. Generally, the process identified restoration design concepts that sought to revert many of the major modifications (described in the previous chapter) that were perceived to be key drivers of landscape processes in this area. Examples of design concepts include breaching levees, realigning the main stem of Fisher Creek, demolishing the Laguna Seca Dam, etc. This

approach sought to incorporate landscape resilience principles into design concepts, which entails incorporating redundancy, connectivity, diversity, and complexity, among other factors, to help ensure that an area will be impacted less severely and recover more quickly under a range of climatic events (SFEI 2015).

Since the movement of surface water regulates or supports many of the objectives of interest, the project team developed and calibrated detailed one-dimensional/two-dimensional (1D/2D) hydrodynamic flood model to evaluate how restoration actions could alter the movement of surface water across that landscape. A range of storm frequencies, storm lengths, and storm centering's were modeled to simulate how flows in creeks and floodplains could vary under a range of precipitation events and how this compares to existing conditions. Generally, smaller, more frequent events (e.g. Q2.33, Q10 and Q25), were used to evaluate ecologically significant events, while larger events (e.g. Q50 and Q100) were used to evaluate more extreme flooding conditions and downstream peak flows. The Q2.33 event was used because previous work by Valley Water has shown this to be the flow that represents bankfull discharge for many creeks in Santa Clara County. Details of the model process is described in more detail in **Appendix A**.

A combination of qualitative and quantitative outputs from these models were used to evaluate potential restoration actions, such as:

- the location and degree of channel-floodplain connectivity
- inundation area, inundation frequency, and inundation depth relative to soils characteristics, historic habitats, and shallow groundwater areas
- Changes in the timing and magnitude of peak flows

Additional evaluation criteria can be found in **Table 2**.

Examples of how this can be interpreted include:

- Frequent, shallow inundation over sandy to sandy loam soils (A and B soils) overlying unconfined aquifer areas indicates potential for supportive subsurface flows and groundwater recharge, and inundation over clayey soils (C and D soils) that were historically seasonal wetlands and riparian areas could enhance areas that could provide critical habitat and improve water quality.
- Areas with deeper inundation areas and shallow groundwater areas could provide critical aquatic habitat to species year-round and improve water quality.
- Connected creeks and floodplains and wetlands indicate positive exchange between habitat features and potential water quality benefits.
- Width and connectivity of potential riparian and wetland areas indicate overall ecosystem health and habitat connectivity.

TABLE 2
INITIAL EVALUATION CRITERIA FOR RESTORATION CONCEPTS

Evaluation Criteria	What this tells us
Qualitative ranking: Relative inundation extent mapped on hydrologic soils group	Shallow inundation over sandy to sandy loam soils (A and B soils) overlying unconfined aquifer areas indicates potential for subsurface flows and groundwater recharge.
Qualitative ranking: Relative inundation extent mapped on hydrologic soils group	Connected creeks and floodplains and wetlands indicate positive exchange between habitat features and water quality benefit.
Total channel length (mi)	Connected channels result in expanded floodplains. This is also an indirect measure of habitat connectivity.
Buffer area (ac)	Width and conditions of buffer areas (both riparian and wetland) indicate overall ecosystem health.
10-yr flow event total inundation area (ac)	The 10-year flow event total inundation area and extent is an indicator of floodplain (or hydrologic) connectivity.
Seasonal wetland area (ac) --10-yr flow event shallow inundation (<5')	Shallow, frequently inundated seasonal wetlands are complex ecosystems that provide critical habitat and improve water quality.
Perennial wetland area (ac) --10-yr flow event shallow inundation (<5')	Perennial wetlands that are supported by larger inundation events and groundwater provide critical habitat to species year-round and improve water quality

These initial restoration design concepts were then rapidly evaluated to find actions that are most likely to enhance conditions and support multiple objectives. Based on the results of this initial assessment (briefly summarized in this chapter and described in more detail in Appendix B), the highest performing restoration concepts were combined, refined, and evaluated further as the integrated restoration design concept (See chapter 5). It is important to note that the restoration concepts in this report are not intended to be a comprehensive list of what is feasible within the study area. Instead, it is meant to rapidly evaluate “big moves” that could support project objectives and provide a proof on concept for the potential ecological and water resource benefits stemming from landscape-scale restoration activities within Coyote Valley.

Initial Fisher Creek Floodplain and Laguna Seca Wetland Restoration Concepts

Initial design concepts for the reaches below are highlighted in **Figures B-1, B-2, B-3, and B-4**.

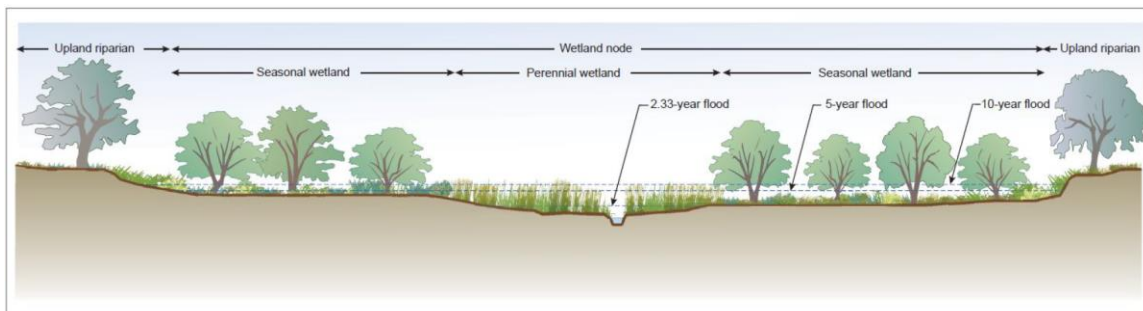
Scheller Avenue to Bailey Avenue

Generally, the project team found that this reach provides several opportunities for enhancing both extent, complexity, and function of mostly seasonal wetlands and riparian habitats associated with Fisher Creek as well as restoring a more natural hydrograph by reducing channel efficiency and increasing water residence time. There is potential to restore sections of Fisher Creek that were straightened and engineered, to create wider and less defined channel to create a more functional riparian corridor. Native runoff in the mainstem of Fisher Creek or its tributaries could

be rerouted to increase development of in-situ wetlands (i.e. across shallow silty clay soils) or groundwater recharge (i.e. across deeper sand and gravel deposits located primarily in foothill alluvial fans) to support downstream wetlands, elevated water tables and extended season in-stream flows. Thus, restoration in this area could allow the establishment of a much wider riparian corridor with seasonal and some perennial wetland habitat by detaining stormwater in floodplains, meadows, and wetlands. Pockets of deep coarser soils dominated by sand and gravel on the historic alluvial fans of Fisher Branches A, C and D, could be leveraged by once again disconnecting these tributaries from Fisher Creek creating berms or other obstructions that increase infiltration of uncontaminated stormwater runoff and distributary flows into these coarser soils areas, increasing percolation around valley floor wetland habitats and helping to restore a less efficient drainage network. Initial design concepts for this reach are described below and shown in **Figures B-1, B-2, B-3, and B-4**.

Restoration of Fisher Creek

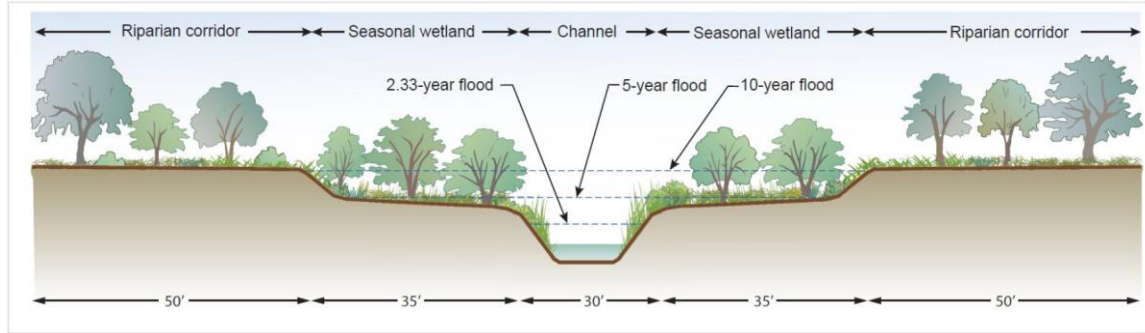
There is a growing recognition across California that many drainages were historically not well-defined channels, but formed broad, shallow swales. These are sometimes referred to as “Stage 0” channels in reference to Schumm’s famous five stage channel evolution model (Schumm et. al., 1984). An assessment of historic conditions indicates Fisher creek had little, if any, defined channels downstream of Scheller Avenue. An initial restoration concept for a new Fisher Creek channel geometry was modeled after “Stage 1” channels, characterized by single-thread bankfull channel geometry, in combination with “Stage 0” nodes characterized by broad wetlands with a broad swale channel more closely mimicking the valley floor’s historic lack of a defined channel for Fisher Creek downstream of Scheller Avenue (**Figures 18 and 19**). For modelling purposes, bankfull channel geometries were developed for Stage 1 and Stage 0 type channels sized using the median Bay Area regional hydraulic geometry curves of Collins and Leventhal (2013). These geometries could be varied to introduce channel heterogeneity to enhance in-channel and off-channel habitat complexity and diversity. Since both riparian and wetland habitats are groundwater dependent, elements that increase exposure to wetted soils and/or raise water table levels would increase ecological function. Three design concept alternatives were developed for restoring Fisher Creek including: (1) relocating Fisher Creek, (2) re-meandering Fisher Creek, and (3) a dual channel design that included both alignments.



SOURCE: ESA

Coyote Valley Restoration

Figure 18
Stage 0 Channel (Wetland Node) Concept Cross-Section



SOURCE: ESA

Coyote Valley Restoration

Figure 19
Stage 1 Channel Concept Cross-Section

Relocating Fisher Creek

Under this design alternative, Fisher Creek is realigned west, along the lowest point of the valley and meanders through a series of seasonal wetland nodes (**Figure 18**) upstream of Bailey Ave. By relocating Fisher Creek to the valley low point (as also generally defined by the center of the existing conditions 10-year floodplain), the design aims to create a more frequent and natural linkage between creek and floodplain, with greater opportunities for more frequent and longer duration inundation across a restored Fisher Creek riparian corridor. This is expected to create the hydrologic conditions for seasonal wetland creation, as well as enabling enhanced filtration of surface water and increasing percolation. Realignment of Fisher Creek to the west of its existing location would enable a closer connection between the channel and shallow groundwater conditions that are likely more prominent at the low point of the valley, creating superior conditions for increased duration, depth and frequency of floodplain inundation.

Re-meandering Fisher Creek

Under this design alternative, more sinuosity would be added to Fisher Creek generally within its existing alignment. This would introduce more function to this reach, while also maintaining the existing creek in its current alignment, requiring less land to implement than relocating Fisher creek. This alternative also includes seasonal wetland nodes upstream of Bailey Ave increasing channel-floodplain connectivity by creating a shallower and wider channel than the existing drainage channel, creating additional channel length through meanders, and grading floodplain nodes to improve connectivity to the creek. However, because it remains close to the current alignment, it would be more prone to avulsion back into filled sections of the former alignment.

Fisher Creek Dual Channel System

The dual channel design alternative would combine the two channel geometries described above to evaluate if surface water flows could be sufficient to possibly support a “twin channel system” that would maintain and enhance the riparian corridor within Fisher Creek’s existing alignment, while also supporting development of a new channel and wetlands in the valley low point.

Disconnection of Tributary Branches

Tributaries from the Santa Cruz Mountains that have been artificially connected to Fisher Creek could be disconnected to reduce downstream flood peaks, enhance wetland and alluvial fan habitat development, and encourage percolation into the groundwater aquifer. Historically, Fisher Creek Branch A and Branch D did not flow directly into Fisher Creek (**Figure 14**), and Fisher Creek Branch C was constructed during reclamation efforts as a drainage ditch. Disconnection of the Fisher Creek Branches A, C & D from the mainstem of Fisher Creek and regrading these areas would help restore a more natural hydrograph by reducing system efficiency, promoting enhancement of local wetland meadow habitats such as wet meadows and isolated “sausals”, as well as spreading out flows across historic floodplains to encourage detention, infiltration, and percolation to support these habitats.

Rapid Assessment of Design Alternatives

Flow hydrographs on Fisher Creek at Bailey Ave show that at Bailey Ave, the downstream extent of the reach, the timing of the peak flow is slightly delayed but overall peak flows slightly increase from the existing condition. The realigned and re-meandered Fisher Creek design alternatives create a slightly more hydraulically efficient pathway under most flow conditions, slightly increasing flow peaks at Bailey Avenue. The slight increase is a function of consolidating flows within a restored open riparian corridor versus the current condition where flooding that escapes the channel flows west away from the channel and is detained on agricultural land before draining back into Fisher Creek through Fisher Creek Branch C. Thus, there is some tension between ecological restoration objectives (best met by creating connected riparian and wetland nodes that are well connected to the Fisher Creek flows) and flood reduction goals (separating flow from Fisher Creek and attenuating it). Although the dual channel design did reduce peak flows over existing conditions, it does not appear capable of providing sufficient flows to maintain both channel alignments. While dual channel design creates the greatest length of channel, the modeling analysis suggests that Fisher Creek is not likely to be capable of supporting two channel alignments due to water availability, creating the risk that neither channel would carry sufficient water to support habitat development as well as a consolidated single channel and floodplain. During later design phases there may be value in assessing a full Stage 0 approach of restoring continuous wetland with no defined channels along the lowest valley floor area as an additional alternative during future planning and design studies.

Both the relocated and re-meandered Fisher Creek design alternatives result in an increase in inundated floodplain over existing conditions during a 2.33-year event, where flows are spread across proposed riparian and wetland areas, providing higher overall ecological function as the wetland nodes by inundated by deeper and longer duration flows. The westerly relocated channel alignment spreads floodplain breakouts over a wider area, resulting in the largest increase in inundation area. During the 10-year flood, flows become somewhat more concentrated as they are routed into the “Stage 0” wetland nodes under both alternatives, inundating a smaller area than under existing conditions but providing greater inundation depths in what would likely be a restored riparian corridor.

To help assess the benefits of transitioning Fisher Creek tributaries back to a disconnected distributary system- the project team used upstream drainage area and flow contributions from these tributary drainage areas to evaluate the relative amount of water that could be captured or slowed by these actions. Valley Water’s hydrologic (HEC-HMS) model (see Appendix A) was used to evaluate the flow contributions of the various tributary drainages to understand the relative change that would result if these tributaries were once again allowed to fan out over the valley floor. These tributaries provide significant contributions to the downstream peak flows on Fisher Creek. The 100-year peak on Fisher Creek at its confluence with Coyote Creek is 2,474 cfs (SCVWD HMS model, 2017). The 100-year peak flow from Fisher Creek Branch A’s sub basin is 383 cfs, or around 15% of the peak flow at Coyote—a relatively significant portion of the overall flow contribution to the main channel. On Fisher Creek Branch C, the foothills make up a relatively small proportion of the overall drainage area. Fisher Creek Branch D captures approximately 1.1 square-miles of drainage from the foothills representing a peak flow of around 180 cfs (approximately 7% of the peak at Coyote Creek). Fisher Creek Branch E captures a similar area and peak flow (approximately 7% of the peak at Coyote Creek). The drainage to Willow Springs is around 0.9 square-miles and represents a 100-year peak of around 190 cfs or 8% of the overall 100-year peak on Fisher Creek. Cumulatively, disconnecting these artificially concentrated drainages into more natural networks of distributary channels could provide peak flow reductions while simultaneously supporting new wetland habitat and facilitating groundwater infiltration.

Bailey Ave to Santa Teresa Boulevard

Generally, the project team found that the constructed Fisher Creek channel, agricultural ditches, partially constructed bypass channel, levees, tile drains, and culverts have severely reduced the frequency and duration of surface water inundation and shallow groundwater conditions in the Laguna Seca wetland. Removing or retrofitting these modifications could greatly increase the stormwater holding capacity of the Laguna Seca basin itself, where rainfall, runoff, and floodwater naturally collect, likely representing the most significant opportunity for water resource restoration in Coyote Valley. The shallow slope in this reach supports actions to increase residence time, depth, and frequency of surface water inundation of the Laguna Seca. This could significantly increase the area’s capacity to slow and capture flood and stormwater runoff, supporting surface and groundwater conditions that would encourage development of habitats that would help improve water quality by capturing and treating pollutants (sediment, fertilizer runoff, etc.). Seasonal groundwater variability and long-term balance of the groundwater basin will have a major influence on the extent and type of wetland and riparian habitats that could be restored in this area (e.g. seasonal wet meadow vs. perennial tule marsh). As noted previously, these conditions are heavily influenced by Valley Water’s ability to manage recharge in Coyote Valley. Initial design concepts for this reach are described below and are highlighted in **Figures B-1, B-2, B-3, and B-4**.

Notch Laguna Seca Dam and connect Fisher Creek to Bypass Channel

This design alternative sought to examine how small modifications to existing infrastructure could support additional habitat enhancement while also setting aside storage in the northern Laguna Seca basin to store floodwater during larger events. Under this alternative, Fisher Creek is realigned to flow directly into the partially constructed bypass channel to provide a more constant supply of

surface water, making the bypass channel the new mainstem of Fisher Creek. The bypass channel's levee is also breached at a slightly elevated area at the base of the Santa Teresa Foothills. While breaching the levee at this location would not inundate the northern Laguna Seca basin during small storm events, it would set aside some level of floodplain storage to capture floodwater during larger flows, likely providing more modest ecological improvements in the Northern Laguna Seca Basin in exchange for possibly greater flood attenuation benefit than under existing conditions.

Demolish Laguna Seca Dam and Bypass Channel, and re-align Fisher Creek

This design alternative sought to maximize ecological restoration potential and the frequency of surface flow into the Laguna Seca. This design alternative restores historic topography by completely filling the partially constructed bypass channel and removing the levee that divides the Laguna Seca Basin into northern and southern areas. Other modifications like historic berms and levees would be removed to promote more frequent sheet flow and surface inundation. Fisher Creek is realigned as a moderately defined "Stage 0" channel that generally meanders through the center of a restored mosaic of seasonal and perennial wetlands in Laguna Seca. This results in more frequent inundation of the entire basin, promoting development of restored wetland and riparian areas, especially in the lowest-lying area in the north. A small defined low-flow channel connection to the Santa Teresa culvert was maintained to ensure summer baseflows continued downstream through the remainder of Fisher Creek, potentially at the expense of stormwater retention

Rapid Assessment of Design Alternatives

Both restoration design alternatives provide more floodplain inundation over the Laguna Seca than existing conditions, indicating that both are likely to improve ecological conditions in comparison to present day conditions. The demolished Laguna Seca Dam and bypass channel alternative allows the realigned Fisher Creek to spill across both the north and south Laguna under even the smallest events modeled (2.33-year), in comparison to the notched dam alternative, which only floods across the southern portion of the Laguna Basin until 10-year events, when water begins to flow into the northern portion of Laguna Seca. This indicates that inundation in the northern basin would be relatively infrequent under the notched dam alternative. Based on the extent and frequency of inundation, from an ecological perspective, full removal of the bypass channel and Laguna Seca dam provides far better channel-floodplain connectivity and habitat restoration potential than leaving those features in place. Thus, removing the entire bypass and levee system and allowing Fisher Creek to fan out into the restored Laguna would improve the feasibility of restoring a mix of perennial and seasonal wetland habitat. While the modeling only evaluated function related to surface water, filling the bypass channel and other artificial surface and subsurface drainages that are transmitting groundwater fed baseflows downstream would likely magnify ecological benefits by helping groundwater to stay and contribute to more saturated soil conditions onsite.

Removing levees and barriers throughout the Laguna Seca basin provides a peak flow attenuation benefit during larger events when the levee breach would be activated, where peak flow is reduced and delayed by several hours. However, partially breaching the levee and realigning

Fisher Creek to flow into the bypass channel actually increases the flow peak for the 2.33-year event by routing flows through the more efficient bypass channel.

Santa Teresa Boulevard to Coyote Creek Confluence

In this reach the lower 2,400 feet of the channel near the Metcalf Energy Center, restoration opportunities are more constrained, where promoting additional floodplain inundation could result in additional risk to facilities like these. Raising the channel back to pre-reclamation elevations and adding sinuosity while also removing surrounding barriers could help reduce peak flows and reestablish local groundwater conditions to support development of a willow riparian woodland. Excavating areas around the channel further to increase the areas of land in close proximity to the current average groundwater table could also promote development of habitats without providing as much floodplain benefits. Additionally, the culverts that cross under the Union Pacific Railroad and Monterey Road are critical infrastructure for wildlife movement between the Santa Cruz Mountains and the Diablo Range. The Open Space Authority and other conservation partners have been coordinating with High Speed Rail Authority to replace these culverts with a larger culvert with better natural lighting to encourage wildlife migration between the two ranges and mitigate potential future impacts of High Speed Rail. While this work is less focused on water resource enhancements, enlarging the culvert could require channel modifications in this reach to mitigate increases in flow if this culvert is enlarged, since it is currently undersized for large flows.

Notch Right Bank Levee & Excavate Triangular Basin

Only one alternative was evaluated for this area due to project constraints. Given this, we chose to evaluate a restoration design that was compatible with the upstream channel which conveys baseflow in the present Fisher Creek alignment, while opportunistically increasing floodplain in this reach. To this end, the right bank levee of Fisher Creek would be breached to allow flows to more frequently spread across the currently disconnected floodplain, restoring the historic willow sausal that occurred on-site. The triangular basin would be excavated down to bring the ground surface closer to the average present-day water table to support development of perennial wetlands and increase flood detention in this basin, which could still be managed to modulate flow releases into Fisher Creek via the slide gate system at the existing culvert.

Rapid Assessment of Design Alternatives

Model results show the triangular basin is more frequently inundated and its storage capacity has increased. Flooding through the right bank appears to be providing additional storage and peak flow delays by expanding floodplain connectivity and expansion during larger events. Excavating these floodplain areas closer to the current groundwater table would support development of riparian and wetland habitat. However, this would not address the relatively deep channel that was excavated into the groundwater table, missing an opportunity to potentially raise local groundwater levels. Although not examined during this phase of work, alternative designs that examine the benefit of raising and adding sinuosity to this reach of Fisher Creek could provide compelling evidence that more benefits could be gained in this area. As mentioned before, this

work could be done in concert with wildlife culvert designs to ensure compatibility and complementarity, depending on how these alternatives would alter flow.

Coyote Creek Floodplain Restoration Concepts

Enhancement opportunities along Coyote Creek were not considered as a part of this project. However, opportunities in areas within Coyote Creek's floodplain that could route flood flows west toward Fisher Creek and Laguna Seca during larger events were evaluated. The natural pattern of floodwaters to flow from east to west across the valley floor from Coyote Creek to Fisher Creek has been disrupted by north-south transportation lines especially Monterey Road and the adjacent UPRR railroad. Providing openings under these barriers could allow more water from Coyote Creek to cross the valley and be detained in Fisher Creek (reducing flooding downstream on Coyote Creek) as well as creating wildlife corridors across the valley. Even though floodplain flows are relatively shallow, the amount of overflow that could be conveyed across the valley if these barriers were removed could be significant. Establishing or enhancing this connection to allow a portion of Coyote Creek's flood water to flow into low-lying areas around Fisher Creek and Laguna Seca could reduce peak flows and lower water depths on Coyote Creek to provide an additional buffer for downstream areas during storm events. To facilitate Coyote Creek flows fanning out across the Valley, the median barrier at Monterey Road and the UPRR berm would need to be addressed and conservation and or flood easements would need to be acquired from willing land owners such that flow could be conveyed across existing agricultural fields while avoiding residential and commercial infrastructure. Two restoration concepts were analyzed to enhance the connection of cross-valley flows from Coyote Creek to Fisher Creek. Key features described in this section are shown spatially in **Figure 20**.

Monterey Road Wildlife Culverts

The primary structural features evaluated for enhancing the cross-valley flow from Coyote Creek to the western side of the valley were wildlife culvert connections underneath Monterey Road and the railroad. The primary use for these culverts would be to convey wildlife under these high traffic barriers; however, during very high flow events, flow could be conveyed through these openings to the western side of the valley which continues to slope towards Fisher Creek and the Laguna Seca. An initial alternative was developed to include three culvert crossings between the two breakout locations identified for the 100-year event. The culverts were assumed to be 40-ft W by 15-ft H, which could potentially support wildlife transit. The culverts were positioned such that flow would be conveyed across existing agricultural fields, potentially providing some flood-managed aquifer recharge benefit, while also avoiding residential and commercial infrastructure. The main components of the concept are shown in **Figure 21**.

