Yolo Small Community Flood Risk Reduction Feasibility Study

Multi-Benefit Opportunities Technical Memorandum

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1 INTRODUCTION

1.1 OVERVIEW

This Technical Memorandum has been prepared to identify multi-benefit opportunities within and surrounding the community of Yolo that can be integrated into identified flood improvement alternatives to enhance the function of the region's flood system, consistent with the objectives of the Central Valley Flood Protection Plan 2017 Update (CVFPP). The CVFPP strongly supports and encourages the planning and implementation of projects that provide multiple benefits, including increasing flood system resilience by protecting and restoring important ecosystems, and improving water supply, water quality, recreation and public education related to integrated water management. According to the CVFPP, a multi-benefit approach more efficiently and effectively leverages flood infrastructure to achieve a broader array of public benefits and may potentially increase access to more funding sources (CVFPB, pg. 3-47).

The preparation of the CVFPP included the development of a Conservation Strategy that identified non-regulatory measurable objectives and long-term approaches for improving riverine and floodplain ecosystems. These improvements were proposed to be implemented through multi-benefit projects that include ecosystem restoration or enhancements. The Conservation Strategy provides guidance for developing and measuring the performance of ecosystem conservation and restoration actions based upon four key goals:

- Improve dynamic hydrologic and geomorphic processes;
- Increase and improve riverine and floodplain habitats;
- Contribute to the recovery of native species; and
- Reduce stressors.

This Technical Memorandum explores a range of opportunities that could achieve the CVFPP objectives for multi-benefit projects, consistent with the Conservation Strategy, including specifically integrating ecosystem restoration with flood risk management. This included identifying and evaluating potential habitat restoration concepts, recreational enhancement opportunities, and water supply improvement opportunities that can be integrated into the flood risk reduction alternatives evaluated in the Yolo Small Community Flood Risk Reduction Feasibility Study (Feasibility Study).

This Technical Memorandum is divided into five chapters: Chapter 1 includes this introduction, Chapter 2 provides a description of the preliminary habitat restoration opportunities and the screening process used to select specific restoration concepts for further evaluation; Chapter 3 describes in greater detail the highest potential habitat restoration concepts; Chapter 4 identifies potential recreational opportunities, recreation recommendations and water supply improvement opportunities; and Chapter 5 includes references used in the preparation of this report.

1.2 CALIFORNIA ENVIRONMENTAL QUALITY ACT COMPLIANCE

The multi-benefit concepts identified in this report have been developed to a conceptual level and they do not meet the definition of a "project" as defined by the California Environmental Quality Act (CEQA) (California Public Resources Code [PRC], Division 13, Section 21000 et seq.). The State CEQA Guidelines define a project as the whole of an action, which has a potential for resulting in either the direct physical change in the environment, or a reasonably foreseeable indirect physical change in the environment (California Code of Regulations [CCR], Chapter 14, Section 15378). State CEQA Guidelines Section 15262 further states that a project involving only feasibility or planning studies for possible future actions which an agency, board, or commission has not approved, adopted, or funded does not required the preparation of an Environmental Impact Report or a Negative Declaration. Section 15262 does not apply to the adoption of a plan that will have a legally binding effect on later activities.

The multi-benefit concepts represented in this report are presented solely for planning purposes. Their inclusion herein does not commit the County to any specific future actions and has no legally binding effect. Therefore, these multi-benefit concepts are statutorily exempt from CEQA, per State CEQA Guidelines Section 15262, and they are not subject to environmental review at this time.

2 PRELIMINARY HABITAT RESTORATION CONCEPTS

2.1 CACHE CREEK ENVIRONMENTAL CHARACTERISTICS

The dominant topographic and biological feature within the community of Yolo is Cache Creek, which forms the community's eastern boundary (Figure 1). Based on this dominance, much of the focus in this Technical Memorandum is on the creek and its habitat characteristics.

Cache Creek originates from below the outlet channel of Clear Lake on the western foothills of the Coast Range and is fed by the North Fork of Cache Creek (Indian Valley Dam and Reservoir) and Bear Creek on the northern slope of the upper watershed. The creek serves residents of Rumsey, Guinda, Brooks, Capay, Esparto, Madison, Woodland, and Yolo as a source of water for domestic use, farming, cattle grazing, gravel mining, other industrial usage, and recreation. The creek and its watershed also serve as a source of water and habitat for fish and wildlife. The creek meanders from the upper watershed to the flat plain near Woodland and Yolo and to the Cache Creek Settling Basin and the Yolo Bypass (U.S. Army Corps of Engineers 1995).

The creek is owned primarily by private interests and is managed by the California Department of Water Resources and Yolo County. Within the last 100 years, the creek has experienced dramatic changes, both natural and human-induced. The natural causes include shifting of the stream channel as a result of eroding banks and storm events, eroding soil from the upper watershed, and poor water quality due to boron and other naturally occurring chemicals. The human-induced causes include channel and levee work for flood protection and irrigation, gravel mining within the channel, residual runoff of agricultural chemicals into the creek, soil erosion in the rangeland portion of the watershed, and nonnative plant species such as arundo (*Arundo donax,* also known as giant reed), Ravennagrass (*Saccharum ravennae*), and tamarisk (*Tamarix* sp., also known as salt-cedar) that have invaded much of the stream channel. The combined natural and human-induced impacts have caused the creek, its riparian corridor, and habitat values to deteriorate (U.S. Army Corps of Engineers 1995).

The creek channel from below Capay to County Road 94 B is broad and braided as a result of disturbance by aggregate mining. The creek channel narrows from County Road 94 B through the community of Yolo and continues as a narrow channel to the Cache Creek Settling Basin. Levees confine the channel from about one mile west of Interstate 5 to the settling basin (Figure 1). The narrowest channel width occurs next to the community of Yolo where the creek banks are steep and vertical on both sides (Figure 2). During storms, floodwaters tend to bottleneck near the community (U.S. Army Corps of Engineers 1995).

Riparian vegetation along Cache Creek consists largely of wild rose, tamarisk, giant reed, sandbar willow, elderberry, wild grape, blackberry, and cottonwood. Lower Cache Creek is dry part of the year primarily as a result of a diversion dam constructed near Capay in 1912 and subsequent irrigation diversions. Despite restricted water availability, some riparian vegetation still grows on the banks and terraces of the low-flow channel. This vegetation generally grows in narrow strips between 35 to 75 feet wide along both sides of the low-flow channel. The riparian canopy consists primarily of willow, Fremont cottonwood, black cottonwood, valley oak, and interior live oak trees. Many of the trees are draped with blackberry and grape vines. California blackberry, western ragweed, sweet anise, curly dock, cocklebur, and several species of thistles, grasses, and forbs make up much of the ground cover (U.S. Army Corps of Engineers 1995).

2.2 CACHE CREEK PLANNING CONTEXT

In the late 1980's and early 1990's, the County experienced a period of extensive controversy and debate regarding appropriate management of the various resources and values along Cache Creek, particularly the stretch of the creek upstream of the community of Yolo. During this period, the County sought to minimize the effects of in-channel mining yet ensure a healthy mining industry. The Board of Supervisors adopted a framework of goals and objectives for regulation in 1994. In doing so, the Board recognized that although mining was an important consideration, the creek is integrally bound to the environmental and social resources of the County, including drainage/flood protection, water supply and conveyance, wildlife habitat, recreation, and agricultural productivity (Yolo County 2018a).

These efforts lead to the adoption of the Cache Creek Area Plan (CCAP) by Yolo County in 1996. The CCAP is a rivershed management plan for 14.5 miles of Lower Cache Creek, between the Capay dam and the town of Yolo. The CCAP actually consists of two distinct complementary plans governing different areas of the overall plan area: the Cache Creek Resources Management Plan (CCRMP) and the Off-Channel Mining Plan (OCMP). Together these plans regulate and protect the area and manage the creek as an integrated system. The overall area covered by the CCAP is 28,130 acres comprised of all land designated by the state as falling within the state mineral resources zones.

The CCRMP is a creek management plan that includes policies and regulations applicable within the creek channel (bank to bank). The goals of the CCRMP include stabilizing the creek channel, reducing erosion, protecting infrastructure, improving habitat values, maintaining flood capacity, and providing recreational opportunities. The CCRMP establishes policy and regulation for 2,324 acres of in-channel area. The CCRMP also established the Cache Creek Improvement Program (CCIP) for implementing ongoing projects to improve, stabilize, and maintain the creek (Yolo County 2017).

The OCMP is a mining plan that establishes a policy and regulatory framework allowing for controlled off-channel gravel mining no closer than 200 feet to the banks of Cache Creek. The OCMP sets policy and establishes regulations for 25,806 acres of area outside the defined banks of Lower Cache Creek (Yolo County 2017).

In 2012, the Yolo County Board of Supervisors also authorized County staff to develop a Cache Creek Parkway Plan to provide a detail vision and integrated management plan for future recreational uses within the parkway (Yolo County 2017). This Parkway Plan is described in greater detail in Chapter 4 of this report.

2.3 METHODOLOGY

The approach used to identify potential habitat restoration concepts for this report initially focused on what could possibly be implemented without regard for existing land use or infrastructure constraints. As an example, the geographic scope was not limited to the Yolo community in recognition of the high value habitats that are located directly outside of the basin, including specifically upstream along Cache Creek. This approach allowed the project team to initially identify opportunities with high restoration potential. Using this approach, the project team identified nine preliminary habitat restoration concepts and one groundwater recharge concept through the use of aerial maps, high-resolution topography, and local knowledge related to land-use, infrastructure, target species, and habitats. Target species included, but were not limited to, numerous avian species (e.g., Swainson's

Hawk, Tri-colored Blackbird, Western Yellow-billed Cuckoo, least Bell's vireo), and reptiles (e.g., giant garter snake).

Following the identification of the preliminary concepts, the project team qualitatively evaluated each one based on a number of factors that are identified in Table 1. These factors included their ability to provide ecological uplift, whether they include or support recreational activities, their cost to construct and operate, the estimated permitting complexity, their effects on agricultural sustainability, the overall feasibility of implementing the improvements, and their contribution to reducing flood risks. This evaluation process was used to screen out those concepts that were likely to be less feasible to implement. Following this screening process, the remaining concepts were evaluated in greater detail. This more detailed evaluation is described in Chapter 3.