Elevated Monterey Road Corridor Infrastructure

Instead of using culverts to route flows under the Monterey Road corridor, the team explored the benefits of elevating this infrastructure above the floodplain over an approximately 3,000 foot segment. Elevating Monterey Road and existing rail embankments would allow conveyance across the valley into Fisher Creek, restoring floodplain connectivity and providing off-stream

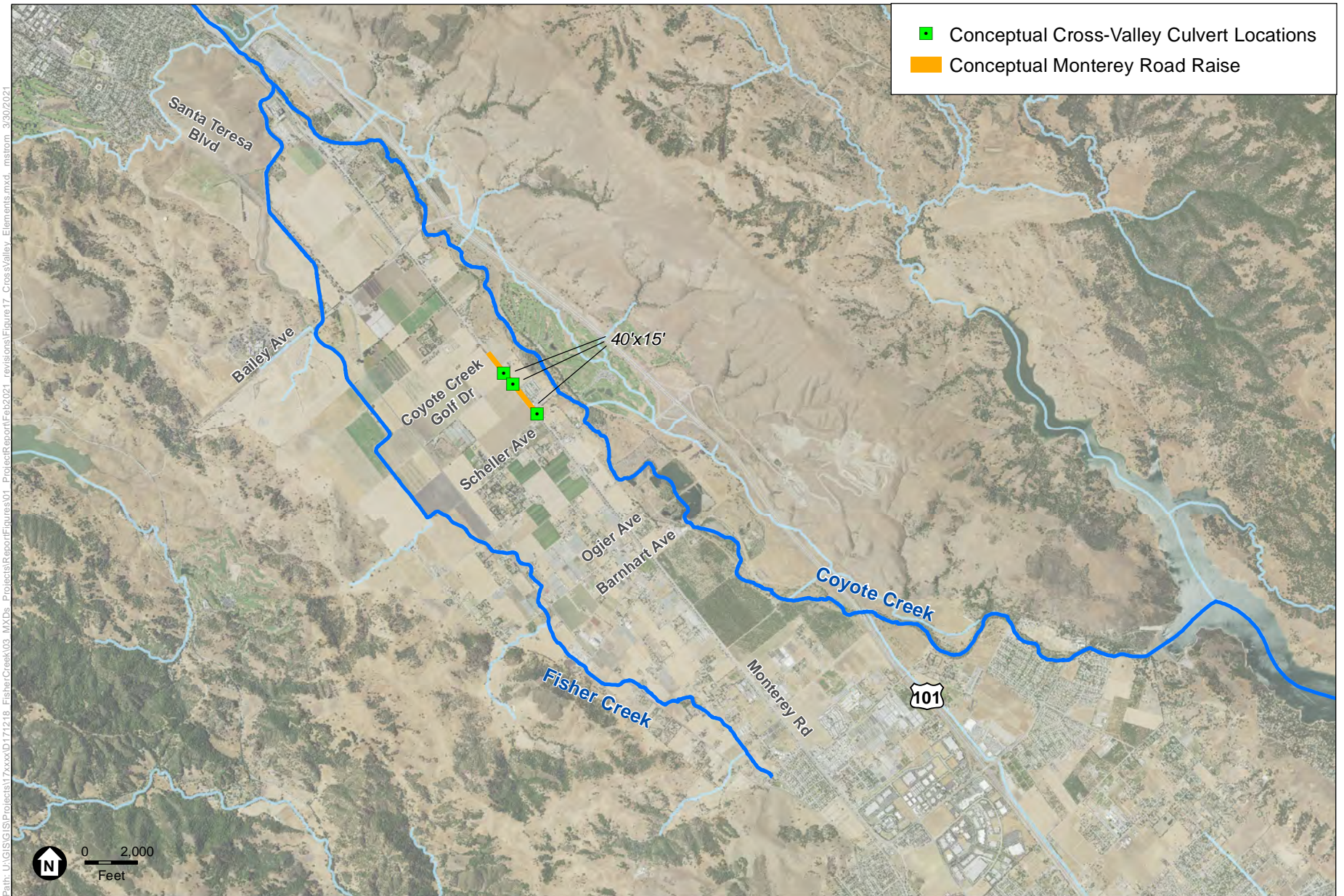
storage for Coyote Creek floodwaters during some flood events. This design concept could also potentially support some level of wildlife movement depending on structure height. Small berms were added along a cluster of residential structures to prevent flow moving across the valley from impacting these existing developments. Also, by grading in swales, flow could be more easily concentrated and connected to the valley where it would spread out and drain towards Fisher Creek. The main components of the concept are shown in **Figure 22**.

Rapid Assessment of Design Concepts

The combined Coyote Creek and Fisher Creek model was used to analyze depth and inundation extent for the 100-year event. For this event, the 72-hour storm flows overtopping Anderson Dam drive peak flows on Coyote Creek thus this duration was used for Coyote Creek. Inundation extents for existing conditions and the two Coyote Creek floodplain restoration concepts described in this section are shown in **Figure 21** and **Figure 22**. As noted in Appendix A, the Elevated Monterey Road Corridor Infrastructure concept was run for the 100-year event with the updated storm centering hydrology received from SCVWD, but the Monterey Road Wildlife Culverts concept was run with the original hydrology, and therefore two figures have been created for comparison with existing conditions that was run with each hydrology.

The inundation map confirms the expected northwest path of flow exiting the Wildlife Corridor culverts and heading toward Fisher Creek. This flow is very shallow, well under 0.5 ft in most locations, and it crosses over to Fisher Creek slowly, thereby helping to attenuate the peak flow in Coyote Creek. The water surface drawdown on the east side of Monterey Road that's associated with the culverts was sufficient to eliminate the breakout around Laguna Avenue. The model reveals transmitting floodwater through the culverts results in a 2% (**300 cfs**) reduction in peak flow in Coyote Creek at Bailey Road relative to existing conditions. The peak flow reduction rapidly decreases from 2% to approximately 1% below the confluence with Fisher Creek, indicating a low likelihood of influencing conditions downstream as flow from other tributaries enter into Coyote Creek further downstream. However, the model shows floodwater still backwaters east of the culverts, indicating that more floodwater could be conveyed with additional culverts or barrier removal.

Model runs for removing UPRR and Monterey Road obstructions provided more encouraging results. The depth of flooding on the floodplain ranges from 1-3 feet but lasts for over 17 hours. Thus, even though flows are shallow, the amount of overflow that could be conveyed across the valley is significant. Water surface drawdown on the east side of Monterey Road was much more pronounced and less shallow, ~0.5 ft in most locations, resulting in a 6% (**800 cfs**) reduction in peak flow in Coyote Creek at Bailey Road relative to existing conditions. Flow across the valley appears to enter Fisher Creek near Scheller avenue, near the Fisher Bend Conservation Property. Based on the timing observed from the previous modeling runs for flows leaving Coyote Creek, flowing to Fisher Creek, and traveling out to the confluence, it is likely that peak flow on Coyote would have passed by the time the overbank flow can return to the confluence. Thus, we do not think constricting the flows draining into Fisher Creek would be necessary to realize the peak flow reduction benefits. Cost estimates were not developed for either Coyote Creek Floodplain Restoration concepts.

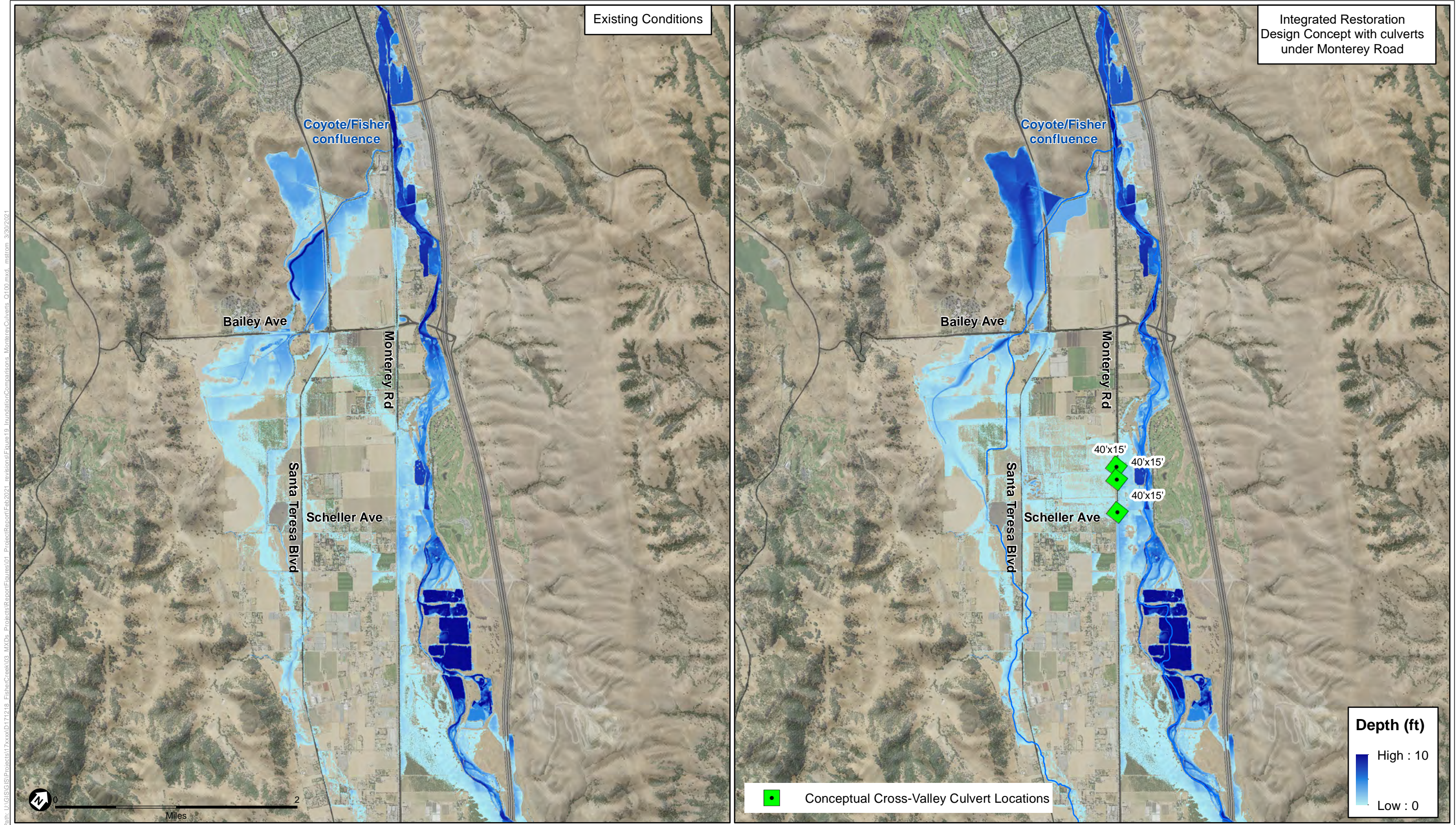


SOURCE: NAIP (2016), SCVWD stream centerlines

Coyote Valley Restoration

Figure 20

Key landscape features for conceptual cross-valley flow connection scenarios

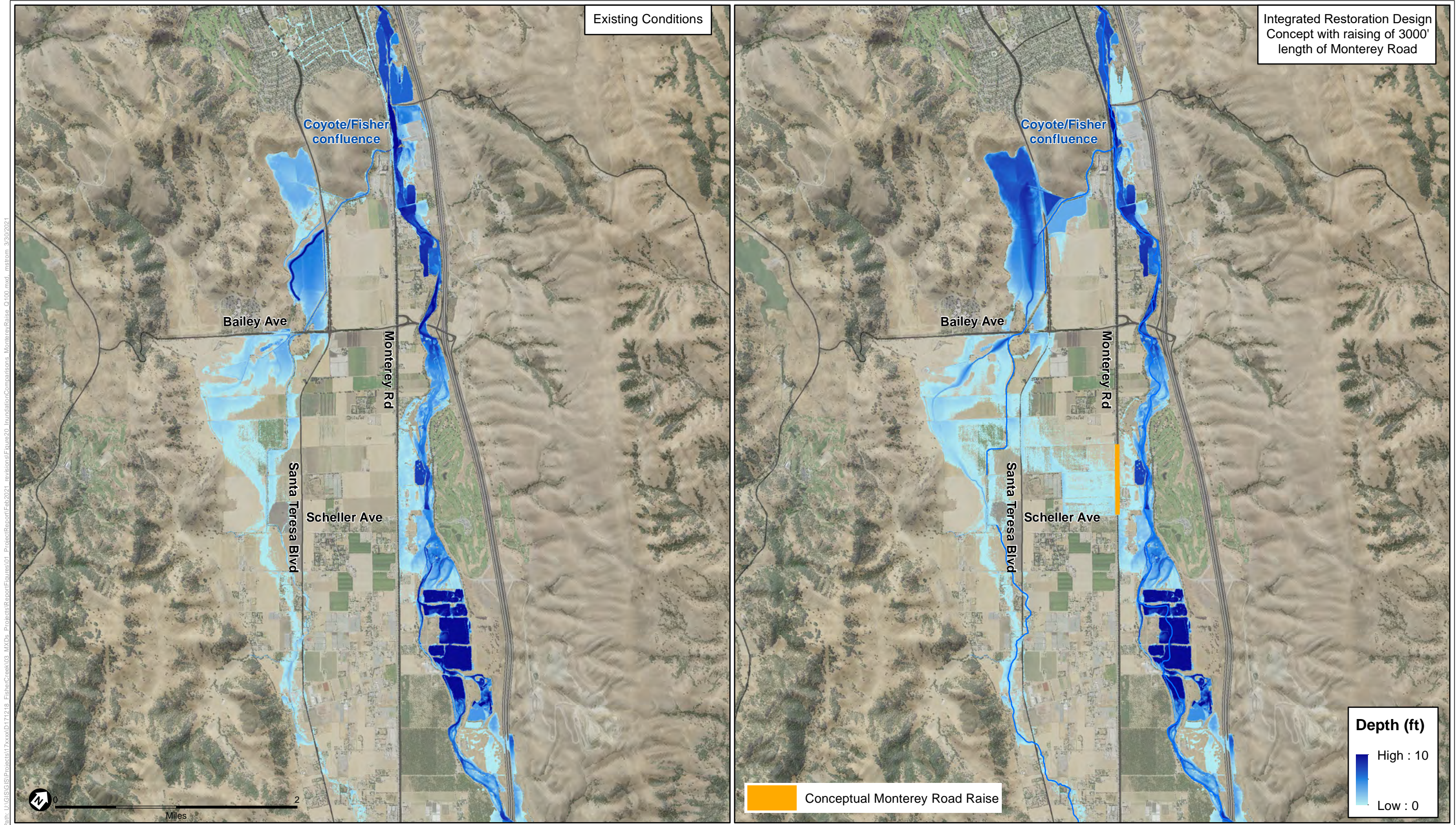


SOURCE: NAIP (2014), SCVWD (stream centerlines)

Coyote Valley Restoration

Figure 21
 Inundation comparisons for Q100 (original hydrology before storm centering update)
 Existing Conditions / Integrated Restoration Design Concept with 3 cross-valley culverts





Path: U:\GIS\Projects\17xxxx\171218_FisherCreek\03_MXD\Projects\Report\Figures\01_ProjectReport\Feb2021_revisions\Figure20_InundationComparisons_MontereyRaise_0100.mxd_mstrcm_3/30/2021

SOURCE: NAIP (2014), SCVWD (stream centerlines)

Coyote Valley Restoration

Figure 22
Inundation comparisons for Q100 (72-hr, Anderson storm center) Existing Conditions / Integrated Restoration Design Concept with Monterey Road raise



CHAPTER 5

Integrated Fisher Creek Floodplain and Coyote Creek Floodplain Restoration Design Concept Assessment

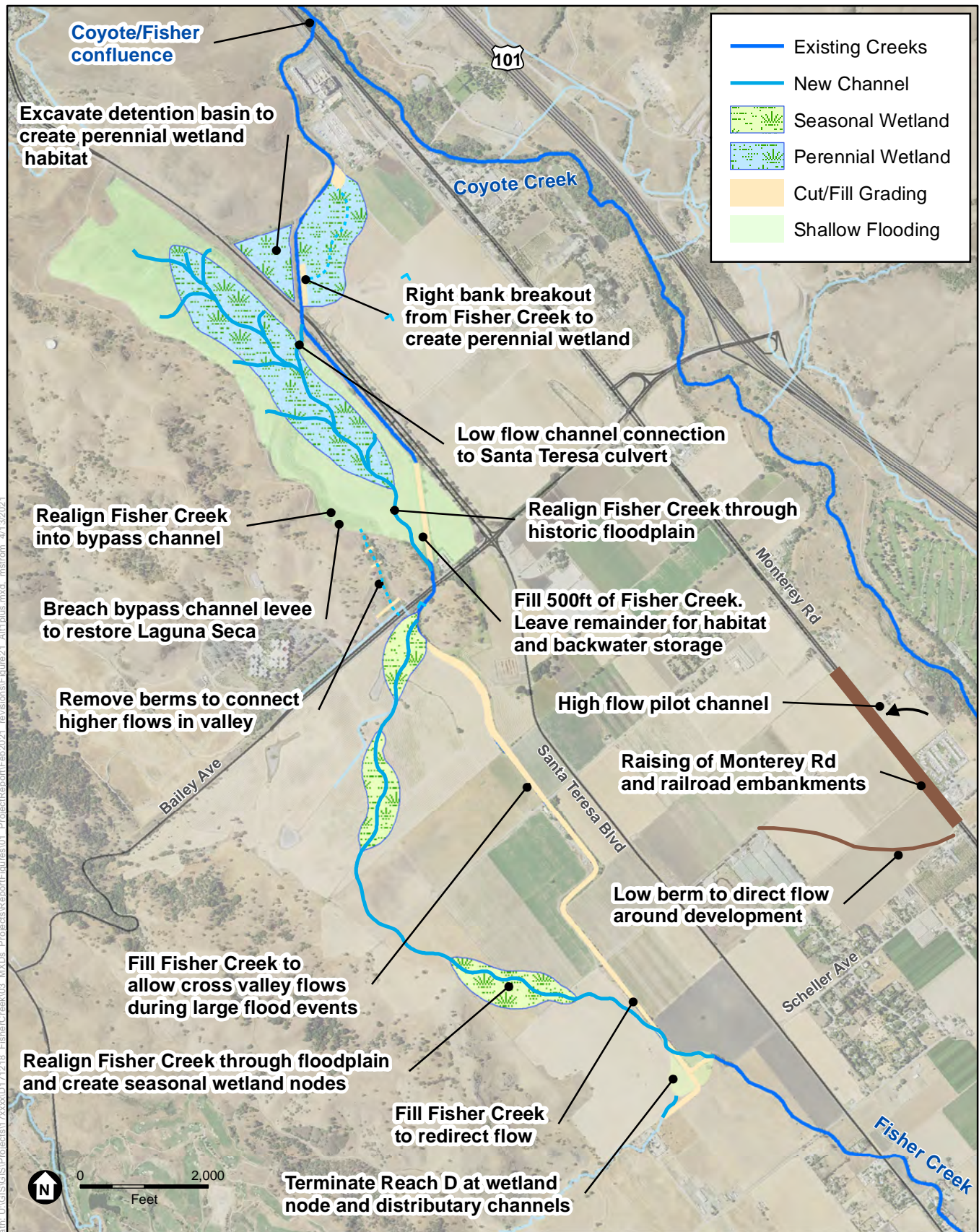
After the initial restoration design concepts were evaluated and compared for each reach, the project team selected the best performing restoration concepts and refined them based on observations from the rapid assessment of restoration concepts (described in **Chapter 4** and **Appendix B**). The following elements were selected from the initial restoration concepts and advanced for further evaluation as the integrated restoration design concept, is shown in **Figure 23**.

Scheller Ave to Bailey Ave

- Realign Fisher Creek west along the natural low point of the valley through seasonal wetland nodes. The bankfull channel is decreased to promote more frequent shallow flooding in the Stage 0 wetland nodes. The bankfull channel was sized using the median Bay Area regional hydraulic geometry curves of Collins and Leventhal (2013), using the smallest channel dimensions (the lowest edge of the envelope) to represent smaller, drier channels.
- Fill 500 ft of the old Fisher Creek alignment to prevent avulsion while leaving the remaining segment to serve as habitat and drainage for agricultural runoff. Sediment-laden runoff from the surrounding agricultural fields would naturally fill in the channel over time allowing cross-valley flooding from Coyote Creek to flow towards the valley low point and Laguna Seca during larger storm events.
- Fill the artificial confluence area between Fisher Creek and Branch D, disconnecting this tributary and promoting development of a sausal wetland node and shallow flooding. Fill sections of Fisher Creek Branch C and unnecessary agricultural ditches to reduce valley floor drainage efficiency.

Bailey Ave to Santa Teresa Boulevard

- Restore the Laguna Seca topography to pre-2006 conditions by filling the bypass channel and removing the levee and small berms and removing existing surface and subsurface drainages to promote more frequent surface water inundation. Fill approximately 500 feet of the existing Fisher Creek channel to prevent avulsion and maintain the remaining existing Fisher Creek as habitat.
- Demolish or fill subsurface drainage and tile drains to encourage shallow groundwater conditions and wet soils.



SOURCE: NAIP (2016), SCVWD (stream centerlines), ESA (2018)

Coyote Valley Restoration

Figure 23
Map of Integrated Restoration Design Concept Elements

- Realign Fisher Creek through a moderately defined Stage 0/ Stage 1 channel that meanders through the historic Laguna Seca creating seasonal and perennial wetland.
- Connect a low-flow channel of the realigned Fisher Creek to the existing Santa Teresa Boulevard culverts to ensure existing summer base flows downstream are maintained.

Santa Teresa Boulevard to Coyote Creek

- Excavate the triangular outlet basin to the winter groundwater table to increase storage capacity and promote wetland habitat development.
- Restore willow sausal in the right Fisher Creek floodplain by breaching the right bank berm just downstream of Santa Teresa Blvd. Excavate the right bank floodplain to the average groundwater table elevation to create perennial wetland habitat and increase flood storage capacity.
- Replace the slide gate on the control structure at the outlet of the detention basin with a flap gate to screen off backwater from the Fisher Creek channel and maintain available storage in advance of the peak flood pulse.

Coyote Creek Floodplain Connection

- Raise Monterey Road and the railroad berm above the water surface for around 3,000 feet, creating a causeway to allow floodwater to traverse this corridor.
- Add small berm around development to prevent inundation.

Ecosystem Function

A proposed new Fisher Creek channel with a riparian corridor and seasonal wetlands would follow the natural low point in the valley. The new primary Fisher Creek alignment is ~5.1 miles in length, an increase of approximately 5,000 ft of riparian channel relative to the current incised and straightened alignment. By relocating Fisher Creek to the valley low point, the project creates a more frequent and natural linkage between creek and floodplain, with greater opportunities for more frequent water exchange. Having better exchange of water between the channel and restored floodplain is expected to improve water quality by distributing creek flow across a wider restored riparian corridor and filtering water as it percolates into the subsurface. Additionally, the increased flow exchange would enhance the hydrologic conditions for seasonal wetlands and potentially increase groundwater recharge. By grading out and removing the levee from the bypass channel, Fisher Creek spills across the entire Laguna Seca basin under even the smallest events providing better channel-floodplain connectivity than existing conditions. Allowing Fisher Creek to more frequently fan out into the restored Laguna would return much of this historic wetland to a mix of perennial and seasonal wetland habitat.

The total acreage of inundation is a key metric for defining the potential wetland conditions. The depth of inundation indicates whether flow is consolidated sufficiently to support the wetlands long-term. A summary of the inundation acreage for each of the events is included in **Table 3**,

and a breakdown of the inundation acreage for different depth ranges is summarized in **Table 4**. As noted in Appendix A, the 2.33-year event was not run with the new storm centering hydrology used to run the 10-year and 25-year events.

TABLE 3
INUNDATION ACREAGE FOR Q2.33, Q10 AND Q25 FOR
EXISTING AND INTEGRATED RESTORATION DESIGN CONCEPT

Scheller Ave to Coyote Creek Confluence		
Flow event (24-hour Fisher Creek)* (24-hour, centered on Fisher Creek)**	Inundation area (ac)	
	Existing	Project
2.33-year*	145	214
10-year**	493	506
25-year**	599	602

* Original hydrology prior to storm centering update

** Updated hydrology with storm centering update

TABLE 4
INUNDATION ACREAGE BY DEPTH FOR 10-YEAR EVENT CENTERED ON FISHER CREEK
FOR EXISTING AND INTEGRATED RESTORATION DESIGN CONCEPT CONDITIONS

Scheller Ave to Coyote Creek Confluence		
Depth (ft)	Inundation area (ac)	
	Existing	Project
<1	274	231
1-5	208	183
>5	12	92

Table 3 illustrates that the integrated restoration design concept increases floodplain inundation during the Q2.33 event by 69 acres (48%). This increase in area of frequent inundation is driven by restored channel geometry, which allows water to fan out across the Stage 1 and 0 wetland nodes, instead of being routed through an incised channel. This frequent inundation is critical for supporting ecological restoration projects into the future. The increase in inundation area is reduced under Q10 and Q25 events. This is caused by consolidating undifferentiated flooding on agricultural land along the western valley into nodes of restored riparian and wetland habitat, resulting in a net increase in inundated habitats.

Depth data is also illustrative from an ecological perspective. When looking at the 10-year event, total inundation acreage for depths less than 1-foot decreases by about 40 acres (16%) but increases by 80 acres (670%) for depths above 5 feet (Table 4). Flooded area deeper than 5 feet is significantly increased, indicating that, by consolidating flow into wetland areas, the restoration design could support substantially deeper wetland area than under existing conditions, including perennial

wetlands. Most of this benefit is realized in the Laguna Seca area, and is due to converting Fisher Creek into broad Stage 1 and 0 channel as it flows into the Laguna. Additionally, by directing flow into these wetland nodes rather than allowing it to spread out unconstrained onto farmland, it would improve water quality by reducing the potential for floodwater traveling over agricultural land and would increase biogeochemical breakdown of pollutants as more water is routed through a network of restored wetlands.

Protecting and restoring areas that recharge local runoff in Coyote Valley could provide additional buffer for groundwater dependent habitats during times of reduced water imports, increased groundwater pumping, and during prolonged droughts. However, quantifying the volume of water that provided shallow and deep recharge was beyond the scope of this project due to the complexity of analyzing surface-groundwater interactions at this scale and the large influence of discrete actions like removing/blocking subsurface tile drains. Additional analysis will be necessary to quantify the potential for groundwater recharge on this system.

The amount of runoff from watershed subbasins and extent of inundation over soil group provides an idea of the potential percolation capacity in these areas. Generally, areas along the realigned Fisher Creek and within its modeled floodplain coincided with less permeable soils (hydrologic soil group C and D), while disconnection of foothills distributaries (notably Fisher Creek Branch A and D) occur over areas with more permeable soils (hydrologic soil group A and B). This indicates that restoration of Fisher Creek and the Laguna Seca wetland would primarily result in saturating clayey soils suitable for wetland development, while disconnection of foothill distributaries has the most potential to support shallow or deep percolation of runoff.

Flood Benefits

Intermediate and large flow events (25-yr, 50-yr, and 100-yr) were modeled to assess how restoration action in the integrated restoration design concept could influence downstream flows in Coyote Creek and downstream flooding. Flows were simulated under existing and project conditions to assess changes at the downstream limits of the model (Interstate 280).

In addition to simulating events with different recurrence intervals, two different event durations were simulated: the 24-hour and 72-hour events. For example, the 25-year 24-hour event is the largest rainfall and runoff event within a 24-hour window occurring on average every 25 years, while the 25-year 72-hour event is the largest event occurring within a 72-hour window occurring on average every 25 years. Often the 24-hour event generates a larger peak flow than the 72-hour event in smaller watersheds such as Fisher Creek, because water can overflow available surface stores and concentrate downstream within that period. In larger watersheds such as Coyote Creek the 72-hour event peak can be higher than the 24-hour event peak, since more time is needed to fill available surface stores and concentrate flow downstream. This is especially true in watersheds such as Coyote Creek that have large reservoirs that capture the first portion of a flood event before filling up and conveying more flow. Three different storm centerings were modeled (1) over Anderson Reservoir, (2) over Fisher Creek, and (3) further downstream over Lower Thompson/Silver Creek to understand how storms located in different locations in the watershed influence flows in Fisher Creek, Coyote Creek and downstream tributaries. The timing of peak

flows is also important; in all or most cases the 24-hour peak flow from Fisher Creek may pass downstream along Coyote Creek before the main peak of Coyote Creek occurs, especially when initial flows in Coyote Creek are detained in Anderson Dam.

The 24-hour duration was used for all flow events on Fisher Creek as this drives the peak flow on this system. For the 50-year and 100-year model runs combining Fisher and Coyote Creek, the 72-hour duration was used on Coyote Creek as this event generates a spill from Anderson Dam which drives flood risk on this channel. In addition to these events, a 25-year scenario was analyzed without a spill from the Dam. For this event, the 24-hour duration was used on both Fisher and Coyote Creeks as this duration provides the largest peak flow on Coyote when no spill occurs.

Peak flows for existing and project conditions are summarized in **Table 5** for Fisher Creek at Bailey Avenue and Monterey Road and in **Table 6** for Coyote Creek at Rock Springs. As noted in Appendix A, the 2.33-year event was not run with the updated storm centering hydrology used to run the 10-year, 25-year, 50-year, and 100-year events.

**TABLE 5
REDUCTION IN FISHER CREEK PEAK FLOW AT BAILEY AVENUE AND MONTEREY ROAD FOR
Q2.33, Q10, Q25, Q50, AND Q100 FOR FISHER CREEK INTEGRATED RESTORATION DESIGN CONCEPT**

Flow event	Flow event*	Scenario	Peak flow (cfs)		Reduction (%)	
			At Bailey Ave	At Monterey Hwy	At Bailey Ave	At Monterey Hwy
Fisher 24-hour storm*	2.33-year	<i>Existing conditions</i>	266	232	-	-
		<i>Integrated concept conditions</i>	291	119	-9%	49%
24-hr storm, centered on Fisher Creek***	10-year	<i>Existing conditions</i>	754	690	-	-
		<i>Integrated concept conditions</i>	937	430	-24%	38%
	25-year	<i>Existing conditions</i>	983	840	-	-
		<i>Integrated concept conditions</i>	1217	580	-24%	31%
	50-year	Existing conditions	1206	940	-	-
		<i>Integrated concept conditions</i>	1491	710	-25%	24%
	100-year	Existing conditions	1414	980	-	-
		<i>Integrated concept conditions</i>	1726	850	-22%	13%

* Original hydrology prior to storm centering update
 ** Project conditions refers to Integrated Restoration Design Concept
 *** Updated hydrology with storm centering update

TABLE 6
REDUCTION IN COYOTE CREEK PEAK FLOW AT ROCK SPRINGS FOR Q25, Q50, AND Q100 FOR
FISHER CREEK INTEGRATED RESTORATION DESIGN CONCEPT

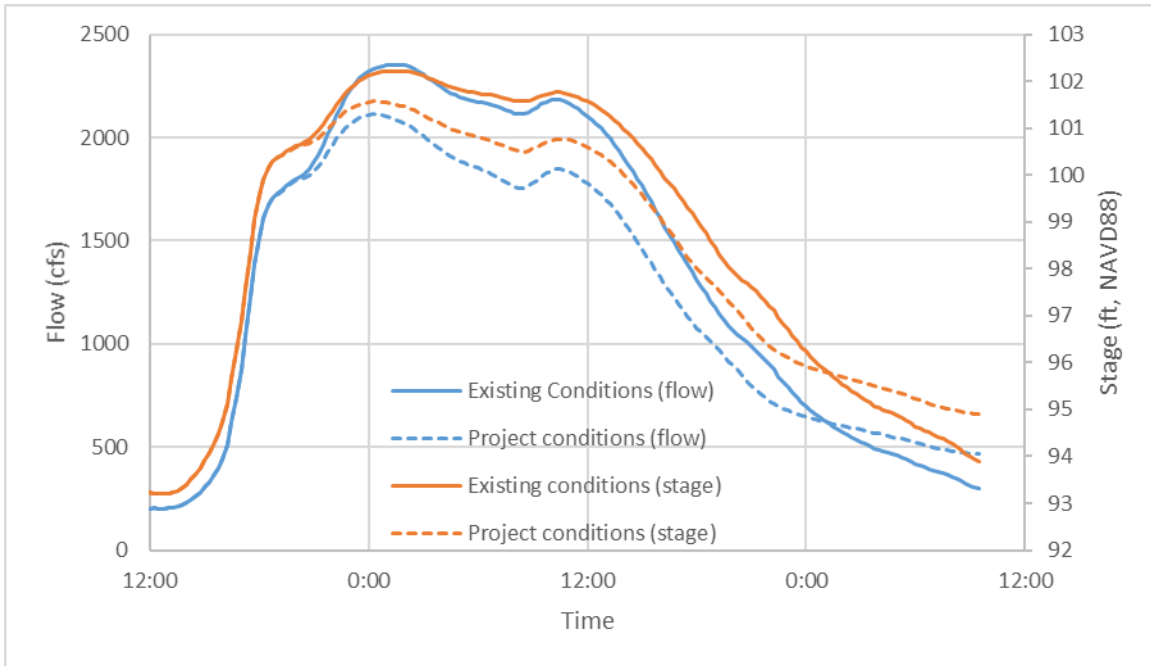
		Coyote Creek at Rock Springs					
		Flow reduction		Water surface elevation reduction			Volume reduction
Flow event	Event	Peak (cfs)	Peak (%)	Peak (ft)	Average (ft) for 12-hours around peak stage reduction*	Average (ft) for 24-hours around peak stage reduction**	Total over storm duration (ac-ft)
Anderson centered 72-hour storm	100-year	490	4%	0.2	0.1	0.1	500
Fisher centered 24-hour storm	25-year	240	10%	0.7	0.7	0.8	510
	50-year	270	9%	0.6	0.6	0.7	500
	100-year	280	8%	0.4	0.5	0.5	410
Lower Silver/Thompson centered 24-hour storm	25-year	190	9%	0.5	0.6	0.7	420
	50-year	180	7%	0.4	0.5	0.7	490
	100-year	180	6%	0.3	0.4	0.7	530

* Day 1 08:00 to 20:00 for 24hr storms, Day 2 06:00 to 18:00 for 72hr storms

** Day 1 08:00 to Day 2 08:00 for 24hr storms, Day 2 00:00 to Day 2 24:00 for 72hr storms

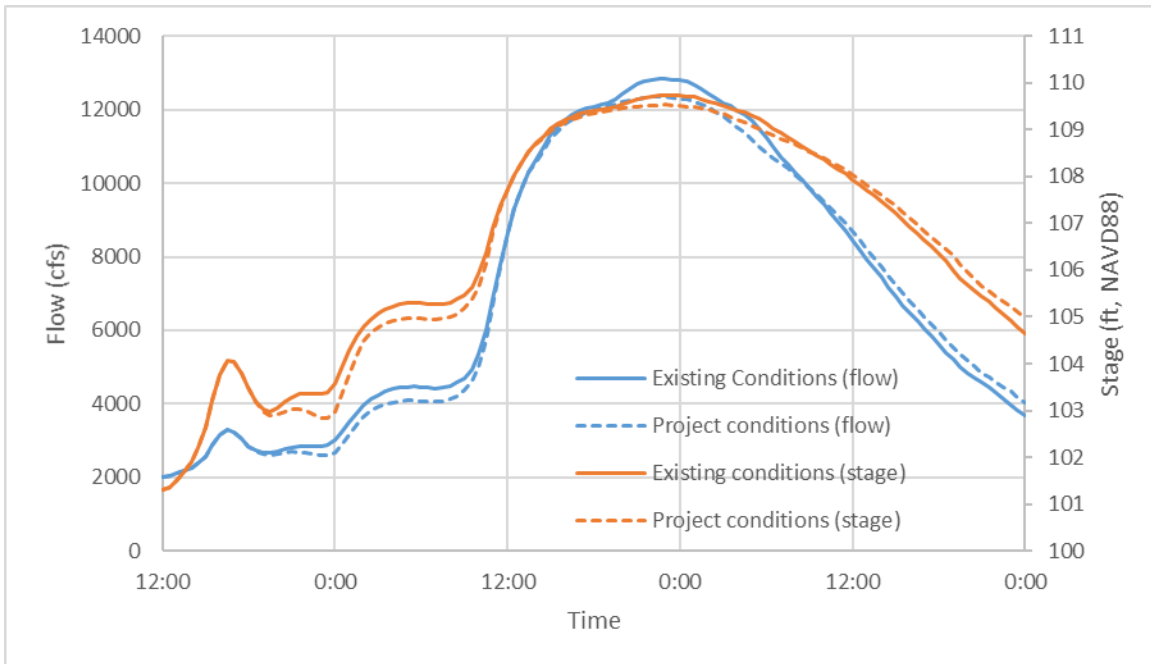
As mentioned in Chapter 3, realigning Fisher Creek to its natural floodplain at the lowest point of the valley has many ecologically desirable features, but has the unintended effect of slightly increasing flow peaks at Bailey Ave. However, expanding the capacity in the Laguna Seca Basin mitigates this increase and results in a reduction in peak flows at the outlet of Fisher Creek across all storm events modeled, reducing them between 13% and 49% over existing conditions. There are a series of potential design refinements that could be made, to reduce or reverse increases at Bailey Ave while retaining the ecological benefits of consolidating the channel and floodplain along the natural valley low point. Key results from the modeling analysis of the integrated restoration design concept include:

- Peak flow timing on Fisher Creek above the confluence is delayed by around 5 hours for the 10-, and 25-year events for the project alternative. Depending on the timing of flows in Coyote Creek, this could aid in reducing flood risk by allowing more time for notification and response. Peak flow hydrographs at the Fisher Creek and Coyote Creek confluence are shown for the 2.33-, 10-, and 25-year events in Appendix A, Figures B-8 through B-13.
- To assess downstream flow and stage reduction benefits at Rock Springs Park, the full combined Fisher Creek and Coyote Creek model was used to analyze a 25-year, 24-hour event centered on Fisher Creek and 72-hour, 100-year event centered on Coyote/Anderson. For the 25-year event, peak flows are reduced by 240 cfs (10%) and water levels are reduced by an average of 0.7 feet for 12 hours. For the 100-year event, peak flow is reduced by 490 cfs (4%) and water levels are reduced by 0.1 feet on average for over 12 hours at Rock Springs Park. Peak flow hydrographs at Rock Springs Park are shown for the 25- and 100-year events in **Figures 24 and 25** respectively.



Coyote Valley Restoration

Figure 24
Coyote Creek stage and flow hydrographs at Rock Springs Park for the 24-hour, Fisher centered 25-year event for Existing and Integrated Restoration Design Concept Conditions



Coyote Valley Restoration

Figure 25
Coyote Creek stage and flow hydrographs at Rock Springs Park for the 72-hour, Anderson centered 100-year event for Existing and Integrated Restoration Design Concept Conditions

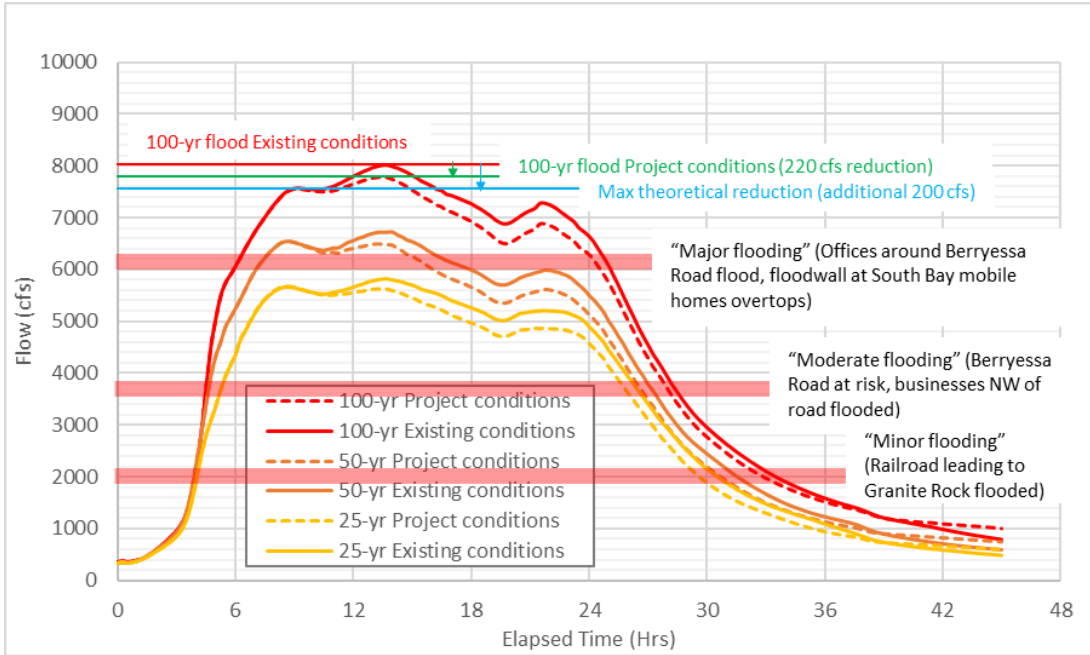
Following the above modeling analysis with a downstream limit at Interstate 280, the model domain was extended through lower Coyote using Valley Water's HEC-RAS model to simulate the potential existing and integrated restoration design concept conditions flood inundation at downstream locations of interest. As described above, storm events were modeled reflecting two storm durations, three storm centerings, and three recurrence intervals. **Table 7** lists the reductions in Coyote Creek peak flow at Rock Springs, Watson Park/Mabury Rd, and Berryessa Rd/Mobile Home Park for the different storm scenarios. **Figure 26** shows Coyote Creek hydrographs at Berryessa Rd/Mobile Home Park for Fisher-centered storms with flooding thresholds highlighted and project conditions peak flow reduction graphically depicted, while **Figure 27** shows Coyote Creek hydrographs at the same location but for a different storm centering at Thompson Creek that affects whether a peak flow reduction occurs. Key results from the modeling analysis of the integrated restoration design concept include:

- The estimated flood benefit varies depending on the site location, the storm centering location and the size of the storm simulated
- The integrated restoration design concept doesn't provide a flood benefit when storms are centered on Thompson Creek or the lower Coyote Creek watershed because local tributaries control flooding there rather than conditions upstream in Coyote Valley
- For storms centered on Fisher Creek and Anderson area, the integrated restoration design concept provides estimated flood peak reductions of 2-9%, with up to a 0.6 feet reduction of inundation depth in channel
- Estimated flooding is delayed by 0-3 hours, providing a potential evacuation benefit
- The estimated volume of flow is reduced by 400-500 acre feet
- There is potential to optimize the design and obtain additional flood benefits for several scenarios by a similar amount

The integrated restoration design concept would preserve floodplain areas that currently provide a flood reduction benefit along Coyote Creek, decreasing the need to add hard infrastructure such as levees, floodwalls, and detention basins if those floodplains were developed. Restoring the Fisher Creek floodplain and Laguna Seca wetland appropriately could provide an additional layer of resiliency that would complement, though not replace the need for, additional flood management approaches downstream. Modeling shows that the integrated restoration design concept could provide an additional safety margin that reduces flood peaks by an estimated value of 0-9% depending on the event, with the potential to increase flood benefits further with project refinements that increase capacity of the Fisher Creek floodplain to attenuate flooding.

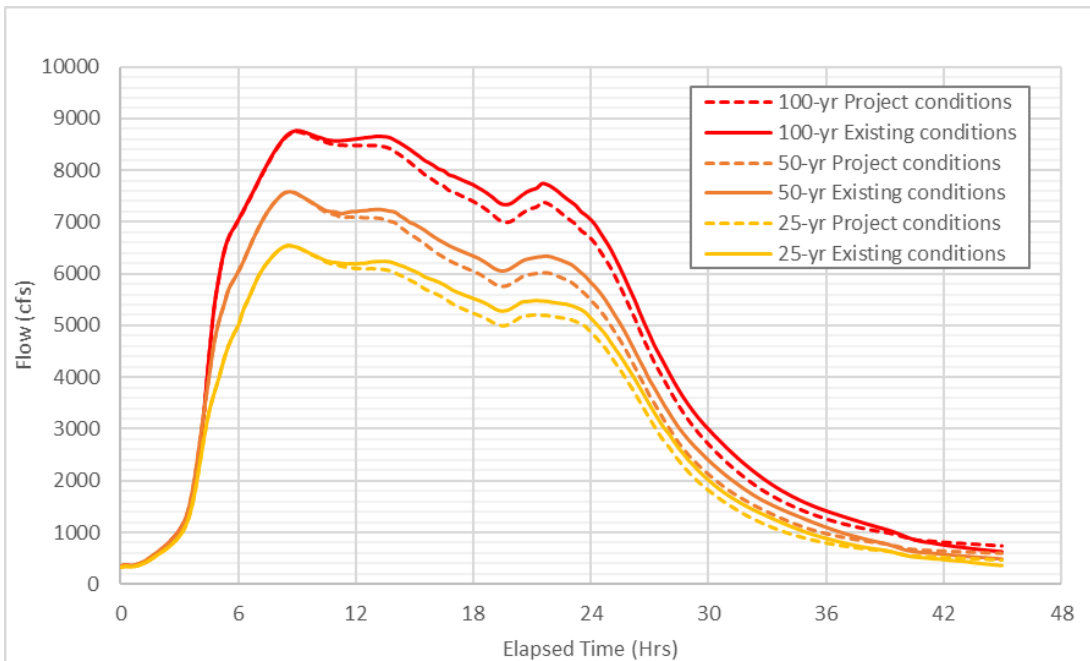
TABLE 7
REDUCTION IN COYOTE CREEK PEAK FLOW AT ROCK SPRINGS, WATSON PARK/MABURY RD, AND BERRYESSA RD/MOBILE HOME PARK FOR Q25, Q50, AND Q100 FOR INTEGRATED RESTORATION DESIGN CONCEPT

Storm center	Event	Rock Springs			Watson Park/Mabury Rd			Berryessa Rd/Mobile Home Park			
		Amount of flooding	Peak flow reduction		Channel Water depth reduction	Amount of flooding	Peak flow reduction		Amount of flooding	Peak flow reduction	
			(cfs)	%			(cfs)	%		(cfs)	%
Thompson - centered 24 hr	25 yr	No flooding	150	6%	0.5 ft	Moderate to Major flooding	0	0%	Major flooding	0	0%
	50 yr	No flooding	170	6%	0.4 ft	Major flooding	0	0%	Major flooding	0	0%
	100 yr	Minor to Moderate flooding	170	5%	0.3 ft	Major flooding	70	1%	Major flooding	0	0%
Fisher - centered 24 hr	25 yr	No flooding	240	10%	0.7 ft	Major flooding	200	4%	Major flooding	160	3%
	50 yr	Minor to Moderate flooding	270	9%	0.6 ft	Major flooding	230	4%	Major flooding	180	3%
	100 yr	Minor to Moderate flooding	270	8%	0.5 ft	Major flooding	220	3%	Major flooding	220	3%
Anderson - centered 72 hr	100 yr	Major flooding	500	4%	0.1 ft	Major flooding	190	2%	Major flooding	480	4%



Coyote Valley Restoration

Figure 26
Coyote Creek flow hydrographs at Berryessa Rd/Mobile Home Park for the 24-hour, Fisher centered 100, 50, and 25-year events for Existing and Integrated Restoration Design Concept Conditions



Coyote Valley Restoration

Figure 27
Coyote Creek flow hydrographs at Berryessa Rd/Mobile Home Park for the 24-hour, Thompson centered 100, 50, and 25-year events for Existing and Integrated Restoration Design Concept Conditions

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CHAPTER 6

Summary and Conclusions

This study focused on evaluating a series of restoration concepts Fisher Creek and Coyote Creek to provide ecologic, and flood, water quality, water supply benefits. To support the analysis, hydrodynamic models of Fisher Creek and the combined Fisher-Coyote system were developed based on prior modeling conducted by Valley Water. The models were used to analyze a range of events and develop quantitative metrics to support conceptual design for the restoration alternatives. An integrated restoration design concept was developed for Fisher Creek and its floodplain, including concepts that could enhance cross-valley flows from Coyote Creek to Fisher Creek.

Initial restoration concepts were identified by the project team based on a combination of existing landscape opportunities, physical layout of the site, and preliminary existing conditions model results. Concepts were refined at a collaborative design charrette conducted with the project team as well as stakeholders from Valley Water. Restoration alternatives were identified and modeled to evaluate benefits and tradeoffs of design elements and a refined integrated restoration design concept was ultimately developed.

The integrated restoration design concept includes realigning the main Fisher Creek channel to the west to follow the natural low point on the valley floor between Bailey Ave and Santa Teresa Boulevard. This alternative also includes restoring the historic, ecologically valuable, Laguna Seca wetland. The proposed channels, wetland, and floodplain creation were designed and refined to provide significant ecological and flood management benefits on Fisher Creek. The restoration actions on Fisher Creek and cross-valley flows from Coyote Creek have the potential to provide substantial ecological uplift to the Coyote Valley while also helping to attenuate peak flows in Coyote Creek.

Key findings include:

- There are sufficient flows to support restoring Fisher Creek to a shallow and moderately defined sinuous channel downstream of Scheller Avenue, adding over 5,000 feet of additional channel length within a ~5 mile long restored riparian forest corridor that connects the Santa Cruz Mountains to the Coyote Creek Parkway.
- Re-routing Fisher Creek to the low-lying western areas of the valley and restoring parts to stage zero and stage 1 swales and wetlands increases channel/floodplain connectivity, inundation area, depth, and frequency of small-scale flow events. This provides a more supportive hydrology for restoration and expansion of sensitive riparian and wetland habitats on the valley floor that were once common under historic conditions. The most notable is Laguna Seca, which could support a diverse mix of shallow and deep wetland habitat.

- Restoration and expansion of riparian and wetland habitat surrounding Fisher Creek and Laguna Seca would provide surface water quality benefits by reducing overland flows over cultivated areas, and routing flows through well-vegetated riparian corridors, wetlands and buffer areas, reducing pollutant loads and increasing pollutant capture and treatment before flows enter Coyote Creek.
- Disconnecting artificial tributary connections and drainage ditches from the main stem of Fisher Creek could help reduce the rate of runoff from the valley and promote percolation into coarser soils, creating more dispersed drainages and wetlands and buffering them from seasonal water deficits and droughts.
- Removing berms and levees around Fisher Creek and the Laguna Seca wetland complex increases floodplain storage capacity, lowering peak flows from Fisher Creek into Coyote Creek during a full range of storm events, and helping to mitigate flood conditions downstream.
- The natural pattern of floodwaters to flow from east to west across the valley floor from Coyote Creek to Fisher Creek has been disrupted by north-south transportation lines especially Monterey Road and the adjacent railroad. Providing openings under these barriers could allow more water from Coyote Creek to cross the valley and be detained in Fisher Creek (reducing flooding downstream on Coyote Creek) as well as creating wildlife corridors across the valley.
- Additional downstream flood risk reduction benefits are possible through refinement of floodplain restoration designs and coordinating upper watershed restoration planning with downstream flood control planning.

Recommendations for further analysis and next steps

This work requires more study and coordination with willing landowners, local tribes, local and state agencies, and land conservation partners to better understand the feasibility, costs, and tradeoffs. The restoration concepts in this report are not a comprehensive list of what is feasible within the study area and should be expanded and reevaluated through CVCAMP and related efforts to determine what restoration actions should be implemented within existing protected areas, and how they can be phased as more lands are conserved. However, the integrated restoration design concept included the best performing suite of restoration actions and provides a clear picture of what landscape scale creek and floodplain restoration could look like in Coyote Valley.

The project team has identified additional recommendations for the integrated restoration concept and important topics for further investigation:

- Design refinements to the integrated restoration design concept
 - From Scheller Avenue to Bailey Ave, elements of the physical channel parameters should be refined as future designs are developed. This includes introducing complexity by increasing channel sinuosity and varying cross-sectional shape in the stage one and stage zero channels. During later design phases there may be value in assessing a full Stage 0 approach of restoring continuous wetland with no defined channels along the lowest valley floor area as an additional alternative. This would encourage more natural channel processes and facilitate habitat diversity.