2.4 DESCRIPTIONS OF PRELIMINARY RESTORATION CONCEPTS

Due to the existing riparian habitat present within Cache Creek and the unique opportunities available for enhancing the creek's ecosystem processes, the majority of the habitat restoration concepts are located within or directly adjacent to the creek. The following are the descriptions of the nine preliminary habitat restoration concepts and one groundwater recharge concept identified during the initial development process (Figure 3).

2.4.1 CACHE CREEK NON-NATIVE SPECIES CONTROL CONCEPT

This concept includes implementing a non-native species control effort within the Cache Creek watershed to control the spread of arundo and other invasive species. Healthy riparian systems in California are biologically diverse, supporting many species of plants, animals and insects as well as aquatic species. Arundo prefers these riparian sites, where it out-competes native plants, monopolizing soil moisture, light and space and creating a monoculture. Cache Creek has significant infestations of arundo and other non-native plants. The control of these non-native species within Cache Creek would increase the water supply available for native riparian habitat, increase riparian vegetation diversity, increase wildlife diversity, reduce channel flow constriction, and enhance flood protection (Yolo Resource Conservation District 2018).

2.4.2 WORKING WATERWAYS PROJECTS IMPLEMENTATION CONCEPT

This concept includes implementing Working Waterways Projects within the agricultural region surrounding the Community of Yolo. Working Waterways Projects are being pursued by the Yolo Resource Conservation District in partnership with the Audubon Landowner Stewardship Program, the Solano Resource Conservation District, and the Solano Land Trust. These projects include the development, installation and maintenance of ecosystem function improvements on working landscapes. Working Waterways Projects include three types of conservation projects: 1) Vegetating levees, ditches, and canals to slow water flow, filter out pesticides and sediments, and provide species habitat; 2) Restoring riparian habitat to stabilize stream banks and support species that provide pollination, biological control, and food; and 3) Constructing habitat or sediment ponds to control sediment and floods, to enable water reuse, and to create habitat (Solano Land Trust 2014).

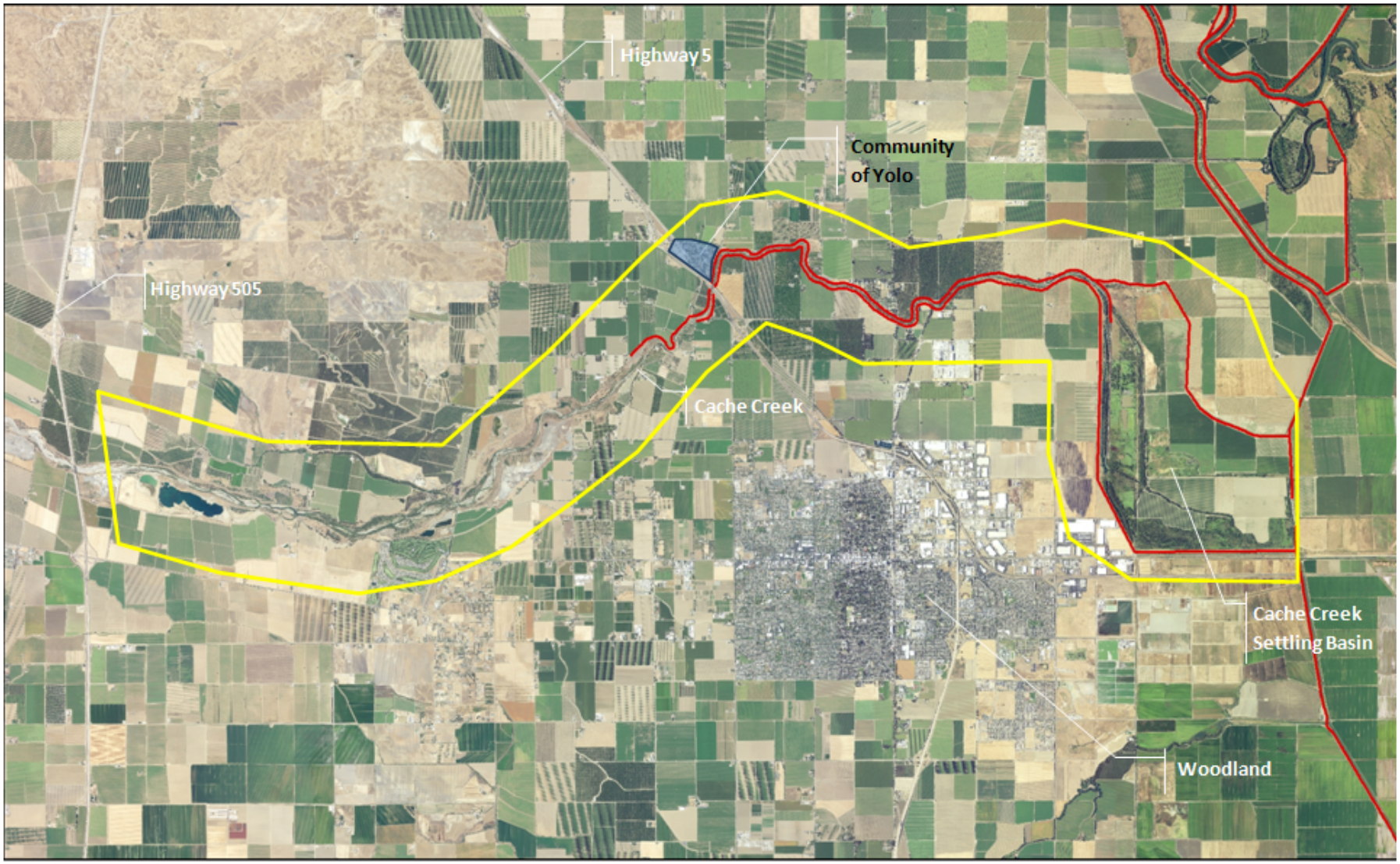

Figure 1. Overview of study area (yellow) showing State Plan of Flood Control levees (red) and additional relevant landmarks

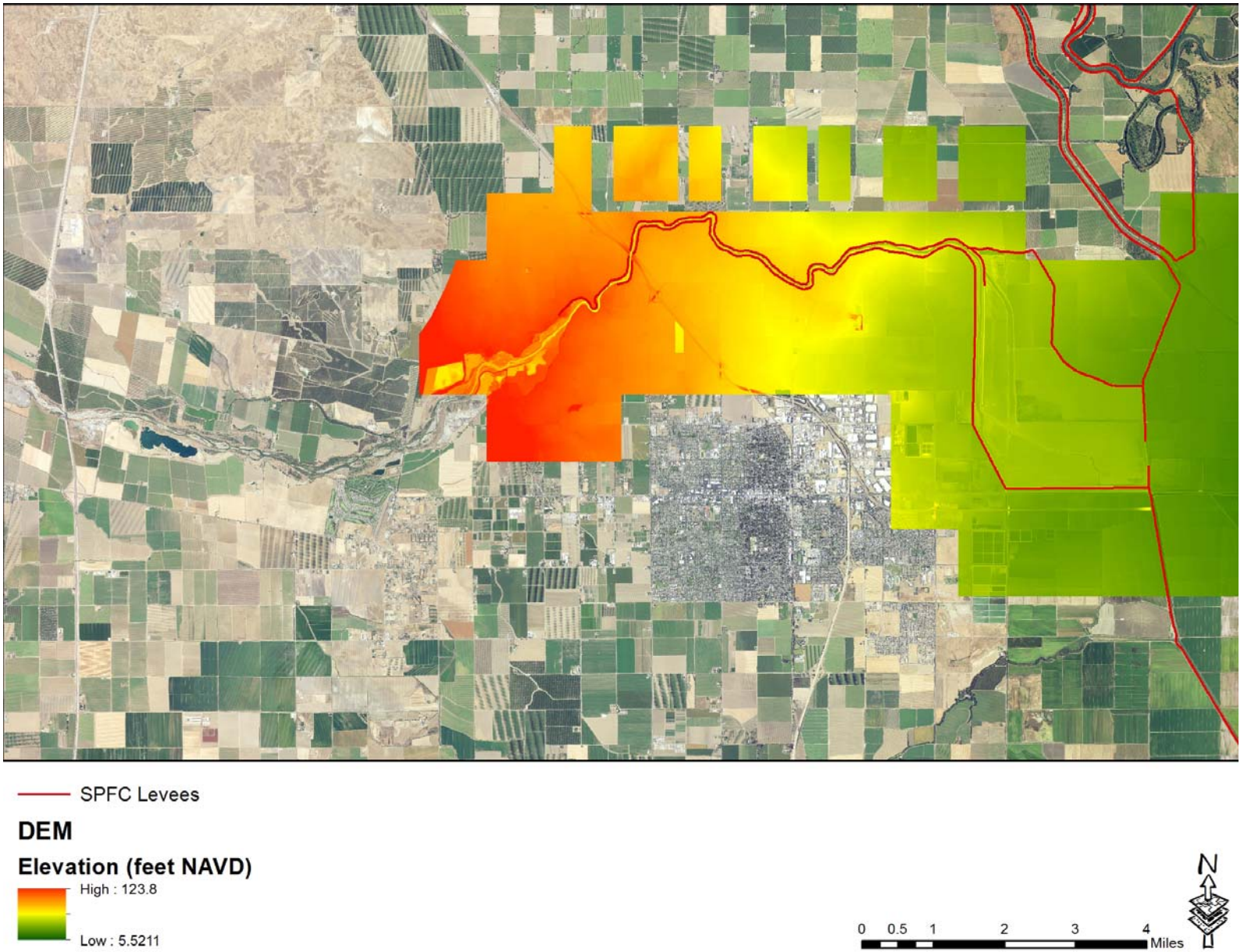

Figure 2. Overview map with high-resolution digital elevation map (DEM) overlay based on available 2008 LiDAR data

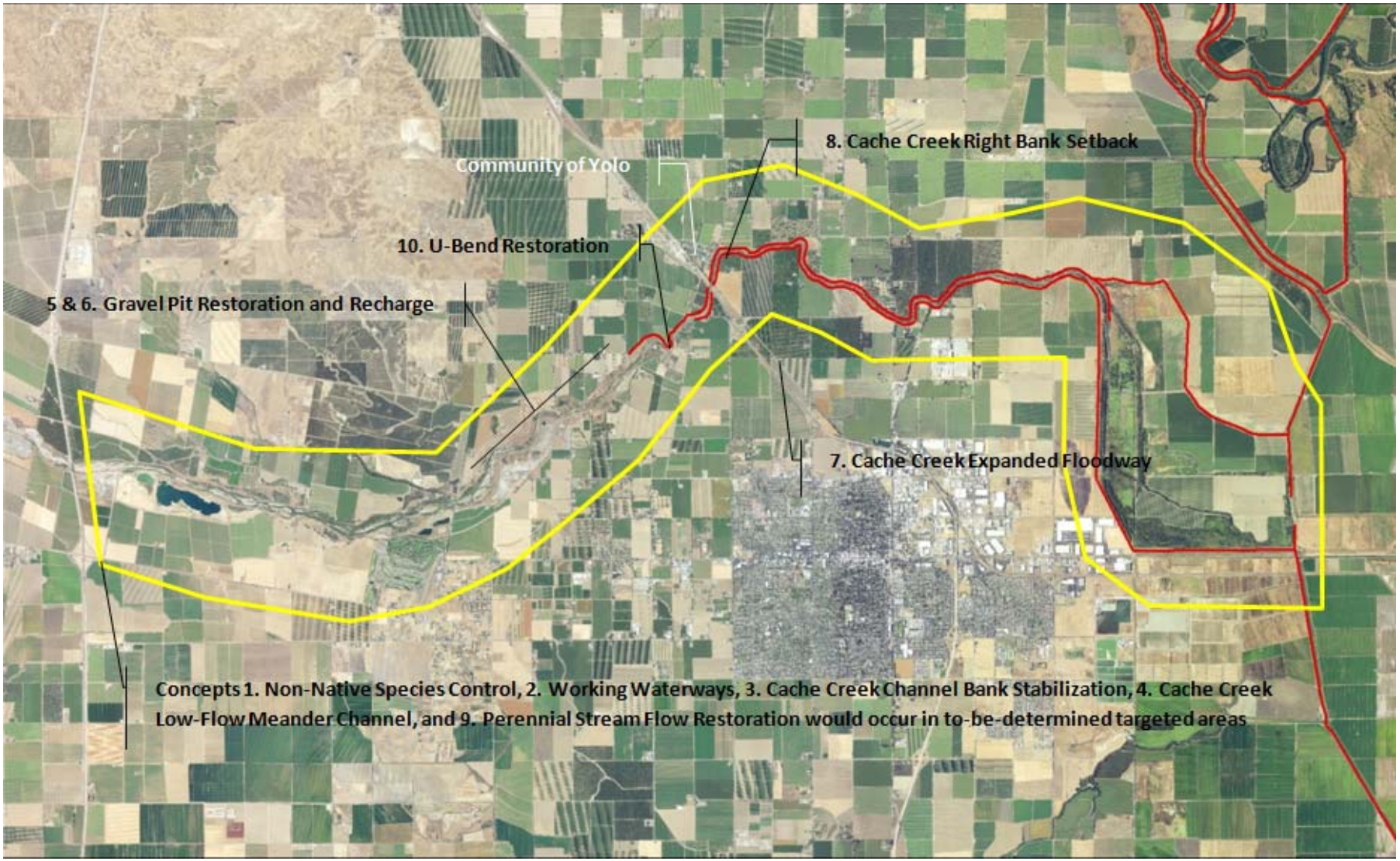

Figure 3. Overview of study area (yellow) showing State Plan of Flood Control levees (red) and the preliminary restoration concepts

2.4.3 CACHE CREEK CHANNEL BANK STABILIZATION CONCEPT

This concept includes revegetating the disturbed bank slopes and land adjacent to Cache Creek to increase wildlife habitat values. This concept was originally proposed by the U.S. Army Corps of Engineers for Cache Creek in 1995 and it included planting native riparian species at various locations along the creek to stabilize the bank slopes. No planting was proposed to occur in the middle of the channel (U.S. Army Corps of Engineers 1995).

This concept was subsequently explored in much more detail in 1995 Technical Studies conducted in support of the Cache Creek Resource Management Plan (CCRMP). These studies included an extensive evaluation of existing and current hydrologic and hydraulic conditions along Cache Creek from the Capay Dam to just upstream of Yolo at the Interstate 5 bridge. The results of the evaluation indicated that the Cache Creek channel had been and was at the time in a state of hydraulic disequilibrium throughout much of the creek's reach. Updated technical evaluations completed in 2017 indicated that significant deposition of sediment has occurred in the CCRMP area, which has resulted in recovery of more natural channel sinuosity and slope in certain locations. While this recovery appears to be occurring faster than originally anticipated in 1996, Cache Creek still exhibits unstable hydraulic and sediment transport conditions (Yolo County 2018b).

Recommendations in the 1995 Technical Studies to improve channel stability along Cache Creek were identified subsequently refined by the 2017 Technical Studies conducted in support of the Cache Creek Area Plan (CCAP) update. The major recommendation from the 1995 Technical Studies was a proposed "reshaping" of the channel to develop more uniform hydraulic conditions and reduce the potential for adverse erosion. The three key elements of the Cache Creek Improvement Program (CCIP), which is a component of the CCRMP, that are intended to promote a more stable Cache Creek channel include: 1) Identification of channel stabilization projects, 2) Identification of channel maintenance activities, and 3) Establishment of a hydrologic monitoring program (Yolo County 2018b).

For the channel stabilization projects, they can be grouped into at least seven categories including: discharge control, revetments, dikes, vegetation (and biotechnical methods), alignment adjustments, bank drainage, and bed scour controls. For the vegetation component, planting can be substituted in place of stone, concrete, timber or other materials for some erosion/stabilization sites. It is often advantageous to combine structural (stone or concrete) features with vegetative alternatives in the form of "biotechnical solutions" to erosion and/or stabilization problems. The success of vegetative measures depends on the survival of the vegetation and substrate stability. The vulnerability of vegetation needs to be considered in site selection (Yolo County 2018b).

Use of vegetation-only controls are unlikely to be effective in Cache Creek. Under high flow conditions the improvements are likely to be washed out. The combination of vegetative solutions with "hard points" to slow velocity and protect plantings effective in lower Cache Creek, particularly in the lower downstream reaches where material is finer grain and there is more water closer to surface. Upstream the water table is lower and the material is coarser which makes establishment of vegetation difficult (Yolo County 2018b).

The CCIP defines the procedures and methodologies for creek monitoring, maintenance, and stabilization activities. It includes specific design guideline recommendations for both channel stabilization projects and channel maintenance activities. While implementation of these activities will likely be relatively limited, primarily due to challenges related to state and federal permitting and to a lesser extent to the varying interests of

private ownership along both banks, the County has put in place the programs that are needed to implement improvements in Cache Creek over the long term (Yolo County 2018b). Therefore, any channel bank stabilization improvements are anticipated to be implemented consistent with the CCRMP and CCIP requirements.

2.4.4 CACHE CREEK LOW-FLOW MEANDER CHANNEL CONCEPT

This concept includes constructing a meandering channel in portions of the riparian reaches to facilitate the creek flow during periods of low flows. This concept was proposed by the U.S. Army Corps of Engineers for Cache Creek in 1995 and is based on taking a disturbed, straight creek channel and, using historic photos and aerial photographs, identifying the natural path. A path would then be designed for each reach of the stream. A low-flow channel, which allows the creek to meander freely, was proposed by the U.S. Army Corps of Engineers to allow regeneration of vegetation as well as preservation of riparian habitats (U.S. Army Corps of Engineers 1995).

A low-flow meandering channel would be laid out within the channel to concentrate the low flow to benefit fish and riparian vegetation. Some portions of the land adjacent to the creek would be set aside to allow the creek to meander during high flows. The objective is to have the low-flow meandering channel conform as closely as possible to the natural flow pattern or to realign the disturbed braided channel into a natural stream. The low-flow meandering channel would be constructed by selecting one of the braided channels as the low-flow channel. This low-flow channel would be widened to about 150 to 300 feet by excavating the soil and gravel about 3 feet. The excess soil and gravel could be used to fill depressions within the creek, to build up the slumping bank slopes, or to build up and form a point bar to guide the low-flow channel meandering pattern. The low-flow channel would follow the natural channel path. In areas where there is no defined path, the low-flow channel would be constructed to meander in an S-curve formation (U.S. Army Corps of Engineers 1995).

The construction of the meander channel could be combined with selective bar skimming. Bar skimming includes removing channel bed sediment (generally gravel and courser material) that has deposited and created significant mid-channel bars. Bar skimming can reduce erosion and scour potential, and increase flow conveyance capacity. Because the width of the Cache Creek channel adjacent to and downstream of the community of Yolo is deep and narrow, the meander concept would not be feasible along this stretch of the creek. However, this concept could be implemented in wider sections of the creek bed upstream of Yolo.

As described under the Cache Creek Channel Bank Stabilization Concept directly above, Yolo County has been conducted detailed resource management planning for Cache Creek since 1995 including adopting the Cache Creek Area Plan, the CCRMP, and the CCIP. The implementation of any channel modifications would need to be implemented in the context of and consistent with these plans. Because these plans identify how channel stabilization and maintenance activities will be implemented, they would dictate if and how a low-flow meander channel and associated bar skimming could be implemented on Cache Creek.

2.4.5 CACHE CREEK GRAVEL PIT RESTORATION CONCEPT

This concept includes rehabilitating and restoring existing gravel pits located along Cache Creek upstream of Yolo. Some pits would require only minor rehabilitation whereas others would involve moderate to significant grading, terracing, and planting of native vegetation, including woody riparian and emergent marsh species. The terracing would help control soil erosion and stabilize existing berms. Natural inundation through existing or modified topography would be recommended over operable water diversions from Cache Creek to inundate pits.