- Specific issues to address include minimizing or reversing flow increases on Fisher Creek at Bailey, increasing downstream peak flow reduction potential from Fisher Creek, and features for increasing cross-valley flow from Coyote Creek to Fisher Creek and Laguna Seca.
- From Bailey Ave to Santa Teresa Boulevard, options should be explored to economize the cost of restoration in this area. More limited actions such as multiple breaches in the existing Laguna Seca Dam and retrofit of the Fisher Creek bypass channel could be a more cost-effective approach to achieve similar benefits and maintain existing habitat features.
- Restoration concepts downstream of Santa Teresa Boulevard could be expanded and optimized further to increase peak flow reduction benefits while also enhancing aquatic and riparian habitat conditions and promoting wildlife movement through the Fisher Creek Culvert and Monterey Road.
- For all project reaches, restoration concepts should consider how to minimize impacts to existing high value habitats and features, enhance conditions for target species, facilitate wildlife movement, and align other natural resource and land management goals held by property owners such as promoting sustainable or regenerative agricultural operations.
- Some key topics that require further investigation include:
 - An assessment of local groundwater conditions in the Fisher Creek floodplain and how conditions vary between normal years, drought years, and different potential aquifer management scenarios. This would support planning for restoration groundwater dependent ecosystems and riparian areas, identification of potential nuisance groundwater conditions, determining the potential for aquifer recharge, and development of water budgets for stream and wetland restoration concepts.
 - An evaluation of local soil characteristics and potential pollutant sources to help ensure that project components that support stormwater capture and flood managed aquifer recharge can buffer and treat potential pollutants and do not introduce pollutants into surface water or groundwater.
 - An evaluation of potential changes to flow conditions along Coyote Creek to help ensure that potential modifications to Fisher Creek flows are coordinated with Coyote Creek flow conditions and operational needs to increase downstream flood reduction benefits and support improvements in instream conditions for aquatic species.
 - Quantification of ecosystem service benefits from potential restoration design alternatives to inform tradeoff and cost-benefit analyses. This would provide a more complete picture of the potential return on investment in nature-based solutions that, unlike gray infrastructure, are expected to appreciate over time.
 - Opportunities to integrate and coordinate this work with other major infrastructure projects like the California High Speed Rail Project and its proposed wildlife crossings to ensure these projects have supportive and compatible design elements.

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CHAPTER 7

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CHAPTER 8

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APPENDIX A

Hydrologic and Hydraulic Models

ESA received a hydrologic model and two independent hydraulic models (one for Fisher Creek and one for Coyote Creek) developed by the Valley Water. These models include:

1. **Coyote Creek hydrologic model** – This model was developed in HEC-HMS and contains the subbasins for the Coyote Creek watershed and primary tributaries including Fisher Creek. The events included in this model are the 10% chance (10-year), and 1% chance (100-year) flows for a 24-hour and 72-hour event. Part way through the project, updated design flows were received from Valley Water reflecting storm centerings on Fisher Creek (24-hour), Lower Silver Creek/Thompson Creek (24-hour), and Anderson Reservoir/Coyote Creek (72-hour). Pre-2006 conditions, existing conditions, and the integrated restoration design concept with raising of Monterey Road were run with the updated storm centering hydrology for the 10-year, 25-year, 50-year, and 100-year events. Alternatives 1 through 3 were not run with this updated hydrology. The 2.33-year event was run not with the updated hydrology for any condition.
2. **Fisher Creek hydraulic model** – This model is a one-dimensional/two-dimensional (1D/2D) hydraulic model developed in HEC-RAS version 5.0.3. The model domain extends from just downstream of Old Monterey Road to the confluence with Coyote Creek.
3. **Coyote Creek hydraulic model** – This model is a one-dimensional/two-dimensional hydraulic model developed in HEC-RAS version 5.0.3. The model domain extends from just downstream of Anderson Dam to the Highway 280 crossing.

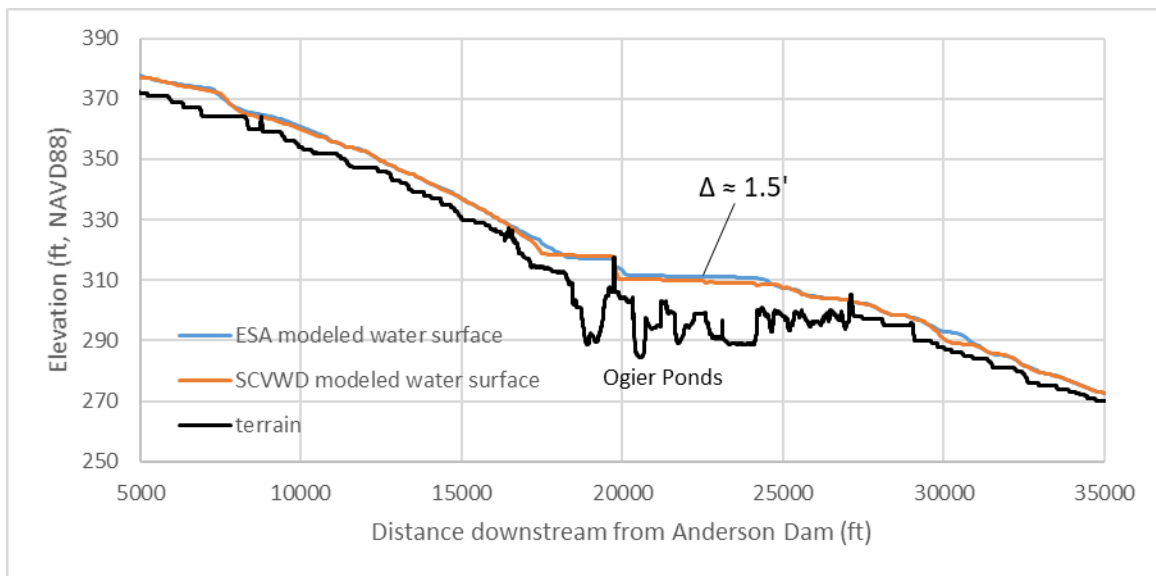
The hydraulic models were refined and updated to address potential problems in the models and to capture key flow dynamics for the alternatives analysis. The refinements are discussed in detail in Appendix C. The primary modifications include:

- The Ogier ponds complex was converted to fully 2D to capture the complex flow through this area
- Model hydrology was updated to match the HEC-HMS flow data
- Minor modifications were incorporated into the terrain, 2D area breaklines, lateral structures, and overbank roughness

2017 Calibration Event

On February 20th and 21st, 2017, a large rainfall event occurred over California releasing a record amount of rainfall in places within the Coyote Creek watershed. In the City of San Jose, 1.87 inches of precipitation fell on February 20th surpassing the previous record of 0.89 inches in a single day set in 1914 (San Jose Airport gage, NOAA). The rainfall event generated a spill over the emergency spillway on Anderson Dam leading to water levels above flood stage on Coyote Creek at Edenvale and Madrone and causing significant residential flooding in San Jose. Valley Water used this event to calibrate their hydraulic model for Coyote Creek (SCVWD, 2018).

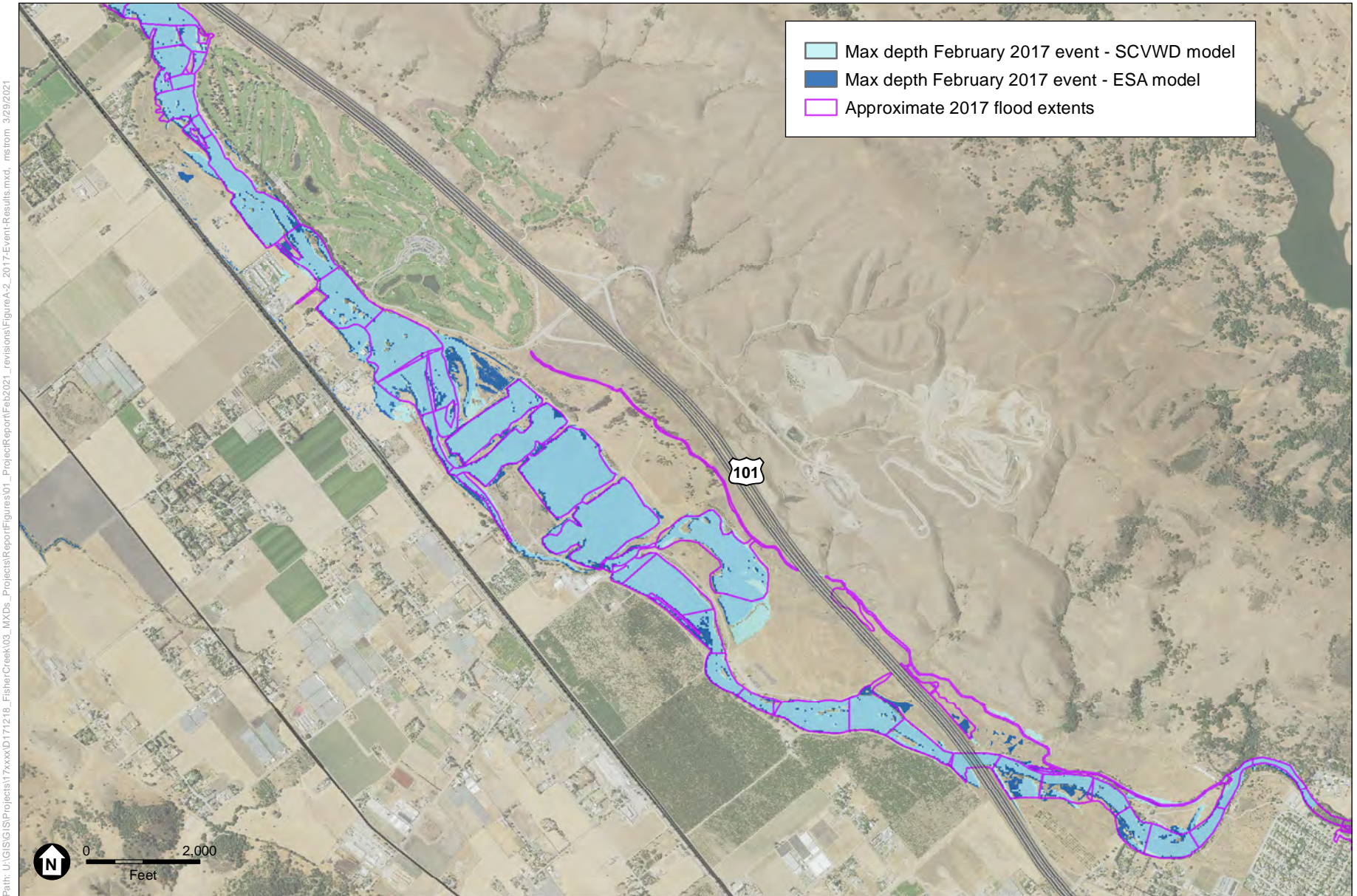
ESA used this same event to verify that the combined hydraulic model was accurately replicating the calibration conducted by the Valley Water. A comparison of the water surface elevations between the two models is shown in **Figure A-1** and a comparison of the flood inundation extents is shown in **Figure A-2**. The majority of the water surface elevations and flood extents match closely, though the ESA model predicts a water surface approximately 1.5 ft higher through the Ogier Ponds (STA 185+00 to 240+00) relative to the Valley Water model. However, this does not translate to a significantly greater inundation extent as shown in **Figure A-2**.



SOURCE: SCVWD (2018 RAS model), ESA (2018 RAS model)

Coyote Valley Restoration

Figure A-1
Coyote Creek water surface elevations for SCVWD and ESA model for February, 2017 flood



SOURCE: SCVWD (modeled, and approximate observed flood extents), NAIP (2016)

Coyote Valley Restoration

Figure A-2

Coyote Creek inundation extents for SCVWD and
ESA hydraulic models for February, 2017 flood

Design flow scenarios

The combined hydrologic and hydraulic models were used to simulate streamflow events with specific probabilities to evaluate existing conditions flow patterns as a basis for comparison to the restoration alternatives. The events were selected to cover a range of relevant flows for ecologic and flooding conditions. In general, the more frequent events drive the geomorphic conditions in the channel as well as the typical habitat conditions while larger, less frequent events, drive flood conditions. Peak flow rates for Fisher and Coyote Creeks for a range of flow scenarios are summarized in **Table A-1**. Note that these flows differ from the flows routed in the hydraulic model.

TABLE A-1
EXISTING CONDITIONS DESIGN FLOW RATES ON FISHER AND COYOTE CREEKS

Watershed	Location	24-hour Peak flow (cfs)*					
		Annual chance					
		43%	20%	10%	4%	2%	1%
		Representative return period (years)					
		2.33	5	10	25	50	100
Fisher Creek	400 feet downstream of Caprista Court	50	100	150	220	280	340
	Kalana Ave	120	230	330	480	600	710
	Richmond Ave	150	300	440	640	790	950
	Bailey Ave	290	550	810	1,160	1,430	1,710
	Santa Teresa Blvd	330	630	920	1,320	1,630	1,940
	At Coyote Creek	310	610	900	1,310	1,630	1,960
		24-hour peak flow (cfs)*					
Coyote Creek	Immediately downstream of Anderson Dam	0	0	0	0	0	0
	2,000 feet downstream of Sycamore Ave (USGS gage 11170000)	30	60	80	120	140	170
	Immediately upstream of Highway 101	90	190	270	400	500	600
	3,500 feet downstream of Coyote Creek Golf Drive	250	490	720	1,040	1,290	1,550
	At Fisher Creek	220	430	640	930	1,160	1,390
	Downstream of Fisher Creek	790	1,370	1,880	2,550	3,050	3,540
		72-hour peak flow (cfs)**					
Coyote Creek	Immediately downstream of Anderson Dam	1,770	3,580	5,400	7,990	10,040	12,150
	2,000 feet downstream of Sycamore Ave (USGS gage 11170000)	1,780	3,600	5,420	8,010	10,060	12,170
	Immediately upstream of Highway 101	1,800	3,640	5,480	8,090	10,160	12,280
	3,500 feet downstream of Coyote Creek Golf Drive	1,860	3,730	5,600	8,260	10,350	12,500
	At Fisher Creek	1,930	3,850	5,750	8,450	10,580	12,750
	Downstream of Fisher Creek	2,030	4,010	5,980	8,740	10,910	13,120

* Storm centered on Fisher Creek

** Storm centered on Coyote Creek/Anderson reservoir

SOURCE: Valley Water HEC-HMS model (SCVWD, 2017)

Surface Water Flow Dynamics

Surface water flow conditions were evaluated to guide the restoration design and to quantify potential project benefits for habitat development, groundwater infiltration, and peak flow reduction. The following sections describe the typical conditions captured by measured streamflow, and the design flow scenarios selected to evaluate project performance. This chapter also includes a discussion of the existing inundation patterns shown in the hydraulic model results.

Pre-2006 Conditions inundation patterns

In 2006, a bypass channel (not completed on the upstream end) and earthen dam were constructed bisecting the Laguna Seca into a northern and southern portion bound by Bailey Road to the south and Santa Teresa Boulevard to the east. Model results from Pre-2006 Conditions provide insight into the ecological function and flood benefit the Laguna Seca provided prior to the bypass channel (functionally a backwater channel) and levee.

Frequent flow events (2.33-year, 5-year)

The Fisher Creek model was used to analyze frequent flow events (2.33- and 5-year) for pre-2006 conditions. Model results show flow breaking out of the Fisher Creek channel downstream of Scheller Road to the western low-lying floodplain. This flow is impeded by agricultural access roads that act as check-dams. There is some breakout in flow to the east of Fisher Creek near the 90-degree bends in the creek alignment. The only inundation in the Laguna Seca comes from the foothills in the vicinity of the wetland including Tulare Hill to the north.

Intermediate flow events (10-year, 25-year)

The Fisher Creek model was used to analyze intermediate flow events (10- and 25-year) for pre-2006 conditions. Model results show broad, shallow flooding along the western low-lying valley south of Scheller Avenue. Overall the Fisher Creek floodplain is disconnected from the existing channelized path. Less flow breaks out to the right floodplain. Similar to the frequent flow events, the floodplain is disconnected by the agricultural access roads that act as check-dams. Within the Laguna Seca, the only inundation results from runoff from the directly adjacent hills. Some of this runoff flows through the smaller Santa Teresa Boulevard culvert to the north and into a small triangular shaped detention basin. During the 25-year event, flows overtop Fisher Creek at a low point on the right bank at the intersection between Santa Teresa Blvd and Emado Avenue. Overtopping flows flood the adjacent fields and pond up adjacent to the right hand side of the channel. A berm along the right bank in this reach prevents flow from draining back into the channel.

Large flow events (100-year)

The Fisher Creek model was used to analyze the 100-year flow event for pre-2006 conditions. Note that the combined model, which includes cross-valley flows from Coyote Creek, would show an influence on overall inundation patterns and timing of flooding. Model results show most of the western low-lying floodplain activated during the 100-year flow event with some

higher dry areas along the access roads. The right floodplain is also activated with a fairly connected floodplain along the creek corridor. Bailey Road floods at the main Fisher Creek crossing and also to the west, with some flow within the small valley west of the main creek alignment. A series of berms prevent a fully continuous flow path through this small valley opening. Most of Santa Teresa Boulevard is flooded downstream of Bailey Road with Fisher Creek breaking out of the left and right banks. Most of Laguna Seca is inundated with the deepest ponding to the north. The small triangular shaped detention basin downstream of Santa Teresa Boulevard is fully inundated and the right floodplain is fully connected with significant inundation.

Existing Conditions inundation patterns

The existing conditions hydraulics are influenced to a large extent by the bypass channel constructed in 2006. The weir structure at the inlet to Santa Teresa Boulevard controls downstream flows and backwaters into the bypass. The hydraulics and inundation patterns vary depending on the flow event.

Frequent flow events (2-year, 5-year)

For the high-frequency, low magnitude, 2- and 5-year events, model results for existing conditions between Scheller Avenue and Bailey Road are similar to pre-2006 conditions, with flow breaking out into the left and right floodplain along Fisher Creek. Downstream of Bailey Road, Fisher Creek backwaters into the bypass channel and inundates the southern Laguna Seca. Flooding in the northern Laguna Seca is similar to pre-2006 conditions with some inundation resulting from Tulare Hill runoff to the north.

Intermediate flow events (10-year, 25-year)

For the 10-, and 25-year events, model results for existing conditions between Scheller Avenue and Bailey Road are similar to pre-2006 conditions, with significant flooding of the western low-lying valley and a disconnected floodplain. Similar to frequent flow events downstream of Bailey Road, Fisher Creek backwaters into the bypass channel and inundates the southern Laguna Seca resulting in significant ponding. None of the three bypass weirs are activated allowing flow to spill into the northern Laguna Seca. The only inundation in the northern Laguna Seca results from Tulare Hill runoff. Some of this runoff flows through the smaller Santa Teresa Boulevard culvert to the north and into a small triangular shaped detention basin similar to pre-2006 conditions. Additionally, some flow in the Fisher Creek channel backs up into a small triangular shaped detention basin through the slightly open slide gate at the outlet to the basin. The low point along Santa Teresa at the Emado Ave intersection is overtopped in the 25-year event, carrying flow into the fields and ponding against the berm separating the incised reach of Fisher Creek downstream of Santa Teresa from its floodplain.

Large flow events (100-year)

The combined Coyote Creek / Fisher Creek model was used to analyze the 100-year flow event for existing conditions. Overall inundation within the Fisher Creek floodplain between Scheller

Avenue and Bailey Road is unaffected by cross-valley flows which are impeded by Santa Teresa Boulevard. Most of the western low-lying floodplain is activated during the 100-year flow event with some higher dry areas along the access roads. The right floodplain is also activated with a fairly connected floodplain along the creek corridor. Bailey Road floods at the main Fisher Creek crossing and also to the west, with some flow connecting to the Laguna Seca through the small valley west of the main creek alignment. The Fisher Creek floodplain activates to the right floodplain and left floodplain with more flow breaking out across Santa Teresa Boulevard at the Emado Ave intersection. The furthest downstream Laguna Seca bypass weir is activated connecting flow into the northern and southern Laguna Seca. A small triangular shaped detention basin downstream of Santa Teresa Boulevard is inundated to an average of 1-2ft deep.

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APPENDIX B

Fisher Creek Restoration Alternatives

This section provides more details on how the restoration concepts in the Fisher Creek floodplain (not including Coyote Creek floodplain modifications) were initially grouped into discrete 1D/2D hydrodynamic flood model alternatives to simulate the hydraulics and inundation patterns for a range of events for each of the alternatives. Restoration concepts were grouped into alternatives (ex. alternatives 1,2,3, and 1+) to reduce the number of modelling runs and reporting requirements and were grouped into discrete alternative based on their general compatibility with each other and to aid in comparison between the alternatives. They should be expanded, reevaluated, and refined as more is known about site conditions and land rights/agreements are secured by working with willing landowners.

Reaches and Preliminary Alternatives

For simplicity, design elements were broken into three project reaches:

- **Reach 1 – Sheller Avenue to Bailey Ave**
 - General Reach Characteristics: Fisher Creek has a 0.3% slope, 40' bank full width, and 6' channel depth.
 - Fisher Creek is largely channelized to drain agricultural runoff with characteristic 90-degree bends around property corners. The Fisher Creek floodplain is largely disconnected from the channel with flood flows in lower-lying terrain in the western valley.

- **Reach 2 – Bailey Ave to Santa Teresa Boulevard**
 - General Reach Characteristics: Fisher Creek has a 0.1% slope, 80' bank full width and 10.5' depth.
 - Fisher Creek was realigned along Bailey Ave and Santa Teresa Boulevard to open the historic Laguna Seca to the north for agricultural production in the early 1900's. In 2006, part of a bypass channel and levee system were built. The bypass channel connects to Fisher Creek before the Santa Teresa Boulevard culvert, but does not connect at the upstream side downstream of Bailey Ave. Laguna Seca covers approximately 260 acres (north of Bailey Ave) and currently drains (via tile drains) through a small culvert across Santa Teresa Boulevard to the north. Fisher Creek passes under Santa Teresa Boulevard through a multi-stage weir and culvert structure creating backwater conditions both in the bypass channel and Fisher Creek.

- **Reach 3 – Santa Teresa Boulevard to Coyote Creek confluence**

- General Reach Characteristics: Fisher Creek has a 0.03% slope, 100' bank full width and 12.5' average depth.
- Key Reach Elements: Fisher Creek was realigned along the toe of Tulare Hill to maximize agricultural production in the floodplain in the early 1900's. Just downstream of Santa Teresa Boulevard, a small triangular shaped detention basin was constructed. This detention basin drains back to Fisher Creek via a control structure that combines dual 5'x4' box culverts controlled by slide gates which flow into a 6' circular reinforced concrete pipe. Fisher Creek is separated from the right floodplain (historically willow sausal) by a berm. The Metcalf Energy Center is located at the Fisher Creek and Coyote Creek confluence along the right bank. Fisher Creek passes through the Monterey Boulevard culvert before dropping more than 5 feet into Coyote Creek. There is no intention of removing this fish passage barrier in the near future.

Alternative 1

Alternative 1 entails a comprehensive approach that has high restoration and floodplain benefits, but also high cost driven by mass grading, land acquisition, design, permitting, and construction. In this alternative, Fisher Creek is realigned to the natural low point of the valley through seasonal wetland nodes upstream of Bailey Ave. The new channel would alternate between “Stage 1” channels, characterized by single-thread bankfull channel geometry, and “Stage 0” channels characterized by broad wetland nodes. Alternating heterogeneous channel types will introduce habitat complexity and diversity. Downstream of Bailey Ave the channel would be realigned through the historic Laguna Seca (existing bypass channel and levee are removed), creating seasonal and perennial wetland. The restoration concepts for this alternative are shown in **Figure B-1** and described by reach below.

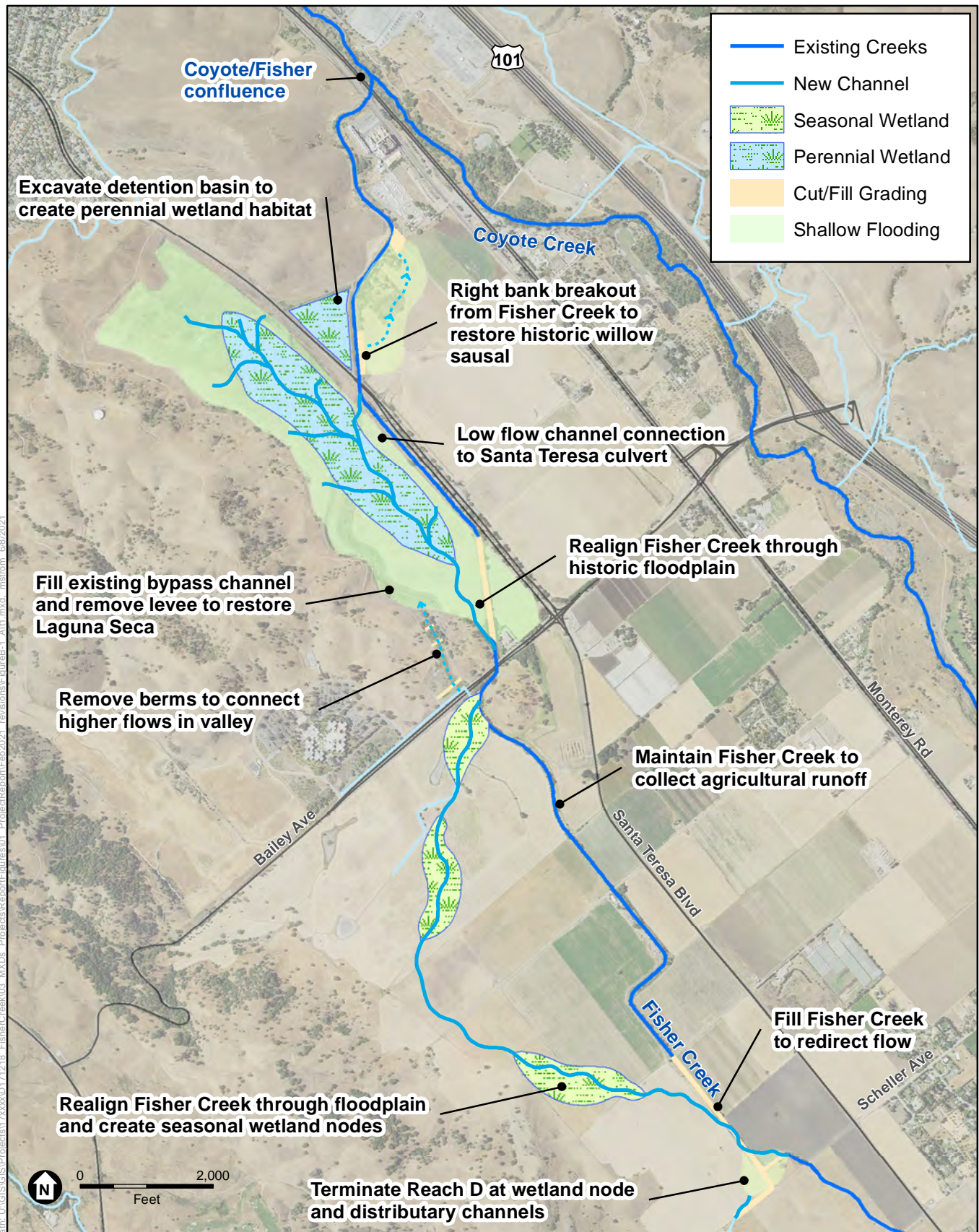
- **Reach 1 – Sheller Avenue to Bailey Ave**

- Restore Fisher Creek and its floodplain by meandering Fisher Creek through the natural low point of the valley and creating meandering through seasonal wetland nodes.
- Fill approximately 500 feet of the existing Fisher Creek channel in order to realign Fisher Creek and prevent avulsion.
- Maintain the remaining existing Fisher Creek channel as habitat and drainage for agricultural runoff.
- Just downstream of Scheller Avenue, disconnect foothills tributary (Fisher Creek Branch D) to promote shallow flooding and realign Fisher Creek to eliminate 90-degree bends in the existing alignment (this portion of the existing creek will be filled).

- **Reach 2 – Bailey Ave to Santa Teresa Boulevard**

- Restore the Laguna Seca topography to pre-2006 conditions, by filling the bypass channel and removing the levee.
- Realign Fisher Creek channel downstream of Bailey Avenue away from Santa Teresa Blvd and into the restored Laguna Seca. The new channel alignment will meander through a seasonal wetland node within the historic Laguna Seca.

- Connect the low-flow channel of the realigned Fisher Creek to the existing Santa Teresa Boulevard culverts to maintain summer base flows downstream.
- Fill approximately 500 feet of the existing Fisher Creek channel in order to realign Fisher Creek and prevent avulsion.
- Maintain the remaining existing Fisher Creek as habitat.
- **Reach 3 – Santa Teresa Boulevard to Coyote Creek confluence**
 - Preserve existing Fisher Creek and its riparian corridor.
 - Increase flood storage capacity in the small triangular shaped detention basin by excavating to the groundwater table.
 - Restore willow sausal in the right Fisher Creek floodplain by breaching the right bank berm just downstream of Santa Teresa Blvd.



SOURCE: ESA (2018), NAIP (2016), SCVWD (stream centerlines)

Coyote Valley Restoration

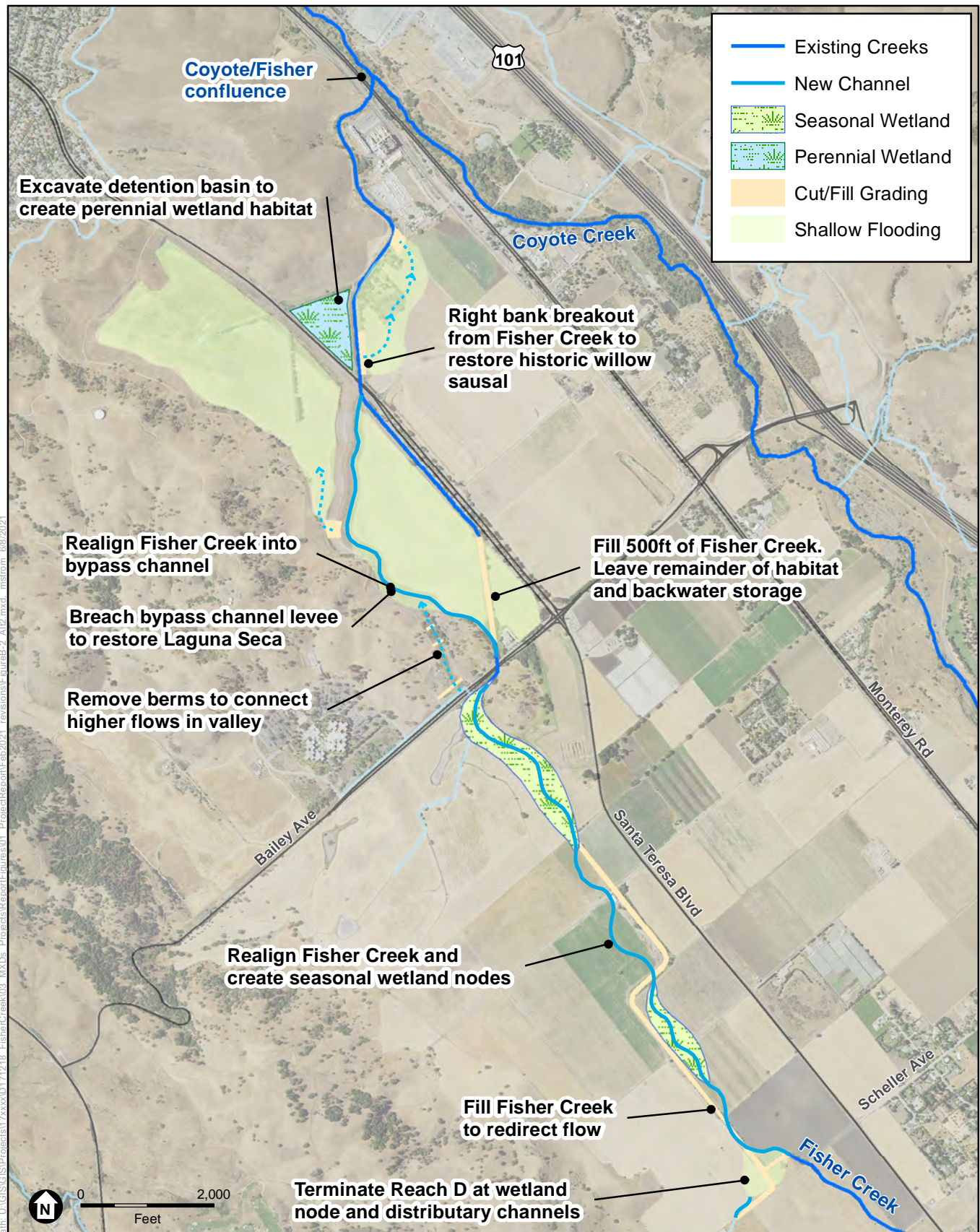
Figure B-1
Map of Alternative 1 Restoration Design Elements



Alternative 2

Alternative 2 is a restoration design concept that takes advantage of existing features and infrastructure. It has the potential for high restoration and flood benefits, with lower costs than Alternative 1. In this alternative, Fisher Creek is realigned along the existing creek corridor through seasonal wetland nodes upstream of Bailey Ave and connected to the existing bypass channel in the Laguna Seca. Part of the bypass channel levee is removed to promote more frequent flooding of the northern Laguna Seca. The restoration concepts for this alternative are shown in **Figure B-2** and described by reach below.

- **Reach 1 – Sheller Avenue to Bailey Ave**
 - Restore Fisher Creek by creating additional channel sinuosity along the existing channel alignment through seasonal wetland nodes.
 - Fill parts of the existing Fisher Creek channel in order to realign Fisher Creek and prevent avulsion.
 - Just downstream of Scheller Avenue, disconnect foothills tributary (Fisher Creek Branch D) to promote shallow flooding and realign Fisher Creek to eliminate 90-degree bends in the existing alignment (this portion of the existing creek will be filled).
- **Reach 2 – Bailey Ave to Santa Teresa Boulevard**
 - Realign Fisher Creek into the bypass channel and fill approximately 500 feet of the existing Fisher Creek channel in order to prevent avulsion.
 - Maintain the remaining existing Fisher Creek as habitat and backwater storage.
 - Breach the bypass channel levee to promote more frequent flooding of the northern Laguna Seca.
- **Reach 3 – Santa Teresa Boulevard to Coyote Creek confluence**
 - Design elements in this reach are the same as Alternative 1.



SOURCE: NAIP (2016), SCVWD (stream centerlines), ESA (2018)

Coyote Valley Restoration

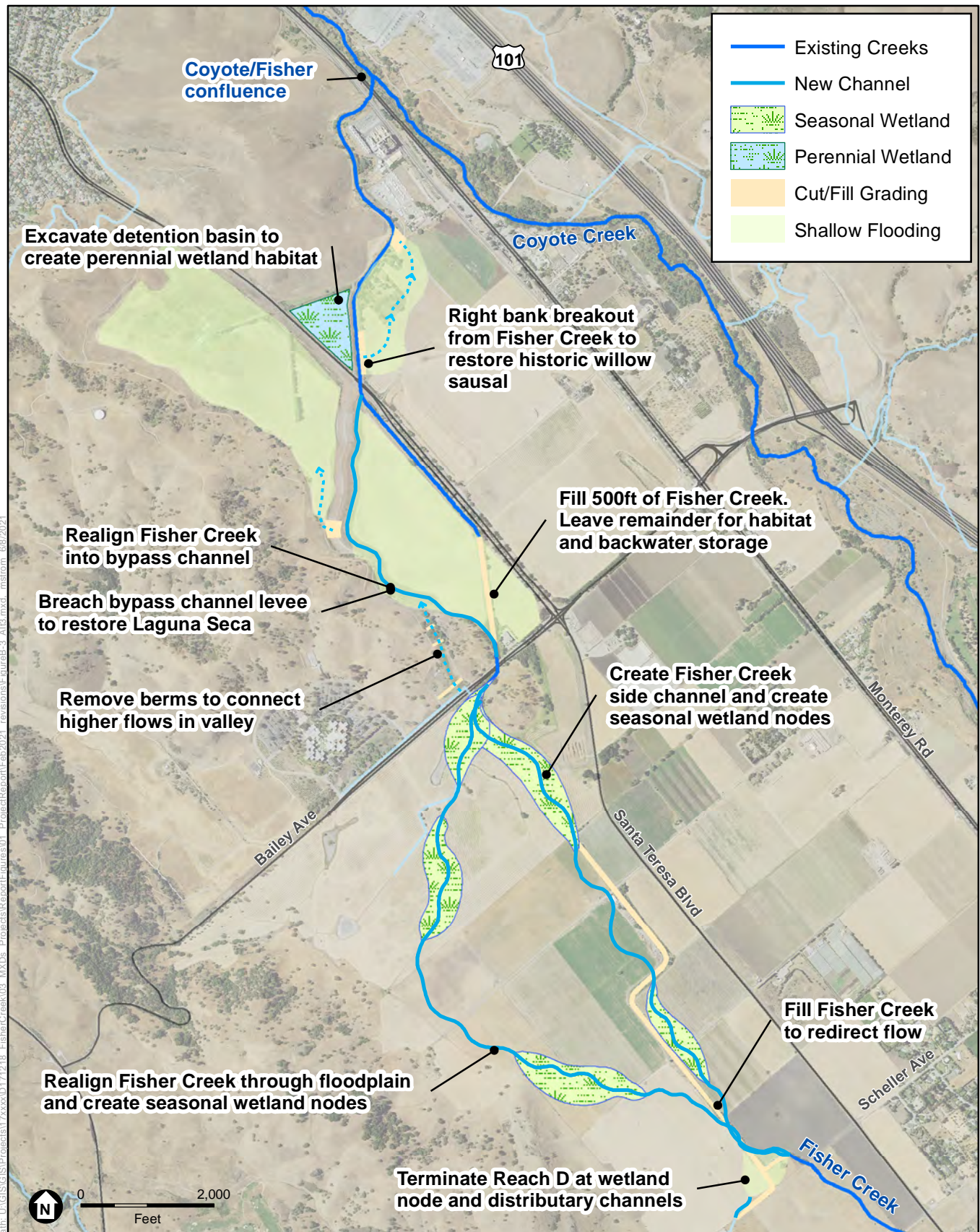
Figure B-2
Map of Alternative 2 Restoration Design Elements



Alternative 3

Alternative 3 combines elements from Alternatives 1 and 2 with flows split between the western and existing channel alignments between Scheller Avenue and Bailey Ave. Downstream of Bailey Ave the design elements match Alternative 2. This scenario has the potential for high restoration and flood benefits, with high cost based on mass grading, land acquisition, design, permitting, and construction. The restoration concepts for this alternative are shown in **Figure B-3** and described by reach below.

- **Reach 1 – Sheller Avenue to Bailey Ave**
 - Combined Alternative 1 and Alternative 2. Flow is split 60 percent (Alternative 1 alignment) / 40 percent (Alternative 2 alignment).
- **Reach 2 – Bailey Ave to Santa Teresa Boulevard**
 - See Alternative 2 description.
- **Reach 3 – Santa Teresa Boulevard to Coyote Creek confluence**
 - See Alternative 1 description.



SOURCE: NAIP (2016), SCVWD (stream centerlines) ESA (2018)

Coyote Valley Restoration

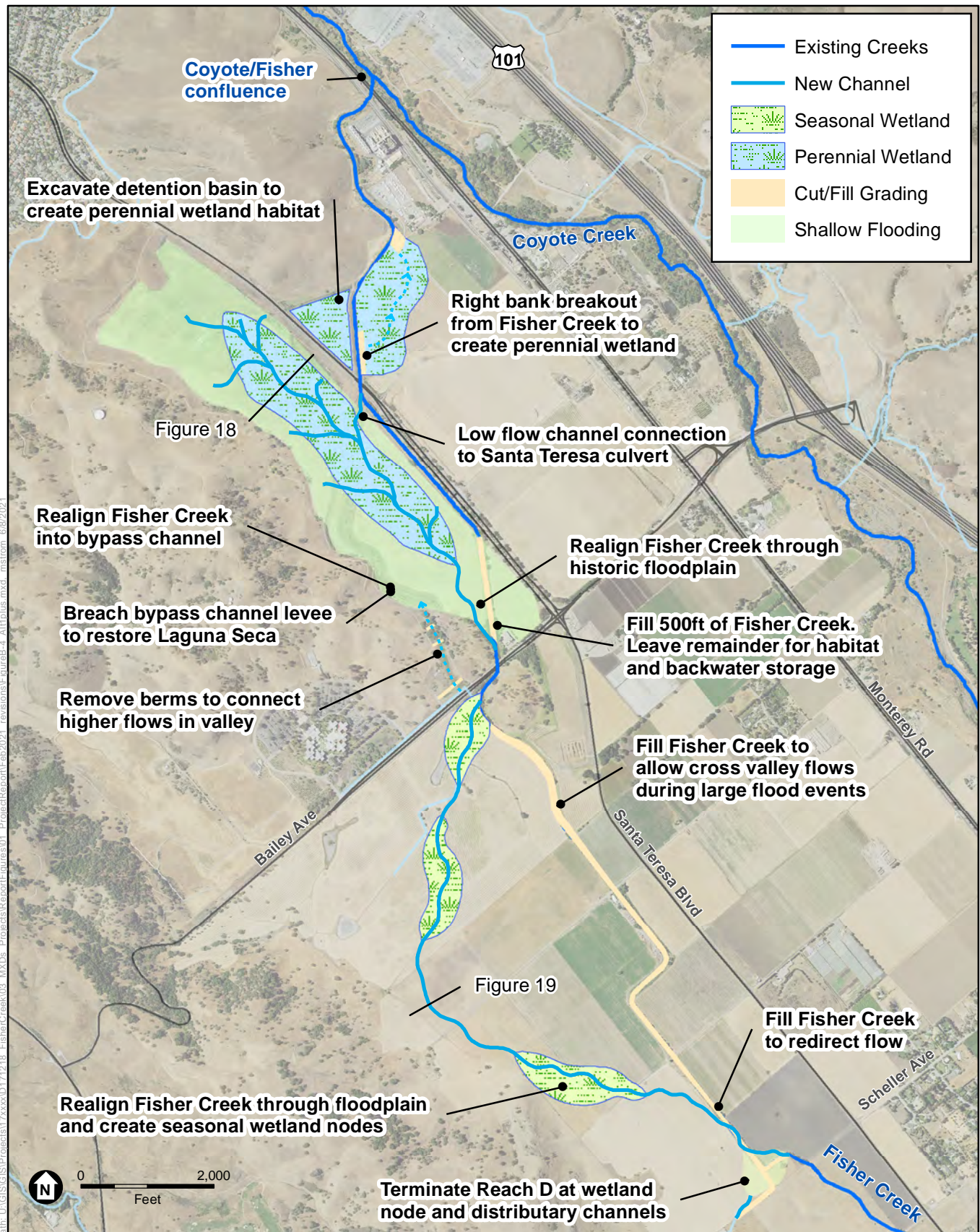
Figure B-3
Map of Alternative 3 Restoration Design Elements



Alternative 1+

Based on modeling results and the restoration and flood benefit potential of the three alternatives described above, a new alternative was developed that is an enhanced version of Alternative 1 (Alt1+). The restoration concepts for this alternative are shown in **Figure B-4** and described by reach below. The following elements for each reach were modified from Alternative 1:

- **Reach 1 – Sheller Avenue to Bailey Ave**
 - The bankfull channel was decreased to promote more frequent shallow flooding in the wetland nodes.
 - The entire existing Fisher Creek was filled to promote cross valley flooding during larger storm events. It was assumed that this condition would evolve naturally as sediment-laden runoff from the surrounding agricultural fields would fill in the channel over time.
- **Reach 2 – Bailey Ave to Santa Teresa Boulevard**
 - No modifications were made in this reach.
- **Reach 3 – Santa Teresa Boulevard to Coyote Creek confluence**
 - The control structure at the outlet of the small triangular shaped detention basin was changed from a slide gate to a flap gate screen off backwater from the Fisher Creek channel and maintain available storage in advance of the peak flood pulse.
 - The right bank floodplain was excavated to the groundwater table elevation to create perennial wetland habitat and increase flood storage capacity.



SOURCE: NAIP (2016), SCVWD (stream centerlines), ESA (2018)

Coyote Valley Restoration

Figure B-4
Map of Alternative 1+ Restoration Design Elements



Initial Fisher Creek and Laguna Seca Wetland Alternatives Cost estimates

Sources and methods

A conceptual-level opinion of probable costs is provided in the next section for planning purposes to allow comparison between the design alternatives, highlight key cost drivers, and inform feasibility. ESA developed two opinions of probable costs based on the conceptual designs for each of the design alternatives and included planning and permitting phase services, design phase services, construction phase services, and construction costs. The approximate new or restored wetland areas shown in the conceptual designs were summed, and the approximate new or restored riparian corridor areas associated with the channel shown in the conceptual designs were also summed. The first cost estimate (Table B-1) conservatively assumed that all material excavated from the restored channels and wetlands would have to be disposed of off-site, and that engineered streambed material (gravel/cobble mixture) would be imported to construct the channel beds. These assumptions strongly affect the construction cost estimate. In response to team feedback ESA developed a second set of cost estimates (Table B-2) that assumed cut and fill were balanced on site, and that the channel was constructed without imported material, in addition to some smaller design refinements. The cut and fill and streambed assumptions significantly reduced the estimated construction cost.

These opinions of probable costs are intended to provide bookends on approximate total project costs appropriate for the conceptual level of design. The estimates are considered to be approximately -30% to +50% accurate, and include a 35% contingency to account for project uncertainties (such as final design, permitting restrictions, and bidding climate). All unit costs are in 2017 dollars and based on recent relevant project experience and contractor bids.

Demolition is the largest project cost based on removal of levee infrastructure (concrete, metal, and geo-grid material). The second largest cost is engineered streambed material. Other significant costs include revegetation and earthwork (excavation fill and placement).

The overall project cost could be decreased in future design iterations by reducing the amount of bypass levee demolished, economizing on total earthwork (e.g. exploring levee breach options, wetland node size, and floodplain excavation), finding ways to use excess soil on-site (e.g. creating check-dams in foothill disconnection locations and creating habitat mounds), and engaging with volunteers for revegetation efforts.

Summary

Four conceptual design alternatives were analyzed to evaluate ecological function and flood management of Fisher Creek and its floodplain and Laguna Seca. While Alternative 3 has the greatest new restored channel length, riparian corridor area, and wetland area, the modeling analysis suggests that Fisher Creek is not likely to support two channel alignments between Bailey Road and Santa Teresa Avenue and maintain high ecological functionality. Of the initial three alternatives, Alternative 1 had the most ecological function and flood benefit; therefore,

Alternative 1 plus additional design elements (primarily excavating the right floodplain downstream of Santa Teresa Boulevard) provided even greater ecological function and flood benefit. Future design iterations are recommended to maximize ecological function and flood benefit, while minimizing total project cost. Key channel metrics and conceptual costs for each alternative are summarized in **Table B-1 and B-2**.

**TABLE B-1
KEY PHYSICAL METRICS AND PROJECT COSTS FOR RESTORATION ALTERNATIVES**

Design alternative	Total channel length (mi)	New or restored riparian corridor (ac)	New or restored wetland (ac)	Construction cost	Total project cost*
1	5.1	31	109	\$32.3M	\$54.9M
2	4.3	31	50	\$24.3M	\$41.3M
3	6.2	51	86	\$32.4M	\$55.0M
1+	5.1	33	141	\$34.8M	\$59.1M

NOTES:

See Appendix B for cost estimation

Metrics are for project area between Scheller Avenue and Coyote Creek confluence

* Total project cost does not include land acquisition costs

**TABLE B-2
KEY PHYSICAL METRICS AND PROJECT COSTS FOR RESTORATION ALTERNATIVES ASSUMING BALANCED CUT AND FILL AND NO IMPORTED STREAMBED MATERIAL**

Design alternative	Total channel length (mi)	New or restored riparian corridor (ac)	New or restored wetland (ac)	Construction cost	Total project cost*
1	5.1	31	109	\$10.8M	\$18.5M
2	4.3	31	50	\$7.4M	\$12.6M
3	6.2	51	86	\$13.9M	\$23.5M
1+	5.1	33	141	\$13.3M	\$22.6M

NOTES:

See Appendix B for cost estimation

Metrics are for project area between Scheller Avenue and Coyote Creek confluence

* Total project cost does not include land acquisition costs

Fisher Creek Restoration Alternative Results

The 1D/2D hydrodynamic flood model was applied to simulate the hydraulics and inundation patterns for a range of events for each of the alternatives described in this appendix. The model geometry that combines both Fisher and Coyote Creek is a computationally intensive model and thus was only run for the largest flow—the 1% annual chance, or 100-year, event—where cross-valley flow interactions are important. For the smaller, more frequent events, Fisher Creek was run in isolation because flows from Coyote Creek do not cross over into Fisher Creek. This chapter describes the results of the modeling analyses for the Fisher Creek and cross-valley connection alternatives.