2.4.6 CACHE CREEK GRAVEL PIT RECHARGE BASIN CONCEPT

This concept includes creating groundwater recharge basins using existing gravel pits located along Cache Creek upstream of Yolo. The best opportunities for groundwater recharge based on the deep percolation data are along the more unconfined channel reaches upstream of Yolo and within existing gravel operations (e.g., Teichert, Vulcan, Cemex). The Teichert facility is the closest to Yolo and has the largest area of high recharge potential. This recharge basin concept would integrate well as a companion or element of the gravel pit restoration concept identified above.

2.4.7 CACHE CREEK EXPANDED FLOODWAY CONCEPT

In 1995, the U.S. Army Corps of Engineers evaluated the creation of a floodway between the City of Woodland and the community of Yolo. The 1995 study assumed that if overflow occurred from the south bank of Cache Creek upstream of Yolo, it would flow from west to east, flooding portions of Interstate 5 and the City of Woodland. This overflow was proposed to be captured by a setback levee that would be located approximately half way between the community of Yolo and the City of Woodland. The levee would vary in height from 4 to 14 feet and would extend east generally from where County Road 96 intersects with Cache Creek to the Cache Creek Settling Basin. This floodway proposal assumed that existing left and right bank levees of Cache Creek northeast of Interstate 5 would be raised up to three feet. During an inundation event, the setback levee would keep floodwaters from inundating Woodland and the raised levees adjacent to Yolo would keep that community from flooding. The inundation of the setback area would accommodate some riparian habitat restoration on the right bank of Cache Creek upstream of the community of Yolo and seasonal wetlands that would be integrated with agricultural production within the larger inundation footprint. This levee setback was determined to be feasible by the U.S. Army Corps of Engineers but the City of Woodland did not believe it would be acceptable to the local residents (U.S. Army Corps of Engineers 1995).

2.4.8 CACHE CREEK RIGHT BANK LEVEE SETBACK CONCEPT

This concept includes constructing a setback levee parallel to the right bank of Cache Creek within the bend of the creek located directly east of the community of Yolo. The new levee would be set back approximately 200 feet from the existing levee at its widest point. Along the east side of Cache Creek, the setback levee would extend north from the existing rail bridge for approximately 0.65 miles before reconnecting to the existing right-bank levee. This concept would include excavating and flattening the right bank of Cache Creek to provide borrow material for the levee construction. Some of this excavated material could also be used to raise the levee on the left bank within the community of Yolo to provide additional flood protection. This excavation would be expected to widen the creek's floodway and potentially reduce water velocities and erosion. The excavated bank would be planted to provide ecosystem habitat. However, due to the channel depth in this area, the excavated bank would likely remain too high above the creek to support riparian vegetation. Inundation of the excavated area would only be expected to occur during the largest of flow events within Cache Creek and would only occur for very short durations. This concept would also result in the loss of approximately 12 acres of orchard and one acre of field/row crops.

2.4.9 PERENNIAL STREAM FLOW RESTORATION CONCEPT

This concept includes acquiring a new increment of water to develop a perennial stream for the lower reaches of Cache Creek. This concept was proposed by the U.S. Army Corps of Engineers for Cache Creek in 1995 based on only portions of Cache Creek having perennial stream flows. The lower reaches are dry during the summer either due to naturally dry years or irrigation diversions. Most rainfall runoff is stored in Clear Lake and Indian Valley Reservoirs for agricultural use. A perennial stream in the lower reaches would benefit riparian and wetland habitat, recreation, and fish and wildlife. A new water supply (increment above what is now available) would need to be identified to achieve the goal of a perennial stream. The additional water could be developed through a surface detention basin or ground-water storage in aquifers. Another method of water acquisition would be to obtain additional storage space at existing reservoirs (U.S. Army Corps of Engineers 1995).

2.4.10 CACHE CREEK U-BEND RESTORATION CONCEPT

This concept includes restoring and enhancing the bend in the river at River Mile 12.3, which is located at the deep U-shaped bend in the creek directly upstream of Yolo (Figure 3). The concept includes removing sand and enhancing the channel banks to reduce erosional forces on the south bank. This concept would also include riparian planting as part of a biotechnical solution to enhance the channel's stability and provide improved habitat conditions. Any improvements in the channel in this location would be required to comply with the requirements of the Cache Creek Area Plan, the CCRMP, and the CCIP.

2.5 SCREENING OF PRELIMINARY HABITAT RESTORATION CONCEPTS

Table 1 provides a summary of categories used to qualitatively compare and screen preliminary habitat restoration concepts. Categories were scored Low, Moderate, or High representing potential or relative values associated with each category. The goal was to identify realistic and feasible restoration concepts that would merit more detailed review due to their potential ability to be planned and implemented in the near future in connection with the flood improvement alternatives identified in the Feasibility Study.

Using this screening process, the preliminary concepts were narrowed to those that would have a high feasibility of implementation. Four of the ten concepts met this criterion. These included the Cache Creek Non-Native Species Control Concept (Concept 1), the Working Waterways Projects Implementation Concept (Concept 2), the Cache Creek Gravel Pit Restoration Concept (Concept 5), and the Cache Creek Gravel Pit Recharge Basin Concept (Concept 6). These concepts were identified as having the highest potential to be implementable in connection with the flood improvement alternatives identified in the Feasibility Study. Therefore, a more detailed evaluation of these four concepts was conducted and is presented in Chapter 3.

Although a more detailed review of the other six concepts was not included in this report, the analysis of these concepts was done at a relatively high planning level and should be considered preliminary. The analysis is not intended to preclude these concepts from being evaluated in greater detail in future planning studies or from ultimately being considered for implementation.

Project Concept	Ecological Uplift	Recreation	Cost	Permitting Effort	Agricultural Sustainability	Overall Feasibility	Flood Risk Benefit
1. Cache Creek Arundo Control	High	Low	Low	Low	NA	High	Mod
2. Working Waterways Projects Implementation	High	Low	Low	Low	Mod	High	Low
3. Cache Creek Channel Bank Stabilization	Mod	Low	High	High	NA	Low	Mod
4. Cache Creek Low-Flow Meander Channel	Low	Low	Mod	High	NA	Low	Low
5. Cache Creek Gravel Pit Restoration	Mod	Mod	Mod	High	NA	High	Low
6. Cache Creek Gravel Pit Recharge Basin	Low	Low	Mod	High	NA	High	Low
7. Cache Creek Expanded Floodway	Low	Low	High	High	Low	Low	High
8. Cache Creek Right Bank Levee Setback	Low	Low	High	High	Low	Low	Mod
9. Perennial Stream Flow Restoration	Mod	Low	High	High	Low	Low	NA
10. Cache Creek U-Bend Restoration	Mod	Low	Mod	Mod	NA	Mod	Mod

LEGEND	LOW	MODERATE	HIGH

Table 1. Screening Criteria and Qualitative Concept Rankings

Notes:
Ecological Uplift: Estimated potential ecological uplift relative to other projects (assumed equal value between target species
Recreation: Potential recreational opportunities associated with concepts
Cost: Preliminary estimate of concept cost relative to other projects
Permitting Effort: Estimated permitting effort relative to other projects
Agricultural Sustainability: Compatibility with continued agricultural production
Overall Feasibility: Relative ability to implement based on a variety of criteria including costs, permitability, level of physical restoration actions necessary, ability to control the land, connection to flood improvements, local acceptability, and compatibility with agricultural lands.
Flood Risk Benefit: Estimated flood risk reduction benefits relative to other projects

3 HIGHEST POTENTIAL HABITAT RESTORATION CONCEPTS

Following the screening process, the four remaining concepts identified with the highest potential to be implementable in connection with the Feasibility Study's flood improvements are described in detail below.

3.1 CACHE CREEK NON-NATIVE SPECIES CONTROL CONCEPT

CONCEPT BACKGROUND

This concept includes implementing a non-native species control effort within the Cache Creek watershed to control the spread of arundo and other invasive species. Healthy riparian systems in California are biologically diverse, supporting many species of plants, animals and insects as well as aquatic species. Arundo out-competes native plants within riparian habitats due to its ability to monopolize soil moisture, light and space. Within the Cache Creek riparian corridor, arundo has successfully infested large areas of the stream bank (see photos below). The California Invasive Plant Council (Cal-IPC) has mapped 85.7 acres of arundo infestation in Cache Creek (Yolo RCD 2018). However, ongoing eradication efforts by the Cache Creek Conservancy through their Invasive Weed Control Program have improved conditions along the lower Cache Creek over the last several years (Cache Creek Technical Advisory Committee 2017).

Arundo is one of the biggest members of the grass (Poaceae) family, growing up to eight meters high. Native to eastern Asia, it was introduced to California in the 1820s for erosion control and building materials. It has no natural enemies here, allowing it to grow unchecked. Arundo spreads through vegetative parts rather than with seeds, primarily rhizomes and occasionally canes, moving downstream during flood events forming new colonies (Yolo RCD 2018).

Under optimal conditions for the plant, arundo can grow 2 to 4 inches per day and it provides almost no food or nesting habitat due to its vertical, poorly-branched bamboo-like structure and the fact that its leaves contain noxious chemicals such as silica, sterols, tri-terpines and alkaloids, making it unpalatable to both grazers and insects (Yolo RCD 2018). Because of these characteristics and conditions, the presence of arundo in riparian systems directly affects listed species.

RESTORATION CONCEPT

The Yolo RCD is pursuing an arundo removal program along 52.8 miles of Cache Creek extending from the Yolo County line to the Sacramento River. The Yolo RCD has submitted a Wildlife Conservation Board Grant Application for California Stream Flow Enhancement Program – Category 1 Implementation planning funds. They are requesting planning funds due to the large scale of the effort, the number of property owners involved, the need to get permits, and the need to comply with the California Environmental Quality Act prior to initiating removal efforts. Once the planning is completed, they will pursue implementation funding (Yolo RCD 2018). However, it will be difficult to secure implementation funding that will be sufficient for the scale of arundo removal being proposed.

Arundo is known to have evapotranspiration rates six times higher than the replacement riparian vegetation (24 acre-feet/acre/year versus 4 acre-feet/acre/year). Based on this rate difference, eradication of arundo from waterways in the Cache Creek watershed would lead to an average net annual increase in flow of approximately

Arundo Along Cache Creek
(Photo Source: Yolo RCD)

Panorama of Arundo Along Cache Creek
(Photo Source: Yolo RCD)

20 acre-feet of water per acre of arundo removed per year. This saved water would be available for native fish and other wildlife species living on the riparian edges, and for native riparian plants that support this wildlife. Water saved would increase baseline flows and extend water in the creeks later into the dry season (Yolo RCD 2018).

Arundo removal and subsequent replant with native species would restore the riparian ecosystem along Cache Creek that has been degraded by non-native species infestations. This would improve riparian function and enhance natural plant species recruitment. Dense monocultures also restrict movement of native fauna through and across the riparian corridor. Riparian zones are critical corridors across the landscape, enhancing their function benefits both wetlands and adjacent uplands. Replanting riparian habitat following arundo removal would also contribute to listed-species recovery and would support native species. Land would be opened up for elderberry shrub recruitment, which supports the Valley elderberry longhorn beetle, and for bank improvements and riparian planting, which supports giant garter snakes, Western yellow-billed cuckoo, and least Bell's vireo (Yolo RCD 2018). Due to its rapid growth rate, arundo can also reduce flood conveyance capacity, reducing the creek's ability to pass large flood events.

The Yolo RCD has piecemeal funding lined up for future arundo control efforts, which has historically come primarily from grants. However, the implementation of flood system improvements in the community of Yolo could provide an opportunity to leverage multi-benefit funding to achieve the ecosystem benefits associated with arundo removal. Because the Yolo RCD has experience with arundo control programs and is pursuing funding to conduct more extensive control, the ability to integrate these efforts into flood system improvements within Yolo substantially enhances the feasibility of this concept.

3.2 WORKING WATERWAYS PROJECTS IMPLEMENTATION CONCEPT

CONCEPT BACKGROUND

The Yolo Resource Conservation District (Yolo RCD) has teamed with the Audubon Landowner Stewardship Program, the Solano Resource Conservation District, and the Solano Land Trust to pursue implementation of Working Waterways Projects. The Working Waterways Projects effort is focused on developing, installing and maintaining ecosystem function improvements on working landscapes in Yolo, Solano, and Colusa Counties. The project was funded by California Department of Fish and Wildlife from 2012 through 2014. The Working Waterways Projects partners implemented a range of environmental projects on farm properties along working waterways using conservation funds from state and federal agencies.

As part of the effort, Solano Land Trust conducted a feasibility analysis to determine ways to implement more working waterways projects in the future by identifying additional funding sources. The analysis identified the environmental benefits of these working waterway projects; determined the current amount of resources going to these types of projects in the counties; named specific groups that are in need of opportunities to do projects that produce similar types of benefits; and recommended a way that the partners might organize to direct funds to additional projects (Solano Land Trust 2014).

Working Waterways Projects include three types of conservation projects: 1) Vegetating levees, ditches, and canals to slow water flow, filter out pesticides and sediments, and provide species habitat; 2) Restoring riparian habitat to stabilize stream banks and support species that provide pollination, biological control, and food; and 3)

Constructing habitat or sediment ponds to control sediment and floods, to enable water reuse, and to create habitat (Solano Land Trust 2014).

Farm edges along working waterways in the region surrounding the Community of Yolo provide a range of ecosystem services. The region has a substantial amount of agricultural land with farm edges along working waterways such as streams, canals, and irrigation ditches. These waterways are often described in terms of the functions they can provide such as improved water quality and quantity, carbon storage, and wildlife habitat. The health of riparian areas along farm edges can affect the quality and quantity of water, which impacts community services such as water treatment and sediment removal, flood control, and the need to drill deeper wells to reach ground water. Some wetland soils and different types of vegetation can also sequester carbon, which keeps greenhouse gases out of the atmosphere. The presence of native habitat increases the availability of wildlife and enhances recreational pursuits such as hiking, bird watching, and photography.

RESTORATION CONCEPT

The objective of this restoration concept is to identify how working waterways can be used to offset ecosystem impacts associated with flood system improvements. As a representative project, the Yolo Resource Conservation District and their partners implemented habitat restoration along Cottonwood Slough as part of this Working Waterways effort. Cottonwood Slough is located east of County Road 89 and south of Madison in Yolo County. The restoration effort included enhancing the north and south banks of the slough with native riparian vegetation. The north bank was sloped back approximately 30 feet into the adjacent farm field to widen flow capacity, and the banks were planted with native trees, shrubs, grasses, sedges and forbs. Post-installation plant maintenance included irrigation and weed management for two growing seasons to ensure satisfactory plant establishment. The project took three and one-half years after the landowner's first expression of interest. Permitting took six to nine months prior to any field activity. Earth-moving and plant installation required nine to twelve months. The project's ecosystem benefits include increased water carrying capacity, floodwater storage and peak flow attenuation, water quality improvement, wildlife and fish habitat, improved aesthetics, increased groundwater recharge, and carbon storage.

This type of project could be integrated into flood planning and design improvements within the Community of Yolo through a collaborative partnership with the Yolo RCD. The region surrounding the community includes an abundance of streams, canals and drainage ditches located along farm edges and the Yolo RCD has developed strong relationships with farmers in the region. Some farmers would be interested in these types of improvements if flood system funding can be leveraged to support the necessary technical work of the Yolo RCD to get the restoration improvement permitted and implemented.

3.3 COMBINED CACHE CREEK GRAVEL PIT RESTORATION AND RECHARGE BASIN CONCEPTS

CONCEPT BACKGROUND

The Cache Creek Gravel Pit Restoration Concept (Concept 5) includes rehabilitating and restoring existing gravel pits located along Cache Creek upstream of Yolo and the Cache Creek Gravel Pit Recharge Basin Concept (Concept 6) includes creating groundwater recharge basins using these same gravel pits. Because these concepts

would likely be complimentary and could be implemented concurrently, they have been combined into a single concept for purposes of this report.

Some of the existing gravel pits would require only minor rehabilitation for habitat purposes whereas others would involve moderate to significant grading, terracing, and planting of native vegetation, including woody riparian and emergent marsh species. The terracing would help control soil erosion and stabilize existing berms. Natural inundation through existing or modified topography would be recommended over operable water diversions from Cache Creek to inundate pits. For groundwater recharge, the best opportunities are located along the more unconfined channel reaches and within existing gravel operations (e.g., Teichert, Vulcan, Cemex).

Figure 4 identifies the general area evaluated for implementation of these concepts. A screening level analysis was conducted of groundwater recharge potential using the UC Davis Soil Agricultural Groundwater Banking Index (SAGBI) Deep Percolation data layer. Figure 5 identifies areas with the highest recharge potential based on this data. Figure 6 identifies topographic data for the reach evaluated based on 2008 LiDAR data. Based on this data, the best opportunities for groundwater recharge using existing gravel pits and mining features are along the more unconfined channel reaches upstream of where project levees end, and within existing gravel operations (Teichert, Vulcan, Cemex).

Substantial planning efforts have been undertaken as part of the CCRMP and the CCIP to identify habitat restoration and groundwater recharge opportunities within the gravel pits adjacent to Cache Creek. This effort focused on identify potential new multi-benefit concepts related to gravel pits in the study area. The Teichert facility is the closest to Yolo and has the largest area of high recharge potential.

RESTORATION CONCEPT

The analysis of these combined concepts was limited to areas near the Community of Yolo that also had LiDAR coverage. The focus of the effort was on identifying existing gravel pits and low-lying areas that could benefit from improved connectivity to Cache Creek with minimal excavation in order to increase the frequency of inundation of these areas for both habitat and groundwater recharge benefits.

Based on the UC Davis SAGBI Deep Percolation layer, the entire Cache Creek corridor has good potential for deep percolation – one characteristic needed for groundwater recharge to occur. This makes sense as substrate in the reach is relatively coarse (sands and gravels). Another characteristic needed for groundwater recharge to occur is adequate space in the soil and rocks for water to infiltrate and fill. Based on the evaluation of fall 2015 and 2017 (following a dry and wet winter/spring respectively) depth to groundwater levels, there seems to be ample pore space for water to infiltrate. Even following a record winter (2017), depth to groundwater in the reach ranged from 70 to 90 feet the following fall.

With the understanding that groundwater recharge potential in the target reach is high, a detailed evaluation of LiDAR topography and aerial photographs led to numerous restoration and rehabilitation actions that could be taken to simultaneously improve habitat and groundwater recharge in this heavily mined reach of Cache Creek. These actions are identified in Figure 6 with detailed cross sections associated with enhancement actions included in Figures 7 through 10. These actions primarily consist of native plantings and targeted excavations to improve connectivity between individual pits and the creek. However, constraints associated with implementing connections between the gravel pits and the creek, such as potential fish stranding, would need to be explored in

more detail before these efforts could progress. Also, extensive landowner and stakeholder engagement would be necessary to further refine and develop these concepts.