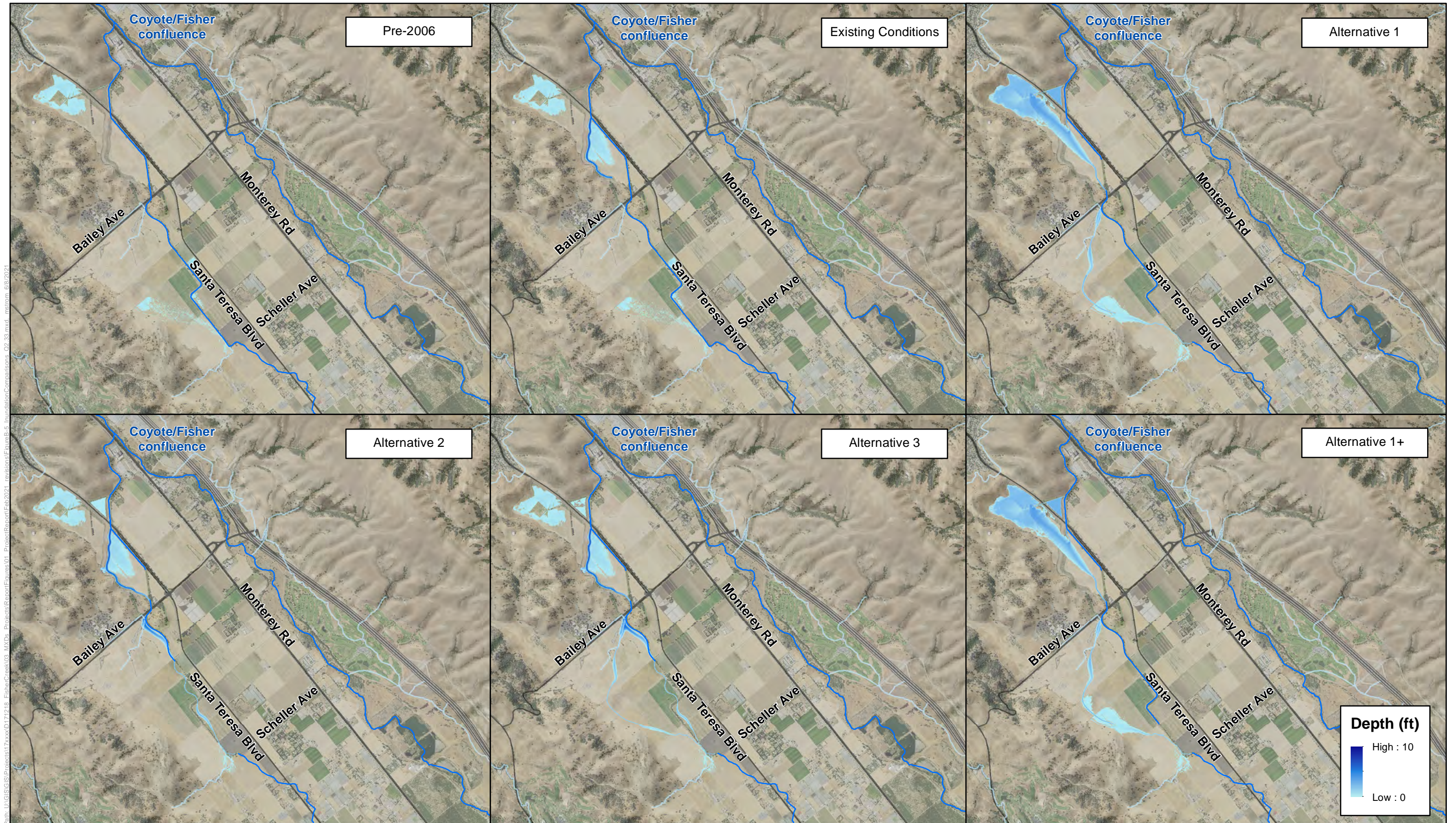
The alternatives were divided into project reaches which include Scheller Avenue to Bailey Ave (Reach 1), Bailey Ave to Santa Teresa Blvd (Reach 2), and Santa Teresa Blvd to the Coyote Creek confluence (Reach 3). Inundation depth and extent were compared for pre-2006, existing, and design alternatives conditions to evaluate ecosystem function (2.33- and 10-year flow events) and flood benefit (25-year flow event).

Ecosystem Function (2.33- and 10-year flow events)

Frequent flow events (<10-year return interval) are important for understanding ecosystem functions such as floodplain evolution. Key parameters for quantifying the restoration benefit of the design alternatives with respect to ecosystem conditions include channel conveyance capacity, floodplain connectivity, inundation area, and inundation depth. Inundation extents for existing conditions, pre-2006 conditions, and all alternatives are shown for the 2.33-, and 10-year events in **Figure B-5**, and **Figure B-6** respectively.

As the inundation extent maps show, Fisher Creek and its floodplain are well connected in Reach 1 upstream of Bailey Ave for Alt 1 and Alt1+. The proposed Fisher Creek alignment and seasonal wetland nodes help to consolidate deeper flow (compared to existing conditions) within restoration areas. Shallow flooding outside of the channel and wetland nodes help to support seasonal wetland habitat. Though floodplain extent is greater under existing conditions for the 10-year event, the majority of existing inundation is very shallow (<1') and less conducive to supporting wetland habitat than the deeper inundation areas created in Alt1 and Alt1+. Concentrating deeper inundation in restoration nodes is expected to create higher ecological lift in those areas compared to the existing condition of very shallow flow over agricultural areas. For Alternatives 2 and 3 the added sinuosity and seasonal wetland nodes to Fisher Creek increase ecosystem function along the creek corridor; however, Fisher Creek and its floodplain continue to be disconnected as seen in the 10-year event (natural floodplain sits within the western low-lying valley).

In Reach 2 significant enhancements to ecosystem function in the Laguna Seca result from Alt1 and Alt1+. The realigned Fisher Creek channel conveys flow into the Laguna inundating significantly more area than under existing conditions for all flow events. This would help establish seasonal wetland and encourage perennial wetland establishments for the lowest elevation portions of the Laguna, especially when combined with the blockage of tile drains that currently lower the water table in this area. Alt 2 and 3 show significantly less inundation in the north Laguna and equivalent

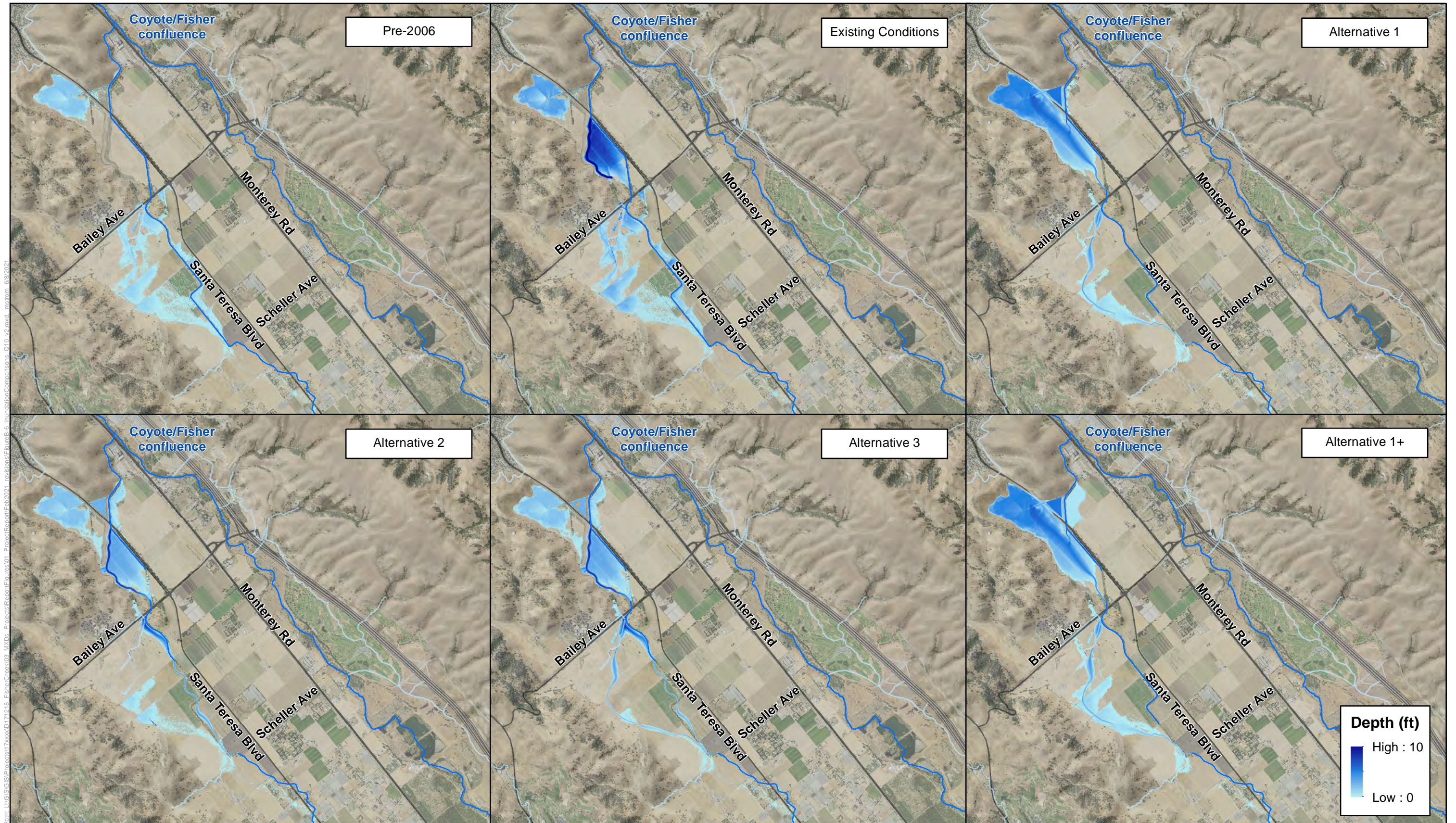


SOURCE: NAIP (2014), SCVWD (stream centerlines)

Coyote Valley Restoration

Figure B-5
 Inundation comparisons for Q2.33 (original hydrology before storm centering update)
 Pre-2006 / Existing Conditions / Alternatives 1, 2, 3, and 1+





SOURCE: NAIP (2014), SCVWD (stream centerlines)

Coyote Valley Restoration

Figure B-6
 Inundation comparisons for Q10 (original hydrology before storm centering update)
 Pre-2006 / Existing Conditions / Alternatives 1, 2, 3, and 1+



inundation adjacent to the bypass relative to existing conditions. In the 2.33-year event, only local hillside drainage contributes to the north Laguna inundation. During the 10-year event, inundation in the north Laguna is constrained under these alternatives relative to Alts 1 and Alt1+.

In Reach 3, the small triangular shaped detention basin is fully inundated creating perennial wetland habitat under Alt 1 and Alt1+. The right bank floodplain receives little inundation through the at-grade breach in Alt 1, while grading this floodplain down for Alt1+ generates an additional 30 acres of floodplain relative to existing conditions for the 10-year event. This breach and floodplain is only activated in the 10-year event, indicating that the channel incision has reduced the channel-floodplain connection on this reach of Fisher Creek. Under Alts 2 and 3 the small triangular shaped detention basin is well inundated; however, the right bank floodplain is not significantly connected in either the 2.33 or 10-year events.

The total acreage of inundation is a key metric for defining the potential wetland conditions for each of the alternatives. The depth of inundation indicates whether flow is consolidated sufficiently to support the wetlands long-term. A summary of the inundation acreage for each of the events is included in **Table B-3**, and a breakdown of the inundation acreage for different depth ranges is summarized in **Table B-4**.

TABLE B-3
INUNDATION ACREAGE FOR Q2.33, Q10 AND Q25 (24-HOUR*) FOR FISHER CREEK ALTERNATIVES

Scheller to Coyote					
Flow event	Inundation area (ac)				
	EC	Alt1	Alt2	Alt3	Alt1+
Q2.33	145	208	153	165	214
Q10	442	360	353	319	416
Q25	541	458	449	389	500

* Original hydrology prior to storm centering update

TABLE B-4
INUNDATION ACREAGE BY DEPTH FOR Q10 (24-HOUR*) FOR FISHER CREEK ALTERNATIVES

Scheller to Coyote					
Depth (ft)	Inundation area (ac)				
	EC	Alt1	Alt2	Alt3	Alt1+
<1	269	113	156	109	170
1-5	164	203	178	190	207
>5	9	43	19	20	39

* Original hydrology prior to storm centering update

As these tables show, the inundation acreage for all of the alternatives is increased for the most frequent flood event relative to existing conditions, and reduced for the larger events. Drilling down further into the 10-year event, we can see that reduction in acres is all within the range of

depths less than 1-ft. For depths from 1-5 feet and above 5-feet, the alternatives significantly increase inundation acreage. This suggests that, by consolidating flow into wetland areas along the valley floor upstream of Bailey, in the restored Laguna Seca, and in the floodplain area downstream of Santa Teresa, the restoration designs are creating substantially more viable wetland area than under existing conditions. Though the total acreage of inundation is reduced, the acreage within depth ranges that are more likely to support long-term habitat establishment is significantly increased. Additionally, by directing flow into these wetland nodes rather than allowing it to spread out unconstrained onto farmland, it will be substantially easier to vegetate the wetlands and manage them as they mature. Concentrating overland flow into restored wetlands rather than over agricultural land is also expected to improve water quality. The enhanced Alternative 1 provides the greatest inundation acreage and most significant improvement for enhancing ecological function in all three reaches on Fisher Creek.

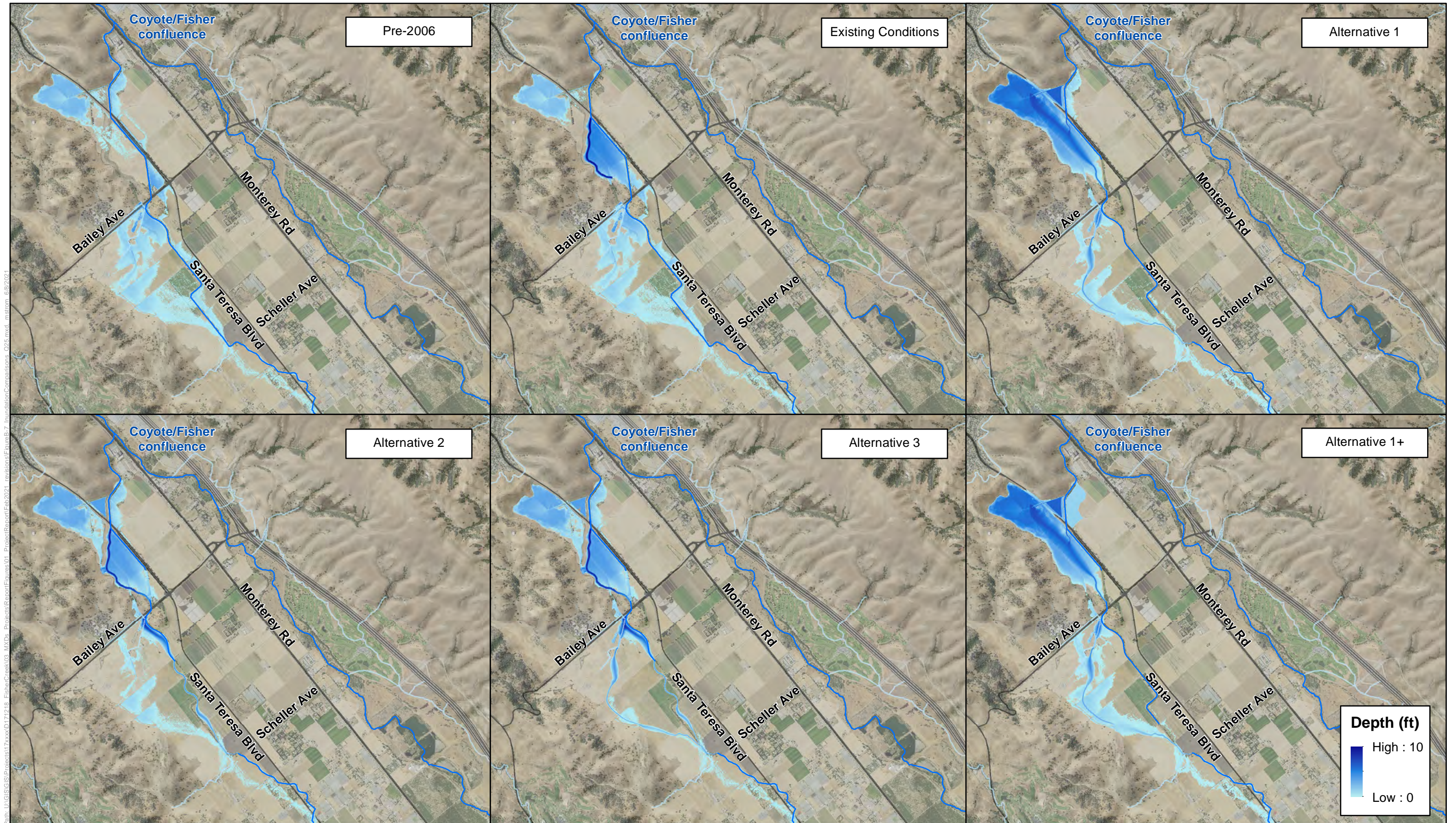
Flood Benefit (25-year flow event)

Intermediate and large flow events (25-year and greater flow events) are important for understanding flood benefit, specifically peak flow and flow volume reduction. Inundation depths and extent show where overtopping occurs and to what degree parcels and infrastructure are flooded. Inundation extents for existing conditions, pre-2006 conditions, and all alternatives are shown for the 25-year event in **Figure B-7**.

As the inundation map for this event shows, the realigned Fisher Creek channel and floodplain in Reach 1 helps to attenuate flow upstream of the Laguna Seca, providing reductions in the volume and the peak of flood flows. Under existing conditions, a portion of the flow overtops along the western edge of the valley while some of the flow remains in the existing alignment. The western flow path is a longer distance than the existing channel and thus has increased flood reduction potential. In Alt 1 and Alt1+, all flows downstream of Scheller Ave are routed to the western alignment, slowing down a higher proportion of the flow and enhancing peak flow attenuation. Fisher Creek and its floodplain are well-connected upstream of Bailey Ave. For Alts 2 and 3, the floodplain is disconnected from the main channel. Flow escaping the channel to the western portion of the valley backs up against existing road crossings which act as check dams and contribute to peak flow attenuation.

In Reach 2, the Laguna Seca provides a high flood benefit for Alt1 and Alt1+. The restored Laguna is highly inundated (providing flood storage capacity), has a well-connected floodplain, and provides substantial peak flow reduction downstream. Flood storage capacity could be increased by either excavating the Laguna Seca and or creating smaller low flow channels to direct flow to higher floodplain areas.

In Reach 3, a small triangular shaped detention basin is inundated under all of the alternatives; however, flooding across Santa Teresa Boulevard, an existing issue during flow events of this magnitude, may need to be addressed at future design stages. Flooding through the right bank breach is minimal under Alts 1, 2 and 3, but increases to around 30 acres of inundation under Alt1+.



SOURCE: NAIP (2014), SCVWD (stream centerlines)

Coyote Valley Restoration

Figure B-7
 Inundation comparisons for Q25 (original hydrology before storm centering update)
 Pre-2006 / Existing Conditions / Alternatives 1, 2, 3, and 1+



A summary of peak flows at Bailey Ave and immediately upstream of the Coyote Creek confluence is included in **Table B-5**. Flows at Bailey Ave indicate how much flow is attenuated within the Fisher Creek floodplain. Flows at the Coyote Creek confluence indicate peak flow reduction of the full project as well as flood storage capacity of the Laguna Seca, small triangular shaped detention basin, and the right bank Fisher Creek floodplain downstream of Santa Teresa Boulevard.

TABLE B-5
PEAK FLOW REDUCTION FOR Q2.33, Q10 AND Q25 FOR FISHER CREEK ALTERNATIVES

Flow event	Scenario	Peak flow (cfs)		Reduction (%)	
		At Bailey Ave	Immediately upstream of Coyote Creek confluence	At Bailey Ave	Immediately upstream of Coyote Creek confluence
Q2.33*	<i>Existing conditions</i>	266	232	-	-
	<i>Alternative 1</i>	293	118	-10%	49%
	<i>Alternative 2</i>	264	234	1%	-1%
	<i>Alternative 3</i>	249	230	7%	1%
	<i>Alternative 1+</i>	291	119	-9%	49%
Q10*	<i>Existing conditions</i>	603	580	-	-
	<i>Alternative 1</i>	784	384	-30%	34%
	<i>Alternative 2</i>	723	521	-20%	10%
	<i>Alternative 3</i>	706	530	-17%	9%
	<i>Alternative 1+</i>	758	374	-26%	35%
Q25*	<i>Existing conditions</i>	885	775	-	-
	<i>Alternative 1</i>	1018	505	-15%	35%
	<i>Alternative 2</i>	939	610	-6%	21%
	<i>Alternative 3</i>	931	618	-5%	20%
	<i>Alternative 1+</i>	1015	505	-15%	35%

* Original hydrology prior to storm centering update

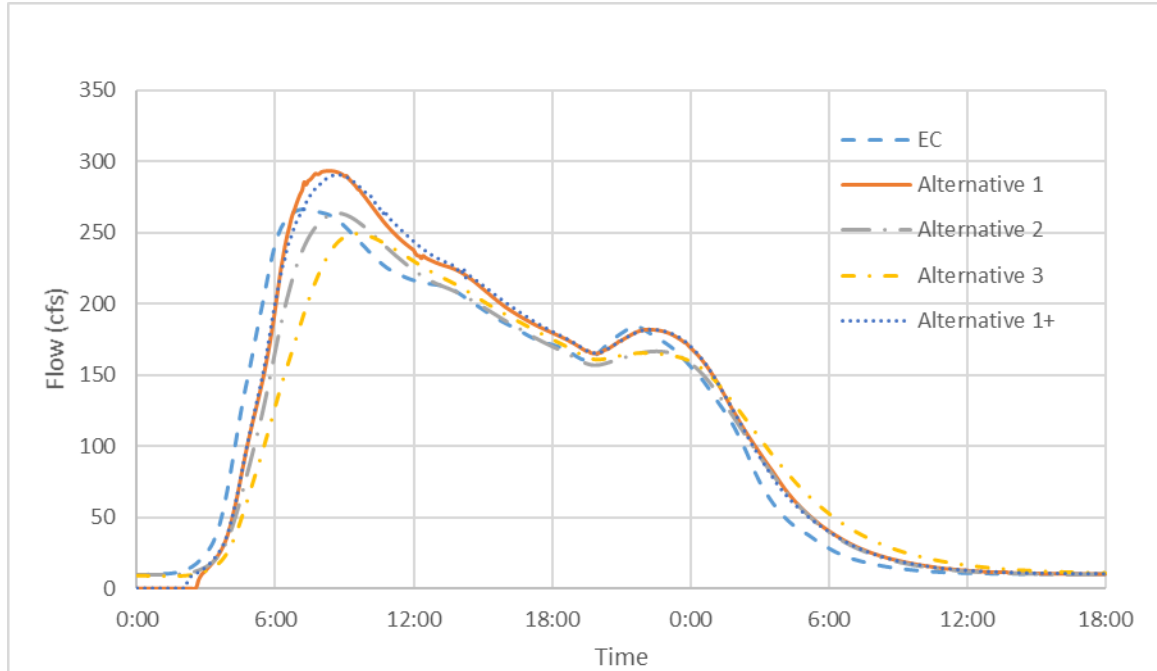
As indicated in this table, flows at Bailey Ave are slightly increased for most of the flow events and restoration alternatives. This is due to the fact that flows are more consolidated in the restored wetland nodes and floodplain inundation is less diffuse than under existing conditions. Though flows at Bailey Ave are increased, the design elements downstream of Bailey Ave contribute to substantial peak flow reductions at Coyote Creek. In particular, the restored and reconnected Laguna under Alt1 and Alt1+ drives the greatest peak flow reduction benefits resulting in a 35% reduction in peak flows before joining Coyote Creek.

Hydrograph results and discussion

Flow hydrographs on Fisher Creek at Bailey Ave and just above the Coyote Creek confluence are shown below. These figures show that at Bailey Ave (**Figures B-8, B-9, and B-10**), the timing of the flow is slightly delayed but overall flows are increased for the majority of the events. The delay is a function of the longer western flow path while the increase in flow is a function of

consolidating flows into the wetland nodes and realigned channel. This indicates that, above Bailey Ave, the restoration improves ecological conditions but does not contribute to the overall peak flow reduction further downstream.

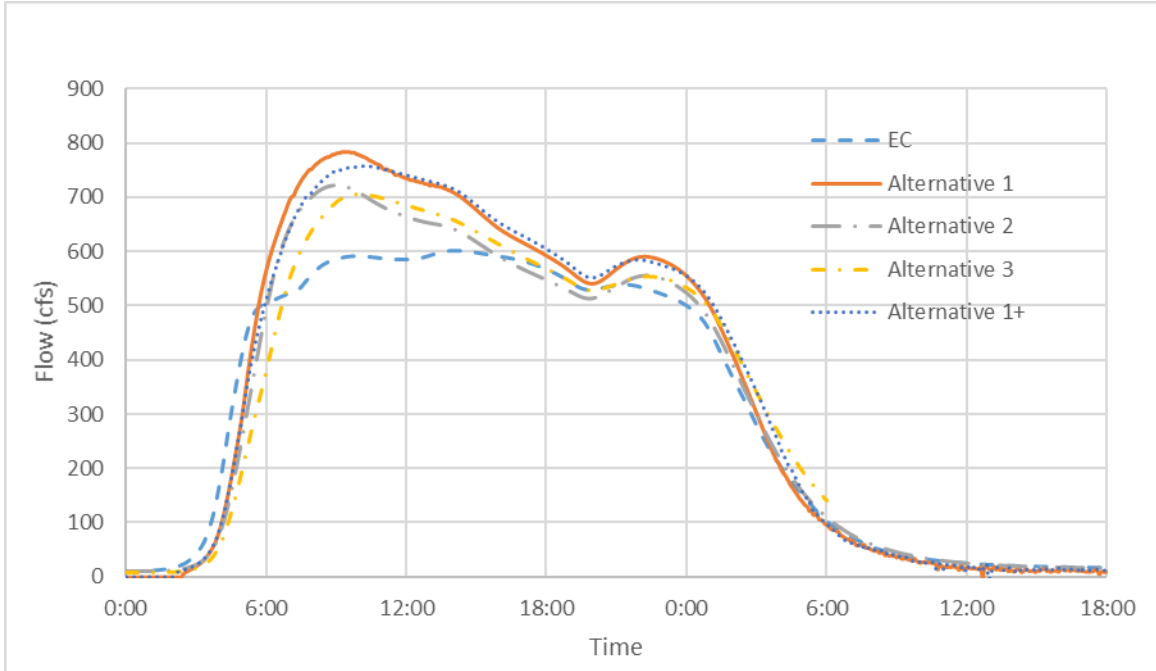
The hydrographs just upstream of the Coyote Creek confluence (**Figures B-11, B-12, and B-13**) show that the peak flow is significantly reduced for Alt1 and Alt1+ and is also delayed by several hours. For Alt1, the 10-year peak flow is delayed by around 3 hours while under Alt1+ it is delayed by 5.5 hours. This is driven by the enhanced right bank breach and floodplain grading on Alt1+ which provides additional storage and delays the peak further than Alt1 which has a smaller breach at existing grade. These hydrographs indicate that, while it further delays the peak, the added right bank floodplain in Alt1+ only slightly reduces the discharge below the reduction provided by Alt1. This is because the majority of the additional storage fills up before the peak flow comes in and thus is not able to provide much additional benefit. This element could be further enhanced for flood reduction by increasing the height of the breach such that the storage remains empty in advance of the peak.