Figure 4. Aerial photo (2016 NAIP) of Cache Creek reach considered for potentially gravel pit restoration and recharge concepts

Figure 5. UC Davis SAGBI Deep Percolation layer for target reach. Higher values (darker reds) indicate increasing recharge potential

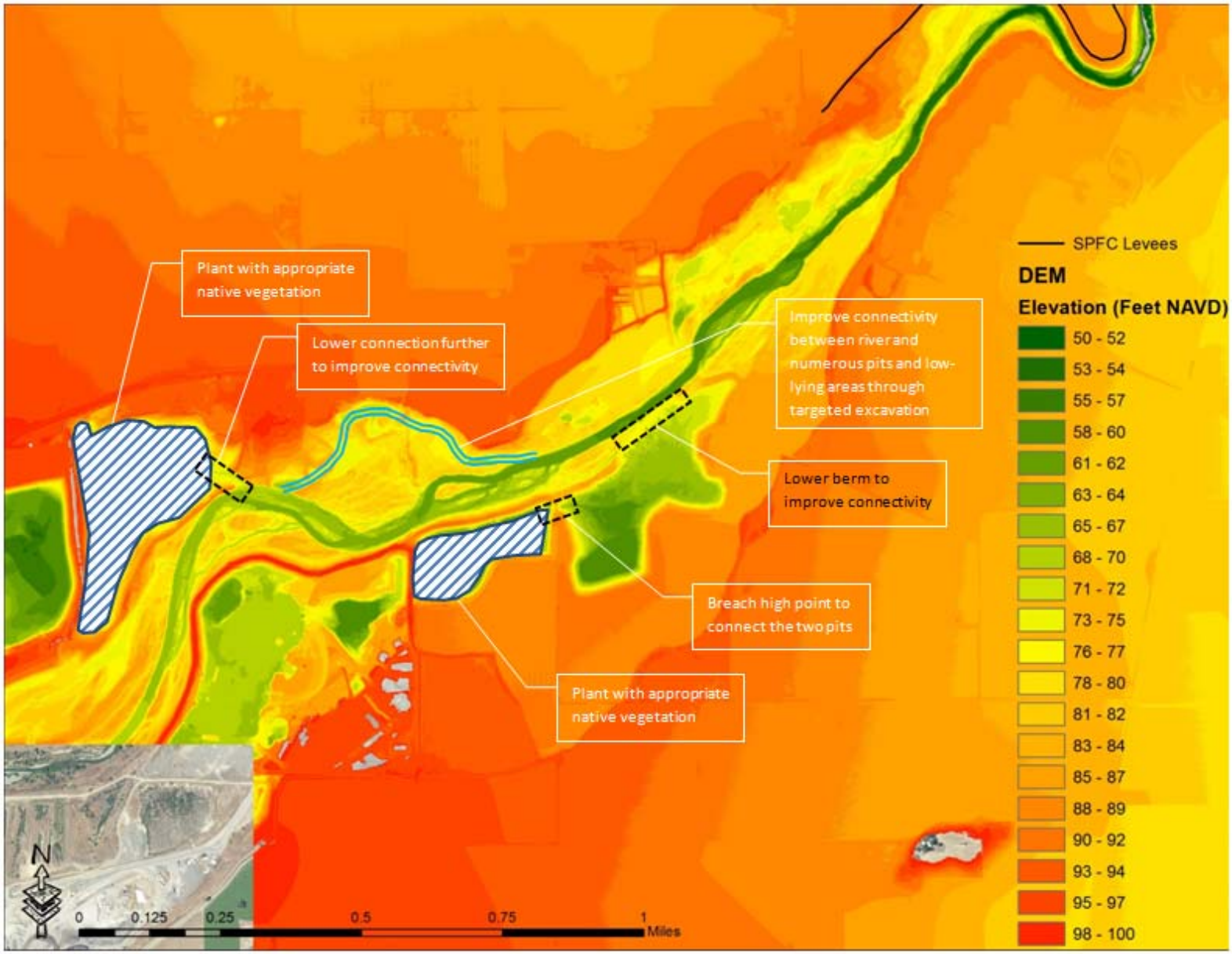

Figure 6. Gravel Pit Rehabilitation concepts for the target reach on a digital elevation map based on 2008 LiDAR dataset