SOURCE: ESA (2018 HEC-RAS model)

Coyote Valley Restoration

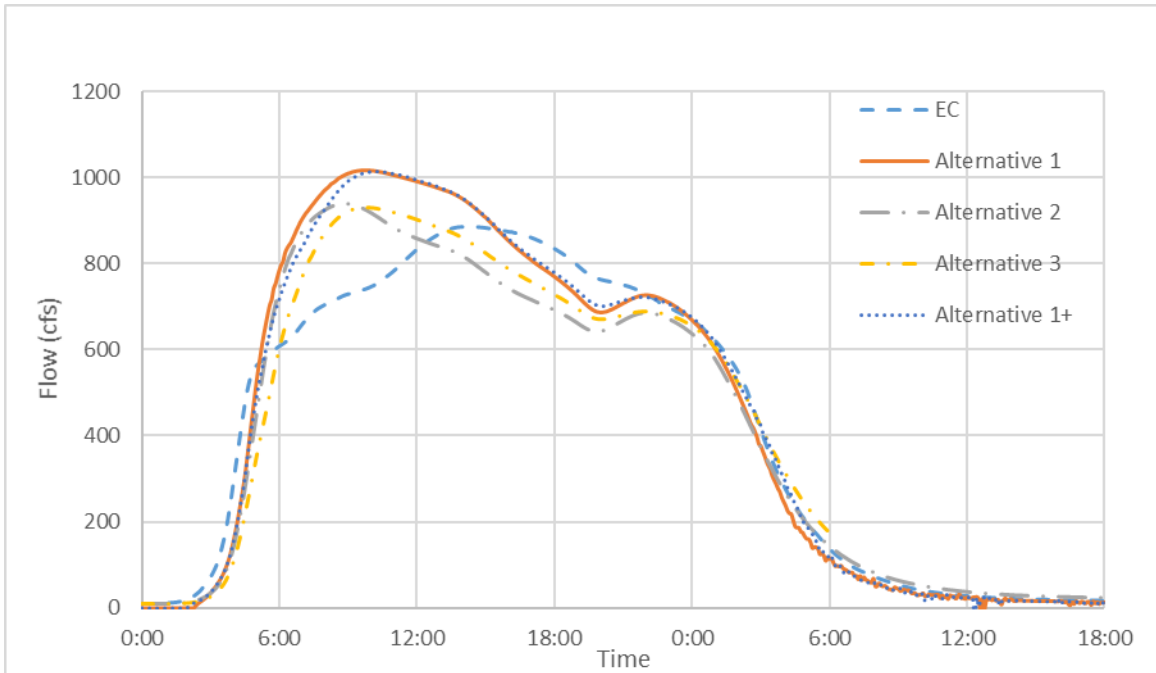
Figure B-8
Hydrographs for the 2.33-year event at Bailey Ave
(original hydrology before storm centering update)



SOURCE: ESA (2018 HEC-RAS model)

Coyote Valley Restoration

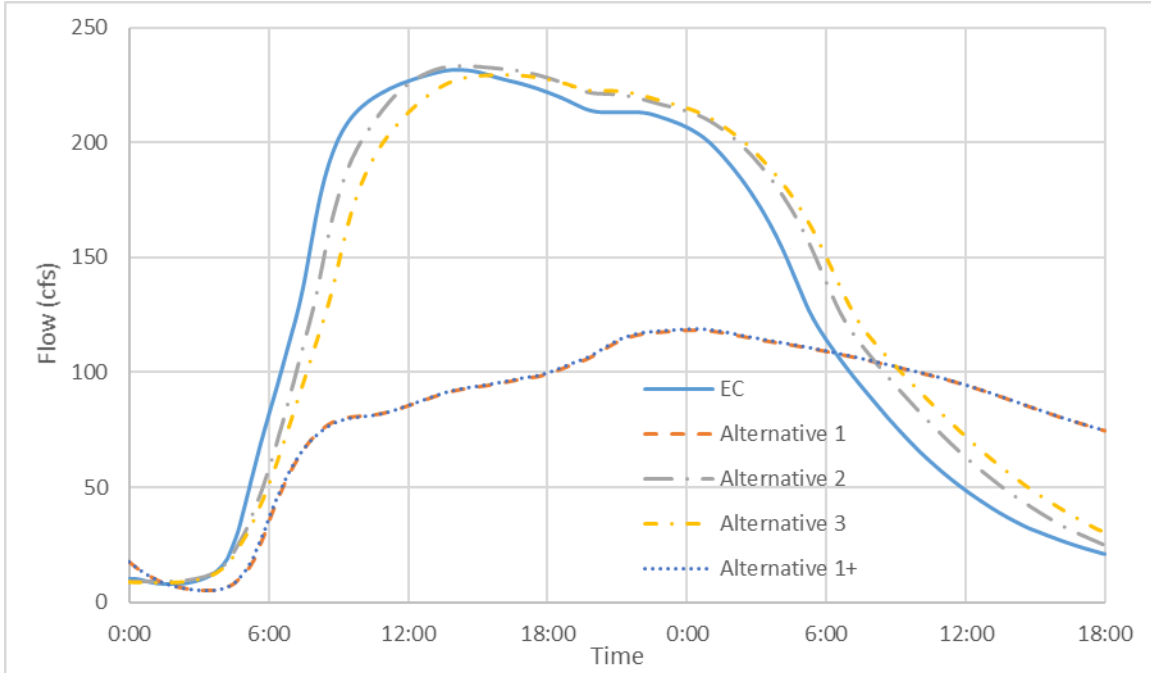
Figure B-9
Hydrographs for the 10-year event at Bailey Ave
(original hydrology before storm centering update)



SOURCE: ESA (2018 HEC-RAS model)

Coyote Valley Restoration

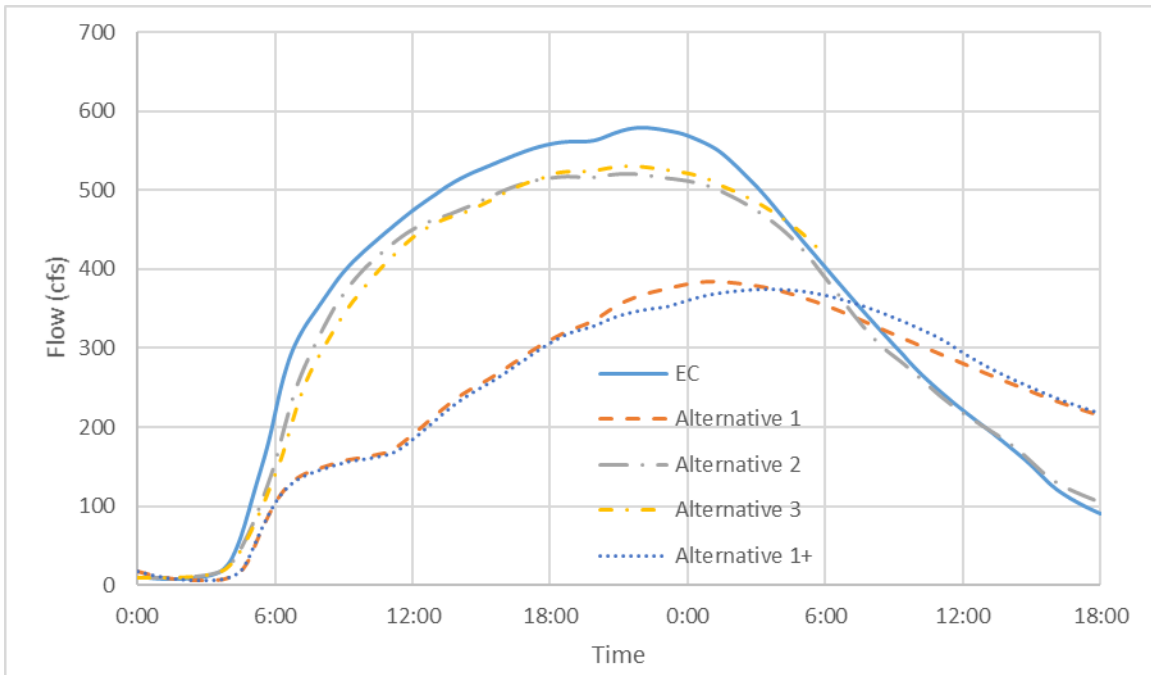
Figure B-10
Hydrographs for the 25-year event at Bailey Ave
(original hydrology before storm centering update)



SOURCE: ESA (2018 HEC-RAS model)

Coyote Valley Restoration

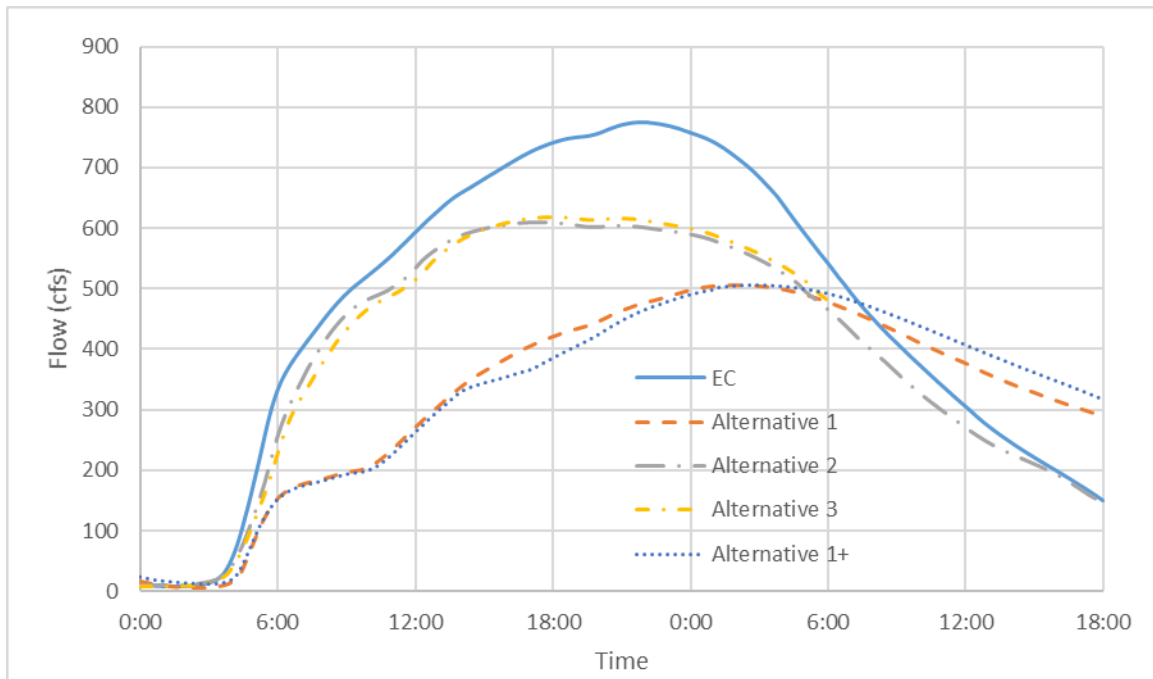
Figure B-11
Hydrographs for the 2.33-year event just upstream of the confluence with Coyote Creek (original hydrology before storm centering update)



SOURCE: ESA (2018 HEC-RAS model)

Coyote Valley Restoration

Figure B-12
Hydrographs for the 10-year event just upstream of the confluence with Coyote Creek (original hydrology before storm centering update)



SOURCE: ESA (2018 HEC-RAS model)

Coyote Valley Restoration

Figure B-13

Hydrographs for the 25 -year event just upstream of the confluence with Coyote Creek (original hydrology before storm centering update)

Potential Enhancements for Alternative 1

At the landscape scale, the primary features of the Alternative 1+ have been well defined for conceptual analysis and modeling. However, a number of higher-detail enhancements have been identified for future consideration to improve the ecological and flood benefit of the Alternative 1+.

For Reach 1, the channel dimensions and planform sinuosity in the new western channel and wetland nodes could be refined to increase seasonal wetland acreage and habitat diversity. Additionally, within the stage-1 channels, the cross-section could be graded as a two-stage channel with floodplain benches to encourage more natural velocity conditions in the channel, benefiting sedimentation and erosion patterns and enhancing habitat complexity. Replacing all the proposed stage-1 channels with stage-0 swales could also both increase the area of wetland and avoid localized increases in flood elevation.

In Reach 2, additional grading could be implemented to provide additional flood storage in the Laguna. Portions of the south Laguna just downstream of Bailey are not inundated during high flow events and this area could be graded down to increase flood storage. The north Laguna could be lowered to increase flood storage; however, the groundwater elevations would limit the amount of grading possible here.

Fisher Creek Foothills Disconnection

The Santa Cruz Mountain foothills which drain to the main stem of Fisher Creek from the West tended to historically fan out as the grade transitions from the steeper foothill terrain to the relatively flat valley floor. This transition in slope would create alluvial fans allowing flow to slow down and spread out into multiple distributary channels and percolate into the soil and potentially into groundwater storage below. Over time, landuse management has altered these flow paths such that flows are concentrated and routed more efficiently to the Creek thereby increasing flows and flood risk downstream. This process is self-perpetuating, as the incising channels will concentrate more flow and incise further over time.

Part of the overall strategy for restoring more natural hydrologic conditions in the Fisher Creek watershed includes disconnecting the foothills drainages to reduce downstream flood peaks, enhance wetland and alluvial fan habitat development, and encourage percolation into the groundwater aquifer recommended. The channel restoration grading for Fisher Creek yields a net positive cut volume. The material from the restoration grading could be used to create subtle berms and microtopography along the foothills drainages to facilitate percolation and peak flow attenuation processes.

Valley Water's hydrologic (HEC-HMS) model was used to evaluate the flow contributions of the various foothills drainages. Subbasins and drainage names are shown in **Figure 3** in the main report. The 100-year peak flow on Fisher Creek just above its confluence with Coyote Creek is 2,474 cfs. The flow from the foothills basins (Fisher_2, Fisher_3, Fisher_4, Fisher_6, and Fisher_7) totals 1,665 cfs. Some of the individual basins represent significant contributions to the downstream peak flows on Fisher Creek while others are more limited. Upstream drainage area, flow contribution, and land availability at the disconnection points can guide which basins to prioritize for disconnecting the foothills drainage.

The two square-mile subbasin draining from the foothills adjacent to the IBM property conveys flow from two primary branches which drain to a relatively flat, undeveloped parcel before routing parallel to Bailey Avenue and into Fisher Creek. The 100-year peak flow from this subbasin (Fisher_7) is 383 cfs, or around 15% of the peak flow at Coyote—a relatively significant portion of the overall flow contribution to the main channel. With the undeveloped parcels at the outlet to the foothills, this drainage presents a high value opportunity for spreading out and infiltrating the foothills flows.

In Fisher Creek Branch C, the foothills make up a small proportion of the overall drainage area. Thus, this basin is not a high priority for disconnecting the drainages from the foothills. Fisher Creek Branch D and E each capture approximately 1.1 square-miles of drainage from foothills representing a peak flow of around 180 cfs from their respective subbasins. Thus, each basin represents around 7% of the overall 100-year peak flow—14% total. The drainage to Willow Springs is around 0.9 square-miles and represents a 100-year peak of around 190 cfs or 8% of the overall 100-year peak on Fisher Creek. These three drainages individually yield a lower cost-benefit ratio than the IBM subbasin.

APPENDIX C

2018 Hydraulic Refinements Memo



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memorandum

date August 13, 2018

to Liang Xu, Emily Zedler, Brian Mendenhall, Jack Xu, Robert Chan - SCVWD

cc Matt Freeman, Jake Smith – Santa Clara Valley Open Space Authority

from James Gregory, Andy Collison, Annika Sullivan – ESA

subject Updates to Coyote Creek and Fisher Creek HEC-RAS models and development of combined system model

This memorandum documents the changes ESA implemented in the process of combining the Fisher Creek and Coyote Creek HEC-RAS models developed by the Santa Clara Valley Water District (SCVWD, District). The District provided the models to the Santa Clara Valley Open Space Authority (OSA) who transferred the files to ESA. The models were developed in HEC-RAS version 5.0.3. The latest version of HEC-RAS, v5.0.5, has bugs in the export process and thus was not used to develop these models. A list of plans contained with the model files is included with this document in an excel file. The following describes the model edits and refinements applied to the model geometry, flow files, and computational settings.

Coyote Creek Model Geometry

2D area extents

Cross-sections were trimmed to the main channel only and the 2D extents were edited to replace the portion of the cross-sections that were edited. Lateral structures were snapped to the edge of the new 2D boundaries. Given the complexity of the flow once it enters the Ogier Ponds complex, this area was configured to be fully 2D and the main channel of Coyote Creek enters and exits the 2D area as 1D/2D connections. The cross-sections (light and dark green lines) and 2D extents (hatched areas) are shown for the District model and the ESA model in the figure below.

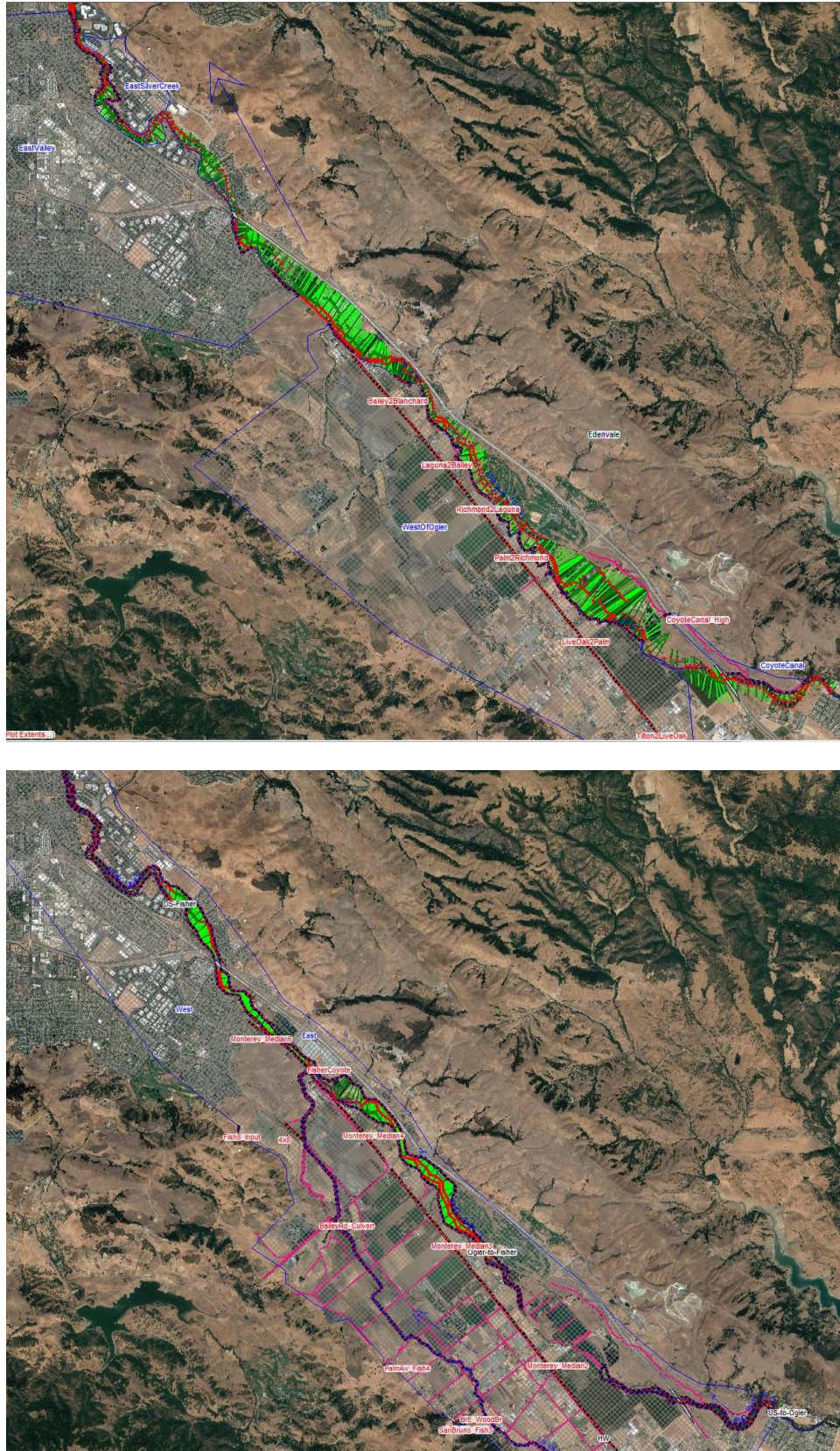


Figure 1. District model geometry (top) ESA model geometry (bottom)

Lateral structures

The lateral structures from the prior model had reversed geospatial coordinates which caused discrepancies between where the structures are located relative to the 1D channel. ESA replaced all these structures and reviewed the geospatial coordinates for accuracy. An example of this issue is shown in the figure below.

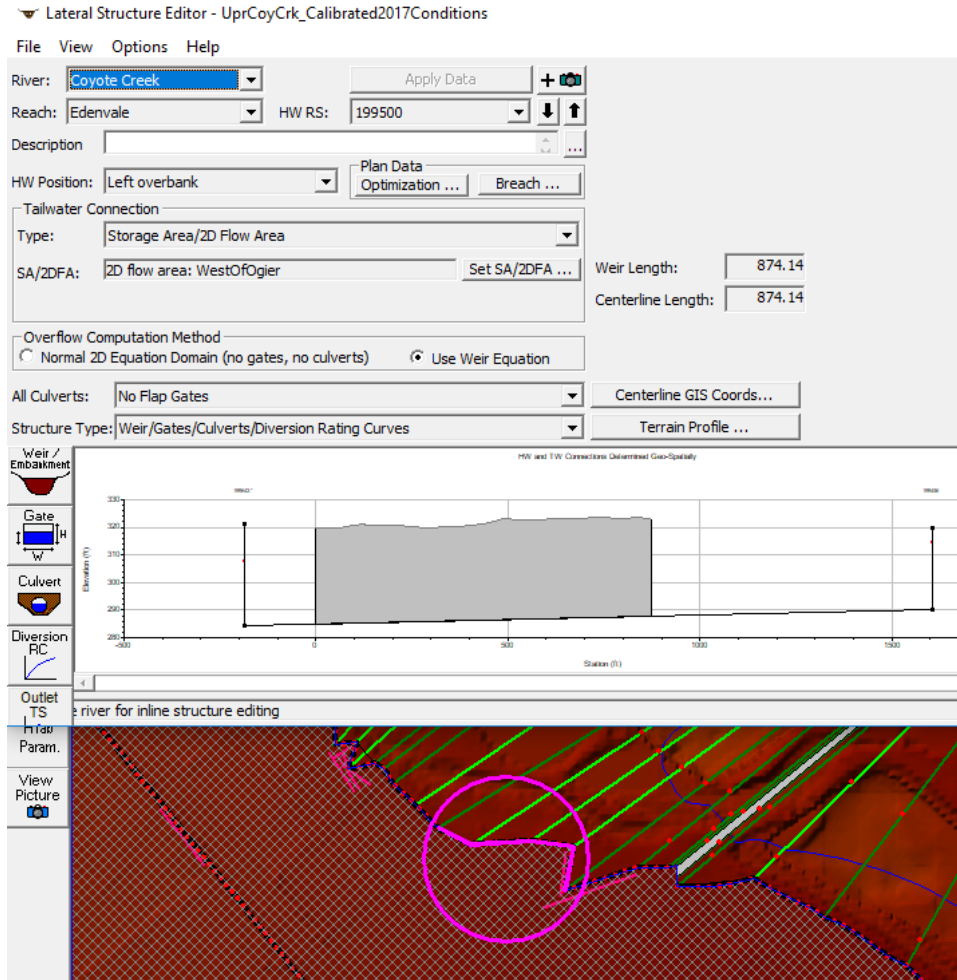
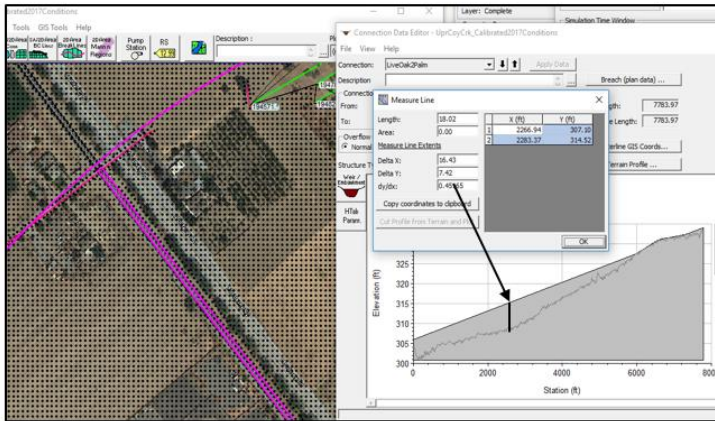


Figure 2. Lateral structure 199500. Lateral structure spans 4 cross-sections as shown in the bottom portion of the figure but is only situated between two sections as shown in the top part of the figure.

Breaklines and 2D connection lines

The original model contained 2D connection lines which were raised well above the ground surface which were removed. Additional 2D connection lines were added to Monterey Avenue to capture the top of the median which was measured in the field at 36". Additional breaklines were added to capture the top of the Caltrain railroad embankment. Figure 3 shows the prior 2D connection lines and an example of the new line added to capture the median. A cross-section of the railroad and the median added in is shown in Figure 4.

SCVWD model



ESA model

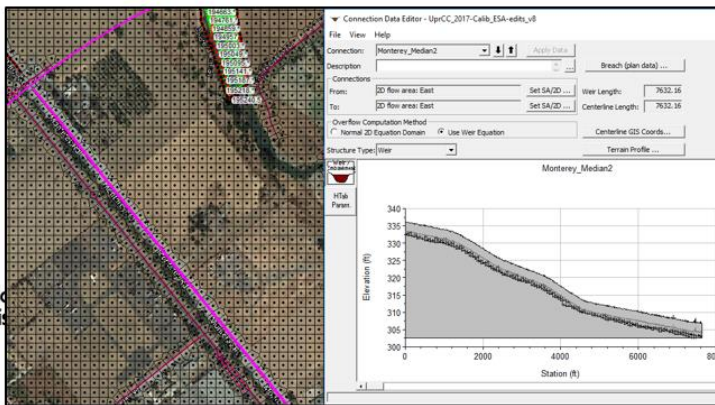


Figure 3. Replaced 2D connection lines for Monterey Avenue median

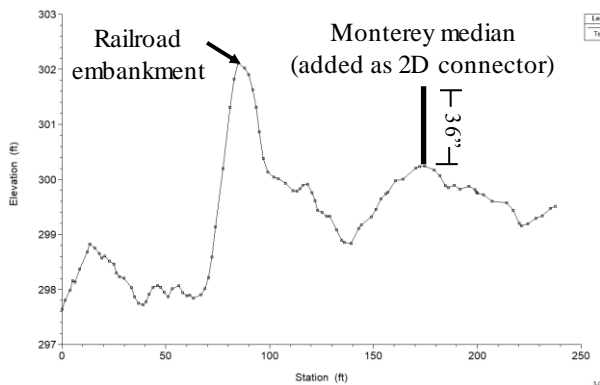


Figure 4. Monterey median and Caltrain railroad

2D manning's roughness

As described in a calibration report (SCVWD, 2018), the District used a combination of 2011 National Landcover Database (NLCD) landuse and a roads layer from the District to associate landcover with roughness values and develop a spatially distributed roughness dataset for the 2D areas. The Fisher Creek model contained a dataset that appeared to use the same inputs. ESA found that the Fisher Creek dataset matched the NLCD data but that

the Coyote Creek dataset did not. Additionally, neither dataset covered the full extent of both models. The District provided ESA with a new roughness layer which matches the NLCD classes and has buildings and roads burned in. The following roughness values are assigned in the landcover dataset in the model.

Table 1. Land Use Class Roughness Values

Raster Value	Description	Manning's n
0	NoData	NA
1	Road	0.025
2	Road	0.025
3	NoData	0.025
5	Barren Land (Rock/Sand/Clay)	0.025
6	Cultivated Crops	0.035
7	Deciduous Forest	0.16
8	Developed, High Intensity	0.15
9	Developed, Low Intensity	0.1
10	Developed, Medium Intensity	0.08
11	Developed, Open Space	0.04
12	Emergent Herbaceous Wetlands	0.07
13	Evergreen Forest	0.16
14	Grassland/Herbaceous	0.035
15	Mixed Forest	0.16
16	Open Water	0.04
17	Pasture/Hay	0.03
18	Shrub/Scrub	0.1
19	Woody Wetlands	0.12
20	Buildings	0.15

Fisher Creek Model Geometry

2D area extents

A gap in the 2D area downstream of Bailey Road on the west side of the bypass channel was revised to make the 2D region continuous. The areas were divided by a weir which is raised above existing grade. The bypass levee is now represented as graded terrain with three ogee weirs and an additional ogee weir at the Santa Teresa culvert inlet, left bank. This area before and after the fix is shown in the figures below.

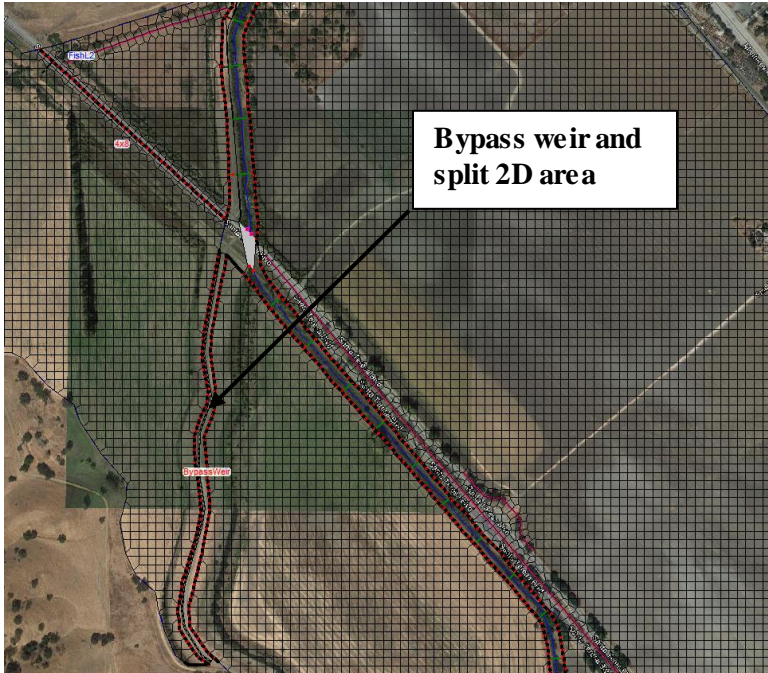


Figure 5. Bypass Weir before Model Update

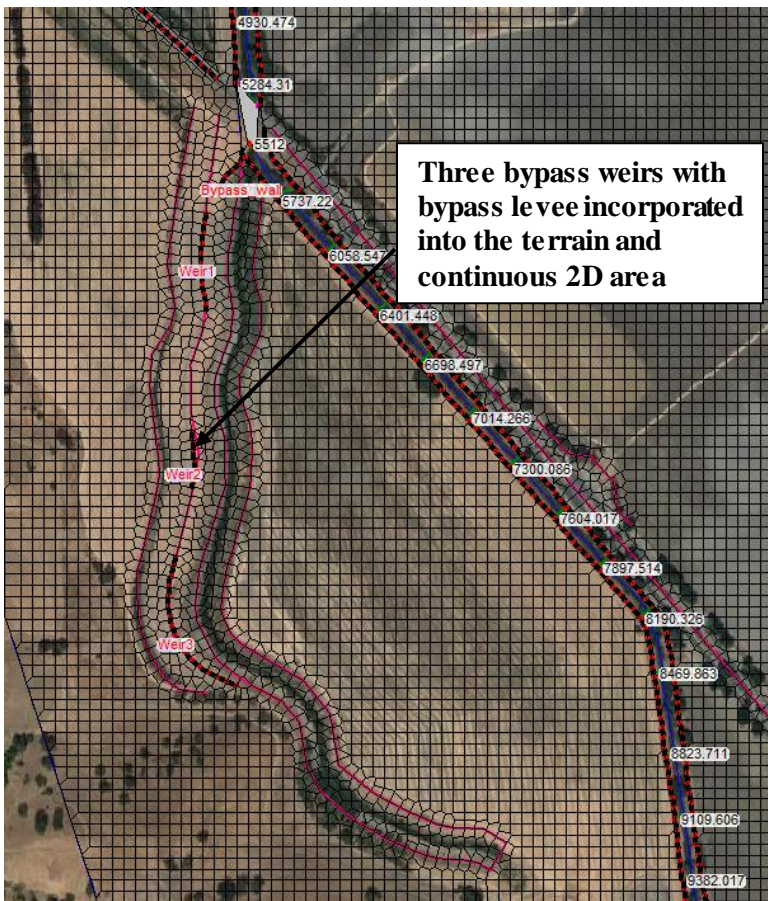


Figure 6. Bypass Weir after Model Update

Culverts

A culvert across Bailey Road (west of the main crossing of Fisher Creek) was added as a 2D connection. Culvert geometry is estimated based on field measurements and photographs. Elevations are approximate. The terrain was graded down at this location to create a flow connection across Bailey Road. The added culvert is shown in the figure below.

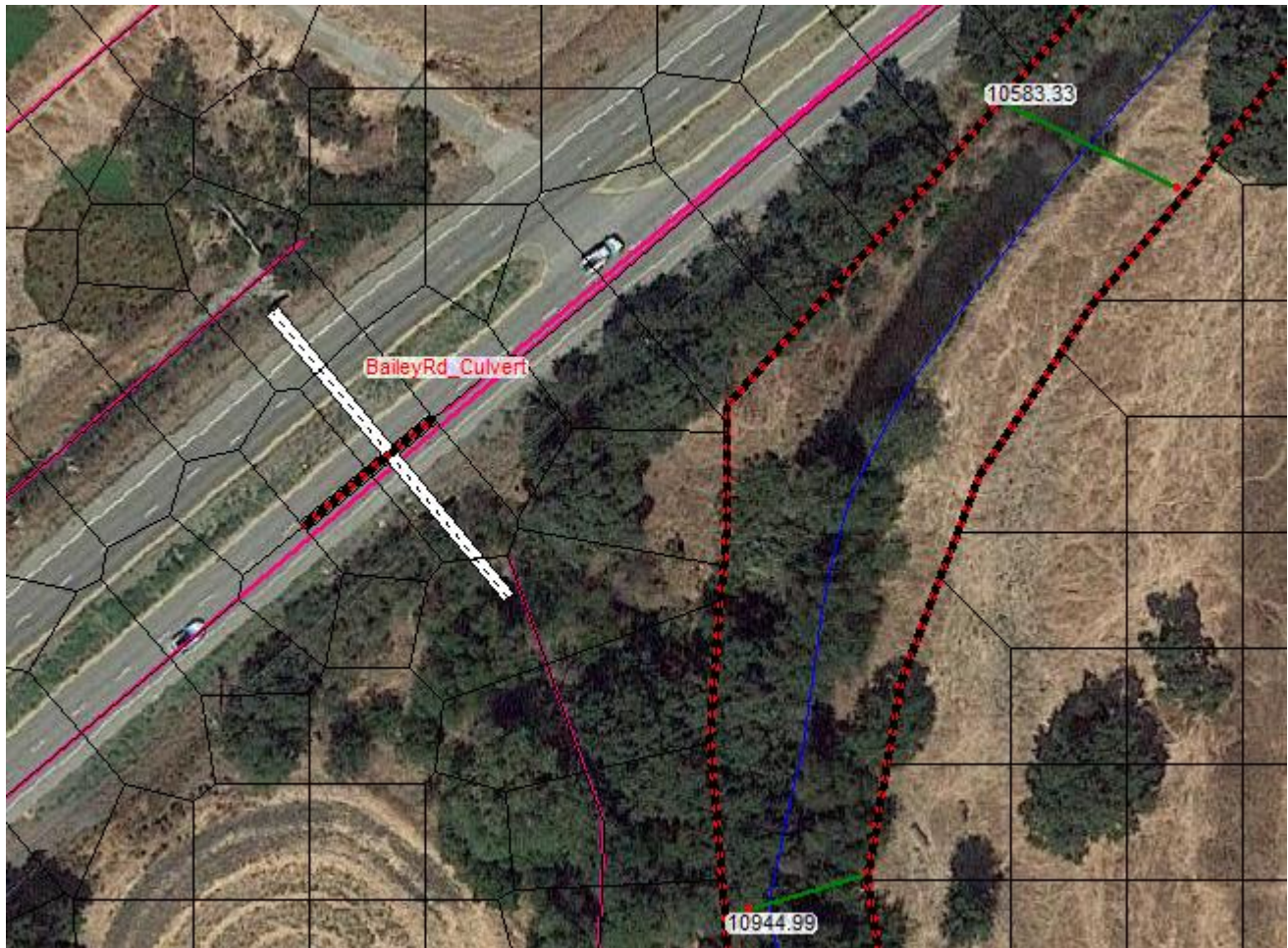


Figure 7. Additional Culvert Across Bailey Road

In addition, fill depth was added to two culverts modeled in 1D. The San Bruno culvert (XS 26700) and Hale culvert (XS 25970) have sedimentation which partially fills the culvert based on field photos.

The basin bound by Santa Teresa Boulevard to the west and Fisher Creek to the east outfalls to Fisher Creek via a 72" diameter culvert and flow is controlled by two 4'x5' slide gates. This culvert was modified to reflect conditions with one slide gate open 1 foot. See figure below.

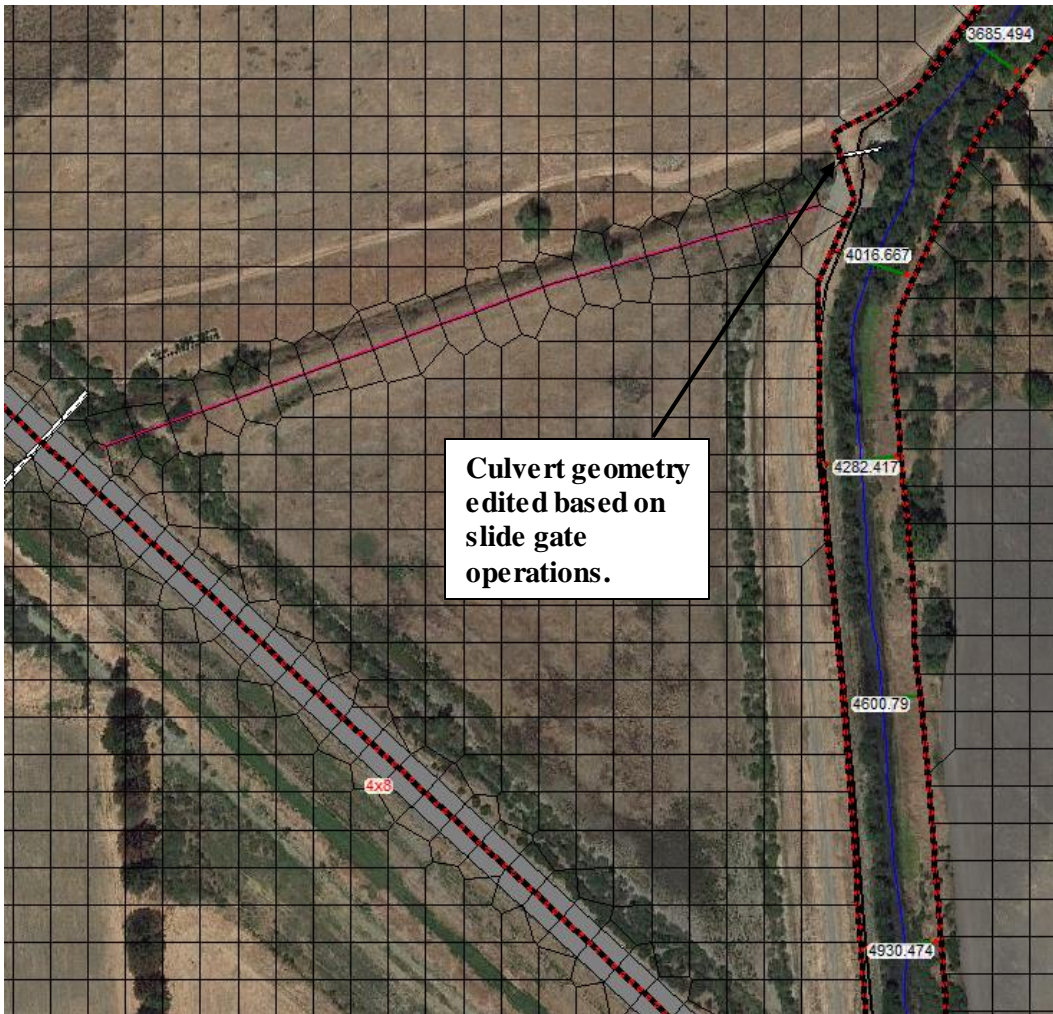


Figure 8. Culvert edited based on slide gate operations.

Lateral Structures

The following lateral structure fixes were implemented:

- Structure at station 35030.7 was connected to the left bank, but is on the right bank of the channel. This was corrected in the geometry.
- Structure at station 35030.2 was connected to the right bank, but is on the left bank of the channel. This was corrected in the geometry.

Cross Sections

Several cross sections were imported backwards creating a crisscrossed cross section interpolation. Cross section stationing and the geospatial alignment were reversed for the following cross sections:

- 20116.38
- 40244.71
- 40594.54
- 41445.6

- 42845.78
- 44319.25
- 47243.89
- 48299.07
- 48770.5
- 49999.31

Combined Model

Model terrain

A few graded elements were added to the terrain in the combined model. The added elements include:

- The bypass levee and channel were graded based on as-built Construction Drawings. (BypassChnl_EC_20180724.tif)
- The culvert across Bailey Road to the west of the main channel crossing was burned in. (BaileyCulvert.tif)
- Overbank topography in the Coyote Creek model area was replaced with 5ft resolution data developed from the County 2006 LiDAR contours (Fisher_5ft.tif)

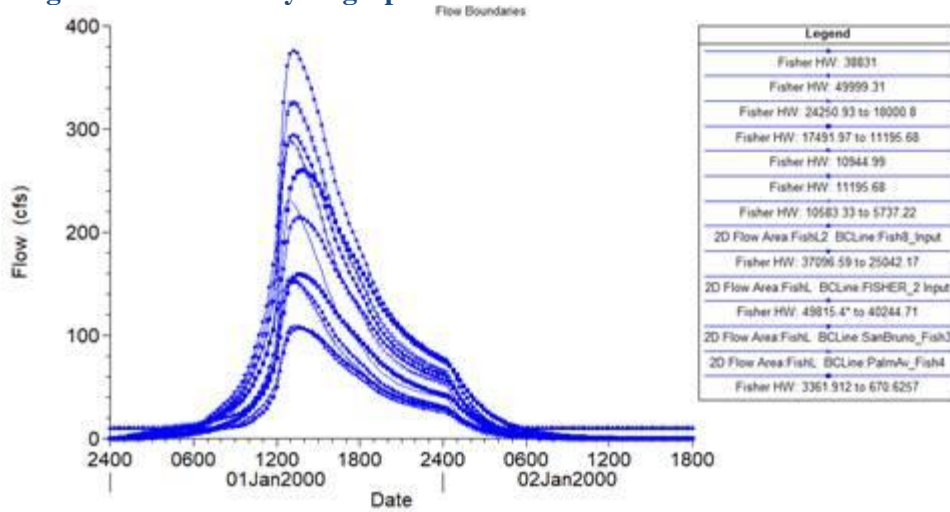
The model terrain is based on the following grading elements mosaicked in the following order of priority:

- BypassChnl_EC_20180724.tif (NEW)
- FISHER_EXISTING_TERRAIN.TerrainCurrentNewTribs.Branches_1x1.tif
- FISHER_EXISTING_TERRAIN.TerrainCurrentNewTribs.WSC_1x1.tif
- FISHER_EXISTING_TERRAIN.WSC_1x1.tif
- BaileyCulvert.tif (NEW)
- CoyoteTerrain9Canal_1_26_2018.TerrainV9.cenogier_v3.tif
- CoyoteTerrain9Canal_1_26_2018.TerrainV9.northogier_v3.tif
- CoyoteTerrain9Canal_1_26_2018.TerrainV9.Senter20ft.tif
- CoyoteTerrain9Canal_1_26_2018.TerrainV9.SouthOgier_v3.tif
- FISHER_EXISTING_TERRAIN.FISHER_TERRAIN.tif
- Fisher_5ft.tif (NEW)

Flow Files

Unsteady flow files for the 2.33-, 5-, 10-, 25-, 50-, and 100-year recurrence interval storms were updated to reflect the hydrology in the HEC-HMS model provided by SCVWD in May, 2018. A comparison of the 100-year hydrographs on Fisher Creek for the original RAS model and the updated HMS model is shown in the following figure.

Original RAS model hydrographs



Updated HMS hydrographs (HMS run DESIGN_24hr_100yr_FISH)

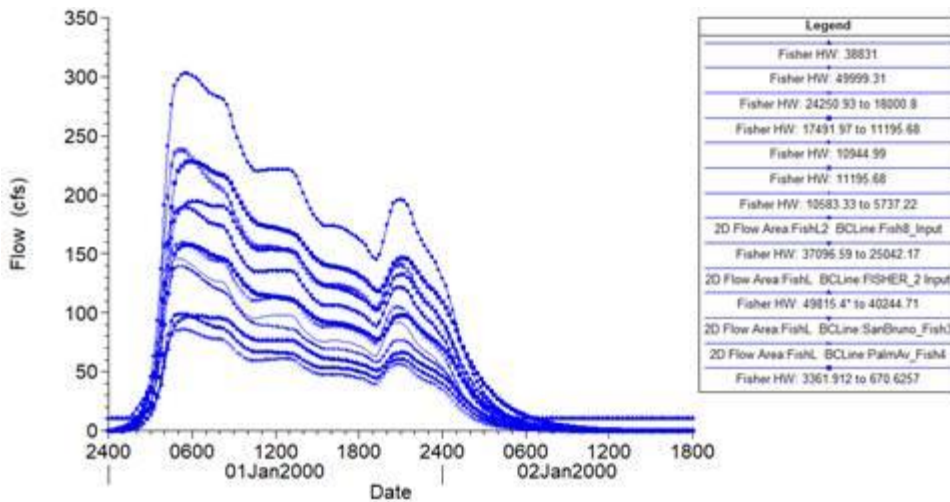


Figure 9. Original and updated flow inputs for the 100-year event on Fisher Creek

Hydrology for the Coyote Creek model was taken from the HEC-HMS model as well. The 100-year hydrology for the Coyote Creek watershed is a 72-hour event. Flows downstream of Anderson Dam peak within the first 24-hours of the event and a spill from the Dam peaks approximately 24 hours after the peak of the downstream flows. For the merged model, the Fisher Creek flows were initiated at the beginning of the 72-hour Coyote Creek flows thus the peaks on Fisher Creek and the drainages on Coyote Creek downstream of the Dam are closely aligned. This results in flooding on Fisher Creek occurring approximately 24-hours before the flooding on Coyote Creek. The hydrology for the combined model is shown in the following figure.

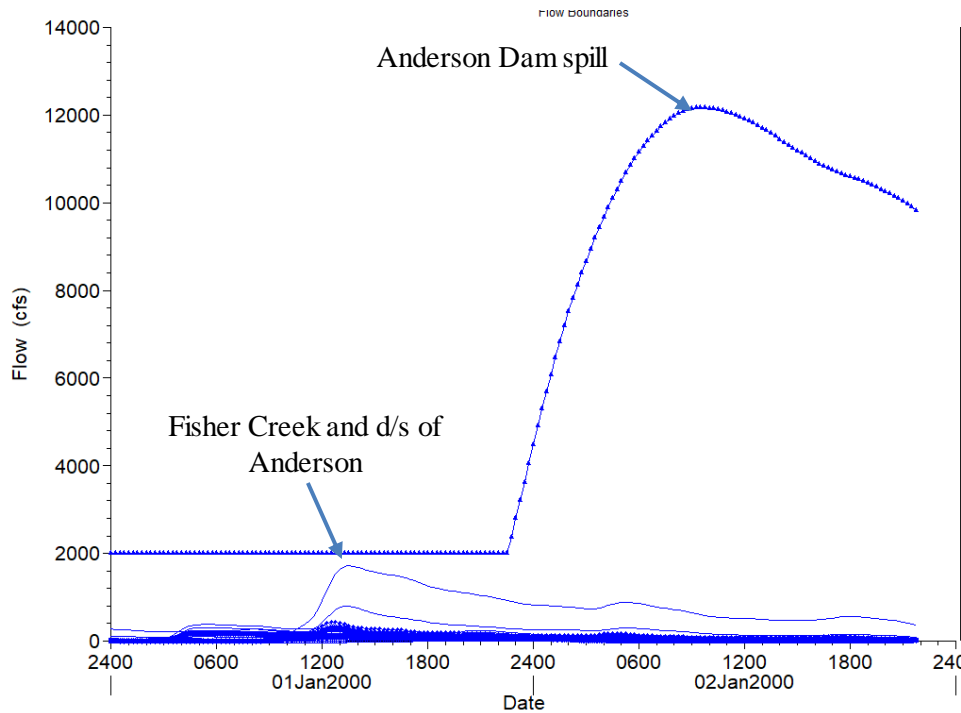


Figure 10. Combined model hydrology for 100-year event

Computational Settings

Computational settings for the Fisher Creek Model were unchanged. For the combined model, computational settings were updated for stability and to reduce the overall run time. The following settings were incorporated:

- **Computational settings adjusted for stability**
 - All interpolated sections on Coyote Creek were removed and new sections were interpolated where needed for stability
 - The lateral structure stability coefficient was set to the maximum value of 3
 - Pilot channels were added to smooth out major grade breaks
 - The 1D warmup period was set to a 1 second timestep for 1 hour
 - The 2D warmup period was set to 1 hour
- **Computational settings adjusted for efficiency**
 - The model timestep was changed from 1 second to 2 seconds
 - For the 2017 model run, the computational period was truncated by 39 hours at the beginning and 39 hours at the end. This eliminated a long constant flow period and a long drawdown period at

the end of the model run. This did not impact the initial conditions in the model as the addition of the warmup period essentially replaced the first 39-hour flow period.

References

HMH, Incorporated. (Construction Drawings). Flood Control/Mass Grading Plan. Coyote Valley Research Park. 3-13970G. City of San Jose, California. 22 June 2001. 39 sheets total.



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