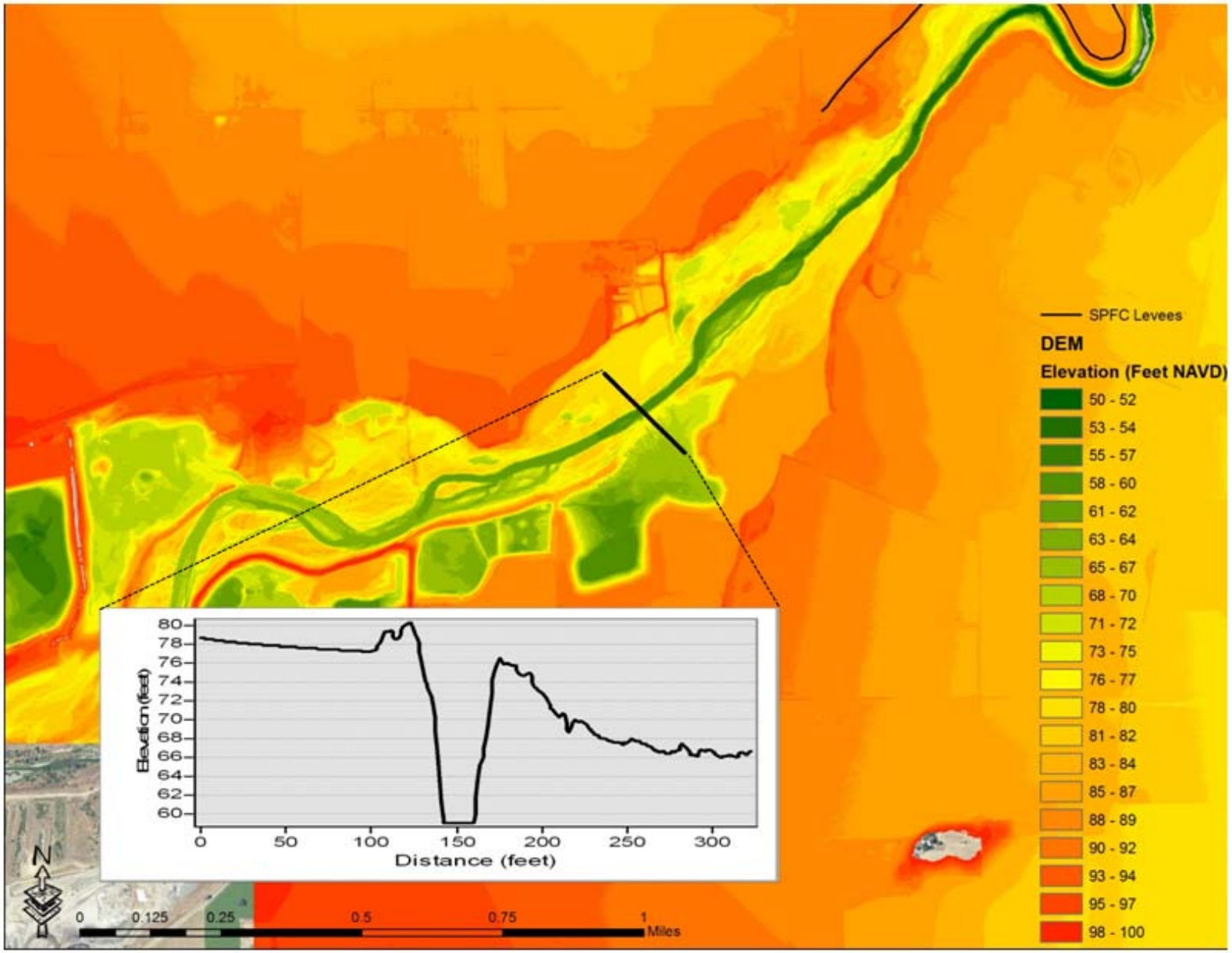

Figure 7. LiDAR cross section across Cache Creek

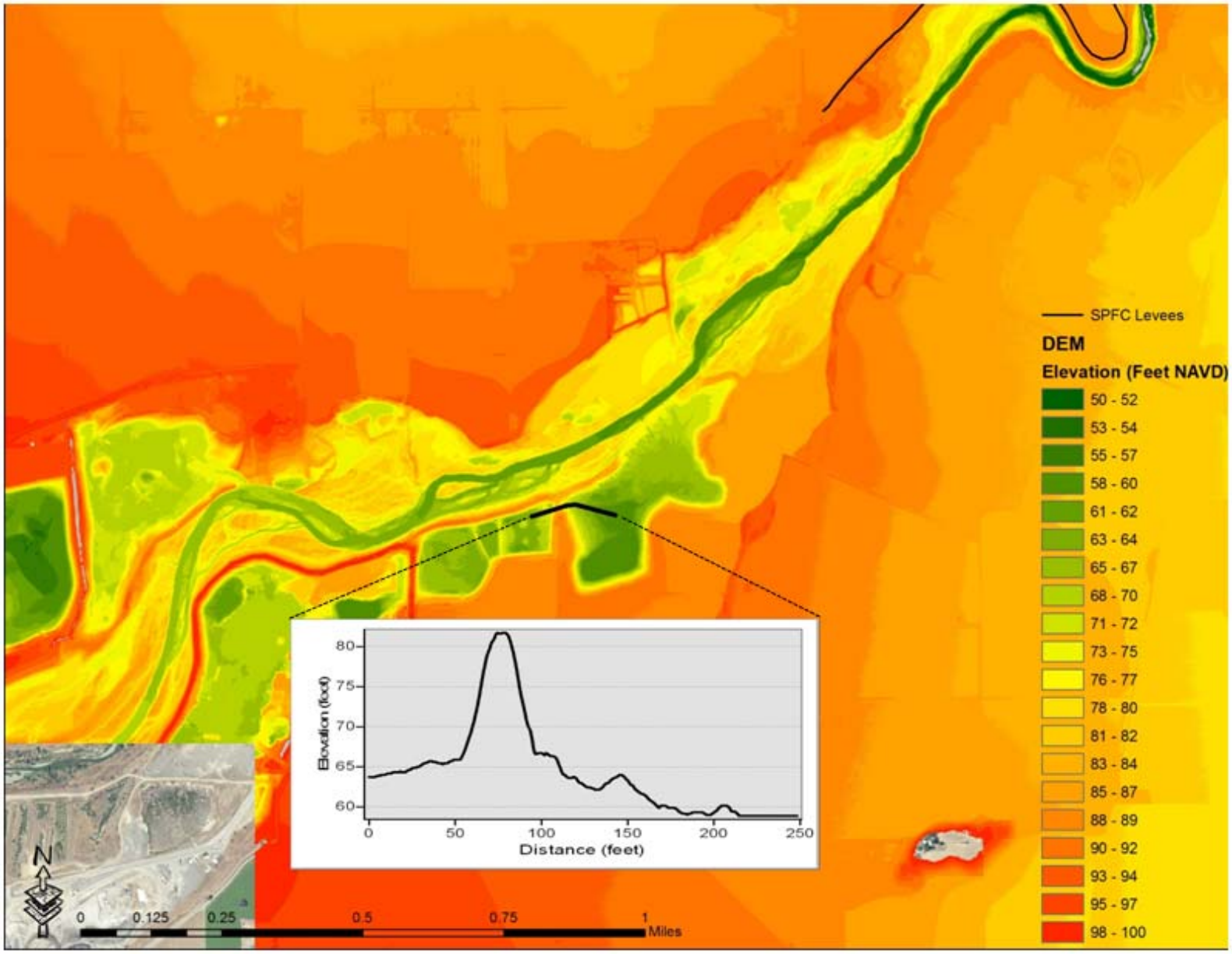

Figure 8. LiDAR cross section across berm that divides two pits

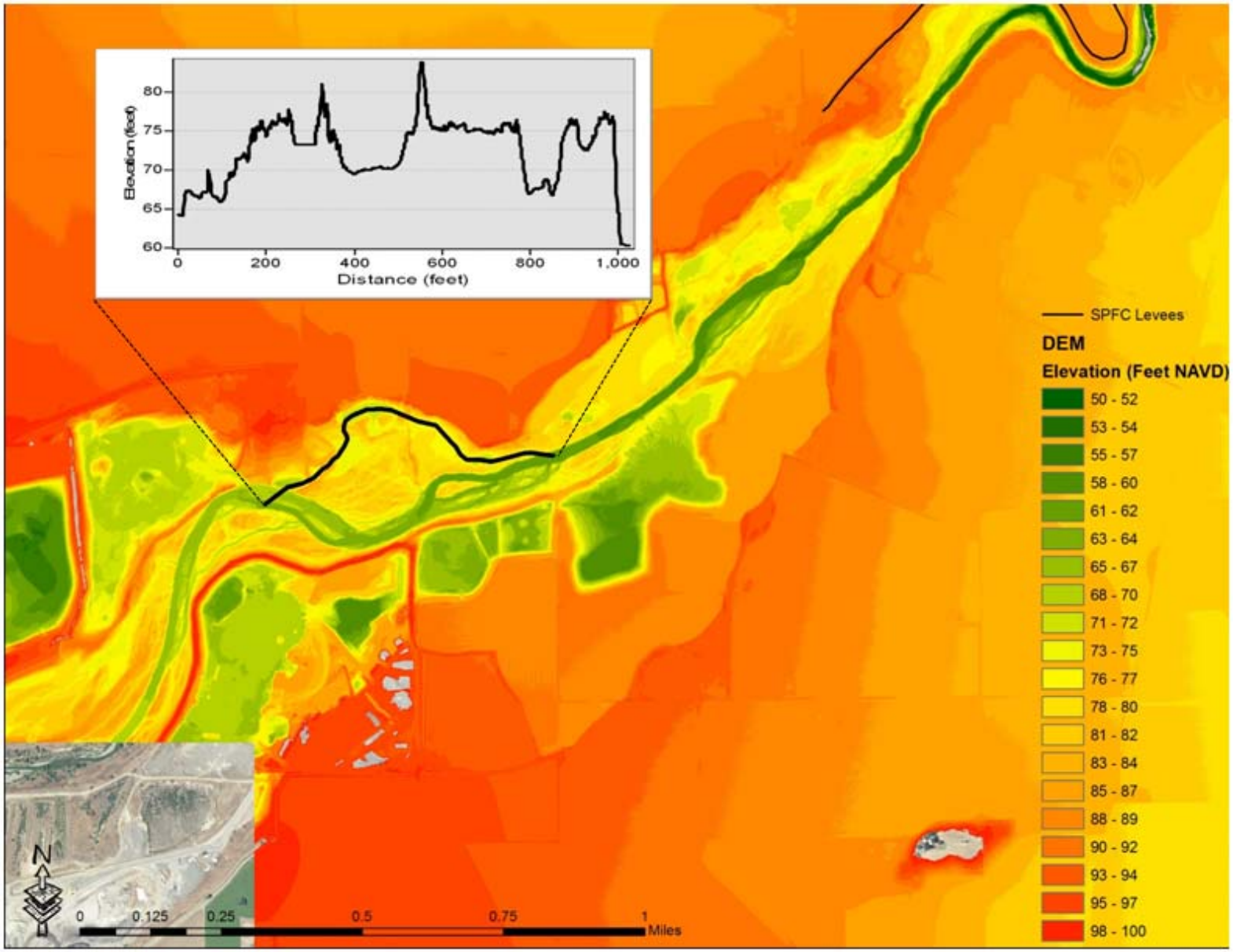

Figure 9. LiDAR cross section along track that could be excavated in a targeted manner to better connect numerous low-lying areas

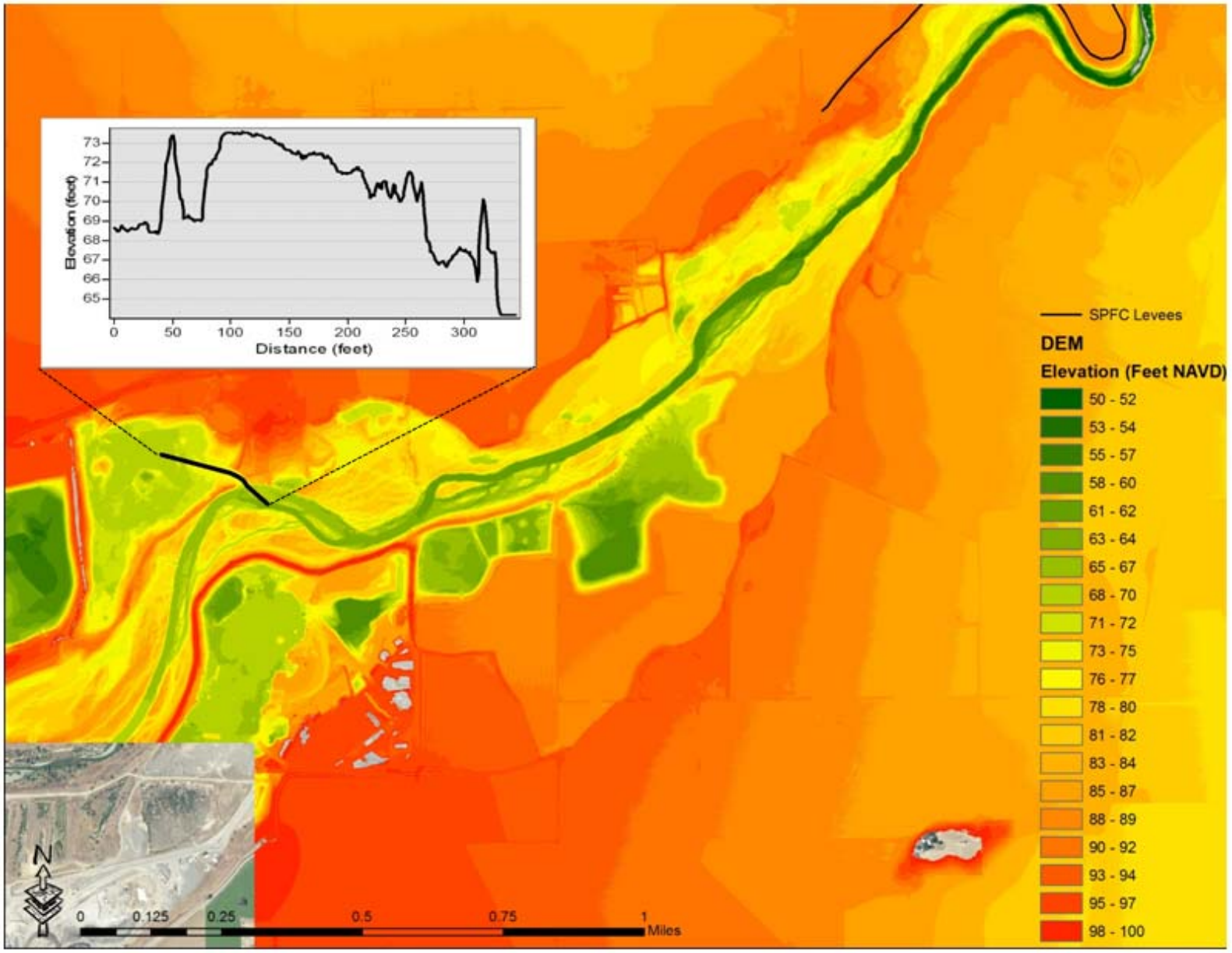

Figure 10. LiDAR cross section along track where existing connection between Cache Creek and gravel pit could be lowered to improve connectivity

4 RECREATION AND WATER SUPPLY OPPORTUNITIES

As part of the Cache Creek planning efforts in the early 1990's, the County prepared a report entitled Technical Studies and Recommendations for the Lower Cache Creek Resources Management Plan (referred to as the "1995 Technical Studies"). The staff report to the Board of Supervisors (dated October 24, 1995) that presented this study noted:

> "In addition, although not addressed directly in the Report, certain recreational opportunities will also present themselves as a result of these long-term planning efforts. Coordination of a minimum of three to five "recreation nodes" (and future public access to them) adjoining the creek, on property controlled by long-term permit applicants, will ensure future opportunities for a parkway concept similar to that of the American River Parkway in Sacramento County. It is important that these nodes be spaced along the entire study area, and that they be located as near to key County Roads and state highways as possible. These nodes would become the future parks, public access points, staging areas, interpretive centers, and trail heads of a comprehensive parkway along the creek. For now, however, the key is simply to identify and hold them."

The recreation and open space uses discussed in the CCRMP are conceptual in nature, providing some guidelines for implementation and suggesting general areas for access and future projects. The plan recommends that the County pursue an integrated system of trails and recreational areas along Cache Creek, similar to efforts occurring along the San Joaquin and American Rivers, although at a less intensive scale of development.

The CCRMP has resulted in several areas that will provide future recreational use that could be easily accessed by the residents of Yolo. They are located at regular intervals of approximately two miles along Cache Creek, in order to function as trailheads or staging areas for a system of bicycle, pedestrian, and/or horse paths. These recreational areas are located on lands included for off-channel mining, where proposed reclamation is to permanent ponds. This ensures that no additional farmland would be lost, while taking advantage of the amenities associated with the bodies of water to be reclaimed through mining. Frontage to County roads and State highways is an important consideration to provide the public with adequate access to the sites and the trail system. The entire CCRMP area was designated as Open Space in the County's General Plan and zoning code in 1996.

The County has undertaken a more detailed analysis of the recreational needs of Yolo County with development of the Cache Creek Parkway Plan. The Cache Creek Parkway Plan is intended to provide a detailed vision and integrated management plan for: 1) properties currently under public ownership or control and managed by the County CCAP [also known as the "gravel program"]; 2) properties and/or ownership interests (e.g., trail easements) that will be dedicated to the County in the future pursuant to the CCAP; and 3) additional properties accepted or purchased for management pursuant to the CCAP (Yolo County 2017). Development of the Cache Creek Parkway Plan will allow for community involvement and provide specific proposals as well as projected costs for developing and maintaining a parkway system along Cache Creek. It will also be valuable for addressing creek ownership and access issues (Yolo County 2018).

The intent of the Parkway Plan is to:

- Establish priorities, guidelines, and specifications for development, access, use, operation, management, and maintenance of each property.

- Develop a comprehensive trail system, coordinated with other planned trails.
- Provide a framework for the County to use in negotiations regarding land dedications associated with future Development Agreements and mining applications.
- Provide guidance regarding additional lands to target for dedication/acquisition from willing landowners in order to provide connectivity and continuity throughout the Parkway.
- Lay the foundation for a mechanism to provide long-term revenues, financing, and management of the Parkway through collaborative efforts among the Natural Resources Division, Parks Division, Cache Creek Conservancy, and other partners.
- Identify areas appropriate for consideration as wildlife and habitat reserves (Yolo County 2017).

The Parkway Plan contains a profile of each of the 18 properties already a part of or planned to become a part of the Parkway, including descriptive information, known opportunities and constraints, and appropriate uses of each property consistent with the goals and aspirations of the CCAP. The Parkway Plan also contains an overall vision of the Parkway including property and trail connections, identification of gaps, and recommendations for future acquisition (Yolo County 2017).

The Parkway Plan is accompanied by the Cache Creek Parkway Plan Feasibility Study, which is a companion analysis of the financial feasibility of various levels of Parkway development. The Feasibility Study identifies costs and potential sources of funding for the "baseline" Parkway as well as possible "upgrades" to the baseline condition in the form of various additional capital improvements and recreational services that could be pursued over time depending on the County's interest, and availability of additional funding. These upgrades, analyzed as optional "tiers" of Parkway development, are defined only for the purposes of the analysis and remain completely scalable subject to the interest of the County over time (Yolo County 2017).

As of 2016, the County has several open space properties along lower Cache Creek including: Capay Open Space Park (41 acres), Millsap property (17 acres), Wild Wings Park (17 acres), Cache Creek Nature Preserve (123 acres), County Borrow Pit (7 acres), Rodgers Property (30 acres), and Correll Property (39 acres). Due to the high proportion of land in private ownership, access to the creek is limited. Present recreational uses are generally limited to canoeing, rafting, hunting, and fishing. Off-highway vehicles (OHVs) use formerly mined pits and streambanks, creating erosions and damaging riparian vegetation. Trespassing is frequent, including poaching, camping, and loitering along the creek, resulting in graffiti, property damage, noise, and trash. These areas of the creek are typically found in remote locations, away from nearby residences and areas frequented by authorized visitors (Yolo County 2018a).

4.1 CACHE CREEK PARKWAY PLAN RECREATIONAL COMPONENTS

The Cache Creek Parkway Plan identifies a number of recreational opportunities within relatively close proximity to the community of Yolo. These include the 98-acre Teichert Woodland Muller property, the Teichert Muller Bridge, the 7-acre County Borrow Pit, the 115-acre Granite Woodland Reiff property, the 30-acre Rodgers Property, and the 38.9-acre Correll Property. All of these current and former mining properties are located east of

County Road 94B along Cache Creek within a 10-minute drive from the community of Yolo. The potential recreational opportunities for these properties include the following:

- **Teichert Woodland Muller Property** – This property includes an existing conveyer bridge that could provide pedestrian access over the creek. It is also adjacent to the Granite Woodland Reiff property to the east and a Nature Preserve to the west, which would allow it to be developed as a recreational node and trail connection location.

- **Teichert Muller Bridge** – This existing bridge could be converted to a pedestrian crossing that would provide a future link to a trail on the south side of the creek connecting to the Rodgers and Correll properties.

- **County Borrow Pit** – The property is leased by Teichert, who would be responsible for reclamation at the end of the lease term.

- **Granite Woodland Reiff property** – This property provides excellent direct public access to Cache Creek and CR 95B with approximately 3,800 linear feet of creek frontage. It also provides a large active recreational opportunity and habitat restoration potential.

- **Rodgers Property** – This property provides passive recreational opportunities and good public access including potential parking.

- **Correll Property** – This property provides passive recreational and riparian vegetation restoration opportunities. It would anchor the east end of the Parkway and could include trail connects with the Rodgers property.

The Parkway Plan also identifies trail and creek channel connections that extend through the length of the Cache Creek included in the CCAP. The Parkway Plan further identifies regional trail connections that extend east and west beyond the CCAP boundaries. For the regional trail extension to the east, it is proposed to follow the levees along the eastern length of Cache Creek extending through Yolo, continuing to the Cache Creek Settling Basin, and then extending along County Road 22 (CR 22) to South River Road and the City of West Sacramento. Two extensions are proposed to extend south from this eastern alignment following CR 99 and CR 102, respectively.

4.2 CLASS II BIKE LANE BETWEEN YOLO AND WOODLAND

The community of Yolo is located approximately 3.5 miles north east of the City of Woodland, which represents a relatively short bicycling distance between the two communities. However, the local roads that would be used for bicycle commuting, including Cacheville Road, County Road 18 (CR 18), and CR 99, have narrow shoulders consisting of a mix of pavement and gravel, and vehicle speeds on these straight rural roadways can be quite high. These conditions discourage bicycle use on these roadways due to safety concerns. However, the Circulation Element of the 2030 Countywide General Plan (County of Yolo 2009) identifies a proposed Class II bike lane alignment that would more safely connect the community of Yolo to the City of Woodland's existing bicycle circulation system.

A Class II bike lane is a paved edge of a street or road delineated as a bike lane by white stripes and stencils. Figure CI-3B in the Circulation Element identifies the proposed bike lane alignment as extending southeast from Yolo along Cacheville Road to the intersection with CR 18. The alignment would continue east along CR 18 to the CR 18/CR 99 intersection, at which point it would extend south on CR 99 (West Street) to CR 20 (Kentucky Avenue), where it would connect to an existing Class II bike lane on CR 99 within the City of Woodland. This same Class II bike lane alignment is also identified in the County of Yolo Bicycle Transportation Plan (Yolo County Transportation Advisory Committee 2013, pg. A2-18). As identified in this plan, the project includes widening the existing 24-foot wide roadways by four feet to accommodate Class II bike lanes on each side of the roadway alignment.

4.3 RECREATIONAL OPPORTUNITIES RECOMMENDATION

The Cache Creek Parkway Plan identifies a long-term vision for recreational opportunities that could be developed within the CCAP. To optimize the recreational benefits for the community of Yolo associated with Parkway Plan implementation, it is recommended that any flood system planning and design improvements proposed within Yolo also consider the integration of the multi-benefit recreational opportunities identified in the Parkway Plan, particularly those east of CR 94B near the community of Yolo. In addition, if the Cache Creek Borrow Pit Restoration and Recharge Basin Concepts described in Chapter 3 above are implemented as a multi-benefit project associated with flood improvements in the Community of Yolo, the recreational improvements identified in the Cache Creek Parkway Plan for that area should be integrated into these concepts.

The implementation of Class II bike path improvements between Yolo and Woodland are also recommended to be integrated into any flood system planning and design improvements proposed within Yolo.

4.4 WATER SUPPLY IMPROVEMENT OPPORTUNITIES

As mentioned in the overview discussion of this report, the 2017 Update to the Central Valley Flood Protection Plan strongly supports and encourages the planning and implementation of projects that provide multiple benefits. These benefits are not solely limited to ecosystem or recreational enhancements, they also include improving water supply and water quality. Within Yolo, the main groundwater well was installed in the early 1970's and it has periodically failed. Approximately three-to-four years ago, the well failed for several months due to deficiencies in the well casing. The existing well currently produces approximately 1,000 gallons per minute (gpm). However the number of water supply connections are near the water supply system's existing capacity. Also, the system's delivery capacity is insufficient for the Yolo Fire Protection District's fire apparatus. The current fire apparatus pumps produce up to 1,250 gpm, which exceeds the production capacity of the existing well. During fire events, this results in the water system being quickly drawn down. Once drawn down, the negative pressure that results from continued apparatus pump operations can damage components of the water delivery system. This water system deficiency requires the Yolo Fire Protection District to carefully manage their use of water during fire events, which can affect their fire suppression effectiveness. When the backup water supply system is used in the community, it only produces 500 gpm. At this level, the District cannot draw water from the system during fires using their apparatus pumps (Tafoya, D. 2019).

The improvements necessary to enhance the water supply system such that it meets applicable standards would likely include the drilling of a new well, the installation of new pumps, and the construction of water storage facilities. The integration of these water system improvements should be considered in any levee improvement

planning and/or design within the community of Yolo, consistent with the integrated water management approach advocated for in the 2017 Update to the CVFPP.

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